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Abstract:
The Victorian Department of Sustainability and Environment (DSE) spent the latter decades of the 20th century fully integrating the surface and sub-surface drainage systems with the water distribution network in northern Victoria, thereby enabling complete recycling of outfalls, leaks and seepage from its channels. Yet in 2007, in repudiation of this recycling capacity, DSE announced a multibillion dollar modernisation project it claims will "create" 450 GL of "new water" by reducing "inefficiencies" in the channel distribution system.

Examination of the northern Victorian irrigation supply system shows it was fully integrated with more than adequate recycling capacity before the project began. In a classic case of double counting, DSE was already delivering the illusory "new water" to regional irrigators and billing them for it. Thus the project cannot deliver real water savings and the Government must effectively reduce irrigation entitlement to increase entitlements for urban consumption and environmental flows.

The financial and economic impact of bogus water savings on stakeholders is discussed in terms of the opportunity cost of appropriated irrigation entitlement and of the effect of overcapitalisation of the distribution system on annual capital charges and thus the viability of irrigation and the operating water authority.

More water for everything?
The problem of bogus water savings in northern Victoria, Australia[1]

Oliver Gyles

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The Victorian Department of Sustainability and Environment (DSE) spent the latter decades of the 20th century fully integrating the surface and sub-surface drainage systems with the water distribution network in northern Victoria, thereby enabling complete recycling of outfalls, leaks and seepage from its channels. Yet in 2007, in repudiation of this recycling capacity, DSE announced a multibillion dollar modernisation project it claims will “create” 450 GL of “new water” by reducing “inefficiencies” in the channel distribution system. Examination of the northern Victorian irrigation supply system shows it was fully integrated with more than adequate recycling capacity before the project began. In a classic case of double counting, DSE was already delivering the illusory “new water” to regional irrigators and billing them for it. Thus the project cannot deliver real water savings and the Government must effectively reduce irrigation entitlement to increase entitlements for urban consumption and environmental flows.

The financial and economic impact of bogus water savings on stakeholders is discussed in terms of the opportunity cost of appropriated irrigation entitlement and of the effect of overcapitalisation of the distribution system on annual capital charges and thus the viability of irrigation and the operating water authority.

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1. INTRODUCTION

1.1 Design and funding of major water resource management projects in northern Victoria.

1.1.1 Multi-agency working groups with stakeholder consultation leading to community and government joint action

In the latter decades of the twentieth century, government funded research and development produce a range of technical options for the management of salinity and nutrient pollution in the irrigation regions of northern Victoria. Options were selected by multi-agency technical working groups and submitted together with cost sharing proposals from local communities as draft plans for the sustainable management of land and water resources[3]. These plans were

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[1] A working paper for presentation at the AARES conference in Melbourne, February 2011

[2] Registered office, 92 Binney St, Euroa, Victoria 3666

[3] SPAC Draft Plan and Working Papers (1989)

assessed using an economic benefit: cost analysis framework[4] as set out in treasury guidelines. Component programs were ranked on the basis of net present value, benefit: cost ratio and internal rate of return, with only those with a positive net present value being eligible for government funding unless large unvalued social or environmental benefits were identified. In some cases, draft plans were not approved until particular programs were redesigned to yield a net benefit[5].

Thus the program of works to complete the construction of the surface and subsurface drainage systems and their integration with the water distribution system in northern Victoria was designed to be technically feasible, maintain equity, improve economic efficiency and avoid overcapitalisation of the water distribution system.

The Department of Sustainability and Environment (DSE)[6] was and is responsible for the coordination of the drafting, funding, implementation and monitoring of the Land and Water Management Plans for northern Victoria.

1.1.2 Single agency project teams with expert dependent consultancies

In contrast to the method of project planning outlined above, DSE has more recently employed a different approach in which the information used as the basis for a benefit: cost analysis is "selected" by staff, consultants and equipment suppliers. This process can be expedient but is an arrangement lacking adequate time and resources for the open forum peer review processes which can identify both absurd or inconsistent information about possible project options and faulty specification of the 'base case' scenario against which they are to be compared. Probity and due process may be casualties in this approach. Therefore faulty benefit: cost analysis can result through the unwitting use of spurious data. In the case of water savings projects, illogical technical analysis will lead to bogus water savings.

A characteristic of this planning approach is that there is very little direct communication or real consultation with individual stakeholders. The project plan is simply presented as *fait accompli.*

1.1.2.1 The Food Bowl Modernisation Project

The Food Bowl Modernisation Project in northern Victoria is an example of a project born of the non-inclusive approach. It is a deal between the Victorian Government and a self appointed elite regional interest group called the Food Bowl Alliance. The first part of this deal involves a billion dollar investment in irrigation infrastructure in the Goulburn

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[4] For example, see Dumsday et al, 1990

[5] Dumsday *et al op cit* recommend exploring a range of options to find those with higher BCRs

[6] DSE and its otherwise named antecedents.

component of the irrigation water distribution system[7] which DSE (2007) claims will "create 225 GL of new water" through the reduction in "losses due to system inefficiency". It is proposed this "new water" will be equally allocated as new entitlements being 75 GL for urban water users outside the Goulburn basin, 75 GL for the environment and 75 GL for Goulburn system high security irrigation water entitlement holders.

In contrast to the enthusiasm of the proponents of this project, a public meeting of irrigators and other affected groups voted against the project and passed a motion repudiating any claim made by the Food Bowl Alliance of universal support for the Food Bowl deal. Irrigators are doubtful that significant real water savings can be made and consider that the 225 GL of "new water" will not be obtained. These irrigators see themselves as victims in scheme to "rob Peter to pay Paul" whereby "dry", or in reality non-existent, water savings result in the appropriation and transfer of existing local water entitlements to distant water users (Seckler, 1996).

This paper has three main aims:-

Firstly, to assess the potential for real water savings.

Secondly, to consider the financial and economic impact on stakeholders in the proposed project and,

Thirdly, to discuss some alternative policy options for the management of the distribution and delivery of water resources in northern Victoria.

2. WATER FLOWS AND CONCEPTS OF SYSTEM EFFICIENCY

2.1 The nature of water flows in the Goulburn channel system

A diagrammatic longitudinal section of a distribution channel showing different categories of water flow is depicted in Figure 1.

[7] The Goulburn irrigation system is a major component of the Goulburn-Murray irrigation system in the northern region of Victoria, Australia. It is a gravity supply channel system operated by Goulburn-Murray Water (G-MW), the government owned monopoly responsible for the supply of water to customers in northern Victorian under a number of Bulk Water Entitlements. The state of Victoria is also committed to deliver water to South Australia via the Murray River for urban/industrial, environmental and agricultural use. DSE advises and supports the Minister for Water who is responsible for the direction of Goulburn-Murray Water in the performance its duties.

