A REVIEW OF THE VEGETATION PLANTING TRIAL ON A SALINE DISCHARGE ZONE AT FARRELL FLAT (1985 – 1999)

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PRIMARY INDUSTRIES AND RESOURCES SA

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Water Management Section
PIRSA RURAL SOLUTIONS

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Introduction

In 1985, with the support of funds from the NSCP and the State Government a program of small demonstrations and trials on selected saline seepage areas was initiated by staff of the then Department of Agriculture.
The general aim of the demonstrations was to achieve some amelioration of unsightly and unproductive salinised areas in the arable non irrigated regions of the State.

Several of the individual projects have been reported earlier as final reports to the NSCP by the regional officers supervising the projects (Harding 1989; Fleer 1992; Hughes 1986).

The original aims of the demonstrations were :-

1 To confirm the suitability of a range of trees and shrubs for planting on saline zones in order to :-

> **1.1** To improve the aesthetic appearance of such areas.
>
> **1.2** To assess the effect on the groundwater due to increased evapotranspiration by a dense planting of salt tolerant vegetation.
>
> **1.3** To increase the productivity of seepage areas with salt tolerant species for forage or timber.

2 To test the efficiency of drains for lowering groundwater tables.

3 To test the efficiency of drains for reducing waterlogging.

A feature of the Farrell Flat site on section 422 , Hundred of Hanson, is the continuous record of 15 years of water table monitoring under a plantation; - possibly the longest such record by PIRSA. This is a significant result to be heeded by anyone planning to plant on dryland saline sites.

The Farrell Flat Site

The main purpose of this site was to test the effect of a small area of dense vegetation on the underlying shallow water table. This was prompted by earlier work, (Morris and Thomson, 1983), who suggested that a depression in the groundwater level under a plantation might be obtained on soils of low hydraulic conductivity.

The site is characteristic of many in the Lower and Mid North regions of the State where the salinised areas appear to have stabilised some time ago compared with sites still active on Eyre Peninsula where the land was cleared after 1950. The site might be characterised topographically as a "break in slope" site and is in a transition between an upper 3% slope and a lower 1% slope which flanks Farrell Creek. In 1985 the discharge zone consisted of bare areas eroded of top soil, interspersed with

samphire and clumps of sea barley grass. The plantation was established on the eastern edge of the degraded area.
The soil type at the plot is a deep red brown earth overlying fractured shale at greater than 6m below ground level.
The long term average annual rainfall at Farrell Flat village 3km distant is 477mm.
The plot consists of 2.5ha of a mixed planting carried out in 1985 of trees and shrubs at 3m row spacings. The plantation is now dominated by the trees.

Figure 1 shows the location of the site, just east of the Farrell Flat - Booborowie Road, and 1km east of the Farrell Creek.

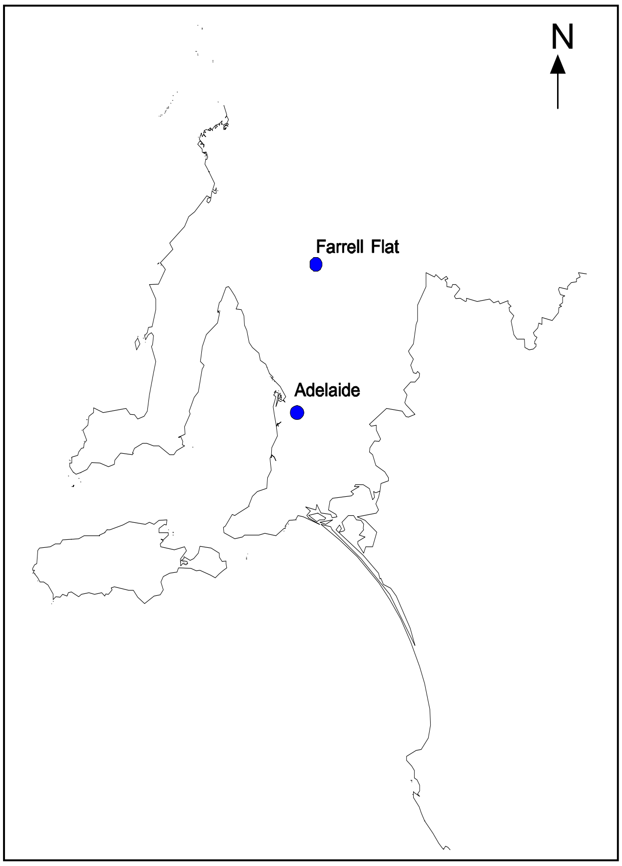

Fig 1: Location of study site

Figure 2 shows the general layout of the plot including topography and the location of wells for monitoring the water table.

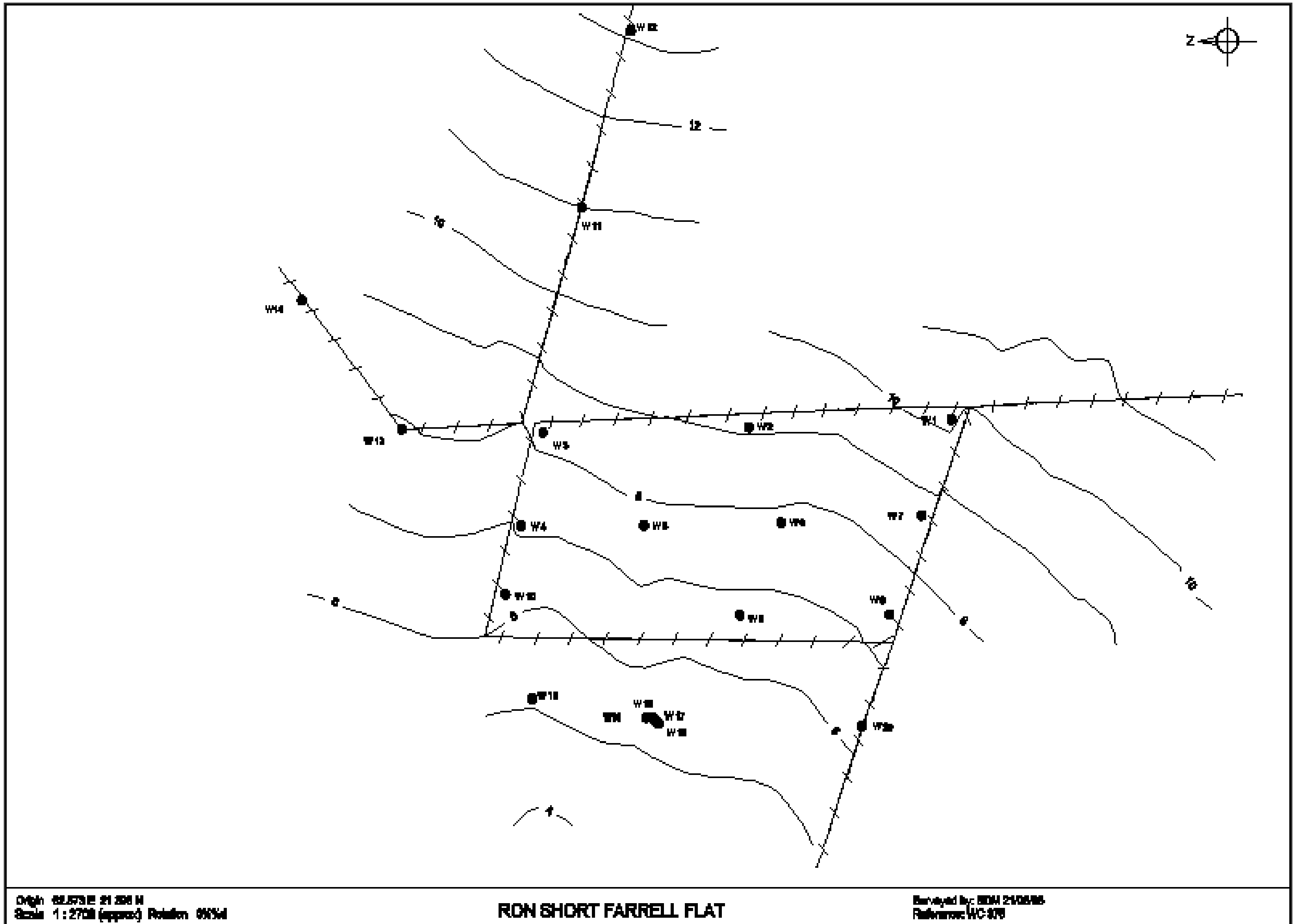

Fig 2: location of test wells

Results

The water table under the trees varies from a winter high average of 0.7m below ground level to a summer low average of 1.4m. The salinity of the ground water under the trees varies spatially from 5000 ECw.to 12000 ECw. Since 1985 the salinity has not significantly altered.

The Data collected

Table 1 shows some ECe values of the top 10cm of soil collected in March 1990. Appendix B contains the graphical record of the watertable fluctuations which occurred from 1985 to 1998. It can be seen from the graphs that within the revegetated area, well no. 6 had water levels closest to the surface. The trees originally planted adjacent to No. 6 died and this area is now colonized by M. halmaturorum.
Table 2 in the appendix shows the yearly rainfall record for the same period. Appendix A contains photographs taken in 1989/90 and again in 1999 which compare the growth of vegetation at the site after a ten year period.

Discussion

Groundwater
The 15 years of records show no trends in the static water level which could be attributed to increased soil moisture consumption by the plantation.
There appears to be a seasonal fluctuation on average of about 1.0 to 1.4 m in the water table. In the winters the levels returned to a constant level, generally followed by a gradual retreat in summer to a lower constant level. The groundwater surface appears to be a reflection of the topographic surface. This effect is apparent in the two sets of transects taken 9 years apart in figures 3 and 4.
The groundwater level also appears to respond directly to rainfall. This was clearly demonstrated in 1992 and 1996, an exceptionally wet year and a wet winter respectively.

The tree plantation (2.5 ha) represents a small fraction of the total area of the local ground water system. Research carried out in W.A. suggests that 20 – 50% of a catchment area should be afforested if significant reductions in water table levels are to be obtained. (Water Authority of W.A. 1989).

The Farrell Flat project suggests that in order to have a significant effect on ground water levels the planted area must comprise a significant proportion of the basin involved.

Any catchment planning aiming to reduce ground water levels should be mindful of these facts. In this catchment and other catchments, an estimate of the size of the groundwater system would be needed in order to design a plantation with the potential to influence ground water levels. A very real commitment to planting is required to have any effect on water tables.

