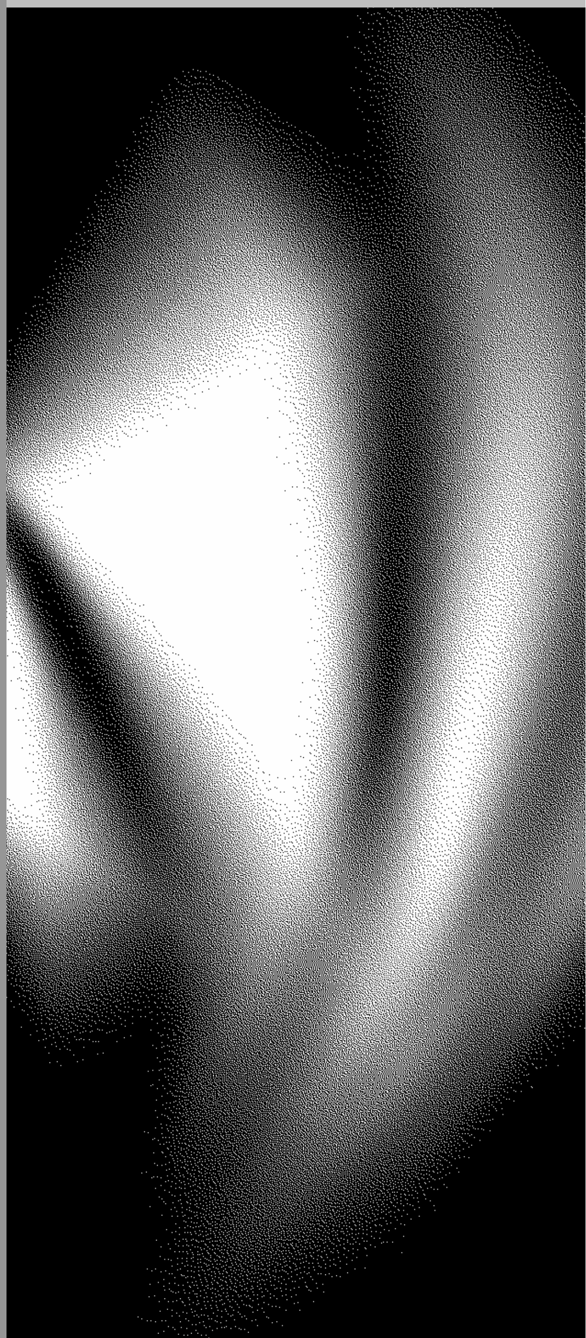
Australian Government
Productivity Commission

Rural Water Use and the Environment: The Role of Market Mechanisms

Productivity Commission Research Report

11 August 2006



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Terms of reference

STUDY TO ACHIEVE PARAGRAPH 61(iii) OF THE NATIONAL WATER INITIATIVE

Productivity Commission Act 1998

The Productivity Commission is requested to undertake a research study to assist jurisdictions in implementing their commitments under the Intergovernmental Agreement on a National Water Initiative (NWI).

The NWI was agreed between the Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and the Northern Territory on 25 June 2004. Tasmania signed up to the NWI on 2 June 2005. The NWI sets out objectives, outcomes and actions for the ongoing process of national water reform, and timelines to achieve this reform.

In relation to water markets and trading, States and Territories have agreed to establish water market and trading arrangements that will (NWI clause 58):

i) facilitate the operation of efficient water markets and the opportunities for trading, within and between States and Territories, where water systems are physically shared or hydrologic connections and water supply considerations will permit water trading;
ii) minimise transaction costs on water trades, including through good information flows in the market and compatible entitlement, registry, regulatory and other arrangements across jurisdictions;
iii) enable the appropriate mix of water products to develop based on access entitlements which can be traded either in whole or in part, and either temporarily or permanently, or through lease arrangements or other trading options that may evolve over time;
iv) recognise and protect the needs of the environment; and
v) provide appropriate protection of third-party interests.

To support jurisdictions in achieving these outcomes, the NWI requires that the signatories complete a series of studies and to consider implementation of any recommendations in relation to a range of studies. This terms of reference relates to the study described in clause 61 (iii) of the NWI.

In undertaking the study the Commission is to:

- assess and report on the feasibility of establishing workable market mechanisms:
  - to provide practical incentives for investment in rural water-use efficiency and water related farm management strategies; and
  - for dealing with rural water-management related environmental externalities;
- take into account relevant practical experiences in other areas, such as with establishing tradeable salinity and pollution credits;
- recognise that the purpose of the study is to support the parties in achieving the water markets and trading outcomes and actions under the NWI; and
- consult with signatories to the NWI (including through the inter-jurisdictional water trading group) and the National Water Commission.

The Commission is to report within six months and its report is to be published.

PETER COSTELLO
[Received 13 December 2005]

Foreword

The National Water Initiative, agreed to by Australian, state and territory governments, sets out objectives, outcomes and actions to support progress on national water reform. A key element for progressing national water reform relates to water markets and trading.

The Australian Government, with the support of the state and territory governments, asked the Productivity Commission to support jurisdictions in achieving the water markets and trading outcomes under the National Water Initiative. The Commission was required to assess and report on the feasibility of establishing workable market mechanisms to encourage investment in efficient rural water use and farm management strategies; and to address environmental externalities related to rural water management.

In conducting the study, the Commission has benefited from information and views received from a wide range of interested parties, including irrigators, water utilities, industry and environmental associations, and governments, as well as a wide array of relevant studies. The Commission is grateful to the many people who have taken the time to contribute to this study, including those who provided feedback on the discussion draft.

The study was overseen by Commissioner Neil Byron and was conducted within the Environmental and Resource Economics Branch under Dr. Deborah Peterson.

Gary Banks
Chairman

August 2006

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Acknowledgments

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The staff research team undertaking the study comprised Dr Deborah Peterson, Gavan Dwyer, Andrew Dolling, Margo Hone, David Appels, Dr Annette Weier, Paul Loke and Anna Williams. Vicki Thompson is also gratefully acknowledged for her administrative assistance.

Abbreviations and explanations

Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
AEW	Adaptive Environmental Water
ATO	Australian Tax Office
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EC	Electrical conductivity
GL	Gigalitre
HIZ	High Impact Zone
IGA	Intergovernmental Agreement on Addressing Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin
LIZ	Low Impact Zone
MCMA	Murrumbidgee Catchment Management Authority
MDBC	Murray–Darling Basin Commission
MIL	Murrumbidgee Irrigation Limited
MIS	Managed Investment Schemes
ML	Megalitre
MWWG	Murray Wetlands Working Group
NMPB	Net marginal private benefits
NWI	Intergovernmental Agreement on a National Water Initiative

SIMRAT	Salinity Impact Rapid Assessment Tool
VMP	Value of the Marginal Product

Explanations

Billion	The convention used for a billion is a thousand million (10^9).
Gigalitre	One billion (10^9) litres.
Megalitre	One million (10^6) litres.

Findings	*Findings in the body of the report are paragraphs highlighted using italics, as this is.*
Recommendations	***Recommendations in the body of the report are highlighted using bold italics, as this is.***

Glossary

Carryover	The option to hold in storage a portion of unused seasonal allocations for use at a later date.
Consumptive use	The application of water to a use which typically diverts water from its natural flow and permanently withdraws at least some of the water from the water source.
Conveyance losses	Water evaporation and seepage from surface water sources and man-made water transportation facilities, such as irrigation channels.
Covenant	In the context of water entitlements, a covenant is a condition placed on an entitlement that prevents its use under certain conditions.
Delivery capacity share	A share of an irrigation supply channel capacity (in a supplemented system) or a watercourse capacity (in an unsupplemented system), specified as a percentage share or a volumetric supply rate at a particular time.
Dilution flow	A volume of relatively fresh water used to dilute salty flows.
EC	Electrical conductivity (EC) measures dissolved salt in water. The standard EC unit is microSiemens per centimetre at 25°C.
Economic water-use efficiency	An activity is economically efficient if there is no other use where the resources would yield a higher value or net benefit.
Entitlement	An entitlement to exclusive access to water in each irrigation season (seasonal allocation), specified in volumetric terms or as a share of a specified consumptive pool.
Environmental manager	An agency with overall managerial responsibility for the achievement of environmental objectives.

Environmental service provider	An agency or person undertaking activities directed towards the achievement of environmental objectives.
Environmental flow	A water regime provided within a river, wetland or estuary to improve or maintain ecosystems and their benefits where there are competing water uses and where flows are regulated.
Exchange rate	The rate of conversion calculated and agreed to be applied to water to be traded from one trading zone and/or jurisdiction to another. Can also be used to factor for conveyance losses.
Exit fee	A charge (often per megalitre) imposed on the trade of a water entitlement out of an irrigation district.
Externality	Occurs when a side effect of a decision by an individual (or business) affects another party's wellbeing, but that effect is not taken into appropriate account by the decision maker.
Extraction	The withdrawal of water from surface water or groundwater sources.
Gross entitlements	Entitlements defined in terms of the volume that is delivered to the farm gate (with no recognition of return flows).
Groundwater	Water that occurs beneath the surface of the earth.
Groundwater recharge	The movement of water from the surface into a body of groundwater via percolation through the soil.
Long-Term Diversion Cap equivalent water	Common volumetric measure for crediting water recovery measures against commitments under the Intergovernmental Agreement on Addressing Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin.
Market mechanism	Instrument that encourages behaviour through market signals rather than through explicit directives.
Murray–Darling Basin Cap	The water cap established by the Murray–Darling Basin Commission to limit the volume of water which can be diverted from the rivers for consumptive uses.
Net entitlements	Entitlements defined in terms of the amount of water that is used on-farm. In effect this is the volume of water delivered to the farm gate minus any return flows.

Non-point source pollution	Pollution originating from many diffuse sources for which it is difficult to identify the precise source, such as that linked to runoff from agricultural land.
Opportunity cost	The forgone benefits from the next best alternative use of a resource.
Options contract	A contract that gives the right, but not the obligation, to purchase or sell a good at a specified price within a specified period of time.
Over-allocation	Refers to situations where, with full development of entitlements in a particular system, the total volume of water able to be extracted by entitlement holders at a given time exceeds the environmentally sustainable level of extraction for that system.
Overland flows	Water that runs across the land after rainfall, either before it enters a watercourse, after it leaves a watercourse as floodwater, or after it rises to the surface naturally from underground.
Physical water-use efficiency	Commonly used to describe the average physical relationship between output and water required (as one input), where both inputs and outputs are measured in physical units.
Point source pollution	Pollution originating from a particular and identifiable source, such as a pipe or other conveyance.
Regulated river or stream	River or stream with flow controlled through the use of weirs, locks and dams. Also known as supplemented river or stream.
Return flow	The portion of extracted water that returns to the water system through seepage or runoff.
Salinity	The presence of salt in streams or the landscape.
Seasonal allocation	Specific volume of water allocated to a water entitlement in a given season. Sometimes referred to as a water allocation, a water determination or a seasonal assignment.

Storage capacity share	An alternative market-compatible water sharing system which defines storage access in terms of a share of dam capacity (not volumetric contents), and inflows and outflows (which include deductions for evaporation and seepage losses).
Surface water	Water that occurs or flows on the surface, including streams, rivers, estuaries, lakes, dams, weirs and channels.
Tagging	A registry system under which traded entitlements retain their original characteristics from their source location.
Temporary trade	Trade in seasonal water allocations that involves transferring some or all of the water allocated to the entitlement for the current irrigation season or for an agreed number of seasons.
Turbidity	Turbidity is a measure of water clarity and an indicator of the presence of suspended material, such as silt and clay, in water sources.
Unbundling	The separating of historic water entitlements which bundled water, land, water use, delivery and works approvals, into separate entitlements or licences.
VMP	Value of the marginal product (VMP) of water is determined by multiplying the marginal product by the price of the output.
Water utility	Water utilities supply irrigation water to irrigators in supplemented systems via infrastructure works. Water utilities are sometimes referred to as water authorities or infrastructure operators.

OVERVIEW

Key points

- Markets are already making a significant contribution to increasing rural water-use efficiency. But further reform is needed to ensure that water continually moves to its highest value uses (including environmental uses).
- Market mechanisms to address environmental externalities need to be targeted to location and scale — no 'one size' fits all. Poorly designed programs can impose high costs that may outweigh potential gains.
- Appropriate arrangements for environmental managers should be established as soon as is practical based on a comprehensive review of different institutional structures. They need clearly defined objectives, good coordination processes and adequate resources. They need to enter markets to source water and to access the full range of water and water-related products on the same terms and conditions as other market participants.
  – 'Saving' water via major infrastructure works is often costly compared with other options and may reduce water available for other uses.
  – Subsidies that seek to improve the uptake of particular technologies or practices solely to increase the productivity of water use are likely to be inefficient.
- The Living Murray Initiative could be implemented more effectively if current efforts to source water 'permanently' are supplemented with additional water products (such as seasonal allocations, leases and options contracts). Appropriate institutional arrangements should be put in place to establish an agency specifically charged with purchasing a portfolio of water products to suit the needs of environmental management in the River Murray.
- Using administrative arrangements to allocate water for environmental purposes conceals the opportunity cost of meeting environmental targets. Market mechanisms are usually a more efficient means of re-allocating resources.
- Climate change, farm dams, vegetation and land-use changes, groundwater extraction, and changes to irrigation water management, have the potential to reduce stream flows substantially. In the Murray–Darling Basin, such reductions undermine efforts to achieve environmental goals and can affect the reliability of existing entitlements. Priority should be given to refining and clarifying existing property rights, undertaking further research on water systems and improving water accounting.
- There are opportunities to improve entitlement regimes through unbundling of water entitlements and water-use approvals, and facilitating efficient intertemporal water-use decisions. Separating delivery entitlements from water entitlements may also be beneficial where there is congestion in water delivery.
- A number of impediments to water trade reduce economic efficiency and should be removed. In particular, governments should:
  – enable other participants to trade in water markets
  – open up interdistrict water entitlement trade, and remove exit fees.

Overview

Markets are already making a significant contribution to increasing rural water-use efficiency. But further reform is needed to ensure that water continually moves to wherever it has the highest value to society (including its value in environmental uses).

This study examines the feasibility of establishing market mechanisms to encourage economic efficiency of rural water use, including managing environmental externalities. An economic definition of water-use efficiency is adopted that incorporates how water resources are allocated and used to achieve the greatest overall social benefit. Although there are a number of potential environmental externalities associated with rural water use, those associated with altered river flows and with irrigation salinity are the main focus in this report.

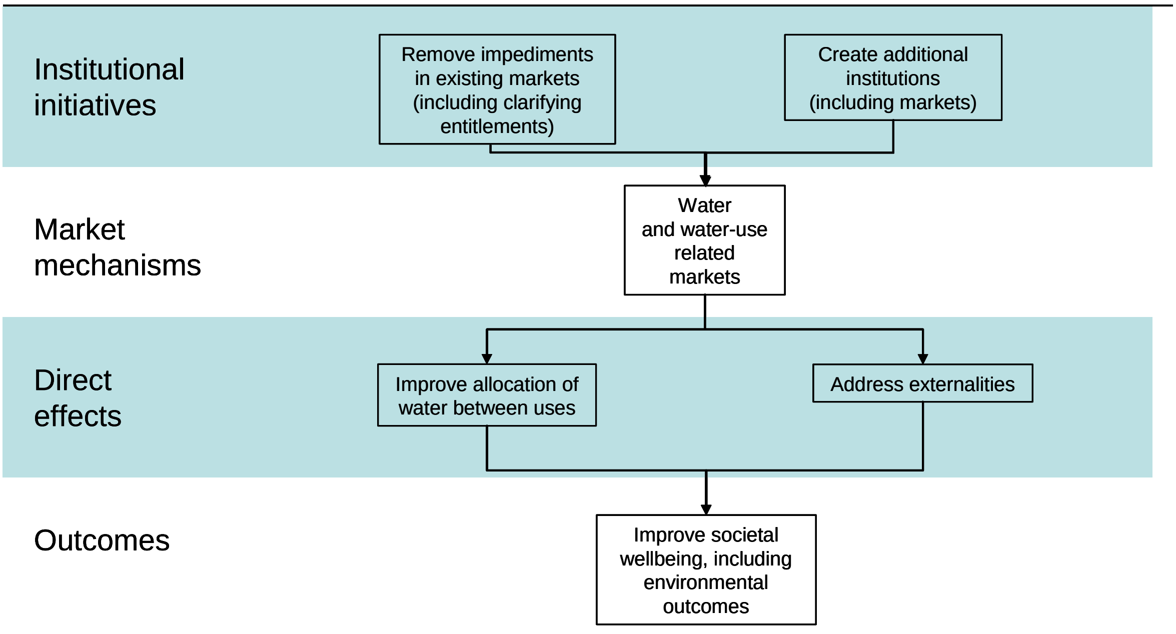
In some regions of Australia, administrative arrangements within planning regimes are exclusively used to allocate water for environmental purposes. These arrangements conceal the opportunity costs of meeting environmental targets. Market mechanisms can play an important role in improving the transparency of the tradeoffs being made and sharpening the incentives for efficient water use.

The study highlights two key complementary actions required to improve water-use efficiency and to address environmental externalities associated with rural water use:

- removal of impediments to the efficient operation of existing water markets and related institutional arrangements, and
- creation of new institutions and markets for water and water-related products.

These key actions are shown in figure 1 and are further elaborated in table 1. Through these actions, returns to society as a whole will be increased through more efficient use of resources.

Figure 1 **Using markets to improve water-use efficiency**



Factors affecting water availability

Long-term climate change, farm dams, vegetation and land-use changes, groundwater extraction and changes to irrigation water management have the potential to erode the long-term availability of water in rivers. Such reductions can substantially undermine efforts to achieve environmental goals, and can affect the reliability of some entitlements and use licences. The impacts will vary across jurisdictions and estimating their size is difficult. However, in the Murray–Darling Basin, initial evidence suggests a likely impact on stream flows in 20 years time in excess of 2500 gigalitres per year.

FINDING

Climate change, farm dams, afforestation, groundwater extraction, bushfires and changes to irrigation water management have the potential in the long term to significantly adversely affect the availability of water in rivers. In some areas, impacts may be more immediate.

To address these issues, high priority should be given to clarifying and refining existing property right arrangements, undertaking further research on water systems and improving water accounting. Improving the integration of groundwater and surface water in management regimes, for example, is a critical task in many connected systems. Evans (2004) estimated that on average, for the Murray–Darling Basin, each 100 megalitres of groundwater extracted would reduce surface water by 60 megalitres.

Table 1 The way forward

Existing arrangements	The way forward	Desired outcomes
Improve entitlement and seasonal allocation regimes		
• Many potentially important factors are poorly accounted for in entitlement arrangements	• Further research on water systems • Recognise connectivity between groundwater and surface water • Better accounting for return flows • Progress water accounting reform • Refine property rights	• Improved river flows • More efficient groundwater and surface water use
• Some entitlements to water can be overly complex, uncertain and linked to use approvals	• Unbundle entitlements and water-use approvals and simplify where feasible • Introduce low-cost and secure titling systems and transparent risk-sharing arrangements • Unbundle into tradeable water entitlements and delivery shares where appropriate	• Lower-cost and more timely water trade • Secure, mortgageable entitlements • Better management of congestion
• Farmers' intertemporal water-use choices are limited in some regions	• Expand carryover provisions • Consider storage capacity shares	• More efficient water use within and across years
Reduce and remove trade constraints		
• Some key regulatory and administrative constraints on water trade remain	• Enable other participants to trade • Open up interdistrict entitlement trade • Progressive removal of exit fees • Review other regulatory restrictions • Improve transparency of trade rules • Benchmark approval processes	• Water moves to higher value uses including environmental uses
Markets to improve altered river flows		
• Over reliance on planning processes to allocate water for environmental purposes • Focus on infrastructure investment to gain additional environmental flows	• Environmental managers and service providers (EMSPs) should participate in water markets • Develop markets for river capacity • Allow EMSPs to develop portfolios of water and related products – Entitlements and seasonal allocations – Derivative products such as leases and options contracts – River capacity shares	• Water can be sourced immediately for environmental purposes • Improved resource allocation • Improved transparency of environmental management costs • More cost-effective measures to achieve river flow objectives
Markets to improve irrigation salinity		
• Salinity objectives pursued mainly through regulatory measures • Reliance on expensive salt interception works • Limited use of salt trade measures at a catchment level	• Develop market mechanisms for addressing irrigation salinity where benefits exceed costs – Cap and trade is a flexible approach at catchment and basin levels – Offset schemes can be effective at the farm level – Investigate market approaches to flushing salt into sea	• More efficient and effective control of irrigation salinity

While much is being done to: improve information related to the connectivity of groundwater and surface water and sustainable extraction rates; develop water accounting frameworks; and improve resource management plans, further action is required to address existing over-allocated systems and introduce integrated groundwater and surface water caps. Although comprehensive solutions may be some time off, conservative separate groundwater and surface water caps could be adopted in the short term, especially in priority areas. Simple ‘rules of thumb’ may be needed (such as capping extraction from all groundwater sources within some distance of connected rivers), with new information informing policy settings over time. In the longer term, groundwater and surface water caps should be integrated where groundwater and surface water are closely connected.

FINDING

Recognising the connectivity between groundwater and surface water systems is fundamental to the efficient management of water resources. In highly connected systems, failure to incorporate these linkages in policy frameworks may reduce or counteract the benefits achieved in other areas of reform, including water trade.

FINDING

Further research on groundwater systems and their connectivity to surface water and sustainable extraction rates, and effective water accounting systems, are essential to managing linkages between groundwater and surface water. However, interim measures, backed by adaptive management, are needed in priority areas, even in the absence of full information.

RECOMMENDATION

In the short term, groundwater use in highly connected systems should be capped in a manner consistent with surface water management. In the long term, groundwater and surface water caps in such systems should be fully integrated.

RECOMMENDATION

The National Water Commission should work with States and Territories to progress reform in water accounting so that a compatible, reliable, transparent and sufficiently comprehensive system can be developed to underpin efficient water-use and environmental water allocation decisions.

Existing entitlements and seasonal allocations in many areas are based on expectations that, when water is applied on farm, some proportion of that water returns to the water system through seepage or runoff. As a consequence, land-use change and improvements in on-farm physical water-use efficiency, which substantially reduce these return flows, reduce water available for other uses (including environmental uses).

In Queensland, water resource plans assume no return flows in allocating entitlements. This highly conservative approach to managing return flows avoids any potential problems of reduced returns flows, but at the cost of having less water allocated to productive uses.

A net approach to specifying water entitlements adjusts entitlements to account for changes in the quantity of return flows. Such approaches could enhance the economic efficiency of water use in areas where reduced return flows are likely to substantially reduce water available for environmental purposes or other entitlement holders. Further advances in knowledge about return flows, however, will be necessary for this to occur on a comprehensive basis. Nevertheless, there may be opportunities in some areas to incorporate aspects of a net approach where at least some return flows are accounted for in entitlements. In the absence of this, or a more comprehensive change, various market-based, or regulatory or planning approaches, need to be considered to manage potential adverse consequences from changes in return flows.

Policy responses will also be necessary to manage the implications for the reliability of entitlements and for environmental flows from changes in the movement of water across landscapes that result from other land uses (such as forestry plantations and farm dams). While water allocation decisions through planning regimes are one approach to managing these issues, market mechanisms can also play a greater role and are likely to be more efficient at re-allocating water to where it is most highly valued.

FINDING

Changes in return flows, resulting from land-use changes, need to be accounted for in entitlement specifications and/or resource management policies. Adaptive management and the use of interim measures are necessary in high priority areas.

Entitlement and seasonal allocation regimes could be improved

Separating water entitlements from land (now complete in most jurisdictions) has been an important reform to facilitate water trade. Some jurisdictions have completed, and others are in the process of completing, unbundling water entitlements and water-use approvals. Governments yet to undertake these important actions should do so as a priority. Further simplifying water entitlements by reducing unwarranted differences in entitlement specifications may facilitate entitlement trade. However, any advantages from simplifying entitlements must be balanced against the benefits that a diverse and flexible set of entitlements can yield. Many differences in entitlements, for example, reflect supply characteristics across catchments (for example, rainfall, dam capacity and runoff).

RECOMMENDATION

Unbundling water entitlements from water-use approvals should be completed by those jurisdictions that have not done so, as a matter of priority. There may be further opportunities to simplify the specification and reduce the number of types of water entitlements.

Separating delivery entitlements from existing water entitlements (as is occurring in Victoria) offers several advantages, including:

- expanding the number of products available to be traded
- expanding the asset and risk management portfolio of entitlement owners
- achieving environmental outcomes without always requiring environmental managers to purchase both water and distribution capacity
- helping to manage congestion in the distribution system.

However, where channel capacity constraints are not substantial, or where congestion costs across irrigators are largely similar, the costs of separating delivery entitlements may outweigh the benefits.

FINDING

Unbundling water entitlements into tradeable water share and delivery share components may be beneficial in areas where there is substantial congestion of water delivery.

Intertemporal water-use decisions could be improved by expanding provisions for individual entitlement holders (including environmental managers) to carry over unused seasonal allocations into subsequent seasons, or by adopting storage capacity share arrangements with perpetual carryover. Carry over of unused allocated water by an irrigator is allowed, within specified limits, in New South Wales and Queensland, but not in Victoria and South Australia.

The main advantages of entitlement holders individually being able to carry over water include more efficient water-use choices across irrigation seasons and a better ability to manage risks associated with changing seasonal conditions. Expanding individual carryover arrangements may, however, require additional strategies, such as storage charges or specific carryover provisions, to manage the risk of over-dam spills and effects on third parties. Because of differences across districts in storage infrastructure, climatic factors and potential third-party effects, uniform carryover rules (such as a rate of carryover or charges for storage) are unlikely to be appropriate. However, common principles could be adopted to guide the choice of rules. In the absence of carryover arrangements in some districts, trading unused seasonal allocations across districts may improve intertemporal water-use choices.

FINDING

Uniform carryover arrangements across districts are unlikely to be appropriate given different water management objectives, storage capacity, evaporation losses and potential third-party impacts.

FINDING

Trading unused seasonal allocations across districts may improve intertemporal water-use choices where carryover is not available in all districts.

RECOMMENDATION

Governments and water utilities should enable entitlement holders, including environmental managers, to carry over water individually, with adjustments to allow for storage and evaporation losses. Appropriate charging for storage management and allocation structures will be required to address third-party impacts. Where feasible, rights to carry over could become tradeable.

Infrequent announcements on upcoming and future allocations can add uncertainty over water availability and hinder farmers' ability to make investment and farm planning decisions. Management options, such as more frequent and pre-scheduled allocation announcements, and supporting information on likely future water availability, may assist in reducing this uncertainty.

Storage capacity sharing, which provides entitlement holders with a percentage of a dam's storage, is an alternative to the periodic announcement of allocations. The corresponding water volumes can be updated daily for water inflow, extraction by water users, and for evaporation and other losses. SunWater has implemented capacity sharing with continuous accounting and perpetual carryover in the St George district in Queensland, and is considering extending the system to other irrigation districts. Under this system, irrigators can more flexibly manage the volume of water held within and across irrigation seasons, and adopt differing risk profiles, with fewer third-party effects on other entitlement holders. Set-up and transitional costs are unlikely to be small, however, and need to be weighed against expected benefits before changing systems.

RECOMMENDATION

For many storage systems, storage capacity share arrangements offer entitlement holders the ability to better manage the storage and use of water to which they are entitled. Governments and rural water utilities should provide for storage capacity share arrangements where the benefits exceed the costs.

FINDING

Where capacity sharing is not feasible, more frequent and pre-scheduled allocation announcements and/or continuous accounting would improve information to irrigators on likely water availability, and thereby assist water-use and investment decisions.

Low-cost and secure titling arrangements are also important goals, to avoid unnecessary uncertainty and help facilitate trade.

Reduce or remove constraints on trade

Through mutually beneficial trade, the value of water (to those trading in the market) is revealed and greater economic efficiency in the use of rural water is facilitated. Water trade can also assist with farm adjustment processes by expanding choices for improving or changing farm enterprises, or exiting the industry. The potential for water trade is diminished by nonregulatory and regulatory constraints. Nonregulatory constraints (including hydrological limits, transaction costs, limited market information regarding available opportunities, and community attitudes towards water leaving their district), are unavoidable and must be accommodated by markets and policy makers. Key regulatory constraints are those limiting or prohibiting water trade between either specified parties or specified areas.

Constraints on who can participate in trade

While regulatory restrictions on who can participate in rural water trade have been or are being eased, some constraints remain. Restricting some potential water users (such as environmental managers, environmental associations, urban water users, and mining and power generation industries) from access to the market prevents the market price of water revealing the true value of alternative water uses, and restricts the benefits the community as a whole can gain from water. To the extent adjustment problems arise, these should be responded to in a manner consistent with adjustment policies applying more broadly in the economy.

RECOMMENDATION

Restrictions on who can participate in water trade should be relaxed or removed to improve the economically efficient use of rural water.

Constraints on trade in seasonal allocations

Trade in seasonal allocations is relatively free in most large irrigation districts and many of the remaining restrictions reflect hydrological realities. Nevertheless, there remain some regulatory and administrative constraints on trade in seasonal allocations, and the rationale for their existence is not always transparent. Such constraints can include trading rules, such as different closing dates for water transfers between districts and intention to sell requirements, and government fees and processes. While some of these arrangements address hydrological conditions or environmental concerns relating to water trade, other policy approaches may be more effective and transparent.

RECOMMENDATION

Each jurisdiction should conduct a public review of remaining restrictions on trade in seasonal allocations. Those which do not generate net public benefits should be removed. Timetables for review should be transparent, and progress and findings publicly reported.

FINDING

More efficient private sector service providers can be crowded out when existing government-funded water exchange charges are not consistent with the principles of competitive neutrality.

RECOMMENDATION

The National Water Commission and States and Territories should consider benchmarking approval processes, and associated costs involved in trading seasonal allocations, against best practice. Independent performance reviews should be conducted periodically.

Constraints on trade in water entitlements

A wider range of restrictions applies to trading water entitlements than seasonal allocations, with restrictions greater for trade between irrigation districts than within districts. A major regulatory constraint on trade in water entitlements is the limit on annual water trade out of a district. These restrictions appear to be aimed predominantly at preventing fewer irrigators having to cover the fixed costs of a district's infrastructure.

FINDING

Constraints on trade are generally greater for water entitlements than for seasonal allocations. Relatively unconstrained trade in seasonal allocations and emerging derivative water products already mean that water is moving to higher value uses. Removal of constraints on trade in water entitlements would build on these gains.

Restrictions on trade in entitlements out of irrigation districts are to be progressively removed under the National Water Initiative. However, the benefits from removing these restrictions will be limited if they are replaced by exit fees, as some water utilities have done and others are considering. Central Irrigation Trust, for example, has imposed exit fees of $370 per megalitre for trades of high security water out of its district, and exit fees of $447 per megalitre for general security water are included in Murray Irrigation's new constitution. Exit fees of these magnitudes are likely to greatly inhibit trade.

Exit fees are distortionary — they increase entitlement prices in importing regions, while reducing entitlement prices to sellers in exporting regions, reduce the quantity of water traded, and deny opportunities for the higher value use of water to contribute to overall economic wellbeing. Further, exit fees can lock water into low productivity enterprises and regions. Where substantial social costs result from the movement of water out of an irrigation district, governments have generic social policies to assist with adjustment issues. On occasions, specific and targeted adjustment assistance may be justified.

There are more efficient responses available to water utilities to fund infrastructure costs than the current or proposed exit fee arrangements. In the Commission's view, abolition of exit fees is the preferable course of action. It is also of the view that the absence of exit fees is unlikely to have any significant short-term implications for the viability of water utilities.

While considering that removal of exit fees is the best solution, the Commission proposes a possible three-phase path to reform that provides irrigators, communities and water utilities in the southern Murray–Darling Basin with security as well as opportunities to manage adjustment. The aim is to provide a transition to more competitive pricing arrangements for water service infrastructure, while recognising the current arrangements cannot be abandoned immediately (table 2).

Table 2 **A three-phase approach to exit fee reform**

	Phase 1	*Phase 2*	*Phase 3*
Infrastructure provider paradigm	Cost recovery	Transitional	Negotiation of competitive supply contracts
Exit fees	Allowed	Decoupled	Ceased
Consistency with efficient water market	Lowest	Intermediate	Highest

The three phases are:

- Phase 1 (short term) — for example, the 2006-07 and 2007-08 irrigation seasons — allow existing exit fees but place limits on existing arrangements to reduce costs to exporters of entitlements.
- Phase 2 (medium term) — for example, the 2008-09, 2009-10 and 2010-11 irrigation seasons — to address trade distortions decouple exit fees from entitlements by levying fixed utility charges on the water-use licence or delivery capacity.
- Phase 3 (long term) — for example, the 2011-12 irrigation season onwards — move toward more competitive charging regimes for infrastructure service provision.

The Commission notes that while the decoupling of exit fees from entitlements addresses the potential trade distortions posed by the current exit fees, decoupling does not address the appropriateness of the charges. There may be opportunities for more rapid progression from the existing arrangements to more competitive arrangements proposed under the third phase.

RECOMMENDATION

Exit fees on sales of water out of an irrigation district constrain trade in entitlements and impede adjustment. They should be phased out.

RECOMMENDATION

Water utilities in the southern Murray–Darling Basin should decouple exit fees from entitlements in the medium term. Infrastructure charges should be levied on the water users' water-use licence or delivery capacity share.

RECOMMENDATION

Water utilities in the southern Murray–Darling Basin should move to competitive supply contract arrangements with water users in the long term.

In most jurisdictions, the costs of transferring entitlements to a new owner are unlikely to be large enough to constrain trade significantly. However, fees and approval times are substantial in some jurisdictions and scope remains to improve performance in this area. Setting appropriate benchmarks and best practice approval timeframes, with appropriate public reporting and appeals processes in place for aggrieved parties, would help keep government impositions on trade to a minimum.

RECOMMENDATION

Approval processes and associated costs involved in trading water entitlements should be benchmarked to best practice. Performance reviews should be conducted periodically by the National Water Commission.

Other factors affecting farmers' decisions on water use

As in other areas of economic activity, improvements in information available to the market will allow more economically-efficient decisions about water use and trade. Examples are improved understanding of soil–water relationships, better weather forecasts, and better information on market opportunities for irrigation commodities and for water. Improvements in such information are not costless, and irrigators generally make good use of currently available information.

FINDING

Irrigators are generally well-informed about water-use choices and are best positioned to make sound decisions about allocating water to privately productive uses. There may, however, remain scope for governments to improve information on the biophysical characteristics of water use common across properties.

The incentives faced by rural water utilities have important effects on efficient rural water use. It is important, for example, that water utilities not over- or under-invest in water-saving projects and that all options for improving water-use efficiency be considered.

FINDING

The management, performance and activities of water utilities have important implications for the efficient use of rural water on- and off-farm. Improving incentives to manage water resources to maximise community benefits, and removing unjustifiable impediments to their activities, are likely to improve water-use efficiency.

Governments have various programs offering subsidies to increase the physical efficiency of water use. It is important that any policies designed to accelerate the adoption of particular technologies or practices, such as drip irrigation technologies, target market failures and offer net public benefits.

The Commission has found little evidence that impediments restrict farmers in making appropriate private cost–benefit calculations in technology adoption decisions or choice of products. On this basis, subsidies that seek to improve the uptake of particular technologies or practices (in effect ‘picking winners’), solely to increase the productivity of water use, are likely to be inefficient. Subsidies may, however, increase economic efficiency if they provide public benefits, such as through efficiently achieving desirable environmental outcomes or providing otherwise inaccessible information or knowledge. As with any policy decision, the costs and benefits of subsidies to improve environmental outcomes need to be assessed and compared with those of alternative policies, including no action.

FINDING

Government subsidies that seek to improve the uptake of particular technologies or practices solely to increase the productivity of water use are likely to be inefficient.

Environmental change and economic externalities

Environmental changes associated with the supply and use of water include changes in hydrological conditions, habitat, water quality and ecological conditions. These changes are often (but not always) associated with economic externalities — side effects on another party’s wellbeing that are not taken into appropriate account by the decision maker. Externalities arise because property rights are not completely specified or not capable of being fully enforced. However, complete specification may involve costs in excess of the benefits.

Choosing the most appropriate policy response is often difficult and context-specific. Important steps in making market mechanisms practical and workable include clearly specifying policy objectives, addressing the potential for conflicting objectives and tradeoffs, and selecting the best available performance measures for the target objectives.

Market mechanisms are already being implemented successfully to improve many environmental problems, but care is needed to ensure they meet their objectives. First, reforming current and perverse incentives may be a more effective way of addressing policy goals than considering new market mechanisms. Second, poorly designed programs can impose high costs that may outweigh potential gains. Third, there is no ‘one size fits all’ approach — market mechanisms must be tailored to the circumstances. Finally, narrow application of market mechanisms may be as costly as prescriptive regulations.

FINDING

Market mechanisms to address environmental externalities need to be targeted appropriately to location and scale — no 'one size' fits all. Poorly designed or narrowly applied market mechanisms can impose high costs that may outweigh potential gains.

Environmental managers

Increasing public and private provision of water-related environmental services, and the complexity of many water-related environmental problems, raise important governance issues for the management and delivery of environmental services.

Through the National Water Initiative, governments have agreed to establish 'accountable environmental water managers' as part of effective and efficient management and institutional arrangements for water. Environmental managers need clearly defined environmental objectives and strategies to address tradeoffs between conflicting objectives. To meet their objectives, they need to enter markets to source and trade water, and they need access to the full range of water and water-related products on the same terms and conditions as other market participants.

Environmental managers do not need the skills to undertake all environmental management functions themselves. They can contract out environmental service provision, research, and trading activities to environmental service providers. Sourcing of water can be undertaken by bodies set up to accept donations of water and funds for the environment.

There are a number of practical issues that need to be considered in establishing environmental managers, including the level of operation (for example, catchment or basin level), institutional structure (for example, trust, private corporation, independent public corporation or government agency), and the level of public funding. Good coordination mechanisms are needed to organise the large number of agents involved in delivering environmental outcomes.

FINDING

Environmental managers need clearly defined objectives, good coordination processes, and adequate resources. They need to enter markets to source water and to access the full range of water and water-related products on the same terms and conditions as other market participants.

RECOMMENDATION

Following a comprehensive review of the advantages and disadvantages of different institutional structures, governments should establish appropriate arrangements for environmental managers as soon as is practical.

Markets can help address some adverse effects of altered river flows

Regulating rivers for the purpose of irrigation alters the volume, frequency and timing of flows, generating a variety of environmental effects and externalities. To address the effects of altered river flows, governments have agreed to provide water for environmental purposes. So far this has been done mainly through regulatory instruments and investment in water-saving infrastructure, although alternative market mechanisms are emerging and attracting increasing attention.

Markets have an important role to play in securing water

Administrative arrangements within water plans are relied on to allocate water to a range of different uses, such as the environment and agriculture. These processes are crowding out more efficient and effective market mechanisms. Market mechanisms not only provide for mutually beneficial exchanges between environmental and non-environmental water users or uses, they can also make allocative decisions more transparent, by revealing the value of water in other uses.

FINDING

Administrative arrangements to allocate water for environmental purposes conceal the opportunity cost of meeting environmental objectives and can crowd out more efficient market mechanisms.

On-farm incentives are unlikely to be cost-effective where the primary objective is to source water for environmental purposes. Any opportunities to source water at a cost below the market price for water are likely to be exploited by irrigators through private investment in water-use efficiency. Hence, it will generally be less expensive for governments to source water through markets.

Other important considerations are the transaction costs associated with negotiating with farmers to secure water savings and the potential for on-farm incentives to have unintended consequences, such as reducing return flows that currently contribute to environmental flows. Increasing physical water-use efficiency through on-farm incentives can, however, serve objectives other than freeing up water for flows, such as reducing negative environmental effects from salinisation, waterlogging or nutrient discharge.

FINDING

On-farm incentives are unlikely to be cost-effective where the primary objective is to source water for environmental purposes.

Governments have invested in infrastructure projects to source water for environmental purposes, particularly in south–east Australia. In many cases, purchasing entitlements and other types of water and water-related products is likely to be a more cost-effective way of sourcing water than infrastructure investment. To date, the focus of the Living Murray Initiative has been on sourcing 500 gigalitres of water for six key ecological assets via a mix of projects, the most prevalent of which are engineering solutions directed at reducing water 'losses'. Studies show that the costs of 'saving' water sourced from engineering projects escalates quickly after initial, lower-cost projects are developed. In many instances, the costs incurred are higher than the cost of buying water in the market. Moreover, claimed water savings can be illusory when 'saved' water is simply removed from return flows or where accessions to groundwater are already used for other purposes.

FINDING

Opportunities to source water for environmental purposes through infrastructure investment, at a cost below the current price for entitlements, appear limited. Further, sourcing water through 'water-saving' infrastructure investment may reduce water available for other uses.

A portfolio of water products is needed

The range of water product purchases is too narrow, and the pace of purchasing is too slow, in key over-allocated river systems. Different water products will have different strengths and weaknesses. Holding entitlements, for example, will provide ongoing access to water and is therefore useful for providing base flows that are relatively stable from year to year. However, holding entitlements alone is unlikely to match variable environmental needs from year to year. Certain types of products will be more applicable in some places than others (depending on the environmental objectives, market development, access to carryover, etc). Environmental managers and service providers would benefit from being able to select a portfolio, according to their various priorities, from a diverse set of water products.

The Intergovernmental Agreement on Addressing Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin allows for purchases of water on the market by tender or by other market mechanisms. However, some clauses focusing on the permanent recovery of water restrict the flexibility of initiatives to source water for environmental flows. Buying seasonal allocations, for example, would increase environmental managers' flexibility to match water availability with environmental needs.

An initial step in meeting river flow objectives at least cost is to give environmental managers and service providers greater access to existing water markets. A second step is to further investigate development of new water products, such as options contracts. In the Commissions' view, the absence of an agency specifically charged with purchasing a portfolio of water products to suit the needs of environmental management in the River Murray is unnecessarily impeding the effective and efficient environmental management of the river.

RECOMMENDATION

Environmental managers should develop portfolios of water products where appropriate to deliver environmental flows in a timely and cost-effective manner.

RECOMMENDATION

An agency should be established as soon as is practical for the purpose of acquiring water for the Living Murray Initiative. This agency should acquire a range of water and water-related products, rather than acquiring water through infrastructure investments and purchase of water entitlements alone.

Markets can address flow objectives flexibly and cost effectively

A variety of market mechanisms could play a role in addressing river flow objectives, either by directly influencing river flows through the purchase of water products (and potentially river capacity rights) or by indirectly influencing river health through incentives for changes to land and water-use practices. A summary assessment is provided in table 3. In particular situations, most of these measures may be able to contribute effectively to environmental objectives.

FINDING

Many river flow objectives require sourcing additional water for environmental purposes. There are often more flexible and cost-effective ways to achieve these objectives than purchasing entitlements or investing in infrastructure.

Table 3 **Market mechanisms for environmental flow objectives**

Criterion	*Costs*	*Feasibility*	*Flexibility*	*Likelihood of achieving desired goals*
Trade in entitlements	H	M-H	L	L-M
Trade in seasonal allocations	L-M	M-H	M-H	H
Leases for entitlements	L-M	H	M-H	M-H
Options contracts for seasonal allocations	L-M	M	M-H	H
Covenants on entitlements	M-H	M	L-M	M-H
Trade in river capacity	H	M	M-H	M
Tender for ecosystem services	M	H	H	H
Volumetric tax on water use by irrigators	M-H	M	M	L

H=high, M=medium, L=low.

Sourcing water will be effective in achieving some, but not all, river flow objectives. A flow variability objective, for example, may require less flow passing down a section of river at certain times to prevent prolonged periods of high and/or constant river height. There may be scope for designing products based on river capacity to address these types of objectives.

FINDING

Creating new, tradeable rights to river capacity may be useful for influencing river heights or reducing flooding.

Volumetric taxes on water use have been suggested as a possible mechanism to address environmental externalities attributable to irrigation water use. However, their effectiveness will depend, among other things, on the degree to which altered river flows are attributable to irrigator water use. Given scientific uncertainty regarding the interaction between irrigation water use and river flows (combined with the presence of several other potential causes), a tax on irrigation water use may be an inefficient instrument for achieving river flow objectives.

In general, the marginal damage of a negative environmental externality caused by water use will vary between regions as well as within them. When the size of the tax on water use varies across water users, the level of the taxes and the differences between tax levels are important for efficiency, if the purpose of the tax is to internalise the externalities. This kind of tailoring is not a simple matter.

FINDING

Arriving at the correct rate for a volumetric tax is not easy. If set too low, the tax may not reduce the externalities associated with water use in the short run. If set too high, the tax may lead to market distortions and have unintended equity consequences. Further, volumetric taxes are unlikely to be effective in addressing those externalities which, although related to altered river flows, are unrelated to the volume of water used by irrigators.

Markets can help address irrigation salinity

Salinity is a well known environmental change associated with supplying and using irrigation water. The incidence and extent of salinity vary but it occurs in some form in all irrigation areas in Australia. Salt emergence is more rapid in irrigation districts where recharge rates are very high and the sources are close to rivers. However, recharge rates are highly variable, depending on site-specific conditions, and regional climatic conditions also have a significant impact on salt emergence.

Salt is a significant problem in the Murray–Darling Basin — because of its hydrogeology, most of the emerged salt remains within the basin. Instream salinity in the southern Murray–Darling Basin has decreased in recent years. This is in part due to management actions over the last decade, and also to recent dry conditions that have contributed to relatively lower watertables and reduced flood events that move salt from floodplains to rivers.

FINDING

Recent dry conditions have reduced and delayed salinity impacts, including those from irrigation activities.

Salinity, environmental flows and land-use management are closely connected. Links between policy objectives can improve the effectiveness and reduce the costs of implementing market mechanisms but also require the coordination of mechanisms. In some cases, salinity management objectives may conflict with objectives or approaches in other areas of water and land management.

Ways to manage salinity

There are five broad approaches to managing salinity, which may be used separately or in combination:

- take actions to prevent salinity from occurring
- prevent saline groundwater from entering rivers
- adapt to the effects
- store saline water in aquifers
- dispose of the salt by flushing salt out of the system.

Salinity management in Australia has focused on the first four approaches. Broad regional and state management plans guide and coordinate salinity management approaches in most irrigation districts. The Murray–Darling Basin Salinity Management Strategy guides management in the basin with jurisdictions allocated salt credits for undertaking salt mitigation. Credits are lost for developments that increase salinity.

In many regions, engineering works have been constructed to mitigate the impacts of irrigation salinity. Surface and subsurface drainage is widely used. Intercepting saline groundwater before it enters the river immediately reduces river salinity and has been successful in mitigating river salinity where it was rapidly increasing. However, the construction, operation and maintenance costs of salt interception have increased over time. It is important that appropriate cost–benefit assessments of proposed salt interception works are undertaken. Assessments should include the costs of water used in salt interception works.

A complementary salinity management approach has been the establishment of high and low impact zoning adjacent to the River Murray to indicate the likely impact of irrigation on future salinity. Water trade into the highest impact zone is prohibited. Levies are applied to trade to four lower impact zones. The levies vary according to source and destination of trade, with higher levies applied to higher impact trades. Revenues are used to fund salt interception schemes. However, the levies do not encourage the removal of water from the higher impact zones. Some incentives to encourage the removal of water from salinity impact zones to reduce salt mobilisation may be required.

Within individual irrigation districts, a variety of arrangements have been established voluntarily by industry agencies to manage the recharge of groundwater. In the southern Murray–Darling Basin, for example, the Ricegrowers' Association of Australia has established industry codes of practice that constrain the production of rice to certain soil types to limit groundwater recharge.

FINDING

Salt interception works can quickly reduce instream salinity. With the costs of existing and potential interception schemes rising, and opportunities for low-cost schemes limited, other approaches to address salinity will be required.

FINDING

Salinity zoning schemes provide incentives to affect landholders' water-purchasing decisions. Incentives may be needed to encourage the removal of water from salinity impact zones to reduce salt mobilisation.

FINDING

Reducing groundwater recharge can reduce the incidence of salinity at its source, but generally takes a long time to affect instream salinity.

Currently there are no incentive arrangements to remove salt from the Murray–Darling Basin. Given that costs of instream salinity in the Murray–Darling Basin are generally lower during the winter months between irrigation seasons, it may be possible to move salt out of the basin using the river during this period. This period may also coincide with efforts to increase flows for environmental purposes.

Market mechanisms to aid the removal of salt include cap and trade of salt at a basin scale, linked offsets arrangements, and purchasing flows for the purposes of salt dilution and flushing. Careful planning and regulatory arrangements would be required to ensure minimum water quality standards are maintained.

FINDING

Market mechanisms for salinity and environmental flows need to be coordinated to capture synergies and ensure mechanisms do not have significant unintended detrimental effects.

Market mechanisms for salinity have potential, but performance varies

A variety of market mechanisms could potentially be used to address salinity management objectives. A summary assessment is provided in table 4. There is potential to further incorporate market mechanisms into existing institutions and instruments used to manage salinity. This would reduce transaction costs and improve the acceptability of the new instruments. Under the Murray–Darling Basin Salinity Management Strategy, for example, jurisdictions can develop market-based abatement strategies at different geographic levels, such as catchments, valleys and/or tributaries that are consistent with meeting their obligations under the overall strategy. The mechanisms could be designed to link between the different levels, effectively cascading from the basin to the farm level.

Table 4 **Market mechanisms for salinity**

Criterion	*Costs*	*Feasibility*	*Flexibility*	*Likelihood of achieving desired goals*
Cap and trade of salt at the regional level	M	M	H	H
Cap and trade of groundwater recharge	M	M	H	M
Offsets for groundwater recharge	M	H	M	H
Zoned salt levies on water trade	M	H	M	M
Tenders for land management change	M-H	H	H	M
Subsidies for relocation and irrigation practice change	M	H	M	M

H=high, M=medium, L=low.

Cap and trade mechanisms could be designed for the regional level, that build upon the existing interjurisdictional credit framework. Different methods could be used to assess the discharge or creation of salt, including on- and off-farm irrigation and land management activities, and on-farm groundwater recharge. Under a cap and trade of salt emissions, a development that abates salt would entitle the landholder to a salt credit which could then be traded to other landholders requiring credits to account for activities that increase salt. In general, cap and trade would be difficult to apply at the farm level.

FINDING

A salt cap and trade scheme may be appropriate at the regional level, but less so at the farm level.

Managing the recharge of the groundwater table can limit the emergence of salinity. By creating property rights that define whether, and how much, each irrigator can contribute to net recharge in their area, a cap and trade scheme for groundwater recharge provides a mechanism to allocate recharge rights to landholders who value it most highly. There are large information costs in designing a cap and trade recharge scheme, and high establishment and implementation costs can outweigh the benefits of managing the recharge in some irrigation areas.

FINDING

A cap and trade scheme for on-farm groundwater recharge may be worthwhile in areas where there is sufficient diversity in land management practices and where benefits from reducing the emergence of salinity are high.

Offsets allow certain practices that can contribute to salinity to occur if prescribed activities are also undertaken that reduce the emergence of salinity. Groundwater recharge could be capped by requiring certain agricultural practices that reduce groundwater recharge to offset other farm management practices that are known to have higher levels of groundwater recharge.

FINDING

Offsets for groundwater recharge can be successfully implemented to address localised salinity problems.

Zoned salt levies can provide similar incentives to landholders as cap and trade in salt — to penalise actions that exacerbate salinity — but, depending on the levy design, may reduce the incentive to sell water out of areas with high salinity effects. Levy schemes should incorporate rewards for actions that reduce salinity. Water export incentives, for example, could be introduced for salt impact regions, thereby avoiding salt interception costs at the margin. Properly calibrated they would equal the avoided costs of salt interception and thereby be revenue neutral.

FINDING

Zoned salt levies penalise actions that exacerbate salinity, but could be complemented by rewards for actions that reduce salinity, such as incentives to trade water out of high impact regions.

Price-based mechanisms can be used to provide incentives to encourage changes in management practices and land use that reduce the emergence of salinity. Dryland farmers in upper catchments could be paid incentive payments to undertake certain land management practices that reduce saline discharge from elsewhere in the catchment or region. Funding dryland action may be more efficient than trying to manage the salinity problem downsteam within the irrigation district.

FINDING

Tenders can be practical for procuring land management changes that generate multiple environmental outcomes, including reductions in dryland and instream salinity.

Sometimes, the most economically efficient means of reducing the emergence of salinity in high impact irrigation areas may be to relocate specific types of farming to lower salinity areas or to cease the use of certain irrigation technologies in high salinity areas. Where fixed assets are a substantial impediment to farm relocation, or to reinvestment in less environmentally damaging irrigation technologies, subsidies may provide a cost-effective means of achieving policy objectives within a specified timeframe.

FINDING

Relocating farm enterprises and/or investing in physical water-use efficiency can reduce groundwater recharge. Carefully designed and targeted incentive payments could accelerate relocation or investments in irrigation technologies that reduce groundwater recharge. The costs and benefits of such a scheme would need to be assessed on a case-by-case basis.

Purchasing additional flows may be required to aid the removal of saline flows. Dilution flows would help ensure salt concentrations (of the transported saline water) do not reach levels that result in undesirable environmental consequences. Markets for dilution flows could be established in the same manner as markets for environmental flows.

FINDING

Flushing salt out of a catchment or basin may be an efficient approach to managing salinity. Seasonal flexibility would be needed in water quality standards to facilitate flushing salt from the Murray–Darling Basin.

FINDING

Dilution flows can assist the flushing of salt from a river system, and can be procured in the same way as environmental flows.

Regulations are still important

Salt can have threshold implications for ecosystems and drinking water standards. Depending on local hydrological factors, critical thresholds can be quickly reached, and some market mechanisms may not be appropriate because environmental or instrument responses may be too slow. In such cases, regulation may be required. Where the effects are gradual and not likely to reach a critical threshold, market mechanisms that involve slower market and environmental responses may be a more cost-effective option.

Recommendations and findings

Recommendations

RECOMMENDATION 2.1

The National Water Commission should work with States and Territories to progress reform in water accounting so that a compatible, reliable, transparent and sufficiently comprehensive system can be developed to underpin efficient water-use and environmental water allocation decisions.

RECOMMENDATION 2.2

In the short term, groundwater use in highly connected systems should be capped in a manner consistent with surface water management. In the long term, groundwater and surface water caps in such systems should be fully integrated.

RECOMMENDATION 3.1

Unbundling water entitlements from water-use approvals should be completed by those jurisdictions that have not done so, as a matter of priority. There may be further opportunities to simplify the specification and reduce the number of types of water entitlements.

RECOMMENDATION 3.2

Governments and water utilities should enable entitlement holders, including environmental managers, to carry over water individually, with adjustments to allow for storage and evaporation losses. Appropriate charging for storage management and allocation structures will be required to address third-party impacts. Where feasible, rights to carry over could become tradeable.

RECOMMENDATION 3.3

For many storage systems, storage capacity share arrangements offer entitlement holders the ability to better manage the storage and use of water to which they are entitled. Governments and rural water utilities should provide for storage capacity share arrangements where the benefits exceed the costs.

RECOMMENDATION 4.1

Restrictions on who can participate in water trade should be relaxed or removed to improve the economically efficient use of rural water.

RECOMMENDATION 4.2

Each jurisdiction should conduct a public review of remaining restrictions on trade in seasonal allocations. Those which do not generate net public benefits should be removed. Timetables for review should be transparent, and progress and findings publicly reported.

RECOMMENDATION 4.3

The National Water Commission and States and Territories should consider benchmarking approval processes, and associated costs involved in trading seasonal allocations, against best practice. Independent performance reviews should be conducted periodically.

RECOMMENDATION 4.4

Exit fees on sales of water out of an irrigation district constrain trade in entitlements and impede adjustment. They should be phased out.

RECOMMENDATION 4.5

Water utilities in the southern Murray–Darling Basin should decouple exit fees from entitlements in the medium term. Infrastructure charges should be levied on the water users' water-use licence or delivery capacity share.

RECOMMENDATION 4.6

Water utilities in the southern Murray–Darling Basin should move to competitive supply contract arrangements with water users in the long term.

RECOMMENDATION 4.7

Approval processes and associated costs involved in trading water entitlements should be benchmarked to best practice. Performance reviews should be conducted periodically by the National Water Commission.

RECOMMENDATION 6.1

Following a comprehensive review of the advantages and disadvantages of different institutional structures, governments should establish appropriate arrangements for environmental managers as soon as is practical.

RECOMMENDATION 7.1

Environmental managers should develop portfolios of water products, where appropriate, to deliver environmental flows in a timely and cost-effective manner.

RECOMMENDATION 8.1

An agency should be established as soon as is practical for the purpose of acquiring water for the Living Murray Initiative. This agency should acquire a range of water and water-related products, rather than acquiring water through infrastructure investments and purchase of water entitlements alone.

Findings

Key factors affecting water availability

FINDING 2.1

Climate change, farm dams, afforestation, groundwater extraction, bushfires and changes to irrigation water management have the potential in the long term to significantly adversely affect the availability of water in rivers. In some areas, impacts may be more immediate.

FINDING 2.2

Recognising the connectivity between groundwater and surface water systems is fundamental to the efficient management of water resources. In highly connected systems, failure to incorporate these linkages in policy frameworks may reduce or counteract the benefits achieved in other areas of reform, including water trade.

FINDING 2.3

Further research on groundwater systems and their connectivity to surface water and sustainable extraction rates, and effective water accounting systems, are essential to managing linkages between groundwater and surface water. However, interim measures, backed by adaptive management, are needed in priority areas, even in the absence of full information.

FINDING 2.4

Changes in return flows, resulting from land-use changes, need to be accounted for in entitlement specifications and/or resource management policies. Adaptive management and the use of interim measures are necessary in high priority areas.

Improving entitlement regimes

FINDING 3.1

Unbundling water entitlements into tradeable water share and delivery share components may be beneficial in areas where there is substantial congestion of water delivery.

FINDING 3.2

Uniform carryover arrangements across districts are unlikely to be appropriate given different water management objectives, storage capacity, evaporation losses and potential third-party impacts.

FINDING 3.3

Trading unused seasonal allocations across districts may improve intertemporal water-use choices where carryover is not available in all districts.

FINDING 3.4

Where capacity sharing is not feasible, more frequent and pre-scheduled allocation announcements and/or continuous accounting would improve information to irrigators on likely water availability and, thereby, assist water-use and investment decisions.

Reducing constraints on water trade

FINDING 4.1

More efficient private sector service providers can be crowded out when existing government-funded water exchange charges are not consistent with the principles of competitive neutrality.

FINDING 4.2

Constraints on trade are generally greater for water entitlements than for seasonal allocations. Relatively unconstrained trade in seasonal allocations and emerging derivative water products already mean that water is moving to higher value uses. Removal of constraints on trade in water entitlements would build on these gains.

Other factors affecting farmers' decisions on water use and trade

FINDING 5.1

Irrigators are generally well-informed about water-use choices and are best positioned to make sound decisions about allocating water to privately productive uses. There may, however, remain scope for governments to improve information on the biophysical characteristics of water use common across properties.

FINDING 5.2

The management, performance and activities of water utilities have important implications for the efficient use of rural water on- and off-farm. Improving incentives to manage water resources to maximise community benefits, and removing unjustifiable impediments to their activities, are likely to improve water-use efficiency.

FINDING 5.3

Government subsidies that seek to improve the uptake of particular technologies or practices solely to increase the productivity of water use are likely to be inefficient.

Externalities, assessment criteria and governance issues

FINDING 6.1

Market mechanisms to address environmental externalities need to be targeted appropriately to location and scale — no 'one size' fits all. Poorly designed or narrowly applied market mechanisms can impose high costs that may outweigh potential gains.

FINDING 6.2

Environmental managers need clearly defined objectives, good coordination processes, and adequate resources. They need to enter markets to source water and to access the full range of water and water-related products on the same terms and conditions as other market participants.

Altered river flow externalities

FINDING 7.1

Administrative arrangements to allocate water for environmental purposes conceal the opportunity cost of meeting environmental objectives and can crowd out more efficient market mechanisms.

FINDING 7.2

Opportunities to source water for environmental purposes through infrastructure investment, at a cost below the current price for entitlements, appear limited. Further, sourcing water through 'water-saving' infrastructure investment may reduce water available for other uses.

FINDING 7.3

On-farm incentives are unlikely to be cost-effective where the primary objective is to source water for environmental purposes.

Assessing market mechanisms for altered river flows

FINDING 8.1

Many river flow objectives require sourcing additional water for environmental purposes. There are often more flexible and cost-effective ways to achieve these objectives than purchasing entitlements or investing in infrastructure.

FINDING 8.2

Creating new, tradeable rights to river capacity may be useful for influencing river heights or reducing flooding.

FINDING 8.3

Arriving at the correct rate for a volumetric tax is not easy. If set too low, the tax may not reduce the externalities associated with water use in the short run. If set too high, the tax may lead to market distortions and have unintended equity consequences. Further, volumetric taxes are unlikely to be effective in addressing those externalities which, although related to altered river flows, are unrelated to the volume of water used by irrigators.

Salinity externalities

FINDING 9.1

Recent dry conditions have reduced and delayed salinity impacts, including those from irrigation activities.

FINDING 9.2

Salt interception works can quickly reduce instream salinity. With the costs of existing and potential interception schemes rising, and opportunities for low-cost schemes limited, other approaches to address salinity will be required.

FINDING 9.3

Salinity zoning schemes provide incentives to affect landholders' water-purchasing decisions. Incentives may be needed to encourage the removal of water from salinity impact zones to reduce salt mobilisation.

FINDING 9.4

Reducing groundwater recharge can reduce the incidence of salinity at its source, but generally takes a long time to affect instream salinity.

FINDING 9.5

Market mechanisms for salinity and environmental flows need to be coordinated to capture synergies and ensure mechanisms do not have significant unintended detrimental effects.

FINDING 9.6

Flushing salt out of a catchment or basin may be an efficient approach to managing salinity. Seasonal flexibility would be needed in water quality standards to facilitate flushing salt from the Murray–Darling Basin.

Assessing market mechanisms for irrigation salinity

FINDING 10.1

A salt cap and trade scheme may be appropriate at the regional level, but less so at the farm level.

FINDING 10.2

A cap and trade scheme for on-farm groundwater recharge may be worthwhile in areas where there is sufficient diversity in land management practices and where benefits from reducing the emergence of salinity are high.

FINDING 10.3

Offsets for groundwater recharge can be successfully implemented to address localised salinity problems.

FINDING 10.4

Zoned salt levies penalise actions that exacerbate salinity, but could be complemented by rewards for actions that reduce salinity, such as incentives to trade water out of high impact regions.

FINDING 10.5

Tenders can be practical for procuring land management changes that generate multiple environmental outcomes, including reductions in dryland and instream salinity.

FINDING 10.6

Relocating farm enterprises and/or investing in physical water-use efficiency can reduce groundwater recharge. Carefully designed and targeted incentive payments could accelerate relocation or investments in irrigation technologies that reduce groundwater recharge. The costs and benefits of such a scheme would need to be assessed on a case-by-case basis.

FINDING 10.7

Dilution flows can assist the flushing of salt from a river system, and can be procured in the same way as environmental flows.

1 Introduction

In 1994, the Council of Australian Governments (COAG) agreed to a reform framework to improve the management of Australia's water resources. Since then, water reform has continued to be prominent on the public policy agenda and has been of increasing concern to governments and the wider community.

The Australian Government, with the support of the state and territory governments, has asked the Productivity Commission to examine the feasibility of establishing market mechanisms to provide incentives for greater investment in rural water-use efficiency and for dealing with environmental externalities.

1.1 Background

In June 2004, the Commonwealth of Australia and all state and territory governments (except Tasmania and Western Australia) agreed to the National Water Initiative (NWI). Tasmania and Western Australia signed in June 2005 and April 2006 respectively. The NWI sets out objectives, outcomes and actions to support progress on national water reform (COAG 2004a). The objective of the NWI is:

> … a nationally-compatible, market, regulatory and planning based system of managing surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes … (COAG 2004a, clause 23)

A key element for progressing national water reform relates to water markets and trading. State and territory governments agreed to:

> … progressive removal of barriers to trade in water and meeting other requirements to facilitate the broadening and deepening of the water market, with an open trading market to be in place. (COAG 2004a, clause 23(v))

The terms of reference (reproduced at the beginning of this report) ask the Productivity Commission to assist jurisdictions to meet their commitments on water markets and trading by undertaking a six-month research study to:

- assess and report on the feasibility of establishing workable market mechanisms:
  - to provide practical incentives for investment in rural water-use efficiency and water-related farm management strategies;
  - for dealing with rural water-management related environmental externalities; and

- take into account relevant practical experiences in other areas. (terms of reference; related to COAG 2004a, clause 61(iii))

In the context of the NWI, states and territories are making progress on rural water reform. The reform agenda is ambitious and the tasks complex. Although some may be frustrated by the pace of reform so far, it is imperative that long-term reforms are well designed and implemented. Where urgent action is needed, such as when serious, irreversible environmental damage is likely to occur unless action is taken, temporary immediate measures may be required. This study will assist jurisdictions to continue the reform process.

The focus on market mechanisms to replace, or complement, traditional regulatory approaches to environmental and resource management has been increasing in Australia and internationally. Market mechanisms are broadly defined as instruments that encourage behaviour through market signals rather than through explicit directives (Stavins 2003). Compared with traditional regulatory approaches, where suitable, they offer greater flexibility for market participants, and have the potential to lower compliance costs and provide dynamic incentives to reduce future costs of achieving targets. Market mechanisms can be used to help existing markets work better, to influence prices in existing markets, and to create new markets.

Market mechanisms are already used to manage a range of water-related issues in rural Australia. In particular, markets for trading water entitlements (a prescribed, defined right to an amount of water — sometimes known as permanent water) and seasonal allocations (a volume of water that an irrigator is allowed to access in a particular season — sometimes known as temporary water) are well established within the major irrigation areas, particularly in the southern Murray–Darling Basin. These markets are beginning to be used to help reallocate water use towards better environmental outcomes, such as purchasing entitlements and seasonal allocations to address over-allocation of water resources. Markets in groundwater, and in partially regulated and unregulated systems, are much less developed.

In some regions of Australia, planning regimes are exclusively used to allocate water for environmental purposes, and in some regions over-allocation is not an environmental concern. Nevertheless, market mechanisms can still play a role in improving the transparency of the tradeoffs being made and sharpening the incentives for efficient use (box 1.1).

This study examines the further application of market mechanisms, including opportunities for improving and extending the application of existing market mechanisms, and the potential for new mechanisms. The Commission's focus is on mechanisms consistent with the broad framework established under the NWI. In box 1.1, however, some aspects of a longer-term vision are introduced that are beyond the scope of this report to develop.

Box 1.1 Developing integrated water markets in the longer term

Within water plans, administrative arrangements are relied on to allocate portions of the water resource pool to a range of different uses, such as the environment, agriculture and urban activities. These administrative arrangements also allocate water use within various subsets of the water resource pool, such as groundwater and surface water. In the Commission's view, insufficient recognition is given to the implications of the integrated nature of water resources and effects of use by one water user on another.

Usually markets are the most efficient mechanism to distribute scarce resources. Administrative arrangements can be used to make initial allocations to water users, and markets can be used to reallocate this water to where it can yield its highest value. However, some potential water users are excluded from these markets either because they are not granted initial allocations or because their rights to the water resource pool are not interchangeable with other water users.

There are opportunities to use markets to substitute for administrative arrangements to more efficiently allocate water among competing users. This could be achieved for subsets of the water resource pool, but third-party effects observed above would remain. Alternatively, markets could allocate water across the total water resource pools with allocations exchangeable across all users. This would require the purchase of water for public water uses, such as environmental flows.

In the longer term, as demand grows and scarcity in one subset of the resource pool drives substitution to other sources, the need for integrated water markets will become even more pressing. The development of integrated water markets that are open to all and that incorporate, where hydrologically feasible, all aspects of the water resource pool, is a radical departure from the existing arrangements in all jurisdictions. This requires a dramatic rethink within government and the community of the way in which water is used as a resource in the wider economy and the contribution it makes to society's overall wellbeing. The development of fully integrated water markets will create powerful competitive pressures and spur innovation in water products, enhance on- and off-farm productivity, and foster more sophisticated market-based responses to environmental management.

Governments have a critical role in providing the appropriate institutional and property right arrangements within which integrated water markets can flourish. The competitive arrangements envisioned by the Commission would increase the need to articulate clear environmental objectives, and require a preparedness to place economic values on environmental objectives and a willingness to financially resource them appropriately. Adjustment and equity issues will also need to be addressed. A reliance on markets may require that those who are insufficiently resourced, but require a certain amount of water, be granted funds to participate in the markets.

1.2 Scope of study

The scope of this study is determined by the terms of reference and the Commission's authorising legislation, the *Productivity Commission Act 1998*. The Act requires the Commission to frame its assessment of rural water-use efficiency reform options in terms of what will deliver the best outcomes for the Australian community, rather than for any particular group or industry. The study is also guided by the broad framework and direction provided in the NWI, particularly clauses 23 and 58, reiterated in the terms of reference.

The terms of reference refer to *rural* water-use efficiency and *rural* water-management related environmental externalities. Because irrigators in the agricultural sector use the majority of extracted rural water, water use by irrigators is the main focus of the study. However, rural water has other, often competing, uses that are valued by the community, including helping to maintain river health and biodiversity; recreation; and supporting other uses, such as mining, power generation and urban settlement. Interactions between irrigation and other uses are, therefore, also considered.

The Commission also focuses on on-farm water use, reflecting the terms of reference which refer to water-use efficiency and water-related farm management strategies. However, off-farm water supply issues (including off-farm water harvesting, storage and distribution) are also relevant because they influence on-farm water use and can affect the environment in ways that impact on community wellbeing, now and in the future.

The study focuses on extracted surface water from regulated river systems because the majority of irrigation in Australia is drawn from these sources via major storage and delivery infrastructure (appendix B). Nevertheless, given the links between surface water and groundwater, and the importance of groundwater to some irrigators, groundwater use is also considered. The interception of rainfall, and the storage and use of overland flows of water, are also recognised as part of the water system.

Given the focus of the terms of reference on practical and workable market mechanisms, the Commission has drawn heavily on examples from several states and territories, including Queensland and Western Australia, and from other countries, such as New Zealand and the United States of America. Most of the examples, however, relate to the southern Murray–Darling Basin because it:

- accounts for a large share (over 50 per cent) of water diverted for irrigation in Australia (WHCF and CRCIF 2005)

- has a concentration of large irrigation schemes, hydrological connectivity, a wide variety of agricultural production, and the predominance of surface gravity delivery and flood irrigation
- has well documented over-allocation issues and other environmental and third-party concerns (Beare and Heaney 2001).

Market mechanisms can be applied to aid the efficient use of water in other river systems — market mechanisms, for example, can be used to aid the allocation and reallocation of water between different uses (including for environmental purposes). And many of the insights into the design and application of market mechanisms are relevant to other irrigation regions in Australia. For example, the general design insights related to markets mechanisms to address water quality issues, such as salinity, are often transferable to other water quality problems, such as high nutrient loads in water courses.

The spatial dimensions of water use and their relationship with the environment are important components of the study. Water use and its effects vary substantially within, and between, irrigation districts, reflecting different farm businesses, soil types and hydrology, and the sources and relative scarcity of water. The scale and significance of environmental impacts from irrigation activities, such as elevated salinity levels or nutrient enrichment in rivers, also vary across production systems and regions, as does the information available about them. Further, institutional and socioeconomic differences between regions may influence the applicability and adoption rates of particular irrigation practices and market mechanisms.

Temporal issues are important because incentives and opportunities for reducing water use, and achieving economic efficiency, vary over time. Irrigators, for example, may adopt approaches that reduce water use during periods of reduced water availability, but revert to more intensive water use once its availability has increased. Long-term investment in new technologies or practices that reduce water use are more likely to occur with major changes in farm activities (such as moving from dairy to horticulture), or when the expected long-term outlook for water prices and availability, or other benefits (such as improved product quality or labour cost savings), justify the investment. Temporal issues are also important because of the often long delays between the change in land-use practices and any measurable impact on the environment or a subsequent water user.

1.3 The Commission's approach

The terms of reference ask the Commission to assess market mechanisms to provide incentives for investment in rural water-use efficiency and for dealing with rural water-management related environmental externalities. These concepts and their interrelationships are discussed below.

A focus on economic efficiency

The concept of economic efficiency, as it relates to rural water use, provides the overarching framework for analysis and assessment of reform options in this study. The Commission has used an *economic* definition of water-use efficiency that incorporates how water resources are allocated and used to achieve the greatest overall net social benefit to the community. This includes investments in irrigation technologies and management practices, and extends to all activities related to water use. An activity is said to be economically efficient if there is no other use of the resources that would yield a higher value or net benefit. The economically efficient use of water relies on individuals and organisations making informed decisions and factoring externalities (see below) into their resource allocation decisions. This approach is consistent with a central objective of the NWI, to manage surface and groundwater resources for rural use in a way that 'optimises economic, social and environmental outcomes' (COAG 2004a, p. 3).

The *economic* meaning of water-use efficiency is different from *physical* water-use efficiency, which is often used to define the relationship between water (as one input) and agricultural production (as an output), such as tonnes of rice per megalitre of water. Physical water-use efficiency, in terms of distributing irrigation water, can refer to the volume of water received at the farm gate as a percentage of the volume of water leaving storages. Physical water-use efficiency is neither necessary nor sufficient to achieve an economically efficient use of water. For example, the adoption of an irrigation technology that increased physical water-use efficiency would *reduce* economic efficiency if the costs of adopting the technology outweighed the benefits from its adoption. The concepts of physical water-use efficiency and economic efficiency are discussed further in box 1.2. To minimise confusion, the Commission refers to the *economically efficient use of water* (or economic efficiency) when referring to economic concepts of water efficiency and *physical water-use efficiency* when referring to physical concepts.

The existence of impediments to the economically efficient use of water may justify government intervention (if such intervention generates benefits to the wider community in excess of its costs). The existence of less physically efficient irrigation practices or technologies does not, by itself, justify such intervention.

Box 1.2 Physical and economic water-use efficiency

Physical water-use efficiency

The term 'physical water-use efficiency' is commonly used to describe the *average* physical relationship between output and water required (as one input), where both inputs and outputs are measured in physical units. Physical water-use efficiency can be measured on-farm, in water supply and delivery systems, and in the delivery of ecosystem services. Some examples of measures are:

Irrigation water-use efficiency	—	Total crop production (kg) per irrigation water applied (ML)
Crop water-use efficiency	—	Total crop production (kg) per evapotranspiration (mm)
Conveyance efficiency	—	Water delivered to the farm gate (ML) per water released from the headworks (ML)
Field application efficiency	—	Irrigation water available to crop (ML) per water received at field inlet (ML)

It is important to remember that these measures do not take into account all factors that contribute to the loss of water in an irrigation system, such as climate, soil type, hydrology, type of irrigation and topography.

Economic water-use efficiency

An activity is economically efficient if there is no other use where the resources would yield a higher value or net benefit to the community. The concept of economic efficiency can be usefully applied to efficiency on-farm, in water delivery, and in 'environmental' uses. Overall economic efficiency incorporates three components:

1. *Productive efficiency* is achieved when an output is produced at minimum cost.
2. *Allocative efficiency* is about ensuring that the community obtains the greatest return (broadly defined) from its resources. Unlike productive efficiency, allocative efficiency requires that production is consistent with the community's demand. The best or 'most efficient' allocation of resources is the one that contributes most to community wellbeing.
3. *Dynamic efficiency* refers to the allocation of resources over time. This can involve finding better products and better ways of producing goods and services.

Sources: ACIL Tasman 2003; Fairweather et al. 2003; NPIRD 1999; PC 1999.

The role of government

Improving economic efficiency may require a reallocation of water resources that increases overall net social benefits. Water markets can, through prices that reflect net social valuations, provide incentives for irrigators, water utilities and environmental managers to make water-use decisions that maximise the economic efficiency of water use. Markets may, however, be imperfect or incomplete, resulting in market failures, such as those related to the under-provision of public goods (for example, some environmental services), externalities (for example, environment and health), market power/imperfect competition (resulting in anti-competitive behaviour) and information failures.

Where markets fail, governments may intervene to make markets work better. The existence of public benefits is a necessary, but not sufficient, condition for government intervention. Governments should intervene only if the benefits of such intervention are likely to exceed the costs on a community-wide basis. Such intervention may involve the establishment of an appropriate institutional setting (see below) or actions to address environmental externalities.

Importance of the institutional setting

The need for, and performance of, market mechanisms depends on the accompanying institutional settings. These include underlying property rights, the legislative framework, existing government policies that can directly, or indirectly, influence rural water-use decisions, and the governance framework.

Property rights

Clear, comprehensive and enforceable property rights are a fundamental requirement for the efficient use of water, even in the absence of trade in water. Irrigators and other water users need to know their rights to water and their responsibilities in accessing and using water to make decisions that are privately or socially optimal on water use, enterprise selection and farm development. In the presence of water trade, property rights also need to provide security for sellers and buyers of water, and allow low-cost water exchange.

The requirements of a property rights regime consistent with efficient trade in, and allocation of, water include clear rules for sharing the water available in each period between rights holders and the incorporation of hydrological realities. These include links between surface water and groundwater, return flows from irrigated farms, and the impact of changes in land use (for example, from pastures to plantation forestry) on total water available. Progress in developing property rights will be limited by the availability of information and by costs. For example, the development of property rights to manage salinity, such as a cap and trade for salt, is limited by a lack of information and the costs of specification and monitoring.

Efficient property rights are also important for the successful introduction of other market mechanisms not directly linked to the water market, such as salinity credit schemes.

Government policies and legislation

The efficiency of rural water use is affected by government policies and legislation that are directly related to water use. For example, state and territory legislation, such as the New South Wales *Water Management Act 2000*, can regulate access to groundwater and surface water, priority use of environmental water, stock and domestic rights, conditions regarding construction and use of dams and bores, and the operation of water utilities (including irrigation corporations). Interjurisdictional water arrangements are also governed by state legislation, such as the various Murray–Darling Basin acts.

Moreover, rural water-use efficiency can also be affected by government policies and legislation that are not directly related to water, including policies and legislation on land management, risk management and adjustment. Policies to facilitate adjustment to changing circumstances and to provide safety-net support to those experiencing very low incomes for any reason are an important part of economic and social policy. A range of such policies is in place, and their presence strengthens the case for adopting policies that do not restrict efficiency-enhancing adjustment in the use of resources, including through water trade.

Governance framework

The NWI noted that governments have agreed to establish 'accountable environmental water managers' as part of effective and efficient management and institutional arrangements for water (COAG 2004a, clause 78). One of the primary functions of environmental managers would be coordinating activities aimed at achieving environmental objectives, including through the use of market mechanisms. Good governance would improve the consistency and effectiveness of environmental water activities, increase transparency and accountability in the use of public funds and environmental water entitlements, and enhance monitoring and reporting of performance (chapter 6).

Enhancing the economic efficiency of water use

Market mechanisms can play a role in improving on-farm water-use decisions and in addressing the incidence of environmental externalities associated with rural water use. As noted above, market mechanisms can have advantages compared with traditional regulatory approaches. However, poorly designed market mechanisms (as with poorly designed regulatory arrangements) can impose high costs that can outweigh potential gains. A number of factors can influence the selection and design of market mechanisms, including policy objectives, the type of market failure being addressed, the specific nature and magnitude of the resource-use problem, cost-sharing arrangements between individuals and government, and existing institutional and policy settings.

The terms of reference specify that the assessment of market mechanisms should focus on *workable* and *practical* options. This requirement has been addressed on two levels. First, the discussion about improving and expanding market mechanisms was placed in the context of the broader policy objectives and the institutional framework, such as current water trading arrangements. Also at the broader level, market mechanisms were assessed according to their ability to be consistent with fundamental economic principles, such as effective property rights, because these determine incentive structures that affect behaviour, and hence *workability*. Second, the Commission has assessed market mechanisms to facilitate workable options by taking into account farm-level decision making.

Improving on-farm water-use efficiency

A number of incentives are already available to irrigators to allocate water to its most productive on-farm uses. The competitive nature of agricultural markets provides discipline for producers to use inputs profitably. Water markets are well developed and active in many areas, and provide some signals to farmers to make efficient water-use decisions within the confines of regulatory and institutional arrangements. While a number of constraints continue to impede water markets, particularly in the trade of water entitlements, the emergence of derivative products for water, such as leasing and forward contracts, may mitigate some of these concerns.

Nevertheless, the Commission has identified several potential constraints on efficient water markets, and considered ways of reducing or removing them. In doing so, workable market mechanisms or reforms have been examined with an emphasis on:

- improving aspects of existing water entitlement and allocation regimes, including unbundling entitlements, improving carryover arrangements, moving to storage capacity share systems, and easing uncertainty (chapter 3)
- removing remaining unnecessary constraints applying to trading in water allocations and entitlements (chapter 4)

- improving information collection and dissemination, the performance of rural water utilities, and reviewing government policies relating to subsidies for efficient water use and taxation arrangements (chapter 5).

In many of these areas, reforms or improvements are already underway. The Commission seeks to build on these by providing additional information and options to progress rural water reform.

Environmental externalities

Beyond encouraging irrigators to use water efficiently for production purposes, social costs and benefits need to be considered for economically efficient water use from a community-wide perspective. To achieve this goal, externalities associated with water use need to be managed. An economic externality occurs when a side effect of a decision by an individual (or business) affects another party's wellbeing, but that effect is not taken into appropriate account by the decision maker. Other parties may include farmers, other groups or the whole community.

In accordance with the terms of reference, the Commission has focused on environmental externalities, and has distinguished between environmental externalities and environmental change. Environmental change resulting from natural processes independent of actions by humans is not considered to be an externality.

