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GROUNDWATER INVESTIGATIONS IN THE MENINGIE-NARRUNG AREA

by

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Groundwater Investigations in the Meningie-Narrung area

S.R. Barnett

Several groundwater issues have been highlighted in the Meningie-Narrung area as a result of the regional investigation into the hydrogeology of the Murray Basin. Dryland salinity is the most important with an estimated 45 000 ha affected by the rising watertables within 50 years if no action is taken. Transient electromagnetic surveys have been used to delineate areas of lower salinity groundwater which could be used for stock supplies in the event of a blue-green algae outbreak in the lakes, or to reduce the costs of using mains water for stock to the east of Meningie. Disposal of dairy effluent on the salt lakes would have virtually no detrimental effects on water quality because they are groundwater discharge areas, however other issues should be considered before the practice is adopted.

INTRODUCTION

Recent regional investigations into the hydrogeology of the Murray Basin have highlighted important issues which impact on the local community in the Meningie-Narrung area eg dryland salinity. Following closer liaison with community groups, other issues concerning groundwater arose, resulting in further localised and detailed work. This report gives a summary of these investigations and the results obtained.

HYDROGEOLOGY

The area of interest (Fig. 1) lies on the low-lying Coastal Plain which was formed about one million years ago when the sea level rose and eroded away the older limestone and sand deposits which underlie the higher Mallee region to the north. The sea extended as far inland as Tailem Bend and the Marmon-Jabuk Scarp before retreating. As it did so, it deposited shallow limestones and sands, sometimes in the form of stranded beach ridges similar to the Younghusland Peninsula on the seaward side of the Coorong. These limestone (Coomandook Formation), sand (Molineaux Sand) and beach ridge (Bridgewater Formation) deposits now contain the watertable or unconfined aquifer (Fig. 2).

Surrounding the lakes are low-lying areas which were inundated about 6-8 000 years ago when the sea level was higher. They contain silts and clays of the St Kilda Formation (Fig. 2) and are generally saline with extensive areas of samphire because of the very shallow watertable which has resulted in evaporative concentration of the groundwater salinity.

Elsewhere, salt lakes occur where the watertable intersects the ground surface and evaporates (Fig. 2). In winter, they may be inundated as the watertable rises.

Underlying the unconfined aquifer at a depth of 50-100 m, is a pressure or confined aquifer which consists of sand and bryozoal limestone capped by a stiff dark brown carbonaceous clay. Very few bores penetrate the confined aquifer and consequently, little information is available.

Groundwater movement in the watertable aquifer occurs in a westerly direction at very slow rates of about 10-15 metres/year (Fig. 3). Discharge from the aquifer occurs to the Coorong, to low-lying salinized areas around the Lakes or to isolated salt lakes. These salinized areas are at a lower level than the Lakes, whose water levels have been raised by the barrages.

DRYLAND SALINITY

This is a major land degradation problem in the area. An estimated 10 000 ha is currently affected in the Coorong and Districts Soil Board area, and if no remedial action is taken, this area will increase to 45 000 ha if the current rising watertable trend in average rainfall years of 10-15 cms/year continues. On the Narrung Peninsula, this trend is lower, at 2-3 cms/year. Figure 3 shows part of the observation well network currently being monitored by contractor, John Boundy. Hydrographs for selected wells are shown in Figures 4 & 5, together with the deviation of the measured monthly rainfall from the average expected for the month. A downward trend in the solid line shows below average rainfall, while an upward trend represents above average rainfall.

It is interesting to note the rising watertable trends from 1990 to 1992 despite the below average rainfall trend. The high rainfall in late 1992 caused a significant rise in water levels, however the very much below average rainfall in 1994 and 1995 has led to falling watertables. This information indicates that, in order to stabilise the regional watertable and prevent further dryland salination, the average rainfall would have to decrease by 15-20%! The higher rainfalls in 1996 have resulted in rising trends once more. It is possible to try and predict the area that will be salinized in the future by extrapolating the rising watertable trend into the future, and determining when the watertable will rise to within the critical two metres beneath the ground surface in any given area. This exercise needs detailed topographic maps with a contour interval of ideally, five metres. It has been done for the Narrung Peninsula (Fig.6) which shows that 14% of the total area will be affected in 25 years. Unfortunately it cannot be done in detail elsewhere on the Coastal Plain because the topographic maps are not detailed enough with only ten metre contour interval maps available. An attempt is shown in Figure 7. The underlying assumption in producing these maps is that the watertable will continue to rise at about 10 cms/year on average (2-3 cms/year at Narrung).

Eventually, as more low lying areas become salinized and more groundwater discharge takes place by evaporation, a balance will be reached with the increased groundwater recharge resulting from clearing. When this will occur and how much additional land will be salinized, is not yet known.

Reducing recharge is the key to controlling dryland salinity and has been recognised as such by the Soil Boards CARE Program, which has initiated a Regional Implementation Strategy to address this issue. Groundwater information, such as depth to the watertable, salinity etc, has been used together with soils and land use data in an exercise to prioritize areas for Local Action Planning to reduce recharge.

GROUNDWATER AS AN ALTERNATIVE WATER SUPPLY

Narrung

The Meningie and Narrung areas are heavily dependent on the lakes for domestic and stock water supply. Although generally a very secure source, outbreaks of blue-green algae can render the lakes unusable for human or stock consumption virtually overnight. In the early days of settlement, shallow wells provided some stock water. Salinities were generally in the range 4 000 to 8 000 mg/L, with supplies being limited due to the problem of underlying saline groundwater contaminating the thin layer of fresh groundwater if it is overpumped.

Some tests were done on three wells shown on Figure 6. Results are tabulated below.

Table 1
Test pumping on Narrung Peninsula

Well	Time Pumped	Drawdown	Rate litres/sec	Salinity mg/L
BKR 8	35 mins	0.6 m	0.5	4 785
BKR 10	28 mins	0.15 m dry	2.3 l	7 900
BKR 11	75 mins	1.2 m	0.9	2 300

Considering that the upper limit for dairy cattle is about 4 200 mg/L, and that each of the estimated 10 000 head on the Peninsula require 70-90 litres/day, the existing shallow wells are not an adequate source with the possible exception of BKR 11.

These wells are not necessarily located in the most favourable areas however. The permeable high dunes of the Bridgewater Formation would allow significant recharge, especially where they are cleared of native vegetation (Fig.2). Another possible source of fresh groundwater could exist below the centre-pivots where irrigation drainage water would form a layer on top of the native more saline groundwater.

In order to test these scenarios, two TEM traverses were run over strategic areas shown in Figure 6. The TEM technique is an electromagnetic one whereby a 50 m^2 wire loop induces a current into the ground and then measures the decay of the current with time, with the rate of decay controlled by the conductivity of the ground. Conductive zones can be delineated at depth which are usually associated with clay layers or highly saline groundwater. Traverse A commenced near observation well BKR 15, travelled across a centre-pivot past BKR 9, and terminated at a low-lying salinized area. Traverse B commences at a salinized area and finishes on top of a high dune running parallel to the Coorong.

Results from both traverses (Figs. 8 & 9) show generally saline groundwater at depths of about 10 metres corresponding with the 2 ohm-metre contour. Not surprisingly, this saline groundwater extends to the ground surface at the salinized areas. Along traverse A, the thickest low salinity zone occurs under the centre-pivot and also to the north where permeable soils may have locally allowed higher than normal recharge.

Traverse B shows an increasing thickness of low salinity groundwater toward the south beneath the dunes which could yield a moderate supply of about 1-2 litres/sec for a limited period.

Meningie East

Dryland dairy farmers along the Meningie-Coonalpyn road rely on mains water for their stock water supply at considerable expense. Eight far mers have an average total annual expenditure of almost $100 000 for stock water. Groundwater could provide an alternative source, either as a stand alone supply or mixed with mains water if the salinity is moderately high.

