

Technical information supporting the 2018 Groundwater (Water level and salinity) Trend and Condition Report Card

DEW Technical note 2018/09



Government of South Australia

Department for Environment
and Water

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Department for Environment and Water

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Summary

This document describes the indicators, data sources, analysis methods and results used to develop the *Groundwater (Water level and salinity)* report card for 2018. In this context, the reliability of data used in the report is also described.

1 Introduction

1.1 Groundwater levels and salinity

The Department for Environment and Water (DEW) is the lead agency for water resources management in South Australia. It has a responsibility to regularly report on the status of prescribed and other at-risk groundwater resources, such that DEW meets its statewide water surveillance responsibilities.

DEW uses the information gathered via water resources surveillance to deliver on DEW's Corporate Plan objectives of: (1) strategic planning and statewide policy for future water availability; (2) water resource planning; and (3) the delivery of water programs. Groundwater level and salinity data play a supporting role in many aspects of groundwater management, such as the preparation and review of water allocation plans, the production of Demand and Supply Statements and annual reporting obligations under the South Australian–Victorian Border Groundwaters Agreement. Groundwater management objectives are achieved, in part, through the assessment of groundwater levels and salinity, and the evaluation of actual extraction volumes compared to sustainable limits.

1.2 Environmental trend and condition reporting

The Minister for Environment and Water under the *Natural Resources Management Act 2004* is required 'to keep the state and condition of the natural resources of the State under review'. Environmental trend and condition report cards are produced as the primary means for the Minister to undertake this review. Previous environmental trend and condition report cards reported against the targets in the South Australian NRM plan (Government of South Australia 2012b) using the broad process outlined in the NRM State and Condition Reporting Framework (Government of South Australia 2012a).

As the State NRM plan is currently under review, environmental trend and condition report cards in early 2018 will instead inform the next South Australian State of the Environment Report (SOE) due in mid-2018. Again, there is a legislative driver to guide the development of SOE reporting. The *Environment Protection Act 1993*, which is the legislative driver to guide the development of SOE reporting, states that the SOE must:

- Include an assessment of the condition of the major environmental resources of South Australia 112(3(a))
- Include a specific assessment of the state of the River Murray, especially taking into account the Objectives for a Healthy River Murray under the *River Murray Act 2003* 112(3(ab))
- Identify significant trends in environmental quality based on an analysis of indicators of environmental quality 112(3(b))

Environmental trend and condition report cards will be used as the primary means to address these SOE requirements.

1.2.1 Environmental trend and condition report card continual improvement

Key documents guiding the content of South Australian environmental trend and condition report cards are:

- Trend and Condition Report Cards Summary Paper (DEWNR 2017)
- NRM State and Condition Reporting Framework (Government of South Australia 2012a)

Both of these documents reference a process of continual improvement in the way environmental trend and condition report cards are produced and communicated. A review based on key stakeholder feedback (O'Connor NRM 2015) indicated five key learnings (DEWNR 2017):

1. The trend and condition report cards are acknowledged as a useful communication tool. There is support for them to continue to be produced to highlight data gaps and reliability issues to a broad audience including: policy makers and investors; environmental managers; and the community
2. There are issues with data availability, access, consistency and transparency, which will need to be addressed and improved over time in future trend and condition report cards
3. The indicators or measures reported on were based on those outlined in the State NRM Plan. Not all of these are considered to be the most appropriate or relevant for those assets. These will be reviewed as part of the current State NRM Plan review and a set of agreed measures will be determined for future trend and condition report cards
4. Greater alignment of reporting relevant to project, regional, state, program and State of the Environment is seen as imperative
5. Better clarity is needed around target evaluation reporting, which should measure the impact or outcome of an investment at a project, regional, state or program scale. However the trend and condition reporting reflects the status of an environmental resource and its change based on impacts that affect its condition. In some cases, the same reporting can be used for both (e.g. soil erosion), and in others it cannot (e.g. threatened species).

As the process by which the environmental trend and condition report cards are produced evolves, there is an increased emphasis, in keeping with the Premier's digital by default declaration, on the use of open data and reproducibility. This is one key response to help address the second key learning outlined above. The report cards being produced to inform the 2018 State of the Environment Report are at varying stages along this route to open data and reproducibility.

2 Methods

2.1 Indicator

The indicators used in the *Groundwater: water level and salinity* report card are the five-year trend in groundwater levels and salinity.