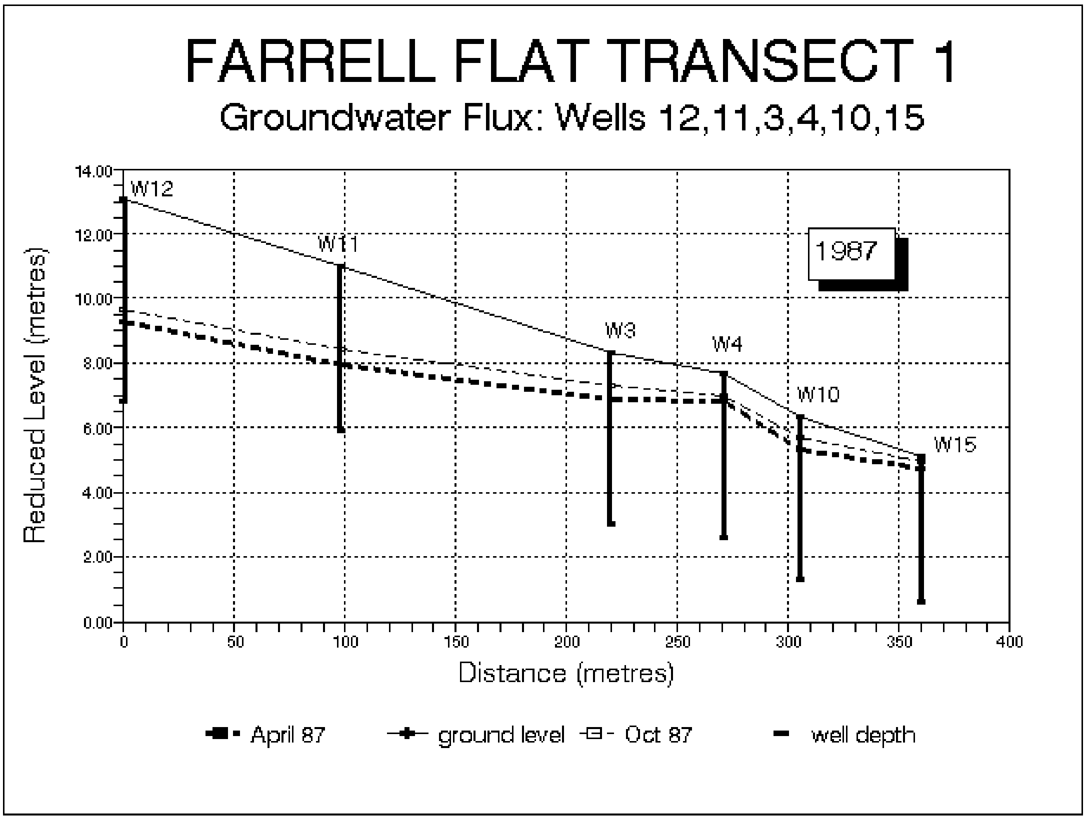

Fig 3: Groundwater fluctuation   Transect 1 (1987)

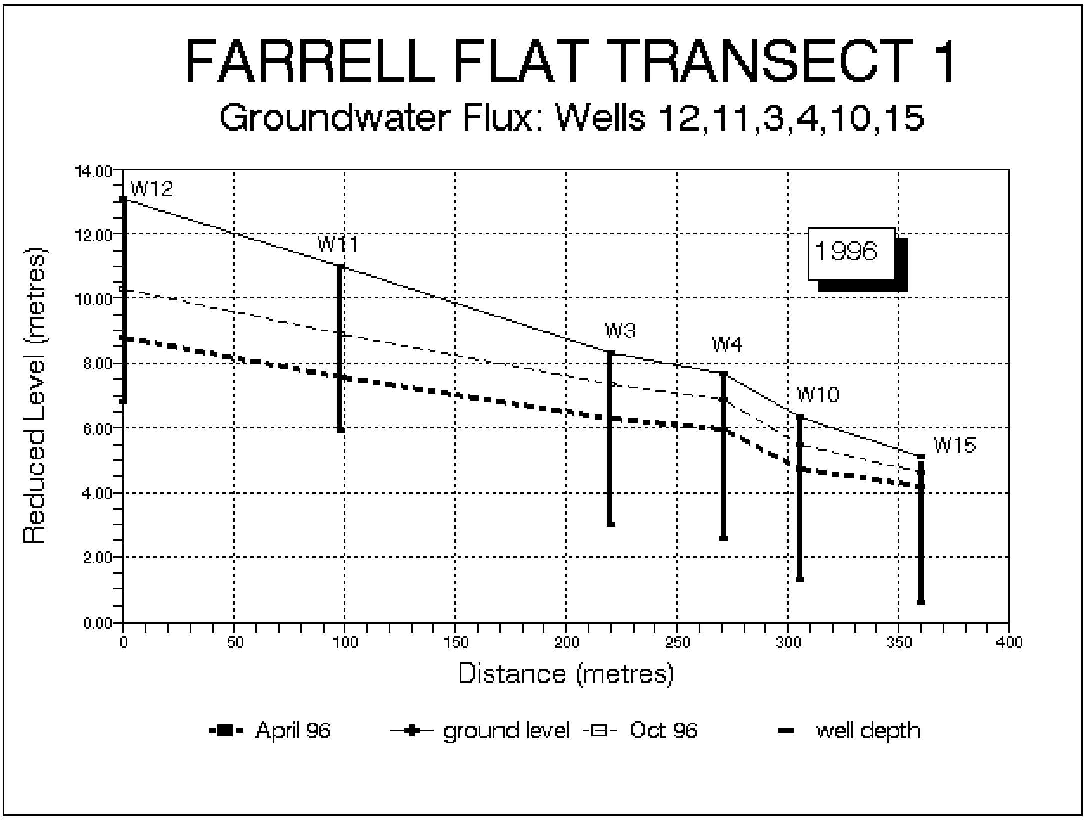

Fig 4: Groundwater fluctuation Transect 1 (1996)

There are other effects to take into account when assessing these projects :-

Vegetation growth

In the case of Farrell Flat, despite the proximity of the groundwater to ground level and the salinity, the growth of the trees and the shrubs has been good, partly a reflection of the site soil, a deep red brown earth.
Two species have been outstanding :-
Eucalyptus occidentalis, has reached heights up to 21m in the 15 years, with a butt diameter up to 0.4m and natural regeneration has been occurring for some years with seedlings now up to 3m in height. (see plates 3,4 and 10 in Appendix A)
Melaleuca halmaturorum, has colonized the most degraded part of the plantation area, with a dense impenetrable mass of vegetation to 3m in height.
Other Eucalypts to have performed well in varying degrees are :-
E.sargentii
E.leucoxylon (on less saline parts of the plot)
E.platypus
E.porosa
E.spathulata
E.camaldulensis (on less saline parts of the plot)
The Casurina glaucas are healthy although slower growing than the best eucalypts, and are currently 12m high.
Atriplex nummalaria is colonizing the areas adjacent to it although heavily shaded by overgrowth from trees.
These results largely confirm the findings by other workers on other sites including our own species trial site located at Ungarra on Eyre Peninsula.

Biodiversity

It is clear that the plantation is functioning as habitat for an increasing range of animals. On periodic visits kangaroos, foxes and hares and a range of bird life have been observed.

Aesthetic changes

There is now plenty of evidence from this site and others around the state, including the River Light Tree Project in the Lower North and the Moody Scheme on Eyre Peninsula, that with some minor landscaping including judicious planting with appropriate species, formerly inhospitable saline discharge areas could be transformed to relatively attractive sites suitable for recreational pursuits.
It is recommended that sites located on communal land particularly, are reviewed from this aspect,
It is felt, but not confirmed, that the aesthetic improvement of these sites increases the market value of the land.

Changes in productivity

Eucalyptus occidentalis has been an exceptional performer on most of our saline groundwater discharge trial sites. The species is excellent for firewood. With growth rates similar to the Farrell Flat site it could be economically viable to farm this species for firewood. Genetic selection is currently being carried out to identify strains suitable for milling quality timber (Peter Bulman pers.comm.).

The long term plan for this site included an extension abutting the 2.5ha of trees. It was planned for this additional area to be planted to the forage plants Puccinellia and Tall Wheat Grass in order to demonstrate the potential for increasing the grazing value of the area which was dominated by sea barley grass and samphire at the time. However Mr. Ron Short the landholder has taken the initiative in the meantime and established a strong stand of Puccinellia and Wheat Grass on the balance of the paddock. The value of these species has been amply demonstrated in other districts (Herrmann, 1996).

The value of this planting is complex and difficult to evaluate. Less obvious items like the potential honey production; the change in land value; effects on "greenhouse", and windbreak effects, should all be taken into account. Further work in this field could include an evaluation of these secondary effects.

Conclusions

Vegetation planting to ameliorate saline discharge areas will have no effect on either the groundwater level or salinity unless a significant proportion of the catchment or basin including recharge areas, is afforested. The result at Farrell Flat confirms the findings by many researchers, notably in Western Australia (Schofield, 1990).

However other benefits may be obtained depending on the specific situation, with smaller areas of planting.

Acknowledgments

Mr. Ron Short of Farrell Flat virtually donated the use of the land indefinitely for the purpose of the trial, and assisted with the establishment of the plantation, and has tolerated our regular access to the site since 1985.
Our former colleague Brendan Lay, now in the Department of Environment, Heritage and Aboriginal Affairs (DEHAA), initiated many vegetation planting demonstrations in the 1980s and jointly managed this project.
The Trees For Life organisation donated some of the plants, and also about a dozen members found their way to Farrell Flat in 1985 and assisted with planting. This was greatly appreciated.
Several of our colleagues have assisted in the maintenance of the project; notably Jocelyn Thomas, and David Woodard.

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Appendices

Table 1
Farrell Flat ECe measurements of the top 10cm. of soil in dS/m.

1 m west of well no.4	0.5
1 m west of well no.5	0.7
1 m west of well no.6	9.2
1 m west of well no.7	2.4
1 m west of well no.8	1.4
1 m west of well no.9	1.9
7 m west of the plantation (puccinellia)	42.3
West of plantation (small patch of juncea)	25.3
Inside plantation (sea barley grass and puccinellia)	15.5
Inside plantation (sea barley grass/oats/annual grass)	7.4
West of main road (best case, annual clover/ rye grass)	1.6
West of main road (medium case, top eroded,puccinellia/ winter annuals)	10.0
West of main road (worst case, top eroded, bare soil)	36.0

Table 2 Farrell Flat Rainfall 1985-1998 in mm

1985	432
1986	500
1987	442
1988	469
1989	438
1990	446
1991	464
1992	756
1993	534
1994	260
1995	400 (incomplete, Jan. and Feb. missing)
1996	523
1997	507
1998	413

The long term average for Farrell Flat is 477mm per year.

