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UPDATES TO THE CAPACITY OF THE SURFACE WATER RESOURCE OF THE EASTERN MOUNT LOFTY RANGES: 2010

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INTRODUCTION

This report provides details on the most recent work carried out to determine the capacity of the surface water resources of the Eastern Mount Lofty Ranges Prescribed Water Resources Area (EMLR PWRA), South Australia. It is an update to previous estimates provided by Alcorn et al (2008) in the technical note; “Capacity of the Surface Water Resource of the Eastern Mount Lofty Ranges”.

This technical note provides the basis for the definition of water availability – herein referred to as the Resource Capacity - in the Eastern Mount Lofty Ranges (Figure 1). Alcorn et al (2008) described the hydrological modelling carried out to determine the long term resource capacity for which a definition is given below. It is intended that the estimates provided in this report be used as a guide in the process of water allocation planning, which is currently being conducted for the EMLR PWRA.

This iteration of the process includes more recent information relating to water resource development and streamflow monitoring that has become available since the first report. The hydrological models have been extended to include data estimates on direct watercourse extractions not included in the first round of modelling. It also extends and revisits two of the five models – the Angas River Catchment Model and the Bremer River Catchment Model – to include previously excluded stream reaches in the lower plains region of the Angas-Bremer Irrigation Management Zone (ABIMZ) (Figure 2).

The existing models were reviewed and recalibrated where necessary, in light of either a change in the assumed water balance of the catchment due to extractions or losses, or as a result of new or improved streamflow calibration data.

DEFINITION OF THE CAPACITY OF THE SURFACE WATER RESOURCE

As noted in Alcorn et al (2008), the previous definition of the resource capacity extended only to include the impacts of farm dams on streamflow:
“…the mean winter runoff (May–November inclusive), with the impact of farm dams removed from the catchment.”

In light of the work undertaken in this assessment and the additional water resource development estimates quantified, the definition of the Resource Capacity is thus updated to:

“The Resource Capacity is defined as the long term (1971-2006) mean annual runoff adjusted to remove the impacts of; farm dams, watercourse diversions, urban runoff, and plantation forestry.”

Figure 1. Catchments in the Eastern Mount Lofty Ranges

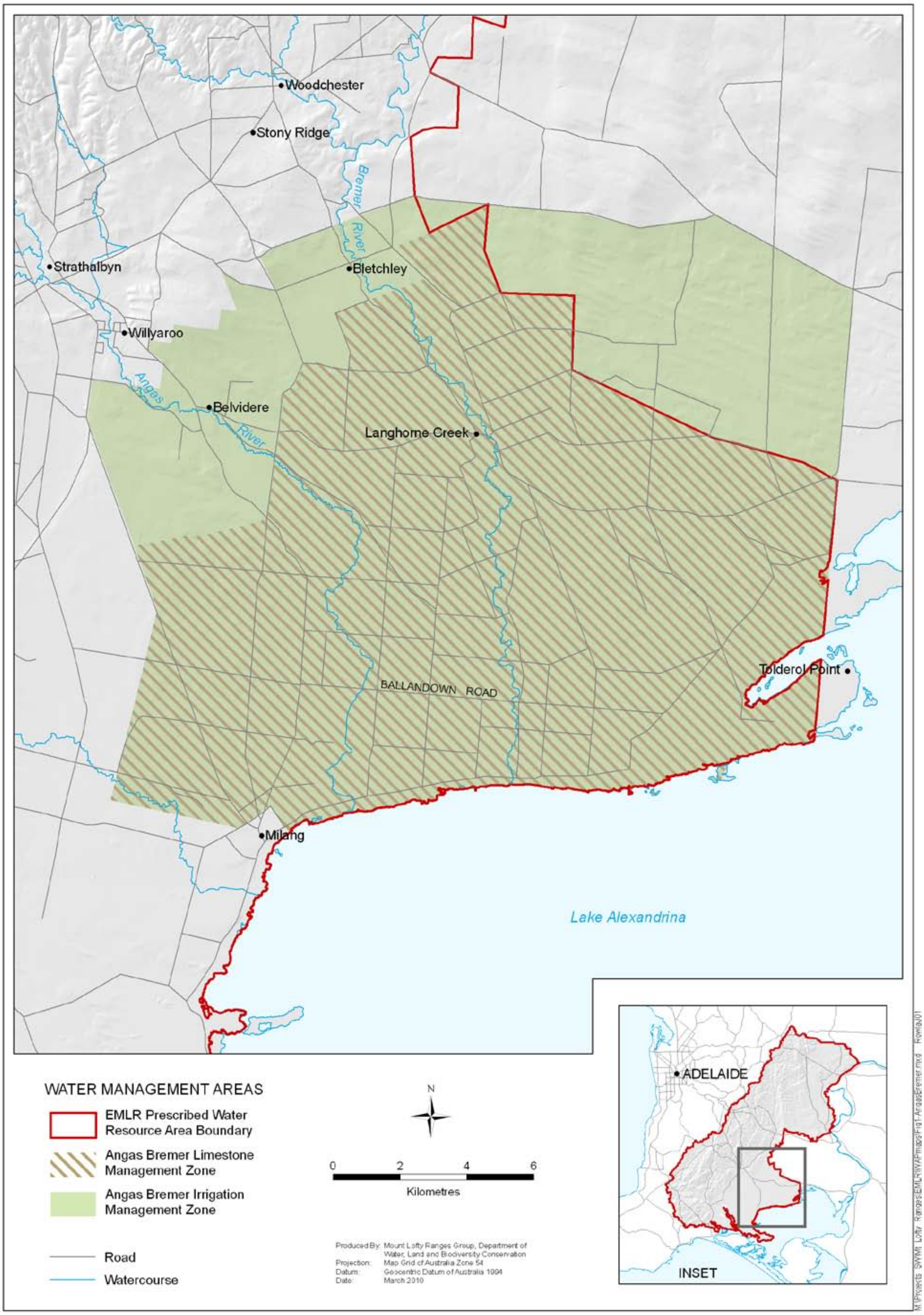

Figure 2. Angas Bremer Irrigation Management Zone

AMENDMENTS TO THE RESOURCE CAPACITY 2007

For this assessment, the existing models and data sets were updated to improve the definition of the resource capacity as well as incorporate a range of factors that had not previously been considered in the catchment modelling. The major factors involved in this are:

- The effect of direct watercourse extractions from streams in the upper catchment areas and flood irrigation diversions and extractions in the lower reaches of the Angas and Bremer Plains
- The impacts of streamflow losses in lower reaches of the Angas and Bremer Plains
- The impacts of plantation forestry on streamflow.

This report outlines changes made only to the modelled catchments of the Angas River, Bremer River, Currency Creek, Finniss River, and Tookayerta Creek. Farm dam data from the 2008 report have not changed, nor has the estimate of resource capacity in ungauged catchments, except for those areas with plantation forestry.

The general outline of the analysis completed is as follows:

1. Input new watercourse extraction data into the existing WaterCRESS models via the use of a text file demand node in the modelling platform. Refer to section: "Watercourse Extraction Data"
2. Extend Angas and Bremer Models to cover the plains reaches of the Angas-Bremer Irrigation Management Zone (ABIMZ) and incorporate stream losses. Refer to section: "Stream Losses""
3. Recalibrate the models where necessary and document calibration statistics. See section "Model Recalibration Details"
4. Remove all farm dams, watercourse diversions and urban nodes from the model to calculate the initial estimate of resource capacity
5. Spatially convert the modelled sub-catchment resource capacity data into the scale of the Surface Water Management Zone (SWMZ) for the purposes of the water allocation planning process. Refer to section: "Conversion of model sub-catchment scale data into Surface Water Management Zone scale data"
6. Apply an adjustment for the assumed impacts of plantation forestry at the SWMZ scale. Refer to section: "Adjustment to the mean annual Runoff to account for the impacts of Plantation forestry"
7. Report the estimate of the surface water resource capacity. Refer to section: "Results"
8. Run a post-allocation scenario with total extractions set at the proposed sustainable development limit. This has been defined as 10% of the surface water resource capacity. Refer to section: "Possible Future Allocation Scenario"
9. Report on the three scenarios – pre-development, post-development and future possible allocations - with respect to total end system flows and total diversions by catchment. Refer to section: "Results".