Existing records show a general rise in salinity from Burnie Lookout westwards toward Meningie (Fig.10). This is because the impermeable granite beneath the range forces the infiltrating rainfall to move laterally, recharging low salinity groundwater in the sediments adjacent to the range. An added complication is the presence of more saline groundwater at depth which could be drawn upwards due to pumping from the overlying low salinity groundwater.

Once again, the TEM method was chosen to detect the presence of deeper saline groundwater. Several soundings were carried out at the preferred sites of dairy farmers who wished to participate in a possible drilling program. Figure 10 shows the sites of the soundings with the results depicted in Figure 12. The TEM profiles generally confirmed the salinity pattern with the thickest section of fresh groundwater closest to the range.

A test hole was drilled at the Williss property by a cable tool rig which allowed sampling of the groundwater to be carried out every metre or so as the hole was drilled. The salinity profile with depth and the corresponding TEM profile are shown in Figure 11. The hole could not be drilled deeper due to alternating very hard cemented layers and unconsolidated sand, which made it extremely difficult to drive the casing to the bottom of the hole in order to take the representative water samples. The hole was completed as a production hole with slotted 152 mm casing from 11-17 m which could supply 1-2 litres/sec of salinity 1 215 mg/L. The salinity may increase slightly with heavy pumping.

The Willis profile in Figure 11 shows that saline groundwater can be expected where the resistivity readings fall below 6 ohm - metres. By matching the Willis profile with the remainder shown in Figure 12, the chances of finding a useable thickness of fresh groundwater can be estimated. Each of the properties will be discussed, starting from the east.

Padman - apart from the Williss property, this is the most promising with no indications of highly saline groundwater. The highest salinity water occurs at 27-30 m but is still good stock quality.

Heading - the sharp decrease in resistivity within a depth of 10 m indicates highly saline water at this depth. There may be a very thin layer (1-2 m) of fresh water on top of the saline water but any pumping would quickly contaminate the fresh with saline water. The more resistive layer at 40 m depth could be basement rocks.

Wright - the three soundings show considerable variation, indicating a complex situation. A possible clay layer is shown at a shallow depth with the most easterly site tested (reading no. 5), showing possible stock water. The increasing resistivity with depth could indicate basement rock eg granite.

Saint - the results are inconsistent and could indicate the present of stock water, especially if clays are present to give the low resistivity readings.

Stockwell - saline groundwater is indicated from 5 to 15 m. Below this, the curves indicate low permeability material as it is unlikely that stock quality water would underlie the saline groundwater.

McKechnie - the readings show saline groundwater down to about 30 m, with possible basement at 40 m depth.

EFFECTS OF IRRIGATION ON DRYLAND SALINITY

The possible contribution of irrigation drainage water to the rising watertable trends causing dryland salinity on the Narrung Peninsula has not been fully understood. During 1987/88, a project to measure the irrigation efficiency on the Narrung Peninsula was carried out by G Cock (SA Dept Agriculture), in response to rising salinity levels in Lake Albert and concerns about long term viability. He found that irrigators were generally conservative rather than wasteful of water and that “it was unlikely that excessive amounts of water are leaching through to the regional watertable”. Given the deep-rooted nature of lucerne and the relatively shallow watertable, it is possible that the lucerne may be taking water direct from the watertable where salinities are suitable, and thus helping to keep the watertable level down.

BKR 9 up until recently, was the only observation well in an irrigation area. Readings were first taken by the landholder in 1983 and show trends reflecting the regional watertable rise and its response to rainfall rather than irrigation drainage. Four new observation wells were drilled in September 1994 (two inside centre pivots and two nearby in dryland areas) and water level recorders placed in them. Locations of the new wells are shown in Figure 6 with details in Table 2.

The water level recorders used ink pens and charts on drums. Problems were encountered with pens not recording and the drums not rotating. There was generally very little response from the watertable to irrigation as recorded on the charts, except when a pivot discharging 95 litres/sec became immobilised for 10 hours near BKR 9, flooding the area and causing a rise in the watertable of 25 cm.

Table 2
New Observation Wells

Well	Depth	Water level	Landholder	Location
BKR 14	11.8 m	6.3m	Eckermann	Pivot
BKR 15	5.8m	4.3m	Gemmell	Dryland
BKR 16	8.0m	2.0m	Pratt	Pivot
BKR 17	6.0m	2.5m	Pratt	Dryland

Because of these difficulties, the recorders were removed and a transducer placed in BKR9. The transducer automatically recorded the water level every four hours to provide an almost continuous record (Fig. 13).

Generally, Figure 13 shows similar trends between irrigation and dryland watertable levels. The important trend to note is that both irrigation observation wells show a falling trend during the summer irrigation season.

DISPOSAL OF DAIRY EFFLUENT ON SALINE AREAS

In the Meningie -Narrung area, groundwater discharge occurs by evaporation from low-lying salinized areas, a process which lowers the watertable elevation below that of the lakes. Consequently, the salinized areas are the focus of regional groundwater discharge in preference to the lakes which are also losing water and contributing to groundwater flow toward these discharge areas.

There are several ramifications for the disposal of dairy waste on salinized areas. Firstly, because groundwater flow is toward these areas and not away from them, there is very little risk of contamination of groundwater or lake water. Secondly, the effects of the waste disposal on the rate of evaporation from the salinized areas is not known.

Although the darker colour of the effluent will increase heating, the increased thickness of sediment above the watertable and the mixing with saline water may reduce evaporation rates.

Other issues to consider are the reuse of the effluent and compliance with the National Water Quality Management Strategy Guidelines No 16A entitled ‘Effluent management for dairy sheds’.

CONCULSIONS AND RECOMMENDATIONS

Dryland salinity is a major land degradation issue in the area, with an estimated 45 000 ha likely to be affected within 50 years. Widespread community action is required to reduce recharge in order to control dryland salinity. Local Action Planning is the key process to achieve this.

Monitoring of groundwater levels in the area should continue, in order to assist with predictions of the area to be affected by dryland salinity and when it might occur. Monitoring will also give an indication of the effectiveness of any treatment options used to reduce recharge.

Irrigation of lucerne using water from Lake Albert is not contributing to the dryland salinity problem on the Narrung Peninsula.

Transient electromagnetic surveys have proved a useful tool in delineating stock quality groundwater on the Narrung Peninsula and to the east of Meningie. Unfortunately, these resources are limited in area.

Although disposal of dairy water onto saline areas will not impact on groundwater or lake quality, the National Water Quality Management Strategy Guidelines No 16A on dairy waste should be examined before any disposal occurs.