Appendix A

Plate 1 : No.9 well looking west (1990)

Plate 2: No.9 well looking east (1999)

Plate 3: <u>Eucalyptus occidentalis</u> and <u>Melaleuca halmaturorum</u> (1990)

Plate 4 : <u>Eucalyptus occidentalis</u> and <u>Melaleuca halmaturorum</u>

after 9 years growth (1999)

Plate 5: No.10 well view to the west , road in middle distance (1989)

Plate 6: No.10 well view to the west, road in middle distance (1999)

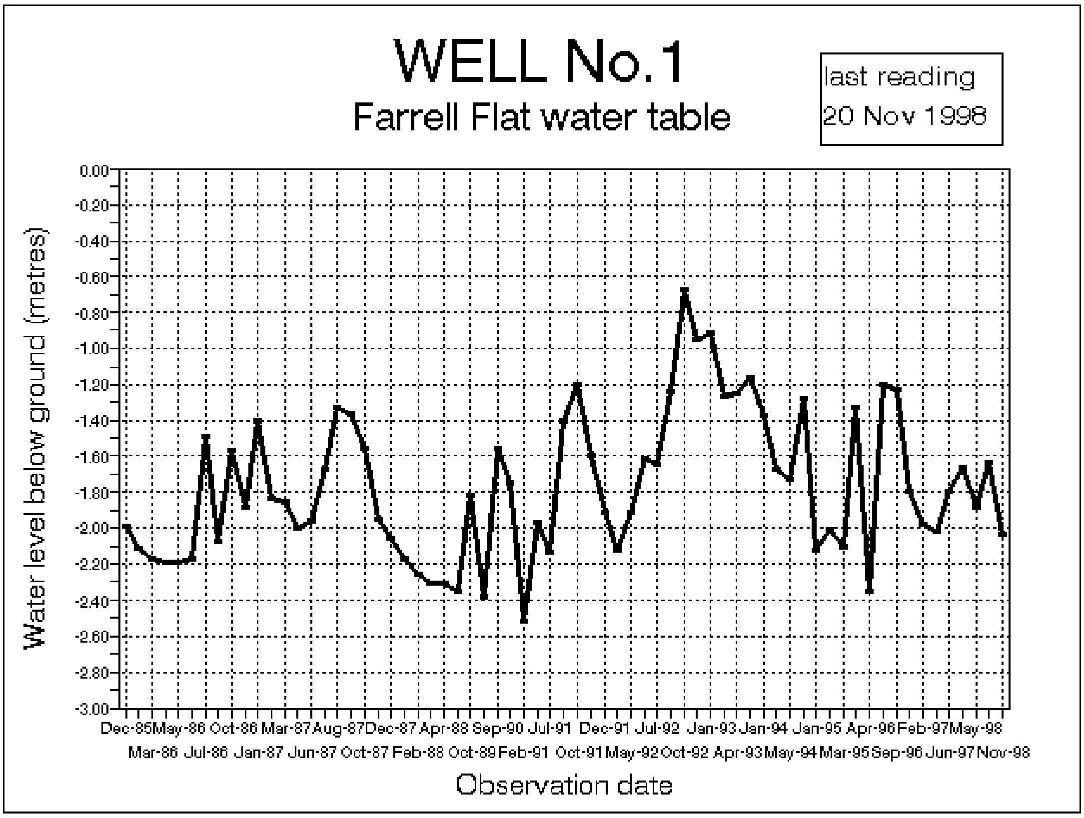
Plate 7: plantation site view south to Farrell Flat (1989)

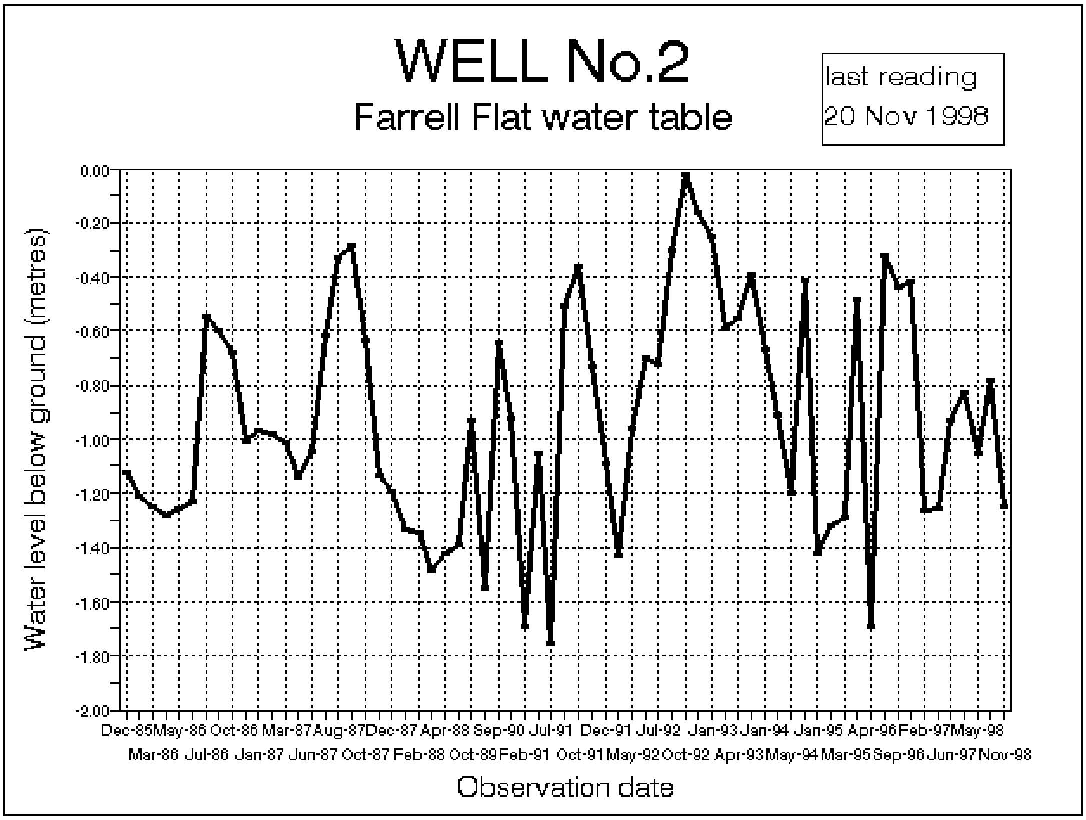
Plate 8: plantation site view south to Farrell Flat (1999)

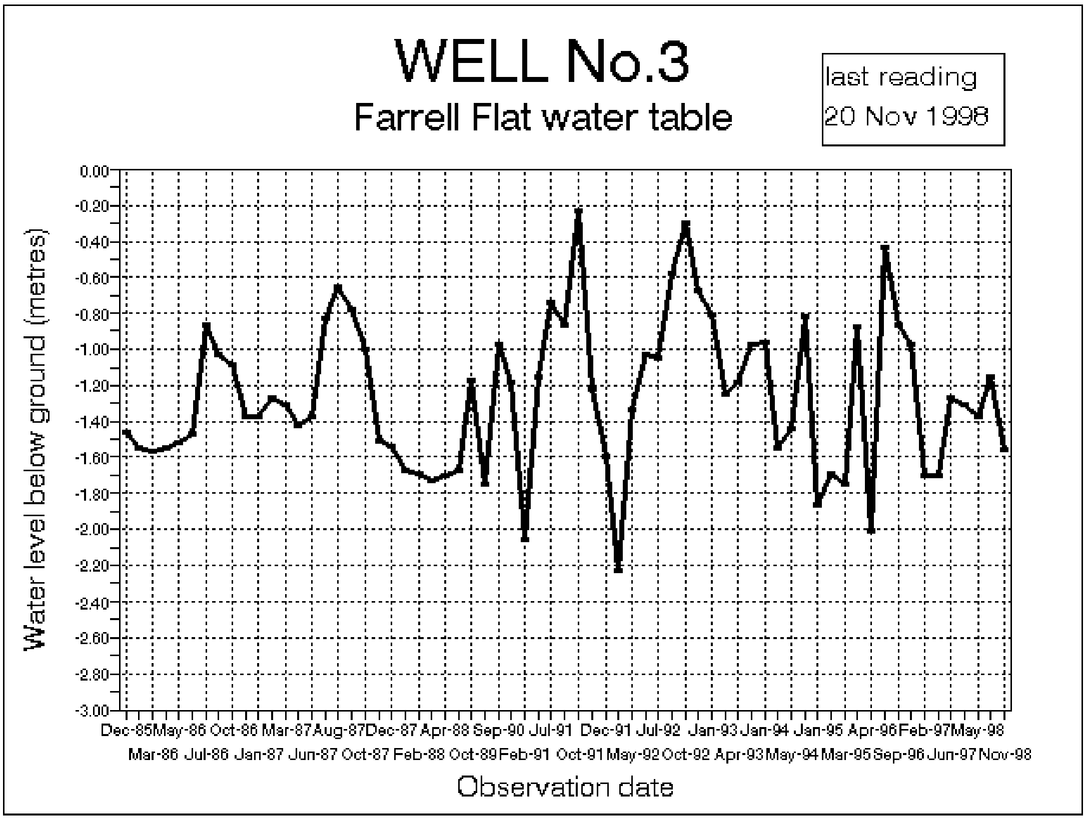
Plate 9: colonization by Melaleuca halmaturorum (1999)

Plate 10: colonization by Eucalyptus occidentalis (1999)

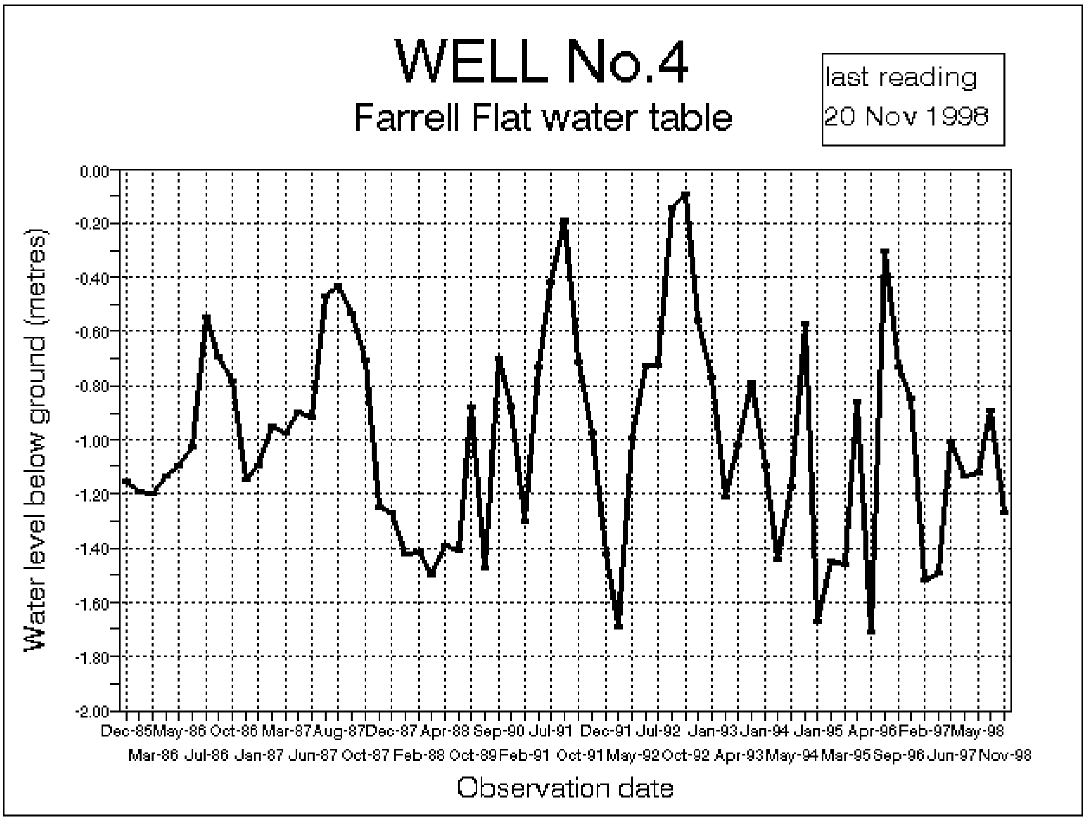
Appendix B: GRAPHICAL SUMMARY OF WATER TABLE FLUCTUATION (1985-1998)