Many of the environmental externalities associated with irrigation water supply and use are complex and the links between sources and effects are not well understood. It is sometimes difficult to identify, observe and measure effects from individual sources and resulting changes in environmental conditions. An environmental externality can be characterised by its source, the way in which it is transmitted, and its effect. These basic elements, along with the complex relationships between them, will determine the appropriate policy response to an environmental externality.

Environmental externalities associated with irrigation water use include salinity, altered river flows, turbidity, and excess nutrients and chemicals transported to surface water and groundwater bodies and coastal regions. In this study, the Commission has focused on assessing market mechanisms to address the two most prominent types of environmental externalities primarily caused by water use in irrigated agriculture — those arising from changes to the timing and volume of natural flows of regulated rivers (chapters 7 and 8), and salinity (chapters 9 and 10).

With a focus on workability, some practical criteria have been developed for assessing market mechanisms to manage environmental externalities associated with altered river flows and salinity (chapter 6). These criteria relate to costs, feasibility, flexibility, distribution of costs and benefits, and the likelihood of the market mechanism achieving its goal.

Market mechanisms which have been assessed (with the aid of the criteria) to address river flow externalities include options contracts, which would operate through existing or emerging water markets, and trade in river capacity. Cap and trade permits specifying salt discharge levels (salinity reduction) and options for salt dilution flows (salinity stabilisation/mitigation) are examples of some potential market mechanisms to manage salinity.

1.4 Conduct of the study

The terms of reference for this study were received on 13 December 2005. The terms of reference specified publication within six months, that is, by 13 June 2006. To enable careful consideration of the complex issues involved and greater participation of stakeholders in the preparation and review of a discussion draft, the Commission requested an extension to the reporting date. The Australian Government granted an extension to 11 August 2006.

The commencement of the study was advertised in the national press and in several regional newspapers, and a circular was sent to a range of individuals and organisations thought to be interested in the study. An issues paper was released in December to assist participants to prepare submissions. A website (www.pc.gov.au/study/waterstudy/index.html) was also established to make available items such as study-related circulars and submissions.

The Commission held informal discussions with a variety of study participants to seek information and canvass a wide range of views. Participants included irrigators, water utilities, industry associations and key government agencies. The Commission also consulted with signatories to the NWI (including through the interjurisdictional water trading group) and the National Water Commission, as required by the terms of reference. Appendix A lists those who participated in discussions and those who made submissions. Fifty-six submissions were received in response to the issues paper.

The Commission released a discussion draft for public comment in June 2006. Interested parties were given the opportunity to respond to issues raised in the discussion draft by way of written submissions. Forty-two supplementary submissions were received (appendix A). Approximately 40 key participants were invited to attend a roundtable to exchange views and comment on the discussion draft. The Commission also met with the interjurisdictional water trading group and the National Water Commission to seek their views on the draft.

A consultant's report on transaction costs in water markets and environmental policy instruments was commissioned and can be accessed on the above website.

The Commission thanks participants for their contribution at meetings and the roundtable, and for their submissions.

1.5 Report structure

A number of factors affecting water availability for environmental and other uses are discussed in chapter 2, with case studies provided on groundwater and surface water management, and changes in irrigation management and return flows. Options to improve water entitlement and seasonal allocation regimes are discussed in chapter 3, and ways to reduce or remove constraints on water trading are considered in chapter 4. Chapter 5 discusses other factors affecting farmers' decisions on water use and trade. Chapter 6 introduces the concept of environmental externalities and develops criteria to assess the relative merits of market mechanisms designed to manage environmental externalities. It also considers key governance issues associated with the management of market mechanisms, with a particular focus on the role of environmental managers. The feasibility of establishing market mechanisms to address externalities (caused by rural water use) associated with altered river flows and salinity are discussed in chapters 7 and 8, and 9 and 10, respectively.

2 Key factors affecting water availability

Key points

- Groundwater extraction, changes to irrigation water management and return flows, farm dams, afforestation, bushfires, and changes in climate that reduce rainfall and increase evaporation, are key factors affecting water availability.
  - In the Murray–Darling Basin, for example, these key factors may significantly reduce stream flows and undermine efforts to achieve environmental goals, and affect the reliability of some entitlements and use licences.
- While administrative allocation arrangements can play an important role, there are opportunities to design property rights in ways that enable markets to improve the efficiency of any re-allocation in water resources that may occur.
- High priority should be given to clarifying and refining existing property right arrangements to better reflect the interlinkages between water resources.
  - Refining property rights will have equity and efficiency implications.
- Market mechanisms, including cap and trade schemes and offsets, are likely to be important components of market-based solutions.
- More research is needed to further understand the interaction of these factors with existing arrangements for water use and property rights. In addition, improvements in water accounting will be required to deal with these interactions and property right arrangements.
- Two case studies considered in this report suggest that:
  - Groundwater use in highly connected systems should be capped in a manner consistent with surface water and both caps fully integrated in the long term.
  - Changes in return flows need to be accounted for in either entitlement specifications and/or resource management policies. Adaptive management and the use of interim measures in high priority areas are necessary.

The efficient use of water depends critically on efficient and effective administrative and property right arrangements. Water users compete for water through both direct and indirect means. Sometimes this competition is not readily apparent because: the means by which the water is accessed by users differs substantially; water users can be long distances from each other; and there can be long lags before others are affected. As a result, where property rights are poorly specified, there are potentially important unintended effects on the environment and/or entitlement holders due to changes to water-use decisions. In addition, where changes in climate reduce rainfall and/or increase evaporation, the total water available to some water users may be reduced.

The structure of this chapter is as follows. In section 2.1, the key factors that will affect the availability of water to alternative uses are identified. Section 2.2 introduces some of the interrelationships between those factors and property right arrangements and considers how they affect water availability. In section 2.3, some broad approaches to the problems are introduced and two case studies (ground water and return flows) are developed to consider possible responses in more detail. Conclusions from the analysis are drawn in section 2.4.

2.1 Identifying key factors affecting water availability

A number of factors are threatening to erode the longer-term availability of water in rivers. These can undermine efforts to achieve environmental objectives and to improve the efficiency of water markets and, in some cases, affect the availability and reliability of water for other uses.

The most significant factors ('risks to shared resources') that may diminish water availability in rivers over the longer term in the Murray–Darling Basin include:

- climate change that reduces rainfall and increases evaporation
- farm dams
- afforestation
- groundwater extractions
- bushfires
- changes to irrigation water management and return flows. (van Dijk et al. 2006)

Many of these factors will also be applicable to other regions.

Other human-induced factors may occur that have similar effects, such as changes to dryland farming in response to climate and commodity markets. In addition, Scanlon (sub. DR59) argued that the management of surplus or unregulated flows is a significant additional factor to the 'risks to shared resources' identified by CSIRO. Pressure on these unregulated flows has increased over time as other components of the water system have increasingly been brought within the regulatory framework. In its *Review of The Living Murray Implementation 2004-05*, the Independent Audit

Group (IAG 2006) noted that the potential impact of altered surplus flow management (including for local environmental benefits) on the achievement of the overall objectives of The Living Murray was the most significant risk it identified in its initial audit.

There are complex distributional issues associated with all of these factors. Within a capped system improvements in water-use efficiency can be at a cost to unregulated flows. However, to the extent that these improvements are then used to re-allocate water for environmental flows, there may be no net loss of flow, but rather a redistribution in time and space.

Some of the reductions in water availability for environmental purposes occur because of increases in water used by others, such as owners of tree plantations, groundwater bores and farm dams. Other reductions, such as those due to climate change, occur because of reduced rainfall and increased evaporation. In connected hydrological systems, the consumption of water by one user ultimately affects the availability of water to another.

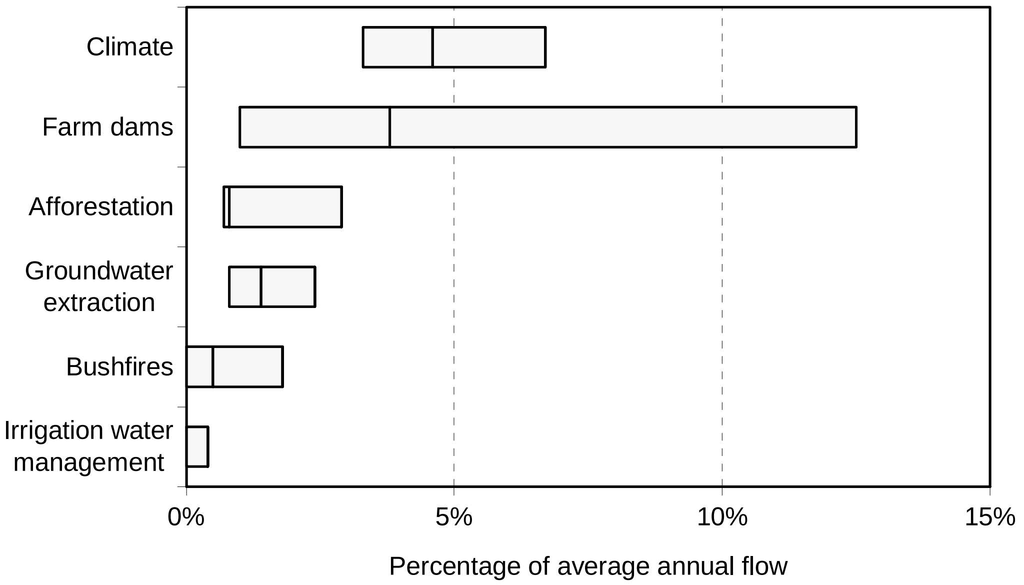
Quantifying the effects on annual stream flow

The impacts of the factors will vary across jurisdictions and estimating their size now, and into the future, is difficult. There are also problems in aggregating the impacts across the different factors. However, estimates have been made and the results suggest substantial impacts. In *Risks to the Shared Resources of the Murray–Darling Basin*, for example, CSIRO noted:

> Initial evidence suggests that climate change, afforestation, groundwater extraction, changes to irrigation water management, farm dams and bushfires are all potential risks in that they may reduce the volume of water in the rivers and streams of the Murray–Darling Basin … Whilst there are limitations to the degree to which the risks can be summed, evidence suggests a likely impact on stream flow in 20 years time of between 2,500 and 5,500 GL/year … (van Dijk et al. 2006, p. 6)

Figure 2.1 presents estimated reductions in average annual stream flow in the Murray–Darling Basin due to each key factor. The CSIRO report noted that these risks are ‘not forgone conclusions’, however, and that ‘understanding of how the risks might impact upon the Basin is by no means complete’ (van Dijk et al. 2006, p. 6).

Figure 2.1 **Estimated reductions in stream flows in the Murray–Darling Basin by 2020 due to six 'risk' factors**



Source: van Dijk et al. 2006.

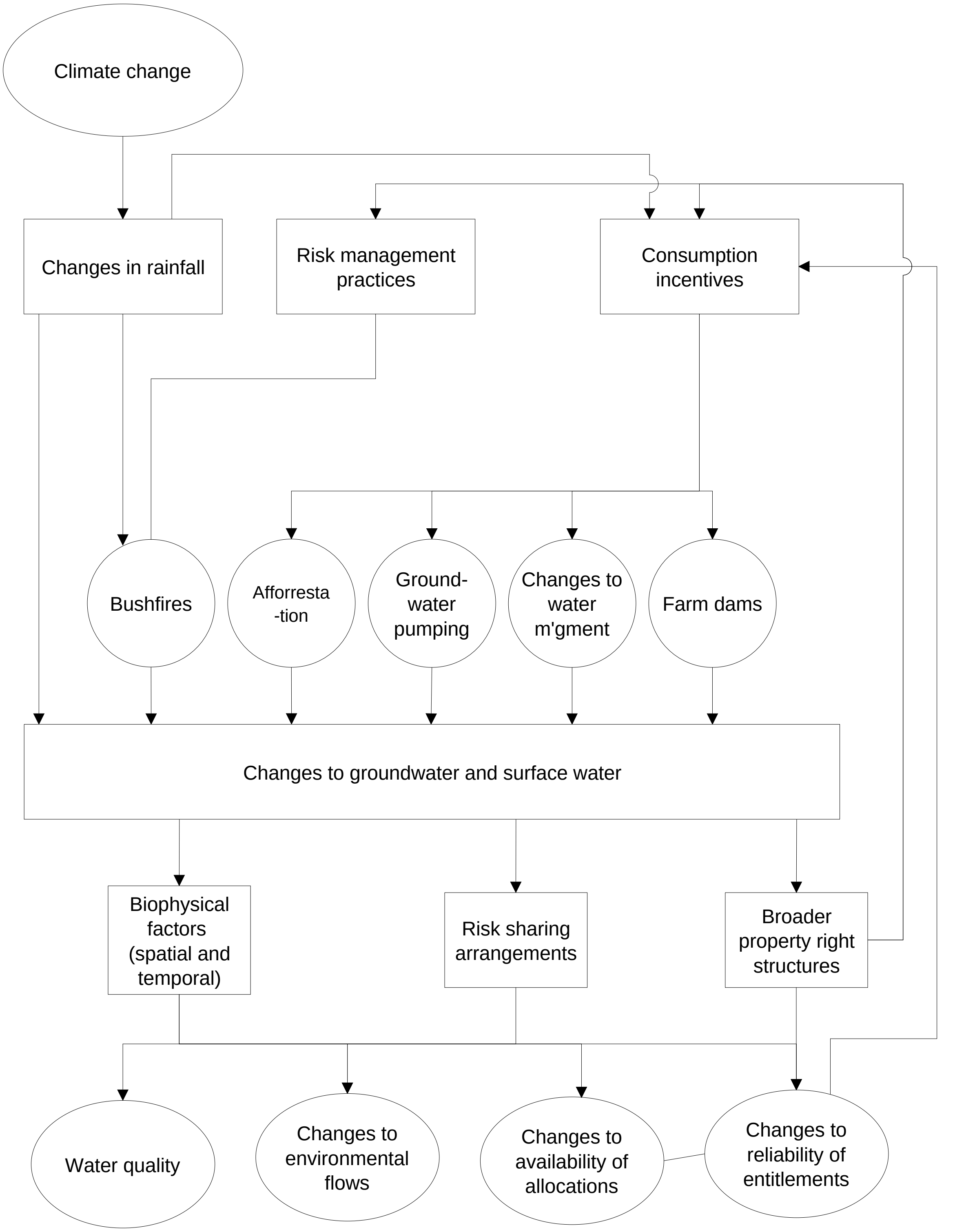
FINDING 2.1

Climate change, farm dams, afforestation, groundwater extraction, bushfires and changes to irrigation water management have the potential in the long term to significantly adversely affect the availability of water in rivers. In some areas, impacts may be more immediate.

2.2 How do these key factors affect water availability?

Some of the interrelationships between the key factors reducing water availability, and property rights are introduced in figure 2.2. Reductions in rainfall, and increased evaporation, will influence the impact of all the other key factors. Drier conditions, for example, will be more conducive to bushfires. Lower rainfall will reduce seasonal allocations and entitlements for surface water and drive substitution to other water sources, such as groundwater and farm dams. Water scarcity will also increase water prices thereby enhancing the viability of adopting new technology. Lower rainfall also may limit or change the nature of the development of afforestation.

Figure 2.2 **Interrelationships of factors affecting instream water availability**



There are complex interrelationships between the endogenous factors — some of them reinforcing another. Increasing groundwater extraction, for example, may drive physical efficiency of water use as the pumped groundwater will be more suited to pressurised water delivery systems.

A key driver of land use changes and reactions to changes in climatic conditions is property rights. They will influence the choices available to water users and the extent to which the impacts of water use on third parties will be taken into account. The action taken to limit water extracted through groundwater bores and intercepted by farm dams, for example, will depend on the extent to which they are capped.

A primary concern resulting from potential changes in water availability due to these factors is the reduced water flows to achieve environmental objectives. However, the factors might not only affect water volumes but also water quality. The impact of the factors on river salinity, for example, is the net result of changes in salt mobilisation and changes in stream flow. If farm dams intercept fresh overland flows they are more likely to increase stream salinity (van Dijk et al. 2006).

Property right specifications may also have efficiency and distributional implications for the availability of water for some entitlement holders. The significance of these factors affecting water availability, and the appropriate policy response, will vary within and across catchments. In the following subsections a more detailed description of how each factor affects water availability is developed.

Climate change and bushfires

Of the key factors considered in the CSIRO study, only climate change directly reduces the total water available for instream use (changes to evaporation excepted). All the other factors which change water use can be viewed as competing uses for the water resource. With the exception of any effects on evaporation, they change the *distribution* of water rather than the *total amount*.

As noted above, property right and planning arrangements play a critical role in determining the impacts of changes in all of these factors. Under the current operation of the Murray–Darling Basin Cap, for example, reductions in stream flow from surface water diversions are capped. By defining the Cap in terms of diversions, however, reductions in total water availability (due to climate change) or increases in water interception or abstraction not covered by the Cap, reduce the amount of water for environmental purposes and for ‘downstream’ entitlement holders.

Bushfires have both short-term and long-term effects on water availability. Immediately after a fire, water availability in a catchment will increase substantially but as vegetation regenerates, water yield gradually declines until eventually returning to pre-fire levels as vegetation matures.

Groundwater

Connectivity between groundwater and surface water varies across systems. In some systems groundwater and surface water are highly connected and are essentially a single source, such as in the Hunter Valley in New South Wales, while in others systems the sources appear quite separate, such as in the Murrumbidgee Valley in New South Wales (DNR 2004; Murrumbidgee Private Diverters, sub. 58). Current resource management in many areas of Australia fails to sufficiently integrate and account for these links. This has resulted in some systems being highly over-allocated, and others being managed under considerable uncertainty (Evans 2005; Young and McColl 2003).

Concerns over the lack of integration between groundwater and surface water, and its implications for the economically efficient use of water, were raised by a number of participants, including the Victorian Farmers Federation (sub. 49), WWF Australia (sub. 34) and the Water Steering Group for Horticulture Australia (sub. 32). Young and McColl noted:

> Many of the most serious problems associated with catchment, river and aquifer management stem from a past failure to understand the hydrology of groundwater connectivity and the generally long time these groundwater systems take to respond to changes in land and water use. Most Australian rivers are inextricably connected to surrounding groundwater aquifers that supply much of their base flow. (2003, p. 3)

Sinclair Knight Merz similarly noted:

> Groundwater and surface water are often connected and interchangeable resources. The capture of surface water by groundwater pumping and/or the reduction of groundwater recharge by surface water diversions can be a significant loophole in current water resource planning. (SKM 2005, p. 1)

Evans (2004) estimated that, on average, in the Murray–Darling Basin, for every 100 megalitres of groundwater extracted, surface water will be reduced by 60 megalitres. Based on these estimates, between 1993-94 and 1999-2000, the growth in groundwater extraction eroded the Murray–Darling Basin Cap by an average of 2 per cent per year. The erosion is likely to increase over time because many groundwater management units are currently only partially developed and demand for groundwater is growing.

The lack of integration of surface water and groundwater systems in how water resources are allocated and regulated, can create perverse incentives for water users and undermine water resource management. Due to the substitutability of these two sources of water, reducing access to one can increase the use of the other. As noted above, extracting groundwater in close proximity to a river can sometimes have the same impact as directly diverting from the river. This potentially reduces the effectiveness of water management policies that address only surface water or groundwater. The South Australian Government stated:

> Reduction in stream flows as a result of increased groundwater use in NSW has already reduced average flows in the River Murray to South Australia by 200 GL *per annum*. (sub. 36, p. 8)

Similarly, the NSW Government observed:

> NSW recognises the interconnection between groundwater and stream flows in some river systems. In many areas of the Murray Darling Basin, the only water available for drought contingencies is from groundwater sources. These sources become even more important during times of climate change. This is an important factor to be considered. (sub. DR93, p. 2)

Indeed, the introduction of the Cap in the Murray–Darling Basin (appendix B), along with expanded water trade, has activated previously unused or underused licences, including groundwater licences.

The Australian Property Institute (NSW Division) and Australian Spatial Information Business Association also highlighted concerns over a lack of integration between groundwater and surface water and the implications that inadequate management can have for the security of water entitlements:

> In summary, it is our strong view that accurate measurement of surface and ground water resources should be an overarching priority of the NWI … (sub. DR88, p. 10)

In particular, they raised concerns over problems that can arise in the case of mining companies extracting groundwater which can lower water tables in the surrounding area making it more difficult for other water users (such as irrigators) to access water under their water pumping entitlement.

A number of factors contribute to a lack of integration of surface water and groundwater systems in policy frameworks and management plans:

- information on many groundwater systems is limited
- water accounting systems have not yet been fully developed and, as a result, the infrastructure for organising information on relationships between groundwater and surface water is limited

- many policy frameworks, including entitlement arrangements, have not been set up to take account of managing groundwater and surface water interactions.

In addition, shifting to new, more integrated arrangements is likely to involve difficult adjustment issues.

Changes in irrigation management and return flows

When water is applied on farm, some proportion of that water returns to the water system through seepage or runoff. This return flow can then be used downstream by other water users or to achieve environmental outcomes. Existing water entitlements in most jurisdictions are based on some expectation of return flows:

> Administrators typically issued licences so that the sum of all licence entitlements is between 10 per cent and 20 per cent over normal usage, and, in some groundwater systems, as much as four times normal usage. (Young and McColl 2003, p. 23)

When return flows are less than the assumed amount, third-party effects and problems of over-allocation can occur. Water Resource Plans in Queensland, however, assume no return flows in determining water plans (from which entitlements are provided). This is a highly conservative approach to managing issues of return flows — it avoids altogether any potential problems of reduced return flows, but at the potential cost of having less water allocated to productive uses.

Changes in the quality of return flows can also affect downstream uses. Reduced return flows can improve or reduce water quality depending on the location of water use. Within the southern Murray–Darling Basin, for example, while relatively high quality return flows from areas characterised by flood irrigation technologies can reduce river salinity, return flows from irrigation areas located above saline groundwater deposits can increase river salinity (Heaney et al. 2005).

A potential problem with most existing entitlement specifications is that there is little formal consideration of changes in return flows, such as from increasing physical water-use efficiency (through water-saving technologies and management practices). The impact of increases in physical water-use efficiency on return flows can be significant.

On-farm water savings may be ‘illusory’ in the sense that they reduce water available to other users, including other irrigators and water for environmental uses (box 2.1).

Box 2.1 On-farm water-use decisions, environmental flows and water available to other users

Increasing on-farm physical water-use efficiency reduces the volume of water that leaves the farm in the form of surface flows or groundwater recharge. This reduces the amount of water available for other uses, including environmental services. In some cases, for example, runoff and drainage directly serve as a source of irrigation water for other irrigators.

Although on-farm increases in physical water-use efficiency are sometimes believed to be desirable because they 'save' water that can then be used for environmental flows, this is often not the case:

> … better water use efficiency by agriculture … does not create 'spare' water that is then automatically available for urban or environmental requirements. (Australian Dairy Farmers, sub. 12, p. 2)
>
> Where physical water-use efficiency is improved, the water saved is usually used to increase the area irrigated. (JD Brooke, sub. 10, p. 2)
>
> To date, any water saved in South Australia through on-farm efficiencies has been used to expand the amount of land under irrigation … Generally this water has not been put aside specifically as a contribution towards environmental flows. (South Australian Government, sub. 36, p. 5)

On-farm water 'saving' may reduce the total amount of water available for environmental and other uses, depending on whether losses are 'true losses' or 'apparent losses' (Pratt Water 2004). True losses occur when water evaporates or recharges into saline aquifers, resulting in water not being available for use by other irrigators or other water users. Apparent losses are groundwater recharges or return flows that can be used by irrigators or other water users. Improvements in on-farm water-use efficiency that only reduce apparent losses are 'illusory' savings — they do not improve total water availability, but simply reduce the amount of water available to other users:

> … the primary environmental impact of increasing the efficiency of water use is due to reduced groundwater leakage and surface water runoff. These reduced return flows impact both water quality and the quantity of water available for the environment and downstream users …
>
> Improving irrigation efficiency is likely to reduce surface water runoff and groundwater leakage. In all cases this would result in a reduction of return flows available for the environment and downstream users. (WWF Australia, sub. 34, pp. 5–6)

Changes in physical water-use efficiency on-farm may also cause changes in water quality or flow characteristics that affect others, including other irrigators and those who value water for environmental services.

Source: Pratt Water 2004.

Water redistributions resulting from on-farm savings may, in some cases, however, have economic efficiency benefits — even though they do not increase the total amount of water available — if they produce a better allocation of water. In such cases, the ‘saved’ water is redirected, sometimes through market transactions, to where its marginal value is greater than in its previous use.

The importance of incorporating return flows in policy frameworks will depend on location. Where other uses depend on return flows, policy responses are needed.

Farm dams

Farm dams are an important source of water to landholders, especially during periods of low rainfall. Farm dams are used to store water for stock and domestic purposes (in the case of smaller dams), or for irrigation (usually requiring larger dams). Farm dams harvest water and store water, for example, by capturing overland flows, runoff, or water from a stream. As farm dams intercept water that would otherwise have continued to flow to become part of the water system — either as runoff to surface water, or recharge to groundwater — failure to incorporate farm dams into water resource management and accounting can result in third-party impacts. While the effects of an individual farm dam may be small, the cumulative impact of farm dams may be significant. Characteristics, such as the timing and volume of water extracted, rates of evaporation, and the location of the farm dam in relation to the landscape, will all affect the likely impact.

In general, potential third-party impacts are likely to increase as the number and cumulative volume of farm dams increases. While there is no comprehensive assessment of the prevalence and impacts of farm dams in Australia, research by CSIRO suggested that the number and size of farm dams has been increasing in the Murray–Darling Basin:

- the number of farm dams was estimated to have increased by 37 per cent in the last ten years
- the volume of farm dams aggregated across the Basin was estimated to have increased by 48 per cent in the same period (van Dijk et al. 2006).

As such, van Dijk et al. (2006) identified farm dams as one of six ‘risks to shared water resources’ in the Murray–Darling Basin. Farm dams have the potential to pose a risk to shared water resources due to past water management decisions not to account for their impact on the water system, and an increase in their predominance due to increased irrigation activity and more frequent periods of extended drought. With water scarcity and the opportunity cost of water increasing (and with a lack of regulations controlling farm dams) farm dams became a relatively less costly method of harvesting additional water. If unmanaged, farm dams would most likely increase in number and total volume, which in turn could significantly reduce stream flows.

In the study, van Dijk et al. estimated the impact of farm dams in the Murray–Darling Basin in terms of the likely reduction in stream flow and the effect on the environment. Using computer modelling, the likely effect on stream flow was a reduction of 0.84 megalitres for each megalitre stored in the farm dam. However, it is difficult to estimate the cumulative effect into the future given that farm dam regulations are being imposed progressively in the jurisdictions. Hence, van Dijk et al. concluded that '[t]he impact from farm dams will depend on the effectiveness of farm dam legislation' (2006, p. 6).

In terms of other environmental impacts, van Dijk et al. concluded that:

- farm dams can be effective sediment and nutrient traps
- farm dams can provide habitat and biodiversity functions by providing aquatic refuges to birdlife and other organisms
- farm dams are likely to increase instream salinity as they intercept fresh overland flows which would otherwise have acted to dilute stream flows and hence, instream salinity.

Plantation forestry

Plantation forestry is an expanding dryland activity. It can offer benefits for the wider community, including carbon sequestration, ameliorating dryland salinity and reducing inundation in low-lying areas. Tree Plantations Australia (sub. 50) noted, for example, that in the Denmark River catchment (southwest Western Australia) it is anticipated that salt concentrations in the water will return to potable levels around 2015 because eucalypt plantations have reduced the discharge of salty groundwater into the river. (The impacts of plantation forestry on salinity are considered in chapters 9 and 10.)

As noted in section 2.1, plantation forestry can also have negative impacts. The CSIRO (2004, p. 1) study concluded that extensive afforestation can 'significantly reduce average annual water flow in streams and rivers and impact on the seasonal distribution of flows'. This can result in reductions in the quantity, and possibly the quality, of water available in the catchment to downstream users and for environmental flows (figure 2.1 and van Dijk et al. 2006). CSIRO modelling of the impact of converting 'land to forest' in the Murray–Darling Basin shows that the greatest reduction in water yields would occur in the eastern regions where rainfall is highest. However, the extent of the impact of forestry plantations on water availability is site-specific, depending on factors such as plantation management, plant species, soil type, rainfall patterns and aquifer responsiveness. For example, dispersing plantations and phasing plantings can potentially reduce the impact on water yield (BRS 2006).

Byrne, O'Brien, Eagle and McDonald commented:

> … MIS [Managed Investment Schemes] tree plantations reduce the supply of water in various catchments. Intensive planting of young trees, which absorb a lot of water in their growth stage over 10-15 years, dries up surface flows and reduces groundwater flows. The use of this water … has a negative cost in reducing the water flows down streams and rivers and into reservoirs. (sub. DR83, p. 27)

The National Water Initiative (NWI) lists large-scale plantation forestry as a activity that has the potential to 'intercept significant volumes of surface and/or ground water' and notes that it presents a 'risk' if not subject to 'some form of planning and regulation' (clauses 55, 56). In South Australia, a management plan was introduced in 2004 to specifically address the impact of commercial forestry in the lower south–east of the state. In this region commercial forestry is a legislatively prescribed 'water-affecting activity' requiring a permit. There is a dedicated area of forest expansion within each water resources management area. When plantation expansion exceeds 59 000 hectares, offsets are required by securing and quarantining an appropriate water allocation (DWLBC 2004–6).

Tree Plantations Australia (sub. 50) is critical of the South Australian plan, noting, for example, a lack of a scientific basis and the inappropriate targeting of forestry. It observes that such rules do not apply to any other dryland activities. Tree Plantations Australia concluded more broadly that plans should take into account the impacts of all land uses, treat conditions for trading water consistently for all land uses, and provide a mechanism for allowing trade or redistribution of water entitlements within catchments.

Australian Forest Growers contends that the focus on the negative impacts of plantation forestry is misleading:

> It has helped to create the misconception that all plantations are excessive water users with detrimental effects on water balance and environmental flows, rather than the potential for some plantations in some parts of some catchments to reduce environmental flows. This also masks points on which broad agreement exists or is possible, and overlooks the significant role plantations are playing in reversing salinity in badly affected regions. (nd, p. 1)

Deep-rooted trees can reduce the amount of groundwater, but the third-party impacts from reduced water availability may be positive or negative. And the planting of trees can have other non-water related benefits to the community (chapter 9). The design of policy instruments should recognise the potential for a range of third-party impacts.

2.3 What is to be done?

In broad terms, improved management of these factors will require improved information, effective water accounting systems and improved policy responses. It is beyond the scope of this report to address all the implications of these factors for water availability. Drawing on previous Commission research, however, two case studies are provided to develop insights into the policy issues and begin the exploration of potential policy solutions. Before presenting them, an overview is given of some of the key considerations in addressing the factors affecting water availability and a brief account is provided of the actions being taken by governments.

Some key considerations

More research is required to understand the biophysical and economic relationships that influence the distributional impacts of the factors affecting water availability.

Further improvements in water accounting arrangements will be required both to understand the spatial and temporal dimensions of the effects, as well as who will be affected. Improved accounting arrangements can also play a key role in helping to refine and clarify underlying property right arrangements that, in turn, drive the distributional consequences.

Climate change is the only factor affecting total water availability that is effectively exogenous to (outside the influence of) those making decisions on water and on land management in the irrigation areas and in the catchments that are the source of their water. There are no water property rights solutions that prevent the occurrence of climate change. All other factors are endogenous and have feedbacks (figure 2.2). Some will have legacy effects that can not be altered by property right solutions. However, alterations to water property rights can change the distributional impacts of legacy effects.

The main types of responses that governments can consider to better integrate into policy these four exogenous factors affecting water availability include:

- Responses broadly based on property rights/entitlements — this could include incorporating water usage into existing entitlement regimes or creating new entitlements (which may, or may not, be tradeable).
- Offset schemes — these may involve catchment or district level water use caps.
- Separate or integrated water usage caps — for example, the use of separate groundwater caps or integration of groundwater caps into surface water caps.

- Regulatory limits and conditions on water-use and land-use changes which significantly affect water use.

The relevant property right arrangements currently vary across jurisdictions and the implications of these property rights need to be better understood. Efforts to address the key factors affecting water availability are likely to raise important equity questions about which water users should gain or lose. Cost sharing issues will need to be resolved. In many cases, policy choices relate to who should bear the risk of changes to water availability (in other words, who has the primary or priority 'property right'). There are also important issues of policy design which can affect the efficiency of policy choices.

The appropriateness of each approach will vary depending on, among other things: the threat to water availability that is being managed; the nature and extent of the risks in the relevant location; availability and cost of information and necessary monitoring; and other institutional matters. In some cases, policy responses can cut across the different factors affecting water availability. Consideration should also be given to existing arrangements (including existing property rights) and opportunities for synergistic benefits from using a mix of instruments. In all cases, policy choices should be informed by appropriate analysis of the benefits and costs.

Action is being taken

Governments have taken actions, in addition to implementing the Murray–Darling Basin Cap, to address factors affecting long-term water availability for environmental and other purposes.

The NWI includes provisions to identify and manage factors affecting water availability, and to develop a risk-sharing framework for entitlement holders. Signatories to the NWI have agreed, for example, to assess the significance of interception activities, such as farm dams and bores, intercepting and storing of overland flows, and large scale plantation forestry, on aquifers and catchments. Where necessary, appropriate planning, management and/or regulatory measures will be applied. As signatories to the NWI noted:

> The intention is therefore to assess the significance of such activities on catchments and aquifers, based on an understanding of the total water cycle, the economic and environmental costs and benefits of the activities of concern, and to apply appropriate planning, management and/or regulatory measures where necessary to protect the integrity of the water access entitlement system and the achievement of environmental objectives. (COAG 2004a, clause 56)

The NWI risk-sharing framework outlines how several risks to water availability for consumptive use (including those from bushfires and climate change) will be shared between governments and entitlement holders under the Cap (box 2.2). Changes in water availability resulting from groundwater and surface water linkages, changes in return flows, farm dams or afforestation, however, were not specified.

Box 2.2 **Risk sharing under the National Water Initiative**

The National Water Initiative (clauses 46–51 and attachment A) provides a framework for managing many of the risks associated with future changes in water availability for water entitlement holders under their entitlements. The risk of future reductions in water availability have been assigned such that:

- risks of reductions arising from 'bona fide improvements' in the knowledge of water systems' capacity to sustain particular extraction levels are to be borne by water users until 2014, after which time risks are to be shared between users and governments
- risks associated with natural events, such as bushfires, drought and climate change, are to be borne by users
- risks of reductions resulting from changes in government policy (for example, new environmental objectives) are to be borne by governments.

Where affected parties — including water access entitlement holders, environmental stakeholders and the relevant governments — agree, on a voluntary basis, to a different risk sharing formula, that will also be considered an acceptable approach.

Source: COAG 2004a.

Initiatives already being implemented include:

- reduced or capped groundwater entitlements in the New South Wales and Queensland sections of the Murray–Darling Basin
- metering of all water extractions in the Australian Capital Territory
- 'Sustainable Water Strategies' and metering of all commercial water extractions in Victoria. (MDBC 2006g)

Further research is also being undertaken. For example, Partners to the Murray–Darling Initiative are collaborating on a number of projects to better understand the risks, including:

- a $7 million research program to improve understanding of climate change and to provide more reliable forecasting methods
- contributing to Victoria's Bushfire Recovery Program, to investigate impacts on water resources, based on the 2003 bushfires
- developing a reporting framework to monitor, investigate and evaluate the effect of groundwater extraction on stream flow in the Basin

- improving data and reporting on farm dams and assessing improved remote sensing technology to estimate farm dam numbers (MDBC 2006g).

Progress is also occurring with water resource accounting. Water resource accounting includes the development of standards, measuring, monitoring and reporting systems, for water resources. Accounting systems can include a wide variety of information, including the stocks and flows of groundwater and surface water, water quality, storage, use, markets, land-use change, and climate change. For this reason water accounting is relevant to all four of the factors affecting water availability focused on in this chapter. The NWI identified water accounting as one of its key elements (box 2.3).

According to the NWI, an accounting system that is transparent and comparable across jurisdictions is fundamental to 'improving hydrological models that underpin water allocation decisions', ensuring confidence in the market, and in achieving environmental outcomes (COAG 2004a, attachment A). The design of the accounting system, however, will need to take appropriate account of development and implementation costs, and weigh the benefits and costs of existing arrangements within jurisdictions.

RECOMMENDATION 2.1

The National Water Commission should work with States and Territories to progress reform in water accounting so that a compatible, reliable, transparent and sufficiently comprehensive system can be developed to underpin efficient water-use and environmental water allocation decisions.

Box 2.3 Water accounting

Water accounting systems in Australia are state-based, rather than national. Several participants commented on the need to improve existing arrangements. For example, Engineers Australia noted:

> … Australia's data collection and monitoring arrangements are relatively primitive. Water trading, in such circumstances, is fraught with difficulties. (sub. 8, p. 9)

WWF Australia commented:

> Without a robust system of water accounting, measuring the effectiveness of water efficiency measures will be impossible, particularly in unregulated water sources. (sub. 34, p. 2)

In discussing the need to restore environmental health to rivers, such as the River Murray, Young and McColl noted that the accounting systems for water quantity and quality are not 'robust'. 'They do not guarantee [in a fully allocated system] that when one person or one process uses more water, another uses less' (2003, p. 4). In particular, there are major system omissions, including the impacts of land-use changes that reduce recharge and runoff, increases in water-use efficiency, salinity interception schemes, and increased groundwater use and climate change.

The NWI identified a number of outcomes and actions to improve water accounting frameworks, including benchmarking water accounting systems, developing accounting system standards, and improving data collection and management systems. Timelines for action included national benchmarking of jurisdictional water accounting systems by June 2005, developing a compatible detailed register of environmental water by mid-2005, and implementing accounting systems to integrate groundwater and surface water use by 2008 (COAG 2004a).

Although the NWI accounting reforms have not yet been fully implemented (with several commitments not due until the end of 2006, 2007 and 2008), progress has been made. For example, the Victorian Department of Sustainability and Environment (sub. 39) noted that it was working with other states through the Murray–Darling Basin Commission and the NWI Committee to develop a consistent national accounting approach, and planned to introduce a web-based water accounts database.

At a national level, Engineers Australia noted that an action plan for a national accounting framework developed in 2005 'offers considerable promise and emphasises building on existing data and information systems' (sub. 8, p. 9).

Sources: COAG 2004a; Victorian Department of Sustainability and Environment sub. 39; Young and McColl 2003.

Case study 1: Groundwater

Moving to an integrated system of surface water and groundwater management may not be a simple task. Indeed, given the information and management costs involved, such a system would not necessarily be desirable in all areas. However, useful steps can, and should, be taken to improve existing arrangements. Given that the impetus for linking the management of surface water and groundwater is stronger in some locations than others, prioritisation is important. While information is incomplete in many areas, interim measures backed by adaptive management are required. Improvements are needed in the area of information, accounting systems and policy frameworks.

Failure to recognise the extent of connectivity between unconfined aquifers (groundwater) and surface water supplies is often (at least in part) due to a lack of understanding of groundwater and surface water processes. Evans stated:

> River – groundwater interaction is a poorly understood process across much of Australia. The lack of technical understanding results in generally separate management of surface water and groundwater resources. This in turn has led to the potentially large scale double allocation in much of Australia. (2005, p. 7)

Sinclair Knight Merz highlighted the difficulty in attaining national information on groundwater and surface water interactions, noting that much work in the area has been at the local scale:

> In general, although a range of technical studies have been conducted in Australia to assist with understanding the process of groundwater – surface water interaction and its associated impacts, the nature of these studies (being largely local in scale) limits the capacity of providing an overview of the issue on a national scale. This is further exacerbated by the contrasting manner in which each jurisdiction classifies the process of groundwater – surface water interaction that ultimately limits any generalisations on a broader (national) scale. (SKM 2006, p. vii and viii)

Improved information

The importance of improved information on groundwater and surface water connectivity was noted by several participants. For example, the Water Steering Group for Horticulture Australia argued, '[g]roundwater resources need conjunctive assessment and management with surface water resources' (sub. 32, p. 4). Coleambally Irrigation Co-operative also stated:

> Rivers are natural features, but regulation has changed a raft of these features, in particular the relationship between surface and groundwater. In better defining and understanding river losses this relationship between groundwater and surface water is critical, as a reduction in river losses through operational changes or engineering works could reduce the recharge of aquifer systems. (sub. 4, p. 12)

Signatories to the NWI have already committed to improving the information collected on groundwater and its connectivity with surface water (COAG 2004a). Victoria, for example, has been expanding its information collection and has introduced a Groundwater Management Strategy and Groundwater Management Plans. The Victorian Government also committed in its White Paper (DSE 2004) that all data collected through the state surface water and groundwater monitoring networks will be made available to the public via the Victorian Water Resources Data Warehouses. The Australian Government also provided funding in March 2006 for a new Cooperative Research Centre (eWater CRC) to help reduce gaps in the knowledge of Australia's water resources.

The Western Australian Government, through the Department of Water, has undertaken a number of actions to assess and review groundwater systems in Western Australia, reflecting the extensive use of groundwater in the state. These actions include establishing 3000 monitoring bores between Moore River and Mandurah in the coastal plain around Perth, and a similar number throughout the rest of Western Australia. The department also provides a publicly available groundwater atlas for Perth and a hydrological atlas for the rest of the state (Department of Water 2006).

In April 2006, the Australian and South Australian governments provided $12.6 million to a Water Smart project to improve the management of groundwater resources across the south–east of South Australia. This includes improved groundwater resource assessments, monitoring and accounting across the region, support for an integrated regional resource management approach and implementation of best practices in irrigation management to meet groundwater targets (Turnbull 2006b). It will also further the South Australian initiative to establish volumetric allocations in the south–east through the installation of telemetry systems, and to use the data to inform groundwater management in the region.

The Australian Government will also provide $1.35 million to a $1.99 million national project on groundwater–surface water interaction (Turnbull 2006d). This investment is aimed at contributing to a greater understanding of the relationships between surface water and groundwater, and in particular providing estimates of the level of connection between major river and groundwater systems in Australia. The results are to contribute to initiatives to return overallocated water to sustainable levels across priority catchments.

The NSW Government noted that a number of studies are underway to ascertain further information on groundwater:

> NSW's approach in the Murray Darling Basin is to: …. identify priority groundwater systems and undertake scientific work to quantify the exchange of water at groundwater source scale (there are several studies already underway, for example, through the CRC eWater, BBRS, Cotton CRC). (sub. DR93, p. 2)

In addition, the Murray–Darling Basin Commission is currently completing the second Groundwater Status Report for the Murray–Darling Basin (for the period

2000 to 2005) that will enable further benchmarking of groundwater resources. More frequent assessments in the future may aid policy development in the area.

In addition to attaining further information on groundwater and linkages to surface water, there remains the task of improving information on surface water flows and extractions. Improved metering of water extraction for irrigation is one way to improve such knowledge. The adequacy and accuracy of current metering systems to measure water use and extractions was raised as a concern by several participants — for example, Coleambally Irrigation Coopertative (sub. 3; sub. 4); A Watson (sub. 2); Western Australian Farmers' Federation (sub. 15); WWF (sub. DR63); NSW Irrigators Council (sub. DR87). The Western Australian Government has stated that improved metering is essential for accurate water use measurement which in turn is required for secure entitlement systems and effective water trading (Water Reform Implementation Committee 2006). Effective measurement of water movements can also be important for managing third-party impacts. While improved metering can offer benefits, it is not without its costs and these need to be compared with the expected benefits before investments are made.

Attention should continue to be given to areas where additional information is most likely to offer the greatest net benefits. Such information could usefully feed into water resource management processes. Improved information should be linked into effective water accounting arrangements (section 2.3).

Improved policy frameworks

Existing policy frameworks, such as catchment management plans, state-based water resource plans and entitlement and allocation regimes, could be improved by better incorporating existing or enhanced information and accounting systems on water flows. At present, the degree of integration varies substantially across regions.

CSIRO proposed changes to entitlements to account for the links between surface water and groundwater, suggesting:

> Defining any unconfined aquifer that is strongly connected to a surface water allocation as part of that system and setting sustainable yield accordingly. This is likely to imply a 1:1 exchange rate set between surface water and groundwater that is close to a river. (sub. 24, p. 9)

Evans (2004) investigated a number of possible solutions to address the problem of over-allocation, including:

- freezing groundwater allocations at current levels
- freezing groundwater use at current levels

- including groundwater in the existing Cap
- expanding the Murray–Darling Basin Cap by the sustainable yield of groundwater
- maintaining separate groundwater and surface water caps, which Evans referred to as accounting for groundwater within the 'spirit' of the Murray–Darling Basin Cap.

The study concluded:

> It is proposed that in the short term, groundwater should be accounted for within the spirit of the [Murray–Darling Basin] Cap. In the long term, groundwater should be included in an expanded 'Cap'. (Evans 2004, p. 1)

Maintaining separate groundwater and surface water caps in the short term, and including groundwater in an expanded Murray–Darling Basin Cap in the long term, would help address the problem of over-allocation, and help to strengthen the effectiveness of the Murray–Darling Basin Cap in controlling the growth of water extraction from rivers in the basin and in protecting and enhancing the riverine environment in the basin (consistent with the goal of the Cap, see MDBC 2006e; appendix B).

While the comprehensive implementation of such arrangements would require further research on the sustainable yield of particular groundwater sources, and greater understanding of their connectivity with surface water sources, the conservative setting of separate groundwater and surface water caps along with adaptive management could be adopted in the interim, especially in priority areas. In developing practical solutions, simple 'rules of thumb' may be needed, with new information informing policy settings over time. Groundwater extraction occurring within a certain number of kilometres of rivers in the Murray–Darling Basin, for example, could be included in the Murray–Darling Basin Cap. While the impacts of groundwater extractions on surface water flows, and vice versa, can vary significantly depending on location, the cost of developing separate optimal caps for all groundwater extractions is likely to be prohibitive.

A conservative approach to allocation and use of water resources, and the use of adaptive management, is employed by the Department of Water in Western Australia to limit the potential for future over-allocation problems (Water Reform Implementation Committee 2006). The use of adaptive management in policy frameworks can be especially helpful by explicitly providing flexibility in management systems so they can adjust as better information and understanding emerges.

Another, more general, response is to jointly manage groundwater and surface water as a single resource within management plans. The South Australian Government, for example, stated:

> In South Australia we have a progressive move towards more integration in management between surface and groundwater systems in many areas. For example recently where we have commenced introducing regulatory frameworks for water resource management (known as prescription of a water in our legislative framework) both surface water and groundwater are being included, for example the Eastern and Western Mount Lofty Ranges. (sub. DR79, p. 12)

This approach has also been recommended for the development of Macro Water Sharing Plans for highly connected systems in the Hunter Region in New South Wales (box 2.4).

Box 2.4 **Integrated groundwater and surface water management in the Hunter Region**

There are a number of highly connected water systems in the Hunter Catchment. The New South Wales Department of Natural Resources identified that separate management of connected groundwater and surface water sources (such as those in the Hunter) can lead to problems such as double counting and over-allocation, and different rules for users who are accessing what is, in effect, a single water source. This is consistent with one of the objectives of the NWI, that there should be 'recognition of the connectivity between surface and groundwater resources and connected systems managed as a single resource' (COAG 2004a, clause 23).

As a result, Macro Water Sharing Plans are being developed in highly connected systems in the Hunter to manage groundwater and surface water as a single resource. These plans will include daily bore height monitoring and 'cease to pump' (or extract) conditions, based on groundwater levels, to ensure sustainability of the water source. Moreover, it is proposed that the same licence conditions and management rules be applied to all users currently holding a groundwater or surface water licence. Local impact rules will also apply to prevent potential third-party impacts from water extraction. These will include buffer distances around existing extraction bores, as well as high value environmental features such as riverine and groundwater dependent ecosystems. In some cases, groundwater height triggers may also be used to manage local impacts.

At present, groundwater monitoring bores are being installed in the highly connected systems within the Hunter Catchment, and data are being collected to use in the setting of pumping and extraction limits. When the plans are operational, licence holders will be able to access pumping information via phone, internet, fax or email.

Sources: COAG 2004a; DNR 2004; New South Wales Department of Natural Resources, pers. comm., 19 July 2006.

In some areas, problems of over-allocation are severe such that cut backs and/or buy backs are necessary to restore systems to sustainable levels. Addressing existing problems of over-allocation is a clear priority for governments as the legacy of past allocation decisions is substantial in many areas, with the full impacts yet to be seen, given the lags between extraction and impact on surface flows.

An example of government action in this area is the New South Wales Government and the Australian Government decision to jointly spend $110 million in the Achieving Sustainable Groundwater Entitlements Program to help six major groundwater systems in New South Wales become sustainable over the long term (Howard 2005). The program comprises a range of measures, including perpetual licences, a financial assistance package, groundwater trading and a ten-year transition period.

Overall, improving the management of groundwater and surface water linkages should be a high priority for governments to avoid problems of over-allocation and third-party effects. It is essential for the success of the NWI, for providing water users with reasonable confidence in the water entitlements they own and, ultimately, for achieving the efficient use of rural water resources. The lack of complete information should not be used as a basis for inaction.

FINDING 2.2

Recognising the connectivity between groundwater and surface water systems is fundamental to the efficient management of water resources. In highly connected systems, failure to incorporate these linkages in policy frameworks may reduce or counteract the benefits achieved in other areas of reform, including water trade.

FINDING 2.3

Further research on groundwater systems and their connectivity to surface water and sustainable extraction rates, and effective water accounting systems, are essential to managing linkages between groundwater and surface water. However, interim measures, backed by adaptive management, are needed in priority areas, even in the absence of full information.

RECOMMENDATION 2.2

In the short term, groundwater use in highly connected systems should be capped in a manner consistent with surface water management. In the long term, groundwater and surface water caps in such systems should be fully integrated.

Case study 2: Return flows

One approach to improve the management of changing return flows is to adopt 'net entitlements' in water entitlement regimes. Entitlement regimes that incorporate the quantity of return flows are referred to as 'net entitlements', while those that define entitlements as water received at the farm gate (and do not include return flows) are called 'gross' entitlements (box 2.5).

Box 2.5 **Gross and net entitlement systems**

When water access entitlements are defined in 'gross' terms, the water saving from investments and changes to irrigation practice that reduce the volume of water returning to an aquifer, or surface water flow, are retained by the (surface) water entitlement holder. This water can then be used to increase the area irrigated or can be sold to another person.

When water access entitlements are defined in 'net' terms (the quantity that is used after allowing for returns to the aquifer and transfers to other systems), reductions in return flows are considered to be part of the water entitlement. Under this approach, only that part of the increase in application efficiency that reduces evaporation or transpiration can be used to expand irrigation.

Source: Young and McColl 2003.

Net entitlement approaches have several advantages, compared with gross systems. They incorporate a system-wide approach to accounting for, and therefore managing, the use of water that takes into account a range of potential third-party impacts. Moreover, they can include the effects of reduced drainage and groundwater returns to a river resulting from increased physical water-use efficiency, reductions in water yield from catchment land-use changes (such as increased forestry or farm dam development), and reduced groundwater flow to rivers due to increased groundwater use (Young and McColl 2003).

Engineers Australia highlighted the potential advantages of net entitlement approaches:

> … higher irrigation efficiency reduces ground water returns to streams and so disadvantages downstream users. Shifting land use from cropping to, say horticulture can lead to higher irrigation efficiency. Studies have shown that increasing irrigation efficiency from 80 to 90 per cent in the Riverland of South Australia reduced ground water inflows to the Murray by about 22 per cent. This highlights the importance of specifying net allocations in water access entitlements and the importance of correctly accounting for water flows. (sub. 8, p. 7)

Other participants expressed concerns about the use of gross, compared with net, entitlements. WWF Australia, for example, argued:

> Water available to users in general has been defined in terms of gross (volume pumped) allocations rather than net (volume consumed) flows. This means that as water is traded from less [technically] efficient to more efficient [water] users, or general [technical] efficiency improves, river flows will decline with no change in the amount of water allocated to users. (sub. 34, p. 5)

However, while moving to comprehensive net approaches has its advantages, there are several reasons for caution:

- Current levels of understanding of groundwater and interactions with surface water are likely to limit its practical use in many areas. Without credible data and modelling capability, integrity in such a system may be difficult to achieve. Impacts on third parties, including environmental effects, would also be difficult to predict.
- Net entitlements would require regular modelling of return flows because technological or other changes to irrigation activities, or changes in natural systems, can substantially affect return flows, adding to the cost and complexity of this approach. Some party would, therefore, have to bear the risks of any incorrect information.
- Net entitlements reduce to some extent the incentive for irrigators to increase their physical water-use efficiency. While any savings from reduced evapotranspiration would be retained by an irrigator, savings that would have become return flows would not. However, because net entitlements would internalise the adverse impacts of increased water-use efficiency on downstream users, the likely lower rate of increase in physical efficiency would be expected to be an improvement on the criterion of economic efficiency.
- Moving to a ‘net entitlement’ approach would introduce substantial changes to existing entitlement regimes. In theory, net entitlement arrangements would also need to vary across areas, but this may escalate administration costs and raise equity concerns. Making such changes would require considerable community engagement.

Further information and stakeholder engagement is necessary before advances could be made in moving comprehensively from a gross to a net specification of entitlements. Such property right approaches also need to be assessed against other market-based or regulatory and planning-based approaches.

That said, there may be scope for the partial application of a net approach where some recognition of reduced return flows is accounted for in water entitlements and seasonal allocations. This may involve conservative estimates based on what information and modelling is available. Such an approach is being considered for the south–east region of South Australia by deeming an amount going to groundwater in calculating water available for allocation (South Australian Government, sub. DR79). A net entitlement approach is also used in California and Colorado in the United States of America (PC 2003) (box 2.6).

FINDING 2.4

Changes in return flows, and other changes in the movement of water resulting from land-use changes, need to be accounted for in entitlement specifications and/or resource management policies. Adaptive management and the use of interim measures are necessary in high priority areas.

Box 2.6 **Net water entitlements in the western United States**

In many states in the western United States, water use is governed by the doctrine of prior appropriation which allocates water on a 'first in time, first in right' basis. Water rights as defined by this doctrine involve the diversion of water from its natural location or course, and its application to a beneficial use (such as irrigation, mining and industrial application, stock watering, or domestic and municipal use).

In 1964, Arizona took California to court to dispute the prior right to water in the lower Colorado River — the principal water source for irrigation and domestic use in Arizona, southern California, and southern Nevada. This court case resulted in the Arizona v. California decree which established the water rights to the Colorado River. The decree defined consumptive use as diversions less return flows, or 'net' water use.

The United States Secretary of the Interior provides detailed and accurate records of diversions, return flows, and thus consumptive use for all water diverted from the mainstream of the lower Colorado River. The Bureau of Reclamation (a subdivision of the Department of the Interior) compiles annual reports on these measures. Return flows have two components — measured return flows and unmeasured return flows. Unmeasured return flows are estimated by multiplying measured return flows by a return flow factor. Consumptive use is then diversions (including groundwater pumping) less total return flows (measured and unmeasured return flows).

The Bureau of Reclamation is continuing to refine estimates of return flows and, hence, net consumptive use.

Sources: Castle 1999; Decree of the Supreme Court of the United States in Arizona v. California Dated 9 March 1964; U.S. Department of the Interior, Bureau of Reclamation 2005, 2006.

2.4 Conclusion

A variety of factors, both exogenous and endogenous to the actions of those making decisions on the use of water and land, have the potential to exert significant distributional effects on water use. These impacts are likely to be highly spatial — some rivers and reaches of rivers will be affected more than others. Property right and planning arrangements play a key role in influencing these distributional effects. A major concern in many catchments is that the current property right arrangements mean that these factors will have a significant effect on the availability of water for environmental flows. Further, given complex interlinkages, some water users will be affected more than others — for some users, water availability will increase while for others it will decrease.

In the Commission's view, there is insufficient recognition given to the implications of the integrated nature of water resources and effects of use by one water user on another. There are complex equity issues associated with these impacts and important efficiency questions of how unintended consequences might be best addressed.

Governments have taken several steps to help manage these changes, including agreeing to a framework for managing many of the risks associated with future changes in water availability for entitlement holders as part of the NWI (COAG 2004a). But more needs to be done. In particular, environmental flows are not included in the risk-sharing framework outlined in the NWI. Many third-party effects on entitlement holders are also not currently managed. Policy responses will require changes in institutional and property right arrangements, as well as additional market mechanisms and regulatory approaches where property right solutions are impractical.

Improving the integration of surface water and groundwater management, managing for changes in return flows and overland flows affected by farm dams and forestry plantations, are essential tasks for governments. While not simple or low cost, useful steps (such as improving information and water accounting systems, and use in some areas of caps on water use or the incorporation of aspects of a net entitlement approach) can be taken to improve existing arrangements and to set the foundation for future improvements. Priority areas for reform should be identified with interim and longer-term solutions investigated and, where appropriate, trialled and implemented. A cost–benefit framework should be used to guide policy making. In the Commission's view, governments should place high priority on further investigating the key factors affecting water availability and developing integrated property right responses.

3 Improving entitlement regimes

Key points

- Although there has already been significant reform, further opportunities remain to improve the specification and administration of some entitlement and seasonal allocation regimes.
- In particular, the Commission suggests governments and rural water utilities:
  – continue to simplify and unbundle entitlements where there are likely to be net benefits, including separating water entitlements from water-use approvals where that has not occurred, and considering the separation of rights in water delivery capacity and water shares in irrigation districts where congestion is a concern, including time dimensions where appropriate
  – facilitate greater flexibility for buyers and sellers in intertemporal water-use decisions — in doing so, governments and water utilities should give consideration to facilitating expanded carryover provisions or moving from traditional allocation systems to storage capacity share systems
  – build on reforms in other areas to reduce uncertainty regarding water entitlements and seasonal allocations, including improving information to irrigators on water available for seasonal allocations, and improving registration and titling arrangements.

Efficient and effective regimes for entitlements and seasonal allocations are fundamental to the economically efficient use and trading of rural water. These systems establish the basis on which irrigators and other existing or potential entitlement holders receive, hold or trade water, and have important implications for water-related farm management and investment. Governments across Australia have already undertaken significant reforms to rural water systems. A number of these reforms are outlined in the National Water Initiative (COAG 2004a). Water utilities have also introduced a number of changes.

However, scope for further improvement remains. Indeed, several aspects of existing entitlement and seasonal allocation regimes have been identified by participants in this study as constraining farmers' ability to make water-related decisions (including trading decisions) that could improve the economically efficient use of water (for example, CSIRO, sub. 24; Water for Rivers, sub. 48; Western Australian Farmers' Federation, sub. 15).

This chapter examines several of these potential impediments and considers market mechanisms (and other policy changes) that governments could introduce to improve existing entitlement and seasonal allocation regimes. Issues discussed include:

- simplifying water entitlements
- unbundling delivery capacity
- improving intertemporal water-use choices
- titling and registration arrangements.

3.1 Simplifying water entitlements

Some participants argued that the number and complexity of water entitlement types increase the costs of trading in entitlements, and may hinder the efficient use and movement of rural water (Engineers Australia, sub. 8; CSIRO, sub. 24).

The most important reform to date to simplify and facilitate water trading has been the unbundling (separating) of water entitlements from land titles (which is now complete in most jurisdictions). The additional unbundling of water entitlements and water-use licences has also occurred in some states to speed up approval processes associated with water trade.

There may also be scope to further simplify entitlements by reducing differences in language, removing purpose conditions and rationalising trading zones.

Unbundling water entitlements from water-use licences and approvals

Unbundling water entitlements from water-use approvals means that proposed trades in water entitlements may be approved more rapidly because the agency approving trades would not need to consider the impacts of using that water on the buyer’s land. This means, for example, that once an irrigator holds a licence to use water, water can be purchased without the need for further approval. It also means that a water-use licence holder can sell a part, or all, of their water entitlement while retaining their works and use approvals. This allows the water entitlement and use approval to perform their specific tasks without being tied to one another, and provides greater opportunity to trade entitlements and lower transaction costs with commensurate efficiency benefits.

Significant progress in unbundling water entitlements from use and works licences has occurred in New South Wales and Queensland, and Victoria is progressing its unbundling (which is due to be completed in July 2007). South Australia and Western Australia have yet to undertake this initiative. The Western Australian Government, however, has proposed the unbundling of water entitlements from site use and works approvals in its draft blueprint for water reform (Water Reform Implementation Committee 2006). Unbundling water entitlements and water-use and works approvals is a fundamental reform to facilitate trading, and governments that have yet to implement these changes should do so as a priority.

Further simplifying water entitlements

Some concerns over complexities in entitlement regimes relate to the number of different entitlement types available across Australia. The number of entitlement types in part reflects underlying differences in the specification of water resources. Some differences are unavoidable because their physical sources differ, and use rights differ as a result (such as rights to surface water and diversion entitlements). Other differences in entitlements can reflect different supply reliability, purposes attached to them, tenure, water-use conditions and zones where trades are allowed.

There are also differences in the language used across the states and territories to describe access rights to water. Water entitlements are termed a ‘water right’, a ‘licensed volume’ or a ‘licensed allocation’, and seasonal allocations are referred to as ‘announced allocations’, ‘licensed allocations’ or ‘temporary allocations’. Such differences are unlikely to contribute to clear trading and policy making. The National Water Initiative (NWI) has explicitly used water ‘access entitlements’ and ‘seasonal allocations’. State and territory governments could consider adopting consistent language to avoid unnecessary confusion.

Shi (2005) argued there is scope to simplify the system of entitlements to lower transaction costs. In addition to introducing standard terminology and continuing with the unbundling of use restrictions from water entitlements, Shi suggested converting existing entitlements into one or more standard types of entitlement (which could involve aligning entitlements with similar reliabilities and standardising tenure). Shi also suggested rationalising zone boundaries so that trading zones are defined solely by hydrological considerations. However, this would only rationalise trading zones in northern Victoria and the New South Wales River Murray regulated surface water system from 24 trading zones to 22.

There may be opportunities to reduce the number of types of entitlements by removing the specification of purpose as part of the entitlement. Defining an entitlement by use (such as rural, urban or industrial) reduces the flexibility of the entitlement and provides an additional unnecessary layer of complexity. Such reforms would be especially beneficial if restrictions on participation in rural water markets were removed (section 4.2, chapter 4).

Further rationalising the number of entitlement types, however, may not involve large gains. This is mainly because there are good reasons for some diversity in water entitlements. Moreover, most of the volume of water trade is in seasonal allocations rather than in water entitlements (appendix B), and it remains unclear how much trade has been inhibited by the large number of entitlement types.

There is a need to balance the advantages of simplifying and reducing the number of entitlements available with the fact that (as noted above) many differences in entitlements reflect differences in the supply characteristics across catchments (for example, rainfall, dam capacity, river flows and runoff). This was acknowledged by the South Australian Government:

> … altering regional rules and systems to account for the proper administration of trade is only part of the equation. These rules and systems need to primarily be compatible with the needs of the local environment and to take into consideration the local hydrology, landscape links and the biodiversity needs of the wider ecosystem. (sub. 36, pp. 8–9)

In the Murray–Darling Basin, for example, there are a number of regulated surface water, unregulated surface water and groundwater areas, plus potentially two levels of security, so it is reasonable to expect the existence of a number of different entitlement types. In some regions, for example, the Goulburn–Murray region, there are a number of sources of water with their own characteristics such that several entitlement types would be expected.

RECOMMENDATION 3.1

Unbundling water entitlements from water-use approvals should be completed by those jurisdictions that have not done so, as a matter of priority. There may be further opportunities to simplify the specification and reduce the number of types of water entitlements.

3.2 Unbundling delivery capacity

In addition to unbundling water entitlements from water-use approvals, there is the potential to unbundle water entitlements further to create distinct entitlements for delivery capacity, as is occurring in Victoria.

Delivery capacity entitlements would provide owners with a right to use the delivery infrastructure from the dam to the farm gate, and designate the levels of service that could be expected from a rural water utility. Owners could then sell water they are entitled to receive without also selling their entitlement to use delivery capacity. The Victorian Government is in the process of providing such an entitlement by unbundling water entitlements into water shares, delivery shares and a water-use licence through the *Water (Resources Management) Act 2005* (Victorian Government, sub. 39).

Separating delivery arrangements from entitlements to the water itself can offer several advantages, including:

- expanding the number of products available to be traded in the 'water market' (this could allow irrigators to arrange more timely delivery without having to purchase additional water)
- expanding the asset and risk management portfolio of entitlement owners — for example, owners could sell water entitlements to free up capital without losing access to the distribution system
- achieving environmental outcomes without environmental managers always needing to purchase both water and delivery capacity (potentially reducing costs) (chapters 7 and 8)
- potentially making delivery charges more transparent, allowing for greater variability in delivery charges, depending on location, perhaps based on zonal charging systems (chapter 5)
- providing a potential mechanism to help manage congestion and ration access to the distribution system.

Some participants argued that an entitlement to a tradeable delivery capacity share would help manage concerns over stranded assets if a charge is placed on the delivery share (negating the need for an exit fee). (A 'stranded asset' may occur when water is traded out of an irrigation area, leaving fewer irrigators to pay the fixed costs of infrastructure (section 4.4, chapter 4).) In this situation, owners of delivery entitlements would pay ongoing charges for the entitlement to delivery services (whether used or not). Unbundling may facilitate the decoupling of ongoing fixed costs from the volume of water traded. Water for Rivers, for example, argued:

> By rating on a delivery capacity share basis, the income base for the infrastructure owner is not at risk from water trade. The onus is on the landholder who is trading water out of a District to continue to pay for the delivery capacity or sell all or part of that capacity. (sub. 48, p. 5)

There could be two types of delivery entitlements — high and low security — which could be used to efficiently manage congestion, allowing those averse to risk to purchase the combination of high and low security entitlements that best matches their needs.

Delivery entitlements could also include a specific time dimension (in other words, delivery capacity could relate to particular months or periods of the year). Potential benefits include:

- providing utilities with another tool to manage their infrastructure and reduce congestion and associated costs
- providing greater flexibility for owners in selling part of their delivery entitlements — for example, owners may sell part of their delivery entitlement and use their remaining entitlement in 'non-peak' times such that their full allocation of water may still be delivered
- improving the reliability of delivery for particular entitlements held (which may be especially helpful for irrigators with water sensitive crops)
- allowing for the removal of some regulatory restrictions on trade that were introduced to manage hydrological constraints related to congestion issues.

Water for Rivers, for example, argued:

> This critical element, not considered in the initial model of unbundling, is the time dimension and this is the key to many aspects of management of the water resource … Changing the time dimension provides certainty and opportunity to all stakeholders. If the time dimension was reduced from one year to one month (initially), farmers could structure their delivery capacity with greater certainty of delivery for their particular crop and enterprise. As the available delivery capacity in any part of the system would be capped at design limits, delivery demands and disputes between infrastructure owners and irrigators would be minimised and market forces would determine allocation of delivery capacity share. (sub. 48, p. 5)

Separating delivery entitlements, however, is not without its costs. These include initial set-up costs (such as legal and institutional frameworks), and additional transaction costs associated with trading two (or more) entitlements rather than one. In districts where capacity constraints are not substantial, or where congestion costs across irrigators are largely homogeneous, these costs may outweigh the benefits. For example, in most of the Northern Territory and in parts of Queensland, there is a limited demand for irrigation water and delivery capacity (relative to its supply and availability) and water trade is limited. Hence, the benefits from unbundling entitlements in those regions would probably not outweigh the costs at present.

ABARE noted:

> While unbundling rights has benefits, managers should consider whether completely defining a property right is justified. In some cases, the costs of establishing,

> administering and enforcing unbundled rights might be prohibitive or the gains from trade in these rights might be small. (2005, p. 4)

In addition, there are alternative mechanisms to manage congestion in delivery apart from property right solutions. These include private contracts between water utilities and irrigators, and flexible administrative arrangements. While these approaches may not offer the benefits of trade, they may involve less set-up and transaction costs, and may be more appropriate for some systems. In Bundaberg, Queensland, for example, SunWater has established contractually-based rights in channel capacity with on- and off-peak arrangements introduced (SunWater, pers. comm., 10 May 2006).

The Victorian Government noted that separating rights to delivery capacity would not make a difference for many irrigators, but that its reforms provide an opportunity for efficiency gains where these are possible:

> For the majority of irrigators, the proposed refinements to rights will make no difference. They can choose to stay exactly as they are now. The reforms are about creating opportunities and choices (and so the potential for efficiencies and broad economic gains for regions and the State), not about compelling changes. (DSE 2004, p. 70)

Overall, it appears the use of congestion management tools is best determined at the irrigation district level. Governments, however, may usefully explore and, where appropriate, facilitate a full range of congestion management choices, including tradeable delivery entitlements.

FINDING 3.1

Unbundling water entitlements into tradeable water share and delivery share components may be beneficial in areas where there is substantial congestion of water delivery.

3.3 Improving intertemporal water-use choices

The economically efficient use of rural water requires efficient water use and trading decisions over time. Many entitlement and allocation systems in Australia currently limit farmers’ choices about water use and trade over time, especially between irrigation seasons.

Two areas of potential reform which may improve intertemporal water-use decisions include improved individual carryover provisions, and the use of storage capacity share arrangements with perpetual carryover and continuous accounting.

Individual carryover rules

Current arrangements for carrying over unused allocated water from one season to the next vary across jurisdictions and irrigation systems. In Victoria and South Australia, for example, carryover by individual irrigators is not allowed. In states where individual carryover is allowed (such as New South Wales and Queensland), arrangements vary significantly across districts. Some arrangements, for example, are based on a perpetual carryover capacity share approach, while others allow for a certain percentage of an entitlement to be carried over each year. As an example of percentage (annual) limits, carryover is allowed up to 50 per cent of total entitlement in the Murray Valley and up to 15 per cent in the Murrumbidgee and Coleambally districts (Coleambally Irrigation Co-operative, sub. 4).

Victoria currently has a form of shared (or 'communal') carryover through sales water. Sales water is water offered by utilities to irrigators in excess of, but proportional to, their entitlement, possibly as a result of unused seasonal allocations in the previous season or due to high rainfall. Importantly, because sales water is pooled (that is, allocated water not used in a season may be made available to all entitlement holders the following season), incentives for individual irrigators to efficiently manage water resources over time are reduced, compared with 'individual' carryover provisions. That is, incentives faced by irrigators to 'use it, trade it or lose it' are effectively the same as if no carryover existed. Sales water in Victoria is scheduled to be replaced in July 2007 by tradeable, low security water entitlements, with 20 per cent provided for environmental purposes (DSE 2005a). There are no carryover provisions for this new level of entitlement.

Existing carryover arrangements raise two issues relevant to the economic efficiency of rural water use:

- the absence or inflexibility of individual carryover provisions — which may reduce farmers' intertemporal water opportunities
- differences in carryover arrangements across districts.

Are carryover arrangements desirable?

The main advantages of individual entitlement holders being able to carry over water include improved intertemporal water choices and a better ability to manage the risks associated with changing seasonal conditions. In particular, it would avoid the problem of irrigators having to 'use it, trade it or lose it' which occurs in the absence of carryover or self-storage options.

Participants gave several examples of the ways in which allowing carryover can improve the economically efficient use of rural water:

> The increase in the use of carryover is a management strategy that has developed during this drought. Rice is the predominant crop in our region and it requires a substantial water allocation early in the season for the irrigator to warrant making the up front investment in the crop. This has not been forthcoming; so many irrigators have been restricting water usage one year and carrying it over so they can continue their profitable rice cropping programs. The use of carryover has also been used by the dairy and winter cereal growers to risk manage seasonal conditions for the following season. (Southern Riverina Irrigators, sub. 25, p. 2)

> With carryover of water and the shift to continuous accounting, there is less likelihood of boom/ bust behaviour. (NSW Government, sub. 41, p. 5)

> Autumn irrigation of annual pastures has stopped in New South Wales but continues in Victoria because there is no opportunity [in Victoria] to use water in the following spring or summer. (Watson 2005, p. 15)

> Carryover water was developed as a product on the basis that it provided a mechanism to irrigators with the capacity to make a decision to plant a reduced crop in low allocation years to carryover water to the subsequent year to enjoy economies of scale in the following year i.e. increase flexibility. (Coleambally Irrigation Co-operative, sub. 3, p. 39)

Some participants also highlighted the problems that can arise when restrictions on carryover are introduced. Fitzroy Basin Food and Fibre Association, for example, argued:

> One issue that significantly affects the efficient use of water in the Emerald Irrigation Area is the cap on carrying water over from one year to the next. Prior to the ROPS [Resource Operation Plans] process that the Fitzroy Basin has recently been through, irrigators were allowed to carry any unused irrigation water over from one year to the next, with a percentage subtracted to allow for evaporation from Fairbairn Dam. As a result irrigators had more choices as to what they could irrigate with their water, and could plan ahead by holding a surplus of water for future years. Having the cap has meant that irrigators with surplus water … have to use it or lose it, causing irrigators to grow crops that are not the most economically efficient, but they prefer to do that than lose their water for no benefit. (sub. 11, p. 4)

The benefits of allowing individual carryover vary, depending particularly on the relative reliability of supply (or security) of entitlements. In general, benefits from carryover are likely to be larger the greater the variability in seasonal allocations across seasons, the greater the water scarcity, and the more limited farmers' options are for storing or trading water. Supplying higher security entitlements or allowing carryover both have opportunity costs from a water storage perspective (appendix B). Carryover arrangements may also assist environmental managers achieve environmental goals (chapters 7 and 8).

Expanding carryover is not without its costs, and careful assignment of property rights and planning would be required to manage potential spills from dams and third-party effects. It can also change the reliability of future allocations as there may be less 'left over' water available at the end of a season. Indeed, there may be cases where the benefits of carryover to a district do not outweigh the costs of changing the rules and management system (which is likely when the benefits of carryover are low, perhaps due to an abundance of water). There may also be opportunities for utilities and individuals to create their own carryover arrangements by negotiating or purchasing access to additional dam capacity, thereby reducing the need for system-wide arrangements (although these arrangements may involve high transaction costs).

In general, however, prohibiting or banning a potentially efficient resource management response, such as individual carryover, is unlikely to be in the community's best interest, at least at the jurisdictional level. While carryover involves storage costs (including evaporation and seepage losses, and the risks of third-party impacts from dam spills), it is often more efficient to incorporate these losses into carryover provisions and storage management arrangements (including charges). Such arrangements would allow entitlement owners the choice of carrying water forward if they are prepared to bear the costs/risks.

Other restrictions on carryover, such as limits on the volumes or percentages of entitlements that can be carried over (for example, the 15 per cent of total entitlement limit in Coleambally and Murrumbidgee districts), and restrictions on the types of entitlements that allow carryover (for example, only allowing carryover on general security entitlements), can limit the benefits available from carryover and constrain intertemporal water-use choices. While arrangements may be needed to manage the risks associated with carryover rules, as discussed above, inflexible approaches that ignore seasonal conditions, dam capacity or the preferences and risk profiles of irrigators, are unlikely to be the most efficient approach. Rules could, for example, be responsive to available capacity and provide that the risks from spills are shared by those who choose to carry over.

However, to the extent that carryover provisions need to include limits or caps on the amount of water each irrigator can carry over, there may be benefits from allowing the trading of such 'rights' to carryover. That is, irrigators who have used their full seasonal allocation could sell their right to carryover for that year to an irrigator who wishes to carry over more than permitted under their own carryover right.

Overall, there are likely to be advantages from governments and utilities allowing individual entitlement holders to carry over water across seasons providing that appropriate (and flexible) management arrangements are in place. Carryover provisions can be added to announced allocation systems, as occurs in New South Wales, or provided for in capacity share arrangements (discussed below).

RECOMMENDATION 3.2

Governments and water utilities should enable entitlement holders, including environmental managers, to carry over water individually, with adjustments to allow for storage and evaporation losses. Appropriate charging for storage management and allocation structures will be required to address third-party impacts. Where feasible, rights to carry over could become tradeable.

Are differences in carryover rules a problem?

Some participants raised concerns that differences in carryover rules are causing inefficiencies. CSIRO, for example, argued that some carryover and borrowing rules vary and that this can impose high transaction and administrative costs:

> Inter-linked trading systems that allow some types of carry forward but do not treat all water in a dam under the same rules, tend to have much higher transaction costs and higher administrative costs. (sub. 24, p. 6)

The main concern is that regulatory differences can drive variations in the value of entitlements and add to the complexity of trading arrangements. These differences have also created opportunities for trading water across systems, which some participants suggested is inappropriate. Examples of such opportunities include irrigators in New South Wales purchasing water from irrigators in South Australia at the end of the irrigation season because they can carry over unused water but irrigators from South Australia cannot.

In relation to differences across carryover systems, two important points need highlighting:

- some differences can be necessary for the efficient management of water resources reflecting different hydrological, climatic and dam conditions
- trading because of differences in carryover rules is not necessarily a problem — indeed, in some cases, it can contribute to the efficient use of rural water by providing a response to more restrictive carryover provisions (which may exist either due to storage cost differences across districts or inflexibility in existing rules).

On the first point, there are often important differences across districts in storage infrastructure and evaporation losses, climatic features of the area, hydrology and different potential third-party impacts. Carryover rules need to take these features into account. This means that uniform carryover rules, such as rates of carryover or prices for storage, are unlikely to be appropriate. This does not deny, however, the potential benefits of adopting consistent principles to guide carryover provisions across districts to avoid unnecessary differences.

On the second point, trading because of differences in carryover rules can improve efficiency in the use of water by providing irrigators who cannot access carryover in their district — perhaps because of a lack of dam capacity or inflexibility in current arrangements — another option for managing water over time. In these cases, buyers and sellers would make their own assessments of the costs and benefits of such trades (including transaction costs). With that said, the third-party impacts of such trades would need to be managed. Also, such trading should not be used as an alternative to fundamental improvements in carryover rules where these offer net benefits.

Overall, if the costs to a district of implementing its own carryover arrangements were greater than any expected benefits, then taking advantage of carryover provisions in another jurisdiction may provide a least-cost approach to carrying forward unused seasonal allocations. Finally, in making changes to carryover provisions it is necessary to ensure water resource plans are updated and take account of anticipated changes in water movements.

FINDING 3.2

Uniform carryover arrangements across districts are unlikely to be appropriate given different water management objectives, storage capacity, evaporation losses and potential third-party impacts.

FINDING 3.3

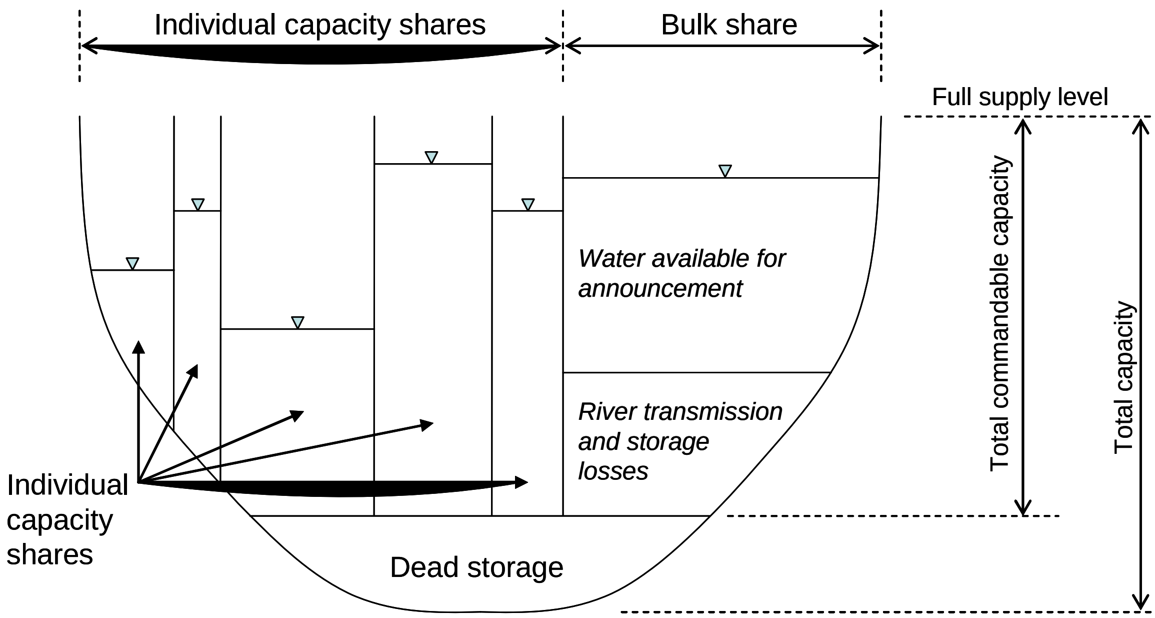
Trading unused seasonal allocations across districts may improve intertemporal water-use choices where carryover is not available in all districts.

Storage capacity share arrangements with continuous accounting and carryover

Another way of improving intertemporal water-use decisions is for water utilities to adopt storage capacity share arrangements, including continuous accounting and perpetual carryover, for managing controlled storages (mostly dams). Capacity sharing defines entitlements in terms of a share of dam capacity (not contents), and inflows and outflows (which include deductions for evaporation and seepage losses) (figure 3.1). Under a capacity share approach, entitlement holders — not water utilities (who instead keep records of withdrawals and net inflows) — determine releases from the dam. Different categories of entitlements could be created using different shares of inflows. A key benefit is that it can help irrigators act according to their own risk preferences when managing their water supply within, and across, seasons.

In Queensland, the state's major water utility, SunWater, has implemented a new capacity share approach to entitlements for its customers in the St George district. Following the success in St George, SunWater is considering replacing a number of traditional 'announced allocation' (or volume sharing) systems with alternative water sharing arrangements, including capacity share arrangements, in many of the irrigation districts it services (Thorstensen and Nayler 2005).

