SINCLAIR KNIGHT MERZ

SKM

INDEPENDENT PRICING AND REGULATORY TRIBUNAL
OF NEW SOUTH WALES

State Water Operating Licence – Water Balance Template

- Final
- 2/03/2005

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1. Introduction

Sinclair Knight Merz recently completed a study for the Independent Pricing and Regulatory Tribunal recommending performance standards and indicators for State Water's Initial Operating Licence (SKM, 2004). One of those recommendations was for State Water to prepare an annual water balance of each river system as part of its general reporting requirements under the operating licence. State Water currently prepares a water balance for each river system in its annual report, and this study seeks to build upon that existing water balance.

The purpose of presenting a water balance for each system is to ensure transparency in the availability and distribution of water resources. Water is a finite resource that is both valuable and scarce. The Council of Australian Governments, through its progressive reforms under the National Water Initiative, has promoted greater accountability for water in recognition of its finite and valuable nature. The preparation of a water balance for each of State Water's regulated river systems is consistent with reforms in the water industry under the National Water Initiative. For stakeholders, a water balance addresses the two basic questions of how much water is available in a given year and how it is distributed.

This report discusses the issues surrounding the preparation of a water balance and presents a preferred water balance template for inclusion in the operating licence. The report includes:

- An overview of the water balance concept (Section 2);
- State Water's existing water balance (Section 3);
- An examination of water balances in the water industry (Section 4);
- The recommended water balance template and requirements for auditing the water balance (Section 5); and
- Stakeholder views on the proposed water balance template (Section 6).

The preparation of the water balance template involved consultation on a draft proposed template with the Tribunal Secretariat, the Department of Infrastructure, Planning and Natural Resources, the Nature Conservation Council of New South Wales, the Inland Rivers Network and the New South Wales Irrigators' Council. Upon the suggestion of the NSW Irrigators' Council, further consultation was undertaken with a representative from the Murrumbidgee Customer Services Committee for discussion of local issues in that river system.

2. The Water Balance Concept

Water is a finite resource that is both valuable and scarce. Water balances are not a new concept, but are increasingly being used as a simple means of reporting on the source and distribution of water amongst competing users. The Council of Australian Governments, through its progressive reforms under the National Water Initiative, has promoted greater accountability for water in recognition of its finite and valuable nature. The preparation of a water balance for each of State Water's regulated river systems is in accordance with reforms in the water industry under the National Water Initiative. In particular, the development of a water balance supports the desire for greater accountability and transparency in water allocation and use. Explicitly accounting for the source and distribution of water in a water balance will provide greater certainty to consumers about the availability and management of those resources.

A water balance is similar in concept to balance sheets prepared for financial statements, except that the unit of currency is water, not dollars. In its simplest form, a water balance is expressed as:

Inflows = Outflows + Change in Storage (Equation 1)

The nature of an individual water balance will depend primarily upon two factors:

1) The delineation of the system boundary; and
2) The degree to which the inflow and outflow components of the water balance are disaggregated into smaller components. For example, outflows can be further split into end of system streamflows plus water use plus losses. Water use can then be further split into urban, irrigation and stock and domestic water use.

The system boundary will be different for different bulk water suppliers, depending on where its delivery points are in relation to inflows and storage. The degree to which inflow and outflow components are specified tends to be a decision made by regulators based on the perceived needs for public reporting of this information.

3. State Water's Existing Water Balance

3.1 Introduction

State Water prepares a water balance for the whole of its operations and a water balance for each individual river system. The information is presented in both tabular and graphical form (as pie charts).

3.2 Tabular presentation format

The presentation of a typical water balance is shown in Table 3-1. The data shown relates to the Macquarie Cudgegong Valley supply area for 2002/03. A State summary is shown in Table 3-2, together with the notes that accompany the State summary. These notes are also applicable to the individual river basin water balances.

Table 3-1: Typical Water Balance currently presented by State Water (2004)

Sources of Water	GL	%	Distribution of Water	GL	%
Storage Inflows	116	20%	Environment	174	30%
Downstream Tributaries (gauged)	13	2%	End of system	7	1%
Estimated downstream tributaries (ungauged)	0	0%	On Allocation	376	64%
Decrease in storage	457	78%	Supplementary Water	0	0%
			Storage Net Evaporation	30	5%
Total	**586**	**100%**	**Total**	**586**	**100%**

- **Table 3-2: State summary currently presented by State Water (Bill Sims, State Water pers.comm. 9/2/05)**

	Sources of Water				Distribution of Water					
	Storage Inflows	Downstream Tributary Inflows	Decrease in Storage	**Total**	Environment	End of System	Licensed Water Use	Increase in Storage	Storage Net Evaporation	**Total**
North Area										
Border	212	672	0	**885**	400	137	191	149	8	**885**
Gwydir	231	375	0	**606**	142	169	159	121	14	**606**
Namoi	215	129	0	**344**	48	73	72	135	17	**344**
Total North Area	**659**	**1176**	**0**	**1835**	**590**	**379**	**422**	**405**	**39**	**1835**
Central Area										
Macquarie	318	53	14	**385**	186	4	175	0	21	**385**
Lachlan	139	62	10	**211**	127	11	44	0	30	**211**
Total Central Area	**457**	**115**	**24**	**596**	**313**	**15**	**218**	**0**	**51**	**596**
South Area										
Murrumbidgee	1952	600	0	**2553**	340	308	1671	228	5	**2553**
Murray	2101	710	0	**2811**	263	906	1271	273	98	**2811**
Total South Area	**4053**	**1310**	**0**	**5363**	**603**	**1214**	**2942**	**501**	**103**	**5363**
Coastal Area										
Hunter	113	230	109	**451**	68	236	133	0	14	**451**
South Coast	6	2	7	**15**	3	3	8	0	1	**15**
North Coast	22	15	0	**37**	0	26	1	6	4	**37**
Total Coastal Area	**141**	**247**	**116**	**503**	**71**	**265**	**142**	**6**	**19**	**503**
State Water Total	**5309**	**2849**	**140**	**8298**	**1577**	**1873**	**3724**	**912**	**212**	**8298**

Notes
All figures rounded to the nearest Gigalitre (GL). One gigalitre is 1 000 megalitres(ML). One megalitre is 1 000 000 litres (L)
Downstream tributaries includes flows measured at gauging stations on the tributaries
as well as ungauged tributary flows measured at the gauging staions on the main river.
Environment includes evaporation from the river, transpiration from the riparian zone and wetlands,
over-bank flows and flows to ungauged effluents, basic rights extractions and seepage to groundwater.
Licenced Water Use includes high security, general security and supplementary (Off-allocation).
Storage Net Evaporation is derived from daily pan evaporations and surface area, and is corrected for rainfall.
North Area Namoi does not include any analysis of the Peel, but does include the flow from the Peel into the Namoi.
South Area includes the NSW share of the Murray under the interstate capacity sharing arrangements.

