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Sustaining Water Resources for Irrigated Cotton Production  
through Capacity Sharing - An Operations Research Project.

Maintaining Access and Security of Water Resources for  
Irrigated Cotton Production.

Conducted on behalf of the

Cooperative Research Centre for Sustainable Cotton Production

by

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and

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Cooperative Research Centre for Sustainable Cotton Production

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Centre for Water Policy Research

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A final report prepared for the CRC for Sustainable Cotton Production

## 1. Summary

The initial proposal for this project involved three phases, the development of an education and advisory package for capacity share holders; a water accounting package to administer capacity shares; and a translation of existing water entitlements to capacity shares. The budget received for the project was less than half that originally proposed, consequently it has not been possible to meet all the original objectives. The education and advisory package was not fully developed. The Integrated Quality-Quantity Model (IQQM) was developed by the Department of Land and Water Conservation (DLWC) to aid decision making on water management for surface water supplies in New South Wales. Its purpose is to simulate river flow characteristics. The majority of the resources dedicated to this project have been directed to the translation of current water entitlements into capacity shares.

The project was originally to begin in 1993 with the Namoi IQQM, however, it was not until mid 1996 that the DLWC supplied a draft version of the model. A methodology was developed to estimate individual capacity shares using a feature of the IQQM that allows for bulk capacity shares. The Namoi IQQM was (and still is) in the process of being calibrated, so an operational IQQM for another valley was sought from the DLWC.

The Macquarie IQQM was supplied to the CWPR. The model was configured to perform a 105 year simulation of the valley at the 1993/94 level of development. The model was however unable to simulate Capacity Sharing where water is ordered from one storage by another (ie. between storages arranged in series). In order to use the model for estimating capacity shares it was necessary to manipulate the program to simulate the Macquarie River system without storage water ordering. Three main approaches were attempted; creating a composite storage; placing the reservoirs on different river branches (in parallel); and configuring the model so that the downstream reservoir behaved as a headwater storage, thereby eliminating storage water ordering. This process was extremely time consuming, and ultimately unsuccessful. The complexities of the model did not lend themselves to this kind of manipulation, and it was not possible to create a modified system that behaved as the original. This work was undertaken in consultation with the IQQM developers, and led to the conclusion that the IQQM alone is unsuitable for modelling Capacity Sharing where reservoirs exist in series.

Therefore an alternative methodology had to be devised to meet the objectives of this project. This involved using data generated within a modified version of the IQQM for further analysis in a spreadsheet model. The modification involved adding extra gauge nodes to provide more detail about the impacts of tributary inflows, transmission losses, and diversions to users on in-stream flows. The spreadsheet model was designed to receive data from the IQQM, and estimate capacity share requirements for each user. That is, the minimum shares that would have been required to provide each user with the same amount of water they received under the Volumetric Allocation scenario.

The model tracks user diversions up through the river system to the storage, and makes allowances for transmission losses and inflow shares. In this way the release required to enable a particular diversion to be made could be calculated. With this information, it was then possible to calculate the storage volume and inflow shares required so that all such releases could be met over the entire simulation.

The capacity shares estimated showed a very high correlation with the associated licence volume. High security licenses, and a varying ability to pump off-allocation water (ie. on-farm storage volumes, and pump capacities) explain what variation is present.

It was found that all town and irrigation water needs downstream of Burrendong Dam could be met from 91.5% of Burrendong's volume and 94% of its inflow (which includes Windemere Dam releases). This allocation of resources would free all unregulated flow for non-consumptive uses. If consumptive users were granted access to unregulated flows, storage capacity shares for non-consumptive uses could be increased accordingly.

The study identified problems associated with the Capacity Sharing of unregulated flows. The periodic access to these flows granted to individuals as 'off-allocation' water represents a minute proportion of the total flow. A system of time-based capacity shares for unregulated flows was devised to allow users to have sufficient access to those flows to meet historical demands, without increasing their overall level of access.