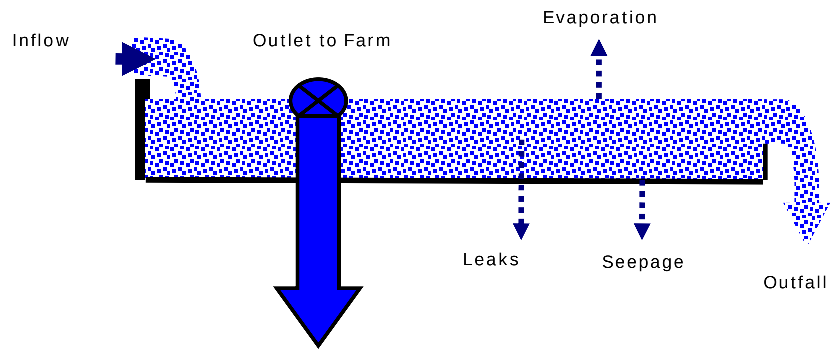

Figure 1: Categories of water flows into and out of a distribution channel.

The different categories of water flows depicted by arrows in the diagram are described in Table 1.

Table 1: Categories of water flows in distribution channels

1. Inflow	Water from upstream is released into the head of the channel through a flow regulating and measuring structure
2. Outlet to farm	Water is delivered to farm through a regulating outlet generally fitted with a water meter
3. Leaks	Water escapes from the channel through leaks in the bank or around regulating structures
4. Evaporation	Water evaporates from the upper surface of the channel
5. Seepage	Water seeps through the bottom of the channel
6. Outfall	Surplus water flows through the downstream regulating and measuring structure

The seasonal volume of different categories of water flow reported by G-MW for a manually operated channel (Douglass *et al*, 2000) is shown in Table 2. The major categories of flow, inflow, metered delivery and outfalls, were continuously measured over four seasons from 1996-97 to 1999-2000.

After allowance for meter inaccuracy and unmetered Domestic and stock water, total deliveries to customers were found to be 83 per cent of inflow to the G-MW channel.

Table 2: Seasonal water flows in a G-MW channel (Douglass *et al*, 2000)

Categories of water flow	**ML**	**%**
Total Inflow	6153	
Recorded via Metered Outlet	4764	77.4
Potential Meter Inaccuracy	308	5.0
Unmetered Domestic & Stock water	97	1.6
Outlet leakage	120	2.0
Leakage Channel	71	1.2
Outfalls	786	12.8
Seepage	38	0.6
Evaporation	90	1.5
Unaccounted for water	-122	-2.0
Total Outflows	6153	100.0

2.1.1 "Distribution Efficiency"

G-MW calculates the "distribution efficiency" of its separate channel systems as metered deliveries to farms divided by inflow. Using the example of Douglass *et al*'s data in Table 2, G-MW would report a distribution efficiency of 77 per cent. This level of distribution efficiency is generally consistent with that reported for channels in the Goulburn system over most of the last three decades by G-MW and its antecedents the State Rivers and Water Supply Commission and Rural Water Commission. SRWSC management noted that although the distribution efficiency for the Central Goulburn Irrigation Area was 87 per cent in 1979/80, "that up to 1994, Central Goulburn Area efficiencies were maintained at levels close to 80 percent with some traditional drop off in lower delivery years"[8].

The term "distribution efficiency" conjures up the axiomatic concept of "losses due to system inefficiency" which implies all water other than metered deliveries to farms is lost from the system. Looking at undelivered channel outflows in isolation suggests the possibility of large potential for water savings. But in reality water undelivered in one part of the system can simply become water in transit to a point of delivery further downstream if the channel is part

[8] If the distribution efficiencies reported by SRWSC are increased by 6.6 percent to allow for potential meter inaccuracy and unmetered stock and domestic supplies, they would be 93.6 per cent and 86.6 percent respectively.

of an integrated water management system. This is the case for the Goulburn system as shown in Appendix I.

2.1.2 "Delivered" and "Undelivered" channel outflows

Douglass *et al* recognise that the calculation of distribution efficiency should be based on the total real volume of water delivered to customers. After including the estimated volume of un-metered "Domestic and Stock" water and allowing for the estimated under recording by water meters they calculated a distribution efficiency of 83%. In a physical sense, "Outlet leakage" is also a delivered outflow in that the water is directly consumed albeit without there being a valid entitlement to its use.

The other outflows shown in Figure 1 may be termed "undelivered channel outflows".

2.2 Current Fate of Undelivered Channel Outflows

2.2.1 Evaporation

Evaporation from the surface of the channel system is an irretrievable water loss. Evaporation is partly offset by rainfall on the channel surface.
The modernisation project is not designed to eliminate evaporation.

2.2.2 Seepage

Water that seeps below the bottom of the channel supplements existing groundwater resources.

The fact that surface and ground waters are interconnected is accepted by G-MW (Diversions division, 2008) who published the block diagram in Figure 2 showing a "losing stream" recharging the underlying groundwater system in a manner analogous to seepage from a channel.

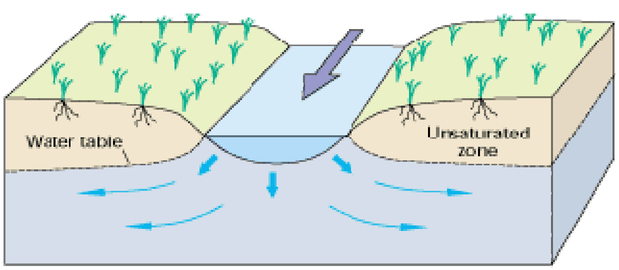

Figure 2: Seepage from a losing stream recharging the groundwater system. (After Winter *et al* 1998)

Groundwater is extensively pumped for irrigation use in the Goulburn region at rates causing the groundwater reserves to shrink (Anon, 2008). The regional groundwater management program is supervised by DSE.

G-MW is paid by Government to pump groundwater which it either returns to the channel system or outfalls into the drainage system. G-MW charges irrigators for using the groundwater it pumps into channels and drains and charges private groundwater pumpers for their use of groundwater.

Seepage from channels is thus recycled by activities approved and monitored by DSE.

2.2.3 Outfalls

Outflows from the end of the distribution channel fall into the next downstream component of the total connected water resource management system. This system has been designed by DSE/G-MW so that outfalls from the upstream component become inflows for the next section downstream such as another distribution channel, a surface drain or return flow into the river.

Outfalls are thus re-diverted by G-MW for delivery to irrigators, pumped by licensed drain diverters who pay annual fees to G-MW, or transported by the river for delivery to downstream water authorities under State and Federal agreements.

A small proportion feeds swamps and wetlands for environmental purposes.