In the above mass balances:

- **Sources of water**
  - *Storage inflows* are the measured or estimated inflows to the storage reservoirs;
  - Flows from *downstream tributaries* entering the supply area may be gauged or ungauged. In the latter case the flow must be estimated, which can be done in a number of ways, as subsequently discussed in Section 5.5.2.
  - The *decrease in storage* is the difference between the recorded storage volumes at the end (30 June) and beginning (1 July) of the financial year. If this number is negative, ie the volume of water in storage has increased over the year, then an "increase in storage" is presented in the "Distribution of Water" side of the water balance.
- **Distribution of water**
  - *Environment* flows are those flows that occur and contribute towards maintaining the environmental condition of the river. State Water compute this number as the balancing item which equalises the "water sources" and "distribution of water". Further discussion of environmental flows is contained in Section 5.6.4. This item includes evaporation from

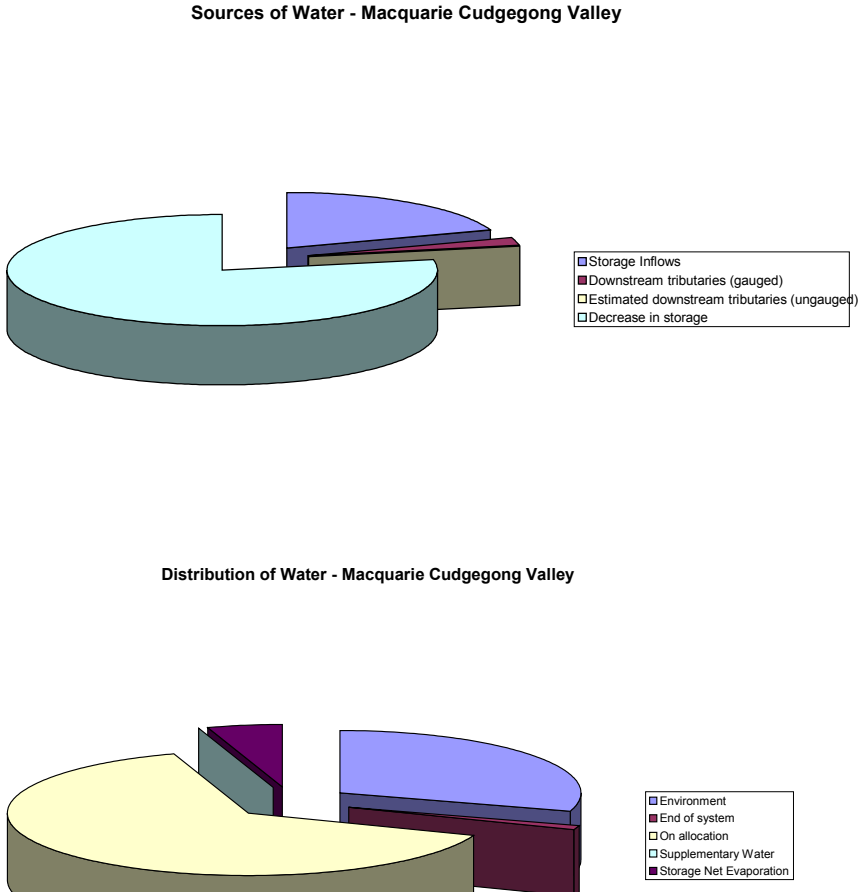
the river, transpiration from the riparian zone and wetlands, over-bank flows, flows to ungauged effluents and seepage to groundwater, but also includes the non-environment term of extractions for water rights, which are not separately metered, measurement errors and water theft.

- *End of system* flows are those flows at the downstream end of the supply system which flow out of the supply area.
- *On allocation water* is the total volume of water abstracted from the supply system by access licence holders, excluding supplementary water as described below.
- *Supplementary water* comprises water abstracted by users during high flow events, after announcement by State Water. The water abstracted is not deducted from the water allocation of the user concerned. Section 5.6.3 contains further description of supplementary water.
- *Storage net evaporation* is the difference between the evaporation occurring from the surface of the water in the reservoir and the rainfall that occurs on that surface. The magnitude of that number depends on climatic conditions (ie the evaporation and rainfall) and the water surface area which contracts or expands according to the volume of water in storage. In New South Wales, evaporation will almost always exceed rainfall (except in very wet years) and this item therefore appears as a "water distribution". If net rainfall were to occur on the storage, then this item would move to the left-hand side of the table to be a source of water.

3.3 Graphical presentation format

The graphical presentation of the data in Table 3-1 is shown in Figure 3-1. It is considered that graphical presentation of the data does not materially contribute to the information transfer and is not suitable for auditing. Graphical presentation is not considered essential for inclusion in the operating licence.

Figure 3-1: Typical water balance presented by State Water



4. Water Industry Water Balances

4.1 Introduction

This study examined water balances prepared by water businesses similar to State Water. These water businesses were previously identified in SKM (2004). Other water balances available in the water industry were collected from a literature search. This section of the report discusses the key common elements of those water balances and their relevance for inclusion in the water balance template for the operating licence.

4.2 Available sources of information

The publications of a number of water authorities within Australia whose operational ambit is similar to State Water were reviewed to ascertain the nature of water balancing reporting undertaken by those authorities. The authorities that were reviewed were as follows:

- Melbourne Water (Victoria);
- Sydney Catchment Authority (NSW);
- Sun Water (Queensland);
- Water Corporation (Western Australia);
- Goulburn-Murray Water (Victoria);
- Southern Rural Water (Victoria);
- Murray Darling Basin Commission's water delivery business River Murray Water; and
- SA Water (South Australia).

Various other published studies and unpublished water balances were also examined and are referred to throughout this report.