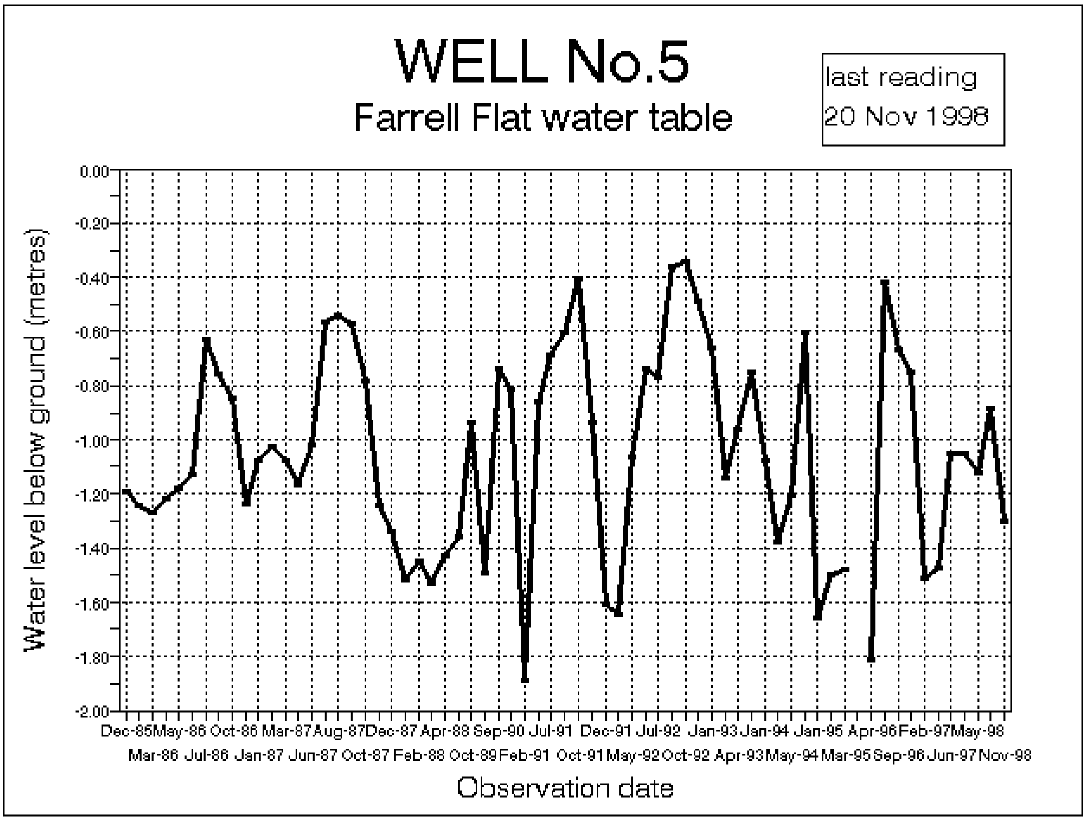




WELL No.3
Farrell Flat water table
last reading
20 Nov 1998
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
-2.20
-2.40
-2.60
-2.80
-3.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date



