SHALLOW GROUNDWATER TRENDS FOR THE WEST WIMMERA

September 2002

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ABSTRACT

Eight key bores within the West Wimmera Region were selected for the analysis of shallow groundwater trends, six managed by SKM, one by South Australia and one managed by CLPR. Regional groundwater monitoring information revealed that the majority of bores displayed water levels that respond to climatic variation. However, groundwater trends in the central part of the catchment did not display this reaction and have remained consistently flat throughout the monitoring record. Similarly, the Edenhope township groundwater trends do not reflect climatic change with water levels rising at a rate of 26 cm/yr. This steep trend may be a result of urban inputs to the watertable. Thus attention to land and water management issues is a high priority in order to prevent saline contamination of the town's water supply (Lake Wallace).

INTRODUCTION

The primary objective of this study is to develop and document an understanding of the shallow groundwater trends that have been recorded in the West Wimmera region. The investigation was undertaken by CLPR (Centre for Land Protection and Research) in support of the proposed West Wimmera Salinity Management Plan (SMP).

DESCRIPTION OF THE STUDY AREA

Location

The West Wimmera region is located in western Victoria. It is bounded by the South Australian border to the west, the Mallee Dryland Region to the north, the Wimmera River catchment to the east and the Glenelg River catchment to the south. Townships located within the region include Edenhope, Gymbowen, Kaniva and Telopea Downs (see Figure 1). The Little Desert National Park extends eastwards across the West Wimmera dividing the region into a northern and southern section. The southern section is characterised by NNW trending sand ridges between which north north-west trending drainage has developed. The northern part of the West Wimmera is predominantly composed of north north-westtrending sand ridges with limited drainage development and to the far north cleared dunefields similar to those of the Little Desert predominate.

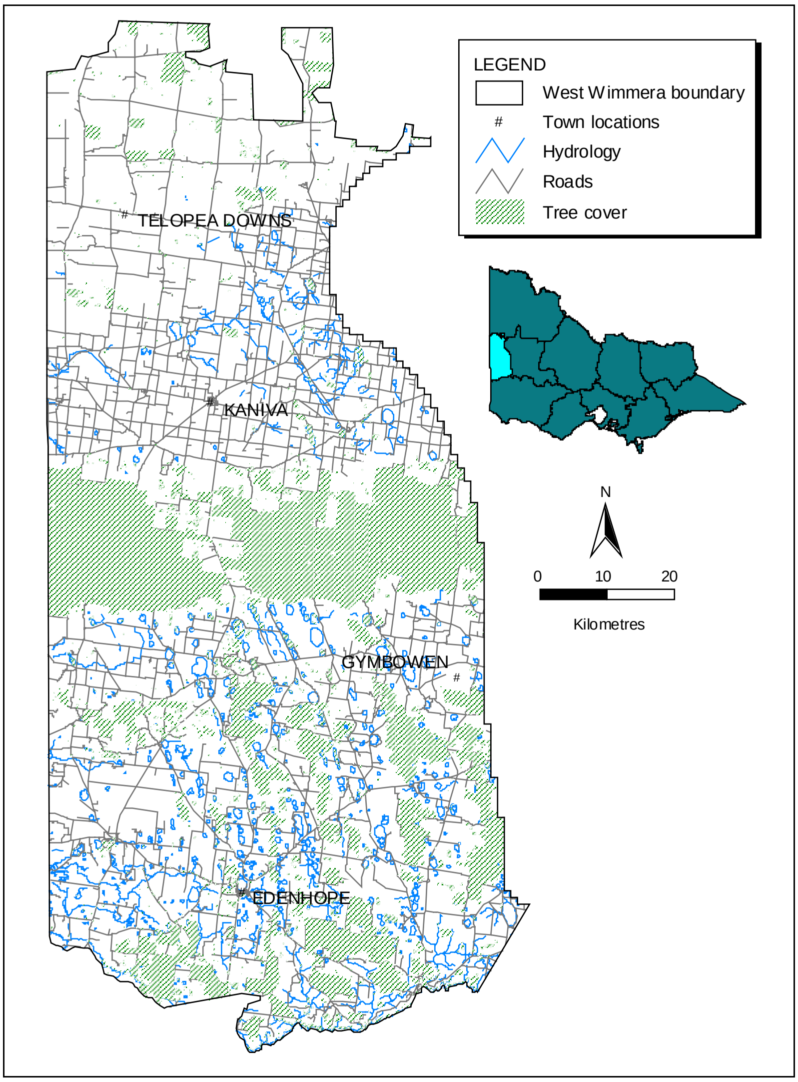

Figure 1 Location map of the West Wimmera

Climate

Significant climate variation occurs across the West Wimmera region. The southern part of the West Wimmera is typified by a Mediterranean type climate of hot summers and cool winters with rainfall predominantly confined to cooler months of the year. Areas further north (such as the Telopea Downs region) are characterised by summer dominant rainfall. For the majority of the year potential evaporation rates exceed rainfall. For this reason high intensity summer rainfall is the major source of effective rainfall in the north despite being generally short duration events.

Average annual rainfall varies between 590 mm in the southern region (recorded at the Edenhope monitoring station, no. 079011) and 390 mm in the north (Telopea monitoring station, no. 077093)

HYDROGEOLOGY

The West Wimmera region comprises part of the upper catchment of the Millicent Coast Basin. It is essential when undertaking a hydrogeological study to consider groundwater impacts at both a local scale and a catchment scale. Surface hydrology can be summarised as north west trending terminal lake chains and westerly flowing creek systems, the catchments of which flow over the South Australian border further into the Millicent Coast Basin (WCMA 2001).

Regional groundwater processes

Regional groundwater flow systems are systems that span a significant area (i.e. 50 km or more). These systems generally include at least one extensive groundwater aquifer. The three dominant regional aquifers in the West Wimmera are the Parilla Sand Aquifer, the Murray Group Limestone Aquifer and the Renmark Group Sand Aquifer. The saline Parilla Sand Aquifer is considered to be the main contributor to dryland salinity within the region (WCMA 2001). Aquitards (layers of low permeability strata) separate the three regional aquifers. The Bookpurnong Beds that underlie the Parilla Sand Aquifer effectively prevent saline contamination of the potable groundwater resource contained within the Murray Group Limestone Aquifer. This aquitard thins out towards the South Australian border, where the Murray Group Limestone Aquifer becomes the watertable aquifer (WCA 1999).

Local groundwater processes

Local groundwater flow systems are defined by areas where recharge and discharge occur in close proximity to one another (e.g. recharge occurring at the top of a hill and discharge occurring at the break-of-slope). Thus groundwater flow paths are short and the entire system generally spans less than 5 km.

Salinity caused by local groundwater processes can be observed in the West Wimmera. Perched watertables can develop as part of local aquifers, particularly in the wetter months of the year. This perching can lead to break-of-slope salinity such as that which occurs in the Telopea Downs region.

