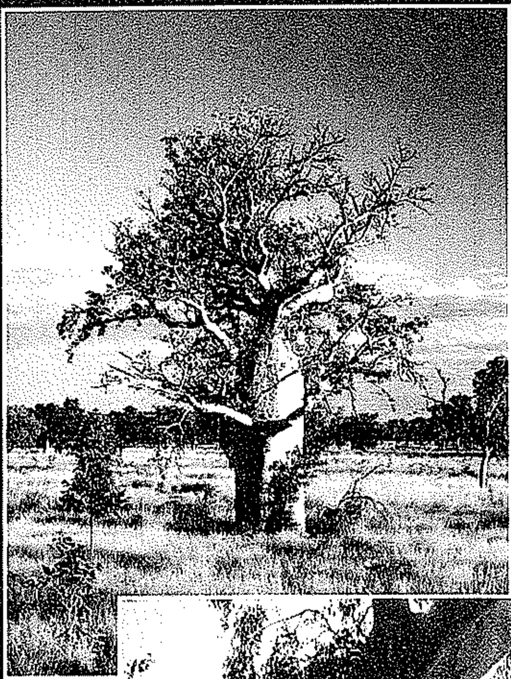
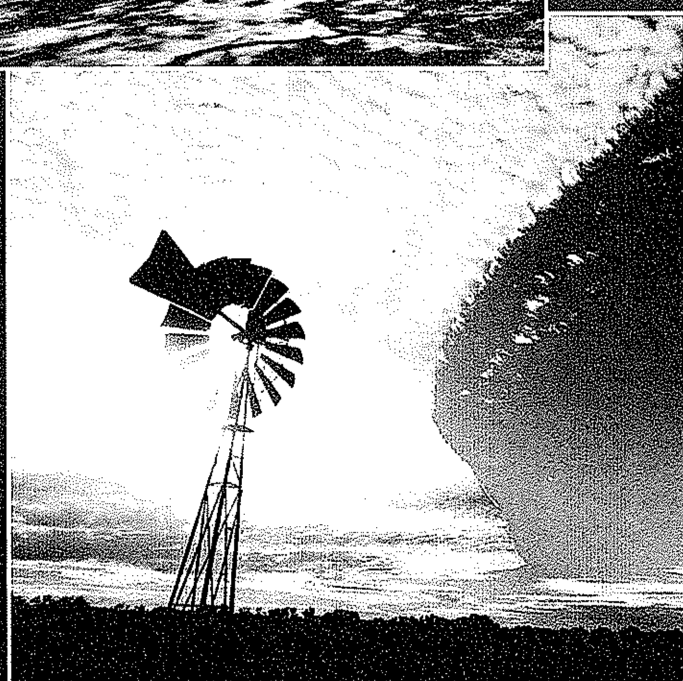


DERBY GROUNDWATER MANAGEMENT PLAN



December 1992

Water Authority
of Western Australia

Water Resources Directorate
Groundwater and Environment Branch

Derby Groundwater Management Plan

December 1992

Produced by Groundwater and Environment Branch,
Water Authority of Western Australia.

The essential principles of the Derby Groundwater Management Plan were endorsed by the Board of the Water Authority of WA on 17th September, 1992.

Water Authority
of Western Australia

Acknowledgements

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1. INTRODUCTION

1.1 Location

Derby is located 2366 km north east of Perth by road, in the south-west Kimberley region of Western Australia, Figure 1. The township is located within the Shire of Derby/West Kimberley and is the administrative centre for the municipality. Derby is a coastal township and is situated on a small north westerly trending peninsula, which is flanked by tidal mud flats of King Sound. The township is linked to the Great Northern Highway and the Gibb River Road by the Derby Highway.

Derby and the surrounding region are detailed on the following topographic and cadastral plans.

Topographic and Cadastral Plans
· Derby SE 51-7, 1:250 000 Topographic · Derby 3663, 1:100 000 Topographic · Derby 3663-III NE, 1:25 000 Cadastral · Derby 3663-III SE, 1:25 000 Cadastral · Butler 5000 CK 75/01.02, 1:5 000 Cadastral · Butler 5000 CK 75/03.03, 1:5 000 Cadastral · Butler 5000 CK 75/02.02, 1:5 000 Cadastral · Butler 5000 CK 75/02.03, 1:5 000 Cadastral

1.2 Town Water Supply

The Derby town water supply is drawn entirely from groundwater resources and is supplied to the residential and industrial areas but not the rural or special rural areas. In June 1991, 975 water services were registered, with an annual consumption of 913 626 m^3/a.

1.3 Groundwater Overview

Derby is reliant on groundwater for both town and private water supply needs. The Derby groundwater resources comprise both unconfined and confined aquifers which exist beneath the Derby peninsula and have substantial inland areal extent. The confined aquifer has superior water quality characteristics compared to the unconfined aquifer, having lower levels of iron, manganese and total dissolved solids (TDS). Well distributions on the Derby peninsula are presented on Plan 1 and in Figures 2 and 3.

From the 1960's to the mid 1980's, only the unconfined aquifer was utilized for town water supply purposes. Since the mid 1980's, the confined aquifer has been the preferred town water supply source and the unconfined wells are gradually being replaced.

Private and municipal use of groundwater in the region includes consumption for domestic purposes and watering of public areas, recreation facilities and institutional gardens.

Groundwater is also used to a limited extent for horticultural and agricultural purposes. Water for private and municipal purposes is generally drawn from the unconfined aquifer, although there are some exceptions.

The confined and unconfined aquifers are both susceptible to saltwater intrusion, because of Derby's situation on a coastal peninsula. Previous studies have indicated that abstraction from the peninsula resources exceeds the estimated recharge and throughflow and therefor saltwater intrusion is a significant threat.

1.4 Water Authority Charter

Groundwater resource utilization and conservation in Western Australian country areas is administered by the Water Authority in accordance with the Rights in Water and Irrigation Act 1914 and the Water Authority Act 1984.

Under the Rights in Water and Irrigation Act, the right to the use, flow and control of groundwater is vested in the Crown. This Act requires the compulsory licensing of all artesian wells throughout Western Australia. In addition, non-artesian wells within specific areas, proclaimed under the Act as Groundwater Areas, require licensing. Provision exists for exemption of stock and domestic supplies from licensing requirements if appropriate.

1.5 Derby Groundwater Area

The Derby Groundwater Area was proclaimed on 5 April 1968 (DWG 44571), amended on 30 June 1972 (DWG 47270) and amended again to the present configuration on 22 September 1986 (DWG AR56). The existing Groundwater Area covers the Derby peninsula as far south as the Knowsley Agricultural Area, Plan 1 and Figure 2. It should be noted that there is some confusion as to the exact boundary of the Groundwater Area, as the declaration relates to the low water mark while the accompanying plan relates to the high water mark. The declaration is being amended to relate to the high water mark in accordance with the plan.

Recommendations have been made to significantly increase the Derby Groundwater Area by extending it further to the south and east, (WAWA 1989).

1.6 Objectives of the Management Plan

The objectives of this management plan are firstly, to summarize the resource characteristics and groundwater abstraction details of the Derby Groundwater Area, and secondly to provide recommendations for management of the resource, in accordance with the beneficial uses. The Derby peninsula groundwater resources are utilized for both town water supply and private purposes and a management strategy is essential to protect the users and to conserve the resource.

2. PREVIOUS INVESTIGATION

Important details of groundwater development and investigation can be summarized chronologically as follows:

- Myall's artesian bore was drilled in 1911 to a depth of 322 m. The well, located near the junction of the Derby and Gibb River Roads was installed for stock watering purposes (Laws and Smith 1989).

- Derby town bore was drilled to a depth of 723 m in 1913, for town water supply purposes. The well, now abandoned was sited within the town precinct, near the site of the present public swimming pool (Laws and Smith 1989).

- Mowanjum Mission No 1 well, located near the old Derby Airport was completed in 1961 to a depth of 272 m and was reported to have intersected saline water (O'Driscoll 1964).

- During the 1960's and 1970's a number of shallow town water supply wells were constructed in the unconfined aquifer, within the township area. During the mid 1970's rising salinity levels were evident in a number of wells on the northern margin of the wellfield and it was speculated that this was the result of excessive pumping causing encroachment of the saltwater interface. Several wells were abandoned to prevent further deterioration of the resource and replacement wells were installed in the unconfined aquifer, expanding the wellfield in a south south-easterly direction. Discussions of the unconfined town water supply wells are presented in O'Driscoll 1964, Leech 1972 and WAWA 1990a

- The introduction of automatic gas chlorination to the town water supply in June 1981 had the detrimental effect of oxidizing dissolved iron and manganese in the supply water to cause problems with scaling and discolouration. This resulted in numerous consumer complaints.

- In 1981, a well was completed to a depth of 305 m for the Sunny Side Market Garden. The well is located approximately 6 km south-east of the township, and constitutes a good quality supply (Laws and Smith 1989).

- In 1982, the GSWA investigated the possibility of installing town water supply wells into the confined Erskine aquifer in order to solve the problems of rising salinity and high iron and manganese levels in the Unconfined water supply. Subsequently one test well, three production wells and three monitoring wells were installed on the Derby peninsula during the period 1982 to 1989. Details of this work are documented in Laws 1982, Laws 1989, Laws 1990b and WAWA 1989.

- In 1987, the GSWA investigated the hydrogeology of the broad Derby region (Laws and Smith 1989). The programme cost $225 000 and included the completion of 14 exploratory wells to evaluate both the unconfined and confined aquifers. The study included estimations of recharge and throughflow to the unconfined and confined aquifers on the Derby peninsula. These estimates were later revised downwards (Laws 1989 and Laws 1990b)

- A well census was conducted at Hamlet Grove in August 1987 by the GSWA to record well locations, salinity levels and water levels (Laws and Smith 1988b and Laws 1990a). The study indicated that while most wells in Hamlet Grove had low TDS levels, some had unacceptable levels.

The Derby town water supply is reviewed at three yearly intervals by the Groundwater and Environment Branch. The last review of the wellfield was completed in August 1990 and is detailed in report WG 108 (WAWA 1990a).

3. SOCIAL ENVIRONMENT

3.1 Population

According to the Australian Bureau of Statistics June 1986 census, Derby had a population of 3258 people. The population growth rate is low, averaging 3.5% over the 10 years to 1986.

3.2 Land Zoning

Land zoning on the Derby peninsula is presented in Figure 4, with the Knowsley Agricultural Area lying just south of the Groundwater Area. Zoning classifications, areas and the percent coverage of the Groundwater Area are as follows:

Land Zoning

Zone	Area ha	%
• Rural	2367.00	74.6
• Residential	217.68	6.9
• Open Space	152.65	4.8
• Special Rural	142.15	4.5
• Government Purposes	82.04	2.6
• Recreation	62.56	2.0
• Industrial	50.46	1.6
• Commercial Centre	49.79	1.6
• Institutions	20.49	0.6
• Cemetery	16.44	0.5
• Rubbish Disposal	10.11	0.3

3.3 Vegetation and Landuse

Distribution of natural vegetation and landuse in the Derby Groundwater Area is presented in Figure 5. This data was interpreted from 1:10,000 colour areal photography taken in July 1989.

A large proportion of the Groundwater Area is covered by native Pindan vegetation, consisting of mixed eucalyptus, casuarina and acacia trees and grasses, with many large boabs trees. Limited horticultural and agricultural activity is also evident.

3.4 Industry

Derby exists as an administrative centre for the surrounding region and services the smaller nearby communities and pastoralists. It is a centre for transport activities and is also experiencing growing tourism. Derby meatworks is no longer operational and no other commercial industries of this nature are proposed.

4. PHYSICAL ENVIRONMENT

4.1 Climate

Derby has a semi-arid tropical climate, experiencing hot and wet conditions from December to March and warm and dry conditions for the remainder of the year. Rainfall, temperature and evaporation data are presented graphically in Figures 6 and 7.

Derby experiences large fluctuations in annual rainfall due to variations in cyclonic conditions. The long term average annual rainfall is 624 mm, however in the last 50 years annual rainfall has ranged from 130 mm to 1102 mm. Most of the rain falls in the months of December to March. Monthly rainfalls range from 0 mm to over 500 mm.

Mean maximum and minimum daily temperatures at Derby range from 30°C to 36°C, while mean minimum daily temperatures range from 15°C to 26°C. Mean pan evaporation ranges from just over 200 mm in February up to 350 mm in October to December, exceeding rainfall in every month of the year. Average annual pan evaporation is 3,300 mm.

4.2 Physiography

The physiography of the Derby Peninsula appears to be strongly controlled by the underlying north-westerly trending Triassic units. According to Laws and Smith 1989 though, the structure of the Triassic sediments should be masked by the superimposed flat lying Jurassic sediments. Topography of the peninsula is presented in Figure 8 as ground elevation contours, the highest point being 22m AHD. Flanking the peninsula are extensive tidal mud flats which are periodically inundated at the peak of the 12m tidal range. Drainage on the peninsula is poorly developed.

Further inland, east of the Derby Highway and south of the Gibb River Road, the land is generally flat, rising to around 40m AHD. Much of the area is characterized by numerous east-west parallel sand ridges, which have induced westerly trending intermittent drainages.

4.3 Geology

Regional

The Derby area is situated in the northern part of the Canning Basin, a large intra-cratonic basin extending between the Hall's Creek Province and the Pilbara Block and underlying the Great Sandy and Gibson Deserts. The Basin contains a faulted and folded sequence of Phanerozoic sedimentary rocks up to 18 000 m thick, ranging in age from Ordovician to Quaternary. The sedimentary pile is approximately 8 000 m thick beneath Derby (Towner 1981).

Stratigraphy

The stratigraphic sequence within the Derby region, pertinent to the management of groundwater, has been described by Laws and Smith 1989. The sequence is described below and summarized in Table 1. A geological cross section of the Derby peninsula is provided in Figure 9, showing the upper parts of the sequence.

Key to Geological Ages		
•	Permian	280-225 million years
•	Triassic	225-195
•	Jurassic	195-135
•	Cretaceous	135-65
•	Tertiary	65-2
•	Quaternary	2-0

Liveringa Group - The Liveringa Group is of Late Permian age and comprises interbedded sandstones, siltstones and shales, which have a maximum thickness in the Derby area of 319 m. The Group was deposited predominantly during a marine regression and has little aquifer potential. The Group conformably overlies the Nookanbah Formation and is disconformably overlain by the Blina Shale.

Blina Shale - The Blina Shale is of Early Triassic age and comprises grey shale, siltstone, minor claystone and fine sandstone. The unit ranges in thickness, with intersections of 185 m to 462 m having been observed in the Derby region. The shale was deposited in a shallow marine tidal environment and has poor aquifer potential. The unit disconformably overlies the Liveringa Group and in turn is disconformably overlain by the Erskine Sandstone.

Erskine Sandstone - The Erskine Sandstone is of Early to Middle Triassic age and consists of very fine to fine grained grey sandstone, shale, siltstone and black shale. The formation can be subdivided into an upper and lower section. The lower half comprises mainly shales with some interbedded sandstone, while the upper section consists predominantly of sandstone with minor shale. The formation has four shale marker horizons which enable correlation between wells. The formation was deposited in an estuarine environment and has a thickness of around 270 m. The formation has major aquifer potential. The contact between the Erskine Sandstone and the underlying Blina Shale is a disconformity or slight unconformity. The formation is conformably overlain by the Munkayarra Shale. For the purposes of this report the upper part of the Erskine Sandstone, above marker horizon III, will be referred to as the **Upper Erskine Sandstone** and lower part, below unit III will be referred to as the **Lower Erskine Sandstone**.

Munkayarra Shale - The Munkayarra Shale is of Middle to Late Triassic age and is comprised of multicoloured shale beds. While the formation underlies much of the Derby area, it appears to have been eroded from the Derby peninsula. The sediments were deposited as a continental red bed sequence and have a thickness of around 185 m. The formation conformably overlies the Erskine Sandstone and is unconformably overlain by the Wallal Sandstone. The Munkayarra Shale constitutes a major aquiclude.

Wallal Sandstone - The Wallal Sandstone is of Early to Late Jurassic age and is comprised of laminated, very fine to very coarse grained sandstone, together with minor siltstone, conglomerate and lignite. The sediments were deposited in a continental to shallow marine environment and have a thickness of up to 82 m in the Derby area. The formation unconformably overlies the Erskine Sandstone and Munkayarra Shale and in turn is unconformably overlain by the Meda Formation. The Wallal Sandstone has good aquifer potential.

Meda Formation - The Meda Formation is Late Jurassic in age and was originally described as comprising medium to coarse grained sandstone with fine conglomerate beds and lenses. The formation has been described as being 9m thick on the Derby peninsula but some confusion remains in differentiating the formation from the Wallal Sandstone. The formation is considered to have small aquifer potential.

Quaternary - The Quaternary deposits in the area comprise clay, silt, sand and minor gravel and are up to 15 m thick in the Derby area. The deposits are both alluvial and aeolian in origin. The sediments generally have no aquifer potential.

Structure

In the region surrounding Derby, gently folded Late Devonian to Triassic rocks plunge to the north-west and are overlain by west-dipping Jurassic sediments. One of the anticlines developed in the older sediments is coincident with the Derby peninsula, where it is warped, forming an elongated dome shaped structure. This is evident in Figure 10, which depicts the basal contours of the Erskine Sandstone. Erosion occurring at the end of the Triassic denuded the Munkayarra Formation from the dome shaped structure and in its absence the Wallal Formation directly overlies the eroded Erskine Sandstone.

5. HYDROGEOLOGY

5.1 Groundwater Occurrence

The main aquifers in the Derby area are identified in Table 1 and are confined to the following geological units:

Geological Units with Aquifer Potential	
• Meda Formation	Shallow
• Wallal Sandstone	.
• Erskine Sandstone	.
• Liveringa Group	.
• Poole Sandstone	.
• Grant Group	Deep

For the purposes of this study, the Erskine Sandstone is divided into upper and lower sections, based on the presence of clay marker horizon III, shown in Figure 9. The marker horizon appears to have extensive lateral coverage and is likely to restrict vertical groundwater flow.

Groundwater within the Upper Erskine Sandstone, Wallal Sandstone and Meda Formation is unconfined, on the Derby peninsula, with all units being in hydraulic connection. For the purposes of this study these units are collectively termed the **Unconfined aquifer**. Groundwater within the Lower Erskine Sandstone is confined, on the Derby peninsula, and for the purposes of this report the unit is termed the **Lower Erskine aquifer**.

The Liveringa Group aquifer has only been exploited by the original deep Derby town Well, while the Poole Sandstone and Grant Group aquifers have not been exploited in the area and may be too deep to justify evaluation.

5.2 Unconfined Aquifer

Distribution and Storage

The Wallal Sandstone and Meda Formation are difficult to differentiate and for convenience will be referred to singularly as the Wallal Sandstone. The Wallal Sandstone is partially saturated over a land area of 450 km^2, covering the peninsula and extending inland to the south-east, Figure 12. Groundwater storage in the Wallal Sandstone, over the peninsula area can be calculated as follows:

Storage of Wallal Sandstone - Derby Peninsula		
	$v = (A \times 10^6) \times b_s \times S_y$	
A	Groundwater Area	$= 33.93\ km^2$
b_s	Saturated Thickness	= 20 m
S_y	Specific Yield	= 0.2
v	**Peninsula Storage**	$= 136 \times 10^6\ m^3$

Groundwater in the Upper Erskine Sandstone is also unconfined on the Derby peninsula, where the Munkayarra Shale has been removed by erosion. Groundwater storage within this section of the Unconfined aquifer, on the Derby peninsula, can be calculated as follows:

Storage of Upper Erskine Sandstone - Derby Peninsula		
	$v = (A \times 10^6) \times b_s \times S_y$	
A	Groundwater Area	$= 33.93\ km^2$
b_s	Saturated Thickness	= 70 m
S_y	Specific Yield	= 0.2
v	**Peninsula Storage**	$= 475 \times 10^6\ m^3$

Storage in the Unconfined aquifer on the Derby peninsula therefore totals $611 \times 10^6\ m^3$.

Recharge, Throughflow, Leakage, Discharge

Recharge to the Unconfined aquifer is directly from rainfall and has been estimated to be 3% of annual rainfall on the basis of chloride ion ratios (Laws and Smith 1989). Recharge to the peninsula area can be calculated as follows:

Rainfall Recharge to the Unconfined Aquifer - Derby peninsula		
	$R_a = (A \times 10^6) \times (P/1000) \times R_p$	
A	Groundwater Area	$= 33.93\ km^2$
P	Mean Annual Rainfall	= 627 mm
R_p	Recharge Proportion	= 0.03
R_a	**Peninsula Recharge Rate**	$= 0.638 \times 10^6\ m^3/a$

Groundwater throughflow to the Derby peninsula via the Wallal Sandstone was originally estimated by Laws and Smith 1989, to be about $1.9 \times 10^6\ m^3/a$. Subsequent to this estimate, further hydrogeological studies were carried out on the peninsula and in accordance with the new data the estimate was revised downwards to approximately $1.0 \times 10^6\ m^3/a$ (Laws 1990b).

Groundwater throughflow to the Derby peninsula via the upper Erskine Sandstone is possibly as much as 85% of the total throughflow of the combined upper and lower Erskine Sandstone, which is estimated to be 3.80×10^6 m^3/a, (Laws and Smith 1989 and Laws 1989). Accordingly, the upper Erskine throughflow to the peninsula is estimated to be 3.23×10^6 m^3/a.

Hydrogeological information from exploratory drill holes RGI 2 and 3, located just south and south-east of the peninsula, indicates that groundwater potentials are slightly higher in the Upper Erskine compared to the lower Erskine. Leakage between the Unconfined aquifer and Lower Erskine aquifer on the peninsula has not been demonstrated. Local discharge is likely to be to the mud flats surrounding the Derby peninsula.

The renewable groundwater resource estimate for the Unconfined aquifer on the Derby peninsula, assuming no leakage to or from the Lower Erskine aquifer, can be summarized as follows:

Renewable Unconfined Groundwater Resource - Derby peninsula	
Rainfall Recharge	0.64×10^6 m^3/a
Wallal Sandstone throughflow	1.00×10^6 m^3/a
Upper Erskine Sandstone throughflow	3.23×10^6 m^3/a
Renewable Resource	**4.87×10^6 m^3/a**

Water Quality

Water Quality data for the Unconfined town water supply wells are presented in Table 2, which also includes NHMRC Australian drinking water guidelines. The parameter ranges for the Unconfined town water supply wells are presented graphically in Figure 13, where they are contrasted with the those of the Lower Erskine town water supply wells.

TDS levels range from 420 mg/L to 840 mg/L and are higher than those of the Lower Erskine aquifer. Iron, manganese and aluminium levels are also higher than those of the Lower Erskine aquifer, and levels in many of the wells exceed the NHMRC guidelines. The high iron and manganese levels have resulted in numerous consumer complaints due to scaling and discolouration. The problem is exacerbated by gas chlorination which causes the oxidation and precipitation of iron and manganese. All other parameters satisfy NHMRC guidelines.

Saltwater Interface

Understanding of the position and form of the saltwater interface in the Unconfined aquifer on the Derby peninsula is very limited at this stage. Laws 1990b has interpreted the presence of saline wedges in the unconfined aquifer at the 2/88, 3/88 and 2/89 deep monitoring sites, detected during construction of the wells. The interpretation was based on limited geophysical logging data which indicated elevated salinities, but no clear interface.

The town water supply well monitoring data, presented graphically in Figures 12 to 18, demonstrates that in many wells there has been considerable variation of salinity with time, in the form of rising trends, pronounced fluctuations or combinations of these. The variations have been interpreted as early indications of movement in the salt water interface. Action has been taken accordingly, including reduction in pumping rates, closure of some wells and increased reliance on the Lower Erskine wells.

The presence of the saltwater interface and the implications it has on Derby peninsula groundwater production are discussed further in Section 10.1.

5.3 Lower Erskine Aquifer

Distribution and Storage

The Lower Erskine Sandstone aquifer is saturated over a land area of approximately 2800 km^2, covering the peninsula and extending inland to the south-east, Figure 12. Groundwater storage in the Lower Erskine Sandstone, over the peninsula area, can be calculated as follows:

Storage of Lower Erskine Sandstone - Derby Peninsula		
	$v = (A \times 10^6) \times b_s \times S_y$	
A	Groundwater Area	$= 33.93\ km^2$
b_s	Saturated Thickness	= 140 m
S_y	Specific Yield	= 0.05
v	**Peninsula Storage**	**$= 238 \times 10^6\ m^3$**

Recharge, Throughflow, Leakage, Discharge

Recharge to the Lower Erskine aquifer is by rainfall recharge in the inland areas where the sandstone outcrops. There is no direct rainfall recharge to the aquifer on the Derby peninsula.

Throughflow via the Lower Erskine aquifer to the Derby peninsula is estimated to be 15% of the total throughflow of the combined upper and Lower Erskine aquifers and amounts to $0.57 \times 10^6\ m^3/a$.

Leakage from the Lower Erskine aquifer to the unconfined aquifer may occur under natural conditions on the peninsula but has not been demonstrated. Mining of groundwater resources from the Lower Erskine aquifer may induce downward leakage from the unconfined aquifer. Interaction between the Lower Erskine aquifer and the underlying aquifers is expected to be negligible because of the presence of the Blina Shale aquiclude.

The renewable groundwater resource estimate for the Lower Erskine aquifer on the Derby Peninsula, assuming no leakage, can be summarized as follows:

Renewable Lower Erskine Groundwater Resource - Derby peninsula	
Rainfall Recharge	0×10^6 m^3/a
Lower Erskine Sandstone throughflow	0.57×10^6 m^3/a
Renewable Resource	**0.57×10^6 m^3/a**

Water Quality

Water Quality data for the Lower Erskine town water supply wells are presented in Table 2, which also includes NHMRC Australian drinking water guidelines for various parameters. The parameter ranges for this data are presented graphically in Figure 13, where they are contrasted with the those of the Unconfined aquifer.

All parameters fall within NHMRC guidelines. TDS levels range from 200 mg/L to 390 mg/L and are lower than those of the Unconfined aquifer. Iron, manganese and aluminium levels are also lower than those of the Unconfined aquifer, with dissolved iron levels ranging up to 0.14 mg/L. The comparatively low iron and manganese levels make the Lower Erskine aquifer a more desirable groundwater resource for town water supply purposes than the Unconfined aquifer.

Saltwater Interface

The position and form of the saltwater interface in the Lower Erskine aquifer is uncertain. Geophysical monitoring at completion of deep monitoring wells 2/88, 3/88 and 2/89, identified slightly elevated salinities at the base of the aquifer on the south-west margin of the peninsula and some elevation of salinities at the north-western end of the peninsula.

The presence and implications of the Lower Erskine saltwater interface is discussed further in Section 10.2.

6. WELL CENSUS

6.1 Objectives and Methods

A well census of the Derby Groundwater Area was undertaken by WAWA staff over a two week period in May 1991. The purpose of the census was firstly to provide important base data, for preparation of the management plan, and secondly to update the well licence files. The census included all existing and abandoned town water supply and private wells located within the Derby Groundwater area. Attempts were made to interview all well owners, however a number were not contactable and data was not forthcoming.

Each of the well owners was requested to provide information in accordance with the census form Appendix I. The main areas of attention can be summarized as follows:

Main Areas of Census Enquiry
• Owner and lot identification • Number of wells on property • Well construction details • Well production details • Well static water level • Well water quality • Lot water usage and purpose • Plans for expansion

Water samples were collected where possible and despatched to the Karratha Water Resources laboratory for determination of electrical conductivity (Ec). Samples were also collected from the Town water supply wells and included for analysis. The Ec data was then converted to a TDS equivalent using the following conversion formula.

Ec to TDS Conversion
Ec(compensated) x 4.9769 + 56.27 = TDS

A census of the Hamlet Grove wells was carried out in August 1987 by the GSWA, the results of which are documented in Laws 1990a. Data recorded included static water level and TDS by conductivity.

6.2 Data

The distribution and status of the town water supply and private water supply wells is presented with census numbers on Plan 1 and without census numbers in Figure 2. The distribution and status of town water supply wells alone, is presented in Figure 3, with TWS numbers.

Data collected during the May 1991 census was collated with data from all other sources, including GSWA records, WAWA records and licence files and entered into a DBASE IV database. The database index is included as Appendix II. The data was then sorted into three categories on the basis of subareas. The subareas are Township, Rural and Hamlet Grove, the locations of which are presented on Plan 1 and in Figures 2 and 3. The designation and purpose of these subareas will be discussed in section 13.4. For report tabulation purposes the subarea data has been further divided into three categories, well identification and ownership, hydrogeological details and lot groundwater usage data.

Town water supply well information is listed in Appendix III, data for the Township subarea wells are listed in Appendices IVa, b and c, data for the Rural subarea wells are listed in Appendices Va, b and c, and data for the Hamlet Grove subarea wells are listed in Appendices VIa, b and c.

The Sunnyside market garden well, Census 116, owned by Mr Iurietich, lies just south of the Derby Groundwater Area, in the Knowsley Agricultural Area. The well draws large volumes of water from the Lower Erskine aquifer and consequently is a very important factor in the management of groundwater on the Derby peninsula. For this reason, the well will be included with those of the Rural subarea, for all tabulations and calculations in this report.

All wells, both town water supply and private, have been given a census number which has been assigned by sorting the wells by both subarea and owners name. Well classification statistics for the groundwater areas are summarized in Table 3. A total of 196 wells were identified in the census.

Analysis and discussion of the census production, water level and water quality data is presented in sections 8, 9 and 10 respectively.

7. MONITORING

Monitoring of the Unconfined and Lower Erskine groundwater systems is conducted by WAWA, using the town water supply production and monitoring wells, listed in Appendix III and summarized as follows.

TWS Wells used for Monitoring Purposes	
Unconfined Aquifer	
Production	1/71, 2/71, 10, 1/65, 1/76, 3/76, 4/76, 5/76, 2/78
Monitor	Test 2, 6, 3/65
Capped	Test 3, 5, 7, 1/78, 3/78, 4/78
Lower Erskine Aquifer	
Production	1/82, 1/86, 1/89
Monitor	2/88, 3/88, 2/89

The wells are monitored for the parameters of abstraction, water level, conductivity derived TDS, iron, manganese, and major ions, according to the schedule outlined in Table 4. Monitoring data is stored in the State Water Resources Information System SWRIS. Water level and TDS data for the town water supply wells are presented graphically in Figures 14 to 20.

Three Lower Erskine monitoring wells 2/88, 3/88 and 2/89 were installed in 1988 and 1989 to monitor changes in salinity that could arise from migration of the saltwater interface. Very little data, for these wells, is available at this stage and for this reason the data has not been presented graphically.

Town water supply well monitoring data are assessed three yearly by Groundwater and Environment Branch, as part of the Derby Groundwater Scheme Reviews. The purpose of the reviews are to assess wellfield performance and provide recommendations for optimal management of the resource. The last review was conducted in 1990 and is documented in report WG 108, WAWA 1990a.

There is no routine monitoring of private wells on the peninsula at this stage. Recommendations for the monitoring of private wells are discussed in Section 13.7.

8. ABSTRACTION

8.1 Derby Town Water Supply

The Derby township water supply was initially serviced by a single town bore, which pumped water from the Liveringa Group aquifer. Abstraction from the present wellfield commenced in 1960/61 when a small number of Unconfined aquifer wells were commissioned. The Unconfined production was augmented by production from the Lower Erskine from 1985 onwards. Currently there are nine Unconfined wells producing at rates of up to 119 000 m^3/a and three Lower Erskine wells, producing at rates of up to 492 000 m^3/a. Individual town water supply well production figures for 1990-91 are presented in Appendix III.

Derby Town water supply annual Unconfined, Lower Erskine and total wellfield production records for years ending June 1980 to June 1991 are presented numerically in Table 5 and graphically in Figure 21. Table 5 also details the annual production increase as percentage of the previous years production. The 1990-91 town water supply abstraction from each Subarea is presented numerically in Table 6 and graphically in Figure 22 and contrasted with private abstraction.

Town water supply abstraction during 1990-91 was responsible for 61% of the total draw from the Derby peninsula. The 1990/91 production was 1 006 308 m^3, of which 289 633 m^3 (29%) was derived from the Unconfined aquifer and 716 675 m^3 (71%) was derived from the Lower Erskine aquifer. The ratio of Unconfined to Lower Erskine town water supply abstraction will gradually decrease with time due to gradual attrition of Unconfined wells and replacement of these with Lower Erskine wells.

Annual increases in wellfield abstraction have fluctuated considerably during the period 1980 to 1991, ranging from +27% to -10% of the previous years production. The largest fall in production was recorded for the 1990-91 production year. Fluctuations in abstraction are probably partially due to the highly variable nature of the local climate, although this correlation isn't immediately evident from the available rainfall data. The average rate of production increase for the 11 year period 1980 to 1991 is 4.7 %, most of which was experienced in the first two years. Excluding the first two years, the annual increase has averaged less than 0.5%. The short term future water supply requirements can be expected to grow at a rate of between 0.5%(production trend) and 3.5%(population trend).

8.2 Private and Municipal Water Supplies

For the purposes of this report **private** includes all groundwater users other than WAWA. Evaluation of the annual production rates for private wells was the most difficult aspect of the well census. Estimates were made on the basis of a number of factors, including pump size, pump output, irrigation routine, irrigation purpose and irrigation area, but in many cases estimates were based on limited information. Accordingly, the data offer a good indication of private groundwater use, but must be regarded with some caution.

Production estimates and source aquifer details are listed in appendices IVb, Vb and VIb for individual wells, while lot production and purpose details are listed in Appendices IVc, Vc and VIc. Private production, according to purpose and Subarea is presented numerically in Table 6 and graphically in Figure 22 and contrasted with town water supply abstraction.

Private groundwater abstraction during 1990-91 was responsible for 39% of the total draw from the Derby peninsula. The 1990-91 production was 632 650 m^3, of which 402 250 m^3 (64%) was derived from the Unconfined aquifer and 230 400 m^3 (36%) was derived from the Lower Erskine aquifer. Groundwater use on the peninsula during 1990-91 by the private sector, as a percentage of combined town water supply and private use, can be summarized as follows: Agriculture 12%, Public grounds 8%, Domestic 8%, Institutions 6%, Miscellaneous 3% and Horticulture 2%.

Only a small number of private wells have estimated annual productions of >8000 m^3/a and these are identified below.

List of Wells with Production Exceeding 8 000 m^3/a

Census	Owner	Unconfined m^3/a	Lower Erskine m^3/a
6	Community Welfare	17000	0
8	Dept of Main Roads	9600	0
13	Derby High School	15000	0
14	Derby High School	15000	0
17	Derby Hospital	0	20400
19	Holy Rosary School	0	9000
25	Numbala Nunga Hospital	11000	0
34	Shire of Derby	60000	0
35	Shire of Derby	3700	0
36	Shire of Derby	25000	0
37	Shire of Derby	30000	0
40	Shire of Derby	12000	0
116	Iurietich HP (Sunnyside)	0	201000
128	Mowanjum Corporation	8000	0
185	Stott B	9000	0

The most significant users of groundwater in the private sector are the Shire of Derby and the Sunnyside Market Garden (Iurietich). The shire draws water from four unconfined wells. Supplies from these wells are used to water public gardens and recreation facilities and amount to 130 700 m^3/a. The Sunny Side Market garden draws 201 000 m^3/a of groundwater from the Lower Erskine aquifer for agricultural purposes. Although the market garden is located in the Knowsley Agricultural Area, just south of the Derby Groundwater Area, it constitutes a very significant factor in determining groundwater management of the peninsula. For the purposes of this report the market garden wells have been included with the Rural Subarea wells.

A large Tourist development, referred to as the McAlpine tourist Park was proposed for the Derby area in the late 1980's but has since been abandoned. The development was to include landscaped gardens and a golf course and would have required a considerable groundwater supply to service these and domestic facilities. The scheme was given Water Authority approval on the condition that domestic supplies could be obtained from shallow groundwater sources at the project site but non-domestic supplies were to be drawn from a wellfield situated a further 7 km inland from the site. This was to prevent over development of the peninsula resources which could have jeopardized existing private and town water supply wells.

8.3 Aquifer Abstraction

Appendices IVb, Vb and VIb detail both the 1990-91 production estimate and aquifer source for each well on the Derby peninsula. From this data aquifer source production details for the individual Subareas and peninsula as a whole have been calculated and are presented numerically in Table 6 and graphically in Figure 23. For the peninsula as a whole, 947 075 m^3 (58%) was drawn from the Lower Erskine aquifer and 691 883 m^3 (42%) was drawn from the Unconfined aquifer, during the 1990-91 production year.

9. WATER LEVELS

9.1 Unconfined Aquifer

Water level data, recorded for the Unconfined town water supply wells, is presented graphically in Figures 14 to 20. The data indicates that well water levels are all above 0 m AHD and are generally fairly stable, showing small fluctuations due to changes in wellfield pumping configuration and pumping interference. There is however, a broad trend, evident in many of the hydrographs as general decline in water levels up to 1982-1983, followed by a subsequent recovery of water levels. This can be explained by the following factors:

- Town water supply production from the Unconfined aquifer was increasing up to 1981/82, with large increases recorded for the production years ending June 1981 and June 1982.