Fig. 1 *Location of Meningie–Narrung area*

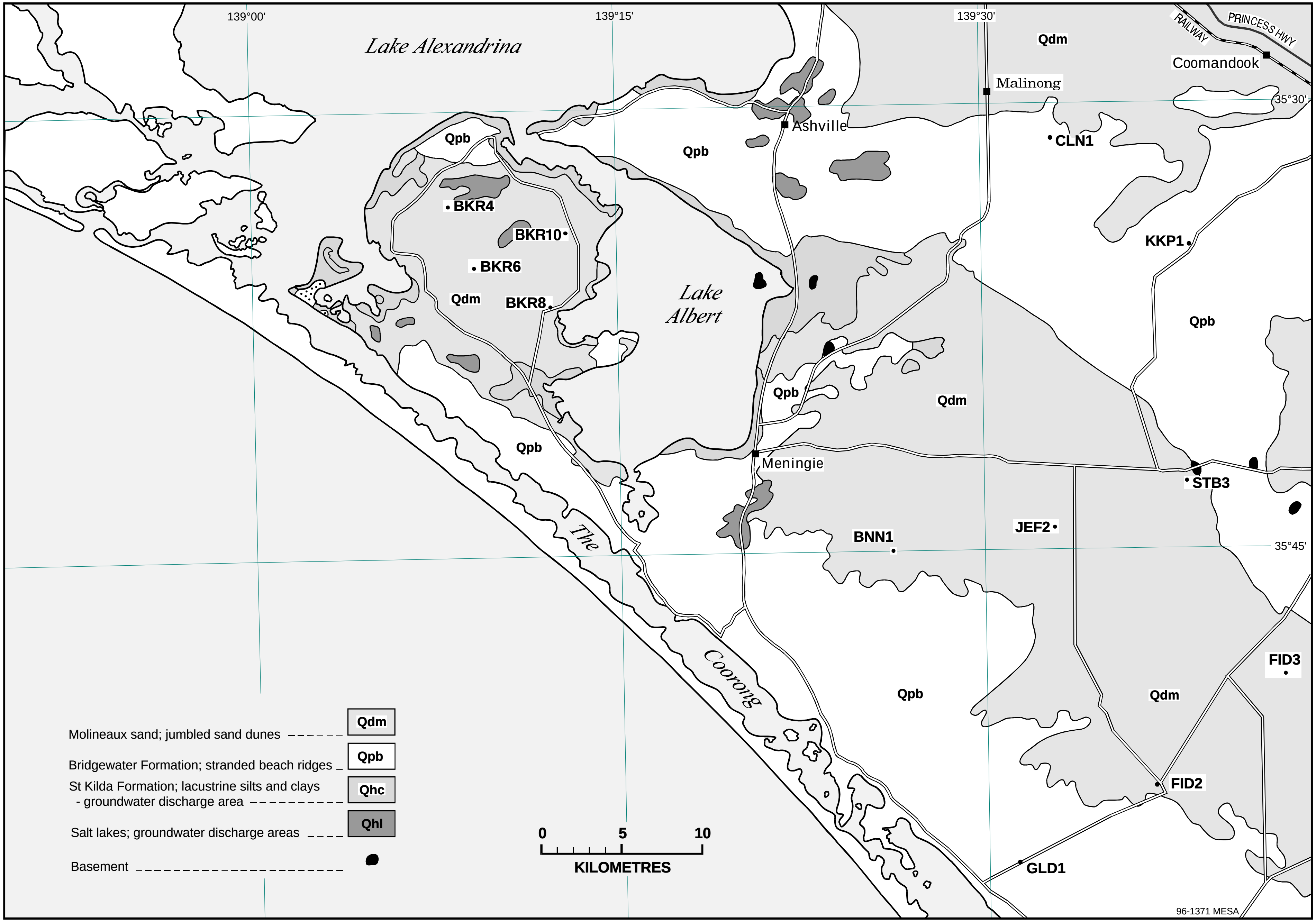

Fig. 2 *Simplified geology of the Meningie–Narrung area*

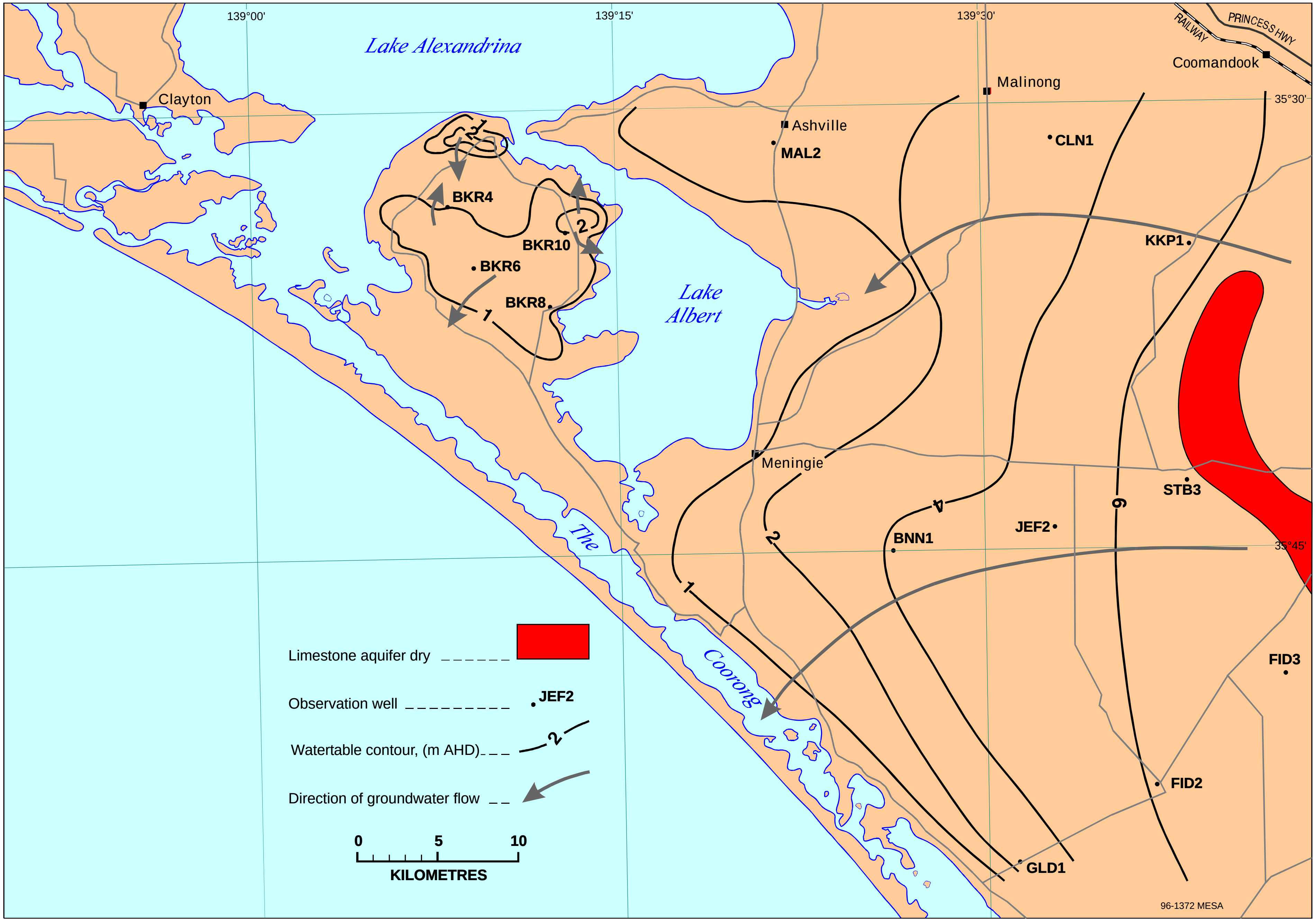