HYDROGRAPH INTERPRETATION

It is important when interpreting hydrograph data that climate trends are considered, as they can influence shallow groundwater trends. The impact of climate on groundwater trends can vary in significance and time of reaction and is mainly governed by the size and hydraulic connection of the groundwater system and the significance of the climatic change. Longer periods of dry or wet weather have a greater impact than one unusual year of rainfall, and local groundwater systems will generally respond more rapidly to variations in climate.

The location of a bore within a groundwater system is also an important factor in hydrograph interpretation. Bores that occur in recharge and discharge areas are likely to exhibit greater seasonal fluctuations and greater responses to longer term climatic trends compared to bores that occur between these areas. Evaporation effects are more prominent at discharge sites and can make fluctuations more dramatic. For this reason, estimations of recharge from hydrograph fluctuations were not conducted where groundwater levels were less than two metres from the ground surface.

Figures 2, 3 and 4 show rainfall variation across the West Wimmera at three rainfall stations. Residual rainfall (deviation from mean annual rainfall) indicates the years that were significantly dry or wet in comparison to the long-term average annual rainfall for each monitoring station. Cumulative rainfall indicates the accumulation of the residual rainfall, exemplifying the longer term trends in rainfall pattern. Some general rainfall characteristics can be observed. For example, all of the rainfall graphs commence with increasing rising trends due to consecutive above-average rainfall in the 1970s. In 1982 very low rainfall occurred, and since 1993 a distinct falling trend can be observed in response to the drier climate that currently exists. The current falling rainfall trend occurred much earlier in the Telopea Downs region (see Figure 4) and although the station monitoring lapsed at this site after 1992 it is anticipated that these falling trends are still apparent.

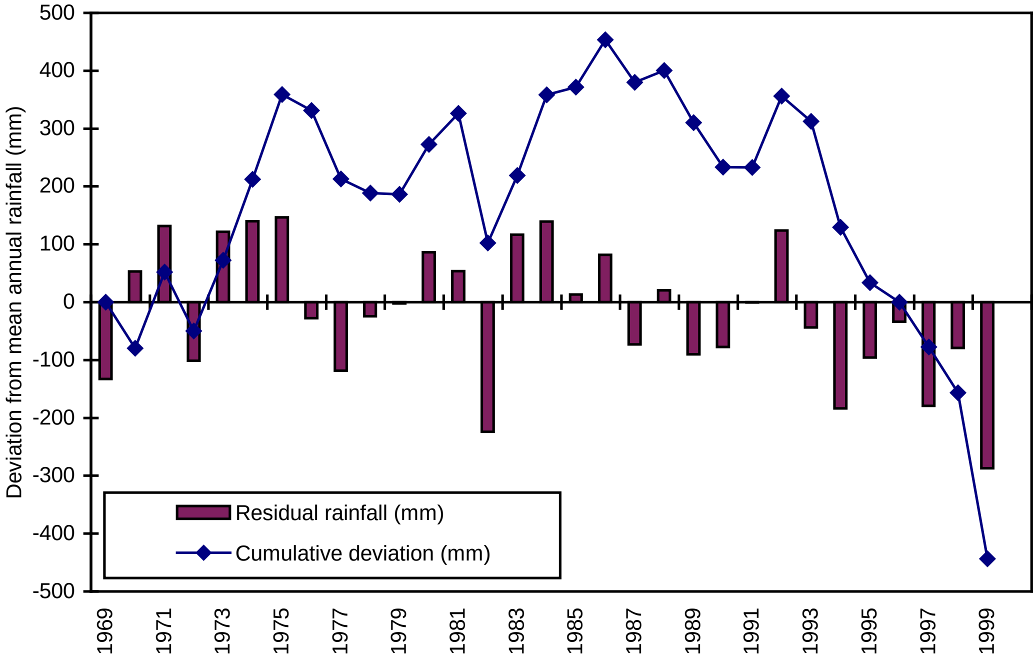

Figure 2
Yearly residual and cumulative rainfall for the Edenhope rainfall station (no. 079011, source: Bureau of Meterology and MetAccess 1998)

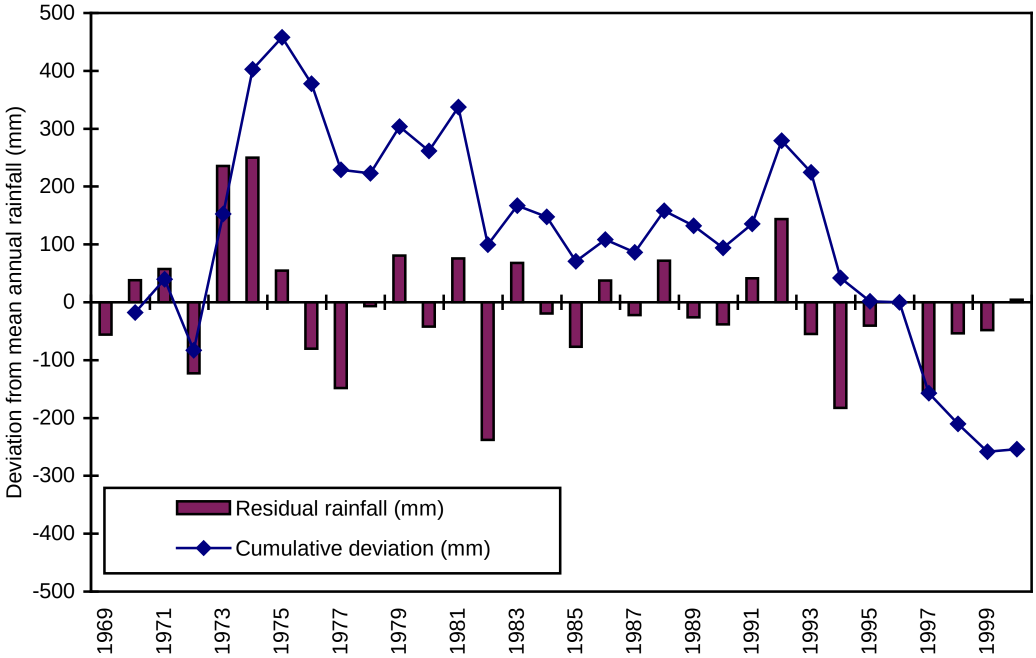

Figure 3
Yearly residual and cumulative rainfall for the Kaniva rainfall station (no. 078078, source: Bureau of Meterology and MetAccess 1998)

