Australian Government
Productivity Commission

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

Productivity Commission Discussion Draft

This is a draft prepared for further public consultation and input.

The Commission will finalise its report to the Government after these processes have taken place.

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**Publications Inquiries:**
Media and Publications
Productivity Commission
Locked Bag 2 Collins Street East
Melbourne VIC 8003
Australia

Tel: + 61 3 9653 2244
Fax: + 61 3 9653 2303
Email: maps@pc.gov.au

**General Inquiries:**
Tel: + 61 3 9653 2100 or + 61 2 6240 3200

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***The Productivity Commission***

The Productivity Commission, an independent agency, is the Australian Government's principal review and advisory body on microeconomic policy and regulation. It conducts public inquiries and research into a broad range of economic and social issues affecting the welfare of Australians.

The Commission's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by consideration for the wellbeing of the community as a whole.

Information on the Productivity Commission, its publications and its current work program can be found on the World Wide Web at www.pc.gov.au or by contacting Media and Publications on + 61 3 9653 2244.

# Opportunity for further comment

You are invited to examine this discussion draft and to provide written comments to the Productivity Commission. This will assist the Commission in preparing its final report.

Submissions should reach the Commission by Wednesday, 5 July 2006. If possible, please provide a copy of your comments by email or on a computer disk. Further details about how to make a submission are available on the Commission's website for this study, which is provided below. After comments have been received and a Roundtable held to canvass the views of invited key participants, a final report will be prepared and submitted to the Australian Government by 11 August 2006.

**CONTACTS**


| | | |
|---|---|---|
| Administrative matters: | Vicki Thompson | Ph: (03) 9653 2214 |
| Other matters: | Deborah Peterson | Ph: (03) 9653 2284 |
| Facsimile: | | (03) 9653 2305 |
| Email address: | | waterstudy@pc.gov.au |
| Website: | | www.pc.gov.au/study/waterstudy/index.html |
| Australian freecall number for regional areas: | | 1800 020 083 |
| Australian telephone typewriter: | | 1800 803 344 |
| Postal address for submissions: | | Rural Water Study<br>Productivity Commission<br>LB2 Collins Street East<br>MELBOURNE VIC 8003 |

# 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]

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# Abbreviations and explanations

## Abbreviations

| | |
|---|---|
| ABARE | Australian Bureau of Agricultural and Resource Economics |
| ABS | Australian Bureau of Statistics |
| ACCC | Australian Competition and Consumer Commission |
| ATO | Australian Tax Office |
| COAG | Council of Australian Governments |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| EC | Electrical conductivity (a measure of salinity) |
| 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 |
| MIS | Managed Investment Schemes |
| ML | Megalitre |
| NWI | Intergovernmental Agreement on a National Water Initiative |

## Explanations

| | |
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| 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. |

# Glossary

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| Allocation | The act of providing a water right to a water user or a use, or the act of modifying the volumetric entitlement of a water right. Allocations can be undertaken administratively (by planning body) or through the purchase in a market for water rights. |
| Assignment | The act of determining at the beginning of each water year or season the volume of water available to a water user. Assignments are determined in accordance with water right and other legislative and regulatory provisions. Sometimes referred to as seasonal allocations, water allocations, water determinations and seasonal assignments. |
| Carryover provisions | Provisions that determine whether, or how much, an entitlement holder can carry over unused allocations in the current season for use in the next season. |
| 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. |
| Conveyancy losses | Water evaporation and seepage from surface water sources and man-made water transportation facilities, such as irrigation channels. |
| Covenant | A condition placed on the sale of an asset, such as restricting certain types of land use. |
| Delivery capacity share | A separate entitlement for water delivery infrastructure which is tradeable and allows the holder to use delivery capacity between the dam and the farm gate. |
| 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 used by the Murray–Darling Basin Commission is microSiemens per centimetre at $25^{o}$C. |

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| Economic water-use efficiency | *Overall* economic efficiency is about ensuring individuals maximise their utility, given all resources (including, but not limited to water) available in the economy. An activity is economically efficient if there is no other use where the resources would yield a higher value or net benefit. |
| Entitlement | A prescribed, defined right to an amount of water — sometimes known as permanent water. |
| Environmental allocations | Water allocated for the specific use of the environment. They may be defined in volumetric terms or as a share of the available resource. Allocations may possess their own legal title and be transferable. |
| Environmental manager | An agency with overall management 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 rates | A number used to convert an entitlement to reflect the characteristics of the destination site to which the entitlement is traded. Can also be used to factor for transmission losses. |
| Exit fees | A charge (often per megalitre) imposed on the trade of a water entitlement out of an irrigation district. |
| Externalities | Externalities are the side-effects, or spillovers, of an activity that an individual or business has not taken into account and that affect another party's wellbeing, either positively or negatively. |
| Extraction | The withdrawal of water from surface water and groundwater sources. |
| Extractive uses | Uses of water that requires its removal from the source. |
| Gigalitres | Equal to 1000 megalitres. |

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| Gross entitlements | Entitlements defined in terms of the volume that is delivered to the farm gate (with no recognition of return flows). |
| Groundwater | Underground water that is held in the soil and in pervious rocks. |
| Groundwater recharge | The movement of water from the surface and into a body of groundwater via percolation through the soil. |
| In-stream use | Water is left *in situ* and the volume of water is largely unaffected by use. Examples of in-stream uses include fishing, recreational purposes and the protection of the environment. |
| Intertemporal | Intertemporal decision making involves the allocation of resources across time. |
| 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. |
| Megalitre | Equal to 1000 cubic metres or one million litres. |
| Murray–Darling Basin Cap | The water cap established by the Murray–Darling Basin Commission to regulate the volume of water diverted from rivers within the basin, in order to protect and enhance the riverine environment. |
| 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, such as that caused by rainfall or snowmelt moving over and through the ground, picking up and carrying away natural and human-made pollutants and finally depositing them into water sources. |

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| Nutrients | Chemical elements essential to plant and animal nutrition. Nitrogen and phosphorus are the two most common and the major components of fertilisers. In low concentrations they benefit plant and animal growth but in high concentrations they become pollutants. |
| Opportunity cost | The forgone benefits from the next best alternative use of a resource. |
| Option 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 the volume of water taken from a source has reached a level that significant environmental damage occurs and future supplies to users are jeopardised. |
| 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. |
| Permanent trade | Trade in water entitlements involves transferring the ongoing right to access water for the term of the right. |
| 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. |
| Recharge rate | The rate at which water enters an aquifer or artesian basin. |
| 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 | Water returned to its original source after its extraction and use. Where they still occur, return flows are from irrigation uses which re-enter the stream via surface run-off or ground water recharge. |

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| River capacity | Maximum amount of water that can pass through a river channel (or part thereof) over a specified period of time. |
| Salinity | The presence of salt in streams or the landscape. |
| Seasonal allocation | A volume of water that an irrigator is allowed to access in a particular season — sometimes known as temporary water. |
| Self-extracted water | Self-extracted water is defined for the purposes of the ABS Water Accounts as water extracted directly from the environment by end users, and includes water from rivers, lakes, farm dams, groundwater and other water bodies. |
| Storage capacity share | Defines entitlements in terms of a share of dam capacity (not 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 and overland flooding. |
| Tagging | A registry system which allows traded entitlements to 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 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. |
| 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 allocating rural water to higher value uses. But institutional arrangements for water need more reform to further improve rural water-use efficiency and address water-related environmental externalities.
- There are opportunities to improve entitlement and allocation regimes. Three priorities are: unbundling water entitlements and water use approvals; addressing linkages between ground and surface water, water use and return flows; and facilitating efficient intertemporal water-use decisions.
- A number of impediments to water trade reduce economic efficiency and should be removed. In particular, governments should:
  - allow other participants to trade in water markets
  - open up interdistrict water entitlement trade
  - remove exit fees
  - improve the transparency of trading rules
  - benchmark approval processes.
- Careful specification of environmental objectives is required. Some tradeoffs are inevitable, and mixes of policy instruments may be necessary. Environmental goals should be underpinned by assessment of the costs and benefits of action, and monitoring of the outcomes achieved.
- 'Saving' water via major infrastructure works to achieve environmental objectives is often costly compared with other options and may not increase water available for the environment.
- Environmental managers and service providers should be able to enter water markets and develop portfolios of water and water-related products.
- The Living Murray Initiative could be implemented more effectively if existing water sourcing arrangements, including the purchase of permanent water entitlements, are supplemented with additional market mechanisms (such as trading allocations, leases and options contracts).
- A variety of market mechanisms could combat the emergence of salt, but they would need to be targeted appropriately to location and scale. Cap and trading schemes seem most suited in a catchment and/or basin context, whereas offset, tender and related market mechanisms seem more appropriate at an individual property level. It may also be possible to establish markets to flush salt out of basins.
- It is difficult to devise efficient and effective taxes on rural water use to address environmental externalities.

# Overview

Markets are already making a significant contribution to allocating rural water to higher value uses. But there is considerable scope to improve performance — and for this to happen, further reform of institutional arrangements is necessary.

This study examines the feasibility of establishing market mechanisms to encourage economic efficiency of rural water-use, including managing environmental externalities (box 1). 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.

Box 1 **Terms of reference**

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 set out objectives, outcomes and actions to support progress on national water reform. A key element for progressing national water reform related 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 2004, clause 23(v))

The Australian Government, with the support of the state and territory governments, has asked the Productivity Commission to support jurisdictions in achieving the water markets and trading outcomes and actions under the NWI. The terms of reference require the Commission to assess and report on the feasibility of establishing workable market mechanisms:

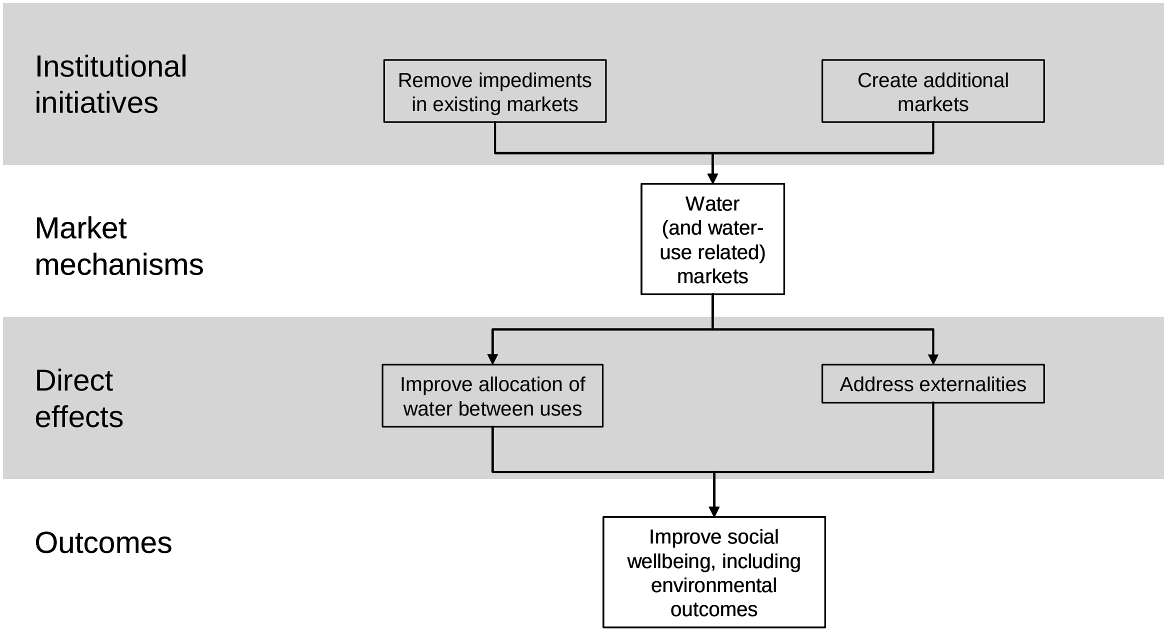
- to provide practical incentives for investment in rural water use efficiency and water-related farm management strategies and
- for dealing with environmental externalities related to rural water management.

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 water and water-related markets.

These key actions to enhance water-use efficiency are shown in figure 1 and are further elaborated in table 1.

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




## Entitlement and allocation regimes could be improved

Separating water entitlements from land titles (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 this initiative should do so as a priority. Further simplifying water entitlements by reducing unwarranted differences in entitlement specifications may decrease the complexity involved in trading entitlements. 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 run-off). Further gains, therefore, while worth pursuing, may be less than what is first apparent because of the diversity of prevailing circumstances.

PRELIMINARY FINDING

*Unbundling water entitlements from water use approvals should be completed by all states as a matter of priority. There may be further opportunities to simplify the specification, and reduce the number of types, of water entitlements.*

## Table 1 **The way forward**

| *Existing arrangements* | *The way forward* | *Desired outcomes* |
| --- | --- | --- |
| | *Improve entitlement and allocation regimes* | |
| • Entitlements to water can be overly complex, uncertain, and linked to use approvals | • Unbundle entitlements and water use approvals and simplify where feasible<br>• Introduce low cost and secure titling systems and transparent risk-sharing arrangements<br>• Unbundle into tradeable water entitlements and delivery shares where appropriate | • Lower cost and more timely water trade<br>• Secure, mortgageable entitlements<br>• Better management of congestion |
| • Ground and surface water management systems are poorly integrated and return flows inadequately managed | • Further research on water systems<br>• Recognise connectivity between groundwater and surface water<br>• Better accounting for return flows<br>• Progress water accounting reform | • More efficient ground and surface water use<br>• Improved river flows |
| • Farmers' intertemporal water-use choices are limited in some regions | • Expand carryover provisions<br>• 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 | • Allow other participants to trade<br>• Open up interdistrict entitlement trade<br>• Remove exit fees<br>• Review other regulatory restrictions<br>• Improve transparency of trade rules<br>• 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<br>• Focus on infrastructure investment to gain additional environmental flows | • Enable environmental managers and service providers (EMSPs) to participate in water markets<br>• Develop markets for river capacity<br>• Allow EMSPs to develop portfolios of water and related products<br>– Entitlements and seasonal allocations<br>– Derivative products such as leases, options and contracts<br>– River capacity shares | • Water can be sourced immediately for environmental purposes<br>• Improved allocation between alternative uses<br>• Improved transparency of environmental management costs<br>• More cost-effective measures to achieve river flow objectives |
| | *Markets to improve irrigation salinity* | |
| • Salinity objectives pursued mainly through regulatory measures<br>• Reliance on expensive salt interception works<br>• Limited use of salt trade measures at a catchment level | • Develop market mechanisms for addressing irrigation salinity where benefits exceed costs<br>– Cap and trade is a flexible approach at catchment and basin levels<br>– Offset schemes can be effective at farm level<br>– Market approaches to flushing salt into sea in winter months merit investigation | • More efficient and effective control of irrigation salinity |

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

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

However, separating delivery entitlements is not without costs. In districts where river or channel capacity constraints are not substantial, or where congestion costs across irrigators are largely similar, these costs may outweigh the benefits. Alternative mechanisms to manage congestion should be compared with solutions involving the creation and use of property rights. Decisions on the use of congestion management tools are likely to be best made at the district level.

PRELIMINARY 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.*

Groundwater and surface water are closely connected in many areas. Evans (2004), for example, estimated that on average, for the Murray–Darling Basin, each 100 megalitres of groundwater extracted would reduce surface water by 60 megalitres. A major limitation to efficient water use is the lack of integration of ground and surface water systems in resource management policies. This reflects limited information on groundwater systems and their relationship to surface water, and the incomplete nature of water accounting systems. The lack of integration creates perverse incentives for water users, diminishes the effectiveness of water resource management and has resulted in water (where it is sourced from interconnected surface and groundwater systems) being overallocated in many areas across Australia.

PRELIMINARY 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 may reduce or counteract the benefits achieved in other areas of reform, including water trade. Undertaking further research on groundwater systems and their connectivity to surface water, and developing effective water accounting systems, are essential to address this issue.*

PRELIMINARY FINDING

*Excluding groundwater extractions from the Murray–Darling Basin Cap significantly reduces its effectiveness in managing the health of the Murray–Darling river system.*

In many irrigation districts, existing entitlements and allocations 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. Land use change and improvements in physical water-use efficiency on-farm can substantially reduce these return flows, with potentially adverse consequences for downstream water users and the environment. For example, studies have found that increasing irrigation efficiency from 80 to 90 per cent in the Riverland of South Australia, can reduce groundwater inflows to the Murray River by about 22 per cent.

A net approach to specifying water entitlements adjusts entitlements to account for changes in return flows and could enhance the economic efficiency of water use. Further advances in knowledge about return flows, however, will be necessary for this to occur on a comprehensive basis. Nevertheless, the partial application of net approaches may be practical in some areas. In the absence of comprehensive or partial net entitlement approaches, various market-based or regulatory approaches need to be considered to manage potential adverse consequences from changes in return flows.

PRELIMINARY FINDING

*Return flows need to be accounted for in entitlement specifications and/or resource management policies. Adaptive management and the use of interim measures in high priority areas may be necessary.*

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

The main advantages of entitlement holders being able to carry over water include more efficient water-use choices across irrigation seasons and the ability to better 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 extra 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.

PRELIMINARY FINDING

*Governments and utilities should enable entitlement holders to carry over water individually, with adjustment to allow for storage and evaporation losses. Appropriate charging for storage management and allocation structures will be required to address third party impacts.*

PRELIMINARY 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.*

PRELIMINARY FINDING

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

Storage capacity sharing, which provides entitlement holders with a specific 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 for its customers 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 without the need for prescriptive carryover rules or blanket prohibitions. If water becomes more valuable, the benefits from the extra management flexibility associated with capacity share arrangements are likely to increase for many water users. Set-up and transitional costs are unlikely to be small, however, and need to be weighed against expected benefits before changing systems.

PRELIMINARY FINDING

*For many storage systems, storage capacity share arrangements offer entitlement holders greater management over 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.*

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.

PRELIMINARY 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.*

Comprehensive and credible risk sharing arrangements for managing long term changes in water availability and low cost and secure titling arrangements, are also important goals to avoid unnecessary uncertainty and help facilitate trade.

## Reduce or remove constraints to trade

Through 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. The potential for water trade is diminished by non-regulatory and regulatory constraints. Non-regulatory constraints include hydrological limits, transaction costs, limited market information regarding available opportunities, and community attitudes towards water leaving their district — these factors are often difficult to avoid and must be accommodated by markets and policy makers. Key regulatory constraints to water trade are those limiting or prohibiting trade either between certain parties or between certain areas.

Trade in seasonal allocations and water entitlements is currently confined mainly to irrigators. Prohibiting some potential water users (such as environmental managers, environmental associations, urban water users, and mining and power generation industries) from the market prevents the price of water from revealing the value of alternative water uses, and restricts the benefits the community as a whole can gain from the use of rural water.

PRELIMINARY FINDING

*Relaxing restrictions on who can participate in water trade would improve the economically efficient use of rural water.*

## Constraints to trading 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 are a number of regulatory and administrative constraints to trade in seasonal allocations, and the rationale for their existence is not always transparent. Such constraints can include trading rules and government fees and processes. Trading rules include different closing dates for water transfers between districts and intention to sell requirements.

While some of these arrangements address hydrological conditions or environmental concerns relating to water trade, other policy approaches may be more effective and transparent. Restrictions should be transparently reviewed for their community-wide benefits and costs, and removed if not justified or replaced if better alternatives exist. Some jurisdictions could streamline approval processes for trade in seasonal allocations and develop benchmarks for acceptable approval times and costs. Government funded water exchanges should operate on a cost recovery basis consistent with principles of competitive neutrality.

PRELIMINARY FINDING

*Remaining restrictions on trade in seasonal allocations should be transparently reviewed and removed where unjustified. Timetables for review should be transparent, and progress and findings publicly reported.*

PRELIMINARY FINDING

*Existing government funded water exchanges should operate on a cost recovery basis consistent with the principles of competitive neutrality.*

PRELIMINARY FINDING

*Approval processes and associated costs involved in trading seasonal allocations should be benchmarked to best practice. Independent performance reviews should be conducted periodically.*

## Constraints to trading in water entitlements

A wider range of restrictions apply to trading water entitlements than seasonal allocations, with restrictions greater for trade between irrigation districts than within districts. A major regulatory constraint to trade in water entitlements is the limit on annual water trade out of a district. These restrictions appear to be aimed predominantly at preventing too few irrigators having to cover the fixed costs of a district's infrastructure. 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 irrigation authorities have done and others are considering. Central Irrigation Trust, for example, has imposed exit fees of $360 per megalitre for trades of high security water out of their 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 be a significant constraint to trade.

Exit fees are distortionary — they increase entitlement prices in importing regions, reduce entitlement prices 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.

Delays in governments agreeing and implementing an appropriate arrangement for trading water entitlements across states and districts has constrained interstate trade in water entitlements to areas included in the Pilot Interstate Water Trading Project. In May 2006, New South Wales, Victoria and South Australia agreed in principle to facilitate expanded interstate trade in water entitlements using a tagging approach which incorporates exchange rates to account for transmission losses. Tagging allows a water entitlement to retain the reliability characteristics of its place of origin when it is traded. Jurisdictions should continue to progress arrangements to implement this reform as a matter of priority.

In most jurisdictions, the costs of transferring entitlements to a new owner are unlikely to be large enough to significantly constrain trade. 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.

PRELIMINARY FINDING

*Exit fees and other unjustified limits on trade out of an irrigation district constrain trade in entitlements, impede adjustment and should be removed.*

PRELIMINARY FINDING

*Approval processes and associated costs involved in trading water entitlements should be benchmarked to best practice. Performance reviews should be conducted periodically.*

Trade in groundwater is both more limited and subject to more regulatory restrictions than trade in surface water. In many cases, restrictions on trade in groundwater reflect uncertainties over the extent of the resource, connectivity with surface water and potential third party impacts, including environmental effects. The physical trade of groundwater is limited by infrastructure access, while trade in groundwater entitlements is often limited by concerns over third party effects (such as impacts on neighbours' bores). Many aquifers are already overallocated and, if not carefully managed, trade could lead to the activation of unused licences and further exacerbate the impacts on river flows and other irrigators. To move ahead, sensible integrated surface water and groundwater caps would need to be established and the issue of unactivated licences addressed.

## Implications of freeing up water trade

Freeing up trade in seasonal allocations and water entitlements, and derivatives of these 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 can also assist with farm adjustment processes by expanding choices for improving or changing farm enterprises, or exiting the industry.

Under current arrangements, a significant 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. Derivative products for water that can be close substitutes for water entitlements (for example, leasing and forward contracts) are also emerging. Nevertheless, freer 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.

PRELIMINARY FINDING

*Constraints to 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. Constraints to trade in water entitlements should be removed to build on these gains.*

## 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 on 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. However, there may be opportunities for governments to improve publicly beneficial information on climate, soils, water flows/connectivity, and other biophysical characteristics common across properties, where private sector responses are inadequate.

PRELIMINARY 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.*

Signatories to the NWI have made commitments to move towards 'full cost recovery pricing' as a way to address concerns about rural water utility charges. With well developed water markets, however, charges paid by irrigators will have little impact on their water-use decisions in the short run if utility charges are below market prices for water. These decisions are guided by market prices for water, rather than utility charges.

The incentives faced by rural water utilities also have important effects on efficient rural water use. Under current arrangements, some utilities (for example, in Queensland and Victoria), face restrictions in selling water they 'save' as a result of infrastructure or other investments. This may prevent investments being undertaken that would have earned a positive return (given the market price of water). It is also important that water utilities not over-invest in water-saving projects and that all options for improving water-use efficiency are considered.

PRELIMINARY 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.*

The Australian Government and state and territory governments have various programs that offer subsidies to increase the physical efficiency of water use. It is important that policies which are 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 cost–benefit calculations in technology adoption decisions or choice of products. On this basis, subsidies that seek to improve the uptake of technologies, purely to increase the productivity of water use, are likely to be inefficient. Subsidies may, however, increase economic efficiency if they provide net public benefits such as through 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. Subsidies to support research and development activities may also offer net community-wide benefits.

PRELIMINARY FINDING

*Government subsidies to encourage the use of specific irrigation technologies need to be carefully designed and targeted to be capable of yielding net public benefits. If this approach is not adopted, they are unlikely to improve the economically efficient use of rural water.*

## 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 of a decision by an individual or business that affect another party's wellbeing. 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.

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 relationship between them, will determine the appropriate response to an environmental externality. Many of the environmental externalities associated with irrigation water supply and use are complex and the links between causes 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. Sometimes parties involved in environmental externalities may be able to negotiate to achieve an efficient outcome. If that is not possible, there may be a case for government intervention, provided the benefits of the action are expected to outweigh the community-wide costs.

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.

## Markets can help address 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

Although planning processes are integral to the efficient allocation of water between environmental and non-environmental uses, an over-reliance on such processes can crowd out more efficient and effective 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.

PRELIMINARY FINDING

*Planning processes aid the efficient allocation of water between environmental and non-environmental uses. However, an over-reliance on them can crowd out more efficient and effective market mechanisms.*

Governments have invested in infrastructure projects to source water for environmental purposes, particularly in south-east Australia. 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 removed from return flows or accessions to groundwater are being used for other purposes.

