Water and Environment

BARRAMBIE WATER SUPPLY INVESTIGATIONS	
Prepared for	Reed Resources
Date of Issue	20 October 2009
Our Reference	767/B12/233b

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	Date	Revision Description
Revision a	16/10/09	Draft for Client Review
Revision b	20/10/09	Final

	Name	Position	Signature	Date
Originator	Kate Holder	Senior Hydrogeologist		20/10/09
Reviewer	Hugh Middlemis	Senior Principal Modeller	pp	20/10/09
	Paul Heaney	Principal Hydrogeologist	pp	20/10/09

	Location	Address
Issuing Office	Perth	Suite 4, 125 Melville Parade, Como WA 6152 Tel: 08 9368 4044 Fax: 08 9368 4055

EXECUTIVE SUMMARY

Definitive Feasibility Studies have been completed by Reed Resources Ltd (Reed Resources) on the development of a vanadium/titanium mine in the Barrambie area, located 80km northwest of Sandstone and 115km southeast of Meekatharra.

The water supply demand required for the processing plant, dust suppression and mining camp was initially estimated to be approximately 3,400kL/d (1.24GL/a) in 2007. However, in April 2008, beneficiation testwork indicated that due to difficulties in dewatering the tailings material, and hence less water return, the predicted forecast water demand was increased to 6,850kL/d (2.5GL/a).

Aquaterra were commissioned to assess water supply options in the Barrambie area and evaluate the potential for a borefield to meet the Project water demand.

Field Investigations and Analysis

Previous investigations completed in 1972 identified the presence of two potential aquifer systems, a shallow calcrete aquifer and a deeper palaeochannel aquifer in the Barrambie area (Geotechnics, 1972). These aquifers form part of the Cogla Downs drainage system which extends from approximately 20km southwest to 40km northwest of Barrambie. The previous investigations completed concluded that the shallow calcrete aquifer contained sufficient resources to meet the Project's water supply requirement (identified to be 2,300kL/d).

Aquaterra conducted a field investigation programme in 2007, which included the installation of fifteen exploration holes, three of which were completed as test production bores, in the calcrete aquifer along the main channel. Seven of the exploration holes were completed as monitoring bores for use as observation points during the subsequent pumping tests undertaken, and to establish a monitoring bore network for future groundwater monitoring.

Hydraulic testing of the test production bores provided yields of 12L/s to 20L/s, with yields being primarily limited by pump capacity. Water level drawdown in the pumped bores and adjacent monitoring bores was generally in the range of 0.13m to 2.37m, and less than 0.5m respectively. Analysis of the pumping tests provided highly variable aquifer parameters with transmissivities derived varying from 610m^2/d to 8,000m^2/d, with corresponding hydraulic conductivity values ranging from 55m/day to 570m/day.

It was initially proposed to also undertake drilling in the east tributary towards Errolls bore but due to the favourable results from the main channel drilling and testing programme this further drilling was postponed. Subsequently the calcrete aquifer intercepted in the area between Limestone Bore and Bedan Well (the area of investigation) was the focus for further assessments to secure the Project water supply.

All available information (from this and previous studies) was considered in order to develop a conceptual hydrogeological understanding of the area of investigation. This conceptual hydrogeology can be summarised as follows:

- **Aquifer Types –** Two aquifers are present within the area of investigation, a calcrete aquifer and a palaeochannel aquifer. Due to favourable drilling/testing results from the calcrete aquifer and drilling difficulties associated with palaeochannel sediments, the calcrete aquifer was the focus of investigations.
- **Aquifer Extent** – The extent of the calcrete appears to be best represented by the outcrop area, as defined in the GSWA 1:250,000 geology map (although calcrete is known to be absent in some locations within this area, and it is also known to exist outside this area).
- **Aquifer Thickness** – The calcrete thins towards the eastern and western margins, but in the central areas the calcrete is generally 15 to 18m thick in the southern area (around Limestone Bore) and 5m thick in the northern area (around B9M).
- **Aquifer Properties** – Hydraulic conductivity and specific yield values of 100m/d and 20%, respectively, are considered to be representative aquifer properties of the calcrete aquifer, although there is likely to be considerable variation in these properties.

- **Depth to Water** – Depth to water within the unconfined alluvium and calcrete is generally between 2 and 7mbgl.
- **Groundwater flow** – Groundwater flow direction is generally north to north-westwards.
- **Recharge** – Recharge is believed to occur at low rates via direct infiltration of rainfall and/or infiltration of surface water runoff. There is currently insufficient data to quantify the rainfall recharge.
- **Water quality** – Typically, TDS ranged from 2,100mg/L to 2,700mg/L and EC ranged from 3,600 to 4,500µS/cm. Generally, salinity increases northwards.

Groundwater Modelling

A numerical groundwater model was developed to evaluate the potential of the calcrete aquifer to meet the projected water supply demand and optimise borefield design. The modelling completed suggests that, under Base Case condition, the water supply demand of 2.5GL/a (6,850kL/d) can be met by a borefield comprising 7 to 10 production bores (each pumping at 7-12L/s) installed within the calcrete aquifer, for a 12 year duration. The model predicts that the above borefield configurations will result in retained saturated thickness of approximately 60% (in the Yilby Bore and Bore 3 (Obs A) areas) and approximately 85% (in the Bedan Well area).

The numerical model completed maintains a conservative approach and does not take into account recharge from rainfall, which is thought to contribute a significant portion of the recharge to the aquifer. It should also be noted that the modelled calcrete extent is conservative and does not take into account the eastern branch of the Cogla Downs drainage system, which will substantially increase the volume of groundwater available in storage. In addition, the inflow to the calcrete aquifer from adjacent alluvial sediments has not been included in this model. These surrounding alluvial sediments are expected to be in hydraulic connection with the calcrete aquifer.

Potential Impacts

There are a number of existing pastoral bores in the vicinity of the proposed Barrambie water supply borefield, both within the calcrete aquifer and in the surrounding sediments further from the borefield. Groundwater dependent vegetation has been identified within the borefield area that may be impacted by water level drawdown resulting from groundwater abstraction (discussed further in Mattiske, 2009). However, it appears that these species may be more dependent on localised rainfall events rather than groundwater levels.

Stygofauna sampling conducted by Outback Ecology in 2008/2009 identified the presence of potentially new taxa in the proposed borefield area. Therefore, the proposed borefield will be managed to maintain a high level of saturated thickness to ensure sufficient habitat area.

In order to monitor, manage and mitigate potential impacts on other groundwater users and the environment, Reed Resources propose the following:

- Implementation of a comprehensive groundwater monitoring programme, which will be developed in consultation with the Department of Water.
- Adopting appropriate groundwater level and groundwater quality action and cut-off triggers, which will be developed in consultation with the Department of Water.
- Maintain an average saturated thickness of 75% across the aquifer (within the borefield area) for the first 5 years of operation.
- A plan will be developed whereby if groundwater levels or quality reach action trigger levels, supplementary water supply options will be investigated such that supplementary water supply options can be commissioned prior to cut-off trigger levels being reached. Potential supplementary water supply (contingencies) include:
  - The calcrete aquifer associated with eastern tributary of the Cogla Downs drainage system, towards Errolls bore.
  - The calcrete aquifers within the Cogla Downs drainage system further north and south of the proposed borefield.
  - The inferred Cogla Downs drainage deeper palaeochannel system.
  - Disused pits at the Gidgee Gold Mine.

Further Work

Prior to applying for a 5C licence to take groundwater, Reed Resources propose to conduct the following work in order to confirm the sustainable yield of the calcrete aquifer and develop a better understanding of local recharge processes.

- Production Bore Installation: install up to an additional 6 production bores to develop a water supply borefield.
- Monitoring Bore Installation: install additional monitoring bores both within the borefield area and regionally.
- Groundwater Monitoring Programme: develop and implement a comprehensive groundwater monitoring programme in consultation with the Department of Water.
- Recharge Mechanisms: further assess the recharge mechanisms of the calcrete aquifer, once more data becomes available (such as site rainfall data, daily water level data, etc).
- Additional Numerical Modelling: additional numerical modelling will be conducted once more data becomes available (including new drilling and testing results, recharge assessments, groundwater monitoring, etc). This modelling will reassess sustainable yield from the calcrete aquifer and potential impact on water levels within the aquifer and regionally.
- Operating Strategy: as part of the requirements of an application for a 5C licence to take groundwater, a detailed Operating Strategy will be developed to efficiently and effectively monitor and manage borefield operation and groundwater monitoring.

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FIGURES

APPENDICES

1 INTRODUCTION

1.1 PROJECT BACKGROUND

Definitive Feasibility Studies have recently been completed by Reed Resources Ltd (Reed Resources) on the development of a vanadium mine at Barrambie, located 80km northwest of Sandstone and 115km southeast of Meekatharra in the Murchison Region of Western Australia (Figure 1.1).

The vanadium, titanium and iron deposits (Barrambie deposit) in the Barrambie area were discovered in the late 1960's by Hector Ward and were acquired by Reed Resources in April 2003 from Precious Metals Australia Ltd and Magnum Properties Pty Ltd.

Reed Resources propose to mine approximately 3Mt of vanadium ore annually over a mine life of 12 years. Previous studies concluded that the Barrambie deposit was amenable to mining via shallow open-pit mining techniques and conventional crushing, grinding and magnetic separation to produce a concentrate. Salt roasting and leaching of the magnetic concentrate achieved recoveries which exceeded 95%.

A water supply will be required for the processing plant, dust suppression and the mining camp. An initial water requirement of approximately 3,400kL/d (1.24GL/a) was identified in 2007, however in April 2008 beneficiation testwork undertaken by Sinclair Knight Mertz (SKM) indicated that due to difficulties in dewatering the tailings material, and hence less return water recovery, the predicted forecast water demand was increased to 6,850kL/d (2.5GL/a).

Reed Resources engaged Aquaterra Consulting Pty Ltd (Aquaterra) to assist with the environmental approvals, surface water and groundwater aspects of the Definitive Feasibility Study.

1.2 OBJECTIVES

The primary objective of the work described in this report was to undertake groundwater investigations to assess water supply options in the Barrambie Project area (the Project area).

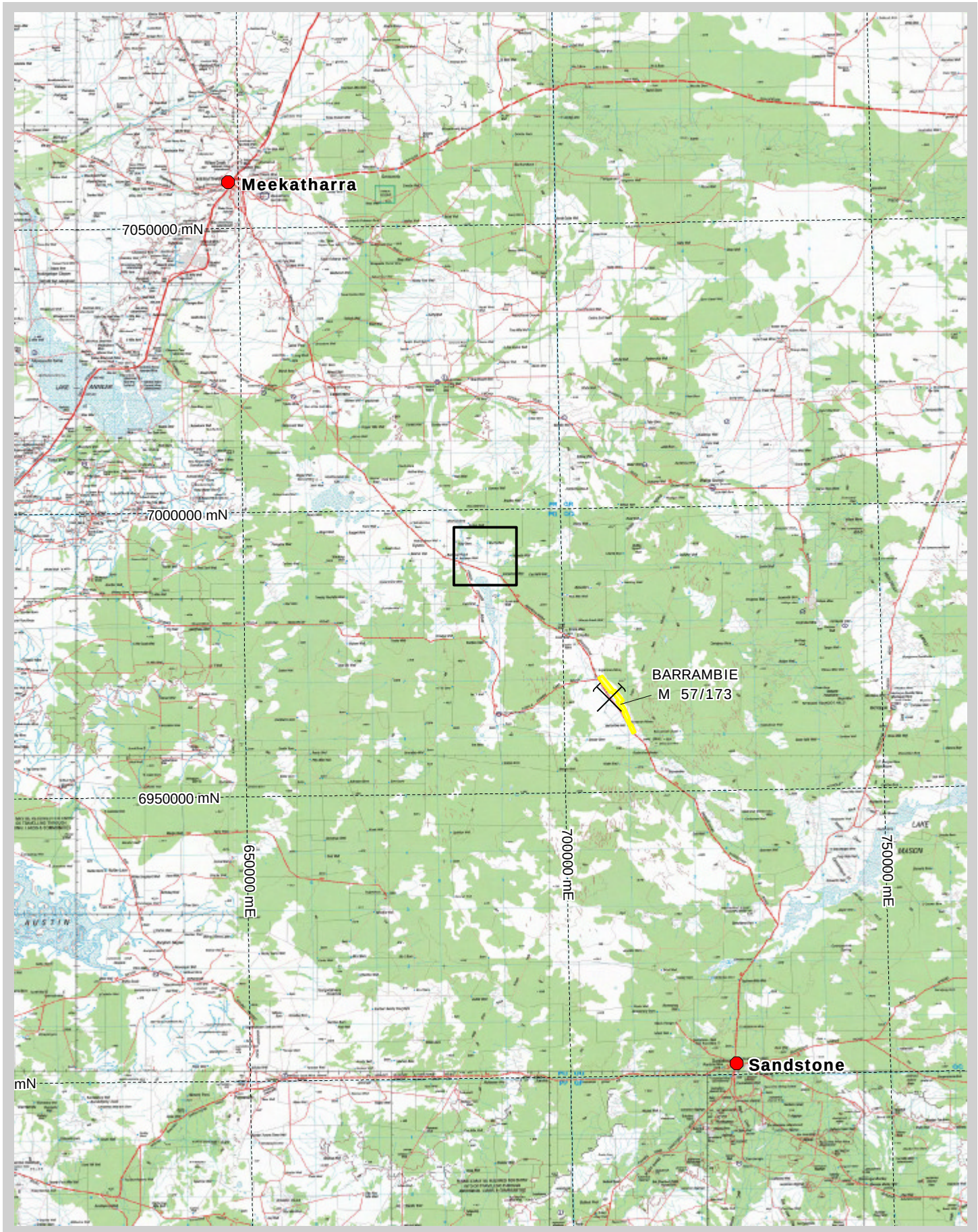
The objectives of the work were to:

- Investigate the extent, properties and water quality of the shallow calcrete aquifer identified in previous investigations by Geotechnics (1972) (and, where possible, the deeper palaeochannel aquifer).
- Evaluate the sustainability of a water supply derived from the shallow calcrete aquifer.
- Provide a preliminary borefield design to meet the project water supply demand of the order of 6,850kL/d (2.5GL/a) for the proposed 12-year mine life.

1.3 SCOPE OF WORK

The scope of work involved the following:

- A desktop study of available data for the proposed area of investigation (Cogla Downs Drainage Area), including a review of previous field investigations completed.
- Design an appropriate field investigation programme.
- Exploratory drilling, including the installation of test production and monitoring bores.
- Hydraulic testing of test production bores.
- Development of a conceptual hydrogeology of the Cogla Downs drainage system.
- Development of a numerical model to evaluate the potential of the calcrete aquifer, based on drawdown constraints, to supply the projected water supply demand and optimise borefield design.
- Provision of a preliminary borefield layout.



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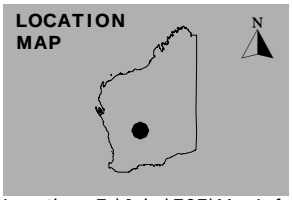
LOCATION MAP



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LEGEND

- Towns
- Barrambie Mine Site
- Barrambie Tenement
- Area of Water Supply Investigation

FIGURE 1.1

PROJECT LOCATION PLAN

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Kilometres

2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Murchison region experiences arid climate conditions with dry, hot summers and mild winters. Mean maximum daily temperatures average between 19 degrees Celsius in July to 38 degrees Celsius in January. The long-term annual average rainfall for Meekatharra during the 64 year period between 1944 and 2009 was 235.5mm, with rain falling on an average of 29 days per year. The long-term annual average rainfall for Sandstone during the 105 year period between 1904 and 2009 was 248.5mm, with rain falling on an average of 31 days per year (Bureau of Meteorology, 2009).

Evaporation rates are high, typically over 200mm/month. Rainfall across the Murchison is highly variable and is largely driven by cyclonic events and localised thunderstorms during the summer months. Total rainfall for the field investigation period from November 2006 to October 2007 was 134.8mm, significantly less than the long term average.

2.2 TOPOGRAPHY AND DRAINAGE

The regional topography and drainage patterns are controlled by the geological structure and geological history of the region. The area is generally of low relief and characterised by playa lakes occupying broad alluvial valleys. Most of the region drains to the west into the Murchison, Greenough and Irwin River catchments, and subsequently into the Indian Ocean. Most drainage, with the exception of the Murchison River, is ephemeral. The interior of the Murchison region is characterised by internal drainage into salt lakes such as Lake Moore and Lake Austin (Johnson and Commander, 2006).

The landscape around the Project area is generally low lying and gently undulating with occasional isolated higher relief features, ranging in elevation between 480mAHD and 500mAHD.

2.3 GEOLOGY AND HYDROGEOLOGY

2.3.1 REGIONAL GEOLOGY

Geological coverage of the Barrambie and Cogla Downs area is provided by the Geological Survey of Western Australia 1:250,000 Map Sheet for Sandstone SG50-16 and 1:100,000 Map Sheet for Nowthanna (GSWA).

The Project area is characterised by geological terrain of Archaean Age. The underlying and surrounding bedrock comprises metamorphosed sedimentary and igneous rocks intruded by granite. Tertiary weathering has formed a lateritic profile over the Archaean bedrock. The lateritic profile overlying granitic rocks typically consists of leached or kaolinitic rocks overlain by a thin ferruginous cap. Whilst overlying metabasic and metasedimentary rocks, the profile is represented by pisolitic laterite over a reddish-brown mottled zone. The Proterozoic basement outcrops extensively, but is overlain in places by relatively thin Tertiary and Quaternary deposits which are associated with both current and palaeo-drainages. Areas of calcrete are exposed in depressions between drainage divides and drainage channels.

2.3.2 GEOLOGY & HYDROGEOLOGY OF THE PROJECT AREA

The Cogla Downs drainage system forms part of an extensive palaeodrainage system which drains northwest toward Lake Annean; this drainage system and the aquifers associated with it extend, from the Barrambie / Cogla Downs area, some 40km to the northwest and approximately 30km to the southwest. A smaller sub-drainage channel exists running in an east-west direction and joining the main Cogla Downs system near Limestone Well. This channel may be of interest in the future (as it is a potential source of additional groundwater supplies, if required), but was not investigated during the 2007 drilling programme.

The surface geology of the Project area is presented in Figure 2.1.

Two main aquifer systems have been identified in the Project area:

- A shallow calcrete aquifer and

- A deeper palaeochannel system.

Calcrete

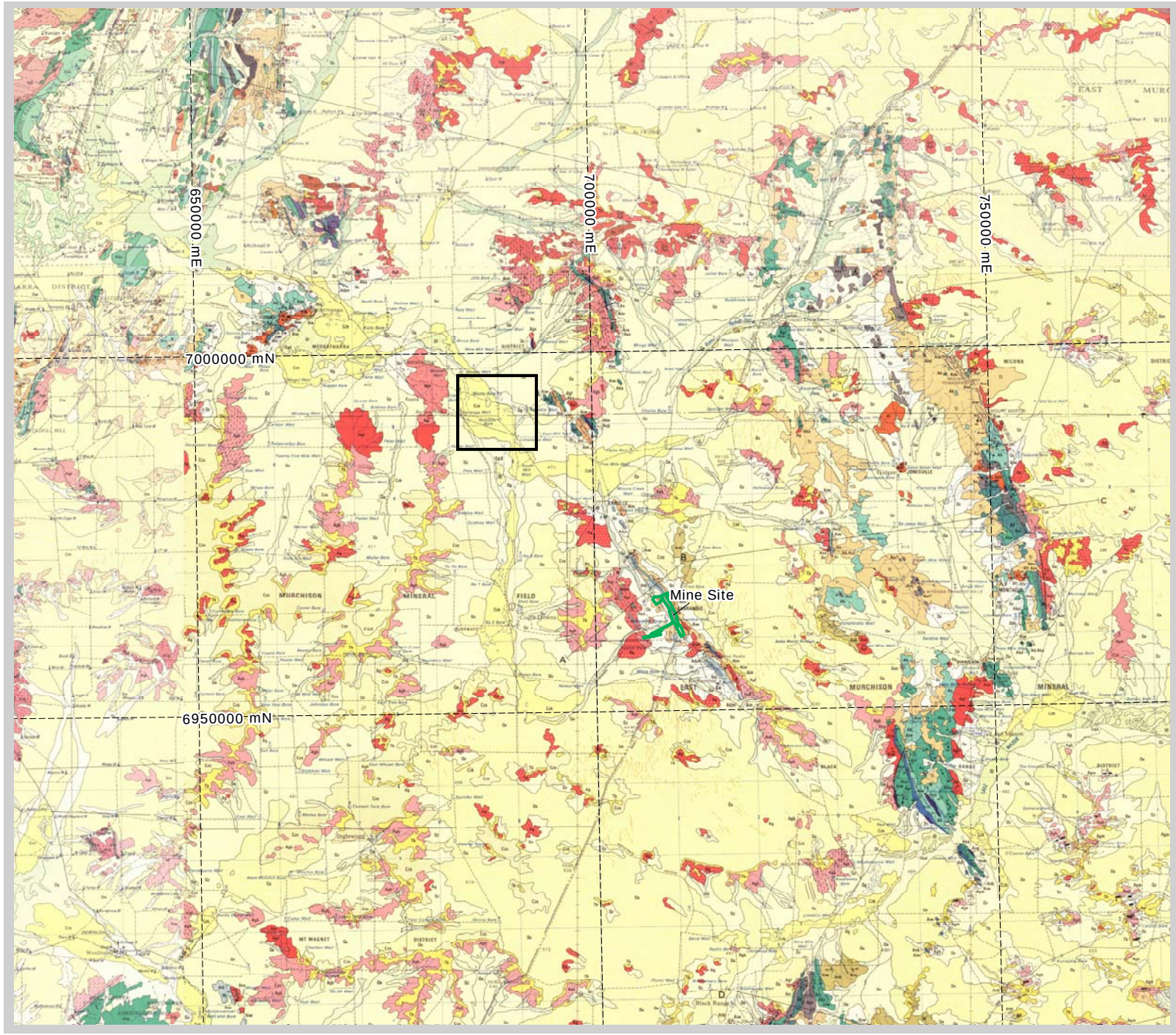
The calcrete extends from surface to depths of up to 20m (although is typically 5 to 15m thick) and is in places separated from the palaeochannel below by a relatively impermeable, kaolinitic clay layer. Previous drilling has confirmed the calcrete as containing karstic solution features. Porosity is high with fractures and fissures, developed and exploited by groundwater flow, enhancing secondary permeability. Thin rubbly soils mean that these aquifers can receive significant direct recharge during rainfall events. Depths to groundwater are typically shallow, generally less than 5 metres below ground level (mbgl).

The calcrete aquifer was identified as the main focus of this investigation and as the primary target for development of a mine water supply borefield.

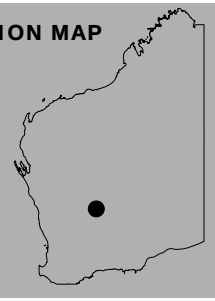
Palaeochannel Deposits

Palaeochannel deposits typically comprise coarse to fine grained carbonaceous, alluvial sand (palaeosands) commonly overlain by significant thicknesses of clay. The palaeosands are usually relatively thin (typically less than 10m), while the overlying clay layer may reach considerable thicknesses (in excess of ten's of metres). Palaeochannel sand aquifers can yield significant volumes of groundwater, primarily sourced from leakage (recharge) from overlying sediments, however, water quality can often be poor (high salinity), except in the upper tributary channels.

The basement material surrounding the palaeochannels may contain groundwater resources within the weathered profile and within faults and fracture systems. Yields and groundwater quality in these weathered/fractured aquifers are typically highly variable, being dependant on structural controls and the extent of weathering. The long term sustainability of fractured rock aquifers is constrained by their limited storage and potential for recharge (recharge is typically either through direct run-off into fractures and weathered zones, or leakage from overlying sediments). The depth of the weathered profile was noted during drilling investigations to aid with development of the conceptual hydrogeological model, however, the aquifer potential of the basement was not the primary focus of investigations.



LOCATION MAP



LEGEND

Area of Water Supply Investigation

Barrambie Mine Site

DATA SOURCE

1:250,000 SG 50-16 Geological Map
First Edition 1984 (GSWA)

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FIGURE 2.1
GEOLOGY OF THE PROJECT AREA

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Location: F:\Jobs\767\MapInfo\233 Figs\Fig2.1.WOR

3 DATA REVIEW

3.1 INTRODUCTION

Prior to the field investigation, a desktop study was conducted to review available data for the proposed Project area (Cogla Downs Drainage Area), including a review of previous field investigation completed.

This included a review of the Department of Water's (DoW) Water Information (WIN) Database and the Geotechnics 1972 report on drilling investigations in the Project area.

The location of bores within a 20km radius of the Project area is presented in Figure 3.1.

3.2 DOW WIN DATABASE

A data search was conducted through the DoW WIN database for hydrogeological information, such as drilled depths, lithological logs, water levels and water quality data, in the Project area. This search returned a number of drill holes in the area around the Cogla Downs drainage system. Table 3.1 provides a summary of the bores and wells installed within 20km of the area. The location of these bores is presented Figure 3.1.

3.3 GEOTECHNICS (1972)

Previous investigations were completed between August and November 1972 (Geotechnics, 1972) as part of the Pre-Feasibility Study (PFS) into the development of a water supply for a proposed mine at Barrambie. The results of the investigations were reported to the Public Works Department of Western Australia in a report entitled "Barrambie Groundwater Investigation (Stage I Geological and Hydrogeological reconnaissance and Stage II Temporary water supply development)" (Geotechnics, 1972).

Stage I of the investigations comprised a geological and hydrogeological reconnaissance of around 16,000km^2 (1.6x10^6 hectares) across the Cue and Sandstone 1:250,000 geological map sheets and led to the identification of six calcrete and alluvial drainage areas, which had the potential to provide the Project water supply requirements (identified at that time as 2,300kL/d).

The Cogla Downs drainage area (extending from approximately 20km southwest to 40km northwest of Barrambie) was identified as worthy of further investigation and was the focus of the subsequent Stage II detailed mapping and exploratory drilling programme. Available bore data, aerial photography and hydrogeological mapping information were compiled and a 1:250,000 scale geological map of a proposed investigation area between Woton Well (689986mE, 6955485mN) in the south and Limestone Well in the north (690379mE, 6988222mN) was produced (Geotechnics, 1972).

The subsequent drilling investigation identified the presence of two potential aquifer systems, a shallow calcrete aquifer and a deeper palaeochannel aquifer, both part of the Cogla Downs drainage system. The programme included the drilling of 16 groundwater exploration bores across an area of approximately 250km^2 between Woton Well and Limestone Well. At the time of the investigations, access to the 'favourable' area of calcrete to the north of Limestone Well was precluded due to the area already being under investigation by the Western Mining Corporation (Geotechnics, 1972). Table 3.2 provides a summary of the bores drilled during the Geotechnics 1972 investigations.

Drilling confirmed the presence of calcrete along the Cogla Downs drainage channel. To the south of Woton Bore the calcrete was found to be siliceous and lack solution / karstic features, however to the north of Woton Bore, karstic features, including sink holes and cavernous mounds were common. Underlying the calcrete aquifer, and separated from it in places by a clay layer, a sandstone formation containing saline water was recorded. Where present, the clay varied in thickness between 1m and 11m.

It was noted that in the area around Limestone Well the calcrete was noticeably cavernous. Bore CD16 (Limestone Bore) was drilled approximately 400m west of Limestone Well and intercepted 13m of saturated cavernous calcrete.

This bore did not fully penetrate the calcrete, due to drilling difficulties. CD16 (Limestone Bore) was test pumped at 1,850kL/d (21L/s), the maximum capacity of the pump, with minimal drawdown (34mm). Subsequent re-testing of CD16 yielded 2,300kL/d (26L/s) for periods of up to two days, although the long-term sustainability of this abstraction was not proven. The nature of the calcrete around CD16 (Limestone Bore) was observed to be similar to the calcrete at Paroo (Sanders, 1972), where the transmissivity was reportedly around 5,000m^2/d and the specific yield around 0.26 (Geotechnics, 1972).

Bore CD10 was test pumped at 800kL/d (9L/s) within minimal drawdown (less than 1.5m), although testing was limited by pump capacity. The calculated transmissivity in this area (1,700m^2/d) was considerably lower than the inferred transmissivity at CD16 (Limestone Bore), where the calcrete is more cavernous.

Estimates of groundwater storage for the calcrete aquifer south of CD16 (Limestone Bore) inferred potential storage volumes of the order of $3x10^7$kL (30GL) to be present, with estimated through-flows of approximately 7,300kL/d near Limestone Well (Geotechnics, 1972). This through-flow estimation is more than the current mine water supply requirement of 6,850kL/d.

Water samples recorded Total Dissolved Solid (TDS) concentrations of the order 2,000-9,000mg/L for the shallow calcrete aquifer, and 5,000-25,000mg/L for the deeper sandstone aquifer.

The work completed as part of the PFS suggested that the identified calcrete should be capable of meeting the project water demand of 2,300kL/d.

Table 3.1: Summary of DoW WIN Bores Within 20km Radius

Bore ID	Easting (mE) (MGA94 Z50)	Northing (mN) (MGA94 Z50)	Approximate Elevation (mRL)	Depth (mbgl)	Lithology	Static Water Level (mbgl)	Static Water Level (mRL)	Date of Static Water Level
NO.362 BORE	686471.00	7003780.00	482	-	Alluvium	-	-	-
NEW MILI WELL	688217.00	7000686.00	485	-	Alluvium	12.5	472.5	1/06/1979
DUMMY WELL	688187.00	7003808.00	489	24.4	Alluvium	13	476	1/01/1979
YELLOW BORE	687726.00	7009000.00	493	-	Alluvium	-	-	-
BRADLEY	693772.00	7001669.00	495	20.1	Alluvium	13.3	481.7	-
CREAMIES BORE	692901.00	7006662.00	508	-	Alluvium	-	-	-
CEMENT WELL	697289.00	7006192.00	511	24.7	River Alluvium	12.6	498.4	-
REID WELL	682764.00	7006497.00	480	9.1	Granite	6.7	473.3	1/06/1979
NO. 361 BORE	682872.00	7001422.00	471	-	-	-	-	-
MONTY BORE	688182.00	6994185.00	473	-	-	-	-	-
LIMESTONE WELL	690521.00	6988754.00		3.7	Calcrete	3.1	-	-
NANADIE WELL	691890.00	6992217.00	475	7.9	Calcrete	4.9	470.1	-
NOEL BORE	694519.00	6997836.00	490	-	Alluvium	-	-	-
EAST MILL WELL	697779.00	6988853.00	482	-	-	2.9	479.1	-
SOUTH MILL WELL	690809.1	6984179.2	470.6*	4.5	-	3.4	467.2	January 2008
BILLEROO WELL	676185.00	6992726.00	479	21.3	Alluvium, possibly Calcrete	4.0	475	1/06/1979
HOMESTEAD BORE	676259.00	6997981.00	471	13.7	Hardpan silt	10.06	460.9	-
HOMESTEAD WELL	676253.00	6997987.00	471	14.6	Hardpan silt/ferricrete	10.67	460.3	-

Bore ID	Easting (mE) (MGA94 Z50)	Northing (mN) (MGA94 Z50)	Approximate Elevation (mRL)	Depth (mbgl)	Lithology	Static Water Level (mbgl)	Static Water Level (mRL)	Date of Static Water Level
WATSON WELL	682145.00	6998262.00	473	10.06	Ferricrete	6.53	466.5	4/10/2007
NULLOR WELL	681907.00	6987481.00	489	21.6	Alluvium, possibly Calcrete	17.3	471.7	-
YILBY BORE	683632.9	6994442	468.5*	4.3	Calcrete	2.7	465.8	January 2008
BARLANGA WELL	683679.4	6991556.94	468.7*	4.6	Alluvium	2.8	465.9	January 2008
BEDAN WELL	685209.00	6998313.00	473	5.5	Alluvium	3.34	469.6	4/10/2007
SCOTTIES WELL	688142.00	6976311.00	477	5.9	-	4.2	472.8	-
PERA WELL	686469.00	6983631.00	477	6.1	Alluvium & Calcrete	5.08	471.9	5/10/2007
BREALYA WELL	682705.00	6977952.00	501	23	Alluvium	21.3	479.7	-
DOWDEN WELL	674390.00	6982434.00	494	5.2	Hardpan silt	2.8	491.2	-
NO.1 BORE	687575.00	6967846.00	477	13.7	Calcrete	7.62	469.4	30/06/1951
YO-YO BORE	682359.00	6969691.00	498	5.5	-	3.05	494.95	-
QUARTZ BORE	671639.00	6993130.00	476	-	-	-	-	-
ERROLL WELL	699198.00	6978760.00	496	18.9	-	16.6	479.4	1/08/1979
ERROLL BORE	700927.00	6978297.00	494	-	Alluvium & Basement	18.29	475.7	1/01/1972
JACK WELL	700330.00	6982622.00	487	3.4	Sand & Calcrete	3.05	483.95	1/01/1972
WINNIE CREEK WELL	701878.00	6980473.00	492	11.3	Ferruginous calcrete & ferruginous silcrete	6.0	486	1/07/1979
NODES BORE	704781.00	6978412.00	501	-	-	-	-	-
DELTA BORE	706643.00	6991880.00	494	9.8	Calcrete over kaolinite	3.658	490	30/06/1963

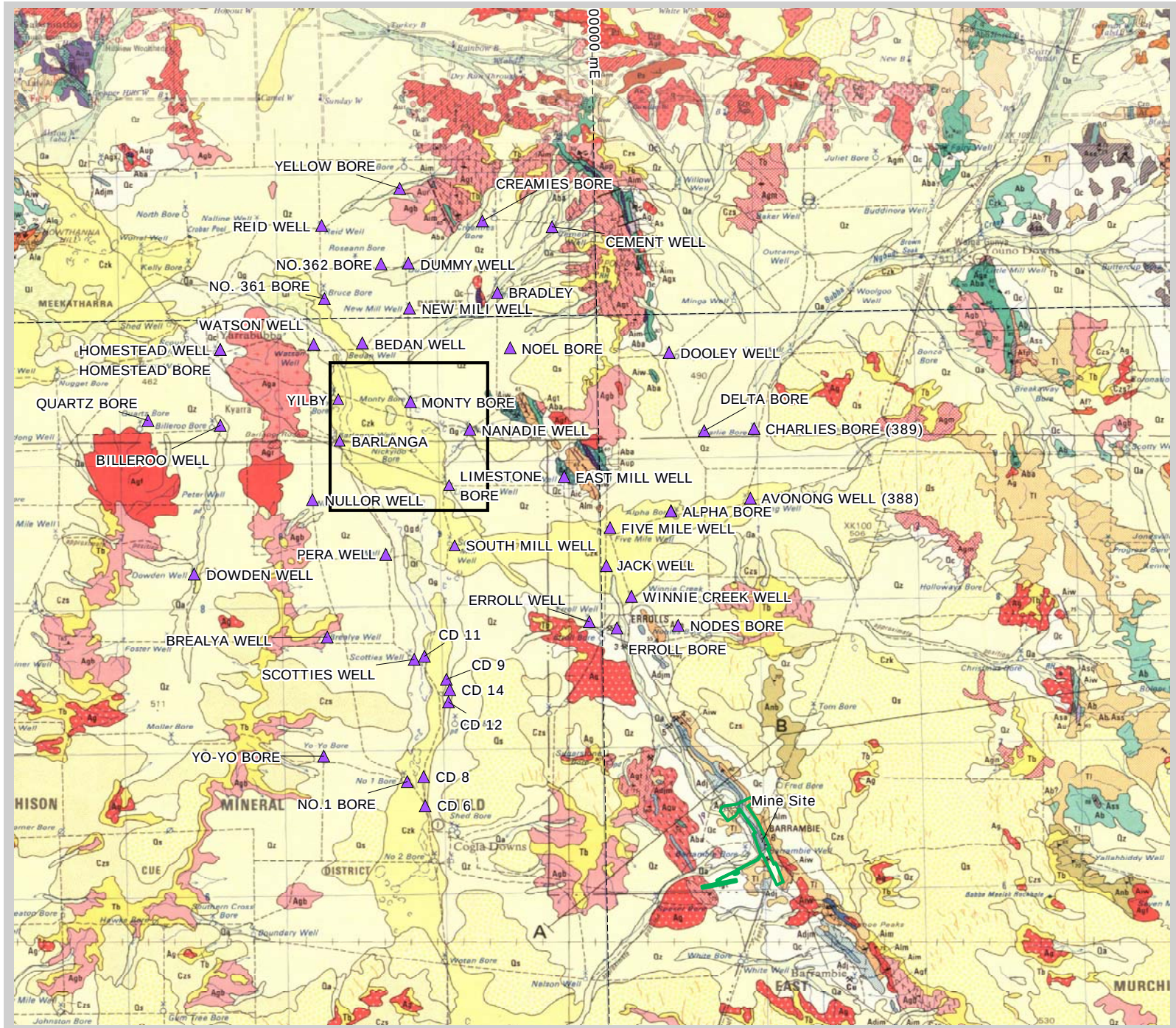
Bore ID	Easting (mE) (MGA94 Z50)	Northing (mN) (MGA94 Z50)	Approximate Elevation (mRL)	Depth (mbgl)	Lithology	Static Water Level (mbgl)	Static Water Level (mRL)	Date of Static Water Level
CHARLIES BORE (389)	709786.00	6991993.00	496	9.8	Kaolinite	5.5	490.5	1/01/1968
ALPHA BORE	704466.00	6986372.00	487	4.6	Ferricrete & Calcrete	2.4	484.6	1/01/1968
AVONONG WELL	709474.00	6987157.00	490	3.1	Alluvium & Calcrete	2.2	487.8	1/07/1979
FIVE MILE WELL	700612.00	6985253.00	484	3.1	Calcrete	2.8	480.95	1/07/1979
DOOLEY WELL	704517.00	6997348.00	504	16.2	Alluvium & Ferricrete	11.3	492.7	1/07/1979

Note:
* Bore surveyed in April 2008

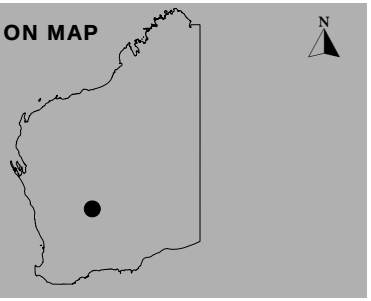
Table 3.2: Summary of Geotechnics Bores (1972)

Bore ID	Easting (mE)	Northing (mN)	Approximate Elevation (mRL)	Depth (mbgl)	Lithology	Calcrete Aquifer Depth (m)	Static Water Level (mbgl)	Date of Static Water Level
CD6	688676.00	6966141.00	478	20	Calcrete & sandstone	0-6	4.7	30/06/1972
CD8	688613.00	6968176.00	475	15	Calcrete	0-6	3.8	30/06/1972
CD9	690147.00	6974902.00	474	18	Calcrete & clay	0-12	4.6	30/06/1972
CD10	690727.00	6983653.00	468	28	Calcrete & granite	0-5.5	3.8	30/06/1972
CD11	688790.00	6976524.00	476	39	Calcrete & granite	0.5-7	3.7	30/06/1972
CD12	690260.00	6973323.00	476	46	Calcrete	0-25	3.5	30/06/1972
CD13	689272.00	6973429.00	477	18	Calcrete	0-18	4.2	30/06/1972
CD14	690352.00	6974185.00	474	30	Calcrete & sandstone	0-12	3.99	30/06/1972
CD15	688947.00	6974416.00	476	30	Calcrete & clay	0-11	3.85	30/06/1972
CD16 (Limestone Bore)	690524.8	6988376	469.73[1]	18	Calcrete	0-18[2]	4.6	Oct 2007

Note:
[1] Bore surveyed in April 2008
[2] Did not fully penetrate calcrete



LOCATION MAP



LEGEND

- Area of Water Supply Investigation
- Barrambie Mine Site
- DoW Bores within 20km Radius

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

DoW WIN Database 2009

7 0 7 14
Kilometres

aquaterra

FIGURE 3.1
LOCATION OF EXISTING BORES

AUTHOR:	KMH	REPORT NO:	233
DRAWN:	KMH	REVISION:	a
DATE:	5/10/2009	SCALE:	1:350,000
JOB NO:	767\B12	PROJECTION:	MGA94 Z50

Location: F:\Jobs\767\MapInfo\233 Figs\Fig3.1.WOR

4 FIELD INVESTIGATIONS

4.1 OBJECTIVES

A field investigation programme was designed to further assess the groundwater resources of the Project area. Investigations focussed on defining the resource potential of the calcrete aquifer, however, at some locations depth of drilling was extended with the aim of investigating the underlying sediments, including the previously identified deeper sand aquifer.

4.2 SITE VISIT & RECONNAISSANCE

Prior to commencing the drilling programme, Aquaterra conducted a walk-over survey and groundtruthing site visit to assess potential drilling locations and investigate the extent of the calcrete outcrop in the Project area.

Observations made during the groundtruthing survey confirmed that the western and southern edges of the calcrete outcrop were consistent with that presented on the published 1:250,000 geological map. The eastern extent of the calcrete outcrop was less well defined with more surficial material present. This visual groundtruthing survey was obviously restricted to assessing areas of outcropping calcrete only, it was not possible to determine the presence of calcrete where it was overlain by surficial sediments.

4.3 LICENSING AND TENURE

The area of field investigation lies within the Yarrabubba Station pastoral lease area. The drilling and testing work undertaken was carried out with the consent of the pastoral lease holder, and in accordance with licences to construct or alter well (CAW) 163685(1) and CAW 163698(1), copies of which are attached in Appendix A.

All bores were drilled in an area approximately 11km by 5km (55km^2) adjacent to the Meekatharra – Sandstone Road.

