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Sustainable Extraction Limits Derived from the Recharge Risk Assessment Method – Australian Capital Territory

CSIRO and SKM

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Description: Windmill pumping water from the River Murray near Purnong, SA. September 2007
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Abbreviations

ACT	Australian Capital Territory
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GS1*	Groundwater SDL area 1
GL	Gigalitre
km^2	kilometres squared
m	metres
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
mg/L	Milligrams per Litre
mm	Millimetres
N/A	Not Applicable
RRAM	Recharge Risk Assessment Method
SDL	Sustainable Diversion Limit
SF	Sustainability Factor
SKM	Sinclair Knight Merz
TDS	Total Dissolved Solids
WAVES	Water Atmosphere Vegetation Energy Soil

*The number at the end of the GS code is unique for each groundwater SDL area

Executive Summary

The Murray-Darling Basin Authority has responsibility for development of the Basin Plan for the Murray-Darling Basin (MDB) as specified under the *Water Act 2007*. The Basin Plan must include a number of mandatory conditions, including the development of a sustainable diversion limit (SDL) for the MDB's water resources. SDLs must encompass both surface water and groundwater. The SDL will limit the take of water for consumptive uses and is expressed as a volume.

The Recharge Risk Assessment Method (RRAM) was developed to derive preliminary SDLs to inform the Basin Plan development process.

The RRAM is based on the requirements of the *Water Act 2007* and the expectation that SDLs will reflect an environmentally sustainable level of take. According to the RRAM, the level of take must not compromise the following characteristics of the resource; key environmental assets, key ecosystem functions, the productive base and key environmental outcomes. In general terms, the RRAM is based on setting an extraction limit by applying a sustainability factor to groundwater recharge. For more information regarding the methodology, refer to CSIRO (2010).

For the ACT, the preliminary RRAM derived extraction limit was 7.5 GL/year and this was superseded by an extraction limit of 4.4 GL/year, with an allowance for trade offset up to the current Plan Limit of 7.25 GL/year.

1 Sustainable extraction limit derived from the RRAM – Australian Capital Territory (Groundwater)

1.1 Australian Capital Territory (Groundwater) (GS65)

This chapter describes the derivation of the preliminary estimated extraction limit resulting from the recharge risk assessment methodology (RRAM) for the Australian Capital Territory (ACT) SDL area.

1.1.1 Background

The Australian Capital Territory SDL area is located in the south eastern corner of the Murray-Darling Basin (MDB). The two main types of aquifer in the region are comprised of fractured rocks and alluvial sediments with low salinity groundwater in both. Groundwater use in the region is primarily drawn from the fractured rock aquifers. There is relatively little groundwater use (0.50 GL/year) in the SDL area (Table 1). For more information regarding the source of the entitlement and use information, refer to CSIRO (2010).

Table 1. Groundwater take summary for the ACT SDL area

ACT SDL area	GL/year*
Total current entitlement	**1.7**
Current metered use for entitlement bores	N/A
Current estimated use for entitlement bores	0.50
Current estimated use for stock & domestic bores	N/A
Total current use	**0.50**

*Entitlement and use volumes sourced from DECCEW (Peter Donnelly, pers. comm. 3/2/2010)

1.1.2 Salinity zoning

The ACT SDL area contains zone 1 salinity groundwater as shown in Figure 1 and summarised in Table 2.