WATERCOURSE EXTRACTION DATA

Watercourse extraction in this section refers only to direct pumping from watercourses, and excludes extractions, diversions and flooding from the Bremer River section in the ABIMZ. Watercourse extractions, diversions and flooding from the Bremer River in the ABIMZ are dealt with in the later “Model Recalibration Details” section of this report.

New estimates of known watercourse extraction were obtained from the ongoing process of water allocation planning conducted by the Department for Water and were incorporated in the original farm dam catchment models. The estimates were aggregated at the scale of the proposed surface water management zones (SWMZ) for the EMLR WAP and assumed to be extracted from the end of the SWMZ’s.

Direct watercourse extraction estimates were based on a number of factors including:

- a theoretical crop requirement – taking into account assumed crop type, rainfall, region and soil type
- the ability to take i.e. what water infrastructure is used to extract and a possible maximum rate
- other water sources available such as other farm dams, or groundwater extractions.

As limited information on the timing of extractions was available, it has been assumed that extractions were related to crop evapotranspiration patterns, i.e., followed a summer dominant pattern with only minor winter extractions. The monthly extraction distributions were designed to mimic the monthly evaporation distribution in the region, as shown in Figure 3. Whilst some industries may extract strictly over the summer irrigation period, the chosen method also allows for those water users who may extract during winter to fill off-stream dams or flood irrigate during times when flow is actually available in the winter dominated stream-flow of the Mount Lofty Ranges. The monthly extraction distribution is shown below in Figure 3.

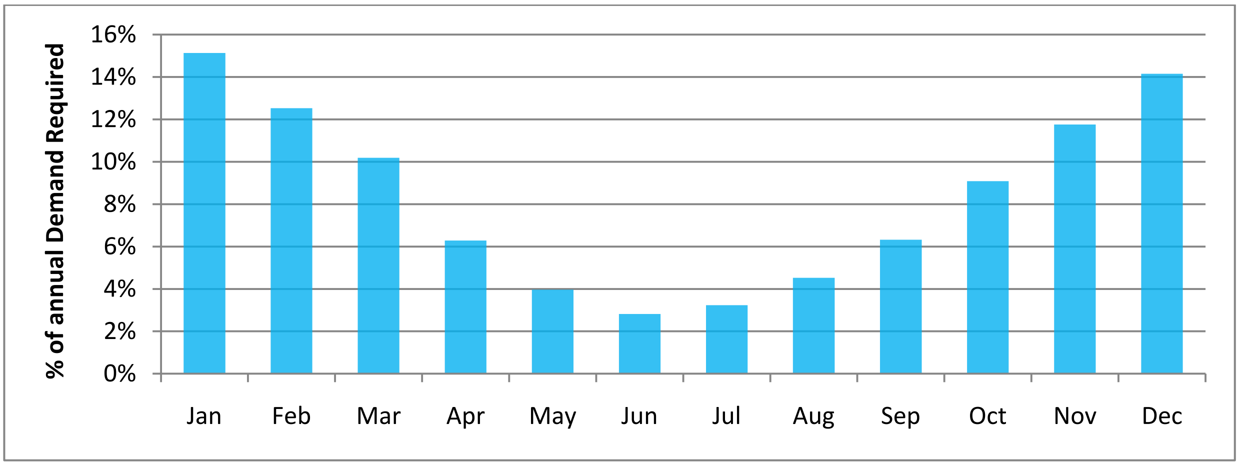

Figure 3. Monthly demand distribution pattern for watercourse diversions

The estimated total extractions are listed in Table 1 below by catchment. The Bremer River extractions listed here are for the area upstream of the ABIMZ. There are further extractions and diversions from the Bremer River in the ABIMZ that are dealt with in a separate manner and detailed in the Model Recalibration **Details** section of this report.

Table 1. Watercourse Diversion Estimates for the EMLR

Catchment	Mean Annual Extraction Estimate (ML/y)
Angas River	873
Bremer River (u/s of ABIMZ)*	838
Currency Creek	290
Finniss River	631
Tookayerta Creek	2355

** Does not include modelled diversions for the Bremer River below the location of Bletchley*

The implication of including a new factor in the water budget was that some of the models required recalibration to account for the extra water extractions. This is particularly the case where the extraction is large and above a previously calibrated stream-flow gauge. Where the extraction is above a gauge and is only small relative to the stream-flow, the model is generally not recalibrated. This is due to the fact that the calibration of stream-flow is generally accurate only within 5 to 10% of the gauged flow at best.

The locations of the watercourse extractions were matched as closely as possible to the downstream end of SWMZ and model sub-catchments. Where necessary, a stream-flow routing node was added to the model to create storage within the river reach to thus allow for direct extraction from the stream. The method chosen for the EMLR models assumes a storage relationship described in Cresswell (2010).

Where:

t = model time step

S(t) = Stream storage (m^3)

0(t) = Outflow at time step t (m^3/s)

a, b are storage and attenuation factors

For each SWMZ, a separate daily water demand file was generated using the monthly distribution pattern shown in Figure 3 above.

STREAM LOSSES

The modelling of EMLR catchments previously undertaken took into account flows leaving only the "Hills" region of the Angas and Bremer catchments. This was primarily due to lack of sufficient streamflow records for the plains section and watercourse extraction data. However, there is known to be an extensive system of diversions for flood irrigation with a complex system of flood pumps, flood gates and levy banks to direct the water in the Angas-Bremer Plains region. Unfortunately, the combined effects of streamflow losses and watercourse diversions/extractions has made the interpretation of more recently collected water level and streamflow data difficult to analyse. Actual water diversions from the two rivers are not measured directly, and thus these have been inferred from a combination of published areal flooding extents; theoretical estimates of likely water use and stream inflows to the plains indicated by upstream gauges measuring outflows from the hills. Estimation is further complicated by the diversification of water sources in the region. Irrigators within the ABIMZ have access to water from River Murray licences and groundwater pumping, and surface water from the Angas and Bremer Rivers. Landholders also regularly store surface water through the process of Aquifer Storage and Recovery (ASR).

Streamflow losses in general were simulated by the use of a seepage rate applied to a stream routing node in the WaterCRESS model platform. As the flow is routed through this node the storage in the reach increases as does the seepage rate.

Watercourse diversions from the Lower Bremer River were simulated by applying a diversion rate from the stream and routing the flow through an off-stream storage. The stored floodplain water was then allowed to either infiltrate into the floodplain, and hence be lost to the river system, or allowed to return to the stream at high flows, such as may occur in a natural flood.

MODEL RECALIBRATION DETAILS

This section describes the calibrations, and where necessary, re-calibrations of the models for each catchment. Details of the calibration statistics are found in sections for each catchment model detailed below. Note that where there are several gauges to calibrate the model to, some stream-flow data is given preference in the calibration routines over others. These stations provide the primary calibration of the models whilst additional data of lower quality is often included to provide a secondary or supplementary calibration. For example, several stations in the Mount Lofty Ranges have water-level loggers located in permanent pools that have only been provided with a preliminary rating on which to base the estimation of stream-flow. Some of these stations appear to have a particularly inaccurate rating. Thus, while confidence levels cannot be given to the recorded flow volumes, the data is still considered useful for showing when the flows occur and their approximate size. This is often of assistance in estimating losses in long plains reaches. Figure 5 shows the location of all gauges used in the calibration process

BREMER RIVER CATCHMENT

Details of the initial model construction and calibration can be found in Alcorn (2008), which can be found at:
http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/dwlbc_report_2008_13_web.pdf

Previously, the Bremer River catchment domain was established to as far south as the township of Woodchester, i.e. downstream of the confluence of the Bremer River and Red and Rodwell creeks, but not extending downstream to the ABIMZ. During this review the model was extended to the outflow of the Bremer River to Lake Alexandrina.

Watercourse extractions upstream of primary calibration gauges

The latest data indicates that approximately 840 ML of additional direct extractions were estimated to take place above the main stream flow gauges than previously estimated. This required minor recalibration of the model to account for this effect.