PRELIMINARY 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

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 investigate the potential to develop new water products, such as options contracts. Different water products will have different strengths and weaknesses. Holding entitlements, for example, will provide ongoing access to water and are therefore useful for providing base flows that are relatively stable from year to year. However, holding entitlements is unlikely to match variable environmental needs from year to year. Environmental managers and service providers would benefit from selecting a portfolio, according to their various priorities, from a diverse set of water products.

PRELIMINARY FINDING

*A portfolio of water products will be required to deliver increases in environmental flows in a timely and cost-effective manner.*

The Intergovernmental Agreement on Addressing Over-allocation 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. Not being able to buy seasonal allocations, for example, reduces environmental managers' flexibility to match water availability with environmental needs.

PRELIMINARY FINDING

*Environmental objectives of the Living Murray Initiative can be more effectively addressed through a range of water products.*

## Markets need to be supported by broad reforms

Progress in broader water reforms will be required if efforts to source water through market mechanisms or other means are not to be undermined by limitations in existing property rights arrangements. The most significant factors that may erode longer-term availability of water for environmental and other purposes are climate change, farm dams, groundwater extraction, bushfires, afforestation, and changes to irrigation water management. If these factors are not addressed, and they have their expected effects, they will substantially reduce stream flow in the Murray–Darling Basin, thereby counteracting efforts to source water for the river systems.

PRELIMINARY FINDING

*A number of factors have the potential to significantly affect the quality and availability of water from rivers in the Murray-Darling Basin in the longer term. If not addressed, they will substantially reduce stream flow in the Murray-Darling Basin, thereby counteracting efforts to source water for the river systems.*

## Markets can address flow objectives flexibly and cost effectively

A variety of market mechanisms could play a role in addressing river flow objectives. A summary assessment is provided in table 2. In particular situations, most of these measures may be able to contribute effectively to environmental objectives. Market mechanisms can be a flexible and cost effective way of addressing externalities associated with altered river flows, 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.

PRELIMINARY 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 1 **Market mechanisms for environmental flow objectives**

| *Criterion* | *Implementation costs* | *Feasibility* | *Flexibility* | *Likelihood of achieving desired goals* |
|---|---|---|---|---|
| Trade in entitlements | H | M-H | L | L-M |
| Trade in allocations | L-M | M-H | H | H |
| Leases for entitlements | L-M | H | M-H | M-H |
| Options contracts for 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-H | 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.

PRELIMINARY FINDING

*Creating new, tradeable rights to river capacity may be required to help reduce river heights or reduce unseasonal flooding.*

Volumetric taxes on water use have been suggested as a possible mechanism to address environmental externalities attributable to irrigation 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 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. Even where a clear relationship can be established, for the tax to reduce overall water use, its rate must exceed the scarcity rents generated by restrictions on water allocations. Such a tax may be effective but inefficient: it may reduce water use by more than is justified on grounds of externalities.

PRELIMINARY FINDING

*Arriving at the correct rate for a volumetric tax is not easy. If set too low, the tax may be ineffective and not reduce the externalities associated with water use, in the short run. If effective on water use, the tax may be higher than is justified on externality grounds. 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, including saline 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.

Irrigation is only one source of human-induced river and groundwater salinity in Australia. Dryland salinity is a major contributor to river and groundwater salinity, particularly in south-west Western Australia and parts of the Murray–Darling Basin. Salt is a more significant problem in the Murray–Darling Basin than in many other catchments — 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 water tables and reduced flood events that move salt from flood plains to rivers.

PRELIMINARY 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. It is important to consider the potential for mechanisms to have conflicting objectives or be counter to other environmental management objectives. In some cases, salinity management objectives may conflict with objectives or approaches in other areas of water and land management.

## Four ways to manage salinity

There are four broad approaches to managing salinity:

- take actions to prevent salinity from occurring
- prevent saline groundwater from entering rivers
- adapt to the effects
- dispose of the salt when economic costs are likely to be low.

Salinity management in Australia has focused on the first three approaches. Broad 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. In the Murray–Darling Basin, large-scale salinity interception schemes pump saline groundwater to evaporative ponds. 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. Salt interception also reduces river flows, and the intercepted water is not included under the Murray–Darling Basin Cap. It is important that appropriate benefit–cost assessments of proposed salt interception works are undertaken.

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 is prohibited into the high impact zone and levies are applied to trade to four low (but progressively higher) impact zones. The levies vary according to source and destination of trade, with higher levies applied to higher impact trades. Resulting revenues are used to fund salt interception schemes. However, the levies do not encourage the removal of salt from the higher impact zones. Some incentives to encourage removal of salt may be required.

Within individual irrigation districts there are a variety of arrangements 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.

If close to a river, preventing groundwater recharge has relatively immediate salinity effects. When recharge occurs further away from the river, it can take years (sometimes hundreds of years) for instream salinity to be affected. Consequently, reducing groundwater recharge is generally a longer-term strategy to address river salinity.

PRELIMINARY FINDING

*Salt interception works can immediately 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.*

PRELIMINARY FINDING

*Salinity zoning schemes provide incentives to affect landholders' water purchasing decisions. Incentives may be needed to encourage the removal of salt.*

PRELIMINARY FINDING

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

Currently there are no incentive arrangements to remove salt from the Murray–Darling Basin. Given that the costs of in-stream salinity in the Murray–Darling Basin are generally lower during the winter months between irrigation seasons, it may be possible to transport 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 offset 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.

PRELIMINARY 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 3. 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 1 **Market mechanisms for salinity**

| *Criterion* | *Costs* | *Feasibility* | *Flexibility* | *Likelihood of achieving desired goals* |
|---|---|---|---|---|
| Cap and trade of salt at the catchment level | M | H | 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 |

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 measurement methods could be used to represent the discharge or creation of salt, including prescribed on-farm 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.

PRELIMINARY FINDING

*Capping and trading salt is feasible at the catchment 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.

PRELIMINARY FINDING

*Capping and trading 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.

PRELIMINARY FINDING

*Offsets for groundwater recharge have been successfully implemented to address localised salinity problems.*

The 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.

PRELIMINARY FINDING

*Zoned salt levies penalise actions that exacerbate salinity, but could be complemented by rewards to 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. Upstream landholders could tender for incentive payments that are funded, for example, by irrigators who benefit from lower net salinity in the water entering their irrigation region and/or by the public who benefit from improved environmental outcomes.

PRELIMINARY FINDING

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

In the Murray–Darling Basin, salinity targets are set by reference to the maximum concentration at different points in the system. The key river salinity target is 800 EC (the World Health Organization's recommended water drinking quality standards), 95 per cent of the time at Morgan in South Australia. Using the river to facilitate removal of salt from the basin could contravene this standard and the effect on urban water supplies would have to be carefully managed. Where alternative urban water sources or storages are available, some flexibility of the target could enable rapid flushing of salt from the basin during the winter/spring or periodic high flow events.

Markets mechanisms could be established to aid the removal of saline flows — purchasing additional flows may be required. Dilution flows would 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.

PRELIMINARY FINDING

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

PRELIMINARY 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 choice.

PRELIMINARY FINDING

*Regulations may be appropriate to manage salinity in the short run, where immediate changes are required.*

## 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 would respond to clearly defined environmental objectives and develop strategies to address tradeoffs between conflicting objectives. In pursuing their environmental objectives they would likely engage in water trading. They could also coordinate and manage environmental service providers.

There are a number of practical issues that need to be considered in establishing environmental managers, including the level of operation (for example, catchment, basin or broader level), institutional structure (for example, trust, private corporation, independent public corporation or government agency), and the level of public funding. Further work is needed on the advantages and disadvantages of different institutional models for environmental managers.

# 1 Introduction

In 1994, the Council of Australian Governments (COAG) agreed to a water reform framework to improve the management of Australia's water resources. Since then, this issue 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. 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. Markets in groundwater, and in partially regulated and unregulated systems, are much less developed. 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.

## 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.

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 is 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 (appendix C). 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. More commonly, an activity is said to be economically inefficient if its costs exceed its benefits, or if it can be shown that the resources could be used to produce something with a higher 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. 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.

## 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.

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 ground 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 supply authorities and 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 5).

### 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, and considered ways of reducing or removing, several potential constraints on efficient water markets. 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 2)
- removing remaining unnecessary constraints applying to trading in water allocations and entitlements (chapter 3)
- 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 4).

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. Externalities are the side effects, or spillovers, of an activity that an individual or business has not taken into account and that affect another party’s wellbeing, either positively or negatively. 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. 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. Moreover, 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 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 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, and salinity (chapters 6 and 7).

With a focus on workability, some practical criteria were developed for assessing market mechanisms to manage environmental externalities associated with altered river flows and salinity (chapter 5). 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 service providers, 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. A total of 56 submissions were received, and appendix A lists those who participated in discussions and those who made submissions. A report on transaction costs in water markets and environmental policy instruments was commissioned and can be accessed on the above website.

The Commission thanks all participants for their contributions. Interested parties are invited to comment on this discussion draft by 5 July 2006.

## 1.5 Report structure

Options to improve water entitlement and allocation regimes are discussed in chapter 2, and ways to reduce or remove constraints on water trading are considered in chapter 3. Chapter 4 discusses other factors affecting farmers' decisions on water use and trade. Chapter 5 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 6 and 7 respectively.

# 2 Improving existing entitlement and allocation regimes

**Key points**

- Despite recent reforms, further opportunities remain to improve entitlement and allocation regimes, particularly:
  - unbundling water entitlements and water use approvals
  - ensuring water entitlement arrangements appropriately reflect the nature of water resources (particularly the interconnectivity between groundwater, surface water and return flows)
  - facilitating efficient intertemporal water use.
- While some reforms can involve substantial change, there are opportunities for the progressive implementation of reforms. Actions that lay the foundations for future change, such as improving water accounting, should be given appropriate priority.
- In particular, the Commission suggests governments and rural water utilities:
  - continue to simplify and unbundle entitlements where there are likely to be net benefits — this should include separating water entitlements and 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
  - improve information on groundwater, surface water and return flows, water accounting systems, and the integration of this information into policy frameworks
  - include groundwater extractions in the Murray–Darling Basin Cap
  - 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
  - develop strategies and progress regulatory systems to improve efficient trading and ease uncertainty over future water entitlements — examples include improving information to irrigators on water availability, and improving registration and titling arrangements.

Efficient and effective entitlement and allocation regimes are fundamental to the 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 allocation regimes have been identified by participants to this study as constraining farmers' ability to make water-related decisions (including trading decisions) that could improve the economically efficient use of water (see, for example, CSIRO, sub. 24; Water for Rivers, sub. 48; CRC for Irrigation Futures, sub. 21; WAFF, 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 allocation regimes. Issues discussed include:

- simplifying water entitlements
- unbundling delivery capacity
- accounting for groundwater, surface water and return flows in resource management policies
- improving intertemporal water-use choices
- risk assignment and security over future levels of entitlements and seasonal allocations (including title arrangements).

## 2.1 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 can be approved more rapidly because the agency approving trades would not need to consider the impacts of using that water. This means, for example, that once an irrigator holds a licence to use water, water can be traded 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.

While significant progress in unbundling of water entitlements and 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. 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

Many of the 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 ‘seasonal allocations’ (Shi 2005). 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 access 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. According to Shi, there is some scope to rationalise trading zones in northern Victoria and the New South Wales River Murray from 24 trading zones to 22, for example.

There also appears to 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 (chapter 3).

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 trade is in seasonal allocations rather than in water entitlements (appendix B).

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 Department of Land, Water and Biodiversity Conservation:

> … 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)

Furthermore, preferred levels of water reliability may be achieved with lower transaction costs with two levels of security for each system rather than one:

> The share entitlement [single security] system of property rights requires more trading of temporary water than will the model based on high-security and low-security entitlements. (Freebairn and Quiggin 2006, p. 18)

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 zones would be expected.

PRELIMINARY FINDING 2.1

*Unbundling water entitlements from water use approvals should be completed by all states as a matter of priority. There may be further opportunities to simplify the specification, and reduce the number of types, of water entitlements.*

## 2.2 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 access entitlements into water shares, delivery shares and a water-use licence through the *Water (Resources Management) Act 2005* (DSE, sub. 39).

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

- providing a mechanism to help manage congestion and ration access to the distribution system
- 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 needing to purchase both water and delivery capacity (hence reducing costs) (chapter 6)
- potentially making delivery charges more transparent, allowing for greater variability in delivery charges, depending on location, perhaps based on zonal charging systems (chapter 4).

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 (chapter 3)). 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, an owner 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 water and delivery capacity (relative to its supply and availability) and trade is limited. Hence, the benefits from unbundling entitlements in those regions would probably not outweigh the costs at present.

ABARE noted in a submission to the Senate Rural and Regional Affairs and Transport References Committee Inquiry into Water Policy Initiatives:

> 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.

PRELIMINARY FINDING 2.2

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

## 2.3 Accounting for groundwater, surface water and return flows

Another area for reform is moving to a more integrated approach to entitlement and water management systems that takes greater account of the entire water system. This could include improving the incorporation of groundwater and surface water links, and accounting for return flows, in policy frameworks and management plans.

### Improving the management of groundwater and surface water linkages

Links between surface water and groundwater systems in Australia are poorly integrated into resource management. This has resulted in some systems being highly over-allocated, and others being managed under considerable uncertainty (Young and McColl 2003b; Evans 2005). Concerns over this lack of integration, and the implications it has 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. (2003b, 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. (2005, p. 1)

The lack of integration of surface water and groundwater systems in the way in which 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. Extracting groundwater in close proximity to a river can sometimes have the same impact as directly diverting from the river, potentially reducing the effectiveness of water management policies that address only surface water or groundwater. The South Australian Department of Water, Land and Biodiversity Conservation stated:

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

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

### *Why is there poor integration?*

There are three main reasons that surface water and groundwater systems may not be well integrated 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.

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)

### *Steps to improve integration*

Moving to an integrated system of surface water and groundwater management is not 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 be taken to improve existing arrangements. Given the impetus for linking the management of surface water and groundwater is stronger in some locations than others — prioritisation is important. Improvements are needed in the area of information, accounting systems and policy frameworks.

#### *Improving 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. 5). 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 the state, 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).

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.

### *Water accounting*

Water resource accounting includes the development of standards — and 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.

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 systems. … The accounting system needs to address:
>
> - return flows
> - interactivity between groundwater and surface water
> - changed land use
> - natural processes of water movement across land, through vegetation, down rivers, through wetlands, into dams, drainage into aquifers, etc. (sub. 34, pp. 2–3)

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' (2003b, 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. (See chapter 6 for a discussion of factors affecting water availability for environmental purposes.)

In recognition of the need to reform the water accounting system, the NWI identified national water accounting as one of its key elements. 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 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.

Although the NWI accounting reforms have not yet been fully implemented (with several commitments not due until 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). The action plan included key principles to underpin the development of a national water accounting framework. For example:

- jurisdictions' approaches to water accounting should be benchmarked against the agreed national water accounting architecture
- a key design objective should be national consistency
- each jurisdiction should use a nationally agreed water data reporting template
- water accounting should be implemented according to the highest priority needs first (NWC and ABS 2005).

Some fundamental requirements of an accounting framework were also developed, including that a framework must be sufficiently robust to meet all users' needs, that understanding the size of water resources using an agreed basis for estimation and forecasting is critical, and that reporting should provide assurance to public and private investors about water resource status and assessment, and be publicly available.

State and territory governments should continue to work together, and with the Australian Government and relevant stakeholders, to progress reform in water accounting so that a comprehensive, compatible, reliable and transparent system can be developed to underpin efficient water-use and environmental water allocation decisions.

### *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)

In the Murray–Darling Basin, reductions to surface water resulting from groundwater extractions range from 10 to 90 per cent of the total amount of groundwater extracted (Evans 2004). This means that for each 100 megalitres of groundwater that is extracted, there is a 10–90 megalitre reduction in available surface water. Evans estimated that, on average, in the Murray–Darling Basin, for every 100 megalitres of groundwater extracted, surface water will be reduced by 60 megalitres. This would amount to an average of 2 per cent of the Murray–Darling Basin Cap being used through groundwater extractions. This proportion is likely to increase because many groundwater management units are currently only partially developed.

Evans 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 [Murray–Darling Basin] '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 re-establish the effectiveness of the Murray–Darling Basin Cap, which has made an important initial contribution in terms of establishing a total quantity of surface water which can be used and traded. Further, the capping of groundwater sources could facilitate greater groundwater trade while minimising third party impacts (chapter 3). However, the implementation of such arrangements would require further research regarding the sustainable yield of particular groundwater sources and greater understanding of their connectivity with surface water sources.

PRELIMINARY FINDING 2.3

*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 may reduce or counteract the benefits achieved in other areas of reform, including water trade. Undertaking further research on groundwater systems and their connectivity to surface water, and developing effective water accounting systems, are essential to address this issue.*

PRELIMINARY FINDING 2.4

*Excluding groundwater extractions from the Murray–Darling Basin Cap significantly reduces its effectiveness in managing the health of the Murray–Darling river system.*

## Accounting for return flows

Another area where more integrated water management could occur is in accounting for return flows in entitlement specifications and/or resource management plans. 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 2003b, 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.

A potential problem with most existing entitlement specifications is that there is little formal consideration of changes in return flows, such as from increasing technical water-use efficiency (through water saving technologies and management practices, appendix C). The impact of increases in physical water-use efficiency on return flows can be significant. For example, it has been estimated that increasing water-use efficiency from 85 to 90 per cent in the Riverland in South Australia would reduce total groundwater inflows to the River Murray by approximately 20 per cent (Australian Water Environments 2003).

Entitlement regimes that incorporate 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 2.1).

Box 2.1 **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 2003b.

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 2003b).

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 technical water-use efficiency. While any savings from reduced evapotranspiration would be retained by an irrigator, savings that would have become return flows would not.
- Moving to a 'net entitlement' approach would introduce substantial changes to existing entitlement regimes. 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 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 that can be used. A form of net approach is also used in California and Colorado in the United States of America (PC 2003).

Where comprehensive or partial net entitlement approaches are not adopted, various market-based or regulatory approaches could be used. An example is to require new developments that impact on return flows (such as new irrigation developments, the building of new dams or forestry plantations) to hold an entitlement equivalent to the amount of return flows reduced as a result of the development. In other words, developers would need to be either granted an entitlement by governments or purchase an entitlement based on the net water taken out of the system (which represents the gross amount stored or applied minus the water that returns to the system). This is often referred to as an ‘offset’ arrangement. The tradability of entitlements would allow the market to determine whether water is more highly valued upstream or downstream. The decision on whether to grant entitlements or require them to be purchased will not impact on efficiency in the long term (assuming low transaction costs and minor differences in environmental outcomes), but will have distributional effects.

The effectiveness of these partial net entitlement or market-based/regulatory approaches (such as offsets) would depend, in part, on reliable information about return flows (so as to calculate appropriate entitlement modifications or offsets). In areas where reduced return flows are unlikely to be a significant problem, implementing such arrangements may not be justified due to the administration and monitoring costs involved. Offset arrangements for new developments also discriminate between existing and new developments and, effectively, ‘grandfathers’ existing entitlements. While auctions may be used as a means of allocating entitlements between current and potential users (upstream and downstream), this would involve a reduction in rights to existing entitlement holders.

Offset arrangements have been incorporated into legislation in Victoria — a farm dam cannot be constructed unless water is purchased that is equal to that which the development will intercept, and this cannot be traded until the dam is no longer used. The Victorian Government (DSE 2004) is also considering new planning, incentive and price-based solutions to help manage the return flow implications of new developments, including undertaking a state-wide assessment to identify where new forestry plantation developments would potentially have a high, medium or low impact on current water availability. A range of policy options is potentially available, including levies, offset schemes and subsidies (these and other policy instruments are discussed in relation to river flows and salinity management in chapters 6 and 7 respectively).

The need for government action regarding land use changes that have the potential to intercept significant volumes of surface water and/or groundwater (now and in the future) was recognised in the NWI (COAG 2004a). 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 the 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, pp. 9–10)

Additional hydrological considerations, such as climate change and forest fires, also need to be considered in either entitlements or resource management plans. The

Murray–Darling Basin Commission is currently undertaking a research project on the 'risks to shared resources' to consider policy responses to these issues. As with other areas of natural resource management, adaptive management is required, with the trialling and reviewing of approaches likely to be beneficial. In priority areas, interim measures may be necessary.

In summary, improving the integration of surface water and groundwater management, and managing for return flows, is an essential task for governments to fulfil. While not a simple or low cost task, useful steps (such as improving information and water accounting systems, and use of partial net entitlement approaches) 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.

PRELIMINARY FINDING 2.5

*Return flows need to be accounted for in entitlement specifications and/or resource management policies. Adaptive management and the use of interim measures in high priority areas may be necessary.*

## 2.4 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 carryover provisions, and the use of storage capacity share arrangements with perpetual carryover and continuous accounting.

### 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 on carryover, 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 (CICL, sub. 4).

Victoria currently has a form of shared 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 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 entitlement holders being able to carryover water include improved intertemporal water choices and the ability to manage 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 Cabinet Office, 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. (CICL, sub. 3, p. 39)

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 water allocations across seasons and the more limited are farmers' options for storing or trading water. The high security nature of water entitlements in Victoria, therefore, reduces the benefits of carryover because there is less fluctuation in allocations across seasons than for general security entitlements. Moreover, supplying higher security entitlements or allowing carryover both have opportunity costs from a water storage perspective (appendix B).

Expanding carryover is not without its costs, and careful planning would be required to manage potential spills from dams and third party effects. 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 carryover.

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

Overall, there are likely to be advantages from governments and utilities allowing entitlement holders to carryover 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).

PRELIMINARY FINDING 2.6

*Governments and utilities should enable entitlement holders to carry over water individually, with adjustment to allow for storage and evaporation losses. Appropriate charging for storage management and allocation structures will be required to address third party impacts.*

*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. CSIRO stated:

> 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.

PRELIMINARY FINDING 2.7

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

PRELIMINARY FINDING 2.8

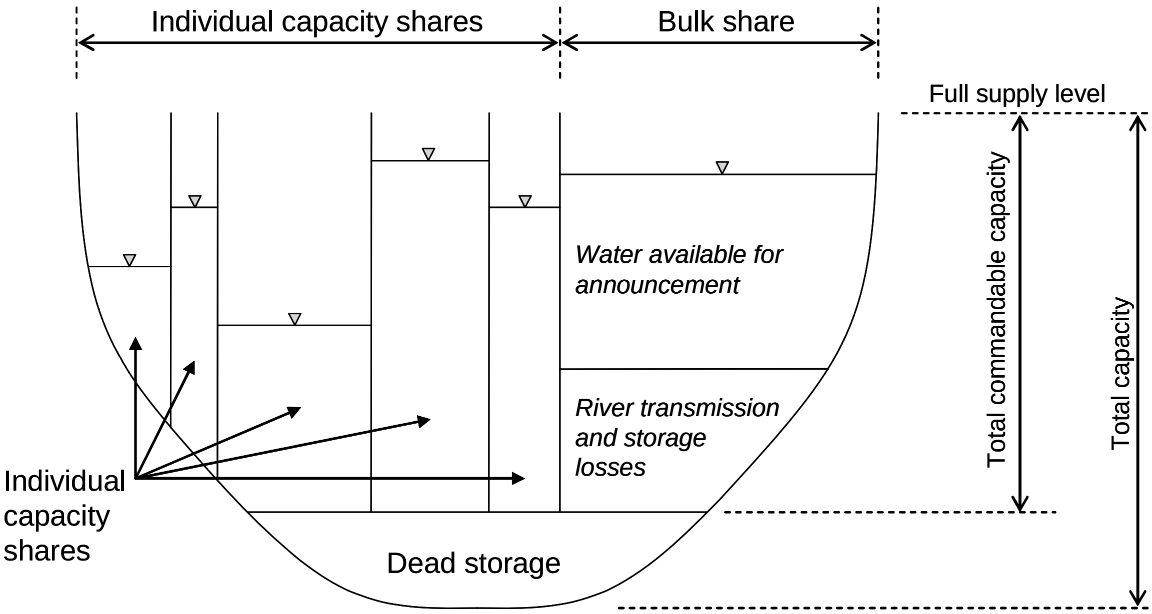
*Trading unused seasonal allocations across districts may improve intertemporal water- use choices where carryover is not available in all districts.*

### 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 2.1). 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 2.1 **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 2.2). Conversion from ‘at the farm gate’ volumes to storage shares are hydologically determined, taking account of transmission losses which depend on water user locations. Carryover is perpetual.

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).

Box 2.2 **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.

*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 hydologically determined and takes account of transmission losses depending on water user locations.
- 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.
  - Water losses in river transmission 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 (1) sufficient water is available in the account, and (2) 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.

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 increasingly 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, when there are significant overland flows and 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). In particular, carryover would be difficult if considerable water in a system came from overland flows which can be hard to store.

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. 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 (chapter 5 and 6). A benefit of this would be that the opportunity cost to other parties 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.