4.3 Prevalence of water balances

Water balances are a common feature in hydrologic studies (eg Jolly, 2001; Maidment et.al. 1997). These studies tend to focus on either the availability of water for agriculture on-farm (ie calculating soil moisture deficits) or groundwater recharge/discharge studies to investigate and manage waterlogging or land salinisation. These studies are concerned with catchment processes rather than water delivery and are at a level of detail that is unsuitable for use in accounting for the bulk delivery of water.

Water balances that include terms for bulk water delivery are generally available at a river basin scale for many areas in Australia and around the world. The approach in the Handbook on Integrated Environmental and Economic Accounting (United Nations et.al. 2003) has been adopted in a number of countries, including most recently New Zealand (Statistics New Zealand, 2004). In

this approach, a water account (or balance) forms part of an overall natural resources account that seeks to place economic value on a region or a nation's natural assets and the value derived from them. The water balance is presented from a nation's point of view and considers all elements of the hydrologic water cycle (eg including change in soil moisture and change in snowpack water storage), many of which are not relevant to State Water's water delivery business.

In Australia in recent years, the increasing scarcity of water has driven the need for greater accountability, which in turn has resulted in the preparation of nation wide water balances. The National Land and Water Resources Audit (2001) prepared water balance data for 1996/97 for each river basin in Australia and further audits are planned at a frequency around every five years. The Australian Bureau of Statistics (2004) also produces a national water account after each census, primarily focussing on the economic and social value of water.

The Victorian State Government is in the process of preparing its first set of annual water accounts for each river basin in Victoria. The water accounts will present bulk water sources and delivery, with an emphasis on accountability against entitlement volumes. The annual water accounts are expected to include a surface water balance, which is similar in intent to the water balance for State Water.

For bulk water suppliers, complete water balances are rarely presented, although various components of the water balance are presented. Examples of complete water balances are shown in Appendix A. The prevalence of specific water balance components in the public reporting of bulk water suppliers is discussed in the following section.

4.4 Water balance components

Table 4-1 presents a summary of the information publicly presented by the bulk water suppliers previously listed as similar to State Water. Sydney Water and Hunter Water, which are water utilties rather than bulk water suppliers, have also been included in this table because they prepare a water balance (Sydney Water) or many components of a water balance (Hunter Water). It can be seen from this table that:

- Most bulk water suppliers present the main components of a water balance, but very few actually present a complete water balance.
- All bulk water suppliers provide the end of year storage and/or the change in storage over the year.
- Most bulk water suppliers present total system inflows, but only State Water, Goulburn-Murray Water and Southern Rural Water are known to report separately on unregulated inflows versus inflows to storages.

- Return flows are rarely reported, however they are reported by both Goulburn-Murray Water and Southern Rural Water, which have significant irrigation and power company return flows.
- Total water delivery is reported by all bulk water suppliers. Environmental water delivery is reported by most bulk water suppliers, although the definition of environmental water delivery varied between suppliers.
- Only Melbourne Water reported on releases for flood control and hydropower. This only occurred in systems where the storage was at the end of the supply system, which does not apply to State Water.
- Reporting on system losses was reported by both urban water utilities, but rarely reported for bulk water suppliers. Water losses are variously defined but generally only include losses that are controllable through repair and replacement of infrastructure.
- The favoured reporting unit was megalitres (ML).
- Maps or schematics were reported by less than half of the water authorities, although they were generally not tailored to display the components of the water balance, such as the location of major diversions or end of system flow points.

In comparison to these similar water businesses, from the information that was publicly available, State Water's current water balance provides more transparent accounting for water in its systems than most other bulk water suppliers. Nevertheless there are some small modifications that can be made to the water balance by drawing on components presented by other water authorities, which are discussed in the following sections. These include the reporting of information in megalitres and specifying start and end of year storage volumes.

Table 4-1 Water source and distribution data publicly reported by water authorities around Australia

Water Balance Component	State Water	Sun Water	Goulburn-Murray Water (3)	Southern Rural Water (3)	Water Corporation (WA)	Melbourne Water	Sydney Catchment Authority	Murray Darling Basin Commission (4)	Hunter Water	Sydney Water
	Water utility or authority									
Water Sources										
Start of year storage		✓	✓	✓				✓		
End of year storage		✓	✓	✓	✓		✓	✓		
Change in storage	✓				✓	✓	✓	✓		
Total inflows	✓	(1)	✓	✓		✓		✓		
- Storage inflows	✓		✓	✓						
- Unregulated inflows	✓		✓							
- Return flows			✓	✓						
Usage / Deliveries										
Total licensed consumptive usage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
- Irrigation		✓	✓	✓				✓		
- Domestic and stock			✓	✓				✓		
- Native title										
- Riparian rights										
- Urban		✓	✓				✓	✓	✓	
- Industrial		✓						✓	✓	
- Supplementary water / flood harvesting	✓									
Environmental water delivery	✓		✓		✓	✓			✓	
Storage releases for flood control						✓				
Storage releases for hydropower						✓				
Other		✓					✓			
End of system flows	✓		✓	✓						
Losses										
Total system losses					✓	✓			✓	✓
- Reservoir seepage										
- Reservoir net evaporation	✓									
- In-stream losses										
Reporting style										
Units	GL	ML	ML	ML	ML	ML	ML	GL	ML	ML
System by system reporting	✓	✓	✓	✓	✓	✓		✓		
% distribution of water by component	✓								✓	✓
% of water use metered					✓				✓	✓
Map or schematic						✓			✓	✓
Water balance	✓		✓					✓		✓

Notes:
(1) SunWater reports total available water allocated for consumptive use
(2) G-MW does not distinguish between gauged and ungauged inflows
(3) Referenced both annual report and resource manager's reports
(4) Referenced both annual report and Independent Audit Group's report on cap compliance

5. Proposed Water Balance Template

5.1 The proposed template

This section of the report presents the proposed water balance template for State Water's operating licence and discusses the ways in which each element should be defined. The proposed template is similar in concept to State Water's current water balance, but provides more detail on how water is distributed by licence type. This approach ensures greater transparency in reporting against water allocated under the Water Sharing Plans, which has been a need expressed by stakeholders during consultation on the water balance template.

Table 5-1 shows the recommended water balance template for inclusion in the operating licence. Key elements of the water balance are:

- The use of terms that are consistent with the terms used in the allocation of water in Water Sharing Plans.
- A double accounting format, similar to a financial balance sheet, which clearly shows that inflows and outflows are equal.
- Subtotals of each of the major components of the water balance.
- The percentage metered (by volume) of each value, which illustrates the degree of confidence in each value in the water balance.
- The inclusion of explanatory notes at the base of the table, as required by State Water to note any peculiarities in the values presented.