Figure 3.1 **Conceptualising capacity share**



Source: Ryan et al. 2000.

The key features of capacity share arrangements in St George are that existing entitlements (high and medium priority) are converted into an equivalent at-storage volume, and water available for users is calculated daily with water accounts provided once a month (box 3.1). Conversion from 'at the farm gate' volumes to storage shares is hydrologically determined, taking account of conveyance losses which depend on the location of water users. Carryover is perpetual.

Box 3.1 **Storage capacity share in St George, Queensland**

Since the 1970s, the distribution of water in Queensland has been through an annual announced allocation system where water users are entitled to use a share of the available water announced in proportion to their water entitlement/allocation. This included high and medium priority users. From July 2000, customers in St George were allowed to opt into a storage capacity share system. A bulk system still operates under the announced allocation approach for those not opting for the new system.

Under the capacity share system, users have access to a share of the total combined storage capacity in the scheme (rather than announced allocation), allowing for a share of losses and inflows, as follows:

Volume in share = previous volume – share of storage losses – withdrawal + share of inflows.

Key features of this storage capacity share arrangement include:

- Existing high and medium priority allocations are converted into an equivalent at-storage volume. This is hydrologically determined and takes account of conveyance losses depending on the location of water users.
- Water available for water users is calculated daily with water accounts provided once a month.

– Owners, therefore, assess the availability of water themselves at any point, based on the water in the share and their estimation of losses and the likelihood of inflows.

– Conveyance losses reflect (in part) the location of users and when they wish to extract. However, storage losses (for example, evaporation losses) and channel losses are shared equally between users.

– Water losses are calculated daily and taken from a user's account, although rates of loss are based on averages for each month (so loss rates vary across months but not days).

– Water is accessible within one day. Under the old announced allocation system, any new inflows would not be available until the announced allocation was revised. When ordering water, SunWater checks that sufficient water is available in the account, and that it does not exceed the usage limit (or resource cap).

– Online business transactions, including water trading, were incorporated into the system in 2005.

- Resource caps apply to the amount available for extraction, set at 100 per cent of the water allocation (entitlement) plus 20 per cent if irrigators have used less than their full capacity the previous year. This is to manage third-party effects.

Source: SunWater 2006.

In the case of St George, capacity share arrangements have been complemented with continuous accounting (where irrigators are kept informed of their water balances on a continuous basis, much like a bank account). Capacity share arrangements do not have to incorporate continuous accounting, but their complementarity is strong for two reasons. First, capacity share arrangements allow irrigators to manage their own water supply decisions, and continuous accounting provides information to help irrigators in making these decisions. Second, providing information on the probabilities of water available to irrigators is easier under a capacity share approach than under volume sharing because it would not be necessary to know all other irrigators' demand over the season (Dudley and Musgrave 1988).

A storage capacity share system (incorporating continuous accounting) has a number of advantages for irrigators, compared with traditional allocation systems which are used in most large-scale surface water irrigation districts across Australia. If water becomes more scarce, these benefits may be particularly important to capture. The potential benefits of introducing capacity share arrangements, compared with traditional allocation systems, include:

- greater flexibility in water management arrangements because water estimates are calculated on a daily basis and carryover is perpetual
- greater certainty in water availability, which assists irrigators to manage supply risks and production decisions — because each user's available water does not depend on periodic announcements made by utilities but, rather, on a pre-determined share of dam space with continuous updates on water levels provided
- expanded water use and trading opportunities, as under the traditional announced allocation system, irrigators have to wait until allocations are announced to trade seasonal water (unless forward contracts are used)
- activities of one user are isolated from those of another, hence some third-party impacts are minimised (Dudley 1992).

The extent and magnitude of these relative benefits will depend on the features of traditional allocation systems, the characteristics of the relevant catchments and dams, and the nature of irrigation activities. Some of these advantages are lessened, for example, when frequent allocation announcements are made and carryover is allowed in traditional allocation systems. The benefits would also be much lower if there were only a few entitlement owners in a system — capacity share arrangements would not be applicable for the Snowy Mountain Scheme, for example. Further, storage capacity share arrangements would be more easily implemented in some regions than in others. For example, Murray Irrigation stated:

> Storage capacity sharing for entitlement holders is more easily implemented where water resources are not shared between states. (sub. DR92, p. 11)

Further, when there are significant groundwater/surface water linkages, capacity share arrangements may need adjusting, which can add to the complexity of the system (given most capacity share arrangements are based on a share of a dam rather than of the water system as a whole).

On the other hand, if flexibility and certainty regarding water management is highly valued — which may increasingly be the case if water becomes more valuable as a resource — the benefits of capacity share arrangements are likely to increase, at least in some areas.

There are also opportunity costs associated with moving towards this type of system. Set-up and transitional costs would be incurred as new systems are designed and implemented. Irrigators would also have to adjust to a new system. SunWater, for example, noted that the initial set-up costs for the St George capacity share arrangements were high, although substantial savings due to reduced ongoing management costs are now being achieved. In addition, SunWater has commenced implementing capacity sharing in a second scheme (the MacIntyre Brook Water Supply Scheme). SunWater has found that the set-up costs in this second scheme have been significantly lower due to the investments already made in the systems developed in St George, and the lessons learned from it (SunWater, pers. comm., 10 May 2006).

In addition, there may be greater risks of dam spills, especially in districts with limited excess storage capacity. In these systems, continuous accounting and perpetual carryover allowances could increase the risks of dam spillage and evaporation losses unless appropriate rules are in place. For example, in many districts in Victoria, dams are already near capacity for some of the year and changing to a capacity share arrangement could have significant costs, particularly in terms of spillage.

There may be cost-effective management options that would minimise these risks, such as creating buffer capacity or additional incentives for entitlement holders to draw down balances when dams are nearing capacity. In some cases, there may not be much need for additional management because entitlement holders have an incentive not to store water beyond their capacity entitlement because they would lose any additional water inflow. Moreover, it would be possible for other parties that may be affected by dam spills to purchase dam capacity to mitigate the risk of spillages. A benefit of this would be that the cost to other parties from dam spills could be more accurately revealed.

Gaining the confidence of irrigators (and, in the case of New South Wales, support of water utility shareholders) would enhance political feasibility. In the case of

St George, irrigators were given the option of swapping to a capacity share system or remaining in the traditional announced allocation system. As of 2005, approximately 90 per cent of eligible customers had moved to capacity share arrangements, representing almost all of the water under management (Thorstensen and Nayler 2005). This may be a useful model for further implementation of capacity share arrangements.

RECOMMENDATION 3.3

For many storage systems, storage capacity share arrangements offer entitlement holders the ability to better manage the storage and use of water to which they are entitled. Governments and rural water utilities should provide for storage capacity share arrangements where the benefits exceed the costs.

3.4 Security of entitlements

As noted in chapter 2, uncertainty surrounding current and future water entitlements, seasonal allocations and available extractions may adversely influence water use and trade, and investment in irrigation activities. Participants have argued that the emergence of a water market will not in itself be able to 'fix' all the underlying problems of uncertainty associated with current entitlement arrangements. Australian Dairy Farmers, for example, noted:

> Markets for water will not function effectively without clear ownership rights having been negotiated and without appropriate allocation of [water] systems in the first place … markets will not address the uncertainty of ownership and allocation that still exists in some systems. (sub. 12, p. 6)

Irrigators face uncertainty in relation to some water entitlements and seasonal allocations.

Uncertainty regarding water entitlements

In addition to the factors which can threaten water availability for entitlement holders identified in chapter 2, other potential sources of uncertainty regarding the value of water entitlements are:

- changes in government policy (sovereign risk)
- inadequacies in titling systems to register entitlements.

Changes in government policy

Changes in government policy have received considerable attention in the water reform process, with past changes in government policies — actual and perceived — having increased uncertainty regarding the ownership of entitlements. In particular, government initiatives that have used institutional measures to redistribute irrigation water to environmental uses have often decreased either the amount of water available under each entitlement or the security of that entitlement. The Water Steering Group for Horticulture Australia, for example, stated that, where reliability of, and access to, water entitlements is reduced through policy decisions and where compensation 'has not occurred in the past it has diminished water property rights and confidence' (sub. 32, p. 1).

Risks associated with changing government policies can influence longer-term decisions in relation to water and farm investments, insurance and water trade. For example, the Winemakers' Federation of Australia highlighted that uncertainty can result in additional insurance measures being undertaken at a cost to irrigators:

> Many grapegrowers will choose to keep extra water entitlement as a form of risk management … [because] there is a fear that governments might be tempted to unilaterally reduce water entitlements to meet environmental flows targets. (sub. 13, p. 6)

However, the goal of improving certainty in relation to changes in government policy needs to be balanced against that of flexibility and other costs associated with improving certainty (including supply and management costs). In the end, it is likely that there will be an optimal level of uncertainty remaining. The challenge is in striking an efficient and equitable balance. The Natural Resource Management Ministerial Council's Chief Executive Officers' Group on Water noted to the Council of Australian Governments:

> There is very significant economic value in having stable entitlements to water, but at the same time there must be processes to protect the environment, including needs that emerge in the future. (NRMMC 2003, p. 8)

Issues of risk sharing were discussed further in chapter 2.

Water title arrangements

Titling systems perform two main functions. They:

- facilitate the enforcement of property rights — providing assurances to the holder to encourage investment in the property and to financiers that loans are secure

- facilitate trade — buyers need to be confident they will gain secure rights if they purchase a title, and titling needs to provide a cost effective way of facilitating changes in ownership (Woolston 2005).

In performing these functions, titling systems need to be able to cater for future developments in market transactions (such as derivative products) and further unbundling (such as of delivery entitlements). Desirable characteristics include ease and timeliness in transacting trades (including part trades) and the ability to mortgage titles.

There are essentially two broad types of titling systems:

- recording systems or registers of deeds
- registration systems or registers of rights — the Torrens system applied to land and CHESS (Clearing House Electronic Subregister System) for company shares are examples.

Some participants (for example, High Catchment Committee, sub. 7 and Australian Spatial Information Business Association, sub. 27) argued that existing water title arrangements are inadequate.

ACIL Tasman in association with Freehills, commented:

> Existing water-licence registers maintained by responsible authorities originally constituted a record of licences. Such 'Old title' registers provide an appropriate way of recording and administering statutory-based privileges. However, as water entitlements are developing into divisible, tradeable and often highly valuable assets, and are being de-linked from 'Torrens title' land titles, registration systems now have an additional purpose — providing certainty of title and facilitating trading markets. (2004, p. 7)

The Australian Spatial Information Business Association (sub. 27) argued for adoption of the recommendation of ACIL Tasman in association with Freehills:

> … that a Torrens-based system be adopted in relation to water rights, as it provides a much higher level of certainty of title to those dealing with the water entitlement and will ultimately be the most appropriate way of facilitating trading and investment. (2004, p. 56)

A key principle in the Torrens system is that a person who becomes the registered proprietor of the land obtains an 'indefeasible' title. Woolston explained:

> … this means that the registered proprietor's title in that land cannot be affected or defeated by any existing estates or interests, other than registered interests that are noted in the Register. The register is intended to provide a record of all dealings with respect to particular land. (2005, p. 81)

Arguments have been made both in favour of, and against, the use of Torrens title systems. The main advantages of a Torrens-based system are that such a system is well respected and understood, and provides good security to title holders, which can both encourage trade and facilitate the borrowing of finance against such assets. In particular, it can reduce the transaction costs in verifying a title and provide for the registration of interests (including mortgages) with a state guarantee of title.

With regard to borrowing against entitlement assets, it has been argued that a Torrens system is superior to a statutory-based registration system because of the 'indefeasible' right it provides. As noted above, this 'right' means that the owner's title cannot be affected by existing interests (other than registered interests noted in the register) and a purchaser or creditor only has to search the register to identify the state (and history) of the title (ACIL Tasman in association with Freehills 2004). The titles recorded in this system are guaranteed by the relevant government and offer protection against possible fraudulent activity or the mismanagement of registered interests. With the value of water entitlements exceeding the value of land in many areas (especially in the Murray–Darling Basin), arguments for water titles to be as protected as land titles do not appear unreasonable.

Arguments against the use of Torrens-based systems include the greater difficulty of dividing a water entitlement, compared with more flexible statutory-based title systems, increasing the costs associated with splitting and part-selling an entitlement. These difficulties reflect requirements for subdivision for splitting property rights under a Torrens system. Where mortgages have been applied to a title, additional processes are required. The Allen Consulting Group noted:

> Where mortgages are held over the entitlement, the process is significantly more laborious and requires removing a mortgage off the title, splitting the entitlement share, selling the share then remortgaging the other part. (2006, p. 14)

Innovations to avoid difficulties in selling part of an entitlement and meeting requirements of subdivision include dividing entitlements into sub-units such that mortgages could be placed on some units but not others (which could then be traded without needing mortgagor approval), and seeking pre-approval from banks to sell entitlements (at least up to pre-agreed levels). Coleambally Irrigation Co-operative noted the first of these ideas is already in practice:

> Irrigation Corporations do not need to subdivide water entitlements as one share = one megalitre of entitlement. If an irrigator wishes to permanently transfer part of their water entitlement the Irrigation Corporation issues a new updated share and water entitlement certificate. It is not unusual for members to have separate share and water entitlement certificates for different parcels of water. (sub. DR64, p. 35)

There have also been concerns that a land-based Torrens system with indefeasibility is inappropriate for water entitlements because governments may wish to retain power to cancel or vary seasonal allocations under an entitlement. However, Woolston commented:

> … a clear distinction must be made between the titling/registration aspect of water entitlements and the management of the resource. If the entitlement is based around specified shares of a resource, the issue of indefeasibility is quite separate from the issue as to whether compensation should be paid for attenuation of entitlements. A clear title to a share of the available resource is not a guarantee to a defined volume of water in perpetuity. (2005, p. 89)

The Australian Property Institute (NSW Division) and Australian Spatial Information Business Association similarly emphasised that the indefeasibility linked with a state guarantee of title does not guarantee the volume of an entitlement but 'merely provide[s] protection against fraud and other misdealings in water entitlements as is the case in land property' (sub. DR88, p. 13).

This does, however, raise the separate issue of compensation for the cancellation of a water entitlement, which can include compensation for the market value of an entitlement or other aspects of compensation to cover additional losses associated with the cancellation. The Australian Property Institute (NSW Division) and Australian Spatial Information Business Association stated:

> … compensation due to resource users in every State water management regime urgently requires clarification, in order that the market place can be confident that funds invested in water access entitlements are protected from abrogation by the State except on payment of full compensation. (sub. DR88, p. 13)

The Commission agrees that frameworks for the provision or otherwise of compensation resulting from the taking back of water entitlements should be transparent. A lack of clarity can unnecessarily reduce investor confidence and adversely affect the economically efficient use of water. Whether compensation should be paid or not, and how much, however, is a matter of cost sharing for governments to determine.

Registers are in different forms and at various stages of implementation in Australia, with some states adopting systems similar to the Torrens land title system, while others have titles managed by departments responsible for water management, or land title offices (Woolston 2005). Irrigation schemes also maintain their own registers.

Participants held different views regarding whether registers should be centralised at the state level, or decentralised with water utilities managing registers. Coleambally Irrigation Co-operative (CICL), for example, argued that greater timeliness and accuracy is achieved when irrigation utilities manage registers:

> CICL expressed the view that existing central registers at present suffered from inherent delays with dealings and high error rates. CICL's register by way of example facilitates dealings to a timeframe of 48 hours, and since registers are linked to billing, has a much higher accuracy level. CICL proposed that registers be maintained at the local level and take on a structure/architecture that allowed them to be rolled up at a State level to facilitate public access. (sub. DR64, p. 4)

On the other hand, the Australian Property Institute (NSW Division) and Australian Spatial Information Business Association argued in favour of centralised title registers:

> It is also our view that centralized title registers should be created by each State rather than decentralized registers, which have apparently been proposed by some wholesale licence holders in NSW irrigation areas. Decentralisation of registers would result in even more complexity and greater difficulty in ascertaining sales data to ensure transparency in valuation. (sub. DR88, p. 8)

The appropriate choice of system depends on weighing up the relative benefits and costs of alternative systems. In the case of assessing the Torrens system, for example, the costs of governments providing a state guarantee and the potentially slower splitting of titles needs to be compared to the benefits that may be expected from public and investor confidence in such systems. Efforts to adopt a flexible variant of a Torrens system, which allows for government guarantees of title and easier splitting of entitlements, may prove worthwhile. Lessons could be learnt from the CHESS registration process, which is highly flexible and credible.

Regardless, improved public accessibility of water entitlement registers is likely to contribute to market efficiency by helping buyers and lenders to verify titles in a timely and inexpensive manner (Woolston 2005). Online searching of land titles already exists. It is also important to have registration and titling processes across the states and territories that recognise each other (to facilitate cross-border trades).

Further work is needed to conclude which system would be most appropriate. An impartial and consultative review of specific options would appear beneficial to explore opportunities for improvements and ease confusion over possible directions, especially given divergent views on some issues. Such a review should include all the states and territories and engage the finance community on its views regarding the risks or otherwise of non-Torrens-based title systems and opportunities to learn from the CHESS registration system.

Uncertainty over seasonal allocations

Another issue that increases uncertainty is the announced allocation system of water supply which operates in most irrigation districts. More specifically, infrequent announcements on upcoming and future allocations can add uncertainty over water availability. This may hinder farmers' ability to make investment and farm planning decisions because they have little certainty over one of their major inputs to production. These issues are fundamentally related to the management decisions of the water utility.

Management options, such as more frequent and pre-scheduled allocation announcements, and supporting information on likely future water availability, may assist in reducing this uncertainty by providing greater information to irrigators. The Water Steering Group for Horticulture Australia recommended water utilities 'make explicit and regularly report the reliability of water to users (probability of annual allocations in the short term and long term)' (sub. 32, p. 1). It also stated:

> Water shares should specify both expected volume and reliability. Changes in future expectations in volume or reliability should be publicised by water resource managers to all entitlement holders. (sub. 32, p. 5)
>
> Where water allocation processes are used water managers should provide estimates to growers of the future probability of percentage allocation increases. This should be an indicator of future water availability with explicit adjustments for carryover, high priority rights, minimum and expected inflows and environmental flow commitments. (sub. 32, p. 8–9)

Where feasible, continuous accounting may also improve information to irrigators on water availability. Continuous accounting provides owners with individual accounts which increase and decrease as water availability changes and water is withdrawn. Other more fundamental reforms, such as using a storage capacity share with continuous accounting (as used in St George), could also increase certainty, as discussed above.

FINDING 3.4

Where capacity sharing is not feasible, more frequent and pre-scheduled allocation announcements and/or continuous accounting would improve information to irrigators on likely water availability and, thereby, assist water-use and investment decisions.

Other initiatives to ease uncertainty

In addition to the measures highlighted above, many uncertainty issues will be eased if entitlements are simplified, streamlined, unbundled and re-specified, and credible risk sharing and property right arrangements are adopted that better reflect the connected nature of water resources.

To complement reforms in these areas, governments could:

- Seek to finalise reforms to entitlement and trade frameworks promptly, recognising that freer markets provide more opportunities for participants. As markets develop and familiarity with them increases, uncertainty over water markets should ease and products to help manage risks (such as option contracts) will become more widely available.
- Provide, and negotiate with stakeholders, clear frameworks for managing changes to entitlements that may be necessary to meet changing circumstances, emerging information or exceptional circumstances, and ensure these are honoured.
- Improve the accountability of demands for environmental services — for example, environmental managers, where publicly funded, should provide clear information on their objectives and intentions for achieving environmental goals.
- Provide further information on the water reform process and on its progress, and support the provision of balanced information on the effects of water trading. This could be usefully coupled with information on adjustment programs.

Many of these activities would not impose substantial costs on governments, utilities or water users, and are likely to be effective in easing uncertainty (at least over time).

4 Reducing constraints on water trade

Key points

- Water trade is extensive in many regions in rural Australia and is already facilitating the continual movement of water to its most highly valued uses. While regulatory and administrative constraints on water trade are being reduced, some constraints remain that impede economic efficiency.
- Constraints on trade, and their impact on economic efficiency, vary considerably across regions and types of water products.
  - Trade in seasonal allocations is reasonably unconstrained in most regions.
  - Water trade across regions is more constrained than water trade within regions.
  - Constraints are generally greater for trade in water entitlements than for trade in seasonal allocations.
- Governments should undertake a number of reforms to reduce constraints on water trade. In particular, governments and, where appropriate, water utilities should:
  - relax current restrictions on who can participate in water markets
  - transparently review, and where appropriate, remove remaining regulatory restrictions on trade in seasonal allocations and water entitlements
  - remove limits on trade in entitlements out of a district
  - remove exit fees: although immediate removal is preferred, a three-phased transition could be adopted where, initially, limits are placed on exit fees (phase 1), exit fees are then decoupled from entitlements (phase 2) and, finally, competitive charging regimes are adopted which provide a more appropriate basis for infrastructure service charging (phase 3)
  - review fees associated with trading seasonal allocations and water entitlements
  - introduce transparent processes and mandatory timelines for approving water trades.
- Structural adjustment issues are better addressed through existing safety-net and rural adjustment programs, and/or additional targeted assistance where appropriate, than through restrictions on water trade.
- While a relatively free seasonal allocation market, and the emergence of new water products (such as leases and forward contracts), may help to reduce the costs of restrictions on trade in water entitlements, reform is still needed.

Water markets and the associated trading of water can improve the economically efficient use of rural water. Trading can reveal the opportunity cost of water to the community — that is, the benefit forgone by not using water in its best alternative use — and, through mutually beneficial trades, facilitate the movement of water to regions and for uses where it is most highly valued. Water markets have expanded considerably over the past decade and water trading, in seasonal allocations in particular, is widespread in many irrigation areas (appendix B).

However, as noted in chapters 2 and 3, limitations of current arrangements governing water entitlements and allocations — such as a lack of integration in water management systems, poor water accounting systems and the number and complexity of entitlement types — constrain water trade. Other potential constraints on water trade reflect nonregulatory or regulatory and administrative characteristics of the water market. Such constraints can unnecessarily hinder the economically efficient use of rural water.

Nonregulatory constraints, such as hydrological constraints, limited market participation and social constraints, are often a product of inherent characteristics of water or the water market. For example, water trade requires connected (natural or built) infrastructure to facilitate the movement of water from the seller to the buyer. In many cases, it may not currently be feasible to remove nonregulatory constraints. These issues are discussed in section 4.1.

Regulatory and administrative arrangements can constrain water trade within and between irrigation districts, as well as between types of users. Such constraints exist at both the state and district level, and are imposed by either state or territory governments, or water utilities (including irrigation companies or irrigation cooperatives). Constraints can involve trading rules and zones, measures imposed to address stranded assets and other costs associated with structural adjustment, inefficient institutional arrangements, excessive charges or slow approval processes.

Regulatory and administrative constraints include:

- restrictions on who can participate in water markets (section 4.2)
- constraints on trade in seasonal allocations (section 4.3)
- constraints on trade in water entitlements (section 4.4)
- constraints on trade in groundwater (section 4.5).

The efficiency impacts of such constraints differ depending on their nature, extent and location. In general, the adverse economic impacts of constraints on water trade are likely to be greatest where:

- there are large differences in the water needs and valuations of water across water users and regions

- water is relatively scarce, additional water is often needed, and alternative sources are not readily available.

In other words, constraints on water trade will have the greatest impact where the potential benefits from trade are greatest.

In general, with the exception of restrictions in some jurisdictions on who can participate in water trade, trade in seasonal allocations is relatively unconstrained. Trade in water entitlements is generally more constrained than trade in seasonal allocations.

Many remaining constraints are to be addressed through commitments made under the National Water Initiative (NWI) (COAG 2004a). For example, signatories are committed to:

- 'establish by 2007 compatible institutional and regulatory arrangements that facilitate intra and interstate trade, and manage differences in entitlement reliability, supply losses, supply source constraints, trading between systems, and cap requirements' (COAG 2004a, clause 60)
- remove institutional barriers to trade in seasonal allocations
- relax, and eventually remove, limits on the volume of trade in water entitlements out of an irrigation district.

4.1 Nonregulatory constraints

Nonregulatory constraints on water trade include hydrological factors, transaction costs, limited market participation, inadequate market information and social constraints.

Hydrological constraints

Hydrological factors, such as the paths of rivers, limit where and when water can be used and traded. Many catchments in Queensland, for example, are not connected and so trade is restricted to schemes within a catchment (Queensland Government, sub. 38).

Hydrological limitations do not usually represent market failures or economic inefficiencies that warrant a policy response. They are more commonly viewed as 'realities of the natural environment'. Nevertheless, investment is sometimes undertaken in infrastructure that connects previously separated water resources. For example, the Snowy Mountains Scheme diverted water from the Snowy River that would have flowed east of the Great Dividing Range, but now flows into the Murray and Murrumbidgee rivers, west of the Great Dividing Range. There are also many smaller scale cases — some relying on gravity and others on pumping — involving the diversion of water using races and pipes.

Proposals for making physical connections between water resources usually have environmental, social and political dimensions as well as an economic one. There is a role for governments to resolve competing views on such proposals, and the greatest value from water and the associated infrastructure investment will be achieved where a cost-benefit framework is used.

It should be noted that a hydrological connection is not a sufficient condition for water trade to occur. Water captured in the Thompson River dam, for example, is shared by irrigators and others in Gippsland and by Melbourne water users. This sharing is done by regulatory means with no provision for water trade between those with rights to water in Gippsland and the Melbourne water system. Thus, even when the physical conditions for a market in water are met, institutional arrangements are necessary for a market to exist.

Transaction costs

Transaction costs include the initial set-up costs of establishing or subsequently reforming a market, often incurred by governments, and ongoing costs involved in conducting trades, generally incurred by traders (see The Allen Consulting Group 2006 for more detail).

Where they reflect the resource costs of establishing, changing or operating markets, transaction costs do not give rise to economic inefficiencies in the use or trade of water. Such economic costs, including the costs of brokerage services or environmental assessments, appropriately influence market behaviour — even if this means less trade than would otherwise occur. Hence, transaction costs in themselves do not necessitate a policy response.

However, overly complex trading rules and restrictions may unnecessarily increase transaction costs and may require review and, where appropriate, reduction or removal (see subsequent sections). Watson, for example, noted:

> Existing restrictions add substantially to the transaction costs of trade. Fixed transactions costs fall heavily on small water trades. Large buyers and sellers have brokers acting on their behalf to handle the paper work. Getting rid of some restrictions on trade is a question of equity as well as economic efficiency. (2005, p. 15)

Further, some transaction costs may be excessive — they may exceed the costs of running a market and the minimum necessary resource costs for approving a trade. They may, therefore, distort market outcomes. Some government taxes, approval activities or utility charges may fall into this category (sections 4.3, 4.4 and 5.2).

Market participation

The number of participants and the volume of water traded in a market are determined by the supply and demand for water, and by any restrictions on participation in water trade. A small number of buyers and sellers in a market may, therefore, reflect adequate existing water allocations relative to demand; homogeneous production, such that water demands are similar across irrigation activities, reducing opportunities for mutually beneficial trade; the inability to transfer water cost-effectively between potential buyers and sellers; or restrictions on participation in water trade, including for environmental purposes.

In many parts of Western Australia, Queensland and the Northern Territory, for example, water is not fully allocated and water users do not need to purchase additional water from other entitlement holders. Indeed, in the Ord Irrigation District in Western Australia, only 2 per cent of available irrigation water is currently being used (Western Australian Farmers' Federation, pers. comm., 24 February 2006). Similarly, the Northern Territory Horticulture Association stated:

> At current levels of development, water supplies in the Northern Territory are generally considered plentiful relative to demand. As a result, there is little, if any, demand for water trading and there has been no trade in licensed water entitlements. (sub. 51, p. 2)

While a small number of participants in a market may hinder competition and increase transaction costs, the Commission has received little evidence of market power being exercised in water markets.

Inadequate market information

Some participants — for example, the Australian Bureau of Statistics (sub. 17), the Australian Competition and Consumer Commission (ACCC) (sub. 42) and CSIRO (sub. 24) — raised concerns about water brokers and governments not being required to register or share information that is useful to buyers and sellers, such as prices of recent trades and trading rules. Waterfind, for example, stated:

> Market transparency is critical to the development of any market and in particular to the development of the water market. Waterfind is particularly concerned about the lack of pricing transparency in various water markets throughout Australia. Sale, date, volume, price and movement (selling and buying trading zones) are factors which assist

> water buyers and sellers to make informed water transfer decisions and provide banks with the appropriate information to base their financing and business equity decisions. (pers. comm., 28 April 2006)

The Winemakers' Federation of Australia also observed that a lack of information on the price of water entitlements may impede market participation and investment:

> Another barrier to trade is the lack of information about water trades, particularly the prices at which permanent entitlements are traded. This makes it difficult for valuers to estimate the value of water entitlements and makes it more difficult for financial institutions to use the entitlement as an asset against which irrigators can borrow. (sub. 13, p. 5)

In developing a 'user-friendly' water market, the Natural Resource Management Ministerial Council's Chief Executive Officers' Group on Water argued for:

> … publicly accessible entitlement registers, which are inter-operable and conform with privacy standards [and] publicly available market information on price, volumes for sale, volumes required by buyers, etc. (NRMMC 2003, p. 13)

Trading facilities — which provide information on historic trade data, trading rules, administrative and regulatory requirements, and other trading possibilities, including leasing, forward contracts and options — are emerging as the water market matures, and significant gains have been made in recent years. Online trading facilities managed by Waterfind (national), Waterexchange (national), Watermove (Victoria and southern New South Wales) and SunWater (parts of Queensland), for example, provide various information relevant to trading water (table 4.1).

While online water brokers are helping to inform water traders, gaps remain in data collected at an aggregated level. In some regions in Victoria, for example, water traders may use Watermove, Waterfind, Waterexchange, an independent water broker, or private negotiation to facilitate water trading. For water entitlements, sales may also occur in conjunction with the transfer of land. Hence, it can be difficult to determine the prices paid and volumes traded in a region or jurisdiction in aggregate, across all sources.

The Australian Property Institute (NSW Division) and the Australian Spatial Information Business Association argued for a verifiable national sales database which is electronic, current, and comprehensive, which will help valuers understand the history and dynamics of the water market (sub. DR88).

Table 4.1 **Information provided by online water brokerages**

	Watermove	*Waterexchange*	*Waterfind*	*SunWater*[a]
Maps and zone boundaries	Provided	Provided	Zone boundaries are identified[b]	Not provided[c]
Trading rules	Provided	Site contains a web link to the relevant rules	Rules are incorporated into the system	Rules are incorporated into the system
Trading fees	Provided	Provided	Provided	Trading is at no charge
Prices and volumes	Provided	Provided	Available to registered users[d]	Provided
Historic trades	Provided	Provided	Available to registered users[d]	Provided
Buyer alerts	Provided	Provided	Available to registered users[d]	An email is sent to buyers when they are outbid
Net movement of trades over time	Not provided	Provided by request for non-commercial purposes	Not provided	Not provided

[a] SunWater only facilitates seasonal allocation trades using a pooled system. [b] Interactive maps are not included so that internet users with a slower connection are not disadvantaged. [c] As the exchange is based on a pooled system, zone based restrictions do not apply and maps would not aid exchange. [d] Registration is completed online and takes up to two business days for approval.

Sources: Peadon, B., Waterexchange, pers. comm., 19 July 2006; SunWater 2006; Waterexchange 2006; Waterfind 2006; Watermove 2006.

The NWI has committed signatories to ensuring adequate market information is provided to water market participants. This is being progressed largely at the state and territory level. For example, Victoria is introducing a new water register to provide web-based information on all water entitlements in Victoria (Victorian Government, sub. 39). The Queensland Government also noted:

> Prices paid for water allocations are publicly available and the sales information can be obtained at NR&M [Department of Natural Resources and Mines (Qld)] service centres throughout Queensland. The NR&M website also has summary information on water trading. (sub. 38, p. 12)
>
> Options for reporting water trading statistics online, are under consideration. NR&M will be publishing periodic reports on the departmental web site. Such information will include the locations of where water has shifted and the price paid per megalitre. This information will be provided on a scheme-by-scheme or water management area basis (i.e. for both supplemented and unsupplemented supply). (sub. 38, p. 13)

Improving the information available on water trades through trading databases and the development of registers generates a range of costs and benefits. These costs and benefits will largely be determined by the maturity and size of the water market in the serviced area. While a number of databases and registers are emerging and a 'one size fits all' model is unlikely to be appropriate, it is important that registers are compatible (chapter 3).

Some participants also argued for the registration of brokers to ensure market participants are protected (for example, NSW Irrigators' Council, sub. DR87). In general, the registration or regulation of professions is undertaken when there is a need to take proactive regulatory steps to minimise fraudulent and misleading advice, especially in the case of asymmetric information or knowledge. This need may occur when the chances of being mislead or the consequences of such are sufficiently severe; the reputation-based incentives on the agents to provide appropriate services are relatively weak; and the ability to, or costs of, seeking adequate redress are sufficiently unreasonable as to justify the additional regulatory costs. However, given the existence of general legislative protections under fair trading laws, growing transparency of the water market, and increasing experience of those trading water, there does not appear a strong case for additional regulation at this stage.

Social constraints

Some participants — for example, First Mildura Irrigation Trust (sub. 6), Australian Dairy Farmers (sub. 12) and JD Brooke (sub. 10) — expressed the view that trading water entitlements can be harmful for the water exporting community.

A research study undertaken by Fenton (2006) for the North Central Catchment Management Authority (Victoria) found that such views exist in the North Central Catchment, and may be limiting trade in water entitlements in this region. The study, based on in-depth interviews in Kerang, Cohuna, Lockington and Boort in northern Victoria, found that some people in those communities considered that trading water entitlements had either negative or mixed consequences for exporting communities, and that, in some cases, social pressure was placed on sellers and potential sellers not to trade.

The results of that study cannot necessarily be generalised across the wider community, and no evidence was found that decisions were actually changed as a result of social pressures. If such views were widespread, however, and if trading decisions were considered to be distorted by false and/or misleading information, there may be an impediment to trade that justifies policy intervention, provided the benefits of intervention outweigh the costs.

4.2 Restrictions on who can participate

A number of restrictions currently limit participation in water markets. In some jurisdictions, for example, legislation prohibits the purchasing of water by government agencies and non-landholders. Such restrictions, along with policies discouraging particular organisations from participating in water trade, can represent substantial barriers to trade, and can reduce the economic efficiency of water use by limiting its movement to those who value it most highly.

Restrictions vary across jurisdictions and districts, with changes underway in some to reduce restrictions on who can participate in water trade. In Victoria, for example, ownership of water is currently restricted to people who own or occupy land that has access to individual water entitlements, and government agencies (including state-owned water utilities). From 1 July 2007, non-water users will be able to purchase water, but this will be limited to a maximum of 10 per cent of the maximum volume of entitlement (for water shares of that class) in the particular water system. ('Water shares', which are defined in section 3.2, chapter 3, are counted as being held by water users if they are linked to land that can be irrigated, or can in some other way use the water — for example, for a piggery — and that is owned or occupied by the owner of the water shares (DSE 2004).) In Queensland, tradeable water access entitlements (other than interim entitlements, see below) can be held or traded by anyone, including non-landholders.

Participation in water markets is also influenced by jurisdictions' progress in implementing (or creating) the legislative arrangements to separate water entitlements from land (chapter 3). In Queensland, for example, 'old' existing water entitlements are in the process of being converted to tradeable water access entitlements, separate from land (these are called 'water allocations'). In several regions interim 'water allocations' are in operation until the Resource Operations Plans are completed and entitlements are converted to water allocations. Restrictions on participation in water trade differ for interim water allocations and for water allocations (Queensland Department of Natural Resources, Mines and Water, pers. comm., 24 July 2006). Western Australia is in the process of creating new legislation to put into effect commitments made by signing to the NWI, including the full separation of water entitlements from land.

Hydrological constraints may also limit participation in water trade (section 4.1). While these constraints may limit some urban–rural water trade, opportunities for trade remain. Water Services Association of Australia, for example, stated:

> What is not widely understood is that, with the exception of Sydney, the other capital cities in Australia have opportunities to trade water with the agricultural sector without the need to build any infrastructure. There are further opportunities to create greater

inter-connection between rural and urban water systems with minor capital works. Compared to other options such as desalination and recycling, water trading is very attractive from both a financial and environmental perspective. (sub. 5, p. 2)

Benefits from expanding participation

Prohibiting or discouraging potential users — such as environmental managers, environmental associations, metropolitan and regional urban water users, and mining and power generation industries — from market participation precludes disclosure of the true value of alternative water uses, and restricts the benefits that the community as a whole can gain from water use.

As observed in other markets, barriers to entry:

- reduce competition and, with it, innovation and productivity improvements
- reduce heterogeneity of demand and therefore reduce the opportunity for mutually beneficial trades and lower transaction costs
- discriminate against those excluded.

Several participants — for example, the Australasian Bottled Water Institute (sub. 26), the ACCC (sub. 42), Watson (2005) and Water Services Association of Australia (sub. 5) — expressed concerns about current rules and regulations that preclude market participation by representatives of the environment (chapter 6), the urban sector and particular industry users. The Australian Conservation Foundation argued that '[t]he flexibility that water trading offers irrigators should also be available to the environment' (sub. 45, p. 6).

As noted in subsequent chapters, many environmental goals could be achieved more effectively and/or at lower cost to the community — and, in a number of cases, to irrigators — if environmental managers could use a broad mix of instruments including the buying and selling of seasonal allocations, water entitlements and derivative water products, such as leases and option contracts. Appropriate governance arrangements for environmental managers would be needed, however, to avoid the potential use of market power or to manage conflict between government's role as a regulator and a market participant (section 6.3, chapter 6). Environmental managers should pay relevant delivery costs and related charges, as should all other participants in the water market.

Urban–rural water trade may be highly beneficial where the costs (to metropolitan or regional urban water utilities) of other means of sourcing additional water, or restricting water use, are large, and where hydrological connectivity between urban and rural systems exists or can be achieved at low cost. Investments in water desalination and recycling projects, for example, can often involve considerable costs and, sometimes, community resistance.

Water trade is likely to be especially important when water allocations provided through planning processes are insufficient to meet the demands of different water users — including water required for environmental purposes.

Potential effects on irrigators and rural communities

Some irrigators and representatives from irrigation communities are opposed to non-irrigators purchasing rural water (Victorian Farmers Federation, sub. DR80; Byrne, O'Brien, Eagle and McDonald, sub. DR83; Shire of Campaspe, sub. DR70). One claim has been that freeing water trade to include all potential market participants will result in substantial increases in water prices, which could threaten the viability of irrigated agriculture in some areas. Some participants — for example, Australian Dairy Farmers (sub. 12) and Victorian Farmers Federation (sub. 49) — raised concerns about the purchasing power of growing urban regions and governments buying water on behalf of the broader community to achieve environmental outcomes.

There are several potential effects on irrigators and irrigation communities from freeing up water trade, including expanded opportunities to buy and sell water, price changes, and the expansion and contraction of irrigation activity across areas. The two main areas of contention appear to be the potential impacts on water prices and the effects on regional and local economies.

The Victorian Department of Sustainability and the Environment stated:

> There is concern in the irrigation community that non-irrigators could buy up much of the water and drive up its price. The Government believes this risk is more imagined than real. No water will be available to buy unless irrigators choose to sell. In the long-term, the price of water will be based on the value people generate from actually using it. (DSE 2004, p. 69)

The price effects of freer participation in water markets by the urban sector will depend on the extent of trade and the relative size of the water markets between which trade is occurring. Dwyer et al. (2005) examined the effects of trade between urban and rural users in the southern Murray–Darling Basin. They observed:

> … when large areas such as Melbourne trade with relatively small rural areas such as Gippsland or Goulburn–Murray, Melbourne consumers dictate the direction and extent of the price changes, leading to rural areas selling water. When the smaller urban areas, such as Adelaide and Canberra, trade with large rural areas, such as the Murrumbidgee and Murray regions, the smaller urban areas do not affect the regional price to any great

extent, causing smaller quantities of water to move in trade and lower regional price effects. (Dwyer et al. 2005, p. 12)

Overall, rural regions are remarkably resilient to change. Irrigators are able to substitute inputs into production and adjust production outputs and practices, reducing impacts on rural communities. Dwyer et al. (2005) found impacts on regional gross product from allowing rural and urban sectors to trade water in south–east Australia under circumstances of reduced water availability in urban areas were generally small. In the full trade scenario (which allows unrestricted water trade between regions that could be connected with some infrastructure development — Melbourne, Adelaide, Canberra, rural regions in the southern Murray–Darling Basin, and Gippsland), the reduction in gross regional product from a 10 per cent reduction in urban and rural water supply was 0.23 per cent for south–east mainland Australia, with no region showing losses greater than 1.52 per cent.

Watson argued:

> With around 70 per cent of water extracted from regulated rivers and streams used for irrigation and around ten per cent for urban use, modest transfers of water to cities or towns could not seriously jeopardise irrigation. Instead, profitable opportunities for trade would arise that would benefit irrigators, individually and collectively. (2005, p. 7)

While the impact of environmental managers being able to participate in rural water markets was not explicitly considered, Peterson et al. (2004) showed that a 10 per cent reduction in water available for irrigation purposes in the southern Murray–Darling Basin (representing approximately 500 gigalitres of water), with trade within and between districts allowed, only reduced gross regional product for the region as a whole by around 0.5 per cent, with the largest regional decline occurring in the Murray region in New South Wales with a fall of 1.21 per cent. If environmental managers attained this amount of water by purchasing water from willing sellers, the economic impacts would be more favourable for irrigators, and the resulting effects on regional gross product less, as they would receive revenue from their sales.

Indeed, not all irrigators or irrigator representative groups are opposed to allowing environmental managers to participate in the water market. The South Australian Farmers Federation, for example, stated that such a reform could benefit irrigators:

> Allowing EMSPs [Environmental Managers and Service Providers] to develop portfolios of water and related products, can have obvious benefits for irrigators, to derive additional income through leasing, options and contracts with environmental managers, and the environment, providing flexibility to access short term water to meet immediate environmental requirements. The Federation would also be particularly favourable to environmental managers having the ability to trade water to industry.

> Again, the benefits could be significant to irrigators and the environment. (sub. DR77, p. 2)

Additionally, if environment managers were able to participate in the water market, many purchases, at least for some environmental flow objectives, are likely to be counter-cyclical — in other words, demand for water will be highest when water levels are high and water prices are generally low. This is also when water demand is generally low so the price effects are likely to be small for most irrigators.

The entrance of 'speculators' or 'water barons' into the market, and the subsequent inflation of entitlement prices, has been raised as another concern (Byrne, O'Brien, Eagle and McDonald, sub. DR83; Water Reform Implementation Committee 2006). 'Speculators', however, are likely to add liquidity to the market and it is unlikely that they, or 'water barons', could impact on prices substantially as this would require them to assert market power. On this issue, the ACCC noted:

> … there is no evidence to suggest that this form of conduct [asserting market power], if possible, is more likely from non landholders or non water users. Limiting the water holdings of these parties will not prevent speculation by current landholders/water users. (sub. 42, p. 3)

Moreover, the use of market power by any participant in the water market would fall within the ambit of general competition and fair trading policies which operate across Australia.

Further, any sustained rise in the price of water due to the entry of new participants into the water market will be reflected in a higher value for entitlements, which will increase the net worth of water utilities.

All this is not to deny that expanding who can participate in water trade may have significant impacts in some areas. This may give rise to concerns over the extent of adjustment pressure experienced by a local community. Nevertheless, in considering adjustment issues (negative and positive) arising from allowing more groups to participate in rural water markets, it is likely that such adjustment will be small compared to the net effects of other factors, including commodity prices and technological change.

Moving forward

The benefits of expanding who can participate in rural water trade are likely to be large — especially if environmental managers and urban water utilities are given greater ability to trade. Governments should therefore seek to remove remaining restrictions on who can participate in rural water markets. This will assist jurisdictions in fulfilling their obligations under the NWI to remove institutional barriers to trade, and to broaden and deepen the water market.

Practical issues to be managed in moving forward include resolving design and implementation issues involved in the expanded participation by environmental managers, and considering where substantial adjustment may occur. Governments should consider any adjustment issues in a manner consistent with adjustment policies applying more broadly in the economy. These are important issues to resolve to achieve efficient and effective policy implementation and broader community acceptance to change.

RECOMMENDATION 4.1

Restrictions on who can participate in water trade should be relaxed or removed to improve the economically efficient use of rural water.

4.3 Constraints on trade in seasonal allocations

Trade in seasonal allocations is relatively free in most of the larger irrigation districts and many of the restrictions that remain reflect hydrological realities. There are fewer regulatory and administrative constraints on trade in seasonal allocations than for trade in water entitlements, and trade within a district is less constrained than interdistrict trade. Nevertheless, there remain regulatory and administrative constraints on trade in seasonal allocations, and there is often a lack of transparency regarding these.

Regulatory and administrative constraints on trade in seasonal allocations can include:

- trading rules
- government taxes, fees and processes
- fees for brokerage services.

Trading rules

A number of trading rules are imposed on seasonal allocations at the state and irrigation district level. While there are very few of these within an irrigation district, they are likely to constrain trade between some districts.

Signatories to the NWI are already in the process of removing a number of restrictions on trade in seasonal allocations. The NWI binds signatories to the 'immediate removal of [existing institutional] barriers to temporary trade' (COAG

2004a, clause 60), though no details are provided on which rules may represent barriers and should be removed.

Murrumbidgee Horticulture Council stated:

> … trade restrictions continue to hinder the market. In particular timing restrictions and inconsistencies between the rules of irrigation corporations continue to undermine confidence in water trade. (sub. 37, p. 2)

Further, in the 2005 assessment of water reform for New South Wales, the National Water Commission 'identified a number of trading rules in water sharing plans that … could pose a considerable barrier to the expansion of water markets in some systems' (NWC 2006a, p. 2.36). These rules are imposed by the New South Wales Government and include:

- the prohibition of trade (in seasonal allocations and water entitlements) between regulated and unregulated rivers
- in the Murray and Lower Darling river valleys in 2004-05, high security entitlements (that were converted from general security entitlements) could not be traded (as seasonal allocations or water entitlements) for five years from the date of conversion
- in the Murrumbidgee irrigation area, seasonal allocations from high security licences cannot be traded after 1 September, and seasonal allocations from general security licences cannot be traded after the end of February.

Murray Irrigation also stated:

> Our customers are particularly frustrated by what appear to be artificial limits placed on annual water trade by other state jurisdictions, NSW Trusts, other NSW Irrigation corporations and even NSW State-endorsed Water sharing plans in the Murrumbidgee Valley. These often appear as convoluted barriers intending [to] protect continuation of socialised under use, unfair cap management, lower local market prices, protection of over use and other local quirks. (sub. 55, p. 3)

Trading rules include restrictions on trade across zones, rules for environmental or hydrological purposes, restrictions on interstate trade, closing dates for trade, and intention to sell requirements. These are discussed below.

Trading zones

Zones are used to determine where seasonal allocations can and cannot be traded, and at what times. In some regions, trade is restricted to within a prescribed zone. The ACCC raised the concern that some trading zones may have been set arbitrarily and may unnecessarily restrict trade in some regions:

Queensland and South Australia’s water resource plans often prohibit trade between defined management zones. Concerns have been raised regarding the arbitrary nature and large number of these zones in both states. For example, South Australian management zones were originally created for administrative reasons. (sub. 42, p. 4)

The Queensland Department of Natural Resources, Mines and Water, however, stated:

… there are only as many zones as are necessary to be able to administer trading rules that are designed to protect environmental flows and the security of water entitlements. In Queensland, the design and number of the zones is based on scientific modeling and is not arbitrary. (sub. DR85, p. 4)

Notwithstanding this, there are many rules that relate to the trading of seasonal allocations between zones. These rules can often be viewed on the relevant water trading site (for example, Watermove) or are integrated into the web-based trading system (as is the case with Waterfind).

Examples of restrictions on trading between zones include the following zone rules for Greater Goulburn, Victoria:

- Sellers will be able to sell to Zone 4A Campaspe or Zone 5A Loddon up to the volume that has been previously traded from these zones.
- Limits may apply to net trade out of Zone 1B Boort.
- Trade from Zone 3 Lower Goulburn may be possible after December in some seasons (Watermove 2006).

Some zoning restrictions have been imposed as a means of limiting any environmental externalities resulting from water trade. In particular, trade into salinity-affected zones is often restricted through prohibitions (in the highest salinity impact zones) or levies and offsets (in more moderate impact zones). This is the case in salinity-affected regions in Victoria and South Australia, where zones are defined using extensive scientific modelling (chapter 10). The South Australian Government stated:

While this will act as a cost constraint on trade, it also manages the salinity impact of the area in a way that gives irrigators more options than would pure regulatory alternatives. (sub. 36, p. 6)

There may be some scope to liberalise trade between expanded zones, or to distinguish time periods when trade is and is not allowed. Ideally, zones should be based on hydrological or environmental considerations. Restrictions should be periodically reviewed and removed if not justified.

Rules imposed for environmental or hydrological considerations

As mentioned above, many zone rules are imposed for environmental or hydrological purposes. There are many other rules imposed for such purposes, including rules to manage trade through specific congestion points or specific environmental conditions. A number of rules restrict water flows through the Barmah Choke, for example. The New South Wales Water Allocation Plan for the Murray and Lower Darling River Valleys 2004-05 specified:

> No inter-valley trades will be allowed where additional water will be required to be delivered downstream of the Barmah Choke to the South Australian border during periods of peak demand. (DIPNR 2005, p. 15)

Victorian irrigators are also subject to restrictions on trade through the Barmah Choke. However, such rules are often imposed asymmetrically and may hinder economic efficiency. The New South Wales restriction listed above, for example, prohibits water delivered downstream of the Barmah Choke even when upstream trade means that less water is being delivered through the Choke and the reciprocal amount could be traded downstream with no net congestion impacts.

Other restrictions imposed in the New South Wales Water Allocation Plan for the Murray and Lower Darling River Valleys 2004-05 reflect environmental conditions such as extended drought:

> Due to the low water availability in the Murrumbidgee River valley at the start of the 2004-2005 season, there will be no temporary (annual) trades into this valley unless a return trade of the same or greater volume has taken place. (DIPNR 2005, p. 15)
>
> Inter-valley trades will not be allowed into, or out of, the Lower Darling River Valley, above Ashvale, until the storage volumes in the Menindee Lakes increases above 640 gigalitres. (DIPNR 2005, p. 15)

While some of these restrictions may be the most effective means of addressing hydrological conditions or environmental concerns relating to water trade, in other cases these concerns may be more effectively and transparently addressed through other policy approaches (chapters 7 through 10).

Closing dates and intention to sell requirements

Other constraints on trade in seasonal allocations relate to different closing dates for water trades:

- Murrumbidgee Irrigation does not allow interdistrict and interstate trades after 31 January and after 28 February for intradistrict trades (Murrumbidgee Horticulture Council, sub. 37). This restriction is included in the Water Sharing

Plan for the Murrumbidgee Regulated River Water Source (amended 1 July 2004) and is hence imposed and enforced by the New South Wales Government.

- Murray Irrigation closes trading on 31 May (Southern Riverina Irrigators, sub. 25).
- Victoria does not allow water to trade to New South Wales after 28 February each year (Southern Riverina Irrigators, sub. 25). This restriction is enforced to try to minimise opportunities for arbitrage which arise due to differences in carryover provisions between the states.

Murrumbidgee Horticulture Council stated:

> … timing restrictions are market limiting and skew prices. Irrigators are required to make decisions on water use very early in the season and consequently trade volumes are conservative. Water that is not activated for use or trade cannot go to its most productive use. In an open market this water could be traded at any time through out the season including to other water users (for use or carry over) or to the environment. (sub. 37, p. 2)

The National Water Commission found:

> For the most part, Victoria has effective arrangements for temporary trade; however, it continues to impose a late-season ban on temporary transfers into New South Wales, due to divergent arrangements for carry over of allocations. The [National Water] Commission acknowledges Victoria's concerns that allowing such trades would transgress competitive neutrality as a trading principle. Nevertheless, the [National Water] Commission considers this restriction to be inconsistent with Victoria's COAG commitment to establish compatible institutional and regulatory arrangements with other jurisdictions that facilitate interstate trade. (NWC 2006a, p. 3.30)

Further, closing dates often give preference to intradistrict trade (over interdistrict or interstate trade), as intradistrict trading closing dates are frequently later than those for trade into or from another district or state. While closing dates may be useful from a management and planning perspective, the lack of consistency between closing dates may form an unnecessary impediment to trade in seasonal allocations, especially between districts.

There are also 'intention to sell' requirements in the rules governing the activation of Murrumbidgee Irrigation seasonal allocations. This requires that irrigators wishing to sell high security water must notify their intention by 1 August in the new irrigation season, and within two weeks of the allocation announcement for general security water. Further, the maximum allowable intent to trade is 75 per cent of the base allocation (or 75 per cent of the average individual's cap based on the average valley cap less 5 per cent for environmental flows). Murray Irrigation (sub. 55) and Murrumbidgee Horticulture Council (sub. 37) noted that intention to sell requirements hindered trade in seasonal allocations trading out of the Murrumbidgee Irrigation Area, and reduced the flexibility available to irrigators in managing water resources.

Intention to sell requirements and maximum allowable intent to trade rules are used by Murrumbidgee Irrigation to ensure that water usage in its district is consistent with the Murray–Darling Basin Cap, less irrigator contributions to environmental flows. This gives individual irrigators incentives to activate their seasonal allocation, for use or trade, in a way that is consistent with the valley cap less environmental flows. This individualised cap responsibility helps to ensure district-wide compliance. Murrumbidgee Irrigation observed that this is an equitable way to prevent third-party impacts from water use in excess of the Cap (Murrumbidgee Irrigation, pers. comm., 24 May 2006). These rules are currently under review.

Assessment of trading rules

Some participants have argued that trade in seasonal allocations in most districts (for trade within and between districts) is relatively free. Coleambally Irrigation Co-operative stated that '[t]here are no restrictions on temporary (annual) trade within, into or out of the CID [Coleambally Irrigation District]' (sub. 3, p. 37). Further, Murray Irrigation stated that it places no restrictions on trading seasonal allocations (sub. 55).

However, a number of participants — for example, Murray Irrigation (sub. 55), Murrumbidgee Horticulture Council (sub. 37), the ACCC (sub. 42) and Southern Riverina Irrigators (sub. 25) — have identified trading rules that constrain trade in seasonal allocations. Murray Irrigation, for example, stated:

> We acknowledge that there are physical limitations on the delivery capacity of the river systems, including the Tumut Choke in the Murrumbidgee and Barmah Choke on the Murray River. However, in addition to physical constraints, we believe rules within the Murrumbidgee water plan and additional rules implemented by Murrumbidgee Irrigation and GMW [Goulburn–Murray Water] in Victoria complicate and restrict annual trading. (sub. 55, p. 3)

One problem in assessing remaining constraints on trading seasonal allocations is that the purpose of, and justification for, many trading rules is not clearly stated. Hence, it is often difficult to determine whether trading rules are imposed for legitimate hydrological considerations and environmental concerns or for other purposes. The number of rules and the lack of transparency surrounding them is likely to reduce the amount of trade in seasonal allocations.

It appears that (to date) many restrictions have been imposed with little consideration of their net benefit, or to alternative mechanisms that may better achieve governments' or utilities' objectives. Other market mechanisms that may be more appropriate than trade restrictions for achieving environmental goals are discussed in chapters 7 through 10.

The Commission is of the view that all remaining restrictions on trade in water allocations should be removed, except where they prove on review to be the most effective and efficient means of reflecting a hydrological reality or achieving a stated environmental objective. Any remaining restrictions should be imposed transparently with their objectives clearly stated.

RECOMMENDATION 4.2

Each jurisdiction should conduct a public review of remaining restrictions on trade in seasonal allocations. Those which do not generate net public benefits should be removed. Timetables for review should be transparent, and progress and findings publicly reported.

Fees and approval times

Where administrative processes and related fees and charges do not reflect reasonable resource costs, these may act as an unnecessary constraint to trade in seasonal allocations. Administrative processes and fees can include:

- state government fees and charges
- approval time lags
- brokerage fees.

Two examples of the possible costs of such fees and charges are provided in box 4.1.

Box 4.1 **Examples of fees and taxes for selling a seasonal allocation**

Example 1: Trading in the River Murray, South Australia

For a parcel of 100 megalitres valued at $42 per megalitre, the value of the trade, before fees and tax are paid, would be $4200. If the trade was to proceed using Waterexchange:

- application fees of $519 would be payable to the South Australian Government
- brokerage fees of $105 would be payable to Waterexchange, equal to 2.5 per cent of the value of the sale (minimum of $50, maximum of $750)
- income tax would be payable on the proceeds of the transfer.

Hence, total fees would amount to $624 and the total amount that would transfer to the seller would be $3576 (excluding income tax). In this example, fees amount to 15 per cent of the total value of the trade.

Example 2: Trading in the Murrumbidgee, New South Wales

For a parcel of 100 megalitres valued at $30 per megalitre, the value of the trade, before fees and tax are paid, would be $3000. If the trade was to proceed using Waterexchange:

- application fees of $75 would be payable to the New South Wales Government
- brokerage fees of $75 would be payable to Waterexchange, equal to 2.5 per cent of the value of the sale (minimum of $50, maximum of $750)
- income tax would be payable on the proceeds of the transfer.

Hence, total fees would amount to $150 and the total amount that would transfer to the seller would be $2850 (excluding income tax). In this example, fees amount to 5 per cent of the total value of the trade.

Sources: South Australian Department of Water, Land, Biodiversity and Conservation, pers. comm., 20 July 2006; Waterexchange 2006; The Allen Consulting Group 2006.

The following section discusses the cost components involved in transacting a seasonal allocation trade.

State government fees and charges

State governments impose a number of fees and charges for processing and assessing a seasonal allocation trade. Administrative processing fees, in particular, vary substantially across districts. CSIRO (sub. 24), for example, noted the cost of undertaking a trade in a seasonal allocation is as high as $750 in some regions, compared with no charge in other regions. Table 4.2 compares four regions — costs in the River Murray district in South Australia stand out at $519.

Table 4.2 **State government fees for trade in seasonal allocations**

Region	*Application and approval fees*
NSW — Murrumbidgee Valley[a]	$25 flat fee plus $1 per megalitre, up to a maximum fee of $75.
Qld — Emerald Irrigation Area	No approval required within 'supplemented' systems. Trades managed by SunWater at no cost to the customer. Application fee of $111.80 for unsupplemented water.
Vic. — Goulburn–Broken	$65 fee for transfer application, payed to Goulburn–Murray Water.
SA — River Murray	$519 flat fee.[b]

[a] Excludes Murrumbidgee Irrigation Corporation channel system, which operates an internal trading system which is not subject to government fees for internal trades. [b] This fee applies to trades that require a technical assessment. If a technical assessment is not required, fees are $311 and only cover the cost of administration.

Sources: South Australian Department of Water, Land, Biodiversity and Conservation, pers. comm., 20 July 2006; The Allen Consulting Group 2006.

The Winemakers' Federation of Australia (sub. 13) also identified South Australia as having higher fees for administering trades, noting administrative costs are between 400 and 750 per cent higher in South Australia than in New South Wales and Victoria. Fees of $519 in South Australia cover the costs of administration and a technical assessment of the use of the water to determine salinity, hydrogeological and other local impacts and, in some areas such as the River Murray, to ensure the proposed application of water meets water-use efficiency requirements. The South Australian Department of Water, Land and Biodiversity Conservation believed technical assessments are required for seasonal allocation trades (not just entitlement trades) as many of these seasonal allocation trades are made each year to permanent plantings (South Australian Department of Water, Land and Biodiversity Conservation, pers. comm., 20 July 2006). Hence, the effects of these trades may be as significant as for water entitlement trades. Because water entitlements and use licences are still bundled together in South Australia, when a 'taking' allocation (which allows for the use of water) is traded, site use issues are considered in the same process.

South Australia is considering unbundling entitlements and creating separate use licences. It is likely that such reforms would reduce transaction costs as site use issues may not need to be considered each time water is traded. Full implementation of these reforms is not likely until the end of 2007 or mid-2008, however, so the South Australian Government may review transaction costs prior to this (South

Australian Department of Water, Land and Biodiversity Conservation, pers. comm., 20 July 2006).

Approval times

The time taken to transact and approve a trade in a seasonal allocation is typically short, ranging from one to seven days (table 4.3).

Longer approval times may reduce a farmer's ability to react in the short term. For example, if rainfall is received between applying for a trade and receiving approval, this may negate the need for additional irrigation water. While the time frames in table 4.3 do not appear unreasonable in most areas, there may be scope to reduce assessment times in some regions.

Table 4.3 **Typical time for regulatory approvals for trade in seasonal allocations**

Region	*Time*
NSW — Murrumbidgee Valley[a]	3 days
Qld — Emerald Irrigation Area	1 day
Vic. — Goulburn–Broken	1 day
SA — River Murray	5–7 days

[a] Excludes Murrumbidgee Irrigation Corporation channel system which operates an internal trading system.

Source: Adapted from The Allen Consulting Group (2006).

Fees for brokerage services

As noted in section 4.1, electronic trading systems are well established in many regions. These include Watermove (provided by Goulburn–Murray Water, a government-owned water utility), SunWaterOnline (provided by SunWater, a government-owned water utility), Waterfind and Waterexchange (both privately owned corporations). Each of these systems provides a different level of brokerage services and has a different charging structure (table 4.4).

Some participants raised concerns about undercharging for brokerage services provided by government-owned organisations. While lower fees will tend to increase the volume traded, where brokerage fees are artificially low, economic efficiency is reduced. Government provision of water brokerage services for free, or below cost, may conceal the true cost of trading and crowd out private provision of brokerage services and trader innovation.

FINDING 4.1

More efficient private sector service providers can be crowded out when existing government-funded water exchange charges are not consistent with the principles of competitive neutrality.

Table 4.4 **Fees charged by major brokerage firms for trade in seasonal allocations**

Brokerage	*Service*	*Fee*
Watermove (Victoria)	For trade in Victoria in zones where trading rules have been defined. Traders submit offers and trade occurs each Thursday using a pooled price.	Buyer pays $55 per trade plus GST. Seller pays 3 per cent of total value plus GST, a minimum fee of $55 up to a total fee of $550.
Waterexchange (National)	Operates a 'direct negotiation' system where participants register their intents, and prices are determined through direct negotiation between buyers and sellers.	Seller pays 2.5 per cent of total value, minimum of $50, maximum of $750.
Waterfind (National)	Registered users submit trade offers and prices are determined through direct negotiation between buyers and sellers.	Buyer pays 1.5 per cent of total value. Seller pays 3 per cent of total value.
SunWater (Queensland)	SunWater customers place offers to buy or sell a volume of water within a scheme-based exchange. Uses a pooled price system which clears fortnightly.	Free to SunWater customers.

Sources: SunWater 2006; The Allen Consulting Group 2006; Watermove 2006.

Assessment of fees and approval times for trade in seasonal allocations

Fees, approval times and brokerage fees vary depending on where trades occur and who facilitates the trade. While the Commission has not conducted an inclusive assessment of fees and approval times for trade in seasonal allocations, government fees and approval times appear significantly greater in South Australia than in New South Wales, Victoria and Queensland. This was reflected in a summary of transaction costs provided by The Allen Consulting Group (2006), who found that, for trade in seasonal allocations, for an average traded volume of 60 megalitres and an average value of $40 per megalitre, transaction costs as a percentage of the value traded represent:

- 3.1 per cent in New South Wales
- 2.7 per cent in Victoria
- 2.5 per cent in Queensland
- 21.0 per cent in South Australia.

While South Australian fees and approval times may be higher and take longer, fees and approval times in other states appear reasonable and are unlikely to unnecessarily constrain trade. Similarly, while brokerage fees vary, they do not seem substantial enough to prevent efficient trade and appear comparable with fees for stock market transactions. CommSec (2006), for example, has charges which range from $19.95 to $66.00 for share trades less than $10 000, depending on the level of service, in a much more active market.

The structure and magnitude of fees is likely to influence decisions on what volumes to trade in seasonal allocations. Where fees have a large fixed cost component in particular, smaller volumes are less likely to be traded. Even where fees are largely variable, higher fees are likely to constrain trades of smaller volumes.

The Commission considers there is scope in some jurisdictions to streamline the approval process for trade in seasonal allocations. An electronic trading system, incorporating required government approvals, could facilitate quicker and more transparent water trade and could reduce transaction costs. The Natural Resource Management Ministerial Council's Chief Executive Officers' Group on Water observed, for example, that developments could include:

> … rapid approval mechanisms to enable trades to take place; rigorous approval and audit procedures to maintain market integrity and confidence; and purpose-designed, user-friendly, water entitlement exchanges which are timely, cost-effective and transparent. (NRMMC 2003, p. 13)

Governments should endeavour to develop benchmarks for acceptable approval times and costs, with transparent performance reporting.

RECOMMENDATION 4.3

The National Water Commission and States and Territories should consider benchmarking approval processes, and associated costs involved in trading seasonal allocations, against best practice. Independent performance reviews should be conducted periodically.

4.4 Constraints on trade in water entitlements

Regulatory and administrative constraints on trade in entitlements include constraints imposed to address concerns over stranded assets, including limits on outward trade and exit fees; other trading rules; the lack of an appropriate system to account for trading different entitlement types; and taxes, fees and approval times.

Constraints on trading water entitlements out of an irrigation district

Trade in water entitlements can result in a permanent net trade of water out of an irrigation district. If utility costs are unchanged and shared between a smaller number of entitlements, charges for remaining irrigators may increase. This may lead to more irrigators trading water out of the region and, ultimately, the utility may no longer provide irrigation water to the assets, and the infrastructure may cease to be used. Heaney et al. (2005) identified that such assets (so-called 'stranded assets') can include:

- dams and diversion works
- major channels and diversion infrastructure
- local channel and delivery works
- on-farm irrigation delivery systems
- other on-farm infrastructure assets associated with irrigation activity.

Limits on trade out of a district and/or exit fees have been adopted as a way to address concerns over stranded assets and other economic and social costs associated with the movement of water entitlements out of an irrigation district. However, such measures constrain trade in water entitlements and decrease economic efficiency.

Limits on trade out of a district

In some districts (and subdistricts), the export of water entitlements has been prohibited, while in others, exports have been limited to a maximum of 2 per cent (net) of the irrigation district's (or subdistrict's) annual bulk licence. Trade constraints of 2 per cent have not been reached in many districts (or subdistricts) so these rules have had little impact to date (Roper et al. 2006). However, trade has been expanding and these limits are likely to be reached in some irrigation districts (or subdistricts) in the future. For example, Victoria's Department of Sustainability and the Environment stated:

> The two per cent annual limit on water trading out of certain areas has been reached — or is close to being reached — for four out of Goulburn–Murray Water's six areas. (DSE 2004, p. 79)

As an interim measure (to be reviewed in 2009), parties to the NWI are moving towards an annual gross limit of 4 per cent of total water entitlements held by the water utility (COAG 2004a). The NSW Government (sub. 41) indicated it has made the necessary legal amendments to facilitate this, and that some water utilities have already implemented this reform. It is difficult to determine whether this reform will be less constraining than the limits it replaces because it is a gross rather than net limit. In the longer term, the NWI requires the removal of all such limits 'by 2014 at the latest' (COAG 2004a, clause 60).

Any benefits from reducing or removing these limits will be minimal or negated, however, if they are simply replaced with other constraints, such as exit fees. Some water utilities have already set exit fees, or are considering introducing exit fees, as they change their interim threshold to 4 per cent per year.

Exit fees

This section outlines the arrangements for exit fees that — in addition to the above mentioned limits on trade out of districts — are being introduced in some parts of the southern Murray–Darling Basin, and summarises their economic effects, especially their distorting effects on trade in water entitlements. Because exit fees have been introduced for the purpose of assisting providers of irrigation infrastructure to recover their expected future costs, and so preventing the 'stranding' of infrastructure investments, brief comments are made on infrastructure pricing and cost recovery. Finally, the section outlines a number of measures that could enhance the efficiency and equity of exit fees in the short run and others that could replace them in the medium to long term.

Use and effects of exit fees

Several water utilities have introduced exit fees on the 'export' of water entitlements as a means of maintaining their revenue base (box 4.2). Table 4.5 details a number of existing exit fees and their significance, as a percentage of the entitlement value.

Box 4.2 **The NWI and exit fees**

The NWI allows the use of exit fees, provided they do not act as a barrier to trade (clause 62). The Murray–Darling Basin Commission commissioned a document on principles for establishing access and exit fees (Hassall et al. 2004). The role of exit fees has recently been considered by the Exit Fees Working Group of COAG and the ACCC is providing advice for New South Wales, Victoria and South Australia regarding a regime for the calculation and application of exit fees to be used to address short-term 'price shocks' resulting from permanent trade of water out of serviced areas.

Sources: COAG 2004a; Hassall et al. 2004.

As noted in the table, however, some utilities are developing variants of exit fees on entitlements traded out of their district. Murray Irrigation, for example, has created a form of retail tagging (discussed further below) whereby non-shareholders buying water from Murray Irrigation shareholders can buy Murray Irrigation entitlements that have obligations to pay ongoing fixed delivery charges but no upfront exit fee.

Table 4.5 **Exit fees in the southern Murray–Darling Basin**

	Exit fee	*Security of entitlement*	*Entitlement price*[a]	*Exit fee as a percentage of entitlement value*	*Additional and alternative arrangements*
	$/ML		$/ML	%	
Coleambally Irrigation Co-operative — NSW	479[b]	General security	650	74	None
	872[b]	High security	1400	62	
Murray Irrigation — NSW	447[b]	General security	550	73[c]	Buyer can pay ongoing charges instead[d]
Murrumbidgee Irrigation — NSW	275[b]	General security	725	38	Alternatives are being investigated[e]
	450[b]	High security	1550	29	
Central Irrigation Trust — SA	370[f]	High security	1450	26	None

[a] Prices are approximate only and are based on either sale prices listed on online water trading sites between May and July 2006, or estimates provided in personal communication. [b] The relevant irrigation company pays tax on this amount. [c] Murray Irrigation entitlements include a 17.5 per cent conveyance loss. Exit fees only apply to the entitlement less the conveyance loss, which is 82.5 per cent of the entitlement. Hence, the exit fee as a percentage of the entitlement value is 447/(550/0.825)*100=73 per cent. [d] Under Murray Irrigation's new constitution, non-landholders (in the Murray irrigation area) buying water from holders of Murray Irrigation entitlements can either buy Murray Irrigation entitlements and pay Murray Irrigation's fixed charges and have the exit fee and voting rights waived, or transfer water to a New South Wales general security access licence (water entitlement) and pay the exit fee. [e] Murrumbidgee Irrigation is currently formulating methods to minimise the potential for overcharging if an exit fee is paid (for example, if infrastructure is subsequently decommissioned or water is traded back into the district). [f] Central Irrigation Trust does not pay tax on this amount.

Sources: CIT 2005; Coleambally Irrigation Co-operative, sub. DR64, p. 3; Howe, J. Murrumbidgee Irrigation, pers. comm., 20 July 2006; McLeod, J. Murray Irrigation, pers. comm., 20 July 2006; Murray Irrigation 2006; MWE 2006; Parish, J. Central Irrigation Trust, pers. comm., 20 July 2006; Smith, M. Coleambally Irrigation Co-operative, pers. comm., 19 July 2006; Waterexchange 2006; Waterfind 2006.

Support for exit fees from participants in this study came from infrastructure providers that are using them and from some others in, or representing, the irrigation sector — for example, Murray Irrigation (sub. DR92), Coleambally Irrigation Co-operative (subs. 4 and DR64), National Farmers' Federation (sub. DR86), Murrumbidgee Horticulture Council (sub. 37), and Australian Dairy Farmers (sub. 12).

Murray Irrigation (which was privatised in 1995) is an unlisted not-for-profit company. Murray Irrigation observed:

> In forming Murray Irrigation, the NSW Government transferred the risk of current and future infrastructure management, operation and the fiscal liability of the scheme to the Directors of the unlisted public company. The environmental risks both current and future were also transferred to directors … it was not envisaged that Murray Irrigation would be forced by government to allow transfer of water entitlements out, with all limits on transfers to be removed over time. (sub. DR92, p. 14)

Murray Irrigation said its exit fees were established using principles derived from a consultancy commissioned by the Murray–Darling Basin Commission:

> The Exit Fee is based on fixed operating and capital costs and is [in] effect the NPV [net present value] of an access fee, which [it] seems is a legitimate charge for an Irrigation Corporation … Collection of an Exit Fee on water entitlements transferred from our licence is a suitable tool to help the company [manage] the financial risk associated with a reduction in water entitlements on our licence. (sub. DR92, p. 13)

Coleambally Irrigation Co-operative asked whether the exit fee was distortion-correcting rather than distortionary in view of its role in the funding of infrastructure maintenance and capital works. It also stated:

> … the irrigation area was privatised based on a range of agreed principles. A large shift in these principles that compromise business viability must be compensated. (sub. DR64, p. 11)

A similar view was advanced by National Farmers' Federation:

> While it is agreed that [exit fees] may constrain trade, NFF [National Farmers' Federation] believes that there are significant equity issues that exit fees address. These particularly relate to stranded assets. It is clearly inequitable for the remaining members of an irrigation scheme to bear the burden of another party's decision to sell water entitlements. To suggest that these issues can be dealt with [by] generic social policies is not a sufficient response to the problem. Any decision to remove exit fees [can] only be considered with a clear commitment by Government to take full responsibility for the equity issues that would result. Exit fees and tagged entitlements are part of the agreement irrigation corporations abided to as the trade off to open permanent trading. (sub. DR86, p. 6)

Other participants have argued that exit fees are not an appropriate instrument to manage concerns regarding stranded assets. Water for Rivers, for example, observed:

> Exit fees are somewhat of a blunt instrument, in terms of protecting infrastructure investment they achieve their objective but at what cost in terms of collateral damage? The most significant damage is the effective barrier an exit fee becomes to open trade by dramatically eroding the return to the seller of the water entitlement. Other issues such as what happens if [a] water entitlement is brought in to a district are unclear in

the current debate. Are exit fees refunded or is that a windfall gain to the infrastructure owner? (sub. 48, p. 2)

The Australian Conservation Foundation (sub. 45) and CSIRO (sub. 24) also opposed exit fees, and the ACCC questioned their efficiency implications:

> If the fixed cost of the irrigation assets are predominantly sunk, imposition of exit fees is likely to have efficiency implications since it will discourage trade of water from lower value to higher value uses. Thus, whether or not to impose exit fees ex post is essentially a matter of trading-off concerns about equity with forgone gains from efficient trade. (sub. 42, p. 7)

Watson argued:

> Proposals for 'exit fees' to be paid when water is shifted from one area to another have no counterpart in other areas of commerce. Plenty of other assets are left 'stranded' by social and economic changes. Stranded assets in irrigation reflect the fact that water is being used more profitably elsewhere. (2005, p. 16)

Similarly, I Wills noted that the increased charges for remaining users of sunk assets when some water exited a district:

> … seems to be a standard pecuniary externality, with no distortion of signals to decision makers. As such, it appears an appropriate market signal regarding the declining competitiveness of an irrigation area. (sub. DR99, p. 2)

Some participants stated that exit fees should not be implemented where structural adjustment means that the infrastructure is no longer required. The Water Steering Group for Horticulture Australia, for example, stated 'infrastructure replacement charges (and exit fees) should not be used to limit trade from infrastructure that will not be replaced in the future' (sub. 32, p. 7).

Efficiency implications of current exit fees

Exit fees as proposed in their current form (a per megalitre levy on the export of entitlements) will tend to increase entitlement prices in importing regions, reduce the net-of-tax price for sellers in exporting regions, reduce the quantity of water traded and reduce economic wellbeing, compared with the situation of unconstrained water trade. Exit fees result in welfare re-allocations (from irrigators — sellers and buyers — to water utilities) and economic inefficiencies (known as deadweight losses) (appendix C). They generate revenue for water utilities and, to the extent that irrigators may be shareholders for these utilities, this revenue may compensate some of the welfare loss of irrigators in the water exporting region. However, buyers, sellers and water utilities, all taken together, lose economic welfare when water trade is restricted by exit fees.

Goesch et al. (2006) found that the sacrifices in economic gains from trade increase at an increasing rate as the exit fee becomes a larger proportion of the traded price of water. Using a stylised empirical model with two water exporting sectors and one water importing sector, they estimated that an exit fee equal to 30 per cent of the traded price in both exporting regions reduced the economic gain by 18 per cent compared with free trade in water. If the exit fee was 70 per cent in both regions, trade was no longer profitable (appendix C). Exit fees of the magnitude detailed in table 4.5 are likely to greatly inhibit trade.

Exit fees can also result in less obvious costs. For example, they can lock water into low-productivity enterprises and regions. They can create distortion in other potential water sources such as groundwater and private diversions. Exit fees can increase the relative price of entitlements held by private diverters (who are not subject to exit fees) and have the potential to distort the mix of trade in the two classes of entitlements (Roper et al. 2006).

In the Commission's view, the current exit fees will substantially reduce the gains from water trade and are incompatible with the NWI objective of increasing water-use efficiency. Nevertheless, the liberalisation of trade in water entitlements under the NWI has increased the uncertainty faced by infrastructure providers about the funding of infrastructure maintenance and replacement. Arguably, it provides a case for an alternative to conventional charges on entitlements to fund those items in circumstances of net exports of water entitlements. Of course, in the absence of trade of entitlements to environmental or other non-irrigator users, aggregate net irrigator exports of water for a connected system are zero.

Alternative exit arrangements: A path to reform

There are more efficient responses available to utilities to fund infrastructure costs than the current or proposed exit fee arrangements. The Productivity Commission believes that the abolition of exit fees is the preferable course of action. The absence of exit fees is unlikely to have any significant *short term* implications for the viability of utilities. In the long term, the Commission's preferred approach incorporates the revaluation of utility assets using the methodology outlined by Roper et al. (2006).

Where substantial social costs result from the movement of water out of an irrigation district, the Australian and state and territory governments have generic social policies to assist with adjustment issues. On occasions, specific and targeted adjustment assistance may be justified, but this should be determined after a review of the costs and benefits of such initiatives. When weighing up the benefits and costs of additional government intervention related to stranded assets, it is important to consider the positive as well as the negative effects that can result from trade in water entitlements out of an irrigation district (Heaney et al. 2005). Positive effects can include the alleviation of congestion and environmental concerns in the water exporting district, and greater economies of size in the importing region. If governments choose to assist affected irrigators, assistance measures should be targeted so that other parties do not bear unnecessary costs.

RECOMMENDATION 4.4

Exit fees on sales of water out of an irrigation district constrain trade in entitlements and impede adjustment. They should be phased out.

While considering that removal of exit fees is the best solution, the Commission proposes a possible three phase path to reform that provides irrigators, communities and water utilities in the southern Murray–Darling Basin with security as well as opportunities to manage adjustment. The broad thrust of the reforms is to provide a transition to more competitive pricing arrangements for water service infrastructure, while recognising the current arrangements cannot be abandoned immediately (table 4.6).

Table 4.6 **A three-phase approach to exit fee reform**

	Phase 1	*Phase 2*	*Phase 3*
Infrastructure provider paradigm	Cost recovery	Transitional	Negotiation of competitive supply contracts
Exit fees	Allowed	Decoupled	Ceased
Consistency with efficient water market	Lowest	Intermediate	Highest

The three phases of the transition could be:

- Phase 1 (short term) — for example, the 2006-07 and 2007-08 irrigation seasons — allow existing exit fees but place limits on existing arrangements to reduce costs to exporters of entitlements.
  - The objective of phase 1 is to provide utilities with sufficient time to establish institutional and administrative arrangements to decouple the exit fees from entitlements and levy the charges on water-use licences or delivery capacity.
- Phase 2 (medium term) — for example, the 2008-09, 2009-10 and 2010-11 irrigation seasons — to address trade distortions decouple exit fees from entitlements by levying fixed utility charges on the water-use licence or delivery capacity share.

– The objective of phase 2 is to provide utilities and irrigators sufficient time to commence the introduction of transferable supply contracts.

- Phase 3 (long term) — for example, the 2011-12 irrigation season onwards — move toward more competitive charging regimes for infrastructure service provision.

– The objective of phase 3 is to reduce the emphasis on regulatory oversight of cost recovery by irrigation utilities and develop a more demand-driven response to utility charges and infrastructure investment.

Under each phase the water utilities would implement the asset valuation methods identified by Roper et al. (2006). However, the Commission notes the Victorian Government observed:

> … the option of writing down the assets values to manage stranded assets is not readily available in Victoria because for price setting purposes, it has already been adopted. (sub. DR98, p. 7)

Phase 1 (short term)

In phase 1, existing exit fees would be reduced to limit their distortionary effects on trade. The Commission recognises that reducing exit fees limits the recovery of costs in the short term. Rather than attempting to calculate the appropriate exit fee from a cost recovery perspective, the approach proposed is to set any exit fee according to the level of trade distortion that is acceptable to the community on equity and efficiency grounds. The rebating of exit fees provides a mechanism to avoid the potential for double charging of fixed costs as water is exported and imported by water users. The rebating scheme would involve transaction costs to establish and maintain. These costs could be avoided by proceeding to latter phases more quickly.

At the commencement of the 2006-07 irrigation season:

- Utilities would be allowed to impose lump sum exit fees on the export of entitlements from their district.
- Exit fees would be capped as a fixed percentage of the export price.

– Exit fees set at the same percentage across regions could help reduce trade distortions.

– Recognising that utilities have different cost structures because of differences in the nature of their infrastructure, and the need to minimise the distortionary effects of trade, setting the cap involves some tradeoffs.

– Exit fees in all jurisdictions where trade is possible could be adjusted to reflect the *net* export from the district (rather than only accounting for gross exports) for the period.