PRELIMINARY FINDING 2.9

*For many storage systems, storage capacity share arrangements offer entitlement holders greater management over 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.*

## 2.5 Risk assignment and security of entitlements

Uncertainty surrounding current and future water entitlements and allocations may adversely influence water use and trade, and investment in irrigation technologies and production activities. Uncertainty over future entitlements can result in hedging behaviour against the contingency of reduced entitlements — for example, irrigators may decide not to sell entitlements or may enter into longer term seasonal allocation contracts. Uncertainty can also cause irrigators to 'take out insurance' at additional expense (by buying entitlements or allocations in excess of what they may otherwise have purchased), and can hinder investment in irrigation technologies and activities. Moreover, undue uncertainty can impede short- and long-term decision making regarding the efficient use of rural water.

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 and allocation arrangements. Australian Dairy Farmers Limited, 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 water entitlements and seasonal allocations.

### Uncertainty regarding water entitlements

Two main sources of uncertainty regarding the value of water entitlements are:

- changes in government policy (sovereign risk)
- reductions in water resources due to climate change and land use change.

Another source of uncertainty relates to the titling system used to register entitlements.

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 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. (2003, p. 8)

Resource declines from climate change or changes in land use can also erode the value of entitlements if the availability and reliability of water declines. In the case of climate change, these changes are likely to be long term, and many irrigators accept bearing and managing these risks. Changes in land use upstream, however, can have substantial and short- to medium-term impacts. Where these impacts are likely to be large, there is a good case for providing or requiring upstream users of water to hold water entitlements (section 2.3). This would add to the security of water available for both upstream and downstream users.

In addition to clearly specifying entitlements, and the rights and obligations they involve, and allowing additional water products to emerge (such as options and leases, appendix B), two tools that may help manage uncertainty regarding water entitlements are:

- transparent risk sharing arrangements
- secure titling systems.

### *Risk sharing arrangements*

A key objective of the NWI is to provide greater certainty for investment decisions, including providing clarity around the assignment of risks associated with future changes in the availability of water for consumptive uses (COAG 2004a, clauses 5, 23). Under the NWI framework, significant risks associated with changes to the availability of water to entitlement holders have been identified and assigned to users or governments (box 2.3).

Some participants argued that governments should compensate entitlement holders if entitlements change due to changes in government policy objectives (for example, to provide more water for the environment or for urban users). The Victorian Farmers Federation commented:

> … compensation is appropriate where changes in inflows result from other causes, for example a reduction in inflows as a result of government policy. (sub. 49, p. 6)

Box 2.3 **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 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.

The Victorian Government White Paper (DSE 2004) noted that changes to the consumptive pool would be made through transparent and consultative processes, with the evaluating of water-related resource health occurring at regular 15-year intervals. Transparent and consultative reviews should provide a degree of certainty to irrigators. The Victorian Farmers Federation (sub. 49), in commenting on the review process, noted that the implementation of any changes to entitlements should consider irrigators' ability to adjust, and provide reasonable notice.

What appears less clear is how risks are managed when they are associated with changes in the availability of water for the 'environmental' pool, such as the risks of reduced return flows to the environment. This issue is discussed in chapter 6.

### *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 and add to uncertainty in entitlement arrangement.

In addition, 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 significantly 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.

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 sub-division 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)

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

> … 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)

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.

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, chapter 3).

Further work is needed to conclude which system would be most appropriate, and an impartial and consultative review of specific options would appear beneficial to explore opportunities for improvements and ease confusion over possible directions. 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 authorities '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). Further:

> 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.

PRELIMINARY FINDING 2.10

*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 specific measures highlighted above, many uncertainty issues will be eased as entitlements are simplified, streamlined, unbundled and re-specified, and credible risk-sharing arrangements are adopted and implemented. Governments have been making headway on these issues.

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.
- 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.
- Encourage water utilities to provide more frequent allocation announcements where cost effective to do so.
- Facilitate, where appropriate, the emergence of risk management tools (such as option contracts).

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).

# 3 Reducing constraints on water trade

**Key points**

- While trade in rural water is extensive in many regions in Australia, regulatory and administrative constraints impede the movement of water to its most highly valued use.
- Constraints on trade, and their impact on economic efficiency, vary considerably across regions and types of water products.
  - Water trade across regions is more constrained than water trade within regions.
  - Trade in seasonal allocations is reasonably unconstrained in most 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, current regulatory restrictions to trade in seasonal allocations and water entitlements
  - remove exit fees and limits on trade out of a district applying to entitlement trades
  - review fees associated with trading seasonal allocations and water entitlements
  - introduce transparent and mandatory timelines and processes for approving water trades
  - improve the transparency of any remaining rules and requirements.
- 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 next best alternative use) and, through mutually beneficial trades, facilitates 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 chapter 2, limitations of current arrangements governing water entitlements and allocations (such as the number and complexity of entitlement types, a lack of integration in water management systems and poor water accounting systems) constrain water trade. Other potential constraints on water trading 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 3.1.

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 governments or irrigation companies. 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 can be categorised as:

- restrictions on who can participate in water markets (section 3.2)
- constraints on trade in seasonal allocations (section 3.3)
- constraints on trade in water entitlements (section 3.4)
- constraints on trade in groundwater (section 3.5).

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 on who can participate in water trade, trade in seasonal allocations is relatively unconstrained. However, it appears that some districts maintain more restrictions to trade in seasonal allocations than others. Trade in water entitlements is 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, p. 11)
- 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.

## 3.1 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 (QDPC, sub. 38, p. 9).

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 benefit–cost 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, 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 3.3, 3.4 and 4.2).

## Market participation

The number of participants and the volumes of water traded in a market are determined by the supply and demand for water. A small number of buyers and sellers in a market may 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; or the inability to transfer water cost-effectively between potential buyers and sellers.

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 (WA 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. Hence, while markets may play little or no role in allocating water in some areas or for some water products, this need not suggest that government action is required.

## Inadequate market information

A lack of information on water trading opportunities and a poor understanding of water markets and associated trading rules may impede trade and the efficient use of rural water. 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. Moreover, there may be a lack of transparency in some water markets. Waterfind, for example, argued:

> 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)

There appears to be scope for improvement in the collection and dissemination of information on opportunities and obligations regarding water trading. One area for improvement relates to establishing a publicly accessible register on which buyers and sellers can list their interests.

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. (2003, p. 13)

Registers could also provide information on historic trade data, trading rules, administrative and regulatory requirements, and other trading possibilities, including leasing, forward contracts and options. Such registers are emerging as the water market matures, and significant gains have been made in recent years. Online trading facilities managed by Waterfind, WaterExchange, Watermove and SunWater, for example, provide some information on current (and sometimes historic) water prices and quantities traded in different areas.

In addition to these developments, 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 (DSE, sub. 39). The Queensland Department of the Premier and Cabinet also noted progress in this area:

> Prices paid for water allocations are publicly available and the sales information can be obtained at NR&M [Queensland Department of Natural Resources and Mines] 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 information gathering 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 registers may emerge and a 'one size fits all' model is unlikely to be appropriate, it is important that registers are compatible.

### Social constraints

Some participants — for example, First Mildura Irrigation Trust (sub. 6), Australian Dairy Farmers (sub. 12) and Brooke (sub. 10) — expressed the view that trading water entitlements, compared with seasonal allocations, 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.

## 3.2 Restrictions on who can participate

A number of restrictions currently prohibit or limit market participation by various water users. Rules vary across jurisdictions and districts, for example:

> Victoria's *Water (Resource Management) Act 2005* limits the volume of water entitlements that can be held by non water users to 10 per cent of the total volume of entitlements in a region. Similarly, Queensland's *Water Act 2000* allows only landholders to hold Interim Water Allocations.
>
> Exclusions are also contained within the charter or constitution of irrigation districts. In some private irrigation districts in NSW only landholders can hold water shares in the irrigation corporation's water entitlement. Although this is soon to be removed from the constitution of Murray Irrigation Limited, similar restrictions may still exist in other districts. (ACCC, sub. 42, pp. 2–3)

Prohibiting potential users — such as environmental managers (entities established to achieve environmental objectives, see chapter 5), environmental associations, urban water users, and mining and power generation industries — from market participation precludes the price of water from revealing the value of alternative water uses, and restricts the benefits that the community as a whole can gain from rural water use.

As observed in other markets, barriers to entry often come at a significant cost to the community because they:

- 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 5), particular industry users or the urban sector. 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). Market participation by environmental managers in particular, would allow a greater range of potentially highly efficient and effective market mechanisms to be used to achieve a range of environmental objectives (chapters 5, 6 and 7). 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 market participant (section 5.3).

Dwyer et al. (2005) examined the benefits of expanding rural water trade in south-east Australia to include urban water users. Regions included in the model were Adelaide, Canberra and Melbourne, and the major irrigation districts in the southern Murray–Darling Basin and Gippsland. The results showed that, for a 10 per cent (154 gigalitres) reduction in urban water availability, losses to gross regional product were reduced by 8 per cent ($184 million) when full urban–rural water trade was allowed. Further, 'net gains are greatest, and the costs to industries and regions are generally more dissipated, when trade is unconstrained' (Dwyer et al. 2005, p. 2). The study concluded that '[a]llowing trade between irrigators and urban users results in gains to both buyers and sellers' (Dwyer et al. 2005, p. 15).

Given urban water authorities are increasingly spending large amounts of money to increase their water supplies (including investment in water desalination and recycling projects), the gains from rural–urban water trade are likely to be large where hydrological connectivity exists or can be achieved at low cost. In terms of feasibility, there are no legal or institutional reasons why trade cannot be expanded. Indeed, in Western Australia there are no restrictions on who can participate in the water market within zones as long as trade is compatible with hydrological and environmental considerations.

Water Services Association Australia stated that the costs of facilitating trade with the capital cities may be relatively low:

> 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. (WSAA, sub. 5, p. 2)

Some irrigators and irrigation authorities still appear opposed to opening water trade to include all water users, particularly environmental service providers and urban users. A common argument against freeing water trade to include all water users is that it would result in substantial increases in water prices, which could threaten the viability of irrigated agriculture in some areas. Certain 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.

However, as the Victorian Government 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)

Also, in many cases, the price effects of allowing freer participation in water markets by the urban sector would be small because irrigation is the dominant water user (appendix B). Watson, for example, stated:

> 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. To think otherwise is to misunderstand (or obfuscate) the simple economics and arithmetic of water use in Australia. (Watson 2005, p. 7)

Dwyer et al. (2005) also found that the price effects of allowing rural and urban sectors to trade water were small in most irrigation districts. For example:

> When regions with relatively low levels of water consumption (such as Adelaide and Canberra) face shortfalls in water availability and trade with regions that use large volumes of water (such as irrigators in the southern Murray–Darling Basin), they have little effect on traded prices and quantities. (Dwyer et al. 2005, p. 2)

Additionally, if environment managers were able to participate in the water market, many purchases, at least for environmental flow objectives, are likely to be countercyclical — 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 minimal for most irrigators.

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 irrigation businesses.

Adjustment issues from freeing up water markets may be significant in some areas, however, and options for managing these (including staggered liberalisation) need to be evaluated in advance of opening the market to all. Governments should consider any adjustment issues in a manner consistent with adjustment policies applying more broadly in the economy. In conclusion, while there may be some adjustment-related issues for governments to manage, the arguments for freeing up participation are strong.

PRELIMINARY FINDING 3.1

*Relaxing restrictions on who can participate in water trade would improve the economically efficient use of rural water.*

## 3.3 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, a number of regulatory and administrative constraints on trade in seasonal allocations remain, 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 related to seasonal allocations are imposed at the state and irrigation district level. While there are very few trade rules associated with trade in seasonal allocations within an irrigation district, trading rules are likely to constrain trade between some districts.

Signatories to the NWI are already in the process of removing a number of restrictions to trade in seasonal allocations. Section 60 of the NWI binds signatories to the 'immediate removal of [existing institutional] barriers to temporary trade' (COAG 2004a, p. 11), though no details are provided on which rules may represent barriers and should be removed.

However, Murrumbidgee Horticulture Council stated that 'trade restrictions continue to hinder the market … 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, converted high security licences 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)

For example, for trade in the Murrumbidgee Valley, separate applications are required for trading of water available before February 28 and water available after February 28 (DNR 2006).

There are as many as 8000 rules associated with seasonal allocation and water entitlement trades occurring in the areas serviced by Waterfind, and up to 30 000 rules nationally (Waterfind, pers. comm., 28 April 2006). 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. 5)

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 6). The South Australian Department of Water, Land and Biodiversity Conservation 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 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. Other rules are also imposed for environmental or hydrological purposes, such as rules to manage trade through specific congestion points or for 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 seasonal conditions such as extended drought conditions:

> 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 6 and 7).

*Closing dates and intention to sell requirements*

Other restrictions 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).
- Some restrictions on trading allocations between states are enforced to try and minimise opportunities for arbitrage which arise due to differences in carryover provisions between states. Victoria, for example, does not allow water to trade to New South Wales after 28 February each year (Southern Riverina Irrigators, sub. 25).

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) because 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 an irrigator wishing to sell high security water must notify their intention by 1 August in the new irrigation season, and within two weeks of the announced allocation increase 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 Murrumbidgee, 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 their 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 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 they place 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 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 6 and 7.

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 achieving a particular policy objective. Any remaining restrictions should be imposed transparently with their objectives clearly stated.

PRELIMINARY FINDING 3.2

*Remaining restrictions on trade in seasonal allocations should be transparently reviewed and removed where unjustified. 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 3.1.

## Box 3.1 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 $500 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 $605 and the total amount that would transfer to the seller would be $3595 (excluding income tax). In this example, fees amount to 14 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*: WaterExchange 2006; The Allen Consulting Group 2006.

The following section discusses the cost components of seasonal allocation trades.

### *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. The 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 3.1 compares four regions — costs in the River Murray district in South Australia stand out at $500.

Table 3.1 **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<br>Trades managed by SunWater at no cost to the customer<br>Application fee of $111.80 for unsupplemented water |
| Vic. — Goulburn–Broken | $65 fee for transfer application, payed to Goulburn–Murray Water |
| SA — River Murray | $500 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 trading 'taking' allocations. Fees for trading 'holding' allocations, which cannot be taken or used, are $300.

*Source*: Adapted from 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 in South Australia cover the costs of administration and of a technical assessment of the use of 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 believe technical assessments are required for seasonal allocation trades as many of these trades are made each year to permanent plantings (DWLBC, pers. comm., 24 May 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, technical assessments are required for each trade and so $500 is payable for each trade.

South Australia is considering unbundling entitlements and creating separate use licences. It is likely that such reforms would reduce transaction costs as technical assessments may not be required each time water is traded. Such reforms are not likely to be completed until the end of 2007 or mid-2008, however, so the South Australian Government may review transaction costs prior to this (DWLBC, pers. comm., 24 May 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 3.2).

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 3.2 do not appear unreasonable in most areas, there may be scope to reduce assessment times in some regions.

Table 3.2 **Typical time for regulatory approvals for trade in seasonal allocations**

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

**a** Excludes Murrumbidgee Irrigation Corporation channel system which operates an internal trading system. **b** Time taken to process a 'holding' allocation trade (for water that cannot be taken or used) is less than for a 'taking' allocation trade.

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

### *Fees for brokerage services*

As noted in section 3.1, electronic processing systems have already been developed in some regions. These include Watermove (provided by Goulburn–Murray Water, a government-owned water authority), SunWaterOnline (provided by SunWater, a government-owned water authority), 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 3.3).

Some participants raised concerns about undercharging for brokerage services provided by government-owned organisations. While lower fees will 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 encourage too much trade or impede private provision of brokerage services and trader innovation.

PRELIMINARY FINDING 3.3

*Existing government-funded water exchanges should operate on a cost recovery basis consistent with the principles of competitive neutrality.*

Table 3.3 **Fees charged by major brokerage firms for trade in seasonal allocations**

| *Broker* | *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, 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 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.

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. (2003, p. 13)

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

PRELIMINARY FINDING 3.4

*Approval processes and associated costs involved in trading seasonal allocations should be benchmarked to best practice. Transparent performance reviews should be conducted periodically.*

## 3.4 Constraints on trade in water entitlements

A wider range of restrictions apply to trading water entitlements than seasonal allocations, with restrictions greater for trade between irrigation districts than within districts. 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. 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 (Heaney et al. 2005).

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 sub-districts), the export of water entitlements has been prohibited, while in others, exports are limited to a maximum of 2 per cent (net) of the irrigation district’s (or sub-district’s) annual bulk licence. Trade constraints of 2 per cent have not been reached in many districts (or sub-districts) so these rules have had little impact to date (Roper, Sayers and Smith 2006 forthcoming). However, trade has been expanding and these limits are likely to be reached in some irrigation districts (or sub-districts) 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, parties to the NWI are moving towards an annual gross limit of 4 per cent of total water entitlements held by the irrigation utility (COAG 2004a). The New South Wales Cabinet Office (sub. 41) indicated it has made the necessary legal amendments to facilitate this, and that some irrigation corporations 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, p. 11).

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 irrigation authorities have already set exit fees, or are considering introducing exit fees, as they change their interim threshold to 4 per cent.

### *Exit fees*

Several irrigation authorities have introduced exit fees on the export of water entitlements as a means of maintaining their revenue base. Central Irrigation Trust in South Australia, for example, has imposed exit fees of around $360 per megalitre for trades out of their district (CIT 2005). The Coleambally Irrigation Co-operative has also adopted an exit fee of $360 on all trades out of the Coleambally Irrigation Area (CICL, pers. comm., 8 June 2006). Exit fees of $447 per megalitre are included in Murray Irrigation's new constitution (Murray Irrigation 2006).

Exit fees of this magnitude are likely to be a significant constraint to trade. Using an example from Murray Irrigation in New South Wales, an exit fee of $447, applied to a general security entitlement valued at approximately $550 (WaterExchange, May 2006), would represent 81 per cent of the entitlement value. In the case of Coleambally, their exit fee of $360, applied to a general security entitlement valued at approximately $650 (WaterExchange, May 2006), would represent 55 per cent of the entitlement value. As entitlements in South Australia are currently valued at around $1450 per megalitre (Waterfind, June 2006), the Central Irrigation Trust exit fee would represent approximately 25 per cent of the entitlement value. New South Wales, Victoria and South Australia have agreed to ask the ACCC to investigate whether particular exit fees are likely to create unfair terms of trade (Sellars 2006).

Exit fees are distortionary — they increase entitlement prices in importing regions, reduce entitlement prices in exporting regions, reduce the quantity of water traded and reduce economic wellbeing, compared with the situation of unconstrained water trade. Further, exit fees can lock water into low productivity enterprises and regions.

Exit fees result in welfare re-allocations (from irrigators to water utilities) and economic inefficiencies (known as deadweight losses) (appendix D). They generate revenue for irrigation water authorities 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 authorities, all taken together, lose economic welfare when water trade is restricted by exit fees. Goesch et al. (2006) found that the losses in economic gains from trade increase at an increasing rate as the exit fee becomes a larger proportion of the traded price of water.

While some participants support exit fees — for example, Murrumbidgee Horticulture Council (sub. 37), Coleambally Irrigation Co-operative (sub. 4), Southern Riverina Irrigators (sub. 25) and Australian Dairy Farmers (sub. 12) — 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 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 also 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)

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 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).

There are more efficient responses available to utilities than exit fees. The utility could rationalise its delivery system, for example, by decommissioning redundant infrastructure (see Roper, Sayers and Smith 2006 forthcoming). In particular, some parts of the local distribution network may not be required if water is no longer diverted from the main distribution network to smaller feeder channels and to the irrigator's farm, allowing the utility to reduce charges to reflect the new patterns of infrastructure use. Heaney et al. (2005), for example, noted that ex post it may be more economical to continue to operate the asset even if it is only covering variable costs. Utilities could also negotiate supply contracts or exit options directly with individual irrigators (Heaney et al. 2005). As Watson suggested:

> Once infrastructure is sunk, the appropriate rule is to charge for variable costs including agreed standards of maintenance. Negotiation between water authorities and irrigators is the best way of solving problems of stranded assets. (2005, p. 16)

Finally, where substantial social costs result from the movement of water out of an irrigation district, the Australian and state 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 actions. 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 (Heaney et al. 2005). Positive effects can include the alleviation of congestion and environmental concerns in the exporting district, and greater economies of scale in the importing region. If governments choose to assist affected irrigators, assistance measures should be targeted such that other parties do not bear unnecessary costs.

PRELIMINARY FINDING 3.5

*Exit fees and other unjustified limits on trade out of an irrigation district constrain trade in entitlements and impede adjustment and should be removed.*

### 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 considered exchange rates and/or tagging systems should be adopted to account for these considerations (COAG 2004a) (box 3.2).

Box 3.2 **Exchange rates and tagging**

**Exchange rates**

Exchange rates 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 possible 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 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, which incorporates exchange rates to account for transmission losses (or losses avoided; if the entitlement is traded upstream, the transmission exchange rate may be above unity). 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 (MBDC 2006).

The use of a tagged system has received widespread support from governments and irrigators — for example, Southern Riverina Irrigators (sub. 25), the Queensland Department of the Premier and Cabinet (sub. 38), the Victorian Department of Sustainability and the Environment (sub. 32) and the New South Wales Cabinet Office (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 also 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
- authority/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 $506.15 in the River Murray in South Australia (table 3.4). Fees for South Australia are discussed in section 3.3 and may be higher due to more stringent technical assessment requirements and because owners can mortgage entitlements, and hence the transfer process must be robust, and legally and financially auditable. 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 (DWLBC, pers. comm., 24 May 2006).

As shown in the far right column of table 3.4, 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 sub-divide 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 2). In this way, titling arrangements can have implications for the costs involved in transacting an entitlement trade.

Table 3.4 **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<br>Capital gains tax | $113 for use approval if not already held |
| Qld — Emerald Irrigation Area | $246.10 for ownership transfer, $83.90 for a change in location | $131.50 | Stamp duty of $2350 on $100 000<br>Capital gains tax | Land and Water Management Plan required Assessment fee of $173 |
| Vic. — Goulburn–Broken | Buyer to pay $145 to Goulburn–Murray Water | N/A | No stamp duty<br>Capital gains tax | Buyer to pay $130 for channel capacity and salinity/drainage assessment |
| SA — River Murray | $500 | $6.15 | Stamp duty of $2830 on $100 000<br>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.

*Source*: Adapted from 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 3.3).

## Box 3.3 **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 are no taxation-related impediments 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 3.5 indicates typical times taken to approve entitlement trades.

Table 3.5 **Typical times for regulatory approvals for entitlement trades**

| *Region* | *Time* |
|---|---|
| NSW — Murrumbidgee Valley[a] | 1 week for pre-tested trades |
| Qld — Emerald Irrigation Area | Up to 6 months |
| 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 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 3.6). 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. As is the case with seasonal allocations, SunWater does not charge to transfer water entitlements between SunWater customers.

Table 3.6 **Fees charged by major brokerage firms for trade in water entitlements**

| *Broker* | *Fee* |
|---|---|
| Watermove | Buyer pays $110 per trade plus GST<br>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<br>Seller pays 3 per cent of total value |
| SunWater | Free to SunWater customers |

*Sources*: SunWater 2006; 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 government 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.

PRELIMINARY FINDING 3.6

*Approval processes and associated costs involved in trading water entitlements should be benchmarked to best practice. Performance reviews should be conducted periodically.*

## 3.5 Constraints specific to trading groundwater

Groundwater entitlements, access and use rules differ markedly from those for regulated surface water. Trade in groundwater is more limited than trade in surface water because groundwater trade is generally only viable within the same aquifer, although opportunities to add surface or storm water to existing groundwater aquifers exist in some areas (appendix B). Trade in groundwater is common in Western Australia, where groundwater is the main source of water (appendix B).

Where trade in groundwater occurs, additional regulatory restrictions to trade are often imposed. In Victoria, for example, there are prohibitions on trade to certain areas or to certain 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).

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)

Restrictions on trade in groundwater often reflect uncertainties about storage levels, connectivity with river 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 granted to groundwater, compared with those granted to surface water. The physical trade of groundwater can also be limited by infrastructure access.

In some areas, trading in groundwater could make extraction levels unsustainable. This is because many aquifers are already overallocated 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). Given the substitutability between surface water and groundwater, increased trade in groundwater could exacerbate problems of system-wide overallocation. To move ahead, appropriate integrated surface water and groundwater caps would be needed and the issue of unactivated licences addressed.

## 3.6 Implications of freeing up water trade

Freeing up trade in seasonal allocations and water entitlements, and derivatives of these 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 enables water to move to higher value uses (in the short and longer term) and helps 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. Furthermore, 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 may be moderate. Partial equilibrium modelling by Heaney et al. (2004), for example, suggested that the removal of administrative 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 (which does not represent a large proportion of total water entitlements in the region).

General equilibrium modelling by Peterson et al. (2004) estimated that, in the long run, the gains from moving from no trade to intraregional and interregional trade more than halves the impact of reductions in irrigation water availability on the gross regional product of the southern Murray–Darling Basin. In particular, the study estimated that allowing 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).

