Competitive tendering for public investment in improving water use efficiency

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In the paper presented here, competitive tendering is considered as a means of appropriating public investment to improve water use efficiency in the irrigation regions of the Murray River. Improvements in water use efficiency have been shown to generate water quality benefits if reduced ground water leakage from irrigation leads to a reduction in the volume of saline discharge being mobilised to the Murray River system. Water quality benefits include an improved riverine environment, and reduction in salt concentration of river flows leading to private benefits that are captured by downstream agricultural, industrial and urban water users.

However, as the external benefits are nonexclusive and diffuse, irrigators will not have the incentive to fully invest in the optimal level of efficiency improvements, as they do not capture all the benefits. Downstream water users do not have an incentive to invest in upstream efficiency improvements as other water users can ‘free ride’ on their investment. This, coupled with the public benefits associated with improved water quality and riverine health, suggest there is strong justification for strategic policy intervention including public investment.

This paper examines some of the institutional arrangements that need to be in place to ensure the tender process operates effectively. The auction format under consideration is a first-price, sealed bid auction that has a price minimisation objective. Three approaches to designing a contract to effectively supply improved levels of water use efficiency, each with implications for monitoring and compliance, are discussed.
Introduction
River health in the Murray Darling river system has been high on both the public and political agenda for several decades and, as a consequence, has been the subject of numerous federal and state government policies to address issues such as declining water quality, particularly increasing salinity, and river flows. In recent years, two major policy initiatives have been developed. The first is the Basin Salinity Management Strategy, a fifteen year initiative to manage salinity and protect key natural resource values in the Murray Darling Basin, that is targeted at maintaining salinity at Morgan at less than 800 EC units for 95 per cent of the time (MDBMC 2001).

The second is the National Action Plan for Salinity and Water Quality that commits $1.4 billion in funding over seven years and provides the framework for bilateral agreements between the Commonwealth and state or territory governments to develop action plans in priority regions. Both of these initiatives promote the need to maintain water quality for agricultural, environmental, urban, industrial and recreational uses and rely heavily on the use of catchment and regional plans developed by communities as tools to achieve salinity targets and outcomes. While a policy framework supporting salinity management and improving water quality has been developed, strategic public investment may be needed to target effective actions to areas that generate the greatest benefit at least cost.

Increasing river salinity is the main water quality issue in the Murray River. A substantial proportion of the salt load in the river comes from the discharge of saline ground water flows from irrigation. In particular, hypersaline ground water coupled with direct seepage to the Murray River in the Victorian and South Australian Mallee irrigation areas have led to predictions that these areas will be significant exporters of salt over coming decades (MDBC 1999a).

Reducing leakage from irrigation regions through improved water use efficiency leads to improved water quality if saline discharge directly into streams is reduced, leading to a reduction in the salt load and concentration of river flows. While improving irrigation efficiency may reduce ground water leakage, it may also reduce surface water runoff. In catchments characterised by low water use efficiency and low ground water salinity, these return flows from irrigation may provide both dilution flows and flows available for use downstream.

It is important, therefore, to target investment in improved water use efficiency to areas where the benefits of the reduction in saline discharge to the river system outweighs any potential disbenefit of a reduction in return flows. For example, substantial salinity benefits may be generated if improvements are targeted to areas such as the Victorian and South Australian Mallee. Even though these areas already have relatively high
levels of water use efficiency, the hydrological characteristics of these irrigation areas mean that further improvements are likely to lead to a large reduction in the volume of salt exported to the river.

Improvements in water use efficiency generally take two forms — improvements to infrastructure, either on- or off-farm, that improve delivery efficiency, and on-farm improvements in management practices. The extent to which investment should target infrastructure or management practices will be location specific. In South Australia, most of the delivery system has been refurbished, capturing many of the off-farm water savings and leaving little potential to further improve water use efficiency through large scale investments in infrastructure. Opportunities to gain further improvements are likely to be through on-farm investment in delivery infrastructure. There is also a need to target on-farm management practices through, for example, the use of soil moisture probes to monitor and reduce leakage to the ground water system. In the Victorian Mallee, there are likely to be opportunities to improve water use efficiency through a combination of infrastructure, both on-farm and off-farm, and improving irrigation management practices.