- Town water supply production from the Unconfined aquifer peaked in 1981/82 at 993 000 m^3/a. Production has subsequently diminished to the present levels of around 290 000 m^3/a.

- There have been several high rainfall years from 1982 onwards which would have resulted in greater recharge to the aquifer.

Water level data, obtained during the May 1991 well census, is listed in Appendices IVb, Vb and VIb. In the greater proportion of cases it was not possible to obtain water level measurements from the private wells because of pump obstruction. Water levels were measured in all accessible town water supply wells. The data is presented graphically as contour plots for the peninsula in Figure 24 and for Hamlet Grove in Figure 26. Water level data collected at Hamlet Grove by the GSWA in August 1987, is presented as a contour plot in Figure 25.

The water level contour plots were digitally prepared with SURFER using minimum curvature. A grid spacing of 100m x 100m was used for the peninsula plot and a spacing of 50m x 50m was used for Hamlet Grove plots. The minimum curvature technique holds true in the vicinity of the contoured wells, which are indicated on each plan, but projects trends away from the data sites. Therefore caution should be used in interpreting water levels at sites removed from measured localities.

The limited water level data indicates that there is mounding along the north-eastern flank of the peninsula, with water levels exceeding 6m AHD. The water table mounding shows a correlation with topography and probably indicates increased rainfall recharge along the topographic high where the Wallal Sandstone is outcropping.

Based on the May 1990 census data the previous calculations of throughflow to the Unconfined aquifer on the Derby peninsula, discussed in Section 5.2.2, appear to be over estimates. It is unlikely that the Township or Hamlet Grove Subareas would receive much throughflow because most of the flow is diverted to the mudflats. A drop in water levels at Hamlet Grove however would capture greater throughflow. The peninsula water table therefor seems to be significantly more influenced by local recharge than throughflow.

9.2 Lower Erskine Aquifer

Water level data, recorded for the Lower Erskine town water supply wells 1/82 and 1/86, is presented in Figure 20. The limited water level data, obtained during the May well census, is listed in Appendices IVb, Vb and VIb. The data has not been contoured because of the insufficient number of data points, but is presented graphically in Figure 27.

Water levels at the pumping wells 1/82 and 1/86 are 33.78m and 29.50m AHD respectively, while water levels in the monitoring wells are between 1.61m and 26.01m AHD. These amount to considerable drawdowns which have resulted from depressurization of the confined aquifer, but are in accordance with predictions.

10. SALINITY LEVELS

10.1 Unconfined Aquifer

Salinity data, recorded for the town water supply wells is presented graphically in Figures 14 to 20. Salinity data collected during the May 1991 census is listed in Appendices IVb, Vb and VIb. The data is presented graphically as contour plots for the peninsula in Figure 28 and for Hamlet Grove in Figure 30. Well salinity data collected at Hamlet Grove by the GSWA in August 1987, is presented as a contour plot in Figure 29.

Salinities within the Unconfined town water supply wellfield have ranged between 200 mg/L and 2000 mg/L TDS, during the period 1972 to 1991. In many instances, individual well salinity levels have been characterized by considerable variation, and have displayed pronounced trends and or considerable fluctuations. On the basis of well salinity trends, the wellfield area can be broadly dived into three sectors, north-western, central and south-eastern.

The north-western sector incorporates the earliest town water supply wells installed into the Unconfined aquifer and also has the highest density of wells. The sector is characterized by wells which generally displayed a pronounced rise in salinities during the 1970's, followed by an apparent sharp reduction and then stabilization of salinities. Caution needs to be adopted in the interpretation of this data. Pumping records for these wells are not available, but is likely that most were decommissioned during the 1970's, coinciding with the salinity changes. It is therefor unclear whether the apparent salinity changes in the sector reflect real aquifer trends and/or simply changes in sampling procedure.

The central sector is characterized by wells with little or no trend in salinity levels throughout the 1970's and 1980's, although some wells show large fluctuations. The south-eastern sector is largely comprised of town water supply wells which were installed late in the history of the Unconfined wellfield. These wells have generally displayed slight rises in salinity levels during the 1980's to the present day.

Although the salinity data for many of the town water supply wells conform to the patterns described for each sector, the data for some wells contrasts with that of the surrounding wells. This anomalous pattern of well salinity distribution has been observed over the peninsula as a whole, amongst the private wells drawing from the unconfined aquifer.

The salinity level contour plots were digitally prepared with SURFER using minimum curvature. A grid spacing of 100m x 100m was used for the peninsula plot and a spacing of 50m x 50m was used for Hamlet Grove plots. The minimum curvature technique holds true in the vicinity of the contoured wells, which are indicated on each plan, but projects trends away from the data sites. Therefore caution should be used in interpreting salinity levels at sites removed from measured localities.

Well salinities determined during the May 1991 census ranged from 170 mg/L TDS to 2400 mg/L TDS. Areas of high salinity are indicated in Figures 28, 29 and 30 by the red and purple contour lines. Salinities of over 1000 mg/L are evident in each of the Subareas, but the Township Subarea has the most significant areas of salinity elevation, indicating a general rise in salinity towards the nose of the peninsula. A number of well owners interviewed commented that well salinities appear to show seasonal fluctuations.

The census data is inherently biased, because a number of wells are known to have been abandoned due to excessive salinity levels, and hence were not sampled. Analysis of all town water supply and private well salinity data at hand provides some insight into salinity distribution on the Derby peninsula. The complex salinity distribution pattern is the result of interaction between numerous factors which are identified as follows.

Climate - The Derby climate is extremely variable being strongly influenced by cyclonic events. Variable rainfall intensity and duration, combined with high evaporation and ablation rates are likely to result in large variations in annual recharge to the unconfined aquifer. This in turn would influence local water qualities. Evaporation from the mudflats is also likely to increase salinities at the peninsula margins.

Transpiration and Interception - Much of the peninsula is covered with native Pindan vegetation, which acts to intercept rainfall before reaching the ground surface. The vegetation also facilitates xerophytic and phreatophytic transpiration. Areas cleared of native vegetation would generally experience increased recharge and fresher water. These influences are probably largely obscured by other more influential factors.

Recharge and Throughflow - Leech 1972 observed that the strata, from which the Unconfined town water supply wells draw water, are characterized by extreme lithological variation. This lithological variation influences groundwater movement and water chemistry. High recharge and/or throughflow rates at a specific locality would facilitate the flushing of salts from the system, resulting in lower groundwater salinity levels.

Palaeoclimate - Variations in the palaeoclimate could have caused significant changes in the rates of recharge and salt loading in the hinterland. Differential hydraulic conductivities of strata within the aquifer may have subsequently resulted in water from different ages, and hence of different salinities, being stacked vertically in the aquifer profile. It is possible that some wells with anomalous, elevated TDS levels may have been influenced by this mechanism, although there is insufficient data for confirmation at this stage.

Sea Level Changes - Within the last 4000 years the sea level rose as much as 2m above the present level. Some connate sea water from this period may still remain within the aquifers on the peninsula.

Tidal Effects - Elevated salinity levels at the margins of the peninsula may be the result of a complex process of mixing of tidal sea water and evaporites with fresh groundwater. The tidal range at Derby is over 12m and only rarely do peak high tides completely inundate the mud flats. During peak inundations the Unconfined aquifer at the peninsula margins is subjected to a brief influx of saline water under reversed potentiometric gradients. The saline water would tend to be slowly flushed out of the system while the tide is low, but may still account for elevated salinities at the peninsula margins. Elevated salinities on the north-eastern flank of the Township Subarea, slow salinity rises within the south-eastern sector of the town water supply wellfield and elevated salinities on the north-eastern flank of the Hamlet Grove Subarea may be attributable to this mechanism. It would be of academic interest to install shallow monitoring wells equipped with data loggers, at the peninsula margin, to monitor the tidal influence within the unconfined aquifer.

Saltwater Interface - The true coastline is situated well beyond the margin of the peninsula where the mud flats are fringed by mangroves. The mud flats are only inundated with seawater during exceptionally high tides and it is therefore probable that the true saltwater interface parallels the mangroves beyond the peninsula, rather than surrounding and encroaching onto the peninsula. No true interface in the range 5000 mg/L TDS to 15000 mg/L TDS has been intersected on the peninsula. The large tidal range of the region may also be responsible for greater mixing of sea water with the fresh aquifer water, resulting in a less pronounced salinity gradient across the interface.

Abstraction - Abstraction has an influence on salinity in that it alters the natural equilibrium of the hydrogeological system. Large abstractions can cause either vertical movement or lateral movement of more saline bodies of water. This is particularly evident in the case of the early Unconfined town water supply wells, which induced substantial movement in a more saline body of water from the north. This body of water appears to have regressed a little with the subsequent reduction of Unconfined pumping, but is still clearly evident in Figure 28 as a large area having salinities exceeding 1000 mg/L TDS. Over pumping of individual private wells, located within the Rural and Hamlet Grove Subareas, may cause localized salinity increases jeopardizing the users own supply. Over pumping in the Township Subarea though, may also jeopardize neighboring supplies.

Irrigation recycling is another way in which abstraction can influence aquifer salinity levels. Where large volumes of water are being used for irrigation, the majority of the salt content of that water is returned to the aquifer but at higher concentrations due to evaporation and transpiration losses. If rainfall recharge and throughflow are small the irrigation water may be recycled becoming progressively more salty.

10.2 Lower Erskine Aquifer

Salinity levels recorded for town water supply well 1/82 are presented graphically in Figure 20. This limited data suggests that salinities are stable within this part of the Lower Erskine aquifer.

Salinity data collected from the private and town water supply wells during the May 1991 census is listed in Appendices IVb, Vb and VIb. The data has not been contoured because of insufficient data points but is presented graphically in Figure 31.

Salinity levels were measured at eight locations over the peninsula and ranged from 293 mg/L TDS to 464 mg/L TDS. In general, there is a gentle rise in the salinity gradient towards the nose of the peninsula.

Abstraction of groundwater from the Lower Erskine aquifer currently exceeds that of resource renewal and will therefor eventually lead to inland migration of the saltwater interface and eventual deterioration of water quality at the pumping wells. The timing of this can not be accurately predicted because of insufficient knowledge of water qualities beneath the mudflats surrounding the peninsula.

11. GROUNDWATER POLLUTION

11.1 Overview

The Water Authority has the responsibility to regulate activities which may result in pollution of groundwater resources within Country Water Areas. The Derby County Water Area lies within the Derby Groundwater Area, Figure 32. There are several potential pollution sources on the peninsula but none of these appears to seriously threaten water quality of the Unconfined aquifer. The potential pollution sources in themselves are considered to be of a low risk and any threat is further reduced by the stratified and variable nature of the geology.

11.2 Potential Pollution Sources

Wastewater Treatment Facilities - The Derby wastewater treatment facility is located on the south-west margin of the peninsula as indicated in Figure 32. Deep sewerage was introduced to Derby about 10 years ago and it is estimated that 65% of the population are now connected to the system, (WAWA 1990c). Detail of the current sewered area is provided in Figure 32. Any nitrates or nitrites entering the aquifer from this source would presently be discharged down gradient out under the mudflats.

Septic Tanks - Approximately 35% of the population and importantly the industrial area is not deep sewered and therefor is serviced by septic tanks. The area covering the existing town water supply wells is not deep sewered, however nitrate and nitrite levels in the wells are well within NHMRC recommendations.

Waste Disposal Site - The waste disposal site is located adjacent to the waste water treatment facility and poses no threat to the groundwater.

Meat Works - The Derby meat works, which was located in the centre of the peninsula, has not operated for over 10 years. There may be some risk of groundwater pollution from animal by products and this should be investigated if the land is proposed for subdivision.

Petroleum Storage Tanks - The Shell and BP regional distribution fuel storage tanks are located in the port industrial area at the north-western end of the peninsula. In addition to these there are a number of local fuel distributors and private and industrial fuel storage tanks located on the peninsula. There is no evidence at this stage of leakage from any of these tanks.

11.3 Monitoring

At this stage there is no routine monitoring of health related constituents in the town water supply wells, other than nitrate and nitrite. Scientific Services however, is currently implementing a sampling programme for Country Regions to check the levels of all major health related constituents and on the basis of initial findings will formulate a routine programme for each wellfield.

12. TOWN WATER SUPPLY DEVELOPMENT

12.1 Water Supply Source

Currently, 29% of the town water supply is drawn from the Unconfined aquifer and 71% from the Lower Erskine aquifer. It is proposed that this ratio will gradually change, by a process of natural attrition of the existing Unconfined wells and the installation of additional Lower Erskine wells. It is envisaged that eventually 100% of the town water supply will be derived from the Lower Erskine aquifer. In addition, demand is expected to gradually rise at a rate of between 0.5% and 3.5% per annum.

In order to meet the rising demands, Lower Erskine wells will be installed progressively further inland, along the centre line of the peninsula. Proposed well sites are presented on Plan 1 and in Figure 3.

12.2 Expansion of Groundwater Area

Expansion of the Derby Groundwater Area has already been proposed, WAWA 1989. The freshwater resources of the Wallal Sandstone and Erskine Sandstone in the Derby hinterland, as defined by Laws and Smith 1989, are substantial and require protection. It feasible that the area may be suitable for some forms of large scale agriculture, such as cotton growing. No proposals have been received by the Water Authority, but it is important to preempt any such developments, as large scale groundwater abstraction and use of pesticides and fertilizers could have detrimental effects on the down gradient town water supply and private wells.

It is recommended that the Derby Groundwater Area be expanded south to the Great Northern Highway and east to approximately 124° 30' East, as indicated in Figure 33.

13. GROUNDWATER RESOURCE MANAGEMENT

13.1 Priority Beneficial Use

Definition

Priority beneficial use of a groundwater resource is the identified present or future community use that should receive priority over other potential uses. The priority beneficial uses will determine the criteria for protection of water quality and quantity. These uses fall into three categories:

Categories of Priority Beneficial Use
• Town water supply • Private and community use • Environment

Unconfined Aquifer

The Unconfined aquifer, on the Derby peninsula, in part constitutes a significant freshwater resource, which is used privately for purposes which include domestic supplies, public garden and recreation facility watering as well as horticultural and agricultural irrigation. The resource is also currently used for town water supply purposes, although the high iron and manganese levels detract from this mode of use.

At this stage the priority beneficial use for the resource is for town water supply purposes, but this will be substituted by private use once the town water supply is drawn exclusively from the Lower Erskine aquifer. There are no known environmental dependencies on the Unconfined resource.

Lower Erskine Aquifer

The Lower Erskine aquifer, on the Derby peninsula, constitutes a significant freshwater resource, which is currently used for institutional and agricultural watering. Most importantly the resource is used for town water supply purposes. The low salinity levels and low iron and manganese levels, compared with those of the Unconfined aquifer, make this the preferred resource for future town water supply development. It is proposed that this resource will eventually supply 100% of the town water supply requirement.

The priority beneficial use for the resource is for town water supply purposes, however this should not jeopardize those private supplies already established in the Lower Erskine aquifer.

13.2 Water Resource Protection

Unconfined Aquifer

Salinities in the Unconfined aquifer range considerably from 170 mg/L TDS to 2400 mg/L TDS, and while a substantial proportion of the aquifer is suitable for domestic, horticultural and agricultural purposes, significant volumes of the resource may have salinities which exceed the desirable limits for these uses:

Desirable Water Qualities	
• Drinking water	<1000 mg/L TDS
• Horticulture	<500 - 1500 mg/L TDS
• Agriculture	<500 - 5000 mg/L TDS

Salinity distribution within the Unconfined aquifer on the Derby peninsula is complex, as discussed in Section 10.1. As a result of this complexity and the lack of detailed three dimensional salinity distribution data, determination of abstraction limits to preserve the existing aquifer constitution, is virtually impossible..

The Unconfined groundwater resource of the Derby peninsula forms part of a much greater resource which extends inland over an area of 450 km^2. The threat of salinization is greatly reduced further inland, making the peninsula resource an intrinsically lower grade resource in comparison. The peninsula Unconfined resource is also down gradient of any hypothetical groundwater uses that may be established outside the groundwater area. For these reasons the value of the peninsula resource is only in serving the existing settlement and satisfying existing and potential users within the area.

It is expected that well salinization, if it occurs, will in many instances be a localized problem, in response to excessive local abstraction. Consequently, excessive draw will in many instances most greatly affect those exploiting the resource. Protection of the integrity of the resource is not of critical importance in this instance other than to protect the user and more importantly protect neighboring users.

Lower Erskine Aquifer

Salinity levels in the Lower Erskine aquifer are at this stage uniformly distributed with a gentle gradient in salinities rising towards the nose of the peninsula. Unlike the Unconfined aquifer, groundwater storage in the Lower Erskine aquifer is comparatively small, there is no rainfall recharge and throughflow is limited. Abstraction from the resource currently exceeds the estimates of throughflow to the peninsula, and is programmed to increase as Unconfined town water supply wells are gradually replaced by Lower Erskine wells. This strategy will ultimately result in some inland migration of the saltwater interface before a new equilibrium is established.

The Lower Erskine groundwater resource of the Derby peninsula forms part of a much greater resource which extends inland over an area of 2800 km^2. The threat of salinization is greatly reduced further inland, making the peninsula resource an intrinsically lower grade resource in comparison. The peninsula Lower Erskine resource is down gradient of any hypothetical groundwater uses that may be established outside the groundwater area. For these reasons the value of the peninsula resource is only in serving the existing settlement and satisfying existing and potential users within the area.

The priority beneficial use for the Lower Erskine aquifer on the Derby peninsula is for town water supply purposes. The low throughflow rates in the aquifer mean that to achieve sustainable abstraction from the resource, the town water supply wellfield would need to be located inland from the peninsula. This is not an economically viable option at this stage because of significant infrastructure costs and consequently mining of the peninsula resource is considered acceptable. It is planned that town water supply wells will be installed successively further inland until sustainable abstraction is achieved. In doing so it is likely that the peninsula resource will in part be degraded, as a result of inland migration of the salt water interface. There may also be degradation, as a result of saline leakage from the overlying Unconfined aquifer.

13.3 User Protection

Town Water Supplies

The current priority beneficial uses for both the Unconfined and Lower Erskine aquifers on the peninsula are for town water supply purposes. In accordance with this, private abstraction of groundwater must not detrimentally effect the water levels or water quality in the town water supply wells.

Private and Municipal Supplies

Private abstraction must not detrimentally effect neighboring users, with respect to water levels or water quality. Excessive abstraction is most likely to cause problems with respect to rising groundwater salinity. In many instances the individual user will be the first to be effected by salinity rises, particularly in the cases of vertical movement of saline water. In cases where large private abstractions or combined abstraction induce horizontal movement of saline water, for example migration of the salt water interface, neighboring users may be influenced first. The neighboring users must be protected.

13.4 Groundwater Subareas

The Derby Groundwater Area has been subdivided into three Groundwater Subareas, Township, Rural and Hamlet Grove, Plan 1 and Figure 2. The purpose for subdivision is to facilitate management of the groundwater resources, by allowing management policy to be formulated for smaller areas with common characteristics. The subarea boundaries were determined on the basis of a number factors:

Criteria used for Subarea Selection
· Land zoning · Vegetation and land use · Water use · Location of town water supply wells · Density of production wells · Hydrogeological data

Details of the Groundwater Subareas and respective management policies are presented in section 14.

13.5 Groundwater Allocation and Licensing

The policies and procedures of groundwater licensing in Western Australia are detailed in WAWA 1990b. Groundwater licence allocations are aimed at ensuring equitable use of the State's groundwater resources, while protecting the long term security of those resources and having regard for the economic, social and environmental consequences. Essentially groundwater licensing is the basal level of water allocation hierarchy, and should function in accordance with the broad policies of the management plan.

Groundwater licence numbers and allocations, on the licensing database at May 1991, are listed in Appendices IVc, Vc and VIc. It should be noted that in a number of instances lot ownership has changed since issue of the licence.

All licences should be granted for a period of 3 years and as a prerequisite to licence renewal, water samples should be analyzed to determine TDS by conductivity. Sampling and analysis is discussed further in Section 13.7.

Licence allocation and renewal policy is outlined in Section 14 for each Groundwater Subarea. The policies are necessarily complicated because of the nature of salinity distribution on the peninsula. Licence applications will be considered by the Water Authority's Regional office with advice from Groundwater and Environment Branch. Licence allocation and renewal applications, not meeting the prerequisites outlined in Section 14, will be forwarded to the Groundwater and Environment Branch for further hydrogeological assessment. For Unconfined well applications, considerations will be based on the following criteria.

Criteria for G & E Branch Assessment of Unconfined Well Licence Applications not meeting Criteria outlined in Section 14
· Abstraction Purpose · Proximity to coast · Proximity to private and town water supply wells · Abstraction rate of proposed well and neighboring wells · Aquifer geology, recharge, throughflow, water levels and salinity · Potential for unacceptable salinity increase at proposed well · Potential for unacceptable salinity increase at neighboring wells · Potential for unacceptable salinity increase in the aquifer in general

Exceptionally large requirements from the Unconfined aquifer should be referred to the WAWA Board for approval at the discretion of the Groundwater and Environment Branch. Applications for licences to draw water from the Lower Erskine aquifer should be assessed by the Groundwater and Environment Branch and referred to the WAWA Board for approval.

13.6 Water Conservation

Groundwater should be used efficiently to avoid wasting a valuable resource. All those applying for groundwater licences should be made aware of this fact and those planning to use large volumes of water should demonstrate that water conservation has been considered and will be implemented where possible.

13.7 Monitoring

Town Water Supply Wells

Monitoring of the town water supply wells should be continued as outlined in Table 4. The Lower Erskine town water supply monitoring wells are presently sampled annually to ascertain TDS levels. The frequency of sampling should be increased to six monthly to provide a more detailed picture of salinity changes if/when they occur.

At present all non-production monitoring wells are sampled by airlifting. It is highly Desirable that samples be collected with an appropriate sampling pump to ensure data reliability.

Private Wells

There is no routine monitoring of the Unconfined or Lower Erskine aquifer at points other than the town water supply wells. In addition, there are a number of wells that have significant annual draws of 8000 m^3/a or more. It is therefor recommended that a number of private wells be monitored to provide important information. The wells recommended for monitoring are as follows:

List of Private Wells Recommended for Monitoring			
Census	Owner	Unconfined m^3/a	Lower Erskine m^3/a

6	Community Welfare	17000	0
8	Dept of Main Roads	9600	0
12	Derby Caravan Park	0	0
13	Derby High School	15000	0
14	Derby High School	15000	0
17	Derby Hospital	0	20400
19	Holy Rosary School	0	9000
25	Numbala Nunga Hospital	11000	0
34	Shire of Derby	60000	0
35	Shire of Derby	3700	0
36	Shire of Derby	25000	0
37	Shire of Derby	30000	0
40	Shire of Derby	12000	0
116	Iurietich HP (Sunnyside)	0	201000
121	McKenzie B & P	2000	0
126	Moore P	2000	0
128	Mowanjum Corporation	8000	0
147	Bergman F	2000	0
184	Storey	2000	0
185	Stott B	9000	0

Each of the wells should be assessed six monthly to determine TDS and if feasible water level and production. Monitoring of the Derby shire and Sunnyside wells should be carried out by the owners if this can be satisfactorily arranged. Monitoring of the remaining wells should be carried out by WAWA personnel. All monitoring data should be entered into SWRIS.

Three yearly licence review water samples should be supplied by the applicant to the Derby office for determination of TDS by conductivity. WAWA staff should collect additional samples if it suspected that the supplied samples are of doubtful reliability. All water sample data should be stored in SWRIS.

13.8 Review

Performance of the town water supply wellfield is reviewed by the Groundwater and Environment Branch three yearly. In addition to these reviews it is recommended that the entire Groundwater Area be reviewed five yearly. It is recommended that these reviews should include a well census in order to update the derby well database and to adequately monitor aquifer changes.

14. GROUNDWATER MANAGEMENT BY SUBAREAS

14.1 Township Subarea

Township Subarea Description	
Area	▪ 537 ha
Land Zoning	▪ Predominantly residential
Vegetation and Landuse	▪ Native vegetation largely cleared. No agriculture or horticulture

Township Groundwater Availability	Unconfined Aquifer
Storage	▪ 96 701 000 m^3
Rainfall Recharge	▪ >101 000 m^3/a
Throughflow	▪ <<669 000 m^3/a
Renewable Resource	▪ <<771 000 m^3/a
Abstraction 1990-1991	▪ 514 183 m^3/a
Abstraction/Renewable	▪ >>67 %
Comments	▪ Storage, recharge, throughflow and renewable resource figures are determined from calculations in section 5.2 and the areas above. The accents indicate that the census data suggests a divergence from the original estimates as indicated. There is insufficient data to quantitatively reassess the values.

Township Licence Allocation and Renewal Policy	Unconfined Aquifer
Licence Allocation Prerequisites	▪ Proposed well depth is <50 m ▪ Proposed allocation is <2000 m^3/a ▪ Proposed radius from nearest well is >20 m for allocations of <1000 m^3/a and >100 m for allocations of >1000 m^3/a ▪ Proposed well site has a salinity of <800 mg/L TDS. Refer to salinity contours in Figure 28
Licence Renewal Prerequisites	▪ Licence may be renewed if the operating well salinity is <1500 mg/L TDS
Comments	▪ Licence allocation and renewal requests that do not satisfy the above criteria should be forwarded to the Groundwater and Environment Branch for further assessment.

Township Groundwater Availability	Lower Erskine Aquifer
Storage	▪ 37 668 000 m^3
Rainfall Recharge	▪ 0 m^3/a
Throughflow	▪ 90 000 m^3/a
Renewable Resource	▪ 90 000 m^3/a
Abstraction 1990-1991	▪ 254 468 m^3/a
Abstraction/Renewable	▪ 283 %
Comments	▪ Storage, throughflow and renewable resource figures are determined from calculations in section 5.3 and the areas above. Although abstraction greatly exceeds the renewable resource estimate, the ratio will reduce with pumping as the drawdown cone expands. The ratio is also dependent on the water quality beneath the mudflats which is unknown.

Township Licence Allocation and Renewal Policy	Lower Erskine Aquifer
Licence Allocation Prerequisites	▪ The priority beneficial use of the Lower Erskine resource is for town water supply purposes. Accordingly, no further licences are to be issued. In some circumstances private abstraction may be acceptable, however applications must be assessed by Groundwater and Environment Branch and reviewed by the WAWA board.
Licence Renewal Prerequisites	▪ Existing Licences may be renewed if the operating well salinity is <450 mg/L TDS. If salinities rise above this level licence renewal must be reviewed by Groundwater and Environment Branch.

14.2 Rural Subarea

Rural Subarea Description	
Area Land Zoning Vegetation and Landuse	▪ 2590 ha ▪ Predominantly rural ▪ Native vegetation has been partially cleared ▪ Limited agriculture and horticulture

Rural Groundwater Availability	Unconfined Aquifer
Storage	▪ 466 398 000 m^3
Rainfall Recharge	▪ >487 000 m^3/a
Throughflow	▪ <3 229 000 m^3/a
Renewable Resource	▪ <3 717 000 m^3/a
Abstraction 1990-1991	▪ 69 450 m^3/a
Abstraction/Renewable	▪ >2 %
Comments	▪ Storage, recharge, throughflow and renewable resource figures are determined from calculations in section 5.2 and the areas above. The accents indicate that the census data suggests a divergence from the original estimates as indicated. There is insufficient data to quantitatively reassess the values.

Rural Licence Allocation and Renewal Policy	Unconfined Aquifer
Licence Allocation Prerequisites	▪ Proposed well depth is <50 m ▪ Proposed allocation is <10 000 m^3/a ▪ Proposed radius from nearest well is >100 m ▪ Proposed well site has a salinity of <800 mg/L TDS. Refer to salinity contours in Figure 28
Licence Renewal Prerequisites	▪ Licence may be renewed if the operating well salinity is <1000 mg/L TDS
Comments	▪ Licence allocation and renewal requests that do not satisfy the above criteria should be forwarded to the Groundwater and Environment Branch for further assessment.

Rural Groundwater Availability	Lower Erskine Aquifer
Storage	▪ 181 674 000 m^3
Rainfall Recharge	▪ 0 m^3/a
Throughflow	▪ 435 000 m^3/a
Renewable Resource	▪ 435 000 m^3/a
Abstraction 1990-1991	▪ 692 607 m^3/a
Abstraction/Renewable	▪ 159 %
Comments	▪ Storage, throughflow and renewable resource figures are determined from calculations in section 5.3 and the areas above. Although abstraction greatly exceeds the renewable resource estimate, the ratio will reduce with pumping as the drawdown cone expands. The ratio is also dependent on the water quality beneath the mudflats which is unknown.

Rural Licence Allocation and Renewal Policy	Lower Erskine Aquifer
Licence Allocation Prerequisites	▪ The priority beneficial use of the Lower Erskine resource is for town water supply purposes. Accordingly, no further licences are to be issued. In some circumstances private abstraction may be acceptable, however applications must be assessed by Groundwater and Environment Branch and reviewed by the WAWA board.
Licence Renewal Prerequisites	▪ Existing Licences may be renewed if the operating well salinity is <450 mg/L TDS. If salinities rise above this level licence renewal must be reviewed by Groundwater and Environment Branch.

14.3 Hamlet Grove Subarea

Hamlet Grove Subarea Description	
Area Land Zoning Vegetation and Landuse	▪ 266 ha ▪ Predominantly special rural ▪ Native vegetation has been partially cleared ▪ No agriculture but some horticulture

Hamlet Grove Groundwater Availability	Unconfined Aquifer
Storage	▪ 47 900 000 m^3
Rainfall Recharge	▪ >50 000 m^3/a
Throughflow	▪ <<332 000 m^3/a
Renewable Resource	▪ <<382 000 m^3/a
Abstraction 1990-1991	▪ 108 250 m^3/a
Abstraction/Renewable	▪ >>28 %
Comments	▪ Storage, recharge, throughflow and renewable resource figures are determined from calculations in section 5.2 and the areas above. The accents indicate that the census data suggests a divergence from the original estimates as indicated. There is insufficient data to quantitatively reassess the values.

Hamlet Grove Licence Allocation and Renewal Policy	Unconfined Aquifer
Licence Allocation Prerequisites	▪ Proposed well depth is <50 m ▪ Proposed allocation is <2000 m^3/a ▪ Proposed radius from nearest well is >30 m ▪ Proposed well site has a salinity of <800 mg/L TDS. Refer to salinity contours in Figure 30
Licence Renewal Prerequisites	▪ Licence may be renewed if the operating well salinity is <1000 mg/L TDS
Comments	▪ Licence allocation and renewal requests that do not satisfy the above criteria should be forwarded to the Groundwater and Environment Branch for further assessment.

Hamlet Grove Groundwater Availability	Lower Erskine Aquifer
Storage	▪ 18 658 000 m^3
Rainfall Recharge	▪ 0 m^3/a
Throughflow	▪ 45 000 m^3/a
Renewable Resource	▪ 45 000 m^3/a
Abstraction 1990-1991	▪ 0 m^3/a
Abstraction/Renewable	▪ 0 %
Comments	▪ Storage, throughflow and renewable resource figures are determined from calculations in section 5.3 and the areas above.

Hamlet Grove Licence Allocation and Renewal Policy	Lower Erskine Aquifer
Licence Allocation Prerequisites	▪ The priority beneficial use of the Lower Erskine resource is for town water supply purposes. Accordingly, no licences are to be issued. In some circumstances private abstraction may be acceptable, however applications must be assessed by Groundwater and Environment Branch and reviewed by the WAWA board.
Licence Renewal Prerequisites	▪ There are currently no licences for abstraction from the Lower Erskine in the Hamlet Grove Subarea. If any licences are granted they may be renewed if the operating well salinity is <450 mg/L TDS. If salinities rise above this level licence renewal must be reviewed by Groundwater and Environment Branch.