4.4 DRILLING AND BORE CONSTRUCTION PROGRAMME

The drilling programme was originally planned to include 2-3 roughly east-west transects across the main Cogla Downs drainage channel and 2 north-south transects across the eastern extension of the drainage channel towards Errolls bore. The actual drilling locations were somewhat constrained by access and vegetation clearing. It was initially proposed that drilling be completed in both the main channel (north of Limestone bore) and in the eastern tributary (near Errolls bore). However, favourable drilling results from the main channel meant that the proposed subsequent drilling in the eastern tributary was postponed. The location of the exploration holes drilled is illustrated in Figure 4.1.

A programme of exploratory drilling, test production/monitoring bore installation and test pumping was completed between 20th August and 8th October 2007. All drilling work was undertaken by Connector Drilling Ltd Pty (Connector Drilling) and the subsequent test pumping work was completed by McArthur Drilling and Pumping Pty Ltd (MDP).

Connector Drilling undertook the exploration drilling and test production/monitoring bore installation under direct contract to Reed Resources with supervision by an experienced Aquaterra hydrogeologist. Connector Drilling mobilised to site on 20th August 2007, all drilling and bore construction was completed by 13th September 2007.

A total of fifteen exploration bores were drilled, of which three were completed as test production bores and seven as monitoring bores. The majority of bores were drilled using air drilling (Down Hole Hammer) techniques, however, mud-rotary techniques were used in order to case out the calcrete when targeting the underlying deeper formations.

Exploration bores were drilled at 6" diameter with a notional maximum target depth of 20mbgl (based on the results of previous drilling).

A summary of the bores drilled (including the previously drilled CD10 and CD16 (Limestone Bore)) are presented in Table 4.1.

Table 4.1: Summary of Drilling

Bore ID	Easting (MGA94 Z50)	Northing (MGA94 Z50)	Elevation (mRL)	Date Drilled	Drill Method	Drilled Dia. (mm)	Cased Dia. & Material	Drilled Depth (mbgl)	Cased Depth (mbgl)	Slotted Interval (mbgl)	Maximum Airlift Yield (L/s)	SWL (mbgl)	Date of SWL	Field EC (µS/cm)
Production Bores														
B8P	687364.4	6989432.9	471.8	30/08/07	DTHH	304.8	195mm PVC	21	19	7-19	13.0	4.8	01/09/07	4,900
B10P	685608.4	6993832.5	471.4	31/08/07	DTHH	304.8	195mm PVC	18	15	3-15	7.0	4.92	01/09/07	15,000
B15P	686823.5	6990933.8	469.4	11/09/07	DTHH	203.2	155mm PVC	15	15	3-9	2.2	2.85	12/09/07	4,500
Limestone Bore (CD16)	690524.8	6988376.2	469.7	Aug 1972	-	187	155mm PVC	18	18	-	-	4.64	Aug 1972	3,400**
Monitoring Bores														
B1M	690047.6	6988468.2	470.6	25/08/07	DTHH	165	50mm PVC	136	90	72.1-90.1	7.0	5.90	04/09/07	>20,000
B3M	690106.7	6988485.1	471.0	28/08/07	DTHH	165	50mm PVC	20	17	4.9-17.1	7.0	4.46	03/10/07	11,800
B5M	685621.6	6993845.5	471.2	29/08/07	DTHH	165	50mm PVC	16	15.6	3.6-15.6	5.6	5.02	03/10/07	14,000
B6M	686266.4	6991062.4	471.0	29/08/07	DTHH	165	50mm PVC	20	18.7	6.7-18.7	3.4	4.60	03/10/07	4,200
B7M	687358.8	6989457.5	471.6	29/08/07	DTHH	165	50mm PVC	21	20.7	8.7-20.7	7.0	4.88	03/10/07	3,900
B9M	685092.4	6994578.3	470.3	31/08/07	DTHH	165	50mm PVC	12	9.9	3.9-9.9	1.4	3.97	01/09/07	18,300
B14M	686832.3	6990935.3	469.2	11/09/07	DTHH	165	50mm PVC	46	15	3-9	7.0	2.71	03/10/07	4, 950

Bore ID	Easting (MGA94 Z50)	Northing (MGA94 Z50)	Elevation (mRL)	Date Drilled	Drill Method	Drilled Dia. (mm)	Cased Dia. & Material	Drilled Depth (mbgl)	Cased Depth (mbgl)	Slotted Interval (mbgl)	Maximum Airlift Yield (L/s)	SWL (mbgl)	Date of SWL	Field EC (µS/cm)
CD10	690625	6983852	475	Aug 1972	-	130	76mm PVC	28	-	-	-	3.81	Aug 1972	-
Exploration Bores														
B2A	689929	6988322	470.9	08/09/07	MR	216	-	63	18.2	Open hole	>30	4.05	03/10/07	17,800
B4X	686288	6993306	473	28/08/07	DTHH	165	-	16	-	-	Dry	-	-	-
B11X	689920	6988322	-	09/09/07	DTHH	165	-	31	-	-	-	3.83	03/10/07	-
B12X	690061	6983422	465	10/09/07	DTHH	165	-	73	-	-	<1	-	-	>20,000
B13X	687288	6993306	472	10/09/07	DTHH	165	-	30	3	-	<1	-	-	>20,000

Note:
DTHH – Down The Hole Hammer
MR – Mud Rotary
- Indicates were information not known / unavailable
** Based on conversion of 1972 TDS data

Drilling was initially undertaken in the area immediately adjacent to CD16 (Limestone Bore), where previous investigations inferred that a sandstone aquifer was present at depth beneath the calcrete. The first exploration bore was drilled to a total depth of 136m. The base of the calcrete was recorded at 17mbgl, below which a total of 75m of weathered basement material (with high sand content) was recorded before fresh granitic basement was encountered at 92mbgl.

Attempts were made to case-out and isolate the calcrete aquifer in order to investigate the underlying weathered basement, however, continual problems with lost circulation and cavities within the calcrete meant this hole could not be completed as a test production bore and alternatively a piezometer was installed, with a slotted section from 72-90mbgl to facilitate future monitoring.

Across the Project area the three most prospective exploration bores were reamed out to a diameter of 203mm or 305mm and completed as test production bores into the calcrete aquifer. Test production bores were constructed using either 155mm or 195mm ND Class 12 PVC casing, with slotted casing (nominal 1mm aperture) placed against prospective aquifer horizons. At each test production bore location a similarly constructed monitoring bore was also installed. In addition, four of the exploration holes were also completed as monitoring bores.

Monitoring bores were completed with 50mm ND Class 12 PVC slotted and plain casing. Both test production and monitoring bores were gravel packed with 1.6mm to 3.2mm graded gravel to just below ground level before being sealed with a cement/grout plug. On completion each test production and monitoring bore was developed by airlifting.

4.5 SUMMARY OF DRILLING RESULTS

Calcrete was recorded in all bores (with the exception of B13X) and varied in thickness between 3m and 18m. The greatest calcrete thickness, and subsequently the greatest saturated aquifer thickness, was in the southern part of the investigation area, in proximity to CD16 (Limestone Bore). In general, the thickness of calcrete decreased to the north, where thicknesses reduced to between 3m and 9m. In some bores a layer of calcareous / carbonate sand of between 3m and 8m thickness, was recorded immediately below the calcrete. Weathered basement material was first recorded at depths of between 10m and 19mbgl and, based on the drilling of B1M and B12X (drilled to 136m and 73mbgl, respectively) extensive thicknesses of weathered material (in excess of 40m) overlies fresh bedrock in some areas.

Airlift yields from exploration holes typically ranged between <1L/s and 13L/s, with the highest yields corresponding to the most productive calcrete horizons. Where bores extended into formations below the calcrete / calcareous sand horizons, no significant increase in bore yields was observed. Groundwater quality of the calcrete was generally fresh to brackish with Electrical Conductivity (EC) typically <5,000µS/cm, however, EC increased rapidly with depth and water quality became increasing saline (EC >20,000µS/cm). Further discussion of water quality data are provided in Section 4.8.

Bore locations are shown in Figure 4.1 and bore completion logs are presented in Appendix B.

4.6 AQUIFER TESTS

Following completion of drilling and bore construction, a test pumping programme was designed to assess the efficiency of the bores (through multi-rate tests) and the sustainable yield of the bores (through constant rate tests).

MDP mobilised to site and commenced work on the 3rd October 2007. The final aquifer test was completed on 8th October 2007. Multi rate (step) tests and Constant Rate Tests (CRT) were completed on the three newly drilled test production bores. Testing of CD16 (Limestone Bore) was also undertaken to confirm earlier test results presented by Geotechnics (1972).

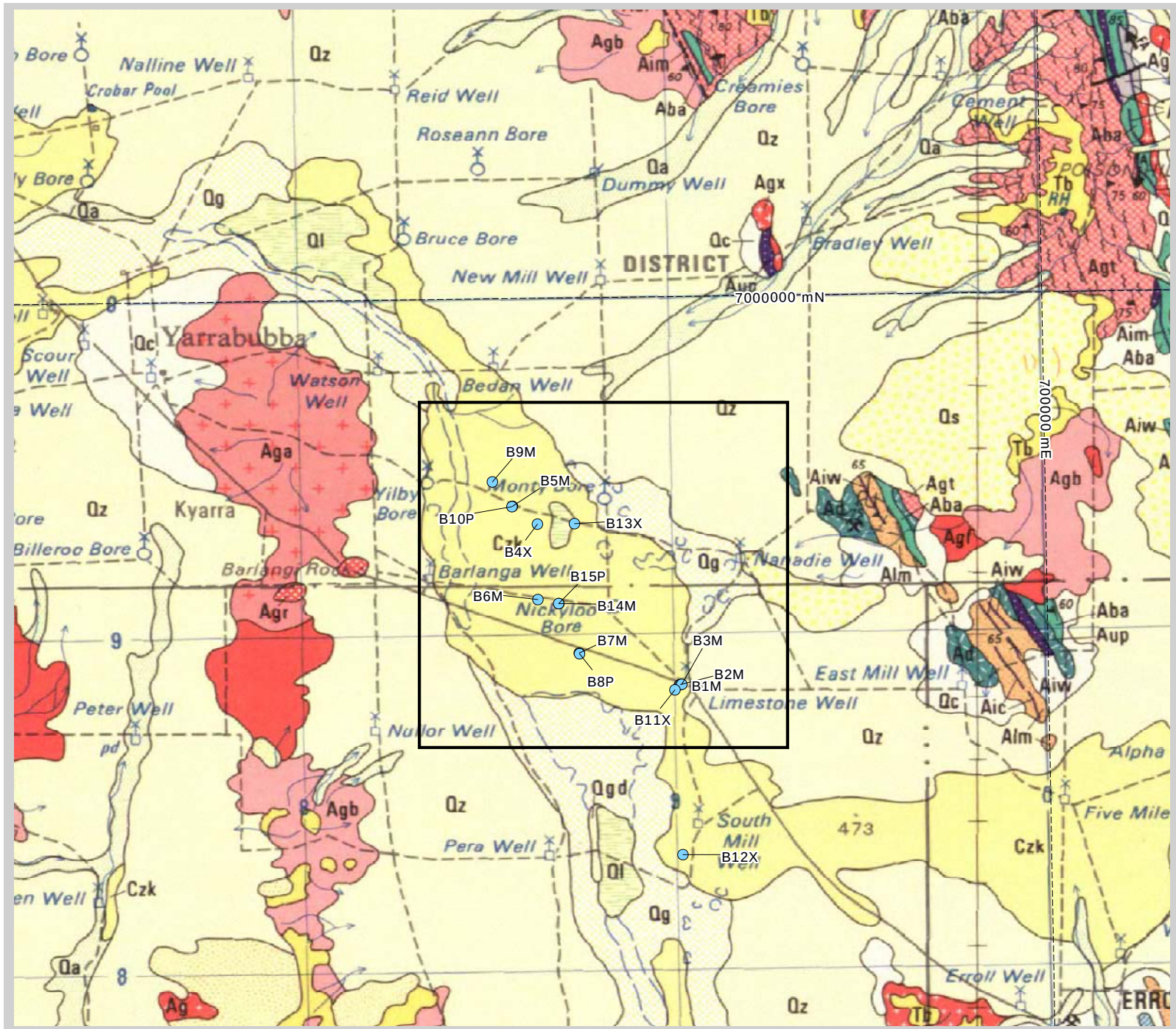
Aquifer tests at each bore comprised stepped multi-rate test (comprising four 60 minute steps) followed by a period of recovery and then a constant rate test. Constant rate testing was undertaken for a period of between 4 and 36 hours. On completion of each CRT, water level recovery was monitored until water levels in the pumped bore had returned to ≥ 90% of the initial static water level.

Water levels were measured manually using electronic water level meters. Test pumping was conducted using a Grundfos electro-submersible pump with the water produced being discharged 200m down-gradient of the pumped bore.

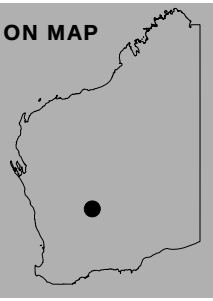
A schedule of test pumping is provided in Table 4.2.

Table 4.2: Schedule of Test Pumping

Bore ID	Cased Depth (m)	Casing Diameter (mm)	Estimated Yield (L/s) based on airlift	Step Test Discharge Rates (L/s) for 60mins	Constant Rate Test Discharge Rate (L/s)	Constant Rate Test Duration (hours)	EC (µS/cm)
B8P	20	195	20	12, 16, 20, 21.2	20.5	24	3,000
B10P	18	195	15	12, 16, 20, 21.2	20.5	12	10,000
B15P	15	155	15	5, 8, 11, 12	12	36	5,000
Limestone Bore	16	155	20-25	7, 9, 11, 12.3	12	4	4,000



LOCATION MAP



LEGEND

Area of Water Supply Investigation

Bore Locations

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

3 0 3 6

Kilometres

aquaterra

FIGURE 4.1

2007 DRILLING PROGRAMME BORE LOCATIONS

AUTHOR:	KMH	REPORT NO:	233
DRAWN:	KMH	REVISION:	a
DATE:	5/10/2009	SCALE:	1:150,000
JOB NO:	767\B12	PROJECTION:	MGA94 Z50

Location: F:\Jobs\767\MapInfo\233 Figs\Fig4.1.WOR

4.6.1 STEP TESTS

The stepped multi-rate testing (step test) data was analysed using Rorabaugh's equation (Kruseman and de Ridder, 1994) to determine the coefficients of aquifer loss (B) and well loss (C) and to determine the proportion of drawdown due to laminar flow in the bore (apparent efficiency) at each pumping rate. Todd's equation (1959) was also used as a secondary indication of well losses. Details of the step test analyses are included in Appendix C and are summarised below in Table 4.3.

Table 4.3: Summary of Step Test Analysis

Bore	Step Number	Discharge Rate (L/s)	Observed Drawdown (m)	Corrected Drawdown (m)	Apparent Well Efficiency (%)	Well Loss C (min^2/m^5)	Specific Capacity (m^2/day)
B8P	1	12	0.06	0.06	66		17,300
	2	16	0.09	0.09	59		15,400
	3	20	0.12	0.13	54		14,400
	4	21.2	0.13	0.14	52	0.041	14,100
B10P	1	12	0.19	0.19	44		5,500
	2	16	0.29	0.30	37		4,800
	3	20	0.43	0.44	32		4,000
	4	21.2	0.45	0.46	31	0.207	3,900
B15P	1	5	0.68	0.71	74		650
	2	8	1.27	1.31	63		540
	3	11	1.99	2.04	56		480
	4	12	2.24	2.32	54	2.07	460
CD16 (Limestone Bore)	1	7	0.005	0.005	77		121,000
	2	9	0.007	0.01	72		111,100
	3	11	0.01	0.01	68		95,000
	4	12	0.01	0.01	65	0.006	106,300

The step test data show B8P, B15P and CD16 (Limestone Bore) to have bore efficiencies between 52% and 77%, at the various rates tested. Specific capacity values are generally high to very high (1000's to 10,000's) and reflect the relatively low drawdown observed in each well. Use of Todd's equation (where C values < 0.5 indicate a well designed and developed bore) confirms that each of these bores has robust construction and responded well to airlift development.

The results of analysis of B10P data show bore efficiencies to range between 31% and 44%, at the rates tested, with a corresponding well loss coefficient (C value) of 2.07. The lower efficiency arises due to both the derived B (aquifer loss) and C (well loss) values being much greater than those calculated for B8P, B15P and Limestone Bore, however, bore yields from B10P were high (the bore was pumped at 20.5L/s during constant rate testing) with only 0.43m observed drawdown over 12 hours. The lower efficiencies are thought to be related to a combination of factors, including greater aquifer loss and a greater contribution of apparent well loss predominantly due to fracture flow.

For the optimal operation of any borefield it is imperative that bores are constructed with screens or slotted casing that maximise efficiency and have a maximum proportion of open area in order to minimise potential inefficiencies and well losses. This is especially true given the potential for high bore yields in relation to casing diameter.

4.6.2 CONSTANT RATE AND RECOVERY TESTS

Based on the results of the step testing, discharge rates for the constant rate tests (CRT) were selected. The selected rates were designed to maximise pumping (and thus maximise the stress on the aquifer) while also ensuring that the rate could be sustained for the duration of the test. Data from the CRT can be used to assess the sustainable yield of a bore and to gain information on aquifer characteristics such as transmissivity (T) and specific yield (Sy) values. These parameters are critical for assessing the aquifer potential and are required as inputs into any analytical or numerical groundwater modelling.

The bores are capable of high yields with only limited resulting water level drawdown, thus it was difficult to stress the bores due to rate limitations incurred by pump capacity and casing diameter. Each bore was pumped at the maximum rate achievable for the pump and casing diameter (20.5L/s for B8P and B10P, cased with 195mm diameter PVC and 12L/s for B15P and CD16 (Limestone Bore), cased with 155mm diameter PVC). Reports on previous aquifer tests by Geotechnics in 1972 also note that bore yields were limited by the capacity of the pumps available at that time.

CRT data and plots of water level drawdown with time for the CRT and recovery testing of the production bores have been included in Appendix D. Results of aquifer test analyses are summarised in Table 4.4. Estimates of bulk aquifer permeability have been calculated based on the derived transmissivity and the inferred saturated thickness of the aquifer.

B8P

B8P was pumped at a constant rate of 20.5L/s for 24 hours (1,440 minutes). Initial water level drawdown in the pumping bore was very rapid with over 90% (0.12m) of the recorded drawdown being observed in the first two minutes as storage within the bore was reduced. Water levels declined slightly (by a further 0.01m) after 6 hours, after which time no further drawdown was evident. A constant discharge rate was maintained throughout the test. Water level drawdown in the pumped bore (B8P) was 0.13m after 24 hours of pumping. Negligible drawdown (0.01m) was recorded in the adjacent monitoring bore (B7M) located approximately 25m from B8P.

On cessation of pumping, water levels recovered almost instantaneously to 0.01m (>95%) of the initial static water level.

B10P

B10P was pumped at a constant rate of 20.5L/s for 12 hours (720 minutes). Initial water level drawdown in the pumping bore was very rapid with over 95% (0.41m) of the recorded drawdown being recorded in the first minute as storage within the bore was reduced. Water levels declined slightly (by a further 0.01m) after 60 minutes and a further 0.01m after 420 minutes, after which no further drawdown was evident. A constant discharge rate was maintained throughout the test. Water level drawdown in the pumped bore (B10P) was 0.43m after 12 hours of pumping. Negligible drawdown (0.02m) was recorded in the adjacent monitoring bore (B5M) located approximately 25m from B10P.

On cessation of pumping water levels recovered almost instantaneously to within 0.01m (>95%) of the initial static water levels.

B15P

B15P was pumped at a constant rate of 12L/s for 36 hours (2,160 minutes). Initial water level drawdown in the pumping bore was very rapid with 85% (2.02m) of the recorded drawdown being recorded in the first minute as storage within the bore was reduced. Water levels continued to decline (by a further 0.35m) through the remainder of the test, on average decreasing by around 0.01m every two hours. A constant discharge rate was maintained throughout the test. Water level drawdown in the pumped bore (B15P) was 2.73m after 36 hours of pumping. In adjacent monitoring bore B14M (located approximately 10m from B15P) a total drawdown of 0.49m was recorded.

On cessation of pumping water levels recovered by 90% within the first 90 seconds, and had recovered to within 0.1m (>95%) of the initial static water levels reading after 60 minutes. Water levels in the adjacent monitoring bore (B14M) recovered to just under 90% of initial levels within 60 minutes.

CD16 (Limestone Bore)

CD16 (Limestone Bore) was pumped at a constant rate of 12L/s for 4 hours (240 minutes). Negligible water level drawdown was recorded (0.01m) in the pumped bore.

Table 4.4: Summary of Aquifer Test Analysis

Pumped Bore	Test Type	Data Observed at Bore	Drawdown (m)	T (m^2/d)	K (m/d)	Comments
B8P	CRT	B8P	0.13	8,000	560	Cooper-Jacob
	Recovery		-	-		>90% recovery in 60 sec
B10P	CRT	B10P	-	-	-	Insufficient drawdown to analyse meaningfully
	Recovery		-	-	>1,900	Theis Recovery >90% recovery in 60 sec
B15P	CRT	B15P	2.37	2,800	235	Cooper-Jacob
		B14M	0.49	2,700	220	Cooper-Jacob
	Recovery	-	-	-	-	90% recovery in 90 sec
CD16 (Limestone Bore)	CRT	CD16	0.01	-	-	Insufficient drawdown to analyse meaningfully. Previous testing (Geotechnics 1972) also limited by insufficient drawdown.
	Recovery	-	-	-	-	-

4.7 AQUIFER PARAMETERS

4.7.1 TRANSMISSIVITY

A range of transmissivity values have been derived for the calcrete aquifer, as outlined in Table 4.4. Transmissivity values were derived by standard analysis of aquifer test drawdown and recovery data, however, analysis was restricted by the limited drawdown recorded (a good indication of the high resource potential of the calcrete aquifer). Representative transmissivity values range from 610m^2/d to 8,000m^2/d, with an average transmissivity of 2,900m^2/d.

The limited water level drawdown observed (0.01m) at CD16 (Limestone Bore) meant that no meaningful data analysis could be undertaken on the test data from this bore. However, it is noted within the previous reporting by Geotechnics (1972) that the nature of the calcrete at Limestone Bore is similar to that of Paroo (located 60km to the northwest of Wiluna) where transmissivity values of the order of 5,000m^2/d were previously derived.

The aquifer transmissivity values derived and the corresponding saturated aquifer thickness, led to estimation of bulk hydraulic conductivity values ranging from 55m/day to 570m/d, with an average hydraulic conductivity of 230m/d.

4.7.2 SPECIFIC YIELD

The lack of water level response to pumping in monitoring bores prevented the estimation of aquifer specific yield (Sy) values. Literature values for similar areas of calcrete, such as that at Paroo, indicate representative specific yield to be of the order of 0.26.

4.8 WATER QUALITY

Field measurements of electrical conductivity (EC) were taken (as an indicator of groundwater salinity) from each bore on completion of airlifting. Measurements were also taken wherever possible from pastoral bores in the vicinity. Groundwater quality samples were collected for laboratory analysis from each test production bore on completion of the CRT. Field EC data have been included in Table 4.1 and 4.2.

Field measurements of electrical conductivity (EC) were taken (as an indicator of groundwater salinity) from each bore on completion of airlifting (Table 4.1) and on completion of hydraulic testing on the test production bores (Table 4.2). Measurements were also taken, wherever possible, from pastoral bores in the near vicinity. Groundwater samples were collected for laboratory analysis from each test production bore on completion of hydraulic testing (after the constant rate test). The results of laboratory analysis are presented in Table 4.5 and as an Expanded Durov Diagram (with the inclusion of available data from the Geotechnics investigation) in Figure 4.2.

Laboratory water quality data indicate groundwater within the calcrete aquifer to be fresh to brackish (typically TDS ranged from 2,100mg/L to 2,700mg/L, and EC ranged from 3,600 to 4,500µS/cm). However, there is a trend for increasing salinity moving northwards; analysis of a sample from bore B10P shows groundwater in this area to have a TDS of 8,600mg/L (and EC 14,000µS/cm). Field EC measurements for each bore are presented in Figure 4.3 and suggest that north of Limestone Well, groundwater salinity generally increases in a northerly direction.

The Expanded Durov diagram indicates that the groundwater samples collected across the Project area and those collected by Geotechnics (1972) to the south around Scotties well have similar chemical composition. Groundwater in the Project area is chloride and sodium dominant, indicative of mature groundwater or evapotranspiration processes (Figure 4.2).

Field data shows that groundwater within the basement/bedrock is brackish to saline, with EC values typically greater than 20,000µS/cm.

For reference, results have been compared to Australian and New Zealand Environment and Conservation Council (ANZECC) Livestock Water Guidelines 2000. With the exception of sulphate (SO_4) concentrations recorded at B10P, all parameters are within the livestock guideline values.

4.9 CONCLUSIONS

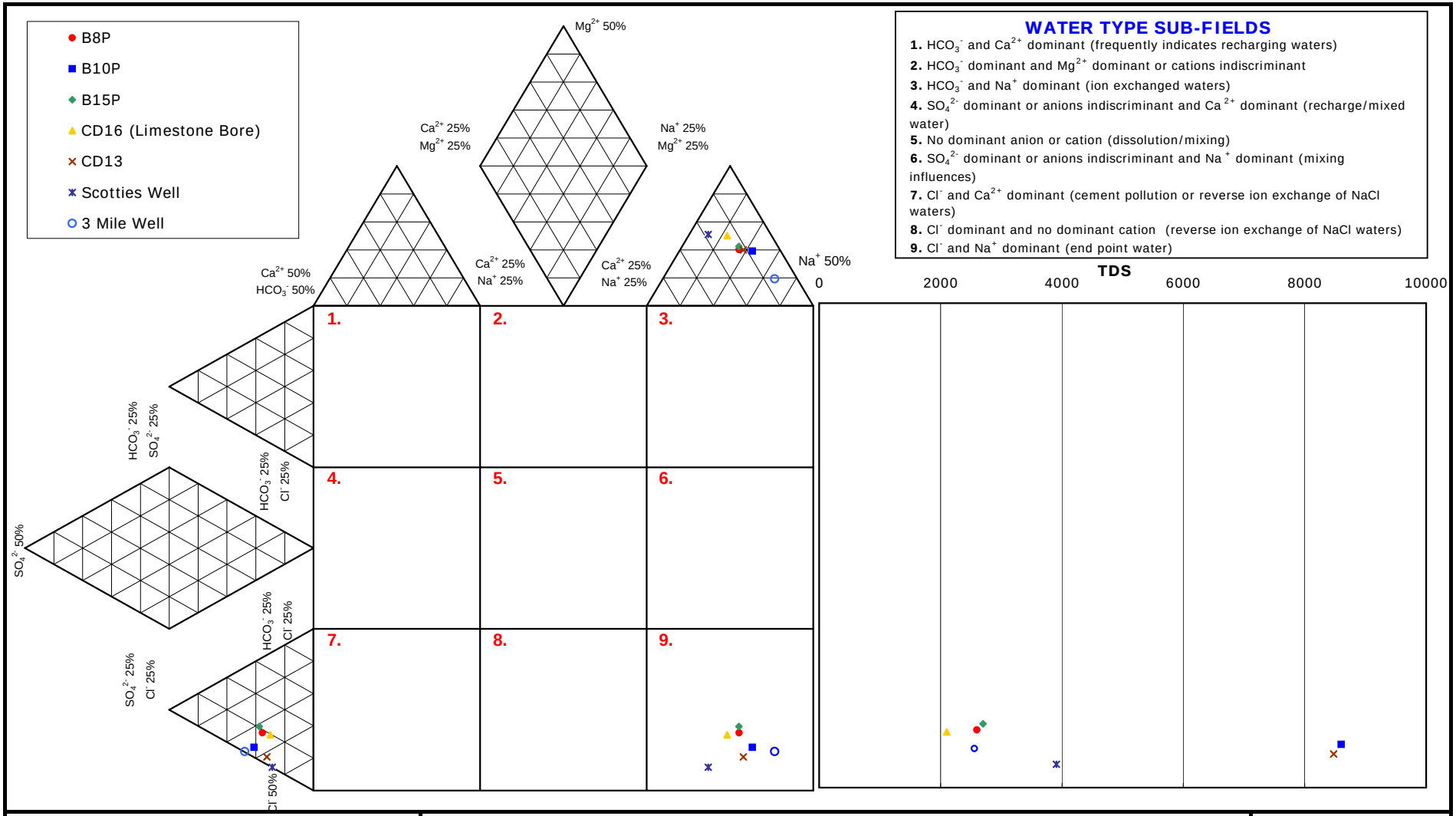
Field investigations conducted by Geotechnics in 1972 and Aquaterra in 2007 in the main Cogla Downs drainage channel between Limestone Bore and Bedan Well confirmed the presence of a calcrete aquifer to depths up to 19m below ground level, with an average saturated thickness of 11m. Test pumping of drilled bores confirmed good yields ranging from 12L/s to 20L/s with minimal water level drawdown.

Due to the favourable results from the main channel drilling and testing programme (Stage I), further drilling in the east tributary towards Errolls bore (Stage II) was postponed. Therefore, the calcrete aquifer intercepted in the area between Limestone Bore and Bedan Well (the area of investigation) was the focus for further assessments to secure a Project water supply and is discussed further in Sections 5 to 8.

Table 4.5: Summary of Water Quality Analysis

Parameter	Units	LOR	B8P	B10P	B15P	CD16 (Limestone Bore)	ANZECC (2000) Livestock Watering Guideline
Date of Sample			05/10/2007	06/10/2007	8/10/2007	8/10/2007	-
pH	pH Units	0.1	8.1	8	8.2	8.2	6 - 8.5
Conductivity @25^{0}C	µS/cm	2	4,300	14,000	4,500	3,600	-
Total Dissolved Solids @ 180°C	mg/L	5	2,600	8,600	2,700	2,100	0 – 10,000
Soluble Iron, Fe	mg/L	0.02	<0.05	<0.05	<0.05	<0.05	-
Sodium, Na	mg/L	0.5	600	2,400	620	480	-
Potassium, K	mg/L	0.1	64	190	66	52	-
Calcium, Ca	mg/L	0.2	100	260	100	96	1,000
Magnesium, Mg	mg/L	0.1	100	360	110	110	-
Chloride, Cl	mg/L	1	1,100	4,100	1,000	1,000	-
Carbonate, CO_3	mg/L	1	<1	<1	<1	<1	-
Bicarbonate, HCO_3	mg/L	5	230	280	250	220	-
Sulphate, SO_4	mg/L	1	360	1,500	360	270	1,000
Nitrate, NO_3	mg/L	0.2	94	120	96	92	400

Note:
Shading values exceed guideline
LOR: Limit of reporting



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Expanded Durov Diagram

Figure 4.2

Date: 16/10/09

F:\Jobs\767\B12\233 Fig\[Fig4.2.xls]EXPANDED DUROV (1)

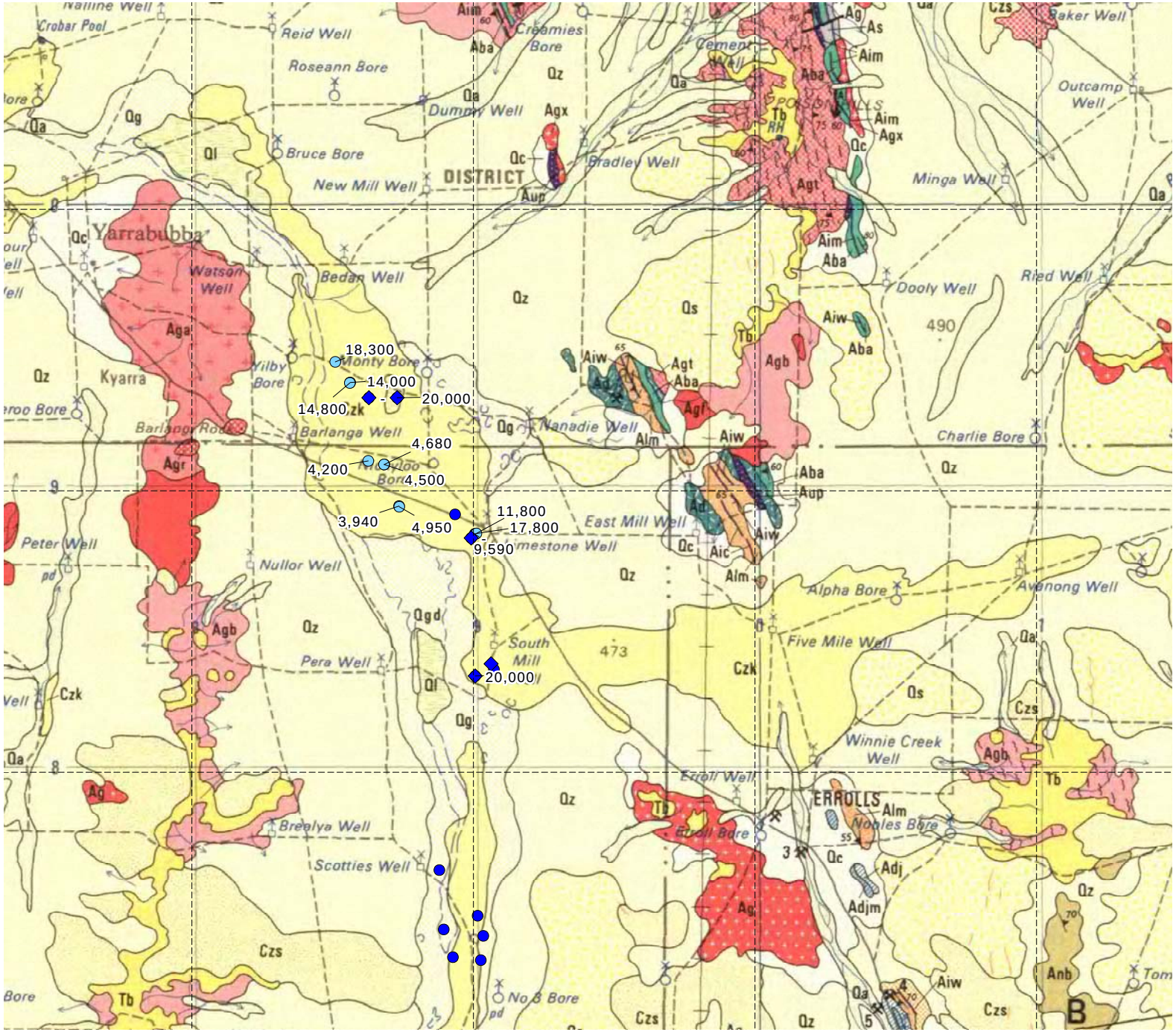
Project: Cogla Downs

Project No: 767

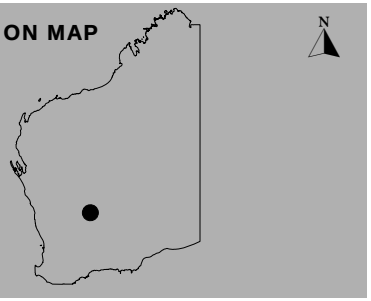
Description: Water Supply

Client: Reed Resources

HydroCHEM 2.0



LOCATION MAP



LEGEND

- 1972 Geotechnics Bores
- Exploration Bores drilled Sept\Oct 2008
- Production\Monitoring Bores surveyed 2009

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

Geotechnics (1972)

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Kilometres

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FIGURE 4.3
BARRAMBIE SALINITY PLAN
EC (uS/cm)

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DRAWN:	KMH	REVISION:	a
DATE:	11/09/2009	SCALE:	1:200,000
JOB NO:	767B\B12	PROJECTION:	MGA94 (Z50)

Location: F:\Jobs\767\MapInfo\233 Figs\Fig4.3.WOR

5 CONCEPTUAL HYDROGEOLOGY

5.1 INTRODUCTION

Our conceptual understanding of the hydrogeology of the area of investigation is based on the interpretation and integration of all available information.

The conceptual hydrogeology represents our current understanding of the aquifer system and provides the technical foundation for the numerical model design and framework.

The area of investigation contains two main aquifer systems: the calcrete aquifer and the deeper palaeochannel system. Due to favourable drilling and testing results from the calcrete aquifer, the water supply investigations have been focussed on the calcrete aquifer.

5.2 CALCRETE AQUIFER

5.2.1 AQUIFER THICKNESS & EXTENT

The unconfined calcrete aquifer outcrops extensively in the overall Project area. In the southern area (to the west of the proposed mine site) near CD8 and Scotties Well, the thickness of the calcrete ranges from around 5-20m, thicknesses are up to 18-20m around CD16 (Limestone Bore), whilst thicknesses then decline moving further northwards to approximately 10m at B9M. There is limited lithological information available for the local pastoral bores, however information in the DoW WIN database identifies the presence of calcrete within the main Cogla Downs drainage system (corresponding to the outcrop areas defined by GSWA) and also outside the identified area of outcrop. Figure 5.1 presents the observed calcrete thickness across the overall Project area and also the area of calcrete outcrop as mapped by the GSWA.

Calcrete channels, due to their depositional nature, are often braided/channelised systems rather than one isotropic, homogeneous aquifer (as illustrated by exploration hole B13X, which intercepted silty sands, gravels and clays overlying weathered bedrock, rather than calcrete). Conversely, the calcrete aquifer is not restricted to the outcrop area defined by the GSWA Geology map, as demonstrated by pastoral bore Nanadie Well located approximately 4.5km east of B13X, which intercepts calcrete (Figure 5.1). In some cases where the calcrete is absent, the sediments present have a lower hydraulic conductivity (0.01 to 1m/d) than the surrounding calcrete, however, the available storage can often be significant.

Representative cross-sections of the larger Project area are presented in Figures 5.2 to 5.4. These cross-sections are based on information obtained during field investigation programmes and review of available data. The location of these cross-sections is presented in Figure 5.5.

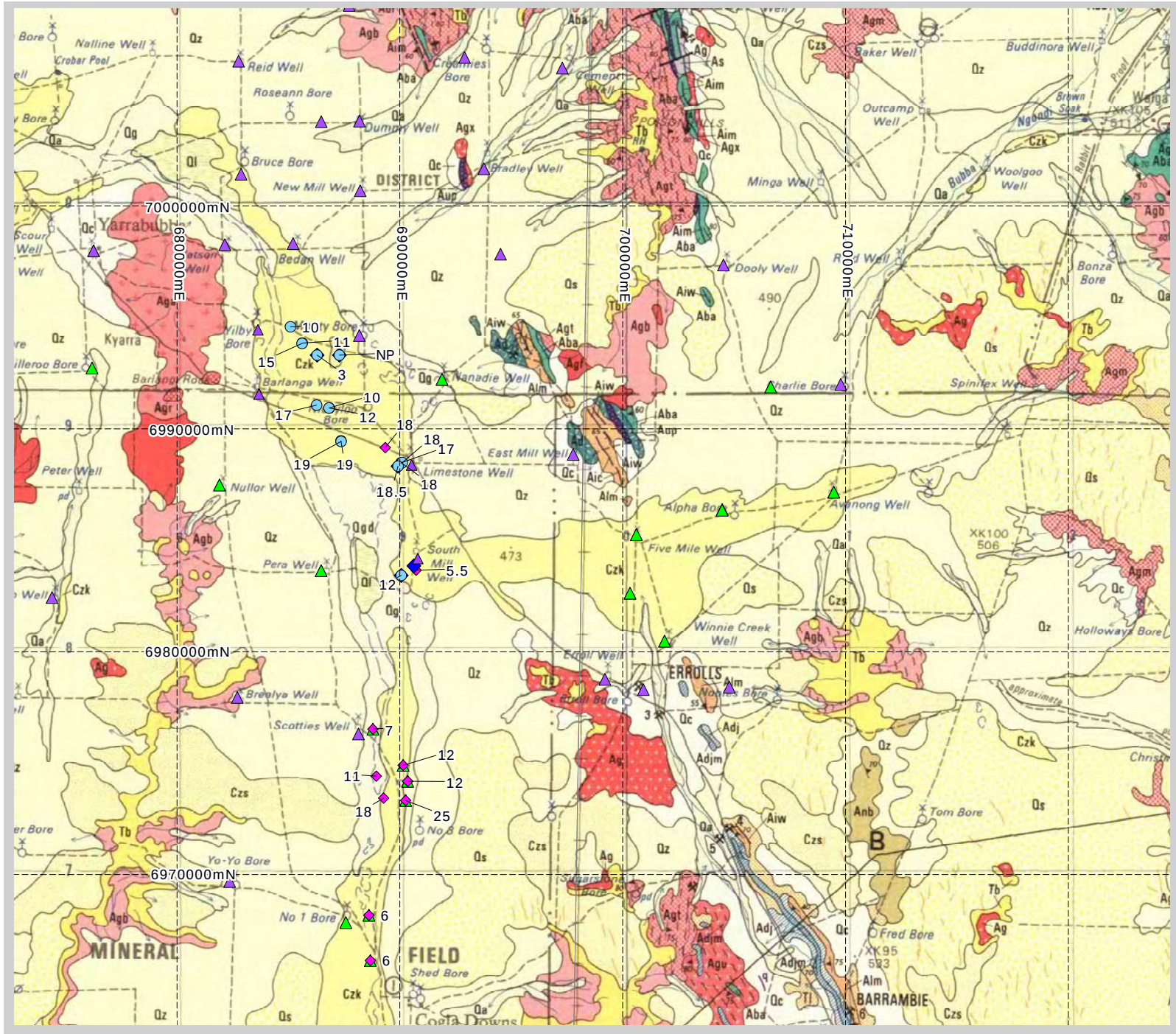
For the purposes of this investigation, the extent of the calcrete aquifer in the area of investigation has been limited to the areas of outcrop, as defined by GSWA, which includes some areas where the calcrete is not present (i.e. B13X) and excludes areas where it is present (i.e. Nanadie Well). In addition, the thickness of the calcrete aquifer in the area of investigation is inferred to range from 5m in the north near Bedan Well up to 15m in the south near Limestone Well.