WELL No.4
Farrell Flat water table
last reading
20 Nov 1998
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date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Farrell Flat water table
last reading
20 Nov 1998
Water level below ground (metres)
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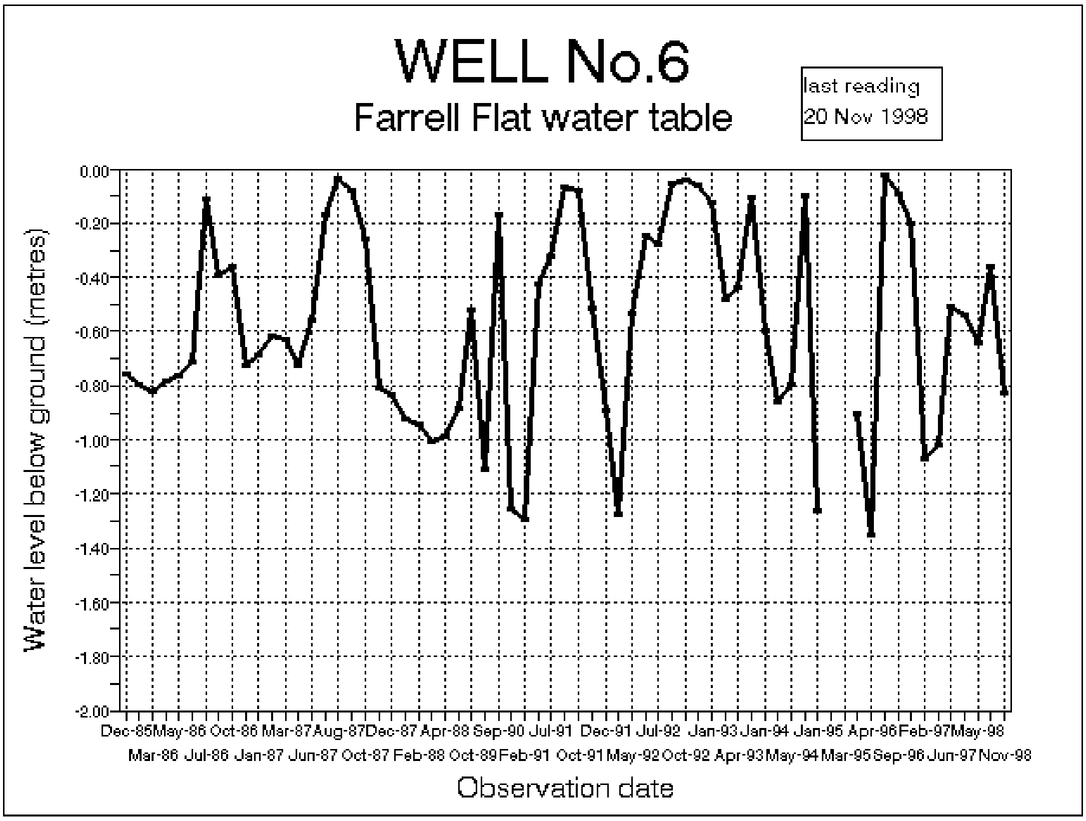
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date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Farrell Flat water table
last reading
20 Nov 1998
Water level below ground (metres)
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-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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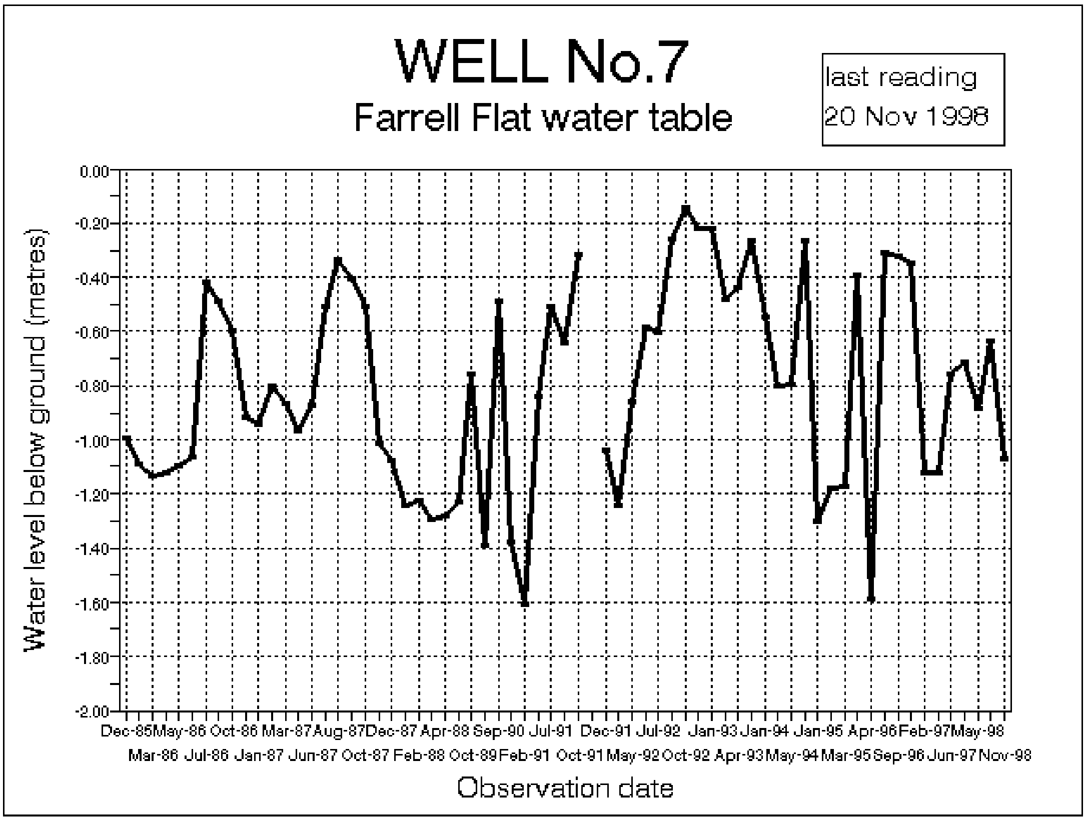
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Water level below ground (metres)
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-0.40
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-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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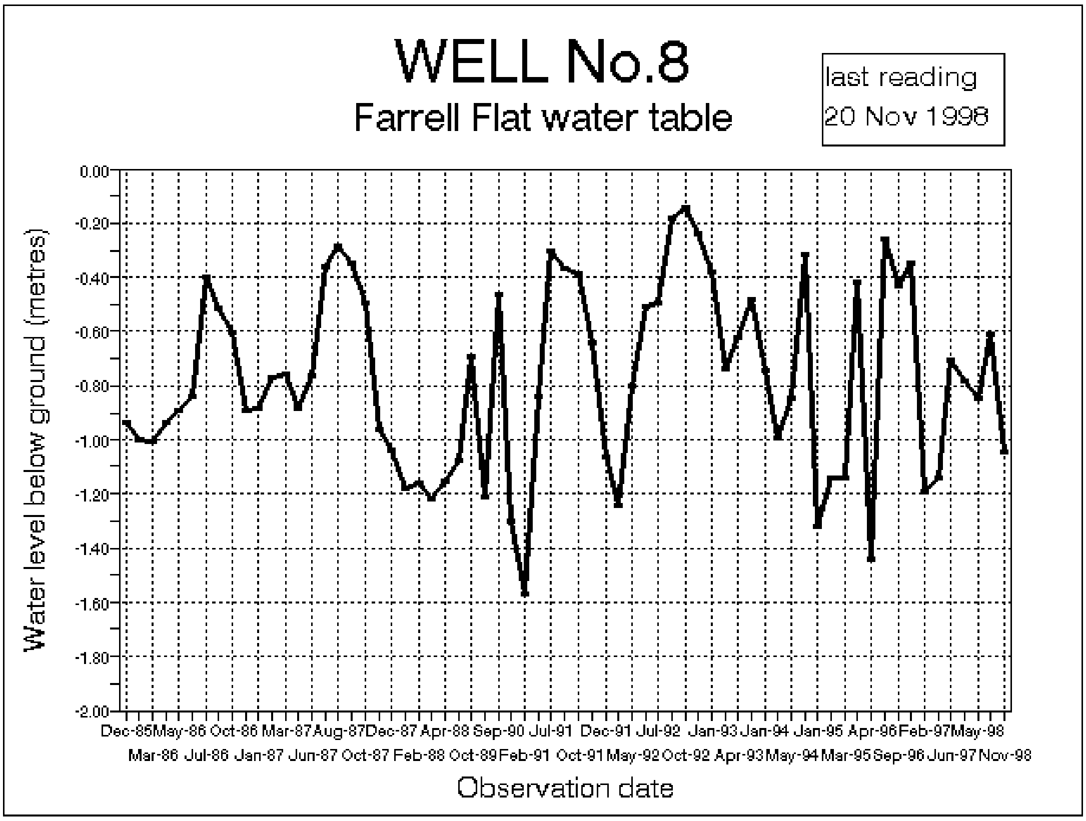