- Utilities would be required to maintain a register of entitlement holders that have paid exit fees during phase 1 and establish a holding fund for fixed charges paid on entitlements imported during phase 1.

– An exit fee holding account could be established with an end-of-irrigation-season adjustment to account for trades entering a district. To the extent entitlements enter the district, funds would be returned to irrigators who had paid exit fees.

– While this approach would mean, in the presence of intraseason uncertainty about the difference between gross and net exports of entitlements, that irrigators would make their decisions on exporting entitlements with uncertainty about the size of their ultimate net exit fee, they would know that this fee would often be smaller than the initial gross exit fee.

- Revenues from fixed charges received on the import of entitlements during phase 1 are to be paid as rebates to individuals and entities that exported entitlements during phase 1.

– Exit fee payments made during phase 1 would be rebated annually (based on annual fixed charges) over five years. Rebates would cease after five years.

- Also, the value of infrastructure assets can be written down to ensure that cost recovery does not cover sunk costs. This action would reduce the size of any cost-reflective exit fee.

Phase 2 (medium term)

The Commission recognises that while decoupling fees from entitlements addresses the potential trade distortions posed by the current exit fees, decoupling does not address the appropriateness of the ongoing charges. The decoupling of exit fees effectively creates a tax on land. While this is more efficient than the current tax on trade, it is not desirable in the longer term on either efficiency or equity grounds. Consequently, the Commission views decoupling as an interim measure to alleviate the immediate and large distortionary effects of current exit fees.

At the end of the 2007-08 irrigation season:

- Exit fees on exported entitlements would cease.
- Exit fees would be decoupled from the entitlement. Infrastructure service provision fees would be levied (independent of the water entitlement) on the water-use licence or the delivery capacity share held by the water user (boxes 4.3

and 4.4). This would amount to a tax on land, widely accepted as one of the less inefficient forms of taxation.

Box 4.3 **Unbundling delivery capacity shares in Victoria**

Victoria is currently in the process of unbundling delivery shares, providing the potential to decouple trade in entitlements from infrastructure service charges.

Goulburn–Murray Water outlined delivery shares in Victoria:

> The delivery share attached to land creates a legal obligation on a rural water utility to provide that land with access to a distribution service and a concomitant entitlement for the land to have access to the distribution service. Associated tariff changes will result in a clearer nexus between the service provided and the payment made by landowners. The payment for access to the distribution system will be based on the delivery share attached to the land, rather than the previous arrangement where the payment was based on the water entitlement attached to the land.
>
> Delivery shares will be able to be issued by the water utility, transferred between landowners and surrendered to the water utility.
>
> Importantly, under this model the amount of water entitlement owned by a landowner has no bearing on the charges paid by a landowner for access to (or use of) the distribution system which is servicing the property. Sale of water entitlements will not trigger an exit fee …
>
> The Victorian model is intended to allow efficient water trading. (sub. DR82, pp. 1–2)

The Victorian model also incorporates policy options for rationalising the delivery system (through the use of reconfiguration plans) and for direct negotiation between irrigators and utilities.

Source: Goulburn–Murray Water, sub. DR82.

- Water users importing entitlements to an irrigation area would be required to purchase delivery capacity and water-use licences from other holders before import trades are approved. Delivery capacity shares will be required for entitlements imported to an existing licence. A water-use licence and delivery capacity shares would be required for entitlements imported to a new water user. Additional water-use licences and (subject to addressing potential third-party effects) additional delivery capacity may need to be made available to the market once existing licences and shares are in use.
- Water users importing entitlements are required to enter into supply contracts with the utility.

Box 4.4 **Access fees and exit fees in Victoria**

The *Water (Resources Management) Act 2005* provided the legislative framework required to create a separate delivery share component from a water entitlement (chapter 3). A delivery share is to be attached to land and entitles the holder to water delivery services to that land. Delivery shares can be transferred with approval from the water utility, where spare delivery capacity is available.

Victoria is currently in the process of converting existing water entitlements into their separate unbundled components. Upon conversion, delivery shares will reflect the average current level of service — 1 per cent of entitlement per day, or 100 per cent in 100 days. For example, in districts supplied by Goulburn–Murray Water, a current entitlement of 100 megalitres will convert to a 1 megalitre per day delivery share. Delivery shares will also specify a minimum rate of water delivery and a maximum total delivery volume for the season (above which casual use fees will apply).

Under the new Victorian legislation, irrigators wishing to cease delivery services will be faced with either an annual access fee or a lump sum exit fee, based on delivery share charges. However, such fees will be waived if:

- there has been a formal decision to phase out irrigation in that area — either through a reconfiguration plan or through direct agreement with all customers — and the farmer does not wish to continue irrigating or keep a right to supply; or
- a new customer is found to take over the delivery capacity share, or if terminating the delivery capacity share would relieve over-commitment; or
- charges have been applied to an unirrigated property for ten years and the landowner has no wish to retain the right to be supplied. In this circumstance, the infrastructure operator should decide whether the existing situation should continue, whether services to the area should cease, or whether remaining irrigators should take responsibility for paying for the service.

Interim delivery shares have been determined for many irrigation districts in northern Victoria. Delivery shares will be officially introduced on 1 July 2007.

Sources: DSE 2004; Hassall et al. 2004; Roper et al. 2006; Watermove 2006.

- Supply contracts would specify obligations of holding water entitlements and delivery capacity shares.

– A range of cost-charging methods could be used in these contracts, including annual service charges, joining fees and/or exit charges and these could be chosen subject to negotiation between irrigators and utilities. (Exit charges need not distort trade when they are agreed in the negotiation of supply contracts.) Contracts could adopt cost-reflective pricing to differentiate between higher and lower-cost services. This would have the additional benefit of improving competitive neutrality with private diverters who have to meet all their infrastructure costs. New supply arrangements would need to comply with the NWI and trade practices legislation to ensure they did not unduly restrict trade.

- Utilities would rationalise and revalue assets then adjust their fees accordingly. The appropriate revaluation of assets, would ensure that prices reflect the value of the service to users. Infrastructure prices would provide guidance on the financial viability of reinvestment decisions. Reinvestment in infrastructure would be funded as the reinvestment occurs, and priced to fully recover costs over the life of the assets.
  - Heaney et al. 2005 proposed that utilities rationalise their delivery systems by decommissioning redundant infrastructure. In particular, some parts of local distribution networks may not be required if water is no longer diverted from the main distribution network to smaller feeder channels and to the farms of some irrigators, allowing the utility to reduce charges to reflect the new patterns of infrastructure use. Utilities could offer incentives to bring forward rationalisation and decommissioning.

Phase 3 (long term)

To keep transaction costs low, some flexibility in the way that supply contracts are formalised would be required. For example, for some water users, such as those developing new greenfield irrigation sites outside existing supply networks, more detailed supply contracts may be needed, whereas for many existing water users the contracts might be formalised through simple variations to the terms and conditions of the water entitlement or delivery capacity share.

At the end of the 2010-11 irrigation season:

- Existing water users would be required to enter into supply contracts that specify financial obligations of holding water entitlements and delivery capacity shares.
- Supply contracts may be tradeable within the delivery system's constraints.
  - In Queensland, irrigators hold contracts with the water utility which specify water transport services (box 4.5).
  - Consideration would need to be given to the appropriate length of contracts and penalties for early termination (not applicable if the contract is traded).

Box 4.5 **Contracts for water transport in Queensland**

In regulated supply systems in Queensland, contracts are required for water transport services — though contract holders are not required to hold a water entitlement to obtain access to these services. These are essentially contracts for the transport of water from the watercourse to the farm through natural and man-made channels and pipelines. If contract holders choose to cease transport services, they are required to pay a termination payment which represents a buyout of the future contracted obligations. The amount of the payment will depend on the contract terms, but for irrigation customers within existing systems it is generally equal to the present value of ten years of service. For new systems the payment depends on the capital financing structure and the likelihood of securing a new customer.

Sources: Boettcher, P., SunWater, pers. comm., 12 July 2006; SunWater, sub. DR67.

RECOMMENDATION 4.5

Water utilities in the southern Murray–Darling Basin should decouple exit fees from entitlements in the medium term. Infrastructure charges should be levied on the water users' water-use licence or delivery capacity share.

RECOMMENDATION 4.6

Water utilities in the southern Murray–Darling Basin should move to competitive supply contract arrangements with water users in the long term.

Other trading rules

As with trade in seasonal allocations, a number of trading rules constrain trade in water entitlements. For the most part, intradistrict trade is relatively unconstrained, with most rules based on hydrological or environmental factors. There are, however, rules in New South Wales that only permit the conversion of a high security licence to a general security licence (in regulated rivers) if a corresponding or larger conversion has occurred in the opposite direction. The National Water Commission identified this rule as inconsistent with NWI commitments (NWC 2006a).

There are also a number of rules for interdistrict trade, the most significant being rules that limit trade out of a district (discussed above). Interstate trade in water entitlements is also restricted to those areas included in, and by, the rules governing the pilot interstate water trading project (box B.2, appendix B). Other rules for trade in entitlements between districts are similar to those for seasonal allocations. While there may be efficiency impacts from these rules, these are likely to be less of a priority compared with other constraints on water trade. Nevertheless, rules that do not serve any justifiable environmental or hydrological purpose should be removed.

A system for trading different water entitlement types

Water entitlements have different characteristics, such as supply reliability and yield, largely determined at the state level (table B.5, appendix B). Trading water entitlements between states or districts with differing entitlement characteristics requires an appropriate mechanism to account for these differences. The NWI stated exchange rates and/or tagging systems should be adopted to account for these considerations (COAG 2004a) (box 4.6).

Box 4.6 **Exchange rates and tagging**

Exchange rates

Exchange rates use a numeric ratio to convert an entitlement to reflect the characteristics of the destination site to which the entitlement is traded. Once converted, the entitlement permanently reflects the seasonal allocations (including the reliability) of the destination location. Exchange rates are likely to have greater third-party impacts than tagging because attributes are likely to vary over time and hence an exchange rate is likely to be wrong at times.

Tagging

Tagging allows the traded entitlement to retain its original characteristics from its source location. Through tagging, entitlements are clearly defined assets that can be traded directly by water traders. Prices determined in the water market will reflect the value of entitlements sourced from different locations.

The failure of states to agree and to implement an appropriate arrangement in a timely manner has constrained trade in water entitlements, particularly interstate trade. In particular, interstate trade in water entitlements has been constrained to areas included in the Pilot Interstate Water Trading Project, implemented in 1998 (box B.2, appendix B). This trade has been facilitated using exchange rates but has been restricted to high security entitlements to minimise potential third-party effects. In moving towards expanded interstate trade, tagging was supported but implementation was delayed due to the complexity of establishing tagging registers. In April 2006, New South Wales, Victoria and South Australia had $39.2 million of their notional competition payments withheld for failing to introduce a system for trading water entitlements between states in the Murray–Darling Basin.

However, in May 2006, the three states agreed in principle to facilitate expanded interstate trade in water entitlements using a tagging approach. While arrangements are yet to be finalised, the states have asked the Australian Government to assist in establishing a body to oversee interstate trading arrangements, and it is believed that tagged interstate trade could start in mid-2006 (MDBMC 2006).

The use of a tagged system has received widespread support from governments and irrigators — for example, Southern Riverina Irrigators (sub. 25), the Queensland Government (sub. 38), the Victorian Government (sub. 32) and the NSW Government (sub. 31). Jurisdictions should continue to progress required arrangements to implement this reform as a matter of priority.

Taxes, fees and approval times

A number of other fees and charges involved in trading water entitlements may constrain trade. These include some or all of the following (depending on the district and whether trade is interdistrict or intradistrict):

- government taxes, fees and charges
- approval times
- brokerage fees
- water utility/trust fees (including exit fees, discussed above).

Government, taxes, fees and charges

In the case studies covered by The Allen Consulting Group (2006), total government charges ranged from $275 (including channel capacity and salinity/drainage assessments) in the Goulburn–Murray, to at least $525 in the River Murray in South Australia (table 4.7). Fees for South Australia are discussed in section 4.3 and may be higher due to more stringent technical assessment requirements and differences in titling arrangements. The South Australian Department of Water, Land and Biodiversity Conservation stated, however, that a review is likely and that, in the longer term, South Australia is likely to unbundle entitlements from use licences (South Australian Department of Water, Land and Biodiversity Conservation, pers. comm., 24 May 2006).

As shown in the far right column of table 4.7, water entitlement trades may be subject to a number of additional approvals, such as use approvals, land and water management plan approvals, and salinity and drainage assessments. The extent of these requirements will vary depending on what approvals the buyer (or seller) already holds.

In addition to these approvals and associated fees, the seller may also be required to subdivide their entitlement if they wish to sell only part of their full entitlement. This requirement is likely to reflect the titling arrangements of the relevant state (chapter 3). In this way, titling arrangements can have implications for the costs involved in transacting an entitlement trade.

Table 4.7 **Government fees and charges for trade in entitlements**

Region	*Application and approval*	*Registration*	*Taxes*	*Other*
NSW — Murrumbidgee Valley[a]	$250	$73.25	Stamp duty depends on the type of licence being sold Capital gains tax	$113 for use approval if not already held
Qld — Emerald Irrigation Area	$86.20 for a change to the entitlement (for example, location), subdivision or amalgamation[b]	$111.30 for transfer of ownership, change, subdivision or amalgamation	Stamp duty of $2350 on $100 000 Capital gains tax	Land and Water Management Plan approval fee[c]
Vic. — Goulburn–Broken	Buyer to pay $145 to Goulburn–Murray Water	na	No stamp duty Capital gains tax	Buyer to pay $130 for channel capacity and salinity/drainage assessment
SA — River Murray	$519	$6.15	No stamp duty Capital gains tax	Additional fee of $132 may be required in some circumstances

[a] Excludes Murrumbidgee Irrigation Corporation channel system, which operates an internal trading system that is not subject to government fees for internal trades. [b] For interim water entitlements, a fee of $252.90 applies for transfer of ownership. These transfers are not registered and hence, no registration fee applies. [c] A Land and Water Management Plan approval fee of: $177.80 applies, if a plan is not already held; $59.30 applies for approving a previously approved plan; $118.60 applies for approving a previously approved plan, if the plan to be approved applies to additional land or to a different or additional irrigation method. na denotes not applicable.

Sources: Department of Natural Resources Mines and Water (Qld), sub. DR85; South Australian Government, sub. DR79; The Allen Consulting Group 2006.

The Allen Consulting Group found:

> One particularly important factor influencing costs is whether or not entitlements are sub-divided prior to undertaking a permanent trade, and whether a mortgage(s) need to be made or discharged on the entitlement … This process is estimated to cost over $1000 in government fees and settlement costs — and adds considerably to the time taken to complete a trade. These costs are likely to pose a significant disincentive to permanent trade. (2006, p. 14)

Hence, even if the minimum fees do not constrain trade in entitlements, additional requirements and their associated costs may.

Trade in water entitlements can also be subject to capital gains tax or stamp duty. While these increase the cost of water trade, such taxes are common to most traded assets (box 4.7).

Box 4.7 **Taxes applying to trade in water entitlements**

The taxation treatment of trade in water entitlements has the potential to influence farmers' decisions on whether to trade or hold; trade seasonal allocations or entitlements; lease; sell in part; or sell entitlements with, or separate from, the land component. Uncertainty regarding the applicability of taxation arrangements can increase risk and also influence decision making. Further, while taxes are an important source of funds for public expenditure, it is desirable from a public policy perspective that taxes influence resource allocation decisions as little as possible, unless a tax is specifically aimed at changing behaviour.

Participants in this study have argued that capital gains tax and stamp duty may be undesirably distorting trade in water (for example, CSIRO, sub. 24; Winemakers' Federation of Australia, sub. 13).

Individual business circumstances for some farmers may be such that the extent of the potential capital gains tax liability or stamp duty may influence (that is, encourage or discourage) trade in water entitlements. To the extent that water entitlements are treated no differently to any other asset or income for taxation purposes, however, resource allocation between water and other business assets is not distorted. Consequently, there do not appear to be any taxation-related impediments that are specific to trade in water.

Approval times

In addition to fees and charges, trades also require approvals and assessments that can delay and constrain trade. It generally takes much longer to approve a water entitlement trade than a seasonal allocation trade because there are often more steps involved, and trading rules tend to be more complex. Approval times for entitlement trade vary considerably depending on the source and destination locations of the trade. For example, Southern Riverina Irrigators stated:

> The other major impediment to trade is some governments having to approve the water transfer. The South Australian transfer requires ministerial consent. As you can imagine this approval process is extremely time consuming. (sub. 25, p. 4)

The Allen Consulting Group found that '[m]ost states have developed a system of "pre-approved" trades [between particular geographic areas] which require only a basic level of assessment before approval can be given' (2006, p. 17). This allows for fast-tracking of some entitlement trades and requires less resource costs. Trades outside of these 'pre-approved' areas, however, may require further assessments such as on-site visits and/or modelling work, which is likely to increase the time and costs involved in processing the trade. Table 4.8 indicates typical times taken to approve entitlement trades.

Table 4.8 **Typical times for regulatory approvals for entitlement trades**

Region	*Time*
NSW — Murrumbidgee Valley[a]	Up to 6 months
Qld — Emerald Irrigation Area	1 week for pre-tested trades
Vic. — Goulburn–Broken	4–6 weeks
SA — River Murray	6–8 weeks

[a] Excludes Murrumbidgee Irrigation Corporation channel system which operates an internal trading system.

Source: Adapted from The Allen Consulting Group 2006.

While delays in approving transfers of water entitlements create uncertainty and involve opportunity costs, many decisions to purchase an entitlement are based on long-term considerations and investment horizons. Moderate one- to two-month approval periods are therefore likely to be only a minor problem for many investors. Approval periods of three to six months, however, appear excessive. Further, as mentioned above, if there are additional approvals or processes required, the time taken to approve these requirements may also deter would-be traders.

Brokerage fees

As with trade in seasonal allocations, brokerage firms charge fees for processing trade in entitlements. Fees for Waterexchange and Waterfind, like those for processing seasonal allocation trades, represent a percentage of the value of the sale (table 4.9). Watermove, however, charges the buyer a fixed fee to process a water entitlement trade. This fixed fee is twice that charged for processing a seasonal allocation trade, but given that prices for entitlements are higher than for seasonal allocations, this appears comparable to fees charged by other brokers. SunWater does not offer customers a brokerage service for the transfer of water entitlements.

Table 4.9 **Fees charged by major brokerage firms for trade in water entitlements**

Broker	*Fee*
Watermove	Buyer pays $110 per trade plus GST. Seller pays 3 per cent of total value, or a minimum fee of $550 up to a total of $4400 plus GST.
Waterexchange	Seller pays 2.5 per cent of total value, minimum of $50, maximum of $750.
Waterfind	Buyer pays 1.5 per cent of total value. Seller pays 3 per cent of total value.

Sources: The Allen Consulting Group 2006; Watermove 2006.

Assessment of fees and approval processes

Basic transaction costs are not likely to constrain trade in water entitlements in most jurisdictions. For example, for trade in water entitlements, The Allen Consulting Group found:

> In Queensland and New South Wales … for straight-forward trades (which do not involve complex settlement procedures) the basic transaction costs charged by government and brokers would not be a constraining factor as the total cost constitutes only about 3.5 per cent of the total value of the trade … (2006, p. 19)

However, fees and approval times are substantially greater and longer in some jurisdictions. Moreover, additional requirements, such as use approvals, land and water management plans, and processes for subdivision may be constraining trade in water entitlements.

Several innovations can be introduced to improve performance in this area. These include setting appropriate benchmarks and best practice approval timeframes, with public reporting and appeals processes in place for aggrieved parties. These should be introduced to help keep government impositions on trade to a minimum.

RECOMMENDATION 4.7

Approval processes and associated costs involved in trading water entitlements should be benchmarked to best practice. Performance reviews should be conducted periodically by the National Water Commission.

4.5 Constraints specific to trading groundwater

Groundwater entitlements, access and use rules differ markedly from those for regulated surface water. Additionally, there are often environmental and hydrological constraints specific to groundwater, making trade in groundwater fundamentally different to trade in surface water. The South Australian Government stated:

> There are significant environmental constraints in transferring groundwater allocations … This requires careful hydrogeological assessment for any potential transfer of an allocation. Care must be taken to ensure that concentrating extractions, or over extracting with poor allocation or transfer rules does not cause pumping interference or resource degradation for other water resource users, including the environment. (sub. DR79, p. 11)

Hence, trade in groundwater is more limited than trade in surface water because groundwater trade is usually only viable within the same aquifer.

Groundwater is traded in Western Australia, where groundwater is the main source of water; however, trade has remained small (appendix B). One reason for limited trade in Western Australia is the predominance of unmeasured use and the lack of incentive to trade entitlements or seasonal allocations if existing use is unmeasured (Water Reform Implementation Committee 2006, p. 25).

Where trade in groundwater does occur, there are often trade restrictions imposed. In Victoria, for example, there are prohibitions on trade to specified areas or to specified water uses. And, in the South–East Catchment in South Australia, groundwater trade is restricted to within a management region, despite the fact that a number of management regions may draw from the same hydrologically connected source. The ACCC stated ‘it is possible that these restrictions on trading across the large number of small regions (management areas), could be constraining efficient trade’ (sub. 42, p. 8). However, the South Australian Government stated:

> Whilst small groundwater management units, or separation of groundwater from surface water may appear as impediments to some trade and transfer of water allocations, they should not be considered as ‘constraining efficient trade’ if the decision is underpinned by a sound technical assessment and justification. (sub. DR79, p. 11)

Trade between groundwater and surface water is also restricted. For example:

> NSW legislation prohibits trade between surface water and groundwater systems. Other states consider this form of trade, although the onus for proving that impacts are negligible is on the transferee, inducing a large transaction cost. (ACCC, sub. 42, p. 8)

However, Coleambally Irrigation Co-operative argued:

> The level of knowledge on the groundwater / surface water interaction is inadequate to allow the trade between the two. In the current knowledge void environment, trade would inevitably erode property rights. (sub. DR64, p. 13)

Hence, restrictions on trade in groundwater often reflect uncertainties about storage levels, connectivity with surface water and potential third-party impacts, including environmental effects. Indeed, information gaps and a lack of water accounting (chapter 2) are often stated as the reasons for far fewer tradeable licences being granted to groundwater, compared with those granted to surface water. The physical trade of groundwater can also be limited by infrastructure access.

Further, in some areas, trading in groundwater could make extraction levels unsustainable. This is because many aquifers are already over-allocated such that if licence owners are able to realise the value of groundwater through trade, a number of currently unused groundwater licences may be activated. The risk of over-extraction is increased in the Murray–Darling Basin by the fact that the Murray–Darling Basin Cap is imposed on surface water alone (appendix B) and not all groundwater sources are capped separately. Given the substitutability between surface water and groundwater, increased trade in groundwater could exacerbate problems of system-wide over-allocation. To move ahead, appropriate integrated surface water and groundwater caps would be needed (chapter 2) and the issue of unactivated licences addressed.

4.6 Implications of freeing up water trade

Freeing up trade in seasonal allocations and water entitlements, and derivative water products, will facilitate the movement of water to regions and for uses where it is most highly valued, through mutually beneficial trades. Freer water trade will provide businesses with expanded opportunities to use resources and earn income, and achieve better returns on other resources used in the economy. Freer water trade can also assist with farm adjustment processes by expanding choices in terms of improving or changing farm enterprises, or exiting the industry.

In general, there are more constraints on trade in water entitlements than in seasonal allocations. These include more widespread direct regulatory restrictions, higher charges and longer approval times. However, as noted above (and in appendix B), a high volume of trade occurs in seasonal allocations and this trade has played, and continues to play, a substantial role in allocating water to its most highly valued uses. As Murray Irrigation stated:

> … annual water markets [trade in seasonal allocations] provide the main market mechanism for delivering water to high economic value uses. The power of the annual water market is often understated outside the irrigation industry. (sub. 55, p. 2)

Derivative products for water that can be close substitutes for water entitlements (for example, leasing and forward contracts) are also emerging in response to irrigators' preferences for more flexible trading arrangements. Some of these derivatives can also have financial management and taxation benefits, compared with water entitlements. Trading opportunities in seasonal allocations and emerging derivative products enable water to move to higher value uses (in the short and longer term) and help facilitate necessary structural adjustment in irrigation districts.

Nevertheless, free trade in entitlements would also contribute to similar outcomes. Continuing to remove impediments to entitlement trade can consolidate and, where overall trade is expanded, build on the efficiency gains made by the relatively free trade in seasonal allocations. Further, seasonal allocations, leases and other derivative products for water are not perfect substitutes for water entitlements, and irrigators (and other market participants) should be able to hold and trade a mix of water products to suit their needs.

The size of the expected benefits from freeing up water trade will vary depending on location, and will be greater over time as resources of a fixed nature can be adjusted and moved to alternative uses. In the short run, however, the gains in terms of expanded trade or economic efficiency from the removal of constraints on trading seasonal allocations or water entitlements (excluding the gains from expanding who can participate in trade) may be moderate (box 4.8).

Structural adjustment may occur in response to expanding who can participate in water trade and removing other current constraints on water trade. As noted in section 4.4, concerns relating to the potential social costs of the net exporting of water out of a district have been used as a reason for imposing trade constraints. However, the extent of any structural adjustment resulting from freeing up trade is likely to be modest in most areas. This is due in part to the substitution effects of resources moving to alternative uses, which reduces the impact on local economies from the net exporting (or importing) of water. Expanded trade in response to freeing up water trade is also likely to occur over time, giving businesses time to adjust.

While water trade may drive some structural adjustment, it can also help businesses to respond to other adjustment pressures. Businesses experience adjustment pressures from a large number of changes occurring in the economy (with both positive and adverse consequences on businesses), many of which are more substantial than the adjustment signals from expanded water trade. Examples include changes in commodity prices, interest rates or large changes in climatic conditions. Winemakers' Federation of Australia, for example, stated:

> In addition to restricting trade [restrictions on the volume of water that can be permanently traded out of the region] this also acts as an impediment to structural

adjustment, particularly where prices being offered outside of the region are significantly higher than those inside the traded region. (sub. 13, p. 5)

Box 4.8 Estimated gains from removing constraints on water trade

Partial equilibrium modelling by Heaney et al. (2004), suggested that removing impediments to trade would result in approximately 600 gigalitres of additional trade in water entitlements in the southern Murray–Darling Basin in the short term (approximately 15 per cent of total water entitlements in the region at that time). This relatively small impact was taken to largely reflect significant sunk investment in on- and off-farm irrigation infrastructure, making water demand inelastic in the short run. Heaney et al. (2004) hypothesised that the volume and value of entitlement trade is likely to increase as infrastructure assets near the end of their life and as other water demands (such as environmental water demands) increase.

Peterson et al. (2004) used a general equilibrium model to examine the regional and industry impacts of reductions of 10, 20 and 30 per cent in water availability in the southern Murray–Darling Basin, under conditions of no trade, intra-regional trade only, and both intra- and interregional trade. The study estimated that allowing both intra- and interregional trade would halve reductions in gross regional product due to a hypothetical decrease in irrigation water availability of 10 per cent (from 1 per cent — $356 million in 2003 — to 0.5 per cent). In years with low water availability, water reductions would have a larger effect on gross regional product (and water trade would provide larger gains through mitigating the impact on gross regional product) than in years with higher water availability.

These studies did not take into account the impact of changes in water trade on environmental conditions such as salinity nor the effects of environmental externalities or other third-party impacts on water trade.

Sources: Heaney et al. 2004; Peterson et al. 2004.

Finally, to the extent that structural adjustment challenges do arise from expanded water trade as a consequence of freeing up trade, there are existing safety-net and rural adjustment programs in place to assist those whose incomes fall to low levels. Where these are inadequate, governments could consider additional, targeted assistance if the benefits outweigh the costs. In doing so, governments should consider assistance measures that minimise distortionary impacts on water trade and on other resource allocation decisions.

Governments should continue to remove constraints on trade in water entitlements and seasonal allocations that impose more costs than benefits, and actively seek alternative means of achieving water management and structural adjustment goals that have less constraining effects on water trade. Reducing constraints on trade in conjunction with improving entitlement and seasonal allocation regimes, and coordinating market mechanisms to help achieve environmental goals, would offer the greatest benefits.

FINDING 4.2

Constraints on trade are generally greater for water entitlements than for seasonal allocations. Relatively unconstrained trade in seasonal allocations and emerging derivative water products already mean that water is moving to higher value uses. Removal of constraints on trade in water entitlements would build on these gains.

5 Other factors affecting farmers' decisions on water use and trade

Key points

- Farmers are generally well informed in terms of making water-use decisions.
- The structure and performance of rural water utilities can affect farmers' decisions regarding water use and trade. Improvements in these arrangements could drive further efficiency gains on- and off-farm.
- It is not correct to assess water's 'highest value use' by an average value (dollars per megalitre, for example). The appropriate measure is the value of the marginal product of water.
- Ensuring that water is allocated to its highest value use does not require governments to 'pick winners' in terms of either products or irrigation technologies.
- Government subsidies to encourage the use of specific irrigation technologies or practices are likely to be inefficient, unless well designed and targeted at achieving specific public benefits.

Farm production decisions and water-related management practices affect how much, as well as where and how, rural water is used. While farmers face a number of incentives to allocate water to its most productive uses on-farm, there may be impediments or distortions affecting their decisions on water use and trade. Chapter 3 discussed limitations of existing entitlement and seasonal allocation regimes, and chapter 4 discussed constraints on water trade. This chapter considers other factors affecting farmers' decisions regarding water use, including:

- the adequacy of information for on-farm water-use decisions
- the efficiency of rural water supply
- government policies relating to agriculture, rural water and water-related markets.

5.1 Information for water-use decisions

Farmers need information about water and land on which to base their decisions regarding water use. Without adequate information, decisions about water use, including production decisions, investments in irrigation technology and water trading, may not be economically efficient.

On-farm water-use decisions

Irrigators face incentives to acquire and use an optimal amount and type of information in making production and water-use decisions as these decisions determine farm profitability. On-farm water-use decisions depend on several factors:

- The cost to farmers of using additional supplemented water, which is determined by utility delivery charges and the traded price of water in their district. These depend on the other demands for water from competing farms and industries as well as the supply of water in dam storages and prevailing weather conditions.
- The benefit of applying water, which depends on the value of the crop being produced, crop type (for example, whether annual or perennial), the cost of other inputs that combine with water in crop production (including fertilisers and labour), and the scope to substitute other inputs for water.

Decisions about investments in more physically efficient irrigation methods also depend on a range of factors. Farmers generally make decisions about investing in technology that increases physical water-use efficiency based on the merits of the expected costs and benefits. Beynon et al. stated ‘it can be expected that the appropriate level of investment in these technologies will occur as part of the normal investment environment in farming’ (2002, p. 1).

Farmers often invest in technology that increases water-use efficiency not solely for the benefits of reducing water consumption, but because such technology can improve output quality and permit savings in other inputs, especially labour (J Brooke, sub. 10; P and S Gault, sub. 14; Southern Riverina Irrigators, sub. 25; Sunraysia Irrigators Council, sub. 33; Winemakers’ Federation of Australia, sub. 13). Decisions to adopt water-saving technology will be influenced by the characteristics of individual farms and farmers, including approaches to risk management.

Water is not a large component of most agricultural input costs. In the more water-intensive irrigated industries, such as rice growing, the cost share is 10–20 per cent. In other irrigated industries where capital and labour intensity is higher, such as horticulture, water's share of input costs may be in the range of 1–2 per cent (Appels et al. 2004). The benefits from highly water-efficient technology may be small if water use is already low, as the Winemakers' Federation of Australia noted:

> … further uptake of technology is limited by the relative costs of installing the technology and the extra profitability that such technology will provide. In some of the cooler climate regions where application rates are less than 1 ML/ha [megalitre per hectare] the potential water savings from the installation of further water saving technologies are likely to be small. (sub. 13, p. 5)

When the costs of new technology (in terms of capital outlay and running costs) outweigh the benefits (in terms of the value of the water saved), investment in these new technologies will reduce economic efficiency (in contrast to physical water-use efficiency):

> … physical water use efficiency may favour sub-surface drip irrigation over other forms, including centre pivot systems. However, economic efficiency may favour laser-levelled, gravity-fed surface irrigation systems because of their low input costs including energy for pumping/pressurising. (Australian Dairy Farmers, sub. 12, p. 8)

> … there is little further opportunity for South Australian River Murray irrigators to improve on-farm water efficiencies *at a cost that is competitive*. [emphasis added] (South Australian Government, sub. 36, p. 4)

Markets create incentives to allocate water to its most productive uses on-farm. The competitive nature of agricultural markets provide disciplines for producers to grow crops sought by consumers and to use inputs efficiently. Existing water markets also provide signals to farmers to make efficient water-related decisions because they reveal the opportunity cost for irrigation water in different regions. Water trading can shift water to uses where it yields higher marginal returns (net of distribution costs) with gains to buyers and sellers. These signals can help guide investments in irrigation technologies and water-related farm management strategies:

> The price of water in an efficiently operating water market is a key signal influencing investment and resource allocation decisions, and is determined by the scarcity value of water and information regarding the characteristics of water products available. (Queensland Government, sub. 38, p. 19)

> The advent of water trading has made irrigators much more aware of the value of water, and as a consequence, it is not used to irrigate unsuitable land, and spillages are much less common than they used to be. (J Brooke, sub. 10, p. 3)

In summary, farmers generally face incentives to optimise their use of water in relation to all other inputs, and to rationally choose the product mix and associated technology (unless there are market imperfections such as deficient information).

Farmers' access to information

Farmers are generally well-informed and have adequate access to information with networks in place to help them gather and process knowledge relevant to water use. Several participants in this study argued strongly that farmers are 'smart' users of water on farms, make rational choices about irrigation technologies and commonly share information with others. P and S Gault, for example, stated:

> Farmers use water to the best of their ability, it is an expensive input, but a very rewarding one if well managed, each farm is an individual operation and soils, stocking rates, labour availability, climatic variation and level of ownership will all drive how a farmer might manage the land and resources available. (sub. 14, p. 4)

There may be circumstances, however, when parties do not have access to sufficient information, or have difficulties processing information, which inhibits informed decision making. P and S Gault noted:

> Without doubt there is still a large gap in awareness, availability and impartiality of information. Farmers and particularly dairy farmers are time deficient … issues such as lack of exposure to IT [information technology] often compound the lack of access to information. (sub. 14, p. 5)

Participants in this study — for example, Australian Spatial Information Business Association (sub. 27), the Australian Bureau of Statistics (sub. 17), Water Corporation (Western Australia) (sub. 29), P and S Gault (sub. 14), and Northern Territory Horticultural Association (sub. 51) — highlighted the need for ongoing improvements in the availability of information and data relevant to rural water use. Water Corporation (Western Australia) stated that '[d]ata and information for improved understanding and assessment of impacts of land use practices is not always readily available' (sub. 29, p. 2).

The critical policy question is whether the information inadequacy leads to economically inefficient outcomes. Incomplete information itself is not necessarily inefficient because information is often costly to gather and process. In many cases, it may not be worthwhile or economically efficient for a farmer (or group of farmers) to undertake information gathering and processing. Instead, farmers may develop risk management strategies (which may be more cost-effective than addressing the information gaps themselves) to address the risks arising from information deficiencies.

Information inefficiencies may arise when information is not gathered or processed despite the community-wide benefits of doing so (net of the costs of information acquisition and dissemination). This may occur when:

- there are public good characteristics associated with the information so that, while there may be a number of beneficiaries, the benefits cannot be restricted to those who have paid for the information provision — as a result, information will tend to be underprovided

- the costs of collective action by a group of farmers to acquire and share information, and to collectively fund the costs of information acquisition and processing, outweigh their benefits of doing so
- the information is so complex that it does not aid rational decision making, including risk management
- market participants hold back information from others for private benefit, yet social wellbeing would be improved by information sharing.

An example of information that may be underprovided by private individuals or organisations is information on climate, soils, water flows/connectivity, and other biophysical characteristics common across properties in an area, and frequently across whole catchments or regions (Bureau of Meteorology, sub. 28; Engineers Australia, sub. 8; Tree Plantations Australia, sub. 50; Water Corporation (Western Australia), sub. 29). The Bureau of Meteorology (sub. 28) stated, for example, that there is scope to improve the accuracy of weather, climate and water supply forecasts, which would improve farmers' capacity to make on-farm management decisions. According to the bureau, improvements could include further research and development on climate data, monitoring and prediction systems, and increased training in climate risk management for target communities. Another area where a lack of information may contribute to economically inefficient rural water use is in relation to information on opportunities and obligations regarding water trading (chapter 4).

Private organisations, such as industry associations, and agricultural and environmental consultants, have sought to bridge many information gaps by tailoring information to meet the needs of individual farmers and water users. Producer organisations may overcome many of the problems of collective action to obtain and disseminate information that is useful to many of their members.

There may be a role for governments to provide, fund or coordinate information collection and dissemination, and the determination of research priorities, where private sector responses are inadequate and there are public benefits from doing so. To a large extent, government agencies, catchment management authorities and research institutes are already responding to information gaps. Catchment management authorities, for example, often provide information on the biophysical characteristics of the catchment, and its implications for best practice land and water management, to local water users.

The Commission is not in a position to comment on the desirability of additional information projects, but notes that opportunities for improving publicly beneficial information on climate, soils, water flows/connectivity and other biophysical characteristics common across properties should be explored where private sector responses are inadequate. As with other potential government responses, the costs and benefits of any information-based responses, and their comparison with other approaches, would need to be considered before judging their relative merits.

FINDING 5.1

Irrigators are generally well-informed about water-use choices and are best positioned to make sound decisions about allocating water to privately productive uses. There may, however, remain scope for governments to improve information on the biophysical characteristics of water use common across properties.

5.2 The efficiency of rural water supply

The economic efficiency of rural water utilities, including operational and management efficiency, is important for the economically efficient use of rural water — whether directly by managing efficiencies in harvesting, storage and distribution, or indirectly in terms of the products and services they offer water users and at what prices. Australian Dairy Farmers, for example, argued '[p]rofessional management of water and irrigation infrastructure is critical in minimising costs in the system, providing service and maintaining capital investment' (sub. 12, p. 3).

The Water Steering Group for Horticulture Australia highlighted the benefits efficient delivery systems can have for on-farm productivity, and stated '[h]igher service levels off-farm can enable higher farm water-use efficiency and easier technology adoption by growers' (sub. 32, p. 7).

Background on rural water supply

Rural water supply in many regions is dominated by bulk water suppliers and distributors (rural water utilities) who provide water using large scale storage and channel distribution systems. Supply arrangements vary across Australia. In New South Wales, the State Water Corporation is responsible for delivering bulk water to rural areas, including to privately-owned rural water infrastructure operators, who in turn supply water to individual irrigators. In contrast, three government-owned water utilities provide bulk water services to rural Victoria. These utilities are responsible for providing bulk water to, and maintaining irrigation infrastructure in, each of their irrigation districts. In South Australia, infrastructure operators pump from the River Murray and supply water directly to individual irrigators. In Queensland, rural water utilities are government-owned businesses, responsible for supplying water to individual irrigators and for maintaining irrigation infrastructure in irrigation districts.

Historically, water utilities have been natural monopolies because of economies of scale in storage and delivery infrastructure, and an absence of trade between districts. The duplication of dams and channels has not been economically or environmentally feasible in most cases. Because of these characteristics of water supply, along with limited opportunities for many irrigators and other large scale water users to get water from other sources (such as from groundwater, overland flows or private dams), rural water utilities have often had significant market power. This has given them significant discretion to set trading rules and charges.

Governments in different states and territories have managed this issue through public ownership, or through the regulation of privately-owned companies and cooperatives. Water utilities in Victoria are government-owned statutory authorities managed under the *Water Act 1989*. The Victorian Government White Paper proposed that the Victorian Essential Services Commission undertake price monitoring of water providers (DSE 2004). In New South Wales, where rural water utilities are either privately-owned corporations or cooperatives (with irrigators being shareholders in both cases), utilities are governed by the *Water Management Act 2000* (with amendments in 2004 and 2005).

Expanding trade will increase competitive pressures on rural water utilities. Storage services in particular are becoming more open to competition because irrigators in some areas can choose to purchase water managed by different utilities. Irrigators in the Central Irrigation Trust district, for example, can buy water entitlements from Murray Irrigation. The movement of water across regions more generally also gives utilities a greater incentive to perform efficiently because poorly serviced areas may lose water to better serviced areas (which may be managed by different utilities).

Some issues regarding charging and investment decisions

A number of participants in the study — for example, T Dwyer (sub. 52), Fitzroy Basin Food and Fibre Association (sub. 11), and A Watson (sub. 2) — have noted that institutional and regulatory arrangements governing utilities have important implications for the efficient use of rural water. In particular, concerns have been raised about:

- the charging regime adopted by utilities

- investment decisions made by utilities.

The National Water Initiative (NWI) includes a range of reforms in relation to utility charges (COAG 2004a). Many of the issues surrounding appropriate charges (including the role of cost recovery in the absence of competitive pricing) are complex, and beyond the scope of this study.

Decisions about investments in water storage and delivery infrastructure and technology affect the volumes of water that can be delivered to users without congestion problems, the reliability and timeliness of delivery, the types of irrigation technology used on-farm, and the ability to deliver environmental outcomes. This affects farmers' decisions about which crops to grow, what on-farm irrigation technologies to use, and what on-farm management practices are required. For example, the Water Steering Group for Horticulture Australia highlighted the need for water infrastructure that does not impede agricultural innovation. One of their key points was that water utilities should:

> Ensure ageing irrigation or drainage infrastructure and new irrigation schemes are designed with levels of service that do not limit horticulture's ability to adopt modern practice. (sub. 32, p. 2)

To the extent that utilities do not face sufficient incentives to perform their tasks efficiently, on-farm water-use efficiency, and the capacity for owners of water entitlements to trade seasonal allocations or entitlements, is reduced. It may also reduce the efficient reconfiguration of water infrastructure assets and the efficient allocation of water across areas. It is important, for example, that utilities do not over- or under-invest in water saving projects and that a full range of options for improving water-use efficiency be considered. All projects should be assessed for their costs and benefits (box 5.1).

A comprehensive review of the conduct and performance of utilities as they relate to water-use efficiency is beyond the scope of this study. The Commission, however, notes the importance of these issues and encourages jurisdictions to seek opportunities for improving how water utilities manage and price their assets and operations.

FINDING 5.2

The management, performance and activities of water utilities have important implications for the efficient use of rural water on- and off-farm. Improving incentives to manage water resources to maximise community benefits, and removing unjustifiable impediments to their activities, are likely to improve water-use efficiency.

Box 5.1 **Water delivery efficiency — some issues**

Delivery systems vary significantly across Australia in terms of the physical efficiency of water delivery to the farm gate. These variations are related to differences in the type of water delivery infrastructure in place, delivery capacity, and hydrological and soil conditions.

The physical efficiency of water delivery can be improved by infrastructure investments, such as lining open channels or piping some sections, or increased expenditure on maintenance, such as reducing weeds within the channel network. Infrastructure investments and higher maintenance expenditures may not, however, be economically efficient. Murray Irrigation, for example, explored options for piping some sections of its channel infrastructure, but found the high cost could not be justified because its channel system generally runs through heavy soils with limited losses. However, in areas of very high evaporation, such as the Wimmera–Mallee, which has losses estimated at 85 per cent (DSE 2005c) due to a series of 16 000 kilometres of open channel running through relatively light soils, the benefits from infrastructure investments may outweigh their costs.

Assessment of the costs of investments to increase physical efficiency should include the costs to irrigators of associated changes in the quality of the water delivery service. Channel management changes in the Murray Irrigation district, for example, have saved 30 gigalitres of water, but have diminished the level of service of water delivery to irrigators:

> A more efficient distribution of water has been achieved by Murray Irrigation Ltd. by reducing the flows from supply channels into drains. This however has reduced the flexibility of the water supply company to meet irrigators' water use as there is no spare water within the channel system. The efficiency gain in one area has been transferred to less flexibility for the irrigator. (Southern Riverina Irrigators, sub. 25, p. 3)

The Victorian Farmers Federation commented:

> Farmers are concerned that in the process of achieving 'within system' operational cost efficiencies the [a]uthorities are imposing higher costs and less efficient systems on customers … on paper these changes may appear to improve the efficiency of the water delivery system but they reduce on-farm efficiency. There may not be an overall improvement in water use efficiency. (sub. 49, p. 5)

In some cases, however, infrastructure investments to improve physical efficiency may also improve the delivery service, and these benefits should be taken into account:

> The improvements following the introduction of water on demand, or piped pressurised supply in water efficiency have been dramatic in several horticultural districts. (Horticulture Australia Water Steering Group, sub. 32, p. 7)

From a system perspective, water 'losses' from physical inefficiencies in water delivery can be true or apparent. True losses refer to water lost from the water delivery system through evaporation or recharges into saline aquifers, while apparent losses refer to groundwater recharge and return flows that are available to other water users.

Sources: DSE 2005c; MIL 2005; Pratt Water 2004; Watson 2003.

5.3 Government policies

Governments have introduced a range of policies related to agriculture, rural water and water-related markets. Some of these policies were discussed in chapters 2, 3 and 4, including the specification of entitlements and allocations, restrictions on participation in water markets, and regulation of water market transactions. Two other potentially important policies influencing rural water use are subsidies to increase physical water-use efficiency, and tax concessions for particular water-using or water-related industries.

Subsidies for physical water-use efficiency

The Australian Government and state and territory governments have run various programs that offer subsidies to increase the physical efficiency of water use (box 5.2). Some programs have been aimed at improving research and development outcomes or increasing farm productivity, while others have sought to achieve environmental goals. Many programs have multiple aims.

Sometimes, a stated goal of such subsidies is to 'speed up' the process of adopting newer, more physically efficient irrigation technologies or practices. For example, Water Smart Australia (NWC 2006c) has the specific objective of accelerating the development and uptake of 'smart' technologies and practices in water use across Australia. It is important that policies designed to accelerate the adoption of particular technologies or practices — such as the adoption of drip irrigation technologies — target market failures, or inadequacies in existing government policies, and offer net public benefits. This can be difficult to achieve. Moreover, observing what some may judge as the 'slow' uptake of technology may not necessarily reveal a policy problem. There are often sound reasons that farmers only upgrade their technologies periodically — most notably because of the cost of doing so.

The Commission has found little evidence, however, that impediments prevent farmers making appropriate private cost–benefit calculations in technology adoption decisions or choice of products. Farmers are generally well informed about new technologies and product opportunities, and incentives exist for acquiring information on technological performance and product profitability (section 5.1).

Box 5.2 Examples of subsidies to increase physical water-use efficiency

Governments provide a range of financial incentives for farmers to adopt particular water-related farm practices and technologies. These typically have multiple objectives, including improving environmental outcomes and productivity. Examples of programs offering on-farm financial incentives include:

- Irrigated Agriculture Water Use Efficiency Scheme — this program was run by the New South Wales Department of Primary Industries between 1998 and 2003, and provided financial incentives to individual irrigators to adopt and monitor best irrigation management practices and water efficient technologies.
- Water Smart Farms — this Victorian Government program is providing $15 million over five years to fund activities, such as assisting farmers in developing farm water management plans and adopting more efficient on-farm irrigation systems.
- The Victorian Government has provided a $1.5 million grant for the development of a smart water management system which uses wireless sensor technology to increase water efficiency for the food industry. The project is funded by a consortium including the Melbourne Water Research Centre, National Information and Communications Technology Australia and Goulburn–Murray Water.
- Queensland Rural Water Use Efficiency Initiative — this initiative included an ‘irrigation for profit’ program to encourage growers to use strategies to manage water efficiently. As part of the irrigation for profit program, a financial incentives scheme was introduced to subsidise growers for their outlays in adopting new irrigation technologies.
- The Pathways to Industry Environmental Management Systems Program provides additional funds to build on existing industry programs to adopt best-practice farm management. Under the program, the Australian Government has allocated $11.7 million to 19 peak bodies, research and development corporations and state farming organisations.

Sources: Brumby 2006; Crean et al. 2004; DAFF 2006; DNRMW 2006; DPI 2003; Thwaites 2004.

There has also been discussion in the media about encouraging farmers to move from one particular irrigation activity (such as dairy) to another (such as horticulture), and moving resources to ‘higher value industries’ (*The Age*, 18 December 2002; ‘Big ideas’ radio program, 14 July 2002). However, statements that water should be allocated to ‘the highest value use’ are valid only if the measurement of ‘value’ is appropriate, that is, one based on marginal values. Suggestions to divert water to ‘higher value-adding’ industries are often based on inappropriate measurements of ‘value’, such as average or ‘value added’ concepts or gross margins (box 5.3).

Box 5.3 **Allocating water to its 'highest value use'**

Traditional farm-management concepts like gross margin are sometimes used to represent the value of using water as an input into agricultural production. These ideas are widely circulated in the general public. For example, *The Age* newspaper reported:

> [A factor increasing agricultural competitiveness] has been an emphasis on getting more high-yield and more valuable agricultural production out of the precious resource of water … Water trading has enabled the transfer of water from areas of low-value production to higher-value output. For example, in beef, prime lamb or wool production, the average gross margin per megalitre of water is about $20, whereas in horticulture it is about $1000. (18 December 2002)

But gross margins per megalitre do not provide information about the value of the marginal product of water. Even if the value of the marginal product of water were equal across uses, large variations in gross margin per megalitre would be expected. The Water Steering Group for Horticulture Australia observed:

> Sustainable profitability depends on a number of things that are not well reflected in the gross return on water. Other aspects are market trend, capital and operating costs, and the need for supporting infrastructure. Governments should be discouraged from using simple gross value and gross margins in comparing the potential profitability of enterprises. (sub. 32, p. 6)

The value of the marginal product of water in a given use reflects the opportunity costs of using the water (and forgoing its use for other production) and any impact that the water use may have on other parties. It is more appropriate, therefore, to refer to water being used efficiently when it is used where it is most highly valued (in terms of water's marginal value of production), rather than when it is used in 'higher value adding industries'.

Source: Based on Douglas et al. 2004.

In terms of enabling water to move to high value uses, it is best to let farmers make decisions through efficient markets based on the specific conditions they face, rather than for governments to try to pick 'winning' products or industries. Suggestions that governments should encourage industries that generate higher average production values for each unit of water ignore the fact that efficient resource allocation is determined by the *marginal* costs and benefits of a *mix* of inputs that businesses, not governments, are best placed to determine (box 5.4).

As Watson argued:

> Water should be used in ways ensuring its marginal value is highest, including environmental uses. That principle does not require that some products are favoured in the allocation of water or that prescription of particular techniques of irrigated production is justified. Farmers are best placed to decide how water should be used given their knowledge of their own circumstances and opportunities. (2003, p. 10)

The Australian Dairy Farmers similarly argued against using the 'value added' by an industry as a basis for allocating water between industries, supporting instead the use of water trading:

> The dairy industry believes that references to 'higher value-adding uses' can embody serious over-simplifications … The ADF [Australian Dairy Farmers] supports water trading in agriculture as a valuable approach to the allocation of the resources, but strongly opposes the superimposition of the nebulous 'value-added' consideration … (sub. 12, p. 4)

Box 5.4 **Efficiency involves marginal decisions about on-farm water use**

The benefit to an irrigator of using an extra unit of water depends on the change in production from using the water, the price received for the products, the cost of the extra water, and the costs of any additional inputs associated with using the water. If all other inputs are held constant, the increase in production from applying an extra unit of water is the marginal product (MP) of the water.

Typically, at some point the MP falls as more units of water are added. The value of the marginal product (VMP) of water is determined by multiplying the MP by the price of the output (such as rice or milk). Assuming there are no changes in other costs, the VMP is the gross benefit to the irrigator from an extra unit of water.

Individual irrigators will only find it profitable to use an extra unit of water on a given crop if the VMP is greater than the marginal cost. If water can be freely traded, the marginal cost of water may be the price at which an extra unit of water can be bought or sold.

Although VMP is difficult to measure, it is the best estimate of the value of additional water (or less water) use on farm or elsewhere. It is also the best estimate of the value to the Australian economy of more or less water being applied to various uses. If an input, such as water, has a low VMP in one use and a high VMP in another, national output would be increased by transferring water at the margin from the low productivity use to the higher productivity use where the difference in VMPs exceed the costs (of transport of water between uses, for example).

National output is maximised when each factor of production (such as land, labour, capital or water) has its VMP equal across all possible uses.

Source: Douglas et al. 2004.

Providing subsidies for 'technically efficient' irrigation technologies, or for industries to increase productivity without targeting market failures or inadequate government policies, will reduce economic efficiency and involve wealth transfers from the public to benefiting irrigators. In particular, it is likely to reduce community welfare as resources are artificially diverted from other productive uses into the subsidised irrigation activity.

Subsidies may, however, increase economic efficiency if they encourage the use of technologies or the production of particular outputs (such as ecosystem goods or services) to address market failures and generate net public benefits. For example, if subsidies are targeted towards achieving desired environmental outcomes (such as salinity improvements, section 10.1, chapter 10), or provide otherwise inaccessible information and knowledge, they *may* generate net benefits, increasing economic efficiency. As with any policy decision, the costs and benefits of using subsidies need to be assessed and compared with those of alternative policies, including no action. These issues are discussed further in chapters 7 to 10.

Subsidies to support research and development activities may also address market failures and offer net community-wide benefits. This reflects the public benefits that can be derived from many aspects of research and development, and its tendency to be underprovided by markets because financial returns may not be captured from many beneficiaries. It is outside the scope of this study to examine the merit in providing support for research and development additional to that currently provided through direct funding, levies and matching funding arrangements for rural industry research, and taxation concessions.

There appears little justification for subsidies to assist businesses on the basis of difficulties in accessing finance. Capital markets in Australia generally function well, and funding is available for projects that offer adequate returns on what lenders would consider acceptable risks.

Other government policies may also distort rural water use and, hence, economic efficiency. Assistance provided to businesses in a particular industry, for example, may encourage resources, including water, to flow to those businesses at the expense of businesses in other industries that value water more highly. Examples of government assistance to agricultural industries include drought assistance and assistance programs to the sugar and ethanol industries (for more information see SCRGSP 2006).

WWF Australia noted the relevance of such issues:

> It may be useful for the Commission to consider the effect of policy settings which result in subsidies being directed towards inefficient farming practices, both with regard to physical and economic inefficiencies. Diversion of water resources into unprofitable agricultural practices as a result of drought-relief or other payments has the potential to warp a market-based approach to water use and to hamper efforts to direct scarce water resources towards the most economically productive rural practices. (sub. 34, p. 5)

While it may be useful to comprehensively review the effects that existing broader policy settings have on the efficient use of rural water, this is beyond the scope of this study.

FINDING 5.3

Government subsidies that seek to improve the uptake of particular technologies or practices solely to increase the productivity of water use are likely to be inefficient.

Taxation arrangements

Taxation policies can also effect rural water-use decisions. Several participants argued that some taxation 'concessions' distort rural water use by encouraging the development of particular primary industries which use water that would otherwise be used by other activities. For example, Sunraysia Irrigators Council stated:

> Currently there is a boom in almond plantings in the Robinvale, Boundary Bend and Wemen area. Virtually all the developments are corporate driven and aided by special tax rulings which enable investors to write off 100% of their investment in that year. This artificial investment environment is leading to many thousands of hectares of farming land being developed to almonds and also entails tens of thousands of megalitres of water to be traded in to the developments. (sub. 33, p. 2)

Most concerns about taxation 'concessions' relate to managed investment schemes (MIS). They have been an important source of investment in the development of emerging rural industries, such as blue gum plantations, viticulture, almonds and olives. MIS pool money from investors with a 'responsible entity' operating the scheme so that investors do not have day-to-day control over operations (ASIC 2005). MIS are applicable to a variety of investments other than those related to rural industries, such as cash management trusts, property trusts, and film and timeshare schemes. They operate in compliance with the *Managed Investments Act 1998* (Cwlth), and Australian Taxation Office (ATO) Taxation Rulings (for example, TR 2000/8 which ruled on deductibility of MIS fees) and Product Rulings (for example, PR2006/40 which ruled on the tax treatment of MIS type hardwood plantation schemes).

MIS offer tax features that appeal to their investors and managers, particularly:

- the generally available business deduction provision which enables the deduction of non-capital costs against all assessable income in the year of expenditure (s. 8.1, *Income Tax Assessment Act 1997* (Cwlth) and ATO TR 95/6)
- pass back of losses to investors (Lacey et al. 2005)

- a 12-month pre-payment rule for forestry, legislated in 2002. It allows, among other things, plantation managers up to 12 months to secure land and undertake plantation establishment for which the investor has claimed a tax deduction (*Taxation Laws Amendment Act (No. 1) 2002* (Cwlth)). A sunset clause of June 2006 has been extended to June 2008.

MIS tax arrangements (and similar schemes) have been contentious. They have been subject to a Senate inquiry, review by the Australian Securities and Investments Commission, ATO test cases and the introduction of ATO Product Rulings to provide greater tax certainty for investors. The Australian Government, in response to its recent review of the taxation treatment of forestry (Brough and Macdonald 2005) has proposed new taxation arrangements for investment in the industry. These include replacing the 12-month rule with new rules governing the deductibility on investments in forestry MIS (Dutton 2006). The Government has sought comment from the public on its proposal.

It has been argued that MIS have positive features (Lacey et al. 2005), have contributed to the development of rural industries (Timbercorp, sub.20; Australian Forest Growers 2005), and can have positive impacts on the environment (DEH 2005). But it has also been argued that there are problems with the way MIS are operated and regulated (Lacey et al. 2005), and that their impact can be negative (for example, Sunraysia Irrigators Council, subs. 33, DR78; Coleambally Irrigation Co-operative, subs. 3, DR64; Ricegrowers' Association of Australia, sub. DR81; Pastoralists and Graziers Association 2005; DEH 2005). Byrne, O'Brien, Eagle and McDonald noted that there were several reasons why 'market distortions [resulting from MIS] extend to the water market' (sub. DR83, p. 27) noting that MIS tree plantations reduce the supply of water to catchments, and they result in the purchase of large quantities of water which increases water prices.

An important economic question is whether industries using MIS receive 'concessional' taxation treatment. Tax 'concessions' can distort resource use and prices (including for rural water) by directing economic resources away from, or towards, particular activities, and associated losses in resource-use efficiency can ensue. The Australian Forest Growers commented that they do not receive concessional taxation treatment:

> Plantation establishment and management does not receive special incentives or subsidies. Plantation forestry operates under the same basic tax regime as other agricultural enterprises — that is, deductions are available for claimable business expenditure, and tax is paid on the profit from the enterprise. (2005, p. 1)

In relation to forestry plantations, the Department of Environment and Heritage noted:

> Current taxation treatment of managed plantation investment schemes may not be characterised as 'concessional' as such, because it is designed to equalise taxation treatment of plantations, taking into account factors such as the length of investment and 'seasonality' of expenditure. (DEH 2005, p. 4)

However, some participants argued that concessional tax treatment does occur (Sunraysia Irrigators Council, sub. 33; McCain 2005). For example, the current 12-month pre-payment rule applies only to forestry, and the MIS pass back of losses is not allowed for stockholders in companies (Lacey et al. 2005). Moreover, the general business deduction provision, when applied under MIS, becomes particularly attractive to investors because, unlike most other businesses, a significant portion of investor expense is brought up-front in a non-capital management/establishment fee which ATO Product Rulings confirm can be deducted (for example, ATO PR 2006/40).

Clearly, there are differing views on this issue. It is beyond the scope of the present study to determine whether MIS and related tax arrangements have a net positive or negative impact on the community as a whole (or on rural water use specifically), or whether they constitute a 'concession' (or subsidy) to particular industries, businesses or individuals.

6 Externalities, assessment criteria and governance issues

Key points

- Externalities are caused by incomplete specification of property rights. Further progress in reforming property rights is desirable to improve economic decision making in water allocation and use.
- Where the actions of one party create environmental externalities that significantly affect another, the parties may be able to negotiate an efficient outcome. If private action does not address an externality adequately, there may be a case for government intervention, provided the benefits of intervention exceed the costs.
- The framework used in this study to assess market mechanisms for water-related environmental externalities uses five criteria — costs, feasibility, flexibility, distribution of costs and benefits, and likelihood of achieving desired goals.
- Environmental managers may improve the efficiency and effectiveness of environmental management and service provision, the transparency and accountability of decision making, and coordination of the various agencies with water-related environmental objectives. Further research is needed, however, to establish the functions, structure and level of operation of environmental managers to ensure that these benefits are obtained.

This chapter discusses the source and nature of environmental externalities and a framework for characterising their key features. Criteria are identified to assess the relative merits of market mechanisms designed to manage environmental externalities. The chapter concludes with a discussion of some of the key governance issues associated with the management of market mechanisms, with a particular focus on the role of environmental managers.

6.1 Environmental externalities

Many different environmental changes — including changes in hydrological conditions, habitat, water quality and ecological conditions — are associated with water supply and use. These environmental changes are often associated with economic externalities.

An economic externality occurs when a side effect of a decision by an individual (or business) affects another party's wellbeing, but that effect is not taken into appropriate account by the decision maker. In terms of economic efficiency, an externality can lead to a sub-optimal outcome if the individual's decision does not take into account (internalise) the full costs or benefits from this side effect. This definition has two implications. First, if there is environmental change that results from water use but the community does not value it (either positively or negatively), an economic externality does not exist. Second, environmental change resulting from natural processes independent of actions by humans is not considered to be an externality (as it does not result from imperfect decision making).

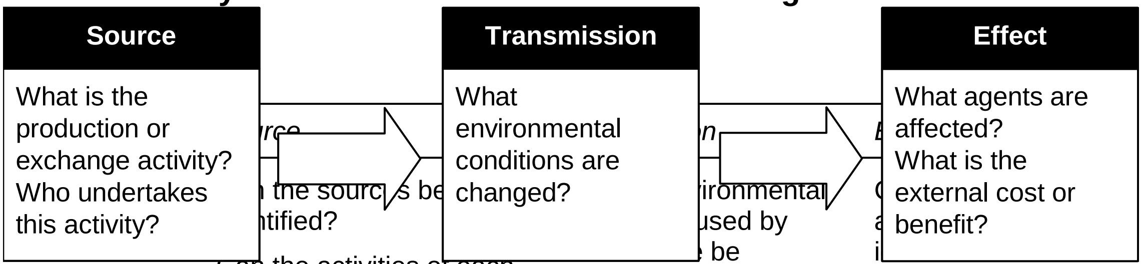
Externalities are caused by incomplete specification (or enforcement) of property rights. Complete specification of property rights is not always feasible, or the costs of complete specification (or of property right enforcement) may exceed the benefits. While further progress in reforming water property rights is desirable to improve economic decision making in water allocation and use, a range of additional measures may also be needed to address environmental externalities.

Possible measures to address a particular environmental externality can focus on any (or all) of the three basic elements that characterise an environmental externality — its source, the environmental change through which it is transmitted, and its effects (box 6.1). Dwyer et al. (2006) discussed these elements in more detail.

Action to address an environmental externality can be taken by either the individual creating the environmental change, the individual affected by the change, or a third party such as the government or a private agent. For example, saline discharges by upstream irrigators (source) may generate salinity (environmental change) that reduces downstream farmers' crop yields (effect). Actions to address the externality include (but are not limited to) measures by upstream irrigators to reduce saline discharges, switching by downstream farmers to salt-resistant crops, relocation by downstream farmers to areas not affected by salinity, or salinity mitigation works by government or the water utility (including irrigation corporations). Actions by upstream irrigators address the source of the environmental change; actions by downstream farmers deal with the effect; while the option of salinity mitigation works is directed at the transmission stage by attempting to mitigate the environmental change and avoid the external effect on downstream farmers.

From a societal point of view, the most efficient measure (or combination of measures) is the one that maximises the net benefit (overall benefits from the measure less total costs). The question of 'who pays' may be determined independently of the choice of action.

Box 6.1 **Key elements of an environmental change**



	…rce …n the sourc…s be …ntified? Can the activities of each source be observed? Do activities other than irrigation supply and use result in the externality?	*…n* …ironmental …used by …be observed and measured?	*E…* C… a… i… Can the effects be observed and measured?
Spatial variation	Where are the sources located? Are they geographically diffuse? Do many sources contribute to the same effect?	Are the sources and effects in different locations? Do the relationships between sources and effects change with location?	Where are the effects located? Are they geographically diffuse? Are many effects attributable to an individual source?
Temporal variation	To what extent do past activities have current (or future) effects? Are activities affected by the natural variability of ecosystems and ecosystem processes?	Are there time lags between source and effect? Are the lags at different temporal scales? Are relationships between sources and effects affected by natural variability?	Can effects be apportioned between past and ongoing activities? Are effects affected by natural variability?
Knowledge and uncertainty about processes	What is the nature of the relationships between sources and effects — for example, linear, increasing, decreasing, with threshold effects? Are the changes reversible or do they display hysteresis (whereby the nature of the relationship between two variables depends on whether the variables are increasing or decreasing)? Is there uncertainty about the relationship between (observable) activities and change to environmental conditions? Is there uncertainty about the relation between changes to environmental conditions and effects?		

Source: Dwyer et al. 2006.

The relative costs and effectiveness of alternative measures will be determined, in large part, by the nature of each of the three elements for a particular environmental change:

- Source — the source of an environmental change can sometimes be attributed to a specific location or person, or to multiple sources that are highly concentrated and identifiable. For other environmental changes, the source may be diffuse (non-point) and hard to identify. Identifiable concentrated sources are easier to deal with than diffuse, hard-to-identify sources.

- Transmission — scientific knowledge about how specific human activities contribute to specific environmental changes varies. Uncertainty may arise because of insufficient data, poor understanding of natural processes, lack of monitoring, natural variability in the environment, or time lags in the recognition of environmental changes. Lack of knowledge may create difficulties in designing measures to alleviate or reverse environmental changes.
- Effect — environmental changes can have different effects on a number of parties. Pollution in rivers, for example, may reduce amenity value for recreational river users, reduce crop production, and affect livestock. Multiple effects may require multiple responses.

Information obtained from an analysis of environmental changes using the framework in box 6.1 will be an important input to an assessment of market mechanisms. The framework for assessing market mechanisms used in this study is described in section 6.2.

Policy responses to environmental externalities

Where the actions of one party create environmental externalities that significantly affect another, the parties may be able to negotiate an efficient outcome, provided transaction costs are not prohibitive (Coase 1960). If private action does not address an externality adequately, there may be a case for government intervention. However, governments should intervene only when the benefits of government action are expected to outweigh the costs (including the costs of policy development, administration, monitoring, enforcement and compliance).

Policy responses to address environmental externalities fall into several categories:

- measures to improve knowledge about environmental effects, such as water education campaigns, which aim to change behaviour through information and moral suasion
- regulatory measures, such as the establishment of environmental standards or an institutional framework for water access rights
- market mechanisms (which may be underpinned by regulatory measures), being:
  - price instruments (taxes and subsidies, such as environmental charges, incentive payments, competitive tenders or auctions) that seek to change the

incentive structure for private decision making and thereby internalise the externality

  - quantity instruments (such as permits or environmental offsets) that are designed to influence behaviour by restricting the quantity of a good or level of an activity, or by allocating rights to participate in an activity
  - market friction instruments (such as information provision and measures to manage uncertainty and risk) that seek to make markets work better

- public provision of environmental services, such as government purchases of environmental water allocations.

Each of these policy mechanisms has advantages and disadvantages. Choosing the most appropriate policy response is often difficult and context-specific. An assessment of the relative costs and benefits of different policy mechanisms for achieving environmental objectives is necessary. In many cases, a combination of policy mechanisms will be optimal. For example, in the absence of fully specified property rights, regulation may be necessary to establish the institutional framework required to permit the use of a particular market mechanism. Institutional issues related to the implementation of market mechanisms are discussed in section 6.2.

From a societal perspective, there is an ‘acceptable’ level of environmental damage, where the costs of avoiding the damage outweigh the benefits of doing so. Society’s judgement as to what is an ‘acceptable’ level of environmental damage will shape governments’ environmental objectives and their policy responses. For example, policies might aim to achieve a ‘healthy, working river’ rather than a return to an earlier natural state. Environmental policies will also be influenced by obligations under international agreements, such as protection of Ramsar wetlands. Environmental policy objectives are discussed further below.

Environmental policy objectives

As with all policy instruments (including tax measures, subsidies, regulations and market mechanisms), clear specification of the environmental objectives to be targeted is essential to assess whether the mechanism has achieved its objectives. It is also essential for comparing the effectiveness of alternative mechanisms, and for ensuring that environmental water uses are economically efficient (box 6.2).

Box 6.2 **Environmental water-use efficiency**

The concept of economic efficiency applies to water used for environmental purposes. A narrow view of economic efficiency — which has been termed *environmental water-use efficiency*, *ecosystem restoration water-use efficiency*, or *managed environmental water-use efficiency* (Deason et al. 2005) — might involve government setting aside an amount of water for environmental flows that generate ecosystem services valued by members of society, with the aim of using this water in a way that brings the greatest benefit from this environmental use.

The initial allocation of water among different uses is currently achieved through administrative arrangements in water plans. In many cases, markets then redistribute the water among a range of water users, causing water to move to higher value uses at the margin. The use of markets improves economic efficiency, benefiting the community as a whole. However, constraints on the application of markets, such as who can buy and sell water and the exclusion of some water sources, can limit the gains in economic efficiency (box 1.2, chapter 1).

Ecosystem services are generated by non-consumptive uses of water (instream flows) and consumptive uses of water, such as when water leaves the river through flood events or diversions of water to wetlands, floodplains and the like. With non-consumptive uses, the water remains available for use downstream for other environmental purposes or by other users, such as irrigators. When using water to generate ecosystem services, water can provide different environmental outcomes depending on when and how it is used.

The different environmental outcomes attained, such as improvements in biodiversity or salt levels, may be difficult to measure and compare. In addition, potential externalities from environmental uses must be considered, as they are for other water uses. Delivering water to wetlands and floodplains, for example, may increase the risk of flooding to other areas by raising the river height and potentially adding to natural floods from subsidiary river flows. The delivery of water to wetlands can mobilise salt stored in the soils of these areas, for example, the Chowilla floodplain.

The Murray–Darling Basin Commission has developed a framework to assess multiple outcomes in the basin to achieve environmental water-use efficiency:

> The *Living Murray Environmental Watering Plan 2005-06* … provides an operational framework for the application of environmental water. This water plan aims to manage competing environmental objectives between sites, and includes a set of criteria to help make ‘trade-off’ decisions. For example, different sites have different requirements for water, and delivery of water at one site governs the amount available for delivery of water at another site. (Murray–Darling Basin Commission, sub. 31, pp. 3–4)

A mechanism that targets a particular environmental objective may have positive or negative effects on other environmental objectives due to hydrological and ecosystem interdependencies. Increasing river flows in particular seasons, for example, may have the primary goal of maintaining wetland health, but there may be additional environmental benefits such as salinity dilution, improvements in other aspects of water quality, and biodiversity preservation. It may be possible to maximise the environmental benefits obtained from particular policy measures by recognising and taking advantage of positive interdependencies or taking action to prevent or mitigate negative interdependencies.

While the pursuit of multiple environmental objectives may be cost-effective, it raises two important issues. First, targeting multiple objectives increases the complexity of assessing and comparing mechanisms — which require a consistent method for calculating and ranking performance across alternative mechanisms.

Second, where a mechanism is directed at achieving several objectives simultaneously, it is important to consider whether there are any conflicts between objectives and, if so, what tradeoffs between objectives are acceptable (box 6.2). The design of mechanisms targeting multiple objectives will therefore require careful attention.

Direct measurement of a mechanism's contribution to the achievement of specified environmental objectives is often not possible, due to technical measurement problems, significant time lags between action and effect, or natural variations in environmental conditions. Intermediate performance indicators may be adopted as proxies for the environmental objectives targeted by a market mechanism. For example, performance in achieving objectives related to biodiversity, habitat, fish migration, and river health may be measured using hydrological performance indicators based on flow volume, flow distribution, flow variability, connectivity of the river channel with its floodplain, and water quality. Each of these measures may itself have specific indicators — water quality, for example, may be calculated by reference to cold water releases, turbidity, salinity levels, and toxic algal blooms (Jones et al. 2002). Other potential indicators may be production-related, such as input use or technology. It is important to ensure that the performance indicators chosen are the best available measures for the target environmental objectives, given the existing state of scientific knowledge.

6.2 Assessment framework

Five criteria — costs, feasibility, flexibility, distribution of costs and benefits, and likelihood of achieving desired goals — are used to assess each market mechanism (table 6.1). These criteria are not independent. For example, information gaps that generate uncertainty about whether a specific mechanism will achieve the desired goal (the fifth criterion) also increase the desirability of flexibility (the third criterion) to adapt the use of the mechanism when better information becomes available. Further, it should be recognised that there are tradeoffs between criteria that may prevent all criteria being satisfied simultaneously. For example, improving the feasibility (the second criterion) of a specific mechanism (such as by introducing supporting regulations) may incur additional costs (the first criterion), but also increase the likelihood that the mechanism achieves the desired goal (the fifth criterion).

Table 6.1 **Criteria to aid assessment of market mechanisms**

Criterion	*Assessment*
Costs	What are the costs (such as set-up, administration, monitoring, enforcement and compliance costs) and when do they occur? Is necessary information accessible to those who may use it, and at reasonable cost?
Feasibility	Are there social, political, legal, technological or informational impediments to implementation? Is there likely to be adequate community participation and acceptance?
Flexibility	Can the mechanism adapt to changing circumstances, for example, changes in participant numbers, technology, new entrants, or new uses for the resource?
Distribution of costs and benefits	What is the distribution of costs and benefits between parties and over time? Is the distribution seen as equitable?
Likelihood of effectiveness	What is the likelihood that the market mechanism will achieve the desired goals?

The assessment framework provides a useful checklist to assist in determining the suitability of a specific mechanism to address particular environmental objectives. In addition, the framework identifies factors that would be considered in a detailed analysis of the costs and benefits of applying a specific mechanism to target certain objectives.

Costs

The nature, size and timing of costs are major considerations in whether a specific market mechanism will be efficient and effective. In comparing alternative market mechanisms for achieving specific policy objectives, costs to be considered include:

- the initial set-up costs of establishing or reforming a market, or of introducing or modifying a market mechanism

- ongoing costs of administration (including the costs of obtaining information, organising trades, or participating in tenders or auctions), monitoring and reporting for compliance, and enforcement
- opportunity costs, that is, the forgone benefits from the next best alternative use of resources.

Initial set-up costs will be influenced by the complexity of the mechanism — more complex mechanisms will be more difficult and costly to design, implement, explain and adopt. Set-up costs may be reduced by using or extending existing institutions and mechanisms, such as existing water markets or salt cap and trade mechanisms. Application of existing institutions and mechanisms to water-related externalities can reduce both design and implementation costs for governments, education costs, and the costs to market participants of adopting those mechanisms.

Ongoing costs will be influenced by the availability of timely information at reasonable cost on market prices and the characteristics of the goods or services being traded. A large degree of diversity in types of water entitlements, for example, can add to information requirements and costs when seeking to trade. However, diversity can also facilitate trade and enable water users to better match water products to needs.

Information on the environmental effects, costs and benefits of certain actions is crucial to the success of market mechanisms, such as competitive tenders for the provision of environmental services. In tender schemes, bidders must provide information on the nature of the services offered, and they require information on the costs of providing such services in order to calculate their offer price. If such information is not readily available — for example, due to knowledge gaps and uncertainty about processes — participation in such tenders may be discouraged or tender prices may be set high to compensate for the risk that costs are higher than estimated. Governments need sufficient information to be able to evaluate the relative environmental outcomes expected from different bidders, and to compare these to bid prices.

The characteristics of an environmental change in terms of observability and measurement, spatial variation and temporal variation (box 6.1) are important influences on information costs. The technical feasibility and cost of monitoring environmental effects are significant determinants of information costs, particularly those associated with quantity-based market mechanisms. Monitoring is generally more practicable and less costly for point source emissions than for diffuse emissions, where the sources of emissions may be difficult to identify. Uncertainty about the extent of compliance, due to difficulties in monitoring performance, makes enforcement more costly and, in some cases, impossible.

Spatial and temporal variations in environmental effects may require mechanisms that are site- or time-specific. The information needed to design effective site- or time-specific mechanisms may be significant, and administration, monitoring and enforcement costs may be relatively high. Failure to account for spatial and temporal variations may, however, lead to other costs in the form of greater environmental damage. For example, trading of emission permits from a reach of the river where high flows significantly dilute emissions (thus reducing their effects) to a river reach where low flows lead to little dilution may increase the environmental damage from a given level of emissions (Hatton McDonald et al. 2004). Attempts to account for spatial or temporal variations, to avoid such perverse consequences, may result in complex trading rules that increase the information requirements and ongoing costs of potential traders. Thus, in some cases, there may be tradeoffs between the effectiveness of particular mechanisms and the costs associated with those mechanisms.

The complexity of a particular market mechanism will also influence its ongoing costs. With more complex mechanisms, market participants are likely to have greater information requirements, and administration, monitoring and enforcement costs may also be relatively high.

Initial set-up costs and ongoing costs are often termed transaction costs. These types of costs are discussed further in The Allen Consulting Group (2006).

Feasibility

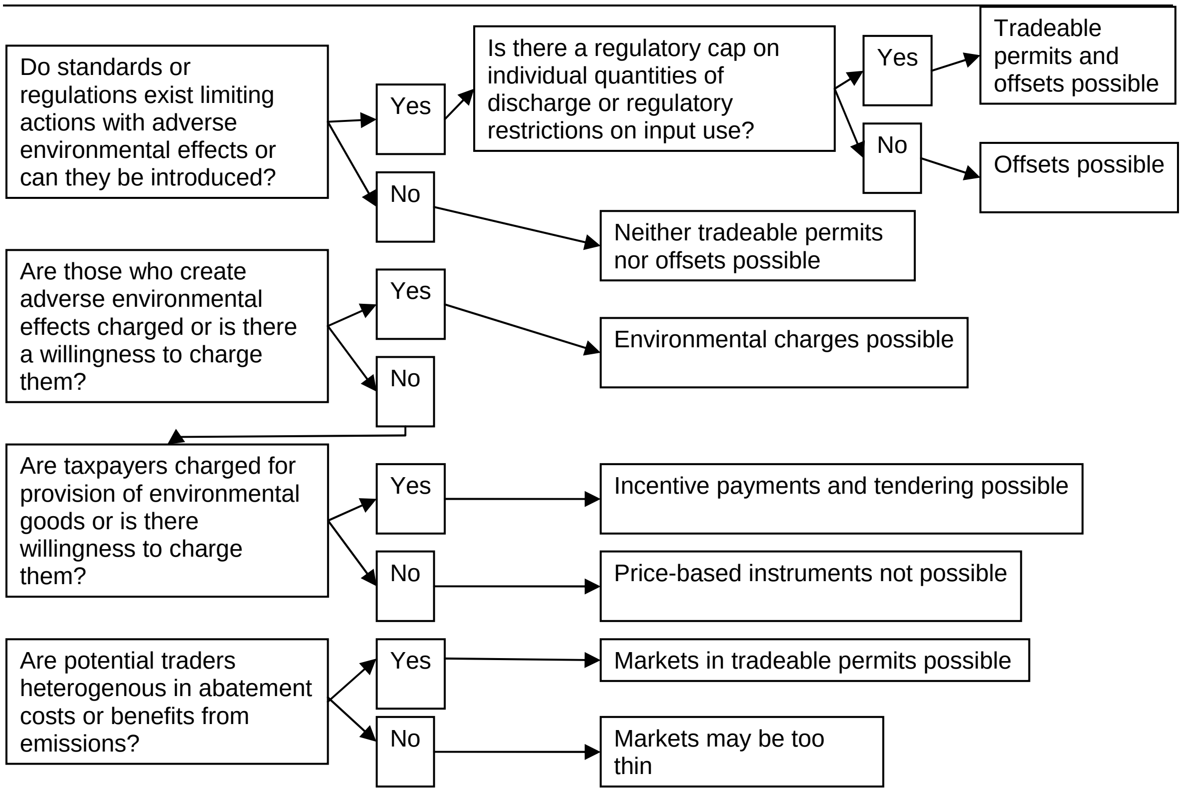
The feasibility of market mechanisms is influenced by the institutional framework, the social and political setting, the characteristics of potential market participants, technological factors, and information requirements. Some of the institutional and social factors are summarised in figure 6.1, which is based on a schema developed by Hatton McDonald et al. (2004) to assess the feasibility of market mechanisms in terms of the institutional conditions required for successful implementation.

The institutional framework, including the legal system and the existing system of property rights, provides the basis on which markets and market mechanisms operate. Regulatory or other measures, including standards, may be necessary to support the introduction of some market mechanisms. Some types of mechanisms, particularly quantity-based mechanisms such as tradeable permits, require the imposition of regulatory restrictions on quantity (such as a cap) and the creation of tradeable rights in order for a market in those rights to exist. For price-based mechanisms, feasibility is:

> … influenced by a key set of institutional rules — rules about who is held responsible to pay the costs of mitigating adverse environmental impacts … So environmental

charges are much more likely to be politically acceptable where there is some tradition of making the polluter pay. Likewise, incentive payments and tendering approaches [subsidies] are more likely to be politically acceptable where there has been a tradition of charging the general public for provision of public environmental goods. (Hatton McDonald et al. 2004, p. 33)

Figure 6.1 **Some determinants of the feasibility of market mechanisms**



Source: Adapted from Hatton McDonald et al. 2004.

The presence or absence of such institutional rules can influence the level of voluntary compliance (and consequently the need for costly enforcement activities) with some types of market mechanisms, or the level of participation for mechanisms such as competitive tenders for environmental services. A higher level of voluntary compliance, or participation in tenders or auctions, may, in turn, reduce the costs (such as monitoring and enforcement costs) associated with a particular mechanism.

