PRIMARY INDUSTRIES AND RESOURCES SA

REPORT BOOK 98/12

FEASIBILITY STUDY REPORT FOR THE CITY OF HAPPY VALLEY, NOARLUNGA AND WILLUNGA

THE CONJUNCTIVE USE OF WATER RESOURCES IN THE RURAL TOWNSHIP OF KANGARILLA

by

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and

Darryl Harvey

FEBRUARY 1998 **DME 97/546**

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PRIMARY INDUSTRIES AND RESOURCES
SOUTH AUSTRALIA

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FEASIBILITY STUDY REPORT FOR THE CITY OF HAPPY VALLEY, NOARLUNGA AND WILLUNGA. THE CONJUNCTIVE USE OF WATER RESOURCES IN THE RURAL TOWNSHIP OF KANGARILLA.

Stephen Pugh and Darryl Harvey

INTRODUCTION

The rural township of Kangarilla is comprised of forty domestic properties, a public school, a shop and with an additional 20 domestic properties within the nearby area of Yaroona.

Currently, the potable water supplies are supplied from domestic rainwater tanks and garden water is generally drawn form individual private bores that mostly penetrate the shallow aquifer (Fig. 1). There is no reticulated water supply system nor common effluent disposal system currently in the township.

The future plans for the township include an anticipated infill of twenty domestic dwellings and a new subdivision of fifty allotments with site development to occur over the next twenty years.

The purpose of the investigation is to consider the available options for a water supply for the township and an appropriate waste water management strategy.

ASSUMPTIONS

To assist with calculations of water supply needs for domestic requirements, and wastewater disposal for the township, State mean domestic consumption figures from the SA Water Corporation have been applied.

These figures suggests an average dwelling, with three occupants, has an annual demand of 400 kL per year; 250 kL is used for the garden, and other external uses, whilst the remaining 150 kL is used 'in house'.

Estimates of water requirements and wastewater production.

Requirements for drinking water are excluded from the calculations as they are generally sourced from private rainwater storage tanks, and are relatively low in volume.

The current annual domestic requirements for garden use and general amenities are calculated as follows (further information in appendix):

60 developed housing allotments	23.98*
School, inhouse needs	1.00*
School oval	10.00*
Septic effluent outflow (60 houses)	10.62*

* amounts in megalitres per annum

AVAILABLE WATER RESOURCES

SURFACE WATERS

The local surface water drains to Dashwood Gully Creek, a tributary of which passes through the township. Stream flow of Dashwood Gully Creek has been monitored at gauging station number 503505 by the Department of Environment, Heritage and Aboriginal Affairs (DEHAA) Water Resources between 1972 and 1983.

Records indicate that annual stream flows range from 0 ML to 574 ML, with median flows of approximately 70 ML/annum. Generally, little or no flows are recorded during the summer (November to June), and with peak flows occurring during the period July to October. A graph of recorded stream flow is in Figure 2.

This region is now incorporated in the new Onkaparinga Catchment Board area and policies to determine the amount of surface water that can be diverted are yet to be established. However, in the past DEHAA has required an allocation of approximately 50% of stream flow for the environment. Using this discount factor, this leaves about 35 ML/annum available for diversion to use by the township. From the appended table, 35 ML/annum would service the needs of 60 developed housing allotments plus the school and including the school oval.

If the school oval was irrigated from its own independent well, the 35 ML/annum could be extended to cater for approximately 80–90 houses.

Additional flows could be harnessed from the tributary of Dashwood Gully Creek between Yaroona and Kangarilla.

The limited records of creek water sampling indicate the stream is relatively low in salts, when flowing. Salinity, pH, NO_2- N, NO_3-N, PO_4 and heavy metals were assessed during the period of water sampling. One sample indicated that lindane was detected in the stream waters, however the use of the chemical, an additive in some superphosphates, has since been banned and it is unlikely to be detected in current stream flows.

	Cond. µS/cm	pH	NO_2-N	NO_3-N	PO_4	Al	Cd	Cr	Cu	Pesticide µg/L
Min	70	6.4	<0.01	<0.01	0.0	0.68	<.001	<.002	<.005	.02
Max	670	7.5	0.36	0.02	0.1	9.0	.003	.02	.105	
date										7/8/1978

units are milligrams per Litre unless otherwise stated.

It should be noted that some of the values in above sample range exceed values for potable water, and whilst it is understood that the proposed scheme is for a non potable water supply, care will have to be exercised in advising appropriate warnings and conditions of supply to the community.

SURFACE WATER MANAGEMENT

To adequately manage the future surface water resources, the streamflow, salinity variance and usage of stream flow should be routinely monitored. The Onkaparinga Catchment Water Management Board (OCWMB) should be approached to assist with this monitoring as part of its local water management planning. In addition, any diversion of water for town use may require legal security through a property right. This is an administrative matter that would need to be addressed by Council with the OCWMB.

GROUNDWATER RESOURCES

Groundwater occurs in the Quaternary and Tertiary sedimentary sequence of the valley and within the surrounding and underlying fractured rock aquifer. The location of wells in the townships is given in Figure 3.

In a report by Aldam, water supplies from the sediments are generally, low yielding (less than 5 L/s) though relatively fresh (less than 2000 mg/L).

It should be noted that potable water should generally be less than 1000 mg/L. Salt sensitive garden plants could suffer damage at such levels, however with appropriate management and careful plant selection, acceptable gardens can be maintained with water salinities in the range of 1500–2000 mg/L.

Groundwater supplies from the deeper fractured rock are variable, but records indicate they are higher yielding though more saline, ranging from 500 mg/L to 7000 mg/L.

Natural recharge to the aquifer system is primarily from local rainfall and stream discharge, though a component of lateral groundwater throughflow from the surrounding fractured basement rocks is considered likely.

The MESA report (Aldam), suggests that groundwater in the Kangarilla region has a relationship with local surface water. Locally, surface waters do not flow to the Willunga Prescribed Wells Area (WPWA), though it does recharge the local aquifer system. The groundwater within these alluvial deposits and the underlying fractured rock aquifer move down gradient, almost at right angles to stream flow.

GROUNDWATER MANAGEMENT

MESA has monitored groundwater levels and salinity in wells in the Willunga Basin since the late 1960s. Several observation wells are completed within the hard rock and sedimentary aquifer of Yaroona - Kangarilla townships. The location of these observation wells and their hydrographs is shown in attached Figures 4 and 6.