2.2 Data sources

Groundwater level and salinity data are available at [Enviro Data SA](#).

Sustainable limits for the applicable groundwater resources were sourced from the relevant [Water Allocation Plans](#).

Allocation and extraction volumes were sourced from the State's Water Information and Licensing Management Application (WILMA).

2.3 Data collection

DEW is the lead agency for water monitoring in South Australia. DEW's Water Resources Monitoring team collects data from 3645 groundwater sites across the state (DEWNR, 2018). The dataset from this monitoring is augmented by data collected by other organisations and water users.

2.4 Analysis

2.4.1 Trend

To determine the trend in groundwater levels, data over the past five years were analysed. This approach is consistent with methods adopted by other government agencies, such as the Bureau of Meteorology (BoM, 2018). The definition of a 'stable' water level is based on tolerances, whereby a well's groundwater level can show a rising or declining trend, but measure within a certain margin (tolerance) and still be considered stable. These tolerances vary with aquifer type and the scale of the resource. This approach was taken to: (1) accommodate wells that show water levels with such low rates of water level rise or decline that they can be considered stable; and (2) account for very small errors (e.g. human or instrument error) that may occur in measurements of this kind, including water levels (where they are in the order of 1 to 2 cm).

The tolerances that have been chosen to demarcate a stable water level are based on the trend (i.e. the average rate of change) in water level over the past five years. For sedimentary systems—i.e. for both regional confined systems with large storages; and for moderately sized unconfined and semi-confined to confined aquifers—the tolerance chosen to delineate stable water levels is 0.02 m/y. Fractured rock aquifers have generally lower storages and are assigned a tolerance of ± 0.01 m/y while Eyre Peninsula's unconfined and thin freshwater lenses that are generally more vulnerable are assigned a tolerance of ± 0.004 m/y.

To determine the trend in groundwater salinity, data over the past five years were analysed. The status for each well is then determined, based on whether the trend in salinity is either decreasing, increasing or stable.

In a similar approach to that taken for groundwater levels, the definition of 'stable' salinity is based on tolerances, whereby a well's groundwater salinity can show an increasing or decreasing trend, but measure within a certain margin (tolerance) and still be considered stable.

The tolerance chosen to delineate stable salinity is $\pm 10\%$, measured over the past five years. A tolerance of $\pm 10\%$ was chosen to account for errors in measuring groundwater salinity (e.g. human or instrument error) and to compensate for possible errors due to:

- Timing of sample collection (i.e. seasonal differences such as winter versus summer)
- Inconsistencies in purging of wells before the salinity sample is collected
- Temperature effects
- Instruments calibration.

Table 2.1. Definition of trend classes

Trend	Description	Threshold*			
		Water level (SA) [#]	Water level (FRA) [#]	Water level (EP) [#]	Salinity (SA, FRA & EP) [#]
Getting better	The indicator is improving in status with good confidence	>0.02 m/y	>0.01 m/y	>0.004 m/y	<-10%
Stable	The indicator is neither improving or declining in status	± 0.02 m/y	± 0.01 m/y	± 0.004 m/y	$\pm 10\%$
Getting worse	The indicator is declining in status with good confidence	<-0.02 m/y	<-0.01 m/y	<-0.004 m/y	>10%
Unknown	Data are not available, or are not available at relevant temporal scales, to determine any trend in the status of this resource				
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above trend classes				

* Rate of change (m/y) or percentage change (%) over the past five years

[#] SA = sedimentary aquifer; FRA = fractured rock aquifer; EP = Eyre Peninsula's freshwater lenses

2.4.2 Condition

The reported condition of the prescribed groundwater resources in South Australia is based on the long-term trends in groundwater levels and salinity, in conjunction with metered water use compared to statewide allocation in the 2016–17 water-use year. The condition classifications used in DEW's Trend and Condition Report Cards are given in Table 2.2.

Table 2.2. Definition of condition classes

Condition	Condition definition
Very good	The natural resource is in a state that meets all environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for all processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought).
Good	The natural resource is in a state that meets most environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for only some processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought).
Fair	The natural resource is in a state that does not meet some environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from many processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought).
Poor	The natural resource is in a state that does not meet most environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from most processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought).
Unknown	Data are not available to determine the state of this natural resource, based on this indicator
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above condition classes

2.4.3 Reliability

Information is scored for reliability based on the average of subjective scores (1 [worst] to 5 [best]) given for information currency (Table 2.3), applicability (Table 2.4), level of spatial representation (Table 2.5) and accuracy (Table 2.6).