The social consequences resulting from the implementation of market mechanisms, such as trading water out of rural districts, may also influence the acceptability, and therefore feasibility, of some mechanisms. The acceptability of market mechanisms may improve over time with positive experience and better understanding of, and familiarity with, these mechanisms.

In addition, the characteristics of potential market participants, and of the mechanism itself, may influence the feasibility of certain market mechanisms. Markets in tradeable permits, for example, will be more active and will operate more efficiently where traders are heterogeneous — differences in marginal costs of abatement, or in marginal benefits from emissions, among potential traders increase the gains from trade. In contrast, a thin market with little trading is likely to result where homogenous traders have a similar willingness to pay for permits. Active markets may be less likely to develop for mechanisms that are difficult and costly for potential market participants to understand and use. Complexity may therefore reduce the feasibility of market mechanisms.

Technological feasibility, and the information requirements associated with various mechanisms, may also be important in determining the circumstances when a particular market mechanism can be adopted. For example, an absence of technically feasible methods for measuring diffuse emissions may rule out the introduction of tradeable permits for such emissions. However, it may be possible, in some cases, to find satisfactory proxies for performance standards, such as adoption of best available technology or best management practice standards, which may have tradeable permits attached (Hatton McDonald et al. 2004).

Flexibility

Flexibility is important because market mechanisms that continue to provide efficient and effective solutions, over time and under a variety of conditions, will outperform those that require adjustment when circumstances change:

> A policy instrument is flexible for a resource management agency if it continues to provide the proper signal or incentive to producers in the face of changing economic and environmental relationships … An inflexible instrument would require an adjustment to continue meeting a policy goal if conditions changed. Adjusting a policy instrument may be costly. (Ribaudo et al. 1999, p. 28)

Adaptability is likely to be important given the diversity of water users and geographic locations, technological developments and innovations, and potential for water-use changes prompted by changes in market prices and other incentive structures.

Further, environmental goals may be modified as scientific knowledge and understanding of hydrological and environmental processes improve. Adaptive management — involving modifications to market mechanisms in response to scientific developments — may be an optimal response to uncertainty and scientific information gaps, and may ensure that policies are based on the best scientific information available at the time.

Spatial variations in hydrological conditions, ecological conditions, water quality and flows, and industry structure may make some market mechanisms better suited for use in particular geographic locations. Flexibility to adapt the use of market mechanisms to local conditions may improve the efficiency and effectiveness of such mechanisms. Adaptive management will permit flexibility to deal with changes in local conditions that occur over time.

Hatton McDonald et al. suggested that water markets may comprise different segments, characterised by differences in attitudes and behaviours towards water quality and the adoption of best practices, and that environmental outcomes may be maximised by a portfolio of mechanisms, each suited to different market segments:

> People in different segments would be … expected to respond differently to different policy instruments … Ideally, a mix of instruments could be devised that will result in behavioural changes in each market segment. (2004, p. 38)

Flexibility may increase the take-up of market mechanisms that improve water-use efficiency, by allowing water users and environmental service providers to choose the most appropriate and least-cost mechanism for their circumstances.

Distribution of costs and benefits

As mentioned in section 6.1, the question of who pays for measures to prevent or alleviate environmental changes may be determined independently of the choice of measure. While different market mechanisms will be associated with certain cost incidences, the overall distribution of costs may be altered by taxes or subsidies, adoption of a mix of mechanisms, or direct provision by governments. The distribution of costs and benefits (a major component of the consideration of equity) between parties and over time can affect the extent of community acceptance of a new or improved market mechanism.

Setting an explicit environmental standard can help to determine the distribution of costs of an environmental externality. Environmental standards establish 'thresholds' or 'acceptable levels' for externalities, up to which the cost of the externalities are borne by those affected. Where sufficient information is available, it may be possible to design the standard such that it coincides with the actual level at which an externality arises. Where standards are mandatory, those identified as the source of an environmental change are required to take action, at their own expense (sometimes called 'polluter pays'), to ensure that the externality does not exceed the threshold. The cost of any measures to reduce an externality below that set by the relevant standard would be borne by those taking the action, who are also likely to be the beneficiaries of those measures.

Changes in environmental standards may redistribute the costs of externalities. Standards may change over time in response to changes in community preferences or new knowledge about environmental changes and their consequences.

Likelihood of effectiveness

Meeting the desired goals is critical to the success of a market mechanism. Practical experience in the application of some market mechanisms is, however, limited and there is consequent uncertainty about the likely effectiveness of some mechanisms in achieving certain objectives. Although the Market-Based Instrument (MBI) Pilot Program funded by the National Action Plan on Salinity and Water Quality provided some important insights into cap and trade approaches, offsets, leverage funds and conservation insurance, knowledge gaps still exist for these market mechanisms. Other market mechanisms, such as options contracts and congestion auctions, have not yet undergone extensive trials or pilot programs. Adoption of an adaptive management approach may be the optimal response to uncertainty and information gaps in the existing knowledge base about the effectiveness of certain mechanisms.

Market mechanisms are often highly context-specific in the sense that their application requires attention to existing policies, the biophysical environment, and the social setting. Policymakers should consider adopting a portfolio of mechanisms that allows a choice of mechanisms to best suit the local conditions and provides for adaptation of policies to account for temporal variations in environmental changes.

The likelihood of success may change over time with changes in the institutional framework. In the absence of fully specified property rights, regulations may be necessary to establish the conditions for workable markets and to permit some types of market mechanisms to operate. Design and implementation of the necessary regulatory measures may take time.

Further, the initial adoption of market mechanisms, or the new technology required to obtain the full efficiency benefits of new practices, may be delayed by uncertainty about how the institutional rules associated with specific mechanisms may change over time (Hatton McDonald et al. 2004). For example, uncertainty about the renewals process for tradeable permits may discourage risk-averse farmers from implementing new water-use practices. Clear specification of the rules for a market mechanism, and transparency in the rule modification process, may improve the likelihood that the mechanism achieves the desired goal.

Despite encouraging signs of success in the implementation of market mechanisms, some caution should be exercised. First, reforming current and perverse incentives may be a more effective way of addressing policy goals than considering new market mechanisms. Second, poorly designed programs can impose high costs that may outweigh potential gains. Third, there is no ‘one size fits all’ approach — market mechanisms must be tailored to the circumstances. Finally, many market mechanisms have been narrowly applied, such as the range of water conservation incentives applicable to appliances, water tanks and irrigation technology. Whitten et al. noted: ‘These instruments limit community responses as much as prescriptive regulations that seek to “pick winners”’ (2003, p. 16).

FINDING 6.1

Market mechanisms to address environmental externalities need to be targeted appropriately to location and scale — no ‘one size’ fits all. Poorly designed or narrowly applied market mechanisms can impose high costs that may outweigh potential gains.

6.3 Governance framework

Increasing public and private provision of water-related environmental services, the entry of environmental service providers to water markets, and the complexity of many water-related environmental problems raise important governance issues for the management and delivery of environmental services. The COAG Water Reform Framework recommended institutional separation of the roles of water resource management, standard setting and regulatory enforcement, and service provision. Establishing separate institutions would facilitate clarification of objectives, avoidance of conflicting objectives, and improvements in accountability and transparency (NCC 2004). The National Water Commission stated:

> Environmental water should be managed in an integrated manner by having in place management entities and management practices that are accountable and effective in achieving the desired environmental and other public benefit outcomes (environmental outcomes). (NWC 2006a, p. 87)

Several participants raised the concept of an environmental manager as a means to address governance issues. Environmental groups and expert commentators (including Wentworth Group 2003; WWF Australia, sub. 34; Young and McColl 2003) have advocated the establishment of environmental managers. The National Water Initiative (NWI) states that governments have agreed to establish ‘accountable environmental water managers’ (COAG 2004a, clause 78) as part of effective and efficient management and institutional arrangements for water.

The role of environmental managers

The role of environmental managers would be to manage environmental water provisions, including trading water to meet environmental goals. In addition, an environmental manager could perform other important functions, such as:

- where necessary, prioritising environmental objectives and making appropriate tradeoffs between those that may conflict
- coordinating the implementation of mechanisms to help meet the objectives
- providing environmental services, and coordinating and managing other environmental service providers
- reporting on, and being accountable for, the performance of delivered environmental services.

Having a single entity responsible for these functions would have a number of benefits. First, it would reduce the potential for duplication and counterproductive activities, improve the consistency of environmental water activities, and thus improve the effectiveness and efficiency of environmental water management. Second, it would increase transparency and accountability in the use of public funds and environmental water entitlements. Third, comparison of the performance of environmental services delivered by the environmental manager and by other environmental service providers would increase incentives for good performance and provide greater opportunities to learn from experience.

Several different models for establishing environmental water managers have been proposed. Generally, they involve an independent, non-profit, skills-based organisation that is responsible for managing and trading water to achieve specific environmental objectives (Wentworth Group 2003; WWF Australia, sub. 34; Young and McColl 2003). The Wentworth Group (2003) supported the creation of environmental water trusts, that would work with local catchment management authorities, to manage and deliver water-related environmental services.

In establishing environmental managers, a number of practical issues need to be considered, including:

- Level of operation — for example, whether at a catchment or basin level. Consideration also needs to be given to jurisdictional authority and coordination when catchments or basins cover more than one jurisdiction. Many environmental externalities vary geographically and are affected by local conditions, but other externalities cover wider areas due to hydrological and ecological interdependencies. Environmental managers may be located at several levels, depending on the nature of the environmental objectives and strategies (box 6.3).

- Coordination mechanisms — good coordination of the different levels of environmental managers is essential to avoid overlap, duplication and/or gaps in activities and to ensure that environmental outcomes are consistent with overall environmental objectives. Murrumbidgee Private Irrigators highlighted the problems created by poor coordination of:

  … the myriad of agencies who purport to be environmental managers … We agree that there needs to be some coordination in the activities of groups seeking to obtain and/or manage environmental water. (sub. DR58, p. 5)

- Institutional structure — for example, whether to establish a trust, private corporation, independent public corporation, or government agency.
- Composition of the governing board of directors — what skills, and what degree of independence from potential conflicts of interest, are required.
- The level of public funding for environmental purposes — the NWI notes that environmental managers should be equipped with the necessary authority and resources to manage environmental water provisions to provide sufficient water at the right times and places to achieve environmental and other public benefit outcomes (COAG 2004a, clause 78). As the Australian Conservation Foundation observed:

  The environmental manager must have a very clear objective in relation to river health outcomes and it is crucial to avoid conflicting objectives. Equally as important is their capacity to participate in the market to secure and be accountable for environmental outcomes and this requires providing adequate resources and skills to the role. (sub. DR96, p. 4)

- Environmental managers' position within the existing environmental water allocation process — the administrative allocation of water for environmental purposes has the potential to crowd out innovative services that could be provided by environmental managers and other service providers. Regulations and planning processes may underprovide for environmental needs in the hope or expectation that the environmental manager will provide the additional services to meet the desired environmental standard.

Box 6.3 **Environmental management — possible institutional structure**

Environmental managers exist, or are being established, at various levels of operation, such as Australian and state government environment or resources departments, the Murray–Darling Basin Commission, catchment management authorities, and river and wetlands managers (discussed further in chapters 7 and 8). The geographical scale of some environmental issues gives rise to the need for careful coordination between the various levels of environmental managers — current arrangements have potential for coordination difficulties. In addition, environmental managers have not been established for all important environmental locations.

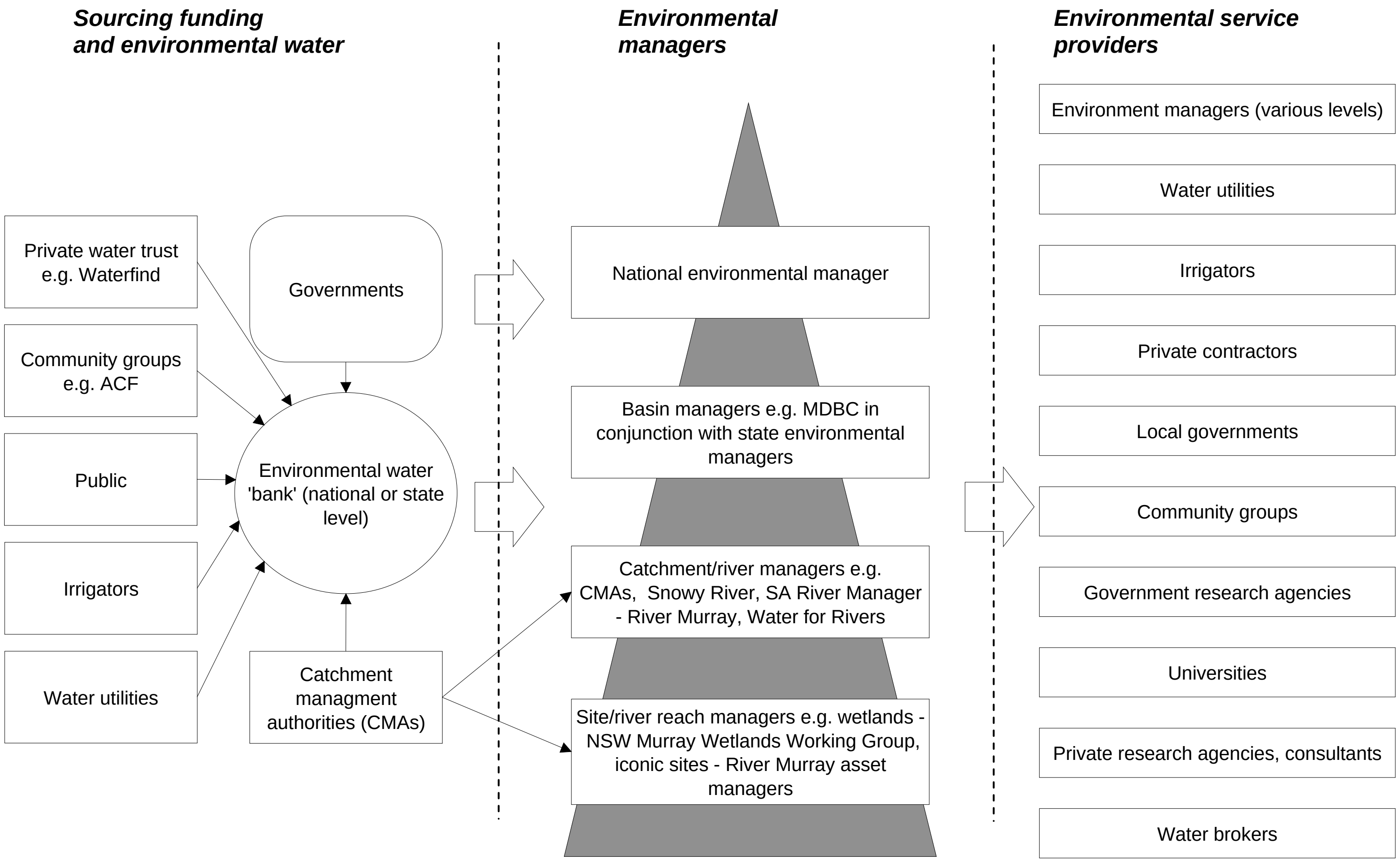
Figure 6.2 shows a possible structure for environmental management. It highlights that:

- Good coordination mechanisms are needed to organise the large number of agents involved in delivering environmental outcomes.
- Environmental managers do not need the skills to undertake all functions themselves. They can contract out environmental service provision, research and trading activities to environmental service providers. Sourcing of environmental water can be undertaken by bodies set up to accept donations of water and funds for the environment.

The structure for environmental management comprises three main components:

- Sourcing funding and environmental water — involves acquiring funds and/or water to achieve environmental objectives. Establishing a central body (such as an environmental water 'bank') to accept funds and/or water donations may help to coordinate the acquisition of water for environmental purposes as donors and environmental managers would interact though one organisation. (Connor and Young 2003 discuss potential governance arrangements for environmental water 'banks'.) Governments may still provide direct funds to environmental managers. Catchment management authorities may retain control of some environmental allocations (rather than transferring them to an environmental bank) to meet specific local environmental objectives.
- Managing environmental water — involves implementing national environmental objectives at the ground level through a tiered operating structure, ranging from a national environmental manager to site/river-specific managers. At each level, environmental managers would have clear objectives for which they would be publicly accountable.
- Providing environmental services — involves undertaking specific actions relating to the management of environmental water, such as temporarily trading allocations. Where environmental managers have the relevant expertise, they could undertake these activities themselves. Otherwise, they could contract specialists to undertake specific services. For example, environmental managers could contract private water brokers to undertake water trades on their behalf.

Figure 6.2 **Environmental management — possible institutional structure**



- Environmental manager's capacity to use water markets and other innovative solutions — environmental managers need to enter markets to source water and access the full range of water and water-related products on the same terms and conditions as other market participants (box 6.4).

Box 6.4 **Options to source water for environmental purposes**

Several participants expressed the view that environmental managers should be free to choose the most cost-effective option to obtain water for environmental purposes:

> Environmental water managers will need a variety of mechanisms for obtaining water to meet their environmental goals. In areas where infrastructure efficiencies on and off farm are high, further improvements in infrastructure might not be economically viable. For example, in some areas it might cost $4000 per ML to invest in further on-farm improvements in irrigation, while water on the market currently costs around $1400 per ML. (South Australian Government, sub. 36, p. 9)

> … if the government is able to purchase water at a lower price than the cost of achieving [physical] efficiency gains then this would be its best economic option. If the community's intention is to improve on farm water efficiency to achieve environmental outcomes then WWF considers it important [that] reducing extractions through [purchasing] irrigator's entitlements also be considered as an alternative. (WWF Australia, sub. 34, p. 6)

The NWI states that all available options for water recovery to achieve environmental and other public benefit outcomes should be considered, including 'purchase of water on the market, by tender or other market based mechanisms' (s. 79(ii)(a)) and that 'environmental managers [should be able] to trade water on temporary markets at times such water is not required to contribute towards environmental and other public benefit outcomes' (s. 79(i)(e)).

- The potential for market manipulation by environmental managers — restrictions on holdings of water entitlements by non-water users, such as environmental managers, have been justified by concerns about the potential for the misuse of market power. However, the Australian Competition and Consumer Commission found 'no evidence to suggest that this form of conduct, if possible, is more likely from non landholders or non water users' than from current landholders and water users, including large private irrigation corporations (sub. 42, p. 3).

These are important issues influencing the capacity of environmental managers to improve environmental outcomes in a cost-effective manner. A comprehensive investigation of practical options to address these issues would be beneficial, but is beyond the scope of this report.

Current environmental management framework

Most moves to date to establish environmental managers appear to involve existing catchment management authorities or natural resource management bodies, for example:

- In June 2004, New South Wales catchment management authorities were given the capacity, under amendments to the *Water Management Act 2000*, to administer environmental water as an integral part of overall catchment management. Catchment management authorities can hold licences for environmental water and establish trust funds to acquire and manage environmental water (NCC 2004).
- In Victoria, catchment management authorities are responsible for managing the operational delivery of the Environmental Water Reserve in regional areas. Legislative review is proposed to clarify the roles and responsibilities of these authorities.
- The South Australian Government recently designated the South Australian Murray–Darling Basin Natural Resources Management Board as the River Murray Environmental Manager. As environmental manager, the Board oversees environmental flow management decisions and determines priorities for state-based environmental water delivery and management. Environmental water trusts and other mechanisms have been established to accept donations of water for the environment.

There are advantages and disadvantages in using catchment management authorities as environmental managers. Some advantages include:

- lower set-up costs and shorter establishment times by using established bodies
- catchment management authorities have experience in applying an integrated approach to water and land management
- catchment management authorities can use existing networks and established links with local communities to facilitate consultation and community participation.

However, studies have identified a number of problems with catchment management authorities, including:

- lack of coordination within and between agencies (Bellamy et al. 2002; HRSCEH 2000)
- inadequate resourcing and limited revenue raising capacity (Bellamy et al. 2002)

- heavy reliance on volunteers to participate in integrated catchment management decision making bodies, which is a demanding role leading to 'burn out' and loss of experience and skills when volunteers 'retire' (Bellamy et al. 2002)
- administrative and political difficulties resulting from catchments crossing local and state government boundaries (HRSCEH 2000)
- poorly defined, and possibly conflicting, objectives (HRSCEH 2000).

In addition to catchment management authorities and natural resource management boards, other organisations providing water-related environmental services include:

- Riverbank, within the New South Wales Department of Environment and Conservation, prepares environmental watering plans and seeks funding from the New South Wales Environment Trust to purchase water entitlements to meet objectives (discussed further in chapter 8, box 8.6).
- SA Water is a statutory authority that acts as an agent of the South Australian Minister for the River Murray to purchase water entitlements for environmental purposes.
- Water for Rivers is an incorporated public company (registered as Joint Government Enterprise) formed by the Australian, New South Wales and Victorian Governments to increase environmental flows to the Snowy River and River Murray systems. It can purchase water entitlements to meet environmental objectives, prior to transferring these entitlements to a state government (discussed further in chapter 7, box 7.3)
- The New South Wales Murray Wetlands Working Group, a community-based environmental incorporated body, is responsible for managing and trading environmental flows (discussed further in chapter 8, box 8.3).
- Waterfind Environment Fund is an incorporated non-profit organisation established to promote and support environmental projects for the preservation of rivers and waterways, including by facilitating donations of water for environmental purposes.

In addition, there may be other community-based environmental organisations and other public bodies established for environmental purposes, such as the Asset Managers provided for in the Living Murray Business Plan (MDBC 2005c). These Asset Managers manage six sites along the River Murray identified as being of especially high value to society:

- the Barmah–Millewa Forest
- the Gunbower and Koondrook–Perricoota Forests
- Hattah Lakes

- the Chowilla Floodplain, including Lindsay and Wallpolla Islands
- the Murray Mouth, Coorong and Lower Lakes
- the River Murray channel.

This partial listing of the agencies operating as environmental managers and service providers highlights the large number of such bodies under existing arrangements. Some of the problems caused by poor coordination of the various bodies have been overcome by voluntary cooperation to achieve environmental goals (an example is given in box 7.5, chapter 7). Such examples highlight the potential for substantial environmental benefits to be obtained at limited cost from better coordination.

The National Water Commission is undertaking a baseline assessment of water governance arrangements, the first phase of which is to be completed in the second half of 2006.

FINDING 6.2

Environmental managers need clearly defined objectives, good coordination processes, and adequate resources. They need to enter markets to source water and to access the full range of water and water-related products on the same terms and conditions as other market participants.

RECOMMENDATION 6.1

Following a comprehensive review of the advantages and disadvantages of different institutional structures, governments should establish appropriate arrangements for environmental managers as soon as is practical.

7 Altered river flow externalities

Key points

- Externalities can occur where irrigation alters river flow volumes, flow variability, flow distribution, connectivity and water quality.
- Market mechanisms can play a role in reducing the cost of delivering environmental outcomes, including more efficiently allocating water between environmental and non-environmental uses.
- In many instances, using market mechanisms to source water for environmental purposes will be more cost-effective than investing in 'water-saving' infrastructure or providing on-farm incentives.
- A portfolio of water products will be required to deliver an environmental flow regime that balances ecological benefits associated with river flows with costs.
- Efforts to source additional water for environmental purposes are generally confined to systems that are considered to be over-allocated. Therefore, sourcing additional water is not relevant to all rivers. However, market mechanisms may nevertheless play a role in reducing the cost of delivering environmental outcomes and allocating water between environmental and non-environmental uses in other river systems.

The following two chapters discuss market mechanisms to address environmental externalities relating to altered river flows (including those that result from changes to estuaries, floodplains and wetlands). The aims of this chapter are to:

- describe environmental changes associated with altering river flows, which can lead to externalities
- discuss current and emerging approaches to addressing the effects of altered river flows, with an emphasis on those that involve sourcing additional water for environmental purposes
- discuss river flow objectives and the characteristics of water products required to meet them.

Chapter 8 assesses the feasibility of establishing market mechanisms to address environmental externalities relating to altered river flows.

7.1 Environmental changes and externalities associated with altered river flows

Irrigators access water from a variety of sources, including rivers, surface water (such as lakes) and groundwater (appendix B). Drawing water from these sources alters river flows, some more directly and rapidly than others. Using rivers as irrigation delivery and drainage systems and placing water storage on them also alters flows.

Regulating rivers and other watercourses for the purpose of irrigation alters the timing as well as the volumes of flows and affects the frequency of flow events, such as floods. In south–east Australia, naturally occurring high flows in winter and low flows in summer have been reversed in regulated rivers downstream of dams. Winter flows are intercepted to replenish dams, and rivers are used to deliver water to irrigators over the spring, summer and autumn. Some dam structures act as flood mitigation works while others allow floods to pass through. Some examples of the key environmental changes associated with the altering of river flows are summarised in table 7.1.

As discussed in chapter 2, surface water and groundwater can be highly connected and, as a consequence, river flows are also affected by groundwater extractions. Evans (2004) observed, for example, that there is substantial evidence to suggest that existing groundwater use is significantly reducing base flows to rivers in the Murray–Darling Basin (chapter 2).

The effects of flow regulation vary from river to river and within reaches of rivers. Gippel and Blackham (2002) assessed the ecological effects of flow regulation along the River Murray and identified hydrological, geomorphic and ecological changes along eight distinct zones. In all cases, the environmental changes varied in magnitude in different zones of the river. In the Hume to Yarrawonga zone, the median annual flow under current conditions is greater that it would have been under natural conditions, due to the inputs from the Snowy Scheme. In contrast, further downstream (such as at Euston) the median annual flow is significantly reduced under current conditions compared with natural flow. In a case study of the upper Murrumbidgee River, Young et al. (2001) also showed that water resource development can lead to very different flow changes (and expected ecological effects) in different locations within the same catchment and on the same river. Box 7.1 describes hydrological change associated with flow regulation in the River Murray.

Table 7.1 **Examples of environmental externalities associated with altering river flows**

Source	*Transmission*	*Effects*
(a) What is the production or exchange activity? *(b) Who undertakes this activity?*	*What changes to environmental conditions can occur?*	*Who can be affected? Are there external costs or benefits?*
1. Creation of dammed water bodies (a) Construction of reservoir and maintenance of water storage levels (b) Water utility (or other organisations) responsible for construction and operation of reservoir	Hydrology — creates a water body; alters volume and seasonality of flow downstream. Water quality — constant, stratified water levels increase risk of algal blooms. Habitat — creates non-flowing lakes upstream; reduces the amount of submerged habitat downstream. Biota — obstructs fish movement pathways; changes species distribution and biodiversity.	Landholders and businesses — benefits from flood mitigation. Recreational users — benefits from increased recreational opportunities. Tourism industry — benefits from increased tourism expenditure. Individuals — benefits and costs from changes in amenity, biodiversity, habitat, culture and/or heritage.
2. Regulation of flows (a) Presence of regulatory structures along watercourses to regulate and divert flows (b) Water utility (or other organisations) responsible for operation of reservoir	Hydrology — alters flow variability, volume, frequency and seasonality. Habitat — physical changes to the river channel and associated habitats; changes to wetland/floodplain wetting/drying regime. Water quality — changes the temporal patterns of water quality. Biota — obstructs fish movement pathways; changes species distribution and biodiversity.	Landholders and businesses — benefits from flood mitigation. Commercial and recreational fisheries — costs from decline in catch yield. Tourism industry — benefits and costs from changes in visitor expenditure. Individuals — benefits and costs from changes in amenity, biodiversity, habitat, culture and/or heritage.
3. Weir pools (a) Weirs that create weir pools from which water is diverted (b) Water utility (or other organisations) responsible for operation of reservoir	Hydrology — raises watertables locally; alters flow variability downstream; elevated and constant water levels upstream; reduced flow velocity in weir pool. Habitat — physical changes to the river channel and associated habitat; permanent inundation and degradation of wetlands. Water quality — constant, stratified water levels increase risk of algal blooms; increased sedimentation upstream of weirs. Biota — changes to biofilm and macroinverterbrate species diversity; changes to littoral plant communities.	Commercial and recreational fisheries — costs from decline in catch yield. Tourism industry — benefits and costs from changes in visitor expenditure. Individuals — benefits and costs from changes in amenity, biodiversity, habitat, culture and/or heritage.

(continued next page)

Table 7.1 (continued)

Source	*Transmission*	*Effects*
4. Cold water dam releases (a) Releases of cold water from low level outlets in reservoir for irrigation (b) Water utility responsible for operation of reservoir	Water quality — decreases downstream water temperature; increases nutrient load and concentrations of natural toxicants such as hydrogen sulphide and heavy metals. Biota — decline in fish species richness and composition.	Commercial and recreational fisheries — costs from decline in catch yield. Tourism industry — costs from decline in visitor expenditure. Individuals — costs from changes in amenity, biodiversity, habitat, culture and/or heritage.
5. Rapid changes in river height (a) Storage releases that cause rapid rises and falls in river height (b) Water utility responsible for operation of reservoir	Hydrology — increased flow variability downstream (daily time scale). Habitat — physical changes to the river channel and associated habitat. Water quality — increases turbidity and sediment transport (through erosion). Biota — indirect effects through changes in habitat availability.	Commercial and recreational fisheries — costs from changes in catch yield and flow regime. Tourism industry — benefits and costs from changes in tourism expenditure. Individuals — costs from changes in amenity, biodiversity, habitat, culture and/or heritage.

Sources: Dwyer et al. 2006, based on Ball et al. 2001; Gippel and Blackham 2002; Murray–Darling Basin Commission, pers. comm., 20 July 2006; Thoms et al. 2000.

Box 7.1 **Hydrological effects of flow regulation on the River Murray**

Hydrological changes are generally measured by comparing modelled current flow data to modelled ‘natural’ data drawn from periods prior to the construction of storage and diversion structures. Commonly documented changes to flow regulation on the River Murray, for example, include:

- a reduction in the frequency and duration of small to medium sized floods
- an unseasonal shift to high flows in summer and low flows in winter below major storages and upstream of major diversion points
- reduced total volume of flow
- increased flow in some reaches resulting from interbasin transfers, such as the Snowy Mountains Scheme
- reduced velocity, increased depth and the removal of drying cycles for the river channel and wetlands upstream of locks and weirs
- modified day-to-day variation in flows (rates of rise and fall).

Sources: Gippel and Blackham 2002; Maheshwari et al. 1995; MDBC 2002; Murray–Darling Basin Commission, pers. comm., 20 July 2006; Roberts and Marston 2000; Thoms et al. 2000; Young 2001.

Time lags between the operation of infrastructure and the environmental effects vary. Decreased (or increased) flooding frequency, for example, may lead to changes in wetlands over several decades, resulting in adverse environmental outcomes, such as an increasing death rate in mature trees, the failure of seeds to germinate, a reduction in the abundance of floristic species, and a decline in fish and waterbird populations. In contrast, constructing a new dam can lead to the local extinction of a fish species in only a few years by impeding fish migration. Environmental changes transmitted through groundwater recharge (such as downstream salinity) may occur some time after water has been delivered if groundwater movement is slow.

Understanding and documentation of the ecological consequences of altered river flows are still in relatively early stages of development because ecological responses are complex, often delayed, and can manifest in a location that is distant from the site of the hydrological disturbance (Gippel and Blackham 2002). In contrast, historical and ongoing flow data are available at small time-steps, which enables analysis and modelling of the hydrological changes resulting from river regulation. Examples of the source, transmission and effects of environmental externalities associated with altered river flows are summarised in table 7.1.

7.2 Current and emerging approaches to addressing the effects of altered river flows

One of the main approaches governments use to address the effects of altered river flows is to source additional water for environmental purposes. To date, governments have mainly focused on sourcing water through regulatory instruments and infrastructure investment. Some governments are, however, developing ways of sourcing water via water markets.

Efforts to source additional water for environmental purposes are generally confined to systems that are considered to be over-allocated. Therefore, sourcing additional water is not relevant to all rivers. However, market mechanisms may nevertheless play a role in reducing the cost of delivering environmental outcomes and allocating water between environmental and non-environmental uses in other river systems.

While chapters 7 and 8 focus on approaches to address altered flows in the Murray–Darling Basin, the same broad market-based approaches might be applicable in other river systems with similar problems (such as declining water quality or occasional congestion).

Reserving water for environmental purposes using regulatory instruments

Water planning continues to underpin arrangements within jurisdictions to allocate water among different environmental and non-environmental uses (box 7.2). There are three broad approaches to reserving water for environmental flows:

- prescribing environmental flows
- allocating water to the environment in the form of an environmental allocation
- changing existing access rights.

These approaches need not be mutually exclusive.

Environmental flow requirements can be prescribed by defining base flows, flow events (flooding, drying events), the timing of flows, and minimum and maximum flows at certain check points in a river. Hydrological modelling and environmental impact studies are used to identify environmental requirements, with the principal objective being to mimic the natural flow pattern of the watercourse. Distributors or the river manager are required to ensure that environmental requirements are satisfied, using powers that are given to them to restrict the volume and timing of water extractions by rights holders (PC 2003).

An alternative approach is for governments to allocate quantities of water for environmental purposes to an agency that is responsible for managing environmental flows, which may or may not be a distributor. These environmental allocations can be specified as non-transferable water allocations or as environmental water rights. The latter possess a separate legal title and are transferable. In New South Wales, Victoria and South Australia, water has been allocated for environmental purposes (PC 2003).

In some jurisdictions, governments can obtain additional water for environmental purposes by reducing the volume of water attached to existing water entitlements. This changes water entitlements to return the level of extractions to sustainable levels so that environmental objectives can be met.

With a few exceptions, environmental flows are determined through water resource plans, which are prepared for surface water and groundwater sources. These plans are developed to meet a range of policy objectives that include meeting the needs of environmental and non-environmental users. There may be a hierarchy of plans, with strategic plans providing a framework for more detailed operational plans, which cover the management of diversions and flows and may also govern the distribution of water. Plans are developed through a process of community consultation. Because scientific knowledge and community preferences change over time, most Australian jurisdictions have statutory requirements to undertake periodic reviews of allocations for environmental purposes (PC 2003).

Box 7.2 Water resource plans and the allocation of water

In Australia, legislative responsibility for water resources lies with the States. In most jurisdictions, water resource plans are used to fulfil water planning objectives contained within the relevant legislation. Water planning in New South Wales, for example, is governed by the *Water Management Act 2000*. Water Sharing Plans established by this Act are the main planning mechanism used to determine the amount of water available for environmental services and to other water users.

Plans are developed to meet a range of policy objectives including meeting the needs of non-consumptive uses (such as providing water for environmental services), as well as ensuring certainty of supply to consumptive users. When water resource plans were first introduced, a common objective was to make the definition and allocation of water rights consistent with the new legislation. In preparing plans, the legislation usually requires that water resource agencies consider the environmental, economic and social benefits and costs of the proposed allocations.

Water resource plans are developed with an expectation that on occasion, water may, or will, be re-allocated administratively between uses. Hence, plans usually last for a predetermined period and often incorporate periodic review.

Arrangements for providing water for environmental purposes in particular, differ between jurisdictions. New South Wales, for example, uses statutory management plans to determine:

- environmental health water — water committed exclusively for ecosystem health
- supplementary environmental water — water committed for a specified environmental purpose at specific times or under specific circumstances
- adaptive environmental water — water committed to a specific environmental purpose by a right holder
- river flow rules.

In Queensland, environmental flow objectives are defined in Water Resource Plans established under the *Water Act 2000*. These plans also determine associated performance indicators and water allocation security objectives.

In Victoria, the *Water (Resources Management) Act 2005* establishes an Environmental Water Reserve using various mechanisms to limit the volume of water made available to consumptive uses and, in some regulated rivers, by establishing environmental entitlements. Under the Act, all or part of an environmental entitlement may be traded as a seasonal allocation, where this does not affect the achievement of the objectives of the Environmental Water Reserve.

Sources: NSW Government, sub. 41; PC 2003; Queensland Government, sub. 38; Victorian Government, sub. 39.

Some participants questioned the applicability of market mechanisms for their jurisdiction:

> Within the Queensland framework, the concept of trading water for the environment is not applicable because the water available in the market is that which has been deemed available for consumptive purposes (after consideration of environmental requirements). The role of the market (for the environment) in this context would be limited to the management of issues of over allocation, whereby the government wishes to see a general and permanent reduction in the total volume available for consumptive use. (SunWater, DR67, p. 1)

> The rules based approach is fully adequate in Queensland because modern planning has been introduced before resources have been over-allocated. However, in over-allocated systems such as the Southern Murray Darling the holding and active management of water access entitlements for environmental outcomes may be needed to supplement the rules based approach. Water access entitlement based provisions for the environment should be recognised as a possible supplementation of the rules based provisions, rather than an alternative. (Department of Natural Resources, Mines and Water (Qld), sub. DR85, p. 2)

As noted in this and earlier reports, the Commission recognises that some jurisdictions rely in whole or in part on a rules based system to provide for environmental flows, as opposed to making a specific allocation of water for environmental purposes. Nevertheless, the Commission has also noted:

> Environmental flow requirements can provide water for environmental purposes without necessarily employing water that has been allocated for the specific and exclusive use of the environment. This is achieved by restricting when downstream users can take their water, and could require them to invest in on-farm storage. However, such rules can at times be complex and lack transparency (Australian Conservation Foundation, pers. comm., 18 July 2003). They are also potentially less flexible than if environmental flows were managed by a dedicated environmental manager.

> Where environmental allocations are made, the purchase of transferable environmental water rights can be an efficient means of re-allocating water between consumptive and non-consumptive uses. Water is obtained at the lowest cost because water users placing the lowest value on water are the most likely to transfer water to the environment (Siebert et al. 2000). (PC 2003, p. 237)

A problem that can affect planning regimes is a lack of transparency when identifying and weighing up the disparate interests within the community in the absence of market signals to reveal preferences. The Productivity Commission (2003) found that, while most Australian jurisdictions impose statutory requirements to consider the social and economic impacts of allocation decisions, comprehensive social cost–benefit studies are generally not conducted. Moreover, the method used in the assessment of impacts is not consistent between jurisdictions or, in some cases, between catchments within jurisdictions. The Commission concluded:

> … it is not always clear how the competing needs of water uses were balanced in the final allocative decision. This lack of transparency is exacerbated by the absence of comprehensive analysis of each of the alternative options … (PC 2003, p. 152)

The National Water Commission's 2005 *National Competition Policy Water Reform Assessment* reported several examples of where planning processes lacked transparency in terms of tradeoffs between environmental and other purposes. The National Water Commission noted, for example:

> [In New South Wales] … planning has lacked transparency in … the way in which trade-offs were reached between consumptive and environmental water in plans. (NWC 2006a, p. iii)
>
> [In South Australia] … the Commission considers that there are issues with the transparency of the trade-offs between the environment and consumptive use, and with the clarity of determining environmental water requirements. (NWC 2006a, p. xvi)

Although planning processes are integral to the efficient allocation of water between environmental and non-environmental uses, an over-reliance on non-market allocative processes can crowd out more efficient market mechanisms. Market mechanisms not only provide for mutually beneficial exchanges between environmental and non-environmental water users, they can also make allocative decisions more transparent, by revealing the value of water in other uses (chapter 1).

FINDING 7.1

Administrative arrangements to allocate water for environmental purposes conceal the opportunity cost of meeting environmental objectives and can crowd out more efficient market mechanisms.

Investing in off-farm infrastructure

Governments have invested in off-farm infrastructure projects to source additional water for environmental purposes in south–east Australia. Two major programs are the Living Murray Initiative and Water for Rivers.

Cost of off-farm infrastructure

The Murray–Darling Basin Ministerial Council established the Living Murray Initiative in 2002 in response to concerns about the health of the River Murray system. This led to the Living Murray 'First Step' decision, which involves the New South Wales, Victorian, South Australian, ACT and Australian governments investing $500 million to source 500 gigalitres of water for six key ecological assets over five years from 2004-05. An Intergovernmental Agreement on Addressing Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin (IGA) signed in June 2004 provides for implementation of the 'First Step' decision (MDBC 2006i). The Australian Government recently announced plans to provide an additional $500 million in funding to the Murray–Darling Basin Commission, including $200 million to contribute towards achieving the Living Murray 'First Step' target of sourcing 500 gigalitres per year for environmental flows (MDBC 2006a).

Water for Rivers is a joint government enterprise between the New South Wales, Victorian and Australian governments that aims to source water for environmental flows in line with the Snowy Water Inquiry Outcomes Implementation Deed. Governments have committed $375 million progressively through to June 2012 to source 282 gigalitres of water for environmental flows for the Snowy River (212 gigalitres) and the River Murray (70 gigalitres) (Water for Rivers 2006a). Other state-based water-saving projects, such as those undertaken by the Victorian Water Trust, are also underway.

To date, the Living Murray and Water for Rivers have focused on sourcing water via engineering projects that reduce water 'losses' from publicly-owned storages and delivery infrastructure (box 7.3) (MDBC 2006i; Turnbull 2006c; Water for Rivers 2006b). Examples include lining channels, installing pipelines, and installing metering systems (MDBC 2006i; Water for Rivers 2006b).

A 2003 review of the scope for water savings to meet increased environmental flows prepared for the Murray–Darling Basin Commission, however, indicated that the engineering projects considered were generally more costly than purchasing water entitlements from irrigators. Using $1000 per megalitre as an upperbound estimate for the price of an entitlement, the consultant noted:

> On the basis of the information available it is concluded that … there are limited opportunities for water use efficiency savings at a marginal cost of less than $1000/ML … (ACIL Tasman 2003, p. xi)

The consultant also noted that the cost of sourcing water through remaining off-farm infrastructure options (that sourced water for above the market price for entitlements) would increase sharply as least-cost projects were progressively exploited:

> The information indicates that there could be up to 365 GL of potential savings at a marginal cost of around $1000/ML to $1500/ML. Costs then rise reaching $4500/ML at around 420 GL … Above 488 GL marginal costs rise sharply … (ACIL Tasman 2003, p. x)

Box 7.3 **Water for Rivers**

Water for Rivers is the registered business name of Joint Government Enterprise Limited, a public company incorporated in December 2003 following legal agreements by the Australian, New South Wales and Victorian governments to achieve ‘significant improvements in environmental flows into the Snowy River and the River Murray’ (Water for Rivers 2006a). Water for Rivers’ purpose is to:

> … improve the health of the Snowy River and River Murray by acquiring water efficiency savings to enable additional dedicated environmental flows of 212GL for the Snowy River and 70GL for the River Murray by the end of June 2012. (Water for Rivers 2006c)

While Water for Rivers’ primary means of sourcing water is through infrastructure investment, it has the option of purchasing entitlements. On its website, Water for Rivers’ listed business activities include:

- investigating water efficiency projects, including potential opportunities for saving water or purchasing water entitlements
- if necessary, purchasing water entitlements from willing sellers in the River Murray upstream of the South Australian border, the Murrumbidgee River system and the Goulburn River system.

Sources: Deamer 2005; Smith, N., Water for Rivers, pers. comm., 17 July 2006; Water For Rivers 2006a, 2006b, 2006c.

The IGA includes provisions to ‘expeditiously identify’ eligible measures for accreditation against funding commitments, to implement the Living Murray ‘First Step’ (COAG 2004b). Signatories to the IGA agreed that, in the first three months from the commencement of the Agreement, a proposal for water recovery would be deemed to be an accredited measure for the purposes of the Agreement, and for crediting volumes of water recovered and the value thereof, if it met certain conditions. Two of these conditions were that the proposal acquired water at ‘a price not exceeding $1000 per megalitre of Long-Term Diversion Cap equivalent water’ and that ‘at the time it is registered, could not be substituted by any other proposal available at the time at the same or lesser cost’ (clause 36). The IGA states that proposals can aggregate the cost of individual sub-components:

> A proposed measure nominated to the register may comprise a number of identifiable sub-components, where such an aggregation is necessary to the feasibility and effectiveness of the proposal. Such a proposal will be assessed as a single measure and may not be disaggregated except at the discretion of the nominating Party. (COAG 2004b, clause 28)

Four proposals have been added to the Living Murray Eligible Measures register so far, two from New South Wales and two from Victoria. Among these proposals, there are four infrastructure projects. Two of these projects will source water for more than $1000 per megalitre — the Greater Darling Anabranch stock and domestic pipeline ($1150 per megalitre) and the reconfiguration component of the Goulburn–Murray water recovery package ($2000 per megalitre). Although works undertaken as part of decommissioning Lake Mokoan have been credited to the Living Murray Eligible Measures register at a cost of approximately $570 per megalitre, the total cost of the project — which is jointly funded by Water for Rivers and the Joint Victorian and South Australian River Murray Environmental Flows Fund — is expected to average approximately $1300 per megalitre (Deamer 2005; DSE 2004; MDBC 2006i; MDBMC 2005).

Although infrastructure projects undertaken by Water for Rivers are outside the scope of the IGA, they do compete for 'savings' with IGA projects and have generally cost more than $1000 per megalitre. Past projects include the Normanville pipeline ($2320 per megalitre) and the Woorinen stock and domestic pipeline ($6000 per megalitre). Current projects include the reduction of evaporation from Barren Box Swamp ($1500 per megalitre), the Wah Wah stock and domestic channel delivery system ($1670 per megalitre) and the Tungamah stock and domestic pipeline ($4250 per megalitre) (Deamer 2005; Water for Rivers 2006b).

In some cases, infrastructure projects that source additional water for environmental flows may have other benefits. ACIL Tasman (2003), for example, pointed out that, while the water savings from the Pyramid Creek groundwater interception scheme were small, the scheme was likely to exhibit significant 'positive externalities' by reducing highly saline inflows. Decommissioning Lake Mokoan is expected to regenerate one of Victoria's largest wetlands (a total of eight swamps) with a total area of 2100 hectares (Victorian Government 2004). The proposed Shepparton Total Channel Control project is expected to have benefits to environmental users and irrigators:

> Currently, outfall water mixes with irrigation tail-water and surface runoff and can be quite high in nutrients at the point of outfall. This may be the cause of negative environmental impacts in the rivers and streams immediately downstream. Hence, diversion of some of these outfalls is presently encouraged to minimise risks to the environment. A reduction in outfalls is likely to benefit the downstream environment by reducing the volume of water causing this environmental damage. However, there will be some decrease in irrigation water available for drain diverters.
>
> As well as benefits for the environment, significant benefits exist for irrigators within the supply system. Primarily, TCC [Total Channel Control] allows an improved service through higher and more consistent flow rates, reduced notice of order and the immediate confirmation of orders. The improved responsiveness of the water delivery system will enable more flexible on-farm management. (MDBC 2006h, p. 2)

The availability of water sourced through infrastructure investment depends on where investment opportunities can be identified. As a result, water sourced through infrastructure investment may not have supply characteristics, such as reliability or access to carryover, that match environmental need. For example, the Australian Conservation Foundation observed:

> We are concerned that some water recovery processes in Australia are proceeding without any understanding or consideration of what the ecological needs of the asset in question are and they are failing therefore to recover water with the right sort of characteristics, in terms of level of security, capacity for carry-over in dams etc. This is happening because the water recovery process is based on where [physical] efficiency measures can be easily identified rather than identifying the required flow characteristics and then developing a portfolio of water products that match those characteristics. (sub. 45, p. 8)

Although water sourced through infrastructure investments may not have the characteristics required for some environmental purposes, it will be well matched to others. High security supply that characterises many infrastructure savings, for example, is effective in providing base flows.

A focus on infrastructure projects, rather than considering the full range of water sourcing alternatives, may affect the timeliness with which water is made available for environmental purposes. The Murray–Darling Basin Ministerial Council released data that suggest the volume of water expected to be sourced through projects on the Living Murray Eligible Measures register and other proposed water recovery projects (which largely comprise off-farm infrastructure projects) is likely to be 40 per cent less than the target established under the Living Murray 'First Step' of 500 gigalitres by 2009 (MDBMC 2005). The Hon. Malcolm Turnbull MP has also identified the relatively slow progress in sourcing water for the Living Murray 'First Step':

> To date the focus has been on funding water efficiency infrastructure projects to be presented by the States. Only one project has reached a point where investment can be committed. At the current rate of progress it is likely that we will miss the 500 GL target by at least 200 GL or more. (Turnbull 2006c, p. 1)

Water 'savings' from infrastructure investment

Although water sourced through infrastructure investment is commonly described as a water saving, these 'savings' can be illusory — the saved water has simply been removed from other uses or sources. Capturing return flows that contribute to downstream allocations, for example, does not create overall system savings. Depending on the interconnectedness of surface water and groundwater, lining channels may reduce local groundwater sources (Gyles 2003). In Coleambally, for example, investment in total channel control has reduced water available to water users in the Coleambally Outfall Drain.

> Landholders along the drain have access to Class F 'opportunistic flow' (with no entitlement) and Class G (3477 ML — based on 15 ML per 1000 hectares) Stock and

> Tank Fill Entitlement … Customers on the Outfall Drain did have the opportunity to acquire water allocation in the 1980s but did not believe this was necessary as they did not foresee that water distribution efficiency in the CIA [Coleambally Irrigation Area] could improve to the extent of vastly diminishing their 'opportunistic' source of water … it is reasonable to expect that opportunistic flows in the Outfall Drain will continue to diminish as further LWMP [Land and Water Management Plan] initiatives are implemented and CICL [Coleambally Irrigation Co-operative Limited] rolls out TCC [Total Channel Control] over a larger area of the Irrigation District. (Coleambally Irrigation Co-operative, sub. 3, pp. 34-35).

Murray Irrigation also noted the potential for water 'savings' to be illusory:

> … there is significant risk that future investment in infrastructure projects which attempt to reduce river losses are highly likely to reduce water available to other users; they will require very close scrutiny. (sub. DR92, p. 18)

True water savings are only made when losses that cannot be recaptured are reduced or eliminated. Projects that reduce evaporation and accessions to saline groundwater tables yield true water savings (Pratt Water 2004).

In some cases, efforts have been made to take into account the effects of water-saving projects on downstream uses. The Woorinen pipeline in Victoria, for example, was initially meant to source 2100 megalitres of water 'lost' from the channel system. However, some of this water flowed into a drainage basin that was important in sustaining a rare fish species living in the drainage basin and for migratory birds. Consequently, the water-savings target for the Woorinen pipeline was reduced by 600 megalitres, the amount necessary to provide the water regime required to sustain the fish species and the bird habitat (Goulburn Broken Catchment Management Authority, pers. comm., 1 August 2006).

Where 'savings' reduce water availability to other users (such as downstream irrigators), those users may enter markets to source the volumes they have lost. If this occurs, the induced purchases can have a similar effect to either an environmental manager directly purchasing the water in existing markets or re-allocating the water away from non-environmental uses via planning arrangements.

FINDING 7.2

Opportunities to source water for environmental purposes through infrastructure investment, at a cost below the current price for entitlements, appear limited. Further, sourcing water through 'water-saving' infrastructure investment may reduce water available for other uses.

Providing on-farm incentives

Governments occasionally offer irrigators incentives to undertake on-farm infrastructure investment to increase physical water-use efficiency. These incentives are sometimes claimed to be justified on the grounds that they will reduce overall water use by irrigators and hence make more water available for environmental purposes. Government programs targeting physical water-use efficiency through direct financial incentives in Australia include the Rural Water Use Efficiency program (Queensland), Water Smart Farms (Victoria) and, until recently, the Irrigated Agriculture Water Use Efficiency Incentive Scheme under the Water Reform Structural Adjustment Program (New South Wales).

On-farm incentives are unlikely to be cost-effective where the primary objective is to source water for environmental purposes. Any opportunities to source water at a cost below the market price for water are likely to be exploited by irrigators through private investment in water-use efficiency. Hence, it will generally be less expensive for governments to source water through markets:

> While it appears that there could be considerable technical scope for improving water application efficiency, it is also likely that those that are currently economic have been (or are being) implemented. (ACIL Tasman 2003, p. xi)

On-farm incentives that require a portion of the water savings to be returned to government are more likely to source water for environmental purposes than those that do not. If governments retain the right to saved water, it can be transferred to an environmental manager or service provider. The benefit to irrigators, in this case, may come from labour-saving technology or improvements in product quality. If irrigators retain the right to 'saved' water, on the other hand, it may simply be used to expand production.

The transaction costs associated with negotiating with farmers to secure water savings may make such programs infeasible. The Victorian Department of Sustainability and Environment's Water Smart Farms program highlights some of the implementation issues that can arise when trying to source water for environmental purposes through on-farm incentives. The program, which provides for the government to negotiate a share of on-farm savings (proportional to its financial contribution) for environmental flows based on an explicit upfront agreement, has not been able to secure water for environmental flows:

> There are currently no viable programs or mechanisms to efficiently secure water savings for environmental flows from on-farm activities. The high transaction costs to do so, plus the lack of incentive for irrigators to participate in such a scheme, have not made this an attractive option for securing water for environmental flows to date … In many instances water-use efficiency on farm does not lead to significant water savings.

> There would be a very high administrative cost in demonstrating and capturing these savings for environmental returns. (DSE 2005b, p. 5)

Programs that attempt to increase environmental flows through on-farm incentives for water-use efficiency may be counterproductive (Appels et al. 2004). Potential outcomes from providing incentives to increase on-farm water-use efficiency include:

- expansion of land under irrigation (if farmers receive the water 'savings' from improvements in water-use efficiency)
- reduction in return flows to rivers, which currently contribute to environmental flows
- distortion of investment decisions, including crop choice.

It should be noted, however, that increasing physical water-use efficiency can serve objectives other than freeing up water for flows. Other objectives may include reducing negative environmental effects, such as salinisation, waterlogging or nutrient discharge, or improving farmer profitability.

The Australian Government recently announced plans to invite tender proposals, including from individual farmers, to undertake works to improve physical water-use efficiency and then transfer recovered water to environmental purposes (box 7.4) (Turnbull 2006c). Careful design will be required to ensure water-use incentives are appropriately targeted, for example:

- if the purpose of the tenders is to encourage water-use efficiency, in principle, they should not be made available for infrastructure investments that have already occurred
- incentives are likely to be better targeted at existing irrigation operations — greenfield developments do not face issues with sunk infrastructure investments and already have sufficient incentives to adopt the most economically efficient irrigation technologies
- the market price for water will provide a floor for tender offers — if significant volumes of water are purchased at a premium through the tender scheme, the market price for water will rise.

While details of the proposal are yet to be released, the Hon. Malcolm Turnbull MP has commented that the government is not expecting to pay 'above or significantly above market' for water:

> 'It would be a waste of time … [for sellers] to offer water at massively above market prices … We hope that through the tender we will be able to buy water but if it's offered at prices way above market … it won't be bought on that basis'. (Malcolm Turnbull, Parliamentary Secretary to the Prime Minister, quoted in Sellars 2006).

The Victorian Farmers Federation, however, suggests prices sought by irrigators are likely to be well above current market prices:

> '[I] would have thought (the price) would need to be 30-50 per cent above market value to make it worthwhile … Most of [the opportunities to source water] under $1500 per megalitre … people have already had a crack at … Most of the savings seem to be above that'. (Geoff Akers, Chairman, Victorian Farmers Federation Water Resources Committee, quoted in Sellars 2006).

Box 7.4 **Australian Government Tender Proposal**

On 28 April 2006, Malcolm Turnbull, Parliamentary Secretary to the Prime Minister, announced that the Australian Government would propose that 'in order to meet the 2009 target to restore 500 gigalitres of water to the River Murray, the participating governments should purchase water from willing sellers on conditions that will ensure the water sold does not reduce the productive capacity of farming communities'. The proposal involves inviting tenders from willing participants to undertake 'water efficiency measures' and then transfer recovered water to environmental purposes. Under the proposal, water recovered from measures completed since 2004 would also be eligible.

Key elements of the tender proposal include:

- water must have become available through water efficiency measures
- anyone entitled to water from the Murray system can submit a tender (including governments, irrigation companies, towns and individual farmers)
- there would be no limits on price or volumes of water that can be offered
- governments would not be obliged to buy a particular quantity of water at a particular price.

The framework for the Australian Government's tender proposal was submitted to the Murray-Darling Basin Ministerial Council at the Council's May 18 meeting. The Council's communiqué noted:

> [The Council] … agreed that jurisdictions would work cooperatively with the Australian Government to enable a call for proposals to be issued by end July 2006 with the aim of commencing investments by mid-December 2006. (MDBMC 2006, p. 1)

Further details of the proposal were not publicly available at the time of this report's publication.

Sources: MDBMC 2006; Turnbull 2006c.

FINDING 7.3

On-farm incentives are unlikely to be cost-effective where the primary objective is to source water for environmental purposes.

Purchasing water

Another means of sourcing water for environment purposes is purchasing water through water markets. The New South Wales Government recently announced plans to set up a $105 million environmental fund to buy water for the State's most stressed rivers and wetlands over the next five years:

> NSW RiverBank will take a commercial approach to acquiring water from willing sellers within the existing water sharing and water management framework, without compromising the rights of existing water users … NSW RiverBank will consider innovative means and partnerships for water access, including potential competitive tender processes and options contracts, and will participate in the trading of annual water allocations where this is consistent with its objectives. (NSW Government, sub. 41, p. 6)

Examples of other plans to purchase water for environmental purposes include:

- South Australia recently announced plans to meet part of its water recovery obligations under the Living Murray 'First Step' by purchasing entitlements from willing sellers.
- New South Wales has indicated it will recover 9 gigalitres for the Living Murray 'First Step' through 'innovative water products', such as leases. It has also indicated it will recover 12 gigalitres for the 'First Step' by purchasing entitlements from irrigators in the Poon Boon Lakes area (ACF 2006).

The Australian Conservation Foundation expressed concern that some parties to the National Water Initiative (NWI) and the Living Murray are resisting the use of market mechanisms to address over-extraction:

> We see no grounds for adopting such an ongoing position. Market mechanisms should be used as one element in a portfolio of water recovery mechanisms, as detailed in the NWI, to address over extraction.
>
> Failing to use market mechanisms will limit water recovery opportunities and drive investment in less cost-effective measures rather than maximise return on the taxpayers' investment. Also, because of the time needed to build infrastructure etc for water efficiency measures, rejecting market mechanisms can delay policy implementation. (sub. 45, p. 4)

The Murray–Darling Basin Ministerial Council agreed in September 2005 to investigate sourcing water through market mechanisms to complement existing infrastructure projects (Murray–Darling Basin Commission, sub. 31). BDA Group's *Issues and Options for applying market based measures in the Living Murray First Step* was publicly released following the Ministerial Council's May 2006 meeting (BDA 2006).

Senior government officials have highlighted the need to explore markets as a means of sourcing water for environmental purposes:

> … it is increasingly difficult to see how the Living Murray Initiative target can be met without the purchase of water for the environment by governments. (Turnbull 2006a, p. 3)
>
> The market is the next step. (Peter Cullen, Commissioner, National Water Commission, quoted in Wahlquist 2006)

Purchasing water can include, but need not be limited to, entitlements, seasonal allocations and other water products such as leases and contracts. A range of purchasing mechanisms is possible, including purchase on the open market, by tender or negotiated contract (section 7.3).

Who should pay for water is a separate question and not necessarily related to economic efficiency. Funding for water purchases, for example, could come from tax payers, through levies on water users, donations or some combination of these.

7.3 Design issues

This section discusses design issues relating to the use of market mechanisms for procuring water and water-related products to meet river flow objectives. First, it discusses the need for environmental managers to clarify river flow objectives and to consider competing objectives such as reducing third-party effects. Then it discusses how these river flow objectives can be addressed through a combination of water product portfolios, water-related products (such as rights to river capacity), and non-market management options.

Clarifying and balancing objectives

The objective of an environmental flow regime should be to achieve the greatest benefit to society by balancing ecological benefits associated with river flows with the costs. To do this, river flow objectives need to be understood, both in terms of specific river flow attributes and the overall flow profile they collectively require — recognising the inherent uncertainty that surrounds this process. Once this is done, environmental managers and service providers can choose water products and other management options that deliver the environmental flow profile in a cost-effective manner.

Environmental flows promote a variety of ecological benefits, which are often expressed in terms of ecological outcomes or indicators (such as maintaining healthy populations of resident native fish or protecting wetlands). Because of the complex relationship between ecological condition and river flows, hydrological indicators are often used as a practical means of measuring river health. River health can be defined by a range of hydrological attributes (table 7.2). Jones et al. (2002) defined five river attributes to serve as proxies for ecological condition: flow volume, flow distribution, flow variability, connectivity and water quality.

Jones et al. (2002) stressed that hydrological outcomes are only an interim performance measure and ecological outcomes and indicators will signal the long-term effectiveness of river management. Further, environmental flows are only one aspect of maintaining and/or improving river health. Other factors such as the condition of its catchment and floodplain lands and in-channel habitats are also important determinants of river health.

As environmental managers and service providers enter water markets and water-related markets (such as potential markets for river capacity), consideration should be given to the potential third-party effects of altering river flows. Various river users will be affected by changing river heights, such as tourist providers, riverboat owners, recreational users, and individuals and communities reliant on the river for drinking water supplies. Infrastructure investment may be required to alter drinking water off-takes on rivers or create off-river storages to address river flow variability and water quality issues.

Altering river flows through water markets and water-related markets can address the environmental effects associated with the use of rivers as delivery systems. Rivers perform drainage as well as supply functions, and there will need to be a balance struck where these functions conflict. Coordination by an environmental manager will be needed to clarify objectives and balance the tradeoffs. In some cases, environmental mangers may be able to partner with other river users to achieve their objectives (box 7.5).

Given the complex biophysical relationships, market mechanisms designed to address flows could also play a crucial role in addressing other environmental changes associated with rural water use. Care is required not to manage the source of environmental effects in isolation. There can be synergies through the careful integration of environmental objectives that can result in win–win opportunities, such as integrating salinity and flows management (chapter 10).

Table 7.2 **System-level attributes, key threats, environmental flow requirements and hydrological indicators for the River Murray system**

Attribute	*Key Threat*	*Environmental Flow Requirement*	*Hydrological Indicator*
Flow volume	Reduced flow volume	Increase flow volume in river channel and across floodplain	Median annual flow (GL/year)
			Total volume of flow >channel capacity (GL)
			Average time above significant floodplain inundation threshold (months/year)
Flow distribution	High summer flows	Reduce summer flows in upper Murray	Median summer flow (Nov–March) (GL/month)
	Loss of flood flow sequence (small to medium floods)	Ensure flood flows are followed by a flow of similar magnitude at an interval promoted towards natural	Median event interval (commence to flow)
			Median event interval (significant floodplain inundation)
Flow variability	Reduced flow range	Increase range of flows on a seasonal basis	Seasonal amplitude index
	Constant flows	Avoid unnaturally prolonged periods of constant river height	75th percentile of daily change in river level (cm/day)(Nov–Feb)
	Unnatural rates of change in river height	The rate of change of the rising and falling limbs of the hydrograph should remain within the natural range	na
Connectivity	Reduced flood plain inundation	Promote towards natural the frequency and duration of flood plain inundation	Median event duration Frequency of events
	Barriers to in-channel fish movement	Enhance opportunities for weir drown-out	Weir drown-out (percentage of years)
			Lock 1 drowned-out (Sep–March)
Flow-related water quality	Cold water release from large dams	Ensure downstream water temperature is within natural seasonal range and changes at close to natural rates	na
	Reduced instream productivity due to high summer turbidity	More natural proportion of Darling River discharge to the Murray during period from November to March	Percentage of Darling water of total at lock 10 (average: Nov–Feb)
	Increased frequency of toxic cyanobacterial blooms	Reduce weir pool residence times to less than ten days	Percentage of years lock 3 < 4000 ML/day Nov–Apr (moderate security threshold)
	Unnatural salination	Maximise river flows for salt dilution purposes, within the natural range	Salinity (average level in EC at Morgan)

na Not assessed in this specific example.

Source: Jones et al. 2002.

Box 7.5 **Coordinating water delivery to achieve environmental objectives**

In 2003-04, extreme drought conditions in the Campaspe River Basin meant that flows in the Campaspe River were much lower than normal. In 2003, a group headed by Goulburn–Murray Water (the water utility) looked at potential impacts of the drought in the coming year, the environmental risks, and what mitigation options (if any) were available. For the lowest section of river (from Rochester to Echuca where the Campaspe flows into the River Murray), under most drought scenarios, the river was projected to be dry from December to June.

In the same year, water was scheduled to be transferred from Goulburn–Murray storages to the River Murray via the Goulburn River. Because the Goulburn River is connected to the Campaspe by irrigation channels, there was an opportunity to divert some of this water from the Goulburn River, through the irrigation channels and into the Campaspe River at Rochester. From there, the water could run down the Campaspe River providing environmental benefits before flowing into the River Murray.

One concern was the additional loss of water that would be incurred by sending the water to the Murray by a less efficient path than the Goulburn River. The Department of Sustainability and Environment, the manager of the Northern Victorian Flora and Fauna Entitlement (used for watering wetlands in Northern Victoria), allocated part of that entitlement to meet the estimated increase in losses. Consequently, flows were provided in the lower Campaspe from December to April.

Through the cooperation of water supply system managers (Goulburn–Murray Water and River Murray Water) and environmental managers (North Central Catchment Management Authority and Department of Sustainability and Environment) the drought threat to the lower Campaspe River was avoided for relatively little water lost.

Source: Goulburn Broken Catchment Management Authority, pers. comm., 19 July 2006.

Water product portfolios

Environmental managers and service providers could potentially use a range of water products, such as entitlements, seasonal allocations, and derivative products (including leases and options contracts). Which products they prefer will depend on specific environmental needs, costs, expectations about future events and attitudes toward risk. They may want to:

- source water at short notice to meet short-term environmental needs
- minimise the opportunity cost of the water used for environmental needs
- minimise transaction costs and infrastructure charges
- protect against reductions in future water supply
- limit ongoing budgetary expenses.

Different water products will have different strengths and weaknesses. Purchasing seasonal allocations, for example, would be effective for sourcing water at short notice, while purchasing entitlements would offer a hedge against reductions in future water supply. Consequently, environmental managers and service providers would benefit from being able to select a portfolio, according to their various priorities, from a diverse set of water products.

Environmental managers and service providers will require a portfolio of water products to yield an environmental flow profile to meet river flow objectives at least cost. The initial step is to obtain greater access to existing markets, and the next is to investigate the potential to develop new products.

The IGA allows for the 'purchase of water on the market, by tender or by other market-based mechanisms' (clause 23 ii) to recover or manage water to meet the environmental water needs of the significant ecological assets identified under the Living Murray (COAG 2004b). However, clauses that focus on the permanent recovery of water may act as an impediment to the development of environmental flow portfolios:

> The objectives of this Agreement include: … to implement arrangements for cost-effective, permanent, recovery of water to achieve the agreed environmental objectives of the Living Murray First Step decision … (clause 16 ii)
>
> Water recovered under this Agreement will be held permanently within the water allocation and access entitlement frameworks … (clause 19)
>
> Any proposed measure nominated to the register will include the means by which the recovered water will be permanently secured through statutory instruments … (clause 29)
>
> Water recovered under this Agreement will be clearly assigned in perpetuity for the purposes of this agreement in licences and associated water accounts … (clause 52). (COAG 2004b)

Purchasing a portfolio of water products is likely to reduce the costs of delivering water for environmental outcomes and improve the flexibility in how that the outcomes are achieved. However, existing institutional arrangements may not be sufficiently flexible for this to occur.

RECOMMENDATION 7.1

Environmental managers should develop portfolios of water products, where appropriate, to deliver environmental flows in a timely and cost-effective manner.

Water-related products

Sourcing water will be effective in achieving some, but not all, river flow objectives. A river flow objective relating to flow variability, for example, may require less flow passing down a river at certain times to prevent prolonged periods of high and constant river height. River flow objectives that require less flow are currently managed by imposing conditions on the operation of water storages and delivery infrastructure. River Murray Water, for example, releases water to ‘meet the needs of irrigators and flows for South Australia within constraints such as minimum flow requirements, dilution of salinity, maximum rates of change of water level, and capacity of the river channels’ (MDBC 2005d). (See *The Living Murray Foundation Report on the significant ecological assets targeted in the First Step Decision* (MDBC 2005e) for examples of operating procedures and practices to protect environmental values.) As discussed in chapter 8, there may be scope for designing products based on river capacity to address these types of objectives.

Integrating market and non-market management options for environmental flows

Achieving river flow objectives at least cost will require a combination of market and non-market mechanisms (box 7.6). In some cases, non-market approaches will be the best, or only, option for achieving certain river flow objectives. Cold water release, for example, is primarily related to dam off-take heights. Engineering solutions are currently the main management option for this issue.

Box 7.6 **Improving delivery and management of environmental flows**

Governments have introduced programs to assist river flow managers to optimise the benefits from existing and future environmental flows. These programs include investigating operational and structural changes to water delivery infrastructure to more effectively target river flow objectives. Projects being undertaken as part of the $150 million Living Murray Environmental Works and Measures program, for example, include construction of flow management structures and channels in Gunbower to deliver water to wetland and forest ecosystems and modification of locks and weirs in the Chowilla floodplain to allow more effective watering.

The Australian Government recently announced that it will provide an additional $500 million in funding for the Murray–Darling Basin Commission to ‘boost progress with The Living Murray Environmental Works and Measures program and to restore the rate of delivery of the salt interception schemes aimed at diverting saline groundwater before it enters the river at various points’ (MDBC 2006a, p. 1).

Sources: MDBC 2004b, 2006a.

Water products and water-related products (such as rights to river capacity) may be less cost-effective in some river reaches, compared with non-market options. Managing flooding by altering the way infrastructure is operated, for example, may provide higher net benefits than implementing specifically designed water and water-related products. River operators have developed a number of innovative ways of operating infrastructure to address river flow objectives (box 7.7).

Box 7.7 **Addressing river flow objectives through changes to the operation of water infrastructure**

River managers have developed ways of operating water infrastructure that reduce the negative environmental effects from rural water supply. River Murray Water, for example, uses a cyclic release pattern for transfers from Dartmouth Dam to Hume Weir to improve ecological outcomes in the Mitta Mitta River.

River flow in the Mitta Mitta is highly regulated by Dartmouth Dam. The timing and duration of releases from Dartmouth depend on the status of the other storages in the River Murray system, particularly Hume Reservoir. In wetter years, when Dartmouth nears capacity, 'harmony transfers' are made to Hume Reservoir to minimise the chance of spills (transferring water from Dartmouth to Hume equalises the probability of spills at each dam).

River Murray Water's management of 'harmony transfers' attempts to minimise flood plain inundation and maintain relatively constant discharge levels. This can, however, result in constant flow conditions, which can have a detrimental effect on the instream and floodplain environments.

River Murray Water's cyclic release pattern introduces flow variability to transfers from Dartmouth Dam to Hume Weir without greatly affecting total flow volume. An initial study of the effects of cyclic release patterns on ecological outcomes by Sutherland, Ryder and Watts (2002) found improvements in a range of water quality and biotic parameters.

Sources: Johnstone Centre nd; Sutherland et al. 2002.

Mechanisms for procuring water and water-related products

The choice of mechanism for procuring water products and water-related products (such as rights to river capacity) will affect whether river flow objectives are met at least cost. Mechanism choice heavily influences transaction costs and the overall budget for acquiring water and water-related products. It also influences environmental outcomes because it determines the breadth of participants buying and selling water and water-related products (which determines the range of products available to environmental managers and service providers) and influences how quickly water can be sourced.

Environmental managers and service providers could use various mechanisms to procure water and water-related products. For example, Quiggin has proposed that an alternative to standing in markets to purchase entitlements would be to 'enter into formal or informal contracts with entitlement holders, whereby users receive the current benefit in return for a commitment to forgo usage rights in the future' (2005, p. 1). Quiggin argues that if entitlement holders have high discount rates, such a scheme may permit a substantial reduction in use over time at a relatively low cost.

Each procurement mechanism has its strengths and weaknesses and so their effectiveness will often depend on the particular context:

> Purchasing approaches could involve irrigation authorities, irrigators along specified supply channels, or individual irrigators … [T]rade prices could be established through bilateral negotiation, government standing in the water market, or competitive tender.
>
> These options embody varying complexity, transaction costs and administrative and legislative requirements. These factors need to be compared with their relative efficiency in bringing the widest possible range of sellers to the market, their ability to price discriminate within that market and ability to incorporate broader non-market factors – such as implications for salinity and infrastructure viability. Ultimately, a balance between instrument efficiency and workability will be required. (BDA Group 2006, p. 22)

Chapter 8 provides specific examples of how some these mechanisms may be employed to develop a portfolio of water products.

Environmental carryover

Carryover provisions can provide water users with increased flexibility in their intertemporal water-use decisions. In addition to the potential gains to irrigators from relaxing carryover provisions, discussed in chapter 3, there may also be benefits to environmental managers. Relaxing carryover rules for environmental allocations (entitlements) would give environmental managers greater flexibility to meet environmental objectives, particularly where watering requirements are highly variable from year to year (BDA 2006). Apart from carryover provisions that apply to general security entitlements in New South Wales, some environmental allocations (entitlements) also have access to carryover.

- Under Victoria's Goulburn–Murray water recovery package, new lower reliability entitlements for environmental purposes will be able to be used over an extended period up to the end of December in the following water year.
- Up to 3.5 times the Barmah–Millewa Forest environmental allocation (entitlement) can be carried over in storage. (BDA 2006)

While carryover has its advantages for environmental managers, depending on its design, it can affect the reliability of supply for other entitlement holders. Also, if carryover arrangements were introduced to environmental entitlements and trade permitted in these entitlements, the issue of how differences in carryover provisions are treated would need to be resolved (BDA 2006). Ricegrowers' Association of Australia, for example, noted:

> RGA [Ricegrowers' Association of Australia] are concerned about the potential for third party impacts from changing the characteristics of existing water to environmental water. In NSW, this has happened on a number of occasions. For example, the Barmah-Millewa Forest allocation was initially 50 GL of general security water. Somewhere the decision was made to make this high security water – but no conversion factor was applied (at the time this should have delivered 25 GL of high security water). This water is also now capable of being carried over for up to six years. In NSW, high security water is expressly excluded from being carried over … the Barmah-Millewa Forest example has created impacts to other water users, particularly general security irrigators. (Ricegrowers' Association of Australia, DR81, p. 11)

The benefits from relaxing carryover provisions for environmental entitlements will be less if environmental managers have access to a wider selection of water products, such as seasonal allocations or options, than if they only had access to entitlements. This is because, like carryover, these water products are a means of overcoming some of the inflexibility associated with holding only entitlements, which supply a relatively fixed supply of water from year to year (chapter 8).

8 Assessing market mechanisms for altered river flows

Key points

- There are often more flexible and cost-effective measures than purchasing entitlements or investing in 'water-saving' infrastructure to source additional water to meet river flow objectives.
- Creating tradeable rights to river capacity may help achieve some river flow objectives, such as influencing river heights or reducing flooding.
- It is difficult to devise efficient and effective taxes on rural water use to address environmental externalities.
- An agency should be established as soon as practicable for the purpose of acquiring water for the Living Murray Initiative. This agency should acquire a range of water and water-related products, rather than acquiring water through infrastructure investments and purchase of water entitlements alone.

This chapter assesses the feasibility of establishing market mechanisms to address environmental externalities relating to altered river flows. In particular, it assesses market mechanisms to acquire water products and water-related products (such as rights to river capacity) to meet river flow objectives. It also assesses other market mechanisms for addressing river flow externalities that target water and land use.

8.1 Assessment of market mechanisms to procure water and water-related products

The following section is divided into two parts: water markets and water-related markets (such as rights to river capacity). The first part discusses the strengths and weaknesses of using different market mechanisms to source water to meet river flow objectives. The second part discusses the scope for addressing river flow-related environmental externalities through markets for access to river capacity.

Water markets

As with other products — such as land, machinery and housing — purchasing an entitlement (or 'ownership' of the asset) may not suit users' needs as well as other forms of exchange, such as leasing. Environmental managers or service providers could potentially use a range of approaches to source additional water for environmental purposes. Some key approaches include:

- enter existing markets for water entitlements and seasonal allocations
- negotiate contracts that specify the right to use seasonal allocations under entitlement for a given period when certain pre-determined conditions are met (leases for entitlements)
- negotiate contracts that specify the right to purchase, or forgo the right to purchase, water under certain predetermined conditions (options contracts)
- purchase entitlements, alter their property right provisions and then sell them back to irrigators (covenants).

The following assessments compare the relative strengths and weaknesses of various water products for sourcing additional water for environmental purposes. The first assessment considers trade in existing markets for entitlements without trade in seasonal allocations. This serves as the benchmark case against which other water products are assessed. In all cases, it is assumed that the environmental manager or service provider starts with an initial base of entitlements, which they are seeking to augment with other water products.

Trade in existing markets for water entitlements

Purchasing entitlements is a means of acquiring ongoing access to water for environmental purposes. An entitlement provides a right to a specific quantity or share of water (seasonal allocation) in each irrigation season. Some unused seasonal allocations can be carried over from year to year, when there is sufficient dam capacity and institutional arrangements allow. Purchases of entitlements for environmental purposes could be funded by government or private endowments or, eventually, through revenue generated from the sale or lease of seasonal allocations under entitlement in years where seasonal allocations exceed environmental requirements (the latter would, however, require access to other markets). Also, irrigators may choose to donate entitlements (box 8.1).

Purchasing entitlements is often a more flexible and cost-effective mechanism for sourcing water for environmental purposes than investing in 'water-saving' infrastructure projects (table 8.1). Purchasing entitlements is not only likely to

Box 8.1 **Environmental water donations**

Voluntary donations are another source of water for environmental purposes. The South Australian Government, for example, is developing a structured system of donating water to achieve environmental outcomes in the River Murray. Donation options include:

- providing water for on-site or local environmental watering projects, accredited by South Australia's River Murray Environmental Manager
- donating seasonal allocations or entitlements to the Environmental Manager, who will direct the water to prioritised projects
- donating seasonal allocations or entitlements to an environmental water trust to be allocated to community groups, or the environmental manager, or to use on watering projects accredited by the Environmental Manager.

To encourage donations, the South Australian Government will exempt donated water from fees and stamp duty and provide refunds for all or part of the River Murray Levy. In addition, the Australian Government (through the Australian Government Water Fund) and the Waterfind Environmental Fund are funding the development of a web-based environmental water trading system in South Australia, which will incorporate donations and provide accountability through an online register.

The Minister for the River Murray, Karlene Maywald, recently announced that more than eight gigalitres in seasonal allocations have been diverted to environmental projects along the river in South Australia as a result of donations of water by irrigators, industry organisations and community groups. Examples of donations include:

- irrigators in the Riverland donated seasonal allocations to local projects at Katarapko, Clarke's Floodplain, Riversleigh and Paringa
- SA Water donated five gigalitres of seasonal allocations to maintain fish passageways at Tauwitcherie and Goolwa
- the Foster's wine group donated one gigalitre of seasonal allocations to water the Markaranka Floodplain near Waikerie
- In June 2005, Timbercorp donated 500 megalitres of seasonal allocations to water red gums in the Murray River National Park.

Other states are also developing ways to facilitate environmental donations. For example, the Mallee Catchment Management Authority, in partnership with the Department of Sustainability and Environment, Parks Victoria, First Mildura Irrigation Trust and Lower Murray Water, will coordinate environmental donations for seven priority sites in Victoria's north–west this year. The program builds on a pilot program established in 2005, in which 1.3 gigalitres of water was donated by 67 local irrigators to stressed river red gum and black box trees on the region's floodplains. As discussed in box 8.6, NSW RiverBank will explore the feasibility of establishing facilities for individuals or groups to donate water.

Sources: Department of Water, Land and Biodiversity Conservation, pers.comm., 2 August 2006; Government of South Australia nd; *Land and Water News,* 5 July 2006; Mallee Catchment Management Authority 2005; NWC 2006b.

Table 8.1 **Trade in entitlements without seasonal trade**

Criterion	*Assessment*
Costs	High — involves relatively high administrative costs, application fees, registration fees, brokerage, exit fees and taxes. Subdividing entitlement before trade involves additional costs. Involves ongoing infrastructure charges. When water under entitlement temporarily exceeds environmental needs, excess water has an opportunity cost if not traded or carried over. Purchase involves relatively large upfront budget outlay (but lower than sourcing water through infrastructure investments) and ongoing outlays to cover infrastructure charges. Revenue from selling entitlements can be used to buy other entitlements that better match environmental needs.
Feasibility	Medium to high — markets for entitlements are already in place in Australia's main irrigation areas (progress remains to be made for interdistrict trade). Purchasing entitlements is subject to relatively stringent trade restrictions. Purchasing entitlements for environmental purposes is less favoured by many irrigators and rural communities compared with other ways of sourcing water.
Flexibility	Low — difficult to match relatively fixed water supply from entitlements to variable environmental needs. Acquiring a portfolio of entitlements can, however, reduce extent of temporary shortfalls or excesses in supply. Markets offer greater scope for building portfolios than infrastructure investment and can access water in a more timely manner. High transaction costs and relatively long waiting times to process trades mean that entitlements are not suitable for responding to temporary shortfalls or excesses in supply.
Distribution of costs and benefits	Cost to tax payers or other interested parties. Benefits to seller and parties that value improved environmental outcomes. Potential positive and negative third-party impacts.
Likelihood of achieving desired goals	Low to medium — effective in meeting fixed water demands. Not effective for adaptive management.

provide water in a more timely manner, it also allows environmental managers and service providers to match the characteristics of the water that is sourced to environmental requirements. While some infrastructure investments may have benefits other than sourcing water, current market prices for entitlements are generally below the cost of proposed infrastructure projects.

Entitlements provide environmental managers and service providers with ongoing access to water and are therefore useful for providing base flows that are relatively stable from year to year. By using a portfolio of entitlements with different levels of reliability, environmental managers and service providers could also generate a more variable water supply to reflect annual variation in environmental water requirements. Lower security entitlements, for example, could be used to provide water mainly required in wetter years. The development of tagged trading, which facilitates interjurisdictional trade, is likely to assist environmental managers and service providers to build portfolios of water entitlements (chapter 7).