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TABLE 1

Stratagraphic Sequence

Age	Group/Formation	Maximum Observed Thickness	Lithology	Aquifer Potential
Quaternary	Surficial	15 m	Clay, Sand, Silt and Gravel	None
Unconformity				
Late Jurassic	Meda Formation	9 m	Conglomerate, Sandstone	Small
Unconformity?				
Middle to Late Jurassic	Wallal Sandstone	82 m	Sandstone, Minor Siltsone and Conglomerate	Good
Major Unconformity				
Middle to Late Jurassic	Munkayarra Shale	185 m	Claystone	Aquiclude
Early to Middle Triassic	Erskine Sandstone	265 m	Sandstone , Siltstone, Claystone	Good
Disconformity/Slight Unconformity				
Early Triassic	Blina Shale	462 m	Shale, Siltstone, Minor Sandstone	Poor
Disconformity/Slight Unconformity				
Early to Late Permian	Liveringa Group	319 m	Sandstone, Siltstone, Shale	Small
Early Permian	Nookanbah Formation	540 m	Shale, Siltstone, Minor Sandstone, Limestone	Poor
Early Permian	Poole Sandstone	133 m	Sandstone, Minor Siltstone, Limestone	Good
Minor Unconformity				
Late Carboniferous to Early Permian	Grant Group	1 082 m	Sandstone, Siltstone, Claystone	Good
Major Unconformity				
Early Carboniferous	Anderson Formation	713 m	Sandstone, Siltstone, Shale	Fair
Late Devonian	Fairfield Group	544 m	Limestone, Shale, Sandstone, Siltstone, Dolomite	Fair

From Laws and Smith 1989

TABLE 2

Water Quality Data - Town Water Supply Wells

Well		NHMRC	Range	Range	1/71	1/71	1/71	2/71	2/71	2/71	5	5
Aquifer			Unconfined	Lower Erskine	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined
Sample Date					15 06 88	22 06 88	08 06 89	15 06 88	22 06 88	08 06 89	16 06 88	22 06 88
pH Lab		6.5 - 8.5	6.25 - 7.25	6.8 - 8.05	6.25		6.3	6.35		6.4	6.25	
Turbidity	NTU	5	0.2 - 110	0.2 - 0.6	70		0.4	70		1.5	110	
Colour	TCU	15	0 - 5	<1 - 3	4		1	3		1	2	
Conductivity Lab @25	µS/m	-	74 - 140	33 - 67	110		110	110		110	92	
TFS sum	mg/L	-	460 - 900	280 - 520	790		660	790		680	610	
TFS -CO2	mg/L	1000	420 - 840	200 - 390	750		610	750		630	600	
Iron Unfiltered	mg/L	0.3	<0.1 - 4.8	<0.1 - 0.14	2.4		<0.1	2.6		0.45	3.6	
Manganese Unfiltered	mg/L	0.1	<0.04 - 1.4	<0.04	<0.04		0.04	0.06		0.06	1.4	
Aluminium Unfiltered	mg/L	0.2	0.011 - 1.3	0.029 - 0.093			0.011			0.049		
Iron Filtered	mg/L	-	<0.1 - 8.5	0.14 - 0.7		1	<0.10		2.2	0.2		8.5
Manganese Filtered	mg/L	-	<0.04 - 1.4	<0.04 - 0.1		0.04	0.016		0.07	0.022		1.4
Sodium	mg/L	300	120 - 190	17 - 150	160		160	160		160	120	
Potassium	mg/L	-	11 - 16	2.4 - 5.5	11		12	12		13	12	
Calcium	mg/L	-	7 - 46	0.8 - 38	15		14	13		17	13	
Magnesium	mg/L	-	13 - 46	0.65 - 12	24		22	20		24	22	
Hardness as CaCO3	mg/L	500	75 - 240	4.5 - 140	130		120	120		140	130	
Alkalinity	meq/L	-	0.6 - 3.7	2.6 - 4.1	1.3		1.4	1.4		1.6	0.6	
Chloride	mg/L	400	175 - 380	19 - 89	380		275	360		275	335	
Sulphate	mg/L	400	29 - 82	4 - 10	56		44	67		44	44	
Silica as SiO2	mg/L	-	19 - 61	15 - 26	48		38	45		51	19	
Filterable Organic Carbon	mg/L	-	0.3 - 12.5	0.4 - 5.5	5.5		0.8	7.4		0.7	2	
Nitrite + Nitrate as N	mg/L	-	0.02 - <1	0.71 - <1	0.8		0.355	0.23		0.445	0.02	
Nitrite as N	mg/L	-	<0.001 - 0.01		0.01		0.002	0.01		0.003	0.01	
Nitrate as N	mg/L	10	0.01 - 0.91		0.79		0.355	0.22		0.44	0.01	

Well		10	10	1/65	1/65	1/65	1/65	1/76	1/76	1/76	3/76	3/76
Aquifer		Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined
Sample Date		21 06 88	08 06 89	15 06 88	21 06 88	08 06 89	11 06 90	15 06 88	21 06 88	08 06 89	21 06 88	08 06 89
pH Lab			6.5	6.6		7.2	6.6	6.7		6.5		6.3
Turbidity	NTU		13	0.6		5.4	0.4	41		80		0.4
Colour	TCU		1	1		1	0	5		2		1
Conductivity Lab @25	µS/m		140	110		130	115	110		105		105
TFS sum	mg/L		760	790		830	810	800		650		620
TFS -CO2	mg/L		740	750		750	700	750		600		590
Iron Unfiltered	mg/L		1.4	<0.10		0.75	<0.10	2		3.8	<0.10	<0.10
Manganese Unfiltered	mg/L		0.15	0.07		0.1	0.07	0.2		0.2		0.07
Aluminium Unfiltered	mg/L		0.038			0.027	0.13			1.3		0.425
Iron Filtered	mg/L	2	0.75		<0.10	<0.1			0.35	1.4	<0.10	0.1
Manganese Filtered	mg/L	0.25	0.15		0.07	0.098			0.25	0.2	<0.04	0.048
Sodium	mg/L		170	150		160	160	160		150		140
Potassium	mg/L		14	13		14	14	11		14		13
Calcium	mg/L		18	17		46	18	14		14		14
Magnesium	mg/L		42	26		30	28	22		22		28
Hardness as CaCO3	mg/L		220	150		240	160	130		130		150
Alkalinity	meq/L		0.7	1.3		2.7	3.7	1.7		1.6		1.1
Chloride	mg/L		380	380		305	290	365		260		265
Sulphate	mg/L		39	59		43	45	58		34		29
Silica as SiO2	mg/L		49	48		61	28	42		49		58
Filterable Organic Carbon	mg/L		0.6	3.8		0.8	0.3	9.3		0.6		1.3
Nitrite + Nitrate as N	mg/L		0.91	0.86		0.73	<1.000	0.08		0.145		0.195
Nitrite as N	mg/L		<0.001	0.01		0.002		0.01		<0.001		<0.001
Nitrate as N	mg/L		0.91	0.85		0.73		0.07		0.145		0.195

Note: NHMRC - Guidelines for drinking water in Australia recommended by the NHMRC
Note: All data derived from SWRIS

TABLE 2

Water Quality Data - Town Water Supply Wells

Well		3/76	4/76	4/76	5/76	5/76	5/76	2/78	2/78	2/78	1/82	1/82
Aquifer		Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Lower Erskine	Lower Erskine
Sample Date		11 06 90	30 04 90	11 06 90	15 06 88	21 06 88	08 06 89	21 06 88	08 06 89	11 06 90	13 12 88	05 01 89
pH Lab		6.65	6.66	6.7	6.65		6.6		7.2	7.25		
Turbidity	NTU	0.8	41	0.3	16		0.2		1.8	1.7		
Colour	TCU	1	5	1	4		1		1	1		
Conductivity Lab @25	µS/m	105	74	78	120		125		120	110		
TFS sum	mg/L	620	460	470	900		760		760	670		
TFS -CO2	mg/L	580	420	430	840		700		690	610		
Iron Unfiltered	mg/L	<0.10	4.8	<0.1	0.7		<0.1		0.45	<0.10		
Manganese Unfiltered	mg/L	<0.04	0.15	0.2	0.35		0.25		0.05	<0.04		
Aluminium Unfiltered	mg/L	0.019	0.41	0.019			0.02		0.175	0.7		
Iron Filtered	mg/L					0.6	0.062	<0.10	0.037		0.7	0.4
Manganese Filtered	mg/L					0.4	0.35	0.04	0.056		0.1	<0.04
Sodium	mg/L	140	120	120	190		180		140	140		
Potassium	mg/L	13	11	12	16		15		12	11		
Calcium	mg/L	15	7	8	17		17		44	32		
Magnesium	mg/L	28	13	15	22		24		30	28		
Hardness as CaCO3	mg/L	160	75	80	130		140		230	200		
Alkalinity	meq/L	1.2	1.3	1.3	2		2		2.5	1.8		
Chloride	mg/L	280	175	175	390		300		280	270		
Sulphate	mg/L	35	37	45	82		46		40	43		
Silica as SiO2	mg/L	28	20	24	33		52		58	28		
Filterable Organic Carbon	mg/L	0.5	1.3	0.7	12.5		1.4		0.9	0.5		
Nitrite + Nitrate as N	mg/L	<1	<1	<1	0.06		0.19		0.82	<1		
Nitrite as N	mg/L				0.01		0.004		<0.001			
Nitrate as N	mg/L				0.05		0.19		0.82			

Well		1/82	2/82	1/86	1/86	1/86	1/89					
Aquifer		Lower Erskine	Lower Erskine	Lower Erskine	Lower Erskine	Lower Erskine	Lower Erskine					
Sample Date		30 05 88	30 05 88	15 06 88	20 06 88	30 04 90	30 04 90					
pH Lab		7.15	6.8	8		8.05	7.95					
Turbidity	NTU	0.2	0.2	0.6		0.3	0.5					
Colour	TCU	<1	<1	3		2	<1					
Conductivity Lab @25	µS/m	48	33	67		65	67					
TFS sum	mg/L	390	280	510		510	520					
TFS -CO2	mg/L	290	200	390		390	390					
Iron Unfiltered	mg/L	<0.1	<0.1	0.14		0.11	<0.1					
Manganese Unfiltered	mg/L	<0.04	<0.04	<0.04		<0.04	<0.04					
Aluminium Unfiltered	mg/L					0.093	0.029					
Iron Filtered	mg/L				0.14							
Manganese Filtered	mg/L				<0.04							
Sodium	mg/L	48	17	150		150	140					
Potassium	mg/L	3	2.4	5		4.8	5.5					
Calcium	mg/L	38	38	0.8		1.2	1.4					
Magnesium	mg/L	12	8.5	0.65		0.8	1					
Hardness as CaCO3	mg/L	140	130	4.5		6	7.5					
Alkalinity	meq/L	3.4	2.6	4		4	4.1					
Chloride	mg/L	44	19	80		83	89					
Sulphate	mg/L	9	4	4		10	10					
Silica as SiO2	mg/L	25	26	15		16.5	16					
Filterable Organic Carbon	mg/L	0.4	0.8	5.5		0.5	0.7					
Nitrite + Nitrate as N	mg/L	0.74	0.87	0.71		<1						
Nitrite as N	mg/L			0.01								
Nitrate as N	mg/L			0.7								

Note: All data derived from SWRIS

TABLE 3

Well Classification Statistics

Well Classification	Derby Groundwater Area	Township Subarea	Rural Subarea	Hamlet Grove Subarea
Town Water Supply Wells				
Unconfined Production	9	9	0	0
Unconfined Monitor	3	2	1	0
Unconfined Capped	6	6	0	0
Unconfined Infilled	11	11	0	0
Lower Erskine Production	3	2	1	0
Lower Erskine Monitor	3	2	1	0
Lower Erskine Capped	1	0	1	0
Lower Erskine Infilled	0	0	0	0
Liveringa Infilled	1	1	0	0
Private Water Supply Wells				
Unconfined Production	94	27	27	40
Unconfined Capped	18	7	8	3
Unconfined Infilled	16	7	7	2
Unconfined Unknown	25	16	0	9
Lower Erskine Production	4	2	2	0
Lower Erskine Capped	1	1	0	0
Lower Erskine Infilled	1	0	1	0
Total Wells	196	93	49	54

TABLE 4

Town Water Supply

Existing Monitoring Schedule

Well Classification	Production	Water Rest Level	Conductivity & Temperature	Iron & Manganese	Major Ions
Unconfined Production	Monthly	Monthly	Monthly	Three Monthly	Yearly
Lower Erskine Production	Monthly	Monthly	Monthly	Three Monthly	Yearly
Unconfined Monitoring		Monthly			
Lower Erskine Monitoring		Monthly	* Yearly		
Unconfined Capped		Two Yearly	Two Yearly		

* A recommendation of this report is to increase monitoring frequency to 6 monthly

TABLE 5

Town Water Supply Abstraction

Year	Unconfined m^3/a	Lower Erskine m^3/a	Total m^3/a	Increase %
1979 - 80	647823		647823	
1980 - 81	822980		822980	27
1981 - 82	993392		993392	21
1982 - 83	901611		901611	-9
1983 - 84	920236		920236	2
1984 - 85	956477	11971	968448	5
1985 - 86	619928	311571	931499	-4
1986 - 87	523199	481217	1004416	8
1987 - 88	775863	347296	1123159	12
1988 - 89	777838	375747	1153585	3
1989 - 90	395506	726864	1122370	-3
1990 - 91	289633	716675	1006308	-10

TABLE 6

Analysis of Groundwater Use 1990-91 m^3/a

Purpose/Aquifer	Township	* Rural	Hamlet Grove	Groundwater Area
Abstraction Purpose				
Public Water Supply	514701	491607	0	1006308
Public Gardens and Recreation	130700	0	0	130700
Institutional Gardens and Recreation	93400	0	0	93400
Domestic	15050	31550	86750	133350
Horticulture	0	10000	21500	31500
Agriculture	0	199000	0	199000
Miscellaneous	14800	29900	0	44700
Total	768651	762057	108250	1638958
Aquifer Abstraction				
Unconfined	514183	69450	108250	691883
Lower Erskine	254468	692607	0	947075
Total	768651	762057	108250	1638958
Town Water Supply Aquifer Abstraction				
Unconfined	289633	0	0	289633
Lower Erskine	225068	491607	0	716675
Total	514701	491607	0	1006308
Private Aquifer Abstraction				
Unconfined	224550	69450	108250	402250
Lower Erskine	29400	201000	0	230400
Total	253950	270450	108250	632650

* Includes Sunnyside Market Garden

TABLE 7

Groundwater Resources and Allocation - Licence Renewal Policies

Unconfined Aquifer

Subarea	Unit	Township	Comment	Rural	Comment	Hamlet Grove	Comment	Derby Peninsula	Comment
Area	ha	537		2590		266		3393	
Storage	m³	96 701 000	2	466 398 000	2	47 900 000	2	611 000 000	2
Rainfall Recharge	m³/a	>101 000	3	>487 000	3	>50 000	3	>638 000	3
Throughflow	m³/a	<<669 000	4	<3 229 000	4	<<332 000	4	<4 230 000	4
Renewable Resource	m³/a	<<771 000	4	<3 717 000	4	<<382 000	4	<4 870 000	4
Abstraction 1990-91	m³/a	514183		69 450		108 250		691883	
Abstraction / Renewable Resource x 100	%	>>67	5	>2	5	>>28	5	>14	5
New Well - Maximum Permitted Well Depth	m	50	6	50	6	50	6	N/A	1
New Well - Abstraction Limit	m³/a	2000	7	10 000	7	2000	7	N/A	1
New Well - Minimum Radius from Nearest Well	m	a) 20 b) 100	8	100	9	30	9	N/A	1
New Well - Maximum Salinity of Locality	mg/L	800	10	800	10	800	10	N/A	1
Existing Well - Maximum Operating Salinity	mg/L	1500	11	1000	11	1000	11	N/A	1

Comments

1 Not applicable
2 Determined from calculations in section 5.2.1 and areas above
3 Determined from calculations in section 5.2.2 and areas above. Recharge is probably higher than estimated
4 Determined from calculations in section 5.2.2 and areas above. Much of the throughflow appears to be diverted to the mudflats
5 Value represents minimum as throughflow is likely to be less
6 Requests for greater well depths should be assessed by G & E Branch
7 Requests for greater allocations should be assessed by G & E Branch
8 a) <1000 m3/a b) >1000 m3/a. Requests for closer spacings to be assessed by G & E Branch
9 Requests for closer spacing should be assessed by G & E Branch
10 Determined from 800 mg/L TDS contours on Figures 28 and 30. >800 mg/L TDS should be assessed by G & E Branch
11 To be assessed at time of licence renewal and future salinity surveys. Excessive salinities should be assessed by G & E Branch

TABLE 8

Resources and Allocation - Licence Renewal Policies

Lower Erskine Aquifer

Subarea		Township		Rural		Hamlet Grove		Derby Peninsula	
Area	ha	537		2590		266		3393	
Storage	m³	37 668 000	2	181 674 000	2	18 658 000	2	238 000 000	2
Rainfall Recharge	m³/a	0		0		0		0	
Throughflow	m³/a	90 000	3	435 000	3	45 000	3	570 000	3
Renewable Resource	m³/a	90 000	3	435 000	3	45 000	3	570 000	3
Abstraction	m³/a	254468		692 607		0		947075	
Abstraction / Renewable Resource x 100	%	283		159		0		166	
New Well - Maximum Permitted Well Depth	m	*	4	*	4	*	4	N/A	1
New Well - Abstraction Limit	m³/a	*	4	*	4	*	4	N/A	1
New Well - Minimum Radius from Nearest Well	m	*	4	*	4	*	4	N/A	1
New Well - Maximum Salinity of locality	mg/L	*	4	*	4	*	4	N/A	1
Existing Well - Maximum Operating Salinity	mg/L	450	5	450	5	450	5	N/A	1

Comments
1 Not applicable
2 Determined from calculations in section 5.3.1 and areas above
3 Determined from calculations in section 5.3.2 and areas above
4 Applications are to be forwarded to G & E Branch for assessment and must be approved by WAWA Board
5 Salinities exceeding these levels should be assessed by G & E Branch

Appendix I

DERBY WELL CENSUS MAY 1991

Form	Date	Officer

IDENTIFICATION
Provisional Number
Map Sheet
Name
Address
Lot Number
Lot Area ha
Post Office Box Number
Telephone Number
Is Scheme Available Y/N

WELL DETAILS
Construction Date
Abandoned Y/N
Depth m BNS
Screened Interval m BNS
Depth to Static Water Level m BNS
Pump Size
Pump Output kL/day
Annual Well Production kL
Well Locations Plotted on Map Y/N

LOT WATER USEAGE	
Daily Lot Useage kL	
Days/Year of Irrigation	
Annual Lot Useage kL	
Domestic Requirement Y/N	
Purpose Other than Domestic	Rate kL/annum

Appendix I Continued

LOT WATER USEAGE

Crop Types	Area ha

Details of Planned Expansion

Projected Annual Requirement kL/a

WELL WATER QUALITY

Conductivity Uncompensated μS/m
Water Temperature C
TDS Derived mg/L
Bottle Number
Fluctuations or Trends

GENERAL COMMENTS

APPENDIX II

DERBY WELL DATABASE INDEX

Code	Description	Units	Data Type	Width	Decimals
CENSUS	Census Number		Numeric	3	0
PROVISION	Provisional Number		Numeric	3	0
NAME	Well Name		Character	10	
AWRC	Australian Water Resources Council Number		Numeric	8	0
GWL	Groundwater Licence Number		Numeric	6	0
GSWA	Geological Survey Number - Map 3663-III		Numeric	3	0
OWNER	Owner		Character	25	
PO BOX	PO Box Number		Character	7	0
PHONE	Telephone Number		Character	10	
LOT	Lot Number		Character	6	0
STREET	Street Name		Character	15	
SUB AREA	Groundwater Sub Area		Character	15	
EASTING	Easting Approx		Numeric	6	0
NORTHING	Northing Approx		Numeric	7	0
CONST DATE	Well Construction Date		Character	9	
STATUS	Well Status		Character	10	
AQUIFER	Aquifer		Character	15	
DEPTH BTOC	Well Depth - Top of Casing	mBTOC	Numeric	6	2
SCRNT BTOC	Screen Top - Top of Casing	mBTOC	Numeric	6	2
SCRNB BTOC	Screen Bottom - Top of Casing	mBTOC	Numeric	6	2
RWLC BTOC	Rest Water Level Construction - Top of Casing	mBTOC	Numeric	5	2
RWLM BTOC	Rest Water Level May 1991 - Top of Casing	mBTOC	Numeric	5	2
TOC ANS	Top of Casing - Natural Surface	mANS	Numeric	4	2
DEPTH BNS	Well Depth - Natural Surface	mBNS	Numeric	6	2
SCRNT BNS	Screen Top - Natural Surface	mBNS	Numeric	6	2
SCRNB BNS	Screen Bottom - Natural Surface	mBNS	Numeric	6	2
RWLC BNS	Rest Water Level Construction - Natural Surface	mBNS	Numeric	6	2
RWLG BNS	Rest Water Level GSWA Census - Natural Surface	mBNS	Numeric	6	2
RWLM BNS	Rest Water Level May 1991 - Natural Surface	mBNS	Numeric	5	2
RL TOC S	RL Top of Casing - Surveyed	mAHD	Numeric	6	3
RL NS S	RL Natural Surface - Surveyed	mAHD	Numeric	6	2
RL NS A	RL Natural Surface - Approximate	mAHD	Numeric	5	1
RL BOT	RL Bottom of Well	mAHD	Numeric	7	2
RL SCRNT	RL Screen Top	mAHD	Numeric	7	2
RL SCRNB	RL Screen Bottom	mAHD	Numeric	7	2
RL RWLC	RL Rest Water Level - Construction	mAHD	Numeric	6	2
RL RWLG	RL - Rest water Level - GSWA Census		Numeric	6	2
RL RWLM	RL Rest Water Level - May 1991	mAHD	Numeric	6	2
F S DATE	Field Sample Date - May 91 Survey		Character	9	
F COND	Field Conductivity Uncompensated - May 91 Survey	μS/m	Numeric	6	1
F TDS	Field TDS Cond - May 91 Survey	mg/L	Numeric	5	0
L S NUMB	Lab Sample Number - May 91 Survey		Numeric	5	0
L COND	Lab Conductivity @ 25C - May 91 Survey	μS/m	Numeric	6	1
L TDS	Lab TDS Cond - May 91 Survey	mg/L	Numeric	5	0
L TDS G	Lab TDS Cond - GSWA August 1987 Survey	mg/L	Numeric	5	0
UNCON PROD	Unconfined Production 1990-91	kL/annum	Numeric	6	0
ERSK PROD	Lower Erskine Production 1990-91	kL/annum	Numeric	6	0
CROSS REF	Lot Data Cross Reference		Character	4	
SCHEME	Scheme Connection Y/N		Character	3	
GWL ALLOC	Current GWL Allocation - June 1991	kL/annum	Numeric	6	0
PUB SUPPLY	Public Water Supply 1990-91	kL/annum	Numeric	6	0
PUB AREA	Public Parks Gardens and recreation facilities 1990-91	kL/annum	Numeric	6	0
INST AREA	Institutional Gardens and Recreation Facilites 1990-91	kL/annum	Numeric	6	0
DOMESTIC	Domestic 1990-91	kL/annum	Numeric	5	0
HORTICULT	Horticulture 1990-91	kL/annum	Numeric	6	0
AGRICULT	Agriculture 1990-91	kL/annum	Numeric	6	0
MISCELLAN	Miscellaneous 1990-91	kL/annum	Numeric	6	0
TOT REQ	Total Groundwater Requirement 1990-91	kL/annum	Numeric	6	0
FUTURE REQ	Future Groundwater Requirement - Short Term	kL/annum	Numeric	6	0
IRRIG AREA	Irrigation Area	Ha	Numeric	6	1

APPENDIX III

TOWN WATER SUPPLY WELL DETAILS

CENSUS	NAME	AWRC	SUB_AREA	EASTING	NORTHING	CONST_DATE	STATUS	AQUIFER	RL_TOC_S	RL_BOT	PUB_SUPPLY
80	Test 1	80219011	Township	567989	8085743		Infilled	Unconfined	0.000	0.00	0
89	Test 2	80219012	Township	568128	8085852		Monitor	Unconfined	16.591	-3.80	0
83	Test 3	80219013	Township	568324	8085746		Capped	Unconfined	16.285	-17.70	0
81	1/71	80219014	Township	568345	8085334		Production	Unconfined	16.103	-17.70	1339
79	2/71	80219015	Township	568269	8085337		Production	Unconfined	16.066	-17.73	320
71	3/71	80219016	Township	568195	8085338		Infilled	Unconfined	15.957	-17.54	0
69	1	80219017	Township	568890	8085827		Infilled	Unconfined	0.000	0.00	0
67	2	80219018	Township	568074	8085889		Infilled	Unconfined	15.286	-9.11	0
65	3	80219019	Township	568101	8085809		Infilled	Unconfined	16.598	-13.90	0
63	4	80219020	Township	567997	8085816		Infilled	Unconfined	15.495	-15.01	0
88	5	80219021	Township	568041	8085736		Capped	Unconfined	15.620	-13.68	0
76	6	80219022	Township	567923	8085745		Monitor	Unconfined	14.587	-15.90	0
84	7	80219023	Township	568190	8085739		Capped	Unconfined	16.573	-14.23	0
87	8	80219024	Township	568212	8085854		Infilled	Unconfined	16.555	-14.25	0
70	9	80219025	Township	568321	8085844		Infilled	Unconfined	0.000	-13.20	0
68	10	80219026	Township	568352	8085650		Production	Unconfined	16.122	-14.38	10562
64	1/65	80219027	Township	568836	8085151		Production	Unconfined	17.818	-13.28	119149
62	2/65	80219028	Township	569267	8084697		Infilled	Unconfined	17.680	-12.82	0
141	3/65	80219029	Rural	569112	8085376		Monitor	Unconfined	17.681	-12.82	0
78	1/69	80219030	Township	568237	8085651		Infilled	Unconfined	16.669	-13.83	0
66	1/76	80219031	Township	568715	8085151		Production	Unconfined	17.146	-22.85	552
86	2/76	80219032	Township	569080	8085139		Infilled	Unconfined	18.058	-21.94	0
82	3/76	80219033	Township	569103	8085045		Production	Unconfined	18.039	-21.98	77341
74	4/76	80219034	Township	569153	8084934		Production	Unconfined	17.881	-20.12	30255
85	5/76	80219035	Township	569208	8084826		Production	Unconfined	17.708	-21.29	0
93	1/78	80219036	Township	568447	8085541	Jul 78	Capped	Unconfined	16.178	-15.82	0
92	2/78	80219037	Township	568648	8085425	Jul 78	Production	Unconfined	16.823	-15.18	50115
91	3/78	80219038	Township	568787	8084972	Jul 78	Capped	Unconfined	16.192	-23.81	0
90	4/78	80219039	Township	568661	8084973	Jul 78	Capped	Unconfined	16.915	-23.08	0
77	1/82	80219040	Township	568172	8085728	Nov 82	Production	Lower Erskine	17.219	-227.80	171013
75	1/86	80219041	Township	569060	8085152	Nov 86	Production	Lower Erskine	18.501	-222.00	54055
140	2/88	0	Rural	569947	8085584	Mar 89	Monitor	Lower Erskine	7.870	0.00	0
73	3/88	0	Township	567466	8084205	Apr 89	Monitor	Lower Erskine	6.322	0.00	0
138	1/89	0	Rural	569729	8084066	Feb 89	Production	Lower Erskine	14.929	-225.10	491607
61	2/89	0	Township	566241	8086813	Mar 89	Monitor	Lower Erskine	6.187	0.00	0
72		0	Township	567961	8085843	1913	Infilled	Liveringa	0.000	-708.20	0
139	1/88	0	Rural	569727	8084080	Nov 88	Capped	Lower Erskine	6.322	0.00	0

Refer to Appendix II for description of column headings

APPENDIX IVa

TOWNSHIP - WELL IDENTIFICATION

CENSUS	NAME	GWL	GSWA	OWNER	LOT	STREET	EASTING	NORTHING	CONST DATE	STATUS	AQUIFER
1		20105	0	Archer KD	499	Loch	567389	8086179	1961	Capped	Unconfined
2		20499	89	Bergman F	708	Wells	568978	8085037	1979	Production	Unconfined
3		21333	0	Davidson MAN	151	Knowsley	569186	8085698	1989	Production	Unconfined
4		0	0	Dept of Community Welfare	528	Ashley	567855	8085268		Capped	Unconfined
5		0	27	Dept of Community Welfare	528	Ashley	567698	8085529		Capped	Unconfined
6		20086	0	Dept of Community Welfare	528	Ashley	567835	8085341	1983/84	Production	Unconfined
7		0	0	Dept of Community Welfare	528	Ashley	567844	8085510		Capped	Unconfined
8	2	24372	0	Dept of Main Roads	R4211	Loch	567834	8086046	Aug 88	Production	Unconfined
9		0	0	Dept of Main Roads	R4211	Loch	567860	8086088		Infilled	Unconfined
10		0	57	Dept of Main Roads	R4211	Loch	567837	8086062		Infilled	Unconfined
11		22412	97	Dept of Main Roads	626	Wodehouse	568727	8085555	Jun 82	Production	Unconfined
12		22259	0	Derby Caravan Park	658	Rowan	566751	8086204	Dec 1990	Production	Unconfined
13		20084	0	Derby High School	524	Stanley	567258	8085818		Production	Unconfined
14		20084	0	Derby High School	524	Stanley	567261	8085936		Production	Unconfined
15		20084	26	Derby High School	524	Stanley	567145	8086061		Production	Unconfined
16		0	16	Derby Racecourse	811	Ashley	568330	8085210		Infilled	Unconfined
17		24014	96	Derby Regional Hospital	454	Loch	567193	8086341	Aug 88	Production	Lower Erskine
18		0	43	Derby Regional Hospital	454	Loch	567160	8086279		Infilled	Unconfined
19		30468	0	Holy Rosary School	388	Loch	567313	8086418	Nov 88	Production	Unconfined
20		34047	0	Jane MR & RA	171	Knowsley	568461	8085697	1990	Production	Unconfined
21		20101	101	Lovell S	169	Knowsley	568528	8085707	Oct 1982	Production	Unconfined
22		20100	105	McCumstie P	167	Knowsley	568575	8085691	Jul 1983	Production	Unconfined
23		0	0	Numbala Nunga Hospital	451	Sutherland	569227	8085997		Capped	Unconfined
24		0	0	Numbala Nunga Hospital	451	Sutherland	569226	8086019	Apr 89	Capped	Lower Erskine
25		30459	0	Numbala Nunga Hospital	208	Dampier	569186	8085665		Production	Unconfined
26		20098	93	Otavi Management P/L	196	Wodehouse	568741	8085635	Jun 82	Production	Unconfined
27		20098	92	Otavi Managment P/L	213	Wodehouse	569348	8085640	Jun 82	Production	Unconfined
28		0	0	Ozie SA	27	Stanley	568219	8086048	1960's	Infilled	Unconfined
29		20094	0	Ozie SA	27	Stanley	568206	8086049	1960's	Infilled	Unconfined
30		20109	98	Rees ARL & VM	191	Wodehouse	568548	8085662	1984	Production	Unconfined
31		31327	0	Rodeo Grounds	812	Ashley	568028	8084614	1990	Production	Unconfined
32		20108	115	Royal Flying Doctor	519	Fairbairn	567281	8086058	Sep 81	Capped	Unconfined
33		20108	107	Royal Flying Doctor	519	Fairbairn	567283	8086086	Apr 85	Capped	Unconfined
34	Apex	21153	0	Shire of Derby	646	Alexander	567275	8085610		Production	Unconfined
35	Boab	0	0	Shire of Derby		Loch	567820	8085970	1983?	Production	Unconfined
36	Nicholson	21154	99	Shire of Derby	636	Delawarr	568008	8086017	Sep 81	Production	Unconfined
37	Office	21140	24	Shire of Derby	277	Loch	566611	8086627		Production	Unconfined
38		0	44	Shire of Derby	636	Delawarr	568025	8086044		Infilled	Unconfined
39		21155	102	Shire of Derby	1050	Yeeda	567552	8084702	Oct 83	Production	Lower Erskine
40	Lytton	21152	100	Shire of Derby	485	Knowsley	568686	8085809	Sep 81	Production	Unconfined
41		36229	0	Sisters of St John of God	109	Knowsley	568549	8085845	1991	Production	Unconfined
42		20085	45	St Josephs Hostel	529	Ashley	568067	8085466		Production	Unconfined
43		20085	28	St Josephs Hostel	529	Ashley	568013	8085536		Production	Unconfined
44		0	0	Taylor	32	Loch	568268	8086006	Mar 89	Production	Unconfined
45		0	34	Unknown	26	Stanley	568247	8086057		Unknown	Unconfined
46		0	23	Unknown	255	Loch	566795	8086710		Unknown	Unconfined
47		0	37	Unknown	85	Delawarr	568580	8085888		Unknown	Unconfined
48		0	38	Unknown	75	Delawarr	568962	8085900		Unknown	Unconfined
49		0	35	Unknown	34	Delawarr	568330	8086008		Unknown	Unconfined
50		0	36	Unknown	18	Stanley	568523	8086047		Unknown	Unconfined
51		0	25	Unknown	327	Clarendon	566602	8086461		Unknown	Unconfined
52		0	50	Unknown	520	Loch	567691	8086001		Unknown	Unconfined
53		0	51	Unknown	1178	Ashley	567941	8085894		Unknown	Unconfined
54		0	52	Unknown	42	Delawarr	568611	8086008		Unknown	Unconfined

APPENDIX IVa Cont

TOWNSHIP - WELL IDENTIFICATION

CENSUS	NAME	GWL	GSWA	OWNER	LOT	STREET	EASTING	NORTHING	CONST DATE	STATUS	AQUIFER
55		0	53	Unknown	76	Delawarr	568936	8085869		Unknown	Unconfined
56		0	54	Unknown	54	Delawarr	569065	8085975		Unknown	Unconfined
57		0	55	Unknown	43	Delawarr	568683	8086008		Unknown	Unconfined
58		0	40	Unknown	129	Knowsley	569284	8085833		Unknown	Unconfined
59		0	33	Unknown	26	Stanley	568236	8086059		Unknown	Unconfined
60		0	56	Unknown	123	Knowsley	569056	8085823		Unknown	Unconfined
61	2/89	0	0	WAWA	643	Elder	566241	8086813	Mar 89	Monitor	Lower Erskine
62	2/65	0	71	WAWA	729	Wells	569267	8084697		Infilled	Unconfined
63	4	0	30	WAWA	1187	Delawarr	567997	8085816		Infilled	Unconfined
64	1/65	0	61	WAWA	706	LeLievre	568836	8085151		Production	Unconfined
65	3	0	31	WAWA	1194	Knowsley	568101	8085809		Infilled	Unconfined
66	1/76	0	76	WAWA	705	LeLievre	568715	8085151		Production	Unconfined
67	2	0	29	WAWA	1187	Delawarr	568074	8085889		Infilled	Unconfined
68	10	0	60	WAWA	1142	Knowsley	568352	8085650		Production	Unconfined
69	1	0	0	WAWA	892	Knowsley	568890	8085827		Infilled	Unconfined
70	9	0	49	WAWA	1198	Knowsley	568321	8085844		Infilled	Unconfined
71	3/71	0	67	WAWA	824	Carnarvon	568195	8085338		Infilled	Unconfined
72		0	22	WAWA	1170	Short	567961	8085843	1913	Infilled	Liveringa
73	3/88	0	0	WAWA	823	Rowan	567466	8084205	Apr 89	Monitor	Lower Erskine
74	4/76	0	79	WAWA	837	Wells	569153	8084934		Production	Unconfined
75	1/86	0	170	WAWA	839	Wells	569060	8085152	Nov 86	Production	Lower Erskine
76	6	0	41	WAWA	1166	Ashley	567923	8085745		Monitor	Unconfined
77	1/82	0	118	WAWA	1142	Knowsley	568172	8085728	Nov 82	Production	Lower Erskine
78	1/69	0	63	WAWA	1142	Wodehouse	568237	8085651		Infilled	Unconfined
79	2/71	0	66	WAWA	824	Carnarvon	568269	8085337		Production	Unconfined
80	Test 1	0	68	WAWA		Holman	567989	8085743		Infilled	Unconfined
81	1/71	0	65	WAWA	824	Carnarvon	568345	8085334		Production	Unconfined
82	3/76	0	78	WAWA	838	Wells	569103	8085045		Production	Unconfined
83	Test 3	0	70	WAWA	1142	Knowsley	568324	8085746		Capped	Unconfined
84	7	0	42	WAWA	1142	Knowsley	568190	8085739		Capped	Unconfined
85	5/76	0	80	WAWA	836	Wells	569208	8084826		Production	Unconfined
86	2/76	0	77	WAWA	839	Wells	569060	8085139		Infilled	Unconfined
87	8	0	48	WAWA	1188	Delawarr	568212	8085854		Infilled	Unconfined
88	5	0	32	WAWA	1156	Knowsley	568041	8085736		Capped	Unconfined
89	Test 2	0	69	WAWA	1187	Loch	568128	8085852		Monitor	Unconfined
90	4/78	0	169	WAWA	926	Millard	568661	8084973	Jul 78	Capped	Unconfined
91	3/78	0	168	WAWA	927	Millard	568787	8084972	Jul 78	Capped	Unconfined
92	2/78	0	167	WAWA	637	Wodehouse	568648	8085425	Jul 78	Production	Unconfined
93	1/78	0	166	WAWA	637	Wodehouse	568447	8085541	Jul 78	Capped	Unconfined

Refer to Appendix II for description of column headings

APPENDIX IVb

TOWNSHIP - WELL HYDROGEOLOGICAL DETAILS

CENSUS	OWNER	DEPTH_BNS	RWLG_BNS	RWLM_BNS	RL_NS_A	RL_BOT	RL_RWLG	RL_RWLM	L_TDS	L_TDS_G	UNCON_PROD	ERSK_PROD
1	Archer KD	20.72	0.00	8.45	10.2	-10.52	0.00	1.75	0	0	0	0
2	Bergman F	24.40	0.00	0.00	18.0	-6.40	0.00	0.00	0	0	850	0
3	Davidson MAN	48.00	0.00	8.86	13.2	-34.80	0.00	4.34	1838	0	1500	0
4	Dept of Community Welfare	0.00	0.00	0.00	14.5	0.00	0.00	0.00	0	0	0	0
5	Dept of Community Welfare	17.40	0.00	0.00	10.5	-6.90	0.00	0.00	0	0	0	0
6	Dept of Community Welfare	30.00	0.00	0.00	13.2	-16.80	0.00	0.00	788	0	17000	0
7	Dept of Community Welfare	0.00	0.00	0.00	13.7	0.00	0.00	0.00	0	0	0	0
8	Dept of Main Roads	30.00	0.00	0.00	11.8	-18.20	0.00	0.00	973	0	9600	0
9	Dept of Main Roads	0.00	0.00	0.00	11.0	0.00	0.00	0.00	0	0	0	0
10	Dept of Main Roads	8.20	0.00	0.00	11.5	3.30	0.00	0.00	0	0	0	0
11	Dept of Main Roads	36.00	0.00	0.00	15.8	-20.20	0.00	0.00	287	0	2000	0
12	Derby Caravan Park	22.00	0.00	0.00	7.2	-14.80	0.00	0.00	0	0	0	0
13	Derby High School	0.00	0.00	0.00	10.2	0.00	0.00	0.00	1126	0	15000	0
14	Derby High School	0.00	0.00	0.00	10.5	0.00	0.00	0.00	0	0	15000	0
15	Derby High School	17.40	0.00	0.00	10.5	-6.90	0.00	0.00	812	0	6000	0
16	Derby Racecourse	30.50	0.00	0.00	16.0	-14.50	0.00	0.00	0	0	0	0
17	Derby Regional Hospital	100.00	0.00	0.00	9.5	-90.50	0.00	0.00	424	0	0	20400
18	Derby Regional Hospital	17.40	0.00	0.00	10.1	-7.30	0.00	0.00	0	0	0	0
19	Holy Rosary School	61.00	0.00	0.00	8.0	-53.00	0.00	0.00	319	0	0	9000
20	Jane MR & RA	45.00	0.00	0.00	15.0	-30.00	0.00	0.00	286	0	850	0
21	Lovell S	30.50	0.00	11.10	14.8	-15.70	0.00	3.70	1045	0	850	0
22	McCumstie P	35.05	0.00	0.00	14.8	-20.25	0.00	0.00	1345	0	1500	0
23	Numbala Nunga Hospital	12.20	0.00	0.00	7.9	-4.30	0.00	0.00	0	0	0	0
24	Numbala Nunga Hospital	110.00	0.00	0.00	7.9	-102.10	0.00	0.00	0	0	0	0
25	Numbala Nunga Hospital	0.00	0.00	0.00	12.8	0.00	0.00	0.00	1604	0	11000	0
26	Otavi Management P/L	31.00	0.00	0.00	15.0	-16.00	0.00	0.00	0	0	850	0
27	Otavi Managment P/L	31.00	0.00	0.00	13.0	-18.00	0.00	0.00	0	0	850	0
28	Ozie SA	0.00	0.00	0.00	12.0	0.00	0.00	0.00	0	0	0	0
29	Ozie SA	0.00	0.00	0.00	12.0	0.00	0.00	0.00	0	0	0	0
30	Rees ARL & VM	30.50	0.00	11.10	15.0	-15.50	0.00	3.90	1515	0	800	0
31	Rodeo Grounds	50.00	0.00	10.60	12.2	-37.80	0.00	1.60	355	0	3200	0
32	Royal Flying Doctor	24.70	0.00	0.00	11.0	-13.70	0.00	0.00	0	0	0	0
33	Royal Flying Doctor	12.20	0.00	0.00	11.0	-1.20	0.00	0.00	0	0	0	0
34	Shire of Derby	0.00	0.00	0.00	8.0	0.00	0.00	0.00	0	0	60000	0
35	Shire of Derby	0.00	0.00	0.00	0.0	0.00	0.00	0.00	431	0	3700	0
36	Shire of Derby	21.90	0.00	0.00	12.5	-9.40	0.00	0.00	2415	0	25000	0
37	Shire of Derby	0.00	0.00	0.00	8.0	0.00	0.00	0.00	432	0	30000	0
38	Shire of Derby	31.70	0.00	0.00	12.2	-19.50	0.00	0.00	0	0	0	0
39	Shire of Derby	110.00	0.00	0.00	9.5	-100.50	0.00	0.00	0	0	0	0
40	Shire of Derby	30.50	0.00	0.00	13.5	-17.00	0.00	0.00	1360	0	12000	0
41	Sisters of St John of God	24.00	0.00	9.21	14.0	0.00	0.00	0.00	0	0	0	0
42	St Josephs Hostel	30.50	0.00	0.00	16.0	-14.50	0.00	0.00	0	0	2500	0
43	St Josephs Hostel	30.50	0.00	0.00	15.7	-14.80	0.00	0.00	385	0	2500	0
44	Taylor	30.50	0.00	8.40	13.0	-17.50	0.00	4.60	2331	0	2000	0
45	Unknown	16.20	0.00	0.00	12.0	-4.20	0.00	0.00	0	0	0	0
46	Unknown	9.10	0.00	0.00	7.0	-2.10	0.00	0.00	0	0	0	0
47	Unknown	15.50	0.00	0.00	13.0	-2.50	0.00	0.00	0	0	0	0
48	Unknown	10.40	0.00	0.00	10.5	0.10	0.00	0.00	0	0	0	0
49	Unknown	14.60	0.00	0.00	13.0	-1.60	0.00	0.00	0	0	0	0
50	Unknown	14.60	0.00	0.00	11.0	-3.60	0.00	0.00	0	0	0	0
51	Unknown	38.10	0.00	0.00	7.0	-31.10	0.00	0.00	0	0	0	0
52	Unknown	13.70	0.00	0.00	11.8	-1.90	0.00	0.00	0	0	0	0
53	Unknown	29.00	0.00	0.00	14.0	-15.00	0.00	0.00	0	0	0	0
54	Unknown	18.30	0.00	0.00	11.0	-7.30	0.00	0.00	0	0	0	0