Table 2.3. Guides for applying information currency

Currency score	Criteria
1	Most recent information >10 years old
2	Most recent information up to 10 years old
3	Most recent information up to 7 years old
4	Most recent information up to 5 years old
5	Most recent information up to 3 years old

Table 2.4. Guides for applying information applicability

Applicability score	Criteria
1	Data are based on expert opinion of the measure
2	All data based on indirect indicators of the measure
3	Most data based on indirect indicators of the measure
4	Most data based on direct indicators of the measure
5	All data based on direct indicators of the measure

Table 2.5. Guides for applying spatial representation of information (sampling design)

Spatial score	Criteria
1	From an area that represents less than 5% the spatial distribution of the asset within the region/state or spatial representation unknown
2	From an area that represents less than 25% the spatial distribution of the asset within the region/state
3	From an area that represents less than half the spatial distribution of the asset within the region/state
4	From across the whole region/state (or whole distribution of asset within the region/state) using a sampling design that is not stratified
5	From across the whole region/state (or whole distribution of asset within the region/state) using a stratified sampling design

Table 2.6. Guides for applying accuracy information

Reliability	Criteria
1	Better than could be expected by chance
2	> 60% better than could be expected by chance
3	> 70 % better than could be expected by chance
4	> 80 % better than could be expected by chance
5	> 90 % better than could be expected by chance

3 Results

3.1 Trend

DEW completes Annual Water Status Reports which provide a summary of how groundwater levels and salinities for various aquifers within the state's prescribed regions have changed over the preceding five year period. The trend data used in the 2017 Annual Water Status Reports (DEW, 2018) provide a summary of the trends observed for the period 2013–17. The reports indicate the percentage of groundwater wells which observed a rise in groundwater level, a decline in groundwater level or a stable groundwater level over the five year period. Additionally the reports provide similar information for groundwater salinity, noting that in some regions there is not enough information available on salinity to provide trend data for this period. These data have been used to determine if a prescribed area should be characterised as having 'stable or rising water levels and/or decreasing salinity' or 'declining water levels and /or increasing salinity'. Table 3.1 outlines the Annual Water Status Report regions and sub regions where applicable, and indicates the percentage of wells in each area which show a rise, decline or stable trend in both groundwater level and salinity over the five year period. The percentage of wells that show either a rise in water level or stable levels have been summed together, similarly for salinity, the percentage of wells which show decreasing or stable salinity trends have been summed together.

Annual Water Report areas were then defined as having either:

- Rising or stable water levels and/or declining or stable salinity (blue)
- Declining water levels and/or increasing salinity (red)
- Declining water levels and decreasing or stable salinity, or rising or stable water levels and increasing salinity (grey)

The data available for the Annual Water Status Report regions were then combined to provide an overall trend for each prescribed area. In prescribed areas where more than two annual reporting regions exist, if the majority of regions demonstrated rising or stable water levels and/or decreasing salinity, the area was coloured blue. If the majority of regions within a prescribed area demonstrated declining water levels and/or increasing salinity then the area was coloured red. If a prescribed area consisted of only one Annual Water Report area which showed declining water levels and decreasing or stable salinity, or rising or stable water levels and increasing salinity the prescribed area was coloured red.

In prescribed areas consisting of two Annual Water Report areas whereby one area resulted in declining water levels and decreasing or stable salinity; or rising or stable water levels and increasing salinity (Lower Limestone Coast and Tatiara) expert opinion was sought to determine if the area should be coloured blue or red.

Table 3.1. Average rate of change over the period from 2013–17, based on Groundwater Status Reports (DEW, 2018)