The purpose in this paper is to consider the feasibility of a tendering process, based on auction principles, as a funding mechanism for improving water use efficiency in existing irrigation developments to generate water quality benefits. A tendering process may be a appropriate as it may provide the vehicle to target actions to areas where the greatest benefits can be generated to deliver cost effective water quality outcomes. A tendering process is more likely to be cost effective than blunt policy instruments such as regulation or taxes because it sources efficiency gains from the least cost suppliers.

Background
Work undertaken at ABARE suggests that significant salinity benefits may be generated from improvements in water use efficiency. Results from the Salinity and Landuse Simulation Analysis (SALSA) model indicate that improving water use efficiency by 5 per cent in each irrigation region in the South Australian Riverland may lead to an overall reduction in salt load of around 20 per cent in 2050, generating agricultural benefits of up to $11 million as a result of the improvement in the quality of water used for irrigation. For further discussion of the SALSA model, see Bell and Heaney (2001). This corresponds to a reduction in salt concentration at Morgan of around 38 EC (figure 1). Benefits also accrue to urban, industrial and agricultural water users below Morgan as a result of improved water quality.

With more efficient irrigation, less water is needed to produce the same amount of output. The water saved by irrigators can be retained and used to expand irrigated
production, left in the river or sold on the water market. In this analysis, it was assumed that irrigators retained the water savings and used those savings to expand irrigated production in the region in which the water is saved (Heaney, Beare and Bell 2001).

The extent to which a reduction in salt loads and concentration is achieved depends on, among other things, the response time of the ground water aquifer (the time taken for a change in recharge to be reflected in a change in discharge, which, in turn, depends on the distance of the irrigation area from the river), the volume of the reduction in ground water leakage and the underlying ground water salinity. As a result the reduction in salt loads varies between irrigation regions. The reduction in salt loads from an improvement in irrigation efficiency is shown for the South Australian Riverland in figure 1. The five irrigation areas under consideration in upstream to downstream order are those between the Victorian/South Australian border and Lock 5, between Lock 5 and Lock 4, between Lock 4 and Lock 3, between Lock 3 and Lock 2 and between Lock 2 and Morgan. In absolute terms, the greatest reductions are in the reaches between Locks 3 and 2 and between the Victorian/South Australian border and Lock 5. These areas have a combination of relatively high ground water salinity and high levels of irrigated activity in comparison with the other areas in the South Australian Riverland.

There are multiple benefits from improvements in water use efficiency, some of which are nonmarket or public benefits. The benefits are derived in two ways. First, benefits may accrue to the individuals undertaking the action as a result of more efficient agricultural production. In the analysis presented above, agricultural revenue was increased as a result of the increased availability of water for irrigation. These benefits are internal to the regions where the efficiency improvements were undertaken — that is, the producers undertaking the action capture the benefits.

Second, improved water use efficiency may decrease the amount of saline ground water being transported to the river system, leading to an improvement in water quality. Benefits derived from improved water quality are external as they are not captured by the individuals undertaking the action but, instead, accrue to downstream water users. These benefits may be private, in that they are captured by downstream water users (for example, in
improved agricultural yields), and public, in that they lead to an improved riverine environment.