APPENDIX IVb Cont

TOWNSHIP - WELL HYDROGEOLOGICAL DETAILS

CENSUS	OWNER	DEPTH_BNS	RWLG_BNS	RWLM_BNS	RL_NS_A	RL_BOT	RL_RWLG	RL_RWLM	L_TDS	L_TDS_G	UNCON_PROD	ERSK_PROD
55	Unknown	15.20	0.00	0.00	12.0	-3.20	0.00	0.00	0	0	0	0
56	Unknown	0.00	0.00	0.00	8.2	0.00	0.00	0.00	0	0	0	0
57	Unknown	15.20	0.00	0.00	10.2	-5.00	0.00	0.00	0	0	0	0
58	Unknown	24.40	0.00	0.00	10.0	-14.00	0.00	0.00	0	0	0	0
59	Unknown	10.70	0.00	0.00	12.0	1.30	0.00	0.00	0	0	0	0
60	Unknown	9.10	0.00	0.00	13.2	4.10	0.00	0.00	0	0	0	0
61	WAWA	0.00	0.00	0.00	0.0	0.00	0.00	-1.61	424	0	0	0
62	WAWA	0.00	0.00	0.00	0.0	-12.82	0.00	0.00	0	0	0	0
63	WAWA	0.00	0.00	0.00	0.0	-15.01	0.00	0.00	0	0	0	0
64	WAWA	0.00	0.00	0.00	0.0	-13.28	0.00	3.44	685	0	119149	0
65	WAWA	0.00	0.00	0.00	0.0	-13.90	0.00	0.00	0	0	0	0
66	WAWA	0.00	0.00	0.00	0.0	-22.85	0.00	3.15	683	0	552	0
67	WAWA	0.00	0.00	0.00	0.0	-9.11	0.00	0.00	0	0	0	0
68	WAWA	0.00	0.00	0.00	0.0	-14.38	0.00	4.14	428	0	10562	0
69	WAWA	0.00	0.00	0.00	12.5	0.00	0.00	0.00	0	0	0	0
70	WAWA	0.00	0.00	0.00	16.4	-13.20	0.00	0.00	0	0	0	0
71	WAWA	0.00	0.00	0.00	0.0	-17.54	0.00	0.00	0	0	0	0
72	WAWA	722.70	0.00	0.00	14.5	-708.20	0.00	0.00	0	0	0	0
73	WAWA	0.00	0.00	0.00	0.0	0.00	0.00	-19.65	464	0	0	0
74	WAWA	0.00	0.00	0.00	0.0	-20.12	0.00	7.38	427	0	30255	0
75	WAWA	0.00	0.00	0.00	0.0	-222.00	0.00	-29.50	390	0	0	54055
76	WAWA	0.00	0.00	0.00	0.0	-15.90	0.00	3.87	0	0	0	0
77	WAWA	0.00	0.00	0.00	0.0	-227.80	0.00	-33.78	389	0	0	171013
78	WAWA	0.00	0.00	0.00	0.0	-13.83	0.00	0.00	0	0	0	0
79	WAWA	0.00	0.00	0.00	0.0	-17.73	0.00	0.00	0	0	320	0
80	WAWA	0.00	0.00	0.00	15.0	0.00	0.00	0.00	0	0	0	0
81	WAWA	0.00	0.00	0.00	0.0	-17.70	0.00	3.18	503	0	1339	0
82	WAWA	0.00	0.00	0.00	0.0	-21.96	0.00	8.04	376	0	77341	0
83	WAWA	0.00	0.00	0.00	0.0	-17.70	0.00	4.15	0	0	0	0
84	WAWA	0.00	0.00	0.00	0.0	-14.23	0.00	4.10	0	0	0	0
85	WAWA	0.00	0.00	0.00	0.0	-21.29	0.00	0.00	0	0	0	0
86	WAWA	0.00	0.00	0.00	0.0	-21.94	0.00	0.00	0	0	0	0
87	WAWA	0.00	0.00	0.00	0.0	-14.25	0.00	0.00	0	0	0	0
88	WAWA	0.00	0.00	0.00	0.0	-13.68	0.00	3.98	0	0	0	0
89	WAWA	0.00	0.00	0.00	0.0	-3.80	0.00	3.43	0	0	0	0
90	WAWA	0.00	0.00	0.00	0.0	-23.08	0.00	4.55	0	0	0	0
91	WAWA	0.00	0.00	0.00	0.0	-23.81	0.00	3.11	0	0	0	0
92	WAWA	0.00	0.00	0.00	0.0	-15.18	0.00	3.82	594	0	50115	0
93	WAWA	0.00	0.00	0.00	0.0	-15.82	0.00	3.95	0	0	0	0
TOTALS											514183	254468

Refer to Appendix II for description of column headings

APPENDIX IVc

TOWNSHIP - LOT WATER USEAGE DETAILS

CENSUS	OWNER	LOT	STREET	GWL_ALLOC	PUB_SUPPLY	PUB_AREA	INST_AREA	DOMESTIC	HORTICULT	AGRICULT	MISCELLAN	TOT_REQ	FUTURE_REQ
1	Archer KD	499	Loch	800									
2	Bergman F	708	Wells	850	0	0	0	850	0	0	0	850	850
3	Davidson MAN	151	Knowsley	1500	0	0	0	1500	0	0	0	1500	1500
6	Dept of Community Welfare	528	Ashley	24000	0	0	17000	0	0	0	0	17000	17000
8	Dept of Main Roads	R4211	Loch	9600	0	0	0	0	0	0	9600	9600	9600
11	Dept of Main Roads	626	Wodehouse	2000	0	0	0	0	0	0	2000	2000	2000
12	Derby Caravan Park	658	Rowan	20000	0	0	0	0	0	0	0	0	20000
15	Derby High School	524	Stanley	15600	0	0	36000	0	0	0	0	36000	36000
17	Derby Regional Hospital	454	Loch	29250	0	0	20400	0	0	0	0	20400	30000
19	Holy Rosary School	388	Loch	9000	0	0	9000	0	0	0	0	9000	9000
20	Jane MR & RA	171	Knowsley	850	0	0	0	850	0	0	0	850	850
21	Lovell S	169	Knowsley	850	0	0	0	850	0	0	0	850	850
22	McCumstie P	167	Knowsley	850	0	0	0	1500	0	0	0	1500	1500
25	Numbala Nunga Hospital	208	Dampier	11000	0	0	11000	0	0	0	0	11000	11000
29	Osie SA	27	Stanley	850									
27	Otavi Managment P/L	213	Wodehouse	1700	0	0	0	1700	0	0	0	1700	1700
30	Rees ARL & VM	191	Wodehouse	800	0	0	0	800	0	0	0	800	800
31	Rodeo Grounds	812	Ashley	6000	0	0	0	0	0	0	3200	3200	3200
32	Royal Flying Doctor	519	Fairbairn	800	0	0	0	0	0	0	0	0	0
34	Shire of Derby	646	Alexander	60000	0	60000	0	0	0	0	0	60000	60000
35	Shire of Derby		Loch	0	0	3700	0	0	0	0	0	3700	3700
36	Shire of Derby	636	Delawarr	25000	0	25000	0	0	0	0	0	25000	25000
37	Shire of Derby	277	Loch	30000	0	30000	0	0	0	0	0	30000	30000
39	Shire of Derby	1050	Yeeda	52800	0	0	0	0	0	0	0	0	52800
40	Shire of Derby	485	Knowsley	12000	0	12000	0	0	0	0	0	12000	12000
41	Sisters of St John of God	109	Knowsley	1500	0	0	0	0	0	0	0	0	1500
43	St Josephs Hostel	529	Ashley	11700	0	0	0	5000	0	0	0	5000	5000
44	Taylor	32	Loch	0	0	0	0	2000	0	0	0	2000	2000
64	WAWA	706	LeLievre	0	119149	0	0	0	0	0	0	119149	119149
66	WAWA	705	LeLievre	0	552	0	0	0	0	0	0	552	552
68	WAWA	1142	Knowsley	0	10562	0	0	0	0	0	0	10562	10562
74	WAWA	837	Wells	0	30255	0	0	0	0	0	0	30255	30255
75	WAWA	839	Wells	0	54055	0	0	0	0	0	0	54055	54055
77	WAWA	1142	Knowsley	0	171013	0	0	0	0	0	0	171013	171013
79	WAWA	824	Carnarvon	0	320	0	0	0	0	0	0	320	320
81	WAWA	824	Carnarvon	0	1339	0	0	0	0	0	0	1339	1339
82	WAWA	838	Wells	0	77341	0	0	0	0	0	0	77341	77341
92	WAWA	637	Wodehouse	0	50115	0	0	0	0	0	0	50115	50115
TOTALS				329300	514701	130700	93400	15050	0	0	14800	768651	852551

Refer to Appendix II for description of column headings

APPENDIX Va

RURAL - WELL IDENTIFICATION

CENSUS	NAME	GWL	GSWA	OWNER	LOT	STREET	EASTING	NORTHING	CONST DATE	STATUS	AQUIFER
94		0	0	Archer AE	14	Guildford	570763	8084473	<1971	Capped	Unconfined
95		32164	0	Archer AE	14	Guildford	570740	8084499	1988	Production	Unconfined
96		0	0	Archer R	11	Guildford	569915	8084353	1970's	Production	Unconfined
97		0	0	Archer R	11	Guildford	570042	8084398		Capped	Unconfined
98		8718	59	Boyle R	31	Fitzroy	570651	8084306	1975	Production	Unconfined
99		20089	0	Brooks FJ	534	Russ	569770	8083771	1970	Production	Unconfined
100		20514	0	Crockett RL	26	Fitzroy	569509	8084164	<1971	Production	Unconfined
101	JP2	20754	0	Dept of Civil Aviation	R1326	Derby Highway	570918	8081881		Production	Unconfined
102	H2	20754	0	Dept of Civil Aviation	R1326	Derby Highway	570919	8081847		Production	Unconfined
103	H1	20754	0	Dept of Civil Aviation	R1326	Derby Highway	570931	8081847		Production	Unconfined
104	JP1	20754	0	Dept of Civil Aviation	R1326	Derby Highway	570929	8081876		Production	Unconfined
105	MW3	0	75	Derby Meat Processing	538	Fitzroy	570578	8083388		Capped	Unconfined
106	Slaught Yd	0	20	Derby Meat Processing	1210	Fitzroy	570546	8083860		Infilled	Unconfined
107	KS1	0	73	Derby Meat Processing	538	Fitzroy	570500	8083579		Infilled	Unconfined
108	MW2	0	74	Derby Meat Processing	538	Fitzroy	570543	8083386		Capped	Unconfined
109	Demco 2	0	19	Derby Meat Processing	1210	Fitzroy	570463	8083787		Infilled	Unconfined
110	Demco 1	20104	18	Derby Meat Processing	1210	Fitzroy	570393	8083852		Production	Unconfined
111		20500	0	Eyre V & Kilpatrick G	635/1	Derby Highway	569912	8083467		Production	Unconfined
112		20088	104	Foot I	527/6	Guildford	569804	8084778	Apr 84	Production	Unconfined
113		20102	0	Ford M	635/2	Derby Highway	569975	8083388	1983	Production	Unconfined
114		30765	0	Hart WS	28	Fitzroy	569918	8084306		Production	Unconfined
115		0	0	Iurietich HP	4	Derby Highway	572133	8079813		Capped	Unconfined
116	Sunnyside	20493	0	Iurietich HP	4	Derby Highway	572089	8079880	Dec 81	Production	Lower Erskine
117		0	0	Iurietich HP	4	Derby Highway	571881	8079739		Infilled	Unconfined
118		0	0	Jess P	12	Guildford	570193	8084451		Production	Unconfined
119		0	0	Kneebone RJ	9	Guildford	569567	8084474		Capped	Unconfined
120		0	0	Kneebone RJ	9	Guildford	569575	8084401		Capped	Unconfined
121		20492	72	McKenzie B&P	9	Guildford	569432	8084485	1970's	Production	Unconfined
122		0	0	Moore B P	492	Derby Highway	569790	8083990		Infilled	Unconfined
123		20752	17	Moore B P	492	Derby Highway	570084	8083836	1960's	Production	Unconfined
124		0	0	Moore K	525/5	Derby Highway	569982	8083699	1990	Production	Unconfined
125		0	0	Moore P	525/1	Fitzroy	570189	8083928	1985	Capped	Unconfined
126		0	0	Moore P	525/1	Fitzroy	570258	8083948	1989	Production	Unconfined
127		0	21	Moore P	525/1	Fitzroy	570255	8084086		Infilled	Unconfined
128	No. 2	34778	0	Mowanjum Corporation	R33858	Gibb River	574298	8080703		Production	Unconfined
129	No. 1	34778	0	Mowanjum Corporation	R33858	Gibb River	574261	8080700	1961	Production	Unconfined
130		0	0	Rigney W	29	Fitzroy	570285	8084190	<1988	Production	Unconfined
131		20114	0	Ring P	631	Russ	569646	8083593	1983	Production	Unconfined
132		20430	0	Rose E	6	Guildford	568787	8084454		Production	Unconfined
133		20495	0	Ross HT	4	Guildford	568218	8084502		Production	Unconfined
134		20107	103	Shaw KL	527/3	Knutsford	569774	8084952	May 84	Production	Unconfined
135	Myalls New	3721	117	Shire of Derby	R28439	Derby Highway	570728	8081523	1981	Production	Lower Erskine
136	Myalls 2	0	2	Shire of Derby	R28459	Derby Highway	570730	8081506		Infilled	Unconfined
137	Myalls	0	1	Shire of Derby	R28439	Derby Highway	570717	8081523	1911	Infilled	Lower Erskine
138	1/89	0	0	WAWA	492	Derby Highway	569729	8084066	Feb 89	Production	Lower Erskine
139	1/88	0	0	WAWA	492	Derby Highway	569727	8084080	Nov 88	Capped	Lower Erskine
140	2/88	0	172	WAWA	527/3	Lovegrove	569947	8085584	Mar 89	Monitor	Lower Erskine
141	3/65	0	62	WAWA	730	Forrest	569112	8085376		Monitor	Unconfined
142		20483	0	Whitnell WE	632	Derby Highway	569738	8083589		Production	Unconfined

Refer to Appendix II for description of column headings

APPENDIX Vb

RURAL - WELL HYDROGEOLOGICAL DETAILS

CENSUS	OWNER	DEPTH_BNS	RWLG_BNS	RWLM_BNS	RL_NS_A	RL_BOT	RL_RWLG	RL_RWLM	L_TDS	L_TDS_G	UNCON_PROD	ERSK_PROD
94	Archer AE	27.43	0.00	12.95	18.0	-9.43	0.00	5.05	0	0	0	0
95	Archer AE	30.50	0.00	0.00	18.0	-12.50	0.00	0.00	472	0	2000	0
96	Archer R	30.00	0.00	0.00	15.5	-14.50	0.00	0.00	447	0	1000	0
97	Archer R	0.00	0.00	0.00	15.7	0.00	0.00	0.00	412	0	0	0
98	Boyle R	34.40	0.00	0.00	19.8	-14.60	0.00	0.00	418	0	5000	0
99	Brooks FJ	33.83	0.00	8.91	14.1	-19.73	0.00	5.19	842	0	1200	0
100	Crockett RL	30.50	0.00	0.00	15.0	-15.50	0.00	0.00	493	0	2000	0
101	Dept of Civil Aviation	0.00	0.00	0.00	7.5	0.00	0.00	0.00	241	0	4500	0
102	Dept of Civil Aviation	0.00	0.00	0.00	7.0	0.00	0.00	0.00	227	0	4500	0
103	Dept of Civil Aviation	0.00	0.00	0.00	7.0	0.00	0.00	0.00	223	0	4500	0
104	Dept of Civil Aviation	0.00	0.00	0.00	7.5	0.00	0.00	0.00	247	0	4500	0
105	Derby Meat Processing	32.00	0.00	15.90	20.0	-12.00	0.00	4.10	0	0	0	0
106	Derby Meat Processing	12.20	0.00	0.00	16.3	4.10	0.00	0.00	0	0	0	0
107	Derby Meat Processing	32.00	0.00	0.00	15.9	-16.10	0.00	0.00	0	0	0	0
108	Derby Meat Processing	32.00	0.00	16.00	20.0	-12.00	0.00	4.00	0	0	0	0
109	Derby Meat Processing	15.20	0.00	0.00	16.3	1.10	0.00	0.00	0	0	0	0
110	Derby Meat Processing	15.20	0.00	10.75	16.0	0.80	0.00	5.25	688	0	4000	0
111	Eyre V & Kilpatrick G	0.00	0.00	6.40	13.0	0.00	0.00	6.60	322	0	2000	0
112	Foot I	36.60	0.00	0.00	17.8	-18.80	0.00	0.00	432	0	2000	0
113	Ford M	36.58	0.00	0.00	13.0	0.00	0.00	0.00	299	0	2000	0
114	Hart WS	15.00	0.00	0.00	15.5	0.50	0.00	0.00	602	0	1600	0
115	Iurietich HP	26.00	0.00	9.54	14.8	-11.20	0.00	5.26	0	0	0	0
116	Iurietich HP	199.03	0.00	7.32	15.0	-184.03	0.00	7.68	293	0	0	201000
117	Iurietich HP	26.00	0.00	0.00	13.0	-13.00	0.00	0.00	0	0	0	0
118	Jess P	30.50	0.00	8.53	16.2	-14.30	0.00	7.67	341	0	3500	0
119	Kneebone RJ	0.00	0.00	11.03	16.5	0.00	0.00	0.00	0	0	0	0
120	Kneebone RJ	0.00	0.00	0.00	16.1	0.00	0.00	0.00	0	0	0	0
121	McKenzie B&P	21.30	0.00	0.00	16.5	-4.80	0.00	0.00	2017	0	2000	0
122	Moore B P	0.00	0.00	0.00	14.8	0.00	0.00	0.00	0	0	0	0
123	Moore B P	17.40	0.00	0.00	15.2	-2.20	0.00	0.00	0	0	1000	0
124	Moore K	0.00	0.00	0.00	15.0	0.00	0.00	0.00	786	0	2000	0
125	Moore P	24.38	0.00	10.02	15.5	-8.88	0.00	5.48	785	0	0	0
126	Moore P	24.38	0.00	10.16	15.6	-8.78	0.00	5.44	1038	0	2000	0
127	Moore P	10.90	0.00	0.00	16.0	5.10	0.00	0.00	0	0	0	0
128	Mowanjum Corporation	0.00	0.00	0.00	23.0	0.00	0.00	0.00	271	0	8000	0
129	Mowanjum Corporation	0.00	0.00	0.00	23.0	0.00	0.00	0.00	243	0	0	0
130	Rigney W	30.50	0.00	0.00	16.2	-14.30	0.00	0.00	369	0	3000	0
131	Ring P	33.50	0.00	7.90	12.2	-21.30	0.00	4.30	341	0	2500	0
132	Rose E	0.00	0.00	0.00	14.8	0.00	0.00	0.00	0	0	850	0
133	Ross HT	0.00	0.00	0.00	12.8	0.00	0.00	0.00	0	0	1000	0
134	Shaw KL	41.50	0.00	0.00	17.8	-23.70	0.00	0.00	509	0	800	0
135	Shire of Derby	157.00	0.00	0.00	6.4	-50.60	0.00	0.00	228	0	0	0
136	Shire of Derby	40.40	0.00	0.00	6.4	-34.00	0.00	0.00	0	0	0	0
137	Shire of Derby	322.00	0.00	0.00	6.4	-315.60	0.00	0.00	0	0	0	0
138	WAWA	0.00	0.00	0.00	0.0	-225.10	0.00	0.00	389	0	0	491607
139	WAWA	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	0	0
140	WAWA	0.00	0.00	0.00	0.0	0.00	0.00	-26.01	390	0	0	0
141	WAWA	0.00	0.00	0.00	0.0	-12.82	0.00	3.84	0	0	0	0
142	Whitnell WE	30.50	0.00	8.06	13.0	-17.50	0.00	4.94	334	0	2000	0
TOTALS											69450	692607

Refer to Apppendix II for description of column headings

APPENDIX Vc

RURAL - LOT WATER USEAGE DETAILS

CENSUS	OWNER	LOT	STREET	GWL_ALLOC	PUB_SUPPLY	PUB_AREA	INST_AREA	DOMESTIC	HORTICULT	AGRICULT	MISCELLAN	TOT_REQ	FUTURE_REQ
95	Archer AE	14	Guildford	2000	0	0	0	2000	0	0	0	2000	2000
96	Archer R	11	Guildford	0	0	0	0	1000	0	0	0	1000	1000
98	Boyle R	31	Fitzroy	2000	0	0	0	2000	3000	0	0	5000	5000
99	Brooks FJ	534	Russ	9900	0	0	0	1200	0	0	0	1200	1200
100	Crockett RL	26	Fitzroy	15150	0	0	0	2000	0	0	0	2000	2000
101	Dept of Civil Aviation	R1326	Derby Highway	18000	0	0	0	0	0	0	18000	18000	18000
110	Derby Meat Processing	1210	Fitzroy	4000	0	0	0	100	0	0	3900	4000	4000
111	Eyre V & Kilpatrick G	635/1	Derby Highway	1000	0	0	0	2000	0	0	0	2000	2000
112	Foot I	527/6	Guildford	12500	0	0	0	2000	0	0	0	2000	2000
113	Ford M	635/2	Derby Highway	850	0	0	0	2000	0	0	0	2000	2000
114	Hart WS	28	Fitzroy	2000	0	0	0	1600	0	0	0	1600	2000
116	Iurietich HP	4	Derby Highway	197000	0	0	0	2000	0	199000	0	201000	400000
118	Jess P	12	Guildford	0	0	0	0	2000	1500	0	0	3500	3500
121	McKenzie B&P	9	Guildford	2000	0	0	0	2000	0	0	0	2000	2000
123	Moore B P	492	Derby Highway	1000	0	0	0	1000	0	0	0	1000	1000
124	Moore K	525/5	Derby Highway	0	0	0	0	2000	0	0	0	2000	2000
126	Moore P	525/1	Fitzroy	0	0	0	0	2000	0	0	0	2000	2000
128	Mowanjum Corporation	R33858	Gibb River	8000	0	0	0	0	0	0	8000	8000	8000
130	Rigney W	29	Fitzroy	0	0	0	0	0	3000	0	0	3000	3000
131	Ring P	631	Russ	12700	0	0	0	2000	500	0	0	2500	2500
132	Rose E	6	Guildford	850	0	0	0	850	0	0	0	850	850
133	Ross HT	4	Guildford	1000	0	0	0	1000	0	0	0	1000	1000
134	Shaw KL	527/3	Knutsford	800	0	0	0	800	0	0	0	800	800
135	Shire of Derby	R28439	Derby Highway	2000	0	0	0	0	0	0	0	0	2000
138	WAWA	492	Derby Highway	0	491607	0	0	0	0	0	0	491607	491607
142	Whitnell WE	632	Derby Highway	9700	0	0	0	0	2000	0	0	2000	2000
TOTALS				302450	491607	0	0	31550	10000	199000	29900	762057	963457

Refer to Appendix II for description of column headings

APPENDIX VIa

HAMLET GROVE - WELL IDENTIFICATION

CENSUS	NAME	GWL	GSWA	OWNER	LOT	STREET	EASTING	NORTHING	CONST_DATE	STATUS	AQUIFER
143		20753	140	Ah Chee WJ	170	Windjana	571995	8082535		Production	Unconfined
144		20148	125	Baker WR	110	Galvins Way	572305	8082159	1983	Production	Unconfined
145		31268	145	Baughen J	174	Windjana	572048	8082879	1985	Production	Unconfined
146		21232	156	Baxter	179	Bell Creek Way	572590	8082883	Jun 86	Production	Unconfined
147		8365	111	Bergman F	185	Lennard	573100	8082472		Production	Unconfined
148		20157	138	Bergman F	54	Lennard	573242	8082623		Capped	Unconfined
149		8364	0	Bergman F	184	Lennard	573220	8082563		Capped	Unconfined
150		20157	151	Bergman F	54	Lennard	573370	8082654		Infilled	Unconfined
151		20157	163	Bergman F	54	Lennard	573354	8082553		Infilled	Unconfined
152		7170	106	Brewster PJ	163	Manning	571721	8082195	Sep 85	Production	Unconfined
153		0	123	Brooking P	112	Adcock	572250	8081936	1982	Production	Unconfined
154		8431	112	Burazor Branko	171	Windjana	571936	8082595		Production	Unconfined
155		0	144	Burt	173	Windjana	572037	8082775	1985	Production	Unconfined
156		20301	142	Burton V	172	Windjana	572031	8082709		Production	Unconfined
157		7587	113	Cairns PJ	200	Windjana	572073	8082568	Dec 1986	Production	Unconfined
158		0	0	Christophers	207	Galvins Way	572648	8082119	1988	Production	Unconfined
159		20494	95	Davey	135	Galvins Way	572258	8082239	1986	Production	Unconfined
160		0	0	Dawson DE	104	Lennard	572642	8081920	1987	Production	Unconfined
161		0	90	De Blasi	108	Lennard	572573	8081980		Production	Unconfined
162		20132	126	Drysdale C	204	Galvins Way	572399	8082213		Production	Unconfined
163		20133	157	Evans J	190	Bell Creek Way	572601	8082738	Nov 86	Production	Unconfined
164		7171	149	Gavranich T	199	Bell Creek Way	572312	8082533	Dec 1985	Production	Unconfined
165		7171	0	Gavranich T	199	Bell Creek Way	572211	8082456		Capped	Unconfined
166		7536	108	Gugeri M	195	Bell Creek Way	572335	8082700	Jan 1986	Production	Unconfined
167		20750	147	Hawke SA & Corbett	175	Windjana	572055	8082974	1986	Production	Unconfined
168		20751	129	Jacob KB	206	Galvins Way	572595	8082132		Production	Unconfined
169		37205	0	Johnston PA	182	Bell Creek Way	573023	8082782		Production	Unconfined
170		20233	154	Lapwood JA	177	Bell Creek Way	572319	8082912	Sep 86	Production	Unconfined
171		20135	128	Lemmon DN	133	Galvins Way	572442	8082206	May 1983	Production	Unconfined
172		20103	152	Lwoy Yee Yan	191	Bell Creek Way	572505	8082757		Production	Unconfined
173		20136	162	Martin BL	183	Bell Creek Way	573124	8082601		Production	Unconfined
174		7295	139	McAuliff EB	201	Windjana	572048	8082342		Production	Unconfined
175		30691	0	McLaren N	202	Galvins Way	572171	8082362		Production	Unconfined
176		8604	153	Mott GJ	192	Bell Creek Way	572342	8082826	1986	Production	Unconfined
177		7533	143	Parter G	193	Windjana	572116	8082780	Nov 1985	Production	Unconfined
178		20131	91	Prouse CL & Brierley N	167	Adcock	572179	8081958		Production	Unconfined
179		7905	110	Rees	176	Windjana	572149	8082958	1984/85	Production	Unconfined
180		20138	158	Roe J	180	Bell Creek Way	572722	8082864	1986	Production	Unconfined
181		20137	137	Russ & Hepburn	164	Windjana	571834	8082163	1987/88	Production	Unconfined
182		20139	96	Say GH	106	Lennard	572729	8082038	Jun 1982	Production	Unconfined
183		36276	109	Spry E	196	Bell Creek Way	572410	8082589		Production	Unconfined
184		20324	120	Storey	194	Windjana	572134	8082659	1987	Production	Unconfined
185		20134	94	Stott B	107	Lennard	572493	8081897		Production	Unconfined
186		20140	160	Sweeney GP	188	Bell Creek Way	572824	8082672		Production	Unconfined
187		0	136	Unknown	165	Galvins Way	572115	8082191		Unknown	Unconfined
188		0	155	Unknown	178	Bell Creek Way	572495	8082881		Unknown	Unconfined
189		0	135	Unknown	116	Adcock	572213	8082126		Unknown	Unconfined
190		0	161	Unknown	186	Lennard	573053	8082376		Unknown	Unconfined
191		0	132	Unknown	105	Lennard	572683	8081973		Unknown	Unconfined
192		0	122	Unknown	166	Adcock	572198	8082062		Unknown	Unconfined
193		0	127	Unknown	109	Galvins Way	572403	8082140		Unknown	Unconfined
194		0	119	Unknown	168	Manning	571914	8082067		Unknown	Unconfined
195		0	124	Unknown	111	Adcock	572264	8082042		Unknown	Unconfined
196		20141	159	Van Duren P	189	Bell Creek Way	572777	8082728		Production	Unconfined

Refer to Appendix II for description of column headings

APPENDIX VIb

HAMLET GROVE - WELL HYDROGEOLOGICAL DETAILS

CENSUS	OWNER	DEPTH_BNS	RWLG_BNS	RWLM_BNS	RL_NS_A	RL_BOT	RL_RWLG	RL_RWLM	L_TDS	L_TDS_G	UNCON_PROD	ERSK_PROD
143	Ah Chee WJ	35.66	10.67	0.00	0.0	-17.16	7.83	0.00	0	200	6000	0
144	Baker WR	36.60	0.00	10.08	0.0	-20.33	0.00	6.19	235	1090	4000	0
145	Baughen J	24.00	0.00	0.00	0.0	-9.03	0.00	0.00	1171	0	2000	0
146	Baxter	23.77	0.00	0.00	0.0	-8.58	0.00	0.00	273	230	2000	0
147	Bergman F	0.00	9.00	0.00	0.0	0.00	4.78	0.00	349	330	2000	0
148	Bergman F	33.53	9.00	0.00	0.0	-22.42	2.11	0.00	0	1690	0	0
149	Bergman F	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	0	0
150	Bergman F	30.48	0.00	0.00	11.0	-19.48	0.00	0.00	0	2000	0	0
151	Bergman F	12.19	0.00	0.00	10.0	-2.19	0.00	0.00	0	2800	0	0
152	Brewster PJ	25.90	8.50	0.00	0.0	-13.34	4.06	0.00	173	0	2100	0
153	Brooking P	36.60	0.00	7.90	0.0	-22.63	0.00	6.07	212	0	2000	0
154	Burazor Branko	30.48	10.00	0.00	0.0	-12.66	7.82	0.00	0	200	2000	0
155	Burt	29.26	0.00	0.00	0.0	-13.53	0.00	0.00	491	600	2000	0
156	Burton V	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	2000	0
157	Cairns PJ	24.30	10.90	0.00	0.0	-6.68	6.72	0.00	243	0	2000	0
158	Christophers	36.58	0.00	0.00	0.0	0.00	0.00	0.00	184	0	1600	0
159	Davey	33.53	0.00	0.00	0.0	-15.14	0.00	0.00	252	0	5000	0
160	Dawson DE	30.50	0.00	9.52	0.0	0.00	0.00	0.00	223	0	2000	0
161	De Blasi	38.80	0.00	8.33	0.0	-23.97	0.00	6.50	323	0	3000	0
162	Drysdale C	30.48	6.10	0.00	0.0	-14.96	9.42	0.00	213	200	2000	0
163	Evans J	35.00	0.00	9.50	0.0	-19.06	0.00	0.00	232	0	850	0
164	Gavranich T	30.00	0.00	0.00	0.0	-13.81	0.00	0.00	209	0	2000	0
165	Gavranich T	0.00	0.00	0.00	18.2	0.00	0.00	0.00	0	0	0	0
166	Gugeri M	34.00	9.00	8.89	0.0	-18.84	6.16	6.27	668	0	2700	0
167	Hawke SA & Corbett	26.80	0.00	0.00	0.0	-11.58	0.00	0.00	680	830	2000	0
168	Jacob KB	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	420	7500	0
169	Johnston PA	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	2000	0
170	Lapwood JA	28.96	0.00	9.02	15.0	-13.96	0.00	5.98	367	360	2000	0
171	Lemmon DN	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	220	2000	0
172	Lwoy Yee Yan	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	180	2000	0
173	Martin BL	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	2000	0
174	McAuliff EB	32.92	7.92	0.00	0.0	-18.84	6.16	0.00	0	170	2000	0
175	McLaren N	30.00	0.00	0.00	0.0	0.00	0.00	0.00	245	0	2000	0
176	Mott GJ	30.50	0.00	0.00	0.0	-15.40	0.00	0.00	246	0	2500	0
177	Parter G	30.50	0.00	0.00	0.0	-15.02	0.00	0.00	0	630	2000	0
178	Prouse CL & Brierley N	45.72	7.62	0.00	0.0	-31.21	6.89	0.00	0	190	2000	0
179	Rees	29.00	10.06	8.75	0.0	-14.00	4.94	6.25	352	190	7000	0
180	Roe J	0.00	0.00	0.00	0.0	0.00	0.00	0.00	423	0	2000	0
181	Russ & Hepburn	28.35	0.00	0.00	0.0	-15.60	0.00	0.00	169	130	2500	0
182	Say GH	25.91	10.67	0.00	0.0	-10.33	4.91	0.00	0	450	2000	0
183	Spry E	25.90	8.00	0.00	0.0	-10.72	7.18	0.00	0	410	2500	0
184	Storey	28.04	0.00	0.00	0.0	-12.60	0.00	0.00	902	1310	2000	0
185	Stott B	34.75	7.62	0.00	0.0	-20.41	6.72	0.00	298	240	9000	0
186	Sweeney GP	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	2000	0
187	Unknown	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	0	0
188	Unknown	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	0	0
189	Unknown	32.80	8.10	0.00	0.0	-14.63	10.08	0.00	0	0	0	0
190	Unknown	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	210	0	0
191	Unknown	24.38	7.92	0.00	0.0	-9.36	7.10	0.00	0	430	0	0
192	Unknown	39.62	8.53	0.00	0.0	-23.14	7.95	0.00	0	160	0	0
193	Unknown	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	0	0
194	Unknown	28.04	9.14	0.00	0.0	-14.25	4.65	0.00	0	160	0	0
195	Unknown	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0	0	0	0
196	Van Duren P	43.00	0.00	0.00	0.0	-27.81	0.00	0.00	0	240	2000	0
TOTALS											108250	0