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 3.3, 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, 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)

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 outweighed 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 trade. Reducing constraints on trade in conjunction with improving entitlement and allocation regimes, and coordinating market mechanisms to help achieve environmental goals, would offer the greatest benefits.

PRELIMINARY FINDING 3.7

*Constraints to 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. Constraints to trade in water entitlements should be removed to build on these gains.*

# 4 Other factors affecting farmers' decisions on water use and trade

**Key points**

- Farmers are generally well informed in terms of making water-use decisions, but there is scope for further improvements in information collection and dissemination about climate, soils and other biophysical characteristics.
- 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.
- Government subsidies for the adoption of particular irrigation technologies or practices are unlikely to be in the public interest unless they are targeted at achieving specific public benefits, such as knowledge sharing from research and development, or achievement of environmental objectives. Even then, alternative measures may be preferable.

Farm production decisions and water-related management practices affect how much, as well as where and how, rural water is used (appendix C). 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 2 discussed limitations of existing entitlement and allocation regimes, and chapter 3 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.

## 4.1 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.

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 among each other. PD and SM 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. PD and SM 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, Australia Spatial Information Business Association (sub. 25), ABS (sub. 17), Water Corporation Western Australia (sub. 29), PD and SM 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. 1).

The critical policy question is whether the information inadequacy leads, in some way, 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 the 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 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. Other areas where a lack of farm-related information may contribute to economically inefficient rural water use include information on opportunities and obligations regarding water trading (chapter 3) and environmental externalities (chapter 5).

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, governments, including catchment management authorities, research institutes, and state agencies, 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.

PRELIMINARY FINDING 4.1

*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.*

## 4.2 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

The supply of rural water to users 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, 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 businesses provide bulk water services to rural Victoria. These businesses 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* and the *Water Management Amendment Act 2004*.

Expanding trade will increase competitive pressures on rural water utilities. Storage services in particular are becoming more open to competition because irrigators in many areas can choose to purchase water from dams run by different utilities. 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, Dwyer (sub. 52), Fitzroy Basin Food and Fibre Association (sub. 11), and 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) are complex, and beyond the scope of this study.

However, the Commission notes that in water markets that are functioning well, the on-farm water-use efficiency implications of utility charges for water services (including water delivery and drainage) are likely to be small or less important (especially in the short run). This is because water users will make water-use, and trade decisions based on the market price of water, which represents the opportunity cost of water, rather than utility charges. The major effect of utility charges on water users is through distributional (or 'wealth') effects (via changing the scarcity rents entitlement holders may receive if market prices for water are above utility charges for water). The efficiency implications of such distributional effects are relevant in the longer term, however, if they influence adjustment decisions (especially when charging is different across districts).

Where water markets do not exist, or have few participants, however, water utility charges may reduce allocative efficiency even in the short term. In addition, to the extent water utilities do not charge appropriately for their services, investment in water infrastructure may be distorted. However, if irrigators own water utilities, as they do in New South Wales and South Australia, these pricing issues need not distort investments.

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. As noted above, poor pricing arrangements may also distort investment decisions.

Some restrictions on the commercial operations of utilities may give rise to inefficiencies. Some utilities (for example, in Queensland and Victoria) face restrictions on selling 'saved' water (from infrastructure works) on the water market. This may prevent some investments from being undertaken that would have earned a positive return (given the market price of water). To the extent that irrigators own water utilities, however, this is less of a concern because water 'saved' can be redistributed to irrigators who would value additional water at market prices.

It is also important that utilities do not over-invest in water saving projects and that a full range of options for improving water-use efficiency are considered. All projects should be assessed for their costs and benefits.

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, including through expanding markets.

PRELIMINARY FINDING 4.2

*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.*

## 4.3 Government policies

Governments have introduced a range of policies related to agriculture, rural water and water-related markets. Some of these policies were considered in chapters 2 and 3, 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 4.1). Some programs have been aimed at improving research and development outcomes or increasing farm productivity, others have sought to achieve environmental goals, many have multiple aims.

Box 4.1 **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 improving productivity. Examples of programs offering on-farm financial incentives include:

- Water Use Efficiency Program — this program was run by the New South Wales Department of Agriculture between 1998 and 2003, and provided $25 million for financial incentives to individual irrigators outside of areas covered by Land and Water Management plans, 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 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 partly subsidise growers for their outlays in adopting new irrigation technologies. This scheme invested $7 million into dairy and lucerne irrigation infrastructure in the first two years of operation.
- The Pathways to Industry Environmental Management Systems Program — provided additional funds to build on existing industry programs for the cotton and rice industries to adopt best-practice farm management.

*Sources*: Australian Government Water Fund 2005; Brumby 2006; Crean et al. 2004; DNRMW 2006; Howard 2005; Thwaites 2004; Warren et al. 2003.

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 2006b) has the specific objective of accelerating the development and uptake of 'smart' technologies and practices in water use across Australia. 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; see also appendix C).

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. 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. Appendix C (section C.2), for example, identifies that farmers only substitute capital for water over a longer time horizon.

The Commission has found little evidence, however, that impediments restrict farmers in making appropriate cost–benefit calculations in technology adoption decisions or choice of products (appendix C). Farmers are generally well informed about new technologies and product opportunities, and incentives exist for acquiring information on technological performance and product profitability.

In terms of encouraging 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 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 (appendix C). Governments should not try to pick which businesses should buy, sell or use water. 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)

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 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)

Providing subsidies for ‘technically efficient’ irrigation technologies, or 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, 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 6 and 7 in relation to addressing environmental externalities associated with rural water use.

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. The Commission has not, however, received evidence to indicate that there is 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 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 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.

PRELIMINARY FINDING 4.3

*Government subsidies to encourage the use of specific irrigation technologies need to be carefully designed and targeted to be capable of yielding net public benefits. If this approach is not adopted, they are unlikely to improve the economically efficient use of rural water.*

## Taxation arrangements

Taxation policies may also have the effect of distorting rural water use and hence, economic efficiency. 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 Irrigation 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, Watson and Crase 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).

It has been argued that MIS have positive features (Lacey, Watson and Crase 2005), have contributed to the development of rural industries (Timbercorp, sub.20; Australian Forest Growers 2005), and can have positive impacts on the environment (Department of Environment and Heritage 2005). But it has also been argued that there are problems with the way MIS are operated and regulated (Lacey, Watson and Crase 2005), and that their impact can be negative (Sunraysia Irrigation Council, sub. 33; Coleambally Irrigation Co-operative, sub. 3; Pastoralists and Graziers Association 2005; Department of Environment and Heritage 2005).

In relation to taxation, industries using MIS argue that they do not receive 'concessional' treatment. For example, the Australian Forest Growers commented:

> 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. (2005, p. 4)

On the other hand, it is argued that favourable tax treatment for MIS projects does occur (Sunraysia Irrigation 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, Watson and Crase 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 this 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. That said, to the extent that there are any tax 'concessions', there is the potential to distort resource use and prices (including for rural water) by directing economic resources away from, or towards, particular activities. Associated losses in resource-use efficiency can ensue.

# 5 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 to achieve 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, a framework for characterising their key features, and possible policy responses and objectives. 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.

## 5.1 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 is a side effect of a decision by an individual (or business) that affects another party's wellbeing. 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. 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. Moreover, environmental change resulting from natural processes independent of actions by humans is not considered to be an externality.

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 5.1). 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 irrigation authority. 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 5.1 **Key elements of an environmental change**

| Source | Transmission | Effect |
| --- | --- | --- |
| What is the production or exchange activity? Who undertakes this activity? | What environmental conditions are changed? | What agents are affected? What is the external cost or benefit? |

| | | | |
| --- | --- | --- | --- |
| | [illegible] the sourc[illegible]s be [illegible]tified?<br>Can the activities of each source be observed?<br>Do activities other than irrigation supply and use result in the externality? | [illegible]ironmental [illegible]used by [illegible] be observed and measured? | [illegible]<br>Can the effects be observed and measured? |
| Spatial variation | Where are the sources located? Are they geographically diffuse?<br>Do many sources contribute to the same effect? | Are the sources and effects in different locations?<br>Do the relationships between sources and effects change with location? | Where are the effects located? Are they geographically diffuse?<br>Are many effects attributable to an individual source? |
| Temporal variation | To what extent do past activities have current (or future) effects?<br>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?<br>Are relationships between sources and effects affected by natural variability? | Can effects be apportioned between past and ongoing activities?<br>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?<br>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)?<br>Is there uncertainty about the relationship between (observable) activities and change to environmental condition? Is there uncertainty about the relation between changes to environmental condition 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.

Dwyer et al. (2006) developed a framework for analysing environmental changes relating to irrigation water use (box 5.1). The framework describes the nature of each element of an externality (source, transmission and effect) according to its observability and ease of measurement, and spatial and temporal variation. It highlights considerations for assessing current knowledge and uncertainty about the underlying relationships between the source, transmission and effect of an environmental change.

Information obtained from an analysis of environmental changes using the framework in box 5.1 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 5.2.

## 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 5.2.

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 policy objectives are discussed further below, while the efficiency of environmental water use is discussed in appendix C.

### 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.

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 (appendix C). 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.

## 5.2 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 5.1). 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 5.1 **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 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 5.1) 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, Connor and Morrison 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.

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

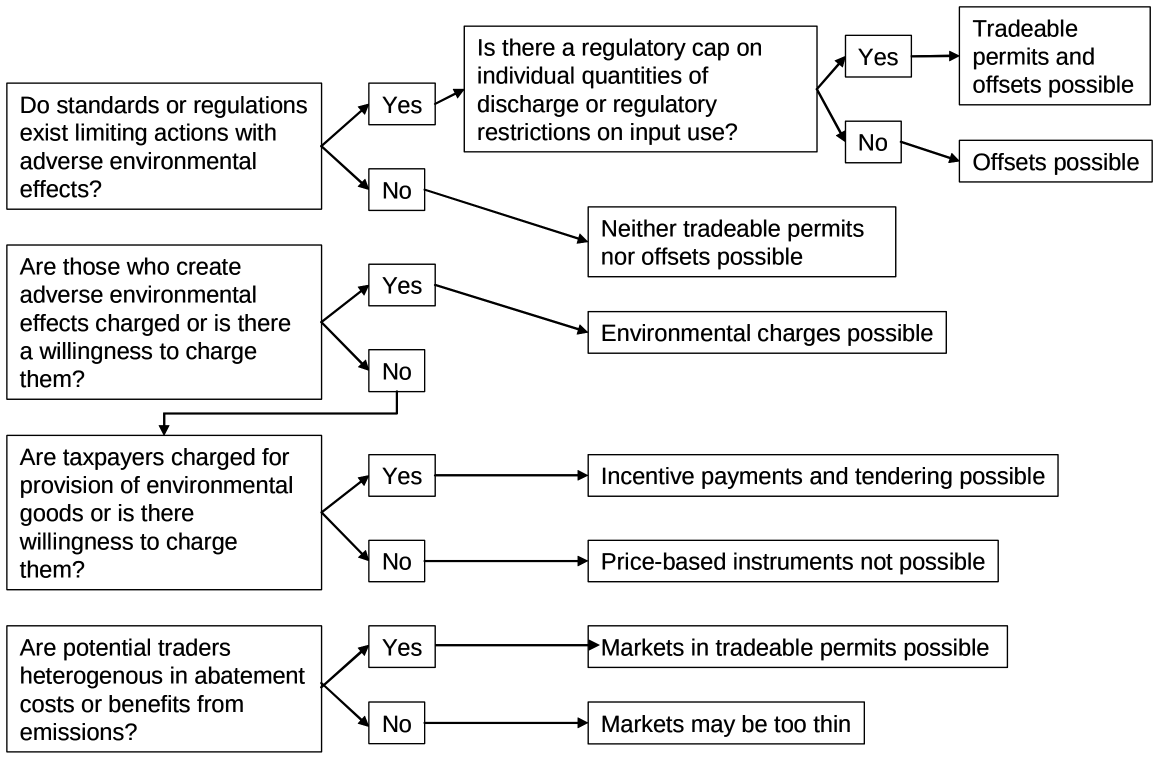
The feasibility of market mechanisms is influenced by the institutional framework, the social and political setting, the characteristics of potential market participants, technological factors, and information requirements. Some of the institutional and social factors are summarised in figure 5.1, which is based on a schema developed by Hatton McDonald, Connor and Morrison (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, Connor and Morrison 2004, p. 33)

Figure 5.1 **Some determinants of the feasibility of market mechanisms**




*Source*: Adapted from Hatton McDonald, Connor and Morrison 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 of 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 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.

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, Connor and Morrison 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, Horan and Smith 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, initial 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.

Finally, flexibility may improve compliance with water access rules and 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. Hatton McDonald, Connor and Morrison (2004) 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. (Hatton McDonald, Connor and Morrison 2004, p. 38)

### Distribution of costs and benefits

As mentioned in section 5.1, 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 will determine the 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 (box 5.1).

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, Connor and Morrison 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, van Bueren and Collins noted: ‘These instruments limit community responses as much as prescriptive regulations that seek to “pick winners”’ (2003, p. 16).

## 5.3 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 2003b) 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 2003b). 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, several practical issues need to be considered, including:

- level of operation — whether at a catchment or basin level or at a broader regional or state level. 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.
- institutional structure — for example, whether to establish a trust, private corporation, independent public corporation, or government agency.
- 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).
- environmental managers' position within the existing environmental water allocation process — environmental regulation and planning have the potential to crowd out innovative services that could be provided by environmental

managers and other service providers. Regulations and planning processes may under-provide for environmental needs in the hope or expectation that the environmental manager will provide the additional services to meet the desired environmental standard.

- 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. Further investigation of practical options to address these issues would be beneficial, but is beyond the scope of this report.

### Current environmental management framework

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. 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 the plans' objectives (chapter 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.

- The New South Wales Murray Wetlands Working Group, a community-based environmental incorporated body, is responsible for managing and trading environmental flows under a three-year trial (currently in its final year).
- 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 2005d).

# 6 Market mechanisms for altered river flows

**Key points**

- Externalities can occur where irrigation alters river flow volumes, flow variability, flow distribution, connectivity and water quality.
- A portfolio of water products will be required to deliver an environmental flow regime that balances ecological benefits associated with river flows with costs.
- 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 reducing river heights or reducing unseasonal flooding.
- It is difficult to devise efficient and effective taxes on rural water use to address environmental externalities.
- Implementation of the Living Murray Initiative should embrace a wide range of water products to meet river flow objectives.

This chapter assesses the feasibility of establishing 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 the 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
- assess a selection of market approaches for acquiring water products and water-related products (such as rights to river capacity) to meet river flow objectives
- assess other market mechanisms for addressing river flow externalities that target water and land use.

## 6.1 Environmental changes and externalities associated with altered river flows

Irrigators access water from a variety of sources, including rivers, surface water and groundwater. Drawing water from these sources alters river flows, some more directly and rapidly than others. Using rivers as irrigation delivery systems and placing water storage on them also alters flows.

Regulating rivers and other water courses 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 major irrigation storage infrastructure. 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 6.1.

As discussed in chapter 2, surface and groundwater can be highly connected and, as a consequence, river flows are also affected by irrigators accessing groundwater. 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. Evans estimated that groundwater use in the Murray–Darling Basin will reduce stream flows by 500 gigalitres per year over the next few decades (Evans 2005).

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 some situations, the direction of change differed among zones — for example, summer/autumn flows increased upstream of Torrumburry Weir, but decreased downstream. In a case study of the upper Murrumbidgee River, Young, Dyer and Thoms (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 6.1 describes hydrological change associated with flow regulation in the River Murray.

## Table 6.1 **Examples of environmental externalities associated with altering river flows**

| *Source* | *Transmission* | *Effects* |
|---|---|---|
| *(a) What is the production or exchange activity?*<br>*(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 dam water bodies**<br>(a) Construction of reservoir and maintenance of water storage levels<br>(b) Water utility (or other organisations) responsible for construction and operation of reservoir | Hydrology — create a water-body; reduce flow.<br>Water quality — constant, stratified water levels have the risk of algal blooms.<br>Habitat — creates non-flowing lakes upstream; reduces the amount of submerged habitat downstream.<br>Ecology — obstructs fish migration pathways; affects species and communities by changing the hydrology (for example, the flow regime) and resulting in habitat loss. | Landholders and businesses — benefits from reduction of flood effects.<br>Recreational users — benefits from increased recreational opportunities.<br>Tourism industry — benefits from increased tourism expenditure.<br>Individuals — benefits and costs from changes in amenity, biodiversity, habitat, culture and/or heritage. |
| **2. Regulation of flows**<br>(a) Presence of regulatory structures along watercourses to regulate and divert flows<br>(b) Water utility (or other organisations) responsible for operation of reservoir | Hydrology — reduces flow variability; reduces flooding frequency, changes the seasonality of flows; changes total flow; changes floodplain drying and wetting; reduces flow through the river mouth.<br>Habitat — changes in flow result in physical changes to the river channel and the habitats within it.<br>Water quality — changes the temporal patterns of the water quality.<br>Ecology — obstructs fish migration pathways; affects species and communities by changing the hydrology (for example, the flow regime) and resulting in habitat loss. | Landholders and businesses — benefits from reduction of flood effects.<br>Commercial and recreational fisheries — costs from decline in catch yield.<br>Tourism industry — benefits and costs from changes in visitor expenditure.<br>Individuals — benefits and costs from changes in amenity, biodiversity, habitat, culture and/or heritage. |
| **3. Weir pools**<br>(a) Weirs that create weir pools from which water is diverted<br>(b) Water utility (or other organisations) responsible for operation of reservoir | Hydrology leads to — unseasonal protracted wetting in low level wetlands; raises watertables under nearby floodplains.<br>Habitat — creates stable water levels upstream and can create fluctuating water levels downstream.<br>Water quality — constant, stratified water levels have the risk of algal booms.<br>Ecology — results in loss of bank habitat due to permanent wetting; reduces productivity. | Commercial and recreational fisheries — costs from decline in catch yield.<br>Tourism industry — benefits and costs from changes in visitor expenditure.<br>Individuals — benefits and costs from changes in amenity, biodiversity, habitat, culture and/or heritage. |

(continued next page)

Table 6.1 (continued)

| *Source* | *Transmission* | *Effects* |
|---|---|---|
| **4. Cold water dam releases**<br>(a) Releases of cold water from low level outlets in reservoir for irrigation<br>(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.<br>Ecology — leads to a decline in the number of fish species; changes species composition. | Commercial and recreational fisheries — costs from decline in catch yield.<br>Tourism industry — costs from decline in visitor expenditure.<br>Individuals — costs from changes in amenity, biodiversity, habitat, culture and/or heritage. |
| **5. Rapid changes in river height**<br>(a) Storage releases that cause rapid rises and falls in river height<br>(b) Water utility responsible for operation of reservoir | Hydrology — affects flow regime; decreases bank stability; changes river morphology.<br>Water quality — increases turbidity and sediment transport (through erosion).<br>Ecology — affects ecology by changing the hydrology (habitat, flow regime) and water quality. | Commercial and recreational fisheries — costs from changes in catch yield and flow regime.<br>Tourism industry — benefits and costs from changes in tourism expenditure.<br>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; Thoms et al. 2000.

### Box 6.1 **Hydrological effects of flow regulation on the River Murray**

Hydrological changes are generally measured by comparing current flow data to historical 'pre-regulation' 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 large storages and upstream of major abstraction plants
- reduced total volume of flow
- increased flow resulting from inter-basin transfers, such as the Snowy Mountains Scheme
- reduced velocity, increased depth and the removal of drying cycles upstream of locks and weirs
- modified day-to-day variation in flows (rates of rise and fall).

*Sources*: Gippel and Blackham 2002; Maheshwari, Walker and McMahon 1995; MDBC 2002; 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 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 6.1.

## 6.2 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.

### Reserving water for environmental purposes using regulatory instruments

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 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 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).

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, for example, noted:

> [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 such processes can crowd out more efficient and effective 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.

PRELIMINARY FINDING 6.1

*Planning processes aid the efficient allocation of water between environmental and non-environmental uses. However, an over-reliance on them can crowd out more efficient and effective market mechanisms.*

## Investing in off-farm infrastructure

Governments have invested in off-farm infrastructure projects to source water for environmental purposes in south-eastern Australia. Two major programs are the Living Murray Initiative and Water for Rivers. The Murray–Darling Basin Ministerial Council established the Living Murray Initiative in 2002 in response to the declining 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 Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin (IGA) signed in June 2004 provides for implementation of the 'First Step' decision (MDBC 2006f). (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 2006). 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 (MDBC 2006f, Turnbull 2006b, Water for Rivers 2006). Examples include lining channels, installing pipelines, and installing metering systems (MDBC 2006f, Water for Rivers 2006).

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:

> On the basis of the information available it is concluded that that there are limited opportunities for water use efficiency savings at a marginal cost of less than $1000/ML … [this is the upper bound estimate the consultant, ACIL Tasman, placed on the market price for a permanent entitlement]. (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)

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 2006f; MDBMC 2005).

Although infrastructure projects undertaken by Water for Rivers are outside the scope of the IGA, they have nevertheless 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 2006).

In some cases, infrastructure projects that source water may have other benefits. ACIL Tasman (2003), for example, pointed out that, while the water-use savings from the Pyramid Creek groundwater interception scheme were small, the scheme was likely to exhibit significant 'positive externalities' by reducing highly saline inflows.

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 potential for 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 environment 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 2006b, p. 1)

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 (for further discussion, see appendix C). 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). True water savings are only made when losses that cannot be recaptured are reduced or eliminated. Projects that reduce evaporation and accessions to saline water tables yield true water savings (Pratt Water 2004).

PRELIMINARY FINDING 6.2

*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 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 unfeasible. 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, Douglas and Dwyer 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, water logging or nutrient discharge, or improving farmer profitability.

### Purchasing water rights

Another means of sourcing water for environment purposes is purchasing water through water markets. The New South Wales Government's 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. (New South Wales Cabinet Office, sub. 41, p. 6)

Examples of other plans to purchase water rights 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 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 (Turnbull 2006b).

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).

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 *The Australian*, 20 March 2006)

## 6.3 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. Second, 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. Third, it outlines various mechanisms for procuring water and water-related products. Fourth, it highlights the need for governments to continue to undertake actions that address the effects that limitations of existing property rights arrangements are likely to have on longer-term water availability for environmental purposes.

### 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 in terms of 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 flows 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 6.2). Jones et al. (2002), for example, defined five river attributes to serve as proxies for ecological condition:

- flow volume
- flow distribution
- flow variability
- connectivity
- 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.

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, 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.

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.

Table 6.2 **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) flow (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 | 75$^{th}$ 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<br>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.

## 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:

- be able to source water at short notice to meet short-term environmental needs
- be able to minimise the opportunity cost of the water used for environmental needs
- be able to 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 having a portfolio selected, 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 the way that the outcomes are achieved. However, existing institutional arrangements may not be sufficiently flexible for this to occur.

PRELIMINARY FINDING 6.3

*A portfolio of water products will be required to deliver increases in environmental flows in a timely and cost-effective manner.*

PRELIMINARY FINDING 6.4

*Environmental objectives of the Living Murray Initiative can be more effectively addressed through a range of water products.*

## 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, release 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 2005e). (See *The Living Murray Foundation Report on the significant ecological assets targeted in the First Step Decision* (MDBC 2005f) for examples of operating procedures and practices to protect environmental values.) As discussed later in the chapter, 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 6.2). In some cases, non-market approaches will be the best, or only, option for achieving certain river flow objectives. The underlying environmental change from 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 6.2 **Improving the delivery and management of environmental flows**

Governments have introduced programs to assist river flow managers to optimise the benefits from existing and future environment 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 6.3).

## 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. Some examples include:

- spot markets
- contracts
- tender auctions.

Box 6.3 **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 flood plain 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 found improvements in a range of water quality and biotic parameters.

*Sources*: Johnstone Centre nd; Sutherland, Ryder and Watts 2002.

In some cases, new markets will need to be created before environmental managers and service providers can procure the water products they require. Section 6.4 provides further detail on how these mechanisms operate.

## Factors affecting longer-term water availability

Further progress in broader water reforms will be required if efforts to source water through market mechanisms or other means are not to be undermined by limitations in existing property rights arrangements. The most significant factors threatening to erode the longer-term availability of water for environmental and other purposes are climate change, farm dams, groundwater extraction, bushfires, afforestation, and changes to irrigation water management. If these factors are not addressed and they have their expected effects, they will substantially reduce stream flow in the Murray–Darling Basin, thereby counteracting efforts to source water for the river systems (box 6.4). In *Risks to the Shared Resources of the Murray–Darling Basin*, for example, the 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 …

The risks might not only affect water volumes but also water security and water quality. The impact of the risks on river salinity is the balance result of changes in salt mobilisation and changes in stream flow. The ongoing trends in climate, afforestation and irrigation water management have a beneficial impact on salt mobilisation in areas that are more important as salt sources than as water sources, but the opposite effect elsewhere. Farm dams intercept fresh overland flows and thus are more likely to increase stream salinity. (van Dijk et al. 2006, p. 6)

The CSIRO's report noted that these risks are 'not forgone conclusions' and that 'understanding of how the risks might impact upon the Basin is by no means complete' (van Dijk et al. 2006, p. 6).