Estimation of streamflow diversion in the Angas-Bremer Plains from the Bremer River

Estimates of stream flow losses and diverted water in the Bremer Plains region around Langhorne Creek are discussed in this section. The extension of the model requires recognition that the Lower Bremer River is an ephemeral stream with postulated stream losses and known watercourse diversions. Watercourse diversions occur via a range of mechanisms including direct pumping from the stream, lateral flood gates, and flood diversion weirs, the largest of which (below Langhorne Creek) has the ability to completely divert the flow of the Bremer River for flood irrigation. This flood irrigation is known to happen annually, however no estimates of the actual volume diverted have been made. The Irrigation Annual reporting in the region affords some records of the areas inundated each irrigation year, and these can be used to estimate the diversion in each year.

The Angas Bremer Floodplain Infiltration Final Report (AWE, 2006) lists the areas inundated for the water years 1996/7 to 2003/4. These estimates have been used to develop a method for estimating possible volumes extracted.

Table 2 below describes the areas inundated for those years, assuming a mean flood depth of 300 mm across the area flooded would yield the volumes in column 3 of the table.

Using a Diversion Weir node and an Off-stream Storage node to represent the weir and the inundated area, the diversions in those years was modelled to try and match the evidence available.

The off-stream storage was given a maximum capacity of 4 GL and an infiltration rate of 50 ML/d to mimic infiltration over the entire area. The maximum storage chosen was designed to allow some return flows in extreme flow years. While water may actually return to the river it may also flow out via the disconnected Mosquito Creek to the east of Langhorne Creek. As part of the current extraction authorisations for flood irrigation in the area, some of the diverted flow is to be channelled to the previously disconnected Red Gum swamps along the Bremer River and Mosquito Creek.

Additional stream flow data from A4261072 (Bremer River at Ballandown Road) was also used to match the timing of stream flow events after losses and extractions have occurred up stream. The rating on this station is considered theoretical however, so the volume of flow passing may not be indicative of actual flows.

Table 2. Inundated Area 1997-2004 (AWE, 2006)

Year	Total Inundated Area (ha)	Volume of Flooded Area at 300mm Depth (ML)
1997-98	330	990
1998-99	106	318
1999-2000	529	1587
2000-01	3474	10422
2001-02	1199	3597
2002-03	86	258
2003-04	587	1761

The estimates of the volume diverted to the floodplain made using the AWE (2006) data and the model agree in total, but differ in individual years (see Figure 4). This annual difference is despite the gauged flow at the Hartley Gauging Station (A4265033) being used as the upstream input to the model in place of the modelled flows (which over-predict the flow during the period between 1997 and 2005). However, since the data is sparse, neither the AWE estimates nor the modelled estimates have great credibility in predicting individual annual diversions.

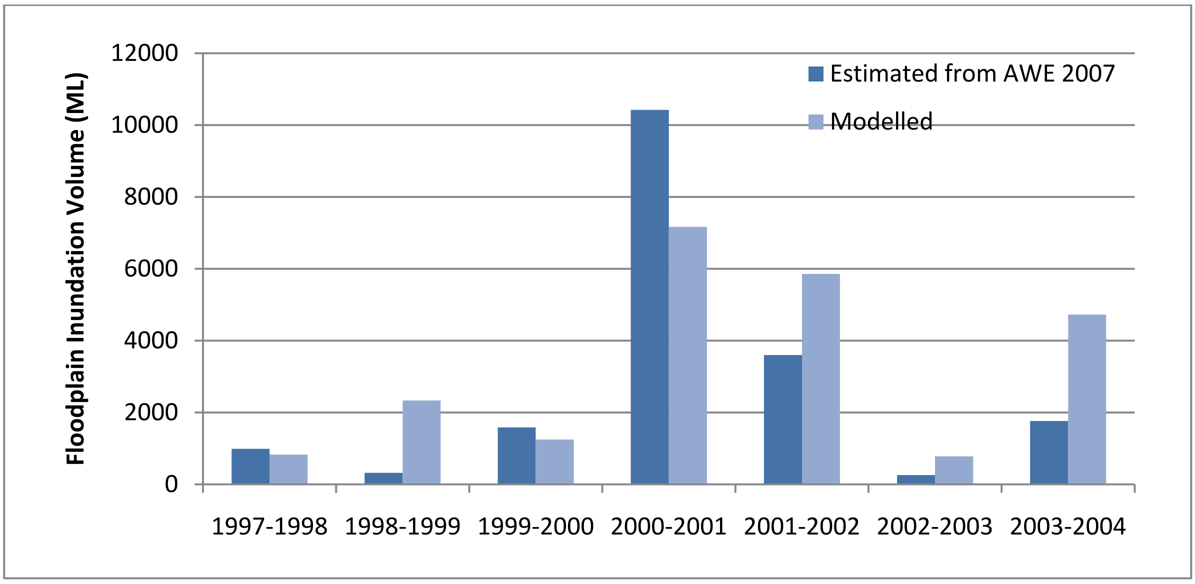

Figure 4. Estimated and modelled diversions from the Lower Bremer River

Calibration Statistics

Table 3. Calibration Statistics for the Bremer River Catchment Model

Station	Description	Calibration Statistics									
		Calibration Period	Daily			Monthly			Annual		
			%Diff	CE	R^2	%Diff	CE	R^2	%Diff	CE	R^2
A4260557	Mt Barker Creek at d/s Mt Barker*	25/04/1979-13/05/2009	-3.3	0.69	0.71	-3.3	0.84	0.84	-3.3	0.85	0.87
A4260558	Dawesley Creek at Dawesley*	30/07/1993-4/12/2006	-1.15	0.49	0.79	-1.17	0.80	0.86	-2.27	0.77	0.87
A4260533	Bremer River at near Hartley*	13/05/1973-27/09/2009	8.07	0.696	0.7	8.87	0.848	0.85	10.17	0.864	0.877
A4260688	Bremer River at u/s Mt Barker Creek Confluence	12/06/1997-31/05/2008	6.6	0.36	0.475	6.6	0.794	0.834	6.6	0.65	0.8
A4260679	Mt Barker Creek at u/s Bremer River Confluence	12/06/1997-7/8/2008	-42.1	0.15	0.484	-42.7	0.13	0.64	-43.9	-0.92	0.62
A4261072	Bremer River at Ballandown	11/08/2004-15/02/2010	-22.2	0.54	0.79	-22.18	0.61	0.81	-22.18	0.67	0.90

* Denotes Primary Calibration Station

Figure 5. Streamflow gauging stations used to calibrate the EMLR models

ANGAS RIVER CATCHMENT

Details of the initial model construction and calibration can be found in Savadamuthu (2006) which can be found at:

http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/ki_dwlbc_report_2006_09.pdf

The initial Angas River catchment model was extended to include the 15 km of stream reach below the town of Strathalbyn that drains to Lake Alexandrina. Streamflow losses were modelled in this section, as well as the inclusion of around 480 ML of plains watercourse extractions

Watercourse extractions upstream of primary calibration gauges

Only around 40 ML of additional watercourse extractions were identified above the primary gauge location of the Angas Weir (A4260503), with the remaining 340 ML being extracted below the main gauge and above the town of Strathalbyn (Figure 5).

Calibration Notes

An addition of only 40 ML of extractions modelled above the upstream gauge would not normally indicate the need to recalibrate the model. However, when the calibration was reviewed, it was decided that the previous calibration was likely to be overestimating flows.

Flow records have been kept at the Angas Weir since 1969. However, until 1996 the weir was also used to divert water to the Strathalbyn reservoir. During this period only rudimentary records were kept of the amount of water diverted, and thus the records of flow over the weir were also approximate only and subject to random and systematic errors. Calibration after 1996 was made potentially more accurate since the reservoir officially ceased to operate and the weir has been measuring the true flow.

The previous calibration at the Angas Weir gauging station used only the record for the years between 1996 and 1999. One of the largest flow years recorded was 1996, whilst the following three years were all below average. It was found that when calibration was reworked over the longer period of the record, the calibration during the earlier shorter period was biased towards the large event in 1996, thereby overestimating flows in average or below average years.