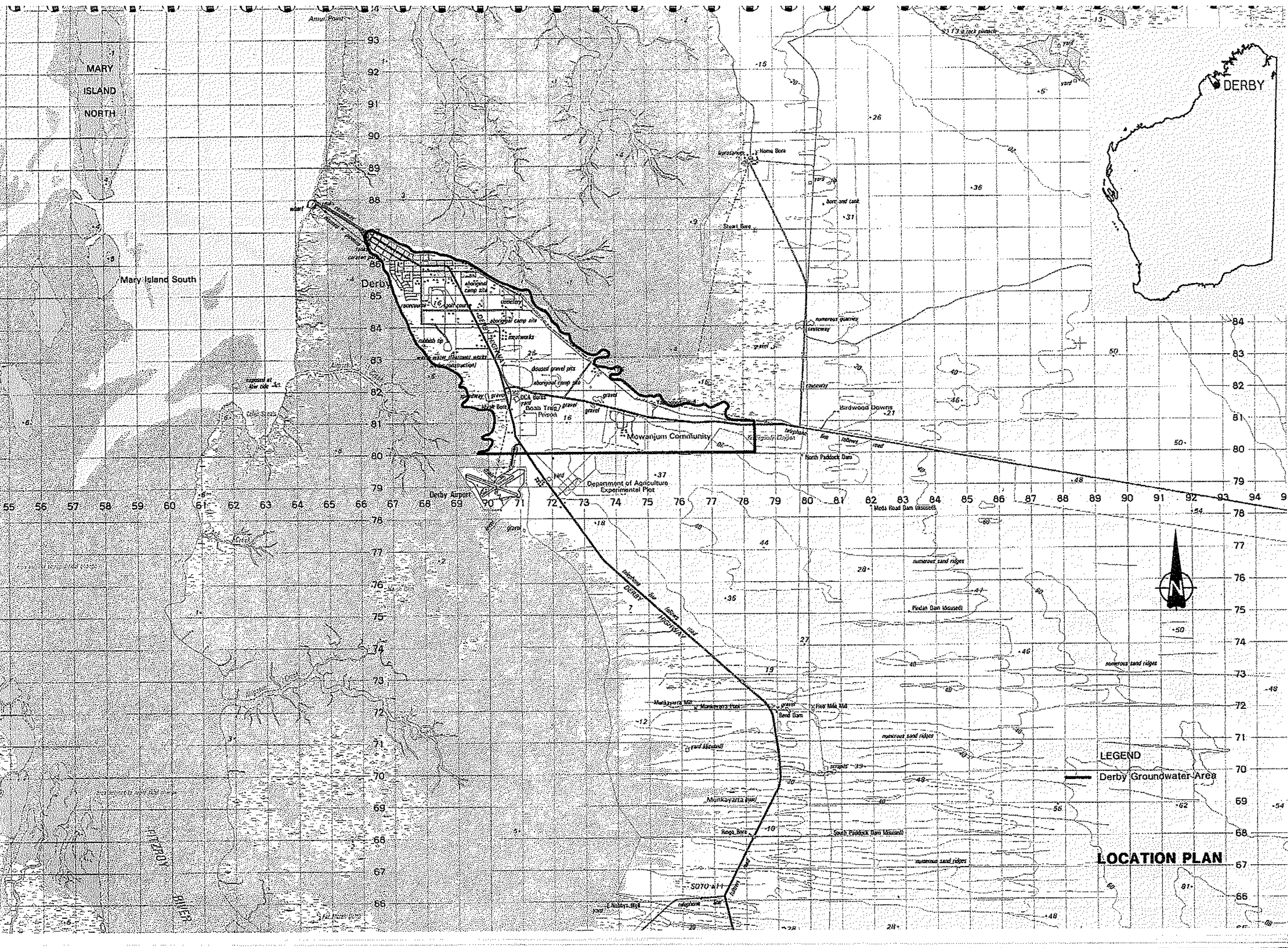
Refer to Appendix II for description of column headings

APPENDIX VIc

HAMLET GROVE - LOT WATER USEAGE DETAILS

CENSUS	OWNER	LOT	STREET	GWL_ALLOC	PUB_SUPPLY	PUB_AREA	INST_AREA	DOMESTIC	HORTICULT	AGRICULT	MISCELLAN	TOT_REQ	FUTURE_REQ
143	Ah Chee WJ	170	Windjana	6000	0	0	0	2000	4000	0	0	6000	6000
144	Baker WR	110	Galvins Way	2000	0	0	0	2000	2000	0	0	4000	4000
145	Baughen J	174	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
146	Baxter	179	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
147	Bergman F	185	Lennard	2000	0	0	0	2000	0	0	0	2000	2000
148	Bergman F	54	Lennard	4000	0	0	0	0	0	0	0	0	0
149	Bergman F	184	Lennard	2000	0	0	0	0	0	0	0	0	0
152	Brewster PJ	163	Manning	2500	0	0	0	2100	0	0	0	2100	2100
153	Brooking P	112	Adcock	0	0	0	0	2000	0	0	0	2000	2000
154	Burazor Branko	171	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
155	Burt	173	Windjana	0	0	0	0	2000	0	0	0	2000	2000
156	Burton V	172	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
157	Cairns PJ	200	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
158	Christophers	207	Galvins Way	0	0	0	0	1600	0	0	0	1600	2000
159	Davey	135	Galvins Way	7500	0	0	0	2000	3000	0	0	5000	5000
160	Dawson DE	104	Lennard	0	0	0	0	2000	0	0	0	2000	2000
161	De Biasi	108	Lennard	2000	0	0	0	3000	0	0	0	3000	3000
162	Drysdale C	204	Galvins Way	2000	0	0	0	2000	0	0	0	2000	2000
163	Evans J	190	Bell Creek Way	2000	0	0	0	850	0	0	0	850	2000
164	Gavranich T	199	Bell Creek Way	2500	0	0	0	2000	0	0	0	2000	2000
166	Gugeri M	195	Bell Creek Way	2000	0	0	0	2700	0	0	0	2700	2700
167	Hawke SA & Corbett	175	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
168	Jacob KB	206	Galvins Way	7500	0	0	0	2000	5500	0	0	7500	7500
169	Johnston PA	182	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
170	Lapwood JA	177	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
171	Lemmon DN	133	Galvins Way	2000	0	0	0	2000	0	0	0	2000	2000
172	Lwoy Yee Yan	191	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
173	Martin BL	183	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
174	McAuliff EB	201	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
175	McLaren N	202	Galvins Way	2000	0	0	0	2000	0	0	0	2000	2000
176	Mott GJ	192	Bell Creek Way	2000	0	0	0	2500	0	0	0	2500	2500
177	Parter G	193	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
178	Prouse CL & Brierley N	167	Adcock	2000	0	0	0	2000	0	0	0	2000	2000
179	Rees	176	Windjana	2000	0	0	0	7000	0	0	0	7000	7000
180	Roe J	180	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
181	Russ & Hepburn	164	Windjana	2000	0	0	0	2500	0	0	0	2500	2500
182	Say GH	106	Lennard	2000	0	0	0	2000	0	0	0	2000	2000
183	Spry E	196	Bell Creek Way	2500	0	0	0	2500	0	0	0	2500	2500
184	Storey	194	Windjana	2000	0	0	0	2000	0	0	0	2000	2000
185	Stott B	107	Lennard	15000	0	0	0	2000	7000	0	0	9000	9000
186	Sweeney GP	188	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
196	Van Duren P	189	Bell Creek Way	2000	0	0	0	2000	0	0	0	2000	2000
TOTALS				107500	0	0	0	86750	21500	0	0	108250	109800

Refer to Appendix II for description of column headings



LOCATION PLAN
LEGEND
Derby Groundwater Area
DERBY
MARY
ISLAND
NORTH
Mary Island South
Derby
Amui Point
Derby Airport
Department of Agriculture Experimental Plot
Mowanjum Community
Boab Tree Prison
Birdwood Downs
North Paddock Dam
Meda Road Dam (disused)
Pindan Dan (disused)
Home Bore
Stuart Bore
Bend Dam
Munkayarra Pool
Munkayarra Mill
Munkayarra (pool)
Five Mile Mill
South Paddock Dam (disused)
Ringo Bore
numerous sand ridges
DERBY HIGHWAY
telephone line follows road
FITZROY
RIVER

Figure 1

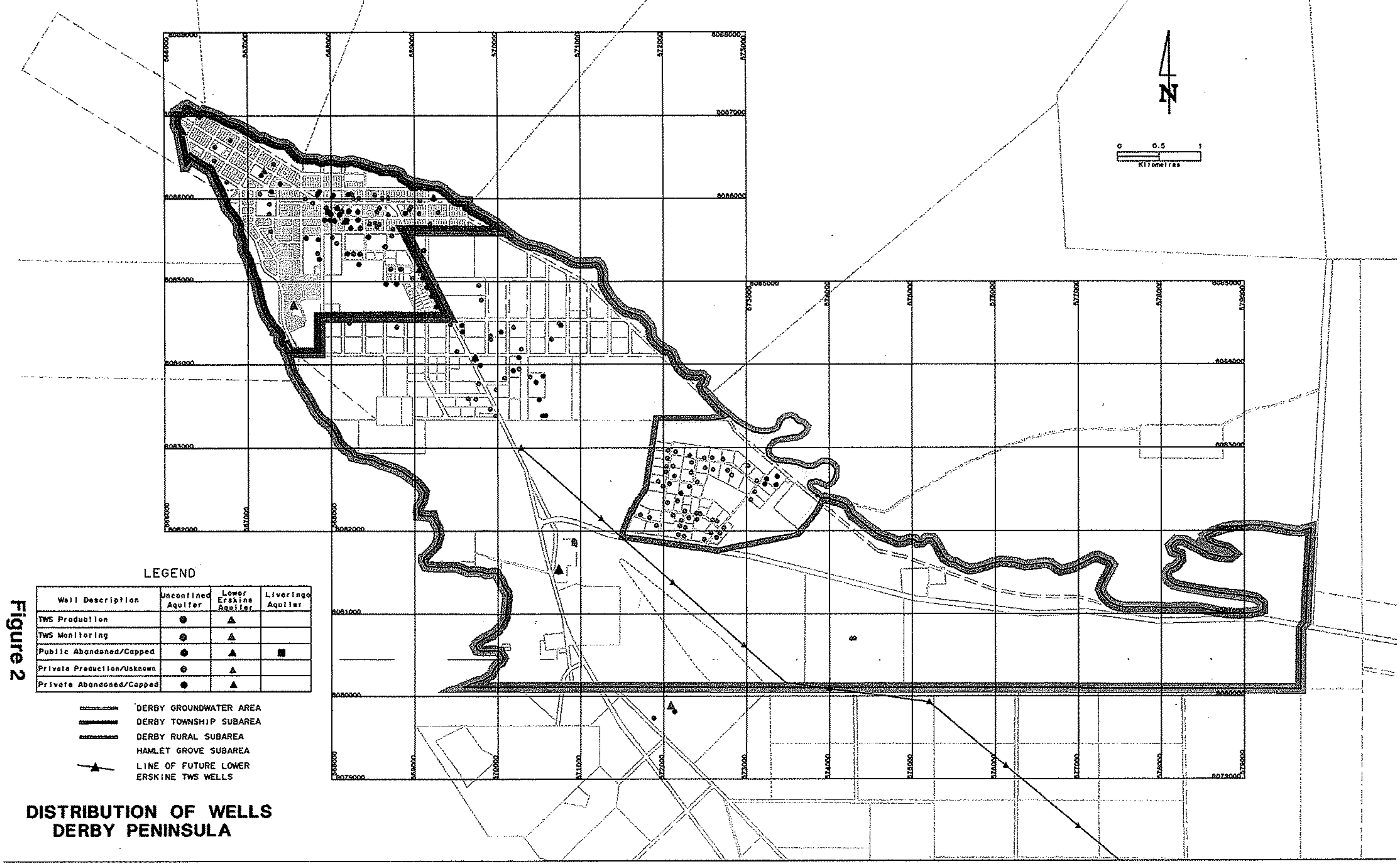


Figure 2

**DISTRIBUTION OF WELLS
DERBY PENINSULA**

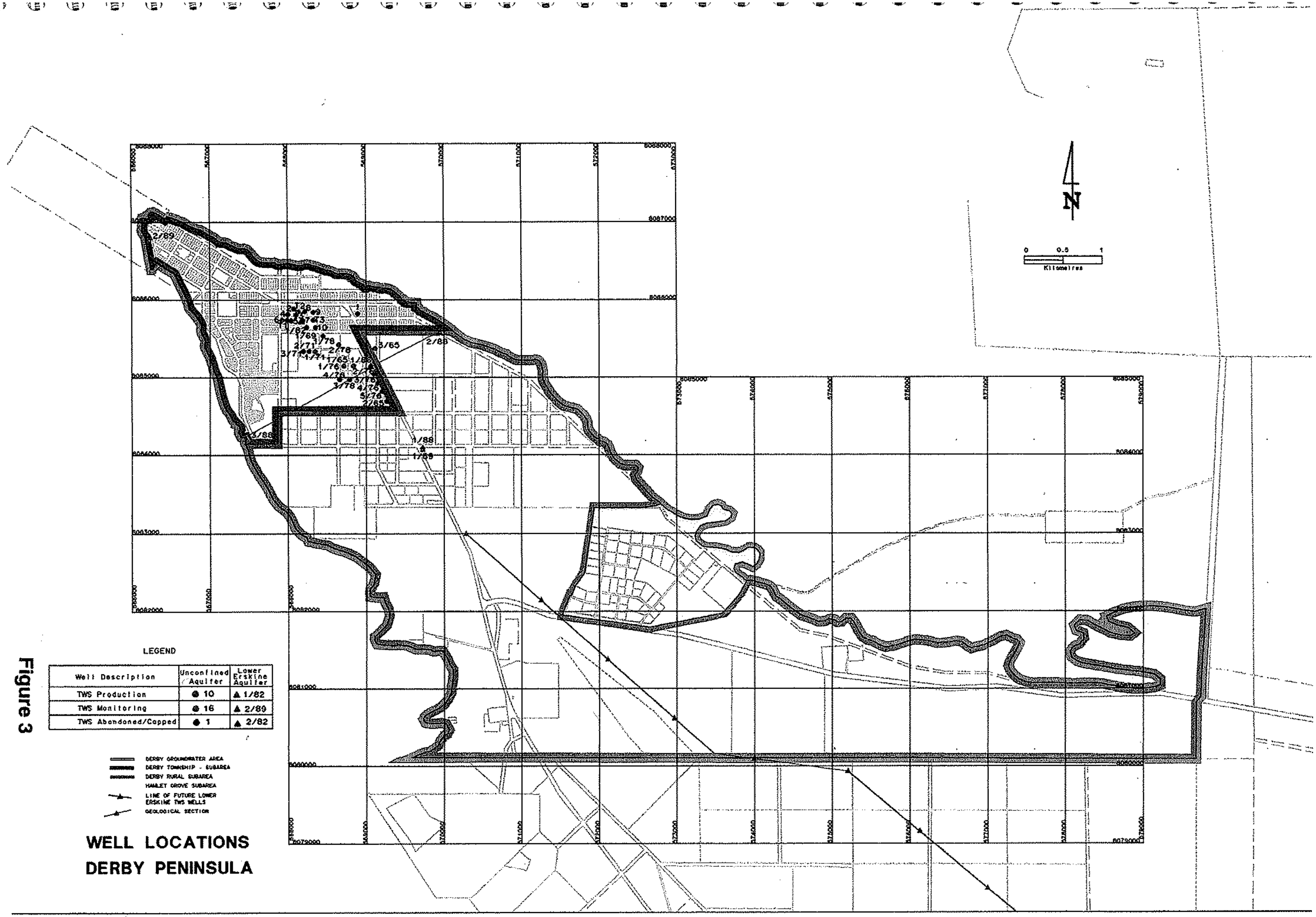
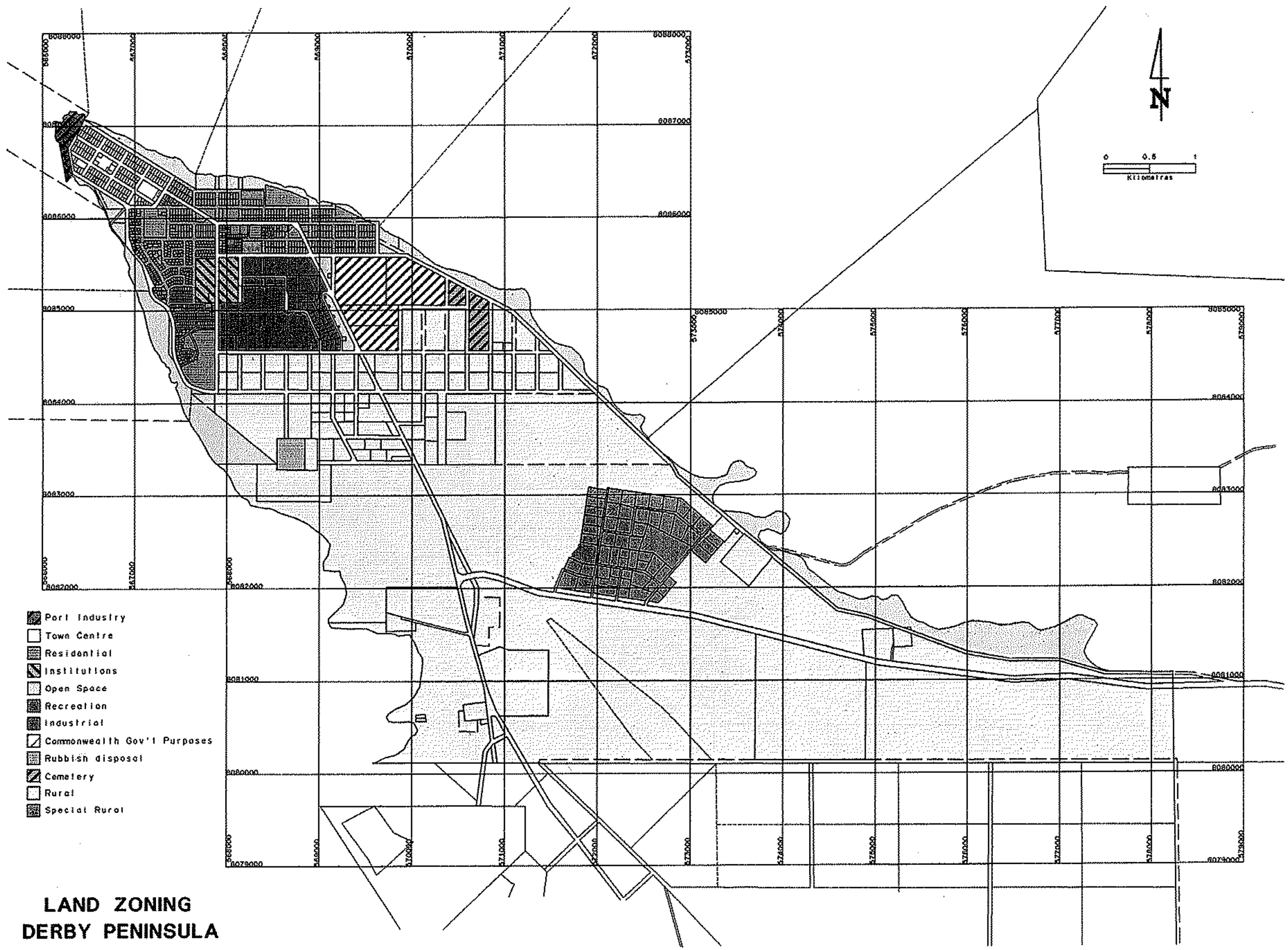

N
0
0.5
1
Kilometres
LEGEND
Well Description | Unconfined Aquifer | Lower Erskine Aquifer
TWS Production | 10 | 1/82
TWS Monitoring | 16 | 2/89
TWS Abandoned/Capped | 1 | 2/82
DERBY GROUNDWATER AREA
DERBY TOWNSHIP - SUBAREA
DERBY RURAL SUBAREA
HAMLET GROVE SUBAREA
LINE OF FUTURE LOWER ERSKINE TWS WELLS
GEOLOGICAL SECTION
WELL LOCATIONS
DERBY PENINSULA

Figure 3



LAND ZONING
DERBY PENINSULA

Figure 4

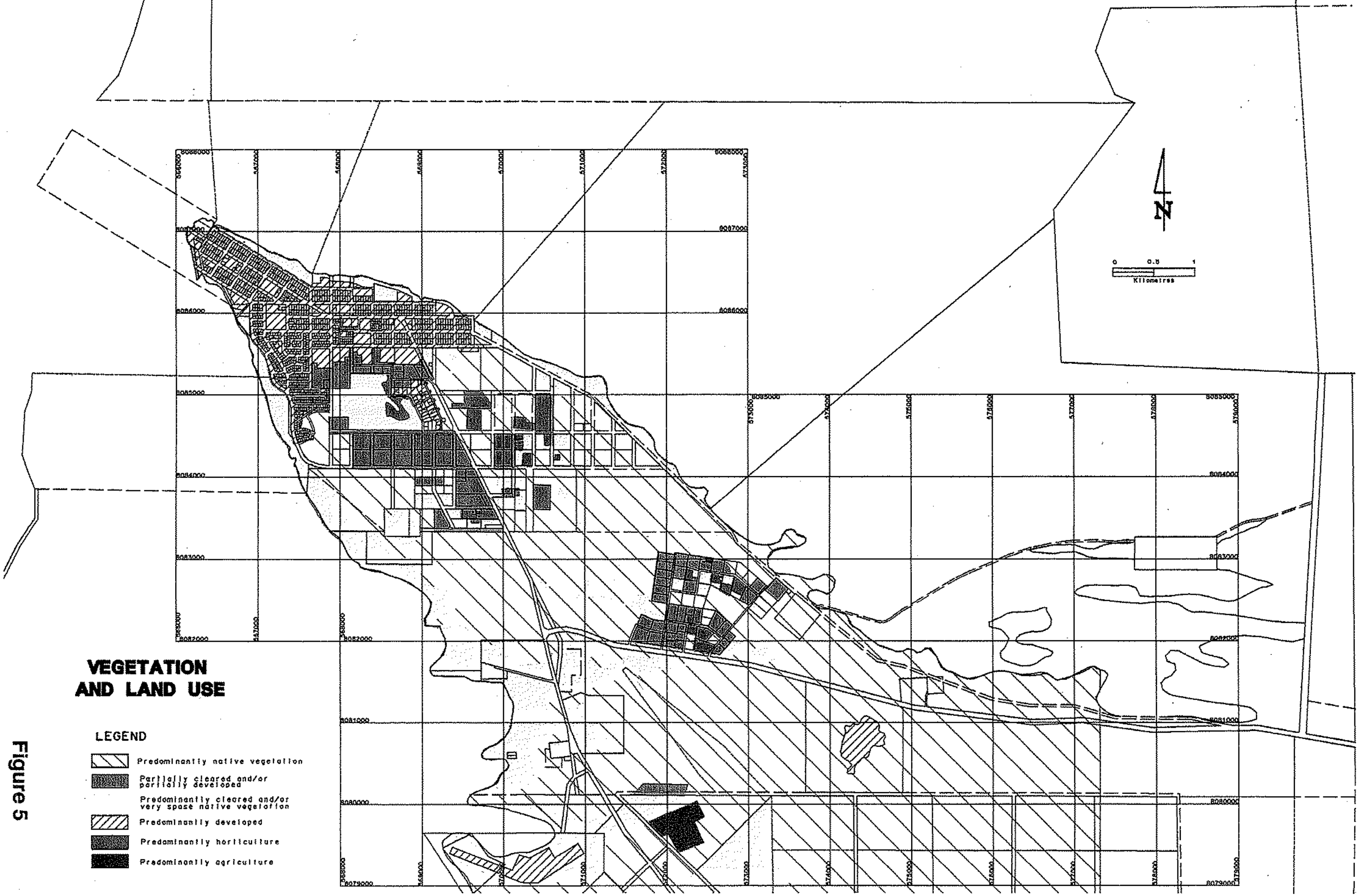
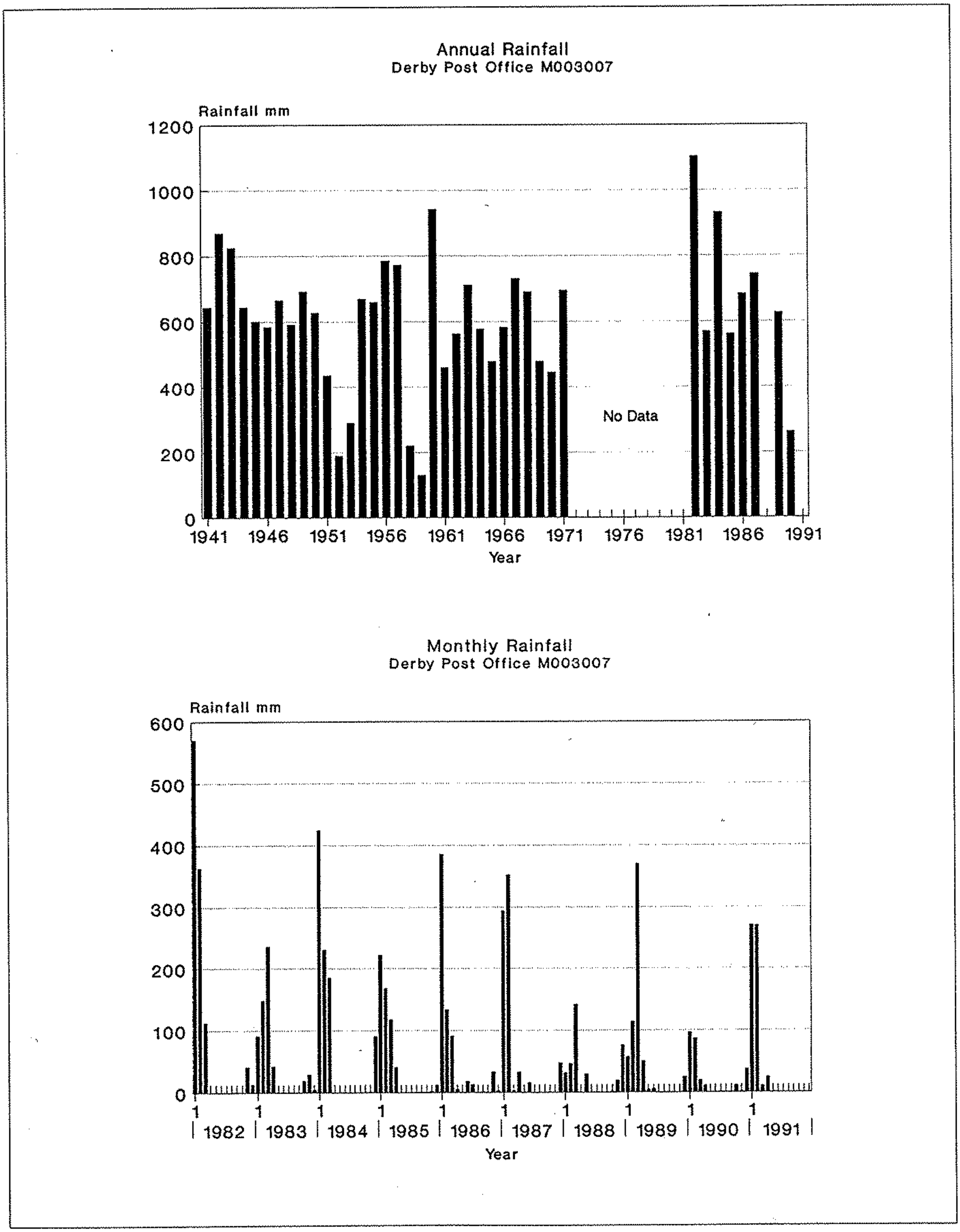
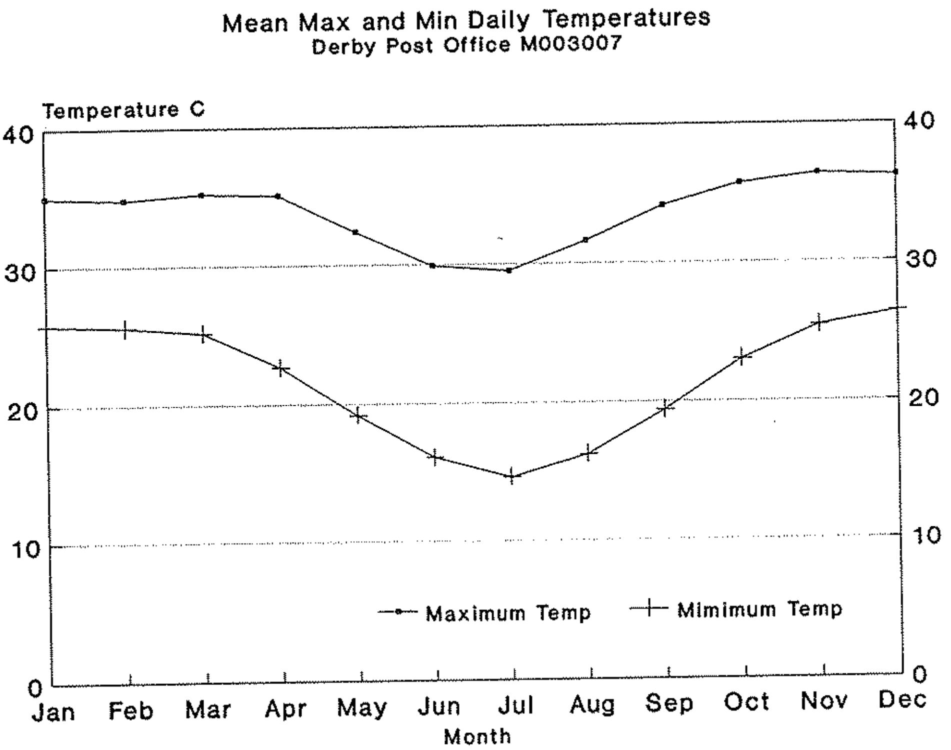

VEGETATION
AND LAND USE
LEGEND
Predominantly native vegetation
Partially cleared and/or partially developed
Predominantly cleared and/or very spase native vegetation
Predominantly developed
Predominantly horticulture
Predominantly agriculture
N
0 0.5 1
Kilometres

Figure 5



Annual Rainfall
Derby Post Office M003007
Rainfall mm
1200
1000
800
600
400
200
0
No Data
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
Year
Monthly Rainfall
Derby Post Office M003007
Rainfall mm
600
500
400
300
200
100
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Year

Figure 6


Mean Max and Min Daily Temperatures
Derby Post Office M003007
Temperature C
40
30
20
10
0
Maximum Temp
Mimimum Temp
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

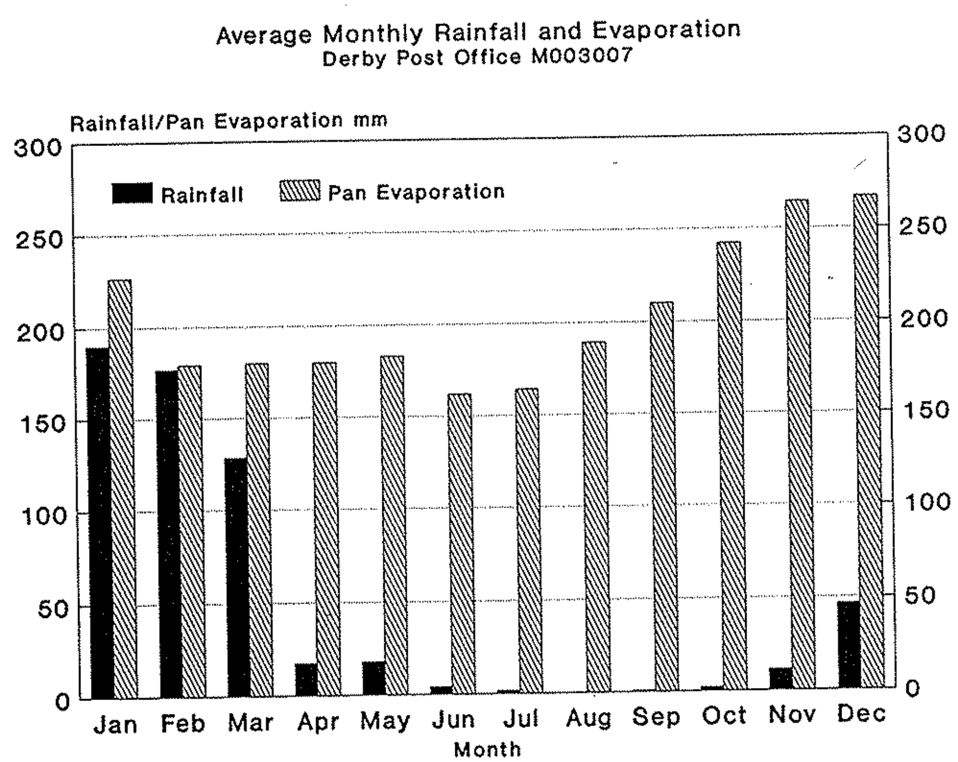

Average Monthly Rainfall and Evaporation
Derby Post Office M003007
Rainfall/Pan Evaporation mm
300
250
200
150
100
50
0
Rainfall
Pan Evaporation
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Figure 7