Under current operation of the Cap, much of the reduction in stream flow would affect water availability for environmental purposes. The Murray–Darling Basin Cap limits diversions from rivers within the Murray–Darling Basin to protect and enhance the riverine environment. By defining the Cap in terms of diversions, reductions in total water availability (such as those from bushfires) or increases in water use not covered by the Cap (such as farm dams, groundwater use, and land use change) reduce the amount of water for environmental purposes.

Governments have taken actions, in addition to implementing the Cap, to address factors affecting long-term water availability for environmental and other purposes. The NWI includes provisions relating to identifying and managing factors affecting water availability and assigning risks from reduction in water availability. Signatories to NWI have agreed 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. The NWI risk sharing framework outlines how risks from reductions in water availability (including those from bushfires and climate change) will be shared between governments and entitlement holders under the Cap (chapter 2).

PRELIMINARY FINDING 6.5

*A number of factors have the potential to significantly affect the quality and availability of water from rivers in the Murray–Darling Basin in the longer term. If not addressed, they will substantially reduce stream flow in the Murray–Darling Basin, thereby counteracting efforts to source water for the river systems.*

## Box 6.4 **Factors affecting longer-term water availability in the Murray–Darling Basin**

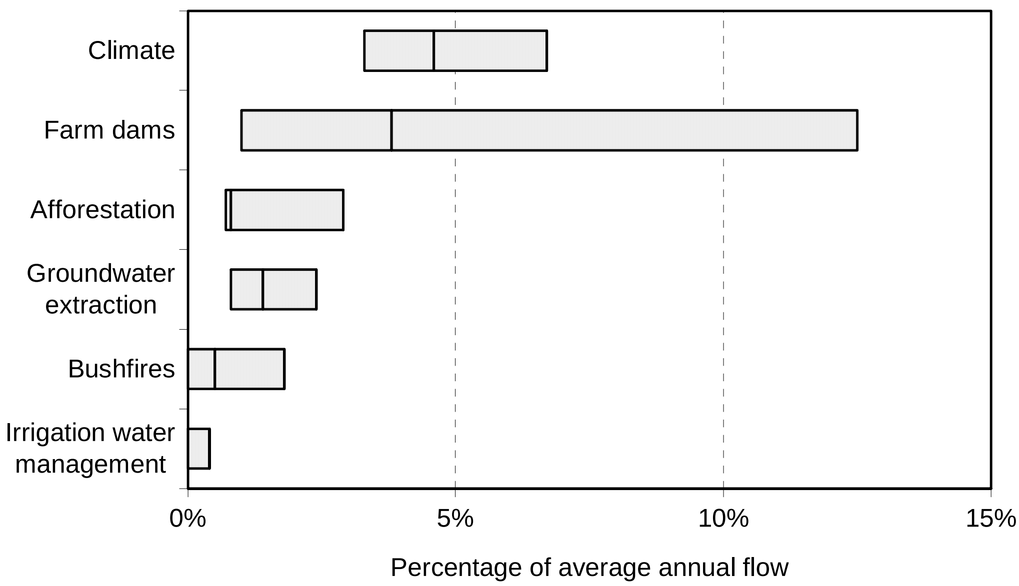
There are a number of factors that may diminish water availability in rivers over the longer term. Key factors in the Murray–Darling Basin include:

- climate change
- farm dams
- groundwater extractions
- bushfires
- afforestation
- changes to irrigation water management.

Some of these factors reduce the amount of total water available (such as bushfires, and climate change), while others will also affect the distribution of water among users (such as farm dams and groundwater extractions). The significance of these factors, and hence the appropriate policy response, will vary across rivers and river reaches.

The figure below presents estimated reductions in average annual stream flow in the Murray–Darling Basin by each key factor. The figures indicate ranges of estimates derived from '… different studies, for different assumptions, and for different levels of likelihood' (van Dijk et al. 2006, p. 37). The solid line inside each bar represents what the CSIRO considered '… the most likely impact'. Because factors interact '… the total impact on annual river flows cannot be equated to their sum, but may be less or more severe' (van Dijk et al. 2006, p. 7).

**Estimated effect of six 'risk' factors on stream flows in the Murray–Darling Basin by 2020**




*Sources*: MDBC 2005a; van Dijk et al. 2006.

## 6.4 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 allocations (box 6.5)
- 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 (option contracts)
- purchasing entitlements, altering their property right provisions and then selling them back to irrigators (covenants).

Box 6.5 **Relationship between prices for entitlements and seasonal allocations**

Conceptually, the value of an entitlement is equivalent to the expected value of an infinite series of seasonal allocations. Consequently, the cost of purchasing water by either entitlement or allocation will be equivalent, if unused allocations can be sold. However, an irrigator's or environmental manager's decision about which water product to use will be influenced by factors such as risk aversion, expectations and transaction costs.

*Source*: Peterson et al. 2004.

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 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 allocations under entitlement in years where allocations exceed environmental requirements (the latter would, however, would require access to other markets). Also, irrigators may choose to donate entitlements.

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 6.3). Purchasing entitlements is not only likely to 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.

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.

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 allocations seasonally. In the longer 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 ongoing infrastructure costs. Water recovered under the IGA may be traded on the permanent market 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).

## Table 6.3 **Trade in entitlements without seasonal trade**

| *Criteria* | *Assessment* |
|---|---|
| Cost | 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 costs. When water under entitlement temporarily exceeds environmental needs, excess water has an opportunity cost if not traded or carried over.<br><br>Purchase involves relatively large upfront budget outlay (but lower than sourcing water through infrastructure investments) and ongoing infrastructure costs. Revenue from selling entitlements can be used to buy other entitlements that better match environmental needs. |
| Feasibility | Medium to high — markets for entitlements already in place in Australia's main irrigation areas (progress remains to be made for inter-district trade). Purchasing entitlements is subject to relatively stringent trade restrictions. Purchasing entitlements for environmental purposes 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 trade means 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. |

### *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. Allocations could be gifted by irrigators, funded on an ongoing basis by governments or private groups, or funded from revenue generated by sales of allocations under entitlements. As with entitlements, unused seasonal allocations 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 on electronic exchanges 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 6.6). The NWI 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 either expressly not permitted (such as in the Murray Wetlands) or generally not undertaken (English, Brearley and Coggan 2004).

Box 6.6 **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 allocations under their entitlements to trade or the markets for 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 allocation (a ‘forward allocation’). Consequently, an expected 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 allocations directly from irrigators or use derivate products such as contracts or leases.

Trade in seasonal allocations would give environmental managers and service providers greater flexibility to respond to temporary shortfalls in water availability (table 6.4). Unlike entitlements, seasonal allocations can be accessed at relatively short notice, making them more suited for adaptive management. Having relatively small transaction costs and fewer trade constraints, seasonal allocations can be readily bought and sold.

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 costs.

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' water 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.

Table 6.4 **Trade in seasonal allocations**

| *Criteria* | *Assessment* |
|---|---|
| Cost | Low to medium — involves lower administration costs and fees than trading entitlements. Selling allocations from entitlements that temporarily exceed environmental needs can reduce the opportunity cost of sourcing water. Selling allocations provides revenue that would not otherwise have been available. Purchasing allocations rather than entitlements to meet variable environmental needs reduces ongoing infrastructure costs. The ability to purchase and sell 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.<br><br>Requires ongoing budget support. However, some or all of the required funds could be raised by selling 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 | High — seasonal allocations can be traded at short notice with low transaction costs, making them effective for addressing temporary shortfalls or excesses in supply. |
| 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. |

*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 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*).

Leases could assist environmental managers and service providers to better match water availability to environmental flow requirements (table 6.5). When specifying the duration of a lease, an environmental manager or service provider could tradeoff 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.

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.

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.

Table 6.5 **Leases for entitlements**

| *Criteria* | *Assessment* |
|---|---|
| Cost | Low to medium — involves initial set-up and negotiation costs and then periodic renegotiation costs thereafter. Ongoing infrastructure costs 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.<br><br>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. |

### *Options contracts for seasonal allocations*

Hafi et al. (2005) proposed the establishment of call options to deliver water for environmental outcomes in the Murrumbidgee River system. This concept could be applied to other river systems. 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. 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.

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 (table 6.6). 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 option 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. Option contracts could reduce transaction costs associated with selling off seasonal allocations in average and drier years, avoid ongoing infrastructure costs 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, such as the Sydney Futures Exchange, or if contracts can be negotiated through the irrigation authority rather than through individual irrigators (Hafi et al. 2005). Once contracts are established, there are ongoing transaction costs, such as monitoring market and weather conditions to assess the likelihood of the option being called on.

Table 6.6 **Options contracts for seasonal allocations**

| *Criteria* | *Assessment* |
|---|---|
| Cost | 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.<br><br>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. |

### *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 environmental needs than purchasing only entitlements (table 6.7). 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.

Table 6.7 **Covenants on entitlements**

| *Criteria* | *Assessment* |
|---|---|
| Cost | 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.<br><br>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. |

PRELIMINARY FINDING 6.6

*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.*

## 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 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 delivery rights could be applied to entire rivers or specific congestion points where there are hydrological 'bottlenecks'.

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). Shares in capped delivery capacity could be then traded through a market of timed capacity shares or through option 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 former Victorian Department of Natural Resources and Environment illustrated a specific case that arose from ill-defined river capacity rights:

> … [I]n spring 2000, a tug-of-war between irrigators' and forests' needs for water out of Hume Dam was only resolved by exceeding normal flow ceilings, temporarily flooding properties along the River. (DNRE 2001, p. 87)

By purchasing river capacity shares, environmental managers and service providers could achieve river flow objectives that cannot be targeted by water purchases (table 6.8). 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, shares could be leased back to irrigators.

River capacity shares would need to be developed and administered, which may impose significant transaction costs. As with any market mechanism, if the expected benefit from establishing a capacity share system is small, it may not be worthwhile.

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.

Table 6.8 **Trade in river capacity**

| *Criteria* | *Assessment* |
|---|---|
| Cost | 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. Reduces impact on regional economies compared to water purchases. |
| Likelihood of achieving desired goals | Medium — where objective is to influence river heights. |

PRELIMINARY FINDING 6.7

*Creating new, tradeable rights to river capacity may be required to help reduce river heights or reduce unseasonal flooding.*

## 6.5 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.

The following section discusses the strengths and weaknesses of ecosystem tenders and volumetric taxes. 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 (Department of Primary Industries (Victoria), 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 6.9). 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 6.9 **Tender auctions for ecosystem services**

| *Criteria* | *Assessment* |
|---|---|
| Cost | 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 is supposed 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 (Dwyer et al 2006). 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. (Dwyer et al. 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 6.10).

Even where a clear relationship between irrigation water use and altered river flows can be established, for the tax to reduce overall water use, 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). Such a tax may be effective but inefficient: it may well reduce water use by more than is justified on grounds of externalities.

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 (Dwyer et al. 2006). Also, Weier (2006) found that care is needed in implementing environmental charges at the state level because of constitutional issues regarding the power to levy excise taxes.

Careful consideration should be given to how revenue collected from water–use charges is used. It seems likely that hypothecating the tax revenues, towards infrastructure or work that address environmental externalities, would make such a tax more acceptable to the community. The revenue raised, however, might be higher (or lower) than the optimal level of expenditure on remedying and/or preventing environmental damage.

Table 6.10 **Volumetric tax on water use by irrigators**

| *Criteria* | *Assessment* |
|---|---|
| Cost | 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 to high — environmental contributions based on a percentage of utility revenue (which is an indirect way of taxing water use) are being introduced in Victoria. |
| Flexibility | Medium — charges could be reviewed periodically. |
| Distribution of costs and benefits | Cost to irrigators. Benefits to taxpayers through an increase in consolidated revenue. Benefits to parties that value improved environmental outcomes if tax reduces water use or if tax revenue is used to fund environmental activities. |
| Likelihood of achieving desired goals | Low — where there is water trade and where restrictions on water allocations result in scarcity rents, a charge will only reduce water use if it exceeds the scarcity rents. A tax on water use will not affect changes in river flows not caused by water use (such as drought or growth in forestry). |

PRELIMINARY FINDING 6.8

*Arriving at the correct rate for a volumetric tax is not easy. If set too low, the tax may be ineffective and not reduce the externalities associated with water use, in the short run. If effective on water use, the tax may be higher than is justified on externality grounds. 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.*

# 7 Market mechanisms to manage salinity

**Key points**

- A single market mechanism for salinity management is unlikely to be appropriate in all situations. In some cases, a mix of mechanisms or a regulatory approach will be required.
- Cap and trade in salt provides a flexible approach to manage catchment- and basin-wide incidence of salt at least cost.
- To reduce localised incidence of salt, promising market mechanisms include:
  - Cap and trade schemes — may be feasible and effective at the catchment level if the benefits of reducing the incidence of salt are sufficiently large. Cap and trade schemes of salt 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 cap and trade of salt 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.

The focus of this chapter is on the environmental externalities associated with salinity caused by rural water use. The assessment framework used is the same as in the previous chapter (and described in section 5.2). Section 7.1 describes the salinity problem. Section 7.2 describes the policy context that surrounds the application of market mechanisms to manage salinity. Design issues of using market mechanisms to manage salinity are considered in section 7.3. Section 7.4 assesses market mechanisms for reducing the incidence of salt, and section 7.5 looks at dilution flows as a method to reduce levels of salt.

## 7.1 Salinity

Salinity is a well-known environmental change associated with supplying and using irrigation water. Although salt is a natural feature of the Australian environment, irrigation practices (and other farming and land management practices) can exacerbate its incidence. 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 salinities might continue to increase as a result of past activities. However, salinity impacts sometimes occur in a relatively short period of time (Barr and Carey 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).

Irrigation is only one source of human-induced river and groundwater salinity in Australia. Dryland salinity is the major contributor 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 significant 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 water tables 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. The 1999 Murray–Darling Basin Salinity Audit estimated that, of changes that increase salinity at Morgan in the period 1988–2050, two thirds of the increase would be from dryland sources. (MDBC 1999a).

Table 7.1 presents some examples of externalities that are associated with salinity. Salinity imposes costs not just to irrigators (through reducing the yield of crops), but also others in the community by affecting the environment, infrastructure, drinking water quality and amenity.

Table 7.1 **Examples of externalities associated with salinity**

| *Source* | *Transmission* | *Effects*[a] |
| --- | --- | --- |
| *(a) What is the production or exchange activity?*<br>*(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**<br>(a) Application of irrigation water in excess of crop requirements, where drainage is insufficient to prevent groundwater recharge[b]<br>(b) Irrigators | Hydrology — increases groundwater recharge and results in waterlogging<br>Water quality — relocates salt in the soil to the soil surface<br>Habitat — may cause freshwater habitats to become salinised<br>Ecology — changes the ecology in response to increased groundwater levels and salinity | Agricultural producers — costs from waterlogging<br>Household/business — costs from damage to buildings and infrastructure<br>Individuals — costs and benefits from changes in amenity, biodiversity, habitat, culture, heritage, and indigenous values<br>Commercial and recreational fisheries (and associated tourism) — costs from decline in catch yield following lost fish breeding sites |
| **2. River salinity**<br>(a) Application of irrigation water in excess of crop requirements, where drainage is insufficient to prevent groundwater recharge, leading to increased baseflow to streams[c]<br>(b) Irrigators | Hydrology — increases groundwater recharge and the flow of water into streams; leads to seawater incursions into surface waterways<br>Water quality — increases the discharge of salt into streams (where groundwater is more saline than river flows)<br>Ecology — changes the ecology in response to increased stream salinity | Downstream water users including agricultural producers, other industries and domestic consumers — costs or benefits, depending on water quality<br>Commercial fisheries — costs or benefits from increased or decreased catch yields[d]<br>Recreational users — costs and benefits from changes in catch yield and flow regime<br>Tourism industry — costs and benefits from changes in tourist expenditure<br>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 buildup in soils. [c] Increasing the baseflow 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 and Ivey ATP (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' (MDBC, 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.

The effects of waterlogging and land salinisation display threshold effects — when the saline water table 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 — see, for example, Hajkowicz and Young (2002). Salinity thresholds also exist for ecosystem health (box 7.1).

Box 7.1 **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 percent, 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 more significant problem in the Murray–Darling Basin than in many other catchments in Australia because most of the emerged salt remains within the basin due to its hydrogeology (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 have applications in other irrigation areas.

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 explain these trends. However, 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 water tables, and salt became more observable in parts of the landscape in the mid-1980s. The dry conditions experienced in the late 1990s and in this decade 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. (MDBC, sub. 31, p. 14)

Relatively drier conditions have contributed to lower water tables. 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 flood plains to the river.

PRELIMINARY FINDING 7.1

*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 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, Beare and Bell 2001a). 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.

## 7.2 Policy context

There are four broad approaches to managing salinity:

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. dispose of the salt — at times when economic costs are likely to be low.

Most salinity management in Australia has focused on the first three 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 inter-government and inter-agency initiative developed by the Murray–Darling Basin Commission (box 7.2). The strategy aids the implementation of the National Action Plan for Salinity and Water Quality (NAP), state salinity strategies (South Australia, Victoria, New South Wales and Queensland) and regional salinity or catchment management plans. Catchment management authorities and water utilities play important roles in implementing these strategies.

## Box 7.2 **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 salinity at Morgan at less than 800 EC for 95 per cent of the time. 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 2005c).

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 (otherwise known as the 'benchmark period'). The benchmark period is 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.

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 (DWLBC, 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 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. (DWLBC, 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 water saving engineering works have also been related to salinity management. Excessive channel seepage, for example, has been linked to localised water logging and salinity in the Emerald Irrigation Area in Central Queensland. Fitzroy Food and Fibre argued:

> An ironic situation in the Fitzroy Basin is that the only salinity problem in the area is caused [by] constant seepage out of delivery channels owned and run by Sunwater, the monopoly GOC [government-owned corporation] responsible for the delivery of water. It has only been due to severe pressure from irrigators that Sunwater has started to do something about the problem by lining the channel with polythene. (sub. 11, pp. 6–7)

In some areas of Australia, groundwater pumping is used to manage high water tables. 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 conjunctively with fresh irrigation water and evaporation basins (Christen, Ajars and Hornbuckle 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. Salt interception works, by their nature, reduce river flows, and this water is not included as part of the Murray–Darling Basin Cap.

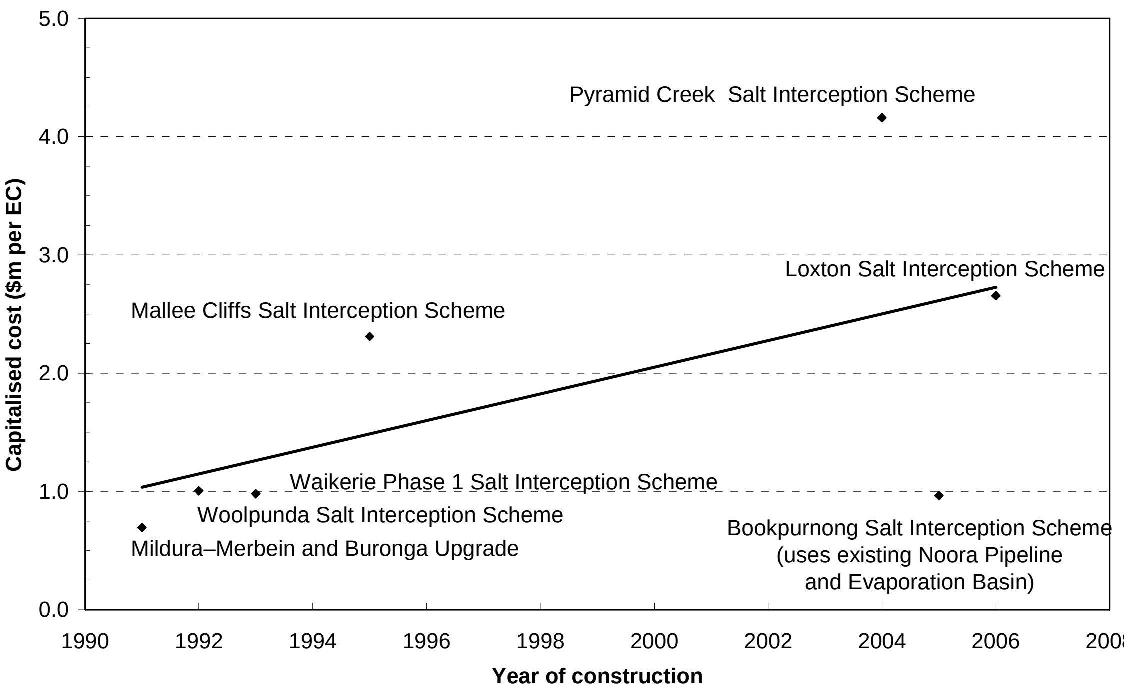
A major benefit of salt interception is the timeliness of its effect. By intercepting saline groundwater that would have entered the river, these schemes immediately reduce the river salinity.

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 Department of Water, Land and Biodiversity Conservation 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 7.1). 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.

Figure 7.1 **Cost of salt interception schemes**[a]




[a] Cost over 30 years, at 4 per cent return for construction, operation and maintenance.

*Source*: MDBC unpublished.

PRELIMINARY FINDING 7.2

*Salt interception works can immediately 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.*

## 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 salinity zones, high salinity zones, and areas of existing high salinity impact (which have salt interception works). A zoning approach similar to Victoria's is being developed in South Australia.

Under the Victorian scheme, levies tie irrigation development with salinity impacts within existing water markets. The levies are designed to ensure that purchasers of water internalise salinity impacts by charging a levy 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.

In some situations, salt interception may not be the least cost method of salt abatement:

> … 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 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). (DSE, sub. 39, p. 11).

The levy scheme, however, has been criticised for not encouraging removal of salt from the zones. For example:

> Victoria's salinity levies are a means of internalising the externalities which arise when water is traded into LIZs. 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. (ACCC, sub. 42, p. 8)
>
> … 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)

PRELIMINARY FINDING 7.3

*Salinity zoning schemes provide incentives to affect landholders' water purchasing decisions. Incentives may be needed to encourage the removal of salt.*

## Management of groundwater recharge

Within individual irrigation districts there is a variety of arrangements 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 water tables 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 Limited, sub. 3). Coleambally Irrigation (sub. 3) described several initiatives under the Coleambally Land and Water Management Plan to address salinity, including a proposed net recharge management. Experimental modelling by Whitten et al. (2005) indicated that the scheme would provide relatively low expected benefits relative to costs (box 7.3).

Box 7.3 **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 any gains from adopting the market instrument.

The pilot also highlighted the importance of the scientific knowledge underpinning institutional design.

*Source*: Whitten et al. 2005.

Addressing salinity problems through reductions in groundwater recharge is a longer term strategy than salt interception, given that the effect of these actions can take a long time to provide benefits. If close to a river, preventing groundwater recharge has relatively immediate effects on river salinity, but also on river flows. When recharge occurs further away from the river, it can take years (sometimes hundreds of years) for instream salinity to be affected. The rate of groundwater movement depends on the hydraulic conductivity of the soil and the hydraulic pressure of the system (WADAF 2004).

PRELIMINARY FINDING 7.4

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

Tree planting can reduce instream salt loads by intercepting water that would otherwise transport salt stored in the soil, but these benefits are not uniform across the landscape. In some areas it may intercept water that would otherwise dilute instream salt. Figure 7.2 shows that, by careful selection of sites for tree planting, there may be opportunities to maximise salinity benefits and minimise stream flow reductions based on an understanding of where runoff is produced in a catchment in relation to where salt discharge occurs.

## 7.3 Design issues

This section explores a number of key factors that need to be considered before developing market mechanisms to manage salinity.