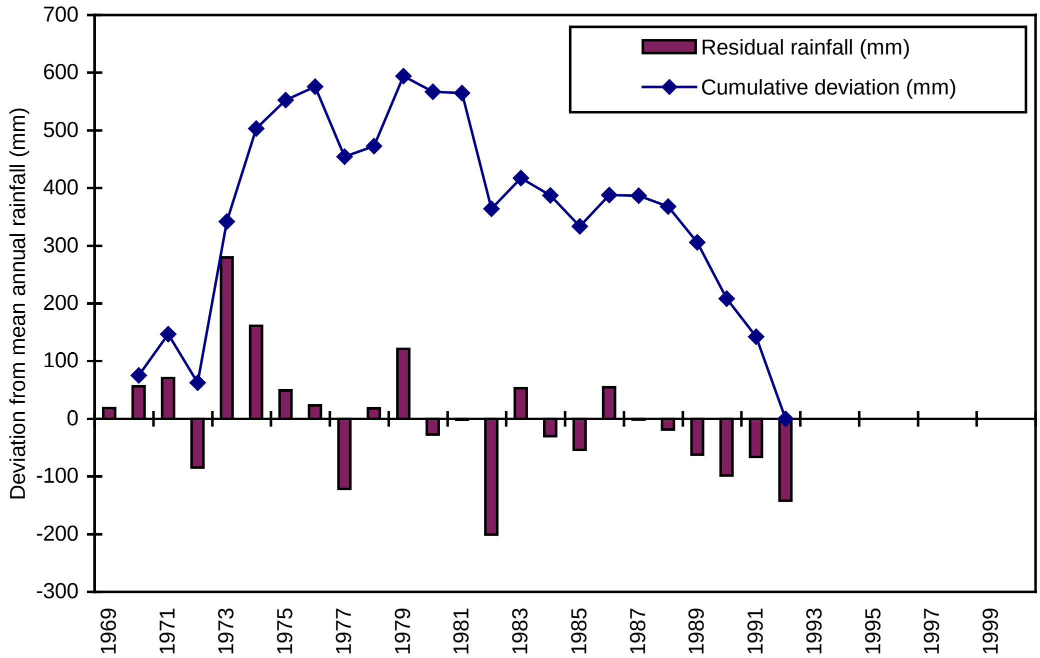

Figure 4 Yearly residual and cumulative rainfall for the Telopea Downs rainfall station (no. 077093, source: Bureau of Meterology and MetAccess 1998)

RECHARGE ESTIMATIONS

Recharge estimations from water level fluctuations for bores in the West Wimmera were calculated with the hydrograph method. The hydrograph method is defined by the following relationship:

$Pi = h \times Sy$ (derived from Todd 1980)

where

Pi = recharge (mm) (the portion of rainfall that reaches the watertable)

h = annual watertable height fluctuations

Sy = specific yield (the ratio defined by the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil)

A specific yield value of 0.21 has been suggested for sandstone (Domenico & Schwartz 1990) and hence the Parilla Sand Aquifer. In order to maintain consistency with past data and reports, this value of 0.21 will not be altered, although 0.15 is now considered to be a better estimate. A specific yield value of 0.14 is inferred for the Murray Group Limestone Aquifer based on the specific yield value suggested for limestone (Domenico & Schwartz 1990).

Recharge does not only occur from vertical movement of direct rainfall, through the soil profile and into the watertable. Lateral sub-surface movement of water and leakage from flooding can also have a major impact on the amplitude of seasonal watertable fluctuations (especially in low-lying areas). Estimated recharge should be considered as net recharge and not exclusively as direct recharge. Other environmental factors such as evapo-transpiration can also influence water level fluctuations.

Due to numerous assumptions required by this method, it is advised that these recharge estimates be considered in relative terms, and not as definitive figures that can be compared with values obtained from other methods of recharge estimation.

SHALLOW GROUNDWATER TRENDS

There are 33 bores that monitor the Parilla Sand Aquifer in the West Wimmera region. The eight bores selected for this report are considered to be representative of the observed groundwater trends in the West Wimmera region (see Appendix 1). In order to gain some idea of watertable trend and behaviour in the Millicent Coast Basin compared to the West Wimmera region, one bore (JOA13) was selected in South Australia. Figure 5 depicts the location of the key bores analysed for this report.