The regional surface drainage program is supervised by DSE.

Outfalls from channels are thus recycled by activities approved and monitored by DSE.

2.2.4 Channel Leakage

Leakage from channel banks and structures either outfalls into downstream channels or drains and is subsequently reused by downstream irrigators including licensed drain diverters, or it may flow onto farm land, or seep into the groundwater system. Leakage intercepted by farm drains and used for irrigation via a recycle system could be termed a delivered outflow.

Improved farm drainage and construction of recycle systems is subsidised and monitored by DSE.

Thus leakage from channels is recycled by activities approved and monitored by DSE.

2.3 Diagrammatic representation of the immediate destination of undelivered outflows from a channel within the G-MW distribution system

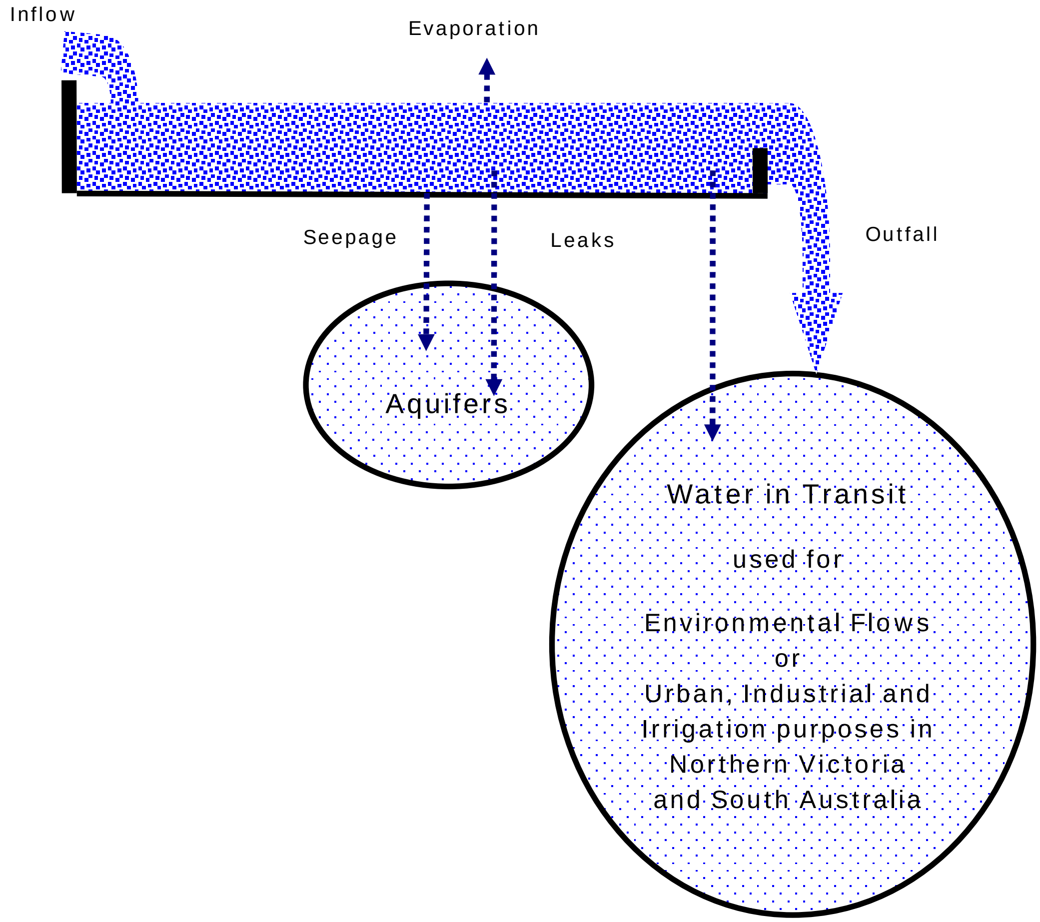

Figure 3: Immediate destination of undelivered outflows from a channel in the G-MW distribution system

The diagram in Figure 3 shows the immediate destination of undelivered outflows leaving a channel within the G-MW channel system. Appendix 1 shows that the integration of the channel system with the DSE's northern Victorian water management system enables recycling of water in transit further down the distribution system.

Surplus flows within the channel system outfall to drains which return water to the river system. Thus return flows from the Murray Valley, Shepparton, Central Goulburn and Rochester-Campaspe irrigation areas become inflows for the Torrumbarry irrigation area. The river town of Swan Hill, situated 133 river kilometres downstream from Torrumbarry Weir and 1505 river kilometres upstream from the mouth of the Murray River (MDBC, 2006), is close to the western border of the G-MW channel system. As G-MW has delivery commitments for both Victorian and South Australian irrigation and for urban diverters and environmental flows downstream of the channel system, any water returning to the river that is not recycled within the channel system, including outflows from both the Torrumbarry and Pyramid-Boort irrigation areas, will help supply those requirements below the channel system. It can be readily seen that there is no potential for DSE to obtain real water savings so long as there is sufficient capacity to recycle drainage flows within its total water delivery system.

2.4 The DSE view of the fate of undelivered channel outflows.

The current view of senior DSE management of the fate of undelivered channel outflows is illustrated in Figure 4.

Keller *et al* (1996) describe this concept of water management as being one where **"drainage water is treated as though it flows to an ultimate "sink". It simply drops out of the system, or "disappears"**.

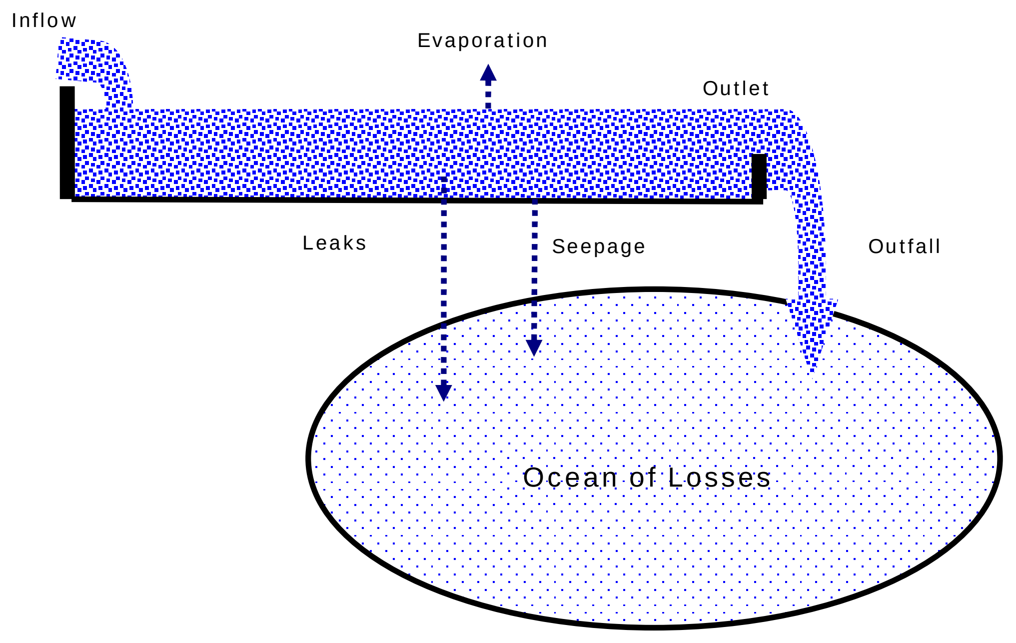

Figure 4: The DSE view of the fate of undelivered outflows in the G-MW channel distribution system

DSE (2007) has published expected diversions and metered deliveries for the Goulburn and Murray components of the G-MW channel distribution system for average and reduced inflow scenarios as shown in Table 3.