The distribution of these benefits is important from a public policy perspective, as policy intervention is usually required to facilitate optimal investment in salinity mitigation options when some benefits are derived externally. The distribution of the total benefits of undertaking an improvement in five irrigation areas in South Australia, using the SALSA model, is shown in figure 2. If an action to improve irrigation efficiency was undertaken in the reach between the Victorian/South Australian border and Lock 5, the total benefits to the South Australian Riverland would be around $6.8 million net present value over a 100 year period. Of this, around $4.4 million is derived from the improvement in water quality, as the irrigation water would be fresher, generating benefits that are captured by downstream water users. The benefits accruing downstream stem from higher agricultural yields from irrigation, rather than from an increase in the volume of water supplied. The variation in the ratio of external to total benefits (shown in figure 2) reflects the different ground water salinities and the number of water users below the area where the action is undertaken (Heaney, Beare and Bell 2001).

Simulating increases in water use efficiency with the SALSA model provided estimates of the downstream benefits of increasing water use efficiency in the South Australian Riverland. Other areas identified with high returns included Colignan and Mildura in the Victorian Mallee and, to a lesser extent, Barr Creek in the Loddon catchment. Efficiency improvements in areas upstream of the Loddon catchment of the Murray River provide only minor salinity benefits downstream.

Results from the SALSA model also highlight some key points on the wider benefits of improved water use efficiency. First, if the benefit derived from the increased agricultural revenue from water savings exceed the costs of undertaking the improvement in efficiency, irrigators will undertake the action themselves in their private interest. The extent of the internal benefit depends on several factors, including retaining the right to all or some of the water saved, the availability of suitable land to extend irrigated production or a suitable market in which to sell the

![Figure 2: Investing in irrigation efficiency](image)
savings, and the cost of undertaking the action. All downstream users would reap the benefit if the improvement led to enhanced water quality.

Second, as the external benefits are nonexclusive and diffuse, irrigators will not have the incentive to fully invest in the optimal level of efficiency improvements, as they do not capture all of the benefits. Individual downstream agricultural, urban and industrial water users do not have an incentive to make adequate upstream investments in improved water use efficiency as others can ‘free ride’ on their upstream investment. Because neither upstream nor downstream irrigators capture all the benefits of improved water quality, they are therefore likely to underinvest in improving water use efficiency, leading to a suboptimal social outcome. Finally, given that there are public benefits associated with improved water quality and riverine health, there is strong justification for strategic public investment.

As the benefits of improved water use efficiency accrue both internally and externally to the region undertaking the action, effective policy initiatives will be those that provide the incentive for an efficient combination of private and public investment in improved irrigation practices and infrastructure. To make cost effective investments, it is necessary to target actions to areas that generate the greatest benefit at the least cost. In the case of improving water use efficiency, this requires knowledge of both irrigation practices and hydrological processes in each irrigation region. A competitive tendering process, where individual irrigators or irrigation districts bid for funds to undertake improvements in water use efficiency, may provide a vehicle for delivering cost effective actions targeted at regions where the largest improvements in water quality can be made. The successful implementation of a competitive tendering process would lead to an efficient outcome if it created an environment in which the prices of accepted tenders were likely to reflect the cost of increasing efficiency less the private benefits that the irrigators can expect to retain.

**Competitive tendering for improvements in water use efficiency**

Competitive tendering or bidding processes have been used extensively to procure commodities or services, such as environmental outcomes, where there is not a well established market. Since 1986, the US Department of Agriculture has been awarding land retirement contracts for the Conservation Reserve Program on the basis of competitive bidding. Under this program, farmers surrender to the government their rights to graze or crop land for a period of up to fifteen years in return for compensation. In Australia, the Victorian Department of Natural Resources and Environment has undertaken a Bush Tender trial in two Victorian regions. The program
uses a tender based approach to allocating biodiversity conservation contracts on private land (Stoneham, Chaudri, Ha and Strappazzon 2002).

The auction mechanism was considered as an approach to allocating government funding for native vegetation management in Victoria for a number of reasons. First, it broadened the spectrum of landholders that participate in vegetation conservation programs and provided them with more flexibility in identifying acceptable cost sharing arrangements. The auction mechanism has also enabled DNRE to quantify outcomes broadly, with particular consideration of multiple benefits, while maximising the cost effectiveness of market based procedures. Experience from the Bush Tender trial suggests that auction processes can lead to efficient and effective environmental policy outcomes (Stoneham et al. 2002).