The recalibration using data to 2002 at Angas Weir was carried out in conjunction with data over a similar period collected from the downstream site A4260629 Angas River at Angas Plains. The catchment area upstream of the Angas Plains site is 3.2 times greater than that of the Angas Weir site. However, the flow at the downstream site is, on average, only 1.2 times the flow leaving the Angas Weir for the concurrent period of record. This would indicate that there are considerable losses occurring in the plains downstream of Strathalbyn. Additional gauging stations downstream of Strathalbyn were also used to calibrate the losses, although over a different time period. The stations A4261073 (Angas River at Ballandown Road) and A4261074 (Angas River at Cheriton Road) were included as supplementary calibration stations for the period covering 2004 to 2010.

With respect to the recent records at Angas Weir, several notes on the station's history file have indicated that un-recorded extractions have taken place in recent years, from 2002 onwards. These extractions appear to have taken place via direct pumping from the weir pool, or by the opening of the weir off-take valve. Evidence of this can be seen in Figure 6 where the water level trace shows significant drawdown to below the cease-to-flow level of the weir during the summer of 2006. This is significant as there is known to be a strong summer baseflow of around

1 ML/d draining to the gauge from the upper catchment. When the record is used for calibration, the recorded flows below 1 ML/d have been assigned a bad quality code so that they are removed over this period in the calibration routine.

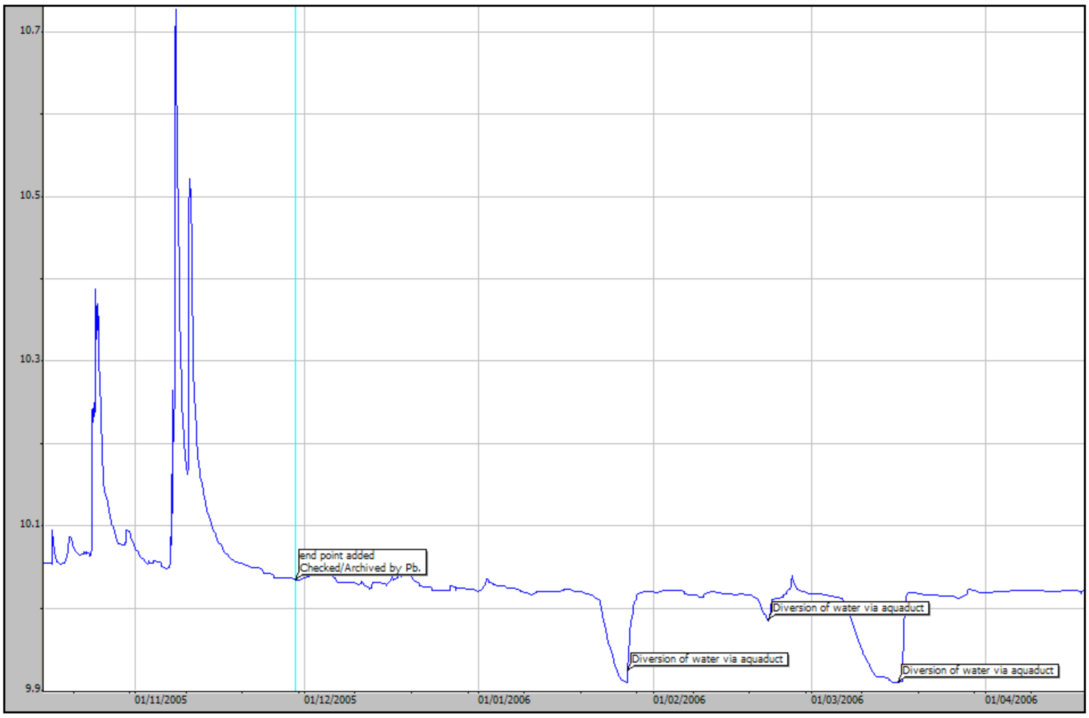

Figure 6. Streamflow trace showing several instances of suspected opening of the diversion off-take at Angas Weir

When good corrected-flow data is used in the calibrations, the model performs similarly well for both the upstream and downstream stations as shown in Table 4 below. While the calibrations at both stations for the three years 1997-99, both overestimate the flows by comparable amounts, the overall model performance, with introduced losses on the plains, is reasonably consistent over the longer timeframe. The calibration of the Angas Plains station could be improved by replacing the modelled flow at Angas Weir with the gauged flow.

Calibration Statistics

Table 4. Calibration Statistics for the Angas River Catchment Model

Station	Description	Calibration Statistics									
		Calibration Period	Daily			Monthly			Annual		
			%Diff	CE	R^2	%Diff	CE	R^2	%Diff	CE	R^2
A4260503	Angas River at Angas Weir*	1/1/1995-1/1/2003	-11.9	0.509	0.546	-11.9	0.83	0.80	-11.9	0.895	0.763
A4260629	Angas River at Angas Plains*	1/1/1995-18/12/2001	25.01	0.82	0.95	25.01	0.90	0.99	25.01	0.87	0.99
A4261073	Angas River at Ballandown Road	7/08/2004-15/02/2010	48.60	0.63	0.82	48.60	0.627	0.91	48.60	-0.56	0.95
A4261074	Angas River at Cheriton Road	7/08/2004-15/02/2010	-17.95	0.70	0.84	-17.95	0.88	0.97	-17.95	0.85	0.98

* Denotes Primary Calibration Station

CURRENCY CREEK CATCHMENT

Details of the initial Currency Creek model construction and calibration can be found in Alcorn (2006) which can be found at:
http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/ki_dwlbc_report_2006_07.pdf

As the more recent data indicated that there were only around 150 ML of new extractions to be added to the model upstream of the gauging station, the model did not require recalibration to remain within a reasonable bias (<5%).

Table 5. Calibration Statistics for the Currency Creek Catchment Model

Station	Description	Calibration Statistics									
		Calibration Period	Daily			Monthly			Annual		
			%Diff	CE	R^2	%Diff	CE	R^2	%Diff	CE	R^2
A4260530	Currency Creek at near Higgins*	07/06/1972-22/08/1993	-3.3	0.733	0.757	-3.23	0.874	0.878	-2.02	0.863	0.87
A4261099	Near Peel Rd Cemetery	10/4/2006-14/02/2010	-0.05	0.492	0.713	0.025	0.657	0.742	0.363	-0.76	0.756

* Denotes Primary Calibration Station

FINNISS RIVER CATCHMENT

Details of the initial Upper Finniss River model construction and calibration can be found in Savadamuthu (2003) which can be found at:
http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/finniss_report.pdf

There were minimal new extractions to be added to the Finniss Catchment model and the primary calibration at the Finniss River @ 4 km East of Yundi gauging station is considered a good calibration in most years. No further recalibration of the model was therefore carried out. A total of 631 ML of direct extractions were added to the whole model.

In addition to the primary streamflow calibration site, two other gauges were considered as secondary calibration data; A4261075 Finniss River at Ford Road, and A4261103 Finniss Giles Creek (Figure 5).

Neither of these two sites have extensive streamflow gaugings carried out, however, the flows reported at these sites match reasonably well when compared to the modelled flow at the same locations.

Calibration Statistics

Table 6. Calibration Statistics for the Finniss River Catchment Model

Station	Description	Calibration Statistics									
		Calibration Period	Daily			Monthly			Annual		
			%Diff	CE	R^2	%Diff	CE	R^2	%Diff	CE	R^2
A4260504	Finniss River at 4 km East of Yundi*	08/03/1969-20/12/2006	-3.09	0.721	0.722	-3.0	0.902	0.904	-3.0	0.894	0.9
A4261075	Finniss River at Ford Road	11/08/2004-15/02/2010	-4.79	0.494	0.495	-4.75	0.749	0.758	-4.5	0.227	0.764
A4261103	Finniss Giles Creek	4/10/2006-15/02/2010	-15.6	0.399	0.62	-15	0.4	0.65	-15	-0.75	0.59

* Denotes Primary Calibration Station

TOOKAYERTA CREEK CATCHMENT

Details of the initial Tookayerta Creek model construction and calibration can be found in Savadamuthu (2004) which can be found at:

http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/took_report1.pdf

Of all the five daily flow models, the Tookayerta Creek model had the most significant potential change to its water budget by the inclusion of more recent watercourse diversion data. A total of 1928 ML of diversions upstream of the calibration gauge had to be incorporated into the model, while a further 426 ML had to be incorporated below the gauge.