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Water level below ground (metres)
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-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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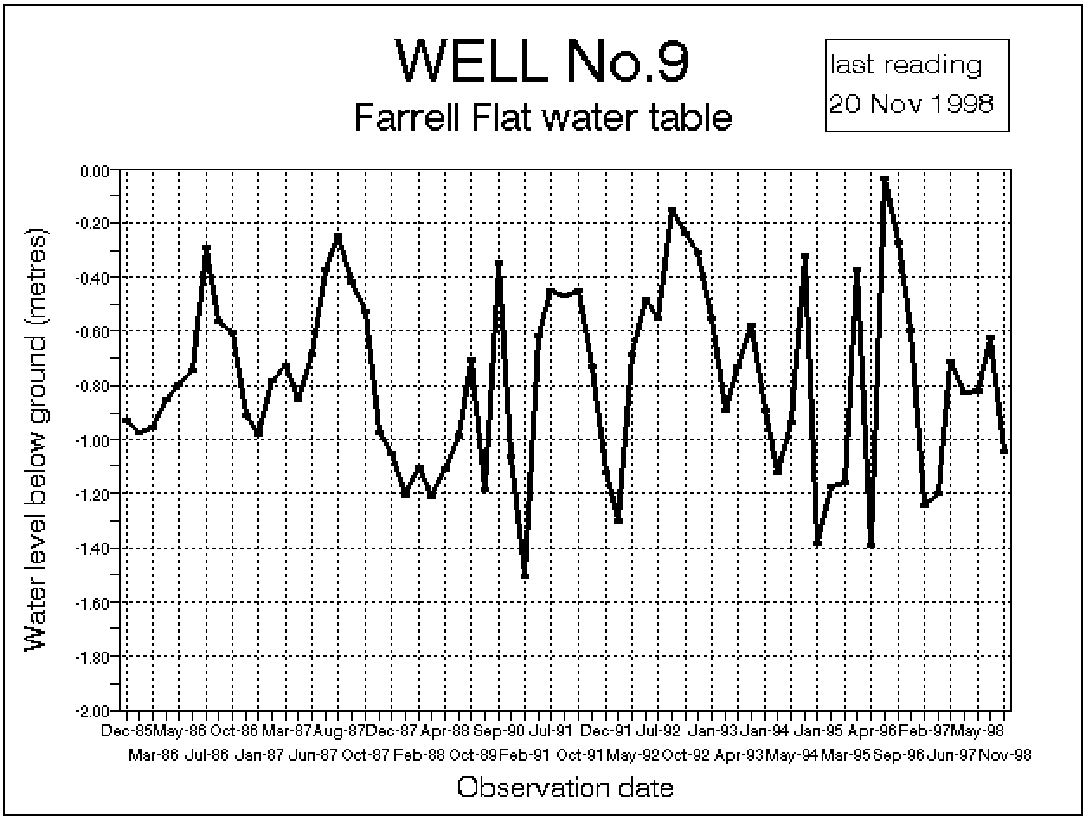
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-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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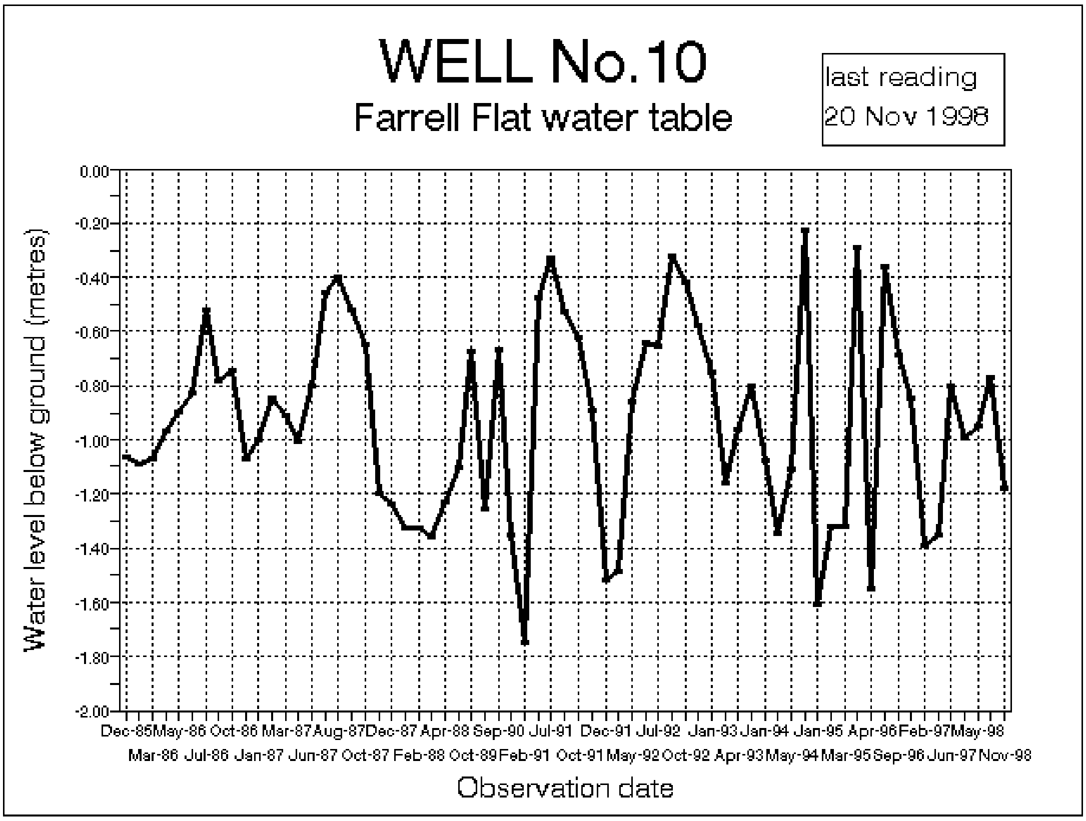
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-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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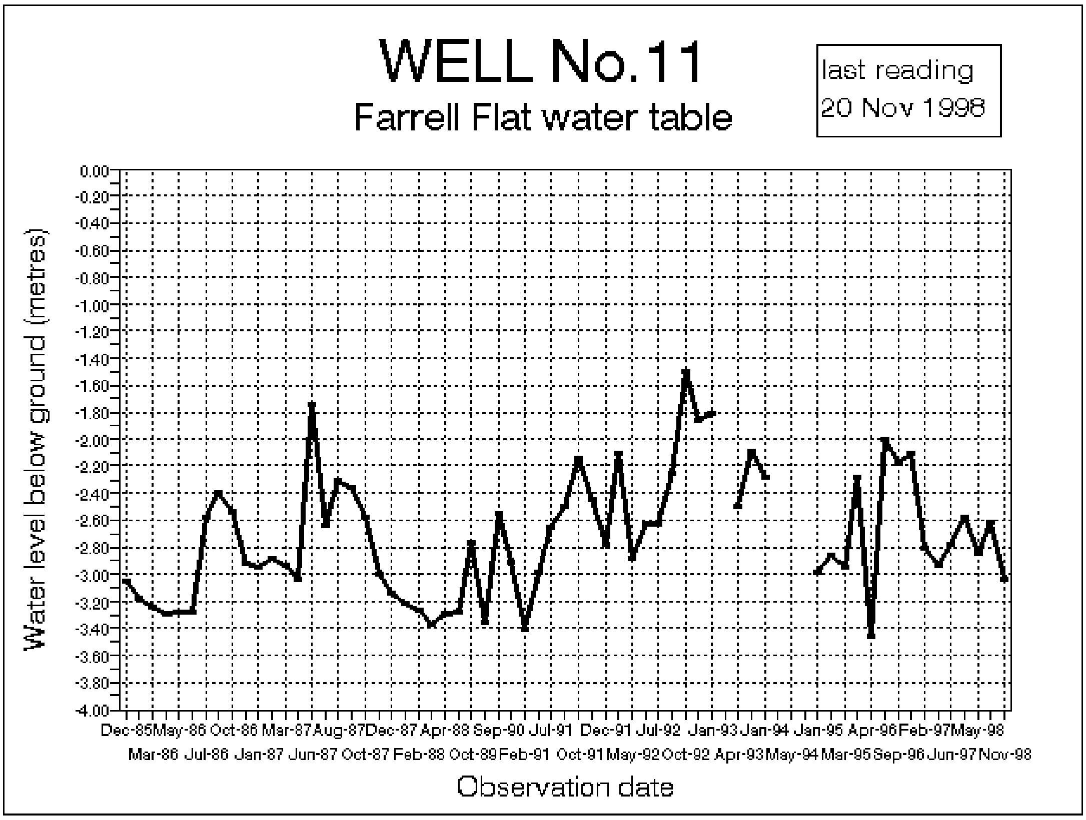
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-1.40
-1.60
-1.80
-2.00
-2.20
-2.40
-2.60
-2.80
-3.00
-3.20
-3.40
-3.60
-3.80
-4.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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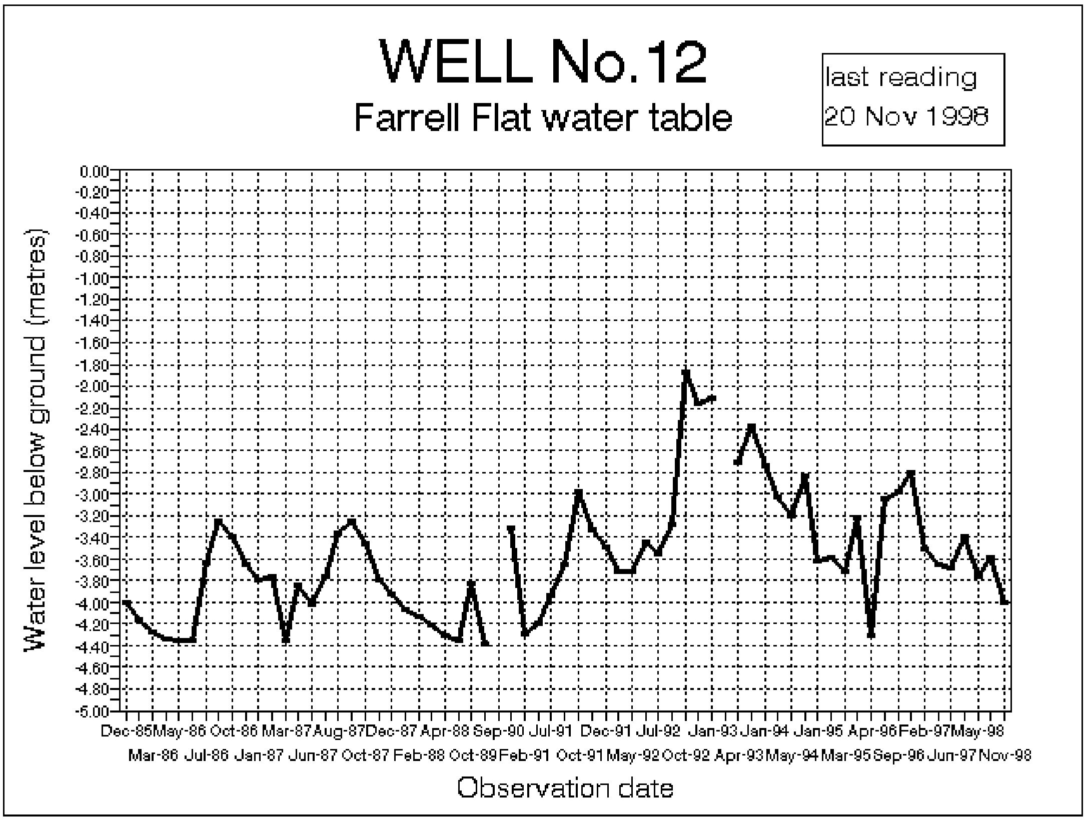
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-1.00
-1.20