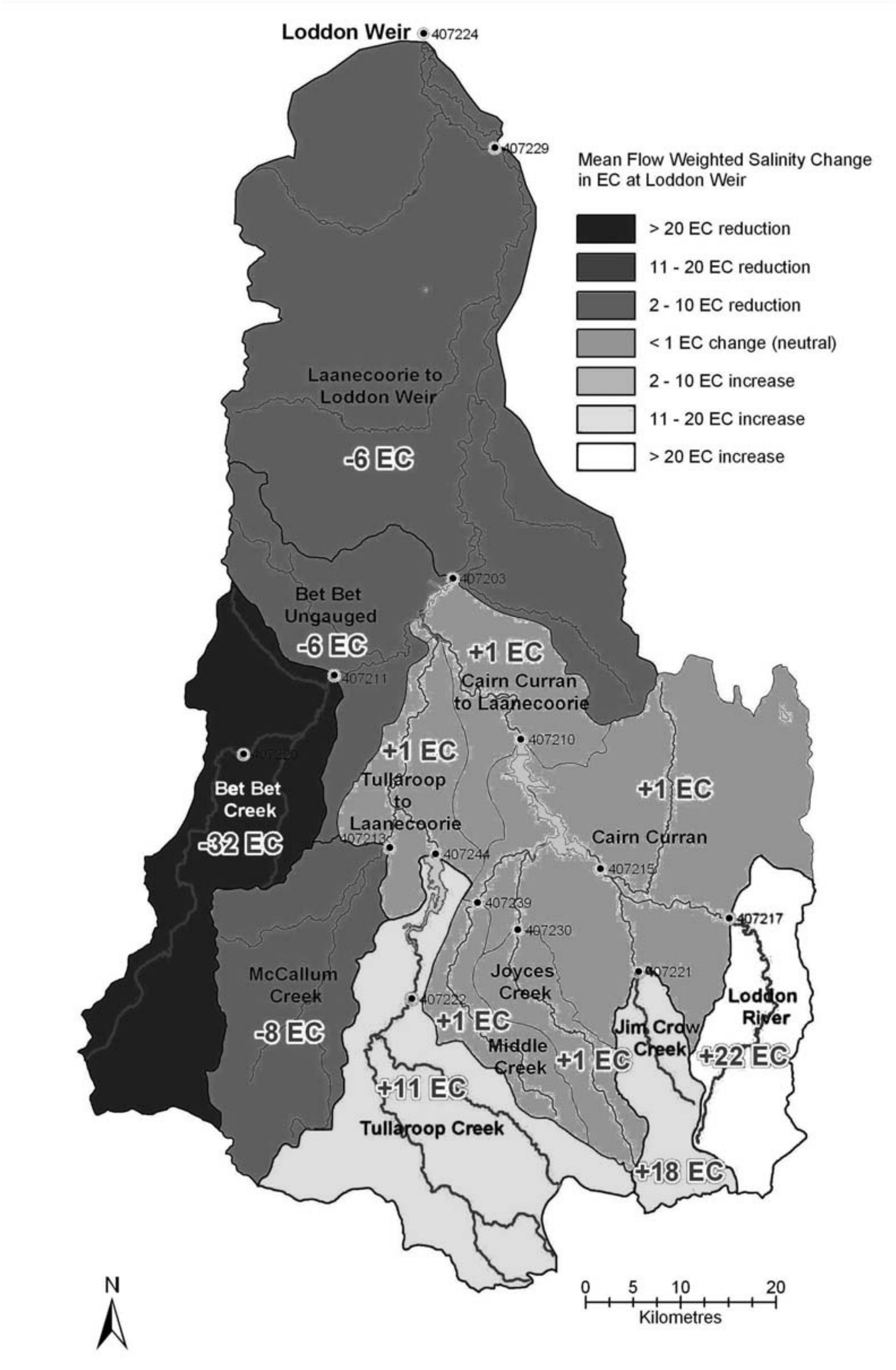
### Using existing institutional arrangements

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)

Figure 7.2 **Effects of tree planting on stream salinity**[a,b]




[a] The Murray–Darling Basin Commission has advised that this map should not be used for operational purposes. [b] 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.

*Data source*: MDBC 2006g.

- 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 interlinking 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 6, if flows are increased to improve flood plain 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 instream water quality standards — the Morgan target is based on the World Health Organization's recommended water drinking quality standards. Some flexibility of the target may be needed to remove salt from the basin in winter during high flow events (box 7.4).
- 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 5, an environmental manager would need to weigh the benefits and costs, and address the complex trade-offs that may be required between environmental objectives.

## Box 7.4 **Flexibility in setting salt targets**

In the Murray–Darling Basin, salinity targets are set by reference to the maximum amount of concentration at different points in the system. The main and most prominent target is that set for Morgan — at this point a target of 800 EC, 95 per cent of the time, is set.

The end-of-basin salinity targets established under the basin salinity strategy were criticised by the CSIRO for being overly prescriptive:

> Economic theory would suggest that it would be appropriate to vary this target to account for changes in the impact of salinity on irrigation and, also, on urban and industrial water users. While we have not done any detailed analysis, we suspect that it would be more efficient to organise river management and trading arrangements so as to ensure that salinity concentrations are low during periods of high use and high during periods of low use. (sub. 24, p. 8)

Heaney, Beare and Bell have also cautioned against only using end-of-valley targets as performance measures for salinity management:

> Taken in isolation, they may misdirect efforts [of] cost effective management of salinity as they do not provide a good measure of internal catchment health, nor do they provide any direct indication of the potential downstream benefits of meeting those targets. (2001, p. 19)

Whether the economic efficiency of the system would be improved depends on the benefits of more closely aligning the third party costs and the abatement costs, and the costs (management and potential risks) of implementing and managing a more complex cap.

Links between policy objectives can improve the effectiveness and reduce the costs of implementation of market mechanisms. For example, managing salinity outcomes is closely linked to managing environmental flows (chapter 6) and land use management. These links mean that mechanisms need to be coordinated to achieve policy objectives.

PRELIMINARY FINDING 7.5

*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 if flexibility in salt concentrations (such as the Morgan target) is introduced. The current target of 800 EC at Morgan is based on the World Health Organization's recommended drinking water quality standards because Morgan is near offtakes that supplement urban water supplies, such as Adelaide and Whyalla. Increasing the Morgan target may be possible if alternative water supplies or storages are available during periods when saline flushes are feasible — such as average to wet winters. 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).

PRELIMINARY FINDING 7.6

*Flushing salt out of a catchment or basin may be an efficient approach to managing salinity. Seasonal flexibility would be needed in the Morgan salinity target 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 information available on the source and incidence of salinity.

Measures of salinity include:

- electrical conductivity — can easily measure the in situ concentration of instream salt
- groundwater recharge — a proxy for farm contributions to salinity, through the mechanism by which they add to rising saline water tables (box 7.5)
- 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.

Increasing the accuracy of measurement is costly, and may not significantly increase the effectiveness of the market mechanism. Tradeoffs that take into account the costs and benefits of different accuracies of approximation techniques are required.

The choice of measure depends on the incentive being targeted. 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 at the farm level because 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, recharge from the property — estimated on farm characteristics that can be altered through landholder actions and that has a close scientific link to the salinity outcome — may be an appropriate proxy at farm level.

Box 7.5 **Estimating groundwater recharge**

There are various methods that could be used to estimate groundwater recharge. The estimation of deep drainage and aquifer recharge in Australia is summarised by Petheram et al. (2002). 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 measurement. The theoretical basis for this is the empirical relationship between deep drainage rates and soil type.

*Source*: Cook, Leaney and Jolly 2001.

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 problem 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 developing a tool to measure the environmental benefits of management decisions is vital and such a tool '… would increase transparency and help limit ad hoc decision making' (National Water Commission, sub. 22, p. 3).

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 improve the potential for market mechanisms to be implemented. The Murray–Darling Basin Commission and the CSIRO, in conjunction with private industry, have developed a model called the Salinity Impact Rapid Assessment Tool (SIMRAT). 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 impact. This accountability is imposed through a levy system (discussed below). South Australia also uses SIMRAT to assist in monitoring water trade approvals because trades are restricted in high salinity impact zones (MDBC, 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).

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).

### 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 attempted to recognise some of the temporal dimensions by recognising and allocating responsibility for legacy effects of past management decisions that result in salinity (box 7.2).

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, Beare and Bell (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 mean 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. Furthermore, 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 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 choice.

PRELIMINARY FINDING 7.7

*Regulations may be appropriate to manage salinity in the short run, where immediate changes are required.*

## 7.4 Reducing the emergence of salinity

This section assesses key quantity and price-based market mechanisms that could be designed to reduce the emergence of salinity. Cap and trade, 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 regional level using different measurement methods to represent the discharge or creation of salt, including:

- 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).

### *Cap and trade of salt emissions*

Under a cap and trade of salt emissions, a development that abates salt entitles the landholder to a salt credit which could then be traded to other landholders requiring credits to account for activities that create 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 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 authorities — discussed in section 6.4).

A cap and trade scheme for salinity has the advantage of allowing landholders to flexibly manage saline discharges by providing incentives to landholders who can more easily reduce their discharge levels to do so (table 7.2). This market mechanism allocates discharge permits to those irrigators that would most value them. Those using 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 systems need well-defined markets for discharge. In general, cap and trade mechanisms are difficult to apply to non-point sources because detailed measurements of discharges and environmental harm to specify the permits are required. 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. However, there can also be substantial savings in the costs of securing the reduction in saline discharge. 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 determining salt permit levels for individual farms may involve more detail than is feasible, specifying permits on a catchment level, capped at a basin level, may be more practical. Hence, this could be useful for mitigating the cost of salinity (shifting it to a low cost area of effect) but not for preventing the emergence of salt at the farm level. Catchment level salinity measures are more reliable and do not require the detailed monitoring or initial specification that farm level permits would. Thus, while a cap and trade of salt may not be cost-effective at the farm level, it may be viable at the catchment 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.

Table 7.2 **Assessment of cap and trade of salt at the catchment level**

| *Issue* | *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 | High — 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. |
| Likelihood of achieving desired goals | High — if implemented at a scale where measured salinity outcomes are highly correlated to the actions of participants. |

PRELIMINARY FINDING 7.8

*Capping and trading salt is feasible at the catchment 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 it 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 on-farm level permits or irrigation/catchment authority level permits (table 7.3).

Heaney, Beare and Bell (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.

The CSIRO and Coleambally Irrigation developed a pilot scheme to manage groundwater recharge in the Coleambally region (box 7.3). 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.

Table 7.3 **Assessment of cap and trade of groundwater recharge**

| *Issue* | *Assessment* |
|---|---|
| Costs | Medium — detailed scientific information is required of 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 benefit more than those with lower water tables. Benefits may be small and incremental. |
| Likelihood of achieving desired goals | Medium — if groundwater recharge at the farm level can be effectively managed and measured by the scheme. |

PRELIMINARY FINDING 7.9

*Capping and trading 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 for on-farm irrigation practices to occur*

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 have 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 7.4).

The Coleambally Irrigation Co-operative Limited 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-wide rice area reductions due in July 2007, via the adoption of rice area offsets (net recharge ratios). (Coleambally Irrigation Co-operative Limited, 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. 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.

Table 7.4 **Assessment of offsets for groundwater recharge**

| *Issue* | *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 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). |
| Likelihood of achieving desired goals | High (in longer term) — some offsets can have lags before effects on groundwater levels occur. |

PRELIMINARY FINDING 7.10

*Offsets for groundwater recharge have been successfully implemented to address localised salinity problems.*

### *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 impact areas along the River Murray are used to fund salt interception works. 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 comparatively reduce the incentive to sell water out of areas with high salinity effects.

> … 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. (ACCC, 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.

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 ability to be site-specific (if such discrimination is possible) (table 7.5).

PRELIMINARY FINDING 7.11

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

Table 7.5 **Assessment of zoned salt levies on water trade**

| *Issue* | *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. |
| Likelihood of achieving desired goals | Medium — will probably stabilise, rather than reduce, current salt levels. |

## 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. Funding dryland action may be more efficient than trying to manage the salinity problem within the irrigation district, or alternatively by the public who benefit from improved environmental outcomes.

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 7.6). 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, for example, could contribute to dryland salinity management in the catchment area between Burrunjuck Dam and the Murrumbidgee Irrigation Area and Coleambally offtakes on the Murrumbidgee River.

Table 7.6 **Assessment of tenders for land management change**

| *Issue* | *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 | Auctions 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. |

PRELIMINARY FINDING 7.12

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

## 7.5 Disposing of salt

The 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 incentive arrangements to deliberately allow salt to enter the river to flush it from the landscape into the river and out of the basin on an ongoing basis.

Given that the costs of instream salinity in the Murray–Darling Basin are generally 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 offset arrangements
- purchasing flows for the purposes of dilution and flushing salt.

Market mechanisms will be required to establish and ensure allowable concentrations are not exceeded. 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 (NSW EPA 2003). Meeting such a target also requires an allocation mechanism.

It may be possible to establish similar arrangements in parts of the Murray–Darling Basin where the removal of salt may be technically feasible. For example, in the lower parts of the River Murray, salt inception scheme pumps could be turned off (saving fuel costs), credits traded for a period of time and saline groundwater allowed to leach into the river (increasing river flows).

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 dilutions flows could be established in the same manner as markets for environmental flows (chapter 5).

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. As noted earlier, there may be opportunities to increase the flexibility of existing water quality standards.

PRELIMINARY FINDING 7.13

*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 |
| Australian Dairy Farmers Limited | 12 |
| Australian Spatial Information Business Association Ltd | 27 |
| Block, JB | 30 |
| Bowring, T and Associates Pty Ltd | 9* |
| Brooke, JD | 10 |
| Bureau of Meteorology | 28 |
| Coleambally Irrigation Co-operative Limited | 3, 4 |
| CRC for Irrigation Futures | 21 |
| CSIRO Water for Healthy Country National Research Flagship | 24 |
| Department of Water (Western Australia) | 56 |
| Department of Water, Land and Biodiversity Conservation (South Australia) | 36 |
| Department of the Premier and Cabinet (Queensland) | 38 |
| Department of Sustainability and Environment (Victoria) | 39 |
| Dwyer, Dr T | 52 |
| Engineers Australia | 8 |
| Emerald Shire Council | 43 |
| First Mildura Irrigation Trust | 6 |
| Fitzroy Basin Food and Fibre Association Ltd | 11 |
| Gault, PD and SM | 14 |
| High Catchment Committee | 7 |
| Horticulture Australia Ltd Water Steering Group | 32 |
| Land and Water Australia | 16 |
| Minerals Council of Australia | 40 |
| Murray–Darling Basin Commission | 31 |
| Murray Irrigation Limited | 55 |
| Murrumbidgee Horticulture Council Inc | 37 |
| National Water Commission | 22 |
| New South Wales Cabinet Office | 41 |
| Northern Territory Horticultural Association | 51 |

(Continued next page)

Table A.1 (continued)

| *Individual or organisation* | *Submission number* |
|---|---|
| Northern Victorian Irrigators Inc | 44 |
| Quiggin, Professor J | 53 |
| Southern Riverina Irrigators | 25 |
| Sunraysia Irrigators Council Inc | 33 |
| Timbercorp Limited | 20 |
| Tree Plantations Australia | 50 |
| University of Technology Sydney | 18 |
| Water Corporation (Western Australia) | 29 |
| Water Find Pty Ltd | 23* |
| 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 |
| Winemakers' Federation of Australia | 13 |
| WWF Australia | 34 |
| Victorian Farmers Federation | 35 |
| Victorian Farmers Federation – Sunraysia Branch | 49 |

* 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 National Committee on Irrigation and Drainage |
| Australian Property Institute |
| Australian Spatial Information Business Association Ltd |
| Australasian Bottled Water Institute Inc |
| Coleambally Irrigation Co-operative Limited |
| Cotton Australia Limited |
| 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 Primary Industries and Fisheries (Queensland) |
| 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) |

(Continued next page)

Table A.2 (continued)

| *Interested parties* |
| --- |
| 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 |
| Murray Irrigation Limited |
| Murrumbidgee Irrigation |
| Murrumbidgee Private Irrigators Inc |
| National Water Commission |
| New South Wales Government |
| North Central Catchment Management Authority |
| NSW Irrigators' Council |
| Queensland Government |
| 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 |
| 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 forestry) 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 the unpredictable nature 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 (including the ACT) (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 + reuse water use – in-stream (non-consumptive) use. **b** Includes the Australian Capital Territory. **c** The majority of water used by this industry is 'in-stream' 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 appendix C. 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 are the next largest users, 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 approximately 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 have been 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 amount 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 70–72 per cent of all irrigation water use in Australia (CIE/LWA 2004; NLWRA 2001a; MDBC 2006b).

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* | *Size*[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* | *Size*[a] *(Entitlement)*[b] | *Location* | *Main source of irrigation water* | *Major irrigated crops (irrigated industries)* |
|---|---|---|---|---|
| Ord River | 13 500[c] (335 000) | Spans the north-eastern 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) | The southern tip of the Great Barrier Reef, Queensland | Controlled stream | Sugarcane, macadamias, tomatoes |
| Burdekin-Haughton | 45 850 (608 521) | North Queensland, between Townsville and Bowen | Controlled stream | Sugarcane and small crops (sugar, horticulture) |
| Mareeba-Dimbulah | 30 000 (152 072) | Northern Queensland at the base of Cape York Peninsula | Controlled stream | Sugarcane, mangoes, peanuts (bananas, sugar) |
| Nogoa-Mackenzie | 24 643 (167 682) | Central Queensland | 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 2).

*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, reuse (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 sixty-eight 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), reuse 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 reuse 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 farm-gate 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 hydrology 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 and floodplains, and irrigation and other consumptive 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. Land use changes such as forestry and clay spreading can reduce return flows, which may in turn increase salinity problems (chapter 7).

The amount of return flow also influences the volume of water available for environmental and other uses. More water 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 water 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 authority (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 businesses in Victoria, three of which provide bulk water services to a number of rural and urban water businesses. 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 affects the determination of water entitlements, water trade and barriers to water trade. Each of these is discussed below and in chapters 2, 3 and 4.

### *Water entitlements and 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.

Note that language also 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 spill. Fitzroy Basin Food and Fibre Association stated that:

> 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.

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%)<br>High (95–97%) | Separated from land | Allowed | *Water Management Act 2000* |
| Vic. | Volumetric[b] | High (96–99%)<br>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 1997* |
| SA | Volumetric | High (almost 100%) | 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-land holders 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 2). [f] Non-landholders cannot hold water. [g] Where relevant water resource allocation plans are complete.

*Sources*: ACIL Tasman in association with Freehills 2004; DNR, pers. comm., 25 May 2006; DNRM, pers. comm., 24 May 2006; DPIW, pers. comm., 25 May 2006; DSE 2004; DSE, pers. comm., 26 May 2006; DWLBC, pers. comm., 18 May 2006; *Northern Territory Water Act 2004*, Section 45; NWC 2006a; Shi 2005.

*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 2006c). 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.

## 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 and 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 all participating states engage in interstate trade.

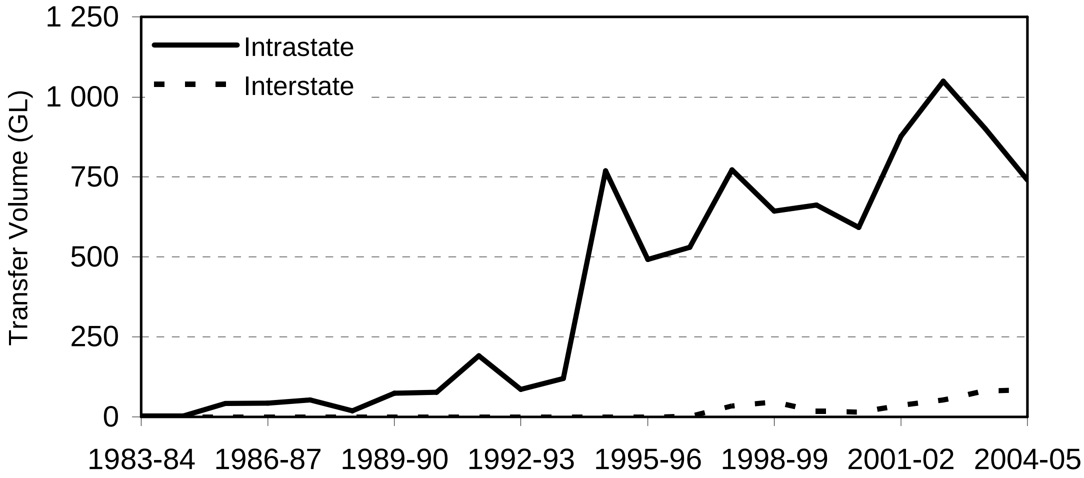
*Sources*: MDBC 2006d; Young et al. 2000.

In 2003-04, 4.8 per cent of all Australian agricultural establishments reported purchasing water and 3.4 per cent reported selling water. Victoria reported the largest percentage of agricultural establishments trading water, followed by New South Wales (ABS 2005). Other jurisdictions, however, are still in the early stages of water market development. In the same year, 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 2006). In all instances, larger volumes have been traded for seasonal allocations than for water entitlements.

## Water trade in the Murray–Darling Basin

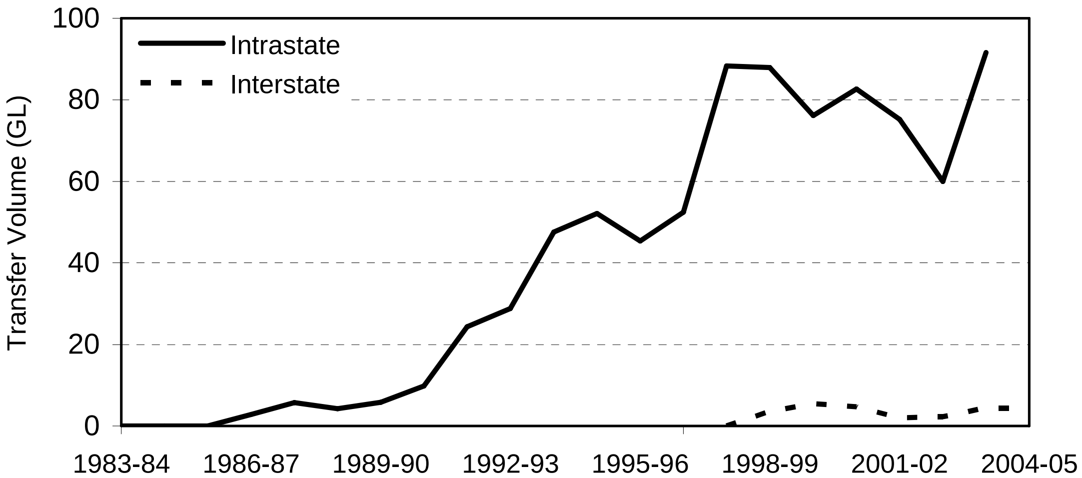
The most active water trading region is in the southern Murray–Darling Basin where trade in entitlements began in 1989 and trade in seasonal allocations has occurred since 1983 (Cummings 1990). This is the only region to have participated in interstate water trading to date (box B.2). Figure B.1 shows 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 3, section 3.4).

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.

Limited price data is publicly available, making comparisons across regions difficult. To give some indication of trade prices and volumes, for 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).

### 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 (QDPC, 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 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 (SunWater, 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 (SunWater, 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 (chapter 2)
  - – 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 3)
- 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 29–89 megalitres for entitlements and 28–131 megalitres for seasonal entitlements. 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 stocks and flows, but these measures are being introduced slowly due to poor 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).

### Current reforms to trade

The Commonwealth, 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':

- 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 chapters 2 and 3.

# C Water-use efficiency

The terms of reference required the Commission to examine market mechanisms as a means of providing incentives for investment in rural water-use efficiency. Section C.1 discusses different measures of water-use efficiency. Sections C.2, C.3 and C.4 consider the efficiency of water use on-farm, in water delivery and for environmental use, and section C.5 concludes by presenting the role of government in furthering the economically efficient use of water.

## C.1 Economic versus physical water-use efficiency

Physical water-use efficiency 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. The economic meaning of water-use efficiency takes into consideration a larger set of factors. The concept of *overall* economic efficiency is about ensuring individuals maximise their utility, given all resources (including, but not limited to water) available in the economy. Increasing economic efficiency, rather than physical efficiency, is what is necessary to achieve the ultimate goal of policy or regulatory endeavours — to improve the wellbeing and living standards of the community.

To minimise confusion with terminology, the report refers to the 'economically efficient use of water', or economic efficiency, when referring to economic concepts of water efficiency. The term 'physical water-use efficiency' is used when referring to physical concepts. This section explains the differences between these two concepts.

### 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. On a farm, 'water-use efficiency' may refer to the tonnes of agricultural production per megalitre of water use, or the proportion of irrigation water applied that enters the root zone (Fairweather, Austin and Hope 2003), and takes the general form of 'crop per drop'. In terms of distributing irrigation water, physical water-use efficiency can refer to the volume of water received at the farm gate as a percentage of the volume of water leaving storages. The National Program for Irrigation Research and Development (NPIRD 1999) released a comprehensive framework for physical water-use efficiency (box C.1).

Box C.1 **Examples of measures of physical water-use efficiency**

| | | |
|---|---|---|
| Irrigation water-use efficiency | — | Total crop production (kg) per irrigation water applied (ML) |
| Crop water-use efficiency | — | Total crop production (kg) per evapotranspiration (mm) |
| Gross production water-use efficiency | — | Total crop production (kg) per total water applied (ML) |
| 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) |

*Source*: NPIRD 1999.

As Fairweather, Austin and Hope (2003) observed, it is difficult to compare physical water-use efficiency measures across different industries because the variables measured are generally not the same. The dairy industry, for example, often reports irrigation performance as a measure of the product divided by sum of irrigation and effective rainfall. And the cotton industry reports water-use indices as the yield of lint divided by the irrigation water applied. While this enables a comparison within each industry if performance based indices reported by others in the same industry concur, it is not possible to make a comparison of performance between industries. Further, these measures do not take into account all factors that contribute to the loss of water in an irrigation system. Factors such as climate, soil type, hydrology, type of irrigation and topography are mostly unpredictable and heterogeneous, and therefore complicate management and measurement of the system.