Current water level monitoring indicates the broader aquifer system is in hydraulic balance, with extractions about equal to the rate of recharge on a long term basis (Figs. 5 & 7). There is some concern with over extraction around well KTP 1 in the sedimentary aquifer, with declining water levels (Fig. 5).

EFFLUENT MANAGEMENT OPTIONS

Currently, septic tank effluent disposal is within each housing allotment through traditional soakage trenches. During winter, local soil conditions, along with high rainfall preclude satisfactory disposal and this can result in surface discharge to neighbouring allotments or to the streets. Such disposal conditions can also result in the contamination of the local groundwater system, particularly the shallow sedimentary sequence.

Septic tank effluent, while usually considered as a waste stream to be disposed of, can also be considered a water resource available for some reuse.

The effluent generated by 80 houses and the school is expected to amounts to 13.4 ML/annum. This calculates to an average flow of 0.45 L/s. through the year.

If this total volume was available for irrigation, it is adequate to irrigate approximately 2 hectares to a depth of 600 mm. This is approximately equivalent to the annual requirements of a football oval. This is a volumetric assessment of the water and does not consider the salinity aspect of the effluent, which would be determined by the quality of domestic inflow water.

Currently, there are indications that the current septic tank effluent disposal systems have the potential to pollute the groundwater system. Contamination can occur by infiltration of effluent through the soil profile, or by effluent, particularly during winter months, flowing across ground surface and down the many domestic supply wells.

There is a duty of care to prevent contamination of groundwater from effluent contamination and there are other options available to manage the town effluent discharge. Some options are:

- onsite Enviro cycle tanks, pump out effluent onto garden/lawns, but there could still be a winter problem. This option would require careful consideration by Council Health committee.
- collective WW Treatment plant (large Enviro cycle system).
- sewage mining and effluent reuse on local parkland/oval/woodlot, etc.
- individual domestic septic tanks discharging effluent into a common effluent drain (CED) to a ‘safe’ lagoon.

If effluent water is stored in CED lagoon, evaporation of ~1 m per year would account for almost all effluent production during the seven dry months of the year, leaving very little for any reuse.

Given the availability of other water resources and the community size, whilst a worthy objective to minimise use of water resources, it is probably not necessary or cost effective to pursue reuse of treated sewage. In addition, without supplementation with other water, recycling will gradually increase water salinity.

USE OF NATURALLY-OCCURRING WATER RESOURCES FOR AQUIFER STORAGE AND RECOVERY (ASR)

PRELIMINARY DISCUSSION

A desk top study suggests that there is generally an adequate volume of quality water available in the Dashwood Gully Creek system to meet the needs of Kangarilla during the anticipated development of the next 20 years. Peak flows are generally of short duration, and predominantly within the 4 month period between July-October.

The problem is how to harvest and store the stream flow for later reuse.

The Groundwater Program of Primary Industry and Resources South Australia (previously known as the Groundwater Branch of Mines and Energy Resources South Australia) has developed expertise in the storage of water resources in local aquifers for recovery and reuse. The technique is referred to as aquifer storage and recovery (ASR).

There are two aquifers basically available in the township area, the younger shallower sedimentary sequence and the deeper fractured rock aquifer. Whilst there can often be substantial variation in wells within the same aquifer, some of the expected characteristics are:

sedimentary sequence aquifer: low yield, generally less than 5 litre/sec. Salinity is generally less than 2000 mg/L. Can be difficult to develop and manage as they can require the use of sand screens to preclude sediments. Such characteristics can be difficult for injection of water and then a latter reversal of flow during extraction phase.

fracture rock aquifer: moderate yield, generally up to about 10 litre/sec. Salinity is highly variable and can be as high as 7000 mg/L. Fractures generally allow reverse flow of water. Total storage capacity is difficult to estimate without testing.

ASR CONCEPTUAL MODEL

Subject to completion of a satisfactory well and storage capacity testing, the fractured rock is the preferred aquifer for the proposal of storing creek flow for later reuse by the town.

The high salinity of the native fractured rock groundwater is not necessarily seen as an impediment as mixing of injectant and native groundwater can form a protective buffer zone around later high quality injectant. Field trials at various ASR sites have shown that there is generally a relatively high recovery rate of useable quality water. The initial injection volume may have to be in excess of the intended extraction volume to allow for a sacrifice in creating the buffer zone.

If the system is monitored and managed appropriately, there may only be the need for a relatively small annual maintenance to the mixing zone. Bubbles or lenses of injected water can be relatively stable as lateral movement of groundwater down gradient can be less than one metre per year. Whilst there is a relatively high level of predictability, if best management practises are observed, site testing is necessary to quantify storage efficiency values for individual sites.

MESA information sheet, *Aquifer Storage and Recovery, directions for water resource management*, provides additional information on the ASR processes and South Australian sites.

ASR INJECTION

Subject to capacity testing of the fractured rock aquifer, during years of high creek flow, additional water could be stored to offset any flow volume deficiencies of low rainfall years.

Whilst yields of up to 10 L/sec are expected in the local fractured rock aquifers, at an injection rate of 5 L/sec, the mean annual flow availability of 35 megalitres could be injected in 81 days. Injection can be by gravity or by pump. The increased pressure from pumping may increase the rate at which injection can occur. Again, this is site specific and should be tested.

CREEK IMPOUNDMENT

It is usual to create some ‘in stream’ or ‘off stream’ structure to impound water prior to injection. This detention allows for settling of sediment prior to injection. Depending upon capacity, the storage also allows for high flows, which may occur for short periods of time, to be injected over longer periods of time, thus increasing the volume that can be injected. If high flow, high quality, water is captured for injection, it may be unnecessary to extend pretreatment beyond the settling out of sediments. Mechanical filtration may be an option if stream flow contains suspended particles which will not settle within a reasonable period of time.

BIOLOGICAL CONTAMINANTS

Trials have indicated that a number of biological organisms are destroyed during residency in the aquifer, however water analysis of stream water would be necessary for a more definitive comment. As water is proposed for non potable uses, the potential for biological contamination may be of low immediate interest.

TOWN WATER SUPPLY PUMP

The ASR well would also be equipped with a suitable submersible pump capable of extracting and raising to an elevated storage the town’s water requirements. SA Water literature recommends a pump with a capacity of 3.2 times the average consumption. For a town of 80 dwellings and a school (but excluding the school grounds) this equates to a pump capacity of 3.3 litre/sec.