Fig. 3 Watertable contour plan

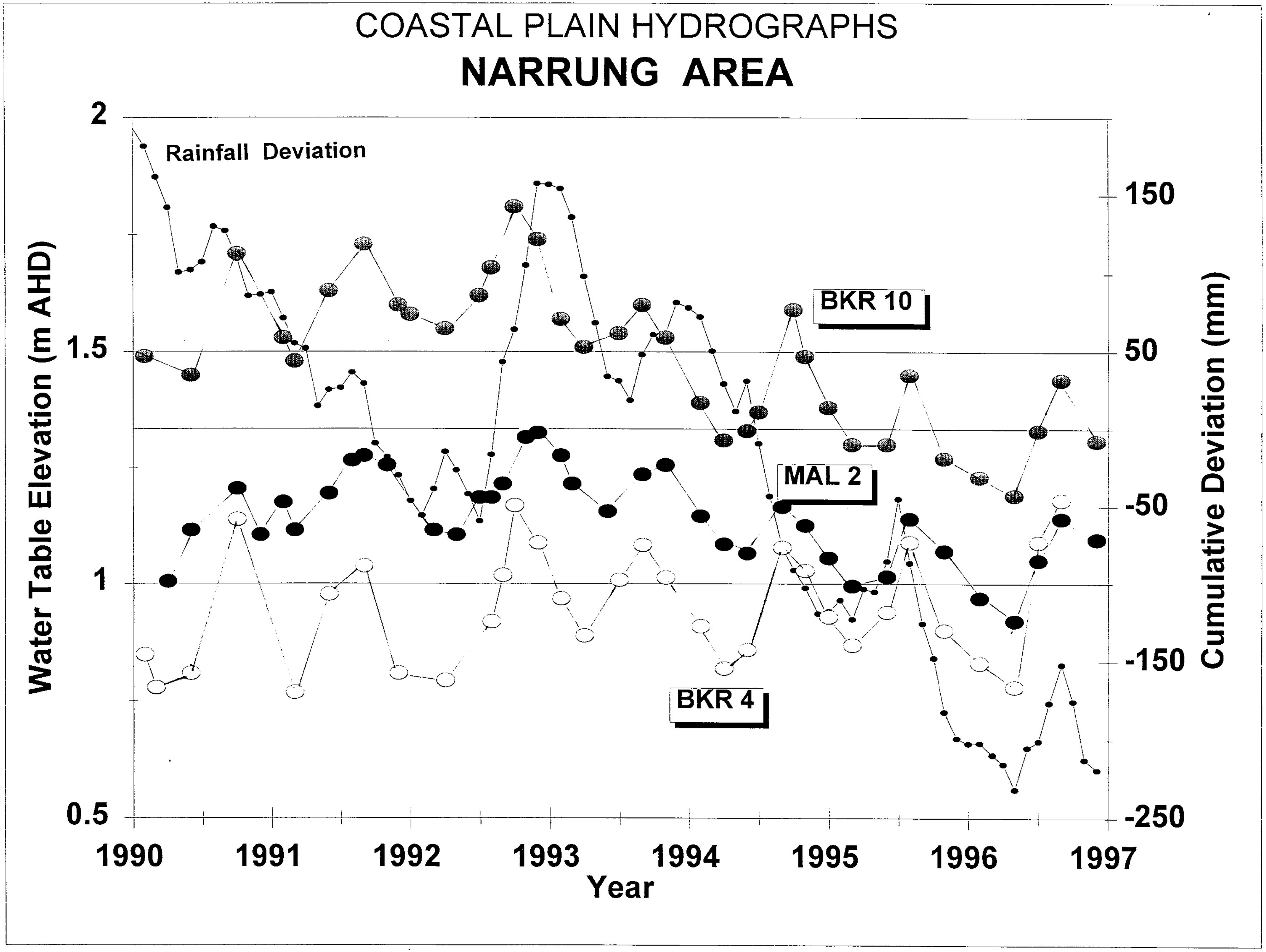

Fig. 4 Hydrographs - Narrung area

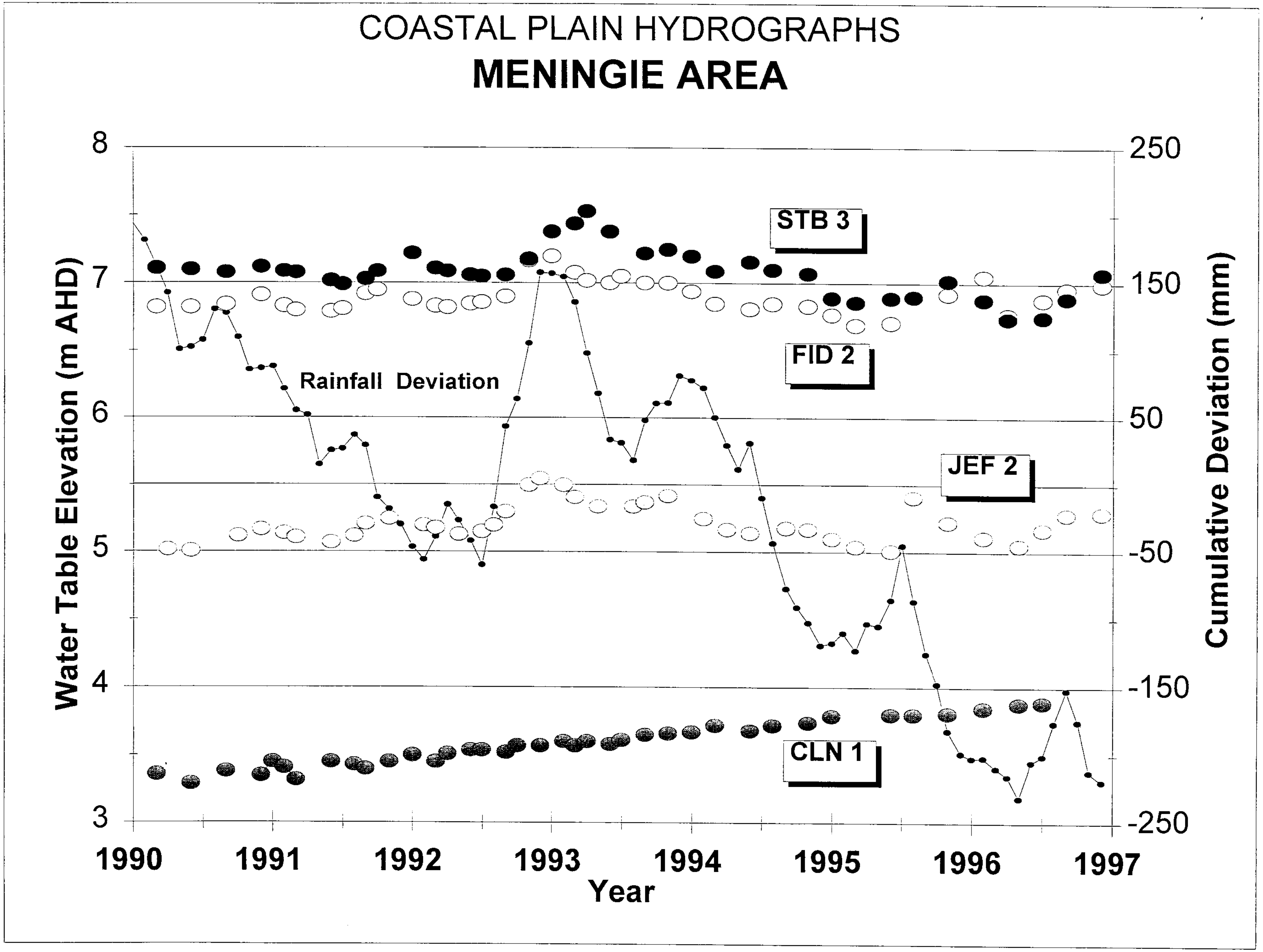

Fig. 5 Hydrographs - Meningie area