5.2.2 AQUIFER PARAMETERS

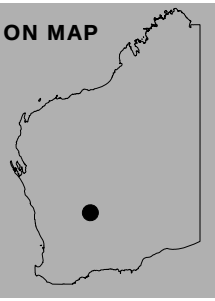
Analysis of aquifer tests conducted on production bores installed by Aquaterra in 2007 and previous testing conducted by Geotechnics in 1972 estimated aquifer transmissivity values ranging from 600m^2/d to 8,000m^2/d, with an average of transmissivity of 2,900m^2/d. Bulk hydraulic conductivity values ranging from 55m/day to 570m/d, with an average hydraulic conductivity of 230m/d, were calculated using observed saturated thicknesses.

As discussed in Section 4, stressing of the calcrete aquifer was not really achieved during the Aquaterra 2007 test pumping programme or by Geotechnics in 1972, due to the high yielding nature of the calcrete aquifer and pumping capacity being limited by casing diameters. Therefore, it was not possible to calculate specific yield values for the calcrete aquifer. However, available literature for other similar calcrete aquifers at Paroo calculated a specific yield of 26% (Sanders, 1972); which is consistent with specific yield values derived for similar calcrete systems in the north-eastern Goldfields.

A hydraulic conductivity value of 100m/d and a specific yield value of 20% are considered to be representative aquifer properties for the calcrete aquifer within our area of investigation (between Limestone Bore and Bedan well). However, as evident from above, there appears to be considerable variation in the aquifer parameters of the calcrete, and thus subsequent work will need to also assess the implications of potentially lower and/or higher hydraulic conductivity and specific yields.



LOCATION MAP



LEGEND

- 1972 Geotechnics Bores
- Exploration Bores drilled Sept\Oct 2008
- Production\Monitoring Bores surveyed 2009

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

DoW WIN Database

Geotechnics (1972)

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FIGURE 5.1
CALCRETE AQUIFER THICKNESS

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DATE:	11/09/2009	SCALE:	1:250,000
JOB NO:	767B\B12	PROJECTION:	MGA94 (Z50)

Location: F:\Jobs\767\MapInfo\233 Figs\Fig5.1.WOR

WEST

A

EAST

A’

YILBY BORE

B9M

B10P

B4X

B13X

480

470

460

450

2m

100m

Silty Sand

Calcrete

Sand

Clay/Sand

Gravel

Calcrete/Sand

Weathered Basement

Water Level

O:\Aquaterra\September 2009\Section 1 A A'.dgn

aquaterra

Cross-Section A A' Figure 5.2

WEST

B

PERA WELL

B12X

CD 10

STH MILL WELL

EAST

B'

480

470

460

450

440

430

420

2m

100m

Silty Sand

Calcrete

Sand

Clay

Silcrete

Weathered Basement

Water Level

O:\Aquaterra\September 2009\Section 2 B B'.dgn

aquaterra

Cross-Section B B' Figure 5.3

C

BARLANGA WELL

B5M

B15P

B8P

B3M

C’

480

470

460

450

440

430

420

2m

100m

?

Alluvium

Calcrete

Calcrete/Sand

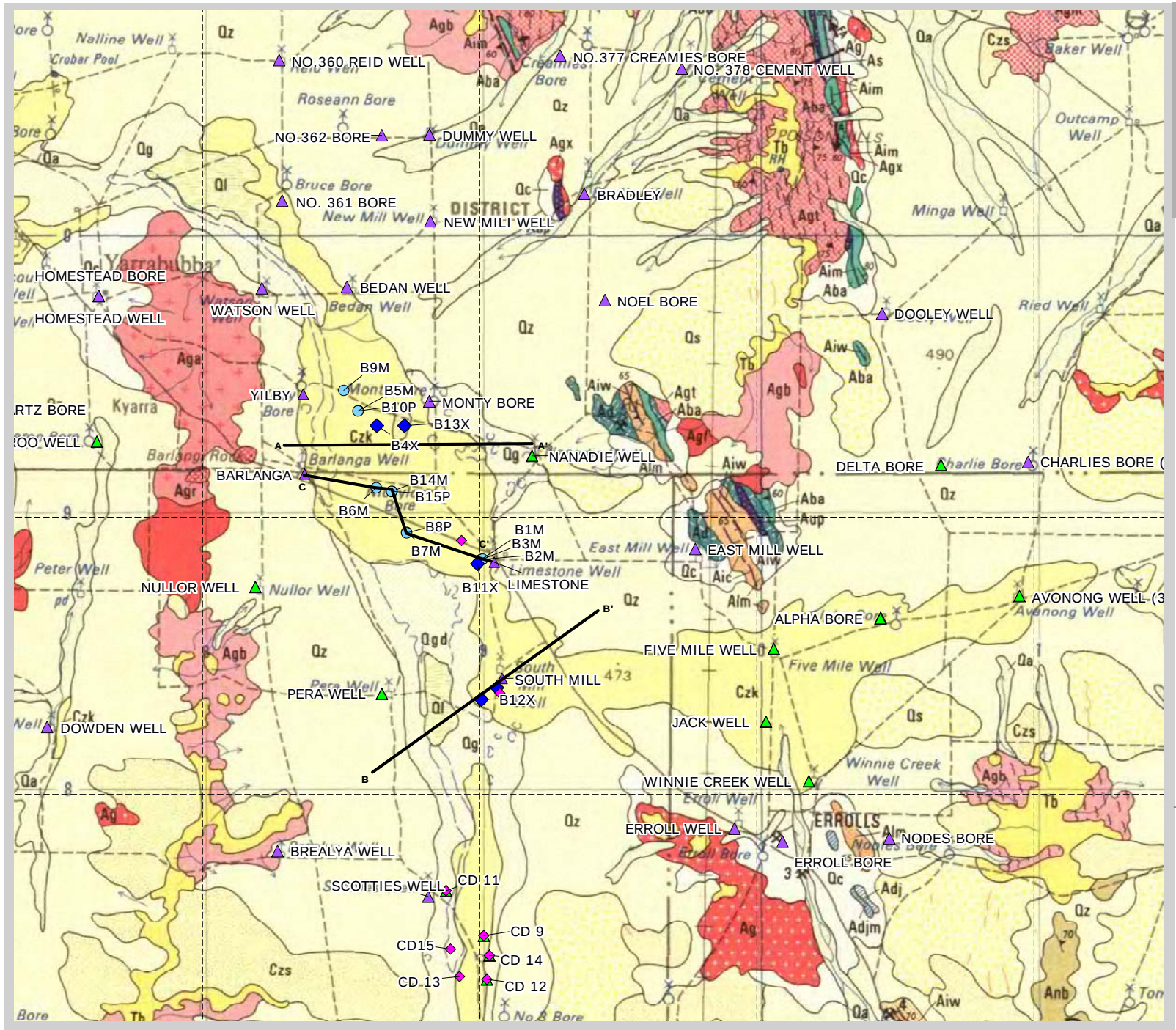
Weathered Basement

Water Level

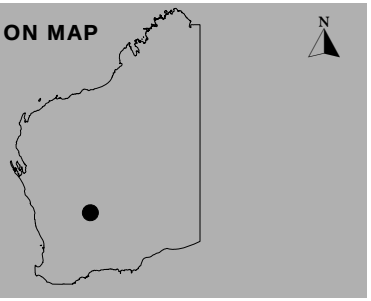
D:\Work\Aquaterra\September 2009\Section 3 C C'.dgn

aquaterra

Cross-Section C C' Figure 5.4



LOCATION MAP



LEGEND

- Exploration Bores drilled Sept\Oct 2007
- DoW Bores Intercept Calcrete
- DoW Bores within 20km radius
- Surveyed Water Bores (drilled Sept\Oct 2007)
- Geotechnics Bores

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

DoW WIN Database

Geotechnics (1972)

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FIGURE 5.5
CROSS SECTION LOCATION PLAN

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DRAWN:	KMH	REVISION:	a
DATE:	11/09/2009	SCALE:	1:200,000
JOB NO:	767B\B12	PROJECTION:	MGA94 (Z50)

Location: F:\Jobs\767\MapInfo\233 Figs\Fig5.5.WOR

5.2.3 GROUNDWATER FLOW

Depth to water within the unconfined alluvium and calcrete in the area of investigation typically ranges from 2 to 7mbgl.

Groundwater flow direction is generally in a north-westerly direction toward Lake Annean. Groundwater discharge is likely to occur through discharge to Lake Annean; downward leakage to the underlying clays and sands of the palaeodrainage system, where present, and weathered basement; and through evapotranspiration.

Table 5.1 and Figure 5.6 present available groundwater level data for the calcrete aquifer in the area of investigation, whilst Figure 5.7 presents available static water level data for the pastoral bores and bores drilled in 2007 across the larger Project area.

5.2.4 RECHARGE

Recharge to the unconfined calcrete aquifer is primarily by direct infiltration of rainfall and infiltration of surface water runoff/flooding (or indirectly by infiltration through overlying sediments) either during or soon after heavy rainfall events.

Literature Review

A detailed study of alluvial and colluvial sediments east of Wiluna calculated a recharge rate of 0.7% of the mean annual rainfall (Bestow, 1992). In addition, Sanders (1972) assessed groundwater recharge in the area west of Wiluna at Paroo to be at a rate of 0.79% of mean annual rainfall.

Bestow (1992) reviewed rates of recharge to the unconfined aquifers using chloride mass balance calculations. The mass balance uses three parameters: the average chloride concentration in rainfall; the long-term mean annual rainfall; and the average chloride concentration in groundwater. This mass balance method estimated recharge rates in the eastern Goldfields to unconfined aquifers to range from 0.09-0.9% of rainfall, reducing with higher chloride concentrations in groundwater.

Recharge Assessment

In June 2008, Aquaterra conducted a review of local recharge mechanisms based on newly available water level data and rainfall information. The watertable responses to significant rainfall events help improve the understanding of the calcrete aquifer recharge mechanisms, such as the relative importance of direct rainfall recharge or infiltration of creek flow during major events.

Aquaterra collected water level measurements from bores located within the area of investigation in September / October 2007 and August 2008. Subsequently, Outback Ecology collected water level measurements from these same bores (during a round of stygofauna sampling) in January and April 2008. The January 2008 water level measurements followed a significant rainfall event in the area in December 2007. The water levels recorded are illustrated in Table 5.1.

The area of investigation is located approximately midway between the Bureau of Meteorology stations in Sandstone (no. 012072) and Meekatharra airport (no. 007045). Data was collected from both these stations in order to assess rainfall variability in the area and to provide an indication of likely rainfall in the area of investigation.

Monthly rainfall data at Sandstone and Meekatharra airport shows that rainfall patterns vary significantly between the two locations and that rainfall events are very localised, rather than regional. For example, Sandstone recorded 49.6mm in December 2007, while Meekatharra recorded 19mm. Both rainfall stations recorded large rainfall totals for February 2008.

Table 5.1: Summary of Barrambie Borefield Water Levels

Bore ID	Elevation (mRL)	SWL (mRL) Sep/Oct 2007	SWL (mRL) Jan 2008	SWL (mRL) Apr 2008	SWL (mRL) Aug 2008	SWL (mRL) Nov 2008	SWL (mRL) Oct 2009
South Mill Well	470.6	467.4	467.2	467.2	-	-	-
Barlanga Well	468.7	465.8	465.9	466.0	-	-	-
Yilby Bore	468.6	465.6	465.9	464.8	-	-	-
B1M	470.6	464.5	464.7	464.4	464.4	464.4	464.3
B3M	471.0	466.4	466.5	466.1	466.2	466.2	-
B5M	471.2	466.1	466.0	465.8	465.9	465.8	-
B6M	471.0	466.3	466.2	-	466.0	466.0	465.9
B7M	471.6	466.6	466.2	466.4	466.4	466.3	-
B8P	471.8	466.7	466.7	-	466.5	466.4	466.3
B9M	470.3	466.3	-	-	465.9	465.8	-
B10P	471.4	466.2	466.1	-	465.9	465.9	465.8
B14M	469.2	-	-	466.1	466.3	466.2	-
B15P	469.4	466.6	-	-	466.2	466.1	466.1
Bedan Well	473*	469.7	-	469.8	-	-	-
Watsons Bore	473*	466.5	-	468	-	-	-

Note
* Estimated elevation - bores not surveyed.

Groundwater levels are available for bores drilled in September/October 2007 and pastoral bores South Mill Well, Barlanga Well, Yilby Bore, Bedan Well and Watsons Bore between September 2007 and October 2009 (refer Figure 5.6).

South Mill Well, Barlanga Well, B6M, B8P, B10P and B15P show relatively stable water levels over the period from September 2007 to October 2009, where data is available. However, Yilby Bore, B1M, B3M and B5M all show a water level rise in January 2008, possibly the result of recharge following a heavy December 2007 rainfall event. Whilst B6M and B8P show a slight water level decline after November 2008, which is likely to be due to low rainfall during this period. Unfortunately there are no water levels available from these bores in February and March 2008 when significant rain also fell in the area. However, water levels for these bores from April 2008 show water levels less than those in January 2008.

Summary of recharge assessment:

- Rainfall events are localised in the area.
- There is some uncertainty with respect to actual rainfall distribution in the area of investigation.
- Maximum rainfall at Sandstone and Meekatharra during December 2007 was 49.6mm and 19mm, respectively.
- Some bores (but not all) showed a water level rise in January 2008 following a significant rainfall event in December 2007.
- No obvious water level rise was evident in April 2008 following large rainfall recorded at Sandstone (92.5mm) and Meekatharra (127.6mm) in February 2008.
- Water level response to recharge due to rainfall and/or runoff appears highly variable.

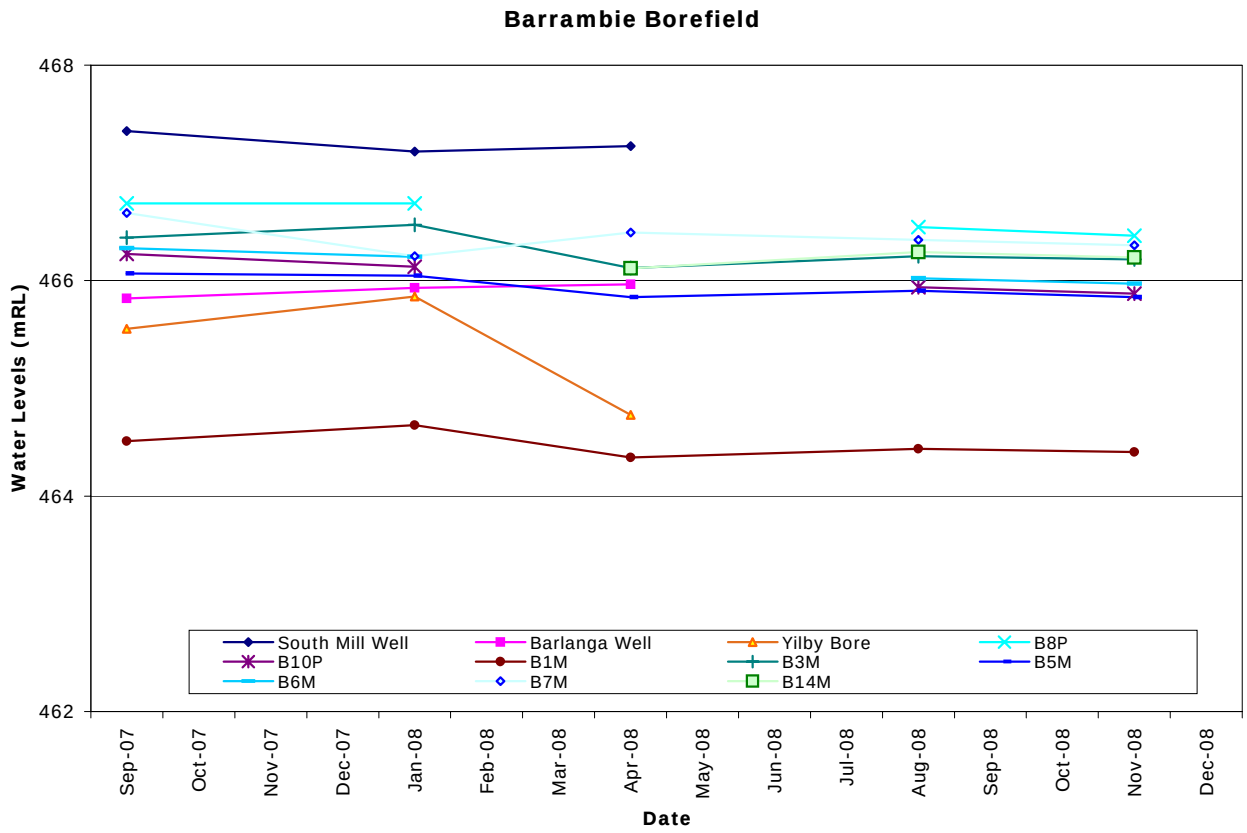
- There is currently insufficient data to quantify the rainfall recharge within the area of investigation.

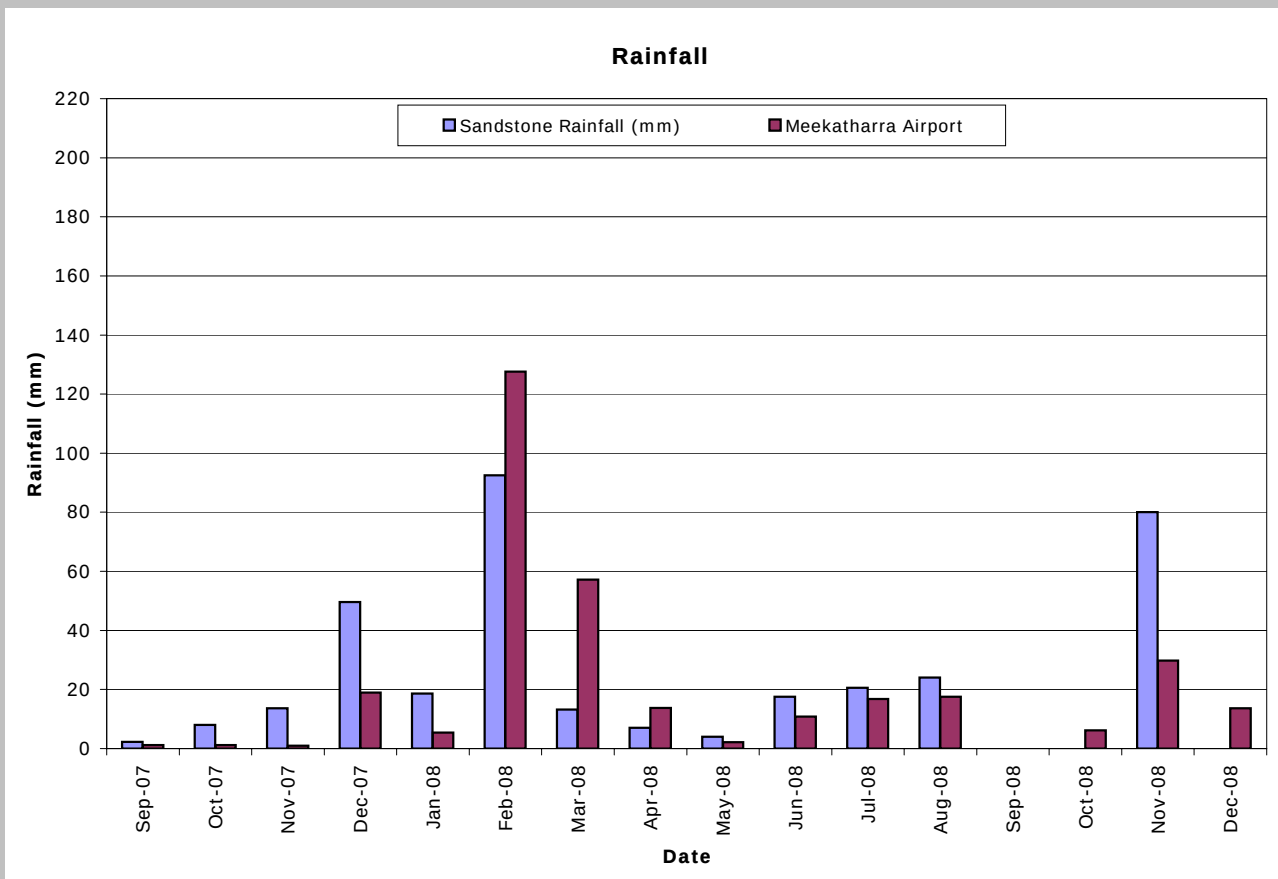
Due to the limited groundwater level monitoring data available and the uncertainty of representative rainfall data, it is not possible to accurately assess and quantify recharge to the calcrete aquifer following rainfall events. However, the water level rise at Yilby Bore, B1M, B3M and B5M may be indicative of recharge occurring following large rainfall events.

In addition, field electrical conductivity (EC) concentrations were recorded during the 2007 drilling programme and available data shows that groundwater salinity increases slightly with depth (refer Appendix B). This observation could be indicative of the aquifer system receiving recharge by infiltration of water directly from rainfall or infiltration from surface water runoff.

Subsequent to the recharge assessment, a weather station was installed in December 2008, beside the proposed airfield (near the mine site). Although this weather station is approximately 35-40km from the area of investigation, it will provide more localised rainfall data, which will greatly assist future recharge assessments.

It is proposed that further work be undertaken to improve our understanding of recharge mechanisms (prior to application for a 5C Licence to Take Groundwater), the proposed scope of further work is discussed in Section 8.





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BARRAMBIE BOREFIELD HYDROGRAPHS FIGURE 5.6

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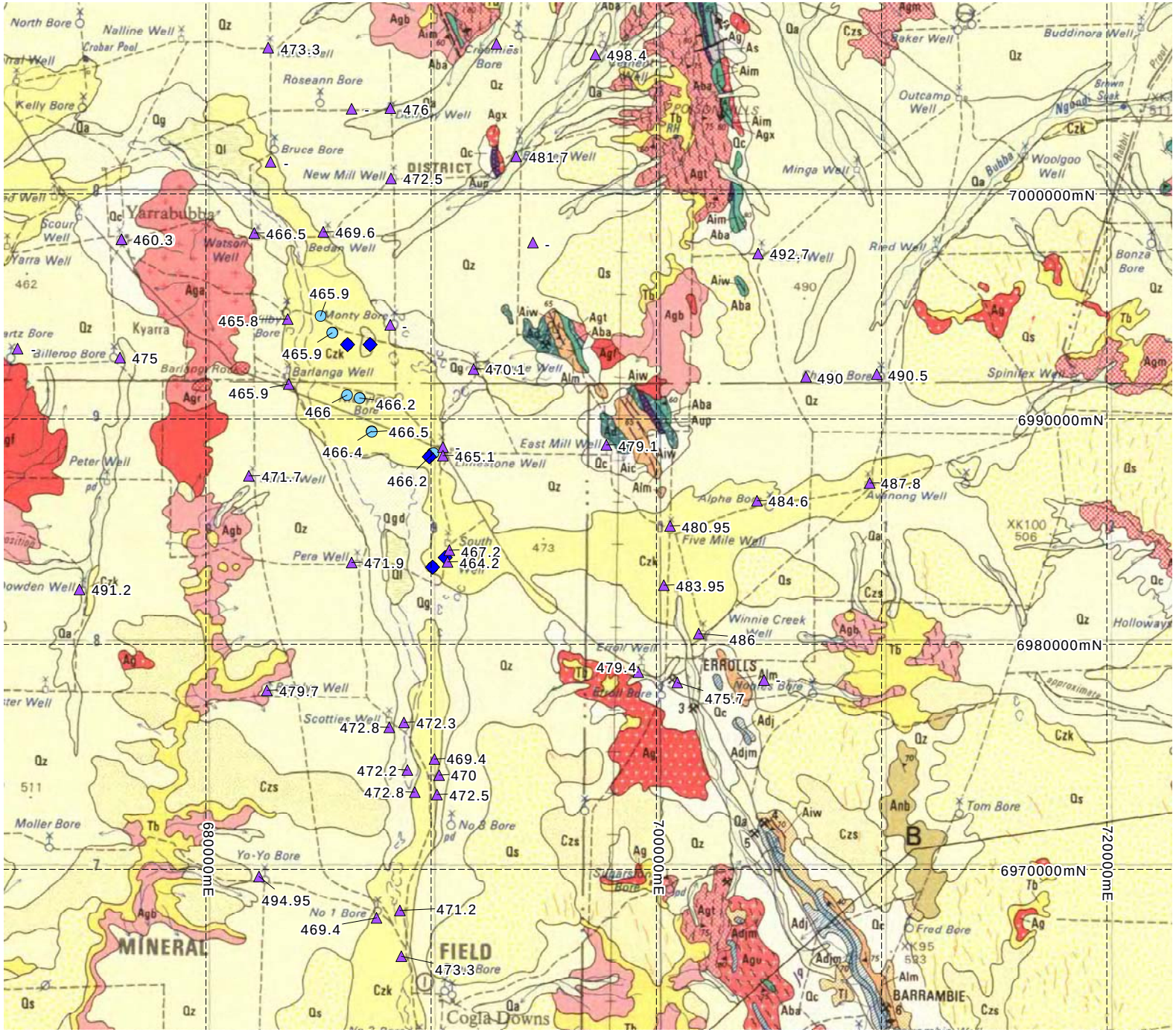

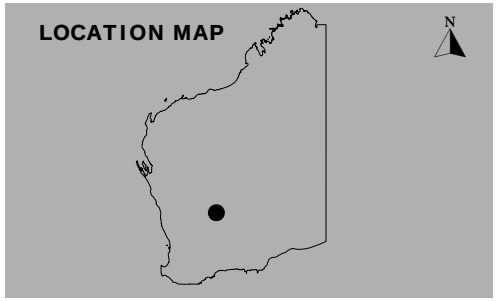

LEGEND

- Exploration Bores drilled Sept\Oct 2008
- Production\Monitoring Bores surveyed 2009
- DoW Bores

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

DoW WIN Database

Geotechnics (1972)

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FIGURE 5.7
REGIONAL WATER LEVELS

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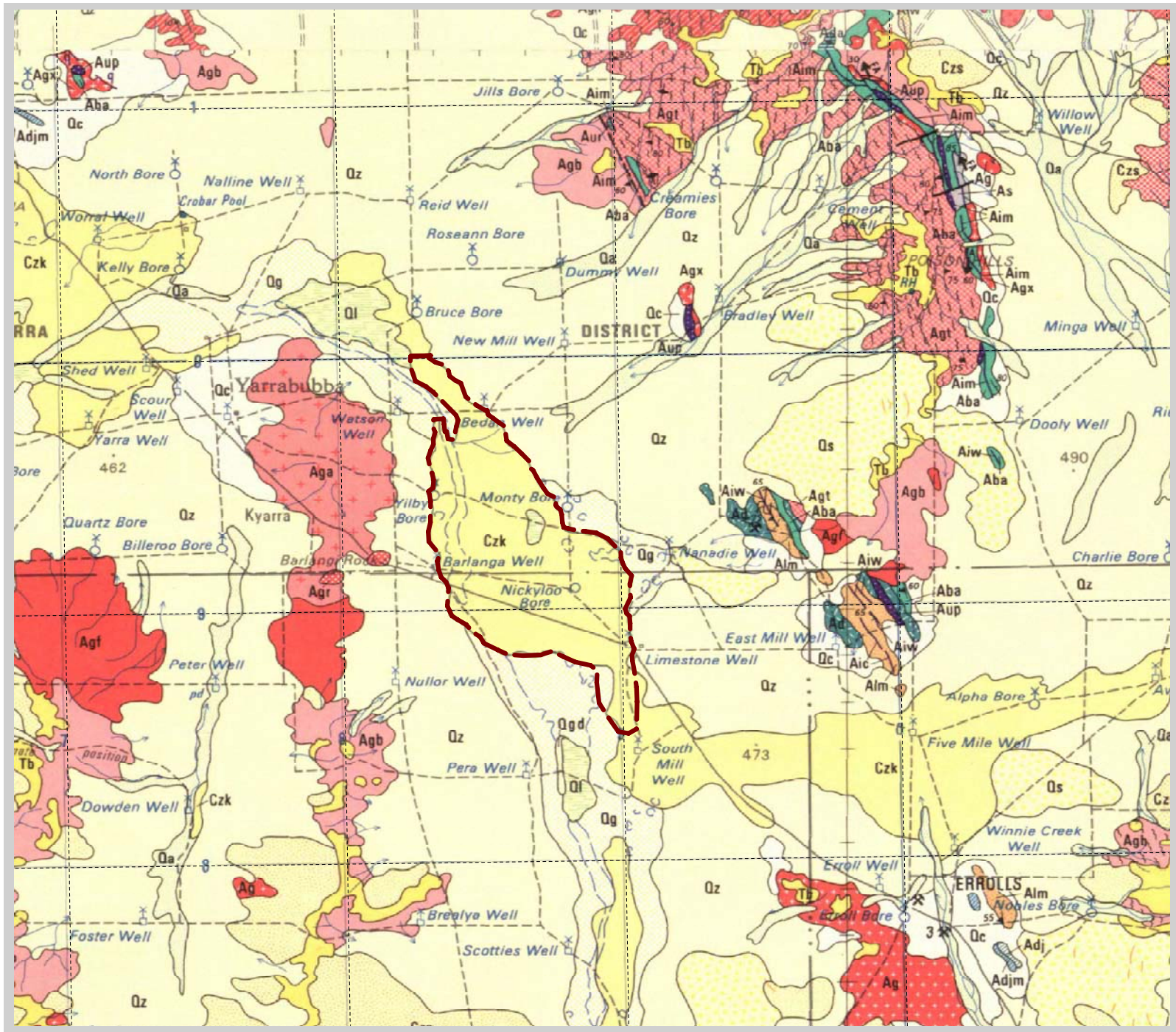
DATE:	11/09/2009	SCALE:	1:250,000
JOB NO:	767B\B12	PROJECTION:	MGA94 (Z50)

Location: F:\Jobs\767\MapInfo\233 Figs\Fig5.7.WOR

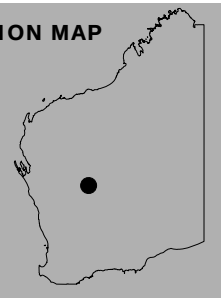
5.3 SUMMARY

The conceptual hydrogeology of the area of investigation, as described in the preceding sections can be summarised as follows:

- **Aquifer Types –** Two aquifers are present within the area of investigation, a calcrete aquifer and a palaeochannel aquifer. Due to favourable drilling/testing results from the calcrete aquifer and drilling difficulties associated with palaeochannel sediments, the calcrete aquifer was the focus of investigation.
- **Aquifer Extent** – The extent of the calcrete appears to be best represented by the outcrop area, as defined in the GSWA 1:250,000 geology map (although calcrete is known to be absent in some locations within this area, and it is also known to exist outside this area).
- **Aquifer Thickness** – The calcrete thins towards the eastern and western margins, but in the central areas the calcrete is generally 15 to 18m thick in the southern area (around Limestone Bore) and 5m thick in the northern area (around B9M).
- **Aquifer Properties** – Hydraulic conductivity values of the order of 100m/d and specific yield values of 20% are considered to be representative aquifer properties of the calcrete aquifer, although there is likely to be considerable variation in these properties.
- **Depth to Water** – Depth to water within the unconfined alluvium and calcrete is generally between 2 and 7mbgl.
- **Groundwater flow** – Groundwater flow direction is generally north to north-westwards.
- **Recharge** – Recharge is believed to occur at low rates via direct infiltration of rainfall and/or infiltration of surface water runoff. There is currently insufficient data to quantify the rainfall recharge.
- **Water quality** – Typically, TDS ranged from 2,100mg/L to 2,700mg/L and EC ranged from 3,600 to 4,500µS/cm. Generally, salinity increases northwards.



LOCATION MAP



Legend

Modelled Extent of Calcrete

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FIGURE 5.8

MODELLED EXTENT OF CALCRETE

AUTHOR:	KMH	REPORT NO:	233
DRAWN:	KMH	REVISION:	a
DATE:	1/10/2009	SCALE:	1:200,000
JOB NO:	767/B12	PROJECTION:	MGA94 (Z50)

Location: F:\Jobs\767\MapInfo\233 Figs\Fig5.8.WOR

6 GROUNDWATER MODELLING

6.1 OVERALL OBJECTIVES

The numerical groundwater flow model developed for the Barrambie borefield was developed consistent with the conceptual hydrogeology as described in Section 5.

The principal aims of the modelling were to:

- Evaluate the potential of the calcrete aquifer, based on drawdown constraints to supply the projected water supply demand.
- Optimise borefield design with regards to bore design, spacing, and interference.

Model predictions were run with an initial water supply demand of 1.24GL/a in December 2007. However, the model was re-run in July 2008 consistent with a revised water supply demand of 2.5GL/a. Model uncertainty was evaluated with further predictions using a range of aquifer parameters. Details of predictions for both water demand cases are discussed further below.

6.2 MODEL SET UP

6.2.1 BACKGROUND & ASSUMPTIONS

The numerical groundwater flow model Modflow (Harbaugh and McDonald, 1996), operating under the Processing Modflow Pro Graphical User Interface (WebTech 360, 2002-2003) was used for this work. Modflow is the industry leading groundwater flow modelling code.

A two layer model was set-up in which the calcrete aquifer (Layer 1) was underlain by, and surrounded by, relatively impermeable granitic bedrock (Layer 2). The model adopts a storage depletion approach (i.e. no recharge is applied), and assumes:

- An idealised aquifer geometry, based on mapping, and informed by field program findings.
- A uniform initial water level across the model domain (this is consistent with measurements in the area).
- No allowance is made for recharge via rainfall events (as a conservative assumption).

A schematic conceptual sketch is shown in Figure 6.1.

6.2.2 MODEL GRID AND EXTENT

The modelled domain extends across an area of approximately 2,500km^2, extending to a maximum width of 48km (west to east) and 52km (north to south). Much of this area represents basement around the calcrete aquifer system. The calcrete is located in the central section of the model domain over an area of approximately 50km^2. The calcrete aquifer is assumed to have limited horizontal extent (approximately 12.5km north-south by 8km east-west) and is surrounded and underlain by lower permeability granite bedrock as illustrated by the schematic conceptual sketch in Figure 6.1. The modelled calcrete aquifer extends north and south to meet the model boundaries, to allow for the application of boundary conditions to represent regional throughflow, if required. However, the model set-up implements a storage depletion approach, with no regional groundwater throughflow and no recharge, and with boundaries sufficiently distant (about 20km) that any drawdown due to abstraction from calcrete would not extend to the boundaries. The extent of the modelled domain and the assumed extent of the calcrete aquifer are shown in Figure 6.2.

The model grid has been set-up to align with MGA94 (Zone 50) grid north. The corner coordinates of the model grid are shown in Table 6.1.

Model cell size ranges from 100m in the central area of the model grid to 200m at the boundaries, distributed over 2 layers, 305 rows, and 224 columns, resulting in approximately 136,640 active cells.

Table 6.1: Model Domain

Model Corner	Easting (MGA94 Z50)	Northing (MGA94 Z50)
Top left	662755	7020229
Top right	710651	7020229
Bottom left	662755	6967781
Bottom right	710651	6967781

6.2.3 MODEL GEOMETRY

The numerical groundwater model has two layers, as outlined in Table 6.2. Available bore data (from current and previous investigations) were used to define the key data requirement of the base of the calcrete. The base of calcrete aquifer is assigned between 450mAHD at the southern end of the proposed borefield area, and increases to 460mAHD close to the northern end of the proposed borefield. The assumed base of Layer 1 is shown as a cross section through easting 6845700mE in Figure 6.3. The bottom of the Layer 2 granite bedrock has been set at a uniform level of 400mAHD. The current model does not allow for the inferred channelized nature of the aquifer and does not include any aquifer heterogeneity.

Table 6.2: Model Layers

Layer	Description	Thickness
Layer 1 (L1)	Calcrete & Granite	Base of layer varies from 450mAHD to 460mAHD
Layer 2 (L2)	Granite Bedrock	Base of layer set at 400mAHD

6.2.4 MODEL BOUNDARY CONDITIONS

The model was developed using a storage depletion approach and as a result it was not calibrated to steady state conditions. Instead the model assumed a flat or uniform water level across the model domain, consistent with measured water level in the calcrete aquifer investigation area. Fixed head boundaries were assigned along all model boundaries (refer Figure 6.2) to allow quantification of groundwater inflow to the model domain, if the drawdown impacts of pumping extended to the model boundaries. The model makes no allowance for recharge to the calcrete aquifer via rainfall events (this is an element of conservatism, adopted as it was not possible to quantify this rainfall recharge as part of the preceding investigations, discussed in Section 5).

Consistent with available data, an initial water level of 465mAHD (a depth below ground level of around 5 metres) is assumed for the entire model, including the fixed head boundaries.

6.2.5 MODEL PARAMETERS

As the model uses the storage depletion approach, base case model parameters assigned in the model are set consistent with the results of available hydraulic testing and current hydrogeological understanding. These parameters are set at the lower end of the expected range of parameters to provide further conservatism in model predictions.

Base case aquifer parameters are summarised in Table 6.3 and presented in Figure 6.4 and Figure 6.5. Sensitivity analysis to aquifer parameter values was also undertaken, including consideration of a transition zone between the high parameter values for the calcrete aquifer and the low values for the granite bedrock.

Table 6.3: Modelled Aquifer Parameters (Base Case)

Formation	Horizontal Hydraulic Conductivity (Kh) (m/d)	Vertical Hydraulic Conductivity (Kv) (m/d)	Storage Coefficient (S)	Specific Yield (Sy)
Calcrete	100	10	0.0001	0.2
Bedrock	0.001	0.0001	0.0001	0.01

6.3 MODEL PREDICTIONS

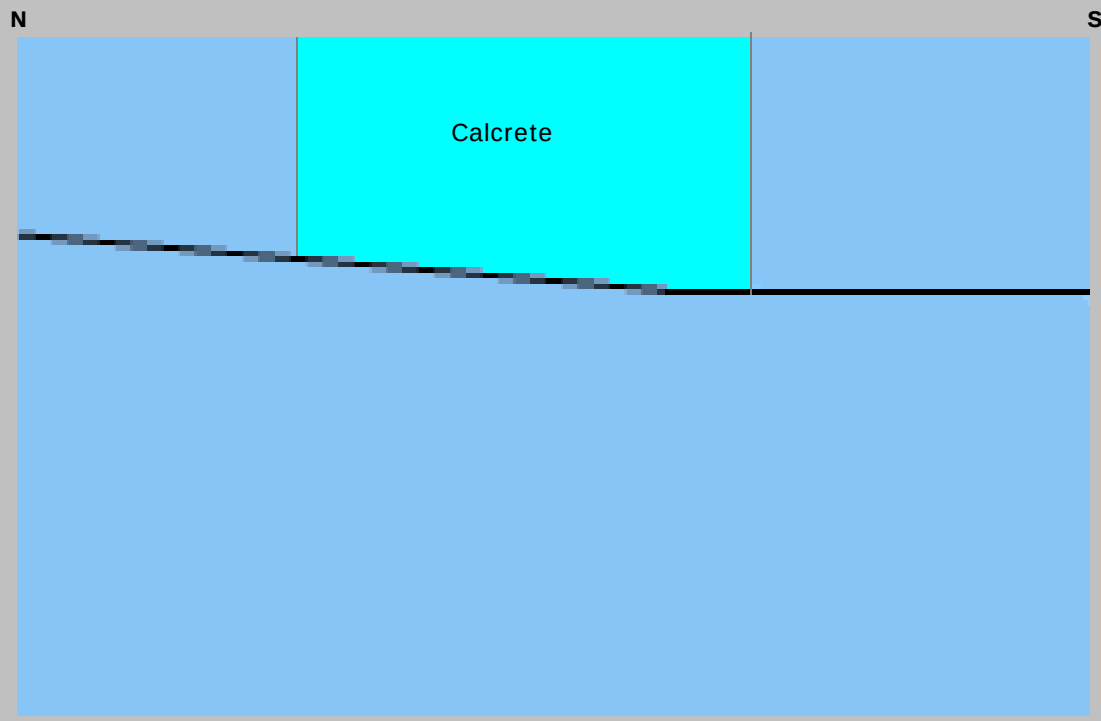
6.3.1 PREDICTION SETUP

The model was used to simulate groundwater abstraction from the calcrete aquifer to supply the projected water demand for a period of twelve years.

Model predictions enabled the evaluation of the potential impact of abstraction on water levels across the calcrete aquifer (i.e. the extent of water level drawdown). The model was set up such that water levels across the aquifer could be observed at a number of specific points with variable saturated thickness across the calcrete aquifer. The co-ordinates of these points, Obs A (Bore 3), Obs B, Obs C, Obs D and existing bores are tabulated in Table 6.4 and shown on Figure 6.6. Note that Obs A corresponds to Bore 3 an active pumping bore.