NRM	Prescribed Area	Annual Water Report Region	Sub Region (if applicable)	Water Level				Salinity				Rising or stable water levels and/or decreasing or stable salinity	Declining water levels and/or increasing salinity	Declining water levels and decreasing or stable salinity, or rising or stable water levels and increasing salinity	Overall Trend for Prescribed Area	
				Rise	Decline	Stable	Rise + Stable	Increase	Decrease	Stable	Decrease + Stable					
EP	Southern Basins PWA	Uley South Lens		9%	91%	0%	9%	0%	0%	100%	100%				Red	
		Uley Vanilla Lens		7%	93%	0%	7%	14%	0%	86%	86%					
		Lincoln South Lenses		48%	24%	28%	76%	7%	7%	86%	93%					
		Coffin Bay A Lens		0%	100%	0%	0%	0%	0%	100%	100%					
	Musgrave PWA	Polda Lens		94%	3%	3%	97%	22%	19%	59%	78%				Blue	
		Bramfield Lens		86%	14%	0%	86%	0%	17%	83%	100%					
AMLR	Northern Adelaide Plains PWA	T1		100%	0%	0%	100%	4%	9%	87%	96%			Blue		
		T2		100%	0%	0%	100%	14%	0%	86%	86%					
		Kangaroo Flat region of the NAP PWA T2		50%	50%	0%	50%	67%	0%	33%	33%		Red			
	Central Adelaide Plains PWA	T1		97%	3%	0%	97%	0%	0%	100%	100%			Red		
	Barossa PWRA	Upper		34%	47%	19%	53%									
		Lower		48%	39%	13%	61%									
		Fractured Rock		42%	58%	0%	42%						Red			
	McLaren Vale PWA	Maslin Sands		39%	39%	22%	61%									Red
		Port Willunga Formation		18%	64%	18%	36%						Red			
		Fractured Rock		39%	55%	6%	45%						Red			
	WMLR PWRA	Permian Sand		90%	0%	10%	100%								Blue	
		Tertiary Limestone	Hindmarsh Tiers		100%	0%	0%	100%								
			Myponga		88%	0%	12%	100%								
Fractured Rock			68%	27%	5%	73%	12%	25%	63%	88%						
N&Y	Clare PWRA	Fractured Rock		87%	8%	5%	92%	33%	23%	44%	67%			Blue		
	Baroota PWRA	Quaternary		79%	14%	7%	86%	0%	0%	100%	100%					
SE	Lower Limestone Coast PWA	Unconfined	Coastal Plain, Donovans & Interdunal Flat		65%	15%	20%	85%	23%	15%	63%	78%		Blue		
			Highlands		21%	60%	19%	40%	0%	12%	88%	100%				
	Padthaway PWA	Unconfined	Range		33%	25%	42%	58%	0%	0%	100%	100%		Blue		
			Flats		54%	25%	21%	75%	16%	26%	58%	74%				
	Tintinara–Coonalpyn PWA	Unconfined			28%	50%	22%	50%	0%	0%	100%	100%		Red		
	Tatiara PWA	Unconfined	Highlands		4%	29%	67%	71%	0%	0%	100%	100%			Red	
Plains and low-lying areas				2%	94%	4%	6%	6%	11%	83%	94%					

Table 3.1. (Continued)

NRM	Prescribed Area	Annual Water Report Region	Sub Region (if applicable)	Water Level				Salinity				Rising or stable water levels and/or decreasing or stable salinity	Declining water levels and/or increasing salinity	Declining water levels and decreasing or stable salinity, or rising or stable water levels and increasing salinity	Overall Trend for Prescribed Area
				Rise	Decline	Stable	Rise + Stable	Increase	Decrease	Stable	Decrease + Stable				
SAMBD	Marne Saunders PWRA	Murray Group Limestone		93%	0%	7%	100%	37%	19%	44%	63%				
		Fractured Rock		82%	12%	0%	82%	14%	0%	86%	86%				
	Mallee PWA	Murray Group Limestone		57%	21.5%	21.5%	78.5%	3%	0%	97%	97%				
	Peake, Roby and Sherlock PWA	Confined aquifer		100%	0%	0%	100%	0%	0%	100%	100%				
	Angas-Bremer PWA	Murray Group Limestone		88%	0%	12%	100%	0%	20%	80%	100%				
	EMLR PWRA	Murray Group Limestone		100%	0%	0%	100%	25%	25%	50%	75%				
		Permian Sand	Finniss		80%	10%	10%	90%							
			Tookayerta		75%	12.5%	12.5%	87.5%							
	Fractured Rock		82%	18%	0%	82%	40%	0%	60%	60%					
SAAL	Far North PWA	GAB		69%	21%	10%	79%	0%	0%	100%	100%				

3.2 Condition

The condition of the majority of the prescribed groundwater resources in South Australia is good. This is based on: (1) the observed long-term trends in groundwater levels and salinity, and (2) that metered water use is below statewide allocation (Fig. 1). This provides the ability for most users to meet their needs now and into the future.