This need to incorporate these additional diversions required that a recalibration of the model be undertaken in order to increase the runoff upstream of the diversion locations. The recalibration of the model centred mostly on redefining the value of the total soil store, but other adjustments were also made in regard of the groundwater recharge and baseflow recession rates to better fit the observed recession curve.

The resulting calibration was considered fair to good, but was not as good as the original model calibration. The daily time step calibration showed that the modelled baseflow was severely impacted by the additional extraction regime, while the observed streamflow data does not show such a marked impact. Further calibration attempts, in future, should be undertaken using the model feature that takes account of rainfall and soil moisture effects in setting demand rates and in seeking improved ways of modelling seepage returns to downstream channels from irrigation applications. Since no new streamflow data was available for this catchment, the model was recalibrated using data described in Savadamuthu (2003).

Calibration Statistics

Table 7. Calibration Statistics for the Tookayerta Creek Catchment Model

Station	Description	Calibration Statistics									
		Calibration Period	Daily			Monthly			Annual		
			%Diff	CE	R^2	%Diff	CE	R^2	%Diff	CE	R^2
	Tookayerta Creek*	19/04/1997-15/04/2002	-2.12	0.69	0.695	-1.97	0.817	0.817	0.61	0.785	0.8

* Denotes Primary Calibration Station

CONVERSION OF MODEL SUB-CATCHMENT SCALE DATA INTO SURFACE WATER MANAGEMENT ZONE SCALE DATA

The scale of the modelled sub-catchments within the WaterCRESS modelling platform is generally smaller than that reported on for the water allocation plan (WAP) for the EMLR. As the model sub-catchment boundaries do not always match the boundaries of the defined Surface Water Management Zones (SWMZ) proposed for the draft WAP, a method of spatial overlaying was employed to assist in aggregation of the results and fitting them to the SWMZ boundaries.

CONVERSION METHOD

To convert the modelled runoff between these two scales the following steps were undertaken:

1. Output the summary file for the WaterCRESS model. This output file contains mean annual statistics for many of the model outputs including the runoff generated from each catchment node. This figure is the estimated runoff depth in the catchments upstream of any farm dams and/or watercourse diversion locations.
2. Convert the sub-catchment scale runoff depth values into a shapefile layer using a GIS layer of the model sub-catchments as a basis.
3. Convert the shapefile values into a raster grid in the GIS using the value of the sub-catchment runoff depth as each of the raster values.
4. Overlay the SWMZ shapefile on the raster layer, and calculate the area weighted mean of all the runoff depth values generated over the whole zone.
5. The SWMZ layer now contains the mean annual runoff depth generated within each zone without the impact of farm dams, watercourse diversions or stream losses. The depth can then be converted to the Zone runoff volume by multiplication of the depth by the zone area.

Adjustment for point location stream losses

Before using the runoff data as the basis for the resource capacity, it is necessary to adjust this data for any naturally occurring other stream losses identified within the catchment that are built into the model. The method of adjustment here is to redistribute the losses evenly across the catchment in which they occur.

To carry out this adjustment, the model was rerun, but with all farm dams, watercourse diversions, and urban areas removed from the model. The model was rerun for the period between 1971 and 2006 (which is the period for which the output summary file was initially run) and the total runoff output at the zone outlet was used to calculate the mean annual runoff depth over the whole zone area.

ADJUSTMENT TO THE MEAN ANNUAL RUNOFF TO ACCOUNT FOR THE IMPACTS OF PLANTATION FORESTRY

This section describes the method used to redistribute water deemed to be used by plantation forestry across the landscape at a major sub-catchment level.

At the time of development of the daily streamflow models, the effects of forestry were not incorporated into the models. Through the process of developing the water allocation plan, it became evident that the impacts on surface-water resources due to plantation forestry were large in some areas and needed be quantified. What follows is a description of the simple water balance method used to account for that impact. The impacts of plantation forestry are accounted for via the adoption of a simple additional adjustment to the mean annual runoff from each catchment (over and above the adjustment made for farm dams). No attempt has been made here to represent this overall single additional adjustment in a temporally varying fashion.

For a total estimated area of commercial forestry of around 2650 Ha within the EMLR, an estimated 3.2 GL of surface water is estimated to be intercepted. A list by catchment can be found in Table 8.

Key Assumptions

1. Plantation Forestry is responsible for an 85% reduction in available surface water resource over the planted areas
2. This usage is incorporated on an area weighted basis to define a finally adjusted “capacity” of the surface water resource – that is the total water that is available before applying any limits or restrictions, but after adjusting for the effects of farm dams, watercourse diversions and forestry.

The use of an 85% reduction figure is consistent with the state policy framework which states;

“Plantation forests, regardless of species, can be assumed to reduce runoff (including groundwater recharge) by 85%.”

And, that…

“…maximum water use should be used to estimate the amount of water used by plantation forests over the lifecycle of the forest” (SA Government, 2009 p15-16).

This assumption has been applied to all plantation forestry areas as defined by the South Australian Land Use data set (DEH, 2008) regardless of age or level of canopy closure. It also assumes steady state coverage over the assessment period, which is generally between 1971 and 2006. In general it is a conservative assumption of the impacts of forestry on surface water runoff.

The following land use classifications were used to define areas of plantation forestry (Bureau of Rural Sciences, 2006):

- 3.1.0 Plantation Forestry
- 3.1.1 Plantation Forestry, Softwood Production e.g. Pine Plantations
- 3.1.2 Plantation Forestry, Hardwood Production e.g. Blue Gum Plantations

Scale of Application

The runoff adjustment is applied at the "major sub-catchment level", which is generally of the order of tens of square kilometres and is the level of calibration of most hydrological models described in this report. Water use from plantation forestry has not been measured and has therefore not been explicitly modelled as part of DFW's hydrological assessments. This is due mostly to a lack of streamflow data at the scale required to validate any assumptions about local forest water use.

With the acceptance that forestry water use is very high and with the recent large increases in the areas planted to forestry, it is necessary to make an assumption about the water use and to apply this assumption in a spatially distributed manner, as for farm dams. For these reasons it is now necessary to redistribute the assumed forest water use back across the landscape at the appropriate scale in order to adjust the first estimates of runoff across each of the Surface Water Management Zones (SWMZ).

Method for redistributing assumed forest water use

The calculation of the impacts of plantation forestry is carried out using the following steps:

1. Calculate the predicted Resource Capacity for each zone assuming that forested areas would reduce the runoff from their proportional zone area by 85%:

   $$\boldsymbol{RC_{z2} = RC_{z1}(1 - P_1 \times 0.85)} \qquad \text{Equation 1}$$

   Where:
   RC_{Z2} = the resource capacity adjusted for decreased runoff from forested areas
   RC_{z1} = the resource capacity adjusted, previously, for farm dams, watercourse diversions and urban areas only
   P_1 = Proportion of total area of the SWMZ that is forested

   This step ensures that the impact of forestry is considered to be proportional to the level of runoff within the catchment. In other words, the higher the runoff, the higher the assumed impact.

2. In order to validate the assumption that the original modelling made no account for the spatial distribution in forestry across the sub-catchment it is necessary to adjust the runoff in each SWMZ by the proportional increase for the whole sub-catchment:

   $$\boldsymbol{RC_{adj(i)} = RC_{z2} \times \frac{\sum_1^n RC_{z1}}{\sum_i^n RC_{z2}}} \qquad \text{Equation 2}$$

   Where:
   $RC_{adj(i)}$ = SWMZ resource capacity adjusted for forest water use, farm dams, watercourse diversions and urban areas (ML)
   RC_{Z2}= Initial estimate of SWMZ resource capacity adjusted down for forest water use (Eq. 1)
   $\sum_1^n RC_{z1}$ = Sum of the original resource capacities for each SWZ in the major sub-catchment unit
   $\sum_1^n RC_{z2}$ = Sum of the resource capacities after adjustment for forest water use for each SWMZ in the major sub-catchment unit

Step 2 then provides what is termed “adjusted runoff”. That is what runoff there would be in each zone, where the impacts of farm dams, watercourse diversions, urban areas and plantation forestry were removed.