TOWN WATER SUPPLY TANKS

SA Water do have recommendations on tank storage capacity, but the final decision is an assessment of risk against pump failure, excess and emergency demands.

SCHOOL GROUNDS REQUIREMENTS

Provision for school grounds irrigation needs has been excluded as it already has own water provision. Alternatively, it may provide an option for the consumption of town effluent stream. Should the school wish to pay the necessary costs to take oval water from the town system, an additional 10 megalitres per annum would be required from the town water supply system.

It should be appreciated that the irrigation needs of a well-maintained oval would be equivalent to the demands of approximately 40 developed housing allotments.

Because the school grounds may be a significantly large consumer of water, direct negotiations should occur between the school management and the community water system manager.

ROLE OF THE ENVIRONMENT PROTECTION AUTHORITY

Establishment of an ASR project for the township of Kangarilla would require approval from the Environment Protection Agency (EPA). On an appropriate application, the EPA would grant a demonstration licence and during its currency, the ASR scheme would be tested and appropriately monitored. A significant component of the licence condition involves the collection and analysis of water samples. This should be seen as a risk management strategy. On expiration of the demonstration licence, subject to agreed management and monitoring program, an operational licence is generally granted.

GENERAL COMMENT

It is believed that it may be unnecessary to capture and store urban stormwater at the Kangarilla site because of the adequacy and quality of Dashwood Creek flows. Excess stormwater from local urban run off (street and roof) should be allowed to pass directly to the creek system, but a duty of care should be exercised to minimise pollution. However, excess roof runoff is suitable for direct recharge of domestic groundwater wells and this should be encouraged.

It should be noted that an ASR well does not have to be sited adjacent to impoundment structure; injection water can be piped (gravity or pump) to a remotely located ASR well.

In general, activities relating to groundwater recharge and extraction at Kangarilla are unlikely to have a measurable impact for down stream groundwater users because of the relatively low volumes of recharge and extraction and the activity will be relatively in balance.

Should town water demand outstrip the creek supply, some supplement from an independent groundwater well could be mixed with the high quality water of the ASR system.

THE WAY FORWARD

Regardless of the decision on the use of an ASR water supply, the town should advance to septic tank effluent management. Apart from the obvious amenity and health risk issues, there is a risk of groundwater contamination with the present disposal management system.

If a decision is made to proceed in principle with an ASR scheme, and subject to funding arrangements, the following steps are suggested in the decision process. It is recommended that a groundwater consultant's services be used for the establishment, testing and commissioning phase of an ASR project. The consultant would also assist in EPA licence application process and negotiations with OCWMB for the assurance of creek water allocation. Tasks to be addressed are:

- Commence monitoring stream flow, and catchment character to assess any pollution risks to creek flow.
- Communicate intentions to OCWMB of establishing an ASR town water suppply.
- Canvass town community for indication of any special water demands, particularly the school grounds.
- Consider options for creek water impoundment sites.
- Select ASR well site, giving consideration to proximity of :
  - recharge water source
  - rising main to town water system
  - suitable power supply
  - general access for service during flood conditions.
- Construct ASR well into fractured rock aquifer.
- Test aquifer for:
  - yield
  - recovery
  - storage capacity
  - water quality.
- Construct impoundment structure (or structures) with overflow spill.
- Select and install extraction pump with appropriate monitoring equipment.
- Test impoundment process, ASR operation, and establish procedures and monitoring program suitable for EPA approval.
- Acquire ASR operational licence from EPA.
- Install town reticulation system and connect ASR supply.

BUDGET COSTS TO ESTABLISH AN ASR SITE

An indicative cost of completing a 100 m deep, 150 mm diameter production well, within the local fractured rock system is approximately	$7500
Well development and aquifer testing ; yield, recovery and storage recovery	$10000
Estimated cost to equip well with submersible pump with control equipment. Determination of pump specification is subject to duty, ie depth of water and head to be pumped against to discharge into storage tanks.	$10000
If injection pump and filter is required for aquifer recharge	$7000
Groundwater consultant, subject to services required	$3000-$8000

Additional costs, which are very site dependent, are for :

- construction of diversion and impoundment tructure at creek site
- cost of electric power supply to ASR site
- cost of rising main to town reticulation site.

SUMMARY

The current system of harnessing rainfall and storing in tanks for potable water is appropriate for this township and should be supported. This provides private potable water supplies to each housing allotment.

The most practical wastewater management for the community would be a common effluent drain to a lined effluent disposal pond. Evaporation would account for the majority of wastewater, whilst irrigation of an area close to the pond would also be a suitable end use.

When the local creek flows are of low salinity and more than sufficient to meet environmental flow requirements, the available water should be stored for sediment settlement and then injected into the local fractured rock aquifer through a purpose built ASR well.