Another component of the project included developing the framework for a water accounting package using a relational database (Filemaker Pro™). The package has been designed to incorporate Volumetric Allocation with Continuous Accounting and includes comprehensive reporting facilities for water users. The package can be customised for any river system. Further development work is proposed to enable data transfer via the Internet (allowing users to check balances and place orders on-line). Customised packages could also incorporate the capability to generate transmission loss estimates, and provide a facility that allows for an order to be held until expected losses have fallen to a level specified when such a conditional order is placed.

While the concept of Capacity Sharing is now well known and has received widespread support, a pragmatic approach must be taken in seeking its implementation. Capacity Sharing of unregulated flows will require changes in resource management procedures. Capacity Sharing lends itself to different levels of implementation; the modifications required to existing water delivery practices could be minimised by introducing storage capacity shares while maintaining current sharing arrangements on unregulated flow. It is also possible to socialise transmission losses within sectors of the water user community, as is the case under the current system, though this compromise reduces incentives for users to improve distribution system (in-river) efficiencies.

## 2. Introduction

There is an increasing competition for surface water resources that have been traditionally available for irrigated cotton production. Water allocations are being sought for environmental purposes and to meet expanding urban and industrial demands. While this trend is somewhat inevitable, it is disturbing to the cotton industry as these demands can result in uncompensated reductions to the volume and security of water supplies for irrigation.

As increased demand for water forces opportunity costs to rise, it is important that it is used more efficiently, both from a strategic and a tactical perspective. Improved strategic off-farm water use efficiency is facilitated if property rights to water resources are clearly defined, and if maximum flexibility for managing the resource is possible.

An alternative to conventional water allocation mechanisms, known as Capacity Sharing, offers a conceptually simple solution to problems of resource use security and the need to improve allocative efficiency. The feasibility of Capacity Sharing has been extensively researched, and it is operational in a limited way in Victoria at the bulk supply level. Capacity Sharing has been given ministerial approval in New South Wales, and the Queensland Department of Natural Resources has been endeavouring to instigate Capacity Sharing trials on several valleys.

## 3. Objectives

- |           |   |
|-----------|---|
| Stage I   | To determine how existing irrigators' water rights would translate into capacity shares.  |
| Stage II  | To develop a water accounting system to manage capacity shares for irrigators who elect to adopt this property right and management system. |
| Stage III | To develop an education and management advisory service package for capacity share holders.   |

## 4. Results and Discussions

The Integrated Quality-Quantity Model (IQQM) hydrology model for the Namoi River was to be used to translate current user entitlements to capacity shares. The model was not available at the commencement of the project, and since the development of a water accounting package for irrigators was associated with that work the initial phase of the project related to informing likely capacity share holders of the potential benefits of the system.

A workshop (funded by the Department of Land and Water Conservation (DLWC)) was held at the University of New England in 1994 to acquaint water users with the new allocation system, and to examine any reservations or enquiries they might have. The workshop highlighted certain misconceptions, and uncertainties regarding Capacity Sharing. This led to the production of two papers addressing these concerns; *New Allocation Water Systems for Irrigators* (Bryant, 1994), and *The Concept of Capacity Sharing, and responses to Questions Posed on Implications for Irrigators* (Dudley and Bryant, 1995).

Throughout the course of this project these and other papers have been distributed widely amongst interested parties and several forums have been addressed outlining and discussing Capacity Sharing. These included meetings with various irrigator associations and the Murray Darling Basin Ministerial Council.

A draft version of the IQQM for the Namoi valley (that was, and still is, in the process of being calibrated) was made available to the CWPR in mid-1996. The model was configured to operate under the present system of Volumetric Allocation. The estimates obtained from the model as supplied were regarded as the base run (or control), any Capacity Sharing portfolios were required to enable the user to match their diversions made under this scenario. The aim of this stage of the project was to estimate capacity share portfolios that allowed users a similar level of supply to that experienced under Volumetric Allocation. The model was able to accommodate Capacity Sharing at the bulk supply level, and this feature was exploited to devise a methodology to estimate shares for individual users.