3. Given the “adjusted runoff” from step 2 above, it is still necessary to assess the existing impact due to the effects of plantation forestry for the purposes of water allocation and water accounting. To calculate the assumed forest water use for use in determining the existing level of development (in addition to existing demands from farm dams), take the product of the adjusted resource capacity, the reduction factor (0.85) and the proportion of area that is covered by plantation forestry, as below.

$$Forest\ Water\ Use = RCadj(i) \times P1 \times 0.85 \qquad \text{Equation 3}$$

Where:

i. *RCadj(i) is the fully redistributed runoff for zone i from Equation 2*
ii. *P1 is the proportion of zone i covered by plantation forestry*

RESULTS

The results presented in Table 8 describe the mean annual data for the period 1971-2006 for each catchment within the EMLR PWRA.

Also presented are the end-of-system flows and estimated diversions for the pre-development scenario (Resource Capacity), the post-development scenario, and the application of a possible future allocation scenario. These data are presented over the longer term period of 1895 to 2009. Scenario descriptions are given below.

SCENARIO DESCRIPTIONS

There are 3 scenarios presented in this section.

Pre-Development Scenario

The runoff that may be expected from the catchment models in the absence of farm dams, watercourse extractions, urban runoff, and plantation forestry. This is the flow that is used to define the resource capacity.

Post Development Scenario

The modelled runoff under the current conditions of water resource development.

Possible Future Allocation Scenario

An initial estimate of 10% extraction limit was used as a possible future allocation scenario. This estimate was based on the premise that, at the time of this study, the sustainable extraction limit for the EMLR catchments was estimated to be 10% of the long-term (1971-2006) resource capacity, based on modelling the environmental outcomes of different levels of extraction from farm dams (not from watercourse extractions) at a range of testing sites. This assumption is tested here to determine what impact, if any, such an extraction regime may have on future diversions and end of system flows.

It should be noted that all dams within a model are given a fixed proportion of the dam capacity as an extraction limit, and are also required to bypass low flows before capture in the dam. For this scenario, all dams were required to bypass low flows as all dams were subjected to the

10% rule. However, it is likely that only licensed dams and diversion structures would be required to bypass low flows, and so the increase in low-flows through the system would be reduced.

This scenario is a rough approximation of what may happen under such an extraction regime, and should be used as a guide to what a future allocation scenario could look like. The actual allocation methodology and mechanisms are currently being finalised as part of the EMLR WAP development process, and they might be different to the scenario presented here.

RESOURCE CAPACITY ESTIMATES

The total surface water resource capacity for the Eastern Mount Lofty Ranges Prescribed Water Resources Area (EMLR PWRA) is estimated at 107.2 GL. This is the mean annual runoff from the EMLR PWRA with the impacts of farm dams, watercourse extractions, urban runoff, and plantation forestry removed.

The minimum and maximum annual flows modelled for the pre-development scenario were 36 GL and 263 GL respectively with a standard deviation of 49.1 GL.

Details of the mean annual values for the period 1971-2006 for the contributing catchments are given in Table 8 below.

Table 8. Resource Capacity Tables for the EMLR PWRA

Catchment	Area (km^2)	"Post-Development Flow (GL)	"No dams-diversions or urban –" Flow (GL)	Impacts due to diversions	Impacts Due to Forestry (GL)	Resource Capacity (GL)	10% SDL** (GL)
Angas Bremer Plains	202	0.0	0.0	0.0	0.0	0.0	0.0
Angas River*	199	6.7	8.4	1.7	0.0	8.4	0.8
Bremer River*	589	9.7	17.9	8.1	0.1	17.9	1.8
Currency Creek*	99	6.9	8.0	1.1	0.0	8.1	0.8
Deep Creek	70	0.6	1.0	0.3	0.0	1.0	0.1
Finniss River*	377	34.7	37.6	2.9	2.5	40.1	4.0
Long Gully	117	0.0	0.0	0.0	0.0	0.0	0.0
Milendella Creek	110	0.5	0.5	0.1	0.0	0.5	0.1
Preamimma Creek	75	0.0	0.0	0.0	0.0	0.0	0.0
Reedy Creek	317	5.3	6.0	0.7	0.0	6.0	0.6
Rocky Gully Creek	101	0.0	0.0	0.0	0.0	0.0	0.0
Salt Creek	200	0.6	0.6	0.0	0.0	0.6	0.1
Sandergrove Plains	287	1.3	1.4	0.1	0.0	1.4	0.1
Tookayerta Creek*	103	19.7	22.5	2.8	0.6	23.1	2.3
Total	2845	86.1	104.0	17.9	3.2	107.2	10.72

* Denotes Daily Hydrological Modelling Results available

** Denotes a Sustainable Diversion Limit (SDL) of 10% of the Resource Capacity. This works out to 10.72ML if all water is taken just from farm dams. This will be higher if water is taken through watercourse extractions and diversions, to account for the evaporation-loss component inherent to farm dams.

END OF SYSTEM FLOWS: ALL SCENARIOS

The total end of system annual flows for all three modelled scenarios are presented in Table 9 and Figure 7. Note that these figures are for the longer modelled period of 1895-2009 to show the full range of climatic conditions over that last century.

For the period between 1895 and 2009 the mean annual end-of-system flows to the Lower Murray River and Lower Lakes are:

Table 9. End of system flows for the EMLR PWRA 1895-2009

Unit	Pre-Development Scenario	Post-Development Scenario	Future Allocation Scenario
EMLR	116.4 GL	94.8 GL	105.6 GL

These data show a 19% reduction in end of system flows for the post development scenario. The implementation of the possible Future Allocation scenario would result in a smaller impact at 9%. This would be due largely to a stricter control on watercourse diversions and the implementation of policies to bypass low flows around dams. The actual improvement due to the future allocation scenario, is likely to be less than this as implementation of low flow bypasses is most likely to be targeted only to dams for which a licence would given to irrigate. The process of authorisation and licensing is ongoing at the time of this study.