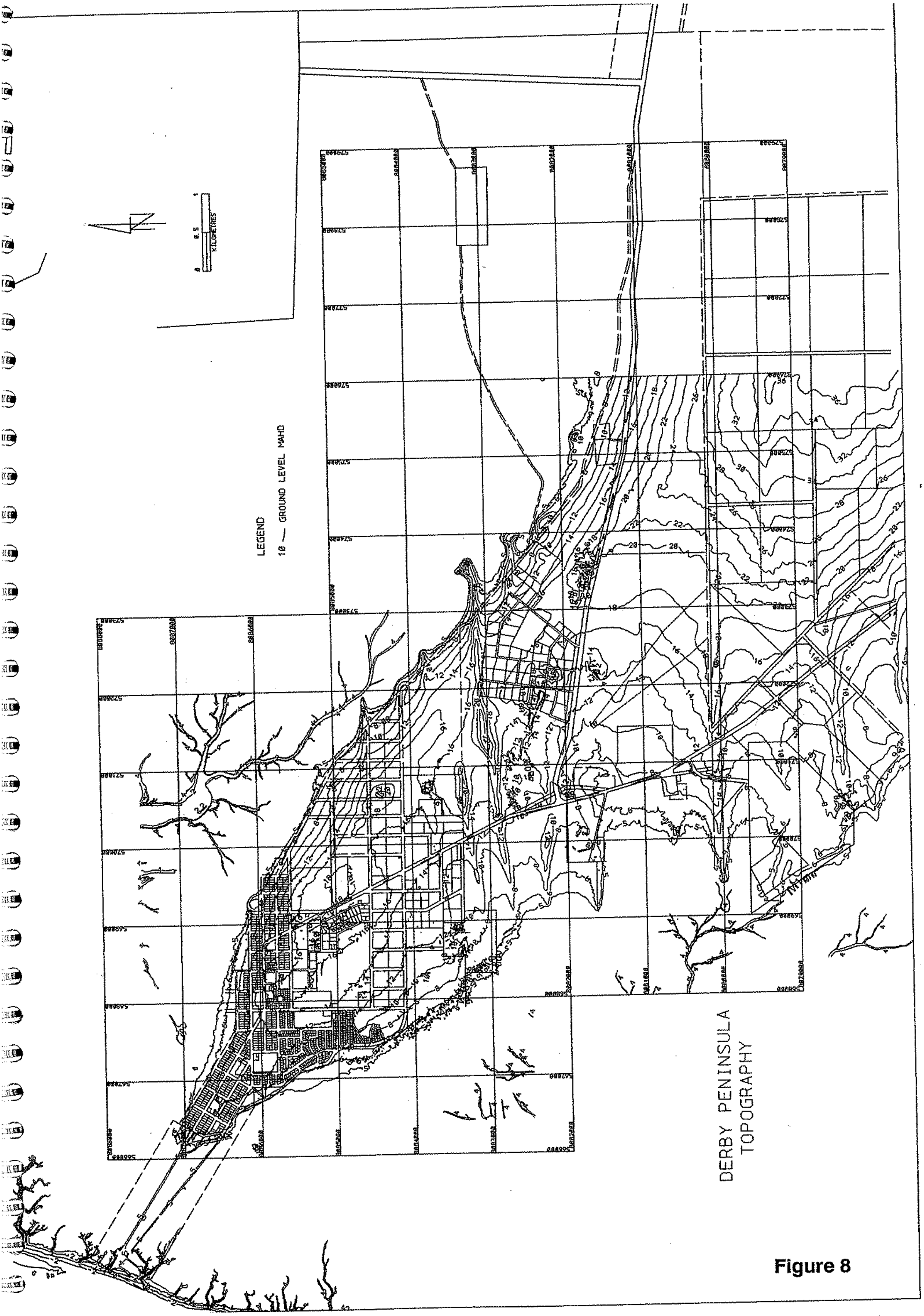

LEGEND
10 — GROUND LEVEL MAHD
0 0.5 1
KILOMETRES
DERBY PENINSULA
TOPOGRAPHY

Figure 8

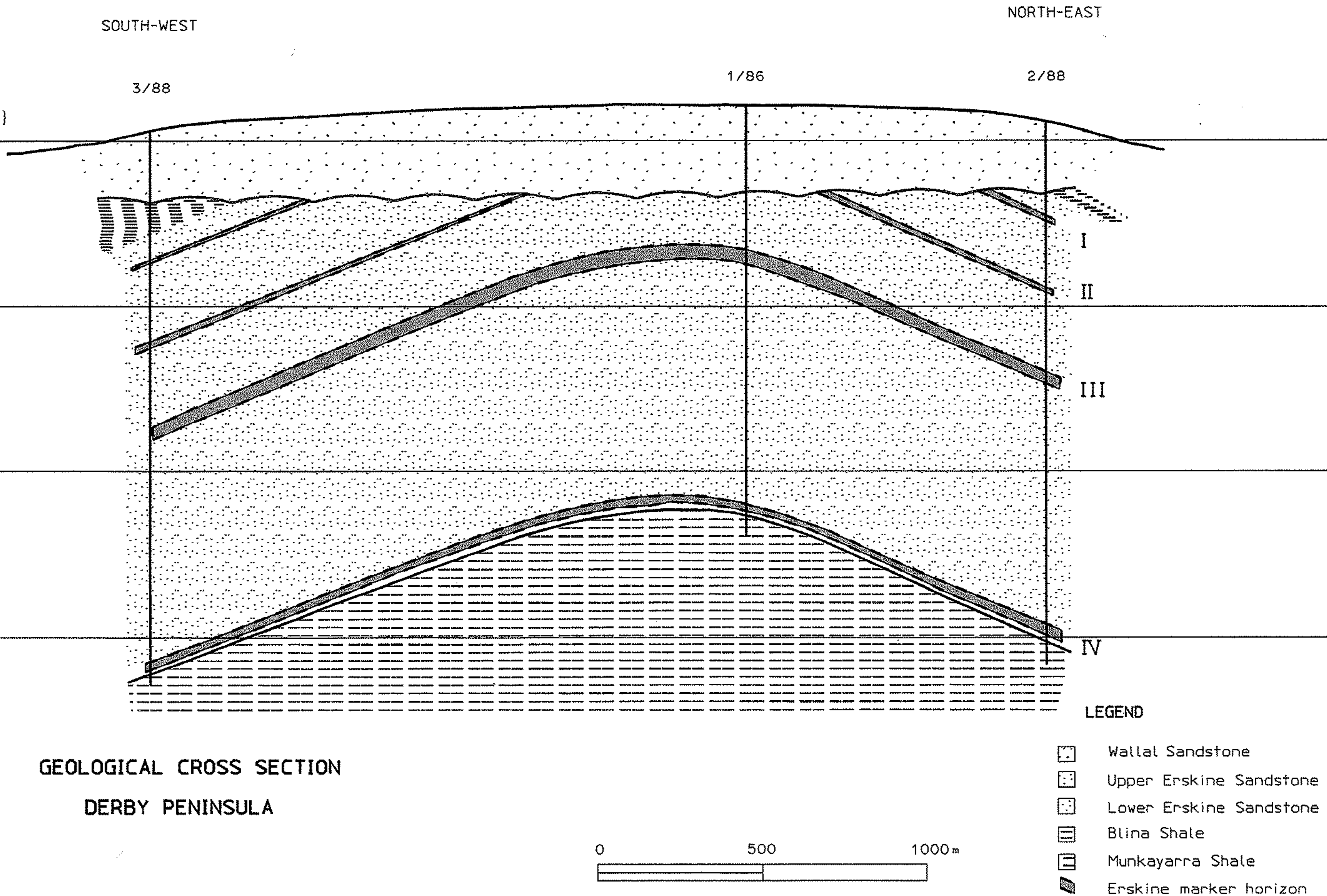
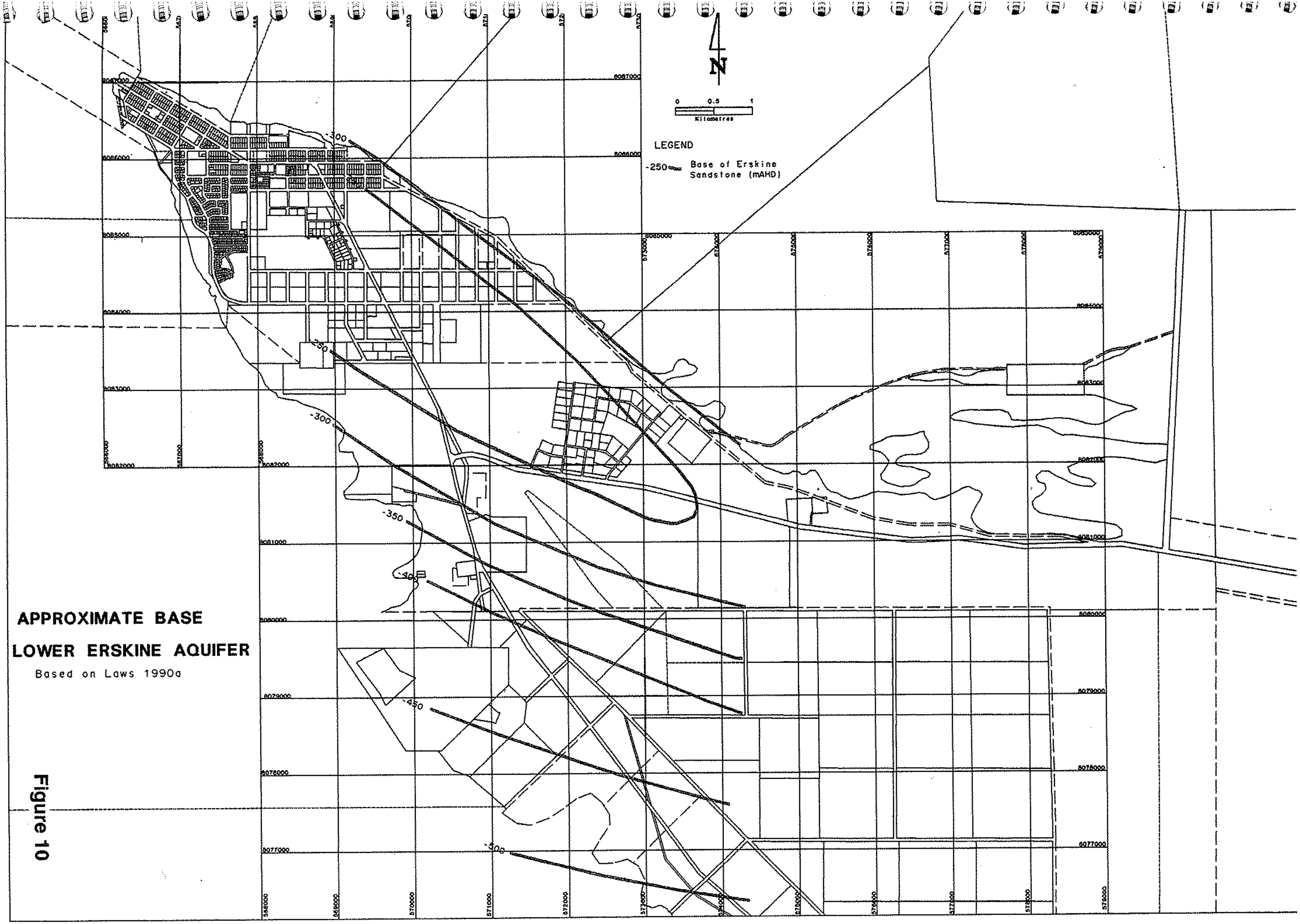

SOUTH-WEST
NORTH-EAST
3/88
1/86
2/88
{mAHD}
0
-100
-200
-300
I
II
III
IV
GEOLOGICAL CROSS SECTION
DERBY PENINSULA
0
500
1000m
LEGEND
Wallal Sandstone
Upper Erskine Sandstone
Lower Erskine Sandstone
Blina Shale
Munkayarra Shale
Erskine marker horizon

Figure 9

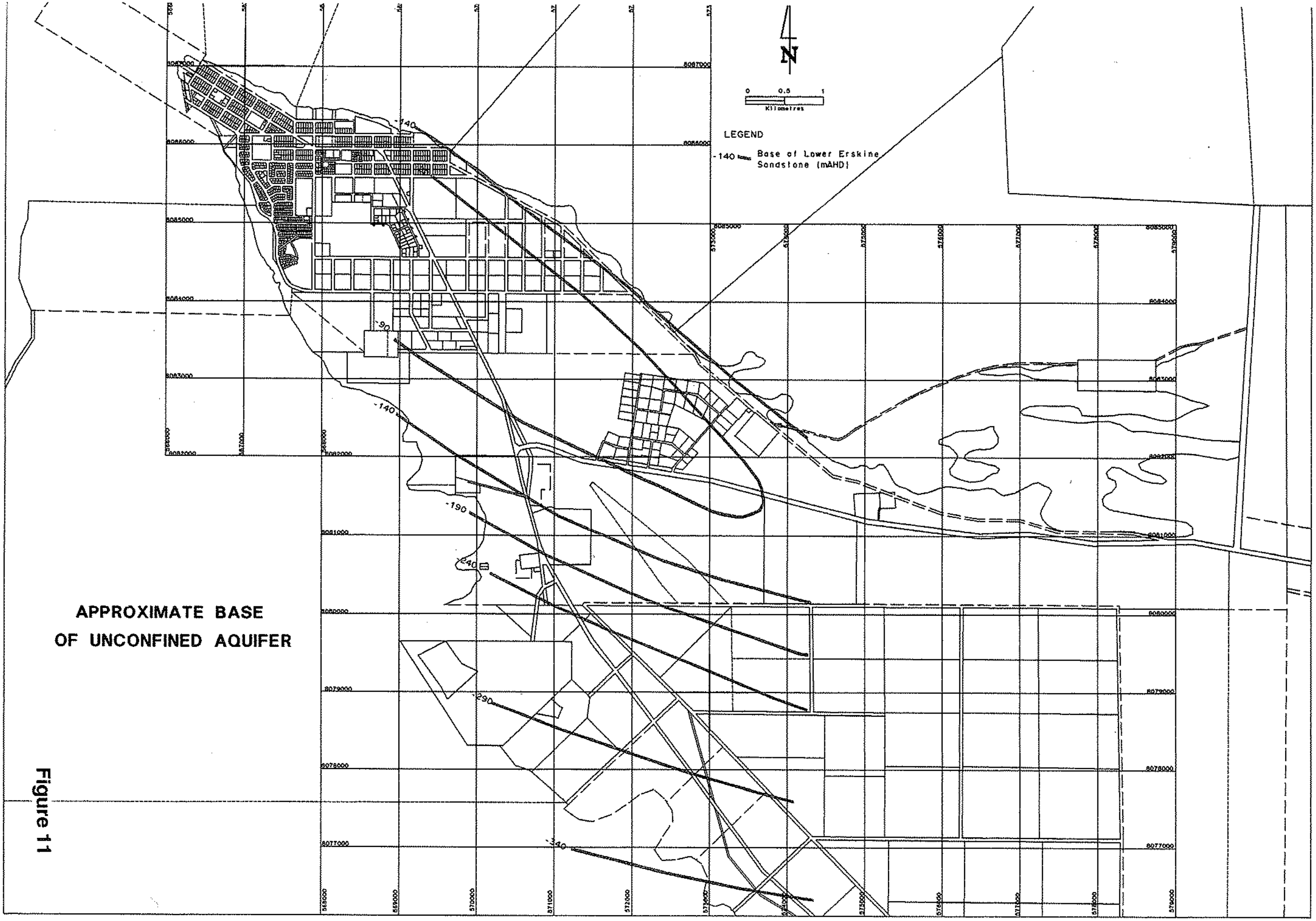


APPROXIMATE BASE

LOWER ERSKINE AQUIFER

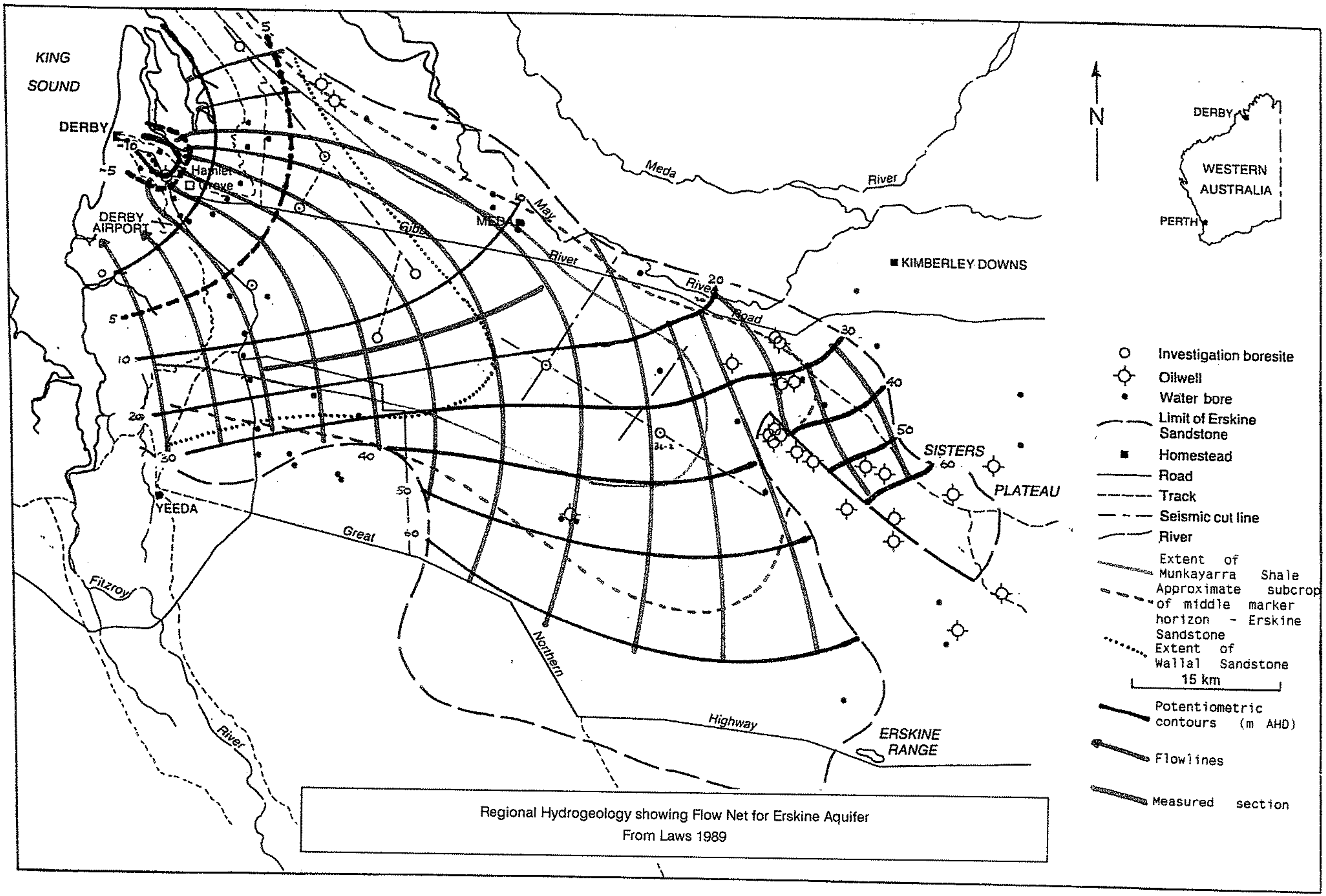
Based on Laws 1990a

Figure 10



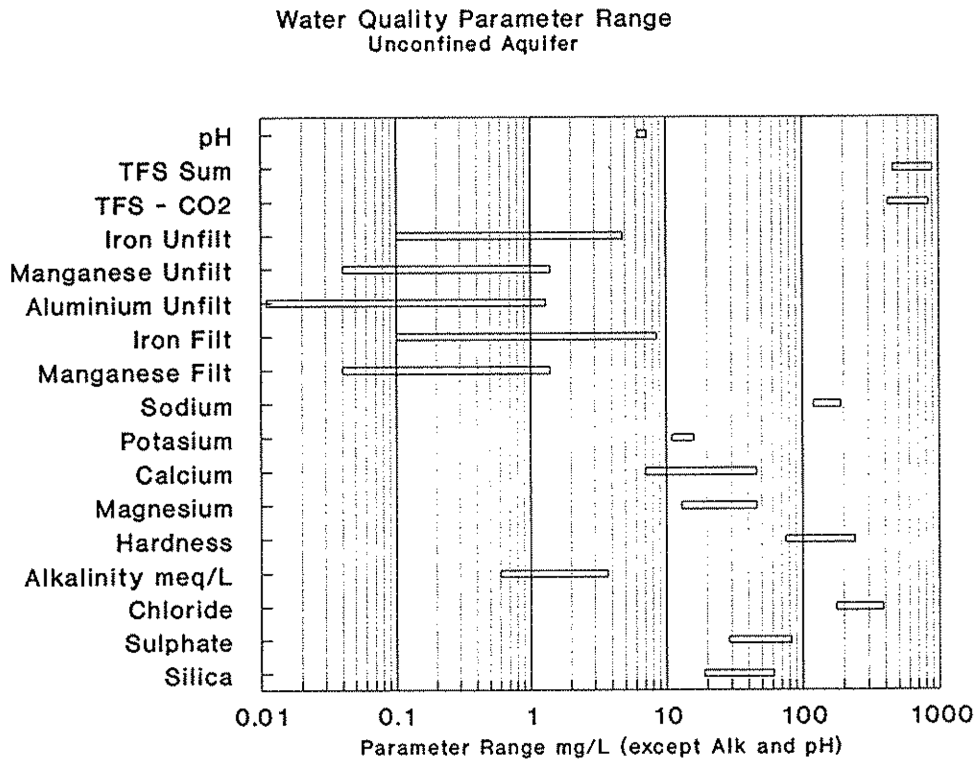
APPROXIMATE BASE
OF UNCONFINED AQUIFER

Figure 11



Regional Hydrogeology showing Flow Net for Erskine Aquifer
From Laws 1989

Figure 12


Water Quality Parameter Range
Unconfined Aquifer
pH
TFS Sum
TFS - CO2
Iron Unfilt
Manganese Unfilt
Aluminium Unfilt
Iron Filt
Manganese Filt
Sodium
Potasium
Calcium
Magnesium
Hardness
Alkalinity meq/L
Chloride
Sulphate
Silica
0.01
0.1
1
10
100
1000
Parameter Range mg/L (except Alk and pH)

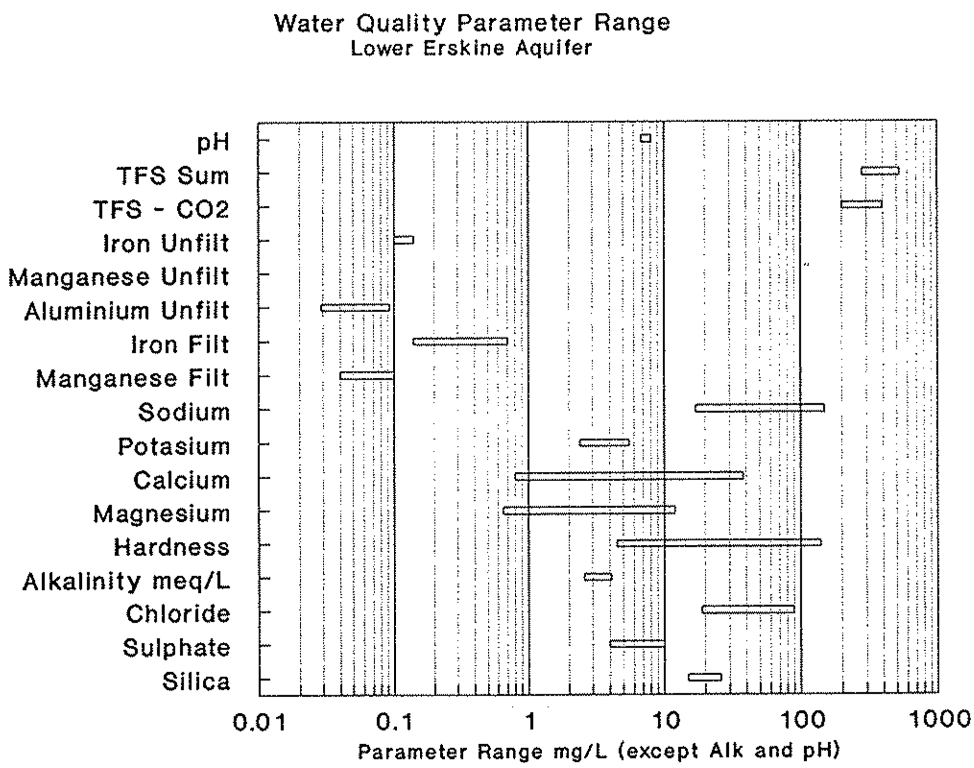
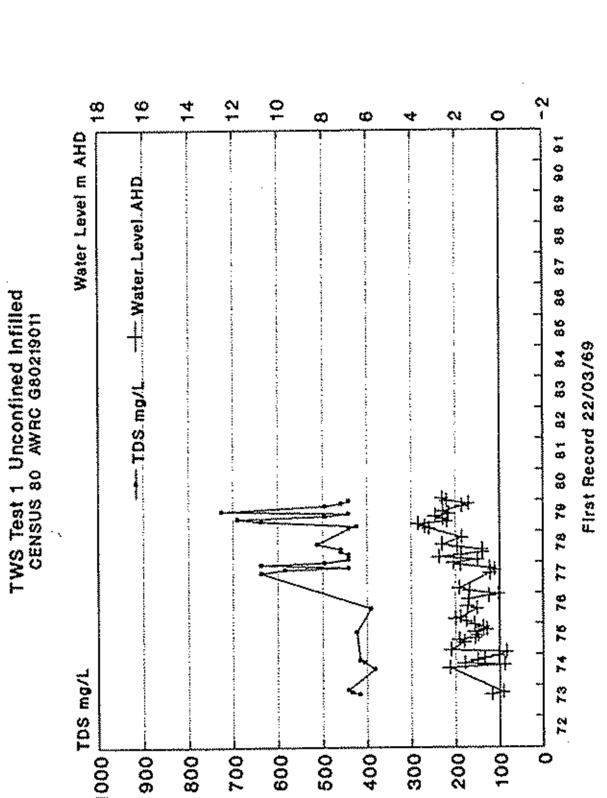
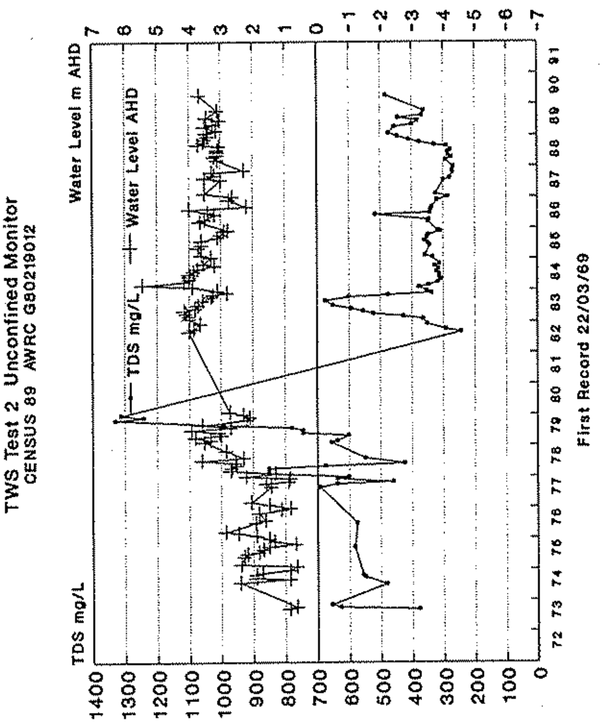
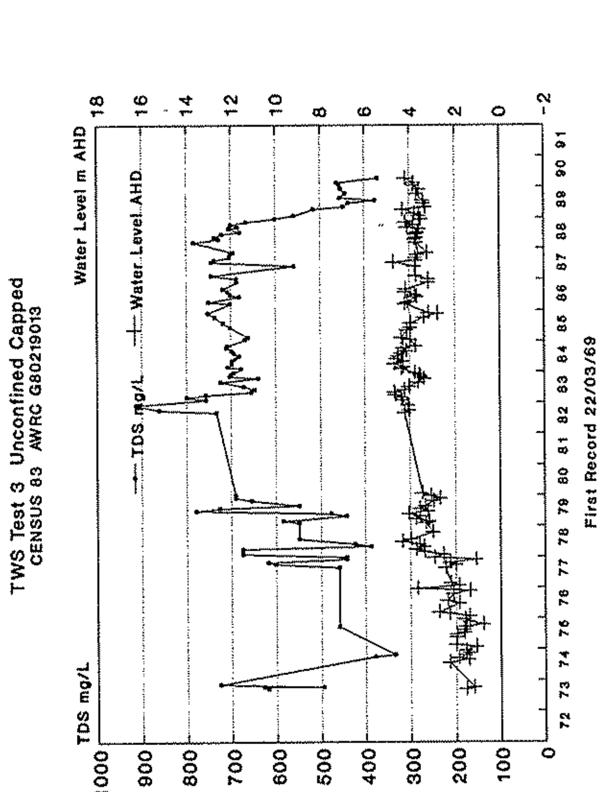

Water Quality Parameter Range
Lower Erskine Aquifer
pH
TFS Sum
TFS - CO2
Iron Unfilt
Manganese Unfilt
Aluminium Unfilt
Iron Filt
Manganese Filt
Sodium
Potasium
Calcium
Magnesium
Hardness
Alkalinity meq/L
Chloride
Sulphate
Silica
0.01
0.1
1
10
100
1000
Parameter Range mg/L (except Alk and pH)

Figure 13


TWS Test 1 Unconfined Infilled
CENSUS 80 AWRC G80219011
TDS mg/L
TDS.mg/L
Water Level.AHD
Water Level m AHD
First Record 22/03/69


TWS Test 2 Unconfined Monitor
CENSUS 89 AWRC G80219012
TDS mg/L
TDS mg/L
Water Level AHD
Water Level m AHD
First Record 22/03/69


TWS Test 3 Unconfined Capped
CENSUS 83 AWRC G80219013
TDS mg/L
TDS.mg/L
Water Level.AHD
Water Level m AHD
First Record 22/03/69

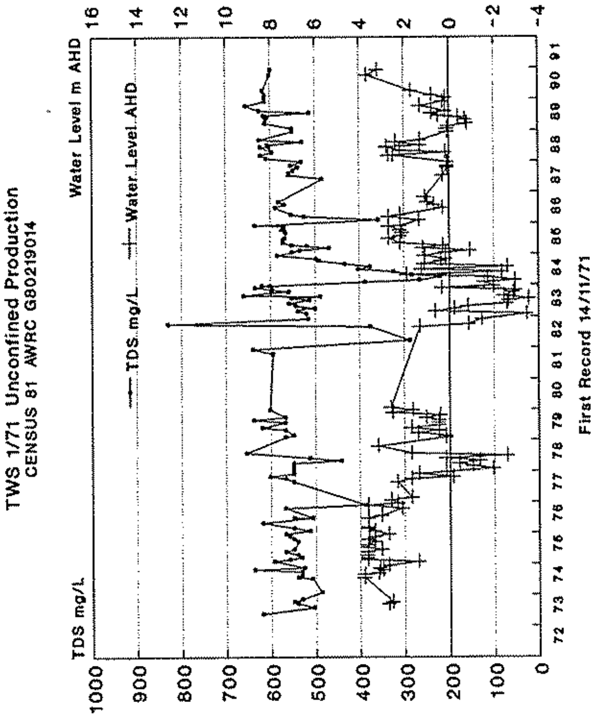
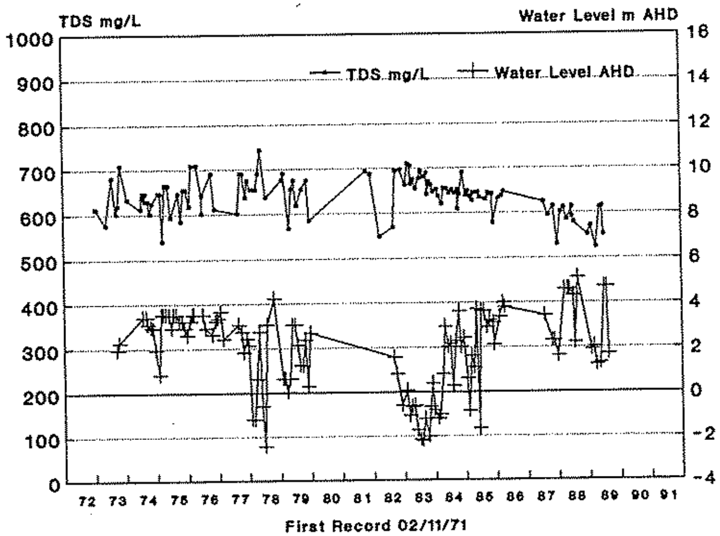
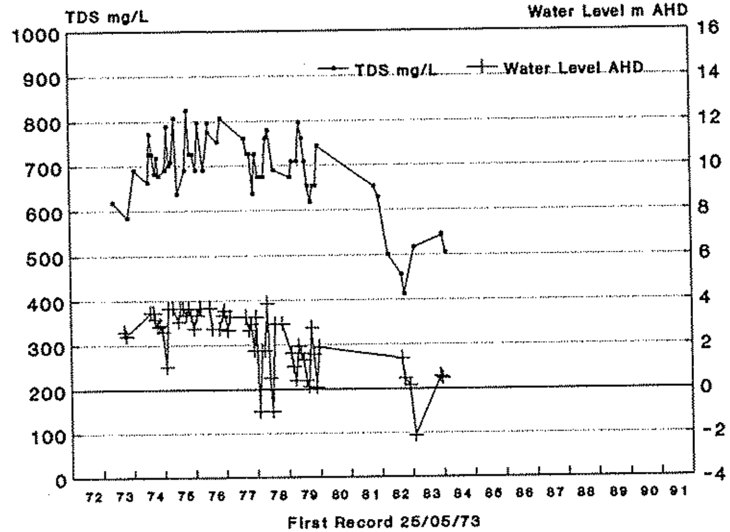

TWS 1/71 Unconfined Production
CENSUS 81 AWRC G80219014
TDS mg/L
TDS.mg/L
Water.Level.AHD
Water Level m AHD
First Record 14/11/71

Figure 14

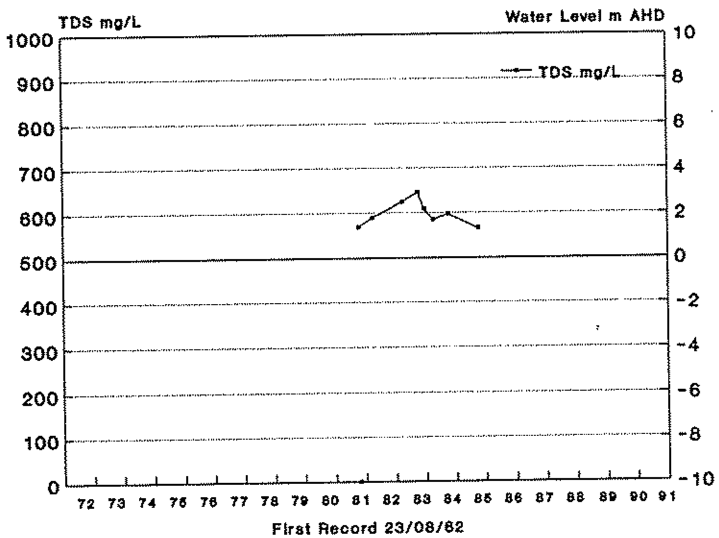
TWS 2/71 Unconfined Production
CENSUS 79 AWRC G80219015



TWS 3/71 Unconfined Infilled
CENSUS 71 AWRC G80219016



TWS 1 Unconfined Infilled
CENSUS 69 AWRC G80219017



TWS 2 Unconfined Infilled
CENSUS 67 AWRC G80219018

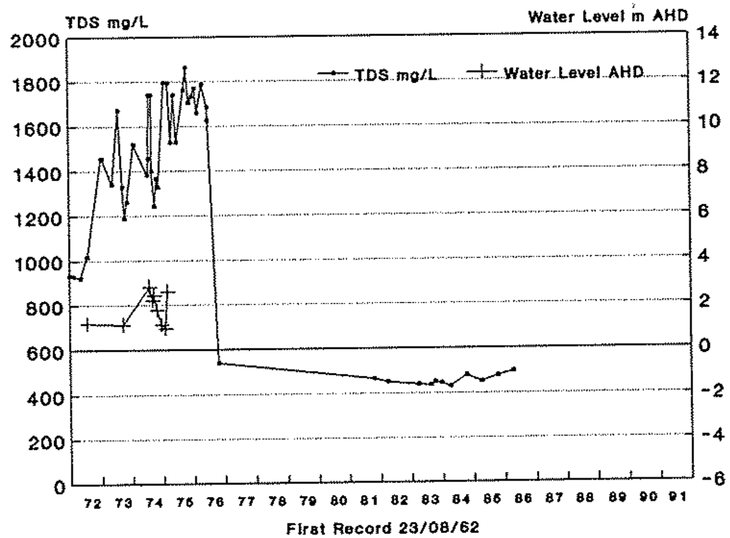
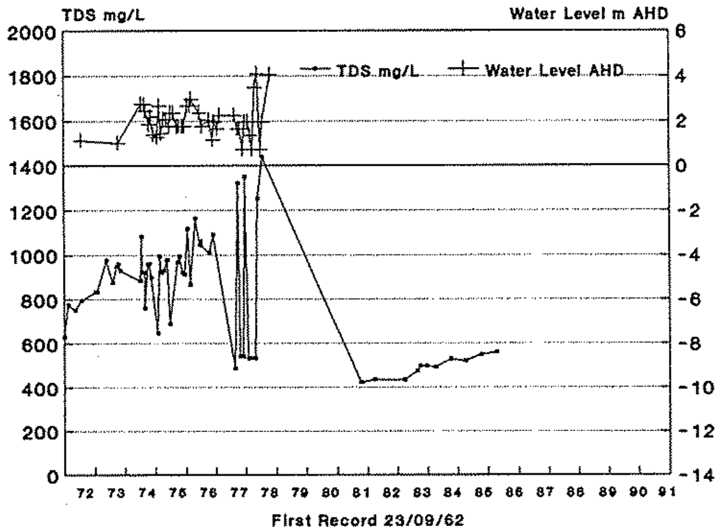
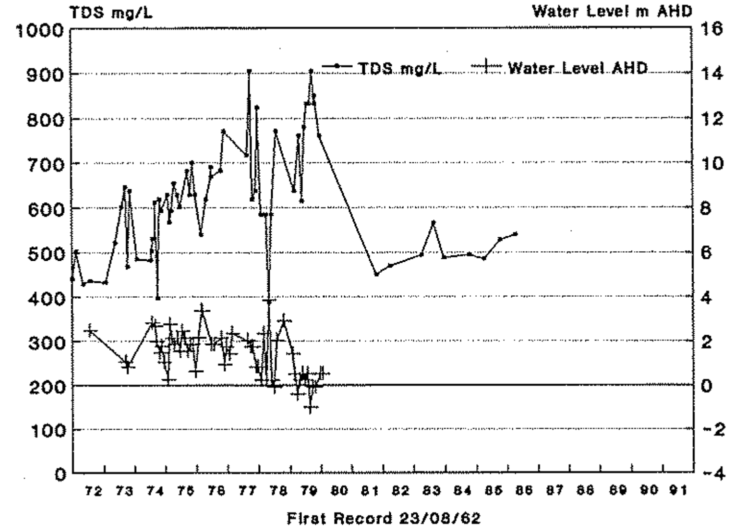


Figure 15

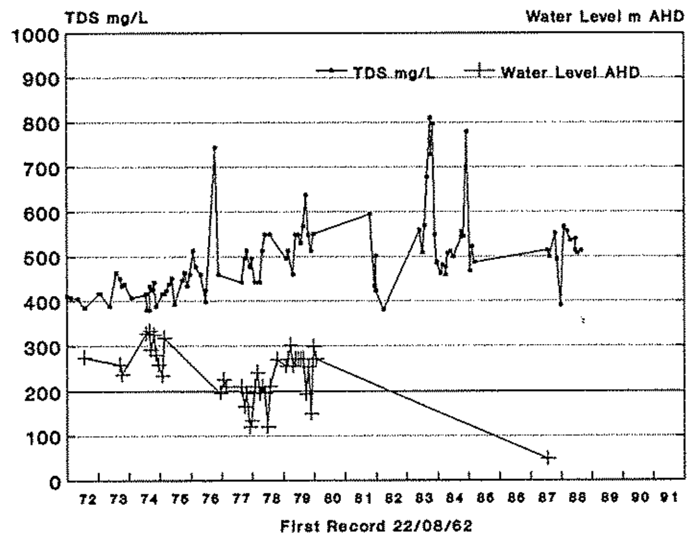
TWS 3 Unconfined Infilled
CENSUS 65 AWRC G80219019