An auction based tendering process would enable irrigators to bid for funds to undertake changes to on-farm infrastructure or management practices on existing irrigation developments that they would not undertake in their private interest. The auction format under consideration in this paper is a first price, sealed bid auction, also referred to here as competitive tendering. The auction has a price minimisation objective, with bidders competing to secure funds to undertake improvements in water use efficiency. Each participant is unaware of the value of rival bids, reducing the likelihood of collusion between bidders. Each participant submits a written bid that is ranked according to the value of the bid and the benefits that the proposed action will deliver. In this instance, there are likely to be several successful bidders as funds are allocated to the most preferred bid first, then to the lesser bids until the auction budget is allocated or the reserve price is met. If there is more than one bid proposing the same level of improvement in water use efficiency but in a different location, the successful bid may not be that with the lowest value as it may have a lower environmental benefit. For example, a bid that is upstream of a valuable environmental or productive asset that is sensitive to water quality would be preferred to an equivalent bid downstream of that asset.

 Competitive tendering is of interest in securing environmental outcomes from improving water use efficiency for at least two reasons. First, there is an asymmetry of information as possible bidders, in this case irrigators, are likely to know better than governments how undertaking efficiency improvements will affect their production and profits. A competitive tender would allow irrigators to identify the actions applicable to their agronomic systems and enable them to deal with the uncertainty about the value of the action required to secure the desired outcome (Latacz-Lohmann and Van der Hamsvoort 1997). Each participant will calculate an asking price based on such factors as expected changes in agricultural revenue from undertaking an improvement in water use efficiency and the direct costs of taking the action. As the process ensures
competition between bidders, winning tenders will be just enough to undertake the improvement but not enough to make excessive profits. Successful bidders enter specific management contracts that outline their commitments to improving water use efficiency in return for payment.

Second, resource management agencies such as state governments or catchment boards are likely to hold information that irrigators do not, such as the hydrological processes underpinning saline discharge into the river system or the location of high impact regions. This is particularly important, as the impacts are highly dependent on the hydrological characteristics of each irrigation area, and these vary considerably along the Murray River system (for further discussion see Heaney and Beare 2001a,b).

Improvements in water use efficiency in different locations are likely to yield a different set of environmental benefits. As mentioned previously, improvements in water use efficiency affect the river system differently, depending on factors such as ground water salinity and the distance between the irrigation area and the river. The salinity of ground water discharge in the Murray River and its tributaries is generally low in the upland catchments and tends to increase moving downstream, reaching levels approaching seawater in low lying regions of Victoria and South Australia. Further, as the distance from the river increases, the time before a change in the level of recharge is fully reflected in the level of ground water discharge increases substantially. For example, it may take fifty years for recharge to be fully reflected in discharge if an action to change ground water recharge is taken within 5 kilometres of the river. On the other hand, it may take up to a hundred years if an action is undertaken more than 10 kilometres from the river.

Consequently, the impacts of undertaking improvements in water use efficiency will vary considerably from site to site, and in some instances may generate a disbenefit. This may be because of changes in the pattern of return flows. Return flows consist of surface runoff from irrigation, irrigation drainage and ground water discharge from irrigation areas that reach the Murray River system. If undertaking improvements in water use efficiency reduces the volume of return flows from irrigation areas with relatively low underlying groundwater salt concentrations and low levels of irrigation efficiency, this may decrease the volume of water available for downstream users and/or increase the salinity of water supplies, also imposing costs on downstream users. These impacts need to be taken into consideration when targeting regions for investment and evaluating tenders.