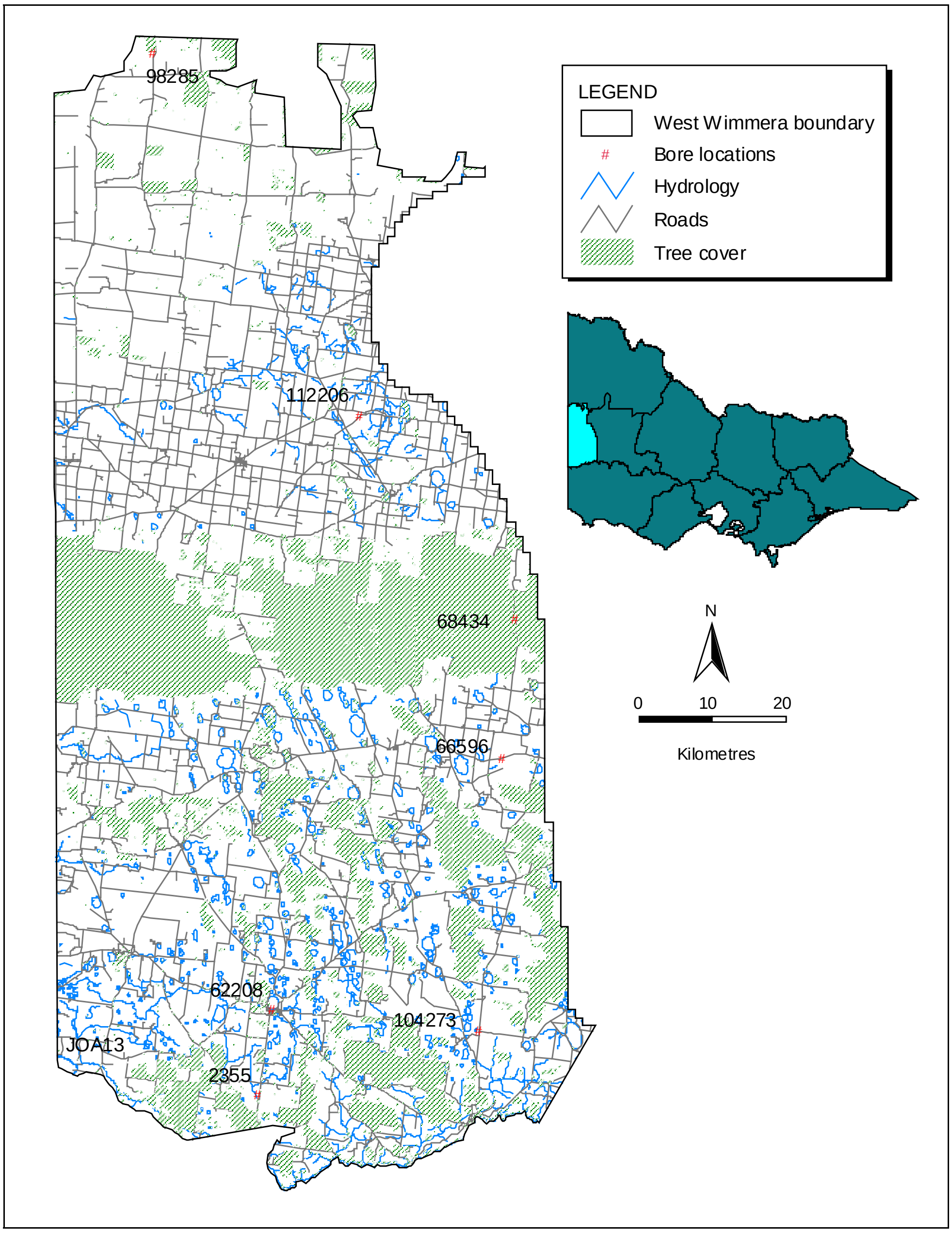

Figure 5 Key bore location map for the West Wimmera Region

Telopea Downs

The Telopea Downs region is characterised by undulating dunefields of fine sand (see Plate 1). Grazing is the predominant land use, although cropping has increased since the introduction of clay spreading in the area. The hydrograph of bore 98285 (Appendix 1) suggests a strong fall in watertable depth in the area since 1997. The sandy texture of the soils, combined with short-term high intensity rainfall events that prevail in the region, dominate groundwater recharge processes. For this reason rainfall trend is perceived as the overriding environmental indicator in the Telopea Downs region.

Plate 1 Undulating dunefields of fine sand form the typical landscape of the Telopea Downs region

Diapur

At Diapur, bore 112206 was not deep enough to intercept the watertable throughout parts of the monitoring record, particularly between early 1995 to late 1998. Thus few interpretations can be made. The most apparent feature of the time series data is a number of significant water level fluctuations of more than two metres. A groundwater trend is not able to be determined at this site due to a lack of adequate data.

The elevated landscape position of this monitoring bore is a key consideration in the presence of deep water levels at this site (see Plate 2). The Parilla Sand ridge that exists here is a dominant land feature of the region. Large annual fluctuations (with some time lag) suggest that this site is a high recharge area. Water level depth did not permit sampling for salinity, although salinities are expected be low due to fresh water influx by recharge at this location.

Plate 2 Bore 112206 (and associated bores of the nested site) occur on a dominant Parilla Sand ridge

Little Desert

Bore 68434 is located within the Little Desert National Park, surrounded by native vegetation (see Plate 3). The bore is positioned on a flat sand plain of the Lowan Sand dunefield that overlies the Parilla Sand Aquifer. A deep water level with a flat trend exists here although two anomalous fluctuations have been recorded during the 33 year record, a high in 1993/94 and a low in 1999. A low salinity of 1200 EC was recorded at this bore and a recharge value of approximately 19 mm/yr was estimated from the hydrograph data.

Plate 3 Bore 68434 is located within the Little Desert National Park

Gymbowen

The groundwater trend appears relatively flat at this site, with the exception of two significant peaks occurring during 1993/94 and 1996/97. It is anticipated that the first of these peaks is genuine but the second may be exaggerated or erroneous. Recharge at this site in an average year is estimated to be in the order of 15 mm/yr. Plate 4 shows that land use at this site is predominantly annual grazing with sparse native trees scattered throughout the landscape. Located near the eastern boundary of the West Wimmera, bore 66596 occurs on the upper slope of a sand ridge, characterised by a deep watertable of approximately 55 m and a low salinity of 1300 EC.

Plate 4 Annual grazing is the predominant land use in the vicinity of bore no. 66596

Wombelano

Bore 104273 displays relatively high groundwater levels (6.0-7.5 m) and a considerable salinity of 13 500 EC. This monitoring site occurs on a plain landscape used for grazing and annual cropping, proximal to the south-east boundary of the West Wimmera (Plate 5). An apparent falling groundwater trend of 3 cm/yr for the past 30 years has occurred since the installation of the piezometer. Annual water level fluctuations of generally less than 30 mm are interpreted as approximately 24 mm/yr of recharge occurring at the site.

Plate 5 Bore 104273 is located on a flat plain landscape surrounded by annual cropping and grazing land

Edenhope

Located adjacent to Lake Wallace (see Plate 6) bore 62208 shows groundwater levels have risen markedly (approximately 26 cm/yr) since the late 1980s. Groundwater levels are now at an elevation that intersects the base of Lake Wallace, thus suggesting a possible threat of salinity to the lake from saline groundwater intrusion. Salinity of the water in the aquifer at this site is considerably lower than the average in the area (800 EC), suggesting some interaction of water between the lake and the watertable. Groundwater levels prior to the late 1980s appear to be relatively stable, which does not correlate with climatic information nor localised environmental changes. Seasonal fluctuations are repetitive and regular. Recharge has not been estimated, as the influence of the lake on these fluctuations is unknown.

Plate 6 Bore 62208 occurs on the foreshore of Lake Wallace, Edenhope

South of Edenhope

Bore 2355 is located adjacent to the Mosquito Creek drainage line surrounded by annual grasses (see Plate 7). A tree planting site was established in the 1980s to combat salinity occurrence along the creek line. Water levels here are very shallow and have remained between 0 - 1 m throughout most of the monitoring record. The past two years have seen water levels fall to below 1 m which is likely to be a result of the prevailing drier climatic conditions.

Plate 7 The salt-affected Mosquito Creek drainage line which occurs proximal to bore 2355

Struan (South Australia)

Bore JOA13 records groundwater trends in the Murray Group Limestone Aquifer down-catchment of the West Wimmera region in the vicinity of Mosquito Creek. Relatively high groundwater levels exist here (7.0 - 8.5 m) and a stable salinity of 1750 EC (based upon more than 10 years monitoring). The 11 year record reveals that groundwater levels have been falling steadily (at 11 cm/yr) since the 1990s. Groundwater behaviour appears relatively subdued, however, the quarterly monitoring pattern may be obscuring full fluctuation of the water levels.

DISCUSSION

Climate correlation

In some parts of the West Wimmera region it is evident that climate variation has a major influence on shallow groundwater trends. Water level responses to the prevailing drier climate can be identified in bores 98285, 104273, JOA13 and 2355. At Struan (bore no. JOA13) the steepest decline in groundwater levels of 11 cm/yr has been recorded. This is a function of net loss of smaller falls in levels, such as at bore no. 2355, and other areas further up-catchment.

Bore 62208 located on the foreshore of Lake Wallace in Edenhope has been rising at an alarming rate of 26 cm/yr for the past 13 years. If this result can be verified, there are possible negative implications for Lake Wallace, Edenhope's potable water supply. This rising trend may be influenced by urban input into the groundwater system, combined with the lowered lake levels reducing the hydraulic confinement that is usually exerted on the watertable when the lake is full.

Bores 68434 and 66596 occur in the central area of the West Wimmera region and both have remained flat for the duration of the record. The flat responses of these bores suggest that lateral groundwater flow has been sufficient to maintain equilibrium despite the prevailing dry conditions.

Representativeness of the key bores

The limited number of bores monitoring the Parilla Sand Aquifer inhibits sound interpretations of groundwater processes. Local processes that may be contributing to water level responses cannot be identified as insufficient water level information exists in areas for trend comparisons to be made.