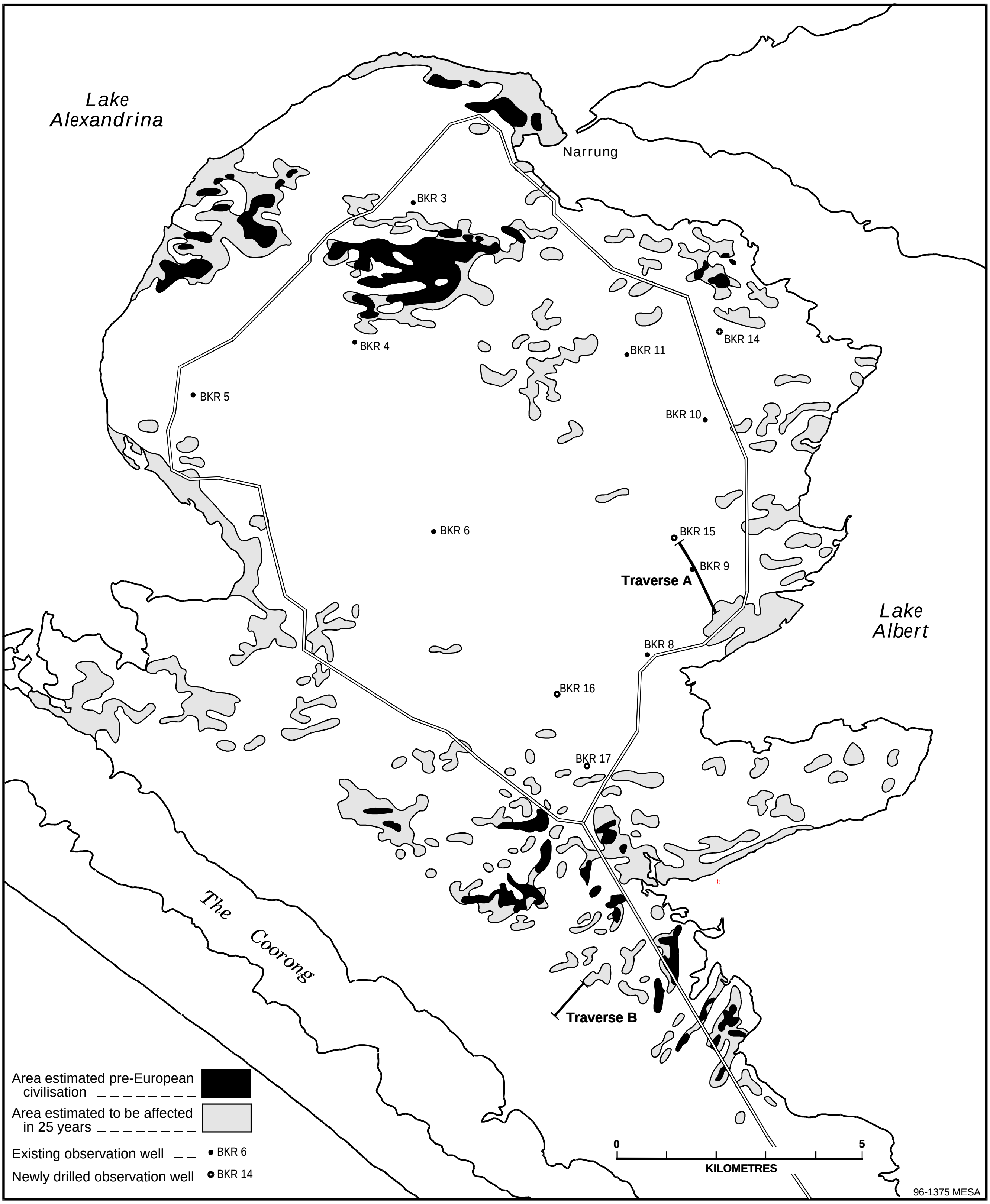

Fig. 6 *Potential area of dryland salinity, Narrung area*

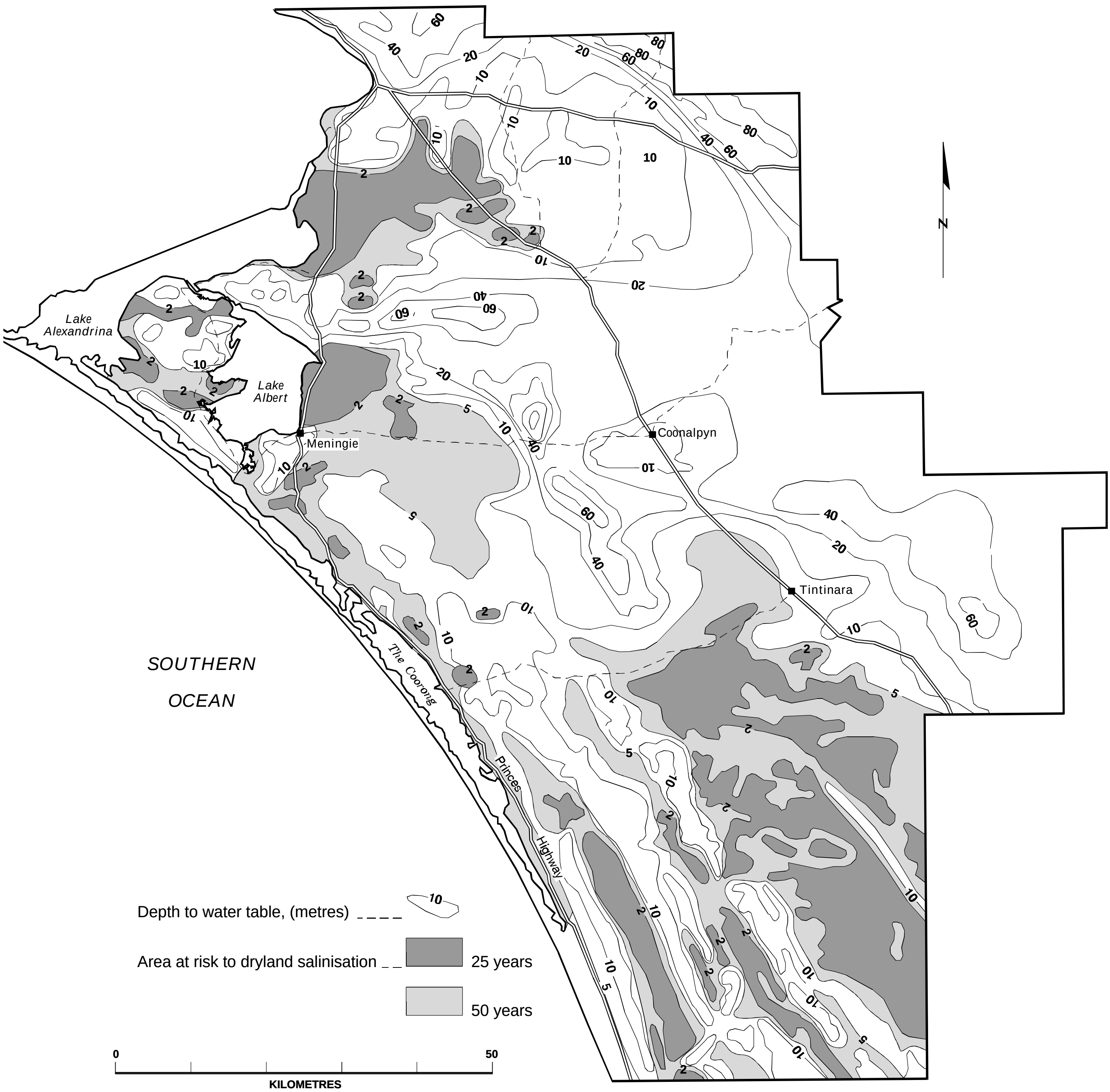

Fig. 7 *Potential area of dryland salinity, Meningie area*