Table 6.4: Coordinates of Model Observation Points

Observation Point	Easting (MGA94 Zone 50)	Northing (MGA94 Zone 50)	Saturated thickness of Calcrete, b (m)	Comment
A (Bore 3)	688295	6992190	10	Active (Pumping) Well
B	685000	6995500	5	Inactive – observation point only
C	685000	6990000	15	Inactive – observation point only
D	688000	6990600	14	Inactive – observation point only
Barlanga Well	683794	6991582	12	Existing User
Yilby Bore	683633	6994442	5	Existing User
South Mill Well	690699	6984179	15	Existing User
Bedan Well	685387	6997689	5	Existing User



LAYER 1
CALCRETE AND GRANITE

LAYER 2
GRANITIC BEDROCK

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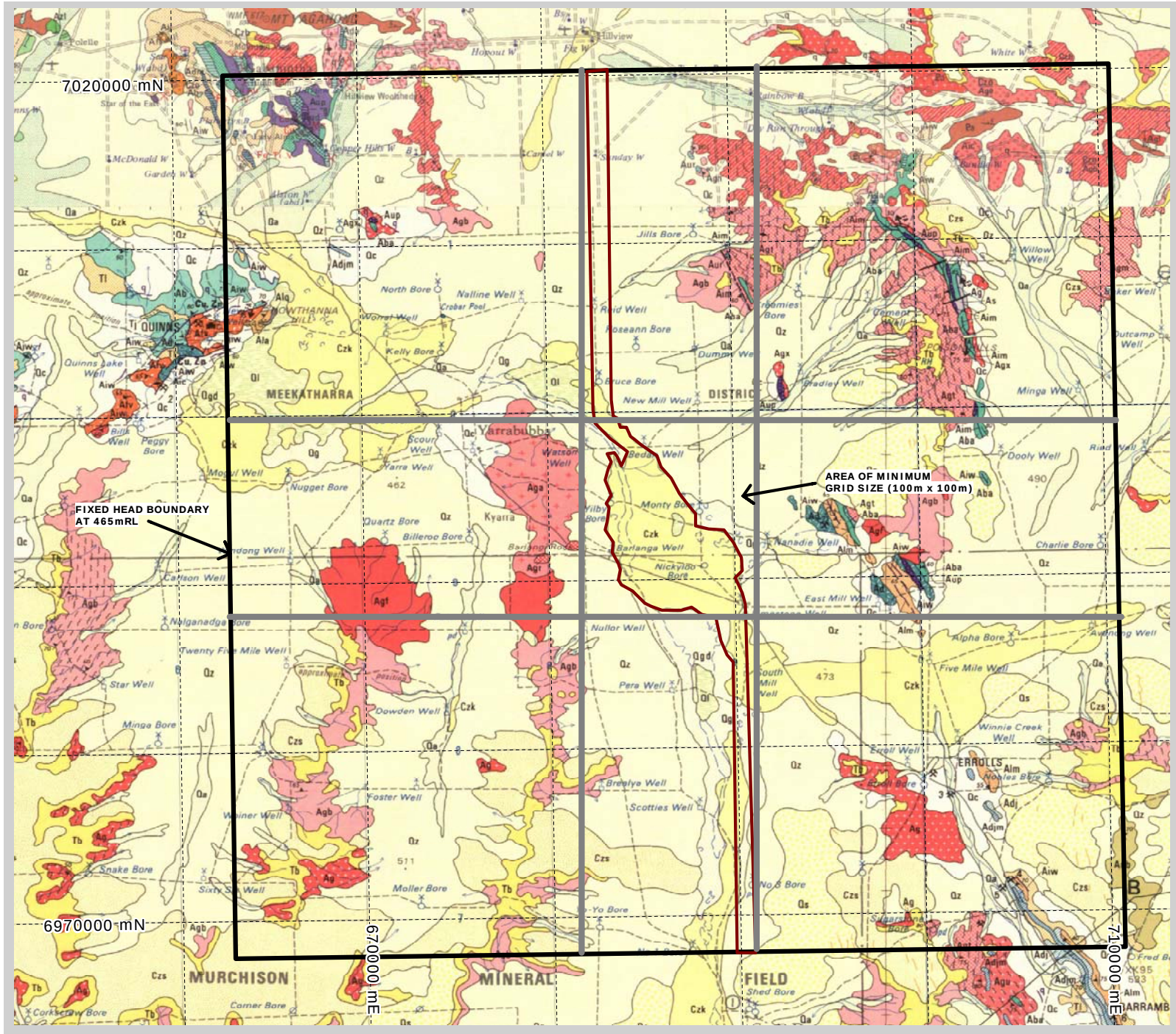
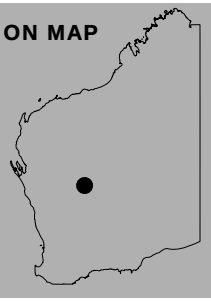
SCHEMATIC MODEL SET UP FIGURE 6.1

F:\Jobs\767\B12\233 Fig\[233_Fig6.1.xls]FIG6.1



LOCATION MAP



Legend

- Model Domain
- Modelled Extent of Calcrete

DATA SOURCE

1:250,000 SG 50-16 Geology Map
First Edition 1984 (GSWA)

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FIGURE 6.2
MODEL EXTENT & BOUNDARY CONDITIONS

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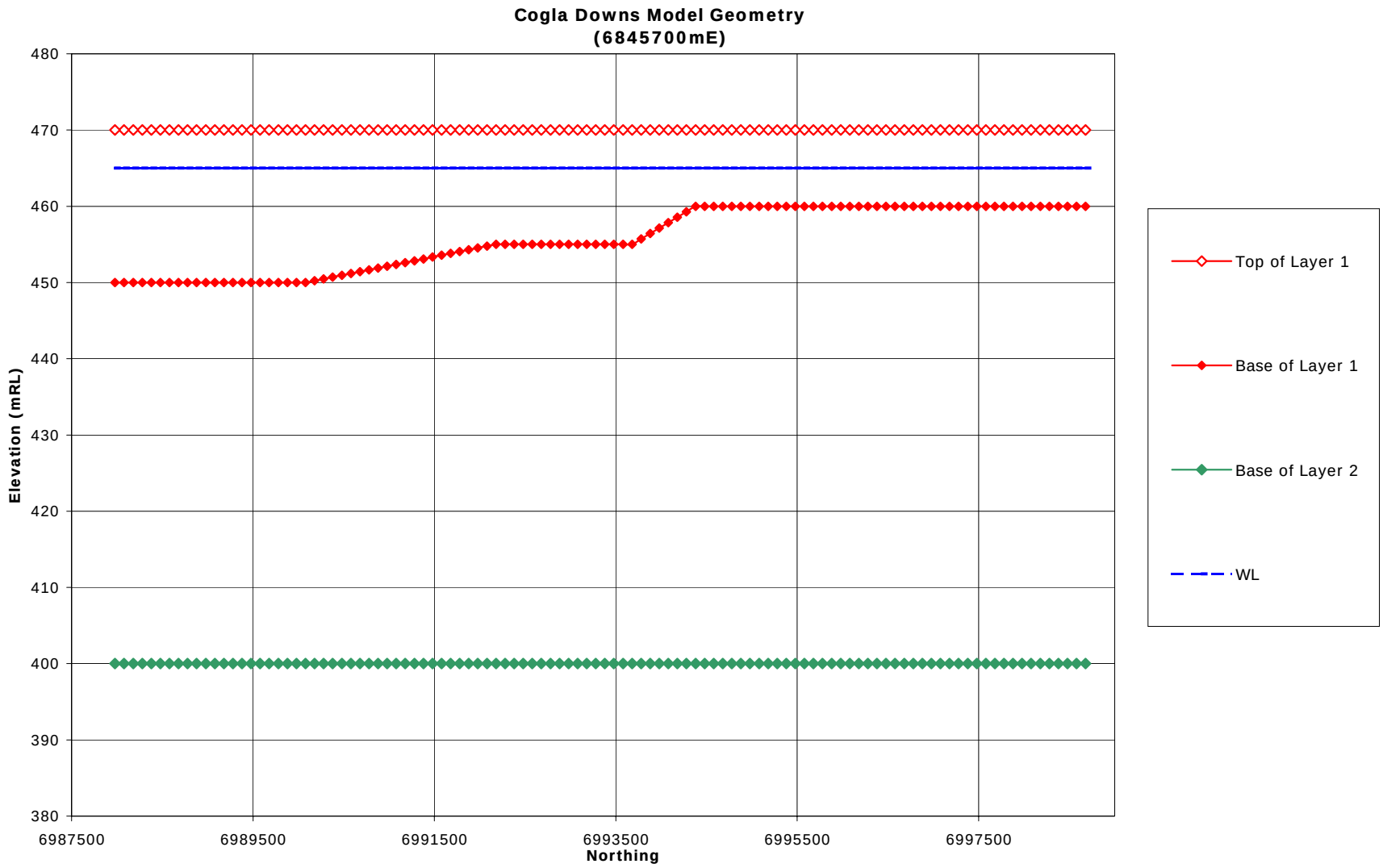
DRAWN:	KMH	REVISION:	a
DATE:	1/10/2009	SCALE:	1:300,000
JOB NO:	767/B12	PROJECTION:	MGA94 (Z50)

Location: F:\Jobs\767\MapInfo\233 Figs\Fig6.2.WOR



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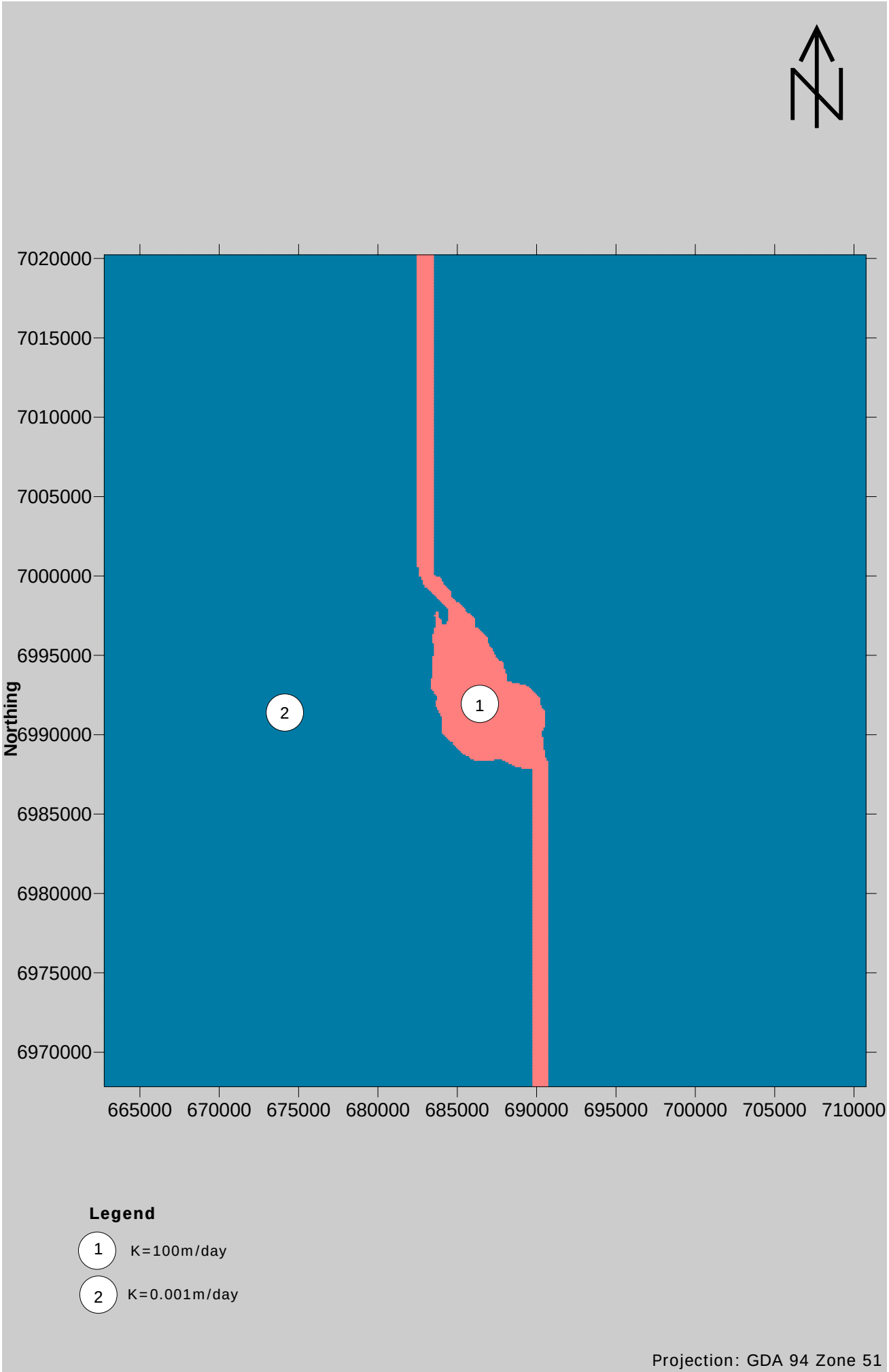
CROSS SECTION OF MODEL GEOMETRY FIGURE 6.3

F:\Jobs\767\B12\233 Fig\[233_FIG6.3.xls]FIG6.3



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MODELLED HYDRAULIC CONDUCTIVITY DISTRIBUTION - LAYER 1 (BASE CASE)

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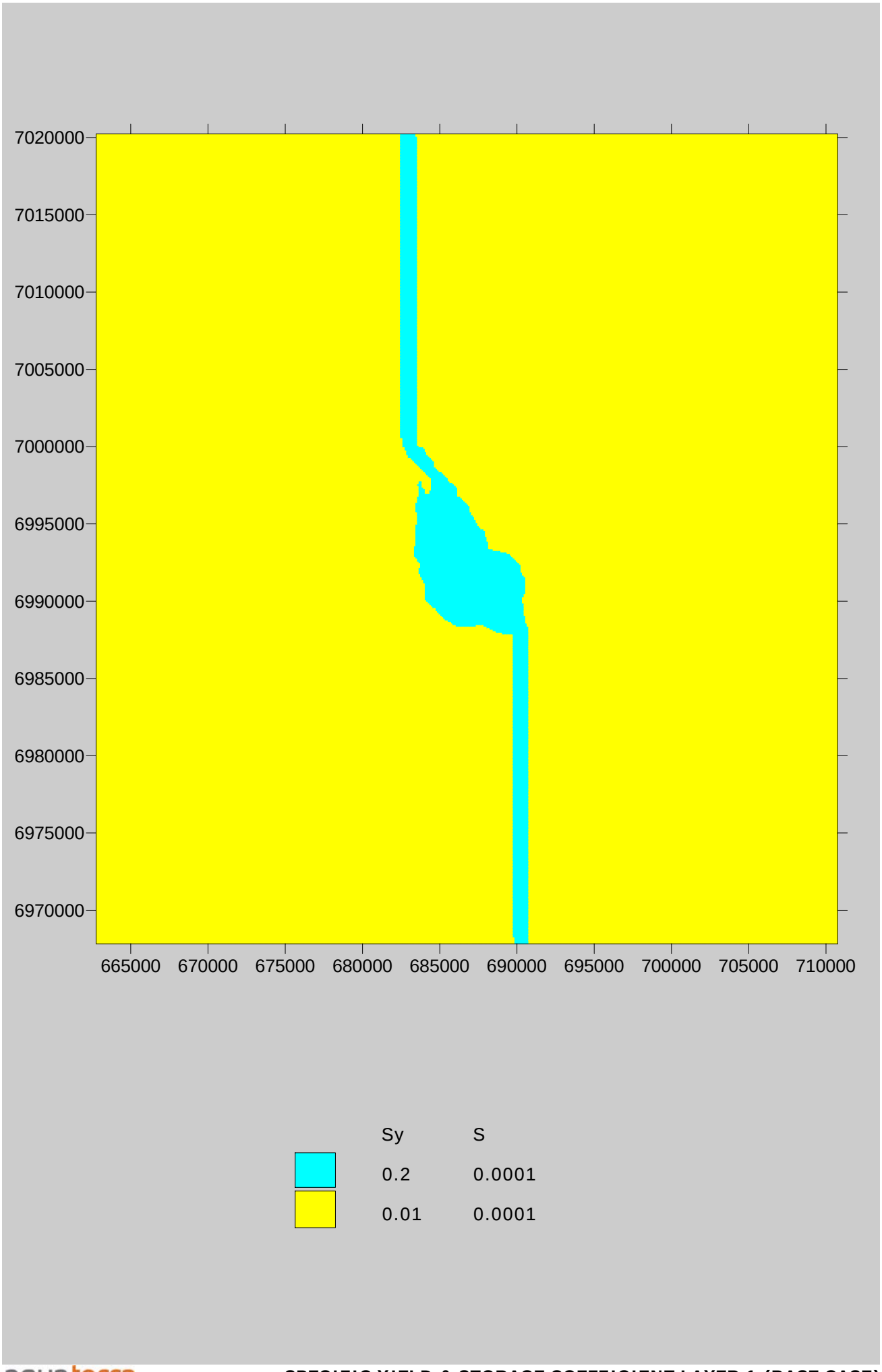
FIGURE 6.4



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SPECIFIC YIELD & STORAGE COEFFICIENT LAYER 1 (BASE CASE)

FIGURE 6.5

6.3.2 BOREFIELD SET-UP

Two different borefield layouts were assessed, the first comprised 7 active production bores assessed in the 1.24GL/annum demand scenario and Run 1 of the 2.5GL/annum demand scenario; the second comprised 10 active production bores, which was assessed in Run 2 of the 2.5GL/annum demand scenario.

The borefields were set up based on the locations of the four existing bores (B8P, B10P, B15P and Limestone Bore), plus additional bores in nominal locations across the aquifer to make up the remaining production bores for the simulation. The borefield is concentrated in the southern area of the calcrete aquifer, where greater saturated thickness is recorded.

The average abstraction rate allocated to each production bore for the two demand scenarios is summarised in Table 6.5.

The modelled borefield configuration with 7 active production bores is shown in Figure 6.6, whilst the modelled borefield configuration with 10 active production bores is shown in Figure 6.7.

Table 6.5: Modelled Borefield Configuration Production Bore Abstraction Rates

Demand Scenario	Borefield Configuration	Average Abstraction Rate (kL/d)
1.24GL/annum	7 Production Bores	490
2.5GL/annum	7 Production Bores	980
	10 Production Bores	685

6.3.3 PREDICTION SCENARIOS

A base case was established based on a best estimate of aquifer parameters in the area (refer Table 6.3). In addition, sensitivity scenarios were run for each demand scenario using alternative aquifer parameters to assess the sustainability of pumping the required water supply under different aquifer conditions, and the effect of specifying a narrow transition zone between the calcrete and granite formations. The range of values selected was based on the field testing results and our experience of other similar hydrogeological environments.

The details of each sensitivity scenario are summarised in Table 6.6.

Adopted aquifer parameters for Scenarios 1 to 4 are presented in Figures 6.8 to 6.10.

Table 6.6: 1.24GL/annum Modelled Prediction Scenarios

Scenario	Formation	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)	Storage Coefficient (S)	Specific Yield (Sy)
Base Case	Calcrete	100	10	0.0001	0.2
	Bedrock	0.001	0.0001	0.0001	0.01
Scenario 1	Calcrete	500	50	0.0001	0.15
	Bedrock	0.001	0.0001	0.0001	0.01
Scenario 2	Calcrete	50	5	0.0001	0.25
	Bedrock	0.001	0.0001	0.0001	0.01
Scenario 3	Calcrete	50	5	0.0001	0.15
	Bedrock	0.001	0.0001	0.0001	0.01
Scenario 4 (2.5GL/annum	Calcrete	100	10	0.0001	0.2
	Bedrock	0.001	0.0001	0.0001	0.01

Scenario	Formation	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)	Storage Coefficient (S)	Specific Yield (Sy)
demand scenario only)	Transition Zone	1.0	0.1	0.0001	0.01

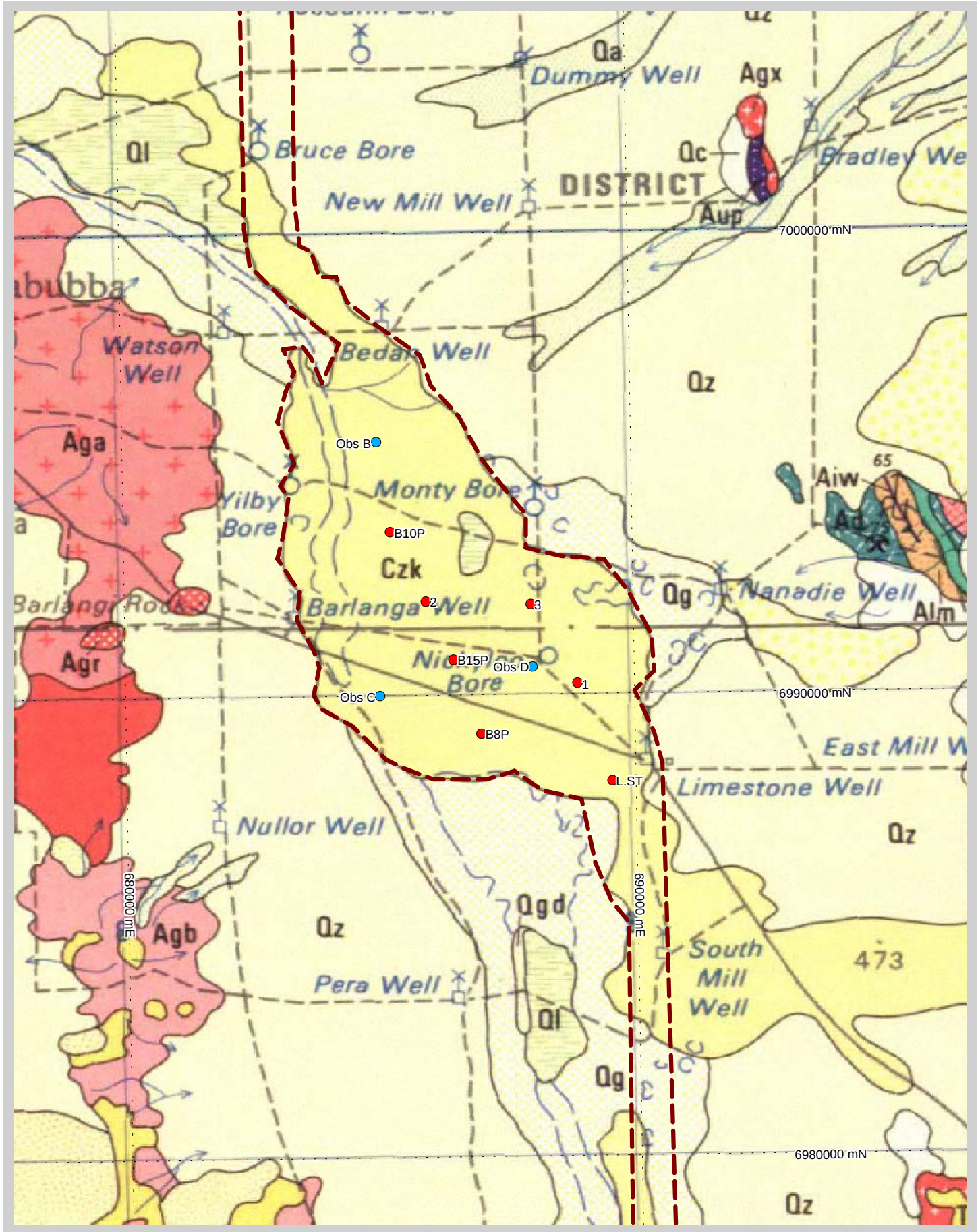
1.24GL/annum Demand Scenario

- Four prediction scenarios were assessed for a range of parameters (Base Case and Scenarios 1 to 3) for the 1.24GL/annum demand scenario, as summarised in Table 6.6.

2.5GL/annum Demand Scenario

Two sets of five model runs each were carried out for the 2.5GL/annum demand scenario. The first model run set (Run 1) used seven active production bores each with an average abstraction rate of 980kL/d (11-12L/s) each, and the second run set (Run 2) consisted of 10 active production bores each with an average abstraction rate of 685kL/d (7-8L/s).

- Run 1: Five prediction scenarios were assessed for a range of parameters (Base Case and Scenarios 1 to 4), as summarised in Table 6.6.
- Run 2: The Base Case model scenario was re-run with a borefield comprising 10 active production bores, using modelled aquifer parameters presented in Table 6.3.



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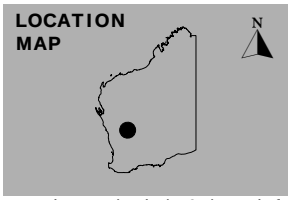
LOCATION MAP



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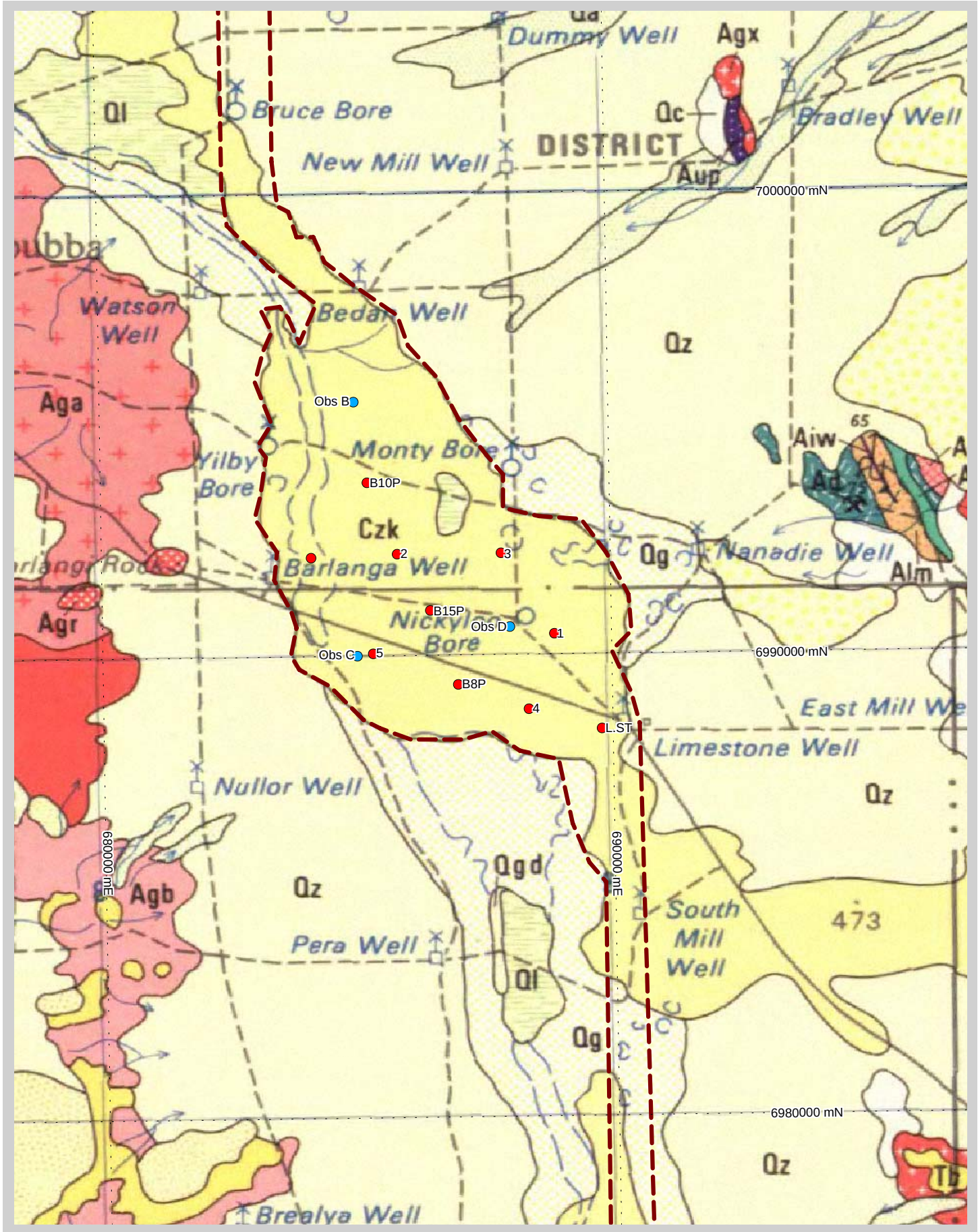
DRAWN:	KMH
DATE:	16/06/2008
JOB NO:	767\B12
REPORT NO:	179c
REVISION:	c
SCALE:	1:100,000
PROJECTION:	MGA94 Zone 50

LEGEND

- Production Bore
- Observation Point
- Extent of Modelled Calcrete

FIGURE 6.6
MODELLED BOREFIELD CONFIGURATION
SEVEN PRODUCTION BORES

Location: F:\Jobs\767\Mapinfo\233 Figs\Fig6.6.WOR



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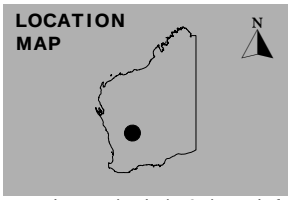
LOCATION MAP



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REVISION:	a
SCALE:	1:100,000
PROJECTION:	MGA94 Zone 50

LEGEND

- Production Bore
- Observation Point
- Extent of Modelled Calcrete

FIGURE 6.7
MODELLED BOREFIELD CONFIGURATION
10 PRODUCTION BORES

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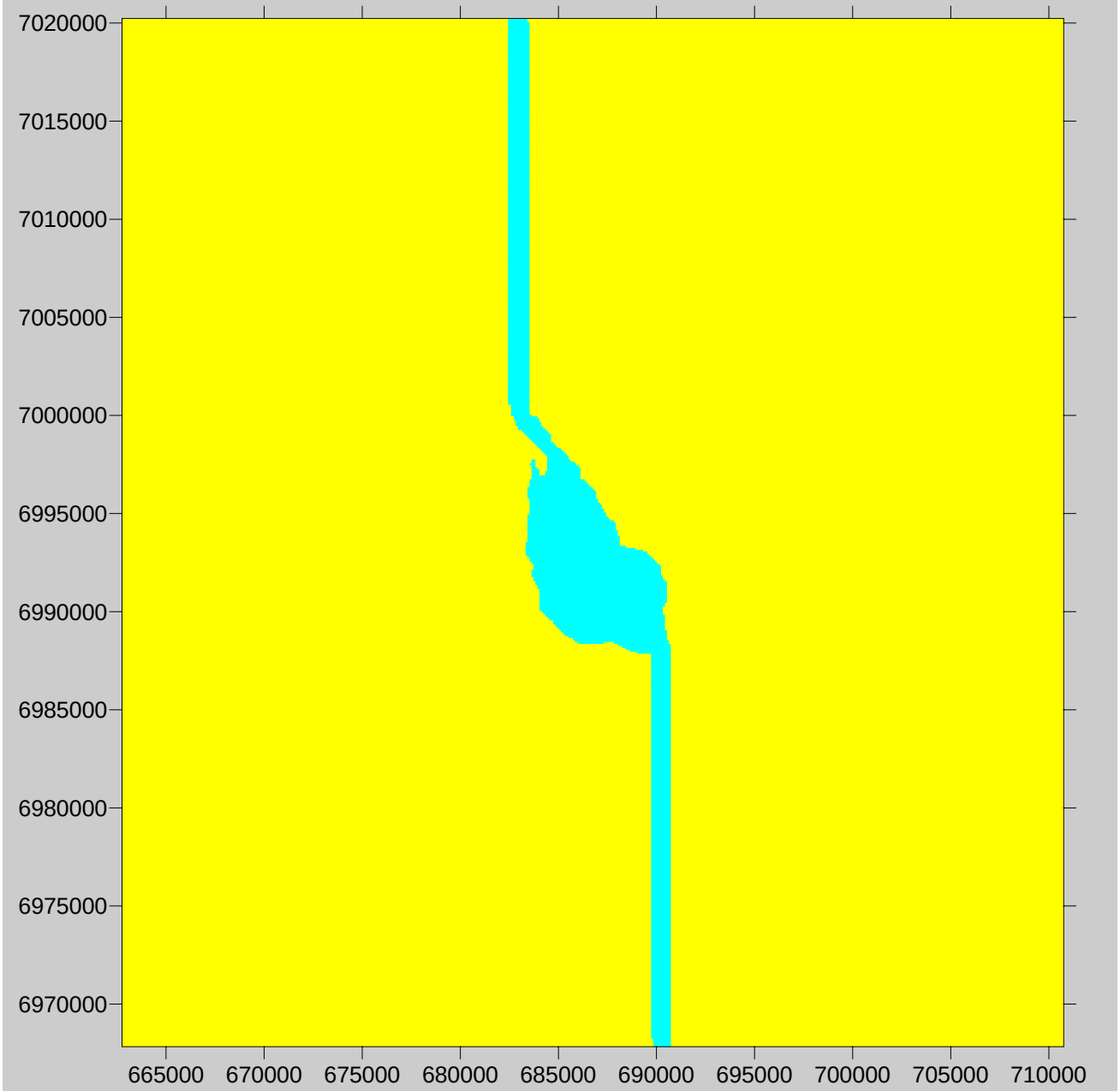

	SCENARIO 1		SCENARIO 2		SCENARIO 3	
	Kh	Kv	Kh	Kv	Kh	Kv
	500	50	50	5	50	5
	0.001	0.0001	0.001	0.0001	0.001	0.0001

aquaterra **MODELLED HYDRAULIC CONDUCTIVITY DISTRIBUTION - LAYER 1 (SCENARIO 1-3)**

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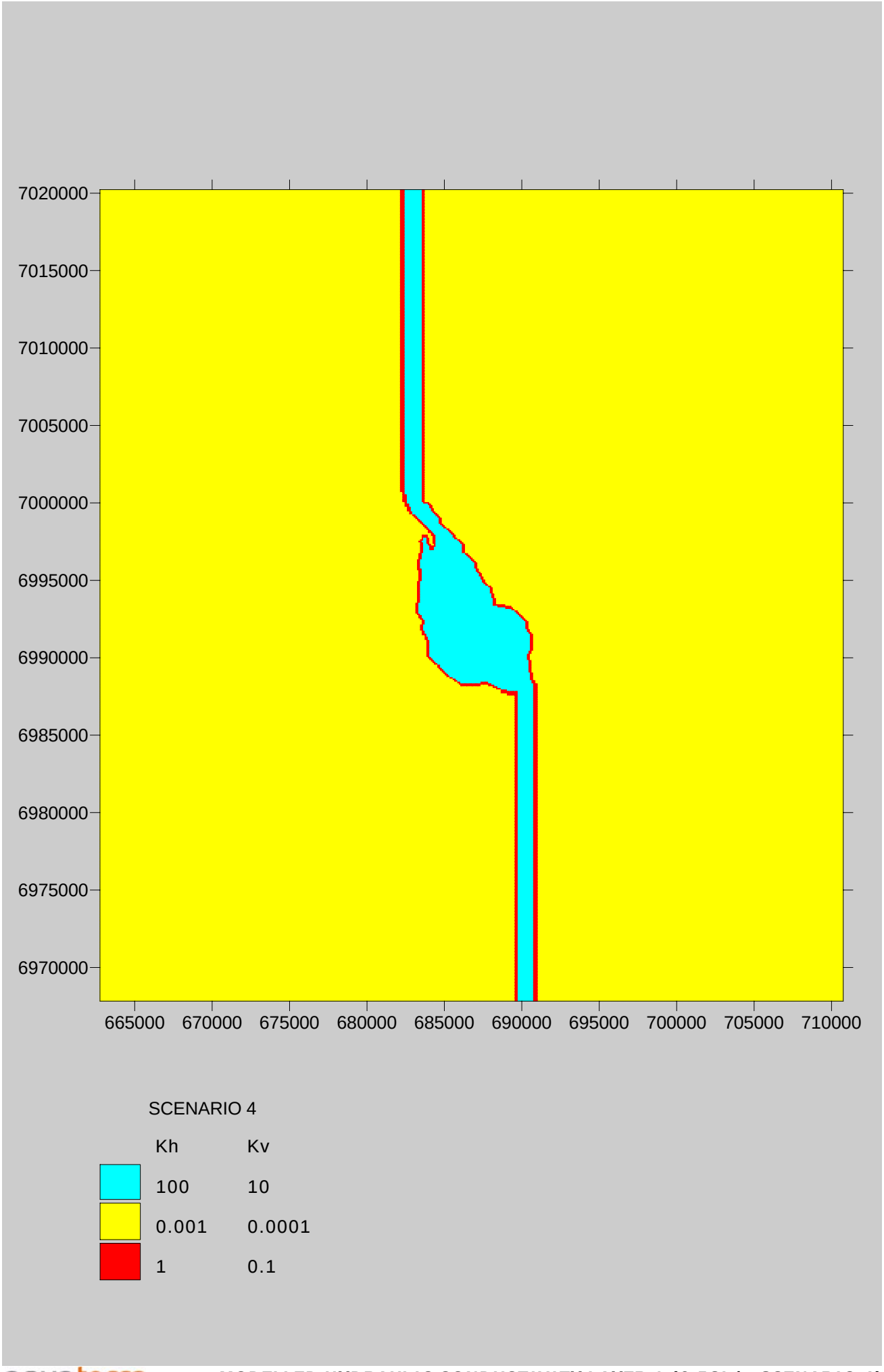
FIGURE 6.8



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MODELLED HYDRAULIC CONDUCTIVITY LAYER 1 (2.5GL/a SCENARIO 4)

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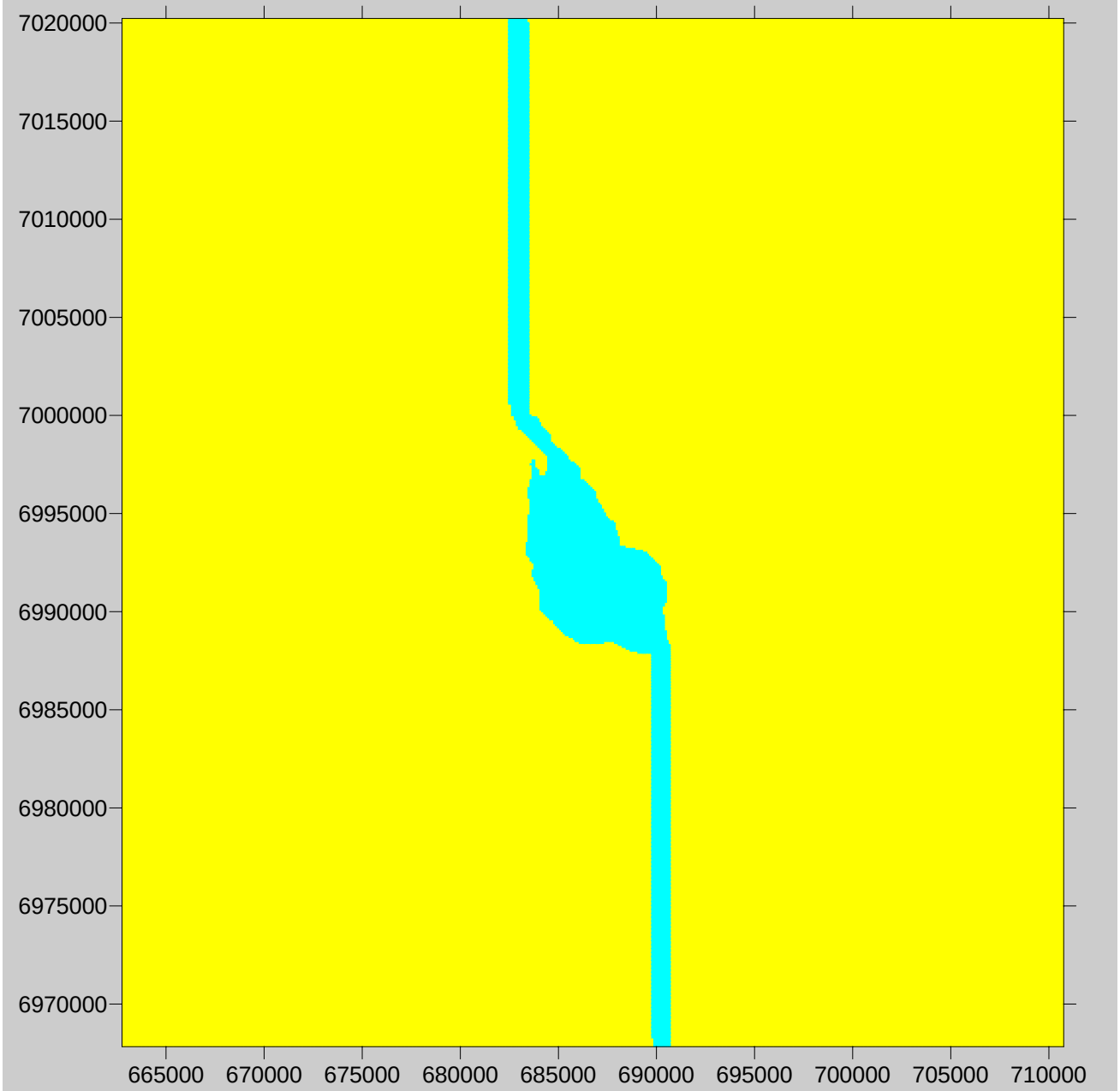
FIGURE 6.9



	SCENARIO 1		SCENARIO 2		SCENARIO 3		SCENARIO 4	
	Sy	S	Sy	S	Sy	S	Sy	S
	0.15	0.0001	0.25	0.0001	0.15	0.0001	0.2	0.0001
	0.01	0.0001	0.01	0.0001	0.01	0.0001	0.01	0.0001

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SPECIFIC YIELD & STORAGE COEFFICIENT - LAYER 1 (SCENARIO 1-4)

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FIGURE 6.10

6.4 1.24GL/ANNUM MODELLING RESULTS

Predicted water level drawdown values for each run at the observation points under Base Case aquifer conditions is summarised in Table 6.7.

Figure 6.11 illustrates the predicted drawdown contours for water levels within the calcrete aquifer after 12 years of pumping. Plots of drawdown against time for each observation point (Obs A – Obs D) are presented in Appendix E.

- The model output shows maximum drawdown observed at Obs A (Bore 3). Predictions show a maximum drawdown of 3.1m, assuming continual abstraction over a twelve year (life of mine) period. This drawdown is based on the most conservative scenario (Scenario 1, Kh=500m/d and Sy = 0.15). Increasing the specific yield (i.e. the volume of water stored within the aquifer) to 0.25 and reducing hydraulic conductivity (k) to 50m/d (Scenario 2) has the effect of reducing predicted drawdown to 2.2m. It should be noted that the drawdown derived at Obs A (Bore 3) relates to long-term water levels at a point of abstraction, rather than across the aquifer as a whole. With increasing distance from pumping wells, the drawdown would be considerably reduced.
- Obs B is located in the north of the modelled area, where the saturated thickness of the calcrete aquifer is 5m. Water level drawdown for Scenarios 1 to 3 ranged between 1.46m (Scenario 1) and 0.46m (Scenario 2). Predicted water level drawdowns are reduced at this location due primarily to the distance of the observation point from active pumping wells.
- Obs C is located in the southwest of the modelled area, where the saturated thickness of the calcrete aquifer is estimated to be of the order of 15m. Water level drawdown of between 1.3m (Scenario 2) and 2.2m (Scenario 3) were predicted.
- Obs D is located in the centre of the proposed borefield, where maximum aquifer water level drawdowns are anticipated. The saturated thickness of calcrete at Obs D is estimated to be of the order of 14m. Water level drawdown of between 1.6m (Scenario 2) and 2.5m (Scenario 3) were predicted.