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- **Table 5-1: Proposed water balance template (hypothetical example only)**

Water balance component	Sources of water		Distribution of water		% of volume measured
	Volume (ML)	% of total	Volume (ML)	% of total	
Storage volume					
Volume in storage at start of year	330,290				
Volume in storage at end of year	320,365				
Change in storage	**9,925**	**6%**			**100%**
Storage net evaporation			**3,051**	**2%**	**100%**
Inflows					
Storage inflows	100,040	61%			100%
Downstream tributaries	55,000	33%			85%
Subtotal	**155,040**	**94%**			**95%**
Net water diverted under water rights					
Domestic and stock rights (1)			2,000	1%	0%
Native title rights (1)			280	0%	0%
Subtotal			**2,280**	**1%**	**0%**
Net water diverted under access licences					
Domestic and stock			4,170	3%	30%
High security			28,410	17%	100%
General security			35,833	22%	100%
Local water utility			4,520	3%	100%
Major water utility			1,080	1%	100%
Supplementary water			3,330	2%	100%
Conveyance			13,060	8%	100%
Subtotal			**90,403**	**55%**	**97%**
Environmental water					
Net diversions to wetlands			2,080	1%	60%
End of system flows			35,060	21%	100%
Subtotal			**37,140**	**23%**	**98%**
Other outflows (2)			**2,341**	**1%**	**100%**
Unaccounted difference (3)			**29,750**	**18%**	**n/a**
TOTAL	**164,965**	**100%**	**164,965**	**100%**	**95%**

Notes:

(1) Water rights are not metered. Values presented are estimated from recommended values provided by DIPNR or as specified in Water Sharing Plans

(2) Name of other outflows, eg to Lowbidgee area. Only include this term if relevant to the supply system.

(3) Unaccounted difference is estimated as the difference between inflows, outflows and change in storage. This includes river evaporation, seepage, overbank flows, theft and any measurement errors recording other components.

5.2 Number of water balances

State Water currently prepares water balances for ten regulated river supply areas. These areas, listed in Table 5-2, each include distinct supply sources and supply systems and act independently of each other. It is recommended that State Water continue to prepare a water balance for each supply area.

Table 5-2: State Water's water supply areas

Area	Name of water supply area
North area	Border
	Gwydir
	Namoi
Central Area	Macquarie
	Lachlan
South Area	Murrimbidgee
	Murray
Coastal Area	Hunter
	South Coast
	North Coast

5.3 System boundary

The water supply system boundary defines which terms can and cannot logically be included in the water balance. The water balance is for the delivery of water in regulated river systems. The system boundary reflects this and is defined by the following boundary points:

- The upstream regulating storages;
- The points at which unregulated inflows enter the regulated river;
- The points at which water is delivered to State Water's customers from the regulated river;
- The points at which losses occur from the regulated river or reservoirs;
- The end of system outlets, as defined in Water Sharing Plans.

The advantage of declaring the system boundary in the above manner is that the sum of inflows is equal to the sum of outflows plus change in storage. The disadvantage is that in-stream uses for part of a regulated river section are not displayed in the water balance. For example, water released from a reservoir to meet environmental flows at a point mid-way down the catchment is not accounted for in the water balance until it leaves the system, either as losses (to groundwater,

evaporation or the floodplain) or as an end of system outflow. If consumptive users downstream of the environmental flow compliance point subsequently take the water that was released to meet the environmental flow target, then the water will be accounted for as a volume delivered to access licence holders, not as an environmental flow. This would similarly occur with reservoir releases for flood control.

In addition to the water balance, it would be beneficial to include a system schematic or map of each water supply system to accompany the water balance. This would help to clarify the system boundary for the water balance and identify the main features of the catchment from a water supply perspective. Maps of each regulated river system or its component river basins are already included in Water Sharing Plans and features within a basin will be known to most stakeholders, hence this is not essential for inclusion in the operating licence. If a schematic or map accompanies the water balance, it should ideally include the following:

- The catchment/system boundary downstream of the regulating storage(s);
- The regulated river and significant unregulated tributaries;
- Reservoirs;
- Wetlands to which water is delivered;
- River flow gauges;
- The end of system flow location(s); and
- Major diversion points.

5.4 Units

Water balances for water supply systems are generally reported in megalitres (ML) or gigalitres (GL), which are equivalent to 1000 megalitres. One megalitre is one million litres. Expressing the water balance in ML encourages precision in the water balance, whilst expressing the water balance in GL promotes reader clarity.

State Water currently report flows in GL. The total volume of either "water sources" or "distribution of water" for their systems ranges from about 350 GL to 2300 GL. Some individual items are reported in single digits (ie total for that item is less than 10 GL). All items are rounded to the nearest GL.

As noted in the review of other water balances, the most popular reporting unit is ML, particularly where compliance reporting is involved. Many terms in the water balance, such as storage evaporation, the unaccounted difference and inflows, will not be accurate to the nearest megalitre, even when aggregated over the year. However this is not considered to inhibit reporting all terms

to the nearest ML. This recommendation to adopt ML as the unit of the water balance is in accordance with the views expressed by stakeholders (see Section 6) that reporting to the nearest ML will encourage improvements in measurement accuracy and therefore should be pursued. State Water record metered diversions to the nearest ML and there should be no practical impediments to adopting this reporting unit.

5.5 Sources of Water

5.5.1 Storage inflows

Storage inflows may be determined in two ways, either:

- By direct measurement, at a gauge(s) upstream of the reservoir; or
- Calculated as the balancing item in a mass a balance of the reservoir. The other items which must be measured in order to complete this mass balance are:
  - Releases (including direct diversions from the reservoir);
  - Spills;
  - Net evaporation; and
  - Change in storage.

The uncertainty in measuring these components makes it highly desirable to measure inflows directly rather than rely on computing storage inflows using a mass balance. In some cases, it may not be practical to gauge inflows (eg because of poor hydrographic control sections or inaccessible streams), in which case a water balance is the most appropriate method to estimate inflows. Reservoir mass balances are prone to error on a daily basis, reasonable on a monthly basis but generally acceptable on an annual basis. For this reason, if all other components are measured in a mass balance to determine inflows, the volume of the inflow that is metered should be presented as 100%. State Water indicate that all of their inflows are currently estimated by reservoir mass balance (D.Berry, pers.comm. 9/2/05).