The relatively fixed supply of water available from a portfolio of entitlements is unlikely to match variable environmental needs from year to year. Where entitlements only are used to meet environmental requirements, there will be either excesses or shortfalls in water available to environmental managers or service providers from year to year. Temporary shortfalls in water supply may have negative environmental effects if water cannot be sourced quickly. Excess annual water supply will increase the opportunity cost of meeting river flow objectives if water cannot be traded or carried over.

Purchasing entitlements is ineffective in responding to temporary shortfalls in water availability. Long waiting periods would cause lags between the time a shortfall is identified and when water is available. In the interim, there may be negative environmental effects. In some cases, the demand for additional water — for example, for a particular seasonal flow — will have passed before the transaction is complete. Further, relatively large transactions costs reduce the incentive to purchase entitlements to meet smaller or temporary changes in demand (chapter 4).

Because entitlements cannot be traded quickly and at low cost, the value of unused (or excess) water supplies can only be realised, in the short term, if environmental managers and service providers can carry over or trade seasonal allocations. In the long term, environmental managers and service providers can buy and sell entitlements to better match their entitlement portfolio to environmental requirements, and hence reduce the extent of oversupply. Environmental requirements may, however, change over time.

Purchasing entitlements involves a large upfront budget outlay and payment of ongoing infrastructure charges. Water recovered under the Intergovernmental Agreement on Addressing Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin (IGA) may be traded on the ‘permanent market’ (market for entitlements) only if the outcome of the transaction is to use the revenue derived to acquire water access entitlements which better match the requirements of the Basin Environmental Watering Plan (clause 71).

Trade in existing markets for seasonal allocations

Purchasing seasonal allocations is a means of accessing water for environmental purposes, within an irrigation season, without the need to own an entitlement. There are fewer barriers to trade in seasonal allocations, and the cost of exchange is less than for entitlements. Seasonal allocations could be gifted by irrigators, funded on an ongoing basis by governments or private groups, or funded from revenue generated by sales of seasonal allocations under entitlements. Purchased seasonal allocations that are not used can be carried over from year to year where there is sufficient dam capacity and institutional arrangements allow.

Trade in seasonal allocations could be used to manage differences between water available under entitlement and environmental requirements. Seasonal allocations could be bought or sold depending on the circumstance in a given year. In some districts, there may also be potential to establish markets for seasonal allocations prior to the commencement of the irrigation season when seasonal markets are normally inactive (box 8.2). The National Water Initiative and IGA provide for seasonal allocations held under entitlements to be traded at times when this is not contrary to specified environmental objectives. However, the purchase of seasonal allocations for environmental purposes is generally not undertaken.

Box 8.2 **Markets for forward allocations**

In some cases, environmental managers may need to source additional water before the start of the irrigation season. If so, they may be unable to acquire water from irrigators because irrigators will not yet have seasonal allocations under their entitlements to trade or the markets for seasonal allocations are very thin.

One approach is to allow irrigators to trade water in advance of the irrigation season as the water storages are being filled. If some reserves already exist, it may be possible to trade a portion of the expected seasonal allocation (a ‘forward allocation’). Consequently, an expected seasonal allocation could effectively be split into a highly secure guaranteed volume available on call prior to the irrigation season and a less secure component that is dependent on the progress of the refill. Once these arrangements are established, an environmental manager could either purchase seasonal allocations directly from irrigators or use derivative products, such as contracts or leases.

A potential issue to consider with forward allocations, however, is how to manage the risk to third parties when expectations about seasonal allocations are greatly overestimated. The Ricegrowers’ Association of Australia noted:

> If irrigators trade a seasonal allocation before it is actually received and the environmental manager uses this non-existent water, the water used by the environmental manager will in fact belong to another water user, such as general security irrigators who have carried over water. Such a situation would create individualised third party impacts. This would be an untenable situation and one which RGA would find most egregious. (sub. DR81, p. 12)

Trade in seasonal allocations would give environmental managers and service providers greater flexibility to respond to temporary shortfalls in water availability (table 8.2). Unlike entitlements, seasonal allocations can be accessed at relatively short notice, making them more suited for adaptive management (although, in some cases, purchasing seasonal allocations may not provide a sufficiently large amount of water quickly when an opportunity arises). Having relatively small transaction costs and fewer trade constraints, seasonal allocations can be readily bought and

Table 8.2 **Trade in seasonal allocations**

Criterion	*Assessment*
Costs	Low to medium — involves lower administration costs and fees than trading entitlements. Selling seasonal allocations from entitlements that temporarily exceed environmental needs can reduce the opportunity cost of sourcing water. Selling seasonal allocations provides revenue that would not otherwise have been available. Purchasing seasonal allocations rather than entitlements to meet variable environmental needs reduces ongoing infrastructure charges. The ability to purchase and sell seasonal allocations (rather than only sell allocations) may reduce transaction costs because fewer trades would be required to address differences between water supply under entitlements and environmental needs.
	Requires ongoing budget support. However, some or all of the required funds could be raised by selling seasonal allocations in years when water supply under entitlement exceeded environmental needs.
Feasibility	Medium to high — markets for seasonal allocations are in place and relatively large volumes are already being traded by irrigators. Fewer constraints apply to trade in allocations than in entitlements. Purchasing seasonal allocations for environmental purposes is likely to be more acceptable to some irrigators than purchasing entitlements.
Flexibility	Medium to high — seasonal allocations can be traded at short notice with low transaction costs, making them effective for addressing temporary shortfalls or excesses in supply. In some cases, purchasing seasonal allocations may not provide a sufficiently large amount of water quickly when required.
Distribution of costs and benefits	Costs to tax payers or other interested parties. Benefits to the seller and parties that value improved environmental outcomes. Potential positive and negative third-party impacts.
Likelihood of achieving desired goals	High — effective for adaptive management. Less suited to providing fixed water demands due to transaction costs.

sold. Drawing on outcomes from a multi-stakeholder workshop convened in May 2006, the Australian Conservation Foundation noted the potential of making greater use of markets for seasonal allocations to source water for environmental flows:

> Enabling the environmental manger to sell environmental allocations when it is not required to meet environmental objectives *and* use the money to buy water whenever it would help achieve environmental outcomes, could make a substantial difference towards meeting highly variable water needs, in particular topping up natural floods for wetlands, floodplains and billabongs during wet years. This option should, therefore, be available to environmental managers. [emphasis added] (sub DR75, p. 9)

Trade in seasonal allocations can reduce the cost of meeting river flow objectives. First, the ability to sell unused water in years when entitlements provide excess supply generates revenue that would not have otherwise been available. Second, trading seasonal allocations to meet variable environmental requirements, rather than purchasing entitlements, may have cost advantages, such as reducing transaction costs and infrastructure charges (box 8.3).

Purchasing seasonal allocations is less suited to meeting relatively fixed environmental requirements, compared with purchasing entitlements. Having to continually enter seasonal markets to access large amounts of ‘base’ flows for environmental purposes is likely to involve ongoing transaction costs and create price increases which would increase the cost of meeting river flow objectives.

Purchasing seasonal allocations would require ongoing expenditure. If an environmental manager or service provider has sufficient entitlements, however, they could raise some or all of the required funds by selling seasonal allocations in years when water supply under entitlement exceeded environmental requirements.

Leases for entitlements

Leases are another means of accessing water without the need to own an entitlement. Unlike seasonal allocations in existing markets, leases provide access to seasonal allocations for more than one year. Leases could be used to complement an existing base of entitlements.

One form of leasing arrangement involves an environmental manager or service provider negotiating with entitlement holders to access some of their seasonal allocations when certain trigger conditions are met (such as the announced allocation reaching a certain level). These leases could potentially be written over many years. The Victorian Government, for example, has announced that it will allow leases of up to 20 years in duration (*Water Resource Management Act 2005*).

Box 8.3 NSW Murray Wetlands Adaptive Environmental Water Allocations

The NSW Murray Wetlands Working Group (MWWG) manages Adaptive Environmental Water (AEW) Allocations (held as entitlements) totalling 32 027 megalitres on behalf of the NSW Water Administration Ministerial Corporation. The entitlements comprise 30 000 megalitres generated through seepage control works within Murray Irrigation that were funded by the New South Wales Government and 2 027 megalitres 'recovered' through hydrologic rehabilitation works on Moira Lake, Moira State Forest, New South Wales. The MWWG first started managing the AEW in 2000 on a three-year trial basis. The 'trial' has subsequently been extended.

NSW MWWG manages the AEW primarily in two ways:

- Diverting water to flood wetlands on the NSW side of the River Murray floodplain from Hume Dam to the South Australian border.
- Selling seasonal allocations within the New South Wales Murray Valley (above the Barmah Choke) to fund further wetland rehabilitation work, and diverting the remaining water to wetlands. Up to 50 per cent of seasonal allocations under entitlement can be traded, subject to the approval of the NSW Water Administration Ministerial Corporation. The table below lists water diversions and trades associated with the Murray Wetlands AEW allocations.

Murray Wetlands AEW allocations — water diverted and traded, 2000 to 2005

Year	Water diverted (ML)	Water traded (ML)
2000	27 500	2500
2001	4061	15 000
2002[a]	3945	23 000
2003	10 610	11 910
2004	16 912	5298
2005[b]	10 405	14 144

[a] The MWWG trial was officially suspended for 2002 due to dry conditions. [b] Preliminary estimates.

Although funds from selling seasonal allocations under the AEW allocations can be used for activities such as on-ground works, developing wetland plans, and funding incentive schemes for wetland rehabilitation, they have not been used to buy additional seasonal allocations or entitlements. The decision not to buy seasonal allocations has been, in part, to protect third-party interests (MWWG, pers. comm., 14 July 2006). English et al. point out such an approach may reduce environmental managers' ability to flexibly manage environmental allocations:

> … the managers of the Murray Wetlands Allocation are not able to re-invest the funds in purchasing either permanent or temporary water from irrigators. If they could buy and sell their allocation, a permanent allocation [entitlement] in the order of 18 % of what the Murray Wetlands Working Group has at its disposal now could be conceivably used to achieve the primary objectives to an equivalent degree. (2004, p. 12)

Sources: English et al. 2004; MWWG, pers. comm., 14,17 July 2006; Nias, D. 2005.

Leases could assist environmental managers and service providers to better match water availability to environmental flow requirements (table 8.3). When specifying the duration of a lease, an environmental manager or service provider could trade off supply security (from purchasing entitlements) with flexibility to manage flows adaptively (from purchasing seasonal allocations). Environmental managers and service providers could also specify the conditions activating the lease to achieve a desired supply reliability at a given cost. Leases are also likely to be more acceptable to some irrigators and rural communities than selling entitlements to an environmental manager or service provider because entitlements would remain with irrigators.

Table 8.3 **Leases for entitlements**

Criterion	*Assessment*
Costs	Low to medium — involves initial set-up and negotiation costs and then periodic renegotiation costs thereafter. Ongoing infrastructure charges would remain with the entitlement holder. May reduce the opportunity cost of meeting environmental needs by reducing incidence and extent of excess water supply in some years. Requires ongoing budget outlays to service lease.
Feasibility	High — leases for entitlements are already being used by irrigators. Leases are likely to be more acceptable to some irrigators and rural communities than selling entitlements to an environmental manager or service provider because entitlements would remain with irrigators. Potentially overcome trade constraints on entitlement trade.
Flexibility	Medium to high — leases are highly flexible when they are being negotiated (tradeoffs can be made between supply security and scope for adaptive management). Leases are less suited to adaptive management if they are specified over many years.
Distribution of costs and benefits	Costs to tax payers or other interested parties. Benefits to the seller and parties that value improved environmental outcomes. Potential positive and negative third-party impacts.
Likelihood of achieving desired goals	Medium to high — depending on how leases are specified, could be used to secure fixed flows or for adaptive management.

If ownership or trade in entitlements is restricted, leasing entitlements may be a way of securing ongoing water supplies for environmental purposes. The degree to which leases are substitutable for entitlements will, however, depend on the tenure and conditions of the lease (box 8.4).

Box 8.4 Washington Department of Ecology Water Rights Purchasing Pilot program

In 1999 the Washington State legislature passed a bill to appropriate $1 million to fund a pilot program enabling the Washington Department of Ecology to purchase or lease water rights. The 2000 appropriation bill stated the funding was ‘for the purpose of improving stream and river flows in fish critical basins.’ (Engrossed House Bill 2487, Chapter 1, Section 1016, Laws of 2000).

In an early progress report to the State legislature, one of the key conclusions from the pilot project was that while leases ‘provided a good means for introducing water users to the program’, the short-term nature of most of the leases they had negotiated did not ‘provide a long term solution to low flows and the recovery of endangered fish species’ (Lowe 2000, p. 7). The reasoning was that the potential for a large portion of water rights holders to opt out of the program at relatively short notice, by not renewing leases, imposed considerable risks:

> … for example, if a large economic investment were to be made in stream rehabilitation and fish recovery efforts in a tributary where we had a lease, if the lease was not renewed then fish recovery would be jeopardized and public funds would possibly have been wasted. (Lowe 2000, p. 7)

Among the recommendations in the progress report, was that the establishment of a program preference for long-term leases or purchases.

Sources: Lovrich et al. 2004; Lowe 2000.

Leases would involve initial set-up costs and may need to be periodically renegotiated, depending on the duration of the lease and whether the environmental manager or service provider chooses to renew the lease. Although the transaction costs for leasing entitlements are not well documented, they are unlikely to be large, given the costs associated with leasing other products such as farm equipment. Leases would require ongoing budget support.

Options contracts for seasonal allocations

Options involve negotiation of contracts between irrigators and environmental managers (or service providers) for access to allocated water under certain conditions and can be used to complement existing entitlements (table 8.4). Using options contracts to deliver environmental outcomes was first proposed by Murrumbidgee Irrigation and has subsequently been developed by Hafi et al. (2005). Under a call option considered by Hafi et al.:

> … [an] environmental manager pays the irrigator an option premium for the right, but not the obligation, to buy a quantity of water at a determined price when allocations are above a certain threshold (for example 70 per cent of allocation), at specified periods

during the year. The irrigator retains the permanent entitlement and, in addition to the option premium, receives further pre-specified payment (the option exercise price) when the environmental manager exercises the option to buy water. (Hafi et al. 2005, p. 1)

Contracts could be written to enable the purchase of water from irrigators in wet periods when irrigation demand is low and enable water to be added to high river flows that naturally occur under wet conditions — thereby increasing the frequency of flood events required for wetlands and riverine forests. Environmental managers and service providers could develop a portfolio of options with a variety of allocation thresholds to balance security of supply and cost.

Table 8.4 **Options contracts for seasonal allocations**

Criterion	*Assessment*
Costs	Low to medium — involves initial set-up and negotiation costs and periodic renegotiation costs thereafter. May reduce the opportunity cost of meeting environmental needs by reducing the incidence and extent of excess water supply in some years. Requires ongoing, but small, budget costs associated with paying option premiums and periodic costs (generally less than the cost of seasonal allocations) relating to exercising options.
Feasibility	Medium — a conceptual model has been developed for the Murrumbidgee Valley. Operation of options would need to be given time to mature. Development of an options market may depend on whether dry or wet seasons are experienced in the early years of the scheme.
Flexibility	Medium to high — options are more flexible than entitlements because environmental managers and service providers can negotiate triggers that make additional water available only when it is needed and can specify relatively short contract durations to facilitate adaptive management. Once agreed to, options can be relatively inflexible if they are specified over many years.
Distribution of costs and benefits	Costs to tax payers or other interested parties. Benefits to the seller and parties that value improved environmental outcome. Potential positive and negative third-party impacts.
Likelihood of achieving desired goals	High — effective where infrequent increases in the volume of water are required. Less effective in meeting more frequent or base watering needs.

In the absence of seasonal trade, options contracts can greatly reduce the cost of sourcing water for infrequent high-flow events, compared with purchasing entitlements. Environmental managers and service providers could take advantage of counter-cyclical demand by negotiating to purchase water only in wetter years when it is generally less valued by irrigators, rather than purchasing entitlements that would provide excess supply in most years. Using an illustrative example, Hafi et al. (2005) estimated the net saving from a ten-year options contract to be $35.40 per megalitre per year, compared with purchasing an entitlement.

However, there are fewer benefits from using options contracts to meet infrequent high flow events if seasonal trade is allowed. Hafi et al. noted that the gains from trade using options ‘can also be obtained if the environmental manager [purchases an entitlement and then] sells surplus water back to irrigators at a market clearing price’ (Hafi et al. 2005, p. 2).

Nevertheless, there are other characteristics of options that have advantages for environmental managers and service providers. Options contracts could reduce transaction costs associated with selling off seasonal allocations in average and drier years, avoid ongoing infrastructure charges associated with holding entitlements, and ensure that enough water can be sourced at short notice to augment high flow events.

Options would involve set-up costs, including developing an institutional framework, advertising, and negotiating contracts. Some of the negotiation costs may be reduced if water options can be integrated into an existing electronic exchange, or if contracts can be negotiated through the water utility rather than through individual irrigators (Hafi et al. 2005). Murrumbidgee Irrigation and the Murrumbidgee Catchment Management Authority have proposed an options exchange for the Murrumbidgee Valley (box 8.5).

Covenants on entitlements

Covenants are a tool that have been used for establishing use conditions on land and have been combined with revolving environmental funds, where environmental service providers purchase land, place covenants on its use and then resell the land back to the market. This concept could be extended to water entitlements.

Covenants could be placed on the timing and use of water under entitlement. Covenants could, for example, require water under entitlement to revert to an environmental manager or service provider under certain conditions (such as when allocations reach 70 per cent, or if five years have passed since a significant wetland flooding event).

Because covenants give environmental managers the ability to specify the conditions under which water is available, they can better match water supply and

Box 8.5 **Murrumbidgee River Reach program**

Murrumbidgee Irrigation Limited (MIL) and the Murrumbidgee Catchment Management Authority (MCMA) have submitted a joint proposal to the Australian Water Fund to establish the Murrumbidgee River Reach program. Under the proposal, MIL would initially make available 40 000 ML of water sourced through system efficiency improvements that could be distributed to irrigators and environmental users via options-based mechanisms. An initial pilot options exchange would be established between major stakeholders (MIL and MCMA) with a view to rolling out the exchange to all stakeholders in the Murrumbidgee Valley.

River Reach aims to take advantage of complementarities between the use of water for production and the use of water for environmental purposes:

> Through this project water security will be maintained for irrigators in dry years and entitlements and the environment will receive water based on agreed triggers in wetter years when water is of optimal benefit. (MIL and MCMA 2006, p. iv)

River Reach has four key elements:

- Water mobilisation — facilitate water user subscription to the options exchange. MIL will initially make available up to 40 000 ML to establish the options exchange. Subsequent marketing of the exchange to other entitlement holders is hoped to substantially increase subscriptions in the Murrumbidgee Valley.
- Exchange mechanism — establish the initial options exchange, provide the institutional/legal framework, products and processes and roll-out of Valley exchange. The early stages of the project will adopt a 'learning by doing' approach with respect to the development of the exchange and its associated products. It is planned for the exchange to eventually become a viable means of redistributing substantial volumes of water for environmental purposes.
- Decision Support System — provide a decision tool to optimise the use of environmental water. This includes establishing a Technical Working Group to advise the MCMA on the timing, volume and management of environmental water to meet specified environmental outcomes. The Decision Support System would be integrated into an Environmental Water Management Plan for the Murrumbidgee.
- Community engagement — incorporate community input, raise awareness, harness support of stakeholders and generate spillover benefits in the valley and basin.

Once fully established, MIL and MCMA expect that the options exchange would have a range of water products (developed through community consultation and informed by expert advice) and that it would source water at a substantially lower cost than purchasing entitlements:

> At the end of stage 2, it is expected that the environmental options exchange would have a wide range of products … MI[L] and MCMA believe that such an exchange could mobilise up to 100 000 ML of environmental water at about half the cost of permanently purchasing that volume of water at current market prices … (MIL and MCMA 2006, p. 17)

Source: MIL and MCMA 2006.

environmental needs than purchasing only entitlements (table 8.5). In the absence of seasonal trade, covenants can therefore improve environmental outcomes by reducing the extent of temporary shortfalls in water supply and/or reduce the opportunity cost of sourcing water by reducing the extent of temporary excesses in supply.

There may be significant transaction costs associated with establishing, registering and monitoring covenants. If covenants are overly prescriptive, there may be little demand for the water entitlements by irrigators. It may also be difficult to reverse changes to entitlements, making them less suitable for adaptive management. Covenants are among a range of water products to be considered by NSW Riverbank for sourcing water for inland regulated rivers in New South Wales (box 8.6).

FINDING 8.1

Many river flow objectives require sourcing additional water for environmental purposes. There are often more flexible and cost-effective ways to achieve these objectives than purchasing entitlements or investing in infrastructure.

Table 8.5 **Covenants on entitlements**

Criterion	*Assessment*
Costs	Medium to high — involves administrative costs associated with establishing, registering and monitoring covenants. May reduce the opportunity cost of meeting environmental needs by reducing the incidence and extent of excess water supply in some years. Once-off budgetary cost to purchase entitlement, some revenue recouped through sale of amended entitlement.
Feasibility	Medium — may be more feasible where there is a Torrens titling system; less feasible when titles are on a regulated register. May be difficult to sell entitlements with covenants if conditions are overly prescriptive.
Flexibility	Low to medium — allows a range of conditions to be attached to property rights, tailored to meet environmental needs. Difficult to change once set.
Distribution of costs and benefits	Costs incurred by tax payers or other interested parties. Benefits to parties that value improved environmental outcomes. Potential positive and negative third-party impacts.
Likelihood of achieving desired goals	Medium to high — effective where periodic increases in the volume of water are required. Less suitable for adaptive management.

Box 8.6 **NSW RiverBank**

NSW RiverBank is a $105 million fund set up by the New South Wales Government to buy and manage water for environmental benefit, and specifically to protect and restore New South Wales' most stressed rivers and wetlands over five years. RiverBank will be administered by the NSW Department of Environment and Conservation which will seek to 'establish RiverBank as a legitimate market participant that supports water-dependent ecological assets on public and private lands, and provides a price signal in the market that reflects ecological values' (DEC 2006, p. 1). Funding for RiverBank will be made available through the NSW Environmental Trust and the Department of Environment and Conservation will be accountable to the Trust against an annual RiverBank Business Plan prepared by the Department.

RiverBank will primarily acquire water products via 'existing markets' such as through formalised registration of expressions of interest in the sale of entitlements, direct negotiations, established water agents and brokers and emerging online water trading platforms. RiverBank will also explore the feasibility of establishing facilities for individuals or groups to donate water or funds. To begin with, RiverBank will call for expressions of interest in the sale of 'particular water products in each of the target valleys.' (DEC 2006, p. 23). Generally, RiverBank will buy entitlements 'at a price consistent with recent or historic market activity or benchmarks' and has a pricing strategy to 'avoid contributing to extreme peaks in water product prices or water shortages' (DEC 2006, pp. 24, 14).

At first, entitlements will be purchased in the inland regulated river valleys of New South Wales which have environmental assets of very high value. Indicative investment targets for 2006-07 total $15 million (Macquarie $6.5 million, Murrumbidgee $3.5 million, Gwydir $3 million and Lachlan $2 million). Actual investment for each valley will depend on relative market opportunities. The initial target assets are the Macquarie Marshes, the Gwydir wetlands, the Lowbidgee wetlands and the Narran Lakes. RiverBank will not operate within the Murray and lower Darling Rivers, recognising the Living Murray is undertaking actions to source water for those rivers.

RiverBank will first focus on acquiring general security entitlements in each valley, which is the 'most commonly available product and provides an appropriate balance of water availability and management flexibility to form the base of a portfolio for each valley' (DEC 2006, p. 21). Each valley's portfolio may be subsequently enhanced through the purchase of entitlements of higher or lower reliability and other more flexible water products. Purchases of seasonal allocations will not be funded through the initial $105 million program. However, proceeds from selling allocations under entitlement may be used to buy entitlements, allocations and other water products as they emerge in the market. Proceeds from the sale of allocations can also be used to meet statutory charges, taxes and service fees associated with the entitlement. During 2006-07, RiverBank will further investigate the potential for emerging water products such as leases, options, forwards contracts and covenants. Purchases will be complemented by the development of water-use plans for each target valley that describe environmental objectives and outline strategies to achieve those objectives.

Source: DEC 2006.

Water-related markets

Creating tradeable rights to river capacity may complement existing non-market management options for managing river flow objectives that require less flow at certain times. The following section considers establishing markets for trading rights to river capacity.

Trade in river capacity

River capacity rights are a means of providing access to a portion of a river's capacity without the need to hold a water entitlement or seasonal allocation. By allowing trade in river capacity rights, water users can buy up capacity to ensure the timely delivery of their water or to make sure capacity is left unused. Trade in river capacity would also reveal the opportunity costs of having water delivered in a timely manner to farms, using capacity to transfer environmental flows and using capacity to control river flow heights. The concept of river capacity rights could be applied to entire rivers or specific congestion points where there are hydrological 'bottlenecks' and congestion. Trade in such rights may assist in managing the environmental implications of downstream water trade, particularly during peak summer months. For example, the Environmental Farmers Network noted:

> Infrastructure access entitlement has been recently introduced by Water Authorities to both share and safeguard existing water delivery infrastructure with-in irrigation areas; however our natural carriers are exposed to unlimited access … Maximum flows need to be agreed upon by all stakeholders and where required a market mechanism developed for tradable rights to river capacity. (sub. DR66, p. 1)

The Environmental Farmers Network illustrated the case of high flows in the Goulburn River:

> 2006 has seen the Goulburn River below the Goulburn Weir at Nagambie consistently flowing at approximately 1 meter above previous summer flow levels. Normal summer flows in the Lower Goulburn are 350 ML/d [megalitres per day] to 600 ML/d however this summer (2005-06) flows of 1300 ML/d to 2350 ML/d were experienced. This has been a quantum and sudden increase in summer flows.
>
> The reasons for this present situation are Inter Valley Transfers, brought about predominately by water trading and the moving of entitlements downstream. (sub. DR66, p. 2)

All existing users of river capacity, such as irrigators, environmental flow managers and utilities could be allocated tradeable access rights to reaches of a river (alternatively, an auction could be used to allocate rights). Murray Irrigation has suggested that the 'practicality' of such a scheme may be 'limited to smaller systems than the Murray River' (sub. DR92, p. 20). Shares in capped river capacity could be then traded through a market of timed capacity shares or through options contracts that specify timing. Trade would reveal the relative value that different users place on river access at different times of the year.

Water for Rivers argued that time-based delivery capacity would reveal valuable information to resource and infrastructure managers and irrigators:

> Time-based delivery capacity would … provide critical information to resource and infrastructure managers in terms of which reaches in a system were at or approaching their limit and enable timely investment or other management actions. Similarly, this information, available to irrigators, would provide them with information critical to the economic future of their enterprise and allow them greater planning flexibility and certainty. (sub. 48, p. 6)

The Australian Conservation Foundation highlighted the potential for market mechanisms to address seasonal inversion of high and low flows:

> The opportunities for using MBIs to address seasonal inversion / channel capacity problems are as important as using MBIs for addressing overextraction and they should be investigated … (sub. DR75, p. 9)

By purchasing river capacity, environmental managers and service providers could achieve river flow objectives that cannot be targeted by water purchases (table 8.6). They could control river height, for example, by purchasing river capacity shares and not using them when they wish to create low flow events. During periods when low river heights are not a priority, river capacity could be leased back to irrigators.

Table 8.6 **Trade in river capacity**

Criterion	*Assessment*
Costs	High — trade would involve initial set-up costs associated with allocating rights and establishing a trading system. There would be ongoing costs administering the trading system. Some costs could be recouped by selling river capacity rights.
Feasibility	Medium — actions to unbundle water and delivery channel capacity rights are already underway in some areas. This could be extended to rivers.
Flexibility	Medium to high — rights may only be required for relatively short periods.
Distribution of costs and benefits	Costs to tax payers or other interested parties. Benefits to the seller and parties that value improved environmental outcomes.
Likelihood of achieving desired goals	Medium — where objective is to influence river heights.

River capacity would need to be allocated and administered, which may impose significant transaction costs. As with any market mechanism, if the expected benefit from establishing a river capacity system is small, it may not be worthwhile. As noted in chapter 7, rights to river capacity need to be compared with available non-market options.

> NSW agrees with the delivery capacity concepts. However, from experience, the initialisation of shares in anything other than a green field situation can cause major disruption to productivity. Experience also tells us that channel capacity shares can indeed incur high transaction costs and as such should not be entered into until all community sharing or rostering options have first been evaluated and compared. (NSW Government, sub. DR93, p. 8)
>
> Any suggestion to reduce the channel capacity of rivers for environmental reasons, there must be a comprehensive investigation of the full gamut of options. For example, unwanted summer incursions into forests can be addressed by engineering solutions. (Ricegrowers' Association of Australia, sub. DR81, p. 12)

Alternative approaches to allocating ongoing rights to river capacity, particularly for congestion points, include applying access charges for specific times of the year when congestion is a problem, or having a bidding process to purchase one-off access rights for a particular time and volume.

FINDING 8.2

Creating new, tradeable rights to river capacity may be useful for influencing river heights or reducing flooding.

8.2 Other market mechanisms to address externalities from altered river flows

Environmental flows are only one determinant of river health. Other important factors are the condition of its catchment, floodplain and in-channel habitats, and its water quality (Jones et al. 2002). In some circumstances, market mechanisms can be used to target land and water management practices that affect these other factors.

Market mechanisms targeting water and land-use practices

The following section discusses the strengths and weaknesses of ecosystem tenders and volumetric taxes on water use by irrigators. In contrast with market mechanisms that seek to address environmental externalities by directly influencing flow regimes, ecosystem tenders and volumetric taxes target water and land-use activities that contribute to externalities.

Tender auctions for ecosystem services

Ecosystem tender auctions provide financial incentives to encourage land-use change on private land to achieve socially desirable environmental outcomes. To date, a number of pilot projects targeting various environmental outcomes have been run, including some relating to river health. The Victorian Department of Primary Industries, for example, conducted a tender auction in Avon Richardson (Victoria) to encourage land-use change to achieve multiple outcomes, including improvements to aquatic function (measured as changes to water quantity and quality entering streams). Similarly, the North East Catchment Management Authority has run tender auctions in the Ovens River valley to achieve biophysical improvement to high priority streams through terrestrial management activities. Although scientific knowledge about riverine ecosystems is not sufficiently advanced to run auctions for specific riverine ecosystems services, in time this may become viable (Victorian Department of Primary Industries, pers. comm., 23 May 2006).

Ecosystem tenders typically involve the government (or its agent) making an initial assessment of the likely environmental benefits (according to a measurable environmental benefit index) that will result from land-use change on each property in a given area. Information from assessments is then communicated to each property owner. Property owners submit tenders to undertake land-use changes, which are weighted by the respective environmental benefit indices. The government accepts those bids that deliver the highest environmental benefit per dollar, up to the point where their budget is fully allocated.

Compared with direct subsidies, ecosystem auctions can provide greater environmental benefits for the same budget (table 8.7). This is because tender auctions provide private landholders with the incentive to truthfully reveal their cost of undertaking specified actions that produce environmental outcomes (Eigenraam et al. 2006). In terms of addressing altered river flows, ecosystem auctions can be used to target land-use practices that either reduce flows directly or contribute to flow-related externalities (such as algal blooms from excess nutrients and slow river flows).

The precise effects that land-use practices have on riverine health are not always well understood, which makes it hard to devise a robust environmental benefit index. Further, ongoing payments may be required for landholders to commit to maintaining on-farm works that contribute toward achieving river flow objectives.

Table 8.7 **Tender auctions for ecosystem services**

Criterion	*Assessment*
Costs	Medium — tender auctions can deliver riparian management outcomes at a lower cost than fixed subsidies. In addition to landholder payments, tender auctions have costs associated with developing the tender system (including environmental benefit indices), assessing bids and monitoring. Costs can be reduced by adapting systems developed in previous tenders.
Feasibility	High — a river tender program is already operating in North Central Victoria. Requires detailed biophysical data.
Flexibility	High — a variety of auction designs could be adopted or adapted to meet river health objectives. Tenders can target large areas or can be site-specific. Tenders can potentially target multiple environmental objectives.
Distribution of costs and benefits	Costs to tax payers or interested parties who fund the tender. Benefits to the seller and parties that value improved environmental outcomes.
Likelihood of achieving desired goals	High — depending on appropriate design. Tender systems have been a successful mechanism for delivering ecosystem services on farm land.

Volumetric tax on water use by irrigators

A volumetric tax on irrigator water use is a price-based mechanism that could be used to address externalities associated with altered river flows. The imposition of such a tax is often interpreted as being in keeping with COAG requirements for utility charges to be based on full cost recovery and to include the cost of externalities (Dwyer et al. 2006).

A simple form of volumetric tax is based on the estimated *average* cost of an externality — that is, the estimated cost of the externality divided by the volume of water supplied. A more sophisticated approach would be to use a schedule in which the tax is set equal to the estimated *marginal* external cost (marginal damage) at each level of water use.

The likelihood that a volumetric tax on irrigator water use would achieve the objective of facing irrigators with the full cost of their decisions will depend on a complex set of factors. One key consideration is the degree to which altered river flows are directly attributable to irrigator water use. Dwyer et al. observed:

> In general, such a tax will be most appropriate where the marginal cost of an externality is directly related to the use of irrigation water, and nothing else. An externalities tax

will be less appropriate where there is little link between the externality and the use of irrigation water. (2006, p. 62)

Given scientific uncertainty regarding the interaction between irrigation water use and river flows — combined with the presence of several other potential causes of altered river flows (such as drought and growth of forestry plantations) — a tax on irrigation water use may be an inefficient instrument for achieving river flow objectives (table 8.8).

Table 8.8 **Volumetric tax on water use by irrigators**

Criterion	*Assessment*
Costs	Medium to high — information costs to accurately calibrate the tax are likely to be high but approximations may be used. Once specified, utilities are likely to have systems in place to collect revenue and monitor water use.
Feasibility	Medium — environmental contributions based on a percentage of utility revenue (which is an indirect way of taxing water use) have been introduced in Victoria.
Flexibility	Medium — charges could be reviewed periodically.
Distribution of costs and benefits	Cost to irrigators. Benefits to tax payers through an increase in consolidated revenue (if tax is not hypothecated). Benefits to parties that value improved environmental outcomes if tax reduces water use or if tax revenue is hypothecate towards funding environmental activities.
Likelihood of achieving desired goals	Low — there is considerable uncertainty regarding the interaction between irrigation water use and altered river flows. A tax on water use will not affect changes in river flows if they are not caused by water use.

Even where a clear relationship between irrigation water use and altered river flows can be established, for a uniform tax on all water users (or, if trade is regionally restricted, on all water users in the trading region) to reduce overall water use in the short run, its rate must exceed the scarcity rents generated by restrictions on water allocations. Otherwise, a volumetric externalities charge will not reduce water use (and reduce consequent environmental costs) (appendix D).

Even if water use does not change, and so there is no short-run improvement in economic efficiency from such a charge, nonetheless, efficiency might still improve in the longer term (Dwyer et al. 2006). Irrigators may undertake abatement activities where these cost less than the tax saved, and if they expect the level of tax in the future to adapt to reduced negative externalities from the abatement activity.

In general, the marginal damage of a negative environmental externality caused by water use will vary between regions as well as within them. This is because the damage is linked to location-specific factors such as salinity impact, as well as larger scale factors such as the externality caused by water storage. The correct levels of (Pigouvian) taxes are equal to the schedule of marginal environmental externality, tailored to each use. When the size of the tax on water use varies across water users, the level of the taxes and the differences between tax levels are important for efficiency, if the purpose of the tax is to internalise the externalities. This kind of tailoring is not a simple matter. A tax set too high may be effective in reducing water use, but may do so by more than is justified on the grounds of externalities. A tax set too low may be ineffective in reducing water use. Furthermore, it is not clear (from an economic efficiency perspective) what party should pay the tax.

Careful consideration should be given to how revenue collected from water-use charges is used. One option is to hypothecate tax revenues towards infrastructure or works that address externalities. In Victoria, for example, revenue generated from environmental contributions from water utilities (which are not a tax on water use per se, but are nevertheless passed on to water users through water charges) are hypothecated for specific water-related projects, including funding Victoria's contribution to the Living Murray Initiative (box 8.7). The revenue raised, however, might be higher (or lower) than the optimal level of expenditure on remedying and/or preventing environmental damage.

Box 8.7 **Victoria's environmental contribution charges**

Under Victoria's *Water Industry (Environmental Contributions) Act 2004*, 'water supply authorities' are required to contribute to the costs of initiatives to 'promote the sustainable management of water; or address adverse water-related environmental impacts' (s. 193,194). The obligation to pay environmental contributions initially applies to the period from 1 October 2004 to 30 June 2008. The Victorian Government expects that environmental contributions made by water utilities will generate approximately $225 million, $35 million of which is earmarked for the Living Murray Initiative.

Environmental contributions are 'calculated by reference to the revenue of the authority' (s.193). Currently rural water utilities are required to pay an environmental contribution equal to 2 per cent of revenue. These contributions can be passed on through increased tariffs and charges.

In 2004-05, $18.5 million was allocated to 'a range of river and aquifer health programs, including $7.6 million for 10 large scale river health projects to improve conditions in key rivers, estuaries and floodplains'. (Victorian Government sub. 39, p. 15).

Sources: DSE 2004; Victorian Government , sub. 39.

FINDING 8.3

Arriving at the correct rate for a volumetric tax is not easy. If set too low, the tax may not reduce the externalities associated with water use in the short run. If set too high, the tax may lead to market distortions and have unintended equity consequences. Further, volumetric taxes are unlikely to be effective in addressing those externalities which, although related to altered river flows, are unrelated to the volume of water used by irrigators.

8.3 Establishing sourcing agencies

Governments and private organisations are increasingly recognising the role markets can play in sourcing water for environmental flows. A number of agencies (for example Water for Rivers and the NSW Murray Wetlands Working Group) have been established to source water and/or deliver water for environmental purposes.

The past and current focus on investing in infrastructure through programs, such as the Living Murray Initiative, is beginning to be supplemented by the more direct and less costly approach of purchasing water from willing irrigators. South Australia recently announced plans to meet part of its water recovery obligations under the Living Murray 'First Step' by purchasing entitlements from willing sellers. The New South Wales Government, through its RiverBank program, announced its intention to buy water for a number of river systems other than the River Murray. Although NSW RiverBank will initially focus on purchasing entitlements, it will investigate the use of a wide range of water products including leases, options, forwards contracts and covenants and purchasing seasonal allocations. Nongovernment sourcing initiatives are also emerging. The Murrumbidgee River Reach proposal of Murrumbidgee Irrigation Limited and the Murrumbidgee Catchment Management Authority, for example, will investigate the use of options contracts to deliver water to enhance periodic flood events in wetlands in the Murrumbidgee river system.

While these signs are encouraging, the range of water products purchased is too narrow, and the pace of purchasing too slow, in key over-allocated river systems. In particular, in the Commissions' view, the absence of an agency specifically charged with purchasing a portfolio of water products to suit the needs of environmental management in the River Murray is unnecessarily impeding the effective and efficient environmental management of the river.

RECOMMENDATION 8.1

An agency should be established as soon as is practical for the purpose of acquiring water for the Living Murray Initiative. This agency should acquire a range of water and water-related products, rather than acquiring water through infrastructure investments and purchase of water entitlements alone.

9 Salinity externalities

Key points

- The incidence and extent of salinity vary across irrigated areas of Australia and across industries.
- Salt interception works can quickly reduce instream salinity. But, with the costs of existing and potential interception schemes rising, and opportunities for low-cost schemes limited, other approaches to address salinity will be required.
- A single market mechanism for salinity management is unlikely to be appropriate in all situations. In some cases, a mix of mechanisms and/or a regulatory approach will be required.

The focus of this chapter is on the environmental externalities associated with salinity caused by rural water use. Section 9.1 describes the salinity problem. Section 9.2 describes the policy context that surrounds the application of market mechanisms to manage salinity. Design issues for using market mechanisms to manage salinity are considered in section 9.3. Chapter 10 assesses the feasibility of market mechanisms for irrigation salinity-related externalities.

9.1 Salinity

Salt is a natural feature of the Australian environment. In the dry season of 1829 the water of the Darling River was too salty for Charles Sturt and his horses to drink (MDBC 2006d). That was not because of agricultural practices, but because the Murray–Darling Basin is a naturally saline environment.

However, farming and other land management practices, including irrigation practices, can exacerbate the incidence of salinity. Salinity is a well-known environmental change associated with supplying and using irrigation water. The physical processes associated with irrigation salinity are generally well understood and described. Salinity arises from activities that change the hydrology of the landscape and accelerate the movement of salts into rivers and to the soil surface. Irrigation tends to increase salinity because it can increase the amounts of dissolved salt entering adjoining rivers and streams. Further, the manipulation of rivers, dams and lakes can also increase instream salinity by changing natural surface water and groundwater flows (NAPSWQ 2001).

Salinity occurs in some form in all irrigation areas in Australia, either as water entering or exiting the irrigation area (river salinity), or as salt retained within the districts (dryland salinity). Both have complex links to saline groundwater. Saline groundwater is the primary source of river salinity and can affect an entire river system and nearby environments downstream of entry to the river (MDBMC 2005). Salinity levels in the rivers are a result of a combination of flow (volume of water) and salt load (quantity of salt). Dryland salinity tends to be localised and, in some cases, contained within a farm or neighbouring farms.

Generally, there is a considerable lag between land-use changes and the emergence of salt and the movement of it to rivers and in the landscape (MDBC 1999b). Consequently, if irrigation practices were to change today, downstream river salinity will, in many areas, continue to increase as a result of past activities. However, salinity impacts sometimes occur in a relatively short period of time (Barr and Cary 1996). Salt emergence occurs more rapidly in irrigation districts where recharge rates are very high and the sources are close to the rivers (MDBC 1999b). However, recharge rates are highly variable, depending on site-specific conditions, and climatic conditions also have a significant impact on the emergence of salt. Uncertainty surrounding the likely future incidence of salinity complicates salinity management and the design of market mechanisms.

Irrigation is only one source of human-induced river and groundwater salinity in Australia. Dryland salinity contributes to river and groundwater salinity, particularly in south–west Western Australia and parts of the Murray–Darling Basin. Addressing irrigation salinity will not counter the impacts of dryland salinity. Changes to vegetation cover — especially the replacement of deep-rooted perennial vegetation with shallow-rooted annuals that have lower water requirements — have, in many areas, resulted in an imbalance between rainfall and plant water use (MDBC 1999b). This imbalance increases the amount of water entering groundwater systems (recharge). As watertables rise through naturally saline soils, potential salinity problems include increased discharge of salt into streams (where groundwater is more saline than river flows), waterlogging and the relocation of salt in the soil to the soil surface.

Table 9.1 presents some examples of externalities that are associated with irrigation-induced salinity. Salinity imposes costs not just on irrigators (through reducing the yield of crops), but also on others in the community by affecting the environment, infrastructure, drinking water quality and amenity.

Table 9.1 **Examples of externalities associated with irrigation salinity**

Source	*Transmission*	*Effects*[a]
(a) What is the production or exchange activity? *(b) Who undertakes this activity?*	*What changes to environmental conditions can occur?*	*Who can be affected? Are there external costs or benefits?*
1. Land salinisation (a) Application of irrigation water in excess of crop requirements, where drainage is insufficient to prevent groundwater recharge[b] (b) Irrigators	Hydrology — increases groundwater recharge and results in waterlogging Water quality — relocates salt in the soil to the soil surface Habitat — may cause freshwater habitats to become salinised Biota — changes the biota in response to increased groundwater levels and salinity	Agricultural producers — costs from waterlogging Household/business — costs from damage to buildings, infrastructure and appliances Individuals — costs and benefits from changes in amenity, biodiversity, habitat, culture, heritage, and indigenous values Commercial and recreational fisheries (and associated tourism) — costs from decline in catch yield following lost fish-breeding sites
2. River salinity (a) Application of irrigation water in excess of crop requirements, where drainage is insufficient to prevent groundwater recharge, leading to increased base flow to streams[c] (b) Irrigators	Hydrology — increases groundwater recharge and the flow of water into streams; leads to seawater incursions into surface waterways Water quality — increases the discharge of salt into streams (where groundwater is more saline than river flows) Biota — changes the biota in response to increased stream salinity	Downstream water users including agricultural producers, other industries and domestic consumers — costs or benefits, depending on water quality Commercial fisheries — costs or benefits from decreased or increased catch yields[d] Recreational users — costs and benefits from changes in catch yield and flow regime Tourism industry — costs and benefits from changes in tourist expenditure Individuals — costs and benefits from changes in amenity, biodiversity, habitat, culture, heritage and indigenous values

a May be positive or negative, unless specified. **b** It is not possible to achieve 100 per cent irrigation efficiency. Some leaching to groundwater is considered necessary to prevent salt build-up in soils. **c** Increasing the base flow to streams may be beneficial, where groundwater is less saline than river flows. **d** Several experimental saline aquaculture schemes, which intercept and pump saline groundwater, are being trialled or developed in Queensland, South Australia and New South Wales.

Sources: Dwyer et al. 2006, based on Ball et al. 2001; MDBC 1999b; PC 2003.

Wilson (2004) estimated the costs of salinity in the Murray–Darling Basin at $305 million per year. The Murray–Darling Basin Commission noted that the full cost is likely to be considerably higher because the study did not consider ‘the impacts on irrigated agriculture, cultural heritage, the environment and the city of Adelaide’ (Murray–Darling Basin Commission, sub. 31, p. 8). There do not appear to be many studies that have estimated the contribution of irrigated agriculture to the costs of salinity.

Careful consideration needs to be given to the analytical approach in studies of the costs of salinity in agriculture. A major problem is specifying the baseline against which salinity costs are assessed. It is unhelpful for practical purposes to compare the net economic output of agriculture with current salinity levels and with zero salinity. It is likely to be more useful if studies focus not on the 'costs of salinity', but on comparison of the benefits and costs of initiatives that reduce future levels of salinity.

The effects of waterlogging and land salinisation display threshold effects — when the saline watertable rises to around 2 metres of the land surface, for example, capillary action, transpiration by plants and evaporation at the land surface draw up the saline water and concentrate the salt. Several studies have examined the effects of salinity on agricultural productivity and infrastructure (for example, Hajkowicz and Young 2002). Salinity thresholds also exist for ecosystem health (box 9.1).

Box 9.1 **Salinity thresholds for ecosystem health**

Salinity exhibits threshold effects for ecosystem health (and presumably the values derived from ecosystems) at a concentration of about 1500 EC (electrical conductivity). At low concentrations, increasing salinity levels result in minor increases in ecosystem effects, because many species of invertebrates, and aquatic and riparian plants can tolerate salinities up to 1500 EC. Beyond this concentration, however, several species exhibit adverse lethal and sub-lethal responses, including loss of vigour, reduced species diversity, and progressive depression of growth and plant size. Although 1500 EC is commonly cited as the 'threshold level' for ecosystem effects of salinity, the rapid increases in ecosystem effects generally occur over a range of 1000–2000 EC.

Source: Hart et al. 2002.

The incidence and extent of salinity vary across irrigated areas of Australia and across industries. According to the Australian Bureau of Statistics (2002), South Australia had the highest percentage of irrigated farms showing signs of salinity in 2002 at around 16 per cent, followed by Victoria (15 per cent), Western Australia (10 per cent) and New South Wales (9 per cent). Only 4 per cent of irrigated farms in Queensland showed signs of salinity. Salt is a significant problem in the Murray–Darling Basin — due to its hydrogeology, most of the emerged salt remains within the basin (Goss 2003). In other catchments, salt can more readily reach the sea.

In this chapter, the Murray–Darling Basin (and areas within it) is used to provide examples of salinity from irrigation and to investigate the management of salinity and the potential role of market mechanisms. Many of the insights may have applications in other irrigation areas. However, significant uncertainty in the measurement of salinity and its effects suggests caution.

Instream salinity in the southern Murray–Darling Basin (as measured at Morgan) has decreased in recent years. Goss (2003) argued that salinity management actions over the past decade have contributed to these trends. Salinity trends are also driven by longer-term climatic conditions. Much of Australia experienced relatively wet conditions in the 1970s, which were then followed by relatively drier conditions since the early 1980s. The wet conditions of the 1970s raised watertables, and salt became more observable in parts of the landscape in the mid–1980s. The dry conditions experienced in the late 1990s and in the 2000s appear to be delaying the emergence of salt in the Murray–Darling Basin.

These longer-term climatic trends affect the baseline around which the irrigation effect on salinity occurs:

> Due to a sequence of drier than average years, there has also been a reduction in groundwater recharge and hence a decline in groundwater levels in parts of the Basin. (Murray–Darling Basin Commission, sub. 31, p. 14)

Relatively drier conditions have contributed to lower watertables. Hence, effects of irrigation leading to the emergence of salt are lower than they would have been under the same irrigation practices in wetter years. In addition, drier conditions lead to fewer flood events that move salt from the floodplains to the river.

FINDING 9.1

Recent dry conditions have reduced and delayed salinity impacts, including those from irrigation activities.

Many factors influence the extent of salinity and explain its spatial variation, including groundwater recharge rates, underlying groundwater salinity, water-use efficiency, soil types, the type and connectivity of aquifers, and the location of irrigation relative to waterways and land use (Beare and Heaney 2002). For example, one reason the salinity is more evident in the south of the Murray–Darling Basin is that this region is underlain by a sedimentary aquifer that has limited storage capacity and is largely saturated (MDBC 1999b).

Salinity is difficult to observe and monitor, but this is becoming less so as technologies used to monitor salinity at the farm and catchment level become increasingly sophisticated. Examples of technologies currently being used include airborne geophysical survey techniques and hand-held electromagnetic induction tools. The NSW Government stated that some of these techniques may have drawbacks in terms of high cost and are not able to indicate whether or when stored salt may be mobilised (sub. DR93). However, combining modern measurement methods with advances in modelling techniques can improve predictions of the origin, impact and eventual destination of stored salts (CSIRO, pers. comm., 25 July 2006).

The groundwater recharge and instream salinity changes that may result from one property's irrigation are generally not observable. Several studies have modelled salt loads from different regions or subcatchments, based on information about soils, crop types and technology (for example, Heaney and Levantis 2001; Heaney et al. 2001). Combinations of these factors can be used as 'proxy indicators' of the potential salinity effects resulting from irrigation and can be used as the basis of market mechanism design.

9.2 Policy context

There are five broad approaches to managing salinity, which may be used separately or in combination:

1. stabilise or reduce its source — take actions to prevent salinity from occurring
2. stabilise or mitigate its effects — prevent saline groundwater from entering rivers
3. adapt to the effects — sometimes the most appropriate action is to learn to live with salinity. The Murray–Darling Basin Ministerial Council's Basin Salinity Management Strategy acknowledged that 'living with salinity is the only choice in some situations' (MDBMC 2001, p. iii)
4. store it in saline aquifers
5. dispose of the salt — by flushing salt out of the system at times when economic costs are likely to be low.

Most salinity management in Australia has focused on the first four approaches. In general, less attention has been given to developing policies to flush salt out of basins to the ocean (one exception is the Hunter River salinity trading scheme). Currently, the broad focus of salinity management in the Murray–Darling Basin is to retain salt within the basin, primarily via salt interception works in highly saline irrigation areas (particularly where there is potential for the saline groundwater to enter the river system). Other types of instruments currently used to manage irrigation-induced salinity include providing incentives to irrigators to improve on-farm management practices, constructing infrastructure such as irrigation district drains, and imposing regulatory controls on water use and trade. There have also been some trials of market mechanisms.

Given that private gains are often low and transaction costs are often high, downstream water users have little incentive to collaborate in order to encourage investment upstream to improve water quality. The usefulness of property right solutions that can capture the benefits of trade between parties is limited. As a consequence, policies need to be directed to activities that are the source of pollution or provide abatement opportunities (Heaney et al. 2005).

Salinity management plans

Broad management plans guide and coordinate salinity management approaches in most irrigation districts. Salinity management in the Murray–Darling Basin centres on the Murray–Darling Basin Salinity Management Strategy — an intergovernment and inter-agency initiative developed by the Murray–Darling Basin Commission. The strategy aids the implementation of the National Action Plan for Salinity and Water Quality (NAP), state salinity strategies (South Australia, Victoria and New South Wales) and regional salinity or catchment management plans. (Queensland has regional salinity plans but no state salinity plan.) Catchment management authorities and water utilities play important roles in implementing these strategies.

Under the strategy, jurisdictions are allocated salt credits for undertaking salt mitigation works to offset salinity caused by development after 1 January 1988. Salt interception works were established in high salinity impact zones. They can allow for expanded irrigation in those areas and the reclassification of the area as low impact (South Australian Government, sub. 36). Jurisdictions lose credits for developments that increase salinity.

States may jointly undertake salinity interception works and split the resulting salinity credits (in line with the cost shares). This adds flexibility to individual state salinity caps by permitting investment in salinity abatement opportunities that may be located across state borders.

The Morgan salinity target established by the Murray–Darling Basin Salinity Management Strategy, and the system of credits and debits for achieving the target, derive from biophysical modelling of salinity, salt load and flow regimes, given the baseline agricultural development and water management situation in the basin and benchmark climate conditions (box 9.2). Because there are often long lags before the effects of various activities on saline emissions into the river are apparent and measurable, modelling is necessary to predict the effects of different activities and to take timely action to ensure that salinity levels do not exceed the Morgan target (which is based on the World Health Organization's upper salinity limit for drinking water desirability). Physical monitoring of salinity levels is also undertaken in order to gather information to improve knowledge of salinity processes and ensure that the models remain consistent with actual physical conditions. Physical measures can also be used to assess the impact of activities with relatively quick effects on salinity, such as salt flushing.

Box 9.2 **Murray–Darling Basin Salinity Management Strategy 2001–2015**

A key feature of the strategy is the Murray–Darling Basin Ministerial Council's basin target to maintain the average daily salinity at Morgan at a simulated level of less than 800 EC for at least 95 per cent of the time, during the benchmark period of 1 May 1975 to 30 April 2000. In addition, end-of-valley targets for each tributary valley are in place for the majority of tributary rivers in each of the basin states. New South Wales, Queensland and South Australia finalised their targets in 2004, and Victoria finalised a number of targets in late 2005. Interim targets remain for the Australian Capital Territory, and the Kiewa, Ovens and Wimmera rivers (MDBC 2005b).

The system of credits and debits for achieving the basin target at Morgan is managed through the 'A' register (for tracking salt disposal entitlements) and the 'B' register (for tracking the 'legacy of history' impacts). The Commission 'B' register assesses the effects of actions (for example, revegetation) to address salinity from past actions. The Commission registers operate together using the common currency of equivalent EC at Morgan. The Commission registers keep account of all significant actions within the basin after agreed baseline dates — 1 January 1988 for New South Wales, Victoria and South Australia and 1 January 2000 for Queensland.

The effect of actions is assessed with models using an agreed climatic/hydrologic sequence (based on the period from July 1975 to June 2000). An action will be considered as significant and included in the registers if it is assessed to cause a change in average EC at Morgan of 0.1 EC or higher within 30 years.

In 2001, partner governments agreed to a new joint program of salt interception works to achieve a reduction of at least 46 EC (and potentially up to 61 EC) in average river salinity at Morgan within seven years. Of the minimum 46 EC reduction, 31 EC has been allocated as legacy of history offsets, and 15 EC as salt disposal entitlements to offset the downstream impacts of future developments.

Each state government allocates its salt disposal entitlements (earned through contributions to salinity mitigation works) to catchment management authorities to implement their salinity management plans. Salt disposal entitlements are taken up for various actions which involve disposal of salt into the River Murray, including new irrigation development and the construction of surface and subsurface drainage for existing irrigation schemes.

Sources: MDBC 2005a; MDBMC 2001.

The South Australian Government noted that state legislation has been established that allows salinity credit trading among South Australian landholders. Although no trading has yet occurred, the scheme will, via an exchange rate mechanism, allow for trading across low and high impact zones.

> This trading scheme operates under a 'no net impact' rule … Under the scheme, the Minister will retain ownership of the offset credits but landowners will be able to trade them to suit their water needs. The scheme is not available between high and low

impact zones and so areas covered by a salt interception scheme are not eligible. (South Australian Government, sub. 36, p. 6)

Engineering works and salt interception schemes

In many regions, engineering works have been constructed to mitigate the impacts of irrigation salinity. At the regional scale, surface and subsurface drainage reduces the incidence and impact of on-farm waterlogging and land salinisation. These projects may be funded jointly by the Australian and state governments and water utilities (who collect drainage charges from irrigators). Land and water management plans often outline details for irrigation drainage upgrades or installation.

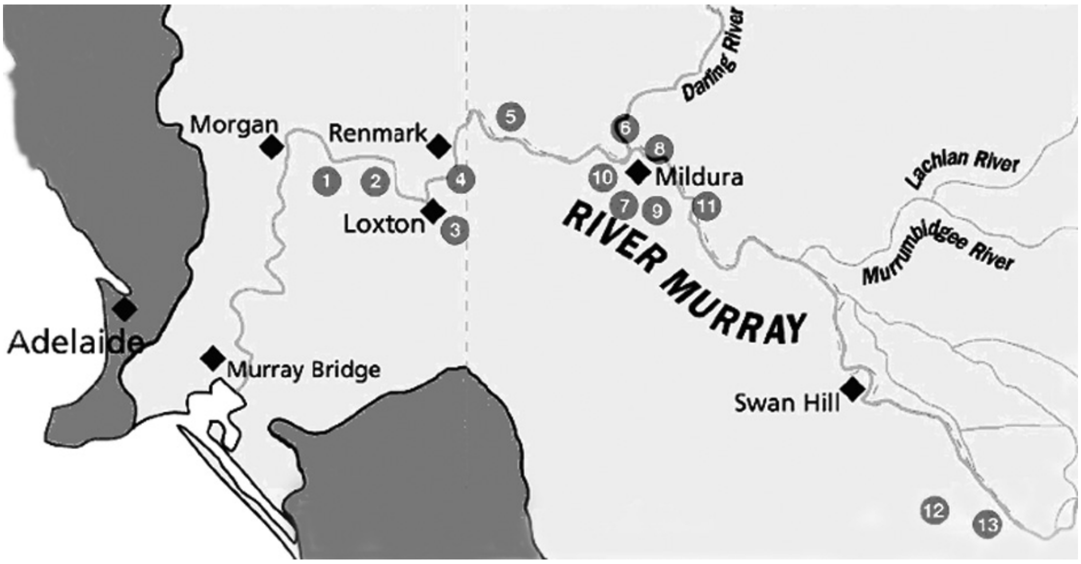
Some engineering works have also been related to salinity management. Excessive channel seepage, for example, has been linked to localised waterlogging and salinity in the Emerald Irrigation Area in Central Queensland. Fitzroy Basin Food and Fibre Association claimed that a major source of salinity in the area had been seepage from delivery channels, which are now being lined (sub. 11).

In some areas of Australia, groundwater pumping is used to manage high watertables. In the southern Murray–Darling Basin, there are physical constraints on subsurface drainage because of limits set on salt disposal in rivers. Other disposal methods considered are the re-use of saline water in combination with fresh irrigation water and evaporation basins (Christen et al. 2001).

A key engineering approach to managing river salinity in the Murray–Darling Basin is large-scale salinity interception schemes through which saline groundwater is pumped and disposed of by evaporation (figure 9.1). Salt interception works, by their nature, reduce river flows, and this water is not included as part of the Murray–Darling Basin Cap. In 2004-05 salt interception schemes in the basin diverted a total of 22 gigalitres with a salt load of 420 000 tonnes, although some of this water may not have been diverted from the river (Murray–Darling Basin Commission, pers. comm., 19 July 2006).

A major benefit of salt interception is the timeliness of its effect. By intercepting saline groundwater that would have entered the river, these schemes can quickly reduce river salinity.

Figure 9.1 Salt interception schemes



1 Waikerie Groundwater Interception Scheme **2** Woolpunda Groundwater Interception Scheme **3** Noora Drainage Disposal Scheme **4** Bookpurnong Groundwater Interception Scheme **5** Rufus River Groundwater Interception Scheme **6** Curlwaa Groundwater Interception Scheme **7** Lake Hawthorn Drainage Diversion Scheme **8** Buronga Groundwater Interception Scheme **9** Psyche Bend Drainage Diversion Scheme **10** Mildura-Merbein Groundwater Interception Scheme **11** Mallee Cliffs Groundwater Interception Scheme **12** Barr Creek Drainage Diversion Scheme **13** Pyramid Creek Groundwater Interception Scheme.

Source: MDBC 2006d.

The costs of salt interception are high — engineering works are required to construct the scheme, and there are ongoing pumping and maintenance costs. The South Australian Government observed:

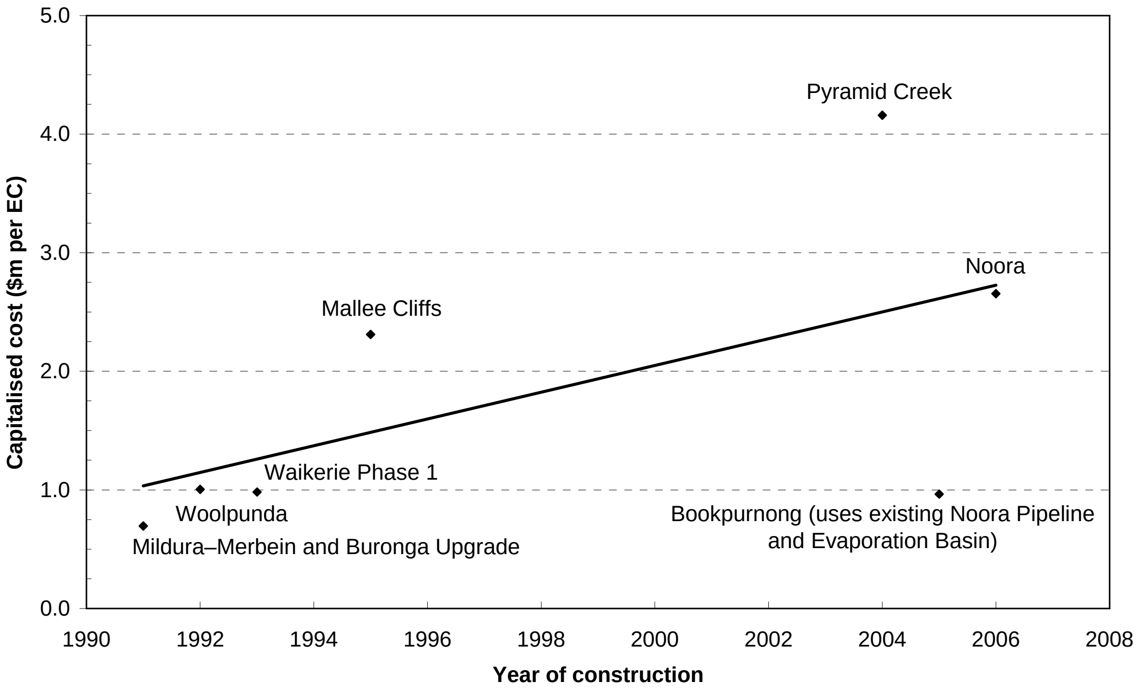
> [Salt interception schemes] are now prominent in the high salinity impact zones. The operating cost of these schemes is between $2 and $3 million *per annum*. (sub. 36, p. 6)

The costs of constructing, operating and maintaining new salt interception works has increased over time (figure 9.2). While past engineering approaches have been successful in mitigating salinity where it was rapidly increasing, it is important that appropriate benefit–cost assessments of proposed salt inception works are undertaken. Assessments should include the costs of water used in salt interception works.

FINDING 9.2

Salt interception works can quickly reduce instream salinity. With the costs of existing and potential interception schemes rising, and opportunities for low-cost schemes limited, other approaches to address salinity will be required.

Figure 9.2 **Cost of salt interception schemes**[a]



[a] Cost over 30 years, at 4 per cent return for construction, operation and maintenance.

Source: Murray–Darling Basin Commission, pers. comm., 17 March 2006, unpublished data.

Incentives

Incentives are available to farmers across most irrigation districts to reduce land salinisation and downstream salinity, including subsidies for whole-farm planning, irrigation water re-use technology and irrigation layouts. Incentives for on-farm works are commonly implemented by catchment management groups through partnership agreements between communities and government, such as land and water management plans. Funding for on-farm incentives is commonly provided by a combination of Australian Government, state government and landholder contributions.

Zoning

A salinity zoning scheme has been adopted by the Victorian Government to implement water trading and the salinity management provisions of the River Murray Water Allocation Plan. Zones along the River Murray have been established to indicate the likely impact of irrigation on future salinity: low impact zones, high impact zones, and areas of existing high salinity impact (which have salt interception works).

Under the Victorian scheme, levies have been introduced to ensure that purchasers of water internalise salinity impacts. A levy is charged on trades that shift water use from outside the salinity impact zone to salinity low impact zones (LIZ1–4) or to the salinity high impact zone (HIZ). The rate of the levy varies according to source and destination of water trade, and increases as water is shifted to higher impact zones — for example, trade in seasonal allocations from LIZ1 (lowest) to LIZ2 is $3.90 per megalitre, while from LIZ1 to LIZ4 it is $23.40 per megalitre. Levy proceeds are used to invest in salt interception schemes.

Introduction of the levy reflects the fact that, in some situations, relocation of water away from salinity impact zones may be more cost-effective than salt interception:

> … water traded away from highly saline areas has substantial benefit. Irrigators in the Kerang Pyramid Hill Boort region claim that trading has enabled them to reduce the extent of salinity they produce by around 20 EC (electrical conductivity) at Morgan (Young et al. 2005). This should be compared with a gain of only 6 EC achievable using infrastructure funding offered under the National Action Plan for Salinity and Water quality. (CSIRO, sub. 24, p. 5)

The Victorian Government aims to reduce the need for expensive salt interception works or other actions to reduce river salinity and uses levies to discourage irrigation expansion in areas identified as high salinity impact. The policy also establishes rules for the approval of licence transactions and allocation of salinity credits within the zones. The Victorian Government stated:

> The scheme is designed to encourage irrigation development to areas that have the least impact on river salinity to ensure new irrigation occurs within a cap on the limits of the Salt Disposal Entitlements available … through the Murray–Darling Basin Ministerial Council's Basin Salinity Management Strategy (BSMS). (sub. 39, p. 11)

The levy scheme has, however, been criticised for not encouraging the removal of water from salinity impact zones to reduce salt mobilisation. For example:

> Victoria's salinity levies are a means of internalising the externalities which arise when water is traded into LIZs [low impact zones]. However, they do not encourage trades out of these salinity affected areas. The use of symmetric exchange rates may resolve this issue, although this mechanism would not provide funding for the implementation of region-wide salinity abatement measures … the use of levies alone does not encourage the implementation of private salinity abatement measures. Tradeable property rights for salt are a potential alternative to levies on water trade, although the cost and practicality of such a scheme would have to be considered. (ACCC, sub. 42, p. 8)

South Australia has a salinity zoning policy for the River Murray that differentiates between high salinity impact, low salinity impact and salt interception zones (South Australian Government, sub. DR79). There are no charges associated with the policy at this stage. Irrigation development in the high salinity impact zone is subject to an offset requirement. Development in the salt interception zones is subject to available scheme capacity, and development in the low salinity impact zone is subject to salinity credits available to South Australia on the Murray–Darling Basin register.

FINDING 9.3

Salinity zoning schemes provide incentives to affect landholders' water-purchasing decisions. Incentives may be needed to encourage the removal of water from salinity impact zones to reduce salt mobilisation.

Management of groundwater recharge

Within individual irrigation districts a variety of arrangements have been established voluntarily by industry agencies to manage the recharge of groundwater. In the southern Murray–Darling Basin, for example, the Ricegrowers' Association of Australia has established industry codes of practice that constrain the production of rice to certain soil types to limit groundwater recharge. Water-use standards have also been introduced in some areas. Murray Irrigation, for example, reduces future allocations to irrigators with water consumption patterns above prescribed standards. In some areas, water trades are not approved to irrigators that exceed defined water-use standards.

Individual irrigation areas are also undertaking initiatives to manage salt. For example, Coleambally Irrigation Area is affected by shallow watertables which, if left unchecked, are predicted to result in 25 per cent of the land area being affected by salinity by 2023 (Coleambally Irrigation Co-operative, sub. 3). Coleambally Irrigation Co-operative described several initiatives under the Coleambally land and water management plan to address salinity, including a proposed net recharge management scheme. Experimental modelling by Whitten et al. (2005) indicated that the scheme would provide relatively low expected benefits relative to costs (box 9.3).

Addressing salinity problems through reductions in groundwater recharge is a longer term strategy than salt interception since the effect of these actions can take a long time to provide benefits. If close to a river, preventing groundwater recharge may, under some conditions, have relatively quick positive effects on river salinity as well as negative effects on river flows, sometimes as short as several years (but typically decades). When recharge occurs further away from the river, it can take hundreds of years for instream salinity to be affected. However, the rate of groundwater movement is highly variable and depends on the hydraulic conductivity of the soil and the hydraulic pressure of the system (Department of Agriculture (Western Australia) 2004).

Box 9.3 **Coleambally Net Recharge Scheme**

The Coleambally Net Recharge Scheme was one of ten pilot projects run under the first round of the National Market Based Instruments Pilot Project, funded through the National Action Plan on Salinity and Water Quality. The object of the pilot project was to explore the potential application of a cap and trade approach to manage net recharge in the Coleambally Irrigation Area.

Cap and trade mechanisms operate by placing a limit on the overall level of an activity or pollution associated with the environmental damage, allocating rights to the agreed level of activity and then allowing individuals to trade these rights. The premise behind cap and trade schemes is that, by allowing trading rights, greater efficiency, effectiveness and flexibility can often be achieved relative to other policy instruments.

The final report on the pilot project, which was released in July 2005, highlighted some important considerations with respect to adopting market mechanisms:

- the additional costs incurred in developing, implementing and operating the cap and trade schemes can be higher than the costs of administering existing policies
- these costs may offset gains from adopting the market instrument.

The pilot also highlighted the importance of the scientific knowledge underpinning institutional design.

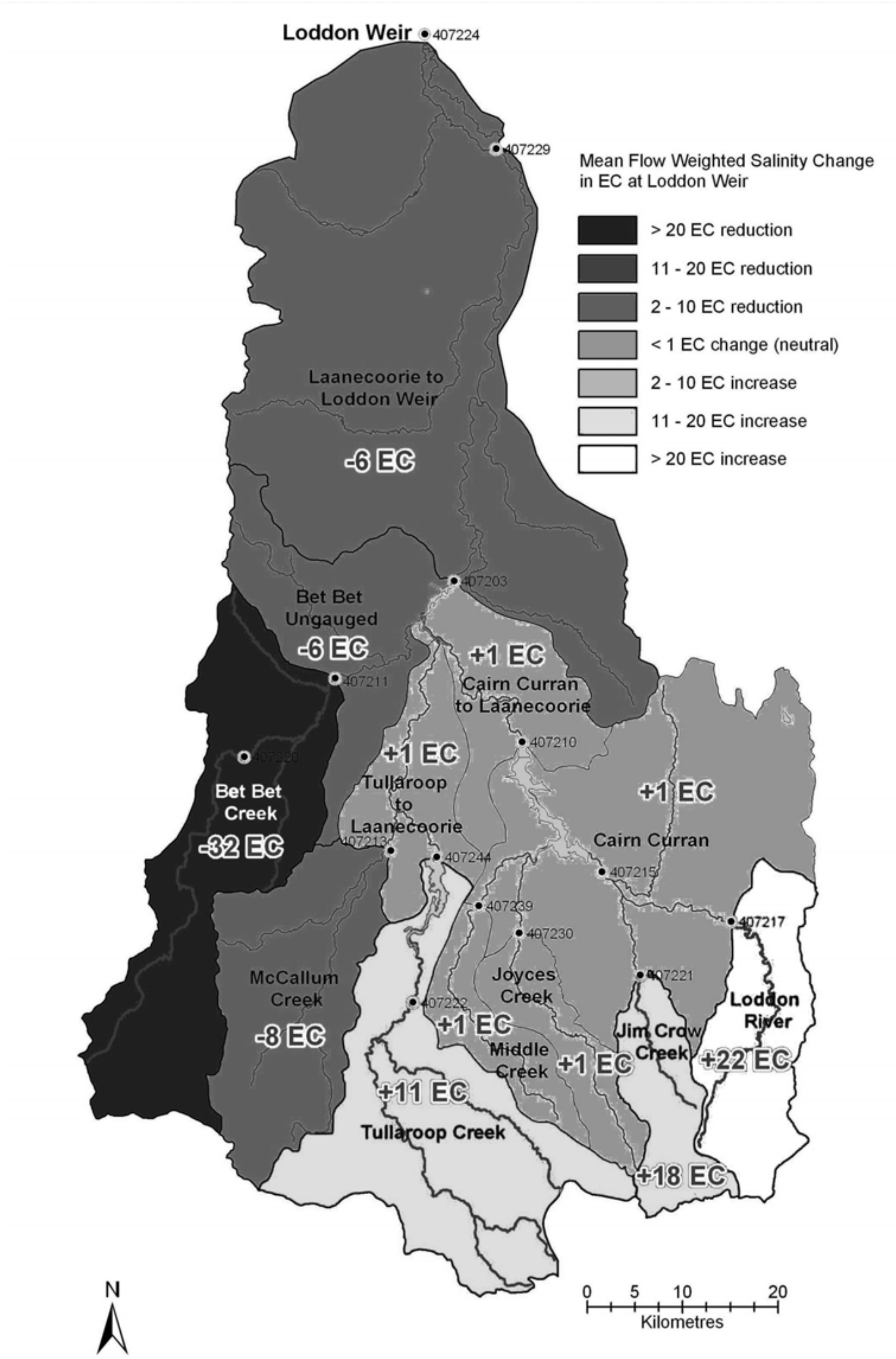
Source: Whitten et al. 2005.

FINDING 9.4

Reducing groundwater recharge can reduce the incidence of salinity at its source, but generally takes a long time to affect instream salinity.

Tree planting can reduce instream salt loads by intercepting water that would otherwise transport salt stored in the soil. These benefits are not uniform across the landscape — in some areas it may intercept water that would otherwise dilute instream salt. Careful selection of sites for tree planting, based on a detailed understanding of where runoff is produced in a catchment in relation to where salt discharge occurs, is essential to identify opportunities to maximise salinity benefits while minimising stream flow reductions.

Figure 9.3 **Indicative effects of tree planting on stream salinity**[a]



[a] The Murray–Darling Basin Commission has advised that this map should not be used for operational purposes as conditions may vary significantly within catchments. In this example, it is assumed that tree planting in each catchment would reduce subcatchment salinity and flow by 50 per cent. Without tree planting, flow weighted salinity at Loddon Weir is 650 EC.

Source: MDBC 2006j.

Figure 9.3 illustrates, for the upper Loddon catchment, very broad areas within which tree planting is expected to produce either positive or negative effects on instream salinity. To identify actual beneficial tree planting sites, however, site-specific conditions within these broad areas would have to be assessed since conditions within these areas will vary. Within the broad areas identified as likely to produce positive effects, some sites will be unsuitable for tree planting. Similarly, areas classified as broadly unsuitable for tree planting may contain specific sites where tree planting would produce positive effects on instream salinity. The NSW Government observed that '[t]he appropriate level for targeting is at about the paddock scale' (sub. DR93, p. 11).

It may be possible on a regional basis to recognise the positive, or in some cases negative, salinity effects of tree plantations within the existing credits and debits system operating under the Murray–Darling Basin Salinity Management Strategy. Establishing tree plantations in suitable locations could give rise to credits that offset other activities within the region known to increase groundwater recharge. Debits would accrue to tree plantations in less desirable locations (from the perspective of salinity). However, inclusion of tree plantations within the credits and debits system would require sufficient scientific knowledge to incorporate the estimated effects of tree plantations in specific locations into salinity modelling. It is doubtful whether such detailed knowledge presently exists.

Some other benefits of plantations may include addressing problems of soil erosion, water pollution and inundation in low-lying areas. Carbon sequestration is another consideration. The full environmental impacts, positive and negative, are not fully captured in timber and other markets, hence there is potential for suboptimal outcomes. While important, such issues are outside the scope of this report.

9.3 Design issues

This section explores a number of key factors that need to be considered before developing market mechanisms to manage salinity.

Using existing institutional arrangements

One of the more important design considerations is the potential to build on the existing institutions and instruments used to manage salinity. This can reduce transaction costs and improve the acceptability of the new instruments.

Under the Basin Salinity Management Strategy, jurisdictions can design salinity management strategies that incorporate market mechanisms. They can develop abatement strategies, for example, at different geographic levels — such as catchments, valleys and/or tributaries — that are consistent with their obligations under the strategy. Consequently, it may be possible to design market mechanisms that link the different levels from the basin to the farm level. Cap and trade mechanisms that build on the existing interjurisdictional credit framework could be designed for the farm or regional level. For example:

- basin level — cap and trade salinity at the jurisdiction level (as measured by EC effects at Morgan) and undertaking abatement activities within and across state borders (a form of limited trade in offsets that potentially moves salt across state borders)
- jurisdictional level — to meet jurisdictional caps, develop mechanisms that require catchments/valleys/districts/irrigators to be responsible for the salinity effects of development or abatement activities, such as under the South Australian credit/debit scheme
- catchment level — develop mechanisms to link individual irrigator activities to catchment level arrangements.

In regions outside the Murray–Darling Basin, market mechanisms could also be designed to build on existing schemes and institutional arrangements.

Conflicting and linked policy objectives

It is important to consider the potential for instruments to have conflicting objectives or to counter other environmental management objectives. In some cases, salinity management objectives may conflict with objectives or approaches in other areas of water and land management. For example:

- Increasing river flows could affect instream salinity. As noted in chapter 7, if flows are increased to improve floodplain connectivity, saline groundwater that could reach the river may be mobilised.
- Improving water-use efficiency could reduce return flows and increase the concentration of saline water flowing to downstream water users. Reducing return flows from irrigation regions could result in the build-up of salt within irrigation regions.
- Facilitating the rapid removal of salt from basins may contravene existing modelled instream water quality standards, such as the Morgan target. Some flexibility of the modelled target may be needed to remove salt from the basin in

winter during high flow events (see below). Physical monitoring of instream salinity may also be necessary.

- Creating river flushes and flooding events for ecological sites can have implications for landholders adjacent to the river. Increasing river flows would need to be carefully managed and it may be necessary to make arrangements with landholders to address the negative impacts associated with flooding.
- Revegetating dryland areas is a means of addressing dryland salinity over the longer term, but revegetation can reduce surface water runoff and affect the availability of water downstream for irrigators or environmental purposes.

As noted in chapter 6, an environmental manager would need to weigh the benefits and costs, and address the complex tradeoffs that may be required between environmental objectives.

Links between policy objectives can improve the effectiveness and reduce the costs of implementing market mechanisms. For example, managing salinity outcomes is closely linked to managing environmental flows (chapter 7) and land-use management. These links mean that mechanisms need to be coordinated to achieve policy objectives.

FINDING 9.5

Market mechanisms for salinity and environmental flows need to be coordinated to capture synergies and ensure mechanisms do not have significant unintended detrimental effects.

The effect on urban water supplies of flushing salt from a catchment or basin would have to be carefully managed. For example, an average of 40 per cent of Adelaide's mains water is drawn from the River Murray, with the other 60 per cent coming from storage in the Adelaide Hills. However, intake into these storages is variable and, in a dry year, up to 85 per cent of mains water may be taken from the River Murray (Water Proofing Adelaide 2004).

When urban water supplies are being drawn from the River Murray, sufficient dilution of saline flushes would have to occur to ensure that the salt concentration at Morgan (which is near off-takes that supplement urban water supplies in Adelaide and Whyalla) did not exceed desirable drinking water quality standards. At other times, when adequate alternative water supplies or storages are available such as during average to wet winters, larger saline flushes down the River Murray could be scheduled, even though they may be expected to temporarily (during the flush) raise the salt concentration at Morgan above acceptable water quality standards. The level to which the target could be raised depends on expected ecosystem effects, which may vary spatially and temporally (box 9.1). Such seasonal flexibility in water quality standards would facilitate the flushing of salt out of the basin.

FINDING 9.6

Flushing salt out of a catchment or basin may be an efficient approach to managing salinity. Seasonal flexibility would be needed in water quality standards to facilitate flushing salt from the Murray–Darling Basin.

Measurement

Measurement of salinity is critical to the success of market mechanisms. The appropriate metric (volumes versus concentrations) must be carefully chosen together with the level of the target. Often the design of the instrument will be critically affected by the availability of information on salinity incidence and source.

There are several ways to measure, or estimate, salinity. Direct measures include:

- electrical conductivity — can easily measure the in situ concentration of instream salt
- total dissolved solids — a true measure of instream salt concentration which can be inferred from electrical conductivity (with variation due to the ionic composition of the water) or obtained directly from an expensive chemical analysis
- salt load — the mass of salt moving into the landscape. However, the effects of salinity are often related to the concentration of salt and, therefore, additional information on water flow is needed.

In addition to direct measures, salinity estimates may be made through the use of proxies or simulation results. While instream salinity can be measured at the basin or catchment level (such as EC at Morgan or end-of-valley targets respectively), there is no equivalent measure at the farm level. Observed effects on groundwater can be the culmination of activities on a number of farms and there is no point source to measure the quantity of recharge. Hence, estimates of groundwater recharge from the property — based on farm characteristics that can be altered through landholder actions and those that have a close scientific link to the salinity outcome (box 9.4) — may be an appropriate proxy for farm contributions to salinity through the mechanism by which they add to rising saline watertables.

Box 9.4 Estimating groundwater recharge

There are various methods that could be used to estimate groundwater recharge. Quantitative estimation of recharge is important in assessing alternative land management options, as well as for providing input into groundwater models that assess impacts on groundwater systems.