The analysis of drill log information at the Diapur site suggests that bore no. 112206 appears to measure water levels at the base of the Parilla Sand Aquifer. This may suggest that at this site the Parilla Sand Aquifer is not saturated at particular times of the year. Although this mean that bore 112206 is a poor example for groundwater trends, it does provide useful information about shallow groundwater aquifer systems in the West Wimmera.

Recharge estimates

Recharge rates estimated for key bores reveal that the watertable receives between 15 - 24 mm/yr. Determination of areas with potentially higher recharge rates within the region is limited due to the lack of groundwater monitoring bores distributed in differing parts of the landscape. Mintern and Hocking (2001) suggested that recharge is more significant below the break-of-slope, although lateral groundwater flow from adjacent areas may also need to be minimised if recharge rates are to be reduced.

CONCLUSIONS

Groundwater information for the West Wimmera region suggests that a number of factors influence water level trends. In the northern and southern parts of the region groundwater trends appear to correlate with climate to various orders. In the central part of the West Wimmera, groundwater levels are flat and probably receive a greater lateral flow than direct recharge. Land management and urban influences may have an impact on groundwater level in the vicinity of Edenhope, with groundwater level rising at 26 cm/yr (bore 62208), the highest recorded for the region.

RECOMMENDATIONS

To assist in the understanding of groundwater processes in the West Wimmera, the following recommendations are made:

- Construction of more groundwater monitoring bores to widen the distribution of data and strengthen present knowledge (in progress).

- A detailed study of the Lake Wallace catchment (Edenhope) to gain further knowledge of the impacts of current land use and possible urban influences on rising groundwater levels.

- Construction of a production bore in the Telopea Downs region for aquifer pump testing to determine aquifer parameters in this northern part of the region (commencing).

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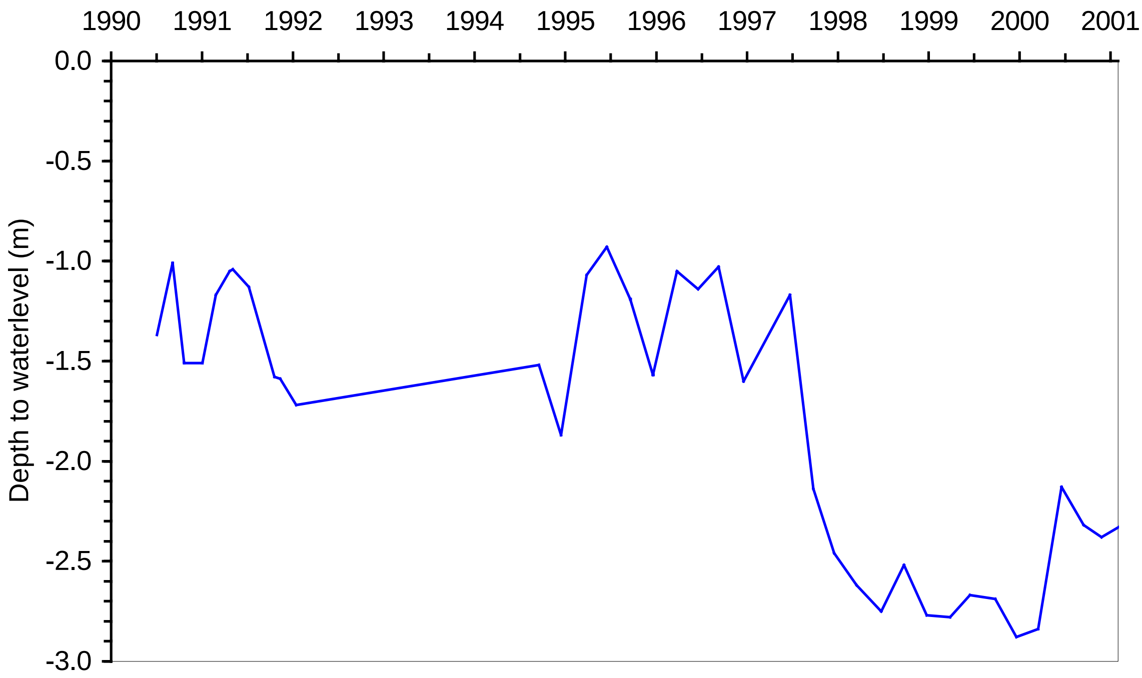
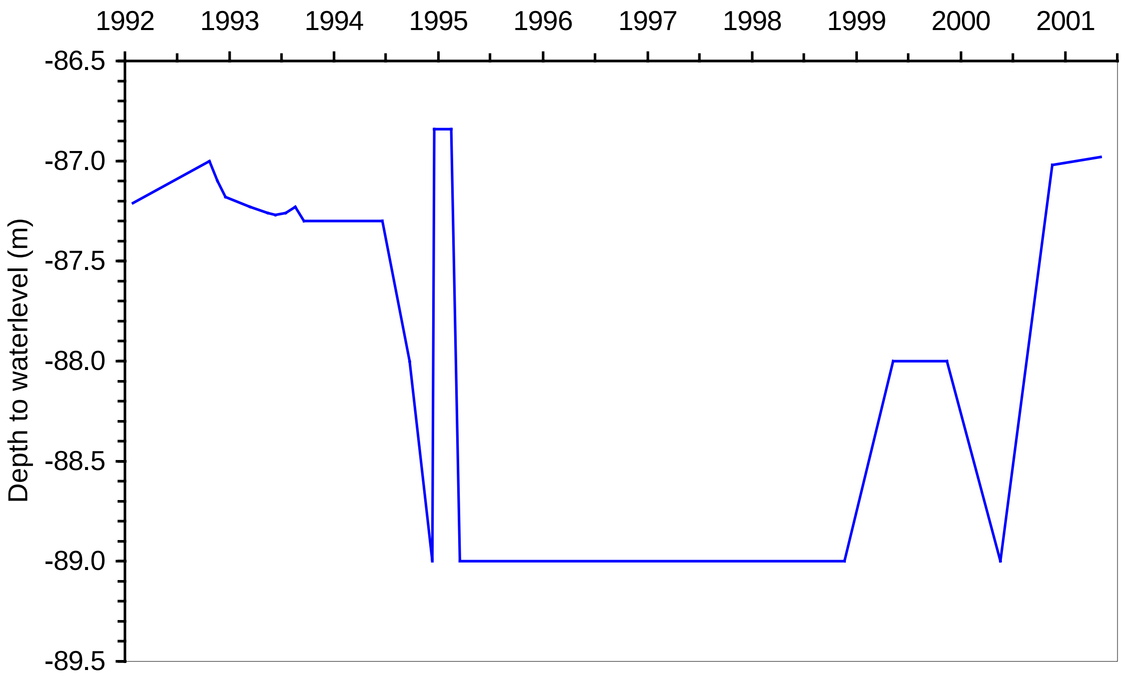
APPENDIX 1 HYDROGRAPH AND BORE SITE INFORMATION