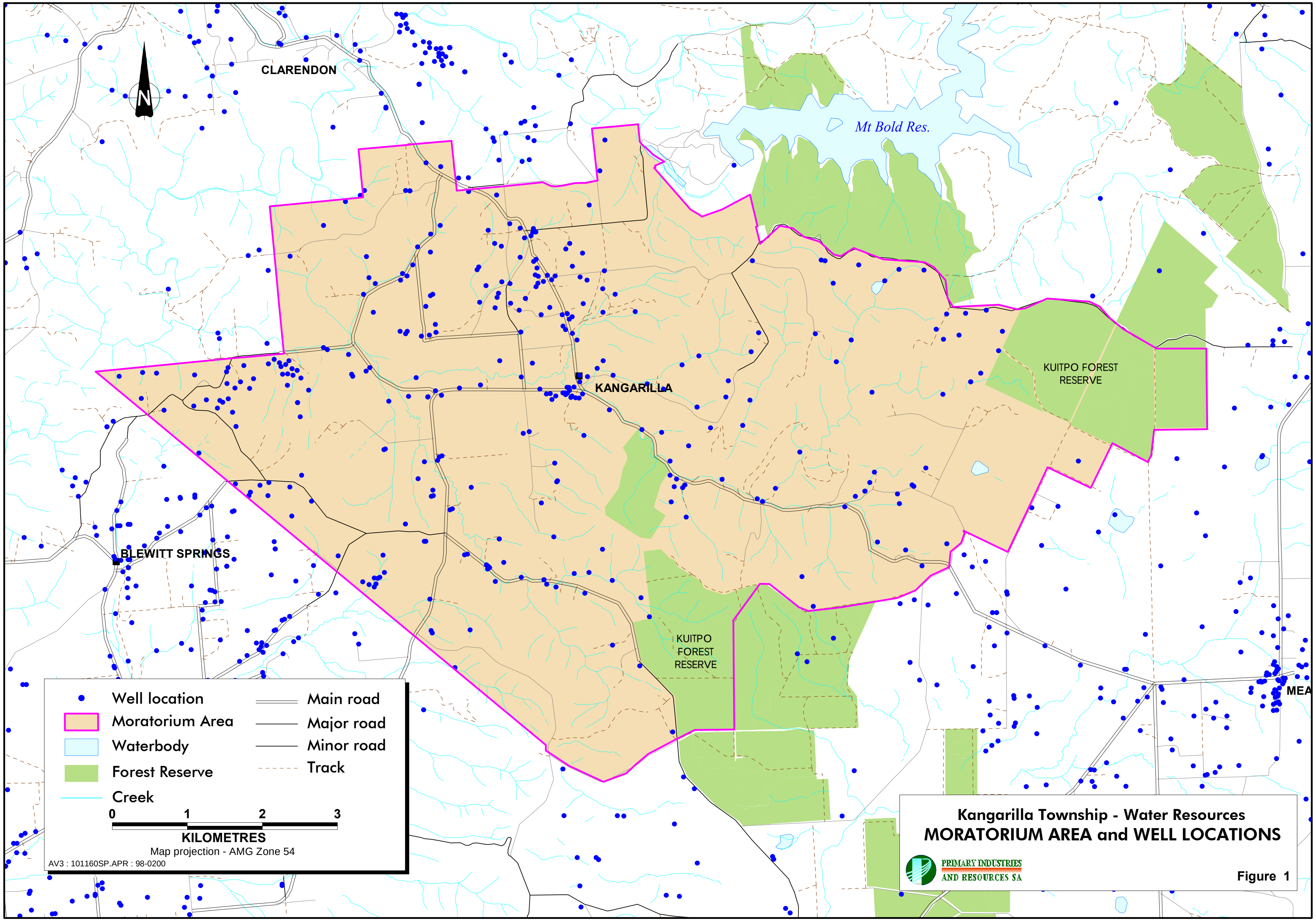
The recharge well would also contain a submersible pump capable of extracting the towns water needs and raising it to elevated storages for gravity feed to the township.

Local surface water has limited flow and quality data available and it is suggested that the Council undertake regular monitoring planning of future needs. The stream water data available indicates low to very low salinity, uncontaminated water, with available flows for recharge in most years.

An ASR water supply scheme for the projected needs of Kangarilla are unlikely to have any detrimental impacts on other groundwater users in the region.

REFERENCES

Aldam, R.G. Willunga Basin Appraisal of water resources in the north east moratorium area.. *South Australia. Department of Mines and Energy* unpublished report book, 94/41.



CLARENDON
N
Mt Bold Res.
KANGARILLA
KUITPO FOREST RESERVE
BLEWITT SPRINGS
KUITPO FOREST RESERVE
MEA
Well location
Moratorium Area
Waterbody
Forest Reserve
Creek
Main road
Major road
Minor road
Track
0
1
2
3
KILOMETRES
Map projection - AMG Zone 54
AV3 : 101160SP.APR : 98-0200
Kangarilla Township - Water Resources
MORATORIUM AREA and WELL LOCATIONS
PRIMARY INDUSTRIES AND RESOURCES SA
Figure 1

Stream Gauging station 5030505 - Dashwood Gully

year	jan	feb	mar	apr	may	jun	jul	aug	sept	oct	nov	dec	auto sum
1972	0	0	0	0	0	0	0	0	0	0	0	0	
1973	0.01	0.04	0	0.02	0.16	20.82	78.92	108.5	179.9	17.03	0.81	0	406.21
1974	0.04	0.39	0.01	0.1	0.88	2.08	97.21	69.46	83.77	134.2	3.2	0	391.34
1975	0	0	0.18	0.01	4.37	0.5	33.61	38.9	14.55	99.32	16.43	0	207.87
1976	0	0	0	0.06	0.02	0.26	0.11	1.37	1.56	47.94	0.82	0	52.14
1977	0	0	0.05	0.09	1.19	7.66	14.07	8.16	16.48	0.46	0	0	48.16
1978	0	0	0	0	0	2.47	48.44	83.87	41.56	1.2	0.1	0	177.64
1979	0	0	0	0.13	0.47	0.33	23.1	70.46	111.4	76.87	2.43	0	285.19
1980	0	0	0	0	0.09	1.35	11.92	13.81	6.63	22.04	6.23	0	62.07
1981	0	0	0	0.06	0.32	90.43	204.7	258.4	17.17	2.66	0.29	0.7	574.73
1982	0.01	0	0.08	0.26	0.32	1.14	1.07	0.59	0.22	0.3	0	0	3.99
1983	0	0	0	0	0	0	0	0	0	0	0	0	0