Table 3: Expected diversions and metered deliveries (GL) within the Goulburn and Murray components of the G-MW channel distribution system under average and reduced catchment runoff conditions. (After DSE, 2007)

	Goulburn Component		Murray Component		Total Goulburn-Murray System	
Inflow Scenario	Average	Reduced	Average	Reduced	Average	Reduced
Diversions	1780	1350	1110	985	2890	2335
Metered Deliveries	1305	932	715	623	2020	1555
"Losses due to system inefficiency"	475	418	395	362	870	780
"Total System Efficiency"		69%		63%		67%

All diverted water (inflow to the channel system) other than metered deliveries is treated by DSE as being "losses due to system inefficiency". DSE claims that 870 GL are lost every year due to system inefficiency.

DSE has not explained where this "ocean of losses" or ultimate sink is situated or how sufficient capacity exists to dispose of 870 GL every year. To annually dispose of 870 GL by evaporation a lake of at least 870 square kilometers in area would be required. The Southern Ocean could dispose of 870 GL of drainage water but this sink lies at Goolwa 1500 river Murray River kilometres downstream of the G-MW channel system (Fig. 2, App 1). DSE has not revealed the whereabouts of an undiscovered lake capable of evaporating 870 GL of perfectly acceptable irrigation water every year. Nor has it described a mechanism by which 870 GL of water could slip down the Murray River and into the sea completely unnoticed. G-MW and DSE reports show water is not accumulating in the regional groundwater system. Therefore there is no ultimate sink for undelivered channel outflows, and the DSE concept of "losses due to system inefficiency" is nonsense.

The only plausible explanation for the non-accumulation of 870 GL of undelivered channel outflows is that this water is being recycled within the G-MW/DSE system. As Keller *et al* (1996) observe that:-

> **"in practically all integrated water management systems, however, the drainage water stays in the system and is incorporated into the initial water supply for additional irrigation applications"**.

3. PROSPECTS FOR REAL WATER SAVINGS

3.1 Integrated Water Management Systems: A logical framework for the assessment of real water savings

Integrated water management systems (IWMS) recycle surface and subsurface drainage. In these systems, channel seepage, leakage and outfalls in one part of the system contribute to the water supply for other parts. Awareness of the degree to which the system is integrated can guard against logically flawed water savings proposals and avoid unnecessary replacement or duplication of expensive infrastructure. For example in Egypt by using the IWMS concept as the analytical framework Keller *et al* (1995) showed that **"If water reuse is accounted for, the scope for real water savings through engineering interventions is much less important than previously thought."** and **"efficiency gains at the canal level are outweighed by the reduced opportunity for reuse downstream."**

Thus DSE's claim that "leaky sections and inefficient operation result in up to 30 per cent of the total volume being lost." is a case in point. And it follows that if DSE used a sensible water accounting framework and **"If water reuse is accounted for, the scope for real water savings through engineering interventions is much less important than previously thought."** Section 2 shows the Goulburn-Murray distribution system is fully integrated with the surface and sub-surface drainage systems. Therefore, apart from reduced evaporation, there is virtually no potential for real water savings arising from the Food Bowl Modernisation project. The project is not designed to significantly reduce evaporation.

In relation to the concept of distribution efficiency as calculated by G-MW in section **2.1.1** above and the illusion of potential water savings, Seckler (1996) states that

> **"The fundamental problem with the concept of water use efficiency based [solely] on supply, that is, diversion to a project, is that it considers inefficient both the evaporative loss of water *and* the drainage water. This is invalid for that part of the drainage water which can be reused. To overcome this confusion in the concept of water use efficiency, knowledgeable people now distinguish between "real" water savings and**

“paper” water savings or, as they say in California, between “wet” and “dry” water savings”.

3.2 Estimating the Volume of Potential Real Water Savings

The potential volume of real water savings depends on the volume of non-recycled undelivered channel outflows. But, as the preceding sections show that virtually all drainage water is recycled, there can be no significant volume of real water savings. Therefore the estimated volume of real water savings is close to zero.

The Food Bowl Modernisation Project is a simply a scheme to appropriate existing entitlements to irrigation water and transfer them to other users. So the question then becomes “What volume of water is appropriated from the different classes of irrigation water entitlement holders and what are the financial and economic consequences?”

4. IMPACT ON STAKEHOLDERS

4.1 The without project scenario.

The base case against which the Food Bowl Modernisation Project is compared in this analysis is different to that assumed by the Food Bowl proponents in which sloppy maintenance and operation is assumed to generate high volumes of channel leakage and outfalls. In the Food Bowl Modernisation Project such incompetent management is assumed to be endemic thereby creating the “necessity” of capital intensive automatic equipment. Yet such an investment appears doomed if management is incompetent.

The base case for this assessment assumes no major investment in new infrastructure but rather that the system wide management of GM-W is if necessary made competent and is capable of producing the pre-existing flow pattern benchmarked by Douglass *et al* (2000). This ensures the recycling capacity of the integrated system is not exceeded while also avoiding increasing the risk of overcapitalization.

It is also assumed that the existing Dethridge meter outlets are made compliant with new national measurement requirements by:-

1. Maintaining all meters to the high standard already achieved at minimal cost by some diligent water services committees.
2. Increasing the calibration factor[9].
3. Adjusting readings based on existing calibration curves[10] to account for flow rate and supply level.

[9] New national measurement requirements are that meter readings shoul be within ± 5% of true volume.

Recent *in situ* testing of meter outlets is testament to the generally low standard, or total lack of maintenance of meters in some water service areas (G-MW, 2009).

4.2 Volume lost by different classes of irrigation water entitlement holders under the Food Bowl scheme

For total system average deliveries of 1171 GL[11] different classes would lose access to the following volumes annually:-

4.2.1 Groundwater licensees

Assuming the project reduces channel seepage by 50%, groundwater pumpers would lose access to around 5 GL.