TELOPEA DOWNS



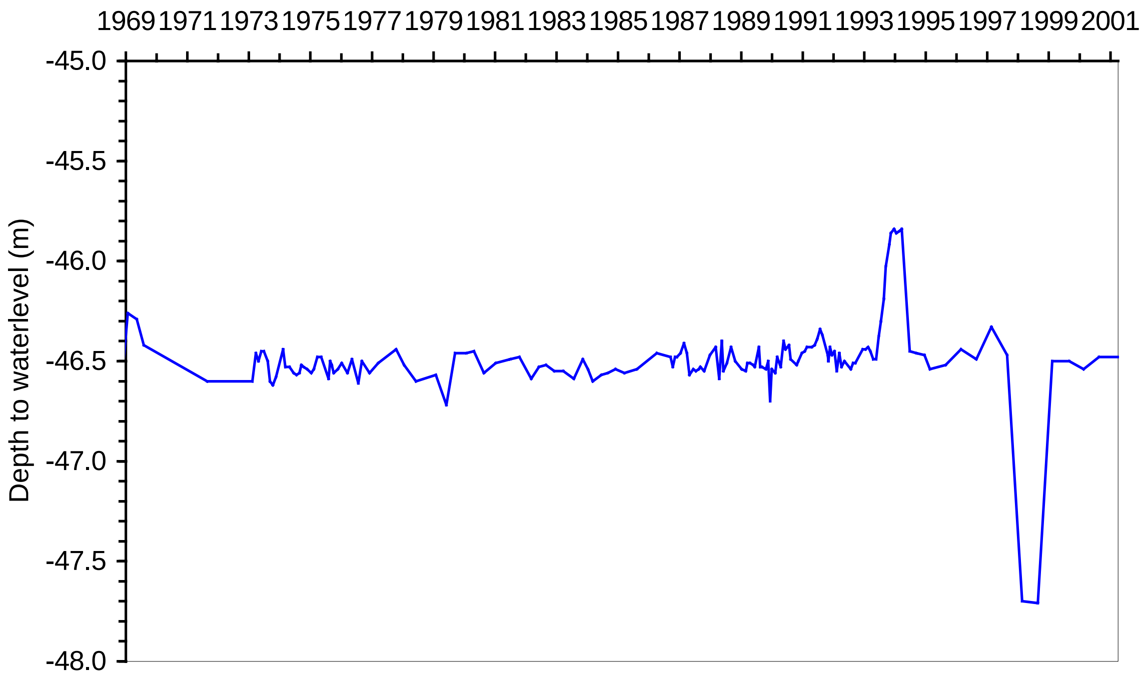
BORE NO.	98285	LOCAL NO.	
LOCALITY DESCRIPTION	North of Arthurs Road, along Chappel Road		
LAND COVER	Grazing with some annual/biannual cropping		
BORE DEPTH (m)	14.2	LANDSCAPE POSITION	Undulating sand rises
AQUIFER DESCRIPTION	Parilla Sand/Shepparton Formation, sandy clays		
AVERAGE ANNUAL RAINFALL (mm/yr)	390	RAINFALL STATION	Telopea Downs No. 078078
DEPTH TO WATER OCT 2001 (mbGL)	2.32	SALINITY (EC)	5900
GROUNDWATER TREND	Overall fall in watertable since 1990, particularly from 1997 to 1998.		

Diapur



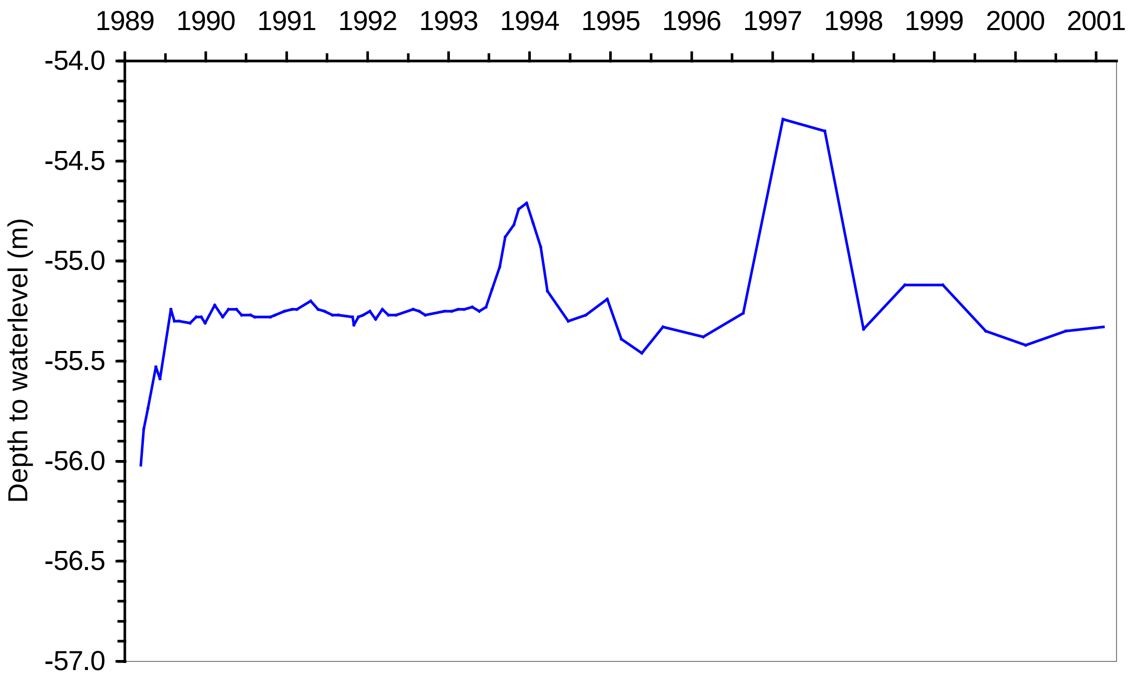
BORE NO.	112206	LOCAL NO.	3554
LOCALITY DESCRIPTION	Intersection of Nhill-Diapur Road and Honeymans Road (near railway crossing		
LAND COVER	Annual cropping		
BORE DEPTH (m)	89	LANDSCAPE POSITION	Hill
AQUIFER DESCRIPTION	Parilla Sand aquifer: fine-medium sand		
AVERAGE ANNUAL RAINFALL (mm/yr)	417	RAINFALL STATION	Nhill (Composite) no. 078031
DEPTH TO WATER OCT 2001 (mbGL)	87.02	SALINITY (EC)	Unknown
GROUNDWATER TREND	Stable around 87-89 metres		