Models and maps of groundwater recharge often use soil types as a surrogate measure. The theoretical basis for this is the empirical relationship between deep drainage rates and soil type.

Sources: Cook et al. 2001; Petheram et al. 2000.

Simulations of salinity levels are made for two reasons. First, some activities lead to increases in measured salinity only after substantial time lags. Modelling of these delayed effects permits assessment of the expected salinity impacts of various activities and allows mitigating action (such as offsets) to be taken before environmental damage occurs. Second, while impacts on ambient water quality, such as salinity levels, can be readily observed, pinpointing the exact source can be problematic, given that pollution can enter water systems over a broad front. This uncertainty can be mitigated where biophysical modelling can demonstrate a strong connection between action (especially on-farm) and effect. However, these links can be difficult to establish, and even when such a connection is made, they may not hold up across a range of conditions. The National Water Commission has argued that tools to measure the environmental benefits of management decisions are vital as they 'increase transparency and help limit ad hoc decision making' (sub. 22, p. 3).

The Murray–Darling Basin Commission and CSIRO, in conjunction with private industry, have developed a model called the Salinity Impact Rapid Assessment Tool (SIMRAT) to simulate salinity effects from changing irrigation land use (box 9.5). It enables the:

> … rapid assessment of groundwater discharge and associated salt load and salinity impact … The model can assess new irrigation development that occurs as a result of water trading and simulates the impact of both new irrigation and the retirement of existing irrigation. (Murray–Darling Basin Commission, sub. 31, p. 10)

This tool (along with other models) assists in implementing a number of states' salinity policies. Victoria's salinity impact policy stipulates that irrigation developers be held accountable for their salinity impacts and imposes a levy on water trade to specified high and low impact areas along the River Murray. South Australia also uses SIMRAT to assist in monitoring water trade approvals because trades are restricted in high salinity impact zones (Murray–Darling Basin

Commission, sub. 31). The SWAGMAN (Salt Water and Groundwater Management) model is a farm-level water and salt balance model for the farms in south–eastern Australia and can estimate net recharge and be used for designing offsets (as was done in the Coleambally Irrigation Area).

Box 9.5 **Salinity Impact Rapid Assessment Tool (SIMRAT)**

The Murray–Darling Basin Commission, in collaboration with partner governments, has developed a rapid assessment tool known as SIMRAT to assess and account for the salinity impacts of irrigation and interstate water trade in the Mallee region of New South Wales, Victoria and South Australia within the Lower Murray–Darling Basin.

The model supports the system of salinity credits and debits under the Murray–Darling Basin Commission's Basin Salinity Management Strategy 2001–2015, and it has been peer reviewed and accredited for assessing the salinity impacts of interstate water trade between New South Wales, Victoria and South Australia and the associated irrigation development in the region.

SIMRAT simulates movement of rainfall and applied excess water vertically through the soil zone to the aquifer using wetting or drying functions. In the aquifer, a response relationship is used to estimate the aquifer discharge at some point remote from the area of application. Allowance can be made for the loss of salt to floodplain processes, or partial connectivity of the aquifer to a river.

SIMRAT enables rapid assessment of groundwater discharge and associated salt load and salinity impact (EC at Morgan and economic cost) based on aquifer recharge and subsequent discharge to the River Murray within an area of 15 km either side of the river from Nyah (Victoria) to Goolwa (South Australia). It draws on detailed geographically specific characteristics of the landscape to identify the source of irrigation salinity impacts.

It can be used to estimate the salinity effects of:

- water trade
- changes in water-use efficiency
- changes in land use on infiltration rates (such as revegetation)
- environmental watering.

When the salinity impact is assessed for a new irrigation development (water arrival site), the trade type is called an 'arrival type' and the impact is generally a salinity debit. Conversely, if the salinity impact is assessed for a site from which water is sold (retired site), then the trade type is called a 'departure type' and the impact is generally a salinity credit.

Sources: eWater 2006; MDBC 2006b; Miles and Kirk 2005; Murray–Darling Basin Commission, sub. 31.

As discussed throughout this report, Australia has a wide variety of soil and vegetation types and climatic regions which affect the natural state of surface water and groundwater. Thus, policy objectives are often stated in terms of specific areas or regions. Determining standards that affect these natural levels, including the natural characteristics of river basins and the capacity of the aquatic ecosystems to assimilate salt, is essential to support the establishment of more site-specific guidelines (NLWRA 2004).

Improved knowledge of salinity and hydrological relationships is increasing the ways in which market mechanisms can be designed and implemented. Improved knowledge of groundwater recharge, for example, has provided new ways for market mechanisms to target salinity. Developments in biophysical modelling also improve the feasibility of implementing market mechanisms. However, increasing the accuracy of measurement is costly, and may not significantly increase the effectiveness of the market mechanism. Decisions to improve measurement or estimation accuracy must be based on assessments of the costs and benefits of doing so.

Temporal and spatial issues

As highlighted earlier, salinity can exhibit high spatial and temporal variation that can have important implications for the design of market mechanisms. The Murray–Darling Basin Salinity Management Strategy (box 9.2) attempted to recognise some of the temporal dimensions by recognising and allocating responsibility for legacy effects of past management decisions that result in salinity.

The relative net benefits of establishing market mechanisms to manage salinity depend, in part, on the physical relationships between the land management practices and the incidence of salinity and the effectiveness and efficiency of the economic tools used to influence land management decisions. Heaney et al. (2001) found that the location of the salinity problem is an important consideration and the net benefits of action are usually more pronounced for salinity in the upper catchments and for salinity located above high-value land uses or key environmental assets.

The diffuse nature of irrigation salinity renders many market mechanisms impractical. Performance-based mechanisms, for example, are difficult to implement given the difficulties in measuring outcomes or the source of the salinity. Salinity management can require both local and system-wide responses. The diversity of ways non-point sources of salinity can occur means that a single market mechanism will not be appropriate. For example, rapidly rising salinity levels in groundwater might require a combination of regulation in high recharge areas and the use of long-term easements to retire marginal cropland. The tool, or combination of tools, best suited for a particular problem is an empirical issue based on policy goals, local conditions and the costs of acquiring information (Ribaudo et al. 1999).

Market mechanisms need to be robust to change. Instruments, such as cap and trade, are often discussed in a fixed context, but the specification of a cap can also occur in a dynamic fashion (for example, caps can be expressed in terms of percentages rather than volumetric amounts). However, there is a tradeoff between the certainty desired by irrigators and the flexibility required for effective environmental management, especially in the face of changes in information and understanding of biophysical processes. Adaptive management may also be required to account for uncertainty in the environmental impacts. Further, it may be desirable to vary design features to ensure acceptance and promote participation in the new markets.

Time dimensions also affect the choice of action to address salinity. For example, tradeoffs will need to be made between engineering options that provide immediate salinity benefits but treat the symptoms not the causes; landscape change options that treat the cause but do so where benefits may only be felt in the longer term, and where there may be less certainty about benefits; and flow management options that can provide immediate salinity benefits (such as dilution flows) but can affect availability of water for irrigation and other environmental purposes.

Salt can have threshold implications for ecosystems and drinking water standards. Depending on local hydrological factors, thresholds can be quickly reached, and some market mechanisms may not be appropriate because environmental or instrument responses may be too slow. In such cases, regulation may be required. Where the effects are gradual and not likely to reach a threshold, market mechanisms that involve slower market and environmental responses may be a more cost-effective option.

10 Assessing market mechanisms for irrigation salinity

Key points

- Cap and trade in salt may provide a flexible approach to manage the regional incidence of salt at relatively low cost.
- To reduce localised incidence of salt, promising market mechanisms include:
  – cap and trade schemes — may be appropriate and effective at the irrigation region level if the benefits of reducing the incidence of salt are sufficiently large. Salt cap and trade schemes at the farm level are unlikely to be practical due to information constraints. Cap and trade in groundwater recharge at the farm level may prove to be more workable
  – offsets schemes — likely to be feasible and effective if designed to suit local conditions.
- Zoned salt levies penalise actions that exacerbate salinity, but could be complemented by rewards for actions that reduce salinity.
- Market mechanisms may be used to remove salt from the river system. A mix of the following instruments will be required to:
  – establish markets to purchase flows specifically for diluting salt
  – create regional salt cap and trade schemes to allow for trading in saline river flows
  – allow offsets to supplement these caps.
- Careful design and management of policies would be required to ensure undesirable environmental outcomes do not occur with the transport of salt. Increasing the flexibility of existing river salinity targets and caps would also be required.

This chapter assesses market mechanisms for managing irrigation salinity using the same assessment framework used in chapter 8 (and described in section 6.2). Section 10.1 assesses market mechanisms for limiting the emergence of salt, and section 10.2 looks at dilution flows as a method to reduce levels of salt.

10.1 Reducing the further emergence of irrigation salinity

This section assesses key quantity and price-based market mechanisms that could be designed to reduce the further emergence of salinity. Cap and trade schemes and offsets are two types of market mechanisms that fix the quantity of salt, or impact of salt-causing actions, that is permitted. Subsidies are discussed as a price mechanism to influence landholder behaviour; taxes are another option.

Quantity-based mechanisms: cap and trade

Cap and trade mechanisms could be designed for the farm or irrigation region level using different measurement methods to represent the discharge or creation of pollutants such as salt. Cap and trade of diffuse source pollutants is emerging in a number of countries. In New Zealand, for example, a cap and trade scheme is proposed to address nutrient pollution of Lake Taupo (box 10.1). Existing and proposed cap and trade schemes, for salt and other diffuse source pollutants, can highlight practical implementation issues and provide some guidance for the design of Australian cap and trade salinity mechanisms. (Similarly, mechanisms developed to address salt emissions may be applied, with appropriate modification, to address nutrient emissions that create significant environmental externalities.) The major requirements for workable cap and trade schemes appear to be:

- an understanding of biophysical relationships, such as salinisation processes
- modelling of the pollution process to produce acceptable estimates of emissions at an appropriate level (such as farm, region or catchment), or availability of satisfactory proxies for performance standards (such as adoption of best available technology or best management practice standards)
- a sufficient number of heterogeneous potential market participants
- extension of the trading scheme to all participants with the potential to trade
- adaptability of the scheme to adjust for new scientific information or the development of new techniques to reduce emissions
- attention in designing the scheme to minimise unnecessary restrictions and complexities, and thereby minimise transaction costs
- a supporting regulatory framework, such as the establishment of a binding cap and tradeable rights
- monitoring of compliance with the scheme, with penalties for non-compliance.

Box 10.1 **Proposed cap and trade scheme for nutrients — Lake Taupo, New Zealand**

Water quality in Lake Taupo, New Zealand's largest lake, is declining due to increasing amounts of nitrogen entering the lake from surrounding rural and urban development. Because nitrogen can take decades to move through the soil, groundwater, streams and into the lake, only recently have the impacts of changes in land use in the 1930s become evident in the lake.

Environment Waikato (the Waikato Regional Council) proposes to stabilise nitrogen levels by, among other things, capping nitrogen outputs from nitrogen-leaching farms ('controlled' activities) in the catchment and permitting trade of nitrogen discharge allowances, so that increases in nitrogen leaching are offset by corresponding reductions elsewhere in the catchment.

The process would include:

- Estimating the amount of nitrogen leached from a farm using a model called 'Overseer'. This would determine a farm's Nitrogen Discharge Allowance.
- Farmers developing nutrient management plans, using the Overseer model, which would be monitored. The model requires information such as farm production, fertilizer inputs and stocking rates.
- Once an allowance is authorised, further increases in nitrogen leaching must be offset and secured by way of a change to the allowance. Nitrogen leaching amounts for offsetting are calculated using the Overseer model.

Comments sought by Environment Waikato have raised several issues regarding practical implementation. An overarching comment which applies to the proposal, and to cap and trade proposals for other diffuse sources of pollution, such as salinity, relates to the necessity to ensure that the practical details are sound. As Sinner noted, 'the design of that system [cap and trade] will affect both its effectiveness at achieving water quality targets and its efficiency at reducing the cost of meeting those targets' (2006, para. 10). In particular:

- The contribution of individual farms to nitrate leaching is difficult to measure. The scheme would rely on a model estimating, rather than measuring, likely discharge based on assumptions about farm inputs. The estimate would be a three-year historical average which would not necessarily reflect leaching in any one year.
- Innovation may be discouraged if there are delays in getting new practices to reduce leaching incorporated into the model.
- There is no transparent and robust process for adjusting the cap or for adjusting the trading rules to reflect new scientific information.
- There is uncertainty regarding the duration of rights, renewal, the impact of changes to the model, monitoring of compliance and penalties for non-compliance.

(continued next page)

Box 10.1 (continued)

- Prior approval is required for trades. Transaction costs could be reduced by removing this requirement.
- Not allowing unused allowances to be banked for the future reduces efficiency by increasing transaction costs.
- Trading is restricted to those undertaking, or wishing to undertake, nitrogen-leaching farming activities. Those involved in permitted activities, such as forestry, would not be allowed to trade, thereby restricting the number of buyers and sellers.

Environment Waikato is considering evidence from submissions and hearings. A decision will then be announced regarding any changes to the proposal.

Sources: Environment Waikato 2005, 2006; Sinner 2006; Sundakov 2006.

Cap and trade mechanisms could be developed for:

- prescribed on-farm and off-farm irrigation and land management activities
- on-farm groundwater recharge.

ABARE observed that these schemes may involve significant initial costs:

> Once the cap of [salt] emissions is set, governments are not required to identify which emitters have the highest value because information on willingness to pay and marginal costs are revealed as a market process. The information costs faced by governments are going to be from determining the efficient level of emissions, or setting the cap, as well as identifying polluters to include in the market. (sub. 54, p. 13)

These costs may be minimised by careful design and by using or extending existing institutions and mechanisms, such as existing water markets or cap and trade mechanisms.

Cap and trade of salt emissions

Under a cap and trade of salt emissions, an activity that abates salt entitles the abater to a salt credit. This credit can be sold to a person or entity requiring credits to permit them to undertake an activity that creates salt debits. Setting the level at which salt emissions are to be capped is necessary to establish this type of market mechanism. Salt emission levels could be capped at a local level (for example, with estimation of each irrigated farm's salt consequences from farming practices employed) or at the whole-of-basin level (for example, with variations in end-of-valley salt measurements being tradeable between areas by institutions above the farm level, such as catchment management authorities and water utilities).

A salinity cap and trade scheme would allow greater flexibility in the management of saline discharges. Those who can more easily and cheaply reduce their discharge levels have incentives to do so because they can sell credits to those who would incur greater costs of reducing discharge levels (table 10.1). Organisations undertaking other forms of salinity abatement, such as engineering salinity interception schemes, would also be able to participate in this market because their actions would create tradeable credits. A trading market for salt would also provide price signals to identify which abatement activities are the least-cost methods, among both the on-farm and engineered interception approaches.

Grafton (2005) observed that cap and trade schemes need well-defined markets for discharge. In general, cap and trade mechanisms are difficult to apply to non-point sources because permit specification requires detailed measurements of discharges and environmental harm. This is particularly the case at the farm level. The necessary biophysical modelling at the farm and paddock level usually implies relatively high establishment costs for cap and trade schemes at a local level. It may be relatively costly to obtain information that is needed to set the cap and permit levels (which includes biophysical modelling on the source and impact of the salinity) and then to set up and facilitate the market. If permits are specified in terms of tonnes of salt, biophysical modelling is needed to establish the link between farm activity and salt loads released. If permits are measured in terms of saline concentration levels, then water discharges need to be monitored and linked to a farm or paddock.

While salt cap and trade schemes may not be cost-effective at the farm level, it may be feasible to specify permits at the irrigation region level, capped at a basin level. Irrigation region salinity measures are more reliable and do not require the detailed monitoring or initial specification that farm-level permits require. Cap and trade schemes based on irrigation regions could be useful for mitigating the cost of salinity, by shifting water from high to lower salinity impact zones, but they will not prevent the emergence of salt at the farm level. If implemented at the catchment level, catchment managers would need the ability to meet catchment responsibilities through engineering works or changes in irrigator activities — with the latter being driven by market mechanisms, planning regimes or other methods.

Within catchments, the greatest benefits from salt cap and trade are likely to come from focussing on irrigation districts where negative impacts from salinity are evident and knowledge about the connections between farming activities and salinity emissions is better (in contrast to impacts from dryland farming where information about the links between land management choices and eventual salinity impacts is less certain). However, hydrological, geological and climatic uncertainties associated with predicting the impacts of irrigation practices on salinity emissions imply that managing cap and trade schemes within irrigation districts will still be difficult. Nevertheless, the Murray–Darling Basin credit and debits system establishes an existing basin-level cap and trade scheme that could be developed further for operation at a catchment level.

Table 10.1 **Assessment of salt cap and trade at the regional level**

Criterion	*Assessment*
Costs	Medium — significant upfront costs to set the cap and permit levels, and design and establish the scheme. Ongoing costs to operate, monitor and enforce could potentially be reduced with technological developments.
Feasibility	Medium — cap has already been established in the Murray–Darling Basin so some upfront costs already incurred. Across border abatement investment resembles limited trade.
Flexibility	High — schemes enable participants to choose their optimum level of abatement, enhancing flexibility with production and investment decisions. Permits a tiered structure of mechanisms at lower levels to meet obligations.
Distribution of costs and benefits	Trade benefits buyers and sellers. Benefits to parties adversely affected by salinity and to those who value improved environmental outcomes.
Likelihood of achieving desired goals	High — if implemented at a scale where measured salinity outcomes are highly correlated to the actions of participants.

FINDING 10.1

A salt cap and trade scheme may be appropriate at the regional level, but less so at the farm level.

Cap and trade of groundwater recharge

Managing the recharge of irrigation water to groundwater can limit the emergence of salinity. By creating property rights that define whether and how much each irrigator can contribute to net recharge in their area, a cap and trade scheme for groundwater recharge provides a mechanism to allocate recharge rights to landholders who value such rights most highly. The potential benefits of trade are greatest when there is variation (heterogeneity) between the landholder characteristics, such as crop type or irrigation technique, because individual differences in the valuation of groundwater recharge occur. These schemes can be tailored to the appropriate spatial dimension, whether that is farm-level permits or irrigation/catchment authority-level permits (table 10.2).

Table 10.2 **Assessment of cap and trade of groundwater recharge**

Criterion	*Assessment*
Costs	Medium — detailed scientific information is required on the source and effects of rising groundwater, across time and space. Design and implementation costs can be high. However, the scheme enables irrigators to find low-cost solutions to managing groundwater and lowers total costs of groundwater management across the irrigation area.
Feasibility	Medium — implemented as pilot project in Coleambally. Feasible in areas with variation in landholder characteristics.
Flexibility	High — enables irrigators to choose their appropriate level of abatement of irrigation water entering groundwater. Appropriate spatial dimension can be chosen.
Distribution of costs and benefits	All irrigators benefit from abatement although those in areas with relatively higher groundwater levels are likely to benefit more than those with lower water tables. Benefits may be small and incremental. Benefits to parties who value improved environmental outcomes.
Likelihood of achieving desired goals	Medium — if groundwater recharge at the farm level can be effectively managed and measured by the scheme.

Heaney et al. (2001) found the success of reducing groundwater recharge in irrigation districts depended on the response time of aquifer recharge. The quicker the effect of the recharge the quicker the benefits could be realised. Benefits are likely to be higher where groundwater salt concentrations are high and groundwater is closer to the surface. Also, decreasing groundwater recharge in upper catchments requires changes in land use that reduce groundwater recharge in those areas. Often these actions (such as accelerating reforestation) reduce surface flows from upper catchments, which has tradeoffs for downstream irrigators and riverine ecosystems.

CSIRO and Coleambally Irrigation developed a pilot scheme to manage groundwater recharge in the Coleambally region (box 9.3, chapter 9). A feature of the scheme was to enable irrigators to more flexibly adjust their farm management practices and thereby lower the costs of recharge abatement.

There are high information costs in designing a cap and trade recharge scheme, particularly in understanding the relationships between different water-use practices, soils and groundwater recharge rates. Whitten et al. (2005) found that high establishment and implementation costs can outweigh the benefits of managing the recharge in some irrigation areas where the gains from trade are low.

In the case of the Coleambally pilot scheme, it was possible to accurately and cost-effectively estimate paddock-scale recharge. Nevertheless, the costs of developing and implementing a cap and trade scheme, and the likely ongoing transaction costs incurred by irrigators in trading recharge rights, were found to be greater than the costs incurred in administering current policies. The relatively low potential benefits meant capping recharge was not the best policy response. The higher net income to farmers achieved under the cap and trade scheme was found to be less than 1 per cent of estimated farm income over the 20-year period (Whitten et al. 2005). In other areas, where the potential benefits from reducing salinity through capping groundwater recharge are greater, the benefits of such a scheme may outweigh the costs, and implementation may be appropriate.

FINDING 10.2

A cap and trade scheme for on-farm groundwater recharge may be worthwhile in areas where there is sufficient diversity in land management practices and where benefits from reducing the emergence of salinity are high.

Quantity-based mechanisms: offsets

Offsets allow certain practices that can contribute to salinity to occur if specified activities are also undertaken that can reduce the emergence of salinity. Offsets do not, therefore, reduce total salinity levels. By offsetting specified activities that generate salinity, they work to prevent an increase in total salinity levels.

Offsets for on-farm irrigation practices

Establishing offsets to allow certain irrigation practices is a variant of the groundwater recharge scheme, with the objective of reducing groundwater recharge. Groundwater recharge is effectively capped by requiring certain agricultural practices that reduce groundwater recharge to offset other farm management practices that are known to cause higher levels of groundwater recharge.

A traditional cap and trade model may be limited to mitigating damaging actions rather than alternative abatement activities that offset the net recharge from irrigation sources. Voluntary offsets incorporate these alternative abatement opportunities because point source emitters can purchase offsets from diffuse source emitters but the diffuse source emitters decide whether they participate (table 10.3).

Table 10.3 **Assessment of offsets for groundwater recharge**

Criterion	*Assessment*
Costs	Medium — land management and irrigation practices that increase or decrease groundwater levels need to be understood and transparent to determine offset ratios. There may be costs associated with enforcement and monitoring.
Feasibility	High — offsets are often easier to design and implement than cap and trade schemes.
Flexibility	Medium — offsets may not fit within the whole-farm plans of individual irrigators because choice of landholder action is limited by allowable offsets.
Distribution of costs and benefits	Costs of offsets are borne by individual irrigators, although all irrigators gain from lower groundwater levels, some more so than others (differing opportunity costs to individual irrigators in application of offsets). Benefits to parties who value improved environmental outcomes.
Likelihood of achieving desired goals	High (in longer term) — some offsets can have lags before effects on groundwater levels occur.

South Australia's zoning scheme requires that irrigation developments in the high salinity impact zone must be offset by activities that reduce saline emissions. The Coleambally Irrigation Co-operative instituted an offsets scheme which was considered successful. Supported approaches included:

> … cropping offset ratios that alleviate the need to reduce rice area. Landholders have been given the option to maintain current rice allowable area and not be affected by the CIA [Coleambally Irrigation Area]-wide rice area reductions due in July 2007, via the adoption of rice area offsets (net recharge ratios). (Coleambally Irrigation Co-operative, sub. 3, p. 19)

A disadvantage of the scheme is the high monitoring and compliance costs required to ensure the appropriate offsets are being made. There may be some limits to flexibility with different soils and topography affecting the effectiveness of allowable offsets. In addition, intertemporal tradeoffs may be an issue when offset benefits are subject to long lags (for example, tree planting to reduce groundwater recharge) but the salinity effects from damaging activities are more immediate. The degree to which offsets are taken up by irrigators will be determined by the degree to which they fit with the existing whole-farm plan.

FINDING 10.3

Offsets for groundwater recharge can be successfully implemented to address localised salinity problems.

More broadly, it may be possible on a regional basis to recognise the positive, or in some cases negative, salinity effects of tree plantations within the existing credits and debits system operating under the Murray–Darling Basin Salinity Management Strategy (section 9.2, chapter 9). While the detailed scientific information required to adopt this option does not currently exist, pilot schemes have been established to improve knowledge about tree plantations' salinity effects and the workability of a salinity offsets scheme (box 10.2). Further investigation of this option may be useful.

Box 10.2 **Potential salinity offsets from tree plantations**

In 2001, Forests NSW initiated a pilot project in the Macquarie catchment to investigate the potential for developing a market in salinity control rights. The project seeks to address salinity in the Macquarie River by revegetating critical recharge areas through the establishment of 100 hectares of hardwood plantations on private property. Landholders receive an annual payment for a minimum of 20 years and Forests NSW receives the use of the land, all timber and timber products, and all rights associated with environmental services, including salinity control credits and carbon sequestration rights. Forests NSW has forward sold all the expected salinity control benefits (based on the transpiration rate of the trees) to Macquarie River Food and Fibre for the first 10 years.

In the Liverpool Plains, Forests NSW is establishing 400 hectares of hardwood forests as an operational scale trial in critical recharge areas within the catchment. The plantings vary in size from 10–60 hectares and are designed to provide information on salinity effects as well as optimal site preparation, planting density, species mix, and plantation configuration. The trial has been set up to stimulate markets for non-traditional wood products and for a range of environmental services, including salinity offsets, carbon sequestration and biodiversity enhancement.

Forests NSW and the New South Wales Department of Agriculture are developing a project to benchmark salinity control and carbon sequestration from tree plantings in low rainfall areas. The project aims to provide the necessary basis for trading in these environmental services, in part by developing cost-effective methods for measuring and estimating water use by tree plantations.

Forty seven demonstration trials of two hectares each have been established in salinity-affected catchments across the Murray–Darling Basin to understand the likely salinity benefits of plantations in various locations.

Sources: DPI 2005; NAPSWQ 2001.

Zoned salt levy on water trades funding salt interception

The HIZ/LIZ scheme in Victoria is a form of salinity offset, whereby levies on water trade to specified high and low salinity impact areas along the River Murray are used to fund salt interception works. (South Australia's zoning scheme has no charges at this stage.) The Australian Competition and Consumer Commission described the scheme:

> … Victoria utilises zoning techniques with defined High and Low Impact Zones (HIZ & LIZ). Trade into HIZs is prohibited while trade into LIZs is permitted but levied at a varying rate per ML to offset the associated salinity impacts and cover the cost of public salt interception schemes. (sub. 42, p. 8)

Salinity levies are ultimately paid partly by sellers through falls in prices. However, with exporters of water to levy-paying salinity zones usually having other options for trading their water, salinity levies will be borne mainly by water importers.

Levies can provide similar incentives to landholders as cap and trade in salt — to penalise actions that exacerbate salinity — but, depending on the levy design, may reduce the comparative incentive to sell water out of areas with high salinity effects. Levy schemes should incorporate rewards for actions that reduce salinity. Water export incentives, for example, could be introduced for salt impact regions, thereby avoiding salt interception costs at the margin. Properly calibrated they would equal the avoided costs of salt interception and thereby be revenue neutral.

While levies can be transparent and involve low-cost implementation, the information requirements needed to accurately assess the cost of salinity impacts can be high. However, they have the potential to be site-specific (if such discrimination is possible) (table 10.4).

Table 10.4 **Assessment of zoned salt levies on water trade**

Criterion	*Assessment*
Costs	Medium — low-cost implementation, however, levy costs may be rising if tied to costs of salt interception schemes. Some continued monitoring needed to define zones. Charge system for water trading already established.
Feasibility	High — already implemented in Victoria.
Flexibility	Medium — updating of zone definitions necessary to reflect current conditions. Can be made site-specific.
Distribution of costs and benefits	Costs fall to new development. Established sources 'grandfathered' in. Benefits to parties adversely affected by salinity and to those who value improved environmental outcomes.
Likelihood of achieving desired goals	Medium — will probably stabilise, rather than reduce, current salt levels.

FINDING 10.4

Zoned salt levies penalise actions that exacerbate salinity, but could be complemented by rewards for actions that reduce salinity, such as incentives to trade water out of high impact regions.

Price-based mechanisms: subsidising land management change

Price-based mechanisms can be used to provide incentives to encourage changes in management practices and land use that reduce the emergence of salinity.

Incentive payments could be made to dryland farmers in upper catchments to undertake certain land management practices that reduce saline discharge from their land. The incentive payments could be funded by irrigators who benefit from lower net salinity in the water entering their irrigation region, or alternatively by the public who benefit from improved environmental outcomes. Funding dryland action may be more efficient than trying to manage the salinity consequences downstream.

An irrigator-funded scheme would depend critically on the ability of irrigators to form a group to fund the collective action and have some means of approaching sufficient dryland farmers. If the dryland salinity is diffuse and caused by a large number of individual farmers, there will be higher costs in identifying and negotiating with them unless there is some existing representative body.

One possible approach to address the diffuse source problem is to deliver the incentive payments for salinity via a tender/auction mechanism. Tenders (procurement auctions) for prescribed land management actions have been piloted in the BushTender process in Victoria (Stoneham et al. 2004).

This tender approach is a method of reducing the costs of delivering transfers to landholders, and is designed to affect incentives for land management decisions. They can minimise the costs of delivering subsidies to land managers (table 10.5). Land managers bid to undertake specified land management practices. These bids are assessed via an index that links them to environmental outcomes. While information requirements can be high to design the environmental index that links proposed land management practices to environmental outcomes, an auction scheme reveals a diverse set of information about costs of, and preferences for, these environmental initiatives (Chaudhri 2004).

Funding of subsidies could come entirely from the general tax payer, or costs could be shared according to the distribution of benefits from any environmental improvements. Irrigators in the Murrumbidgee region, for example, could contribute to dryland salinity management in the catchment area between Burrunjuck Dam and the Murrumbidgee Irrigation Area and Coleambally off-takes on the Murrumbidgee River.

Table 10.5 **Assessment of tenders for land management change**

Criterion	*Assessment*
Costs	Medium to high — can be high depending on the nature of the auction system. Requires good understanding of biophysical and land management relationships to evaluate bids. Often slow to deliver. Can be expensive to set up.
Feasibility	High — BushTender and other programs underway.
Flexibility	High — variety of auction designs that could be adopted or adapted to suit the biophysical problem and policy objectives. Can be site-specific.
Distribution of costs and benefits	Auction payments are funded by tax payers or private interest groups.
Likelihood of achieving desired goals	Medium — reveals preferences of both government and participants, but requires willing participants.

FINDING 10.5

Tenders can be practical for procuring land management changes that generate multiple environmental outcomes, including reductions in dryland and instream salinity.

Price-based mechanisms: subsidising relocation and asset substitution

Sometimes, the most economically efficient means of reducing salinity in high impact irrigation areas may be to relocate specific types of farming to lower salinity areas or to cease the use of certain irrigation technologies in high salinity areas. Where fixed assets are a substantial impediment to farm relocation, or to reinvestment in less environmentally damaging irrigation technologies, subsidies may provide a cost-effective means of achieving policy objectives within a specified timeframe.

'Asset fixity' — which results from investments characterised by long economic life, low salvage value and high immobility — makes irrigators less responsive to market signals. Where existing investments in fixed assets will continue to provide economic benefits over a long period, irrigators' returns from continuing to use these assets may exceed expected returns from changing location or from investing in less environmentally damaging irrigation assets. In these circumstances, a targeted subsidy may be more effective than an environmental levy in changing these irrigators' location or investment decisions (Gordon et al. 2005).

Whether the benefits from reducing salinity justify the cost of such subsidies varies by enterprise and location. Irrigators with assets nearing the end of their useful life will be more responsive to such subsidies. Subsidies targeted at these irrigators may therefore achieve salinity improvements more quickly than environmental levies and at more modest cost than broad subsidies.

Location-specific characteristics will also influence the effectiveness of policies designed to improve salinity outcomes by encouraging the relocation of farming activities and changes in irrigation technologies:

> The extent to which a reduction in salt loads and concentration is achieved depends, among other things, on the response time of the ground water aquifer, the volume of the reduction in ground water leakage and the underlying ground water salinity.
>
> The overall net benefit from an increase in water use efficiency can be highly location specific. (Heaney et al. 2001, p. 16)

A subsidy scheme to address asset fixity would, therefore, require careful design, and the costs and benefits of such a scheme would need to be assessed before its introduction in a specific area (table 10.6). It is likely that a scheme would produce the greatest net benefits in high impact salinity areas such as the lower Murray.

Table 10.6 **Assessment of subsidies for relocation and irrigation practice change**

Criterion	*Assessment*
Costs	Medium — small subsidies may be required to alter incentives given the presence of sunk irrigation infrastructure, although designing the appropriate level of subsidy can be difficult.
Feasibility	High — existing incentives are in place.
Flexibility	Medium — the compatibility of irrigation and farm management practices with existing landholders' skills may vary.
Distribution of costs and benefits	Costs to tax payers of funding the scheme. Can be costs to irrigators in configuring land and infrastructure depending on the compatibility of the irrigation technology with existing farm management practices. Costs of new inputs associated with the technology, such as fuel for pumps. May be additional monitoring and management costs. Benefits to parties adversely affected by salinity and to those who value improved environmental outcomes.
Likelihood of achieving desired goals	Medium — will depend on the design of the scheme. There may be long lags and incentives may drive an expansion of irrigated agriculture.

FINDING 10.6

Relocating farm enterprises and/or investing in physical water-use efficiency can reduce groundwater recharge. Carefully designed and targeted incentive payments could accelerate relocation or investments in irrigation technologies that reduce groundwater recharge. The costs and benefits of such a scheme would need to be assessed on a case-by-case basis.

10.2 Disposing of salt

CSIRO highlighted that there are currently no incentive arrangements to remove salt from the Murray–Darling Basin:

> In the Murray–Darling Basin system, salinity management arrangements seek to retain salt within the system and transfer it to evaporation basins. There is no incentive or institutional arrangement that encourages the removal of salt to the sea. (sub. 24, p. 7)

Dilution flows have been used to manage events that have introduced high levels of salt into the river. For example, in 2004, water entering the River Murray from the Darling River had a peak salinity of 4000 EC and management of this event used dilution with fresh Murray water and mixing in Lake Victoria to reduce the size of the salinity peak to less than 100 EC above the background river salinity

(MDBC 2004a). However, there has not been a coordinated strategy or ongoing incentive arrangements to deliberately allow salt to enter the river to flush it from the landscape into the river and out of the basin at times when this would cause little or no harm.

Given that the costs of instream salinity in the Murray–Darling Basin can be lower during the winter months between irrigation seasons, it may be possible to flush salt out of the basin into the ocean during this period. This period may also coincide with efforts to increase flows for environmental purposes.

Market mechanisms to aid the removal of salt could include:

- a cap and trade scheme for salt across the basin, linked to offsets arrangements
- purchasing flows for the purposes of dilution and flushing salt.

Processes would have to be designed to establish conditions under which salt flushing can occur in order to minimise potential negative health, environmental or productive consequences. The Hunter River Salinity Trading Scheme, for example, allows saline emissions under two possible conditions. When the river is in high flow, limited discharge is allowed, controlled by a system of salt credits. The amount of discharge allowed depends on the ambient salinity in the river, so it can change daily. The total allowable discharge is calculated so that the salt concentration does not go above 900 EC in the middle and lower sectors of the river, or above 600 EC in the upper sector. When the river is in flood, unlimited discharges are allowed, as long as the salt concentration does not go above 900 EC (EPA 2003). Salt flushing rules have also been developed for Lake Charm (box 10.3).

While the conditions suitable for salt flushing will vary according to the specific site characteristics, rules would have to be developed for each site where flushing may occur within the basin. Environmental managers could have a role in designing such arrangements and could specify:

- threshold flows in the receiving river(s) — where the lower limit indicates the level below which flushing cannot occur to avoid salt remaining in the river system, and the upper limit indicates high flow events that could deposit salt on floodplains and in wetlands
- the required duration of threshold flows — based on the expected timeframe required to move salt all the way to the sea
- threshold salinity levels in the receiving river(s) above which flushing cannot occur

Box 10.3 **Salt flushing in Lake Charm**

Lake Charm is a shallow natural lake located between Kerang and Swan Hill, Victoria. The construction of an inlet regulator in the 1960s altered the natural flushing cycle of the lake, preventing natural outflow from the lake. This resulted in the gradual build-up of salt in the lake, wth salinity concentrations reaching up to 5000 EC. This issue was identified as a key issue in the Kerang-Swan Hill Salinity Management Strategy, and in 1997, the Lake Charm outfall was built (at a cost of $1.4 million) to reduce salinity by allowing for flushing events to remove salt from the lake. The stated objective of the outfall project was to reduce salinity in the lake, over a period of 15 years, to a steady state of 2500 EC.

The North Central Catchment Management Authority is responsible for the management of salt discharge requirements (and adherence to Schedule C of the Murray-Darling Basin Agreement). Goulburn-Murray Water constructed, and is responsible for, the operation of the Lake Charm outfall on its behalf. The operation of the outfall is an Accountable Action under Schedule C and is included in Register A of the schedule, with a salinity credit of 0.47 ECs based on REALM modelling conducted by Victoria.

Operating rules were developed to minimise potential downstream impacts of salt flushing from Lake Charm. These outline conditions in which flushing can occur, including: minimum flow requirements in the River Murray (above which flushing can occur); threshold salinity levels in the River Murray (above which flushing cannot occur); and flow thresholds in the Loddon River (above which flushing cannot occur). A surface and groundwater monitoring program was developed to monitor the downstream salinity and flow impact of flushing Lake Charm. However, it is difficult to measure downstream environmental impacts accurately and in isolation.

Salt flushing events have occurred over three intervals:

- twice between 28 September to 9 October 1998 for a total of seven days
- three times between 6 September to 7 November 2000 for a total of 43 days
- once from 28 August to 5 September 2003 for eight days.

Dry climatic conditions have prevented flushing events from occurring since 2003 or on a more regular basis. These six events resulted in 4844 megalitres of water and around 12 000 tonnes of salt being pumped into the River Murray. However, this is only 55 per cent of the assumed amount used in the REALM model to create the salt credit impact of the outfall.

A performance review of the project, completed by Hydro Environmental in 2005, recommended a comprehensive review of the operating rules and the monitoring and reporting requirements.

Sources: Goulburn-Murray Water 2003; Hydro Environmental 2005; SKM 2004.

- threshold flows in interconnected rivers, tributaries, creeks, and other water bodies such as wetlands — determined on the basis of the potential for backflows, river capacity (to avoid flooding and dumping salt onto floodplains or into wetlands), and other site-specific characteristics
- permissible timing of flushes to avoid unacceptable negative impacts on drinking water supplies, irrigators, other water users and the ecosystem
- thresholds above which salinity levels cannot rise — based on ecosystem, health or other requirements.

As well as site-specific rules, environmental managers would have to coordinate the timing of flushing events to ensure that too many flushing events did not occur at once. Rules for the basin as a whole may be needed to ensure that thresholds for the river were not exceeded. Careful planning and regulatory arrangements would be required to ensure minimum water quality standards are maintained under a scheme to remove salt from the basin.

In addition, impacts on salinity targets from flushing need to be accommodated within the credits and debits system for achieving the basin target at Morgan. As mentioned in chapter 9 (section 9.3), seasonal flexibility in the target may facilitate flushing salt out of the basin. Further, while salt flushing uses credits (or creates debits) when salt is put into a river during flushing, credits should be allocated at the successful completion of a flushing event when all of the salt exits into the sea. Allocating credits for successful flushes would recognise the longer-term benefits from removing salt from the basin and create incentives for appropriate flushing within the credit and debit system.

It may be possible to establish similar arrangements to the Hunter River Salinity Trading Scheme and the Lake Charm flushing arrangements in other parts of the Murray–Darling Basin where the removal of salt may be technically feasible. It might be possible to allow some salt interception schemes in the lower Murray to participate in salt flushing. For example, where saline groundwater rapidly enters the river, salt inception scheme pumps could be turned off (saving fuel costs) and saline groundwater could be allowed to leach into the river (increasing river flows and allowing salt to move down the river).

Any policy decision on salt flushing would need to consider the cost and benefits of using the river to move salt out of the landscape and into the sea (box 10.4). The magnitude of many costs and benefits would be affected by prevailing weather conditions and seasonal conditions, and the duration of the flushing event. Unsuccessful flushes, where salt is deposited elsewhere in the system, would impose environmental costs additional to those listed in box 10.4, but these could be minimised by careful management and timing of planned flushes. In addition, the costs and benefits of flushing would have to be compared to the costs and benefits of alternative methods of salt disposal, such as storage in saline aquifers.

Box 10.4 **Costs and benefits of salt flushing**

In the Murray–Darling system, for example, costs may include:

- Managing urban water supplies (such as to Adelaide and Whyalla) to function without access to River Murray water for the period of the flush. These costs may be low in the winters of average-to-wet years if other available storages are relatively full. These costs may be high in dry summers when River Murray water is heavily relied upon.
- Lost productivity from irrigated crops drawing River Murray water during the flushing event. These costs would be low in the winter when irrigated agriculture is limited, but may be high in summer when the majority of irrigated agriculture occurs.

Benefits may include:

- removing salt from landscape storages
- the ability to water key environmental sites (such as the Chowilla Floodplain) that would mobilise salt, without having to undertake offsetting activities to maintain the EC target at Morgan
- saved fuel costs from turning off salt interception schemes
- reducing the risk of large effects of natural flooding events that may mobilise salt in the landscape.

Many of the costs are lowest in average-to-wet winters, and some benefits are highest under these conditions.

To aid the exit of saline flows, additional flows may be required. Dilution flows would also help ensure salt concentrations (of the transported saline water) did not reach levels that result in undesirable environmental consequences. Markets for dilution flows could be established in the same manner as markets for environmental flows (chapter 8).

FINDING 10.7

Dilution flows can assist the flushing of salt from a river system, and can be procured in the same way as environmental flows.

APPENDIXES

A Consultation

Table A.1 **List of submissions**

Individual or organisation	*Submission number*
ABARE	54
Alliance Resource Economics	1
Aquaponics Network Australia	46
Australasian Bottled Water Institute Inc	26
Australian Bureau of Statistics	17
Australian Competition and Consumer Commission	42
Australian Conservation Foundation	45, DR75, DR96
Australian Dairy Farmers Limited	12
Australian Property Institute (New South Wales Division) and Australian Spatial Information Business Association	DR88
Australian Spatial Information Business Association Ltd	27
Block, JB	30
Bowring, T and Associates Pty Ltd	9*, DR84
Brooke, JD	10
Bundaberg Regional Irrigators Group	DR65
Bureau of Meteorology	28
Byrne, O'Brien, Eagle and McDonald	DR83
Central Irrigation Trust	DR74
Chamber of Commerce and Industry of Western Australia	DR73
Coleambally Irrigation Co-operative Limited	3, 4, DR64
Cotton Australia Ltd	DR90
CRC for Irrigation Futures	21
CSIRO Water for Healthy Country National Research Flagship	24
Department of Natural Resources, Mines & Water (Qld)	DR85
Department of Water (Western Australia)	56
Dwyer, Dr T	52, DR57
Engineers Australia	8, DR72
Emerald Shire Council	43, DR91
Environmental Farmers Network	DR66
First Mildura Irrigation Trust	6
Fitzroy Basin Food and Fibre Association Ltd	11
Gault, PD and SM	14
Goulburn–Murray Water	DR82
Harvey Water	DR69
High Catchment Committee	7
Horticulture Australia Ltd Water Steering Group	32, DR68
Lamble, Dr P	DR60

(Continued next page)

Table A.1 (continued)

Individual or organisation	*Submission number*
Land and Water Australia	16
Minerals Council of Australia	40
Murray–Darling Basin Commission	31, DR89
Murray Irrigation Limited	55, DR92
Murray Valley Water Diverters Advisory Association	DR95
Murrumbidgee Horticulture Council Inc	37
Murrumbidgee Private Irrigators	DR58
National Farmers' Federation	DR86
National Water Commission	22
NSW Government	41, DR93
Northern Territory Horticultural Association	51
Northern Victorian Irrigators Inc	44
NSW Irrigators' Council	DR87
Pastoralists & Graziers Association of WA	DR94
Queensland Government	38
Quiggin, Professor J	53, DR97
Ricegrowers' Association of Australia Inc	DR81
Scanlon, J	DR59
Shire of Campaspe	DR70
South Australian Farmers Federation	DR77
South Australian Government	36, DR79
Southern Riverina Irrigators	25
Sunraysia Irrigators Council Inc	33, DR78
SunWater	DR67
Timbercorp Limited	20
Tree Plantations Australia	50, DR76
University of Technology Sydney	18
Water Corporation (Western Australia)	29
Water Find Pty Ltd	23*, DR62*
Water for Rivers	48
Water Services Association of Australia	5
Watson, Dr A	2
Wellington Shire Council	19
Wentworth-Walsh, Ms D	47
Western Australian Farmers' Federation (Inc)	15, DR61
Winemakers' Federation of Australia	13
WWF Australia	34, DR63
Victorian Farmers Federation	49, DR80
Victorian Farmers Federation – Sunraysia Branch	35
Victorian Government	39, DR98

* Indicates that the submission contains confidential material not available to the public.

Table A.2 **List of visits and meetings**

Interested parties
ABARE
Australian Conservation Foundation
Australian Dairy Farmers Ltd
Australian National Committee on Irrigation and Drainage
Australian Property Institute
Australian Spatial Information Business Association Ltd
Australasian Bottled Water Institute Inc
Byrne, Mr P
Central Irrigation Trust
Coleambally Irrigation Co-operative Limited
Cotton Australia Limited
Crase, Dr L
CRC for Irrigation Futures
CSIRO Division of Land and Water
Department of Agriculture, Fisheries and Forestry
Department of Premier and Cabinet (Victoria)
Department of Primary Industries (Victoria)
Department of Sustainability and Environment (Victoria)
Department of the Environment and Heritage
Department of the Prime Minister and Cabinet
Department of Transport and Regional Services
Department of Treasury and Finance (Victoria)
Department of Water (Western Australia)
Eagle, Mr N
Emerald Shire Council
Environment and Behaviour Consultants
Environment Protection Authority
Environment Victoria
Fitzroy Basin Food and Fibre Association
Goulburn Broken Catchment Management Authority
Goulburn–Murray Water
Integrated Natural Resources Management Group for the South Australian Murray–Darling Basin
Interjurisdictional Water Trading Group
Murray–Darling Basin Commission
Murray–Darling Basin Ministerial Council
Murray Irrigation Limited
Murrumbidgee Irrigation
Murrumbidgee Private Irrigators Inc
National Water Commission
New South Wales Government
North Central Catchment Management Authority
NSW Irrigators’ Council
NSW Murray Wetlands Working Group
O’Brien, Mr J
Queensland Government

(Continued next page)

Table A.2 (continued)

Interested parties
Ricegrowers' Association of Australia
SA Water
Sinclair Knight Merz
South Australian Farmers Federation
South Australian Government
SunWater
The Treasury
Tree Plantations Australia
Victorian Farmers Federation
Water Find Pty Ltd
Water for Rivers
Western Australian Farmers Federation Inc
WWF Australia
Water Exchange Pty Ltd

B Rural water use, supply and trade

Water in rural Australia is used by households, in industry (including mining) and for irrigated agriculture. Irrigated agriculture accounts for a high proportion of rural water use in most regions.

Australia is a relatively dry continent with greater annual rainfall variability than any other continental region (Smith 1998). Due to this variability of rainfall across regions, seasons and years, many agricultural producers supplement rainfall with irrigation. Indeed, many agricultural activities undertaken in Australia are only possible with irrigation. Water storage and delivery infrastructure helps to manage rainfall variability and to create a more reliable supply of water. Australia has the highest water storage capacity per capita in the world. In 2001, Australia had approximately 500 large dams with a total storage capacity of 93 657 gigalitres (ANCOLD 2001).

B.1 Water use in Australia

Agriculture accounts for approximately 67 per cent (16 660 gigalitres in 2000-01) of total extracted water use in Australia, with almost all being used in irrigated agriculture (ABS 2004a) (table B.1). This proportion is higher in rural areas where agriculture is the dominant sector. The gross value of irrigated agriculture was $9.6 billion in 2000-01, representing 28 per cent of total gross value for all agriculture. Most of the water used by Australian agriculture is used in New South Wales (44 per cent), Victoria (22 per cent) and Queensland (21 per cent).

Demand for water use in irrigation

Demand for irrigation water ultimately depends on the potential economic return derived from the use of that water. This is influenced by prevailing prices for agricultural outputs and the contribution of water as an input to production, which is dependent on its marginal product. Given these economic conditions, the demand for water in irrigated agriculture is related to the irrigated area, crop type, soil type, topography, climate and water application rate.

Table B.1 **Sector water use as a share of total water used by state or territory[a], 2000-01**

	NSW[b]	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*Aust.*
	%	%	%	%	%	%	%	%
Agriculture	77.69	52.17	73.32	79.10	40.12	53.13	43.78	66.89
Forestry and fishing	0.03	0.06	0.04	0.07	0.74	0.50	0.15	0.09
Mining	0.55	0.10	2.31	0.74	13.84	5.09	2.85	1.61
Manufacturing	1.90	3.49	3.85	5.20	5.91	18.95	5.70	3.48
Electricity and gas[c]	0.63	21.52	1.50	0.10	1.36	0.01	0.41	6.78
Water services[d]	7.17	10.44	4.59	1.46	8.07	2.29	5.59	7.20
Cultural, recreational & personal services	1.19	1.32	1.61	1.33	5.84	1.73	0.99	1.59
Household	7.21	6.61	10.63	10.97	17.35	14.21	27.84	8.76
Environment	2.13	3.55	0.09	0.05	–	0.09	–	1.84
Other[e]	1.51	0.76	2.04	0.98	6.76	4.00	12.68	1.77
Total volume (GL)	**9 425**	**7 140**	**4 711**	**1 647**	**1 409**	**417**	**160**	**24 909**

[a] Water use = self-extracted use + net mains water use + re-use water use – instream use (water used in situ that can be used downstream for another use as volume and quantity are unaffected). [b] Includes the Australian Capital Territory. [c] The majority of water used by this industry is 'instream' and is often used again downstream by other water users. [d] Includes losses from seepage and evapotranspiration (where measured) and water used by the water supply, sewerage and drainage services sector. [e] Includes water use in services to agriculture; hunting and trapping; construction; wholesale and retail trade; accommodation, cafes and restaurants; transport and storage; finance, property and business services; government administration; education; and health and community services. – denotes negligible.

Source: ABS 2004a.

Given rainfall and crop type, the volume of on-farm water use is primarily determined by the choice of irrigation technology, for example, surface, sprinkler, micro-sprinkler or drip technologies. Surface irrigation methods, such as flood and furrow, tend to use more water per irrigated area than sprinkler and drip technologies. The choice of irrigation technology and its impact on economic efficiency are discussed in chapter 5. The following section describes water demand as determined by the type of irrigated agriculture (such as crop type) and the region.

Types of irrigated agriculture

Most livestock farming incorporates the production of pasture and/or grains for feeding livestock. The Australian Bureau of Statistics (ABS) therefore collect data on water use for these activities in an aggregated category ‘livestock, pasture, grains and other’. This category also included water used in dairy farming until 2000-01. Livestock, pasture, grains and other is the largest category of irrigated water users, accounting for approximately one-third of all water used in agriculture in 2000-01 (table B.2). Cotton and dairy were the next largest users, each accounting for approximately 17 per cent of total water used in irrigation; followed by the rice (12 per cent) and sugar industries (8 per cent).

Water use trends in irrigation

Table B.2 shows water use for Australian agriculture for 1993-94, 1996-97 and 2000-01 (ABS 2000, 2004a). Total extracted water use in agriculture increased by 37 per cent over this time, with most of the increase occurring between 1993-94 and 1996-97. Since 1996-97, total water use in irrigated agriculture has increased by 7.5 per cent. The largest increases in water use over the period 1993-94 to 2000-01 were in cotton, grapevines, rice and fruit.

Table B.2 **Water use in agriculture in Australia**

1993-94, 1996-97 and 2000-01[a]

	1993-94		*1996-97*		*2000-01*		*Growth*[b]
	GL	% of total	GL	% of total	GL	% of total	%
Livestock, pasture, grains and other	6 525	53.7	8 795	56.7	5 568	33.4	22.8[c]
Dairy farming[d]	na	na	na	na	2 834	17.0	na
Vegetables	536	4.4	635	4.1	556	3.3	3.6
Sugar	1 377	11.3	1 236	8.0	1 311	7.9	–4.8
Fruit	570	4.7	704	4.5	803	4.8	40.7
Grapevines	446	3.7	649	4.2	729	4.4	63.5
Cotton	1 355	11.1	1 841	11.9	2 908	17.5	114.6
Rice	1 349	11.1	1 643	10.6	1 951	11.7	44.6
Total agriculture[e]	**12 159**	**100**	**15 503**	**100**	**16 660**	**100**	**37.0**

[a] These years are used because they are the most recent comparable data. Some variation in annual use reflects differences in climatic conditions. [b] Growth in water use between 1993-94 and 2000-01. [c] Livestock, pasture, grains and other, and dairy farming have been consolidated in calculating the growth rate over the period. [d] Water use in dairy farming is included in the total for livestock, pasture, grains and other in 1993-94 and 1996-97 because data were not collected separately in these years. [e] Column may not add to the total shown due to rounding. **na** denotes not available or not applicable.

Sources: ABS 2000, 2004a.

The increase in water use between 1993-94 and 2000-01 corresponds with an expansion in the area of land under irrigation and a decrease in water use per hectare. In the period between 1996-97 and 2000-01, land under irrigation increased by 22 per cent while total water use increased by 7.5 per cent (ABS 2004a).

Regional water use in irrigation

Irrigation regions can be classed into three distinct categories according to their main source of irrigation water:

- supplemented regions, where irrigation water is predominantly supplied by rural water utilities
- private diverter regions, where irrigation water is predominantly sourced through self-extraction from rivers and waterways
- groundwater regions, where groundwater is the major source of irrigation water.

The majority of irrigation districts in rural Australia are predominantly supplemented irrigation regions (ANCID 2005a).

Irrigation water use in the Murray–Darling Basin

The Murray–Darling Basin is the dominant irrigation region in Australia (ABS 2001; ANCID 2004; NLWRA 2001b). It covers over 1 million square kilometres or 14 per cent of Australia’s total landmass across parts of New South Wales, Victoria, Queensland and South Australia (DEH 2006). The Murray–Darling Basin accounts for an estimated 70 to 72 per cent of all irrigation water use in Australia (CIE/LWA 2004; NLWRA 2001a; MDBC 2006c).

The Murray–Darling Basin is characterised by:

- a diverse range of irrigated agriculture, including rice, cotton, dairy, horticulture and viticulture, with varying water demands (NLWRA 2001b)
- a variety of land management types and on-farm management techniques, including the type of irrigation technology used
- a number of environmental concerns including salinity, reduced biodiversity and other water quality issues, as well as reduced amenity value
- diversity in topography, climate, soil type and geology
- fully or over-allocated water resources
- high connectivity between districts
- the most established water markets in Australia.

Table B.3 summarises some of the larger irrigation districts in the Murray–Darling Basin.

Table B.3 **Major irrigation districts in the Murray–Darling Basin**

Irrigation district	*Area*[a] *(Entitlement)*[b]	*Location*	*Main source of irrigation water*	*Major irrigated crops (irrigated industries)*
Coleambally	95 153 (497 892)	West of Wagga Wagga, central New South Wales	Controlled stream	Wheat and rice
Murray Irrigation	748 000 (1 479 000)	Southern New South Wales	Controlled stream	Rice and annual pastures (rice and cereals)
Murrumbidgee	480 000 (1 193 370)	Near Griffith, New South Wales	Controlled stream	Rice and horticulture (rice and wine)
South–east region	80 000 (718 685)	South–east South Australia	Groundwater	Pasture and grapes (beef and wine)
Central Irrigation	15 000 (155 751)	North–east of Adelaide, South Australia	Controlled stream	Grapes and citrus (wine and juice)
Murray Valley	122 457 (273 657)	Central–north Victoria	Direct from reservoir	Perennial and annual pasture (dairy and can fruit)
Torrumbarry	173 366 (352 109)	Central–north Victoria	Controlled stream	Perennial and annual pasture (dairy and grazing)
Central Goulburn	172 131 (455 660)	Central–north Victoria	Controlled stream	Perennial and annual pasture (dairy and horticulture)

a Area in the irrigation system, measured in hectares. **b** Total entitlement to water, measured in megalitres per year.

Source: ANCID 2005b.

Other major irrigation districts

Table B.4 provides a summary of other major irrigation districts outside the Murray–Darling Basin, including those in Western Australia, Queensland and Victoria.

The dominant irrigated crops in Tasmania are pasture and vegetables including green peas, onions and potatoes (ABS 2001; ANCID 2004). There is no publicly funded or owned rural water infrastructure in the Northern Territory and the bulk of water used in the Northern Territory is drawn from groundwater sources (NCC 2004).

Table B.4 **Other major irrigation districts**

Irrigation district	*Area*[a] *(Entitlement)*[b]	*Location*	*Main source of irrigation water*	*Major irrigated crops (irrigated industries)*
Ord River	13 500[c] (335 000)	Spans the north–east border of Western Australia	Controlled stream	Sugarcane, melons (sugar, fresh fruit)
Harvey district	112 000 (108 736)	South of Perth (west of the Darling Range)	Direct from reservoir	Perennial and annual pasture (dairy and beef)
Bundaberg	59 200 (181 238)	Southern Queensland	Controlled stream	Sugarcane, macadamias, tomatoes
Burdekin-Haughton	45 850 (608 521)	Northern Queensland, between Townsville and Bowen	Controlled stream	Sugarcane and small crops (sugar, horticulture)
Mareeba-Dimbulah	30 000 (152 072)	Northern Queensland, west of Cairns	Controlled stream	Sugarcane, mangoes, peanuts (bananas, sugar)
Nogoa-Mackenzie	24 643 (167 682)	Central Queensland, near Emerald	Controlled stream	Cotton, citrus, wine
St George[d]	16 119 (71 763)	500 km west of Brisbane, Queensland	Controlled stream	Cotton, grape vines, vegetables
Macalister	55 000 (124 226)	Central Gippsland, Victoria	Direct from reservoir	Perennial and annual pasture (dairy and beef)

[a] Area in the irrigation system, measured in hectares. [b] Total entitlement to water, measured in megalitres per year. [c] There are plans to expand this area to include another 43 000 ha, including an area in the Northern Territory. [d] St George uses a capacity share arrangement (chapter 3).

Sources: ANCID 2005b; Harvey Water 2003; Kimberley Primary Industry Association 2004; Southern Rural Water 2006.

B.2 Water availability and supply

Irrigators and other rural water users rely on a number of water sources to supplement rainfall. These include surface water (stored and distributed via natural and constructed infrastructure), groundwater, and to a lesser extent, re-use (or recycled) water. These water sources are supplied to the user either though self-extraction or via mains water supply (also extracted from the environment). This section describes water availability in Australia generally and for irrigation purposes in particular, and characterises the water supply from these available water sources.

Water availability

Physical water availability is determined by the amount of rainfall received, the mean annual runoff (effectively the amount of rainfall that runs into storage), and the resulting surface water and groundwater stores. Water available to irrigators is then determined by the natural and built infrastructure and water supply services.

Rainfall

Annual rainfall in Australia differs greatly between regions, with higher rainfall recorded in northern Queensland and Tasmania and along the eastern and northern coastline of Australia. Rainfall variability is a key feature of Australia's climate, and extended drought and flooding are common. The greatest risk associated with rainfall availability lies not with quantity received but rather the unpredictability as to when and where it will occur. By supplementing with water from runoff (surface) and groundwater sources, irrigators attempt to lessen their dependence on direct rainfall. While irrigating lessens the water supply risk, the amount of rainfall will still influence the timing and amount of irrigation water required and available from storage and supply.

Surface water stocks

Australia has 246 river basins that drain into 12 major drainage divisions, all of which support agriculture (ABS 2003). These drainage divisions vary greatly in size, the smallest being Tasmania (68 000 square kilometres) and the largest being the Western Plateau, which covers parts of Western Australia, South Australia and the Northern Territory (2 450 000 square kilometres).

Surface water availability is measured as mean annual runoff. Mean annual runoff received in each drainage division, as a percentage of total mean annual runoff for Australia, varies from below 1 per cent to greater than 20 per cent, depending on the environmental and geological characteristics of the region. The percentage change in runoff has been estimated as two to three times the percentage change in rainfall (Chiew et al. 2005).

Groundwater stocks

Approximately 68 per cent of Australia has groundwater access through bores or natural springs (ABS 2003). Due to salinity, however, approximately 70 per cent is suitable for irrigation purposes while only about 20 per cent is suitable for livestock.

Ongoing groundwater use is dependent on the recharge rate of the groundwater source (box B.1). To maintain ecosystem health, water use should be restricted to the 'sustainable yield' (NLWRA 2001a). Almost 30 per cent of Australia's 538 groundwater management units (physically connected water systems) are extracting groundwater at or above 70 per cent of the estimated sustainable yield (ABS 2004b). Just over 25 per cent of Australia's 325 surface water management units are extracting at or above 70 per cent of the sustainable yield.

Groundwater and surface water use

About 82 per cent of extracted water is sourced from surface water stocks across Australia, while the remaining 18 per cent comes from groundwater stocks (NAPSWQ 2001). The relative dependence on groundwater and surface water differs between states and territories. For example, Western Australia and the Northern Territory rely predominantly on groundwater extractions while all other states and territories mostly use extracted surface water (NLWRA 2001a).

Surface water supply to irrigation in supplemented systems

Irrigators access water either directly from the environment (from bores, on-farm dams or rivers), re-use schemes or water providers. Of the 16 660 gigalitres of water used in irrigation in 2000-01, 55 per cent was self-extracted, 43 per cent was from mains water supply, and the remaining 3 per cent was re-use water (note these figures do not add to 100 per cent due to rounding) (ABS 2004a).

The role of water providers

Distribution of water from the water store to the household, business or farmgate is primarily the function of water providers. The 479 water providers in Australia in 2000-01 collectively supplied water users with 12 784 gigalitres of mains water, representing an 11 per cent increase from that supplied in 1996-97 (ABS 2004a).

Mains water is 'water that is supplied to a user often through a non-natural network (piped or open channel), and where an economic transaction has occurred for the exchange of water' (ABS 2004a, p. 32). Many rural regions also use natural waterways, such as rivers, for delivery purposes.

Water providers are classed as metropolitan providers, non-major urban providers or irrigation/rural providers. Of these, irrigation/rural providers supply the largest volume of mains water, accounting for 63 per cent of total mains water in 2000-01 (ABS 2004a). They also record the highest system losses through seepage and evaporation, due primarily to the type of delivery and storage infrastructure used by rural water utilities (predominantly unlined with a large surface area). While system losses can be significant, the cost of replacing or upgrading existing storage and delivery infrastructure with water 'saving' infrastructure may outweigh benefits from 'saving' water at existing water prices.

Box B.1 **Environmental flows and complexities**

The extraction and storage of water for irrigation purposes can significantly affect the natural hydrogeology of rivers (surface water), aquifers (groundwater) and the surrounding environment. Water extraction and storage (such as dams) often change the volume of water available for groundwater and environmental flows. Changes to environmental flows and groundwater stocks can have a significant effect on the natural environment. This is especially relevant where upstream extractions and storage reduce the amount of water available for environmental services, floodplains, irrigation and other uses downstream.

The demand for irrigation water in some regions results in stream flows that are the seasonal opposite of those occurring naturally. In the southern Murray–Darling Basin, for example, many rivers now have low flows in winter and spring, when rain in their catchments is being stored. Conversely, in summer and autumn, when flows were traditionally low, rivers run at full capacity to supply irrigation regions. While the environmental and ecological implications can be substantial, they have been historically difficult to quantify.

The on-farm application of water also affects the environment because some (or most) of the water applied will return to water stores through runoff and seepage. These return flows depend on the irrigation technology used, the crop type, the soil type, the climate and the amount of water applied. Runoff to surface water stocks can be problematic where the water carries fertilisers and nutrients that reduce water quality and increase turbidity, affecting other water users and the environment.

Seepage into groundwater stocks can also cause serious environmental damage. When flood and furrow irrigation in particular are used, the rate of recharge and seepage can be greater than the natural rate and can cause the groundwater level to rise. In areas of saline groundwater, rising groundwater levels can seep through the soil, making that soil unsuitable for agricultural use. These problems are exacerbated by the clearing of native vegetation, which also increases runoff, seepage and recharge. Such effects can have system-wide impacts.

The amount of return flow also influences the volume of water available for environmental and other uses. More physically efficient irrigation technology will usually reduce the amount of return flow, with implications for the 'net' versus 'gross' water entitlements debate (chapter 2). Central to this debate is the fact that water entitlements were originally allocated with an expectation of an amount of return flow. Where the amount of return flow has fallen (for example, where irrigators have changed to more physically efficient irrigation technologies), a system may become over-allocated (chapter 2).

Institutional and legislative arrangements relating to rural water utilities vary across states and territories. Some are government-owned, some are privately-run public companies, and some are privately-run irrigation companies or cooperatives. In New South Wales, for example, one publicly-owned utility (State Water) is responsible for delivering water to all rural areas in the state. Among its many customers are the privately-owned irrigation authorities, which in turn supply to individual irrigators. Individual irrigators hold share rights in an irrigation company's entitlement and have supply contracts for a specified volume. In comparison, SunWater (a government-owned corporation) holds most of the bulk water licences in Queensland. Victorian arrangements differ again because all water utilities are government-owned and have the obligation to supply water entitlement holders and environmental flows. There are five government-owned rural water utilities in Victoria, three of which provide bulk water services to a number of rural and urban water utilities. South Australia has a slightly different arrangement, where most water utilities are organised as irrigation trusts. Each holds a bulk water entitlement and pumps directly from the River Murray to supply individual irrigators. The institutional arrangements of irrigation utilities affect the determination of water entitlements, water trade and constraints on water trade. Each of these is discussed below and in chapters 3 through 5.

Water entitlements and seasonal allocations

The rights to control and use water ultimately lie with the state or territory. Irrigators' rights to access water vary by jurisdiction. The amount of water available to an irrigator will generally depend on:

- rainfall received, which influences both irrigation water requirements and irrigation water availability
- their water entitlement, a defined right to an amount of water prescribed by the relevant state or territory, which have varying characteristics (table B.5)
- their seasonal allocation, or the amount of water an irrigator is allowed to access in a particular season as determined by their water entitlement and water availability
- water traded, either a seasonal allocation or an entitlement
- carryover, the amount permitted to be carried over from one season to the next, usually expressed as a proportion of the total entitlement (where allowed)
- any sales water (only in Victoria)
- other licence(s) held, either for groundwater, unregulated streams or for overland flows.

Irrigators generally satisfy the water needs of their crop first from rainfall, then from seasonal allocations, and finally by purchasing traded water.

Language differs across jurisdictions. Water entitlements are termed a ‘water right’ in Victoria, a ‘water access licence’ in New South Wales, or a ‘licensed allocation’ in South Australia. Seasonal allocations are referred to as ‘seasonal allocations’ in Victoria, ‘announced allocations’ in New South Wales, or ‘licensed allocations’ in South Australia (Shi 2005).

The reliability of water entitlements varies by state or territory and reflects differences in water management choices. In New South Wales, for example, irrigators can hold either high security or general security entitlements, while Victorian arrangements allow for only a highly reliable entitlement. Variation is due, in part, to the opportunity costs of storage solutions, for example, from evaporation and spillover. Fitzroy Basin Food and Fibre Association stated:

> It has been shown in this area, [the Fitzroy Basin] that to provide 1 megalitre of medium priority, 2 megalitres of water must be stored in Fairbairn Dam, but to provide 1 megalitre of high priority water, at least 6 megalitres of water must be stored in Fairbairn Dam. (sub. 11, p. 3)

Table B.5 contains a summary of entitlement types for regulated surface water.

The Murray–Darling Basin Cap

An audit of water use in the Murray–Darling Basin conducted by the Murray–Darling Basin Ministerial Council and completed in June 1995 ‘showed that if the volume of water diversions continued to increase, this would exacerbate river health problems, reduce the security of water supply for existing irrigators in the Basin, and reduce the reliability of water supply during long droughts’ (MDBC 2006e). To mitigate this, the Council agreed to impose a limit or Cap on water diversions within the Basin, where diversions are defined as the ‘movement of water from a river system by means of pumping or gravity channels’ (IAG 1996, p. 39).

The Cap was imposed in December 1996 and restricts water diversions to the volume that would have been diverted under 1993-94 levels of development. Moreover, water diversions are restricted to the ‘level of water resource development for rivers within the Murray–Darling Basin as at 30 June 1994 determined by reference to … [the infrastructure, rules, management systems, entitlements and demand for water] at that date’ (Murray–Darling Basin Agreement 1992 — Schedule F). The Ministerial Council conducts annual reviews of water use in the basin to monitor compliance with the Cap.

A ‘base Cap’ is set for each valley or region at the start of each irrigation season by estimating the volume of diversions that would have occurred given the climatic conditions of the previous season, under the 1993-94 level of development. This base Cap is sometimes extended to a Cap on individual users in that valley or region. The Cap for the following season is then set at the estimated base Cap minus any excess use in the previous season (and with any adjustments as determined by the Murray–Darling Basin Agreement 1992 — Schedule F). Caps have been set at specific volumes for valleys and regions in New South Wales, Victoria and South Australia. Caps are yet to be set for the Queensland and ACT regions within the basin.

Table B.5 **Surface water entitlement characteristics by state or territory**

	Volumetric or share	*Security*[a]	*Separation from land*	*Individual carryover*	*Governing legislation*
NSW	Share	General (55%) High (95–97%)	Separated from land	Allowed	*Water Management Act 2000*
Vic.	Volumetric[b]	High (96–99%) Sales water[c] (45–75%)	Being separated from land[d]	Not allowed	*Water Act 1989*
Qld	Volumetric[e]	Medium or High	Being separated from land	Depends on water sharing rules[e]	*Water Act 2000,* Water Regulation 2002
WA	Volumetric	Various levels of security	Separated from land[f]	Not allowed	*Rights in Water and Irrigation Act 1914*
SA	Volumetric	High (almost 100%)	Being separated from land	Not allowed	*Natural Resources Management Act 2004*
Tas.	Volumetric	80%	Separated from land	Not allowed	*Water Management Act 1999*
NT	Volumetric	High	Separated from land[g]	Not allowed	*Northern Territory Water Act 2004*

[a] Percentages refer to expected chance of receiving the full entitlement, for example, number of years out of 100. [b] Moving towards a share of the consumptive pool by July 2007. [c] Sales water will be replaced with a new class of low security water in July 2007. [d] Non-landholders can only hold up to 10 per cent of the bulk entitlement. [e] There is a capacity share arrangement in St George which defines entitlements as a share of dam capacity and allows perpetual carryover (chapter 3). [f] Non-landholders cannot hold water. [g] Where relevant water resource allocation plans are complete.

Sources: ACIL Tasman in association with Freehills 2004; Department of Natural Resources (New South Wales), pers. comm., 25 May 2006; Department of Natural Resources and Mines (Queensland), pers. comm., 24 May 2006; Department of Primary Industries and Water (Tasmania), pers. comm., 25 May 2006; DSE 2004; Department of Sustainability and the Environment (Victoria), pers. comm., 26 May 2006; Department of Water, Land and Biodiversity Conservation (South Australia), pers. comm., 18 May 2006; NWC 2006a; Shi 2005.

B.3 Water trade

Surface water trade was first introduced in Australia in 1983 (IC 1992) and was further enhanced by the COAG agreement in 1994. The National Water Initiative established in 2004 has since extended these initiatives to aid in expanding water trade at a state, territory and national level.

Water trading in Australia was initially restricted to trade between irrigators within the same irrigation district. Over time, trading has expanded to include intervalley, and more recently, interstate water trading. All states and territories have the potential to trade water as water entitlements are now (or are in the process of being) separated from land rights. Water is generally traded through the buying and selling of water entitlements (also known as permanent trades) or seasonal allocations (also known as temporary trades), although there is a growing number of derivative products, including forward contracts, leasing and options. Water trade is well established in Victoria, South Australia and in New South Wales. Trade in seasonal allocations is relatively unrestricted and intrastate trade is generally possible where sources are hydrologically connected. Interstate trade in water entitlements, however, is restricted to regions in the pilot interstate trading project (box B.2).

Box B.2 **The pilot interstate water trading project**

The Murray–Darling Basin Commission instituted a pilot interstate water entitlement trading project in 1998. The project is located in the Mallee Region of South Australia, Victoria and New South Wales and covers all sections along the River Murray between Nyah in northern Victoria (downstream of Swan Hill) and the Barrages at the mouth of the Murray in South Australia. The Murray–Darling Basin Commission states that this region was selected because crop types and water prices were relatively uniform across the three states and because these areas are hydrologically linked.

Within the pilot project, trade in entitlements is limited to high security water held by private diverters. While high security entitlements vary slightly between each state, they are of similar security in all instances, with allocations being relatively stable from year to year and guaranteed for all but the worst drought years. High security water in New South Wales includes private high security licences; in South Australia it refers to water licences granted under the *Water Resources Act 1997*; and in Victoria, high security water is all private diversion licences.

The project has seen irrigators from each of the three participating states engage in interstate trade.

Sources: MDBC 2006f; Young et al. 2000.

In 2004-05, 5 per cent of all Australian agricultural establishments reported purchasing water and 4 per cent reported selling water. This represented a 4 per cent increase in the number of establishments buying water in 2003-04, and an 8 per cent increase in the number of establishments selling water. Victoria reported the largest percentage of agricultural establishments trading water in both 2003-04 and 2004-05, followed by New South Wales (ABS 2005; 2006b). Other jurisdictions, however, are still in the early stages of water market development.

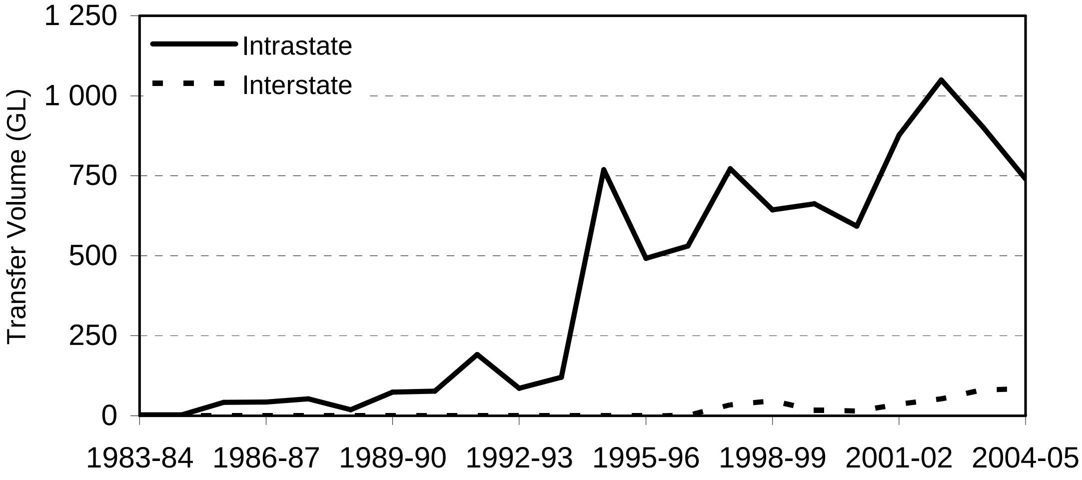
In 2003-04, 49 per cent of water trade was by irrigated pasture farms, 31 per cent by irrigated horticultural establishments, and the remaining 20 per cent undertaken by irrigated broadacre farms (ABS 2006a). In all instances, larger volumes have been traded for seasonal allocations than for water entitlements.

Water trade in the Murray–Darling Basin

The most active water trading region is in the southern Murray–Darling Basin where trade in entitlements began in 1989 and trade in seasonal allocations has occurred since 1983 (Cummings 1990). This is the only region to have participated in interstate water trading to date (box B.2). Figure B.1 shows intra- and interstate trade in seasonal allocations in the southern Murray–Darling Basin. Figure B.2 shows intra- and interstate trade in water entitlements in the southern Murray–Darling Basin. All interstate trade in water entitlements to date has been from trade in the pilot interstate water trading project. Interstate trade in water entitlements is likely to expand as South Australia and Victoria have signed an interstate water trading agreement for the River Murray (Milne and Hughes 2006). This is likely to expand even more as tagging arrangements are progressed in New South Wales, Victoria and South Australia (chapter 4).

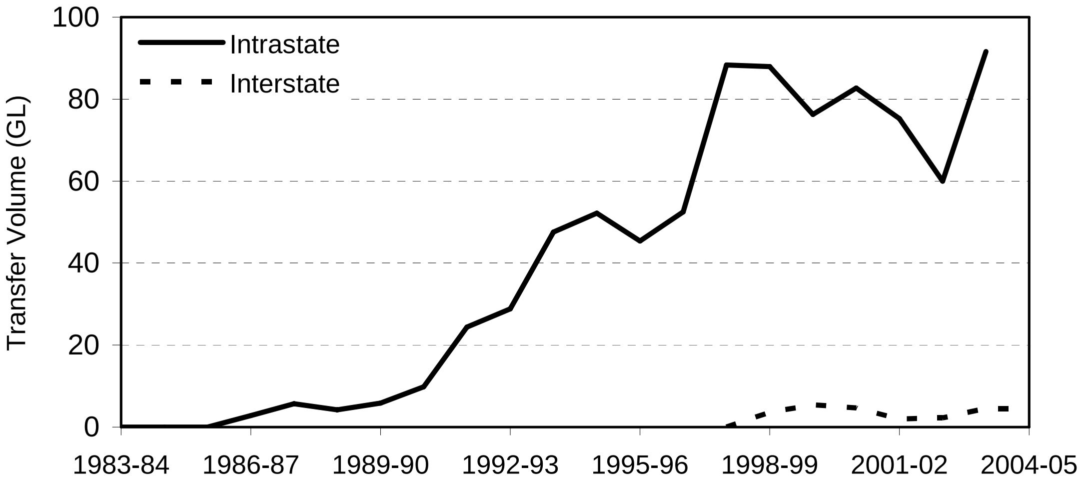
Publicly available price data are limited, making comparisons across regions difficult. To give some indication of trade prices and volumes, for *seasonal allocations* traded on the Murrumbidgee Water Exchange between 16 August 2005 and 10 February 2006, prices ranged between $31 and $80 per megalitre and volumes ranged between 5 and 500 megalitres. The average price and volume for *water entitlements* in the same region have varied from around $600 to $1600 per megalitre, and from below 10 megalitres to above 190 megalitres from November 2002 to January 2005 (MWE 2006).

Figure B.1 **Seasonal allocation trade in the southern Murray–Darling Basin**



Data source: MDBC, pers. comm., 26 May 2006.

Figure B.2 **Water entitlement trade in the southern Murray–Darling Basin**



Data source: MDBC, pers. comm., 26 May 2006.

Water trade outside the Murray–Darling Basin

While water trade is permitted in all jurisdictions, trade outside the Murray–Darling Basin is limited. Contributing factors include a lack of hydrological connectivity and a limited demand for water relative to supply and availability. Queensland catchments outside the Murray–Darling Basin, for example, have a low degree of hydrological connectivity and, hence, trading opportunities are limited to intravalley trades (Queensland Government, sub. 38). Tasmania is restricted to intrastate trade, and water markets in Western Australia and the Northern Territory are thin due to low demand and low connectivity.

However, water markets are developing outside of the Murray–Darling Basin. In Queensland, the number and volume of seasonal allocations traded has increased over time (Queensland Government, sub. 38). Where trade in entitlements has occurred in Queensland, typical prices have been about $1300 per megalitre in the Burnett basin and $2000 per megalitre in the Fitzroy basin (Queensland Government, sub. 38).

Trade in groundwater

Trade in groundwater is limited for a number of reasons, including:

- groundwater trade is often restricted to trade within a hydrologically connected groundwater system and these tend to cover smaller areas
- little is known about groundwater connectivity and levels of sustainable use in many regions
- entitlements to groundwater are not clearly defined in some regions and there are often significant regional differences in groundwater management
- groundwater is not currently included in the Murray–Darling Basin Cap and increased use of groundwater through trade may exacerbate problems of over-allocation (chapters 2 and 4)
  – however, some progress is being made in this regard, for example, Queensland and New South Wales have reduced or capped groundwater entitlements in the Murray–Darling Basin (van Dijk et al. 2006)
- entitlements to groundwater are still tied to land in many regions
- there are often regulatory restrictions on trade in groundwater (chapter 4)
- many groundwater sources are not metered.

Despite this, varying degrees of trade in groundwater has occurred in New South Wales, Victoria, Queensland, South Australia and Western Australia. The largest volume of trade in groundwater seasonal allocations has been in Queensland and the largest volume of trade in entitlements has been in South Australia. Average volumes traded vary from 29 to 89 megalitres for entitlements and 28 to 131 megalitres for seasonal allocations. Average prices for entitlements are about $1000 per megalitre and range from $7 to $500 per megalitre for seasonal allocations (SKM, pers. comm., 20 January 2006).

Several jurisdictions are in the process of investigating trading opportunities between groundwater and surface water, but these measures are being introduced slowly due to limited understanding of groundwater and surface water connectivity.

South Australia has developed a number of artificial recharge or aquifer storage recovery schemes that involve gravity feeding or pumping excess surface water and stormwater into groundwater stores for use at a later date. This scheme 'has the potential to capture largely unused surface water resources, including stormwater runoff, and relieve the pressure on groundwater resources' (DWLBC 2006, p. 6). Entitlements have a three-year life and specify a right to a proportion of the volume of artificial recharge (DWLBC 2006).

Reforms to trade

The Australian, state and territory governments, and rural water utilities, have undertaken (or are in the process of undertaking) a number of reforms to improve water trade through improved entitlement arrangements and by easing administrative regulations and restrictions. Examples include further unbundling of entitlements and lifting of specific trading restrictions.