Water-use efficiency in water supply and delivery systems is generally reported in terms of the water delivered to the farm as a proportion of the water diverted from the river system (ACIL Tasman 2003). When using water to generate ecosystem services, a simple measure of water use can be average flow, or the annual volume of water out of the mouth of the river.

## Economic water-use efficiency

The Commission has used an economic definition of water-use efficiency that incorporates how water resources are allocated and used to achieve the greatest net social benefit, including social and environmental costs and benefits. This approach is consistent with a central objective of the National Water Initiative (NWI), which is to manage surface and groundwater resources for rural uses in a way that 'optimises economic, social and environmental outcomes' (COAG 2004, p. 3).

This approach was welcomed and agreed to at the Commission's consultation (table A.2) and in the submissions received (table A.1). Australian Dairy Farmers, for example, '… strongly recommend that on-farm efficiency of resource use be analysed over the spectrum of all inputs and outputs, rather than focusing on one component such as water' (sub. 12, p. 5).

An activity is economically efficient if there is no other use where the resources would yield a higher value or net benefit. More commonly, an activity is described as economically inefficient if its costs exceed its benefits, or it can be demonstrated that the resources could be used to produce something with a higher net benefit. Overall economic efficiency requires satisfaction of *productive*, *allocative* and *dynamic* efficiency (box C.2).

Box C.2 **Components of economic efficiency**

Economic efficiency is about maximising the wellbeing of the members of the community. Economic efficiency requires satisfaction of three components:

1. *Productive efficiency* is achieved when output is produced at minimum cost. It incorporates technical efficiency, which refers to the extent that it is technically feasible (in the production of any good or service) to reduce any input without decreasing the output, and without increasing any other input. If waste is avoided in this way, improvements in productive efficiency can generate more income and improve living standards.
2. *Allocative efficiency* is about ensuring that the community gets the greatest return (broadly defined) from its scarce resources. A nation's resources can be used in many different ways. The best or 'most efficient' allocation of resources is the one that contributes most to community wellbeing. Improvements in allocative efficiency bring improvements in living standards because resources are used to generate more income and satisfy more needs and desires.
3. *Dynamic efficiency* refers to the allocation of resources over time, including allocations designed to improve economic efficiency and to generate more resources. This can mean finding better products and better ways of producing goods and services. Investments in education, research, development and innovation are involved. Dynamic efficiency can also refer to the ability to adapt efficiently to changed economic conditions, a capacity for optimally modifying output and productivity performance in the face of economic 'shocks'. Improvements in dynamic efficiency bring growth in living standards over time.

*Source*: Adapted from PC 1999.

The concept of economic efficiency can be usefully applied to efficiency on farm, efficiency in water delivery, and efficiency of 'environmental' uses that generate ecosystem services valued by society.

## C.2 Efficiency on farm

Farm managers participate in many markets and manage a mix of inputs (not just water) and outputs. The economic efficiency of a farm or activity covers *all* the inputs used in production and outputs produced.

> Among other things, economic efficiency depends on the cost of irrigation equipment, the prices of commodities and the price of water. There are a vast number of irrigation techniques and production systems that will be profitable at any time for different capital and input costs and product prices. A major influence on costs is the resources already available to the farmer. (Watson 2003, p. 10)

> Water is one of the inputs to agricultural production. It cannot be treated in isolation from other inputs such as energy, labour, equipment, fertilisers, chemicals etc. (Australian Dairy Farmers, sub. 12, p. 4)

Irrigators are generally well-informed about water-use choices and are best positioned to make privately sound decisions about allocating water to productive uses. They face clear incentives because such production decisions determine farm profitability.

Farmers often invest in technology that increases water-use efficiency, not purely for the benefits of reducing water consumption, but because such technology also brings benefits in terms of improved quality of output and savings in other inputs such as labour (box C.3). Many submissions also noted this interaction between on-farm water-use decisions and decisions regarding other inputs and outputs:

> Reduced water use is of itself seldom a factor, but more efficient use of available water certainly is. Where centre pivot installation and/or subsurface drip irrigation is concerned, efficiency gains are likely to be derived from greater production per hectare and an increase in the number of hectares irrigated. In respect of flood irrigation, devices which avoid water wastage usually allow a greater area to be irrigated. (JD Brooke, sub. 10, p. 1)

> … many grapegrowers use water to influence specific quality attributes of the grapes as they grow grapes according to the specifications required for particular price segments within the wine market. (Winemakers' Federation of Australia, sub. 13, p. 5)

> Labour is the driving force behind most infrastructure spending, agronomic need dictates water requirement and it is a poor farm system indeed where large savings can be made through on farm water infrastructure. (PD and SM Gault, sub. 14, p. 5)

> The majority of water use efficiency [investment] is driven by higher productivity. This comes in the form of higher crop and pasture yields, these are the main drivers. Other drivers are labo[u]r efficiencies and environmental benefits such as less water being

used per ton[ne] grown and water infiltration into the water table. Water saved is then put back into the production system in driving the over all farm profitability. (Southern Riverina Irrigators, sub. 25, p. 1)

… irrigators [are] installing more efficient on farm irrigation systems, both for labour saving and increased water use efficiency. This has not necessarily resulted in less water use per hectare, but has seen an increase in production for the same amount of water applied more efficiently. (Sunraysia Irrigators Council, sub. 33, p. 3)

Box C.3 **Water-use technology decisions**

An irrigator faces many choices about the best way to use available resources. Some of these choices are directly related to on-farm water use, such as irrigation scheduling methods or investment in different irrigation technologies. Water is not, however, the only input to production, and often accounts for only a small proportion of total farm costs. Irrigators must also make decisions about how and when to use labour, capital and land. The choice of irrigation technology will depend on the topography, soils and enterprise mix on the farm.

Improving the proportion of applied water that reaches the crop root zone could reduce the costs of water used on farm, but does not necessarily drive an irrigator's decisions, particularly when the price of water is low. Two examples of improving physical water-use efficiency include:

1. *Laser grading* is a technique employed to level the land on an irrigated paddock. Laser grading typically creates much wider and longer irrigation 'bays' in a border check flood irrigation system. This reduces the labour involved in monitoring and adjusting the flows of water, and allows for a more even application of water. Laser grading can reduce the volume of irrigation water required, and may improve crop yields and quality by reducing high and low areas on the field. For many irrigators, the decision to undertake laser grading is driven by the labour savings rather than by the value of reduced irrigation water required.
2. *Converting from flood to centre pivot sprinkler irrigation* can reduce water use and alleviate the off-farm environmental impacts from irrigating pasture or crops. The value of water saved, however, may be outweighed by the costs associated with the centre pivot system, including:
   - the capital cost of the sprinkler system
   - reducing the area of land that can be irrigated (due to the circular wetting pattern)
   - pressurising water supplies.

The extent to which reconfiguring infrastructure and vegetation (to allow for clearance of the system) reduces irrigation water requirements will also vary significantly from one property to another, depending on factors including crop types, local climate conditions and soil types. Flood irrigation is well-suited to heavier soils, for example, so for a farmer flood irrigating pasture on clay-type soils, the cost of converting to sprinkler irrigation might outweigh the value of the reduced water required. In contrast, a farmer growing pasture on sandy soils, which hold less water, might prefer sprinkler irrigation because of the greater potential to reduce water used and other economic benefits.

## On-farm productive efficiency

On-farm decisions on water use are a function of many factors:

- The cost to farmers of using additional supplemented water is determined by utility delivery charges and the traded price on water in their district. These depend on the other demands on water from competing farms and industries as well as the supply of water in dam storages and from prevailing weather conditions.
- The benefit of applying water depends on the value of the crop being produced and the use of other inputs that combine with water in crop production, including fertilisers and labour.

Water is not a large component of most agricultural input costs. In the most water-intensive irrigated industries, such as rice growing, the cost share is 10–20 per cent. In 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, Douglas and Dwyer 2004).

Regardless of the intensity of water use in a given production system, economic efficiency requires all inputs (including water) to be used so that the value of their *marginal* contribution to production is equal to their price (box C.4). The volume of water demanded by an irrigator in a particular season is the difference between the water requirements of the irrigator's irrigated activities and local rainfall during the growing season. The irrigation water is sourced from holding water entitlements that give seasonal water allocations, and from water trade. The quantity of irrigation water demanded will vary with the prevailing price for which additional water can be bought and sold.

### *Reactions to changes in the price of water*

Rainfall and other weather conditions in irrigation districts and their storages vary significantly both within and between years, leading to changes in irrigator demands for water, and prices of water in regions where water trading is possible. Most farmers have farm plans that include a water-use component and adopt a range a farm management strategies.

The way that farm managers react by changing water use can depend on the length of crop rotation, for example, leaving land fallow and demanding less water, or applying less water to the crop and risking some yield loss (in the case of rice or cotton). Southern Riverina Irrigators noted:

> [a high water] price, in conjunction with a low commodity price, could mean that the irrigator will not go ahead with that crop because the return is not sufficient once these added costs are factored into the cost of production. (sub. 25, p. 1)

**Box C.4 Efficiency involves marginal decisions of 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 production, 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. A rice farmer, for example, may use extra water to increase the yield of a rice crop, while a dairy farmer may use extra water to grow more pasture to produce extra milk.

Typically, at some point the MP falls as more units of water are added. Beyond some threshold, additional units of water can reduce production — the MP can be negative. The value of the marginal product (VMP) of water is determined by multiplying the MP with 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 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, Dwyer and Peterson 2004.

Management of perennial crops is different to managing annual crops when dealing with changing water prices because a minimum amount of water is required to protect trees and vines (a biological capital asset), and it takes many years and dollars to replace such assets if they die (Appels, Douglas and Dwyer 2004). The Water Steering Group for Horticulture Australia held the view:

> High water reliability … is required for permanent horticultural crops, and [there is a] huge cost of replanting if permanent crops suffer from water restrictions (several years income as well as replanting cost). (sub. 32, p. 1)
>
> The cost of replanting can be up to 7 years production loss. This is very important where irrigators do not have access to water trade to help manage the risk of inadequate water allocation. (sub. 32, p. 5)

The Department of Water, Land and Biodiversity Conservation (South Australia) also noted the impact that crop type, whether annual or perennial, has on farm management:

> The majority of crops in South Australia are 'permanent' plantings ([for example], vines, citrus fruit and almonds) and hence, irrigators are dependent on permanent water allocations. Unlike NSW and Victoria, few opportunistic crops (such as wheat and rice) are grown and hence there is little opportunity to undertake 'opportunistic' cropping when commodity prices are high. As a result, South Australia[n] irrigators are dependent on high water security with trade in temporary water. (sub. 36, p. 5)

Other inputs may be able to substitute for water in the productive process to some degree. For example, labour may be able to substitute for some water by increased monitoring and management of irrigation bays, and by providing some dry feed for cattle rather than using as much water to irrigate pasture (Appels, Douglas and Dwyer 2004). Substituting other inputs for water is limited, however, making demand fairly inelastic in the short run.

### Allocative efficiency of on-farm water use

Allocative efficiency of water use is concerned with allocating water between different uses — be they agricultural irrigated production, urban household consumption, other industries, or the generation of ecosystem services valued by society. Discussion in policy arenas generally follows the argument that the system should allocate 'water to the highest value use' (DSE 2003), a desirable goal if the measurement of 'value' is appropriate (such as one based on marginal values, and not average or 'value added' concepts). As Australian Dairy Farmers noted, however:

> … references to 'higher value-adding uses' can embody serious over-simplifications. Apart from the considerable differences in the proportion of value added pre- and post-farm gate across different agricultural industries, there are the very real market risks of domestic over-production ([for example], wine grapes currently) or producing products that are outpriced by cheaper imports ([for example], oranges currently). (sub. 12, p. 4)

Similarly, Watson commented:

> Talking about 'high value products' where irrigation water should be used was economic nonsense. The information needed to make such judgements is too daunting given [the] differences between farms and farmers. Water should be used in ways ensuring its marginal value is highest, including environmental uses. … Farmers are best placed to decide how water should be used given their knowledge of their own circumstances and opportunities. (2003, p. 10)

In addition, the Victorian Farmers Federation submitted:

> Diverting water from dairy to allegedly 'higher value-adding' industries such as horticulture is often raised in the literature as a desirable outcome. … The VFF believes

that such references are a serious over-simplification as there are considerable differences in the proportion of pre- and post-farm gate value added across different industries. (sub. 49, p. 4)

Traditional farm-management tools like gross margin are sometimes used to evaluate the value of using water as an input into agriculture 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 as Douglas, Dwyer and Peterson noted:

> 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, we would expect to still see large variations in gross margin per megalitre. Grape production, for example, may have a higher gross margin per megalitre than dairying even after water has been optimally allocated between grapes and dairying. (2004, p. 2)

The Water Steering Group for Horticulture Australia also 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)

Box C.4 indicates that the value of the marginal product of water of a given use is the measure of value that is ideal when markets are complete and fully functioning. That is, it 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. Because private decision makers determine on-farm water use in their own best interests, using water up until the point that the value of their marginal production from water equals the price they pay for water, water markets help to improve allocative efficiency.

It is more appropriate, therefore, to refer to the allocation of water to where it is most highly valued (in terms of water's marginal value to production). And farmers and business managers are best placed to determine this value using the production opportunities available to them, and using water markets to assist water trade. Chapters 2 and 3 explores some of the impediments that may prevent water markets from fully realising this result.

## Dynamic efficiency of on-farm water use

Economic water-use efficiency also has a dynamic component — how the productive and allocative efficiency of water use is maintained over time in the context of a changing world. This includes long run farm management decisions (such as investment decisions for technology that increases physical water-use efficiency) and the changing mix of irrigated activities as a reaction to economic changes (such as fluctuations in commodity prices).

Over a long time horizon, capital can substitute for water through investment in water saving technology and more physically efficient irrigation methods. As noted, these changes also have effects on the quality and quantity of the output produced. The decision to take up such technology can be complicated by:

- individual farm characteristics
  - Because decisions vary across regions and industries — reflecting factors such as the products being produced, scale of operation, biophysical characteristics of the land being irrigated, the extent and dependability of water supplies, and whether water is pressurised — simple comparisons of technological uptake across regions and types of enterprises can be misleading. (Wellington Shire Council, sub. 19, p. 5)
- farmer characteristics such as risk aversion as embodied in their risk management approach
  - Many grapegrowers will chose to keep extra water entitlement as a form of risk management. For example, extra water is kept to protect against both unexpected hot weather and to offer frost protection. (Winemakers' Federation of Australia, sub. 13, p. 6)
- uncertainty about the value of the new technology and the need for further development
  - Rapid uptake of relevant new irrigation technologies is an obvious characteristic of irrigation farming and can be seen on almost all horticulture, dairying and irrigated cropping farms. Until the recent drought Murray and Goulburn Valley farmers had spent at least $10 000 per year over the preceding 15 years on typical 80 ha farms. But the proviso of relevance means economic decisions associated with labour saving and improved productivity must underpin these investments. Many techniques have not had widespread adoption because they are either unprofitable, require more development or do not fit into current systems. As usual early adopters will try these techniques. This trial and adaptation phase would benefit from encouragement and assistance in evaluation. (Northern Victorian Irrigators, sub. 44, p. 4)
- changes to the *relative* price of water with respect to other inputs
  - It is not just water use efficiency that needs to be looked at but the energy costs as well. (Southern Riverina Irrigators, sub. 25, p. 1)

When evaluating the merits of water-related projects, an expectation of future prices of water and other inputs must be formed rather than simply using current prices. Some participants considered that the energy costs used in evaluating different water-use technologies, which are especially important in pumped and pressurised systems, may need to be more forward looking given technology investments are long lived:

> … whole-of-life energy requirements of different water management approaches are becoming rapidly more critical because of greenhouse and climate change considerations, and water policy must come to grips with this issue as a matter of urgency. Analyses based on today's seemingly unsustainably low energy costs should be viewed with caution in relation to any long-term decisions… (Australian Dairy Farmers, sub. 12, p. 8)

Farmers generally will make decisions about investing in technology that increases physical water-use efficiency based on the merits of the expected costs and benefits in terms of capital expenditure and changed input use:

> In general, farmers will adopt new technologies for [physical water-use efficiency] if they perceive net benefits from investment in upgrading their irrigation practices. Thus, it can be expected that the appropriate level of investment in these technologies will occur as part of the normal investment environment in farming. (Beynon, Kingma and White 2002, p. 1)

But the benefits of 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 [megalitre per hectare] the potential water savings from the installation of further water saving technologies are likely to be small. (sub. 13, p. 5)

This means that economic efficiency, rather than physical water-use efficiency, may not be increased by further investment in available irrigation technologies, because the costs (in terms of capital outlay and running costs) outweigh the benefits (in terms of the value of the water saved):

> … 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] (DWLBC, sub. 36, p. 4)

Changes in commodity prices through time would be expected to change the 'efficient' allocation of water since the marginal value of water in production is linked to the price of the commodity produced. This would result in movements of water between irrigated industries:

> Water allocation trading is principally used to match water availability to existing need, but there is some early evidence that water trading is facilitating structural adjustment in the industry. For example, one third of respondents changed their main water-using industry after selling their water allocations. In particular, water allocation holders in the Burnett basin moved out of the sugar industry and into less water intensive industries such as livestock and small crops. (QDPC, sub. 38, p. 14)
>
> Another possible factor may be the differing fortunes of the industries in the respective basins. Some sugar growers in the Burnett basin have been selling their water allocations as part of ongoing restructuring in the sugar industry (thereby increasing the supply of water on the market). In the Fitzroy basin, greater demand for water from highly profitable coal mining industries and the water-intensive cotton industry may have contributed to higher water prices in that region. (QDPC, sub. 38, p. 11).

The existence of a market for water that can inform private on-farm decision making regarding the value of water for market participants could therefore promote the more efficient use of the resources over time.

### Existing incentives and markets are contributing to the economically efficient use of rural water

Irrigators in many parts of Australia, particularly in the southern Murray–Darling Basin, face a number of incentives to allocate water to its most productive uses on farm. This in part reflects the competitive nature of agricultural markets, which provides disciplines for producers to grow crops sought by consumers and to use inputs efficiently. There are also existing water markets that provide signals to farmers to make efficient water-related decisions because they reveal the opportunity cost for irrigation water in different regions, and assist water trades that can shift water to uses where it yields higher marginal returns (net of distribution costs) with gains to buyers and sellers (Peterson et al. 2004). These signals can help guide investments in irrigation technologies and water-related farm management strategies:

> The original reason for introducing trade among regions and across state borders was to encourage competition and thereby efficiency in the use of water. Without doubt, this has increased the productivity and profitability of irrigation in Australia. (CSIRO, sub. 24, p. 5)
>
> 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. (QDPC, sub. 38, p. 19)

Many study participants consider that existing water markets provide incentives for farmer decision making:

> 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. (JD Brooke, sub. 10, p. 3)
>
> Existing water markets provide good market signals for the products they trade. (JD Brooke, sub. 10, p. 5)

*Improvements could be made where impediments to efficiency exist*

Generally, in markets with well-defined and enforceable property rights, good information and low barriers to entry will provide for an economically efficient use of water where the net social benefits from water use are maximised. There may, however, be characteristics of markets or government policies (or an absence of both of these) that impede the efficient use of rural water by distorting the decisions of water users, or by allowing economically relevant externalities to occur. This discussion is developed in chapters 2 and 4.

### On-farm water-use decisions affect environmental flows and water available to other users

Irrigation water use can affect the availability of water to other users, including ecosystems that generate services valued by society (chapter 5). There is a direct relationship between on-farm physical water-use efficiency and the volume of water that leaves the farm in the form of surface flows or groundwater recharge.

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:

> … when water use is technically [physically] inefficient, most of the water eventually returns to the river for use by others and the environment. Under present arrangements, most irrigators are allowed to keep the 'savings' from increases in [physical] water-use efficiency and expand irrigation. Increases in [physical] water-use efficiency and most water recycling simply erode the Cap … increased [physical] water-use efficiency is not the answer to the maiden's prayer. (Young and McColl 2003a, pp. 226–7)
>
> … better water use efficiency by agriculture … does not create 'spare' water that is then automatically available for urban or environmental requirements. Similarly, the notion of [trade] moving water from one irrigation system or crop to another does not

> affect water availability — it merely affects the way in which the available water is used. (Australian Dairy Farmers, sub. 12, p. 2)
>
> Without some mechanism to capture water savings for environmental purposes, on-farm savings by farmers are irrelevant. (Watson 2003, p. 12)

An irrigator may install a new irrigation system that reduces water requirements per tonne of production, but may use some (or all) of the ‘saved’ water to increase the area under production, or sell the water on temporary markets to other irrigators:

> 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. (DWLBC, sub. 36, p. 5)

In some cases, runoff and drainage directly serve as a source of irrigation water for other irrigators. The Coleambally Outfall Drain, for example, provides a drainage service to farms in the Coleambally district. Coleambally Irrigation Co-operative Limited noted that ‘landholders along the drain have access to Class F “opportunistic flow” (with no entitlement) and Class G (3477 megalitres — based on 15 [megalitres] per 1000 hectares) Stock and Tank Fill Entitlement’ (sub. 3, p. 34).

On-farm water ‘saving’ may reduce the total amount of water available depending on whether losses are ‘true losses’ or ‘apparent losses’ (Pratt Water 2005). 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. Improving on-farm water-use efficiency may, in some situations, indirectly reduce stream flows if the volume of surface runoff, or recharge to groundwater, is reduced:

> Especially with flood irrigation, one farmer’s drainage water or return flow was another farmer’s irrigation entitlement in low technology irrigation systems. (Watson 2003, p. 218)
>
> … higher irrigation efficiency reduces groundwater returns to streams and so disadvantages downstream users. (Engineers Australia, sub. 8, p. 7)
>
> Assuming no change in the amount of water extracted for irrigation use, 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. (WWF Australia, sub. 34, p. 5)
>
> 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. The impact on groundwater salinity and water quality would depend on the characteristics of the site. In areas with high groundwater salinity, a reduction in saline discharge may improve water quality despite a reduction in the volume of water available to dilute in-stream levels of salinity. (WWF Australia, sub. 34, pp. 5–6)

Australian Water Environments (2003, cited in Young and McColl 2003a) found that increasing irrigation efficiency from 85 to 90 per cent in the Riverland of South Australia reduced groundwater inflows to the River Murray by about 22 per cent. Other than water volume effects, changes to the physical water-use efficiency on farm may also cause changes to water quality or flow that affect other users, such as other irrigators and water used to generate ecosystem services. These externalities are considered fully in chapters 5, 6 and 7.

## C.3 Efficiency in water delivery

The economic efficiency of decisions regarding water delivery concern resources allocated to achieve benefits from water supply to irrigated farms. This has several aspects and can require appropriately balancing a number of factors such as:

- the volume of water delivered to the farm gate from a given amount of water entering the water delivery system, versus the infrastructure costs of improving this physical efficiency
- the ‘quality’ of the water delivery service in terms of channel height, time between ordering water and delivery and other factors, versus the infrastructure costs and reduced physical efficiency (from water losses) of improving this quality of supply
- the accuracy of measuring water entering the farm gate, versus the cost of improving metering
- maintaining provision of water delivery services in areas where water use has reduced, versus the infrastructure costs of assets for which there is a reduced demand.

In terms of the physical efficiency of water delivery to the farm gate, significant variations in the delivery systems exist in Australia:

- drawing water from Glenmaggie Dam, ‘30 per cent of the water harvested [in Wellington Shire] is unfortunately lost prior to delivery due to extremely high hydrological conductivity in the ageing channel system, poor delivery capacity and possibly some evaporation’ (Wellington Shire Council, sub. 19, p. 3)

- Murray Irrigation Limited has only 4–5 per cent ‘losses’ because their channel system is through heavy clay soils, with the few channels in more porous soils being lined (Murray Irrigation, pers. comm., 20 January 2006)
- Murrumbidgee Irrigation has 13–15 per cent loss (Murrumbidgee Irrigation, pers. comm., 10 May 2005)
- Coleambally irrigation area ‘… is a leader in the use of computerised flume gates to provide total channel control. This system, which is designed to minimise wastage (a formidable challenge in an open and hence unpressurised channel system) has a 91 per cent distribution efficiency [9 per cent loss] which compares favourably with the 85 per cent distribution efficiency [15 per cent loss] of Sydney Water, whose system of course is piped and pressurised’ (Turnbull 2006c)
- Central Irrigation Trust have no water losses as they have a fully pressurised piped system. Prior to the introduction of the piped system it was not uncommon to experience water losses of 40 per cent in the Loxton district
- the stock and domestic water delivery system in the Wimmera–Mallee (which is not capable of delivering the same volumes as an irrigation water delivery system) has losses estimated to be at 85 per cent (DSE 2005c). This is due to a series of 16 000 kilometres of open channel running through relatively light soils.

Water ‘losses’ from physical inefficiencies in water delivery can also be true or apparent. This depends on whether water lost from the water delivery system evaporates or recharges into saline aquifers, or if it recharges or return flows to a source usable to irrigators or other water users, respectively.