Seepage from reservoirs is almost never measured and is assumed to be zero, both because its volume is negligible relative to other water balance components and because it is difficult to accurately measure. Excluding seepage from the water balance is appropriate unless there is clear evidence of seepage to groundwater that does not reappear as groundwater discharge to streams downstream of the dam within the same accounting year. This situation is unlikely to occur and can only be assessed by State Water on a case by case basis.

5.5.2 Downstream tributary inflows

Downstream tributary inflows may most accurately be determined by measurement at a flow gauge. In instances where a gauge is not available, flow estimates may be prepared by a number of methods including:

- Transposition from nearby streamflow gauges;
- Mass balance of main stream gauges upstream and downstream of the tributary; and
- Rainfall - runoff models.

The most appropriate method will be determined by the individual circumstances surrounding the estimation of a particular inflow. It will depend primarily on the availability of flow gauges within the catchment, which are specified by DIPNR.

It is recommended that the most appropriate method to estimate each unregulated inflow should be determined by State Water, with sufficient records kept for audit purposes. State Water's approach will need to be flexible to allow for changes in the method of data preparation during periods where data is missing.

State Water currently account for gauged and ungauged tributary inflows separately in their water balance. This approach is supported as different levels of accuracy are associated with each component. The inclusion of the percentage of volume measured in the proposed water balance will highlight the extent to which tributary inflows are gauged.

5.5.3 Return flows

Return flows include those flows returned to the river after previously being diverted for consumptive use. These include major irrigation drains, sewage treatment plant discharges and outflows back into the river from effluent creek systems. Return flows contribute towards meeting end of system flows or supplying downstream users, and therefore affect State Water's operations. State Water has indicated that it deducts any return flows from the gross diversion, so that they report on only the net diversion. This approach is appropriate and hence there is no need to explicitly include return flows in the water balance.

5.5.4 Change in storage

The change in storage may be estimated from reading the water level within the storage at the beginning and end of each water year. It is considered that, in reporting this figure, there is value in reporting both the start and end of year storage values as well as the decrease (or increase) in storage. This informs the reader of the water in storage, which is an asset for the coming year, as well as the change in that asset that has occurred over the year.

If the change in storage is an increase, then this item should appear on the right hand side of the water balance as a distribution of water. This practice is evident in State Water's 2003/04 water balances (Table 3-2, Section 3.2), which display separate columns for the increase and decrease in storage. This practice avoids the use of negative numbers in the water balance and ensures that both the sources and distribution of water are equal.

5.5.5 Non-consumptive uses

Non-consumptive uses (eg hydropower) are not shown in the water balance because there is no net diversion from the regulated river. Where hydropower has a consumptive access licence, the volume diverted should appear as part of the total diversion in the relevant access licence category.

5.6 Distribution of water

5.6.1 Water Rights

Water rights for stock and domestic and native title use are typically small in volume, but rarely metered. Inclusion of water rights as a separate item will highlight that this water use is small but not accurately quantifiable. When calculating stock and domestic water use, a nominal value of around 2 ML/yr is typically assigned for annual usage. The alternative to this would be to estimate usage from stocking rates by animal type, which is considered both onerous and inaccurate and is not recommended.

State Water should seek appropriate advice from DIPNR or take values from individual Water Sharing Plans, where available, when assigning a volume to water rights.

5.6.2 Access Licences

The access licence types in the water balance reflect the categories used in the Water Sharing Plans and are amalgamated categories from the full list of access licence categories. State Water collects usage data against 19 categories of access licence, which are listed in Table 5-3. This table also lists the water balance component to which each access licence category has been assigned.

Water use cannot always be attributed to a particular access licence category. For example, an individual irrigator in a given year may have been allocated 80 ML of high security water and 20 ML of general security water, based on the irrigator's access licences and the available water determination. If the irrigator only uses 70 ML, it is not clear whether the whole 70 ML has been taken from the high security licence, or whether only 50 ML has been taken from the high security licence and 20 ML has been taken from the general security licence. There are however order of debit rules that are designed to maximise carryover of entitlements from year to year, which State Water can adhere to. These rules are specified in Water Sharing Plans. For example, under Section 45 of the Gwydir Regulated River Water Sharing Plan, up to 50% of the general security allocation can be carried over from one year to the next, but high security allocation cannot (DIPNR, 2004a). The high security water would therefore be debited first in order to maximise carryover of entitlement. State Water should keep a record of how water use has been assigned to entitlements where the full entitlement has not been used in a particular year.

Water abstraction from the system by licensed water users is customarily measured at the point of abstraction. Metering of access licences should be deemed only to occur when the meter complies to the standards in State Water's metering policy.

Most systems have a small number of licensed extractions below the end of system flow gauge (D.Berry, State Water pers.comm.9/2/2005). As suggested by State Water, notes to the water balance can explain this.

The conveyance licence is specific to some of the irrigation companies and allows for water losses in distributing water from the river offtake to the access licence holder at the farm gate. This term may be unfamiliar to some readers, but for consistency with the Water Sharing Plan it should be retained in the water balance.

- **Table 5-3 Access licence categories and their respective water balance component**

Water balance term	Access Licence Category or Subcategory
High security	Regulated River (High Security)
	Regulated River (High Security) – town water supply
	Regulated River (High Security) – research
	Regulated River (High Security) – Aboriginal cultural
	Regulated River (High Security) – community and education
General security	Regulated River (General Security)
	Regulated River (General Security) - research
	Regulated River (General Security) - community and education
	Regulated River (General Security) - Aboriginal commercial
Local water utility	Local Water Utility
	Local Water Utility – domestic and commercial
Major water utility	Major Water Utility – urban water
	Major Water Utility – power generation
Domestic and stock	Domestic and Stock
	Domestic and Stock – domestic
	Domestic and Stock – stock
	Domestic and Stock – town water supply
Conveyance	Regulated River (Conveyance)
	Murrumbidgee Irrigation Conveyance
	Coleambally Irrigation Conveyance
Supplementary water access licences	Supplementary

Licence categories are slightly different for areas not covered by a Water Sharing Plan, which are governed by the *Water Act 1912*. State Water has indicated that the amalgamated licence categories in Table 5-3 will be applicable to licence types under the *Water Act 1912* and that there are no impediments to completing the water balance template where a Water Sharing Plan is not in place (D.Berry, State Water pers.comm.1/3/2005). State Water did indicate that domestic and stock water use will be difficult to separately identify and will most likely be recorded under the high security access licence category. Town water supply, which is equivalent to the local and major water utility access licence categories, can be identified manually by State Water. Based on the above, it is advised that State Water should be granted some flexibility in assigning licence types to the amalgamated categories in Table 5-3 over the period of the Initial Operating Licence where a Water Sharing Plan is not in place.