96-1376 MESA

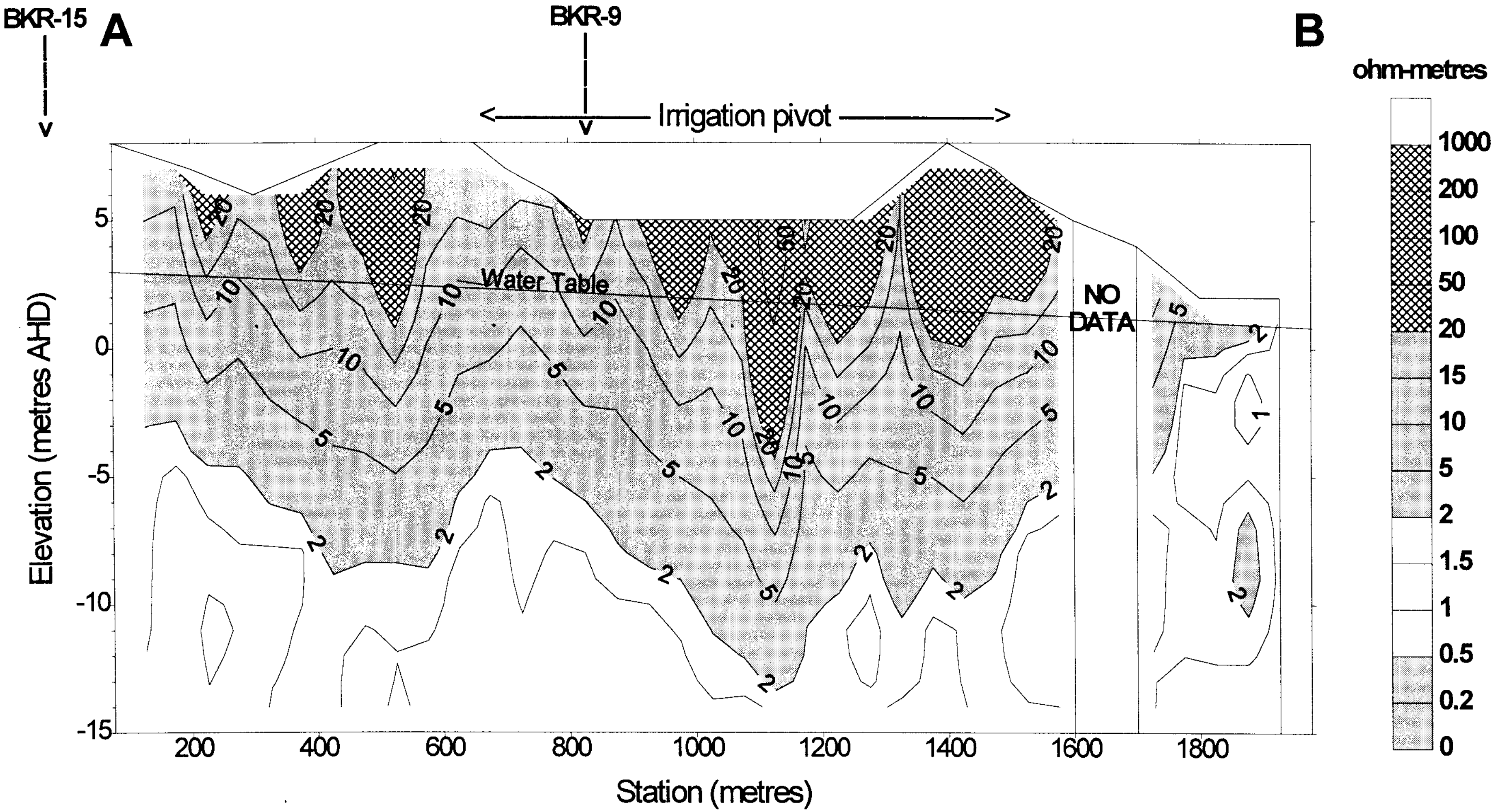

Fig. 8

NARRUNG TEM SURVEY - TRAVERSE A

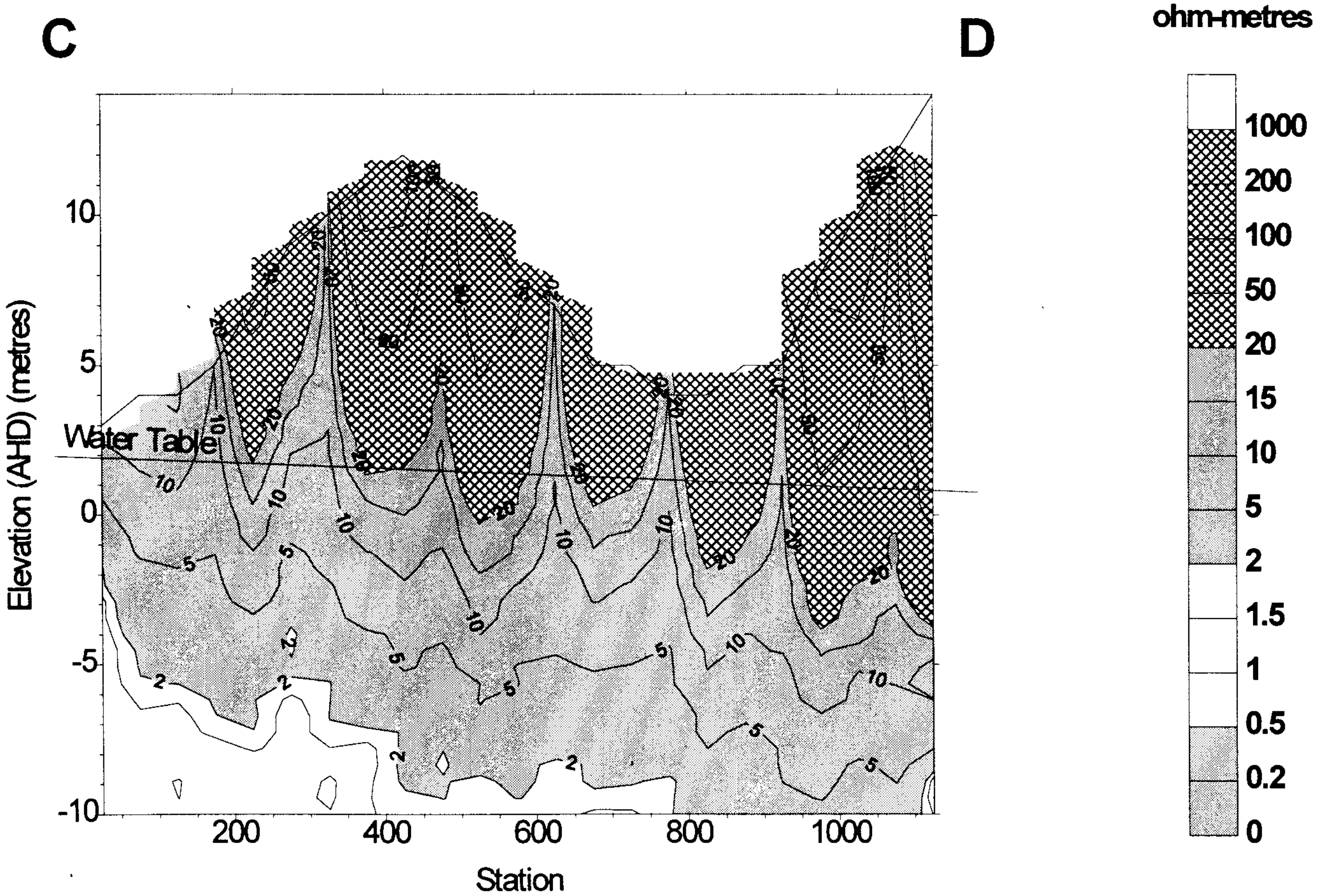

Fig. 9 **NARRUNG TEM SURVEY - TRAVERSE B**