Table 6.7: Predicted Water Level Drawdown after 12 years of Abstraction (1.24GL/annum Base Case)

Bore ID	Predicted Drawdown (m)
Obs A (Bore 3)	2.04
Obs B	0.84
Obs C	1.58
Obs D	1.78
Barlanga Well	1.31
Yilby Bore	1.1
South Mill Well	0.77
Bedan Well	0.49

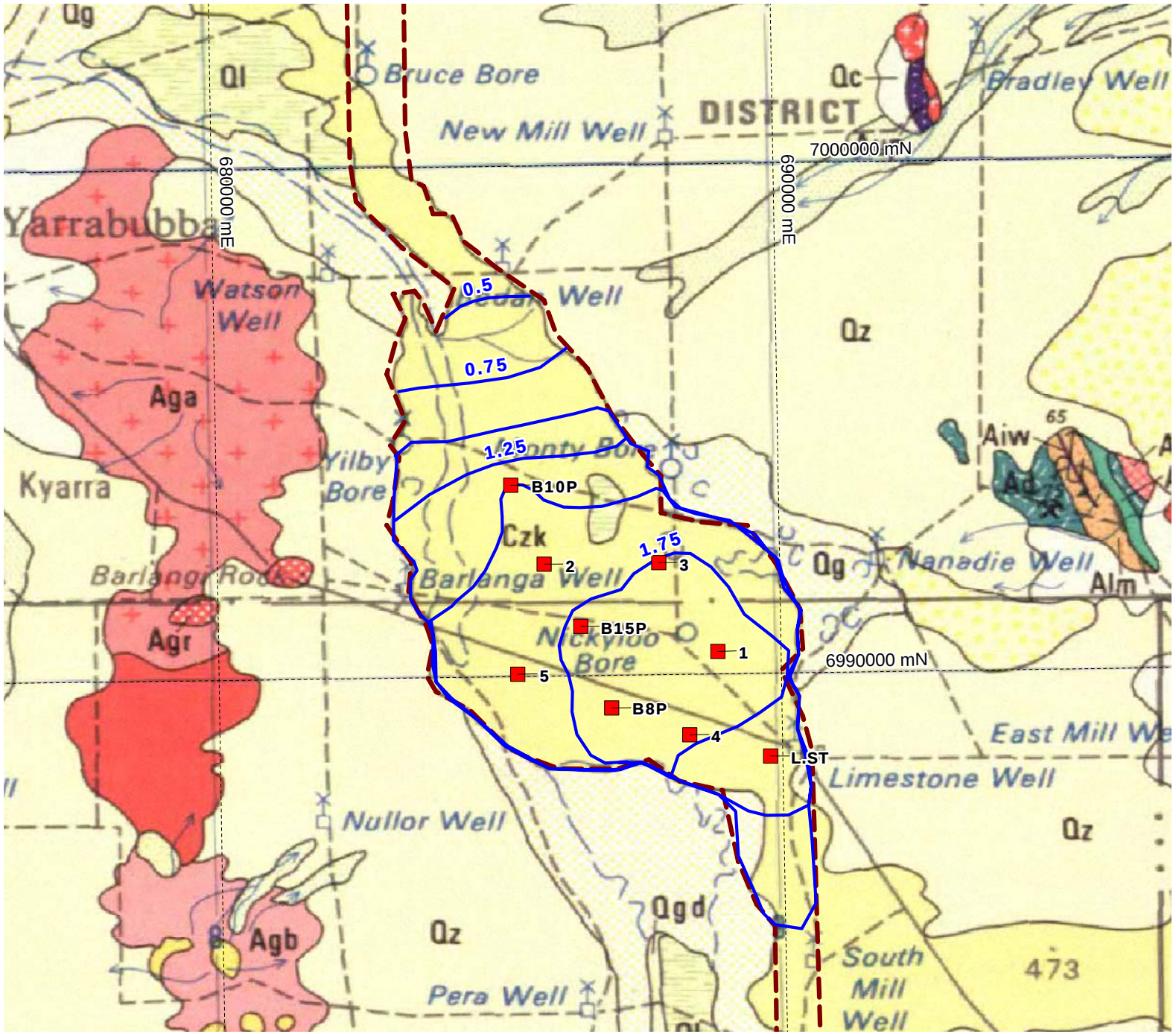
6.4.1 WATER BALANCE

The predicted model water balance values for the various prediction scenarios of the 1.24GL/annum demand model after 12 years of abstraction are presented in Table 6.8. The predicted water balance shows that the source of the water for groundwater abstraction, which represents the majority of the water balance, is aquifer storage (i.e. storage depletion is manifested as aquifer drawdown, which is mostly constrained to the calcrete formation). It also shows that there is minor groundwater throughflow ("groundwater inflow" and "groundwater outflow") from the model boundaries.

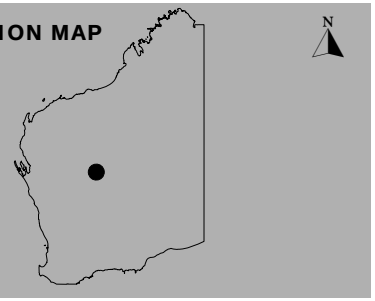
Whereas, our estimates of groundwater throughflow near Limestone Well range from approximately 680kL/d (0.25GL/a) to 1,100kL/d (0.4GL/a), which is at least three times greater than that shown in the predicted water balance. This calculated throughflow was based on an average hydraulic conductivity of 100m/d, conservative cross-sectional area of approximately 11,250m^2 and a hydraulic gradient ranging from approximately 0.0006-0.001. However, there is a high level of uncertainty around the hydraulic gradient due to limited available survey data and water level data, in addition the hydraulic gradient will increase once groundwater abstraction commences, inducing greater throughflow.

Table 6.8: 1.24GL/a Model Predictions Water Balance

	Base Case (kL/d)		Scenario 1 (kL/d)		Scenario 2 (kL/d)		Scenario 3 (kL/d)	
	In	Out	In	Out	In	Out	In	Out
Storage	3,500	0	3,318	0	3,495	0	3,499	0
Groundwater Inflow	1.4	0	181	0	0	0	0	0
Groundwater Outflow	0	0	0	0	0	0	0	0
Pumping	0	3,500	0	3,500	0	3,500	0	3,500
TOTAL	3,501.4	3,500	3,499	3,500	3,495	3,500	3,499	3,500



LOCATION MAP



LEGEND

- Modelled Borefield
- Drawdown Contours (m)
- Modelled Calcrete Extent

DATA SOURCE

1:250,000 SG50-16 Geology Map
First Edition 1984 (GSWA)

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FIGURE 6.11

1.24GL/A PREDICTED DRAWDOWNS (BASE CASE) AT 12 YEARS

AUTHOR:	KMH	REPORT NO:	233
DRAWN:	KMH	REVISION:	a
DATE:	1/10/2009	SCALE:	1:100,000
JOB NO:	767\B12	PROJECTION:	MGA94 Z50

Location: F:\Jobs\767\Mapinfo\233 Figs\Fig6.11

6.5 2.5GL/ANNUM MODELLING RESULTS

Predicted water level drawdown values for each run at the observation points under Base Case aquifer conditions is summarised in Table 6.9.

Table 6.9: Predicted Water Level Drawdown after 12 years of Abstraction (2.5GL/annum Base Case)

Bore ID	Predicted Drawdown (m)	
	Seven Active Bores (Run 1)	Ten Active Bores (Run 2)
Obs A (Bore 3)	4.2	3.8
Obs B	1.6	1.5
Obs C	3.2	3.5
Obs D	3.6	3.5
Barlanga Well	2.6	2.9
Yilby Bore	2.1	2.2
South Mill Well	1.5	1.4
Bedan Well	0.8	0.85

6.5.1 RUN 1 – BASE CASE PARAMETERS

Predicted water level drawdown over time at each production bore and observation point for Run 1 is presented in Figure 6.12 to 6.15. Under Base Case aquifer parameters, the modelling completed predicts the following after 12 years of abstraction:

Borefield

- Bore 3 (Obs A) - maximum water level drawdown of 4.2m, which results in a reduction of aquifer saturated thickness at this location from 10m to 5.8m (a retention of 58% of aquifer saturated thickness). It should be noted this is an active production bore, therefore, water level drawdown in the production bore itself will be greater than 4m.
- Obs B (located in the north of the investigation area) - water level drawdown of 1.55m, which results in a reduction of aquifer saturated thickness from 5m to 3.45m (a retention of 69% of aquifer saturated thickness). Predicted drawdowns are reduced at this location primarily due to the distance from active production bores.
- Obs C (located in the south west of the investigation area) – water level drawdown of 3.2m, which results in a reduction of aquifer saturated thickness from 15m to 11.8m (a retention of 79% of aquifer saturated thickness).
- Obs D (located in the centre of the proposed borefield area) - water level drawdown of 3.55m, which results in a reduction of aquifer saturated thickness from 14m to 10.45m (a retention of 75% of aquifer saturated thickness).

Existing Users

- Barlanga Well – greatest water level drawdown of the existing users, with a water level drawdown of 2.6m after 12 years of abstraction. This results in a reduced aquifer saturated thickness from 12m to 9.4m (a retention of 78% of aquifer saturated thickness).
- Yilby Bore – water level drawdown of 2.1m, which results in a reduction of aquifer saturated thickness from 5m to 2.9m (a retention of 58% of aquifer saturated thickness).
- South Mill Well – water level drawdown of 1.5m, which results in a reduced aquifer saturated thickness from 15m to 13.5m (a retention of 90% of aquifer saturated thickness).

- Bedan Well – water level drawdown of 0.8m, which results in a reduced aquifer saturated thickness from 5m to 4.2m (a retention of 85% of aquifer saturated thickness).

Figure 6.16 presents the predicted water level drawdown contours within the calcrete aquifer after 12 years of pumping for the Base Case.

6.5.2 RUN 1 - SCENARIO 3

Scenario 3 was run to represent "worst case" aquifer parameters, therefore the model predicted maximum water level drawdown under this scenario.

- Maximum water level drawdown was predicted at Bore 3 (Obs A), with a drawdown greater than 8m predicted after 12 years of abstraction (saturated thickness from 10m to less than 2m, retention of less than 20% aquifer saturated thickness).
- Predictions under this scenario suggest that Bore 3 and Bore 2 cannot maintain groundwater levels above the screened interval during continuous groundwater abstraction after 12 years (end of mine life). However, it should be noted that operationally, bore yields may decrease due to reduced saturated aquifer thickness and turbulent flows. Production bores would be rotationally operated to ensure efficient pumping and maximum saturated aquifer thickness.

6.5.3 RUN 1 - SCENARIO 1, 2 AND 4

Scenarios 1, 2 and 4 predict water level drawdown values similar to the Base Case, with variations generally ranging between ± 0.5m of the Base Case value.

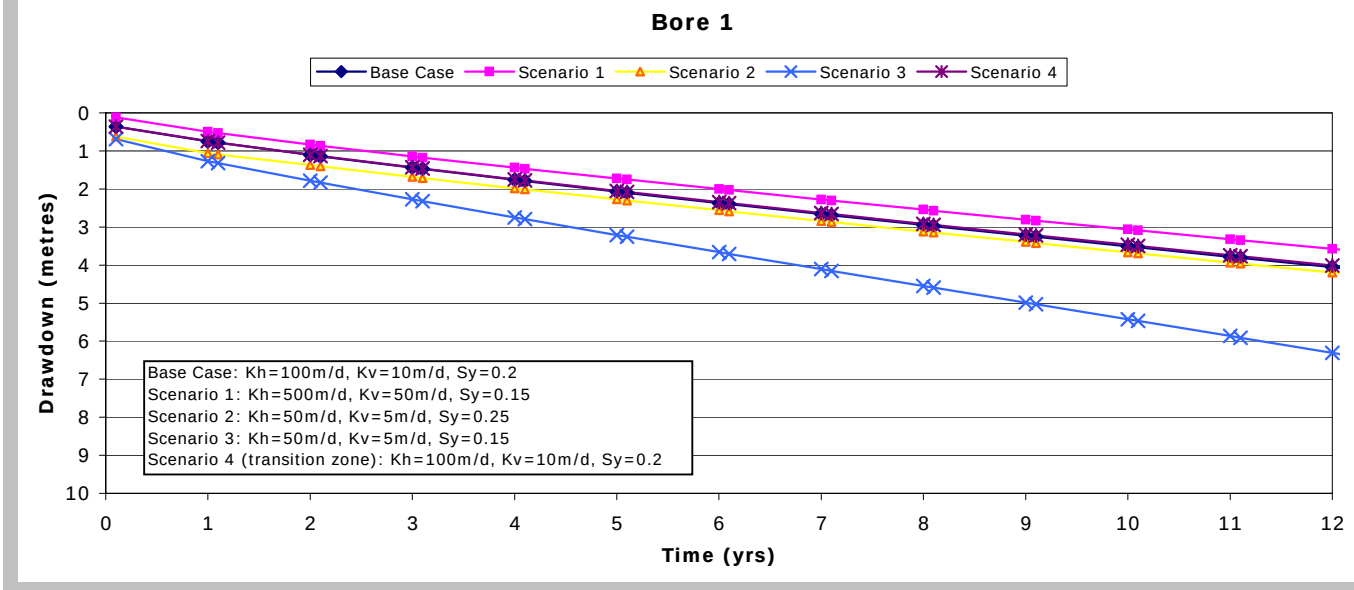
6.5.4 WATER BALANCE

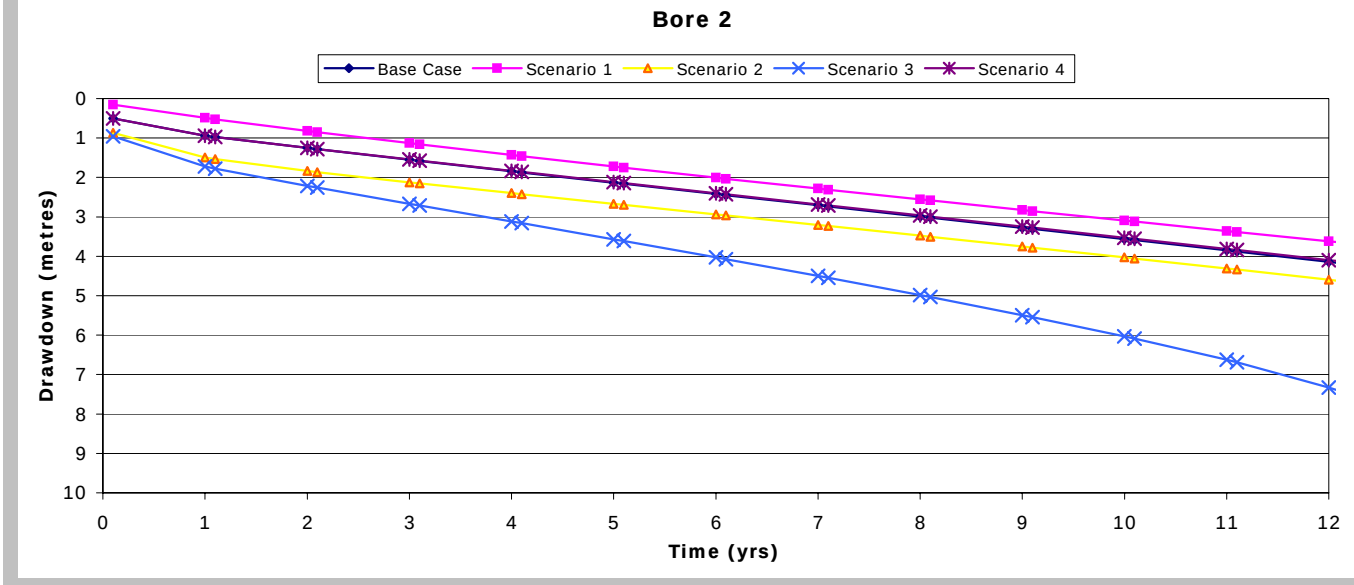
The cumulative water balance, averaged over the model duration, for each prediction scenario of the 2.5GL/annum demand case (Run 1), is presented in Table 6.10. The predicted model water balance shows that groundwater abstraction, which represents the majority of the water balance for each prediction scenario, is sourced mainly from groundwater storage. With the exception of Scenario 1, groundwater throughflow ("groundwater inflow" and "groundwater outflow") from the model boundaries represents less than 1% of the overall water balance. The predicted water balance for Scenario 1 (K_h=500m/d and Sy=15%) suggests that groundwater inflow represents 5% of the total water balance.

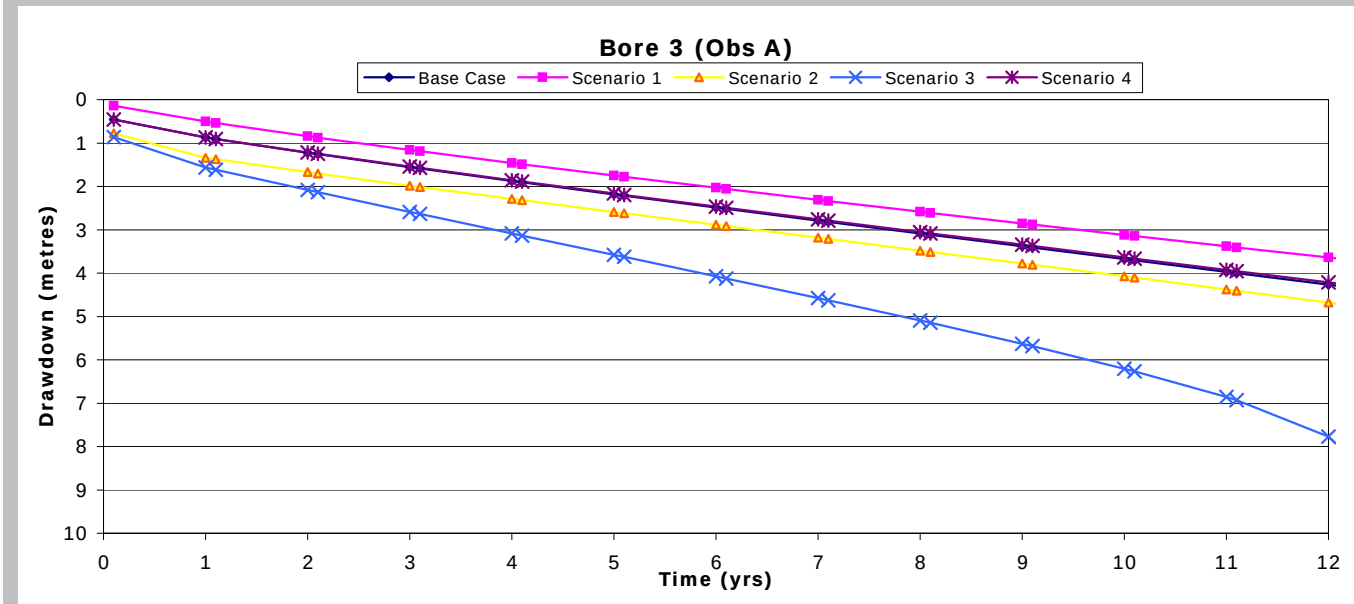
However, our estimated groundwater throughflow near Limestone Well ranged from approximately 680kL/d (0.25GL/a) to 1,100kL/d (0.4GL/a), which is at least double that shown in the predicted water balance.

Table 6.10: 2.5GL/a (Run 1) Model Predictions Water Balance

	Base Case (kL/d)		Scenario 1 (kL/d)		Scenario 2 (kL/d)		Scenario 3 (kL/d)		Scenario 4 (kL/d)	
	In	Out	In	Out	In	Out	In	Out	In	Out
Storage	6,867.4	0	6,511.6	0	6,863.3	0	6,865.4	0	6,867.6	0
Groundwater Inflow	3.5	0	354.5	0	0	0	0.5	0	3.3	0
Groundwater Outflow	0	0	0	0	0	0	0	9	0	0
Pumping	0	6,864.7	0	6,864.7	0	6,864.7	0	6,864.7	0	6,864.7
TOTAL	6,870.9	6,864.7	6,866.1	6,864.7	6,863.3	6,864.7	6,865.9	6,864.7	6870.9	6,864.7







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2.5 GL/a PREDICTED DRAWDOWN (RUN 1) - BORE 1, 2 & 3 FIGURE 6.12

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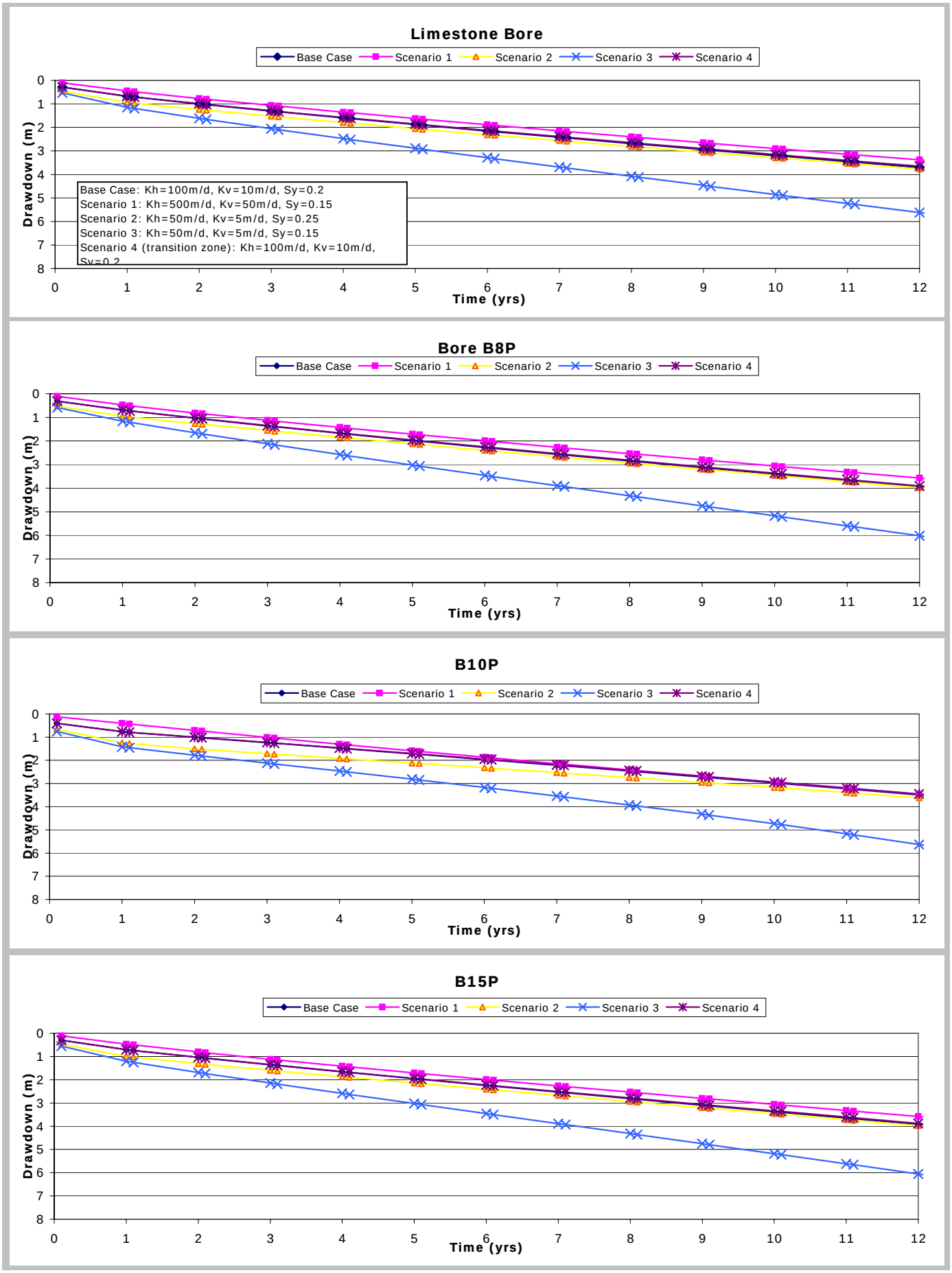

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2.5GL/a PREDICTED DRAWDOWN (RUN 1) - LIMESTONE BORE, B8P, B10P & B15P

FIGURE 6.13

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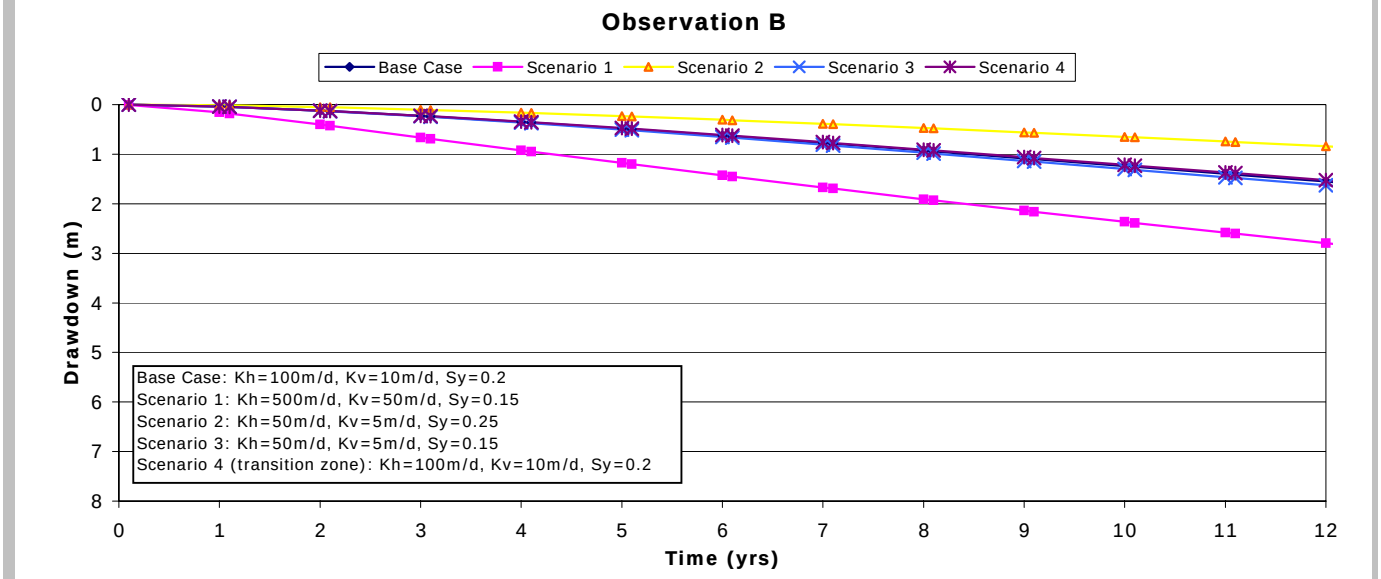
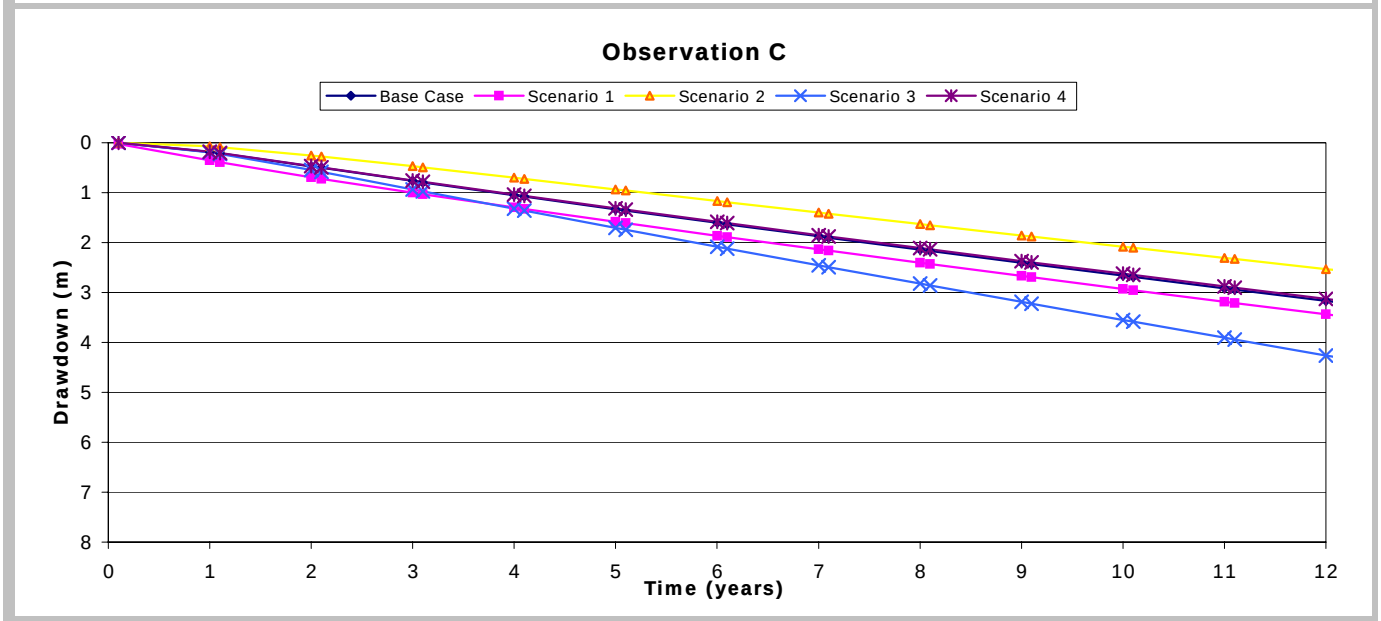
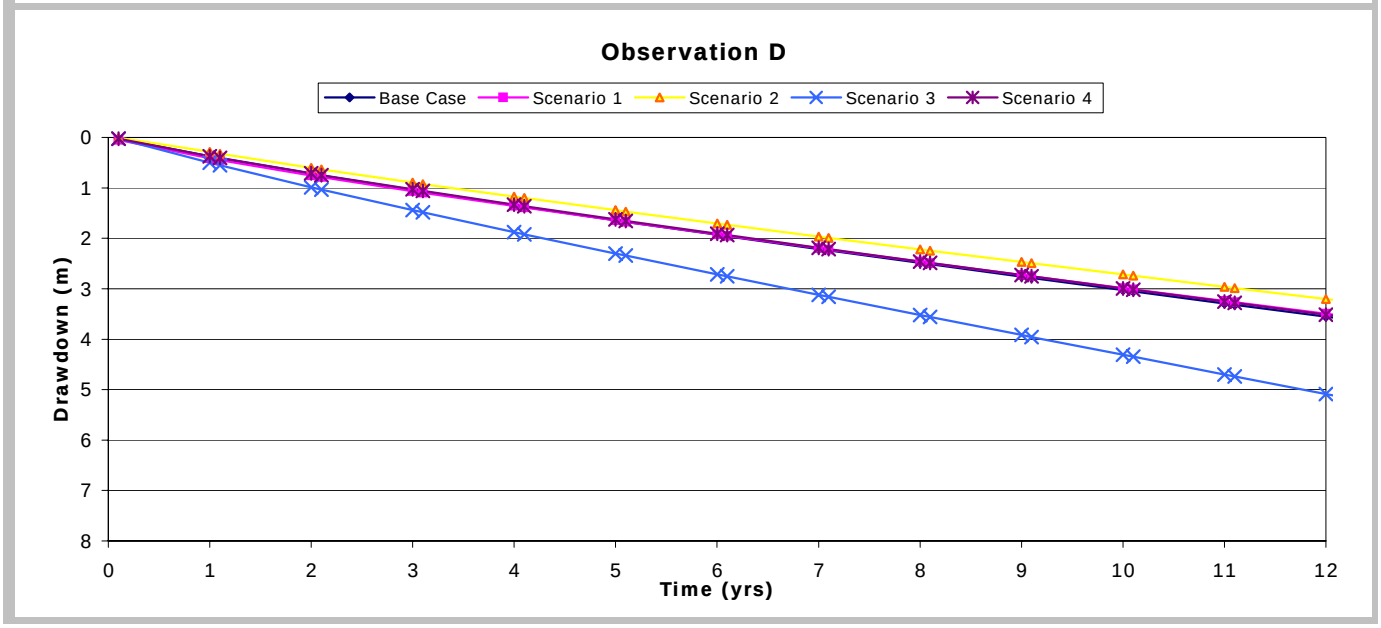
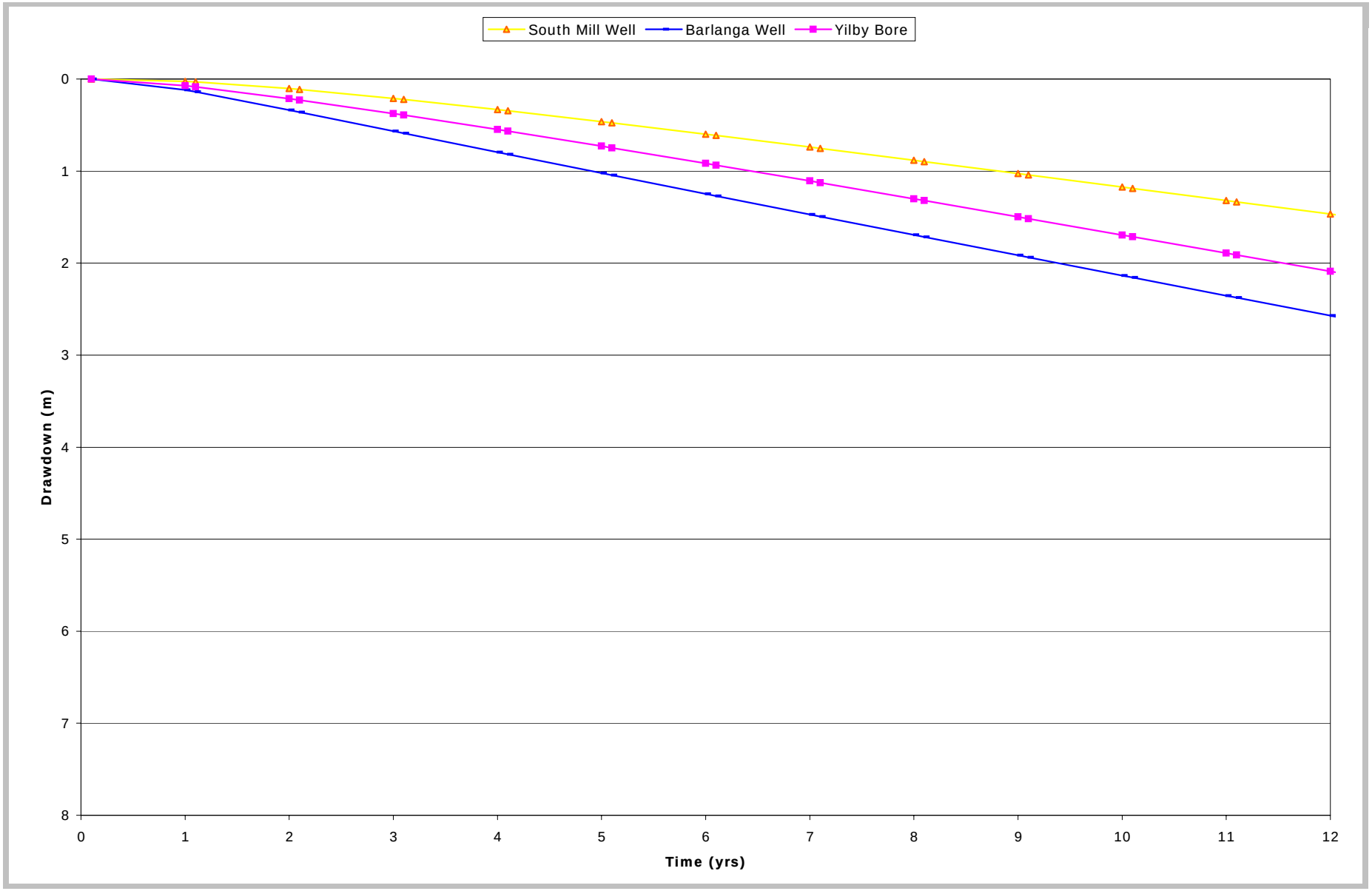

Observation B
Base Case
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Drawdown (m)
Time (yrs)
Base Case: Kh=100m/d, Kv=10m/d, Sy=0.2
Scenario 1: Kh=500m/d, Kv=50m/d, Sy=0.15
Scenario 2: Kh=50m/d, Kv=5m/d, Sy=0.25
Scenario 3: Kh=50m/d, Kv=5m/d, Sy=0.15
Scenario 4 (transition zone): Kh=100m/d, Kv=10m/d, Sy=0.2


Observation C
Base Case
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Drawdown (m)
Time (years)


Observation D
Base Case
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Drawdown (m)
Time (yrs)



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2.5GL/a PREDICTED DRAWDOWN (RUN 1 BASE CASE) - EXISTING USERS FIGURE 6.15

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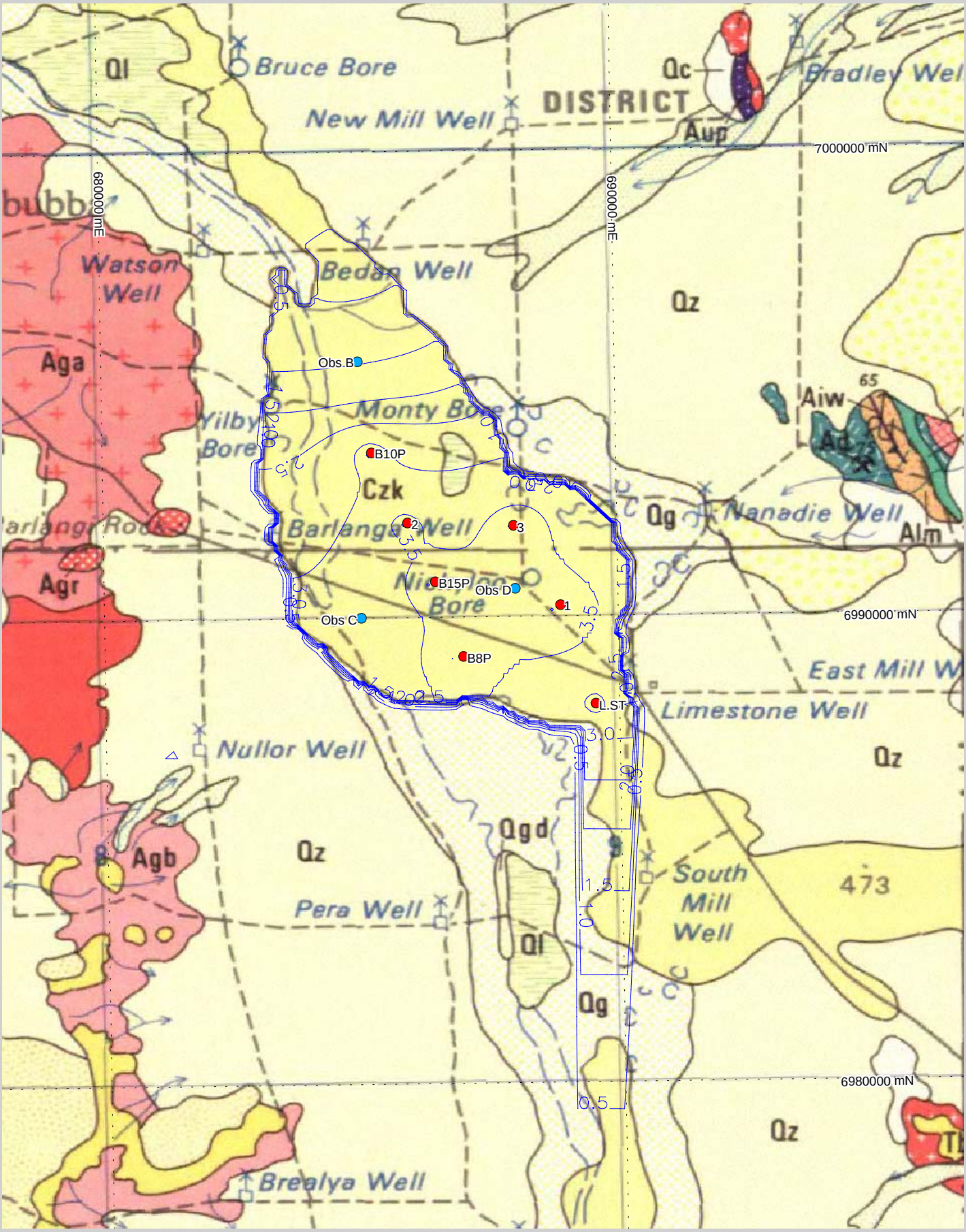

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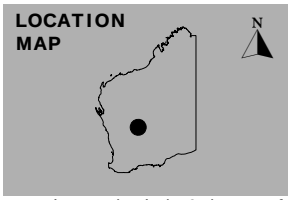
LOCATION MAP



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DRAWN:	KMH
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SCALE:	1:100,000
PROJECTION:	MGA94 (Zone 50)

LEGEND

- Production Bore
- Observation Point

FIGURE 6.16

2.5GL/A PREDICTED DRAWDOWN CONTOURS (RUN 1) BASE CASE AT 12 YEARS

2 0 2 4

Kilometers

Location: F:\Jobs\767\MapInfo\233_Figs\Fig6.16.WOR

6.6 RUN 2

Predicted water level drawdown at each production bore and observation point for Run 2 is presented in Figure 6.17 and 6.18. Under Base Case aquifer parameters, the modelling completed predicts the following:

Borefield

- Bore 3 (Obs A) - greatest water level drawdown of the four observation points, with a water level drawdown of 3.8m after 12 years of abstraction (a retention of 62% of aquifer saturated thickness).
- Obs B - water level drawdown of 1.5m after 12 years of abstraction (a retention of 70% of aquifer saturated thickness).
- Obs C and Obs D – both had similar water level drawdowns of 3.5m after 12 years of abstraction (an approximate retention of 75% aquifer saturated thickness).