By assigning one user a bulk share, and adjusting that share to a level that just allowed the isolated user to match their diversions made in the base run, it was envisaged that capacity share portfolios could be estimated for all users across the valley. This would be done while ensuring that all other users were also allowed to maintain their level of supply. For comparisons across runs it was necessary to modify the isolated users' node to read from external files containing their diversions made under the base run scenario. In this way it was possible to ensure that their water demand was constant across scenarios. IQQM had a limit on the number of nodes that would read from such diversion files, so it was not possible, at this stage to replace all demand nodes in this manner, as desired.

Problems were envisaged with the Volumetric Allocation underlying the bulk shares, and changes in user behaviour under Capacity Sharing could not be incorporated. It was not possible to specify individual security carryovers for each bulk share. While it was desirable to eliminate security carryover for the isolated user, this was not possible without disrupting the water supplied to all other users, making comparison between runs subjective. The effectiveness of the proposed methodology could only be tested in a limited manner on the unfinished Namoi IQQM, so the model for another valley was sought from the DLWC.

The DLWC advised that the Macquarie IQQM would be the most suitable for further exploration of Capacity Sharing scenarios, and supplied the Centre for Water Policy Research (CWPR) with the model. The DLWC also undertook to supply a version of the model that allowed for separate security carry overs to be specified across bulk shares, and an increased number of nodes reading from time series diversions, so water demand could be made constant across different allocation scenarios.

After a period of investigation, it became clear that IQQM was unsuitable for modelling Capacity Sharing on a system where reservoirs existed in series (as is the case on the Macquarie, with Burrendong and Windemere dams). Where storages are sited in this manner the downstream storage may order water from an upstream storage to enable supply to the lower reaches of the system. Under Capacity Sharing this water would be transferred from the particular user's share of the upstream storage to that user's share of the downstream storage. In its current form, IQQM is unable to replicate this, and allocates the inflow into the downstream storage according to the (modeller-specified) storage inflow share proportions.

Consequently, it was necessary to eliminate storage water ordering to enable capacity share portfolios to be estimated. This led to the creation of a new (short term) objective, to represent the valley in such a way that no water transfers occurred between the storages, but water use was similar to that observed in the original ("actual") representation of the river, that is, the base run. This would realise a

modified base run from which Capacity Sharing portfolios could be estimated using the methodology previously developed. Several approaches were tried to create a system that behaved as the Macquarie, without transferring storage water.

Initially, the two reservoirs were combined into a composite storage. The users above Burrendong represent a small proportion of the valleys' total demand, and since Burrendong is significantly larger than Windemere the composite storage was sited at Burrendong, and (for the short-term) water users in the Windemere - Burrendong reach were disregarded. The focus lay downstream of the Burrendong reservoir.

Many iterations were performed, adjusting the size, and other aspects of the storage in an attempt to create a system that closely resembled the base run in its behaviour downstream of Burrendong. It was not possible however to create such a scenario, so another approach was adopted.

A system was created where the reservoirs were placed in parallel. A reach was created from Windemere to just upstream of Burrendong, linking to a branch containing Burrendong dam only. The inflow to Burrendong was that from the base run, specified in an external file, and only Burrendong's outflow was allowed to pass downstream. All flow from the Windemere branch was diverted before the confluence. This method however, led to different allocation announcements, and to different irrigator demand behaviour therefore rendering it impossible to emulate the base run. Forcing releases from Burrendong was also attempted, but no satisfactory output was obtained. Caution must be taken when employing such methods as forcing storage releases. Any such "hard-wired" instructions in the model may compromise its capabilities.

The DLWC advised that it was possible to alter the on-river storage node (at Burrendong) to a headwater node of the type used to describe Windemere. The headwater node obviously does not pass orders upstream, but may read from an external file of modeller-specified inflows. This was the approach deemed most likely to succeed by the DLWC.

This approach also proved to be unsuccessful, it was not possible to specify a set of parameters for the "Burrendong headwater" that did not significantly alter water allocation and use from that observed in the base run. It would have been possible to specify irrigator diversions in external files, but that would have been misleading. The nature of the valley has been fundamentally altered when moving to two headwater storages, so that the base run diversions could no longer be regarded as an acceptable control group when testing Capacity Sharing portfolios. Similarly, it would be undesirable to run the model under Volumetric Allocation with the two headwater storages. Though the Capacity Sharing scenarios would now be comparing like with like, there would be no way of validating the model. Indeed, it must be assumed that the further the output deviates from the base run, the less accurate it becomes.