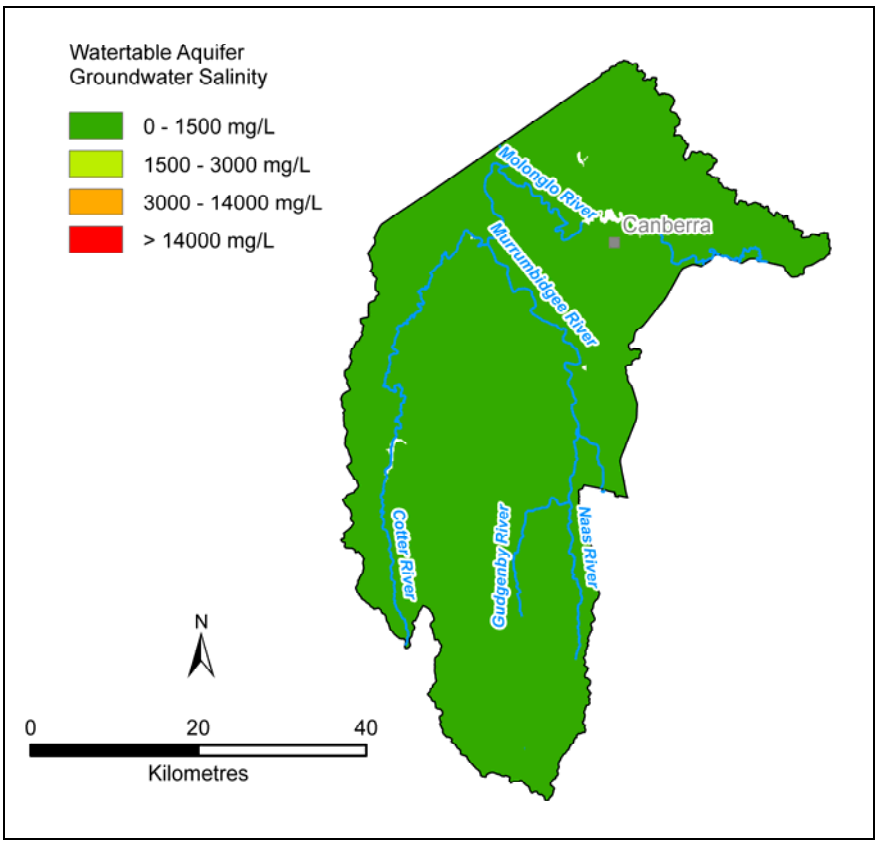

Figure 1. ACT watertable aquifer salinity distribution, from the shallow salinity layer of the MDBA Basin in a Box dataset (MDBA, 2000)

Table 2. Summary of salinity zones in the ACT SDL area

Watertable salinity zone	Portion of total area	Area
	percent	km^2
Zone 1 (0–1500 mg/L TDS)	100	2349
Zone 2 (1500–3000 mg/L TDS)	N/A	N/A
Zone 3 (3000–14,000 mg/L TDS)	N/A	N/A
Zone 4 (>14,000 mg/L TDS)	N/A	N/A
Water bodies	0	6
Total	**100**	**2355**

1.1.3 Key environmental assets

There have been no key environmental assets identified in the ACT SDL area that are groundwater dependent and sensitive to groundwater take and therefore the risk to the key environmental assets is low.

1.1.4 Key ecosystem function

The ACT SDL area contains three main rivers, the Molonglo, Cotter and the Murrumbidgee. The Molonglo flows from south to north and is regulated at Googong Reservoir and Lake Burley Griffin before joining the Murrumbidgee. The Cotter flows out of the highlands in the south-west of the ACT and is regulated at Corin, Bendora, and Cotter Dams before joining the Murrumbidgee. Meanwhile the Murrumbidgee is regulated at Tantangara Dam to the south-west of the ACT before it travels around the southern end of the State and flows from the southeast to the north-west. The higher order streams are unregulated and baseflow dominant with high connection to the fractured rock aquifer. Therefore there is a high risk of impact to key ecosystem function in the SDL area.

1.1.5 Productive base

Recharge

Dryland diffuse groundwater recharge derived from WAVES modelling (Crosbie et al., 2010) was used to calculate recharge to the alluvial and fractured rock aquifers. The dry climate scenario for a median 15-year period, results in a recharge rate of 49 mm/year, or 115 GL/year (Table 3).

Table 3. Recharge calculation

	Salinity zone 1	Salinity zone 2	Salinity zone 3	Salinity zone 4
Area (km2)	2349	N/A	N/A	N/A
Diffuse recharge (mm/yr)	49	N/A	N/A	N/A
Total recharge (GL/yr)	115	N/A	N/A	N/A

Storage

Water bearing fractures are not considered to extend beyond 100 m in the fractured rock aquifers in the ACT and therefore a saturated thickness of 100 m has been used for the purpose of the storage calculation. Specific yield values for fractured rock aquifers are generally low given that groundwater storage only occurs within discrete fractures and within shallow weathered zones. Since the majority of the SDL area consists of fractured rock aquifers, a value of 0.01. This value represents an attempt to account for the low storage of fractured rock aquifers and the higher storage of the shallow weathered zone of the fractured rock aquifers. Total storage of the fractured rock aquifer is 2349 GL (Table 4).