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-2.00
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-3.60
-3.80
-4.00
-4.20
-4.40
-4.60
-4.80
-5.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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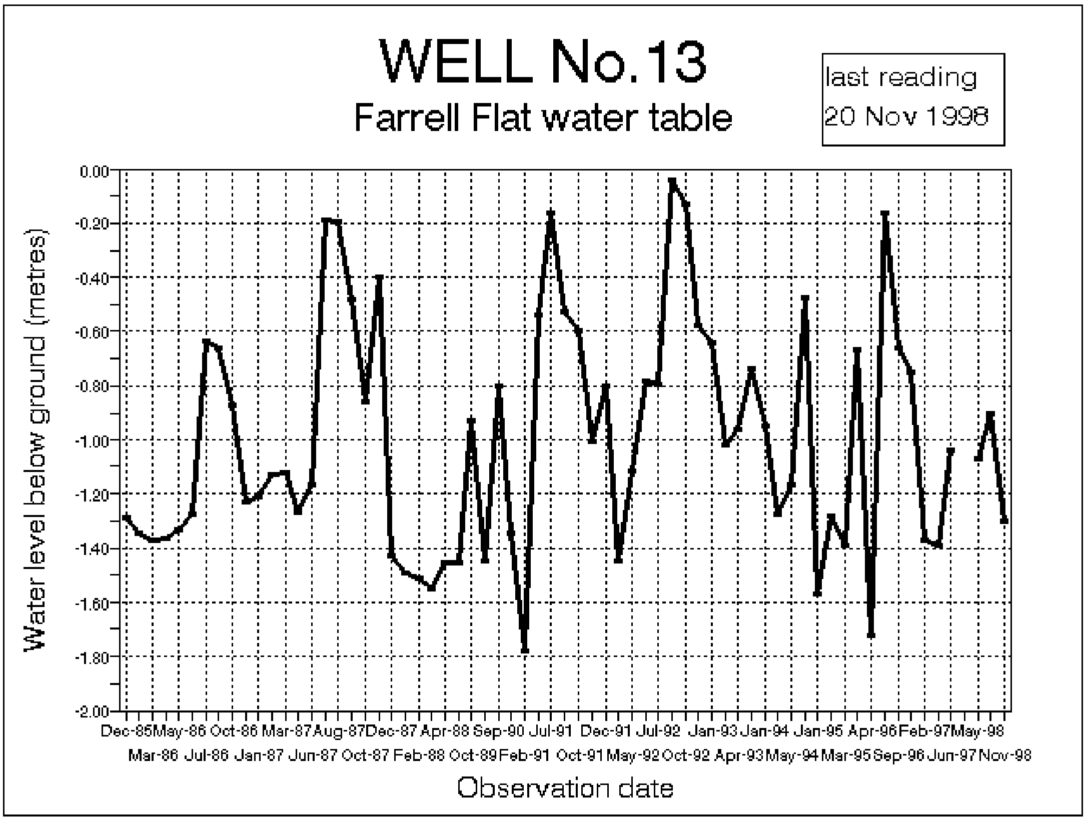
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-1.20
-1.40
-1.60
-1.80
-2.00
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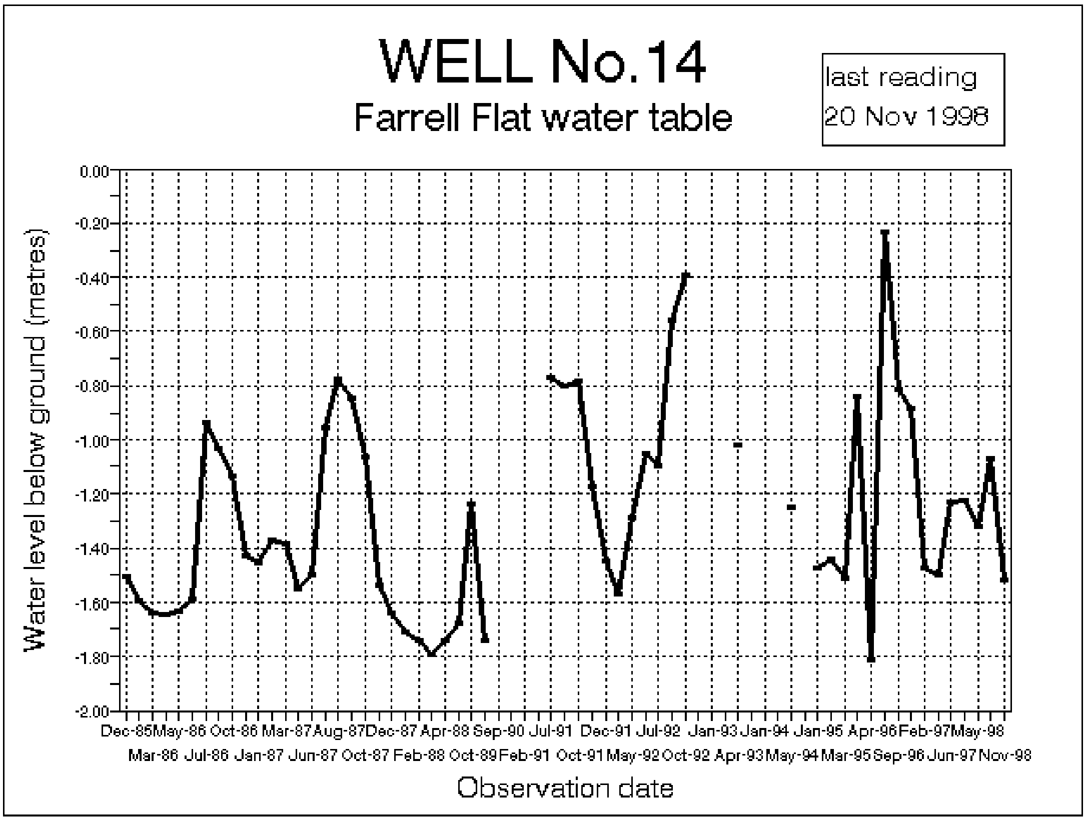
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-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
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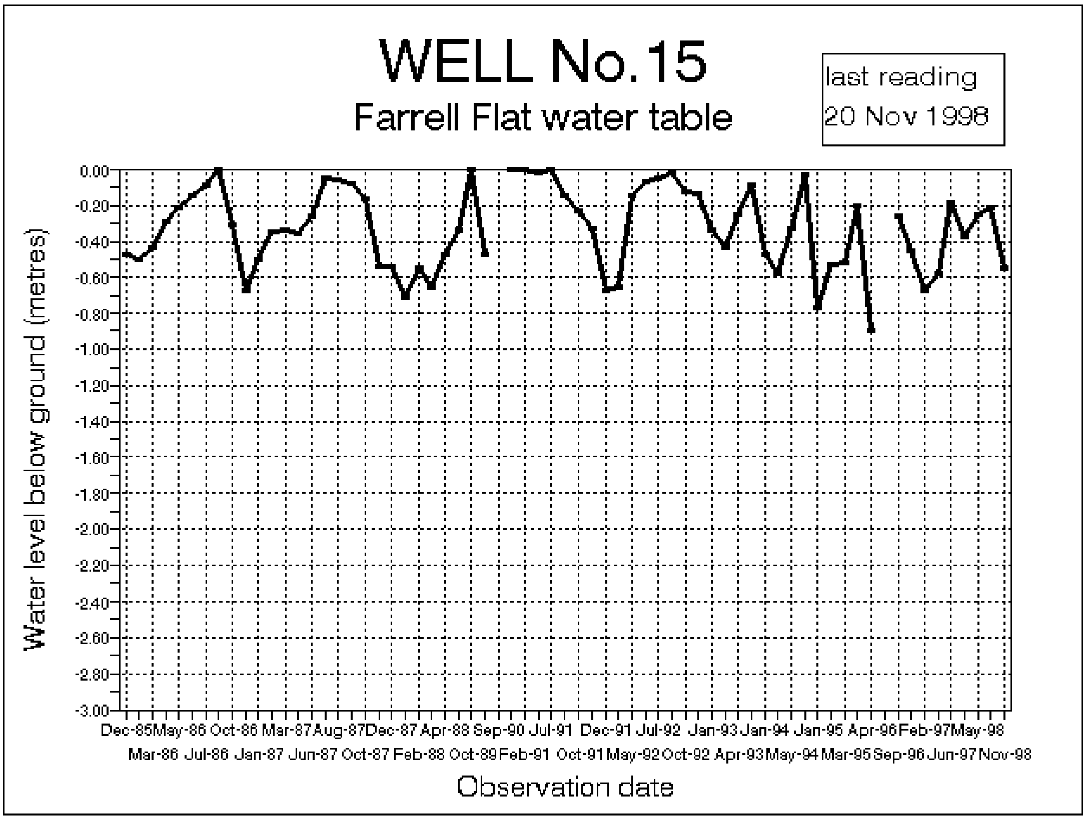
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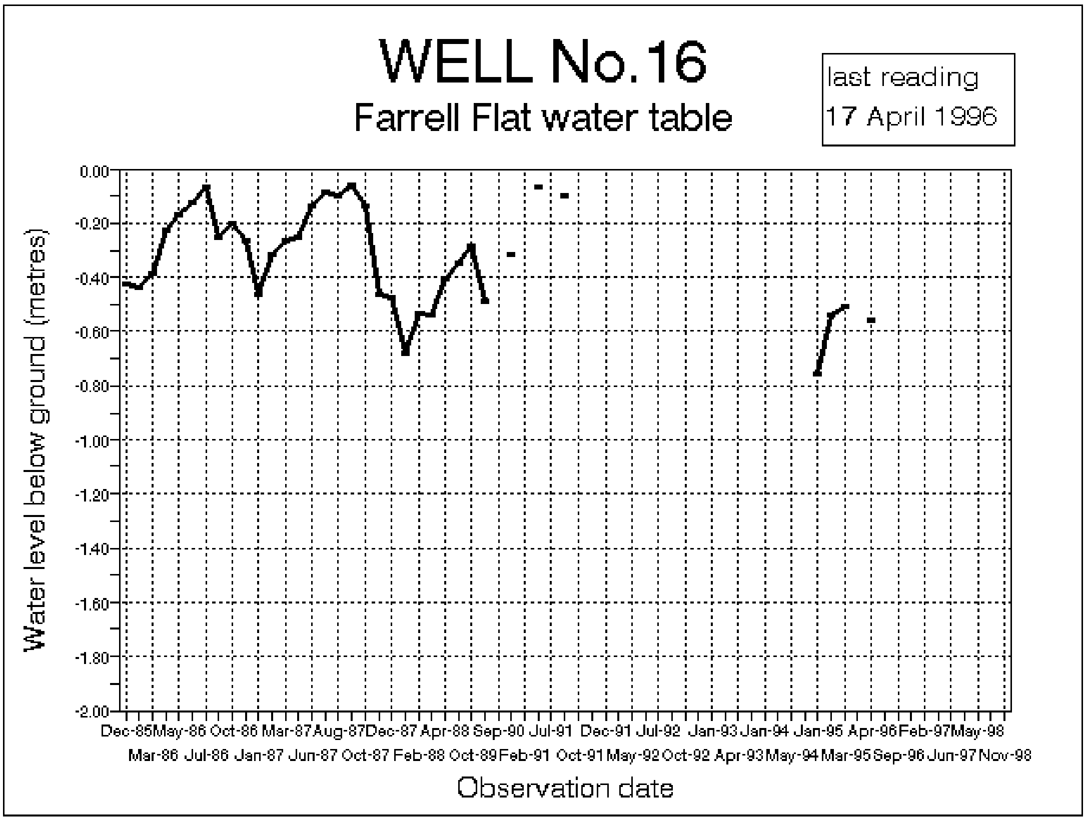
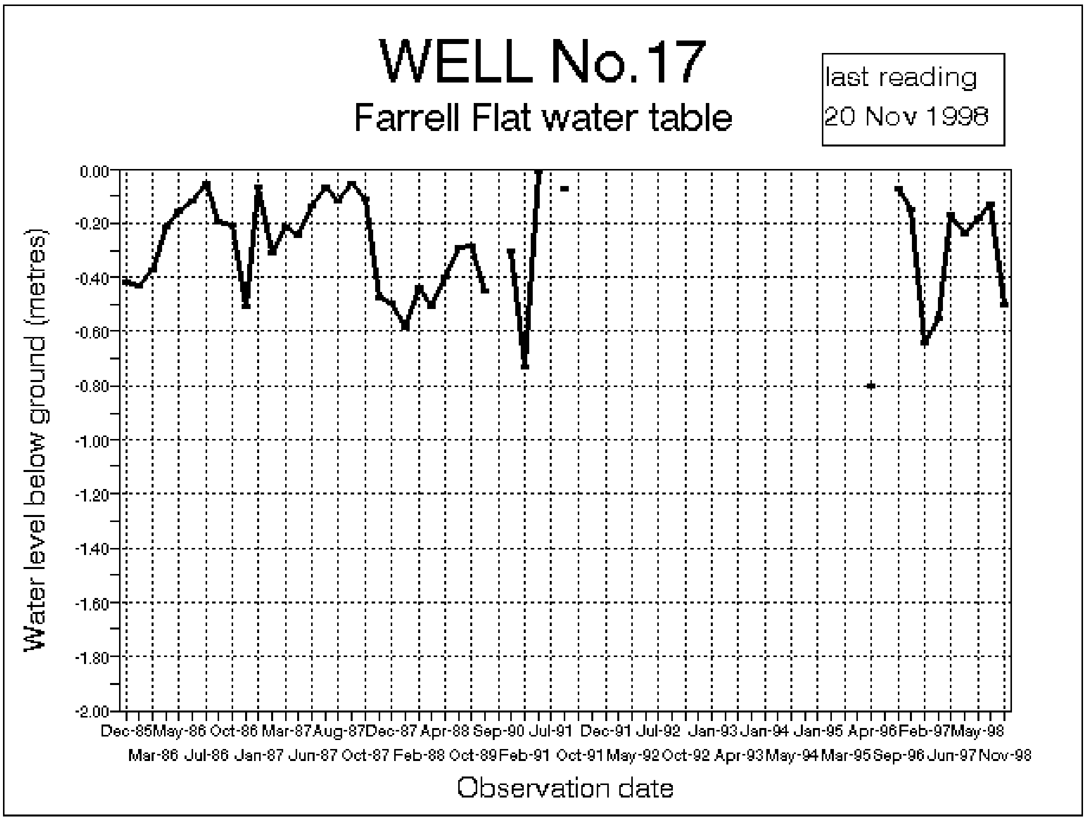
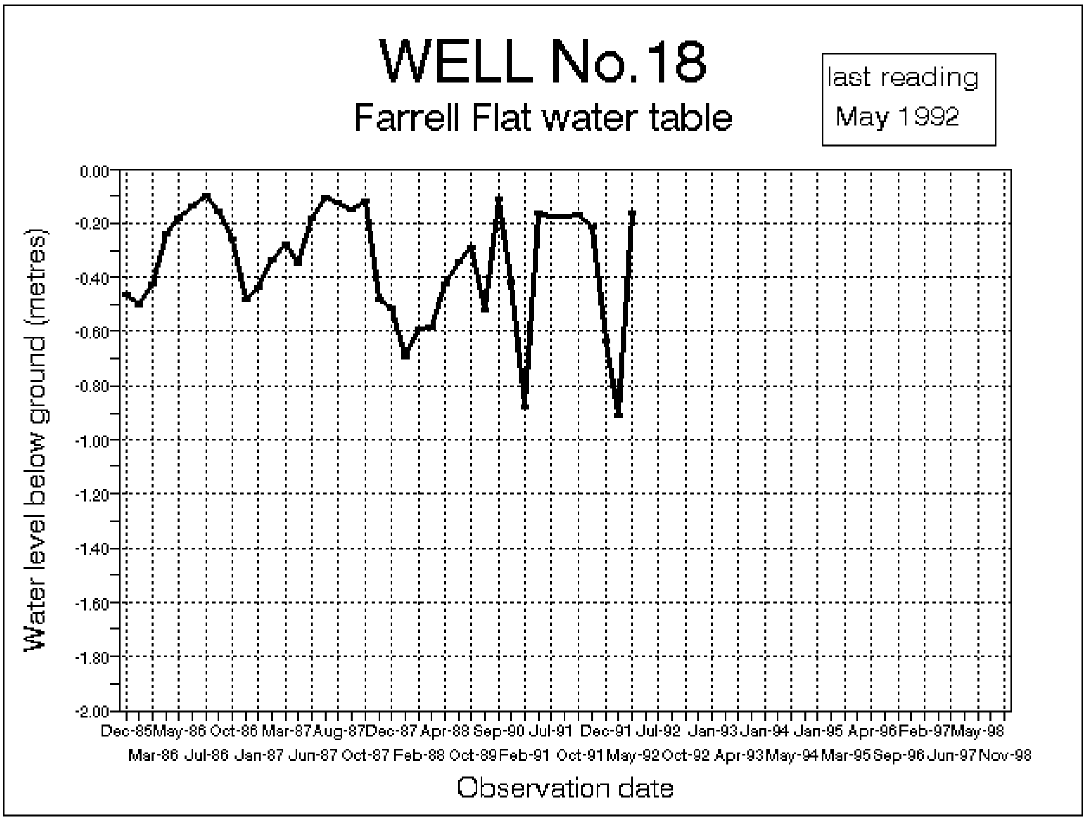
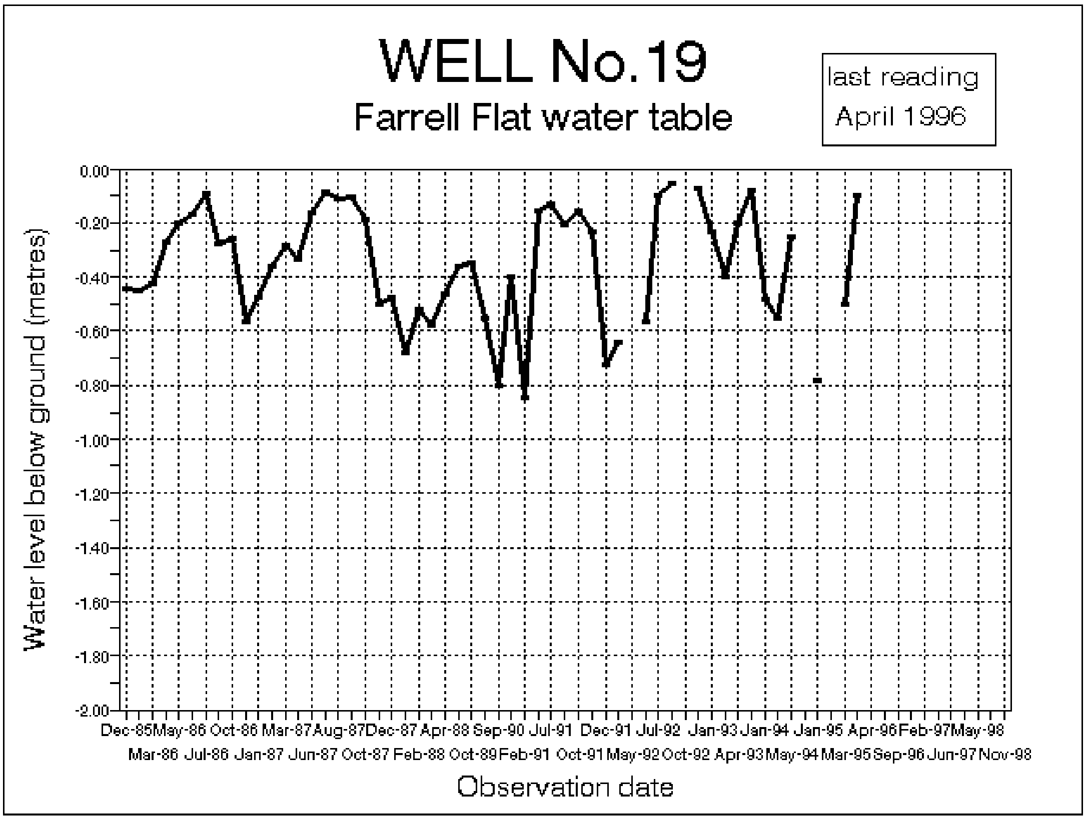
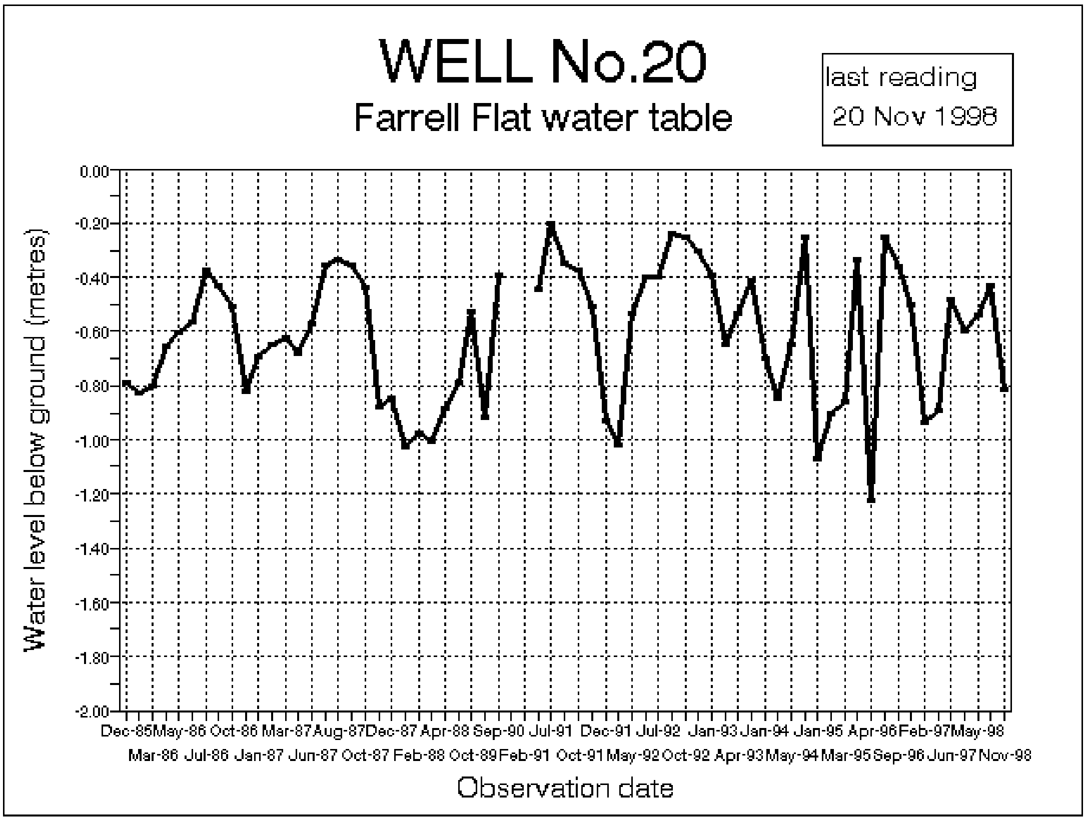
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
-2.20
-2.40
-2.60
-2.80
-3.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date