The previously established methodology took a "top down" approach, using the model to implement new allocation procedures, eg. shares in storages and inflows are input as parameters of the model, runs are then made, and output analysed to ascertain if the required levels of supply have been achieved with the share portfolio specified. The elimination of water transfer between storages was required to facilitate the application of the methodology. A "bottom up" approach would allow for the estimation of capacity shares using the model in its original form.

The model, as supplied, simulated the operation of the Macquarie Valley under a Volumetric Allocation system. In this simulation mode, user demand, supply, river flows, losses and gains are all calculated. With the use of gauge nodes it is possible to output the river's flow at all points along the valley. Irrigation diversion estimates (on and off allocation) are also available, as are the orders placed by those irrigators. Loss functions employed by the model can be defined as a ratio for each day of the simulation. Similarly, storage volumes can be output. The model can be used to estimate all significant events regarding the river's flow.

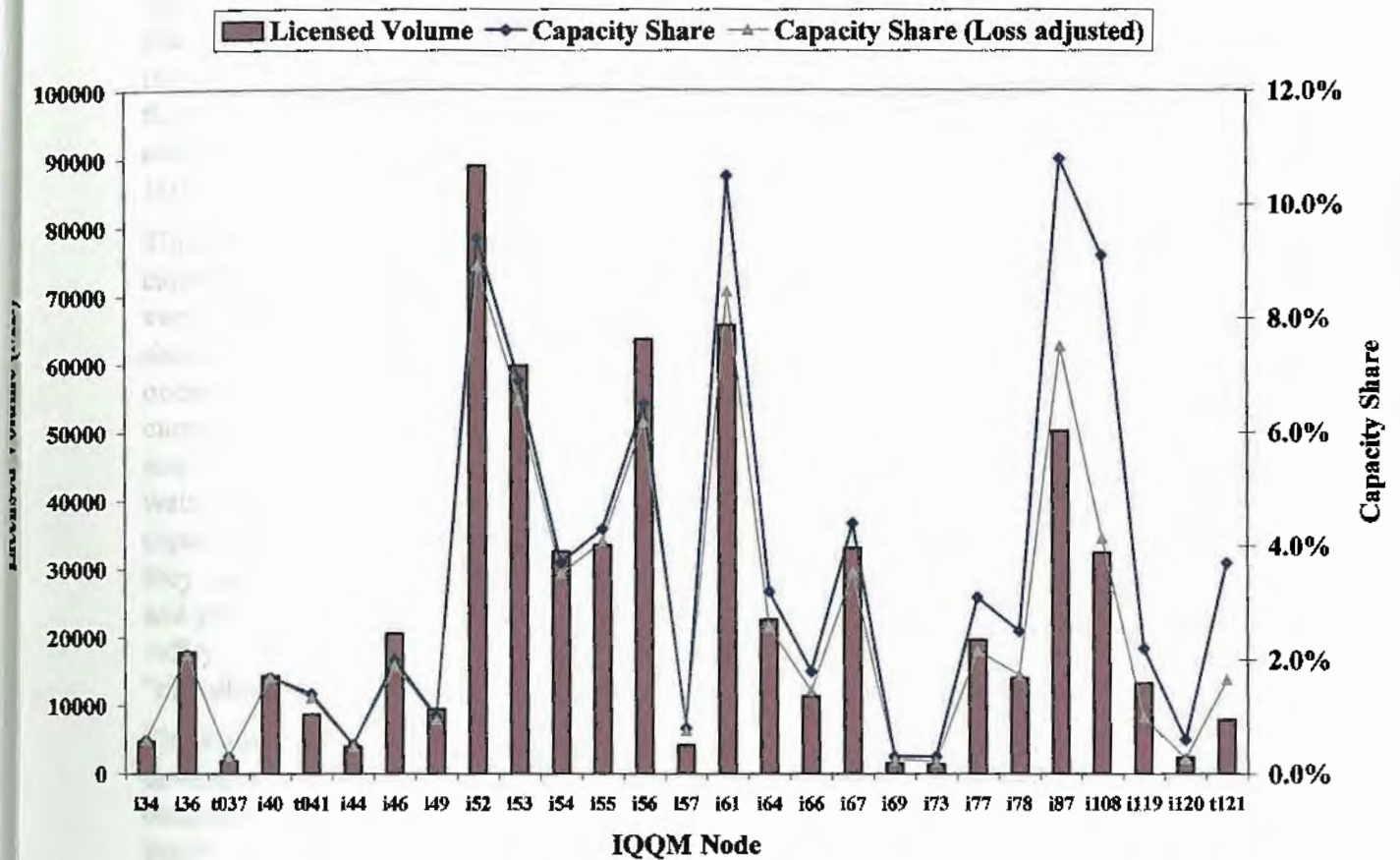
Applying a "bottom-up" methodology allows the modeller to start processes at the point of delivery, and work upstream to estimate capacity shares. Output from the model's volumetric simulation is used to retrospectively calculate the capacity share that would have been required to match the deliveries received by the user under the volumetric simulation. All water diverted can be tracked upstream, being increased by losses, and decreased by inflow shares to allow estimates of the release required at the storage to achieve the desired delivery. By examining differing proportions of inflows and storage capacity, it is possible to estimate the smallest capacity share that allows a user to meet their diversions made under Volumetric Allocation.