A competitive tendering process brings the two information sets together in a market context, enabling program managers to assess bids on the basis of both impacts and costs. In this way, resource managers would be able to target water use efficiency
improvements to the areas where the greatest benefits are generated. For example, all other things being equal, a bid from a farm near the river could be given preference over a more distant farm, as the impact on ground water discharge of a reduction in the volume of water used will more immediate. Through careful framing of the process to assess the tenders, the government is able to control the allocation of funds.

The onus is on the government to hold site specific information on the environmental impacts of improving water use efficiency, and process the information required to assess the bids. In many instances, this level of detail may not be available. While work is already under way in some states to categorise irrigation areas into high and low impact zones, enabling agencies to rank bids according to their anticipated impacts, this process may need to be supported by increased investment in research. Good information on the impacts of irrigation practices on the environment is necessary for cost effective policy outcomes, regardless of the mechanism used to allocate funding.

Implementing a competitive tendering program

The design of the competitive tendering process is critical to its effective operation. Several failures in auction processes in Europe, the United States, Australia and New Zealand highlight the need for a carefully thought out tendering process to ensure that the public policy objectives are met. Things to consider when designing a tendering process for improving water use efficiency include attractiveness and simplicity of participation, setting the reserve price, bid assessment and the specification of management contracts.

Auction participation

In a well designed process, auctions can be highly efficient even in the presence of a few participants. For example, small numbers of buyers or sellers, say three or four, have been shown to be sufficient to achieve essentially competitive outcomes in auction market experiments (Freidman and Ostroy 1995). Possible pitfalls of having a smaller number of potential bidders include a lower level of bidding competition and a higher risk of collusion and strategic bidding (Latacz-Lohmann and Van der Hamsvoort 1998).

Higher levels of participation can be considered desirable in auctions for environmental goods and services, for reasons other than economic efficiency. In the US Department of Agriculture’s Conservation Reserve Program, for example, the objective was to maximise participation in the program with a limited budget for the first nine rounds of the auction. Stoneham et al. (2002) note that one of the indirect benefits of participating in the Bush Tender process was that landholders received quite sophisticated information on their properties and also had an opportunity to discuss the quality and
management of their site with a field officer. This raised the possibility that some unsuccessful bidders may initiate proposed management actions as a result of having learned more about conservation values on their property.

Sealed bid auctions are generally attractive to participants. Even ‘weaker’ bidders will have at least some chance of victory as all bidders must make a single, final offer in the face of uncertainty about rivals’ bids. Experience with timber programs using sealed bid auctions in the United States shows that they attract more bidders than ascending auctions do (Klemperer 2002). Risk aversion among irrigators may also attract participation as the payment increases their income security. This may also translate into a higher level of cost effectiveness if the payment increases farmers’ income security, inducing them to enter marginally lower bids (as compared with the risk neutral bidder) to increase the probability of acceptance.

Participation in the tendering process will not be costless, however. For example, it may be costly for irrigators to acquire information about the costs of water use efficiency improvements and the impact of them on production systems. These costs will be a loss to the irrigator if the bid is rejected, or a reduction in the economic returns earned if the bid is accepted, or may act as a deterrent to participation if bid preparation costs are too high (Latacz-Lohmann and Van der Hamsvoort 1997). One way of attempting to minimise the cost to bidders is to ensure that potential participants have information available to assist with bid preparation. For example, information on strategies to improve water use efficiency, developments in irrigation technology and best practices, cost and water savings details could save potential participants time and effort when preparing their bid.

Reserve prices

A reserve price is the maximum value of a bid for a given level of water quality benefit that the government will accept. The setting of the reserve price at the appropriate level is critical to the success of the tendering process, and important to ensure that environmental outcomes are purchased at reasonable prices. Determining the level of the reserve can be complex when auctioning nonpriced goods and services. Attempts have been made to estimate the cost of increasing salt concentrations in the Murray River to water users. For example, the Murray Darling Basin Commission has linked changes in river salinity, on the basis of incremental changes in EC, with estimates of cost impacts to urban, industrial and agricultural water users. These estimates are location dependent, with increases in salt concentration of river flows in the upper reaches of the Murray River generating greater cost increases downstream as more water users are affected (MDBC 1999b).
An appropriate reserve price for undertaking efficiency improvements for water quality benefits should ensure that the costs of these contracts would not exceed the marginal benefits of control. Further, the cost of improving water quality though improvements in water use efficiency should not exceed that of other forms of intervention, such as salt interception or ground water pumping schemes. If participants propose to surrender water savings, the value tendered for a megalitre of water should not exceed the traded price.