TWS 4 Unconfined Infilled
CENSUS 63 AWRC G80219020



TWS 5 Unconfined Capped
CENSUS 88 AWRC G80219021



TWS 6 Unconfined Monitor
CENSUS 76 AWRC G80219022

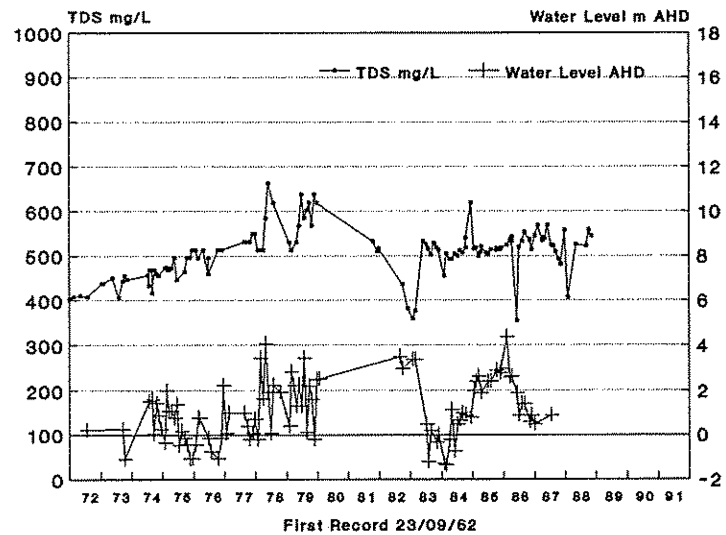
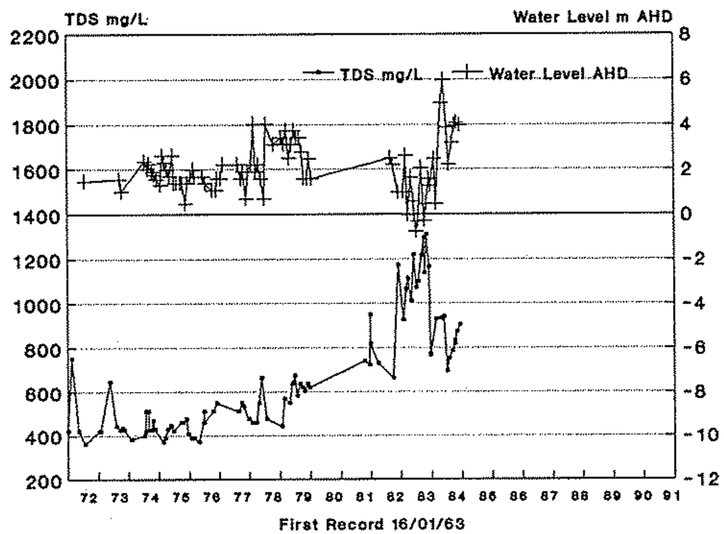
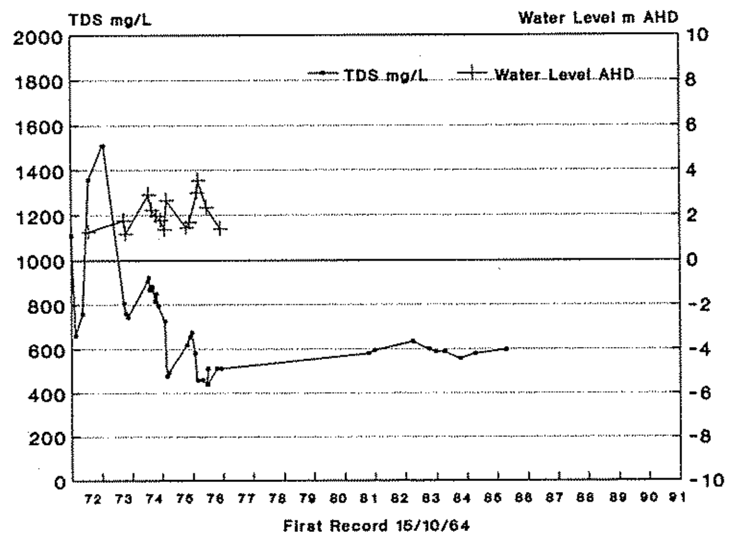


Figure 16

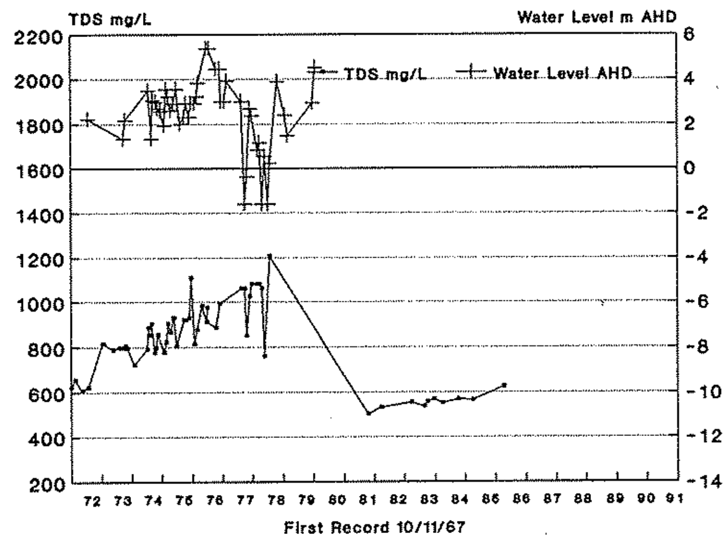
TWS 7 Unconfined Capped
CENSUS 84 AWRC G80219023



TWS 8 Unconfined Infilled
CENSUS 87 AWRC G80219024



TWS 9 Unconfined Infilled
CENSUS 70 AWRC G80219025



TWS 10 Unconfined Production
CENSUS 68 AWRC G80219026

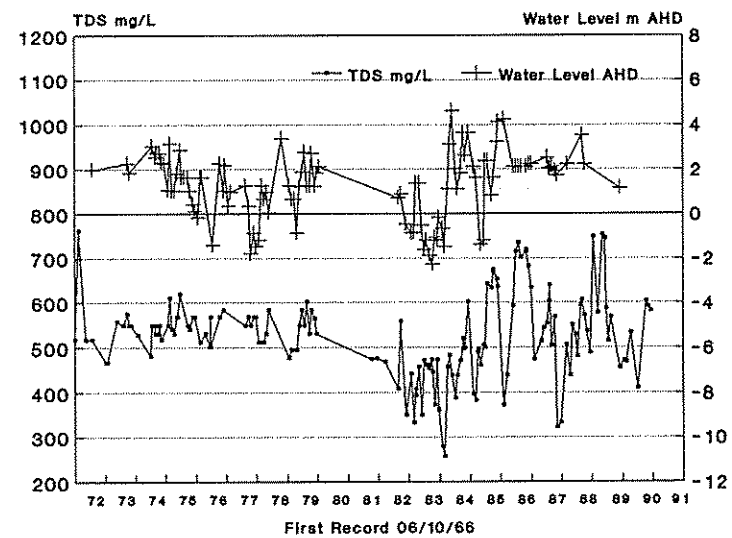
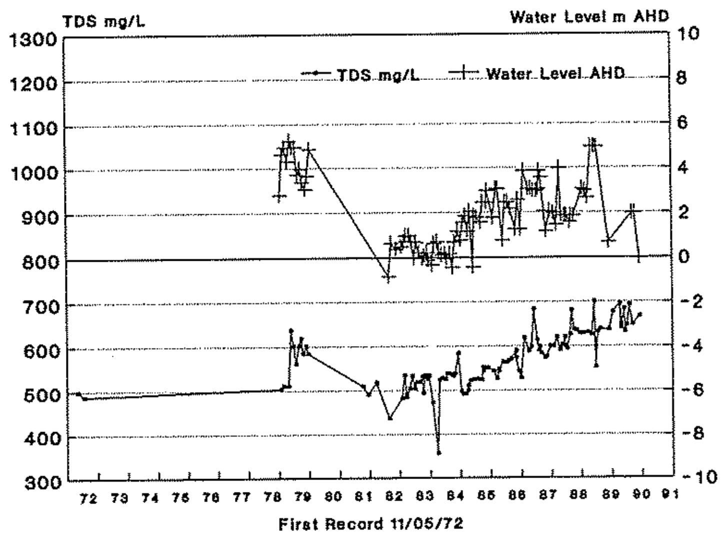
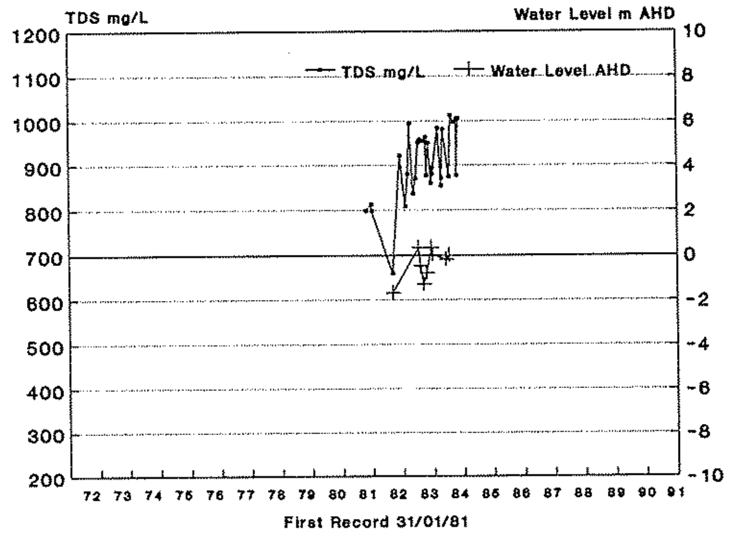


Figure 17

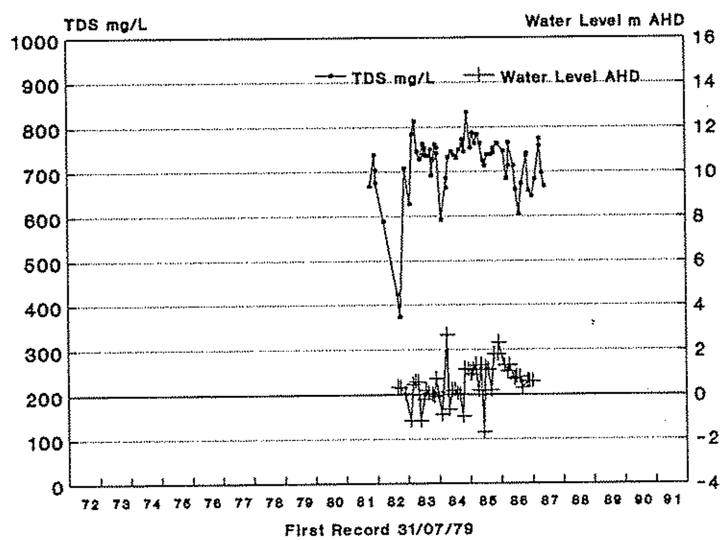
TWS 1/65 Unconfined Production
CENSUS 64 AWRC G80219027



TWS 2/65 Unconfined Infilled
CENSUS 62 AWRC G80219028



TWS 3/65 Unconfined Monitor
CENSUS 141 AWRC G80219029



TWS 1/69 Unconfined Infilled
CENSUS 78 AWRC G80219030

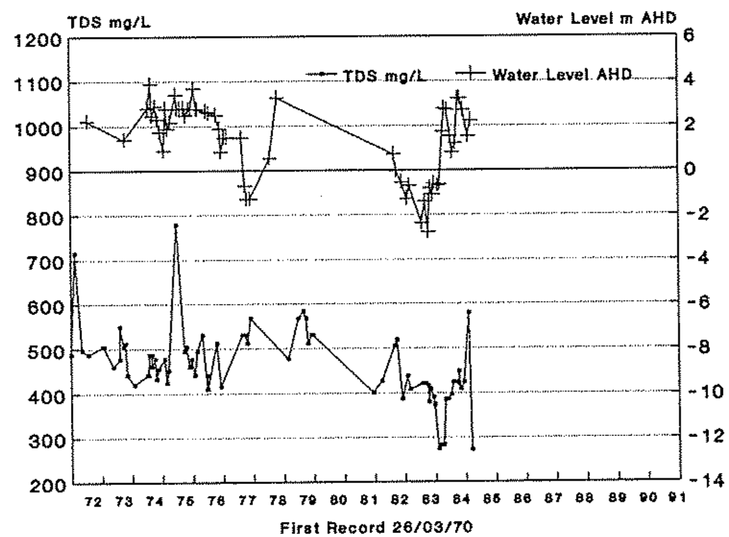
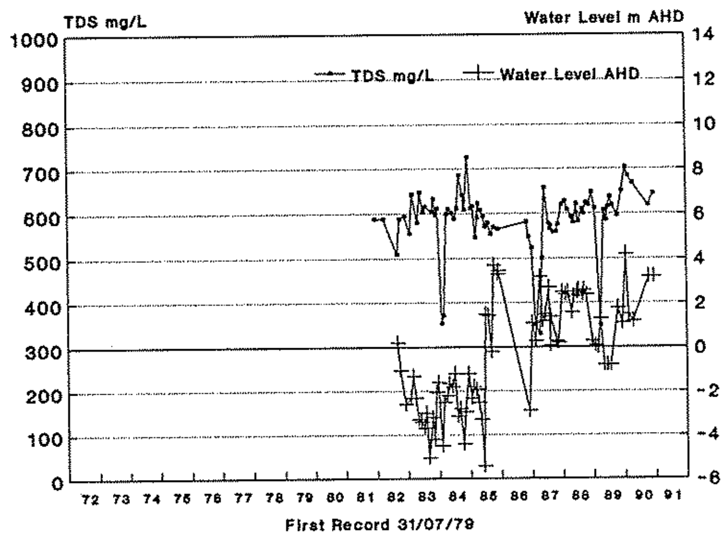
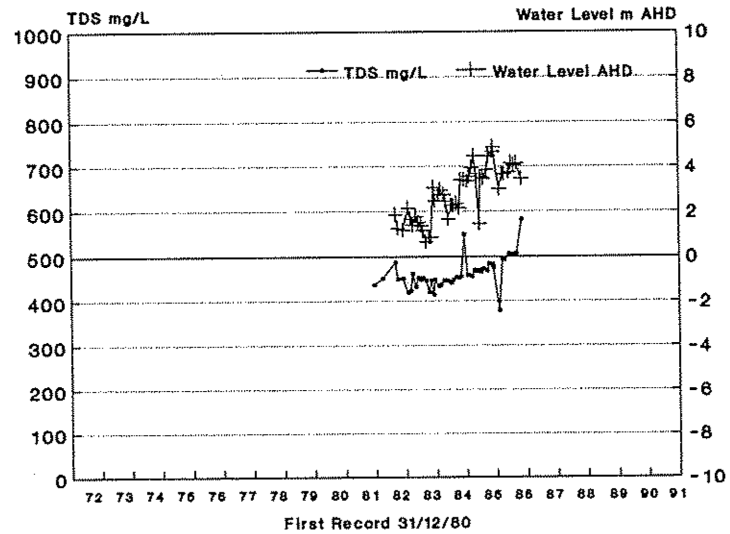


Figure 18

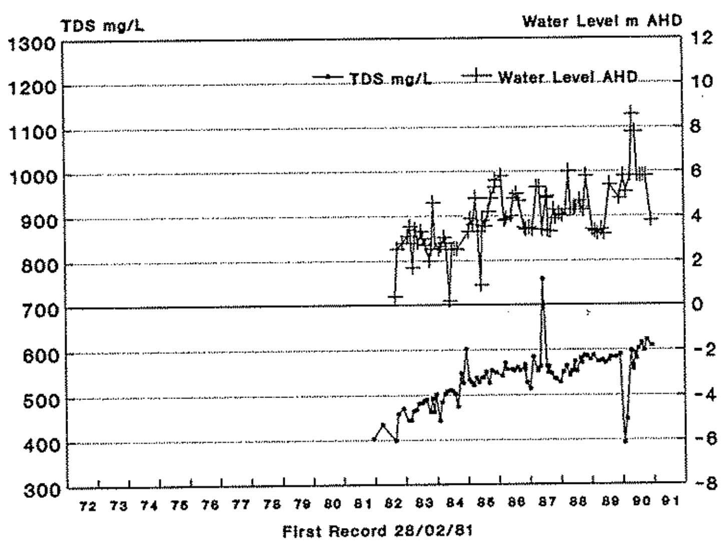
TWS 1/76 Unconfined Production
CENSUS 66 AWRC G80219031



TWS 2/76 Unconfined Infilled
CENSUS 86 AWRC G80219032



TWS 3/76 Unconfined Production
CENSUS 82 AWRC G80219033



TWS 4/76 Unconfined Production
CENSUS 74 AWRC G80219034

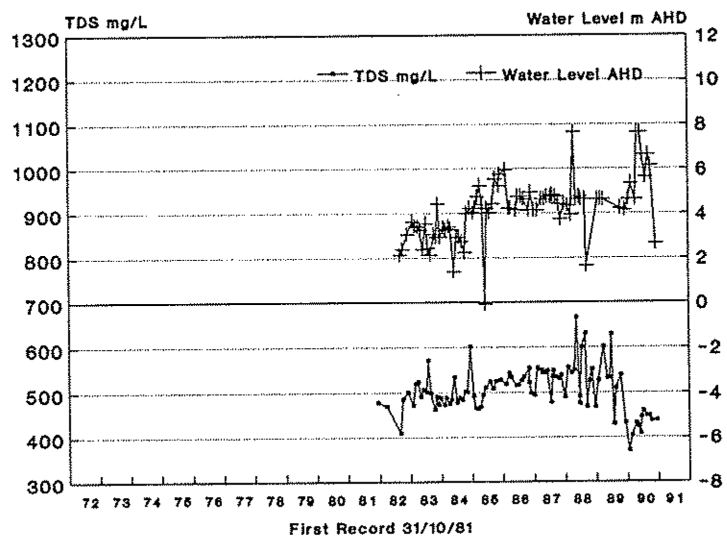
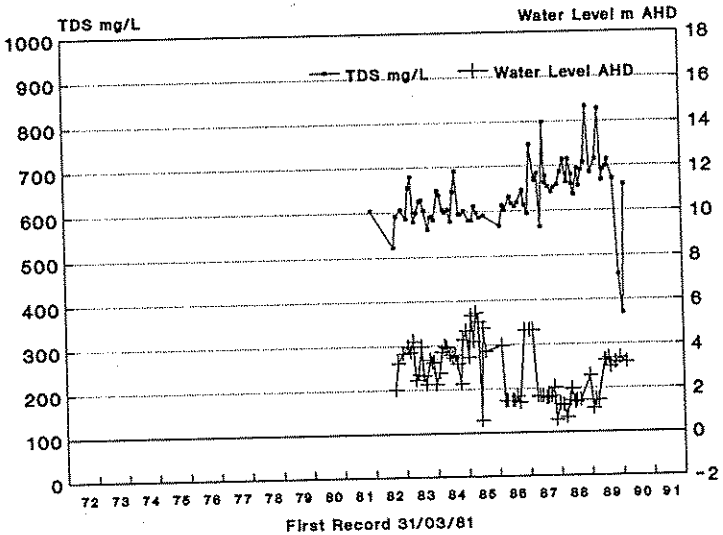
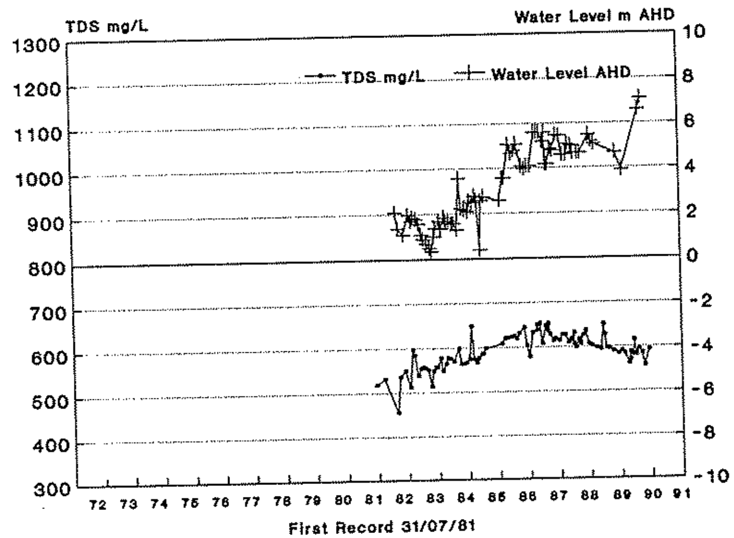


Figure 19

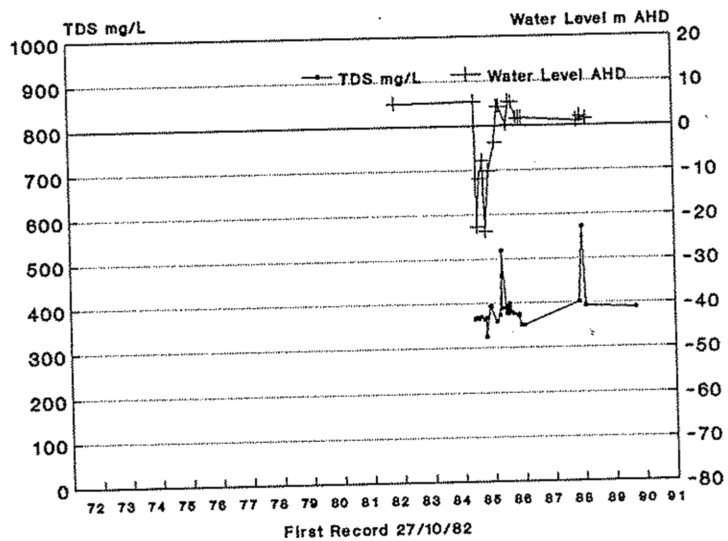
TWS 5/76 Unconfined Production
CENSUS 85 AWRC G80219035



TWS 2/78 Unconfined Production
CENSUS 92 AWRC G80219037



TWS 1/82 Lower Erskine Production
CENSUS 77 AWRC G80219040



TWS 1/86 Lower Erskine Production
CENSUS 75 AWRC G80219041

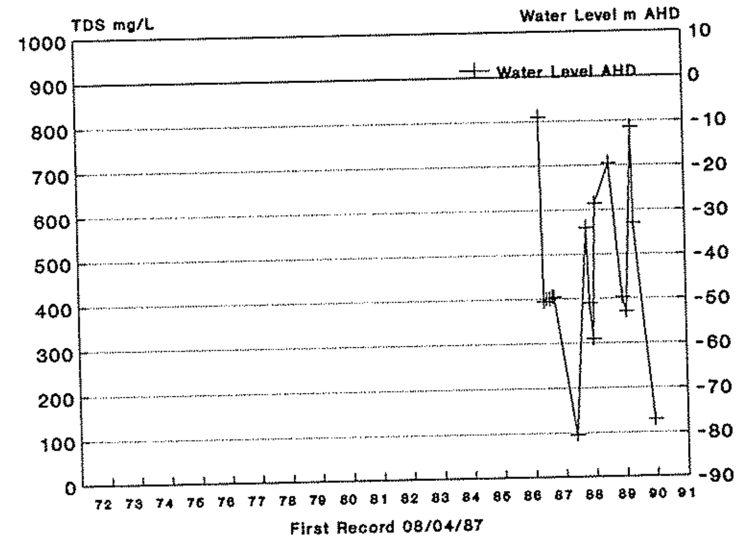
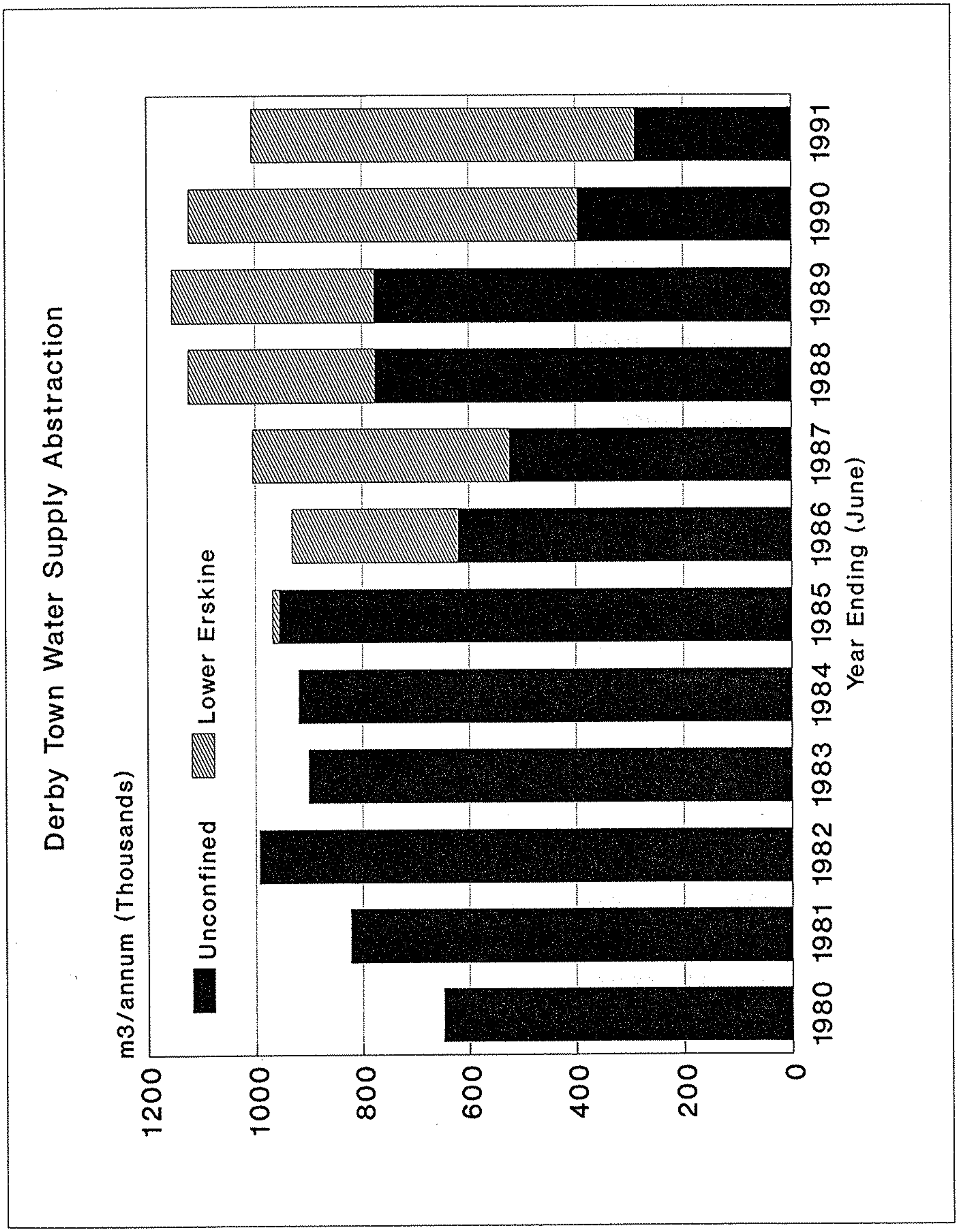
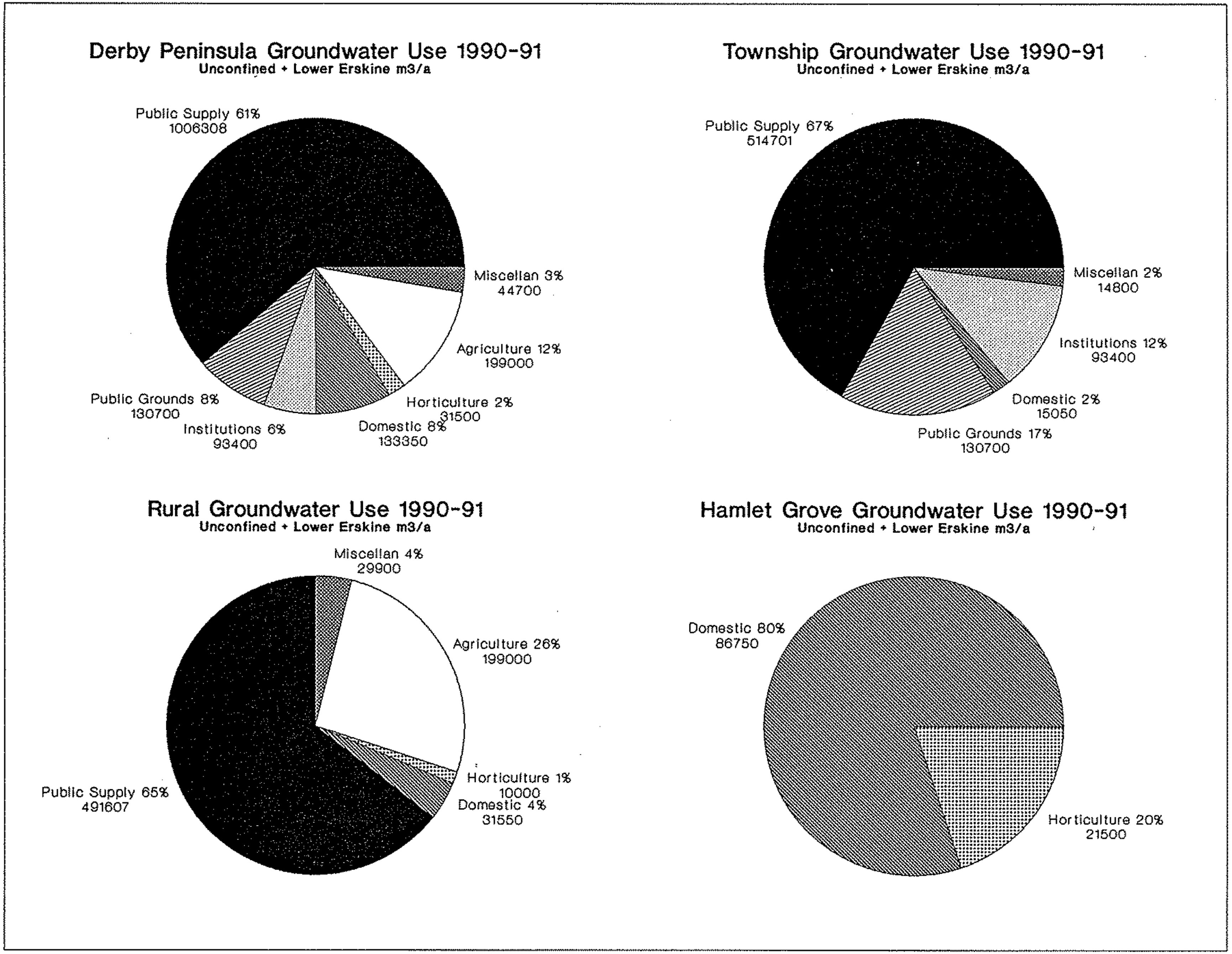


Figure 20



Derby Town Water Supply Abstraction
m3/annum (Thousands)
Unconfined
Lower Erskine
1200
1000
800
600
400
200
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Year Ending (June)

Figure 21



Derby Peninsula Groundwater Use 1990-91
Unconfined + Lower Erskine m3/a
Public Supply 61%
1006308
Miscellan 3%
44700
Agriculture 12%
199000
Horticulture 2%
31500
Domestic 8%
133350
Institutions 6%
93400
Public Grounds 8%
130700
Township Groundwater Use 1990-91
Unconfined + Lower Erskine m3/a
Public Supply 67%
514701
Miscellan 2%
14800
Institutions 12%
93400
Domestic 2%
15050
Public Grounds 17%
130700
Rural Groundwater Use 1990-91
Unconfined + Lower Erskine m3/a
Miscellan 4%
29900
Agriculture 26%
199000
Horticulture 1%
10000
Domestic 4%
31550
Public Supply 65%
491607
Hamlet Grove Groundwater Use 1990-91
Unconfined + Lower Erskine m3/a
Domestic 80%
86750
Horticulture 20%
21500

Figure 22

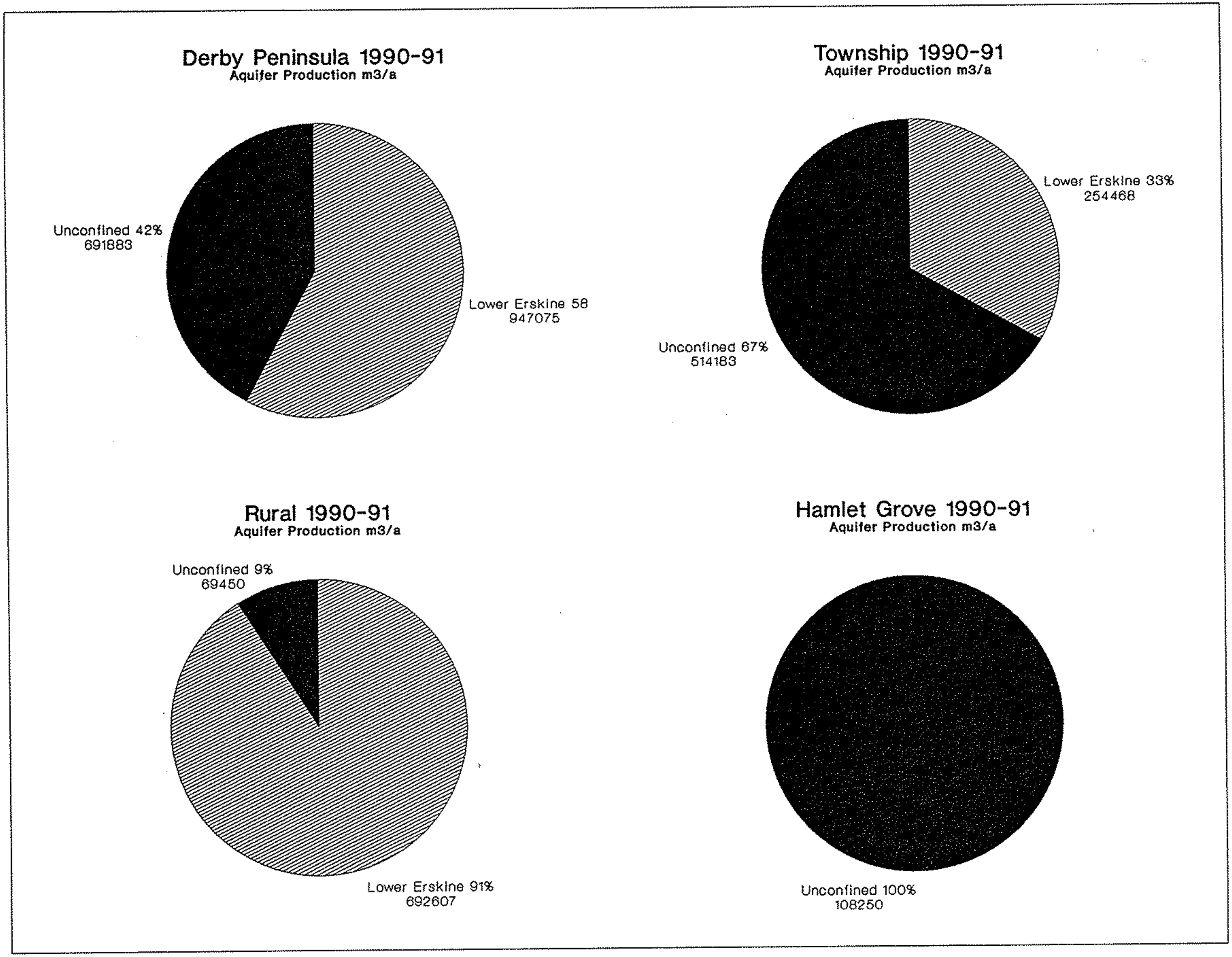

Derby Peninsula 1990-91
Aquifer Production m3/a
Unconfined 42%
691883
Lower Erskine 58
947075
Township 1990-91
Aquifer Production m3/a
Lower Erskine 33%
254468
Unconfined 67%
514183
Rural 1990-91
Aquifer Production m3/a
Unconfined 9%
69450
Lower Erskine 91%
692607
Hamlet Grove 1990-91
Aquifer Production m3/a
Unconfined 100%
108250