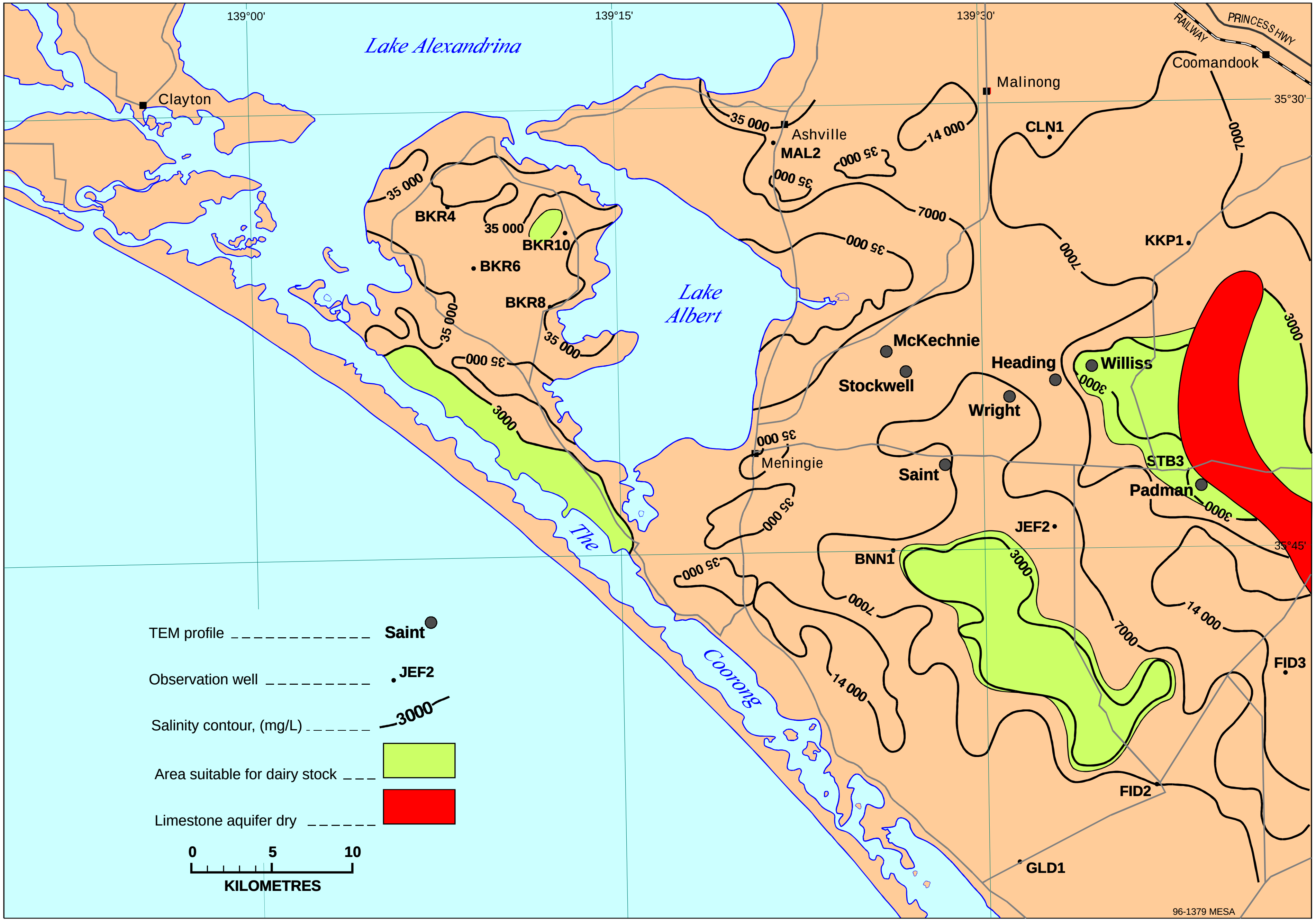

Fig. 10 Groundwater salinity contours and location of TEM profiles

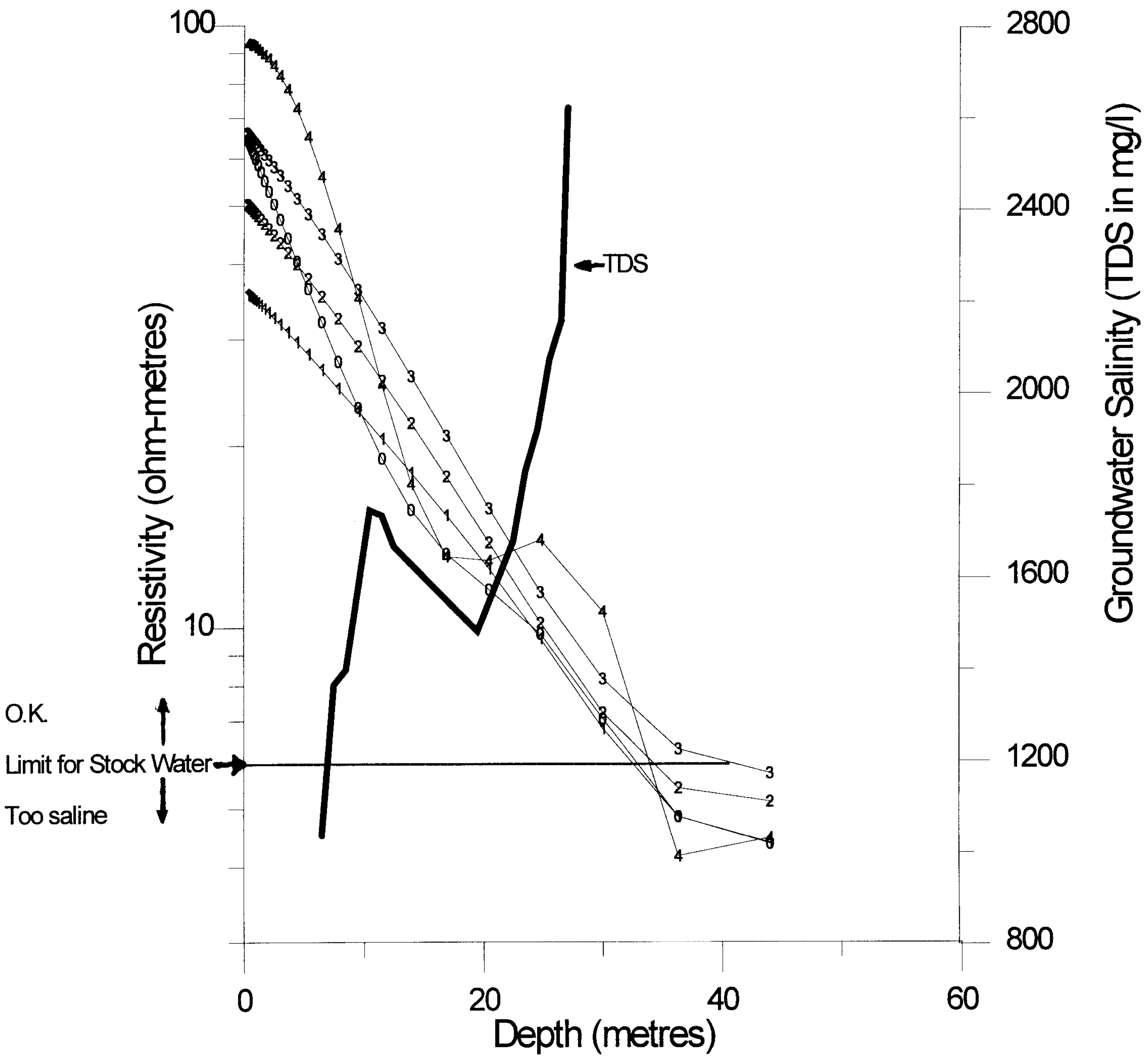

Fig. 11 **TEM SOUNDING RESULTS AND SALINITY PROFILE WILLISS PROPERTY**