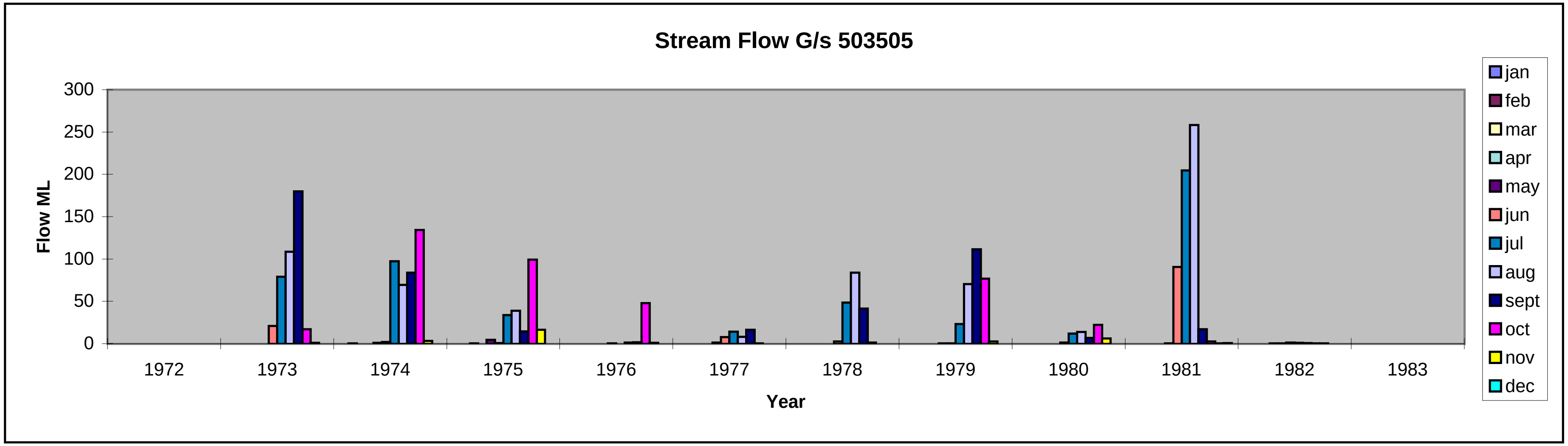
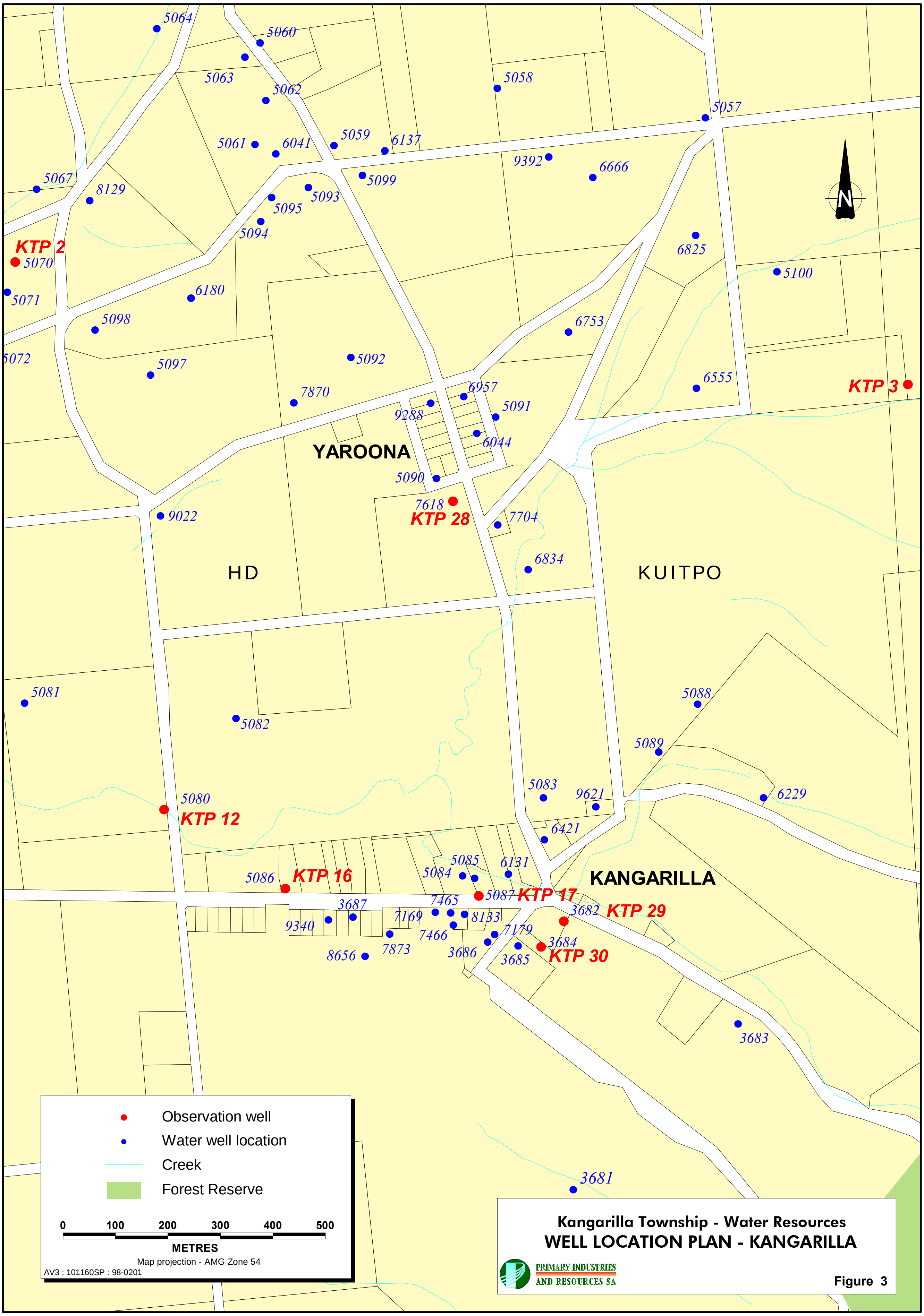