**Bid assessment**

Successfully implementing a competitive tendering process is heavily reliant on the program administrator having sufficient information to estimate the prospective environmental benefits, as well as the capability to rank the bids on the basis of both impacts and cost. In several tendering programs, an index has been developed that incorporates both the environmental benefits and the nominal value of the bid. An environmental benefit index was developed for the US Department of Agriculture’s Conservation Reserve Program as a relative preference measure for the different environmental goods and services arising from the land use change. Several environmental factors, weighted to reflect scarcity, and a cost factor are used to assign each bid a point score to assess its relative environmental benefit (Latacz-Lohmann and Van der Hamsvoort 1997). A similar approach was used in Victoria for the Bush Tender scheme where a biodiversity benefits index was developed. The index incorporated the current conservation value of the site, the amount of service offered by the landholder and the cost of the conservation action, nominated in the bid. Bids were then ranked according to their biodiversity benefit (Stoneham et al. 2002).

A different approach to ranking the bids in a water use efficiency tender could be developed using a simple benefit–cost ratio. The ratio would be largely determined by the extent and timing of the benefits of undertaking the improvement, in turn determined by the underlying ground water salinity, the distance from river where the action is undertaken and the downstream assets that are affected by water quality. An improvement in water use efficiency leads to a reduction in recharge that, over time, leads to a reduction in saline discharge to the river system. The reduction in saline discharge can be converted into a reduction in the volume of salt being mobilised into the river system. If each unit of salt is given a value, then a benefit–cost ratio can be evaluated based on the cost nominated in the bid and the tenders ranked from highest to lowest for acceptance. A minimum benefit–cost ratio could then be used to establish a reserve price for the auction.

Valuing a reduction in salt load is a three step process. First, the effect of a change in load on salt concentrations needs to be estimated. Second, the impact of a change in salt
concentrations on the economic returns from productive downstream assets needs to be determined. Finally, it may be important to qualitatively assess any nonmarket benefits from, for example, an improved riverine environment. A simpler process is possible when the tendering process is targeted to a small region where the downstream impact of a given reduction in salt load is the same for all tenders. The bids could be ranked by applying an appropriate discount rate to the salt loads to construct a current time equivalent index of salt loads. However, establishing a reserve price for such an index would be highly subjective.

**Management contracts**

The management contract is an agreement between the irrigator and, in this instance, the government to undertake specified water use efficiency improvements in return for payment. Since the impact of improvements in water use efficiency are highly location specific, individual management agreements or contracts between the irrigators and the government would need to be developed to accommodate nonstandard or multiple benefits. Management contracts will vary depending on whether the proposed actions involve changes to on-farm infrastructure or management practices, and location of the investments undertaken. The contract would stipulate, among other things, the rights and conditions necessary to implement the water use efficiency improvements, ownership of the right to the water savings, conditions of payment and compliance, and, most likely, a penalty clause for noncompliance.

As institutional arrangements governing water use vary substantially from state to state, it is beyond the scope of this paper to detail the property right requirements to operationalise a tendering scheme. However, there are three approaches to designing a contract to effectively supply improved levels of water use efficiency, each with implications for monitoring and compliance. One is to specify a set of investments or changes to management practices that will be undertaken over a defined period of time. For example, the contract could specify that open irrigation channels be lined or that an overhead sprinkler system be upgraded to a drip irrigation system. Covenants on irrigation management practices could also be stipulated in the contract. For example, a contract could stipulate the maximum allowable wetted depth for an individual irrigation activity.