The problems associated with storage water transfers are overcome by regarding Burrendong as the headwater for water users below that reservoir (ie. Windemere is not part of the system). Allocating a particular share of the inflow to Burrendong is equivalent to the allocation of a share in all upstream resources (ie. Windemere inflow, Windemere storage volume, and all tributary inflow between the storages) in the same proportion. This method does not allow for variable shares across those resources, but ensures that regulated flow is not allocated twice.

The evolution of the methodology consisted of several phases, examining different treatments of the translation of water received during "off-allocation" periods into capacity shares. The initial approach was to meet water received "on-allocation" from storage capacity shares (ie. inflow and volume), and previous "off-allocation" water from shares in unregulated flow. This approach had appeal because of its similarity to the present system allowing for transparency of entitlement conversion, but proved to be unachievable, and highlighted difficulties associated with the application of capacity shares for unregulated flows. Off allocation in the model is declared on a reach by reach basis, with rules to ensure equitable distribution over time. That is at different times irrigators in different reaches may have access to all the potential off-allocation flow in the system. It is impossible to establish capacity shares that allow all users to access these peak shares of flows when they occur since they have previously been allocated on a rota basis.

An option was to consider the total amount of water diverted, and proceed on the assumption that the user would first access their unregulated flow share (which is otherwise lost to them as it passes the pump). Further requirements would be initially met from on-farm storages, then from water held in on-river storages. Where the unregulated flow share exceeded demand, and space was available, the remainder was held in on-farm storage.

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**Figure 1 Capacity Share Estimates: Storage Volume and all Inflow above Windemere dam.**

Figure 1 illustrates capacity share estimates that would allow irrigation and town water users downstream of Burrendong dam to meet their historical water supply. The shares specified are of the inflow to Windemere, the current volume of both Burrendong and Windemere dams, and all tributary inflow between the dams, no shares have been allocated in tributary inflow below Burrendong dam. The loss-adjusted series depicts the portion of the capacity share that contains "deliverable" water; the remainder of the share is required for the losses incurred in the delivery of that water. This figure has been calculated from the capacity share using the average daily delivery efficiency across the entire simulation.

The model aggregates similar users in the same reach into composite sites (or nodes); the distribution of shares within the node should be made on a pro-rata basis according to current licensed volume. Further information on the IQQM nodes, and more extensive results are presented in a tabular form in the appendix. Storage volume shares are ultimately assigned in megalitres, not as a percentage of the total volume ensuring that an extension of the storage does not necessarily result in an increased capacity share for all users.