Existing Users

- Barlanga Well – greatest water level drawdown of the existing users, with a water level drawdown of 2.9m after 12 years of abstraction. This results in a reduced aquifer saturated thickness from 12m to 9.1m (a retention of 76% of aquifer saturated thickness).
- Yilby Bore - water level drawdown of 2.2m after 12 years of abstraction, which results in a reduced aquifer saturated thickness from 5m to 2.8m (a retention of 55% of aquifer saturated thickness).
- South Mill Well - water level drawdown of 1.4m after 12 years of abstraction. This results in a reduced aquifer saturated thickness from 15m to 13.6m (a retention of 90% of aquifer saturated thickness).
- Bedan Well (4.5km north of production bore B10P) – water level drawdown of 0.85m, which results in a reduced aquifer saturated thickness from 5m to 4.15m (a retention of approximately 85% of aquifer saturated thickness).

Predicted water level drawdown contours within the calcrete aquifer after 12 years of abstraction from ten bores is presented in Figure 6.19.

The modelling undertaken predicts that the vertical and lateral extent of water level drawdown across the borefield area is similar for both borefield configurations (Run 1 with 7 active bores or Run 2 with 10 active bores) for abstraction over a 12 year period (refer Table 6.8).

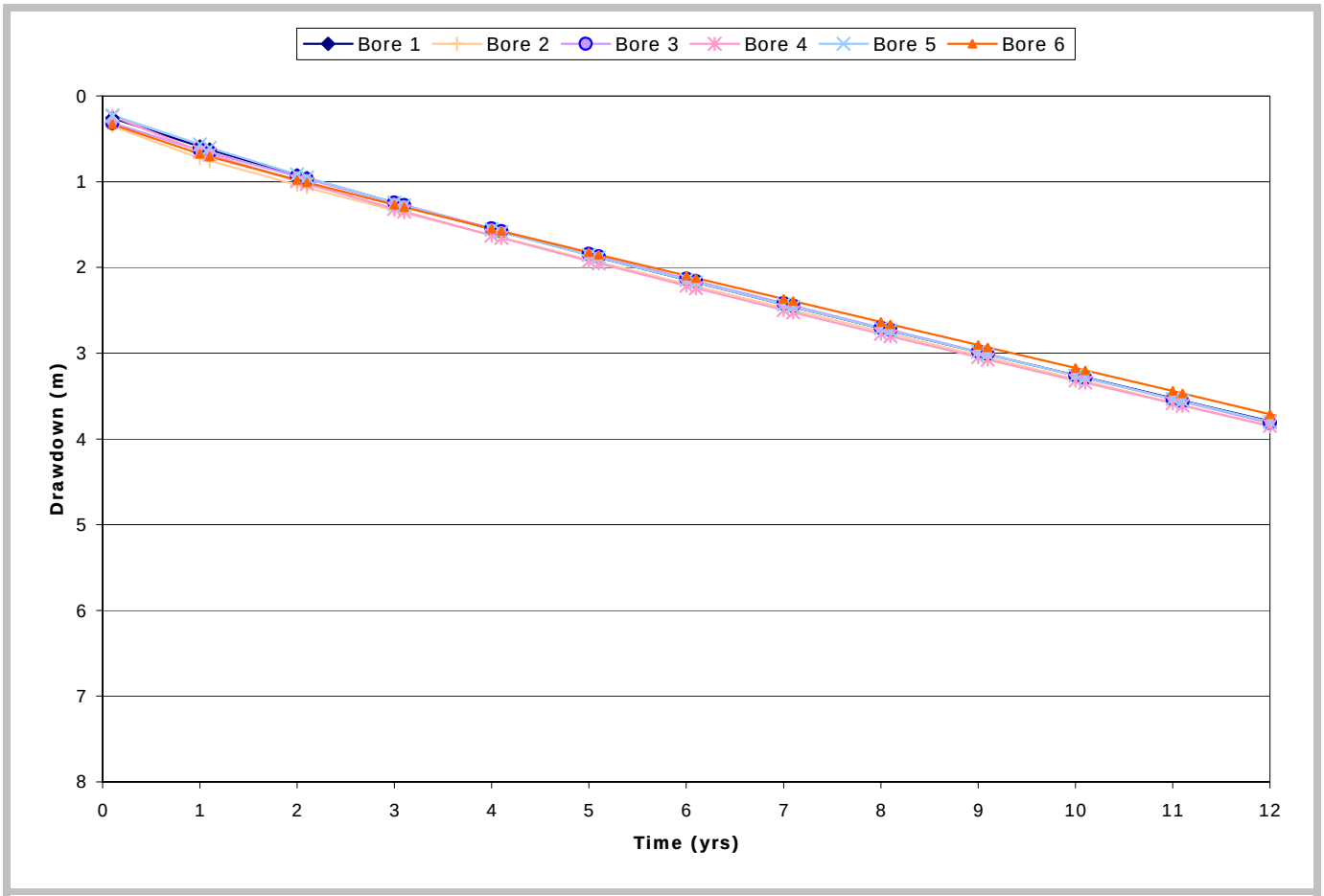
6.6.2 WATER BALANCE

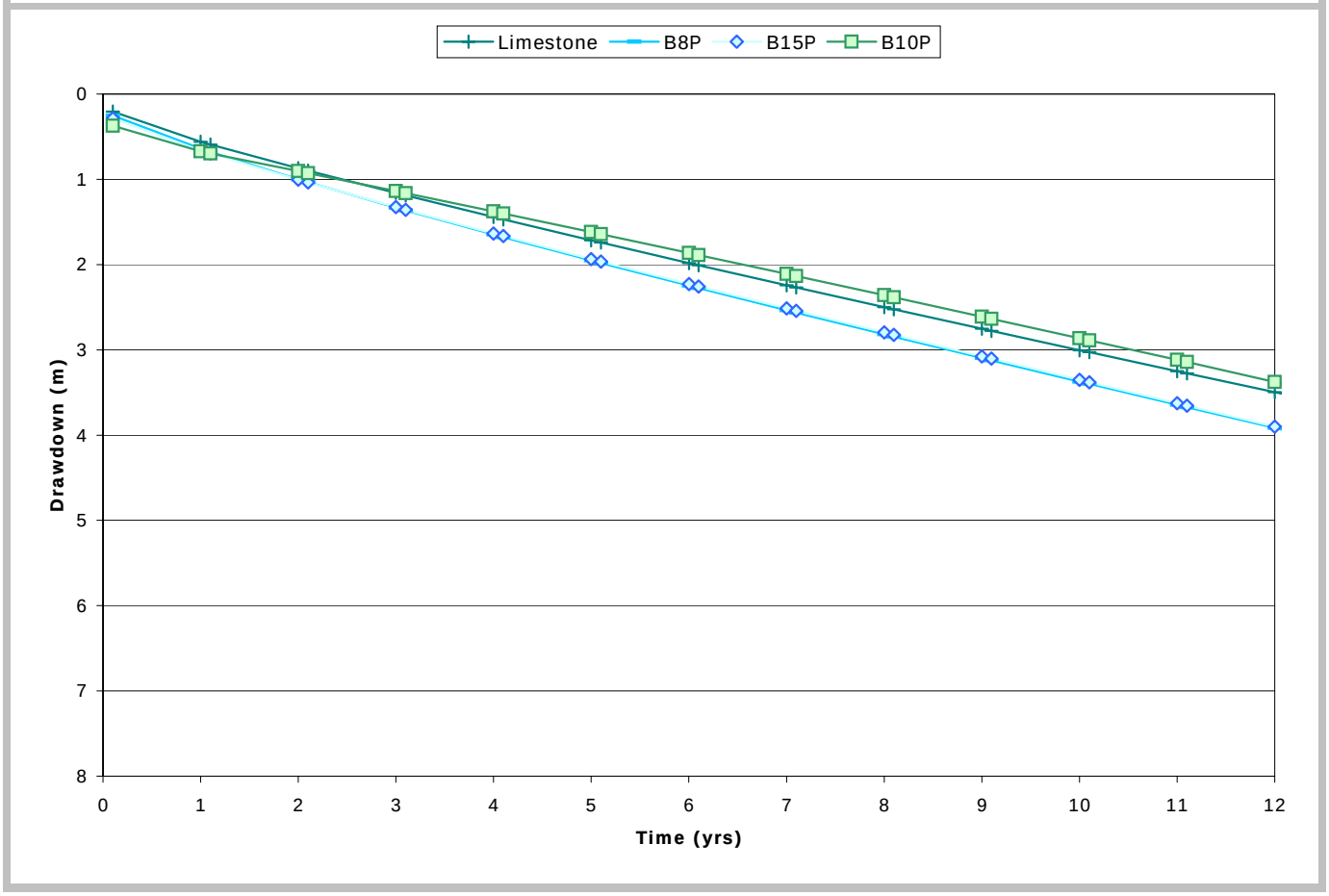
The predicted model water balance, averaged over the model duration, for Run 2 of the 2.5GL/annum demand case, is presented in Table 6.11. As observed in the previous model runs, the predicted model water balance shows that groundwater abstraction represents the majority of the water balance for each prediction scenario. Table 6.11 shows that the source of this water is aquifer storage and groundwater throughflow ("groundwater inflow" and "groundwater outflow") from the model boundaries represents less than 1% of the overall water balance.

However, our estimated groundwater throughflow near Limestone Well ranged from approximately 680kL/d (0.25GL/a) to 1,100kL/d (0.4GL/a), which is considerably greater than that shown in the predicted water balance.

Table 6.11: 2.54GL/a (Run 2) Model Predictions Water Balance

	Base Case (kL/d)	
	In	**Out**
Storage	6857.6	0
Groundwater Inflow	3.3	0
Groundwater Outflow	0	0
Pumping	0	6854.7
TOTAL	6,860.9	6854.7





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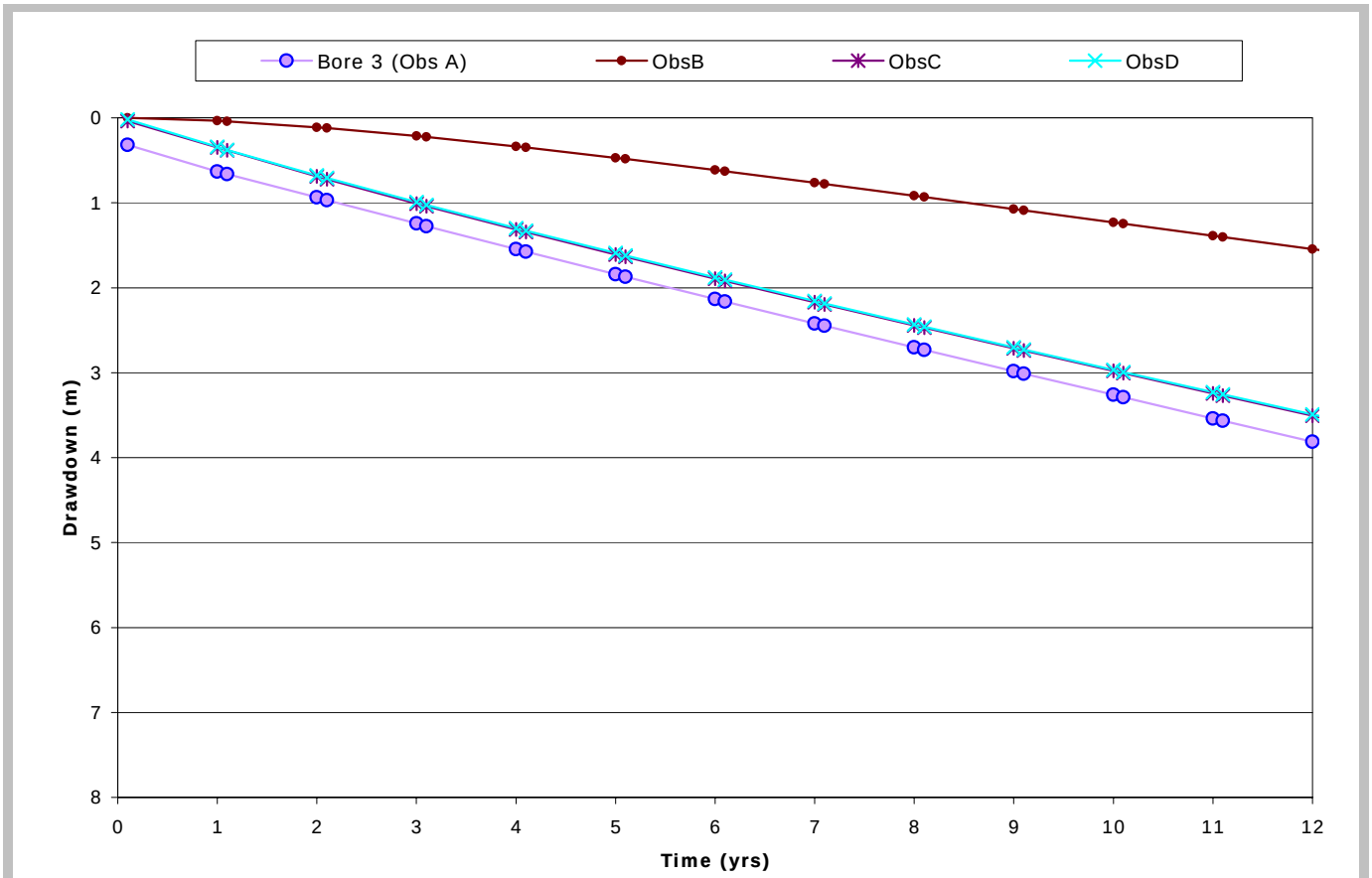
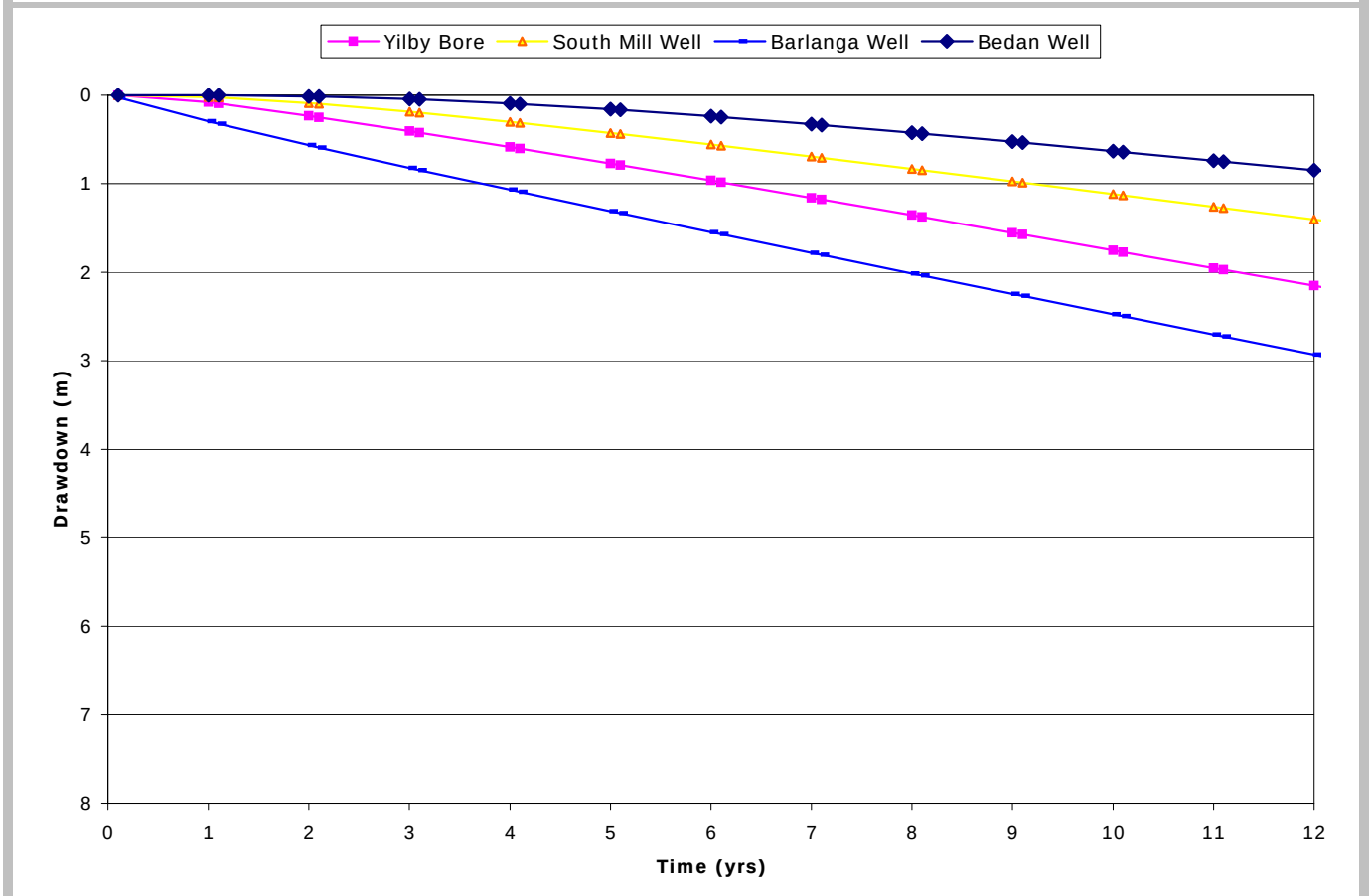
2.5GL/a PREDICTED DRAWDOWN (RUN 2) - PUMPING BORES

FIGURE 6.17

F:\Jobs\767\B12\233 Fig\[233_Fig6.17.xls]FIG6.17





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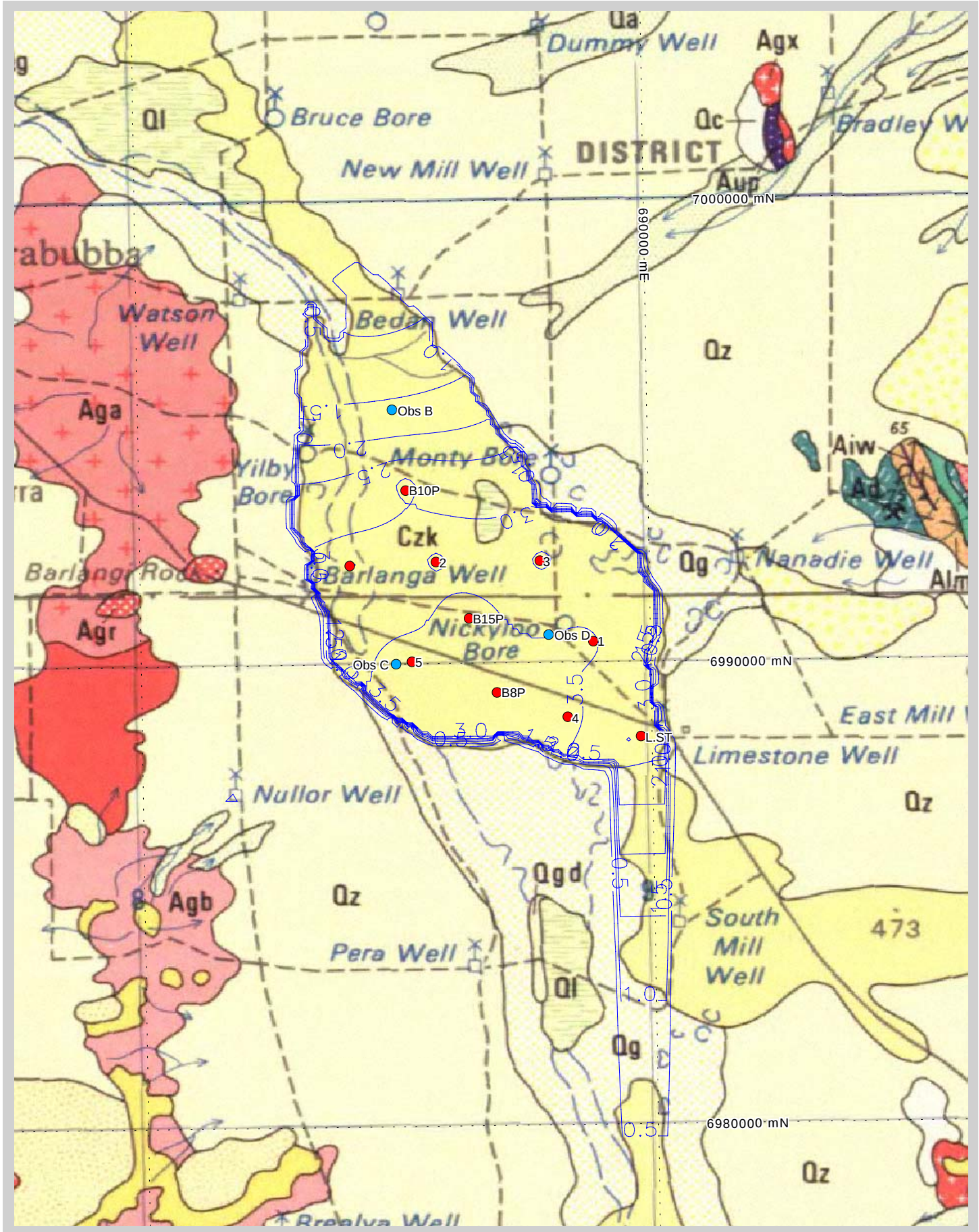
2.5GL/a PREDICTED DRAWDOWN (RUN 2) - OBSERVATION POINTS

FIGURE 6.18

F:\Jobs\767\B12\233 Fig\[233_FIG6.18.xls]FIG6.18



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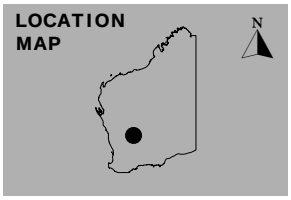
LOCATION MAP



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PROJECTION:	MGA94 (Zone 50)

LEGEND

- Observation Point
- Production Bore

FIGURE 6.19
2.5GL/A PREDICTED DRAWDOWN CONTOURS (RUN 2) AT 12 YEARS

2 0 2 4
Kilometres

Location: F:\Jobs\767\Mapinfo\233 Figs\Fig6.19.WOR

6.7 MODEL CONCLUSIONS

Under Base Case aquifer parameters, groundwater modelling predicts that a water supply demand of 2.5GL/a (6,850kL/d) can be met for a 12 year duration from a borefield comprising 7 to 10 production bores (each pumping at 7-12L/s) installed within the calcrete aquifer.

Groundwater modelling suggests that, under base case aquifer parameters, a borefield comprising 7 production bores (each pumping at around 11-12L/s for a duration of 12 years) will result in 58% retained saturated thickness (at Yilby Bore and Bore 3 (Obs A)) to 85% (at Bedan Well). Whilst a borefield comprising 10 production bores (each pumping at around 7-8L/s for a duration of 12 years) will result in a retained saturated thickness of 55% (at Yilby Bore) to 85% (at Bedan Well).

The number of bores required will depend on the actual sustainable yield achieved from each bore. The lateral and vertical extent of water level drawdown across the borefield will be dependent on the quantity of water abstracted, the duration of abstraction, the nature and extent of the aquifer, and the degree of interference between adjacent bores. The modelling suggests that there is limited difference in the extent of overall water level drawdown between the two borefield configurations evaluated.

However, if the aquifer conditions are found to be more representative of the "worst case" parameters, a sustained groundwater abstraction rate of 11-12L/s from each production bore may not be achievable at some production bore locations (such as Bore 2 and Bore 3 where less than 40% and 20% saturated thickness was retained, respectively), due to localised water level drawdown. However, a borefield comprising 7-10 bores is likely to be operated on a rotational basis, using standby production bores, allowing localised groundwater levels to recover whilst non-operational.

The numerical model maintains a conservative approach as:

- It does not take into account recharge from rainfall, which is thought to contribute a significant portion of the recharge to the aquifer and
- The results of the predicted model water balance show that groundwater abstraction is sourced mainly from groundwater storage and had minimal groundwater inflow from the model boundaries. However, we expect groundwater throughflow to contribute in reality to the calcrete aquifer resource (although we have not allowed for that in the model as a conservative assumption), in which case, it would reduce the volume of water abstracted from storage in the real system.
- In addition, the modelled calcrete extent is conservative and does not take into account the eastern branch of the Cogla Downs drainage system, which, if included, would substantially increase the volume of groundwater available in storage (Figure 6.2).
- It should also be noted that inflow to the calcrete aquifer from adjacent alluvial sediments has not been included in this model. These surrounding alluvial sediments are expected to be in hydraulic connection with the calcrete aquifer.

Prior to applying for a 5C Licence to take groundwater and once further information is available (including new drilling and testing results, recharge assessments, groundwater monitoring, etc), it is proposed that additional numerical modelling be undertaken to reassess sustainable yield from the calcrete aquifer and the potential impact on water levels within the aquifer and regionally.

7 GROUNDWATER MANAGEMENT

7.1 POTENTIAL IMPACTS

7.1.1 OTHER USERS

Other groundwater users in the borefield area include pastoral bores (Figure 3.1): South Mill Well, Monty Bore, Yilby Bore, Nickyloo Bore, Bedan Well, Limestone Well and Barlanga Well. Of these bores, South Mill Well, Bedan Well, Yilby Bore and Barlanga Well were included in the numerical model as observation points to assess the potential impact from operation of the proposed borefield.

In addition to the above listed pastoral bores, there are other bores outside the calcrete outcrop area, and include Bruce Bore (No. 361 Bore) located 4-5km to the north, Pera Well located 3-4km to the south, Nanadie Well located approximately 2km to the east and Five Mile Well located approximately 10km east of the borefield area.

Numerical modelling results predicted water level drawdowns up to 2.9m at Barlanga Well on the edge of the calcrete outcrop. Pastoral bore Nickyloo Bore is located within close proximity to production bore B15P, in the middle of the borefield area and the greatest area of impact. The remaining pastoral bores, such as Bruce Bore, Pera Well and Five Mile Well are unlikely to be impacted by the proposed abstraction due to their distance from the proposed borefield.

7.1.2 GROUNDWATER DEPENDENT ECOSYSTEMS

Vegetation

Mattiske Consulting Pty Ltd (Mattiske) conducted flora and vegetation surveys in the larger Project area (Mattiske, 2009). The results of this survey found that a few defined groundwater dependent vegetation, such as tall shrubland of *Acacia* species, *Melaleuca* Shrublands and *Eucalypt* woodland, occur within the proposed borefield area. These communities contain a range of tree and tall shrub species that may be dependent on groundwater, such as *Acacia aneura*, *Melaleuca stereophloia*, *Melaleuca xerophila* and *Eucalyptus victrix*. These communities occur along waterways and floodplains that are infrequently subjected to rainfall events (Mattiske, 2009).

The list above is a conservative list of potential communities that may be impacted by water level drawdown resulting from abstraction. As the floodplain is dominated by clay and clay loam solids, the potential impacts from groundwater abstraction may be reduced as the communities may be more dependent on the rainfall events rather than groundwater levels. Therefore, water abstraction impacts should have limited impacts (Mattiske, 2009).

Stygofauna

Outback Ecology were commissioned by Reed Resources to undertake a stygofauna sampling programme to determine the presence of stygofauna species and assess the potential risk to identified stygofauna from groundwater abstraction at the proposed Barrambie borefield (Outback Ecology, 2009).

Sampling of the calcrete aquifer at the proposed Barrambie borefield identified a diverse stygofauna community. The majority of the stygofauna collected have known distributions outside the Barrambie borefield. However, potentially new taxa were identified during the surveys and as yet their distribution is limited to bores located within the Barrambie borefield area. Therefore there is a potential risk to these potentially new stygofauna from water level drawdown associated with groundwater abstraction at the Barrambie borefield (Outback Ecology, 2009). As discussed in previous sections, this level of drawdown varies across the aquifer. Therefore, the proposed borefield will be managed to maintain a high level of saturated thickness within the borefield area to ensure sufficient habitat area.

7.2 IMPACT MANAGEMENT & MITIGATION

7.2.1 GROUNDWATER MONITORING

Prior to applying for a 5C licence to take groundwater, Reed Resources propose to develop (in consultation with the DoW) and initiate a comprehensive groundwater monitoring programme. Reed Resources propose to install a number of additional monitoring bores within the proposed borefield area, as well as regional monitoring bores, to augment the existing bore network. The monitoring programme will include monitoring abstraction volumes, groundwater levels and groundwater quality on a regular basis at existing/new monitoring bores and existing pastoral bores (where possible). In addition, the monitoring programme will include monitoring vegetation health on a periodical basis at defined locations.

7.2.2 TRIGGER LEVELS

In addition to regular groundwater monitoring, Reed Resources will adopt appropriate groundwater level and quality action and cut-off triggers for representative monitoring bores, in consultation with the Department of Water, to ensure the effective management and mitigation of potential impacts on other groundwater users and the environment (e.g. stygofauna). These trigger levels will be set prior to applying for a 5C licence to take groundwater, but will be reviewed regularly as new data becomes available.

It is proposed that during the first 5 years of operation of the Barrambie Borefield, that 75% of the saturated thickness across the aquifer be retained. However, it should be noted that this 75% saturated thickness retention relates to aquifer water levels and not pumping water levels as measured in production bores. The proposed Barrambie borefield will be managed to ensure that the saturated thickness of the calcrete aquifer does not fall below 50% at representative monitoring bores during the life of the Project.

A plan will be developed whereby if groundwater levels or quality reach action trigger levels, supplementary water supply options will be investigated such that other options can be commissioned prior to cut-off trigger levels being reached. The potential supplementary water supply options (contingencies) are discussed further in Section 7.2.3 below.

In the event that abstraction from the Barrambie borefield reduces the capacity of existing pastoral bores, Reed Resources will supplement the required water supply for the pastoralist. We understand that discussions have already taken place between Reed Resources and surrounding pastoralists regarding potential impacts and reductions in their water supply.

7.2.3 WATER SUPPLY CONTINGENCIES

As discussed above, in the event that the saturated thickness across the aquifer is reaches an adopted trigger level, Reed Resources will commission an investigation into an supplementary water supply.

Supplementary water supply options near the Project area are presented on Figure 7.1 and include the following:

- The calcrete aquifer associated with the eastern tributary of the Cogla Downs drainage system towards Errolls Bore.
- The calcrete aquifers within the Cogla Downs drainage system further north and south.
- The inferred Cogla Downs drainage deeper palaeochannel system.
- Disused pits at the Gidgee Gold Mine.

Errolls Tributary

The calcrete sediments associated with the eastern tributary of the Cogla Downs drainage system towards Errolls bore are thought to have similar hydraulic properties to the Barrambie borefield area. It was initially proposed to undertake exploration drilling within this tributary, however, this was postponed following the favourable drilling results in the proposed borefield area (north of Limestone Bore).

The potential yield of the Errolls calcrete aquifer was estimated to be approximately 45L/s (1.5GL/annum) for a period of 15 years. This estimated supply potential was calculated based on the aquifer extent corresponding with the calcrete outcrop presented on the 1:250,000 GSWA Geology Map and by assessing the volume of water that could be removed by dropping the groundwater level by 2m over the aquifer, assuming a specific yield of 20%, and not taking account of any aquifer recharge. However, this assessment is a desktop estimate only and it would be necessary to undertake exploration drilling and aquifer testing to confirm the potential sustainable yield of the area.

Cogla Downs Calcrete

The proposed Barrambie borefield is restricted to a relatively small area of calcrete within the Cogla Downs drainage system. Previous investigations by Geotechnics (1972) identified the presence of a calcrete aquifer in the Scotties Well area to the south. In addition, the GSWA 1:250,000 Geological map also suggests that there are calcrete aquifers located further to the northwest of the proposed Barrambie borefield.

The combined potential yield of these calcrete aquifers was estimated to be approximately 130L/s (4GL/annum) for a 15 year period. This estimated supply potential was calculated based on the aquifer extent corresponding with the calcrete outcrop presented on the 1:250,000 Geology Map and by assessing the volume of water that could be removed by dropping the groundwater level by 2m over the aquifer, assuming a specific yield of 20%. However, this assessment is a desktop estimate only and it would be necessary to undertake exploration drilling and aquifer testing to confirm the potential sustainable yield of the area.

Cogla Downs Palaeochannel

Exploration drilling conducted by Geotechnics in 1972 and Aquaterra in 2007 attempted to assess the location, extent and saturated thickness of the inferred palaeochannel sediments associated with the Cogla Downs drainage system.

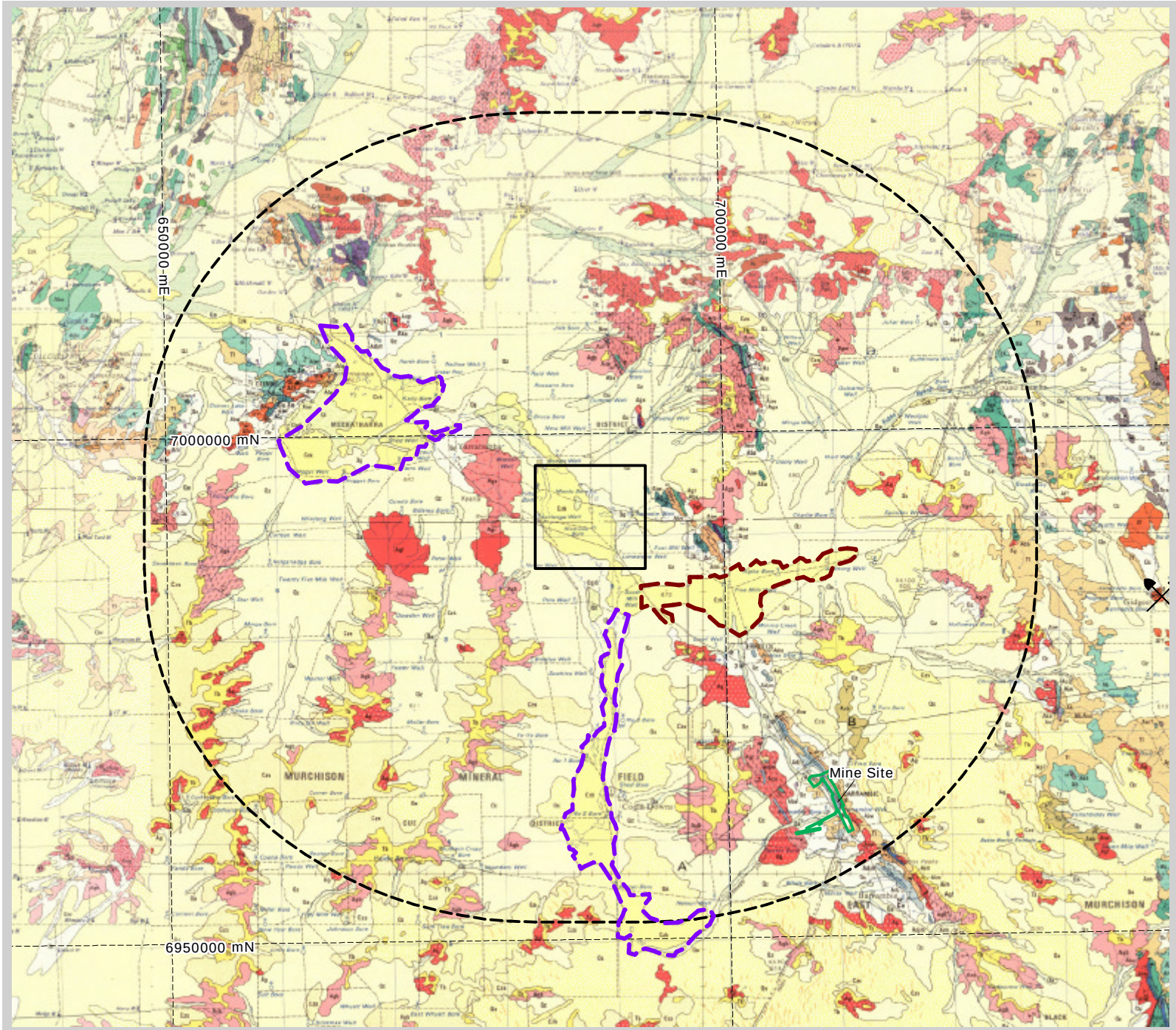
The exploration drilling programme conducted by Geotechnics (1972) confirmed the presence of a sandy aquifer underlying the calcrete aquifer in the Project area, however the supply potential was not assessed.

The exploration drilling programme conducted by Aquaterra in September\October 2007 attempted to assess the supply potential of the inferred palaeochannel sediments, however, this aquifer (where intercepted) could not be assessed due to drilling difficulties and difficulties casing out the overlying calcrete aquifer.

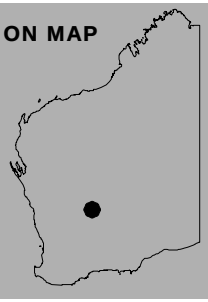
Palaeochannel aquifers have highly variable yields depending on numerous factors, including the aquifer thickness (particularly the basal sand/gravel unit) and the nature of the material (percentage permeable sands/gravels).

Gidgee Gold Mine Disused Pits

The Gidgee Gold Mine is located approximately 40km northeast of Barrambie and was recently acquired by Apex Minerals NL. The Gidgee Gold Mine has been on care and maintenance for a number of years and it is understood that Apex are currently conducting drilling feasibility studies. Therefore, this operation may recommence active mining in the coming years. The Gidgee Mine pits are currently filled with saline water and may provide a supplementary water supply option for Barrambie, if required.



LOCATION MAP



LEGEND

- Area of Water Supply Investigation
- Barrambie Mine Site
- 35km buffer
- Gidgee Mine
- Cogla Downs Calcrete
- Errolls Calcrete

DATA SOURCE

1:250,000 SG50-16 Geological Map
First Edition 1984 (GSWA)

10 0 10 20
Kilometres

aquaterra

FIGURE 7.1
SUMMARY OF CONTINGENCY OPTION

AUTHOR:	KMH	REPORT NO:	233
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Location: F:\Jobs\767\MapInfo\233 Figs\Fig7.1.WOR

8 CONCLUSIONS & RECOMMENDATIONS

8.1 CONCLUSIONS

The conceptual hydrogeology of the area of investigation (between Limestone Bore and Bedan Well) can be summarised as follows:

- **Aquifer Types –** Two aquifers are present within the area of investigation, a calcrete aquifer and a palaeochannel aquifer. Due to favourable drilling/testing results from the calcrete aquifer and drilling difficulties associated with palaeochannel sediments, the calcrete aquifer was the focus of investigations.
- **Aquifer Extent** – The extent of the calcrete appears to be best represented by the outcrop area, as defined in the GSWA 1:250,000 geology map (although calcrete is known to be absent in some locations within this area, and it is also known to exist outside this area).
- **Aquifer Thickness** – The calcrete thins towards the eastern and western margins, but in the central areas the calcrete is generally 15 to 18m thick in the southern area (around Limestone Bore) and 5m thick in the northern area (around B9M).
- **Aquifer Properties** – Hydraulic conductivity values of the order of 100m/d and a specific yield value of 20%, respectively, are considered to be representative aquifer properties of the calcrete aquifer, although there is likely to be considerable variation in these properties.
- **Depth to Water** – Depth to groundwater within the unconfined alluvium and calcrete is generally between 2m and 7m below ground level.
- **Groundwater flow** – Groundwater flow direction is generally north to north-westwards.
- **Recharge** – Recharge is believed to occur at low rates via direct infiltration of rainfall and/or infiltration of surface water runoff. However, there is currently insufficient data to quantify the rainfall recharge.
- **Water quality** – Typically, TDS ranged from 2,100mg/L to 2,700mg/L and EC ranged from 3,600 to 4,500µS/cm, with a general increase in salinity in a northwards direction.

A numerical groundwater model was developed to evaluate the potential of the calcrete aquifer, based on drawdown constraints, to supply the projected water supply demand. Under base case conditions, the numerical model predicts the following:

- A water supply demand of 2.5GL/annum can be provided from a borefield comprising 7 to 10 production bores (each pumping at 7-12L/s) installed within the Cogla Downs calcrete aquifer on Yarrabubba station for a 12 year duration.
- The model predicts that both borefield configurations will result in retained saturated thickness of approximately 60% (in the Yilby Bore and Bore 3 (Obs A) areas) and approximately 85% (in the Bedan Well area).
- The number of bores required will depend on the sustainable yield from each bore. The lateral and vertical extent of water level drawdown across the borefield will be dependent on the quantity of water abstracted, the duration of abstraction, the nature and extent of the aquifer, and the degree of interference between adjacent bores.

The numerical model completed maintains a conservative approach and does not take into account recharge from rainfall, which is thought to contribute a significant portion of the recharge to the aquifer. It should also be noted that the modelled calcrete extent is conservative and does not take into account the eastern branch of the Cogla Downs drainage system, which will substantially increase the volume of groundwater available in storage.

There are a number of existing pastoral bores in the vicinity of the proposed Barrambie water supply borefield, both within the calcrete aquifer and in the surrounding sediments further from the borefield.

In addition, groundwater dependent vegetation has been identified within the proposed borefield area that may be impacted by water level drawdown resulting from groundwater abstraction. However, it appears that these species may be more dependent on localised rainfall events rather than groundwater levels.

Stygofauna sampling conducted by Outback Ecology in 2008/2009 identified the presence of potentially new taxa in the proposed borefield area. Therefore, the proposed borefield will be managed to maintain a high level of saturated thickness to ensure sufficient habitat area.