5.6.3 Supplementary Water Events

A supplementary water event is announced by State Water when an unregulated high flow event (ie a flood) occurs in a catchment. This can occur on an unregulated river, but can also occur on a regulated river when the regulating storage is full and is spilling. The announcement is made for individual river reaches and therefore does not necessarily apply to all diverters within a river basin. The river reaches to which the announcement extends depends upon the extent of rainfall in different parts of the river basin and whether reservoirs are full at the time when the rainfall occurs.

In its annual report, State Water currently accounts for the volume of water supplied to diverters during supplementary water events. It does not separately account for the volume of water supplied to the environment during these events. This is because of the potential for double counting of water. In the reach where the supplementary water event is declared, the water not diverted is provided to the environment at that location. As the flow event travels downstream, it attenuates (ie the flow peak drops) and mixes with flows from other streams. The conditions which govern the announcement of a supplementary flow event may prevail in upstream river reaches, but not at downstream river reaches.

This could occur, for example, in the Murrumbidgee River Basin, which is regulated by both Blowering Dam and Burrinjuck Dam. If a localised storm occurs in the catchment upstream of Burrinjuck Dam and causes it to spill, then a supplementary water event would be announced for diverters on the Murrumbidgee River immediately downstream of Burrinjuck Dam. Water not diverted during the event would by default be allocated to the environment in that reach. The same storm event could miss the catchment upstream of Blowering Reservoir, such that the reservoir does not spill. No supplementary water event would therefore be declared in the Tumut River downstream of Blowering Dam. When the two rivers meet near Gundagai, the sum of flows from the two rivers may be insufficient to declare a supplementary water event downstream of their confluence. This would mean that supplementary water allocated by default to the environment

upstream of Gundagai would no longer exist as a supplementary water event downstream of Gundagai and could be diverted by access licence holders, provided that end of system minimum flow targets are still met.

The conclusion drawn from the above is that whilst diversions during supplementary water events can be accounted for, the volume supplied to the environment during that supplementary water event cannot. For this reason, flow to the environment during supplementary water events has not been explicitly accounted for in the water balance table and will only be evident in the end of system flows in the table.

5.6.4 Environmental flows

Environmental benefit is derived from delivering water to the environment throughout the regulated river reach, including in-stream, and not just at the end of system.

Environmental flows may be sourced from:

- Water releases made from system storage as environmental releases;
- Spills from the reservoir at times when it is overflowing, including those occurring during supplementary flow events;
- Flows from unregulated streams; including those occurring during supplementary flow events; and
- Return flows from water users e.g. irrigation return flows.

This water may be distributed as follows:

- Meeting the end of system flow requirements, as specified in the *Water Sharing Plan.* These requirements may also include the water rights of downstream users in addition to an environment flow;
- Flows passing the end of system which exceed the end of system flow requirement;
- Riverine evaporation and evapotranspiration losses;
- Overbank flows to wetlands and the floodplain;
- Specific delivery of water to wetlands; and
- Seepage to groundwater.

Several components of the sources and distribution points of environment flows may not feasibly be measured and are subject to significant estimation uncertainty. These components include the riverine, floodplain and groundwater losses. To avoid double counting, and eliminate the above

estimation uncertainty, it is proposed that water delivered to the environment should only be accounted for at the point where it leaves the river system as follows:

- The end of system flow should be as recorded at the river system outlet. The end of system location is as defined in the Water Sharing Plan.
- Delivery to wetlands should be separately accounted for where the water is ordered. The volume delivered should be the net volume delivered. Metering can only be deemed to occur where a rated wetland regulator measures the flow in and out of the wetland or where streamflow gauges are located immediately (within approximately 5 km) upstream and downstream of the wetland and all consumptive use of water can be accounted for in the reach.
- The unaccounted difference, which includes seepage to groundwater, evaporation and overbank flows, should be calculated as the balancing item in the overall mass balance.

5.6.5 Other outflows

In the lower reaches of some river systems, water from the main stream can flow down smaller creeks and rivers known as distributaries or effluent creeks. The presence of these distributaries are unique to each particular river system, and hence the term "other outflows" has been included in the water balance for State Water to account for water that does not flow out of the designated end of system flow points. An example of this could include water supplied to the Lowbidgee area in the Murrumbidgee system, which is a combination of environmental flows and water for diverters that is not covered by the access licences issued under the Murrumbidgee Water Sharing Plan. This item should not be included in the water balance for river systems where no "other outflows" occur.

5.7 Applicability of the template to all river systems

The water balance template is applicable to all river systems operated by State Water. The "other outflows" term in the water balance gives State Water some flexibility in preparing the water balance in river systems with effluent creeks not considered end of system flows in the Water Sharing Plans, such as in the Murrumbidgee River system.

State Water will also need to include spills to and from Victoria's share of storage in the Murray system and account only for New South Wales' share of inflows and New South Wales's share of end of system flow (to South Australia) obligations. This is State Water's current practice under the *Murray Darling Basin Agreement* (MDBMC, 2000). If Victoria's share of storages (in Menindee Lakes, Lake Hume, Dartmouth Reservoir and Lake Victoria) spill to New South Wales, then this can be implicitly included in the inflow term. If New South Wales' storages spill to Victoria, this can be included in the "other outflows" term provided that a note explains that this

term includes those spills. Spills to and from each State's share of storage will generally only occur in wet years.

5.8 Auditing

The water balances presented should be auditable. For audit purposes the following minimum information should be available:

- Records of all streamflow measurements and climate data used in preparing the water balance;
- Records of all storage level measurements and reservoir rating tables used in estimating change in storage;
- Records of all metered consumption;
- Records of the assignment of water use to access licence categories; and
- Records of calculations used in developing estimates for ungauged inflows and unmetered consumption (or distribution) of water and clear explanations of the methodologies used.