The investigation of unregulated flow shares identified difficulties with regard to translating access rights to those flows. An unregulated flow capacity share sufficiently large to allow for considerable access in periods of historical high demand (eg. the irrigation season) allows greatly increased overall access. Conversely the share that grants equivalent overall access is minute, since it assumes that every portion of the available flow is diverted. Time based capacity shares would overcome these concerns, varying access could be granted over different time periods, allowing consumptive users significant access over certain periods, and non-consumptive uses 100% access at others.

This study was concerned with matching historical usage as opposed to allocating capacity shares on the basis of previous entitlement. However, the results indicate a very high correlation between both mechanisms when viewing estimated capacity shares (loss-adjusted) in relation to volumetric entitlement. The variation that does occur is apparent in Figure 1, when relating the loss-adjusted capacity shares to current licensed volume. The variation is most noticeable at nodes i57, i61 and i87 and t121. Node i57 represents a high-security licence, and t121 Gunningbar town water supply. It is expected that such users will be granted proportionally higher capacity shares to allow them the security of supply associated with the access right they currently hold. Nodes i61 and i87 have proportionally larger on-farm storages and pump capacities in relation to their licensed volume than other water users in the valley. They have historically received a greater proportion of their water through "off-allocation", and this is reflected in the capacity share estimated.

The framework for a water accounting package to manage Capacity Sharing has been developed in conjunction with a system to administer Continuous Accounting, commissioned by the DLWC. The package has been constructed using Filemaker Pro™ a commercial database program, a developer's version of the program is available, that enables the creation of fully licensed, stand alone databases meeting all software copyright obligations of the end user. Budget constraints have meant that it was not possible to fully develop the accounting package, though it is operational at a basic level.

## **5. Discussions**

### **Stage I**

The larger part of this study was spent attempting to model Capacity Sharing scenarios using IQQM. A primary outcome from the project is that IQQM in its present form is unsuitable for evaluating capacity shares on a valley where reservoirs exist in series, and modifications are required for modelling Capacity Sharing on any river system. However, the output from the model (run under Volumetric Allocation) may be exported to a spreadsheet platform, where the effects of Capacity Sharing portfolios may be evaluated. The methodology developed in the course of the project offers a great deal of transparency in the translation of current water entitlements to equivalent capacity shares, and can be applied to any river system.

### **Stage II**

The framework for a water accounting package to administer the operation of Capacity Sharing has been developed in conjunction with the formation of a system to manage Continuous Accounting, commissioned by the DLWC. The package is in the form of a Filemaker Pro™ relational database that incorporates extensive reporting facilities in the form of customer statements, and it is envisaged that the end product

would allow for information transfer via the Internet. The system is operational, though in its current form data entry is cumbersome; utilities for communication with current systems are not in place; and proposed facilities for generating loss estimates have not yet been incorporated.

### Stage III

The resources allocated for this project have not allowed for the production of a management and advisory package for capacity share holders. However the CWPR has been actively involved in raising industry (and community) awareness of the many issues regarding the implementation of Capacity Sharing. During the course of this project possible refinements to the management system have been identified and communicated to members of the cotton industry through various forums.

## **6. Conclusions, Recommendations and Application to Industry**

The DLWC intends to complete an IQQM for every catchment under its authority and will use information obtained from these models to aid its water management decisions. The methodology adopted in this study allows an alternative allocation mechanism to be investigated using estimates generated from IQQM. The objective in estimating capacity shares was to ensure equivalent access to water to that found under the present system.

While full Capacity Sharing is feasible, its implementation will be difficult to achieve without the support of all interested parties. It would be possible to give individual users the option of remaining under the current system of Volumetric Allocation, drawing their water from a bulk capacity share administered by the DLWC.

A possible implementation of Capacity Sharing could involve the socialisation of transmission losses within sectors of the water using community. Since a transmission loss share would be large enough to cover all contingencies, it may be possible to periodically distribute any unused portion in such a way that rewards individuals for efficient water use.