Table 4. Storage calculation

Parameter	Salinity zone 1	Salinity zone 2	Salinity zone 3	Salinity zone 4
Area (km^2)	2349	N/A	N/A	N/A
Saturated thickness (m)	100	N/A	N/A	N/A
Specific yield	0.01	N/A	N/A	N/A
Total storage (GL)	2349	N/A	N/A	N/A

Storage relative to recharge

The ratio of storage to recharge is 20. This indicates that there is a high risk of the productive base of the aquifer being jeopardised by factors such as climate change and the short-term over extraction of the groundwater source.

1.1.6 The risk matrix

Table 5 provides a summary of the risk ranking associated with: key environmental assets, key ecosystem function, the productive base, the key environmental outcome and the uncertainty inherent in the RRAM calculation. In summary:

- the SDL area is ranked low risk in terms of key environmental assets, as there are none identified as groundwater dependent in the ACT SDL area
- the SDL area is ranked high risk in terms of ecosystem function, given that the headwaters of each of the major rivers are unregulated and baseflow dominated
- the SDL area is ranked high risk in terms of the productive base, given that the storage/recharge ratio is not greater than 20
- there is no risk to the key environmental outcome (i.e. groundwater salinity)
- there is a high level of uncertainty given that the RRAM is derived from diffuse groundwater recharge derived from WAVES modelling only. It does not include other potential components of groundwater recharge, including river leakage, irrigation returns, throughflow etc.

Table 5. Risk matrix

Risk ranking	Environmental assets (EAs)	OR	Ecosystem function	OR	Productive base	Sustainability factor (SF)	Key environmental outcome	Degree of uncertainty
High	EA that is highly groundwater-dependent and highly sensitive to take		In the current state, groundwater discharge provides baseflow to the unregulated river reach. Groundwater extraction is likely to result in streamflow depletion		Storage/ recharge <20	0.10	Where there is no risk to the key environmental outcome (i.e. groundwater salinity) there is no reduction to the SF for any of the salinity classes Where there is a risk to the key environmental outcome, as a measure to reduce risk to groundwater quality, the following reductions are made: Salinity class 1: reduce SF by 20% Salinity class 2: reduce SF by 10% Salinity classes 3 & 4: no reduction	Where the uncertainty is low (e.g. good quality time series data, recharge well understood, metered extraction) there is no further reduction to the SF Where there is high uncertainty associated with the SDL (e.g. no numerical model available for comparison, uncertain hydrogeology, poor extraction data) the SF is further reduced by 50%
Medium	EA that is highly groundwater-dependent and is moderately sensitive to take EA that is moderately groundwater-dependent and is highly sensitive to take		The rivers in the SDL unit are regulated and they are highly connected to the groundwater system (i.e. >50% impact of pumping on streamflow within 50 years)		Storage/ recharge 20–40	0.50		
Low	EA that has a low groundwater dependence and low sensitivity to take EAs do not exist in the SDL unit		The rivers in the SDL unit are regulated or unregulated and they have low–moderate connection with the groundwater system (i.e. <50% impact of pumping on streamflow within 50 years)		Storage/ recharge >40	0.70		Where the uncertainty is low (e.g. good quality time series data, recharge well understood, metered extraction) there is no further reduction to the SF Where there is high uncertainty associated with the SDL (e.g. no numerical model available for comparison, uncertain hydrogeology, poor extraction data) the SF is further reduced by 25%

1.1.7 Preliminary RRAM extraction limit

The preliminary estimated extraction limit resulting from the RRAM for the ACT SDL area is 5.7 GL/yr (Table 6). This is greater than the volume of current use (0.50 GL/year). However, given the high level of groundwater and surface water connectivity, the groundwater extraction limit will be set at current use. Further development of the groundwater system is feasible up to the RRAM derived extraction limit of 5.7 GL/year, where an equivalent reduction in surface water is acquired to offset the additional groundwater take on the basis of a 1:1 relationship between groundwater take and surface water streamflow reduction.

This RRAM extraction limit has been superseded by an extraction limit of 4.4 GL/year, with an allowance for trade offset up to the current plan limit (i.e. 7.25 GL/year).

Table 6. Extraction limit summary

	Salinity zone 1	Salinity zone 2	Salinity zone 3	Salinity zone 4
Recharge (GL/yr)	115	0.0	0.0	0.0
Sustainability factor	0.05	NA	NA	NA
Extraction limit (GL/yr)	5.7	NA	NA	NA

References

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