Little Desert



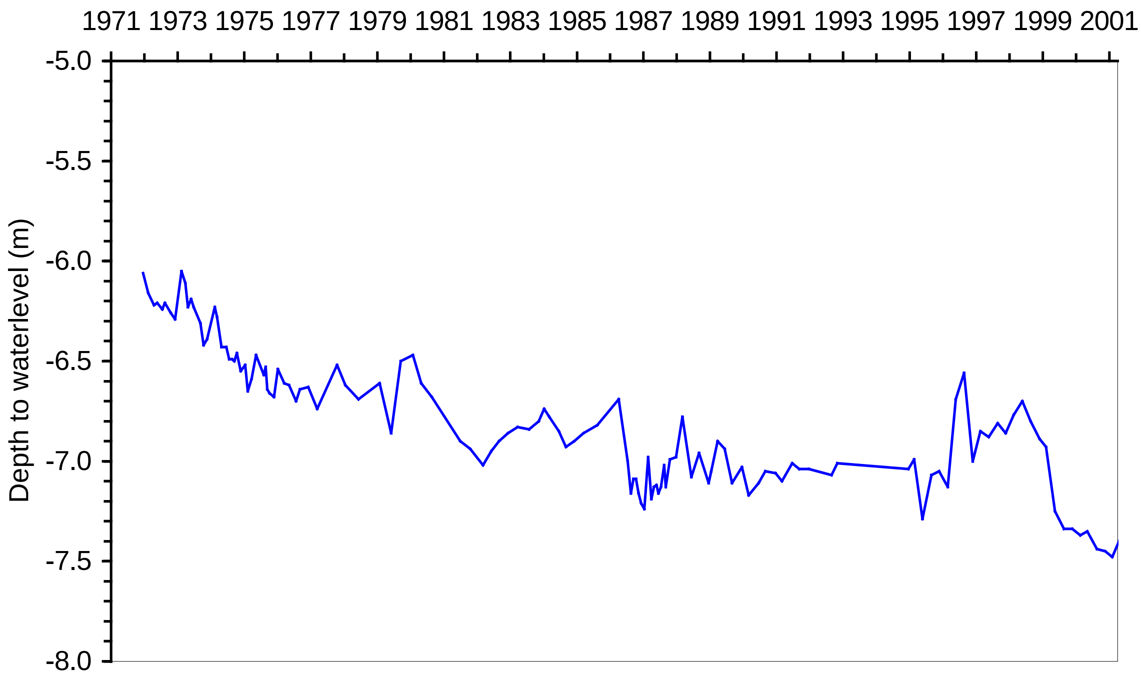
BORE NO.	68434	LOCAL NO.	
LOCALITY DESCRIPTION	Roadside		
LAND COVER	Native vegetation (Mallee scrub)		
BORE DEPTH (m)	57	LANDSCAPE POSITION	Flat sand plain
AQUIFER DESCRIPTION	Parilla Sand aquifer: orange medium grained sands		
AVERAGE ANNUAL RAINFALL (mm/yr)	518	RAINFALL STATION	Goroke Post Office no. 079017
DEPTH TO WATER OCT 2001 (mbGL)	46.48	SALINITY (EC)	1200
GROUNDWATER TREND	Flat. Fluctuation in late 1993 could perhaps be due to impact of high rainfall event at that time.		

Gymbowen



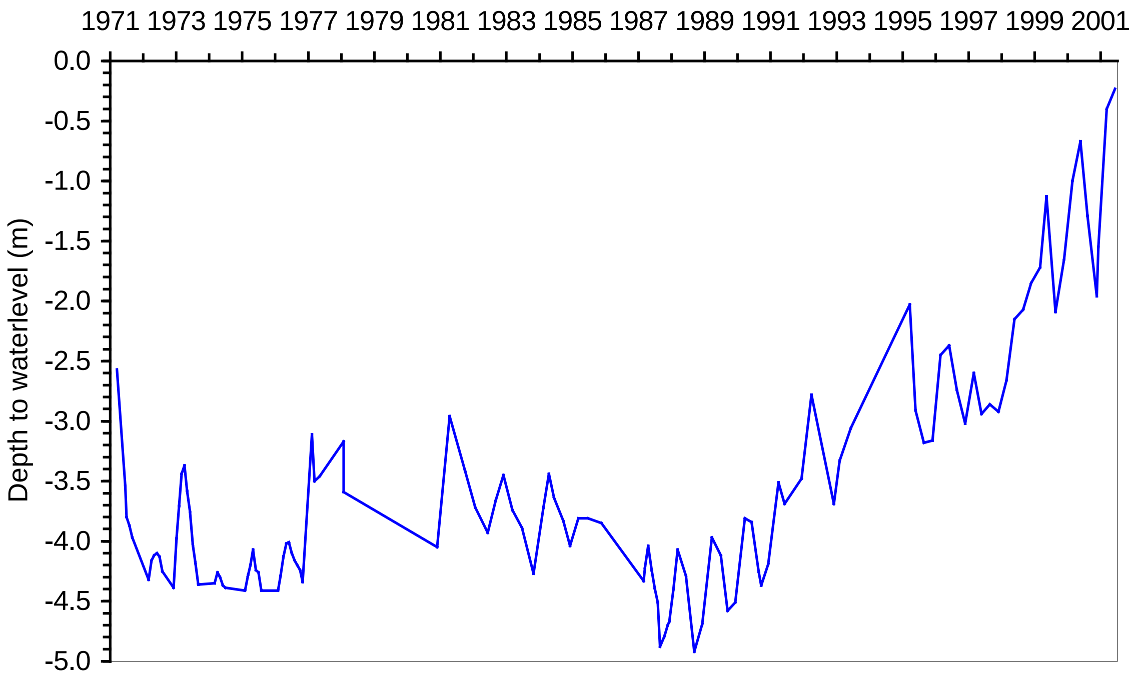
BORE NO.	66596	LOCAL NO.	
LOCALITY DESCRIPTION	Roadside, 4 km east of Gymbowen		
LAND COVER	Annual pastures		
BORE DEPTH (m)	63	LANDSCAPE POSITION	Upper slope of sand ridge
AQUIFER DESCRIPTION	Parilla Sand aquifer: orange medium grained sands		
AVERAGE ANNUAL RAINFALL (mm/yr)	518	RAINFALL STATION	Goroke Post Office no. 079017
DEPTH TO WATER OCT 2001 (mbGL)		SALINITY (EC)	1300
GROUNDWATER TREND	Flat		