4.2.2 Surface Drainage Diverters

If 50% of outfalls and channel leaks currently return to the river for recycling by G-MW (Nayar, 2006), drainage diverters would lose access to approximately 106 GL.

4.2.3 Channel Supplied Irrigators

At first glance it seems that all the extra volume of water irrigators receive due to under recording of deliveries by Dethridge meters is a potential saving and therefore the use of accurate meters would save a volume equal to metered deliveries multiplied by the meter error every year. This is not the case however because the full volume of entitlement is not allocated every year. And transfer of surplus irrigation entitlement to the environment does not start before both high and low security entitlement are fully allocated.

If Dethridge meters are under recording, more accurate measurement of retail deliveries to channel supplied irrigators will reduce the volume released from storage to supply the annual allocation. But savings do not become available for the environment[12] until the volume of the irrigators' share of the run of the river in storage exceeds the volume required to fully supply the irrigation bulk entitlement.

In the Goulburn system for volumes of 968 GL and 436 GL of high reliability and low reliability water share respectively, and an under recording inaccuracy of five percent, no oversupply of entitlement would occur until the total meter reading of deliveries exceeds 1336 GL. There is a reason for the term "low reliability" meaning this class of water share is

[10] SRWSC Drawing No:136 224 - Standard Large Dethridge Meter Rating Graphs
[11] Equivalent to 1.2 times the volume of high reliability water share.
[12] The total volume of low reliability water share issued was limited to 45% of the total volume of high reliability water share.

rarely fully allocated. The total annual allocation on the Goulburn system has not exceeded 138% of high reliability water share since 1996/97.

Assuming the total annual allocation on the Goulburn system exceeds 138% and reaches 145% one year in ten, the average annual additional volume of water that would be taken from the irrigation bulk entitlement pool, or share of the run of the river, and directed to the environment would be 7 GL. This is a much smaller volume than the 70 GL which is equivalent to 5% of metered deliveries every year. The under recording of deliveries is mainly an equity issue for channel supplied irrigators because when high reliability water share holders are allocated their full entitlement they get five percent extra volume before low reliability water share holders are given an allocation. Low reliability water share holders lose eleven percent of their entitlement under such circumstances. It does not become an equity issue in terms of losses for the environment until the annual allocation exceeds 138%.

Any shortfall remaining in the desired 150 GL combined increase in urban and environmental bulk entitlements would be appropriated from the annual allocation of channel irrigators.

4.3 Ownership of "Savings"

G-MW does not own any bulk water entitlement. It is responsible for storing and delivering water to entitlement holders. Irrigation releases from the G-MW storage and distribution system is the property of irrigation water share entitlement holders.

As measures taken to reduce the volume of channel outfalls, leaks and seepage result in more irrigation water remaining in the channel distribution system this increase in retained water is the property of irrigation water share entitlement holders. This tenure holds regardless of whether reduced volumes of outfalls and leaks are due to improved management or replacement of existing equipment.

G-MW does have jurisdiction over water in drains and licenses drainage diversion and groundwater pumping. Drainage and groundwater pumping licences may specify maximum allowable diversions but do not guarantee minimum volumes of supply. Licences are for fixed terms and may be renewed. Therefore these classes of entitlement holders may be disenfranchised with no acknowledgement of their contribution to the salinity and nutrient management programs. No assessment of the impact of reduced pumping on the effectiveness of the management programs appears to have been made.

4.4 Value of water appropriated from different classes of irrigators

The price paid by government for recent water entitlement buybacks using offers tendered by irrigators has been around $2000 to $2400 per megalitre. Subtracting an infra structure access termination fee of $350 per megalitre and making allowance for varying temporary trading opportunities yields a net price of $1650 per megalitre.

4.4.1 Groundwater licensees

On this basis, the present value of 5 GL of water seeping from channels into the groundwater every year is $8 million.

4.4.2 Surface Drainage Diverters

The present value of 106 GL of outfalls and leaks pumped by drainage diverters every year is $175 million.

4.4.3 Channel Supplied Irrigators

The present value of an annual average of 7 GL of irrigation bulk entitlement transferred to the environment under a more accurate measurement regime is $12 million.

To bring the total volume transferred from irrigation to urban and environmental bulk entitlements to 150 GL, an additional 33 GL of irrigation bulk entitlement valued at $54 million would be appropriated the under the guise of additional bogus savings invented by the exaggeration of meter errors, outfalls and leaks occurring under the slack management allowed in the DSE “without project” scenario.

4.4.4 Total appropriated from Irrigators

Putting aside the 7 GL transferred to the environment to account for improvements in accuracy of metering, the total value of 143 GL water appropriated from irrigators is $236 million. Using an input output multiplier of three, the impact on the regional economy of reduced irrigated activity would be $708 million.

4.5 Financial Impact on stake holders

The estimated losses suffered, or increases in costs imposed on different groups of stakeholders are shown below.

4.5.1 Goulburn Irrigators

Apart from all classes of irrigators in general losing access to 150 GL of water, channel irrigators are expected to contribute $100 million to construction costs. This sum is supposed to pay for 75 GL of entitlement to bogus “new water” and improved water services. A trial of new equipment resulted in a deterioration of the quality of water services.

Channel irrigators are also expected to pay a rate of return on the capital value of new infrastructure and contribute to a sinking fund (Chisholm and Dillon, 1988) to finance replacement of new infrastructure. The estimate of capital charges includes a required rate of return of five percent and is based on an average asset life of 50 years, levied in perpetuity. A project construction cost of $1 billion is assumed. This estimate is likely to be significantly exceeded. It is assumed that the renewals charges for existing regulators and outlets are offset by increased maintenance costs of the new equipment.

Table 4: Financial impact on Goulburn irrigators

Loss/Cost Increase	Estimated present value ($million)
Lost access to water	236
Contribution to construction costs	100
Increased capital charges	1000
Total	1336

4.5.2 Melbourne Water Customers

Melbourne water customers are expected to contribute $300 million to the cost of the Goulburn component of the FBMP. On the basis of present market prices for water entitlement, 75 GL of high security entitlement could be purchased for $124 million

Table 5: Financial impact on Melbourne Water customers

Loss/Cost Increase	Estimated present value ($million)
Higher cost for 75 GL of urban water	176

4.5.3 Regional Economy

This loss is based on the value of reduced irrigation activity. No allowance has been made for reduced consumer spending as irrigators struggle to service the increased capital costs of the irrigation system.

Table 6: Financial impact on regional economy

Loss/Cost Increase	Estimated present value ($million)
Reduced economic activity	708

4.5.4 Victorian Community

The wider Victorian community is expected to contribute $600 million to the cost of the Goulburn component of the FBMP. On the basis of present market prices for water entitlement, 75 GL of high security entitlement could be purchased for $124 million.