Where stakeholders have reached mutually acceptable sharing arrangements on unregulated flow (or, as on the Macquarie, regulated flows are sufficient to meet consumptive uses) Capacity Sharing of storage volume and inflows only would simplify transition to the new system. All water for consumptive use could be stored in on-river storage, minimising evaporation loss. The "piggy-backing" of releases would allow users a level of control over their transmission losses. This would still allow for trade, both monetary and in-kind between consumptive users and any bodies established to safeguard environmental concerns. Capacity Sharing potentially allows mutual benefits, for the irrigation industry and the environment.

The adoption of time-based capacity shares in unregulated flows would allow for efficient use of water for irrigation needs, and may allow non-consumptive water uses (eg. environmental) unrestricted access to natural flows for certain periods. It is envisaged that operational Capacity Sharing would allow for water orders to be placed that were conditional on transmission loss estimates. A release to fulfil an order would be made when expected transmission losses fell to a certain level, or on a specified date, whichever is the sooner.

The Macquarie example indicates that all consumptive water uses could be met from regulated flows, allowing non-consumptive uses full access to unregulated flows. Alternatively, sharing arrangements on the unregulated flow may allow increased storage space for non-consumptive uses that could allow for remedial measures, such as river flushing, and the maintenance of bird-breeding events.

Although the previous Minister for Land and Water Conservation in New South Wales (Yeadon) expressed his support for Capacity Sharing, and his desire to see a trial implemented in New South Wales, no trial has yet occurred. The possible share portfolios proposed in this study may be acceptable to the environmental movement, while still offering the irrigation industry freedom in their water management decisions. Capacity Sharing does have potential benefits for non-consumptive water uses, and further research is required to investigate these considerations.

A pre-requisite for the application of Capacity Sharing is a water accounting package to track users' activities. The development of such a package has the potential to significantly delay the implementation of (even a trial of) the new system when agreement has been reached in principle. The framework for determining capacity share portfolios developed in the course of this project would now enable Capacity Sharing to be fully operational and compatible with current systems within in a matter of months.

#### **7. Communication of Results**

The CWPR has been instrumental in promoting Capacity Sharing, and informing interested parties on the form of its application, and associated potential benefits. *Ten Answers to Irrigators Questions*, a summary of the issues identified at the workshop held at the University of New England, has been widely circulated, and a high level of awareness now exists with regard to Capacity Sharing within the water community.

Various forums have been addressed outlining and discussing Capacity Sharing, and the methodology established in this study. This has led to further research being commissioned, covering both the translation of existing entitlements to capacity shares, and the development of a water accounting package to administer Continuous Accounting.