6. Stakeholder views

The preparation of the water balance template involved consultation on a draft proposed template with State Water, the Department of Infrastructure, Planning and Natural Resources (DIPNR), the Nature Conservation Council of New South Wales, the Inland Rivers Network and the New South Wales Irrigators' Council. Upon the suggestion of the NSW Irrigators' Council, further consultation was undertaken with a representative from the Murrumbidgee Customer Services Committee for discussion of local issues in that river system.

State Water generally accepted the draft proposed template, subject to not including return flows or non-consumptive uses as separately accounted for items. State Water expressed caution in amalgamating access licence categories. The final amalgamation of access licence categories was shown to State Water, which agreed that this was a workable formulation for the Initial Operating Licence.

DIPNR would like to see a "Gross Unaccounted Difference" in the water balance instead of in-stream losses and diversions under water rights. Sinclair Knight Merz feels that diversions under water rights should be separately accounted for, even if they cannot reliably be estimated, in order to promote transparency and accountability against Water Sharing Plans. The remaining unaccounted difference has been included in the water balance. This volume is a combination of measurement errors, water theft and water provided to the environment as losses to evaporation, the floodplain, riparian vegetation and groundwater. DIPNR also commented that the percentage metered should be accompanied by a quality code for each data source, as to whether it is measured, calculated or estimated. This was considered by Sinclair Knight Merz to over-complicate the water balance table and that the use of explanatory notes would be sufficient to highlight any deficiencies in data quality.

DIPNR would like to see monthly water balances as well as an annual water balance. Sinclair Knight Merz considers the public reporting of monthly water balances to be unwieldy and would not generate additional benefit to stakeholders. The preparation of monthly water balances can be negotiated separately between DIPNR and State Water for compliance reporting against Water Sharing Plans.

DIPNR expressed the desire to see a separate item in the water balance for effluent creek systems (that branch away from the main stream). An item for "other outflows" was added to the water balance to accommodate this.

The Nature Conservation Council (NCC) and the Inland Rivers Network (IRN) were seeking more detailed accounting of environmental water releases from storages against Water Sharing Plan rules. Sinclair Knight Merz note that DIPNR is responsible for regulating State Water's

compliance with Water Sharing Plans and the Minister for Natural Resources is required to report annually on the implementation of those plans via the DIPNR Annual report. The reporting and auditing of the full compliment of Water Sharing Plan rules is a comprehensive exercise requiring detailed understanding and interpretation of those rules. If IPART were to assume responsibility for reporting against these rules, there is a risk that the assessment will differ from that undertaken by DIPNR, resulting in conflicts in public reporting. In addition, a water balance of the river system as a whole does not easily accommodate reporting against environmental flow targets at locations within the river system, because of the potential for double counting of water in the water balance. For these reasons, it is recommended that only end of system flow targets from the Water Sharing Plans, which are considered to be of principal environmental importance, are presented in the water balance.

The NCC and IRN supported the reporting of the water balance in ML, because it is consistent with the Water Sharing Plans. The NCC and IRN would also like to see some limits placed on the distance of streamflow gauges from an extraction point when measuring deliveries to wetlands. Sinclair Knight Merz have nominally suggested a distance of 5 km where all other inflows and outflows in the reach are known, subject to revision at individual sites during future auditing.

NSW Irrigators' Council would like to see the water balance reported in ML, which will encourage State Water to improve metering accuracy. The council supported the idea of including a schematic with the water balance. Similar to the NCC and IRN, the council would have preferred to see more explicit accounting of environmental water deliveries into the different classes of fundamental and adaptive water for the environment. Reasons for not including more detailed accounting of Water Sharing Plan rules in the water balance template are as discussed previously.

The chairman of the Murrumbidgee Customer Services Committee similarly expressed the desire for greater accountability of environmental releases against the Water Sharing Plan rules. Discussions with the chairman highlighted some of the complexities in the lower Murrumbidgee system with effluent creeks, which will complicate the water balance for this river system. This is accommodated in the recommended water balance template by the inclusion of the "other outflows" term.

7. Conclusions and Recommendations

The current water balance presented by State Water in its annual reports provides a sound basis for a more detailed water balance that will enhance operational transparency and ensure that water is adequately accounted for. Relative to other water authorities in Australia, State Water's current water balance is one of the better examples available.

The proposed water balance template in Table 5-1 should be adopted for inclusion in State Water's Initial Operating Licence. The key features of the water balance template are:

- The use of terms that are consistent with the terms used in the allocation of water in Water Sharing Plans. This is the key advantage of the proposed template over the existing template prepared by State Water and is in response to requests by stakeholders for this information.
- A double accounting format, similar to a financial balance sheet, which clearly shows that inflows and outflows are equal.
- Subtotals of each of the major components of the water balance.
- The percentage metered (by volume) of each value, which illustrates the degree of confidence in each value in the water balance.
- The inclusion of explanatory notes at the base of the table, as required by State Water to note any peculiarities in the values presented.

The water balance template is applicable to all river systems operated by State Water. The "other outflows" term in the water balance gives State Water some flexibility in preparing the water balance in river systems with effluent creeks that are not considered part of end of system flows in the Water Sharing Plans, such as in the Murrumbidgee River system. State Water will also need to include spills to and from Victoria's share of storage in the Murray system and account only for New South Wales' share of inflows and New South Wales' end of system flow (to South Australia) obligations. This is in accordance with State Water's current practice.

In addition to the water balance, it would be beneficial to include a system schematic or map of each water supply system to accompany the water balance. This would help to clarify the system boundary for the water balance and identify the main features of the catchment from a water supply perspective. Maps of each regulated river system (or its component river basins) are already included in Water Sharing Plans and features within a basin will be known to most stakeholders, hence this is not essential for inclusion in the operating licence. If a schematic or map accompanies the water balance, it should ideally include the following:

- The catchment/system boundary downstream of the regulating storage(s);
- The regulated river and significant unregulated tributaries;

- Reservoirs;
- Wetlands to which water is delivered;
- River flow gauges;
- The end of system flow location(s); and
- Major diversion points.

State Water should maintain clear records of the derivation of the values in the water balances. Where values are estimated, rather than derived from measurement, these records should demonstrate best practice in the procedures used for estimation. For auditing purposes, State Water should maintain the following information:

- Records of all streamflow measurements and climate data used in preparing the water balance;
- Records of all storage level measurements and reservoir rating tables used in estimating change in storage;
- Records of all metered consumption;
- Records of the assignment of water use to access licence categories; and
- Records of calculations prepared in developing flow estimates for ungauged inflows and unmetered consumption (or distribution) of water and clear explanations of the methodologies used.