WELL No.16
Farrell Flat water table
last reading
17 April 1996
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date


WELL No.17
Farrell Flat water table
last reading
20 Nov 1998
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date


WELL No.18
Farrell Flat water table
last reading
May 1992
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date


WELL No.19
Farrell Flat water table
last reading
April 1996
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date


WELL No.20
Farrell Flat water table
last reading
20 Nov 1998
Water level below ground (metres)
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
Dec-85 May-86 Oct-86 Mar-87 Aug-87 Dec-87 Apr-88 Sep-90 Jul-91 Dec-91 Jul-92 Jan-93 Jan-94 Jan-95 Apr-96 Feb-97 May-98
Mar-86 Jul-86 Jan-87 Jun-87 Oct-87 Feb-88 Oct-89 Feb-91 Oct-91 May-92 Oct-92 Apr-93 May-94 Mar-95 Sep-96 Jun-97 Nov-98
Observation date

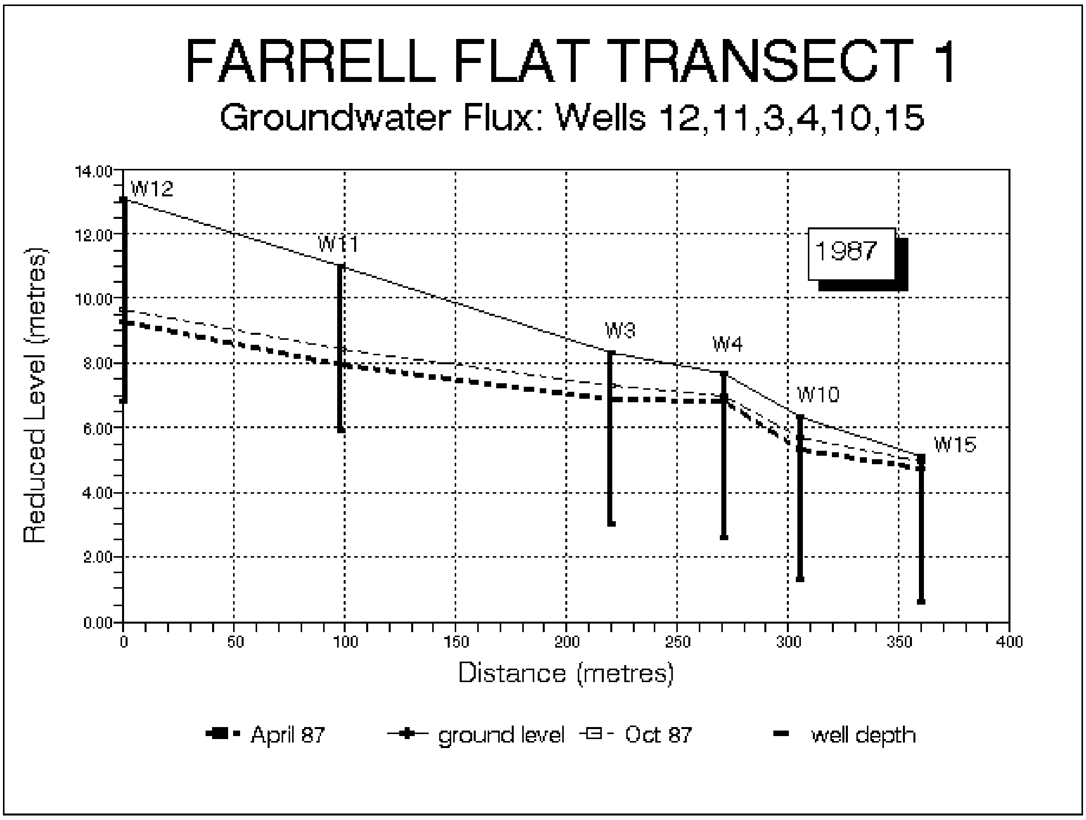


Fig 3: Groundwater fluctuation Transect 1 (1987)

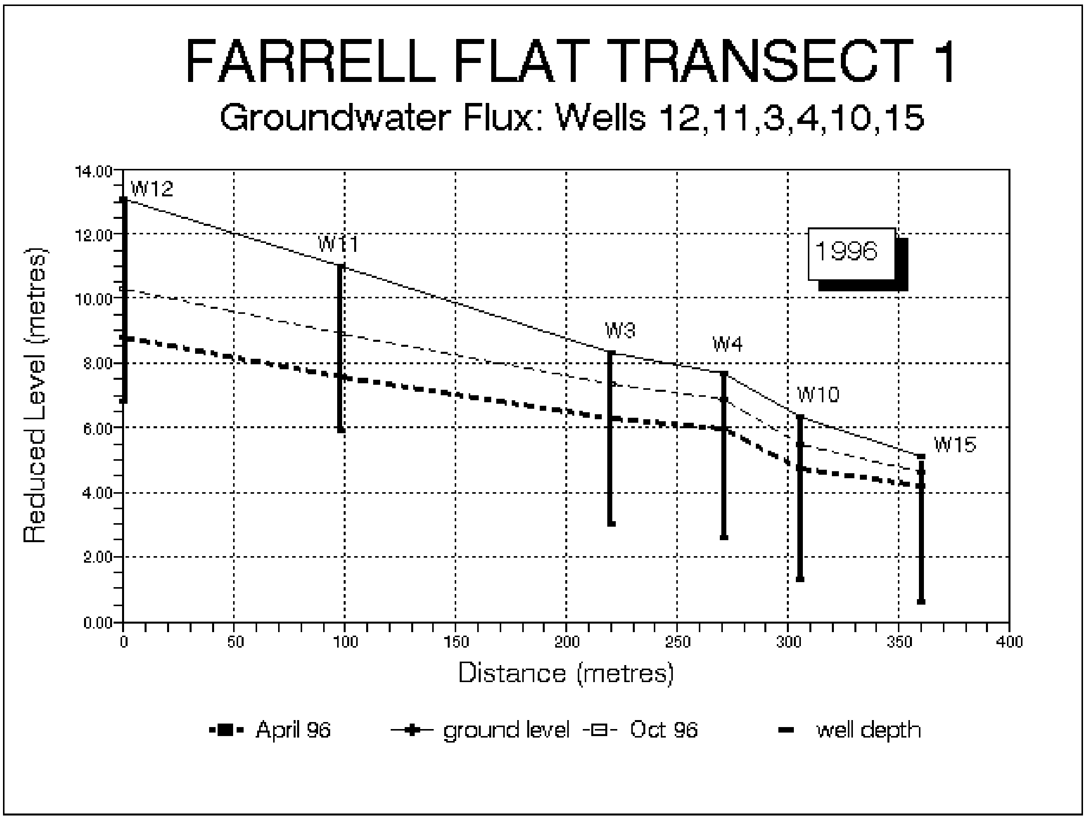


Fig 4: Groundwater fluctuation Transect 1 (1996)