Wombelano



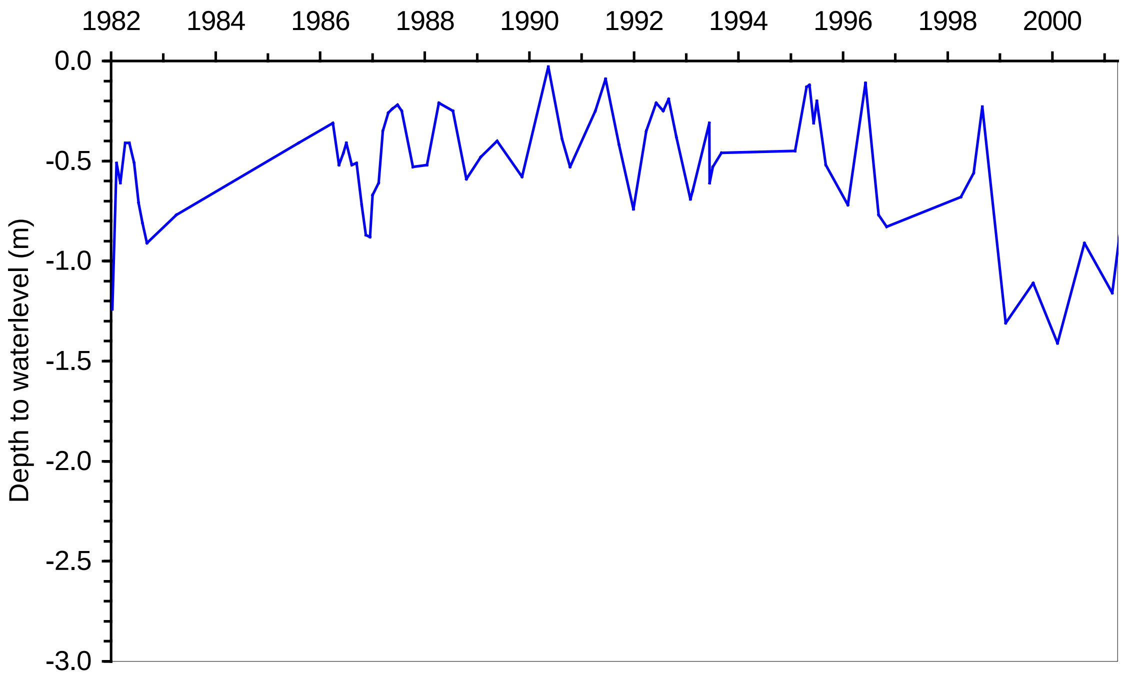
BORE NO.	104273	LOCAL NO.	
LOCALITY DESCRIPTION	Corner of Harrow-Horsham Road and Mullagh-Kanagulk Road		
LAND COVER	Annual cropping and pastures		
BORE DEPTH (m)	50	LANDSCAPE POSITION	Plain
AQUIFER DESCRIPTION	Parilla Sand aquifer: medium sand		
AVERAGE ANNUAL RAINFALL (mm/yr)	586	RAINFALL STATION	Harrow Post Office no. 079021
DEPTH TO WATER OCT 2001 (mbGL)	7.5	SALINITY (EC)	13 500
GROUNDWATER TREND	Falling by 3 cm/yr		

Edenhope



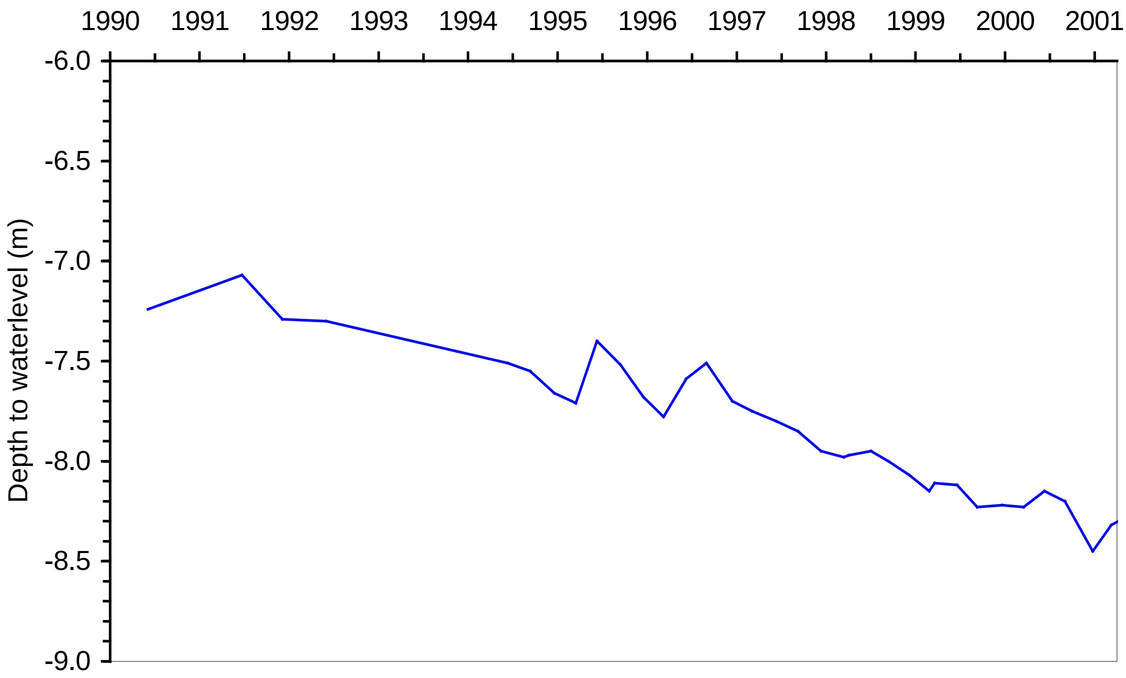
BORE NO.	62208	LOCAL NO.	
LOCALITY DESCRIPTION	Lake Wallace, southern foreshore		
LAND COVER	Annual grass and sporadic tree cover		
BORE DEPTH (m)	9.44	LANDSCAPE POSITION	Lake front
AQUIFER DESCRIPTION	Parilla Sand aquifer		
AVERAGE ANNUAL RAINFALL (mm/yr)	590	RAINFALL STATION	Edenhope Post Office no. 079011
DEPTH TO WATER OCT 2001 (mbGL)	1.5	SALINITY (EC)	800
GROUNDWATER TREND	Rising since 1989 by 26 cm/yr		

South of Edenhope



BORE NO.	2355	LOCAL NO.	4D
LOCALITY DESCRIPTION	Mosquito Creek, south of Edenhope		
LAND COVER	Annual pastures		
BORE DEPTH (m)	20	LANDSCAPE POSITION	Adjacent to drainage line
AQUIFER DESCRIPTION	Parilla Sand aquifer: orange medium grained sands		
AVERAGE ANNUAL RAINFALL (mm/yr)	590	RAINFALL STATION	Edenhope Post Office no. 079011
DEPTH TO WATER OCT 2001 (mbGL)	0.63	SALINITY (EC)	5484
GROUNDWATER TREND	Dropping since 1997 by 12.5 cm/yr		

Struan (South Australia)



BORE NO.	JAO13	LOCAL NO.	
LOCALITY DESCRIPTION	Roadside		
LAND COVER	Annual pasture		
BORE DEPTH (m)	60	LANDSCAPE POSITION	Plain
AQUIFER DESCRIPTION	Murray Group Limestone; pale grey to yellow fossiliferous limestone		
AVERAGE ANNUAL RAINFALL (mm/yr)	600	RAINFALL STATION	Struan
DEPTH TO WATER OCT 2001 (mbGL)	8.26	SALINITY (EC)	1750
GROUNDWATER TREND	Dropping since 1990 by 11 cm/yr		