Table 7: Financial impact on Victorian community

Loss/Cost Increase	Estimated present value ($million)
Higher cost for 75 GL of environmental water	476

5. DISCUSSION AND CONCLUSION

5.1 Promoters of the Food Bowl Modernisation Project have not shown how their claimed losses disappear.

This comparison between options for obtaining more water for the environment and Melbourne relies on the assumption that virtually all the undelivered outflows from the channel system were already recycled within the boundaries of the water distribution system in northern Victoria before the inception of the FBMP. The technical material used in the drafting of the land and water management plans previously adopted and monitored by DSE supports this contention. Those who disagree with that assumption must show how 870 GL of water are lost every year through evaporation or by disappearing into a very saline water body. Otherwise they must concede that the FBMP will have the effect of a scheme to appropriate 150 GL of the Goulburn region's irrigation water.

And in so conceding, they must also admit they have ignored the opportunity cost of the water they seek to appropriate from the owners of irrigation entitlement.

5.2 Issues in Equity and Efficiency

A properly resourced benefit: cost analysis based on sound information produced by multi-agency working groups and community forums, and compliance with Treasury investment appraisal guidelines would ensure government departments avoid unprofitable investments in irrigation infrastructure. But the government department must believe its role is to increase net social welfare. DSE did commission a limited *ex ante* benefit: cost analysis (URS, 2004) which showed that the Food Bowl Modernisation Project did not meet Treasury's economic criteria. And it ignored it.

In view of the absurd nature of DSE's claimed water savings and the dubious legality of their appropriation by government, it is highly inequitable that irrigators on the channel system are expected to pay all the capital charges for the new FBMP infrastructure in perpetuity. If the government is appropriating irrigation bulk entitlement in perpetuity it should maintain and replace the new the infrastructure in perpetuity. It also should not expect irrigators to pay an annual dividend on the cost of construction of the new infrastructure. Otherwise channel irrigators will be charged $55 million every year to pay for unnecessary overcapitalisation of the system. This trebling in capital charges would substantially reduce the profitability of irrigation in the Goulburn system relative to that in other states and districts. In the government sector a desire for fairness might raise the solution for early irrigation schemes described by Davidson (1969) where "the Pike judgement of 1926 established the principle that a farmer could only repay from the profits he earned, and that this was not related to the cost of supplying him with water". But some farm management economics would be needed to determine that.

The trebling of capital charges would also triple exit fees to $1050/ ML on water entitlement leaving the Goulburn system. In terms of encouraging the market based redistribution of property rights to water resources, few contracts would be written under the inhibiting influence of such horrendous transaction costs. This trade barrier would underpin a sinecure that more greatly rewarded inefficient management of a monopoly the more it overcapitalised the system. In a competitive market such financially inefficient providers of water services would simply go out of business. A new management may acquire the distribution assets for a price not exceeding the present value of expected net returns and aspire to profitable operations. Or in the absence of a new operator, and given normal transaction costs, the undeliverable water rights would be sold to users in other areas. The former alternative would appear to be preferable for the economy of the Goulburn region.

The increasing demand for environmental flows will further accentuate the need to rationalise the area and location of irrigation in northern Victoria. Overcapitalisation of a system delivering smaller volumes of water is not the recipe for financial sustainability. It would have been better to substitute efficiently managed labour for capital so that operating and capital costs became competitive with other systems. Avoidance of investment in expensive long term infrastructure before the pattern of distribution is determined would be the prudent approach.

Channel irrigators are also expected to pay $100 million up front as a contribution to installation of the FBMP infrastructure. This supposedly offset by the benefits of improved water services. Like the bogus water savings component of the FBMP, the claimed outcomes are obtainable far more cheaply. But that is another story.

6. CONCLUSION

The FBMP will appropriate 150 GL water for Melbourne and the environment at a vastly increased cost to that of the alternative option of purchasing water entitlement through the market. The latter option would compensate irrigators for loss of irrigated production.

The estimated total increase in costs for the Victorian community is $1.8 billion.

Table 8: Estimated total increase in costs for the Victorian community

Loss/Cost Increase	**Estimated present value ($million)**
Irrigator's contribution to construction costs	100
Increased capital charges for irrigators	1000
Increased cost for 75 GL of urban water entitlement	176
Increased cost for 75 GL of environmental water entitlement	476
Total	1752

It is assumed that economic return from irrigation, urban and environmental uses is equal at the margin of current levels of water use.

The estimated total increase in costs for the Goulburn regional community is $2 billion.

Table 9: Estimated total increase in costs for the Goulburn regional community

Loss/Cost Increase	**Estimated present value ($million)**
Lost access to water	236
Irrigator's contribution to construction costs	100
Increased capital charges for irrigators	1000
Reduced economic activity	708
Total	2044

If rather than appropriating bogus water savings via the Food Bowl fiasco, 150 GL of water entitlement is purchased from the Goulburn system for urban or environment use elsewhere than in the Goulburn region, the cost to the local community would be $944 million in terms of the loss of production and associated economic activity less $236 million income from water sales or $708 million.

The other benefits claimed for the new distribution infrastructure have not been subject to a critical review. However experience with a trial of the system indicated that benefits were overestimated and obtainable at lower cost employing other methods. The general non-adoption of these alternatives prior to the trial suggests the value of other benefits is close to zero. Therefore the Food Bowl Modernisation Project will cost the region $1.3 billion more than the water market solution.

All in all not a great way to assist a regional community and its economy already under stress from increasing demands for environmental flows while squandering funding that might have been used for worthwhile projects elsewhere in Victoria at the same time.

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APPENDIX I

THE GOULBURN IRRIGATION SYSTEM AS PART OF DSE'S INTEGRATED WATER MANAGEMENT SYSTEM FOR NORTHERN VICTORIA

The Goulburn irrigation system is a major component of the Goulburn-Murray irrigation system in the northern region of Victoria, Australia. It is a gravity supply channel system operated by Goulburn-Murray Water (G-MW), the government owned monopoly responsible for the supply of water to customers in northern Victorian under a number of Bulk Water Entitlements. The state of Victoria is also committed to deliver water to South Australia via the Murray River for urban/industrial, environmental and agricultural use. The Department of Sustainability and Environment (DSE) advises and supports the Minister for Water who is responsible for the direction of Goulburn-Murray Water in the performance its duties.

The state of Victoria lies in the south-east corner of the mainland of Australia as shown in Figure 1.

Figure 1: Location of the state of Victoria, Australia (after G-MW, 2007)

The northern boundary of Victoria follows the course of the Murray River, the overall flow regime of which is controlled by the Murray-Darling Basin Commission (MDBC) under cooperative arrangements with the states of New South Wales, Victoria, South Australia and Queensland.