In order to monitor, manage and mitigate potential impacts on other groundwater users and the environment, Reed Resources propose the following:

- Implementation of a comprehensive groundwater monitoring programme, which will be developed in consultation with the DoW.
- Adopting appropriate groundwater level and quality action and cut-off triggers, which will be developed in consultation with the DoW.
- Maintain an average saturated thickness of 75% of the across the aquifer (within the borefield area) for the first 5 years of operation.
- A plan will be developed whereby if groundwater levels or quality reach action trigger levels, that supplementary water supply options will be investigated such that other water supply options can be commissioned prior to cut-off trigger levels being reached. Potential supplementary water supply (contingencies) include:
  - The calcrete aquifer associated with eastern tributary of the Cogla Downs drainage system, towards Errolls bore.
  - The calcrete aquifers within the Cogla Downs drainage system further north and south of the proposed borefield.
  - The inferred Cogla Downs drainage deeper palaeochannel system.
  - Disused pits at the Gidgee Gold Mine.

8.2 RECOMMENDATIONS

Prior to applying for a 5C licence to take groundwater, Reed Resources propose to conduct the following work in order to confirm the sustainable yield of the calcrete aquifer and develop a better understanding of local recharge processes. The proposed work is discussed further below.

8.2.1 PRODUCTION BORE INSTALLATION

It is proposed that the existing four production bores (B8P, B10P, B15P and Limestone Bore) be augmented by the installation of up to an additional 6 new production bores. The notional borefield layout and proposed tenement boundary are shown in Figure 8.1, with bore coordinates detailed in Table 8.1. However, the actual number and location of the new production bores, within the calcrete aquifer, will depend on the results of exploration drilling (identifying available saturated thickness) and subsequent bore/aquifer testing.

If unfavourable aquifer conditions are encountered during the drilling and installation of the proposed production bores, then it may be necessary to undertake investigative drilling in the eastern area toward Errolls bore in order to assess the extent and saturated thickness of the calcrete aquifer in the east-west trending branch of the Cogla Downs drainage system.

Table 8.1: Notional Borefield Configuration

Bore ID	Easting	Northing	Comments
B8P	687364.4	6989433	Existing Bore
B10P	685608.4	6993833	Existing Bore
B15P	686823.5	6990934	Existing Bore
CD16 (Limestone Bore)	690524.8	6988376	Existing Bore
Bore 1	689104	6990384	Proposed New Bore Location
Bore 2	686206	6992179	Proposed New Bore Location
Bore 3	688296	6992190	Proposed New Bore Location
Bore 4	688500	6988800	Proposed New Bore Location
Bore 5	685500	6990000	Proposed New Bore Location
Bore 6	684510	6992090	Proposed New Bore Location

8.2.2 MONITORING BORE INSTALLATION

It is proposed that a number of additional monitoring bores be installed within the proposed borefield area, and also as regional monitoring bores within the calcrete further to the north and south, as well as outside of the main calcrete aquifer.

8.2.3 GROUNDWATER MONITORING PROGRAMME

In conjunction with the DoW, it is proposed to develop and implement a comprehensive groundwater monitoring programme.

8.2.4 RECHARGE MECHANISMS

Understanding the recharge mechanisms to the calcrete aquifer is important in assessing the long-term sustainable yield of the aquifer. In order to enhance our understanding of the recharge mechanisms, the following work is proposed prior to applying for a 5C licence to take groundwater:

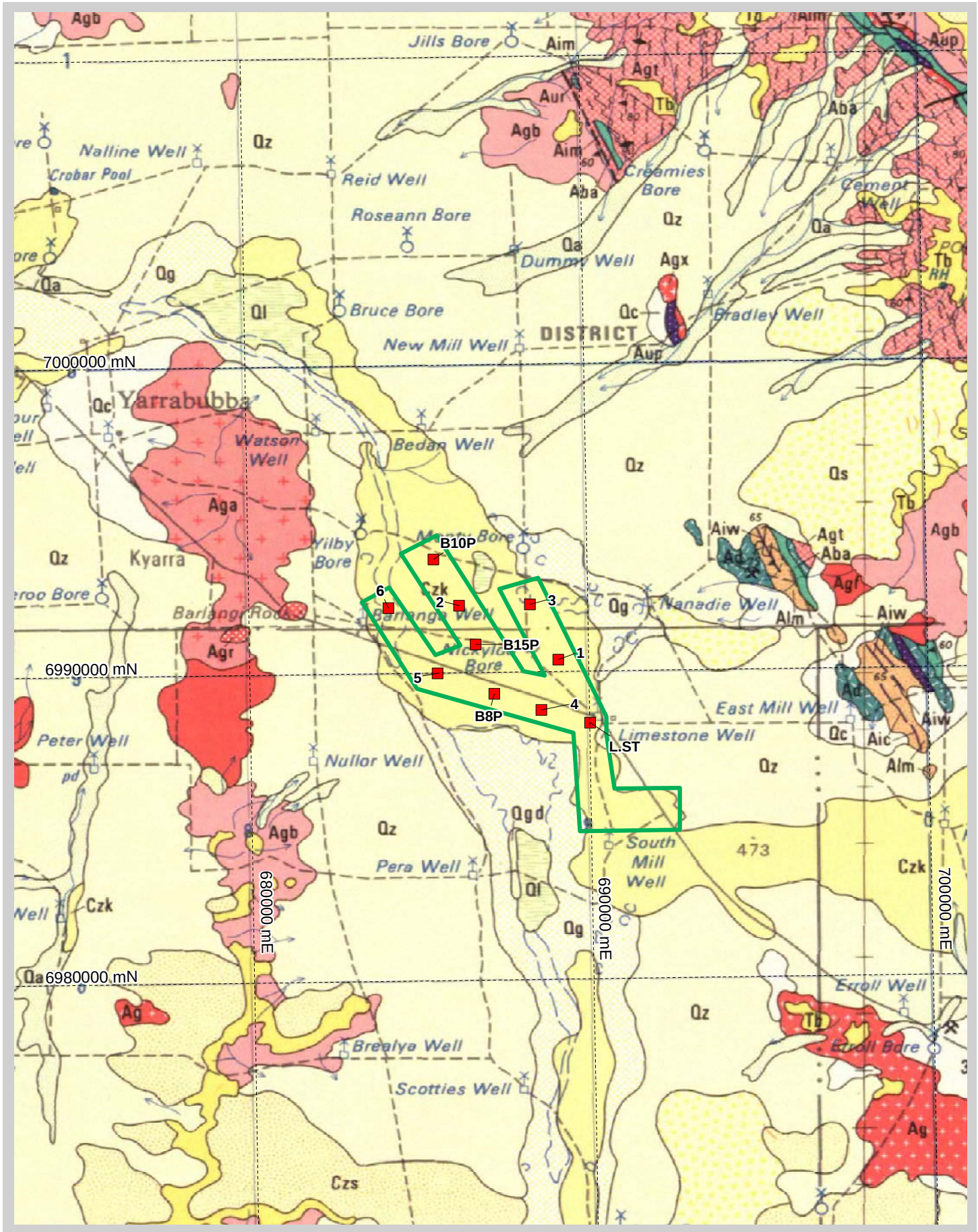
- Install data loggers in selected production and monitoring bores within the area of investigation in order to regularly monitor groundwater levels and to monitor water level responses to heavy rainfall events.
- Undertake a regular groundwater level monitoring programme on bores within the area of investigation and the surrounding stock\pastoral bores.
- Undertake daily rainfall monitoring from the weather station, which was installed at the mine site in December 2008.
- Review water level and rainfall data with a view to further understanding and quantifying recharge in the area.

8.2.5 ADDITIONAL NUMERICAL MODELLING

In consultation with the DoW, it is proposed that additional numerical modelling be conducted to reassess sustainable yield from the calcrete aquifer and potential impact on water levels within the aquifer and regionally. This additional numerical modelling would be conducted following the drilling, installation and testing of the proposed additional production and monitoring bores, the review of recharge to the calcrete aquifer and establishment of a good baseline data set from the groundwater monitoring programme.

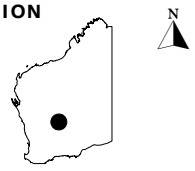
8.2.6 OPERATING STRATEGY

In conjunction with any borefield operations, the development of a detailed Operating Strategy will be required prior to a 5C licence to take groundwater being approved. The Operating Strategy will assist to efficiently and effectively monitor and manage borefield operation and groundwater monitoring.



aquaterra

LOCATION MAP



AUTHOR:	KMH
DRAWN:	KMH
DATE:	1/10/2009
JOB NO:	767\B12
REPORT NO:	233
REVISION:	a
SCALE:	1:150,000
PROJECTION:	MGA94 Z50

Location: F:\Jobs\767\Mapinfo\233 Figs\Fig8.1.WOR

LEGEND

- Current Tenement Boundary
- Production Bores
- Revised Tenement Boundary

3 0 3 6

Kilometers

FIGURE 8.1
NOTIONAL BOREFIELD LAYOUT

9 REFERENCE LIST

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APPENDIX A LICENCE TO CONSTRUCT OR ALTER A WELL: CAW 163685(1) & CAW 163698(1)

Department of Water
Government of Western Australia

Your ref: CAW 163685
CAW 163698
Our ref: RF1597
Enquiries: Ron Miragliotta

AQUATERRA
SUITE 4
125 MELVILLE PARADE
COMO W.A. 6152

Dear Mr Christopher Reed

Re: Issue of a Licences to Construct or Alter Wells
Property: Mineral Lease 20/49

Please find enclosed your Licences, authorising you to Construct or Alter a Well, subject to certain terms, conditions or restrictions.

It is important that you read the conditions of your licence carefully. If you do not understand your licence, please contact the Commission as soon as possible, as there are penalties for failing to comply with all of your licence conditions. Under Section 26GI of the *Rights in Water and Irrigation Act 1914*, you have a right to apply to the State Administrative Tribunal for a review of the decision to Issue a *Licence to Construct or Alter a Well*. You have 28 days from the date you received this letter to request that the decision be reviewed.

For further information please contact the State Administrative Tribunal:

State Administrative Tribunal
12 St Georges Terrace
PERTH WA 6000

GPO Box U1991
PERTH WA 6845

Telephone: (08) 9219 3111
Toll-free: 1300 306 017
Facsimile: (08) 9202 1180
www.sat.justice.wa.gov.au

Under section 21 of the *State Administrative Tribunal Act 2004*, you have a right to request a written statement of reasons for the decision to Issue a *Licence to Construct or Alter a Well*. This request must be made, in writing, to the Water and Rivers Commission within 28 days after the day on which you received this letter.

Midwest Gascoyne Region 81 Forrest Street Geraldton Western Australia 6530
PO Box 73 Geraldton Western Australia 6531
Telephone (08) 9964 5978 Facsimile (08) 9964 5983
www.water.wa.gov.au

Within one month of completing the well, you are required to submit **Form L – Particulars of Completed Borehole** to the Water and Rivers Commission Office in Geraldton. A penalty of $150 applies for failure to submit this Form.

If the water from this well is being improperly used, is being wasted or is having a harmful effect, the Commission may direct the closing of this well. For further information, please read the enclosed pamphlet *What are my obligations as a licence holder?*

Compliance with the terms, conditions or restrictions of this licence does not absolve the licensee from responsibility for compliance with the requirements of all Commonwealth and State legislation.

If you have any queries relating to the above matter, please contact Ron Miragliotta on telephone 08 99657400.

Yours faithfully

T Sandooyea.

Tasnim Sandooyea
Natural Resource Management Officer
Mid West Gascoyne Office

May 18, 2007

Cc: Reed Resources Ltd
Note – Original forms, correspondence and licenses forwarded to Reed Resources

Department of Water
Government of Western Australia

Your ref: CAW 163685
CAW 163698
Our ref: RF1597
Enquiries: Ron Miragliotta

REED RESOURCES LTD
97 OUTRAM STREET
WEST PERTH W.A. 6005

Dear Mr Christopher Reed

Re: Issue of Licence to Construct or Alter Well
Property: Mineral Lease 20/49

Please be advised that we are issuing you with two CAW Licences (Construct or Alter Well) incorporating up to 20 exploration wells, including 4 pump test wells for the above property location.

We are issuing 2 Caw licences because your proposed exploration area covers two separate aquifers.

I have included a **Form L** (Particulars of Completed Borehole) for you to complete and return to this office . We require a completed Form L for all your successful exploration wells on the above location.

If you have any queries relating to the above matter, please contact Ron Miragliotta on telephone 08 99657400

Yours faithfully

Tasnim Sandooyea
Natural Resource Management Officer
Mid West Gascoyne Region

May 18, 2007

Midwest Gascoyne Region 81 Forrest Street Geraldton Western Australia 6530
PO Box 73 Geraldton Western Australia 6531
Telephone (08) 9964 5978 Facsimile (08) 9964 5983
www.water.wa.gov.au

File No: RF1597

Water and Rivers Commission
Government of Western Australia

Instrument No. CAW163698(1)

LICENCE TO CONSTRUCT OR ALTER WELL

Granted by the Commission under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Reed Resources Ltd	
Description of Water Resource	East Murchison Combined - Fractured Rock West - Palaeochannel	
Location of Well(s)	L20/49 Barambie Mine, Meekathara	
Authorised Activities	**Activity**	**Location of Activity**
	Construct 10 exploratory well(s). Construct 2 non-artesian well(s).	L20/49 Barambie Mine, Meekathara
Duration of Licence	From 24 May 2007 to 23 May 2008	

This Licence is subject to the following terms, conditions and restrictions:

1 The well must be constructed by a driller having a current class 1 water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or other certification approved by the Water and Rivers Commission as equivalent.

2 The licensee is required to provide to the Water and Rivers Commission a completed ' Particulars of Completed Bore Hole Form ' on completion of the approved drilling programme.

3 That the licensee shall allow access, in an agreed manner, by Water And Rivers Commission personnel for the purposes of inspection at any time.

4 Approval by the Water and Rivers Commission is to be obtained prior to the construction of additional and replacement wells and the modification or refurbishment of existing wells.

5 This licence is not renewable.

End of terms, conditions and restrictions

COPY

Sandooyen.
24/05/2007

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.

File No: RF1597

Water and Rivers Commission
Government of Western Australia

Instrument No. CAW163685(1)

LICENCE TO CONSTRUCT OR ALTER WELL

Granted by the Commission under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Reed Resources Ltd	
Description of Water Resource	East Murchison Combined - Fractured Rock West - Calcrete	
Location of Well(s)	L20/49 Barambie Mine, Meekathara	
Authorised Activities	**Activity**	**Location of Activity**
	Construct 10 exploratory well(s). Construct 2 non-artesian well(s).	L20/49 Barambie Mine, Meekathara
Duration of Licence	From 24 May 2007 to 23 May 2008	

This Licence is subject to the following terms, conditions and restrictions:

1 The well must be constructed by a driller having a current class 1 water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or other certification approved by the Water and Rivers Commission as equivalent.

2 The licensee is required to provide to the Water and Rivers Commission a completed ' Particulars of Completed Bore Hole Form ' on completion of the approved drilling programme.

3 That the licensee shall allow access, in an agreed manner, by Water And Rivers Commission personnel for the purposes of inspection at any time.

4 Approval by the Water and Rivers Commission is to be obtained prior to the construction of additional and replacement wells and the modification or refurbishment of existing wells.

5 This licence is not renewable.

End of terms, conditions and restrictions

COPY

Bandcoyer.
24/05/2007

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.

APPENDIX B BORE COMPLETION LOGS

aquaterra
Suite 4, 125 Melville Parade
Como WA 6152
Australia
Tel: +61 8 9368 4044
Fax: +61 8 9368 4055
www.aquaterra.com.au

COMPOSITE WELL LOG

Well No: B1M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 23 Aug 2007
Completed: 25 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 10 3/4"
3-136 mbgl 6 1/2"

Area: Cogla Downs
East: 690047.64mE
North: 6988468.2mN
Projection: MGA94 Z50

Static Water Level: 464.5mRL **Date:** Aug 2008

Elevation: 470.6 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Calcrete		CALCRETE: white, off-white, hard, partly porcellanous, partly granular with rounded, fine to medium grained, well sorted quartz, solution channels and cavities 5-6m irregular grey 'veins' - fine, black manganese grains 6-8m vughy 8-9m abundant white and clear quartz 9-17m hard, partly siliceous, fewer solution features	SWL: 6.1 mbgl Airlift yield 7 L/s EC 9.59 mS/cm		Top of casing 0.15 magl 8.5" (205mm ID) steel surface casing (0.15magl to 2.0mbgl) 6 1/2" drilled hole
20	WB		SAND: green brown, grey brown, quartz, fine to medium grained, sub-rounded, minor manganese, thin CLAY/SILT layers SANDY CLAY: green brown, abundant quartz SAND: orange brown, quartz, medium to coarse grained, poorly sorted, sub-rounded, clean with minor manganese and thin CLAY layer SAND AND CLAY: SAND, quartz, white, clear, medium grained with pink CLAY layers SAND: light grey, quartz, fine to medium grained, rounded, well sorted with soft, light grey CLAY layers SAND: light grey, quartz, fine to medium grained, well sorted, sub-rounded, fine SILT/CLAY matrix SAND: white, clear, yellow quartz, fine to medium grained, poorly sorted, sub-rounded with pink SILT matrix and abundant dark pink SILT bands 50-55m minor CLAY layers SAND: light yellow brown, quartz (white, clear), fine to medium grained, poorly sorted, sub-rounded, soft SAND: yellow brown, dark yellow, quartz, medium to coarse grained, moderately sorted, sub-angular, clean	Difficulty completing bore; Unable to install gravel pack below swelling clays at 50mbgl.		50mm PVC blank casing (0.15magl to 72.1mbgl) Bentonite seal (50.6 to 51.1mbgl) 50mm PVC slotted casing (72.1 to 90.1mbgl) End cap @ 90.1mbgl
100			BASEMENT: samples heavily contaminated with sand from above, traces of coarse quartz with dark flecks of pyroxene/amphibole, silver, gold platy mica throughout			

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COMPOSITE WELL LOG

Well No: B1M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 23 Aug 2007
Completed: 25 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 10 3/4"
3-136 mbgl 6 1/2"

Area: Cogla Downs
East: 690047.64mE
North: 6988468.2mN
Projection: MGA94 Z50

Static Water Level: 464.5mRL
Date: Aug 2008

Elevation: 470.6 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
110	Granite					Overdrill/fallback
120						
130				End of hole 136mbgl		
140						
150						

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COMPOSITE WELL LOG

Well No: B2A

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 26 Aug 2007
Completed: 8 Sept 2007
Drilled: Connector
Logged By: IRL

Method: Mud rotary
Fluid: Polymer
Bit Record: 0-18 mbgl 15"
18-63 mbgl 8.5"

Area: Cogla Downs
East: 690072.41mE
North: 6988477.1mN
Projection: MGA94 Z50

Static Water Level: 466.9 mRL
Date: 3 Oct 2007
Elevation: 470.97 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		CALCRETE: buff, red-brown, hard with dark red siltstone inclusions and silt infill	SWL: 4.05 mbgl		Top of casing 0.45magl 17" (432mm ID) steel surfaces casing (0.45magl to 2.5mbgl)
10			CALCRETE: brown to red orange, grey, embedded in variable coloured silt matrix	Abandoned hole, unable to case off calcrete. High loss of circulation through calcrete layer		10.5" (260mm ID) steel surface casing (0.45magl to 18.2mbgl) Due to difficulties casing out calcrete, bore eventually abandoned at 63 mbgl
20	WB		WEATHERED BASEMENT: brown to red orange, grey, embedded in coloured silt clay matrix WEATHERED BASEMENT: no sample collected, assumed clay	Airlift yield >30L/s EC: 17.8 mS/cm		195mm open hole (18.2 to 63 mbgl)
30						
40						
50			WEATHERED BASEMENT: dark pinky red, slightly gritty clay			
60			WEATHERED BASEMENT: light yellow/brown, slightly gritty clay			
70				End of hole 63mbgl		
80						
90						
100						

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COMPOSITE WELL LOG

Well No: B3M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 28 Aug 2007
Completed: 28 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-20 mbgl 6 1/2"

Area: Cogla Downs
East: 690106.65mE
North: 6988485.1mN
Projection: MGA94 Z50

Static Water Level: 466.23 mRL **Date:** Aug 2008

Elevation: 471 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Calcrete		CALCRETE: white, off-white, hard, partly porcellanous, partly granular with rounded, fine to medium grained, well sorted quartz, solution channels and cavities, abundant silica	SWL: 4.79 mbgl EC: 11.8mS/cm		Top of casing 0.16magl 8.5" (205mm ID) steel surface casing (+0.16magl to 2.5mbgl) 50mm PVC blank casing (0 to 5.1mbgl) Gravel pack (1.6 -3.2mm) 50mm PVC slotted casing (4.9 to 17.1mbgl) 6 1/2" drilled hole End cap @ 17.1mbgl Fallback (17.1 to 20mbgl)
10						
20	WB		SANDSTONE	End of hole 20mbgl		
30						
40						
50						

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Suite 4, 125 Melville Parade
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Australia
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Fax: +61 8 9368 4055
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COMPOSITE WELL LOG

Well No: B4X

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 28 Aug 2007
Completed: 28 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-6 mbgl 6 1/2"

Area: Cogla Downs
East: 686288mE
North: 6993306mN
Projection: UTM84 Z50

Static Water Level: NA
Date: NA

Elevation: 473 mRL (est)

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		SILTY SAND: red brown with loose CALCRETE	Calcrete unsaturated		Surface casing retrieved
			CALCRETE: off-white, silty			Bore site rehabilitated
			SILT: red brown, minor CALCRETE			Open hole (0 to 16mbgl)
10	WB		SILTY SAND: yellow brown			
			SANDY CLAY: brown, yellow brown, damp			
				End of hole 16mbgl		
20						
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B5M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

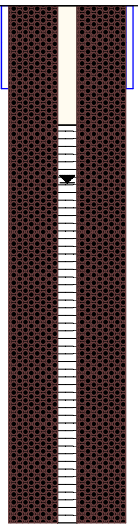
Commenced: 29 Aug 2007
Completed: 29 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-16 mbgl 6 1/2"

Area: Cogla Downs
East: 685621.63mE
North: 6993845.5mN
Projection: MGA94 Z50

Static Water Level: 465.91 mRL **Date:** Aug 2008

Elevation: 471.25 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		CALCRETE: red brown, silty becoming off-white, hard, siliceous	SWL: 5.34 mbgl		Top of casing 0.16magl 8.5" (205mm ID) steel surface casing (0.16magl to 2.5mbgl) 50mm PVC blank casing (0 to 3.6mbgl) 6 1/2" drilled hole Gravel pack (1.6-3.2mm) 50mm PVC slotted casing (3.6 to 15.6mbgl) End cap @ 15.6mbgl
10	WB		SAND: dark orange brown, carbonate with minor quartz, fine to medium grained, sub-angular, poorly sorted	At 10mbgl EC 13.3mS/cm, Airlift yield 3.4L/s		
			SANDY CLAY: yellow brown, sticky	At 16mbgl EC 14.0mS/cm, Airlift yield 5.6L/s End of hole 16mbgl		
20						
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B6M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 29 Aug 2007
Completed: 29 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-20 mbgl 6 1/2"

Area: Cogla Downs
East: 686266.42mE
North: 6991062.4mN
Projection: MGA94 Z50

Static Water Level: 466.02 mRL
Date: Aug 2008
Elevation: 471.02 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Calcrete		CALCRETE: buff, light brown, SILT			Top of casing 0.12magl
			CALCRETE: white, off-white, hard	SWL: 5 mbgl		8.5" (205mm ID) steel surface casing (0.12magl to 2.5mbgl) 6 1/2" drilled hole
			CALCRETE: buff, light brown, loose, carbonate sand			50mm PVC blank casing (0 to 6.7mbgl)
10			SAND: carbonate sand 10-13m medium grained 13-17m fine grained	At 10mbgl EC 4.45mS/cm, Airlift yield 1.2L/s		Gravel pack (1.6-3.2mm)
	WB		SANDY CLAY: light green brown, granitic	At 16mbgl EC 4.22mS/cm, Airlift yield 3.4L/s		50mm PVC slotted casing (6.7 to 18.7mbgl)
20				End of hole 20mbgl		End cap @ 18.7mbgl Fallback (18.5 to 20mbgl)
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B7M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

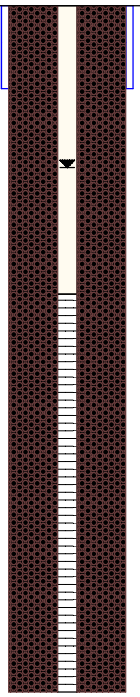
Commenced: 29 Aug 2007
Completed: 29 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-21 mbgl 6 1/2"

Area: Cogla Downs
East: 687358.78mE
North: 6989457.5mN
Projection: MGA94 Z50

Static Water Level: 466.38 mRL **Date:** Aug 2008

Elevation: 471.63 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		CALCRETE: white, porcellanous, hard, solution features, siliceous	SWL: 5.25 mbgl		Top of casing 0.2magl 8" steel surface casing (0.2magl to 2.5mbgl) 6 1/2" drilled hole 50mm PVC blank casing (0 to 8.7mbgl)
10				At 10mbgl EC 3.73mS/cm, Airlift yield 3.7L/s		50mm PVC slotted casing (8.7 to 20.7mbgl)
			CALCRETE: brown, orange brown, loose sand	At 16mbgl EC 3.94mS/cm, Airlift yield 7.0L/s		Gravel pack (1.6-3.2mm)
20	WB		SAND: grey green brown, quartz, sub-angular, fine to medium grained, poorly sorted, silty	End of hole 21mbgl		End cap @ 20.6mbgl
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B8P

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

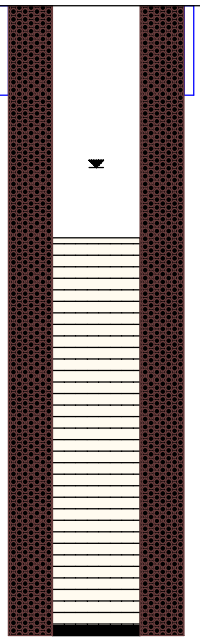
Commenced: 30-Aug-07
Completed: 30-Aug-07
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 17"
3-21 mbgl 12"

Area: Cogla Downs
East: 687364.4mE
North: 6989432.9mN
Projection: MGA94 Z50

Static Water Level: 466.5 mRL **Date:** Aug 2008

Elevation: 471.8 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		CALCRETE: white, porcellanous, hard, solution features, siliceous	Developed by airlift pumping Duration: 1hr Airlift yield: 13 L/s SWL: 5.32 mbgl EC: 4.95 mS/cm		Top of casing 0.3magl 14" (340mm ID) steel surface casing (0.3magl to 2.7mbgl) 12" drilled hole 195mm blank PVC casing (+0.3 to 7mbgl) Gravel pack (1.6-3.2mm) 195mm slotted PVC casing (7 to 19mbgl) End cap @ 19mbgl
10			CALCRETE: brown, orange brown, loose "sand"			
20	WB		SAND: grey green brown, quartz, sub-angular, fine to medium grained, poorly sorted, silty	End of hole 21mbgl		
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B9M

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 31 Aug 2007
Completed: 31 Aug 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-12 mbgl 6 1/2"

Area: Cogla Downs
East: 685092.43mE
North: 6994578.3mN
Projection: MGA94 Z50

Static Water Level: 465.86 mRL **Date:** Aug 2008

Elevation: 470.3 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		SILT: red brown, sandy, soft, minor CALCRETE			Top of casing 0.3magl
			CALCRETE: off-white,brown, silty, soft, loose			8" (195mm ID) PVC surface casing (0.3magl to 2.5mbgl) 6 1/2" drilled hole
			CALCRETE: white, off-white, hard, siliceous, damp at 6m	SWL: 4.43 mbgl		50mm PVC blank casing (0 to 3.9mbgl)
			CALCRETE: grey, off-white, hard, cemented, cavities			50mm PVC slotted casing (3.9 to 9.9mbgl) Gravel pack (1.6-3.2mm)
10	WB		SAND: orange brown, quartz, fine to medium grained, moiderately sorted, sub-angular	At 10mbgl EC 18.3mS/cm, Airlift yield 1.4L/s End of hole 12mbgl		End cap @ 9.9mbgl
20						
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B10P

Client: Reed Resources Ltd **Project:** Barrambie Water Supply Investigation

Commenced: 31-Aug-07
Completed: 31-Aug-07
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 17"
3-12 mbgl 6 1/2"

Area: Cogla Downs
East: 685608.42mE
North: 6993832.5mN
Projection: MGA94 Z50

Static Water Level: 465.94 mRL **Date:** Aug 2008
Elevation: 471.4 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		CALCRETE: white, off-white, rubbly with red brown SILT			Top of casing 0.26magl
			CALCRETE: white, off-white, buff, hard, broken, siliceous 6m abundant silica 10m abundant silica	SWL: 5.49 mbgl		14" (340mm ID) steel surface casing (0.26magl to 2.7mbgl) 12" drilled hole 195mm blank PVC casing (0.26magl to 3mbgl)
10	Calcrete "sand"		Carbonate: SAND, brown, orange brown, angular carbonate chips, minor quartz inclusions, loose, fine to medium grained, clean	Development by airlift pumping Duration: 1hr		195mm slotted PVC casing (3 to 15mbgl) Gravel pack (1.6-3.2mm)
			Carbonate: SAND, brown, light brown, fine grained, silty	EC 14.8mS/cm, Airlift yield 9.3L/s		End cap @ 15mbgl
	WB		CLAY: orange brown, non-carbonate, gritty			Fallback (15 to 18mbgl)
20				End of hole 18mbgl		
30						
40						
50						

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COMPOSITE WELL LOG

Well No: B11X

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 9 Sept 2007
Completed: 9 Sept 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-31 mbgl 6 1/2"

Area: Cogla Downs
East: 689920mE
North: 6988322mN
Projection: UTM84 Z50

Static Water Level: 3.83 mbgl **Date:** 3 Oct 2007

Elevation: NA

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Calcrete		CALCRETE: white, off-white, abundent silica	SWL: 3.83 mbgl		Bore site rehabilitated 8" (195mm ID) PVC surface casing retrieved
10						
20	WB		CLAY AND SAND: yellow brown, some quartz SAND: organic brown, quartz, fine to medium grained, poorly sorted slightly silty SAND: brown, quartz, fine to coarse, poorly sorted	Slow drilling, abandon hole		Open hole (0 to 31mbgl)
30			CLAY: grey, gritty, dark red, ferruginised, very hard drilling, some carbonate cobbles	End of hole 31mbgl		
40						
50						

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COMPOSITE WELL LOG

Well No: B12X

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

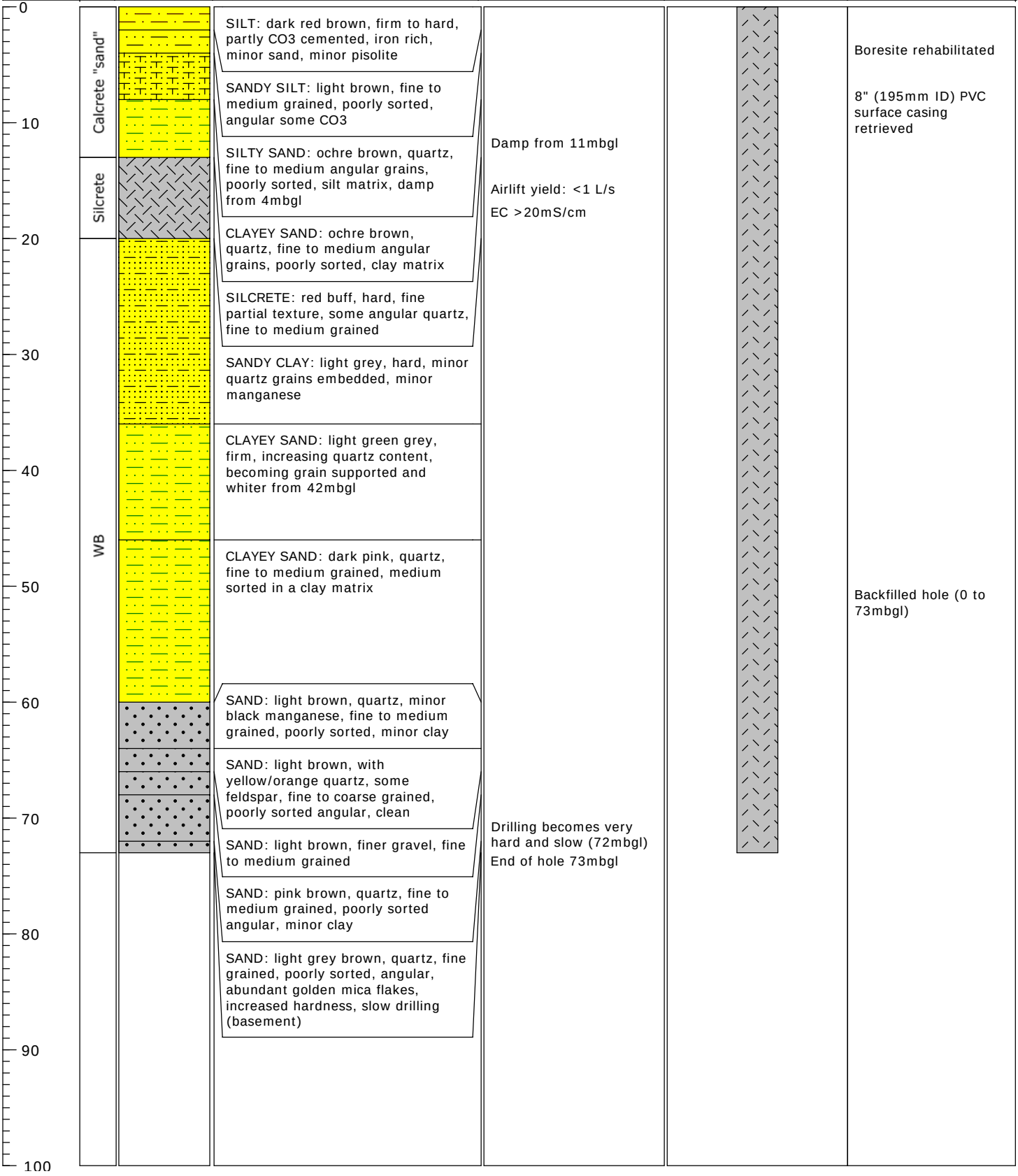
Commenced: 10 Sept 2007
Completed: 10 Sept 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air/Foam
Bit Record: 0-3 mbgl 12"
3-73 mbgl 6 1/2"

Area: Cogla Downs
East: 690061mE
North: 6983422mN
Projection: UTM84 Z50

Static Water Level: NA
Date: NA

Elevation: 465 (GPS)



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COMPOSITE WELL LOG

Well No: B13X

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

Commenced: 10 Sept 2007
Completed: 10 Sept 2007
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-30 mbgl 6 1/2"

Area: Cogla Downs
East: 687288mE
North: 6993306mN
Projection: UTM84 Z50

Static Water Level: NA
Date: NA

Elevation: 472 (est)

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Alluvial		SILT: red brown			Boresite rehabilitated
			CLAY: light green brown, silty, abundant gypsum			8" (195mm ID) PVC surface casing (to 3mbgl)
			CLAY AND SAND: brown, quartz, gypsum, poorly sorted, angular, fine to coarse, some silt	EC: >20mS/cm Airlift yield: <1 L/s		
10			GRAVEL: grey brown, quartz, mica, gypsum, partly silicified, fine grained sand, medium grained gravel, poorly sorted angular, clean			Backfilled hole (0 to 30mbgl)
			SAND: light grey, quartz, fine to coarse, poorly sorted, angular grains, abundant fine mica, some clay at 20mbgl, iron stained			
20			CLAYEY SAND: light brown, quartz, fine to medium grained, angular, mica and granite chips			
	WB		WEATHERED BASEMENT: light green becoming dark green grey, abundant quartz and mica, dark green veins on quartz			
30				End of hole 30mbgl		
40						
50						

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COMPOSITE WELL LOG

Well No: B14M

Client: Reed Resources Ltd **Project:** Barrambie Water Supply Investigation

Commenced: 11-Sep-07
Completed: 11-Sep-07
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-46 mbgl 6 1/2"

Area: Cogla Downs
East: 686832.3mE
North: 6990935.3mN
Projection: MGA94 Z50

Static Water Level: 466.26 mRL **Date:** Aug 2008 **Elevation:** 469.2 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Calcrete		SILT: red brown silt with off-white calcrete, loose rubble			8" (195mm ID) PVC surface casing (0.08magl to 2.5mbgl)
			CALCRETE: off-white, hard, broken some silt	SWL: 2.95mbgl		
			CALCRETE: broken with yellow/brown clay			Blank 50mm PVC casing (0.2magl to 3mbgl)
10			SAND: light grey, quartz, mainly loose grains with abundant consolidated rock fragments			Slotted 50mm PVC casing (3 to 9mbgl)
	WB		SAND: brown to light brown, quartz, fine to medium, poorly sorted, angular loose grains			Blank 50mm PVC casing (9 to 15mbgl)
			SAND: light grey, quartz, hard drilling, consolidated formation, weathered basement profile			Gravel pack (1.6-3.2mm)
20			SAND: light yellow brown, quartz, weak, possible fracture zone	At 28mbgl EC:4.68 Airlift yield: 6.97L/s		End cap @15mbgl
			SAND: light grey, quartz, fine to medium, poorly sorted, angular grains, hard drilling			
30			SAND: light brown, quartz, weak zone, deeply weathered or fracture, fast drilling			Backfill (16 to 46mbgl)
			SAND: light grey			
			SAND: light brown			
40			SAND: light grey, hard, quartz			
				End of hole 46mbgl		
50						

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COMPOSITE WELL LOG

Well No: B15P

Client: Reed Resources Ltd

Project: Barrambie Water Supply Investigation

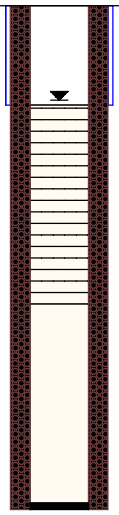
Commenced: 11-Sep-07
Completed: 11-Sep-07
Drilled: Connector
Logged By: IRL

Method: Down Hole Hammer
Fluid: Air
Bit Record: 0-3 mbgl 12"
3-46 mbgl 8"

Area: Cogla Downs
East: 686823.5mE
North: 6990933.8mN
Projection: MGA94 Z50

Static Water Level: 466.2 mRL **Date:** Aug 2008

Elevation: 469.4 mRL

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0	Calcrete		CALCRETE: off white and red brown SILT, loose rubble	SWL: 3.2 mbgl		8" (195mm ID) PVC surface casing (0.12magl to 2.5mbgl)
			CALCRETE: off-white, hard, broken, some silt	Developed by airlift pumping		155mm blank PVC (0.12magl to 3mbgl)
			CALCRETE: broken with yellow brown clay	Airlift duration: 1hr Airlift yield 2 L/s EC 4.5 mS/cm		155mm slotted PVC (3 to 9mbgl)
10						Gravel pack (1.6-3.2mm)
	WB		SAND: light grey to brown, quartz, fine to medium, poorly sorted, angular, loose grains			155mm blank PVC (9 to 15mbgl)
				End of hole 15mbgl		End cap @ 15mbgl
20						
30						
40						
50						

APPENDIX C STEP TEST DATA

Multi Rate Test (60)

Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 3/10/2007 Time: 7pm

Details	Pumping Bore	Comment	Details	Pumping Bore	Comment
Bore No.	B8P			B8P	
Reference point (magl)	0.75			0.75	
Static water level (mbrp)	5.64			5.64	
Time	Test Rate 1 (L/s): 12	Comment	Time	Test Rate 2 (L/s): 16	Comment

Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	0.5	5.69	0.05		60.5	5.73	0.09	
	1.0	5.69	0.05		61	5.73	0.09	
	1.5	5.69	0.05		61.5	5.73	0.09	
	2.0	5.7	0.06		62	5.73	0.09	
	2.5	5.7	0.06		62.5	5.73	0.09	
	3.0	5.7	0.06		63	5.73	0.09	
	3.5	5.7	0.06		63.5	5.73	0.09	
	4.0	5.7	0.06		64	5.73	0.09	
	4.5	5.7	0.06		64.5	5.73	0.09	
	5.0	5.7	0.06		65	5.73	0.09	
	5.5	5.7	0.06		65.5	5.73	0.09	
	6.0	5.7	0.06		66	5.73	0.09	
	6.5	5.7	0.06		66.5	5.73	0.09	
	7.0	5.7	0.06		67	5.73	0.09	
	7.5	5.7	0.06		67.5	5.73	0.09	
	8.0	5.7	0.06		68	5.73	0.09	
	8.5	5.7	0.06		68.5	5.73	0.09	
	9.0	5.7	0.06		69	5.73	0.09	
	9.5	5.7	0.06		69.5	5.73	0.09	
	10	5.7	0.06		70	5.73	0.09	
	15	5.7	0.06		75	5.73	0.09	
	20	5.7	0.06		80	5.73	0.09	
	25	5.7	0.06		85	5.73	0.09	
	30	5.7	0.06		90	5.73	0.09	
	35	5.7	0.06		95	5.73	0.09	
	40	5.7	0.06		100	5.73	0.09	
	45	5.7	0.06		105	5.73	0.09	
	50	5.7	0.06		110	5.73	0.09	
	55	5.7	0.06		115	5.73	0.09	
	60	5.7	0.06	Total Litres=42501	120	5.73	0.09	Total litres=99817

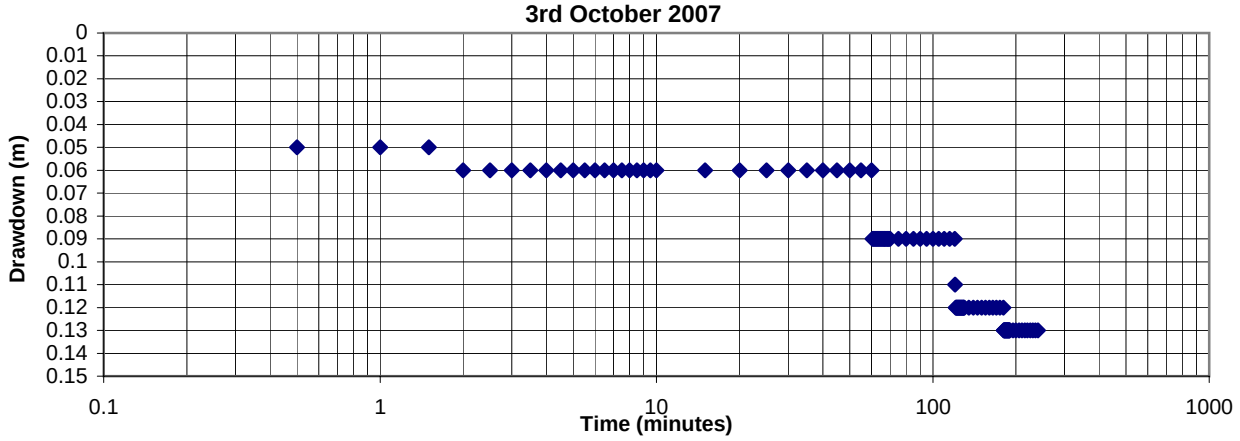
Multi Rate Test (60)

Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 3/10/2007	Time: 7pm

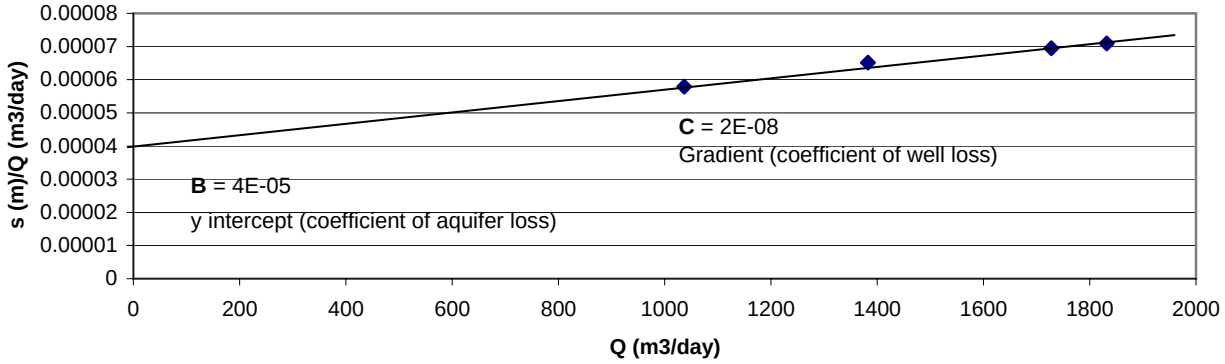
Details	Pumping Bore	Comment	Details	Pumping Bore	Comments
Bore No.	B8P			B8P	Recovered, at the end of
Reference point (magl)	0.75			0.75	the 4 steps, to 5.64m in
Static water level (mbrp)	5.64			5.64	20secs

Time		Test Rate 3 (L/s): 20		Comment	Time	Test Rate 4: 21.2 (L/s)		Comment
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	120.5	5.75	0.11		180.5	5.77	0.13	
	121.0	5.76	0.12		181	5.77	0.13	
	121.5	5.76	0.12		181.5	5.77	0.13	
	122.0	5.76	0.12		182	5.77	0.13	
	122.5	5.76	0.12		182.5	5.77	0.13	
	123.0	5.76	0.12		183	5.77	0.13	
	123.5	5.76	0.12		183.5	5.77	0.13	
	124.0	5.76	0.12		184	5.77	0.13	
	124.5	5.76	0.12		184.5	5.77	0.13	
	125.0	5.76	0.12		185	5.77	0.13	
	125.5	5.76	0.12		185.5	5.77	0.13	
	126.0	5.76	0.12		186	5.77	0.13	
	126.5	5.76	0.12		186.5	5.77	0.13	
	127.0	5.76	0.12		187	5.77	0.13	
	127.5	5.76	0.12		187.5	5.77	0.13	
	128.0	5.76	0.12		188	5.77	0.13	
	128.5	5.76	0.12		188.5	5.77	0.13	
	129.0	5.76	0.12		189	5.77	0.13	
	129.5	5.76	0.12		189.5	5.77	0.13	
	130	5.76	0.12		190	5.77	0.13	
	135	5.76	0.12		195	5.77	0.13	
	140	5.76	0.12		200	5.77	0.13	
	145	5.76	0.12		205	5.77	0.13	
	150	5.76	0.12		210	5.77	0.13	
	155	5.76	0.12		215	5.77	0.13	
	160	5.76	0.12		220	5.77	0.13	
	165	5.76	0.12		225	5.77	0.13	
	170	5.76	0.12		230	5.77	0.13	
	175	5.76	0.12		235	5.77	0.13	
	180	5.76	0.12	Total Litres=171501	240	5.77	0.13	Total Litres=247834

Barrambie - B8P Step Discharge Pumping Test
Observed drawdown v Time
3rd October 2007



Barrambie - B8P Analytical Plot s/Q v Q
3rd October 2007



$s_{w(n)} = BQ_n + CQ^P{}_n$ (Rorabaugh's equation)

Where, B = Intercept with y axis (coefficient of aquifer loss or laminar flow)

C = Gradient (coefficient of turbulent flow loss or apparent well loss)

s = Drawdown in the borehole

P = Value determined using Rorabaugh's method of superposition

Components of the equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively.