All states and territories have completed the legal and institutional requirements needed to separate water access entitlements from land titles. Several states are extending the process of entitlement 'unbundling' (chapter 3):

- New South Wales is in the process of separating water entitlement arrangements from those associated with supply work and use approvals (*Water Management Act 2000*).
- Victoria has announced its intention to unbundle water entitlements into four components:
  - a water share (a right to a proportion of the consumptive pool)
  - a seasonal allocation (specified as a volume)
  - distribution capacity share (the right to space in the distribution network)
  - a site use licence (linked to the land capacity and intended land use).
- SunWater, Queensland's largest water utility, has respecified water entitlements in the St George district to be defined as a storage capacity share.

Other reforms involve the removal of regulations that restrict trade between particular users or areas. The National Water Initiative, for example, binds parties to relax current restrictions that limit net trade out of a district. These and other current initiatives, and remaining trade restrictions, are discussed in chapter 4.

C Water trade and exit fees

This appendix identifies the benefits of trade in water entitlements and the efficiency implications of imposing fees on their export from irrigation regions. While the analysis applies most simply to water trade between irrigators, it can also encompass trade between irrigators and other users of water, including environmental managers.

C.1 Benefits from trading water entitlements

Trade in water entitlements allows re-allocation of water between competing users and uses. In a competitive market for water, gains from trading water are the difference between the value of the traded water to buyers and the value to the sellers. That difference shrinks as restrictions on trade are lifted. There are no further gains from trade and all the gains are maximised when the price demanded by sellers is equal to the price offered by buyers, which is where aggregate supply equals aggregate demand at quantity Q^* in figure C.1.

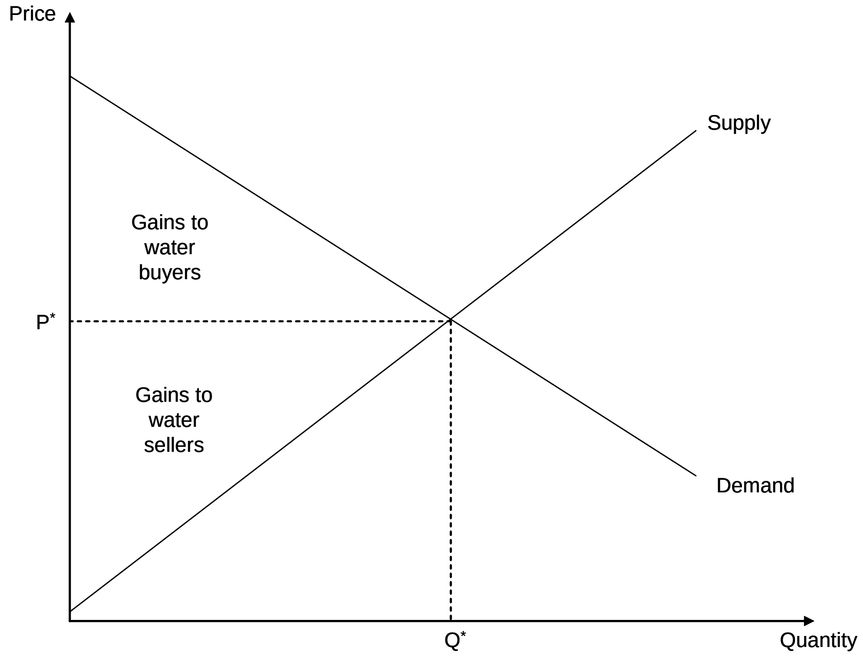
Trade is beneficial to both parties. Buyers gain from the additional production they generate from the water purchased. Sellers gain by receiving more for the water than if they had used it for productive purposes themselves.

C.2 Exit fees

Historically, there has been a variety of constraints to the trade in water entitlements between irrigation regions (Peterson et al. 2004). As these constraints are removed, some irrigation water utilities are imposing a levy on the export of entitlements from their region. Generally, these exit fees are specified as a fixed payment per megalitre traded out.

In part, exit fees are being established to address the ongoing funding of the supply infrastructure, which is being provided by the water utilities, as well as the adjustment issues associated with exit of entitlements from a region. Exit fees are being proposed or implemented by a number of water utilities, including Murray Irrigation, Murrumbidgee Irrigation, Coleambally Irrigation Co-operative and Central Irrigation Trust.

Figure C.1 **Potential gains from water trade**



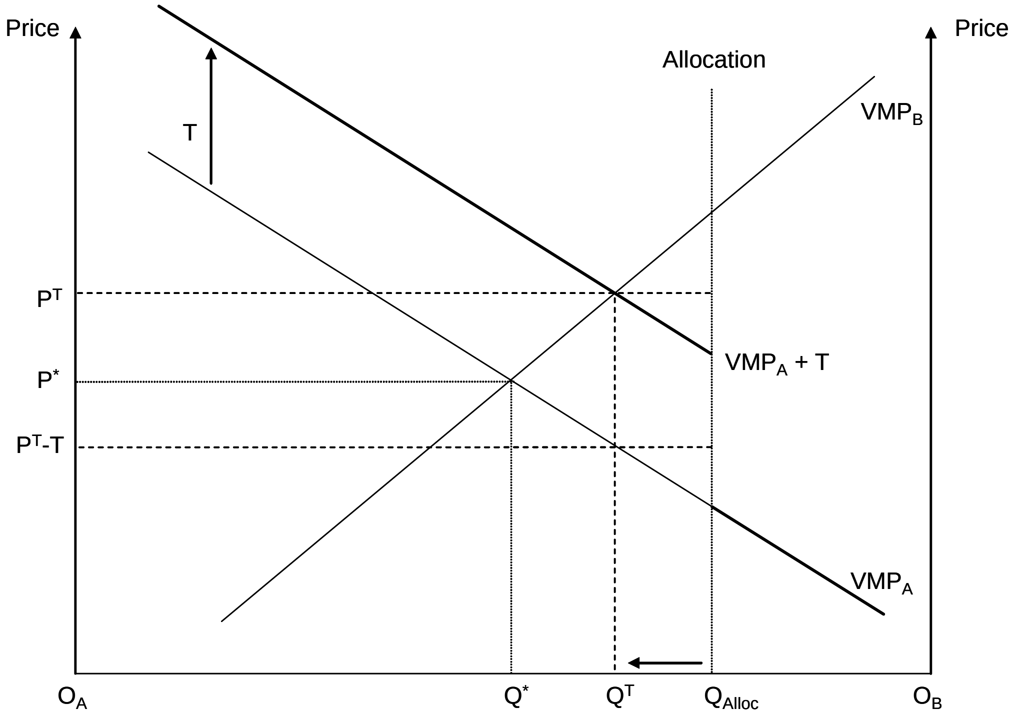
C.3 Exit fees constrain trade

An exit fee is equivalent to an export tax on water entitlements (boxes C.1 and C.2). It reduces the quantity of water traded and drives a wedge between the (higher) price of entitlements in importing regions, and the (lower) price of entitlements in exporting regions.

If the exit fee is large enough, it may make any water trade out of a region financially unattractive to buyers and sellers.

The situation of a region imposing an exit fee when it is an importer of water is noted in box C.3.

Box C.1 **Exit fees reduce the re-allocation of water resources via trade**



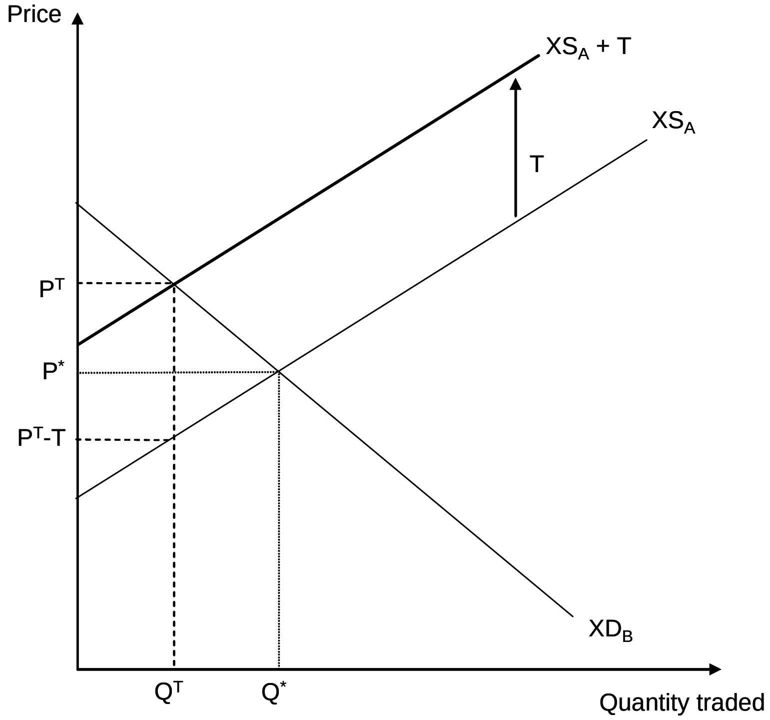
Before any trade between regions, irrigators in region A have entitlements that amount to the horizontal distance O_A– Q_{Alloc}, while region B's entitlements are Q_{Alloc}– O_B. The curve VMP_A shows what would be the value of the marginal product of water used in region A, for each quantity used. This is similar for VMP_B (which is drawn with respect to the axes through O_B).

If interregional trade were unencumbered, region A would sell Q^*– Q_{Alloc} to region B at price P^*. The traded quantity settles here because irrigators in region A are financially indifferent between using more water than O_A– Q^*, and selling that marginal water at the price P^*. Similarly, for irrigators in region B, the price P^* is just equal to their marginal value of water in use.

An exit fee of T per ML is a tax on movement away from the initial allocation Q_{Alloc}.

If an exit fee of T is imposed on all water trades out of region A, then sellers of water from this region require extra compensation of T to induce them to trade. Instead of selling Q^*– Q_{alloc} at price P^*, they now sell Q^T– Q_{alloc}; the buyers pay P^T, but the sellers retain only P^T–T, because they are required to pay an exit fee on any water they trade outside region A.

Box C.2 **Exit fees constrain water trade**



The figure above presents the same situation as box C.1, but with a more conventional representation of (excess) demand and supply relationships for water trade (movement away from the initial endowment of water resources).

Under an exit fee of T, the excess supply of entitlements shifts to XS_A+T. The traded price of entitlements is P^T and irrigators in region B import Q^T of water (a reduction of $Q^*– Q^T$, compared with unconstrained trade).

The buyers pay the market price of P^T, while sellers only receive P^T–T because they are required to pay an exit fee on water they trade outside region A.

Box C.3 **Exit fees in a water importing region**

Exit fees are not a binding constraint if the region imports water when unrestricted water trade is possible.

The fact that a region is a net importer of water when exit fees are in place, however, does not imply that exit fees are not a binding constraint. Variation in water supplies and demand throughout the season may lead to imports of water at times, and to exports at other times, in the absence of exit fees. If exit fees prevent trade of water away from region A at some times, the exit fee has the efficiency implication discussed in boxes C.4 and C.5.

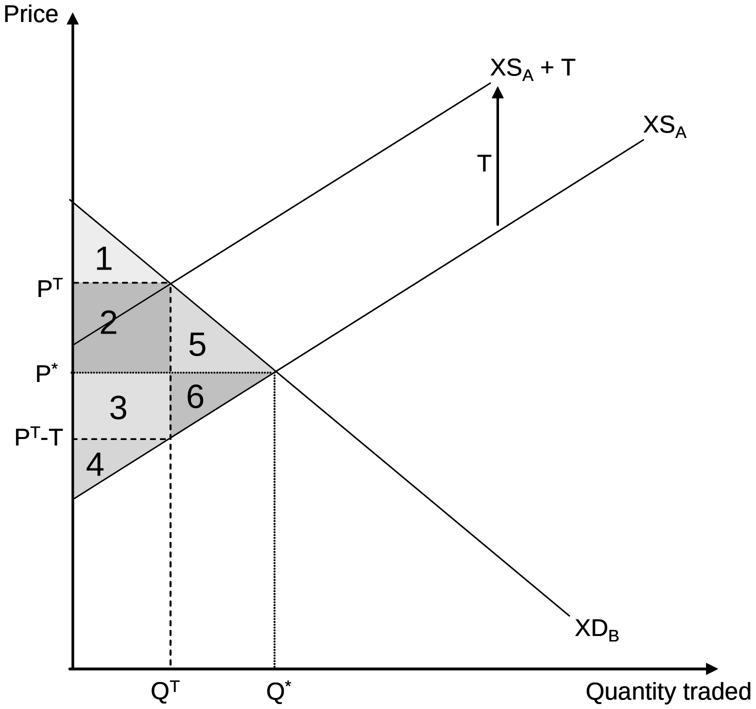
C.4 Exit fees reduce welfare

Exit fees reduce the economic welfare of buyers and sellers of entitlements in both trading regions (box C.4).

An exit fee results in a 'dead weight' economic loss, and significant welfare re-allocations:

- Buyers in the importing region B are unambiguously worse off.
- Sellers in the exporting region A are unambiguously worse off (if they are not shareholders in the water utility).
- The water utility in region A is better off with revenue from the exit fee.
- Region A, in aggregate, faces an ambiguous welfare change, the value of which is determined by the size of the exit fee imposed, and the characteristics of demand in regions A and B.
- Importantly, the gain to the water utility is less than the sum of the losses imposed on the buyers and sellers.

Box C.4 **Welfare effects of an exit fee**



In the absence of exit fees, unrestricted trade in entitlements results in:

- surplus to region A water sellers of the areas 3, 4 and 6
- surplus to region B water purchasers of areas 1, 2 and 5.

Where an exit fee restricts trade:

- surplus to sellers in region A is the area 4
- surplus to buyers in region B is the area 1
- surplus to the water utility in region A is areas 2 and 3; area 2 is the tax incidence falling on buyers, and area 3 that falling on sellers. In effect, region A 'exports' the exit fee to region B, in an amount equal to area 2.

For regions A and B combined, an exit fee results in a net economic or 'dead weight' loss of areas 5 and 6.

Region A, in aggregate, faces an ambiguous welfare change (area 2– area 6 ≥ 0), the value of which is determined by the size of the exit fee imposed, and the characteristics of demand in regions A and B.

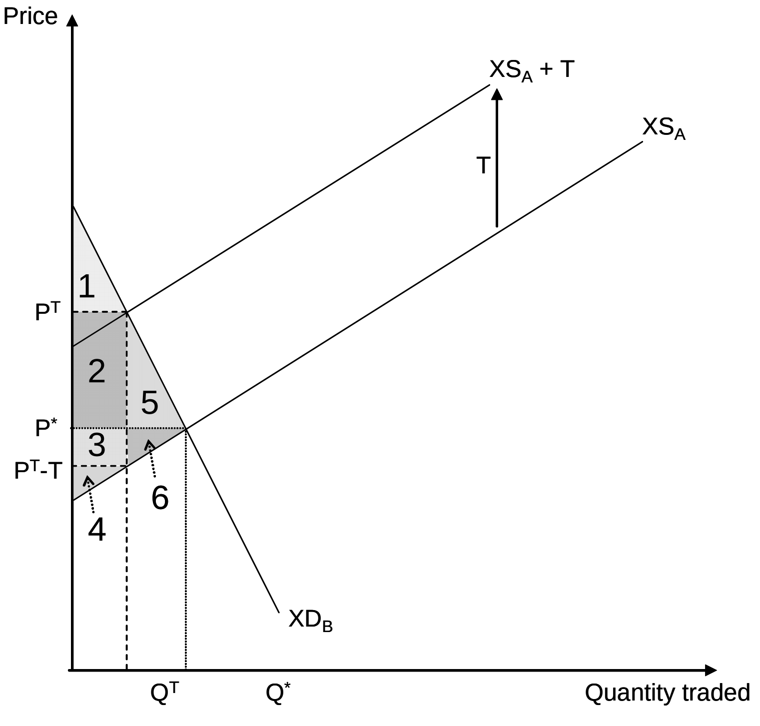
All gains and losses identified above are per period — for example, per year.

C.5 Sensitivity of results to water demand characteristics

Other things being equal, the size of the exit fee will affect the extent of the rise in the price of water entitlements, the reduction in the quantity of entitlements traded and the extent of welfare losses. A smaller exit fee (analogous to a smaller tax on water trade), for example, will result in smaller restrictions to trade and smaller welfare losses. Exit revenue will also be less.

The extent of the welfare losses also depends on the elasticity of demand for entitlements in trading regions (box C.5). If the excess (import) demand for water in region B is more price inelastic (than in previously presented figures) around the initial water endowment, for example, then less water trade is prevented by exit fees and there are smaller aggregate welfare losses. Also, buyers bear a higher proportion of the tax effect of the fee than in box C.4. It is more likely that region A will gain overall from an exit fee if excess demand for water in region B is price inelastic.

Box C.5 **Welfare effects if region B water demand is very inelastic**



If the demand for water by irrigators in region B is very inelastic, the aggregate welfare loss from the exit fee in region A (areas 5 and 6) is smaller, other things equal, than when excess demand is more price elastic. Because the price of water rises more in region B and falls less in region A, as a result of the tax, than when excess demand is more price elastic, it is more likely that the net welfare effects in region A (areas 2–6) will be positive.

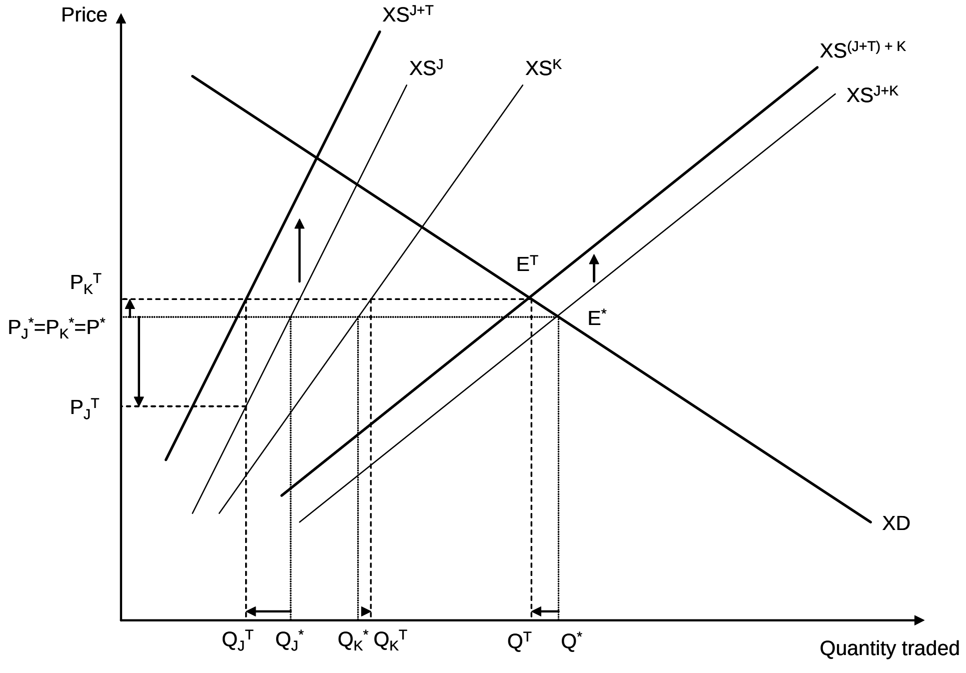
C.6 Differing exit fees between exporting regions

Exit fees may differ between irrigation regions (figure C.2 and box C.6). If an exit fee is implemented on all trades out of region J only, then sellers in the region will have to receive a higher price to supply a given amount of water in order to cover the exit fee. Because supply has been constricted by the imposition of an exit fee in one region, this equilibrium is at a higher price and reduced quantity than in the unconstrained trade situation. The imposed exit fee has also changed the relative composition of the water supplied to the market:

- Water sellers in region K now receive a higher price for their water. This means that the economic surplus to region K water suppliers has increased.
- Water sellers in region J receive a lower price for their water sales and hence sell a reduced quantity. This reduces the surplus of water suppliers in region J. Meanwhile, the water utility in region J raises revenue from exit fees. The aggregate welfare outcome to region J depends on the relative magnitudes of this loss of supplier surplus and the revenue raised.
- Purchasers of water face a reduction in buyers' surplus due to the increase in the equilibrium price.

Sellers of water from region J have an exit fee imposed on their sales, but they still have to compete with sellers from other regions (in this case, region K) that are not constrained by an exit fee.

Figure C.2 **If one of two regions that generally export water has an exit fee**



Box C.6 **Understanding the effects of differing exit fees**

In figure C.2, two exporting regions (J and K) supply entitlements (XS^J and XS^K) with the aggregate excess supply of XS^{J+K}, at an equilibrium price P^*, with the quantity of water traded Q^*. Sellers of water in regions J and K receive price $P_J^* = P_K^* = P^*$, and sell the quantities Q_J^* and Q_K^* respectively.

If an exit fee is implemented on all trades out of region J, then sellers in the region will have to receive a higher price to supply a given amount of water in order to cover the exit fee — hence their supply schedule shifts vertically, by the value of the exit fee, to XS^{J+T}. This, in turn, shifts aggregate supply upwards to $XS^{(J+T)+K}$ — which is parallel to XS^{J+K} if supply schedules XS^J and XS^K are linear.

The exit fee results in a new equilibrium at price $P^T{}_K$ and quantity Q^T (while sellers in region J receive $P^T{}_J$. Because supply has been constricted by the imposition of an exit fee in one region, this equilibrium is at a higher price and reduced quantity than the unconstrained one (Q^*,P^*). The imposed exit fee has also changed the relative composition of the water supplied to the market:

- Water sellers in region K now receive a higher price for their water ($P_K^T>P_K^*$) and sell more water ($Q_K^T> Q_K^*$). This means that the surplus to region K water suppliers has increased by approximately $(P_K^T– P_K^*).(Q_K^T+Q_K^*)/2$.
- Water sellers in region J receive P_J^T (= $P^T– T$) for their water sales and hence only sell a quantity of Q_J^T (a reduction from Q_J^*). This reduces the surplus of water suppliers in region J (by approximately $(P_J^*– P_J^T).(Q_J^T+Q_J^*)/2$). The water utility in region J raises revenue of $T.Q_J^T$. The aggregate welfare outcome to region J depends on the relative magnitudes of $(P_K^T– P_K^*).Q_J^T$ and $(P_J^*– P_J^T).(Q_J^T– Q_J^*)/2$.
- Purchasers of water face a reduction in consumer surplus due to the increase in the equilibrium price.

C.7 Empirical analysis of efficiency effects of exit fees

Goesch et al. (2006) developed a stylised empirical model of three hypothetical irrigation regions (importing — region 1, exporting — regions 2, 3) to examine the magnitude of efficiency impacts of exit fees (table C.1). The elasticity of demand for each region was estimated from empirical data and is representative of typical irrigation districts in the southern Murray–Darling Basin. They found that the larger the exit fee (as a proportion of the traded price of water) the larger the loss in economic gain from trade to the point that water trade is no longer profitable.

Table C.1 **Stylised model assumptions**

	Initial entitlement	*Price*	*Demand elasticity*[a]
	GL	$/ML	ratio
Region 1 (buying)	1 500	1 500	–2.00
Region 2 (selling)	750	750	–1.75
Region 3 (selling)	250	500	–1.25

a Per cent reduction in the quantity of water demanded given a 1 per cent increase in price of water.

Source: Goesch et al. 2006.

An exit fee of 10 per cent of the traded price imposed in both exporting regions reduced the economic gain by around 1.4 per cent compared with free trade. An exit fee of 30 per cent of the traded price reduced the economic gain by 18 per cent. If the fee was 70 per cent in both regions, trade was no longer profitable.

Goesch et al. (2006) also found that the losses in the economic gains from trade increase at an increasing rate as the exit fee becomes a larger proportion of the traded price of water. The losses were also found to be substantially higher if exit fees were applied in all exporting regions. For example, the imposition of a 30 per cent exit fee in only one exporting region led to a 3 per cent loss, whereas the imposition of this fee in both exporting regions led to an 18 per cent loss.

C.8 Concluding remarks

Exit fees increase entitlement prices in importing regions, reduce entitlement prices in exporting regions, reduce the quantity of water traded and reduce the economic wellbeing of irrigators, compared with the situation of unconstrained water trade. Exit fees generate revenue to irrigation water utilities and, to the extent that irrigators may be shareholders of these utilities, this revenue may compensate some of the welfare loss of irrigators in water exporting regions. However, the buyers, sellers and water utilities, in water exporting and importing regions combined, lose economic welfare when water trade is restricted by exit fees.

D Effects of a tax on water use on price and quantity of water

This appendix examines the effects of a tax, or set of taxes, aimed at reducing or eliminating environmental externalities on rural water use.

D.1 A uniform tax on all water users

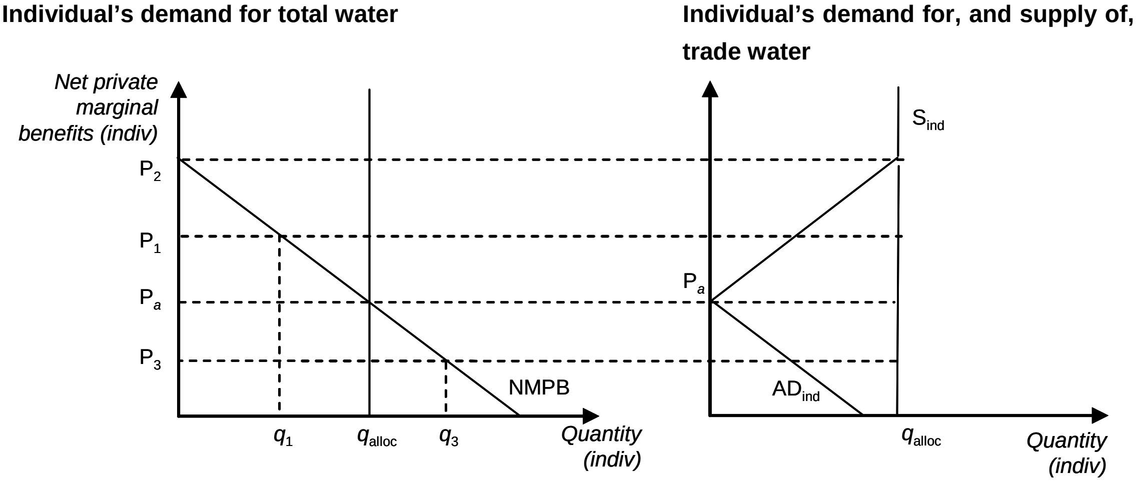
Dwyer et al. (2006) found that a small tax (uniform across all water users) could result in a fall in the market price of water, but not necessarily affect patterns of water use in the short run — if scarcity rents exist, the opportunity cost of water use does not change because the magnitude of the small tax is exactly offset by the fall in the market price of water (box D.1). (This rent is the gap between the value in use or the market price (if water is traded), whichever is the higher, and the charges levied on the user for water use, including delivery charges.)

This result is also illustrated in box D.2, where is it assumed that there are two water users in the market, each facing the same tax on water use. A uniform tax or charge on water use will have no effect on resource allocation in the short run, if the tax does not exceed the scarcity rent. Even if a tax does not improve efficiency in the short run, it may provide incentives for dynamic efficiency improvements. Irrigators might reduce water use if they expect the level of tax in the future to adapt to the reduced external costs from activities to abate water-use related environmental damage.

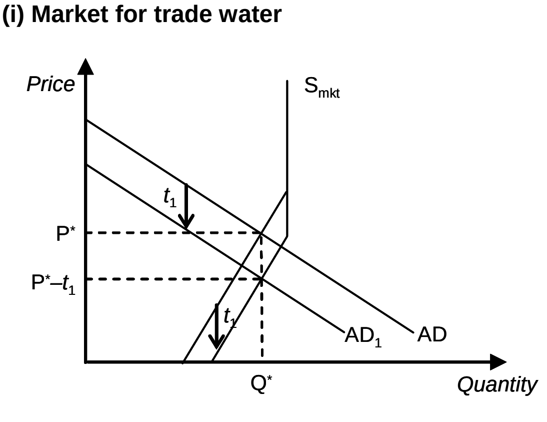
Dwyer et al. (2006) also observed that if a volumetric tax on water use is sufficiently large (or the market price was zero without the tax, such as in a year with abundant rainfall), the market price of water could fall to zero with the tax. Less water will be traded and the overall quantity of water used by irrigators will fall.

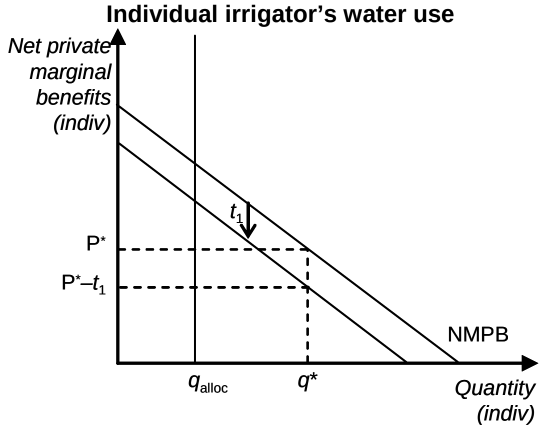
Box D.1 **Effect of a uniform tax on water use**

An irrigator's demand for water is based on their net marginal private benefits (NMPB) gained from water use. For simplicity, it is assumed that utility charges are zero, so the 'market price' of traded water reflects scarcity rents available to holders of water allocations. At price P_a, the individual demands the full allocation (q_{alloc}) and does not supply water to the market. Above P_a the irrigator supplies water to the market — for example, at P_1, the irrigator uses q_1, and sells (supplies) the balance of their allocation in the market (quantity supplied = $q_{alloc} – q_1$). If the price rises to P_2 or above, the irrigator supplies all of their water to the market (quantity supplied = q_{alloc}). If, however, the price is below P_a (such as P_3), the irrigator increases water use to q_3, by supplementing the allocation with water purchases (quantity demanded = $q_3 – q_{alloc}$).



Aggregate demand and supply of traded water (the sum of all individual demands and supplies) shift down by the size of the tax when a tax is applied. In situation (i), where the price (P^*) is initially positive, a tax of t_1 (which is less than P^*) results in the price falling by t_1. There is no change in the quantity of water traded (Q^*). Because each irrigator's NMPB curves also fall by t_1, the tax does not have an allocative effect. The irrigator still uses q^* and buys $q^* – q_{alloc}$ in the market.



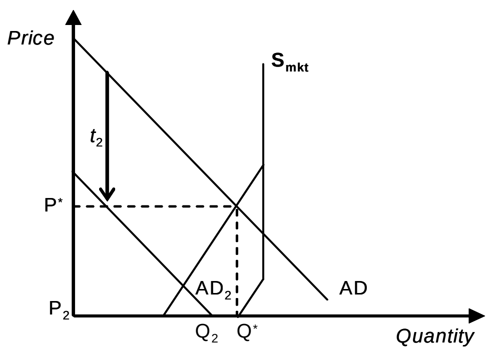


(continued next page)

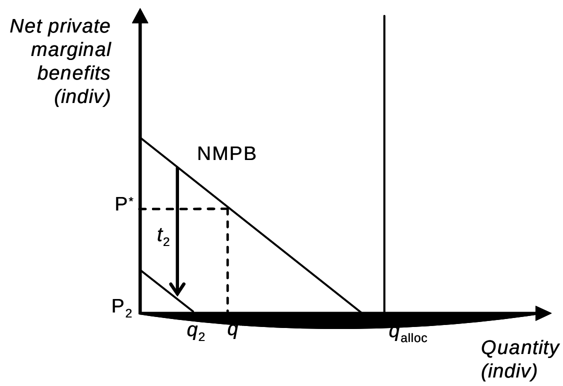
Box D.1 **(continued)**

In situation (ii), where the market price (P^*) is initially positive, a tax of t_2 (where $t_2 > P^*$) results in the market price falling to zero. The quantity of water traded falls to Q_2. Given that fewer unused allocations are being traded, a tax of t_2 results in a reduction in the total quantity of water used. Some individual irrigators who (before the tax) could sell their unused allocations will (after the tax) be unable to sell some (or all) of their unused allocations. As a result of a tax t_2, the individual irrigator shown below reduces their water use from q^* to q_2.

(ii) Market for trade water

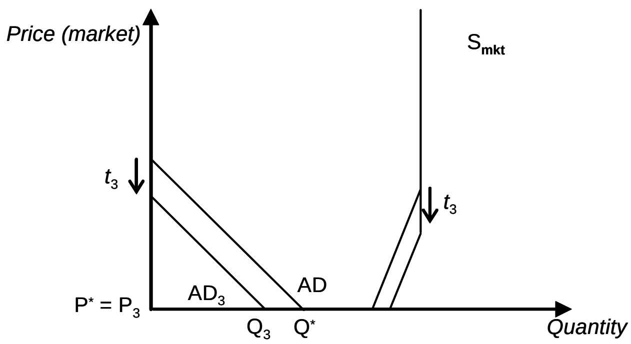


Individual irrigator's water use



In situation (iii), where the price (P^*) is initially zero and only unused water allocations are being sold, a tax of any size results in fewer unused water allocations being traded and a reduction in overall water use.

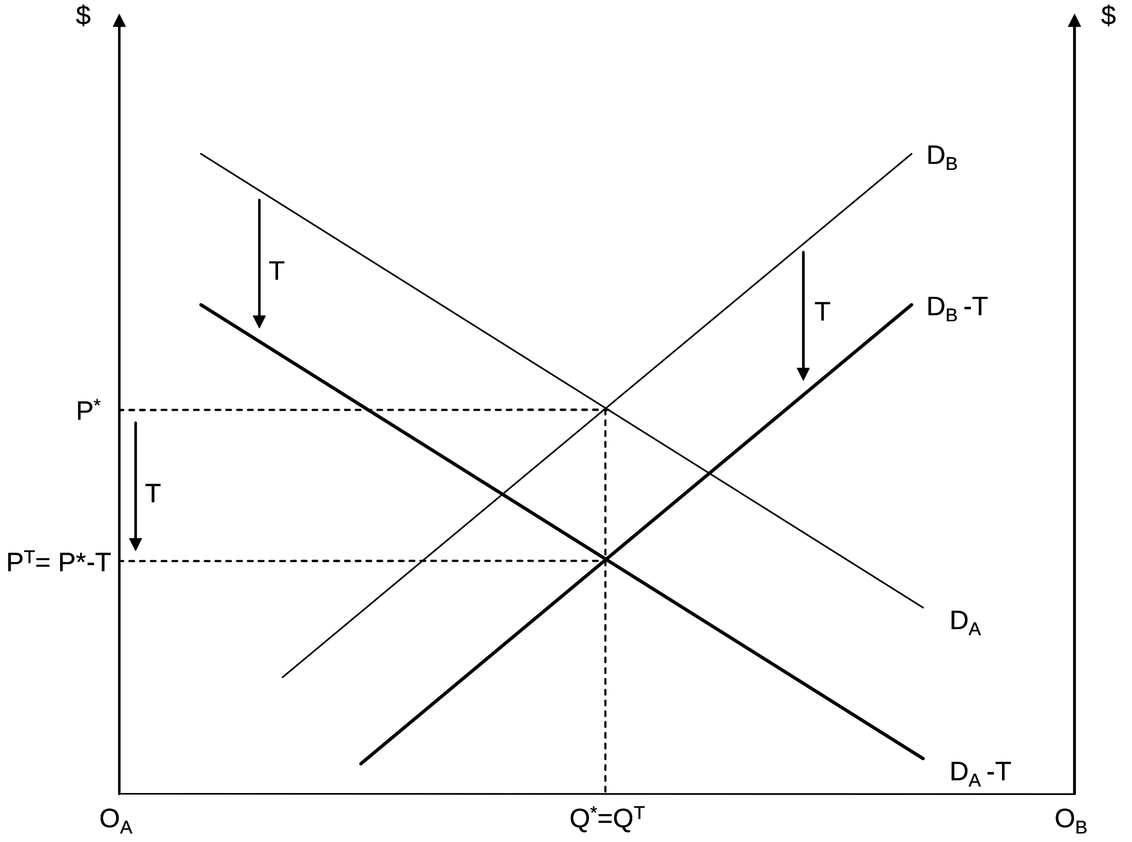
(iii) Market for water



Source: Dwyer et al. 2006.

Uniform charges, on environmental grounds, have been applied by, or been proposed in, some states and territories. Examples include water abstraction charges in the ACT and environmental contributions in Victoria (box 8.7, chapter 8). The assumption of a uniform tax is relevant if trade is confined to an irrigation district where a single tax is imposed.

Box D.2 **Effect of a uniform tax on water use: the case of two water users**



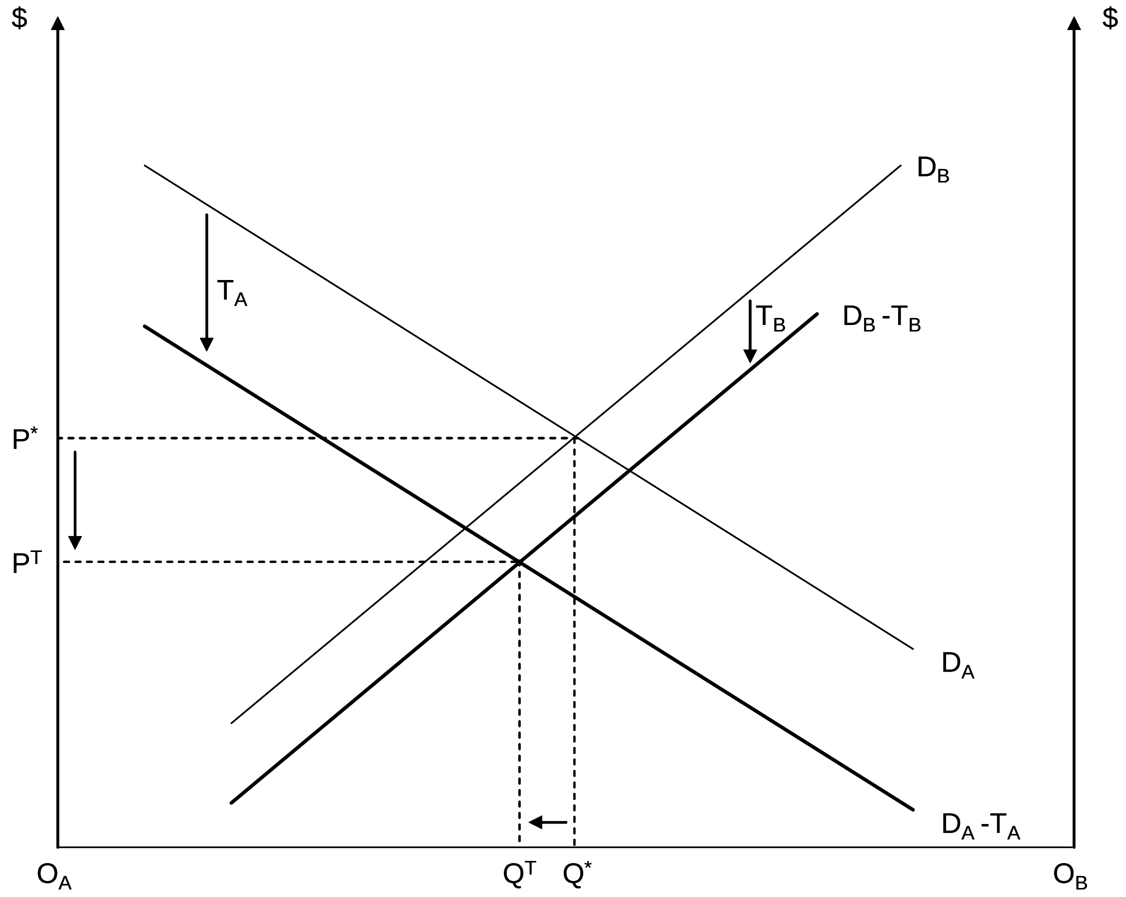
If demand in both regions shifts the same vertical distance (since the tax applied, T, is the same in both regions) then the quantity of water used is unchanged, and the price observed reduces by exactly T.

D.2 Differentiated taxes on water use

In general, the marginal damage of a negative environmental externality caused by water use will vary between regions as well as within them. This is because the damage is linked to location-specific factors, such as salinity impact, as well as larger scale factors, such as the externality caused by water storage.

This situation can be examined in the diagram using two water users, each facing a different tax on water use (box D.3).

Box D.3 **Effect of differentiated taxes on water use: the case of two water users**



The demand for water is determined by a combination of the cost of buying water (the market price), the utility charges for water delivery (assumed to be zero in the above analysis for simplicity), and any externality taxes (T_A and T_B) — which add up to the total cost of the input.

A set of differential taxes on water use will alter the water use and trade. Thus, if use A has a high tax, and use B has a low one, then water will flow from use A to use B.

In these limited circumstances, the size of the individual taxes do not matter for resource allocation, but only their differentials. So, the following sets of taxes will have the same effect on resource use, so long as they all are less than the rents, and if there are no other water uses but A and B (table D.1).

Table D.1 **Sets of use taxes with the same effects on trade and resource allocation**

	Use A's tax rate per ML	*Use B's tax rate per ML*	*Difference in rates*
Set 1	$10	$0	$10
Set 2	$110	$100	$10

The tax collector will gather different amounts of revenue, depending on the elasticities involved.

If there are some other uses, say, use C, then the tax set 2 will cause a greater fall in total water used by A and B, than would the lower set of taxes (set 1). Thus, in this general case, the correct levels of (Pigouvian) taxes are equal to the schedule of marginal environmental externality, tailored to each use. That is, not only the differentials but also the levels of the taxes are important on efficiency grounds, if the sole purpose of the taxes is to internalise the externalities. This kind of tailoring is not a simple matter. Furthermore, it is not clear (from an economic efficiency perspective) which party should pay the tax.

D.3 Charges on water traded out of an irrigation district

Exit fees (volumetric fees on water traded out of an irrigation district) differentiate between own use and trade, and that differentiation is what alters resource allocation and trade. So a uniform exit fee would have the expected results: the volume of trade would be reduced even for a small fee; and reduced more as the fee rises until it is high enough to extinguish trade.

Differential exit fees will have differential effects, as expected. The following sets of fees will have different effects (in contrast with taxes), even if the only uses are A and B (table D.2). Set 4 will reduce trade more than will set 3 (assuming that rents are not exhausted).

Table D.2 **Sets of exit fees with different effects on trade and resource allocation**

	A's exit fee per ML	*B's exit fee per ML*	*Difference in fees*
Set 3	$10	$0	$10
Set 4	$110	$100	$10

References

ABARE (Australian Bureau of Agricultural and Resource Economics) 2005, *ABARE Submission to the Senate Rural and Regional Affairs and Transport References Committee inquiry into water policy initiatives*, www.aph.gov.au/Senate/ committee/rrat_ctte/rural_water/submissions/sub12.pdf (accessed 7 June 2006).

ABS (Australian Bureau of Statistics) 2000, *Water account Australia 1993-94 to 1996-97*, Cat. no. 4610.0, Canberra.

—— 2001, *Agriculture Australia 1999-2000*, Cat. no. 7113.0, Canberra.

—— 2002, *Salinity on Australian farms*, Cat. no. 4615.0, Canberra.

—— 2003, *Australia's environment issues and trends 2003*, Cat. no. 4613.0, Canberra.

—— 2004a, *Water account Australia 2000-01*, Cat. no. 4610.0, Canberra.

—— 2004b, *Measures of Australia's progress 2004*, Cat. no. 1370.0, Canberra.

—— 2005, *Water use on Australian farms 2003-04*, Cat. no. 4618.0, Canberra.

—— 2006a, Special data request for irrigation water use and trade statistics.

—— 2006b, *Water use on Australian farms 2004-05*, Cat. no. 4618.0, Canberra.

ACF (Australian Conservation Foundation) 2006, *Market mechanism and water recovery for the River Murray*, Media brief, 17 May.

ACIL Tasman 2003, *Scope for water use efficiency savings as a source of water to meet increased environmental flows: independent review*, Report to the Murray–Darling Basin Commission.

—— in association with Freehills 2004, *An effective system of defining water property titles: research report*, Land and Water Australia, Canberra.

ANCID (Australian National Committee on Irrigation and Drainage) 2004, *Australian irrigation water provider: benchmarking report for 2002-03*, www.ancid.org.au/pdf/290604/ANCID2004Summweb.pdf (accessed 1 August 2006).

—— 2005a, *Australian irrigation water provider: benchmarking report for 2003-04*, www.ancid.org.au/pdf/290405/2003-2004Tier1-2SummaryBenchmarking Report.pdf (accessed 2 June 2006).

—— 2005b, *Australian irrigation water provider: benchmarking data report for 2003-04*, www.ancid.org.au/pdf/290405/2003-2004Tier1-2SummaryBenchmarkingReport.pdf (accessed 1 August 2006).

ANCOLD (Australian National Committee on Large Dams) 2001, *Register of large dams in Australia*, www.ancold.org.au/dam_register.html (accessed 19 December 2005).

Appels, D, Douglas, R, and Dwyer, G 2004, *Responsiveness of demand for irrigation water: a focus on the Southern Murray–Darling Basin*, Productivity Commission Staff Working Paper, Canberra.

ASIC (Australian Securities & Investments Commission) 2005, *Managed investment schemes*, www.asic.gov.au/asic/asic-polprac.nsf/byheadline/Managed+investment+schemes (accessed 6 April 2006).

Australian Forest Growers nd, *Water policy*, www.afg.asn.au/policy/water.html, (accessed 27 July 2006).

—— and Treefarm Investment Managers Australia (TIMA) 2005, *AGF/TIMA Submission to the review of the taxation treatment of plantation forestry*, www.treasury.gov.au/documents/1000/PDF/062_AFG_TIMA_combined.pdf (accessed 18 April 2006).

Ball, J, Donnelley, L, Erlanger, P, Evans, R, Kollmorgen, A, Neal, B and Shirley, M 2001, *Inland waters, Australia state of the environment report 2001*, Theme report, Department of the Environment and Heritage, Canberra.

Barnett, S and Yan, W 2006, *Review of Mallee clearing saltloads to the River Murray in SA – 2005*, Report DWLBC 2006/08, Government of South Australia.

Barr, N and Cary, J 1992, *Greening a brown land: the Australian search for sustainable land use*, MacMillan, South Melbourne.

BDA Group 2006, *Issues and Options for applying market based measures in the Living Murray First Step*, Report to the Murray–Darling Basin Commission, Canberra.

Beare, S and Heaney, A 2001, *Irrigation, water quality and water rights in the Murray–Darling Basin, Australia*, ABARE Conference Paper 2001.15.

——, and ——, 2002, *Water trade and the externalities of water use in Australia: interim report*, ABARE paper for Natural Resource Management Business Unit, Canberra.

Bellamy, J, Ross, H, Ewing, S and Meppem, T 2002, *Integrated catchment management: learning from the Australian experience for the Murray–Darling Basin*, Final report, CSIRO Sustainable Ecosystems, Canberra.

Beynon, N, Kingma, O and White, D 2002, *The potential for improving water use efficiency: a scoping study of opportunities for change and possible policy approaches for the Murray–Darling Basin*, Australian National Committee on Irrigation and Drainage.

BRS (Bureau of Rural Sciences) 2006, *Science for decision makers, plantations and water: plantation impacts on stream flow*, Department of Agriculture, Fisheries and Forestry, revised edn, February.

Brough, M and Macdonald, I (Minister for Revenue and Assistant Treasurer; Minister for Fisheries, Forestry and Conservation) 2005, *Review of the taxation of plantation forestry*, Joint media release no. 056, 17 June.

Brumby, J (Minister for Innovation, Victoria) 2006, *Smarter irrigation delivers economic benefits*, Media release, Melbourne, 10 February.

Castle, AJ 1999, *Water Rights Law* – *Prior Appropriation*, library.findlaw.com/1999/Jan/1/241492.html (accessed 9 August 2006).

Chaudhri, V 2004, 'Market based instruments and NRM: back to basics', in *Proceedings of the 6th Annual AARES National Symposium 2003*, Canberra, 2–3 September, RIRDC publication no. 04/142, pp. 24–32.

Chiew, FHS, Jones, RN and Boughton, WC 2005, Modelling climatic sensitivity to climate conditions, Paper presented at Engineers Australia '29th Hydrology and Water Resources Symposium', 21–23 February, Canberra.

Christen, EW, Ayars, JE and Hornbuckle, JW 2001, 'Subsurface drainage design and management in irrigated areas of Australia', *Irrigation Science*, vol. 21, pp. 35–43.

CIE/LWA (Centre for International Economics and Land and Water Australia) 2004, *Implications of water reforms for the national economy*, Canberra.

CIT (Central Irrigation Trust) 2005, *Water trade, fact sheet no. 1*, www.cit.org.au/ (accessed 8 June 2006).

CEOGW (Chief Executive Officers' Group on Water) 2003, *Water access entitlements*, Final report to the Council of Australian Governments.

COAG (Council of Australian Governments) 2004a, *Intergovernmental agreement on a national water initiative*, www.coag.gov.au/meetings/250604/iga_national_water_initiative.pdf (accessed 4 May 2006).

—— 2004b, *Intergovernmental agreement in addressing over-allocation and achieving environmental objectives in the Murray–Darling Basin*, www.coag.gov.au/meetings/250604/iga_water_overallocation_murray_darling.pdf (accessed 1 August 2006).

Coase, RH 1960, ‘The problem of social cost’, *Journal of Law and Economics*, vol. 3, no. 2, pp. 1–44.

CommSec (Commonwealth Securities Limited) 2006, *What it costs*, www.comsec.com.au/Public/WhatItCosts.aspx (accessed 14 May 2006).

Connor, J and Young, M 2003, *Environmental water bank options for the South Australian River Murray*, Final report to South Australian Department of Water, Land and Biodiversity Conservation, Folio no. 03/745, CSIRO Land and Water.

Cook, PG, Leaney, FW and Jolly, D 2001, *Groundwater recharge in the Mallee region, and salinity implications for the Murray River: a review*, CSIRO Land and Water Technical Report 45/01.

Crean, J, Shaw, A, Singh, R and Mullen, J 2004, *An assessment of the economic, environmental and social impacts of New South Wales agriculture’s advisory programs in water-use efficiency*, Economic Research Report 21, Department of Primary Industries, Water Conservation Strategy 2000 and Department of Land and Water Conservation, New South Wales.

CSIRO 2004, *Tree Planting and Catchment Water Yield*, Heartlands Fact sheet 5, www.clw.csiro.au/heartlands/publications/factsheets/Heartlands_FS5_Tree_Planting_and_Catchment_Water_Yield.pdf (accessed 27 July 2006).

DAFF (Department of Agriculture, Fisheries and Forestry) 2006, *Pathways to industry EMS programme*, www.affa.gov.au/content/output.cfm?ObjectID=54B97FAD-550D-4E3A-A211DB623F42891E (accessed 3 August 2006).

Deamer, P 2005, A review of water saving costs and volumes, Paper presented at the ANCID 2005 Conference, ‘One Life, One River, Our Future’, Mildura, 23–26 October, www.ancid.org.au/pdf/mildura_pdfs/DriversinWaterValue/DeamerPJ ANCID.pdf (accessed 22 May 2006).

DEC (Department of Environment and Conservation, New South Wales) 2006, *NSW City and Country Environment Restoration Program: New South Wales RiverBank 2006‑07*, Business Plan, July, Sydney.

Deason, J, Fast, J, Schroeer, L, Turner, B and van Staveren, R 2005, ‘Considering water use efficiency for the environmental sector’, *California water plan update 2005*, vol. 4, pp. 401–37, California Department of Water Resources, www.waterplan.water.ca.gov/docs/cwpu2005/vol4/vol4-environment-considering wateruseefficiency.pdf (accessed 8 March 2006).

DEH (Department of the Environment and Heritage) 2005, *Submission to the Review of the taxation treatment of plantation forestry*, www.treasury.gov.au/documents/1000/PDF/067_Department_of_the_Environment_and_Heritage.pdf (accessed 18 April 2006).

—— 2006, *Murray–Darling Basin*, www.deh.gov.au/water/basins/murray-darling.html (accessed 1 June 2006).

Department of Agriculture (Western Australia) 2004, *Salinity in Western Australia*, www.agric.wa.gov.au/pls/portal30/docs/FOLDER/IKMP/LWE/SALIN/salinity_intro.htm (accessed 26 April 2006.

Department of Water (Western Australia) 2006, *Groundwater*, portal.water.wa.gov.au/portal/page?_pageid=1318,5510369&_dad=portal&_schema =PORTAL (accessed 28 April 2006).

DIPNR (Department of Infrastructure, Planning and Natural Resources, New South Wales) 2005, *Water allocation plan for the Murray–Lower Darling Valleys 2004-05*.

DNR (Department of Natural Resources, New South Wales) 2004, *Water sharing in the Lower Wollombi Brook water source*, Newcastle.

DNRMW (Department of Natural Resources, Mines and Water, Queensland) 2006, *Rural water use efficiency*, www.nrm.qld.gov.au/rwue/ (accessed 7 June 2006).

DPI (Department of Primary Industries, New South Wales) 2003, *Funds for rural water use efficiency incentive fully used*, www.agric.nsw.gov.au/reader/wwfunding/end-iawueis.htm (accessed 28 July 2006).

—— 2005, *Salinity Control*, www.forest.nsw.gov.au/env_services/salinity_control/mrff_qa/Macquarie_River_QA.pdf (accessed 28 July 2006).

Douglas, R, Dwyer, G and Peterson, D 2004, ‘Activity gross margins and water reform’, *Connections*, www.agrifood.info/Connections/Autumn2004/Douglas (accessed 3 April 2006).

DSE (Department of Sustainability and Environment, Victoria) 2004, *Our water our future: securing our water future together*, Victorian Government White Paper, Melbourne.

—— 2005a, *Securing our water future together; key concepts explained*, Fact Sheet ‘lower-reliability water shares and the “80:20” sales water deal’, Melbourne, October.

—— 2005b, *Water smart farms: 2004-05 funding guidelines*, Melbourne.

—— 2005c, *Wimmera Mallee pipleline*, www.dse.vic.gov.au/CA256F310024B628/0/9A03C4F45D81EDB7CA256FF500289239/$File/FS-Wimmera.pdf (accessed 2 August 2006).

Dudley, NJ 1992, ‘Water allocation by markets, common property and capacity sharing: companions or competitors?’, *Natural Resources Journal*, no. 32, pp. 757–78.

—— and Musgrave, F 1988, ‘Capacity sharing of water reservoirs’, *Water Resources Research*, vol. 26, no. 5, pp 649–58.

Dutton, P (Minister for Revenue and the Assistant Treasurer) 2006, *Consultation on proposed taxation arrangements for plantation forestry*, Media release no. 025, 9 May.

DWLBC (Department of Water, Land and Biodiversity Conservation, South Australia) 2004–2006, *Managing the Impact of Commercial Forestry*, www.dwlbc.sa.gov.au/water/wrm/commercial_forestry/managing_impact.html, (accessed 27 July 2006).

—— 2006, *Aquifer storage & recovery in SA, Fact sheet 5*, www.dwlbc.sa.gov.au/files/fs5_asr_in_sa.pdf (accessed 17 March 2006).

Dwyer, G, Loke, P, Appels, D, Stone, S and Peterson, D 2005, Integrating rural and urban water markets in south east Australia: preliminary analysis, Paper presented at OECD ‘Workshop on Agriculture and Water: Sustainability, Markets and Policies’, Adelaide, 14–18 November.

——, Douglas, R, Peterson, D, Chong, J and Maddern, K 2006, *Irrigation externalities: pricing and charges*, Productivity Commission staff working paper, Melbourne.

Eigenraam, M, Strappazzon, L, Lansdell, N, Ha, A, Beverly, C and Todd, J 2006, *EcoTender: Auction for multiple environmental outcomes*, National Action Plan for Salinity and Water Quality, National Market Based Instruments Pilot Program, Project Final Report.

English, B, Brearley, T and Coggan, A 2004, Environmental flow allocations and counter-cyclical trading in the River Murray System, Paper presented at the 48th Australian Agriculture and Resource Economics Society Conference, Melbourne, 11–13 February.

Environment Waikato 2005, *Proposed Waikato Regional Plan Variation 5 – Lake Taupo Catchment*, Waikato Regional Council Policy Series 2005/03, Hamilton East, New Zealand.

—— 2006, *Protecting Lake Taupo*, www.ew.govt.nzpolicyandplans/taupo/index.htm (accessed 14 July 2006).

EPA (Environment Protection Authority, New South Wales) 2003, *How the scheme works*, www.environment.nsw.gov.au/licensing/hrsts/how_the_scheme_works (accessed 30 March 2006).

Evans, R 2004, River-groundwater interaction in the Murray–Darling Basin: technical status and management options, Paper presented at the ‘9th Murray–Darling Basin Groundwater Workshop’, Bendigo, 12–19 February.

—— 2005, Double accounting of surface water and groundwater resources: the tyranny of the time lag, Paper presented at ABARE 'Outlook Conference', Canberra, 1–2 March.

eWater 2006, *Catchment modelling toolkit — Overview*, www.toolkit.net.au/cgi-bin/WebObjects/toolkit.woa/1/wa/productDetails?productID=1000062&wosid (accessed 2 August 2006).

Fairweather, H, Austin, N and Hope, M 2003, *Water use efficiency: an information package*, Irrigation insights 5, National Program for Irrigation Research and Development, New South Wales Agriculture, www.lwa.gov.au/downloads/publications_pdf/PR030566.pdf (accessed 27 February 2006).

Fenton, M 2006, *The social implications of permanent water trading in the Loddon-Campaspe irrigation region of northern Victoria*, Report prepared for North Central Catchment Management Authority.

Gippel, CJ and Blackham, D 2002, *Review of environmental impacts of flow regulation and other water resource developments in the River Murray and Lower Darling River system*, Final report by Fluvial Systems Pty Ltd, Stockton, to Murray–Darling Basin Commission, Canberra.

Goulburn–Murray Water 2003, *Water salinity being improved at Lake Charm*, www.g-mwater.com.au/article.asp?ContentID=water_salinity_being_improved_ (accessed 28 July 2006).

Goesch, T, Hafi, A, Heaney, A and Szakiel, S 2006, *Exit fees and interregional trade: An analysis of the efficiency impacts of exit fees*, ABARE Research Report 06.5 to the Natural Resource Management Division, Department of Agriculture, Fisheries and Forestry, Canberra, May.

Gordon, W, Heaney, A and Hafi, A 2005, Asset fixity and environmental policy: an application to water quality management, ABARE conference paper presented at OECD 'Workshop on Agriculture and Water: Sustainability, Markets and Policies', Adelaide and Barmera, 14–18 November.

Goss, K 2003, 'Environmental flows, river salinity and biodiversity conservation: managing trade-offs in the Murray–Darling Basin', *Australian Journal of Botany*, vol. 51, no. 6, pp. 619–25.

Government of South Australia nd, *Environmental Flows for the River Murray*, information leaflet.

Grafton, R 2005, *Evaluation of round one of the market based instrument pilot program*, www.napswq.gov.au/mbi/round1-evaluation.html (accessed 11 November 2005).

Gyles, O 2003 ‘More water for irrigation and the environment? Some problems and prospects for worthwhile investments’, *Connections*, www.agrifood.info/connections/autumn_2003/Gyles.html (accessed 10 March 2006).

Hafi, A, Beare, S, Heaney, A and Page, S 2005, *Water options for environmental flows*, ABARE e-Report prepared for the Department of Agriculture, Fisheries and Forestry, Canberra.

Hajkowicz, S and Young, M (eds) 2002, *Value of returns and costs of resource degradation*, Consulting report to the National Land and Water Resources Audit, CSIRO Land and Water Division, Canberra.

Harvey Water 2003, *History and development*, www.harveywater.com.au/history%20and%20development/history_and_development__the_irr.asp (accessed 21 February 2006).

Hart, B, Lake, P, Angus Webb, J and Grace, M 2002, ‘Ecological risk to aquatic systems from salinity increases’, *Australian Journal of Botany*, vol. 51, no. 6, pp. 689–702.

Hassall and Associates and SCRIVCO Pty Ltd 2004, *A guide to dealing with stranded irrigation assets*, Paper prepared for the Murray–Darling Basin Commission, August.

Hatton McDonald, D, Connor, J and Morrison, M 2004, *Market-based instruments for managing water quality in New Zealand*, Final report for the New Zealand Ministry for the Environment, Folio no. S/03/1393, CSIRO Land and Water.

Heaney, A, Beare, S and Bell, R 2001, *Targeting land and water use options for salinity management in the Murray–Darling Basin*, ABARE report to the Murray–Darling Basin Commission, Canberra.

——, Thorpe, S, Klijn, N, Beare, S and Want, S 2004, Water charges and interregional trade in the southern Murray Darling Basin, Paper presented at the Establishing Water Markets Symposium, Melbourne, 9 August.

——, Dwyer, G, Beare, S, Peterson, D and Pechey, L 2005, Third party effects of water trading and potential policy responses, Paper presented at the 25th annual American Agricultural Economics Association Conference, Providence, Rhode Island, 25–27 July.

—— and Levantis, C 2001, Salinity management in the northern Murray–Darling Basin, Paper presented at the Tamworth Regional Outlook Conference, 14 August, Tamworth.

Howard, J (Prime Minister of Australia) 2005, *Protecting major groundwater resources in NSW for future generations*, www.pm.gov.au/news/media_Releases/media_Release1417.html (accessed 3 August 2006).

HRSCEH (House of Representatives Standing Committee on Environment and Heritage) 2000, *Coordinating catchment management: report of the inquiry into catchment management*, Australian Government, Canberra.

Hydro Environmental Pty Ltd 2005, *Optimal Performance Review of the Lake Charm flushing outfall events Spring 2000 and Winter/Spring 2003*, Final report prepared for Goulburn–Murray Water.

IAG (Independent Audit Group) 1996, *Setting the cap, report to the Murray–Darling Basin Ministerial Commission*, www.mdbc.gov.au/__data/page/86/ SETTING_THE_CAP.pdf (accessed 15 March 2006).

—— 2006 forthcoming, *Review of the Living Murray Implementation 2004-05*.

IC (Industry Commission) 1992, *Water resources and waste water disposal*, Report no. 26, Canberra.

Johnstone Centre Research in Natural Resources and Society nd, *Ecological assessment of cyclic release patterns from Dartmouth Dam to the Mitta Mitta River, Victoria*, www.csu.edu.au/research/jcentre/project_summaries/ summary_ rw_ecological.pdf (accessed 4 May 2006).

Jones, G, Hillman, T, Kingsford, R, McMahon, M, Walker, K, Arthington, A, Whittington, J and Cartwright, S 2002, *Independent report of the Expert Reference Panel on Environmental Flows and Water Quality Requirements for the River Murray System*, prepared for the Environmental Flows and Water Quality Objectives for the River Murray Project Board, Cooperative Research Centre for Freshwater Ecology.

Keogh, M 2005, 'The National Dryland Salinity Audit 5 years on: is the 17 million hectare estimate still valid or useful?', *Farm Policy Journal*, vol. 2, no. 4, pp. 19–27.

Kimberley Primary Industry Association 2004, *Ord River irrigation area*, www.kimberleyagriculture.com/html/oria.htm (accessed 21 February 2006).

Lacey, R, Watson, A and Crase J 2005, *Economic effects of income-tax law on investments in Australian agriculture, with particular reference to new and emerging industries*, Report for the Rural Industries Research and Development Corporation, RIRDC publication no. 05/078.

Lovrich, N, Siemann, D, Brock, J, Bireley, RM, Gaffney, MJ, Kent, C and Huckabay, J 2004, *Of Water and Trust: A Review of the Washington Water Acquisition Program*, Policy Consensus Center, prepared for the Washington State Department of Ecology and the Division of Governmental Studies and Services at Washington State University, Olympia, United States.

Lowe, L 2000, *2000 Report to the Legislature: Water Rights Purchasing Pilot Project Progress Report and Recommendations*, Washington State Department of Ecology, December, www.ecy.wa.gov/pubs/0011009.pdf (accessed 5 August 2006).

Maheshwari, BL, Walker, KF and McMahon, TA 1995, 'Effects of flow regulation on the flow regime of the River Murray, Australia', *Regulated rivers: research and management*, vol. 10, pp. 15–38.

Mallee Catchment Management Authority 2005, *Irrigation water donations fact sheet*, www.malleecma.vic.gov.au/documents/FactSheetIrrigationDoc.pdf (accessed 2 August 2006).

McCain Foods 2005, *Submission to the Review of the taxation treatment of plantation forestry*, www.treasury.gov.au/documents/1000/PDF/ 061_McCain_ Foods_(Aust)_Pty_Ltd.pdf (accessed 18 April 2006).

MDBC (Murray–Darling Basin Commission) 1999a, *The salinity audit of the Murray–Darling Basin: A 100-year perspective*, www.mdbc.gov.au/__ data/page/303/Final_Salt_Audit2.pdf (accessed 21 February 2006).

—— 1999b, *Water quality*, www.mdbc.gov.au/nrm/water_management/water_ issues/water_quality (accessed 21 February 2006).

—— 2002, *The impacts of water regulation and storage on the Basin's rivers*, www.mdbc.gov.au/encyclopedia/eduation/water_regulation/water_regulation_ impact (accessed 16 April 2004).

—— 2004a, *Murray–Darling Basin Commission annual report 2003-2004*, www.mdbc.gov.au/subs/annual_reports/AR_2003-04/PDF/MDBC_AR_ PrintAll.pdf (accessed 15 May 2006).

—— 2004b, *The Living Murray environmental works and measures program*, Canberra.

—— 2005a, *Basin salinity management strategy 2003-04: annual implementation report*, Canberra.

—— 2005b, *E-letter no. 49*, www.mdbc.gov.au/__data/page/140/Issue49-dec05.html (accessed 9 March 2006).

—— 2005c , *Living Murray business plan*, publication no. 05/05, April.

—— 2005d, *River Murray Water*, www.mdbc.gov.au/rmw/river_murray_water (accessed 30 May 2006).

—— 2005e, *The Living Murray foundation report on the significant ecological assets targeted in the first step decision*, www.mdbc.gov.au/subs/dynamic_ reports/foundation_report/7.html#wp1003925 (accessed 25 May 2006).

—— 2006a, *Additional $500 million from Australian Government to improve Murray River health welcomed by MDBC,* Media release no. 06/9534, 10 May.

—— 2006b, *Assessing the salinity impacts of irrigation and interstate water trade — Salinity impact rapid analysis tool,* www.mdbc.gov.au/salinity/salinity_ impact_rapid_analysis_tool (accessed 2 August 2006).

—— 2006c, *Irrigation*, www.mdbc.gov.au/nrm/water_management/water_issues/ irrigation (accessed 1 June 2006).

—— 2006d, *Keeping salt out of the Murray*, www.mdbc.gov.au/__data/page/105/ SIS_brochure.pdf (accessed 2 August 2006).

—— 2006e, *Natural resource management: the cap*, www.mdbc.gov.au/nrm/ water_management/the_cap (accessed 15 March 2006).

—— 2006f, *Pilot interstate trading project*, www.mdbc.gov.au/nrm/water_ management/water_issues/water_trade/pilot_interstate_water_trading_project (accessed 2 June 2006).

—— 2006g, *Risks to shared resources*, www.mdbc.gov.au/nrm/risks_ to_shared_water_resources (accessed 3 August 2006).

—— 2006h, Summary of *Recovering Water for the Environment – The Shepparton Irrigation Area Total Channel Control Project*, pre-feasibility assessment prepared by Marsden Jacob Associates for the Murray–Darling Basin Commission.

—— 2006i, *The Living Murray: water recovery*, www.thelivingmurray. mdbc.gov.au/implementing/water_recovery (accessed 16 April 2006).

—— 2006j, *Where to plant trees for salinity outcomes*, www.mdbc.gov.au/ salinity/where_to_planting_trees_for_salinity_outcomes_ poster (accessed 15 May 2006).

MDBMC (Murray–Darling Basin Ministerial Council) 2001, *Basin salinity management strategy 2001–2015*, www.mdbc.gov.au/salinity/basin_salinity _management_strategy_20012015 (accessed 21 February 2006).

—— 2005, *Murray–Darling Basin Ministerial Council communiqué*, 30 September.

—— 2006, *Murray–Darling Basin Ministerial Council communiqué*, 19 May.

MIL (Murray Irrigation Limited) 2005, *Murray irrigation sustainability report 2005*, Deniliquin, New South Wales.

—— 2006, *Standard fees and service charges, effective 016/03/06*, www.murrayirrigation.com.au/download/3263856.pdf (accessed 19 May 2006).

—— and MCMA (Murrumbidgee Catchment Management Authority) 2006, *Murrumbidgee River Reach: A proposal to the Water Smart Australia Programme*, June.

Miles, M and Kirk, J 2005, ‘SIMPACT–Salinity modelling for policy and catchment management in the Lower Murray–Darling Basin’, in Zerger, A and Argent, R (eds) *MODSIM 2005 International Congress on Modelling and Similation Society of Australia and New Zealand*, December, pp. 2145–52, www.mssanz.org.au/modsim05/papers/miles.pdf (accessed on 26 June 2006).

Milne, C and Hughes, D 2006, ‘SA, Victoria sign deal to trade water’, *The Australian Financial Review*, 17 February.

MWE (Murrumbidgee Water Exchange) 2006, www.murrumbidgeewater.com.au (accessed 21 February 2006).

NAPSWQ (National Action Plan for Salinity and Water Quality) 2001, *National Action Plan for Salinity and Water Quality*, www.napswq.gov.au/ publications/water-facts.html (accessed 8 December 2005).

NCC (National Competition Council) 2004, *Assessment of governments' progress in implementing the national competition policy and related reforms: water*, vol. 2, Australian Government.

Nias, D 2005, *Adaptive Environmental Water in the Murray Valley*, NSW 2000–2003, NSW Murray Wetlands Working Group Inc, Albury, New South Wales.

NLWRA (National Land and Water Resource Audit) 2001a, *Australian water resources assessment 2000*, Canberra.

—— 2001b, *Australian agriculture assessment 2001*, Canberra.

—— 2001c, *National dryland salinity assessment 2000*, Canberra.

—— 2004, *Water–surface water quality Australia*, National Heritage Foundation, www.audit.ea.gov.au/anra/water/water_frame.cfm?region_type=AUS&region_ code=AUS&info=quality (accessed 21 February 2006).

NPIRD (National Program on Irrigation Research and Development) 1999, *Framework*, www.npird.gov.au/projects/finalrep_pdf/pdf/npirdframeworkweb. pdf (accessed 20 February 2006).

NRMMC (Natural Resource Management Ministerial Council) 2003, *Water access entitlements*, Final report of the Chief Executive Officers’ Group on Water to the Council of Australian Governments.

NWC (National Water Commission) 2006a, *National competition policy water reform assessment*, www.nwc.gov.au/reform/water_reform.cfm (accessed 24 May 2006).

—— 2006b, *Project information: Environmental Water Trading System, Berri South Australia*, www.nwc.gov.au/publications/project_info_water_trading.cfm (accessed 2 August 2006).

—— 2006c, *Water smart Australia programme special call for irrigation proposals guidelines*, www.nwc.gov.au/water_fund/water_smart_aust_proposal.cfm#sp_guidelines (accessed 19 May 2006).

—— and ABS (National Water Commission and Australian Bureau of Statistics) 2005, *National Water Resource Accounting Workshop*, Paper prepared by Palm Consulting Group, Canberra, 29 June.

PC (Productivity Commission) 1999, *Microeconomic reforms and Australian productivity: exploring the links*, Productivity Commission research paper, AusInfo, Canberra.

——2003, *Water rights arrangements in Australia and overseas*, Productivity Commission research paper, Melbourne.

Peterson, D, Dwyer, G, Appels, D and Fry, JM 2004, *Modelling water trade in the southern Murray–Darling Basin*, Productivity Commission staff working paper, Melbourne.

Petheram, C, Zhang, L, Walker, G and Grayson, R 2002, *Towards a framework for predicting impacts of land-use on recharge: a review of recharge studies in Australia*, CSIRO Land and Water Technical Report 28/00.

Pratt Water 2004, *Business of saving water, the report of the Murrumbidgee Valley water efficiency feasibility project*, www.napswq.gov.au/publications/pubs/pratt-water-main.pdf (accessed 22 May 2006).

Quiggin J 2005, *Repurchase of renewal rights: a policy option for the national water initiative*, University of Queensland.

Ribaudo, M, Horan, R and Smith, M 1999, *Economics of water quality from non-point sources: theory and practice*, Agricultural Economic Report no. 782, Economic Research Service, United States Department of Agriculture, Washington.

Roberts, J and Marston, F 2000, *Water regime of wetland and floodplain plants in the Murray–Darling Basin: a source book of ecological knowledge*, CSIRO Land and Water, Technical report 30/00, Canberra.

Roper, H, Sayers, C and Smith, A 2006, *Stranded Irrigation Assets*, Productivity Commission staff working paper, Melbourne, June.

Ryan, I, Keogh, R, Fernando, N and Boettcher, P 2000, Capacity sharing - a new water management system for the St George water supply scheme, Paper presented at the 47th Annual ANCID 2000 Conference, 'A Decade of Change', Toowoomba, Queensland, 10–12 September, www.ancid.org.au/pdf/cd_pdfs/ Keogh_R.pdf (accessed 17 May 2006).

SCRGSP (Steering Committee for the Review of Government Service Provision) 2006, *Report on government services 2006*, Productivity Commission, Canberra.

Sellars, P. 2006, '$5000 for Water? Not on, says Turnbull', *The Weekly Times*, 14 June, p. na.

Shi, T 2005, *Simplifying complexity: a framework for the rationalisation of water entitlements in the southern connected River Murray system*, CSIRO Land and Water technical report, Adelaide.

Sinner, JA 2006, Evidence presented at a hearing in support of the submission of the Environmental Defence Society in the matter of the Resource Management Act 1991 and proposed Waikato Regional Plan Variation 5 – Lake Taupo Catchment (Proposed), 21 June, Hamilton, New Zealand.

SKM (Sinclair Knight Merz) 2004, *BSMS 2003-04 Annual Report – SIR Interim Submission to IAG*, File note.

—— 2005, *Towards a national framework for managing the impacts of groundwater and surface water interaction in Australia*, Discussion paper prepared for the Australian Government.

—— 2006, *Towards a national framework for managing the impacts of groundwater and surface water interaction in Australia*, Final report prepared for the Australian Government.

Smith, DI 1998, *Water in Australia: resources and management*, Oxford University Press, Melbourne.

Southern Rural Water 2006, *Macalister irrigation district*, www.srw.com.au/ irrigation/maca.html (accessed 21 February 2006).

Stavins, R 2003, *Market-based environmental policies: what can we learn from US experience (and related research)?*, Centre for Business and Government, John F Kennedy School of Government, Harvard University.

Stoneham, G, Chaudhri, V, Ha, A and Strappazzon, L 2004, 'Auctioning conservation contracts: evaluating Victoria's BushTender trial', *Proceedings of the 6th Annual AARES National Symposium, Canberra, 2–3 September 2003*, RIRDC publication no. 04/142, pp. 33–46.

Sundakov, A 2006, Evidence in the matter of the Resource Management Act 1991 and in the matter of a hearing of Variation 5 to the Waikato Regional Plan under the First Schedule of the Act between Carter Holt Harvey Limited and Waikato Regional Council, New Zealand.

SunWater 2006, *Your water supply solution*, www.sunwater.com.au (accessed 4 April 2006).

Sutherland, L, Ryder, D and Watts, R 2002, *Ecological assessment of cyclic release patterns (CRP) from Dartmouth Dam to the Mitta Mitta River, Victoria*, Johnstone Centre Research in Natural Resources and Society, Environmental Consulting Report No. 27, Charles Sturt University.

The Allen Consulting Group 2006, *Transaction costs of water markets and environmental policy instruments*, Report to the Productivity Commission.

Thoms, M, Suter, P, Roberts, J, Koehn, J, Jones, G, Hillman, T and Close, A 2000, *River Murray–Dartmouth to Wellington and the Lower Darling River*, Report of the River Murray Scientific Panel on Environmental Flows, Murray–Darling Basin Commission, Canberra.

Thorstensen, C and Nayler, G 2005, Changing times — changing systems, Paper presented at the ANCID 2005 Conference, 'One Life, One River, Our Future', Mildura, 23–26 October.

Thwaites, J (Minister for Water, Victoria) 2004, *$470,000 Water smart farms project to save 700 ML*, Media release, 23 November, www.dpc.vic.gov.au/domino/Web_Notes/newmedia.nsf/b0222c68d27626e2ca256c8c001a3d2d/18a6fccefe222697ca256f5600041724!OpenDocument (accessed 25 May 2006).

Turnbull, M (Parliamentary Secretary to the Prime Minister) 2006a, *Keynote speech to Australian Water Summit*, 14 March, www.malcolmturnbull.com.au/news/default.asp?action=article&ID=385, (accessed 24 March 2006).

—— 2006b, *Major water projects for South Australia to receive funding*, www.malcolmturnbull.com.au/news/article.aspx?ID=424 (accessed 3 August 2006).

—— 2006c, *Malcolm Turnbull announces new measures to recover water for the River Murray*, www.malcolmturnbull.com.au/news/default.asp?action=article&ID=423 (accessed 25 May 2006).

—— 2006d, *Nationally significant water saving projects to receive funding*, www.malcolmturnbull.com.au/news/article.aspx?ID=407 (accessed 3 August 2006).

U.S. Department of the Interior, Bureau of Reclamation 2005, *Reclamation, Managing Water in the West*, www.usbr.gov/lc/region/g4000/4200Rpts/DecreeRpt/2003/2003.pdf (accessed 9 August 2006).

—— 2006, *Lower Colorado River Water Accounting*, www.usbr.gov/lc/region/g4000/wtracct.html (accessed 9 August 2006).

van Dijk, A, Evans, R, Hairsine, P, Khan, S, Nathan, R, Paydar, Z, Viney, N and Zhang, L 2006, *Risks to the shared water resources of the Murray–Darling Basin*, prepared by CSIRO for the MDBC, Canberra.

Victorian Government 2004, Victoria's Water Recovery Proposals under Clause 36 of the CoAG Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in Murray-Darling Basin (June 2004) as agreed by Murray–Darling Basin Ministerial Council on 26 November 2004 for listing on its Eligible Water Recovery Measures Register.

Walquist, A, 'Water for the Murray 'must be bought'', *The Australian*, 20 March, www.theaustralian.news.com.au/story/0,20867,18528589-2702,00.html (accessed 29 May 2006).

Waterexchange 2006, www.waterexchange.com.au (accessed 19 May 2006).

Waterfind 2006, www.waterfind.com.au (accessed 7 June 2006).

Water for Rivers 2006a, *Formation*, www.waterforrivers.org.au/background/formation/index.htm (accessed 1 August 2006).

—— 2006b, *Projects*, www.waterforrivers.org.au/projects/index.htm (accessed 22 May 2006).

—— 2006c, *Purpose*, www.waterforrivers.org.au/background/purpose/index.htm (accessed 1 August 2006).

Water Proofing Adelaide 2004, *Water proofing Adelaide: exploring the issues — a discussion paper*, www.sawater.com.au/NR/rdonlyres/89168780-C8FA-4132-916E-4429C08D5F0F/0/WPA_Exploring_Issues.pdf (accessed 1 May 2006).

Water Reform Implementation Committee 2006, *A draft blueprint for water reform in Western Australia*, Government of Western Australia, dows.lincdigital.com.au/files/WaterReformBlueprint.pdf (accessed 26 July 2006).

Watermove 2006, www.watermove.com.au (accessed 8 December 2005).

Watson, A 2003, 'Approaches to increasing river flows', *Australian Economic Review*, vol. 36, no. 2, pp. 213–24.

—— 2005, Competition and water: a curmudgeon's view, Paper prepared for the Australian Competition and Consumer Commission Conference, 'Relationship Between Essential Facilities and Downstream Markets', Gold Coast, Queensland, 28 July.

Wentworth Group of Concerned Scientists 2003, *Blueprint for a national water plan*, WWF Australia, Sydney.

WHCF and CRCIF (Water for a Healthy Country Flagship and the Cooperative Research Centre for Irrigation Futures) 2005, *Irrigation in perspective:*

irrigation in the Murray and Murrumbidgee Basins, a birds eye view, Commonwealth of Australia, www.csiro.au/files/files/p3we.pdf (accessed 14 July 2006).

Whitten, SM, van Bueren, M and Collins, D 2003, An overview of market-based instruments and environmental policy in Australia, Paper presented at the 6th Annual National AARES Symposium, Canberra, 2–3 September.

——, Khan, S, Collins, D, Robinson, D, Ward, J and Rana, T 2005, *Tradeable recharge credits in Coleambally irrigation area: report — experiences, lessons and findings*, CSIRO and BDA Group.

Wilson, S 2004, *Dryland and urban salinity costs across the Murray–Darling Basin — An overview and guidelines for identifying and valuing the impacts*, Murray–Darling Basin Commission, Canberra.

Woolston, M 2005, ‘Registration of water titles: key issues in developing systems to underpin market development’ in Bennett, J (ed), *The evolution of markets for water*, Edward Elgar Publishing, Cheltenham, UK, pp. 76–93.

Young, M and McColl, J 2003, *Robust reform: implementing robust institutional arrangements to achieve efficient water use in Australia*, Folio no. S/03/1258, CSIRO Land and Water.

——, MacDonald, DH, Stringer, R and Bjornlund, B 2000, *Interstate water trading: a two year review*, CSIRO Land and Water, Adelaide.

Young, W (ed.) 2001, *Rivers as ecological systems*, Murray–Darling Basin Commission, Canberra.

——, Dyer, F and Thoms, M 2001, ‘An index of river hydrology change for use in assessing river condition’, in Rutherford, I, Sheldon, F, Brierley, G and Kenyon, C (eds), *The value of healthy streams*, Proceedings of the third Australian ‘Stream Management Conference’, vol. 2, Cooperative Research Centre for Catchment Hydrology, Melbourne, pp. 695–700.