The course of the Murray River from its source in north-eastern Victoria to its mouth at Goolwa in South Australia is shown in Figure 2.

Figure 2: Map showing the course of the Murray River along the boundary between New South Wales and Victoria and through South Australia (After MDBC, 2007)

The location of the Goulburn-Murray Water region in northern Victoria is shown in Figure 3

Figure 3: The location of the Goulburn-Murray Water region (after G-MW, 2007)

The extent of the G-MW channel distribution system within the Goulburn-Murray Water region is shown in Figure 4.

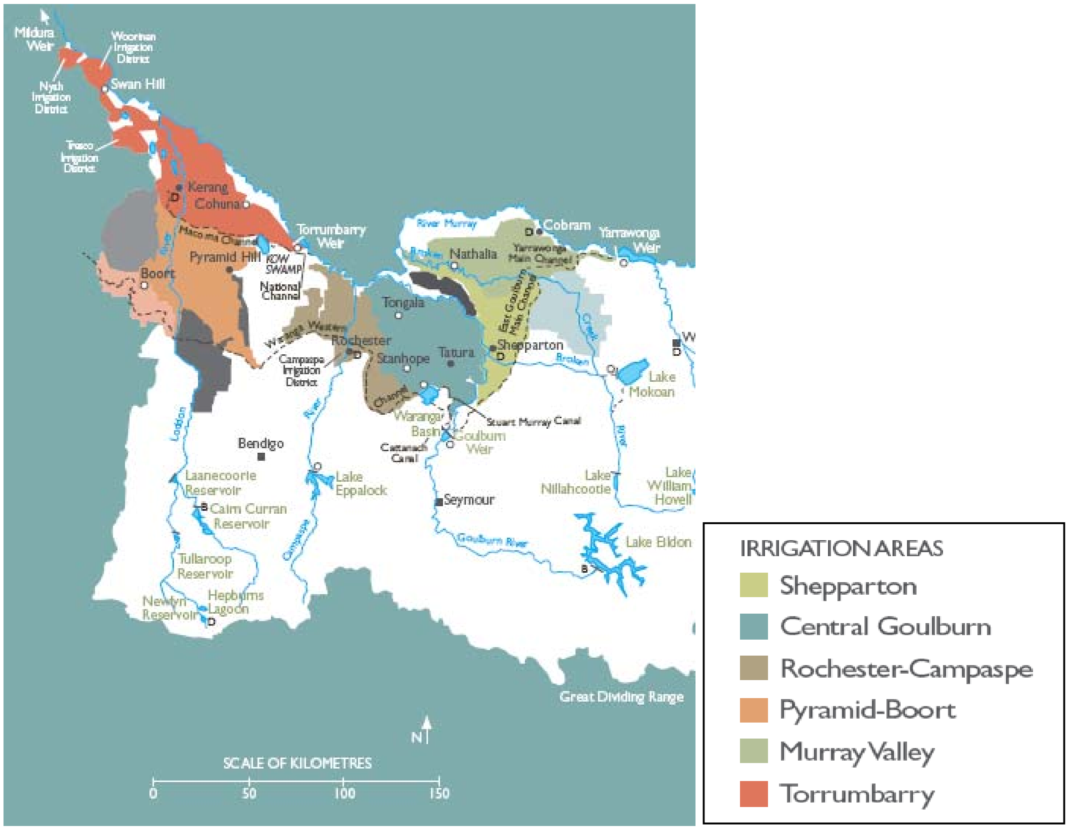

Figure 4: The location and extent of the irrigation areas supplied by the G-MW channel system in northern Victoria (after G-MW, 2007)

Water is diverted from the Goulburn, Campaspe, Loddon and Murray Rivers to the channel system to supply gravity irrigators.

There are two main channel distribution systems in the G-MW region. The Murray system comprises the Murray Valley and Torrumbarry irrigation areas. The Goulburn system includes the Shepparton, Central Goulburn, Rochester-Campaspe and Pyramid-Boort irrigation areas. Both systems are integral parts of the DSE water management system for northern Victoria.

Surplus flows within the channel system outfall to drains which return water to the river system. Thus return flows from the Murray Valley, Shepparton, Central Goulburn and Rochester-Campaspe irrigation areas become inflows for the Torrumbarry irrigation area. As G-MW has delivery commitments for both Victorian and South Australian diverters downstream of the channel system, any water returning to the river that is not recycled within the channel system, including outflows from both the Torrumbarry and Pyramid-Boort irrigation areas, will help supply those customers situated below the channel system. The river town of Swan Hill, situated 133 river kilometres downstream from Torrumbarry Weir and 1505 river kilometres upstream from the mouth of the Murray River (MDBC, 2006), is close to the western border of the G-MW channel system.

APPENDIX II

THE CREATION AND SUBSEQUENT DENIAL OF THE EXISTENCE OF VICTORIA'S FULLY INTEGRATED LAND AND WATER MANAGEMENT PLANS

The capacity of the DSE water management system to recycle surface and sub-surface drainage water was threatened by salinity and nutrient pollution in the latter part of the 20th century. Over the past three decades, the Victorian government, irrigators and local communities combined in joint action and spent hundreds of thousands of hours and billions of dollars in the development and implementation of land and water management plans for the northern irrigation region (SPAC, 1989). These plans are fully integrated water management systems (IWMSs) that protect water quality and thus enable complete recycling of virtually all surface and subsurface drainage water[13]. Not surprisingly, water accounting procedures for an IWMS include credits for the volume of drainage water that is recycled by downstream activities. These credits fully offset any notional losses previously attributed to undelivered outflows in upstream components of the water supply system (Keller *et al* 1996).

DSE was the managing government agency for the preparation of IWMSs for Victorian irrigation areas. This community led process involved the research and verification of the technical feasibility of potential management options by multi-agency technical working groups, followed by the development of integrated management plans incorporating preferred options. An assessment of the social, environmental and economic aspects of projects was carried out according to Government guidelines before any response to joint funding proposals was made (Anon, 1988).

DSE remains the managing agency for the both the implementation and monitoring of land and water management plans.

Given this background in the development and implementation of the overall IWMS for northern Victoria over the past 30 years, it is astonishing that in its information paper DSE now claims that:-

"At present, about 30% of the water in the Goulburn-Murray Irrigation District is lost as a result of leakage, seepage and evaporation in channels, meter inaccuracies and outflows at the end of channels. Total losses across the Goulburn-Murray Irrigation District due to system inefficiencies have typically been in the order of 900 GL each year" (DSE 2007a)

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[13] There is some loss of channel water involved in the operation of public works combating salinity.
In the Goulburn system, some groundwater (of which channel seepage can constitute only a very small proportion) is evaporated at Girgarre but most is shandied with surface water for recycling.
In the Murray system, saline discharge generated by dryland artesian processes in the Loddon Valley (Macumber, 1985) is diverted from Barr Creek for evaporative disposal (MDBC, 2006). Under the local land and water management plan, the volume of good quality water diverted for evaporation is minimised by preventing channel water and run-off entering the creek.