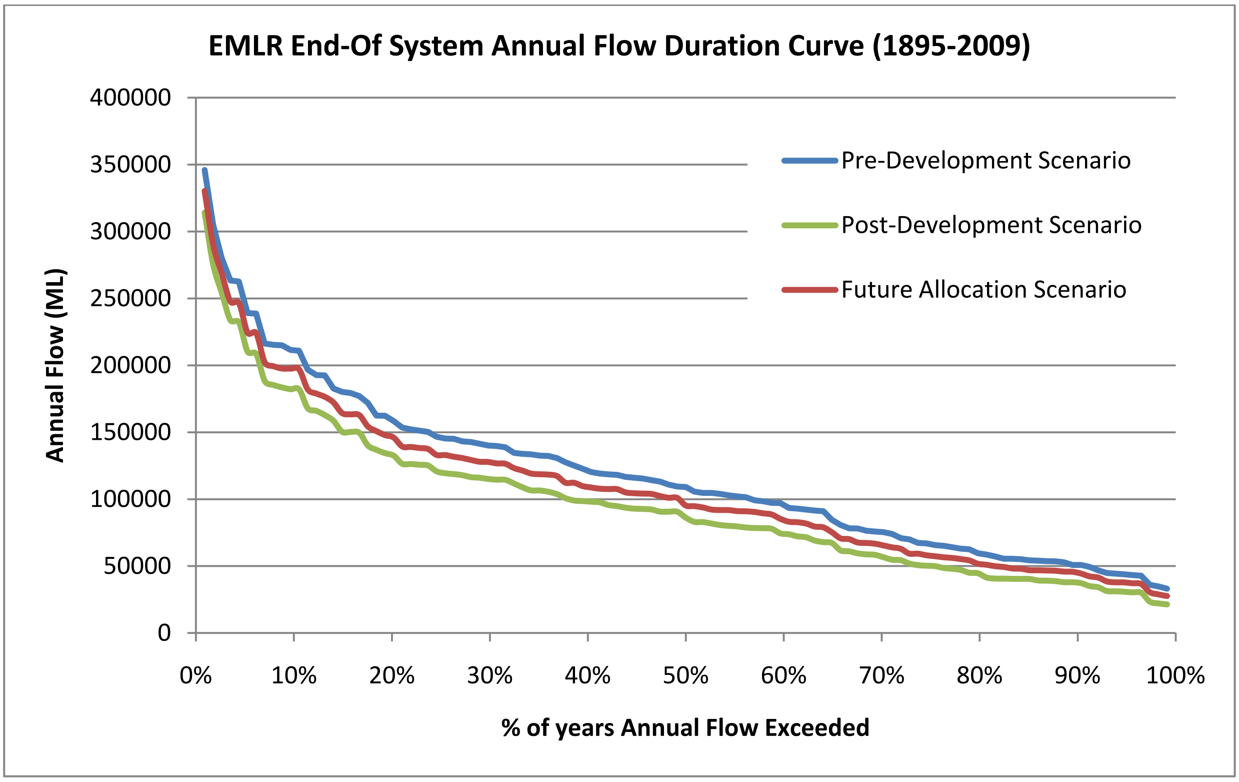

Figure 7. Annual Flow Duration Curves for the EMLR (1895-2009)

ANNUAL DIVERSIONS: POST-DEVELOPMENT AND FUTURE ALLOCATION SCENARIO

The mean annual diversions under all scenarios for the period 1895-2009 are given below in Table 10. The results take into account that assumed forest water use is firstly taken off the sustainable diversion limit for each catchment. The maximum annual impact due to plantation forestry is later added back on to the total annual diversion. This figure is calculated at 3.2 GL/y.

The reduced annual diversion for the Future Allocation scenario is due to both the reduction in some catchments of the allowable diversion from farm dams and the assumption of a different diversion regime in the Lower Bremer River. The latter is responsible for 4.6 GL of the total 7.2 GL reduction in the mean annual diversion. At the time of writing, the actual diversion regime that will be implemented in that area is yet to be decided. Future decisions on the nature of the diversion regime in the area will affect the calculation of this estimate.

Table 10. Mean Annual Diversions for the EMLR

Unit	Current (Post-Development Scenario) Diversions	Future Allocation Scenario Diversions
EMLR	17.7 GL	10.5 GL

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UNITS OF MEASUREMENT

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol	Definition in terms of other metric units	Quantity
day	d	24 h	time interval
gigalitre	GL	10^6 m^3	volume
gram	g	10^{-3} kg	mass
hectare	ha	10^4 m^2	area
hour	h	60 min	time interval
kilogram	kg	base unit	mass
kilolitre	kL	1 m^3	volume
kilometre	km	10^3 m	length
litre	L	10^{-3} m^3	volume
megalitre	ML	10^3 m^3	volume
metre	m	base unit	length
microgram	µg	10^{-6} g	mass
microlitre	µL	10^{-9} m^3	volume
milligram	mg	10^{-3} g	mass
millilitre	mL	10^{-6} m^3	volume
millimetre	mm	10^{-3} m	length
minute	min	60 s	time interval
second	s	base unit	time interval
tonne	t	1000 kg	mass
year	y	365 or 366 days	time interval

Shortened forms

~	approximately equal to
bgs	below ground surface
EC	electrical conductivity (µS/cm)
K	hydraulic conductivity (m/d)
pH	acidity
pMC	percent of modern carbon
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
w/v	weight in volume
w/w	weight in weight

GLOSSARY

Act, the — the Natural Resources Management Act 2004

Annual adjusted catchment yield — Annual catchment yield with the impact of dams, watercourse diversion, urban areas and commercial forestry removed

Aquatic ecosystem — The stream channel, lake or estuary bed, water, and/or biotic communities, and the habitat features that occur therein

Aquifer — An underground layer of rock or sediment that holds water and allows water to percolate through

Aquifer, confined — Aquifer in which the upper surface is impervious and the water is held at greater than atmospheric pressure; water in a penetrating well will rise above the surface of the aquifer

Aquifer, unconfined — Aquifer in which the upper surface has free connection to the ground surface and the water surface is at atmospheric pressure

ASR — Aquifer Storage and Recovery; involves the process of recharging water into an aquifer for the purpose of storage and subsequent withdrawal; also known as aquifer storage and retrieval

Artificial recharge — The process of artificially diverting water from the surface to an aquifer; artificial recharge can reduce evaporation losses and increase aquifer yield; see also 'natural recharge', 'aquifer'

AWS — Automatic Weather Station

Baseflow — The water in a stream that results from groundwater discharge to the stream; often maintains flows during seasonal dry periods and has important ecological functions

Basin — The area drained by a major river and its tributaries

Biodiversity — (1) The number and variety of organisms found within a specified geographic region. (2) The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems

Biological diversity — See 'biodiversity'

Biological integrity — Functionally defined as the condition of the aquatic community that inhabits unimpaired water bodies of a specified habitat as measured by community structure and function

BoM — Bureau of Meteorology, Australia

Bore — See 'well'

Catchment — That area of land determined by topographic features within which rainfall will contribute to run-off at a particular point

Dams, off-stream dam — A dam, wall or other structure that is not constructed across a watercourse or drainage path and is designed to hold water diverted or pumped from a watercourse, a drainage path, an aquifer or from another source; may capture a limited volume of surface water from the catchment above the dam

Dams, on-stream dam — A dam, wall or other structure placed or constructed on, in or across a watercourse or drainage path for the purpose of holding and storing the natural flow of that watercourse or the surface water

Dams, turkey nest dam — An off-stream dam that does not capture any surface water from the catchment above the dam

DFW — Department for Water (Government of South Australia)

Domestic purpose — The taking of water for ordinary household purposes; includes the watering of land in conjunction with a dwelling not exceeding 0.4 hectares

Domestic wastewater — Water used in the disposal of human waste, for personal washing, washing clothes or dishes, and swimming pools

d/s — Downstream

DWLBC — Department of Water, Land and Biodiversity Conservation (Government of South Australia)

Ecological indicators — Plant or animal species, communities, or special habitats with a narrow range of ecological tolerance; for example, in forest areas, such indicators may be selected for emphasis and monitored during forest plan implementation because their presence and abundance serve as a barometer of ecological conditions within a management unit

Ecological processes — All biological, physical or chemical processes that maintain an ecosystem

Ecological values — The habitats, natural ecological processes and biodiversity of ecosystems

Ecology — The study of the relationships between living organisms and their environment

Ecosystem — Any system in which there is an interdependence upon, and interaction between, living organisms and their immediate physical, chemical and biological environment

Ecosystem services — All biological, physical or chemical processes that maintain ecosystems and biodiversity and provide inputs and waste treatment services that support human activities

Effluent — Domestic and industrial wastewater

EMLR — Eastern Mount Lofty Ranges

Endangered species — (1) Any species in danger of extinction throughout all or a significant portion of its range

Environmental water provisions — That part of environmental water requirements that can be met; what can be provided at a particular time after consideration of existing users' rights, and social and economic impacts

Environmental water requirements — The water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

EPA — Environment Protection Authority (Government of South Australia)

Ephemeral streams or wetlands — Those streams or wetlands that usually contain water only on an occasional basis after rainfall events. Many arid zone streams and wetlands are ephemeral.