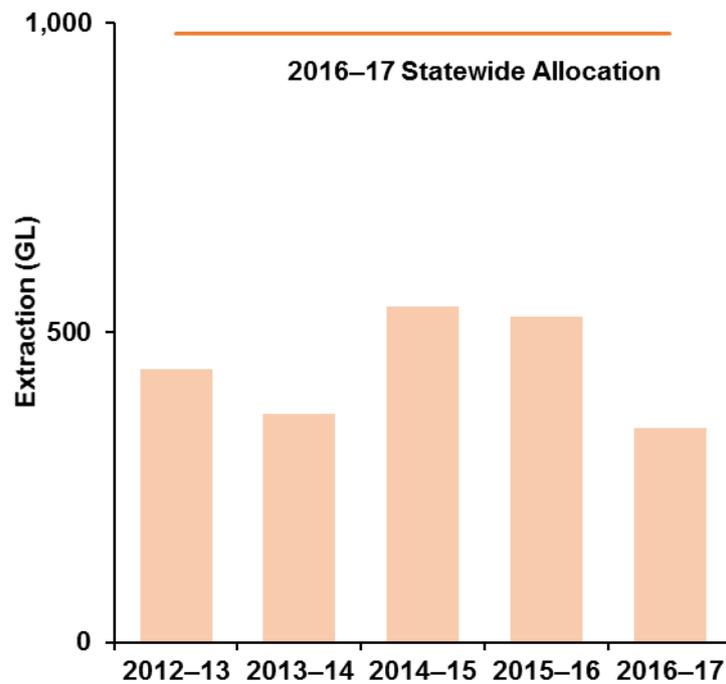


Figure 1. Metered groundwater extraction compared to statewide allocated volume in 2016-17

In some cases the volumes allocated and the sustainable limit are different. The sustainable limit is the volume of water which can be taken from the resource which is unlikely to cause any undesired impacts on the resource. In some cases the volumes allocated are much less than this and there is more water available in the region to be allocated, and in other areas the volumes allocated are higher because the determination of the sustainable limit was reviewed after the development of the water allocation plan and the licence roll out.

In determining the allocated volumes for the different prescribed areas, some water allocated for specific purposes (holding, rollover/carryover, recharge, frost and Special Production Requirement) was excluded as they are not relevant for this assessment

Note: some areas which are prescribed and have therefore have some metered use do not yet have licenced allocations and as such they are exempt from this assessment. Furthermore, whilst allocations exist for the Eastern and Western Mount Lofty Ranges, this information is not readily available in WILMA and as such has not been used in this assessment.

The summary of extraction and allocations for each prescribed area can be seen in Table 3.2.

Table 3.2. Metered extraction as a percentage of licenced allocation

NRM region	Prescribed area	Metered Extractions (ML)	Allocations (ML)	Extraction as a % of Allocation
		2016-2017	2016-2017	2016-2017
EP	Southern Basins PWA	5129	7249.9	71%
	Musgrave PWA	89	226	39%
AMLR	Kangaroo Flat region	N/A	N/A	N/A
	Northern Adelaide Plains PWA	9886	27278	36%
	Central Adelaide PWA	extractions not metered	N/A	N/A
	Barossa PWRA	2350	7867	30%
	McLaren Vale PWA	3009	6507	46%
	WMLR PWRA	N/A	N/A	N/A
N&Y	Clare PWRA	425	2120	20%
	Baroota PWRA	NA	N/A	N/A
SE	Lower Limestone Coast PWA	173147	582948	30%
	Padthaway PWA	22186	56021	40%
	Tintinara-Coonalpyn PWA	26405	80788	33%
	Tatiara PWA	73912	137932	54%
SAMBD	Marne-Saunders PWRA	1298	3942	33%
	Mallee PWA	26018	60851	43%
	Peake, Roby and Sherlock PWA	572	2211	26%
	Angas Bremer PWA	922	6534	14%
	EMLR PWRA	N/A	N/A	N/A
SAAL	Far North PWA	extractions not metered	N/A	N/A
Total across the State		345347	982478	35%

3.3 Reliability

The overall reliability score for this report card is **4.33**, based on Table 3.3. The methodology used to determine the reliability score is provided in section 2.4.3.

Table 3.3. Information reliability scores for groundwater

Indicator	Currency	Applicability	Spatial	Accuracy	Reliability
Groundwater levels and salinity	5	5	3	N/A*	4.33

*The accuracy indicator has not been assessed in this report.

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