**(iii) Further Supporting Data**

NODE	Location	Activity level	Licensed Volume	Estimated Capacity Share	Share Type	Average Annual Diversions (ML)	Average Delivery Efficiency (*1000)	Minimum Balance (ML)	Estimated Burrendong Share (ML)	Estimated Windemere Share (ML)
i11	Guttawang Gauge - Wyaldra Creek	10%	17600	2.5%	2	1474	1000	533		9300
i12	Guttawang Gauge - Wyaldra Creek	10%	4400	0.1%	2	437	1000	285		400
i34	Burrendong-Bell River inflow.	95%	4767	0.6%	1	3794	1000	1194	8800	2300
i36	Bell River - Wellington	95%	17824	2.1%	1	13582	1000	2013	32700	7800
t037	Wellington	100%	1855	0.3%	1	1790	1000	220	4800	1200
i40	Little River - Dubbo	95%	14319	1.7%	1	10967	1000	1325	26800	6300
t041	Dubbo	100%	8700	1.4%	1	8399	953	1181	22000	5200
i44	Dubbo gauge- Talbragar inflow	95%	3992	0.5%	1	3160	953	457	7800	1900
i46	Talbragar - Coobaggie Ck	95%	20522	2.0%	1	12406	953	2500	31900	7000
i49	Ungauged inflow - Baroona Gauge	95%	9458	1.0%	1	6354	953	821	15700	3700
i52	Baroona Gauge - Gin Gin gauge	98%	88874	9.4%	1	60668	949	2601	152600	34700
i53	Baroona Gauge - Gin Gin gauge	100%	59706	6.9%	1	44612	949	1581	112400	25500
i54	Baroona Gauge - Gin Gin gauge	100%	32500	3.7%	1	24476	949	368	60800	13700
i55	Baroona Gauge - Gin Gin gauge	100%	33431	4.3%	1	29591	949	1870	69200	15900
i56	Baroona Gauge - Gin Gin gauge	100%	63511	6.5%	1	42880	949	367	107000	24000
i57	Baroona Gauge - Gin Gin gauge	98%	4172	0.8%	1	5138	949	639	12600	3000
i61	Gin Gin Gauge - Reddenville Break	98%	65673	10.5%	1	52909	806	1703	171700	38700
i64	Reddenville Break - Beleringar offtake	98%	22537	3.2%	1	15832	806	2258	50600	11800
i66	Beleringar offtake-Gunningbar Creek offtake	98%	11365	1.8%	1	8738	806	1453	28300	6700
i67	Beleringar offtake-Gunningbar Creek offtake	98%	33024	4.4%	1	21761	806	809	71900	16200
i69	Gunningbar Creek offtake-Warren Weir	98%	1528	0.3%	1	1405	806	14	5000	1200
i73	Warren Weir-Reddenville return	93%	1340	0.3%	1	1024	714	1776	3200	1200
i77	Ewenmar Ck inflow-Marra Break	93%	19621	3.1%	1	13688	695	348	50900	11500
i78	Ewenmar Ck inflow-Marra Break	93%	13989	2.5%	1	10906	695	1650	39700	9300
i87	Oxley Breaks-Oxley Gauge	93%	50169	10.8%	1	43914	695	2861	175500	39800
i108	Bulgeraga Ck Gauge - Mcq confluence	93%	32315	9.1%	1	27152	454	1931	148300	33500
i119	Beleringar Jnc - Gunningbar	93%	13246	2.2%	1	5650	445	2469	33900	8100
i120	Beleringar Jnc - Gunningbar	93%	2390	0.6%	1	1454	445	1686	8300	2300
t121	Gunningbar	100%	7890	3.7%	1	7727	445	2567	58600	13700
Total			615192	93.8% 2.6%	1 2	465146			1509700 (91.5%)	322100 (96.8%)

Share type 1 refers to storage volumes, Windemere inflow, and tributary inflow between the storages.

Share type 2 refers to Windemere storage volume and Windemere inflow only.

Burrendong volume shares are calculated by :- % share \* total volume - minimum simulation balance, rounded up to 100 ML

Windemere volume shares are calculated by :- % share \* total volume, rounded up to 100ML

Extended supporting data is available from the Centre for Water Policy Research

#### **(iv) Abstract**

The project focused on using the Macquarie Valley Integrated Quality Quantity Model (IQQM) to translate current irrigation water access rights to capacity shares. The IQQM was found to be unsuitable for estimating capacity shares, where reservoirs exist in series, due its inability to transfer water between user shares in different storages. However, a methodology was developed to retrospectively estimate capacity shares through analysis of the output from the IQQM. In the case of the Macquarie Valley all consumptive water use demands could be met from regulated flows.

It was observed that an efficient allocation of unregulated flows could be achieved through time-based capacity shares that would allow increased availability of water at times of high demand without increasing overall access.

The project also involved the education of potential capacity share holders, and led to the publication of several papers addressing both general topics, and the particular concerns of stakeholders.

A framework for a water accounting package was developed in the form of a relational database, using Filemaker Pro™. The database has been designed to incorporate information transfer via the Internet, the generation of transmission loss estimates, and facilities for conditional ordering, where releases are made only when expected loss falls below a specified level.

#### **9. Special Considerations**

The objectives referred to in the body of the report were contained in the original research proposal, with a budget including in kind support from the DLWC. High-level changes in personnel at the DLWC meant this aid was not forthcoming at the institutional level. DLWC staff members, however, provided informal support. The project was due to start in 1993/94, but was delayed two years, waiting for the Namoi IQQM to become available. The model when supplied was incomplete. Current estimates are that it will be ready for use at the end of 1999. The Macquarie IQQM was supplied as a compromise to enable this project to proceed.

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