Figure 23

RWL UNCONFINED mAHD DERBY PENINSULA MAY 1991

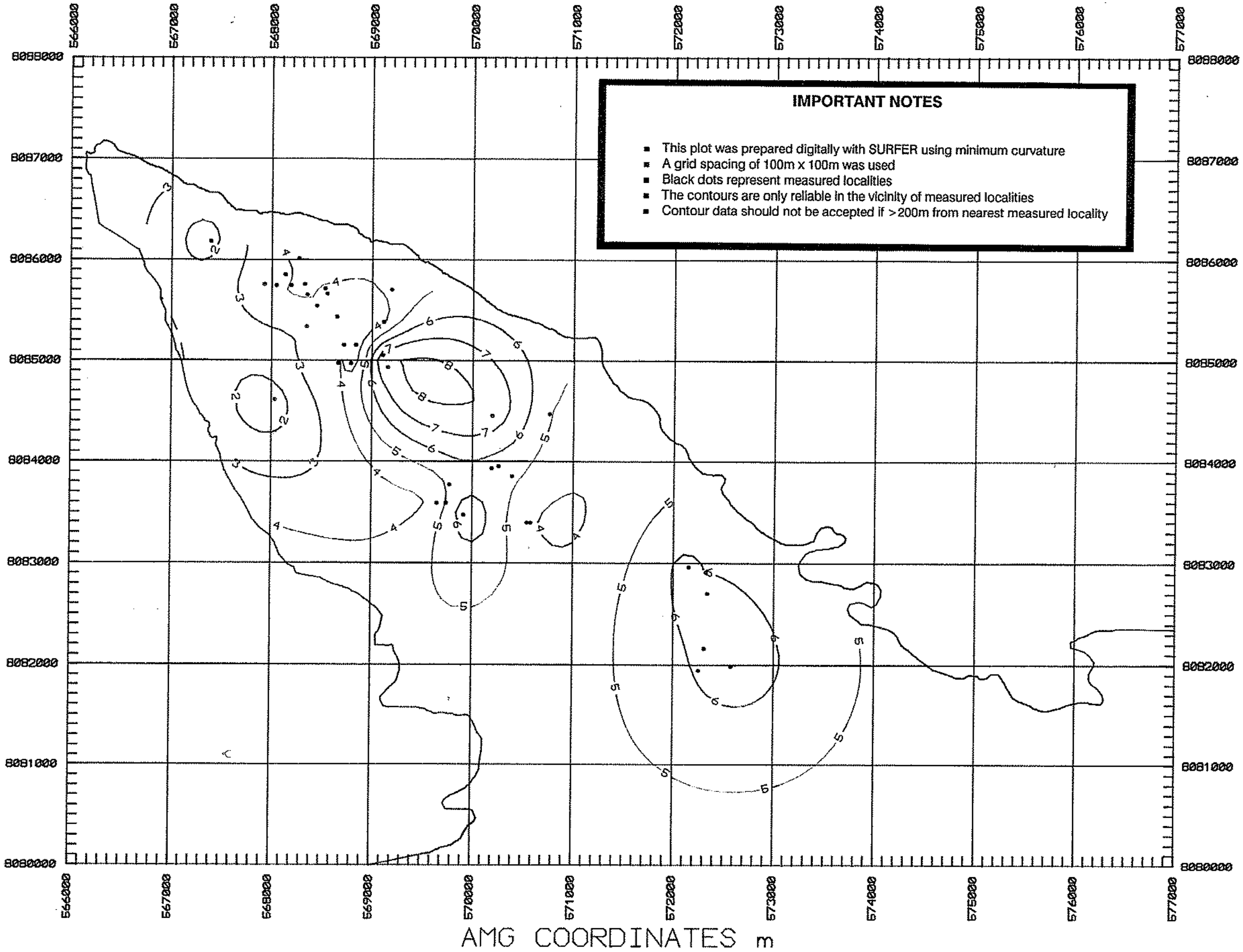


Figure 24

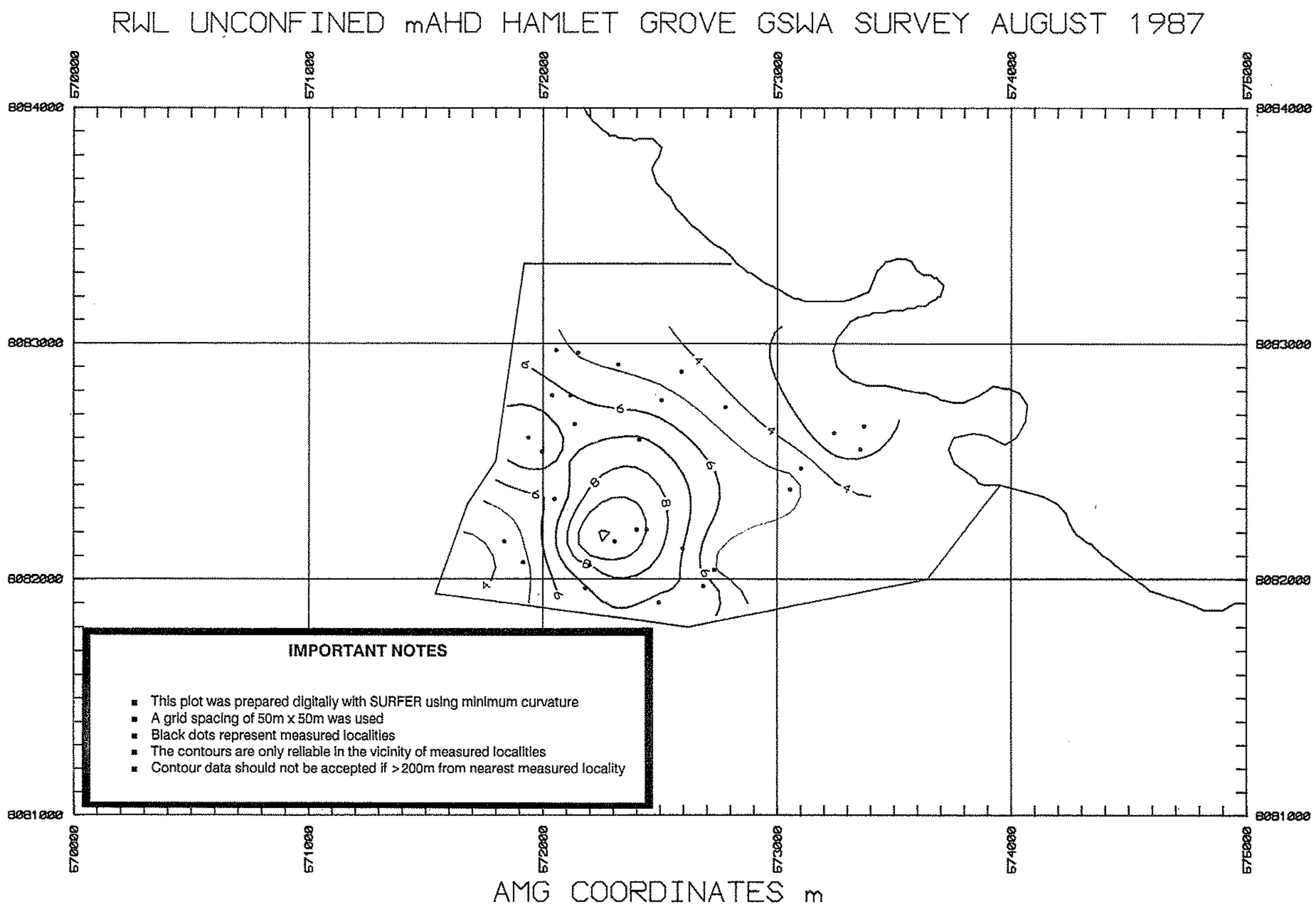
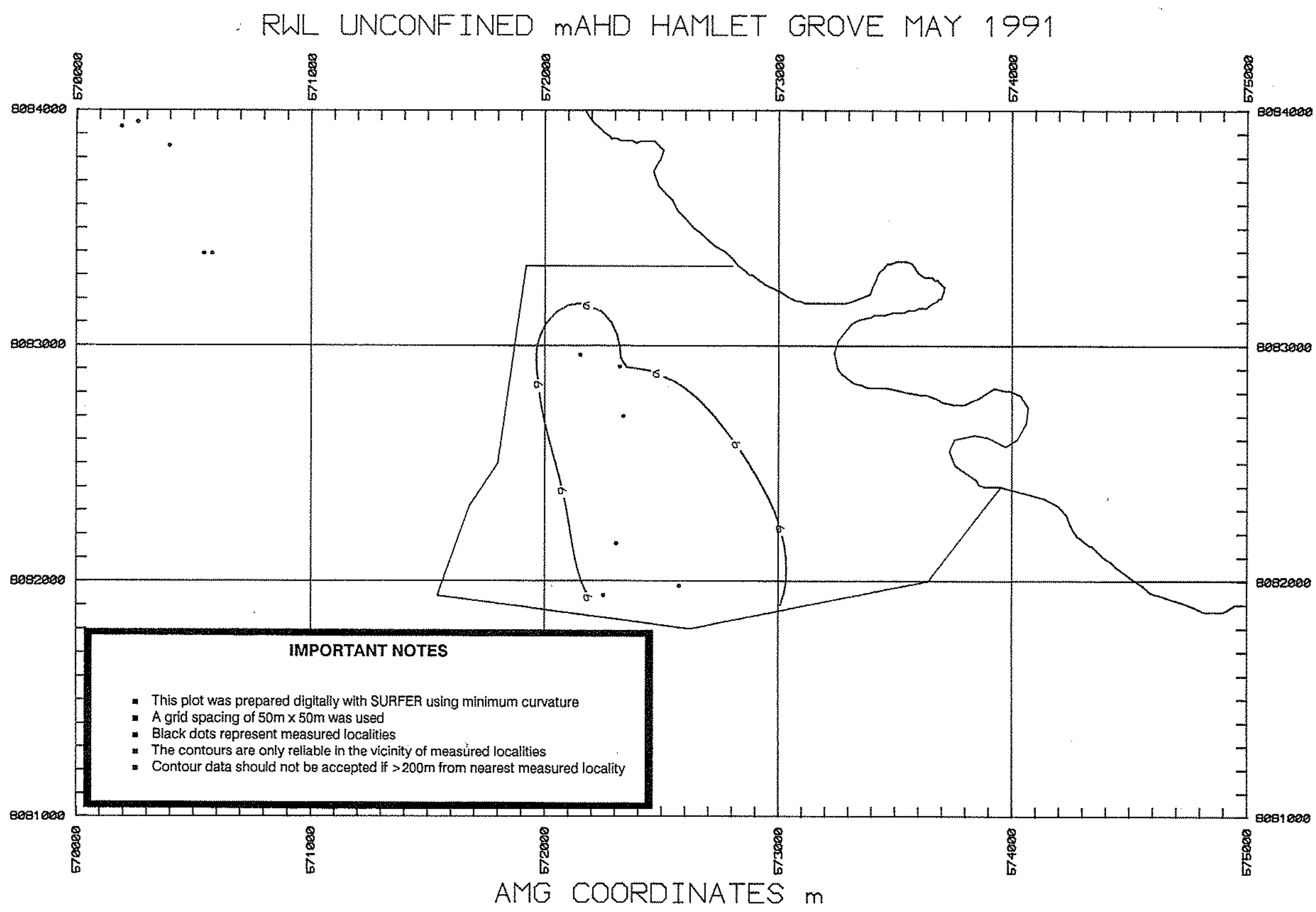

RWL UNCONFINED mAHD HAMLET GROVE GSWA SURVEY AUGUST 1987
570000
571000
572000
573000
574000
575000
8084000
8083000
8082000
8081000
4
6
8
IMPORTANT NOTES
This plot was prepared digitally with SURFER using minimum curvature
A grid spacing of 50m x 50m was used
Black dots represent measured localities
The contours are only reliable in the vicinity of measured localities
Contour data should not be accepted if >200m from nearest measured locality
AMG COORDINATES m

Figure 25



RWL UNCONFINED mAHD HAMLET GROVE MAY 1991
570000
571000
572000
573000
574000
575000
8084000
8083000
8082000
8081000
6
IMPORTANT NOTES
- This plot was prepared digitally with SURFER using minimum curvature
- A grid spacing of 50m x 50m was used
- Black dots represent measured localities
- The contours are only reliable in the vicinity of measured localities
- Contour data should not be accepted if >200m from nearest measured locality
AMG COORDINATES m

Figure 26

RWL mAHD LOWER ERSKINE DERBY PENINSULA MAY 1991

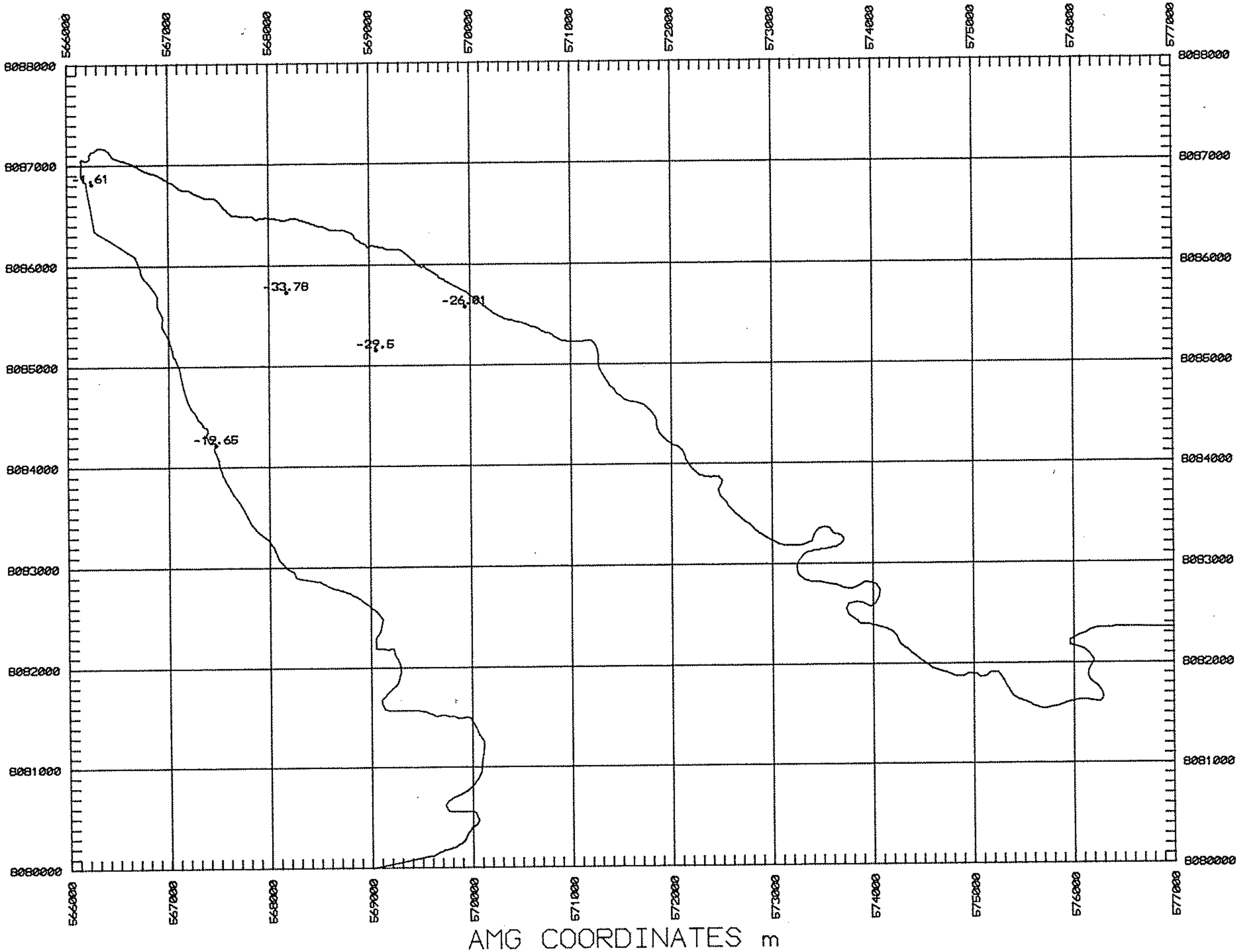


Figure 27

TDS mg/L UNCONFINED DERBY PENINSULA MAY 1991

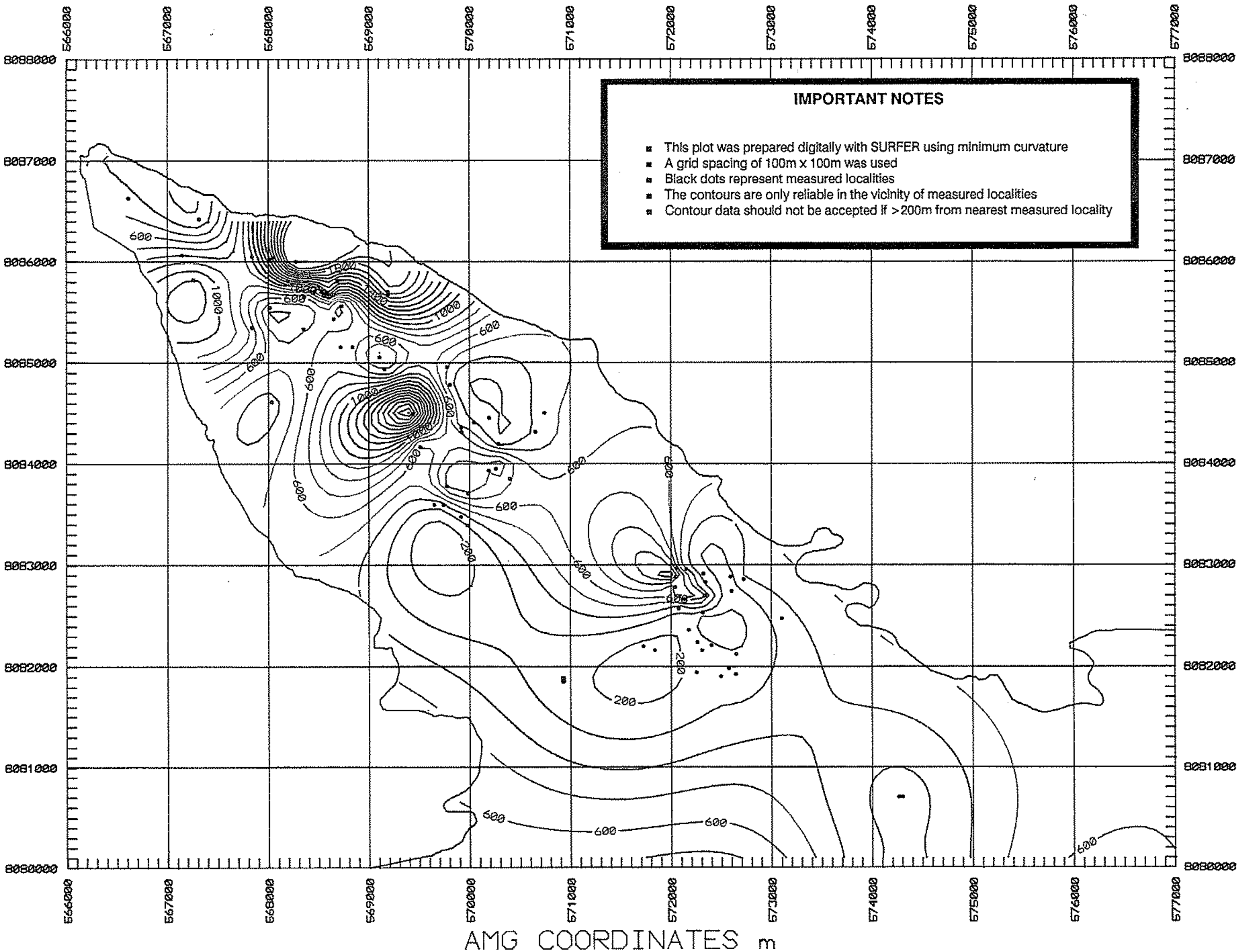


Figure 28

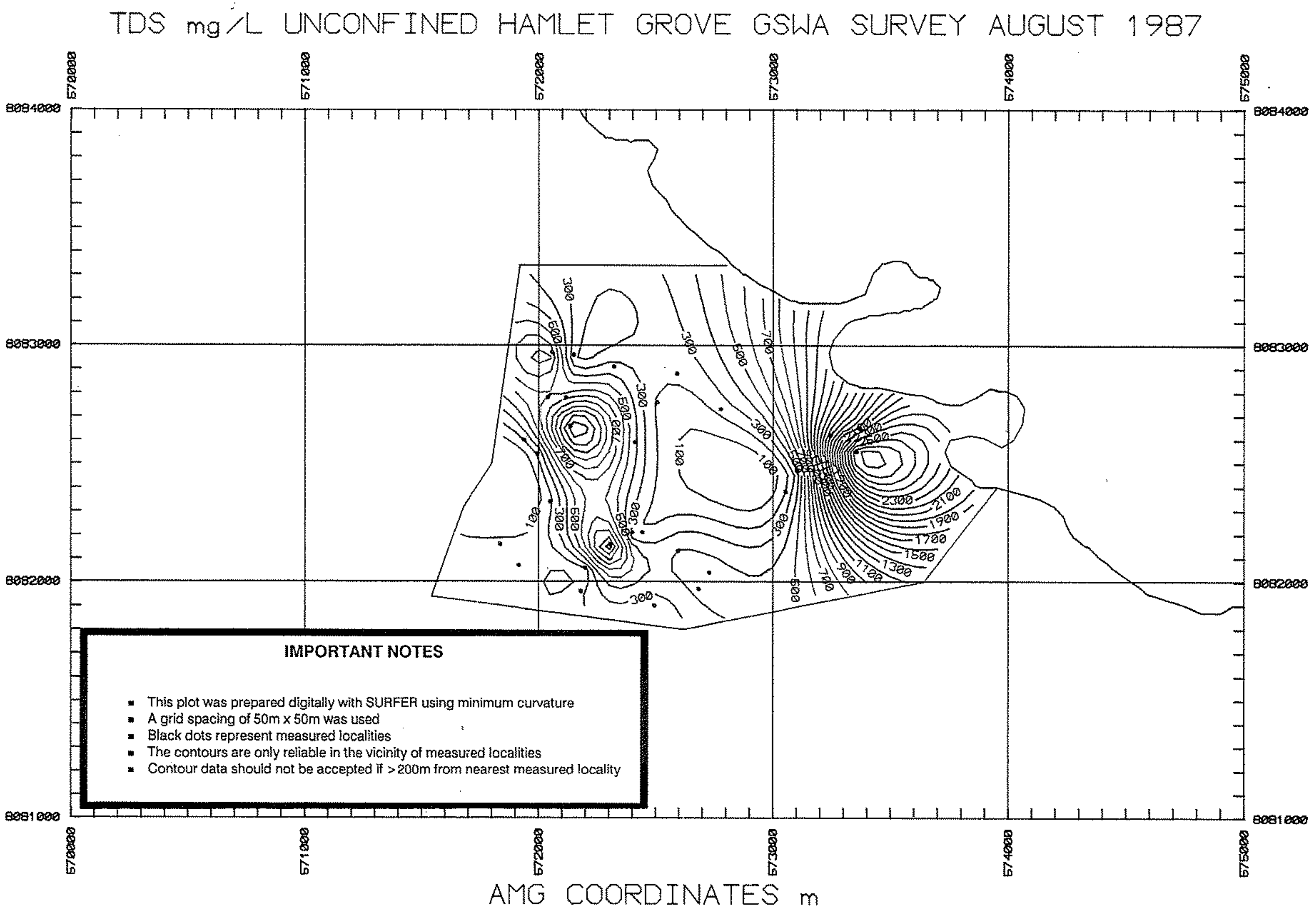
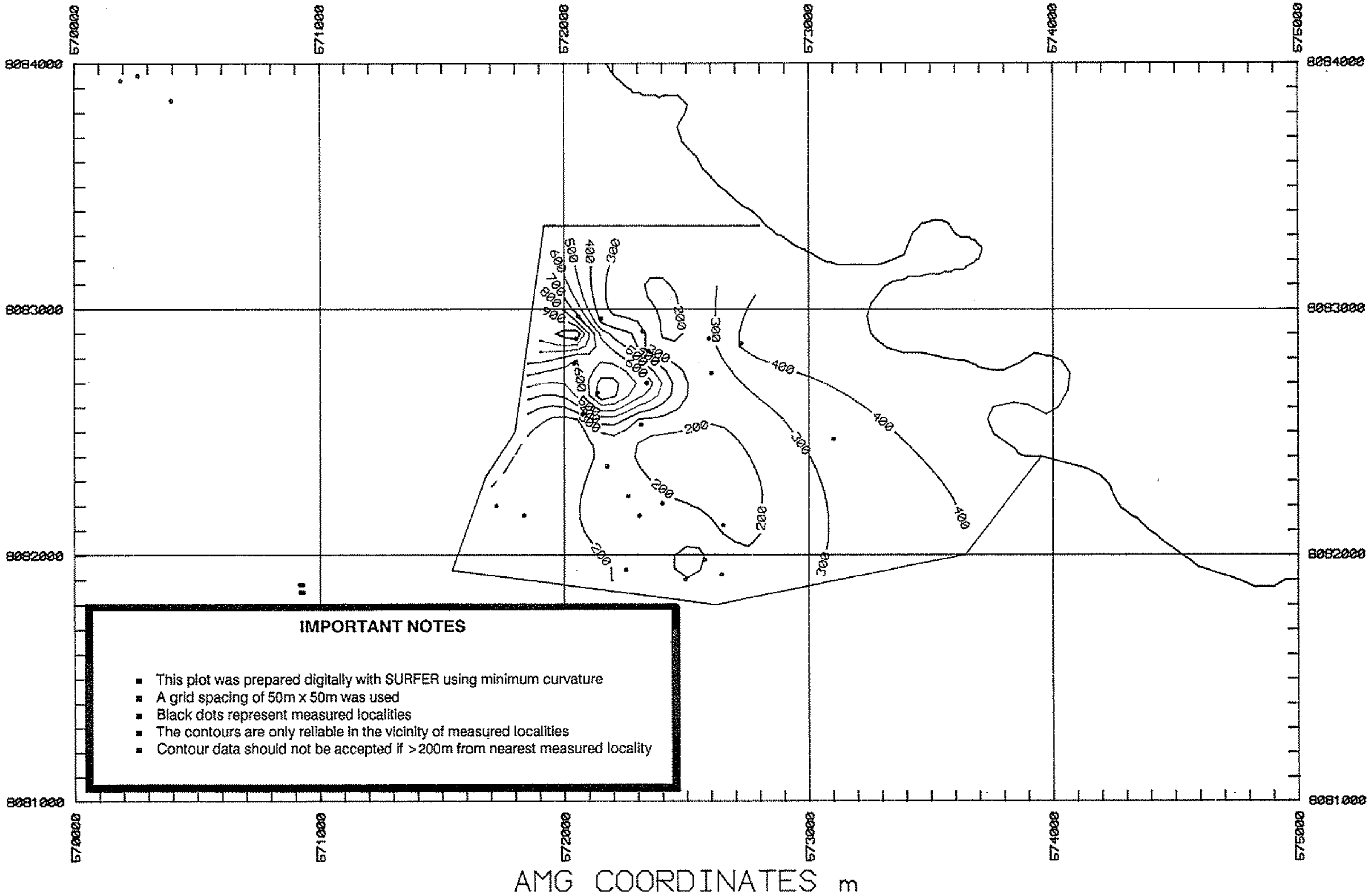

TDS mg/L UNCONFINED HAMLET GROVE GSWA SURVEY AUGUST 1987
570000
571000
572000
573000
574000
575000
8084000
8083000
8082000
8081000
AMG COORDINATES m
IMPORTANT NOTES
This plot was prepared digitally with SURFER using minimum curvature
A grid spacing of 50m x 50m was used
Black dots represent measured localities
The contours are only reliable in the vicinity of measured localities
Contour data should not be accepted if >200m from nearest measured locality

Figure 29

TDS mg/L UNCONFINED HAMLET GROVE MAY 1991

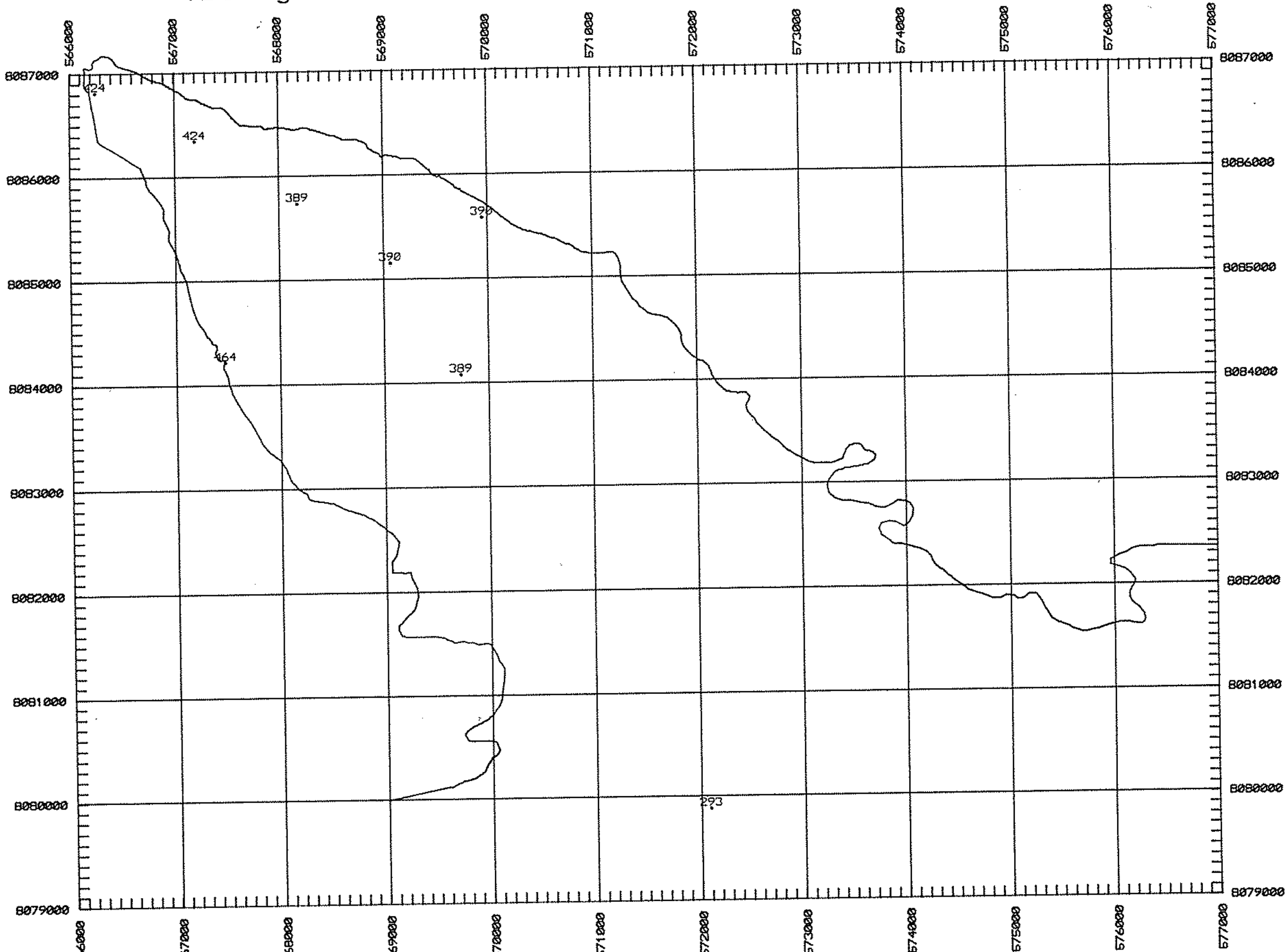


IMPORTANT NOTES

- This plot was prepared digitally with SURFER using minimum curvature
- A grid spacing of 50m x 50m was used
- Black dots represent measured localities
- The contours are only reliable in the vicinity of measured localities
- Contour data should not be accepted if >200m from nearest measured locality

Figure 30

TDS mg/L LOWER ERSKINE DERBY PENINSULA MAY 1991



AMG COORDINATES m

Figure 31

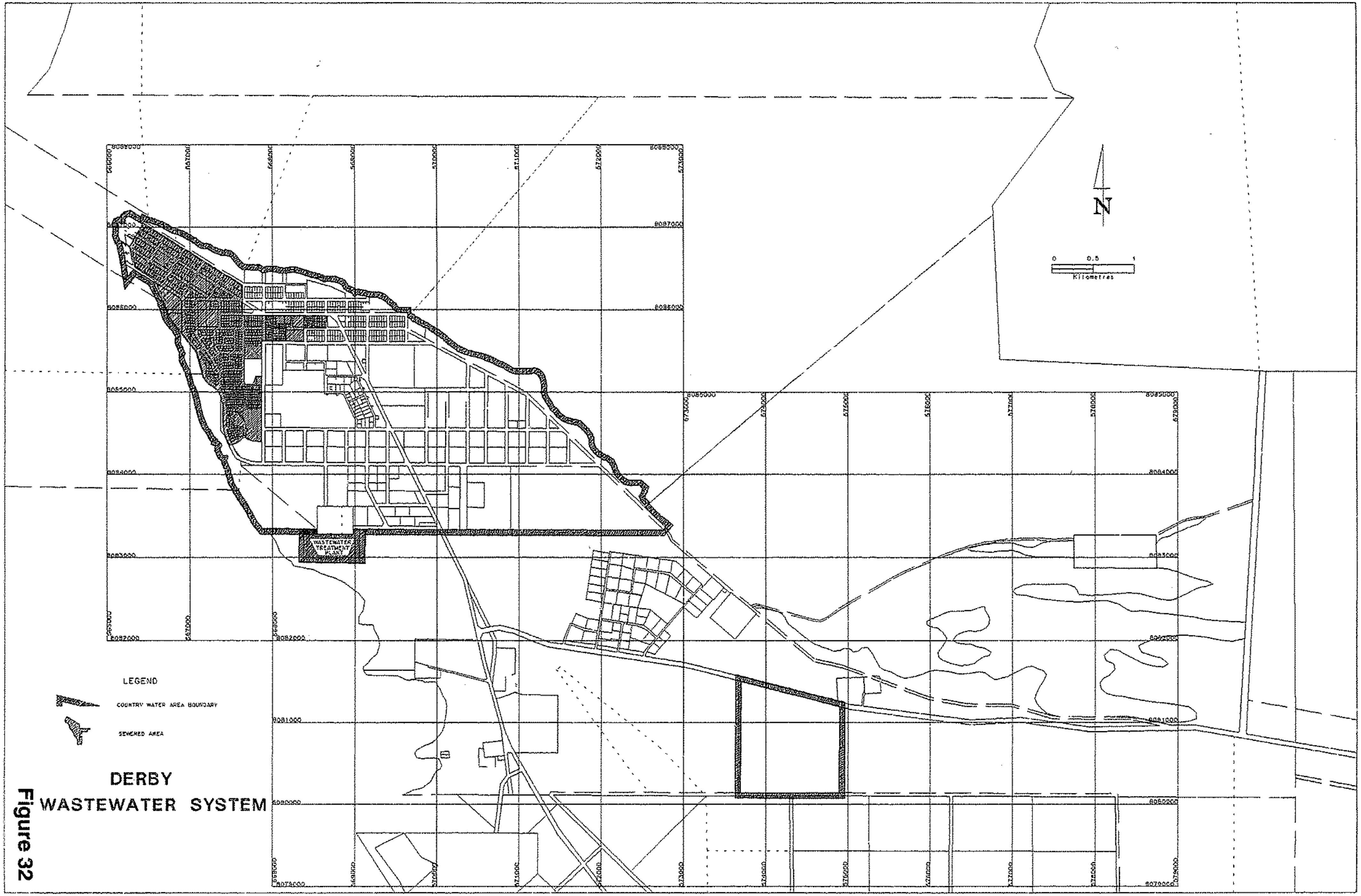
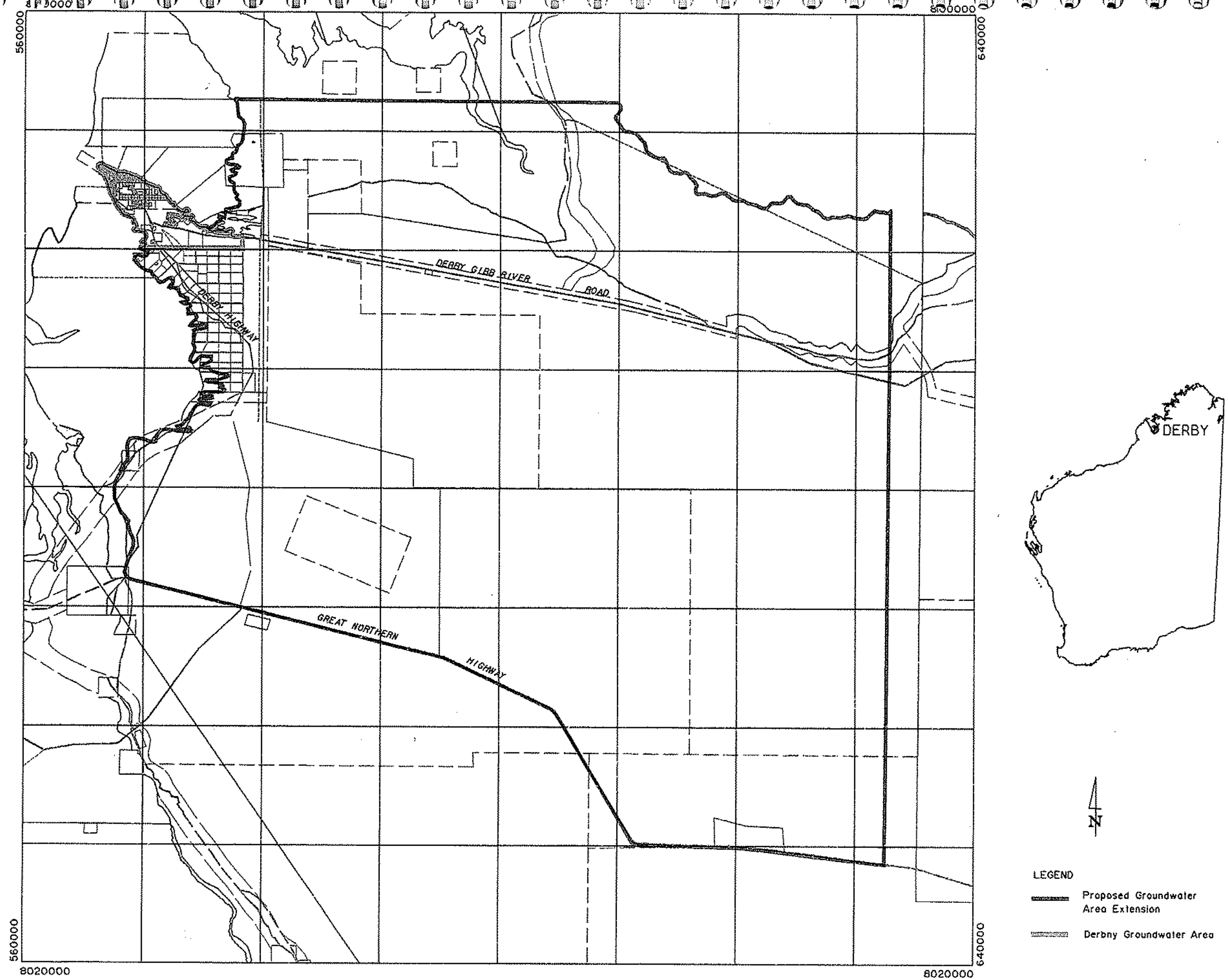

N
0 0.5 1
Kilometres
WASTEWATER TREATMENT PLANT
LEGEND
COUNTRY WATER AREA BOUNDARY
SEWERED AREA
DERBY
WASTEWATER SYSTEM

Figure 32



PROPOSED EXTENSION OF DERBY GROUNDWATER AREA

Figure 33