Figure 2



N
YAROONA
HD
KUITPO
KANGARILLA
KTP 2
KTP 3
KTP 12
KTP 16
KTP 17
KTP 28
KTP 29
KTP 30
5064
5060
5063
5062
5058
5057
5061
6041
5059
6137
9392
6666
5099
5067
8129
5093
5095
5094
6825
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5071
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5072
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6044
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9621
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5080
6421
5085
6131
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5086
5087
3687
7465
7169
8133
9340
3682
7466
7179
8656
7873
3686
3684
3685
3683
3681
Observation well
Water well location
Creek
Forest Reserve
0
100
200
300
400
500
METRES
Map projection - AMG Zone 54
AV3 : 101160SP : 98-0201
Kangarilla Township - Water Resources
WELL LOCATION PLAN - KANGARILLA
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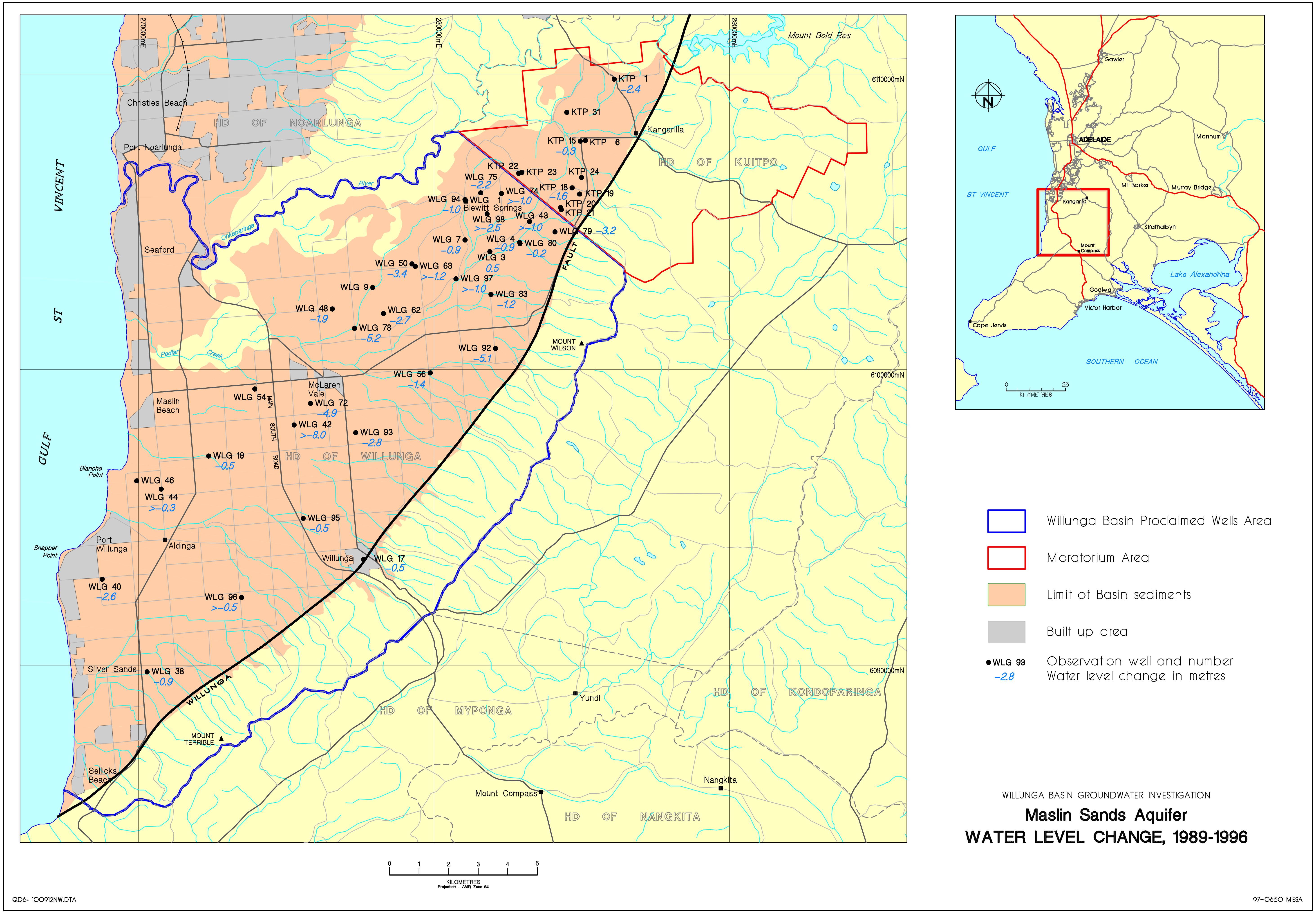
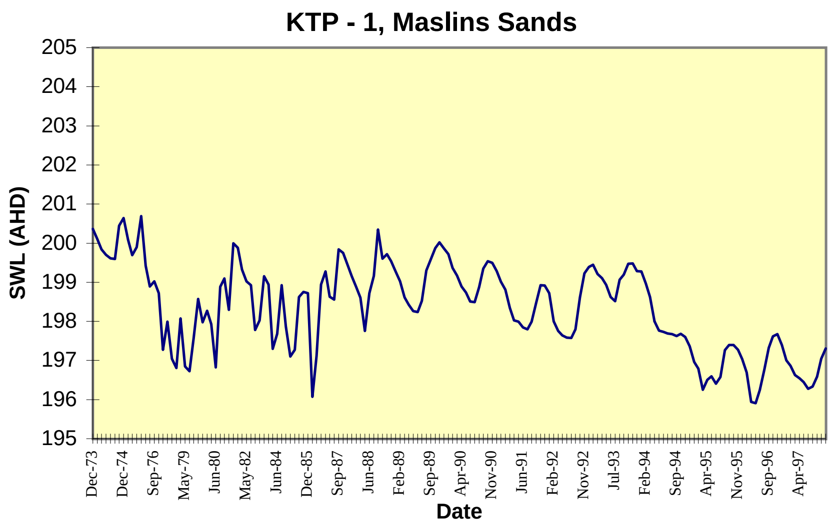
Figure 3

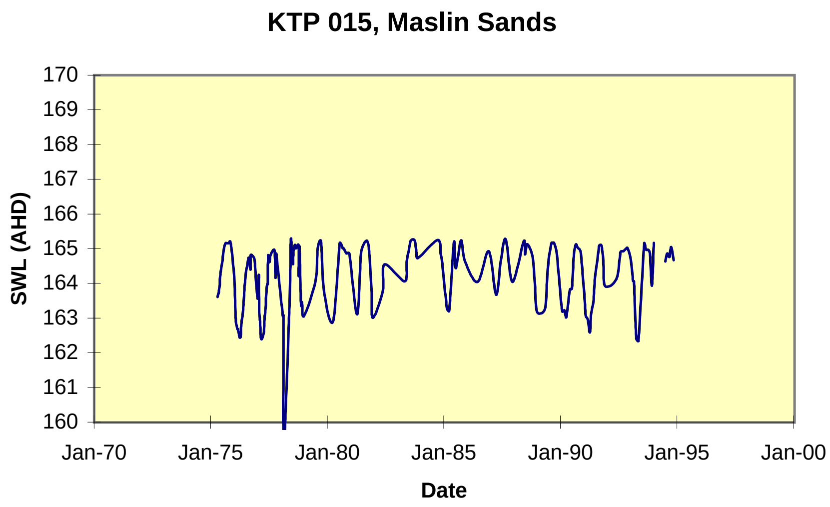


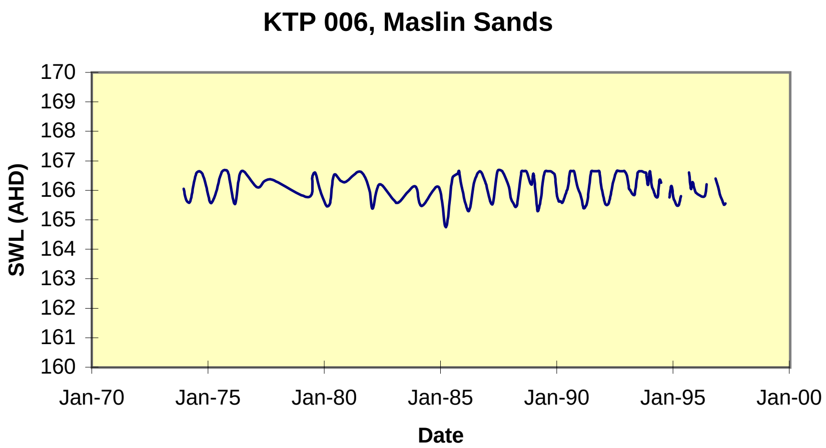
WILLUNGA BASIN GROUNDWATER INVESTIGATION