Compliance with this type of contract is likely to be attached to the undertaking of the improvements, either in delivery infrastructure or management practices, not to the resulting water quality benefits. The uneven distribution of information between the tender agency and the irrigators can lead to difficulties in ensuring compliance. Difficulties arise if the tender agency cannot observe perfectly, and without cost, the irrigators’ actions against the provisions of the contract. This may give rise to a moral
hazard problem if the irrigator puts less effort into the provision of the services than is consistent with the contract, resulting in smaller improvements in water quality than would otherwise have been generated. However, the cost of monitoring compliance need not be prohibitive and could be accounted for in the budget for the competitive tender. Monitoring and enforcement costs are an issue that may need to be considered in the tender evaluation process.

Ensuring that improvements to infrastructure are undertaken is likely to be relatively easy and may only require a site visit. However, improvements to infrastructure will not maximise the water quality benefits of the auction process if management practices are inappropriate. Therefore, both forms of water use efficiency improvement are likely to require changes to irrigation management practices. Covenants in the tender contract may be necessary to ensure that appropriate irrigation management standards are met and, consequently, ground water leakage is minimised. This could involve supporting the use of irrigation technology to measure the depth that irrigation water penetrates and self monitoring of the reduction in the volume of ground water leakage over time.

However, the risk of whether improvements to on-farm infrastructure or management practices actually deliver the level of water use efficiency gains that they were intended to supply will generally be borne by the buyer in the contract.

A second approach to the design of the management agreement is to specify a contract in terms of water use. As water allocations can be bought and sold on the water market, they do not necessarily correspond to a given level of water use at a particular location. It is necessary to link an allocation back to the land on which it is being applied by specifying a contract in terms of water use through, for example, a water use right. A water use right is the right to apply a given volume of irrigation water at a specific location. A contract might specify that average water use over the next five years on a particular farm block be reduced from an initial allocation right of 8 ML/ha to 6 ML/ha. There may be provisions in the contract to account for both higher and lower water use in the contract, to provide irrigators some security against variable seasonal conditions. An important aspect of having a use right as opposed to simply surrendering an allocation is that it prevents the irrigator from purchasing back the entitlement on the water market.

There are two potential problems with defining water use rights. The first is to establish the initial volumetric allocation of the use right. Irrigators will have an incentive to secure an initial allocation in excess of what they intend to use, and offer up the balance as a water use efficiency gain as part of their bid. While there is no ideal way to allocate initial use rights, an objective and transparent process is required. One option is to use the record of irrigators’ water delivery or use patterns to establish their average water
use over a number of years for comparison with the volume of water used after the efficiency improvement was undertaken. This is to try to avoid the situation where irrigators simply sell off the excess water that they did not intend to use. The second problem is to ensure that a contract to surrender all or part of a water use right remains binding. For example, an irrigator could enter into a contract to reduce their water use and then simply sell their water entitlement to another irrigator. This might require that payment for reducing water use is given after the use right has been exercised.

One advantage of specifying a water use efficiency contract in terms of water use is that the risk of taking actions that do not deliver the water savings offered can be shared between the buyer and the seller in the contract. This would simply depend on the penalties associated with using more water than specified under the use right. Nevertheless, the risk that a given level of water use saving will generate a lower level of downstream water quality benefits than expected is still borne by the buyer in the contract.

The third approach to designing a management agreement is for the contract to specify both irrigation practices and water use. The water use right establishes a basic level of accountability but the addition of, for example, a covenant on maximum applications rates or irrigation depths might further reduce leakage into the groundwater system and reduce the discharge of saline groundwater over time. While this approach is potentially more flexible and can deliver additional salinity benefits, it may also make the tendering, bid assessment, ranking and monitoring process more complex.