The physical efficiency of water delivery can be improved by lining open channels or piping some sections, for example:

> Southern Rural Water … recently completed piping a particularly porous section of channel with significant water savings made. (Wellington Shire Council, sub. 19, p. 3)

Such investments, however, may not be economically efficient, even if they increase physical efficiency:

> … increased water savings in irrigation areas through government (taxpayer) funded piping of irrigation water. Back of the envelope figuring shows that this suggestion is just as implausible. The cost of piping water, sealing channels and the like is more than the value of the water saved. (Watson 2003, p. 10)

Most water authorities have ownership of the water losses in the delivery system. Bulk water entitlements/licences specify the amount of water the authority can extract from the river system, and this amount is split between deliveries of water to the farm gate and water used to maintain and run the delivery system.

Reductions in losses in the delivery system can therefore lead to increased volumes of water delivered to the farm gate for a given bulk water entitlement/licence. For example, 'Historically [Coleambally Irrigation Co-operative Limited] has made investment in water saving initiatives ([for example], [total channel control]) and kept the water savings that resulted for distribution to our customers' (Coleambally Irrigation Co-operative Limited, sub. 3, p. 43). Another example is Murray Irrigation, which explored options for piping some sections of its channel infrastructure (MIL 2005) but found the expense to be prohibitively costly and not justifiable because its channel system generally runs through heavy soils with limited losses.

By owning potential gains (reduced water losses) from increases in the physical water-use efficiency of the delivery system, water authority managers have created 'incentives' in terms of decision making about infrastructure investment, because they face the cost of the capital improvements and own the water saved as a result. These incentives may be increased if water authority managers can sell water saved on the market.

Channel management through changes to management of channel heights or by investment in technology such as automated 'total channel control', can alter characteristics of the water delivery service irrigators receive. In the Murray Irrigation district, for example, 'escape flows' at the end of a channel from maintaining high water levels historically used about 8 per cent of water in the district. A decision to lower channel heights and reduce escape flow losses has saved 30 gigalitres of water, but diminishes the level of service of water delivery to irrigators. Similarly, Southern Riverina Irrigators noted:

> 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. (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. For example water authorities could choose to run channels at lower levels or require farmers to take water at less convenient times.
>
> While 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. When implementing changes to improve water-use efficiency water authorities should be required to undertake an assessment of the impact on customers. (sub. 49, p. 5)

An example of the implementation of a total channel control system is in the Goulburn–Murray Water district, where a first stage investment of $2.1 million was made (a total investment of $14 million has been allocated over five years) to install automated gate control and regulators in the channel network (MIL 2005), resulting in:

- reducing operational spills
- increasing ability to account for water
- reducing labour of gate operation and monitoring
- reducing delivery time for orders of water and channel height of delivery (Rubicon 2005).

Total channel control investments will increase economic efficiency if the cost of the required capital improvements is outweighed by benefits in terms of water saved and quality of service delivered. The Northern Victorian Irrigators, however, noted:

> The [Northern Victorian Irrigators] members who have had to work with the system have found serious weaknesses in the operation of [total channel control], and more importantly the operating cost of the system when costed against the water supplied will make farms in total channel control areas quite uncompetitive. Despite the expenditure of many millions of dollars on [total channel control] in a small part of the channel system significant savings in water have not been demonstrated. (sub. 44, p. 5)

The characteristics of the delivery service are also changed in areas that introduce piped pressurised systems, because this enables irrigators to access water in a different way, one that provides addition options for on-farm water use:

> The improvements following the introduction of water on demand, or piped pressurised supply in water efficiency have been dramatic in several horticultural districts. … Higher service levels off farm can enable higher farm water use efficiency and easier technology adoption by growers. (Water Steering Group for Horticulture Australia, sub. 32, p. 7)

Metering of irrigation water volumes has been raised as a concern in a number of submissions to this study. The Dethridge wheel invented in 1910 (AATSE 2001) is used widely throughout Australia, but has its limitations:

> Dethridge wheels are well known to be inaccurate at both low and high flows. These programs are being implemented at great cost to our shareholders, but are seen as being essential in managing our water entitlement, [that is], if you can't measure it (accurately), you can't manage it. (Coleambally Irrigation Limited, sub. 3, p. 14)

Updating meters would be a costly exercise. There has been some move to improve metering in the Murray Irrigation district, for example, but this would cost $40–50 million for all meters to be improved (Murray Irrigation, pers. comm., 20 January 2006). The flat landscape of this area also means that other options such as knife edge weirs are not cost effective. Decisions to improve on the 5–10 per cent undermeasurement usually associated with Dethridge wheels must take into account such significant capital costs.

The economically efficient provision of water delivery infrastructure is further complicated because demand for the services provided by irrigation infrastructure depends on crop types in the irrigation district, and has consequences for potential congestion:

> ...water used for pasture may be used over a 6-month period whereas for almonds and vines it would be used over 4 months, increasing the peak river flow.
>
> … [Congestion may hinder] the ability of the river to deliver the water as increased amounts of water are traded into Sunraysia, as any interruption of supply during the peak irrigation period would have disastrous results. (Sunraysia Irrigators Council, sub. 33, pp. 2–3)

Further, irrigation infrastructure is a very long-lived asset that requires ongoing maintenance, and economically efficient provision involves a relatively lumpy decision to either supply a property with water, or to not provide a water delivery service. Chapter 3 further discusses the perceived problem of irrigation infrastructure assets becoming ‘stranded’ when water delivery volumes fall. Reform is ongoing in this area regarding the fee structures associated with infrastructure maintenance and the regulation on asset management.

Another issue affecting the physical efficiency of distribution is weeds within the channel network:

> The efficiency of water distribution is being influenced by major weed (particularly arrowhead) infestation in channels that were not apparent 20 years ago. Control methods remain largely ineffectual, expensive and constrained by increasing restrictions on herbicides and their methods of application. Meanwhile the channel system is facing serious reduction in delivery capability, which in turn restricts both timely application of water at high flow rates associated with efficient water use. (Northern Victorian Irrigators, sub. 44, p. 5)

Dealing with this issue in an economically efficient manner requires consideration of the water resources being lost due to the weed problem and the resources required to change the situation.

## C.4 Efficiency of environmental use

The economically efficient use of water may also be considered for environmental purposes. A narrow view of economic efficiency might see the 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 highest value of benefit from this environmental use. This consideration may be termed *environmental water-use efficiency*, *ecosystem restoration water-use efficiency*, or *managed environmental water-use efficiency* (Deason et al. 2005). A broader interpretation of ‘efficiency’ for water-use that generates ecosystem services would go further, to allocate water between agriculturally productive uses and environmental uses so that the highest aggregate ‘value’ to society for water use is attained.

Maximising the amount of water that flows down a river is not the goal of environmental management; the goals are to maximise the value to society of the ecosystem services derived from the amount of water used by the environment, and setting this amount of water efficiently:

> Even more fundamentally, the essential question should not be flow per se but a more carefully defined and refined concept of river ‘health’. Flow, and especially average annual flow, is only one dimension of the problem. (Watson 2003, p. 6)

There are non-consumptive and consumptive uses of water that generate ecosystem services; the former is in-stream flows while the latter occurs when flood events or diversions of water leave the river to water wetlands, floodplains and the like. When using water to generate ecosystem services, water can provide different environmental outcomes depending on when and how it is used.

The different outcomes attained, such as improvements in biodiversity or salt levels, may be difficult to measure and compare. To use environmental water to efficiently generate the mix of ecosystem services most valued by society, it is necessary to place relative values on different types of environmental outcomes, but this valuing is difficult:

> Defining the value, economic or otherwise, that a community puts on a public asset [environmental water] in a meaningful and quantifiable way is challenging, especially in the context of shifting social attitudes and environmental variability. (WWF Australia, sub. 34, p. 2)

As part of the Living Murray Initiative (MDBC 2006e), six sites along the River Murray have been identified as 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.

Assessing the relative value of different types of ecosystem services is further complicated by irreversibility and long timeframes of many environmental effects. Nonetheless, some form of value judgement needs to be made to make economically efficient use of water. To this end, the National Water Commission commented:

> Regardless of the mechanism used, a valuation process is required to measure the environmental benefits of management decisions. (sub. 22, p. 3)

How water is used to generate ecosystem services must take into account the potential externalities that it may cause on other users of water, just like any other use of water. 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. Or the delivery of water to wetlands can mobilise salt stored in the soils of these areas. The Chowilla floodplain has been identified as an example of this latter possibility.

For the Murray–Darling Basin, the Murray–Darling Basin Commission has developed a framework for assessing these multiple outcomes:

> 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. (MDBC, sub. 31, pp. 3–4)

If the concept of 'efficiency' for environmental uses were to consider the allocation of water between agriculturally productive uses and environmental uses so that the highest aggregate 'value' for water use is attained, the mechanism by which this transfer between uses occurs is also important. This allocation is currently dealt with in the water planning process. On this matter, WWF Australia commented:

> Investment in water use efficiency is currently being funded by the government under the NWI as a method of restoring river flows. However, the cost of achieving the savings relative to the value of the water saved will determine whether implementing water use efficiency measures is the most economic alternative. Studies have shown that there is limited scope for achieving efficiency gains at low cost, with most cost-efficient options already being implemented (see ACIL Tasman 2003).
>
> Further efficiency measures would therefore need to be subsidised to some extent by the government. However, if the government is able to purchase water at a lower price than the cost of achieving 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. (sub. 34, p. 6)

The South Australian Department of Water, Land and Biodiversity Conservation noted:

> 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 $4 000 per [megalitre] to invest in further on-farm improvements in irrigation, while water on the market currently costs around $1 400 per [megalitre]. (sub. 36, p. 9)

The role of an environmental manager, to make water-use decisions on behalf of the environment and maximise the efficiency of the generation of ecosystems services from the rivers and their connected ecosystems, is discussed further in chapter 5.

## C.5 Role of government

Participants in fully competitive markets interact and trade on the basis of price signals to reconcile their needs with the scarce resources available. Markets are often imperfect or incomplete, however, resulting in market failures such as those related to under-provision of public goods (for example, defence), externalities (for example, environment and health), market power/imperfect competition (resulting in anti-competitive behaviour) and information failures.

Where markets are perceived to fail, governments may intervene to correct for possible adverse effects. The existence of public benefits is a necessary, but not sufficient, condition for government intervention.

The difficulty in characterising water as a well defined and tradeable good may require government intervention to clarify property rights for facets such as water volumes, water use, water delivery, and water quality to aid further expansion of water markets. The public-good nature of the environmental consequences may also require governments to make decisions on the basis of aggregated societal values.

As discussed, improving economic efficiency implies reallocating water resources to increase overall net social benefits. If governments can change the incentives to which irrigators, water authorities and environmental managers react — to better reflect the overall net social valuations — such actions by government may increase the economic efficiency of water use. Water markets can provide these incentives, where an improvement to the market structure leads to prices that better reflects net social valuations.

Governments should only intervene if the benefits of such intervention are likely to exceed the costs on a community-wide basis. Where governments decide to intervene, intervention must be designed to address the relevant problem and produce the greatest possible net benefits (PC 2002). In addition to market failure, governments might also act to address distortions created by previous government intervention (government failure). For economic efficiency, the benefits of such action also need to outweigh the costs. Chapters 2, 3 and 4 examine the potential impediments that may need to be addressed by government action.

# D 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.

## D.1 Benefits from trading water entitlements

Trade in water entitlements allows reallocation of water between competing users and uses, from counter value purposes to higher value ones. In a competitive market for water, gains from trading water are the difference between the value of water in agricultural production (or other water use) to buyers and to the sellers. These gains are collectively the highest when the price received by sellers is equal to the price paid by buyers, which is where aggregate supply equals aggregate demand at quantity $Q^*$ in figure D.1.

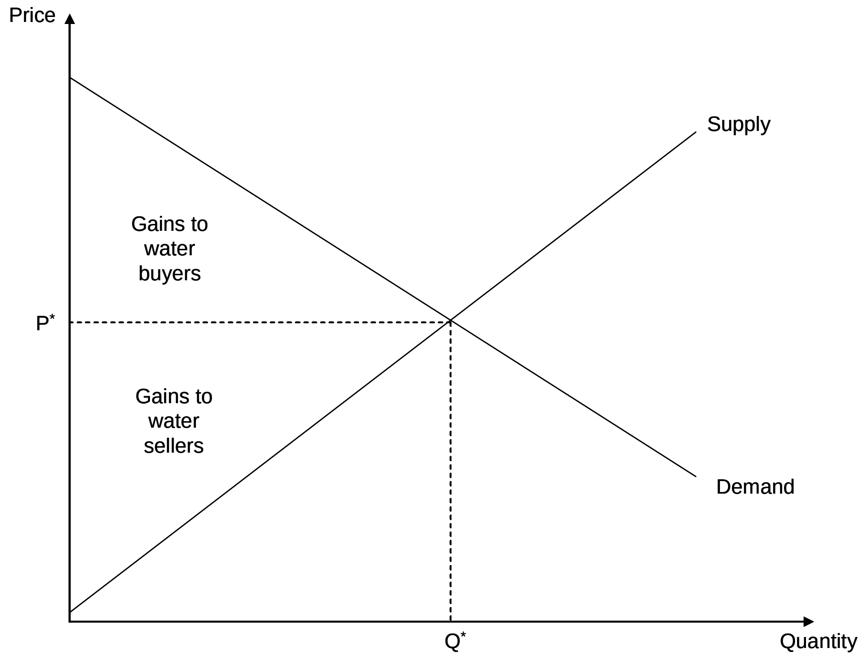
Trade is beneficial to both parties. Buyers gain from the additional production they generate from the water purchased. Sellers gain by receiving more for the water than if they had used it for productive purposes.

## D.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 authorities 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 authorities, 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 authorities, including Murray Irrigation Limited, Murrumbidgee Irrigation, Coleambally Irrigation and Central Irrigation Trust.

Figure D.1 **Potential gains from water trade**



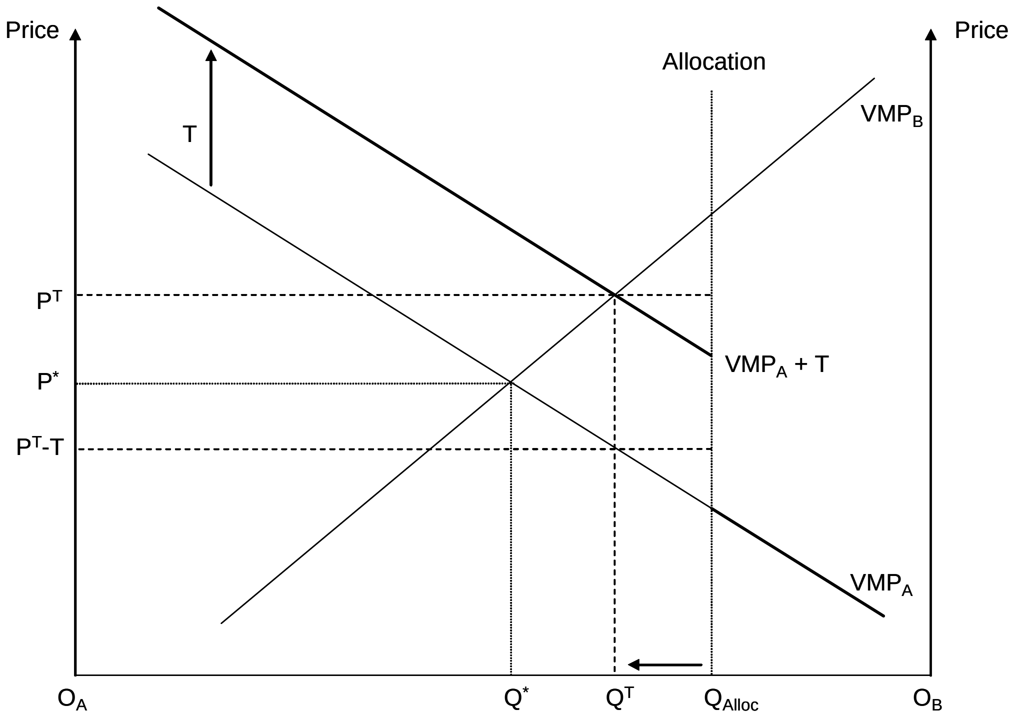

## D.3 Exit fees constrain trade

An exit fee is equivalent to an export tax on water entitlements (boxes D.1 and D.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 being an importer of water is noted in box D.3.

Box D.1 **Exit fees reduce the reallocation of water resources via trade**



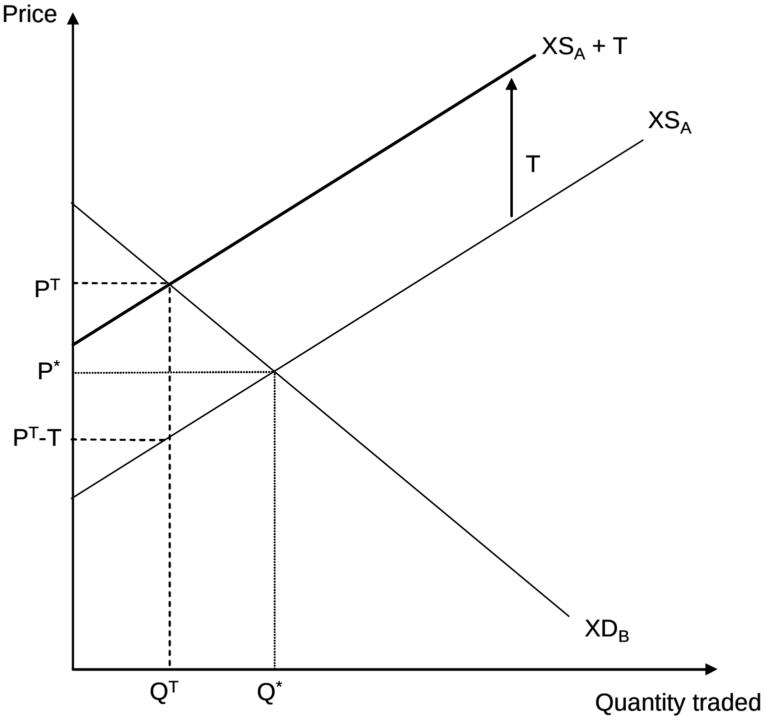

Before any trade between regions, irrigators in region A have entitlements that amount to the horizontal distance $O_A$– $Q_{Alloc}$, while region B's entitlements are $Q_{Alloc}$– $O_B$. The curve $VMP_A$ shows what would be the value of the marginal product of water used in region A, for each quantity 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 D.2 **Exit fees constrain water trade**




The figure above presents the same situation as box D.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 D.3 **Exit fees in a water importing region**

Exit fees are not a binding constraint if the region would be importing water when unrestricted water trade was 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 D.4 and D.5.

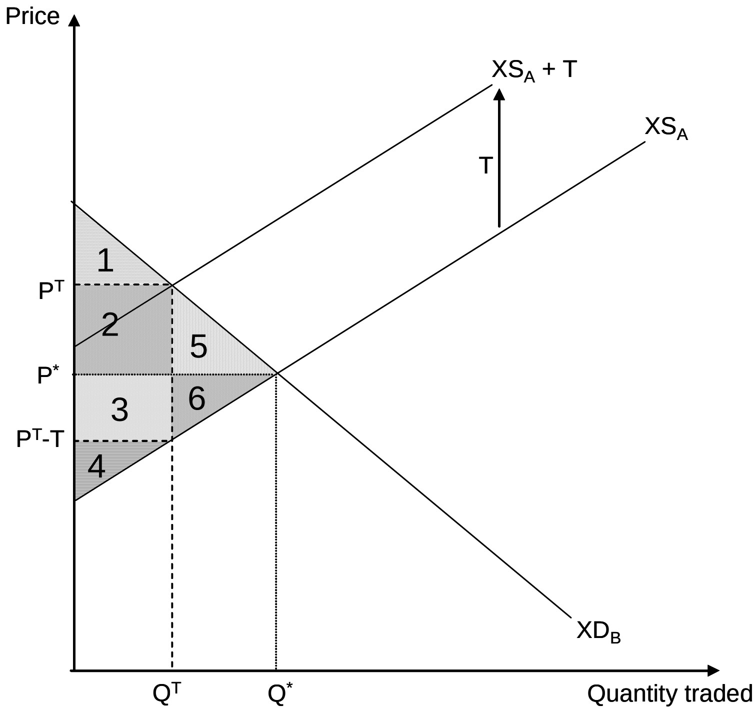
## D.4 Exit fees reduce welfare

Exit fees reduce the economic welfare of buyers and sellers of entitlements in both trading regions (box D.4).

An exit fee results in a 'dead weight' economic loss, and significant welfare reallocations:

- 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 authority).
- The water authority 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 authority is less than the sum of the losses imposed on the buyers and sellers.

Box D.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 authority in region A is area 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 ($2–6 \gtrless 0$), the value of which is determined by the size of the exit fee imposed, and the characteristics of demand in regions A and B.

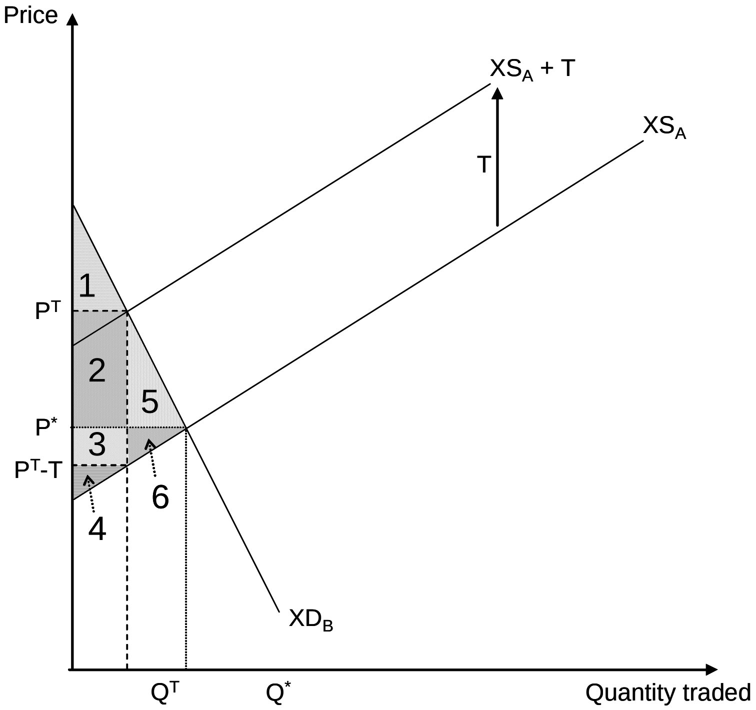
All gains and losses identified above are per period — for example, per year.

# D.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 D.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 D.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 D.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.

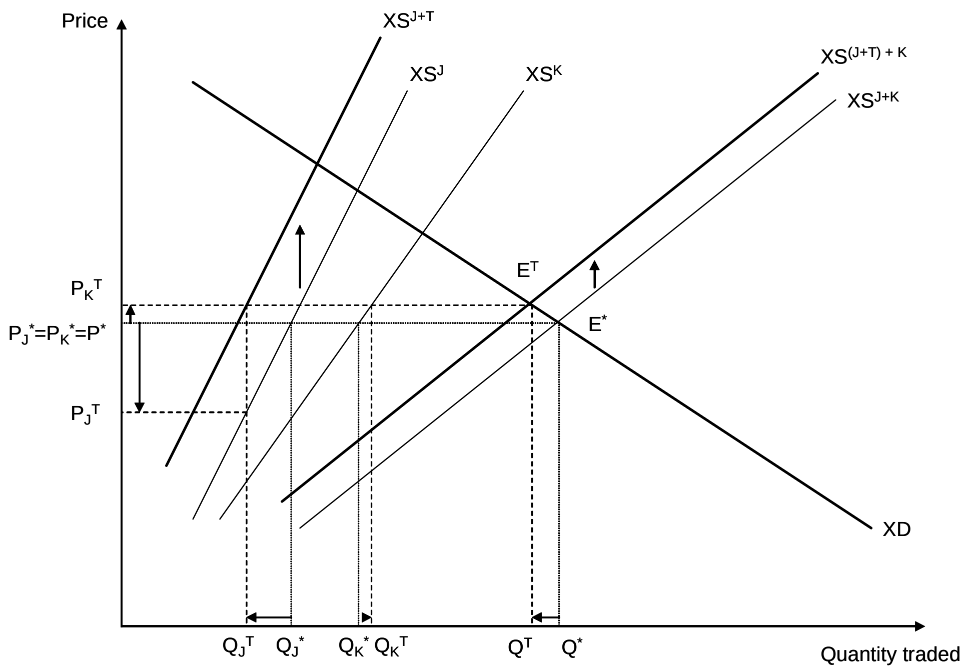
# D.6 Differing exit fees between exporting regions

Exit fees may differ between irrigation regions (figure D.2 and box D.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 authority 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 D.2 **If one of two regions that generally export water has an exit fee**



Box D.6 **Discussion of figure D.2**

Consider two exporting regions (J and K) supplying 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 authority 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.

## D.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 D.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 D.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.

## D.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 authorities 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 authorities, in water exporting and importing regions combined, lose economic welfare when water trade is restricted by exit fees.

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