Maslin Sands Aquifer
WATER LEVEL CHANGE, 1989-1996

Maslin Sand Aquifer - hydrographs







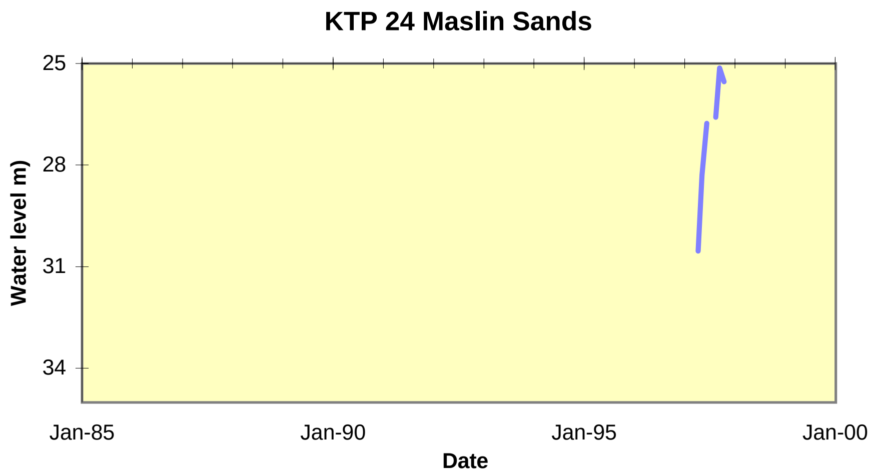
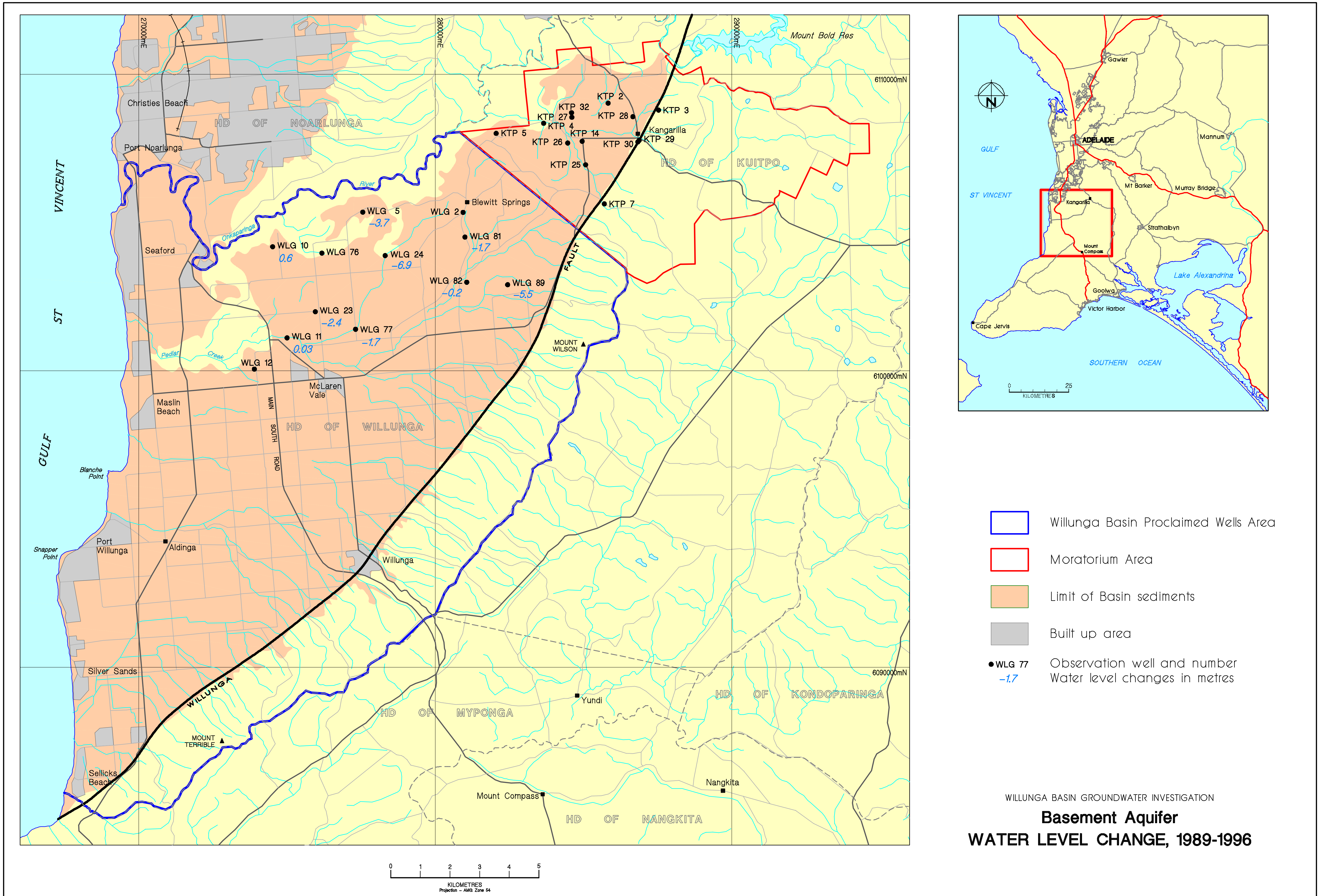