Evapotranspiration — The total loss of water as a result of transpiration from plants and evaporation from land, and surface water bodies

Floodout — An area where channelised flow ceases and floodwaters spill across adjacent alluvial plains

Floodplain — Of a watercourse means: (1) floodplain (if any) of the watercourse identified in a catchment water management plan or a local water management plan; adopted under the Act; or (2) where (1) does not apply — the floodplain (if any) of the watercourse identified in a development plan under the *Development (SA) Act 1993*; or (3) where neither (1) nor (2) applies — the land adjoining the watercourse that is periodically subject to flooding from the watercourse

Flow bands — Flows of different frequency, volume and duration

Flow regime — The character of the timing and amount of flow in a stream

GIS — Geographic Information System; computer software linking geographic data (for example land parcels) to textual data (soil type, land value, ownership). It allows for a range of features, from simple map production to complex data analysis

Groundwater — Water occurring naturally below ground level or water pumped, diverted and released into a well for storage underground

Hydraulic conductivity (K) — A measure of the ease of flow through aquifer material: high K indicates low resistance, or high flow conditions; measured in metres per day

Hydrogeology — The study of groundwater, which includes its occurrence, recharge and discharge processes, and the properties of aquifers; see also 'hydrology'

Hydrography — The discipline related to the measurement and recording of parameters associated with the hydrological cycle, both historic and real time

Hydrology — The study of the characteristics, occurrence, movement and utilisation of water on and below the Earth's surface and within its atmosphere; see also 'hydrogeology'

Hydrometric — Literally relating to water measurement, from the Greek words 'hydro' (water) and metrikos (measurement); see also DWLBC fact sheet FS1 <http://www.dwlbc.sa.gov.au/assets/files/fs0001_hydrometric_surface_water_monitoring.pdf>

Hydstra — A time series data management system that stores continuously recorded water-related data such as water level, salinity and temperature; it provides a powerful data analysis, modelling and simulation system; contains details of site locations, setup and other supporting information

Infrastructure — Artificial lakes; dams or reservoirs; embankments, walls, channels or other works; buildings or structures; or pipes, machinery or other equipment

Injection well — An artificial recharge well through which water is pumped or gravity-fed into the ground

Irrigation — Watering land by any means for the purpose of growing plants

Irrigation season — The period in which major irrigation diversions occur, usually starting in August–September and ending in April–May

Lake — A natural lake, pond, lagoon, wetland or spring (whether modified or not) that includes part of a lake and a body of water declared by regulation to be a lake. A reference to a lake is a reference to either the bed, banks and shores of the lake or the water for the time being held by the bed, banks and shores of the lake, or both, depending on the context.

Land — Whether under water or not, and includes an interest in land and any building or structure fixed to the land

Licence — A licence to take water in accordance with the Act; see also 'water licence'

Licensee — A person who holds a water licence

m AHD — Defines elevation in metres (m) according to the Australian Height Datum (AHD)

MLR — Mount Lofty Ranges

Model — A conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating storm run-off, assessing the impacts of dams or predicting ecological response to environmental change

Monitoring — (1) The repeated measurement of parameters to assess the current status and changes over time of the parameters measured (2) Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals, and other living things

Natural recharge — The infiltration of water into an aquifer from the surface (rainfall, streamflow, irrigation etc). See also artificial recharge

Natural resources — Soil, water resources, geological features and landscapes, native vegetation, native animals and other native organisms, ecosystems

NRM — Natural Resources Management

NRM plans — The State NRM Plan, regional NRM plans and water allocation plans prepared under Chapter 4 of the Act

Pasture — Grassland used for the production of grazing animals such as sheep and cattle

Percentile — A way of describing sets of data by ranking the dataset and establishing the value for each percentage of the total number of data records. The 90th percentile of the distribution is the value such that 90% of the observations fall at or below it.

Perennial streams — Permanently inundated surface stream courses. Surface water flows throughout the year except in years of infrequent drought.

PIRSA — Primary Industries and Resources South Australia (Government of South Australia)

Pluviometer — An automated rain gauge consisting of an instrument to measure the quantity of precipitation over a set period of time

Prescribed area, surface water — Part of the state declared to be a surface water prescribed area under the Act

Prescribed lake — A lake declared to be a prescribed lake under the Act

Prescribed watercourse — A watercourse declared to be a prescribed watercourse under the Act

Prescribed water resource — A water resource declared by the Governor to be prescribed under the Act, and includes underground water to which access is obtained by prescribed wells. Prescription of a water resource requires that future management of the resource be regulated via a licensing system.

Prescribed well — A well declared to be a prescribed well under the Act

Production well — The pumped well in an aquifer test, as opposed to observation wells; a wide-hole well, fully developed and screened for water supply, drilled on the basis of previous exploration wells

PWA — Prescribed Wells Area

PWCA — Prescribed Watercourse Area

PWRA — Prescribed Water Resources Area

Quickflow — Also known as direct run-off or event flow, refers to that portion of streamflow generated during a storm event that enters the watercourse via direct run-off. It is defined as that volume of total observed streamflow for a given day that remains following subtraction of the volume identified as baseflow by the digital baseflow filter.

SARDI — South Australian Research and Development Institute, a division within PIRSA

SA Water — South Australian Water Corporation (Government of South Australia)

Seasonal watercourses or wetlands — Those watercourses or wetlands that contain water on a seasonal basis, usually over the winter–spring period, although there may be some flow or standing water at other times

State NRM Plan — Policy document prepared by the Minister that sets the strategic direction for natural resource management in the State and policies for achieving the objects of the Act

Stock use — The taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act)

Stormwater — Run-off in an urban area

Sub-catchment — The area of land determined by topographical features within which rainfall will contribute to run-off at a particular point

Surface water — (a) water flowing over land (except in a watercourse), (i) after having fallen as rain or hail or having precipitated in any another manner, (ii) or after rising to the surface naturally from underground; (b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir

Surface Water Archive — An internet-based database linked to Hydstra and operated by DFW. It contains rainfall, water level, streamflow and salinity data collected from a network of surface water monitoring sites located throughout South Australia

To take water — From a water resource includes (a) to take water by pumping or siphoning the water; (b) to stop, impede or divert the flow of water over land (whether in a watercourse or not) for the purpose of collecting the water; (c) to divert the flow of water from the watercourse; (d) to release water from a lake; (e) to permit water to flow under natural pressure from a well; (f) to permit stock to drink from a watercourse, a natural or artificial lake, a dam or reservoir

Tributary — A river or creek that flows into a larger river

u/s — Upstream

Volumetric allocation — An allocation of water expressed on a water licence as a volume (eg. kilolitres) to be used over a specified period of time, usually per water use year (as distinct from any other sort of allocation)

Water affecting activities — Activities referred to in section 127 of the Act

Water allocation — (1) In respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence. (2) In respect of water taken pursuant to an authorisation under s.11 means the maximum quantity of water that can be taken and used pursuant to the authorisation

Water allocation, area based — An allocation of water that entitles the licensee to irrigate a specified area of land for a specified period of time usually per water–use year

WAP — Water Allocation Plan; a plan prepared by a NRM Board and adopted by the Minister in accordance with the Act

Water body — Includes watercourses, riparian zones, floodplains, wetlands, estuaries, lakes and groundwater aquifers

Watercourse — A river, creek or other natural watercourse (whether modified or not) and includes: a dam or reservoir that collects water flowing in a watercourse; a lake through which water flows; a channel (but not a channel declared by regulation to be excluded from this definition) into which the water of a watercourse has been diverted; and part of a watercourse

Water-dependent ecosystems — Those parts of the environment, the species composition and natural ecological processes, that are determined by the permanent or temporary presence of flowing or standing water, above or below ground; the in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

Water licence — A licence granted under the Act entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area; this grants the licensee a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water; a water licence confers a property right on the holder of the licence and this right is separate from land title

Watershed — The land area that drains into a stream, river, lake, estuary, or coastal zone

Water-use year — The period between 1 July in any given calendar year and 30 June the following calendar year; also called a licensing year

WDE — Water dependent ecosystem

Well — (1) An opening in the ground excavated for the purpose of obtaining access to underground water. (2) An opening in the ground excavated for some other purpose but that gives access to underground water. (3) A natural opening in the ground that gives access to underground water

Wetlands — Defined by the Act as an area that comprises land that is permanently or periodically inundated with water (whether through a natural or artificial process) where the water may be static or flowing and may range from fresh water to saline water and where the inundation with water influences the biota or ecological processes (whether permanently or from time to time) and includes any other area designated as a wetland (a) by an NRM plan; or (b) by a Development Plan under the Development Act 1993, but does not include (c) a dam or reservoir that has been constructed by a person wholly or predominantly for the provision of water for primary production or human consumption; or (d) an area within an estuary or within any part of the sea; or (e) an area excluded from the ambit of this definition by the regulations

WMLR — Western Mount Lofty Ranges

WWTP — Wastewater Treatment Plant