Water requirements for crop production will be less after an improvement in water use efficiency and the contract would also have to specify who owned the right to the water saved. Under the current property right framework, irrigators have an implicit right to the water savings. The excess water can be used in three ways, each having a different impact on the river system. First, the irrigator may retain the water savings and apply it to an additional area. Depending on the hydrology of the area irrigated, water quality benefits will be generated even if the water is retained if the improvement reduces the volume of leakage past the root zone and less salt is mobilised to the river system (see box 1). However, in irrigation areas where return flows are fresh and the base efficiency is low, there may be a disbenefit associated with the irrigator retaining the water savings.

Second, the savings may be left in the river as a dilution flow. However, the price of the bid will be high if the water is surrendered at market value. Third, the irrigator may sell the savings if an operational water market exists. Being able to retain or trade the water saving can significantly lower the cost of undertaking efficiency improvements to the irrigator. Allowing trade to higher impact areas would erode the benefits of the
efficiency. The benefits could be maintained if the water could be sold to low impact areas as long as institutional arrangements were in place to ensure that the savings were not onsold. However, for all three options, the manner in which the excess water is used will have an impact on water quality, and therefore on the attractiveness of a bid.

The conditions of payment may vary depending on whether the bidder intends to undertake infrastructure or management changes, or a combination of both. Upfront payment may be required to enable the irrigator to make the capital investment. It may be more appropriate to compensate for improvements in management practices on an incremental basis, as there is little incentive for adherence to contract conditions if full payment is received early in the life of the agreement. An incremental payment need not necessarily be of equal value in each year of the agreement.

Concluding remarks
The successful implementation of competitive tendering for water use efficiency improvements to enhance water quality in the Murray River system will require a carefully thought out and constructed bidding and assessment process. Its success would also be heavily reliant on the availability of good, site specific information on which to assess the bids and the appropriate institutional arrangements to provide the rights and legal framework to make the process operational.

There are, however, many advantages of developing auctions for environmental outcomes. They provide low cost solutions to the provision of environmental benefits because they introduce competition between participants. Auctions also reveal

Box 1: The difference between the irrigator retaining and not retaining the water savings can be seen in the following example. If, before an efficiency improvement, irrigation water is applied at a rate of 8 ML/ha at an efficiency of 70 per cent on soils where all water applied enters the ground water system, that is, there is no surface water runoff, then the volume of water transpired is 5.6 ML/ha and the volume of ground water leakage 2.4 ML/ha.

If water use efficiency is improved to 80 per cent, the irrigator does not retain the savings, and the volume of water transpired must remain at 5.6 ML/ha to maintain yield, then the required application rate would be 7 ML/ha. The volume of ground water leakage would be 1.4 ML/ha.

If water use efficiency is improved to 80 per cent and the irrigator does retain the savings and the savings are also applied at an efficiency of 80 per cent, then of the original 8ML, the volume of
information about the costs of program participation and allow the government to discriminate positively between bids. The highest efficiency gains can be achieved when there is enough information available to target the project objectives in the bid selection process.

Several elements of tender design have been explored in this paper but the final specification of the tendering process should be tailored to the location of the auctioning process, its scale and budget constraints. Depending on these factors, there may also be other issues to consider such as the possibility of staging the bidding process where bids for the same contracts are invited in a sequence of several years, or several times a year as in the US Department of Agriculture’s Conservation Reserve Program. The possibility of divisible bids, where part of a bid is accepted, has not been considered here. While divisible bids may increase the costs of bid assessment, they may enhance the overall efficacy of the program in terms of it meeting the water quality objectives.

It may also be possible to explore a wider set of applications and options for increasing water use efficiency through tendering schemes. Other applications might include purchasing water for increased environmental flows and managing other water quality issues such as nutrification. There may be alternative institutional arrangements that would better suit conditions where there is a potential for collective investments in delivery infrastructure or where water users do not hold permanent entitlements.

References