Figure 5



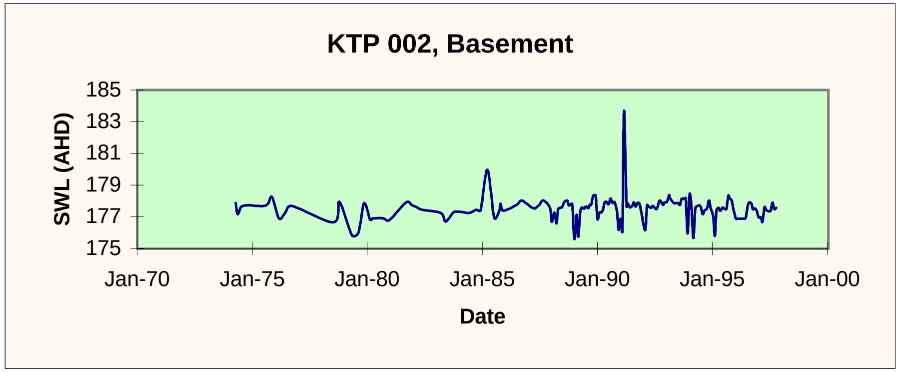
WILLUNGA BASIN GROUNDWATER INVESTIGATION

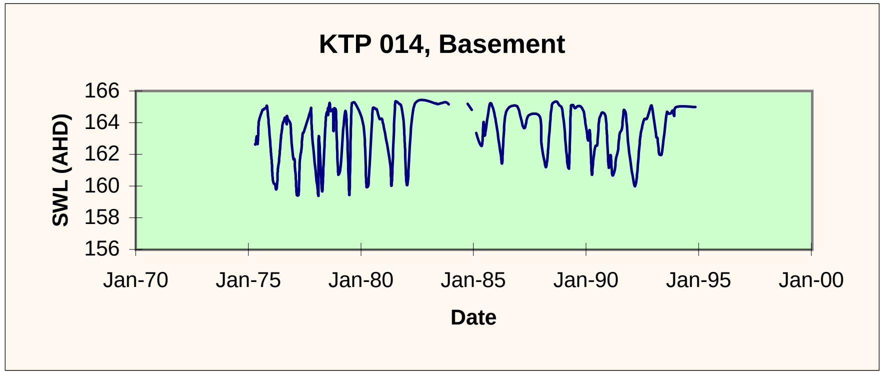
Basement Aquifer
WATER LEVEL CHANGE, 1989-1996

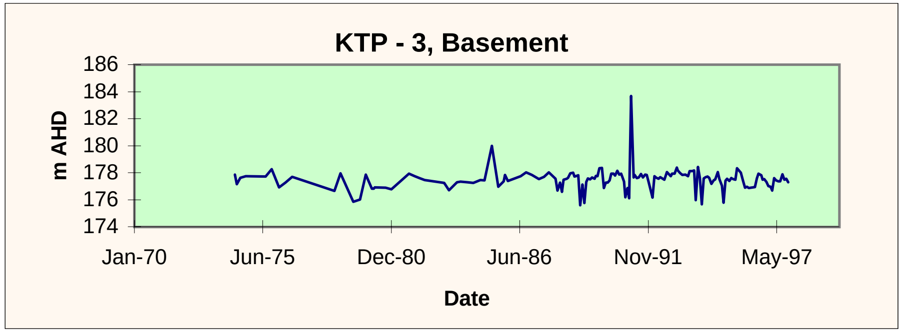
GD6: 100912NW.DTA

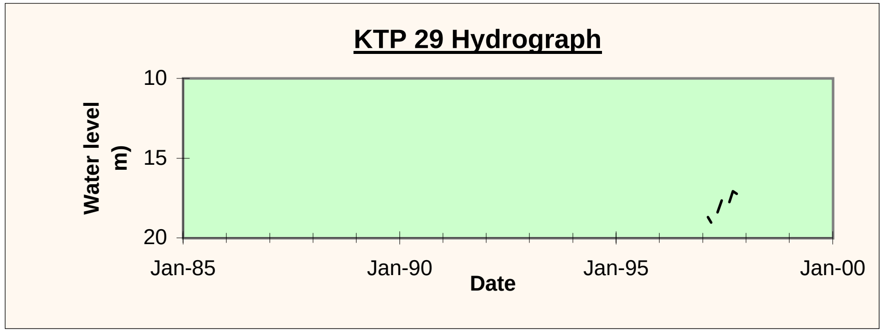
97-0652 MESA

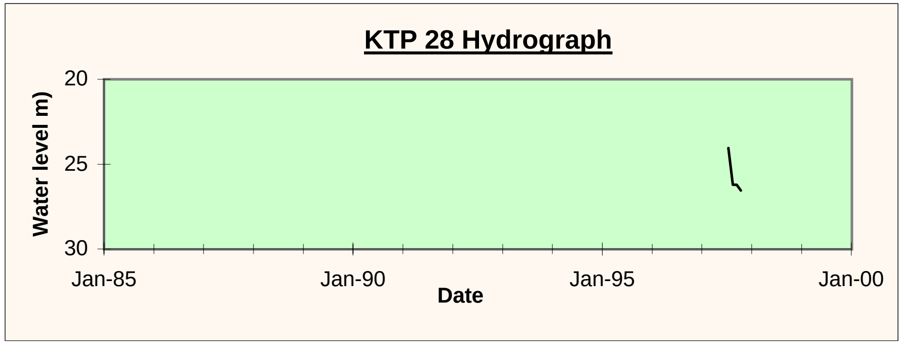
Fractured Rock Aquifer - hydrographs











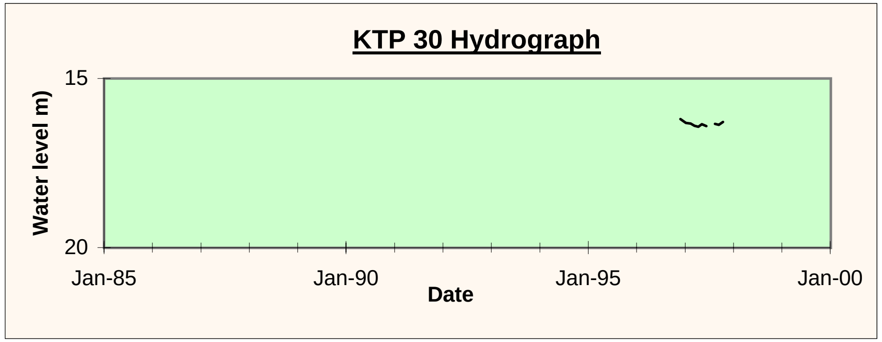


Figure 7