DSE say the modernisation project is designed to “create new water” by reducing “system inefficiencies”. Apparently DSE believes “new water” or real water savings can be made because they now treat “system inefficiencies” as irretrievable water losses.
Yet these “system inefficiencies” are simply undelivered outflows that flow on to become inflows for users in other parts of the IWMS for northern Victoria and the Murray River already developed and supervised by DSE.
The current senior management of DSE appears to be either unaware of the existence of the government endorsed IWMS for northern Victoria for which their department is responsible or they are unable to appreciate its capacity to recycle any surplus water flows arising in the G-MW channel system.

APPENDIX III

CAPACITY OF THE DSE INTEGRATED SYSTEM TO RECYCLE UNDELIVERED CHANNEL OUTFLOWS

DSE (2007) has published expected diversions and metered deliveries for the Goulburn and Murray components of the G-MW channel distribution system as shown in Table 1.

Table 1: Expected diversions and metered deliveries (GL) within the Goulburn and Murray components of the G-MW channel distribution system under average and reduced catchment runoff conditions. (After DSE, 2007)

	Goulburn Component		Murray Component		Total Goulburn-Murray System	
Inflow Scenario	Average	Reduced	Average	Reduced	Average	Reduced
Diversions	1780	1350	1110	985	2890	2335
Metered Deliveries	1305	932	715	623	2020	1555
"Losses due to system inefficiency"	475	418	395	362	870	780
"Total System Efficiency"		69%		63%		67%

All diverted water (inflow to the channel system) other than metered deliveries is treated by DSE as being "losses due to system inefficiency". DSE claims that, on average, 870 GL are lost every year due to system inefficiency. This is an example of incorrect thinking described by Keller *et al* (1996) where **"drainage water is treated as though it flows to an ultimate "sink". It simply drops out of the system or "disappears".**

DSE has not explained where this ultimate sink is situated or how sufficient capacity exists to dispose of 870 GL every year. To annually dispose of 870 GL by evaporation a lake of at least 870 square kilometers in area would be required. The Southern Ocean could dispose of 870 GL of drainage water but this sink lies at Goolwa 1500 river Murray River kilometres downstream of the G-MW channel system (Figure 2, Appendix 1). DSE has not revealed the whereabouts of an undiscovered lake capable of evaporating 870 GL of perfectly acceptable irrigation water every year. Nor has it described a mechanism by which 870 GL of water could slip down the Murray River and into the sea completely unnoticed.

G-MW and DSE reports show water is not accumulating in the regional groundwater system. Therefore there is no ultimate sink for undelivered channel outflows, and the DSE concept of "losses due to system inefficiency" is foolish nonsense.

The only explanation for the non-accumulation of 870 GL of undelivered channel outflows is that this water is being recycled within the G-MW/DSE system. As Keller *et al* (1996) observe:-

> that "in practically all integrated water management systems, however, the drainage water stays in the system and is incorporated into the initial water supply for additional irrigation applications".

For example, in the G-MW channel system the outfalls and channel leaks of the Murray Valley, Shepparton, Central Goulburn and Rochester-Campaspe irrigation areas return to the Murray River above the off-take for the Torrumbarry irrigation area at Torrumbarry Weir (Figure 4).

The volume of water right/high security water entitlement attached to G-MW irrigation areas is shown in Table 2. Based on the Distribution Efficiency reported by DSE in Table 1, 509 GL of water would be diverted at Torrumbarry Weir in order to provide 341 GL of metered deliveries in a year when there is full allocation of water right. For the same level of allocation, the combined calculated total volume of outfalls and channel leaks[14] entering the surface drainage system that returns water to the Murray River from the Murray Valley, Shepparton, Central Goulburn and Rochester-Campaspe irrigation areas is 312 GL. This volume is 197 GL less than the necessary diversions to the Torrumbarry area and thus can be completely recycled. There is no need to reduce outfalls from the Murray Valley, Shepparton, Central Goulburn and Rochester-Campaspe irrigation areas to "save" water because the integrated channel distribution system has the capacity to recycle more than 1.6 times the calculated volume of outfalls and channel leaks[15].

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[14] By adding the percentages of unrecorded deliveries in Table 2 in the main paper to the percentage metered deliveries in Table 3 in the main paper, delivered channel outflows for the Goulburn and Murray systems are calculated as 78% and 76% of inflows respectively. Subtraction of the percentages of evaporation and seepage shown in Table 2 from the remaining undelivered outflows puts the DSE implied combined outfalls and channel leaks of the Goulburn and Murray Components at 20% and 22% respectively.

[15] This relationship holds true whatever the level of seasonal allocation, provided the percentage allocation for the Murray component is at least as high as that for the Goulburn component of the G-MW system.

Licensed pumping from the surface drains conducting undelivered outflows from G-MW channels to the Murray River further increases the recycling capacity of the whole system.

Table 2: Volume of Water Right/High Security Water Entitlement allocated to irrigation areas supplied by G-MW channel system.

Irrigation Area	Water Right/High Security Entitlement (GL)	Diversion required to supply Water Right based on reported distribution efficiency (GL)	Calculated Volume of Outfalls and Channel Leaks (GL)
Shepparton	182	263	53
Central Goulburn	385	558	113
Rochester-Campaspe	187	272	55
Pyramid-Boort	214	310	63
Goulburn Component	968	1403	
Murray Valley	274	408	91
Torrumbarry	341	509	114
Murray Component	615	917	
Total G-MW Channel System	1583	2320	

Recycling of the drainage outflows from the Pyramid-Boort and Torrumbarry irrigation areas occurs further down the Murray River as water is diverted into pumped pipeline systems supplying horticultural irrigation areas and stock and domestic requirements in Victoria or flows on to supply urban, industrial, irrigation and environmental demand in South Australia.

Applying the DSE concept of efficiency to an isolated part of a much larger water distribution system ignores the potential for the recycling of the distribution inefficiencies in upstream parts by the downstream parts of the whole system. This ignorance results in serious underestimation of whole of system efficiency. For example, if is assumed the surface drainage from a channel system is 20% of channel inflow, firstly one and then a second cycle of reuse by downstream components of an integrated system would reduce this volume to 4% and then 0.8% of channel inflow respectively (Keller *et al*, 1996).

As there are plenty of opportunities for recycling within the DSE integrated water management system (DSE, 1989 onwards), losses due to system inefficiencies are insignificant.