It is acknowledged that the proposed water balance template does not address stakeholder desires to explicitly account for all environmental water releases, however it is considered that previous consultation has identified that those stakeholder wishes will be met by DIPNR's compliance reporting. The reporting and auditing of the full compliment of Water Sharing Plan rules is a comprehensive exercise requiring detailed understanding and interpretation of those rules. If IPART were to assume responsibility for reporting against these rules, there is a risk that the assessment will differ from that undertaken by DIPNR, resulting in conflicts in public reporting. In addition, a water balance of the river system as a whole does not easily accommodate reporting against environmental flow targets at locations within the river system, because of the potential for double counting of water in the water balance. For these reasons, it is recommended that only end of system flow targets from the Water Sharing Plans, which are considered to be of principal environmental importance, are presented in the water balance.

8. References

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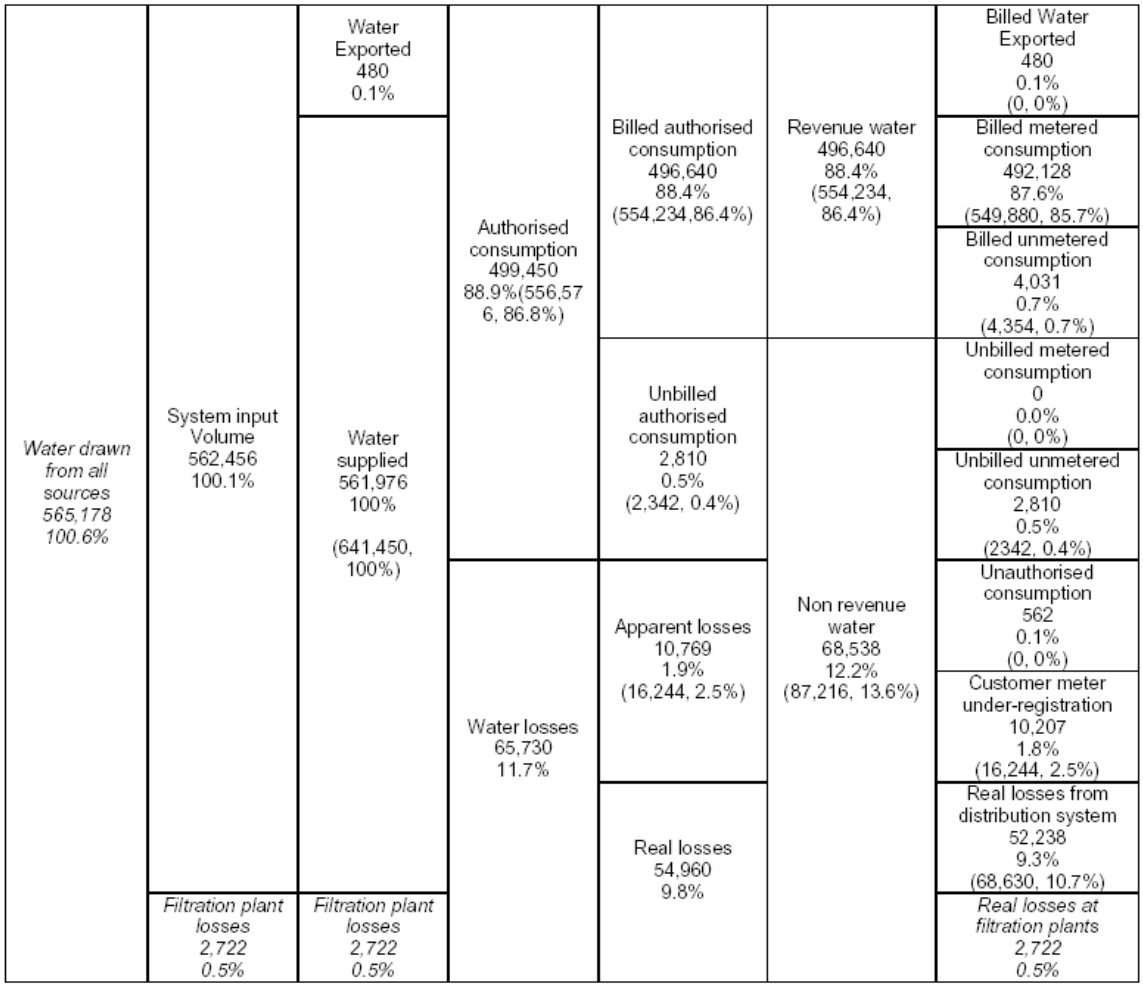
Appendix A Water Industry Water Balances

- **Figure 8-1 Sydney Water's Water Balance 2003/04 (Sydney Water, 2004)**



- **Figure 8-2 Goulburn Murray Water Resource Manager's Summary Resource Account for the Campaspe River Basin, 2002/03 (G-MW, 2004b)**

	GL	GL
Lake Eppalock Volume in store 1/7/02	88.4	88.4
Plus inflows to system		
To Lake Eppalock	7.8	
Less River and Upper Coliban losses/gains and Storage losses (balancing item)	8.9 (Gain)	
Total		16.7
Gross Resource		105.6
Less diversions and outflows		
Total source diversions from waterways (see Appendix A)	74.8	
Outflow as measured at Rochester (as recorded by Thiess Env.)	7.8	
Total		83.1
Equals Lake Eppalock Volume in store 30/6/03		22.5

Total diversions as % of total inflows - 448%
as % of inflows to Lake Eppalock 959%

- **Figure 8-3 Southern Rural Water Resource Manager's Summary Resource Account for the Latrobe River Basin, 2003/04 (SRW, 2004b)**

RESOURCE	ML
Blue Rock Volume in Storage 1/7/2003	+208,188
Narracan Volume in Storage 1/7/2003	+8,000
Annual inflow from Latrobe River above Narracan storage	+219,746
Annual inflow from Tanjil River above Blue Rock	+117,541
Return inflows to river from power companies	+12,320
Blue Rock Volume in Storage 30/6/2004	-148,690
Narracan Volume in Storage 30/6/2004	-8,000
Total Diversions (Including urban BEs)	-162,709
Storage evaporation losses	-1,541
Outflows from System	+244,855