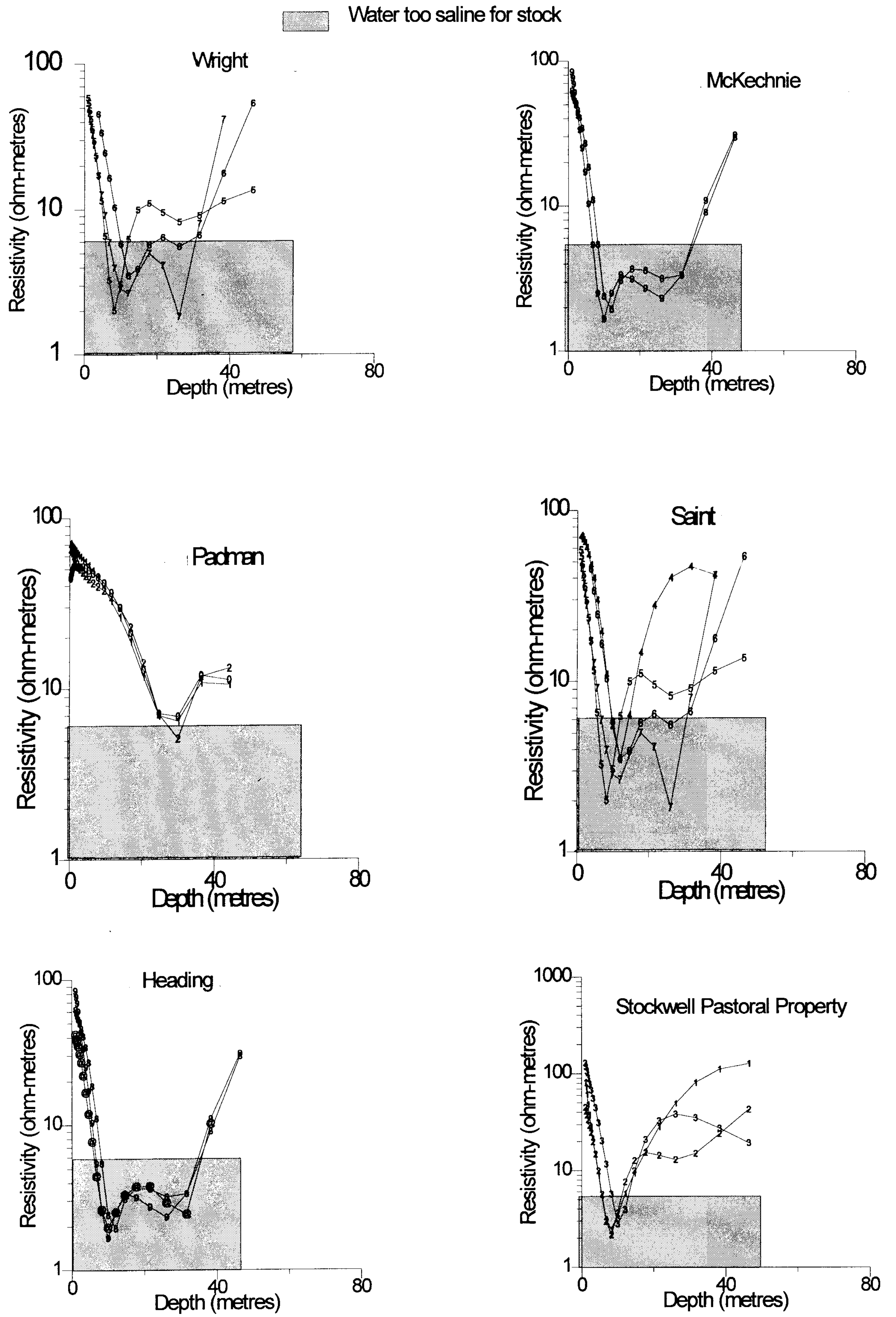

Fig. 12 **TEM SOUNDINGS - MENINGIE EAST**

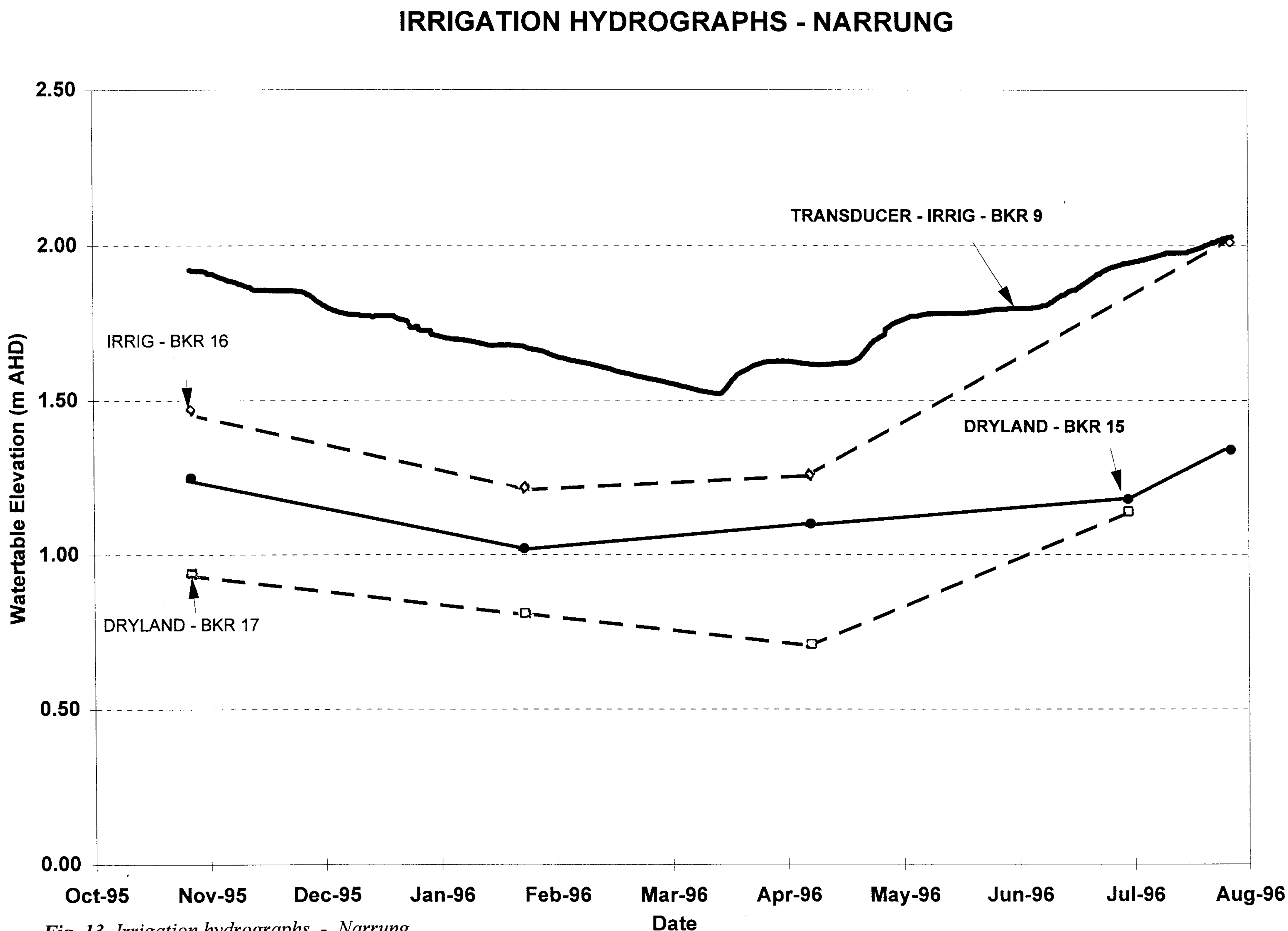

Fig. 13 Irrigation hydrographs - Narrung