They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

It should be noted:

1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

$Ew = (BQ/(BQ + CQ^P)) \times 100$

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow

Comparison of Observed and Predicted Drawdowns

			Observed	Predicted		Apparent
Step (60 min steps)	Discharge (L/s)	Discharge (Q) (m^3/d)	Corrected Drawdown (s) (metres)	Drawdown (metres)	s/Q	Efficiency (Ew) %
1	12.0	1037	0.06		0.000058	66
2	16.0	1382	0.09		0.000065	59
3	20.0	1728	0.12		0.000069	54
4	21.2	1832	0.13		0.000071	52

Step Test Analysis Data

Barrambie B8P

Well ID	Step Test Date	Step	Q[1] (m^3/day)	Q (Ml/day)[10]	$S_{w(o)}$[2] (m)	$S_{w(co)}$[3] (m)	$S_{w(i)}$[4] (m)	$S_{w(ci)}$[5] (m)	$S_{w(ci)}/Q$ (day/m^2)	S_w[6] (m)	E_w[7] (%)	B[8]	C[9] (day^2/m^5)	C ($min.^2/m^5$)	S.C.[10] (m^2/day)
B8P	3/10/2007	1	1036.8	1.04	0.06	0.06	0.06	0.06	5.79E-05	0.06	69	na	na	na	17280
		2	1382.4	1.38	0.03	0.09	0.03	0.09	6.51E-05	0.09	61	na	na	na	15360
		3	1728.0	1.73	0.03	0.12	0.03	0.12	6.94E-05	0.13	58	na	na	na	14400
		4	1831.7	1.83	0.01	0.13	0.01	0.13	7.10E-05	0.14	56	4.00E-05	2E-08	0.041	14090

Notes:

1. Q = well pumping rate in m^3/day
2. $S_{w(o)}$ = observed drawdown in well
3. $S_{w(co)}$ = cumulative observed drawdown in well
4. $S_{w(i)}$ = incremental drawdown in well
5. $S_{w(ci)}$ = cumulative incremental drawdown in well
6. S_w = calculated well drawdown (see Equation 1.0)
7. E_w = well efficiency (see Equation 3.0)
8. B = formation loss coefficient
9. C = well loss coefficient (see Equation 2.0)
10. S.C. = Specific Capacity ($Q/S_{w(co)}$)

Equation 1.0

$$S_w = BQ + CQ^2$$

Equation 2.0

$$C = \frac{\Delta\left(S_{w(ci)}/Q\right)}{\Delta Q}$$

B= 4.00E-05
C= 2.00E-08

Equation 3.0

$$E_w = \frac{BQ}{S_w} \times 100\%$$

Multi Rate Test (60)

Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 5/1007	Time: 10am

Details	Pumping Bore	Comment	Details	Pumping Bore	Comment
Bore No.	B10P			B10P	
Reference point (magl)	0.8			0.8	
Static water level (mbrp)	5.94			5.94	
Time	Test Rate 1 (L/s): 12	Comment	Time	Test Rate 2 (L/s): 16	Comment

Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	0.5	6.12	0.18		60.5	6.21	0.27	
	1.0	6.13	0.19		61	6.22	0.28	
	1.5	6.13	0.19		61.5	6.23	0.29	
	2.0	6.13	0.19		62	6.23	0.29	
	2.5	6.13	0.19		62.5	6.23	0.29	
	3.0	6.13	0.19		63	6.23	0.29	
	3.5	6.13	0.19		63.5	6.23	0.29	
	4.0	6.13	0.19		64	6.23	0.29	
	4.5	6.13	0.19		64.5	6.23	0.29	
	5.0	6.13	0.19		65	6.23	0.29	
	5.5	6.13	0.19		65.5	6.23	0.29	
	6.0	6.13	0.19		66	6.23	0.29	
	6.5	6.13	0.19		66.5	6.23	0.29	
	7.0	6.13	0.19		67	6.23	0.29	
	7.5	6.13	0.19		67.5	6.23	0.29	
	8.0	6.13	0.19		68	6.23	0.29	
	8.5	6.13	0.19		68.5	6.23	0.29	
	9.0	6.13	0.19		69	6.23	0.29	
	9.5	6.13	0.19		69.5	6.23	0.29	
	10	6.13	0.19		70	6.23	0.29	
	15	6.13	0.19		75	6.23	0.29	
	20	6.13	0.19	EC=11.70ma at 28.1 dC	80	6.23	0.29	
	25	6.13	0.19		85	6.23	0.29	
	30	6.13	0.19		90	6.23	0.29	
	35	6.13	0.19		95	6.23	0.29	
	40	6.13	0.19		100	6.23	0.29	
	45	6.13	0.19		105	6.23	0.29	
	50	6.13	0.19		110	6.23	0.29	
	55	6.13	0.19		115	6.23	0.29	
	60	6.13	0.19	42700 Litres	120	6.23	0.29	99958 L

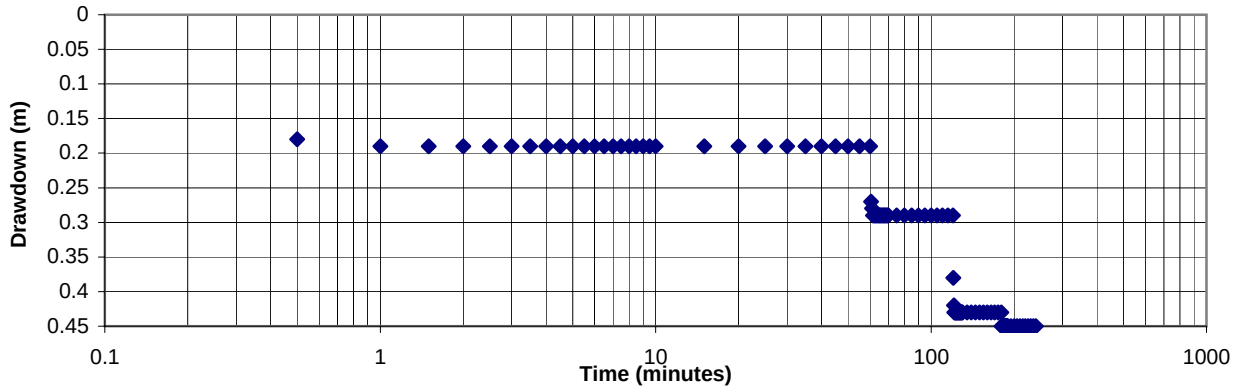
Multi Rate Test (60)

Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 5/1007	Time: 10am

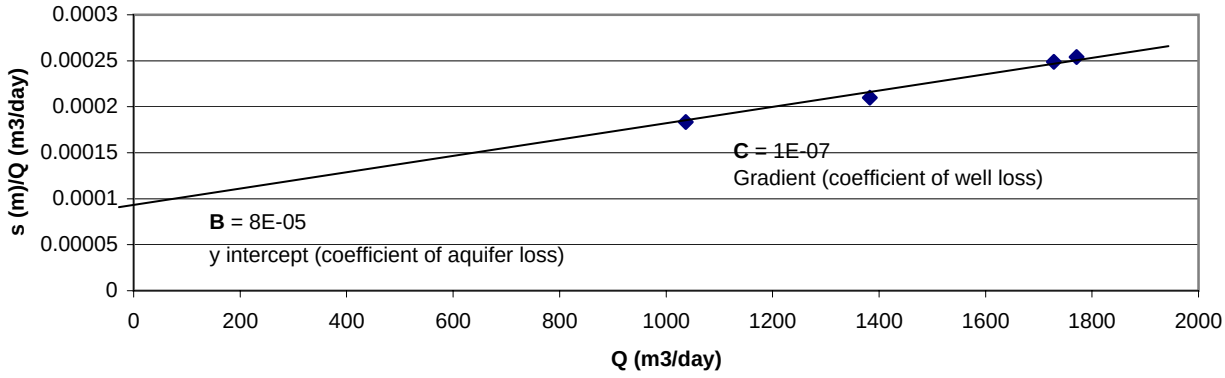
Details	Pumping Bore	Comment	Details	Pumping Bore	Comments
Bore No.	B10P			B10P	
Reference point (magl)	0.8			0.8	
Static water level (mbrp)	5.94			5.94	

Time		Test Rate 3 (L/s): 20		Comment	Time	Test Rate 4 (L/s): 20.5		Comment
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	120.5	6.32	0.38		180.5	6.39	6.45	
	121.0	6.36	0.42		181	6.39	6.45	
	121.5	6.37	0.43		181.5	6.39	6.45	
	122.0	6.37	0.43		182	6.39	6.45	
	122.5	6.37	0.43		182.5	6.39	6.45	
	123.0	6.37	0.43		183	6.39	6.45	
	123.5	6.37	0.43		183.5	6.39	6.45	
	124.0	6.37	0.43		184	6.39	6.45	
	124.5	6.37	0.43		184.5	6.39	6.45	
	125.0	6.37	0.43		185	6.39	6.45	
	125.5	6.37	0.43		185.5	6.39	6.45	
	126.0	6.37	0.43		186	6.39	6.45	
	126.5	6.37	0.43		186.5	6.39	6.45	
	127.0	6.37	0.43		187	6.39	6.45	
	127.5	6.37	0.43		187.5	6.39	6.45	
	128.0	6.37	0.43		188	6.39	6.45	
	128.5	6.37	0.43		188.5	6.39	6.45	
	129.0	6.37	0.43		189	6.39	6.45	
	129.5	6.37	0.43		189.5	6.39	6.45	
	130	6.37	0.43		190	6.39	6.45	
	135	6.37	0.43		195	6.39	6.45	
	140	6.37	0.43		200	6.39	6.45	
	145	6.37	0.43		205	6.39	6.45	
	150	6.37	0.43		210	6.39	6.45	
	155	6.37	0.43		215	6.39	6.45	
	160	6.37	0.43		220	6.39	6.45	
	165	6.37	0.43		225	6.39	6.45	
	170	6.37	0.43		230	6.39	6.45	
	175	6.37	0.43		235	6.39	6.45	
	180	6.37	0.43	172262 L	240	6.39	6.45	246216 L

Barrambie - B10P Step Discharge Pumping Test
Observed drawdown v Time
5th October 2007



Barrambie - B10P Anylitical Plot s/Q v Q
5th October 2007



$s_{w(n)} = BQ_n + CQ^P{}_n$ (Rorabaugh's equation)

Where, B = Intercept with y axis (coefficient of aquifer loss or laminar flow)

C = Gradient (coefficient of turbulent flow loss or apparent well loss)

s = Drawdown in the borehole

P = Value determined using Rorabaugh's method of superposition

Components of the equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively.

They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

It should be noted:

1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

$Ew = (BQ/(BQ + CQ^P)) \times 100$

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow

Comparison of Observed and Predicted Drawdowns						
			Observed	Predicted		Apparent
Step (60 min steps)	Discharge (L/s)	Discharge (Q) (m^3/d)	Corrected Drawdown (s) (metres)	Drawdown (metres)	s/Q	Efficiency (Ew) %
1	12.0	1037	0.19		0.000183	44
2	16.0	1382	0.29		0.000210	37
3	20.0	1728	0.43		0.000249	32
4	20.5	1771	0.45		0.000254	31

Step Test Analysis Data

Barrambie B10P

Well ID	Step Test Date	Step	Q[1] (m^3/day)	Q (Ml/day)[10]	$S_{w(o)}$[2] (m)	$S_{w(co)}$[3] (m)	$S_{w(i)}$[4] (m)	$S_{w(ci)}$[5] (m)	$S_{w(ci)}/Q$ (day/m^2)	S_w[6] (m)	E_w[7] (%)	B[8]	C[9] (day^2/m^5)	C ($min.^2/m^5$)	S.C.[10] (m^2/day)
B10P	5/10/2007	1	1036.8	1.04	0.19	0.19	0.19	0.19	1.83E-04	0.19	44	na	na	na	5457
		2	1382.4	1.38	0.10	0.29	0.10	0.29	2.10E-04	0.30	38	na	na	na	4767
		3	1728.0	1.73	0.14	0.43	0.14	0.43	2.49E-04	0.44	32	na	na	na	4019
		4	1771.2	1.77	0.02	0.45	0.02	0.45	2.54E-04	0.46	31	8.00E-05	1.00E-07	0.20736	3936

Notes:

1. Q = well pumping rate in m^3/day
2. $S_{w(o)}$ = observed drawdown in well
3. $S_{w(co)}$ = cumulative observed drawdown in well
4. $S_{w(i)}$ = incremental drawdown in well
5. $S_{w(ci)}$ = cumulative incremental drawdown in well
6. S_w = calculated well drawdown (see Equation 1.0)
7. E_w = well efficiency (see Equation 3.0)
8. B = formation loss coefficient
9. C = well loss coefficient (see Equation 2.0)
10. S.C. = Specific Capacity ($Q/S_{w(co)}$)

Equation 1.0

$$S_w = BQ + CQ^2$$

Equation 2.0

$$C = \frac{\Delta\left(S_{w(ci)}/Q\right)}{\Delta Q}$$

B= 8.00E-05
C= 1.00E-07

Equation 3.0

$$E_w = \frac{BQ}{S_w} \times 100\%$$

Multi Rate Test (60)

Job No.: 767	Job Name: Barrambie	Client: Reed Resoureces
Location: Cogla Downs	Logged by: MDP	Date: 6/10/2007 Time: 10:00 AM

Details	Pumping Bore	Comment	Details	Pumping Bore	Comment
Bore No.	B15P			B15P	
Reference point (magl)	0.7			0.7	
Static water level (mbrp)	3.69			3.69	
Time	Test Rate 1 (L/s): 5	Comment	Time	Test Rate 2 (L/s): 8	Comment

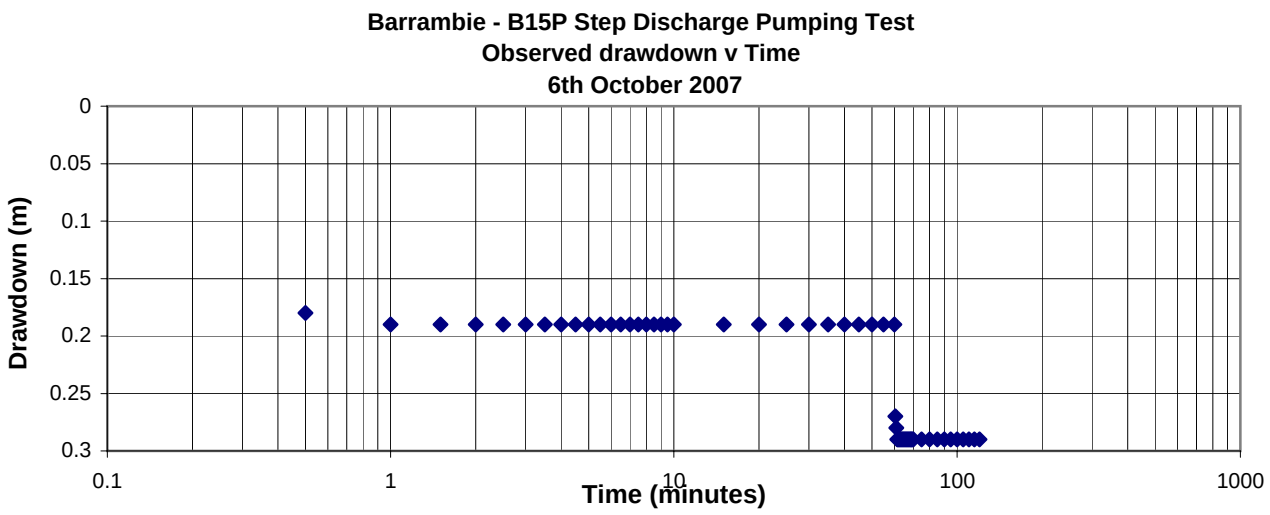
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	0.5	4.25	0.56		60.5	4.91	1.22	
	1.0	4.29	0.6		61	4.92	1.23	
	1.5	4.29	0.6		61.5	4.92	1.23	
	2.0	4.29	0.6		62	4.92	1.23	
	2.5	4.29	0.6		62.5	4.93	1.24	
	3.0	4.29	0.6		63	4.93	1.24	
	3.5	4.29	0.6		63.5	4.93	1.24	
	4.0	4.29	0.6		64	4.93	1.24	
	4.5	4.29	0.6		64.5	4.93	1.24	
	5.0	4.29	0.6		65	4.93	1.24	
	5.5	4.29	0.6		65.5	4.93	1.24	
	6.0	4.29	0.6		66	4.93	1.24	
	6.5	4.29	0.6		66.5	4.93	1.24	
	7.0	4.29	0.6		67	4.93	1.24	
	7.5	4.29	0.6		67.5	4.94	1.25	
	8.0	4.3	0.61		68	4.94	1.25	
	8.5	4.3	0.61		68.5	4.94	1.25	
	9.0	4.3	0.61		69	4.94	1.25	
	9.5	4.3	0.61		69.5	4.94	1.25	
	10	4.31	0.62		70	4.95	1.26	
	15	4.35	0.66		75	4.96	1.27	
	20	4.35	0.66		80	4.96	1.27	
	25	4.35	0.66		85	4.96	1.27	
	30	4.36	0.67		90	4.96	1.27	
	35	4.36	0.67		95	4.96	1.27	
	40	4.36	0.67		100	4.96	1.27	
	45	4.36	0.67		105	4.96	1.27	
	50	4.37	0.68		110	4.96	1.27	
	55	4.37	0.68		115	4.96	1.27	
	60	4.37	0.68	17636 Litres	120	4.96	1.27	46300Litres

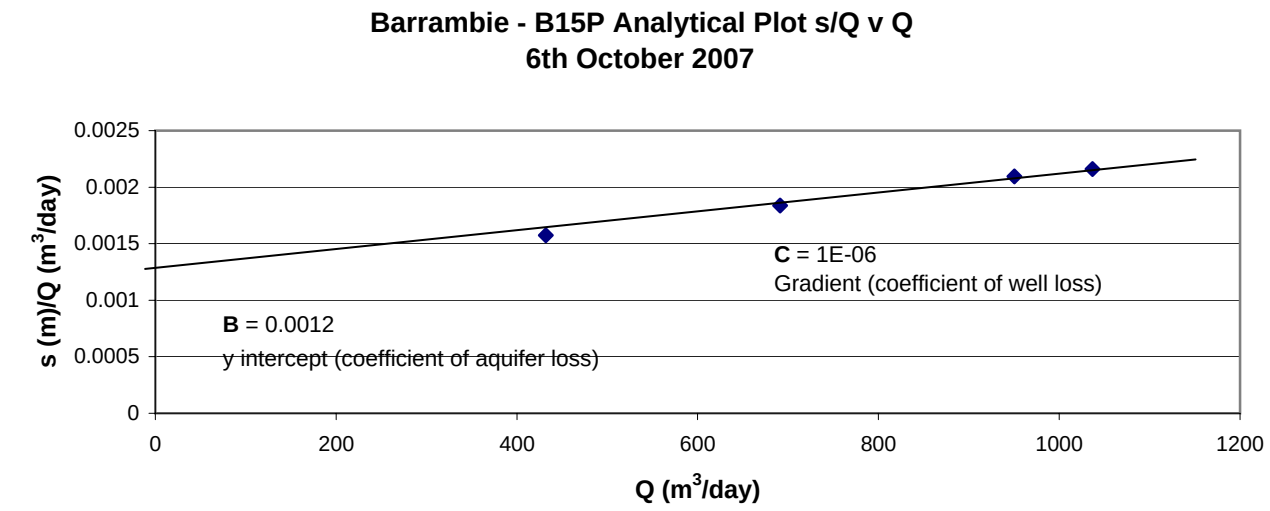
Multi Rate Test (60)

Job No.:	767	Job Name:	Barrambie	Client:	Reed Resoureces
Location:	Cogla Downs	Logged by:	MDP	Date:	6/10/2007
Time:	10:00 AM				

Details	Pumping Bore	Comment	Details	Pumping Bore	Comments
Bore No.	B15P			B15P	
Reference point (magl)	0.7			0.7	
Static water level (mbrp)	3.69			3.69	

Time		Test Rate 3 (L/s): 11		Comment	Time	Test Rate 4 (L/s): 12		Comment
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Recovery
	120.5	5.54	1.85		180.5	5.89	2.2	4.01
	121.0	5.62	1.93		181	5.89	2.2	3.91
	121.5	5.62	1.93		181.5	5.9	2.21	3.87
	122.0	5.62	1.93		182	5.9	2.21	3.85
	122.5	5.63	1.94		182.5	5.91	2.22	3.83
	123.0	5.64	1.95		183	5.91	2.22	3.81
	123.5	5.64	1.95		183.5	5.91	2.22	3.78
	124.0	5.64	1.95		184	5.91	2.22	3.77
	124.5	5.64	1.95		184.5	5.91	2.22	3.76
	125.0	5.64	1.95		185	5.91	2.22	3.76
	125.5	5.65	1.96		185.5	5.91	2.22	
	126.0	5.65	1.96		186	5.91	2.22	
	126.5	5.65	1.96		186.5	5.91	2.22	
	127.0	5.65	1.96		187	5.91	2.22	3.75
	127.5	5.65	1.96		187.5	5.91	2.22	
	128.0	5.66	1.97		188	5.91	2.22	
	128.5	5.66	1.97		188.5	5.91	2.22	
	129.0	5.66	1.97		189	5.91	2.22	
	129.5	5.66	1.97		189.5	5.91	2.22	
	130	5.66	1.97		190	5.91	2.22	3.74
	135	5.67	1.98		195	5.91	2.22	3.73
	140	5.67	1.98		200	5.92	2.23	
	145	5.67	1.98		205	5.92	2.23	
	150	5.67	1.98		210	5.92	2.23	
	155	5.68	1.99		215	5.92	2.23	
	160	5.68	1.99		220	5.92	2.23	3.72
	165	5.68	1.99		225	5.92	2.23	
	170	5.68	1.99		230	5.93	2.24	
	175	5.68	1.99		235	5.93	2.24	
	180	5.68	1.99	85951 Litres	240	5.93	2.24	129165 Litres





$s_{w(n)} = BQ_n + CQ^P_n$ (Rorabaugh's equation)

Where, B = Intercept with y axis (coefficient of aquifer loss or laminar flow)

C = Gradient (coefficient of turbulent flow loss or apparent well loss)

s = Drawdown in the borehole

P = Value determined using Rorabaugh's method of superposition

Components of the equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively.

They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

It should be noted:

1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

$Ew = (BQ/(BQ + CQ^P)) \times 100$

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow

Comparison of Observed and Predicted Drawdowns						
			Observed	Predicted		Apparent
Step (60 min steps)	Discharge (L/s)	Discharge (Q) (m^3/d)	Corrected Drawdown (s) (metres)	Drawdown (metres)	s/Q	Efficiency (Ew) %
1	5.0	432	0.68		0.001574	74
2	8.0	691	1.27		0.001837	63
3	11.0	950	1.99		0.002094	56
4	12.0	1037	2.24		0.002160	54

Step Test Analysis Data

Barrambie B15P

Well ID	Step Test Date	Step	Q[1] (m^3/day)	Q (Ml/day)[10]	$S_{w(o)}$[2] (m)	$S_{w(co)}$[3] (m)	$S_{w(i)}$[4] (m)	$S_{w(ci)}$[5] (m)	$S_{w(ci)}$/Q (day/m^2)	S_w[6] (m)	E_w[7] (%)	B[8]	C[9] (day^2/m^5)	C (min.^{2}/m^5)	S.C.[10] (m^2/day)
B15P	6/10/2007	1	432.0	0.43	0.68	0.68	0.68	0.68	1.57E-03	0.71	76	na	na	na	635
		2	691.2	0.69	0.59	1.27	0.59	1.27	1.84E-03	1.31	65	na	na	na	544
		3	950.4	0.95	0.72	1.99	0.72	1.99	2.09E-03	2.04	57	na	na	na	478
		4	1036.8	1.04	0.25	2.24	0.25	2.24	2.16E-03	2.32	56	1.20E-03	1.00E-06	2.0736	463

Notes:

1. Q = well pumping rate in m^3/day
2. $S_{w(o)}$ = observed drawdown in well
3. $S_{w(co)}$ = cumulative observed drawdown in well
4. $S_{w(i)}$ = incremental drawdown in well
5. $S_{w(ci)}$ = cumulative incremental drawdown in well
6. S_w = calculated well drawdown (see Equation 1.0)
7. E_w = well efficiency (see Equation 3.0)
8. B = formation loss coefficient
9. C = well loss coefficient (see Equation 2.0)
10. S.C. = Specific Capacity ($Q/S_{w(co)}$)

Equation 1.0

$$S_w = BQ + CQ^2$$

Equation 2.0

$$C = \frac{\Delta\left(S_{w(ci)}/Q\right)}{\Delta Q}$$

B= 1.20E-03
C= 1.00E-06

Equation 3.0

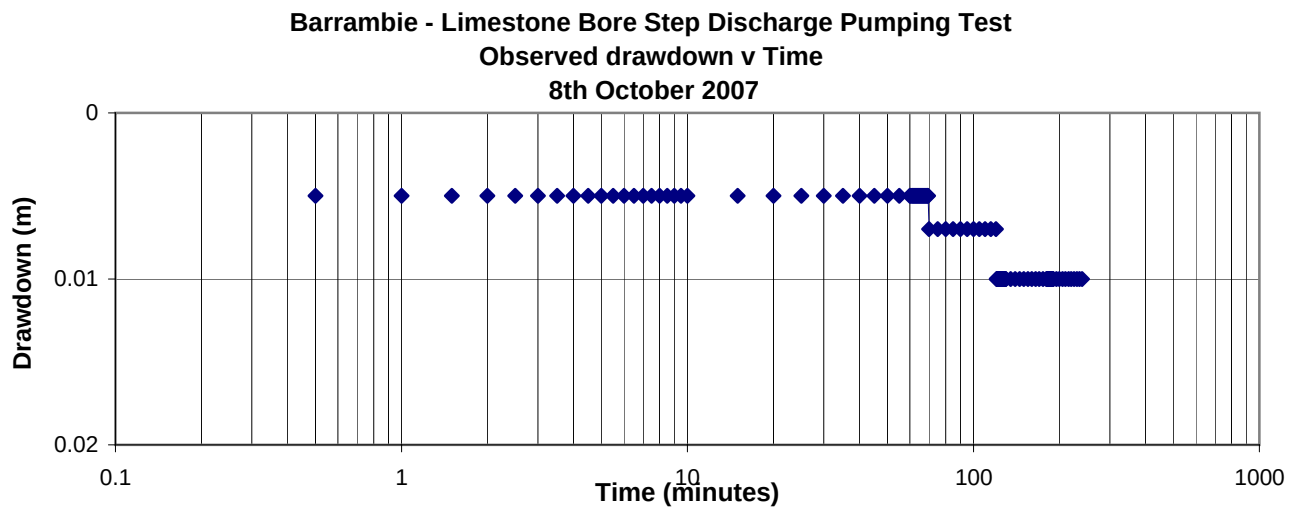
$$E_w = \frac{BQ}{S_w} \times 100\%$$

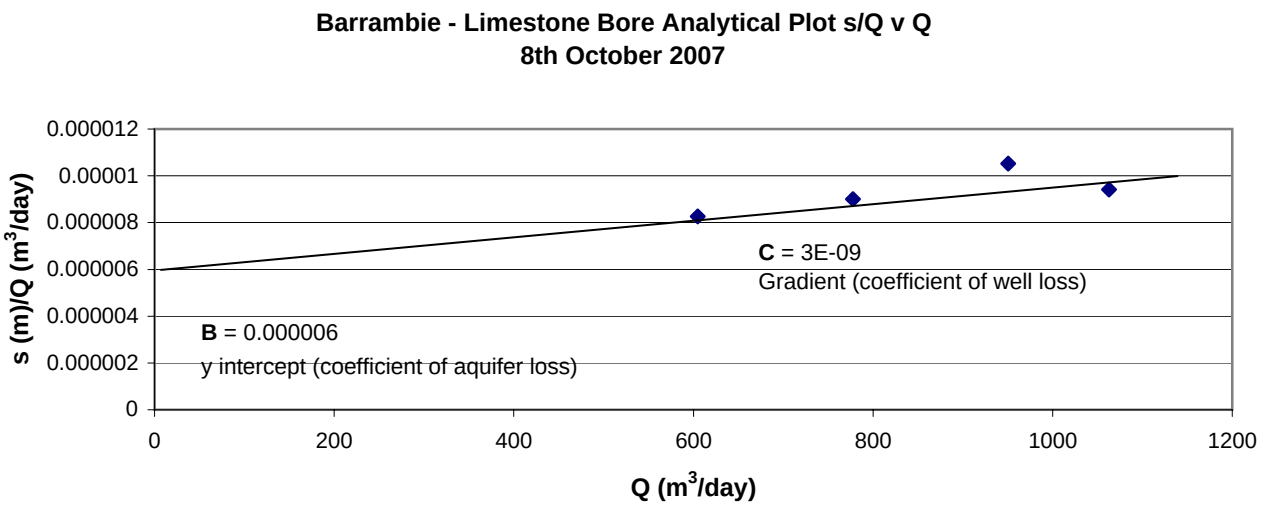
Multi Rate Test (60)

Job No.:	767	Job Name:	Barrambie			Client:	Reed Resources	
Location:	Cogla Downs		Logged by:	MDP		Date:	8/10/2007	Time: 10am
Details		Pumping Bore		Comment	Details	Pumping Bore		Comment
Bore No.		Limestone Bore				Limestone Bore		
Reference point (magl)		0.84				0.84		
Static water level (mbrp)		5.11				5.11		
Time		Test Rate 1 (L/s): 7		Comment	Time	Test Rate 2 (L/s): 9		Comment
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	0.5	5.115	0.005		60.5	5.115	0.005	
	1.0	5.115	0.005		61	5.115	0.005	
	1.5	5.115	0.005		61.5	5.115	0.005	
	2.0	5.115	0.005		62	5.115	0.005	
	2.5	5.115	0.005		62.5	5.115	0.005	
	3.0	5.115	0.005		63	5.115	0.005	
	3.5	5.115	0.005		63.5	5.115	0.005	
	4.0	5.115	0.005		64	5.115	0.005	
	4.5	5.115	0.005		64.5	5.115	0.005	
	5.0	5.115	0.005		65	5.115	0.005	
	5.5	5.115	0.005		65.5	5.115	0.005	
	6.0	5.115	0.005		66	5.115	0.005	
	6.5	5.115	0.005		66.5	5.115	0.005	
	7.0	5.115	0.005		67	5.115	0.005	
	7.5	5.115	0.005		67.5	5.115	0.005	
	8.0	5.115	0.005		68	5.115	0.005	
	8.5	5.115	0.005		68.5	5.115	0.005	
	9.0	5.115	0.005		69	5.115	0.005	
	9.5	5.115	0.005		69.5	5.115	0.005	
	10	5.115	0.005	EC=3.24ms at 25.7 dC	70	5.117	0.007	
	15	5.115	0.005		75	5.117	0.007	
	20	5.115	0.005		80	5.117	0.007	
	25	5.115	0.005		85	5.117	0.007	
	30	5.115	0.005		90	5.117	0.007	
	35	5.115	0.005		95	5.117	0.007	
	40	5.115	0.005		100	5.117	0.007	
	45	5.115	0.005		105	5.117	0.007	
	50	5.115	0.005		110	5.117	0.007	
	55	5.115	0.005		115	5.117	0.007	
	60	5.115	0.005	24500 Litres	120	5.117	0.007	57452 Litres

Multi Rate Test (60)

Job No.: 767		Job Name:	Barrambie		Client:	Reed Resources	
Location: Cogla Downs			Logged by: MDP		Date: 8/10/2007	Time: 10am	
Details	Pumping Bore		Comment	Details	Pumping Bore		Comments
Bore No.	Limestone Bore				Limestone Bore		
Reference point (magl)	0.84				0.84		
Static water level (mbrp)	5.11				5.11		
Time	Test Rate 3 (L/s): 11		Comment	Time	Test Rate 4 (L/s): 12.30		Comment
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)		Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	
	120.5	5.12	0.01		180.5	5.12	0.01	
	121.0	5.12	0.01		181	5.12	0.01	
	121.5	5.12	0.01		181.5	5.12	0.01	
	122.0	5.12	0.01		182	5.12	0.01	
	122.5	5.12	0.01		182.5	5.12	0.01	
	123.0	5.12	0.01		183	5.12	0.01	
	123.5	5.12	0.01		183.5	5.12	0.01	
	124.0	5.12	0.01		184	5.12	0.01	
	124.5	5.12	0.01		184.5	5.12	0.01	
	125.0	5.12	0.01		185	5.12	0.01	
	125.5	5.12	0.01		185.5	5.12	0.01	
	126.0	5.12	0.01		186	5.12	0.01	
	126.5	5.12	0.01		186.5	5.12	0.01	
	127.0	5.12	0.01		187	5.12	0.01	
	127.5	5.12	0.01		187.5	5.12	0.01	
	128.0	5.12	0.01		188	5.12	0.01	
	128.5	5.12	0.01		188.5	5.12	0.01	
	129.0	5.12	0.01		189	5.12	0.01	
	129.5	5.12	0.01		189.5	5.12	0.01	
	130	5.12	0.01		190	5.12	0.01	
	135	5.12	0.01		195	5.12	0.01	
	140	5.12	0.01		200	5.12	0.01	
	145	5.12	0.01		205	5.12	0.01	
	150	5.12	0.01		210	5.12	0.01	
	155	5.12	0.01		215	5.12	0.01	
	160	5.12	0.01		220	5.12	0.01	
	165	5.12	0.01		225	5.12	0.01	
	170	5.12	0.01		230	5.12	0.01	
	175	5.12	0.01		235	5.12	0.01	
	180	5.12	0.01	96935 Litres	240	5.12	0.01	141268 Litres





$s_{w(n)} = BQ_n + CQ^P_n$ (Rorabaugh's equation)

Where, B = Intercept with y axis (coefficient of aquifer loss or laminar flow)

C = Gradient (coefficient of turbulent flow loss or apparent well loss)

s = Drawdown in the borehole

P = Value determined using Rorabaugh's method of superposition

Components of the equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively.

They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

It should be noted:

1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

$Ew = (BQ/(BQ + CQ^P) \times 100$

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow

Comparison of Observed and Predicted Drawdowns						
			Observed	Predicted		Apparent
Step (60 min steps)	Discharge (L/s)	Discharge (Q) (m^3/d)	Corrected Drawdown (s) (metres)	Drawdown (metres)	s/Q	Efficiency (Ew) %
1	7.0	605	0.005		0.000008	77
2	9.0	778	0.007		0.000009	72
3	11.0	950	0.010		0.000011	68
4	12.3	1063	0.010		0.000009	65

Step Test Analysis Data

Barrambie Limestone Bore

Well ID	Step Test Date	Step	Q[1] (m^3/day)	Q (Ml/day)[10]	$S_{w(o)}$[2] (m)	$S_{w(co)}$[3] (m)	$S_{w(i)}$[4] (m)	$S_{w(ci)}$[5] (m)	$S_{w(ci)}/Q$ (day/m^2)	S_w[6] (m)	E_w[7] (%)	B[8]	C[9] (day^2/m^5)	C (min.^{2}/m^5)	S.C.[10] (m^2/day)
Limestone	8/10/2007	1	604.8	0.60	0.005	0.005	0.005	0.005	8.27E-06	0.00	73	na	na	na	120960
		2	777.6	0.78	0.002	0.007	0.002	0.007	9.00E-06	0.01	67	na	na	na	111086
		3	950.4	0.95	0.003	0.010	0.003	0.01	1.05E-05	0.01	57	na	na	na	95040
		4	1062.7	1.06	0	0.010	0	0.01	9.41E-06	0.01	64	6.00E-06	3.00E-09	0.0062208	106270

Notes:

1. Q = well pumping rate in m^3/day
2. $S_{w(o)}$ = observed drawdown in well
3. $S_{w(co)}$ = cumulative observed drawdown in well
4. $S_{w(i)}$ = incremental drawdown in well
5. $S_{w(ci)}$ = cumulative incremental drawdown in well
6. S_w = calculated well drawdown (see Equation 1.0)
7. E_w = well efficiency (see Equation 3.0)
8. B = formation loss coefficient
9. C = well loss coefficient (see Equation 2.0)
10. S.C. = Specific Capacity ($Q/S_{w(co)}$)

Equation 1.0

$$S_w = BQ + CQ^2$$

Equation 2.0

$$C = \frac{\Delta\left(S_{w(ci)}/Q\right)}{\Delta Q}$$

Equation 3.0

$$E_w = \frac{BQ}{S_w} \times 100\%$$

B= 6.00E-06

C= 3.00E-09

APPENDIX D CONSTANT RATE TEST DATA

Constant Rate (Pump and Observation)

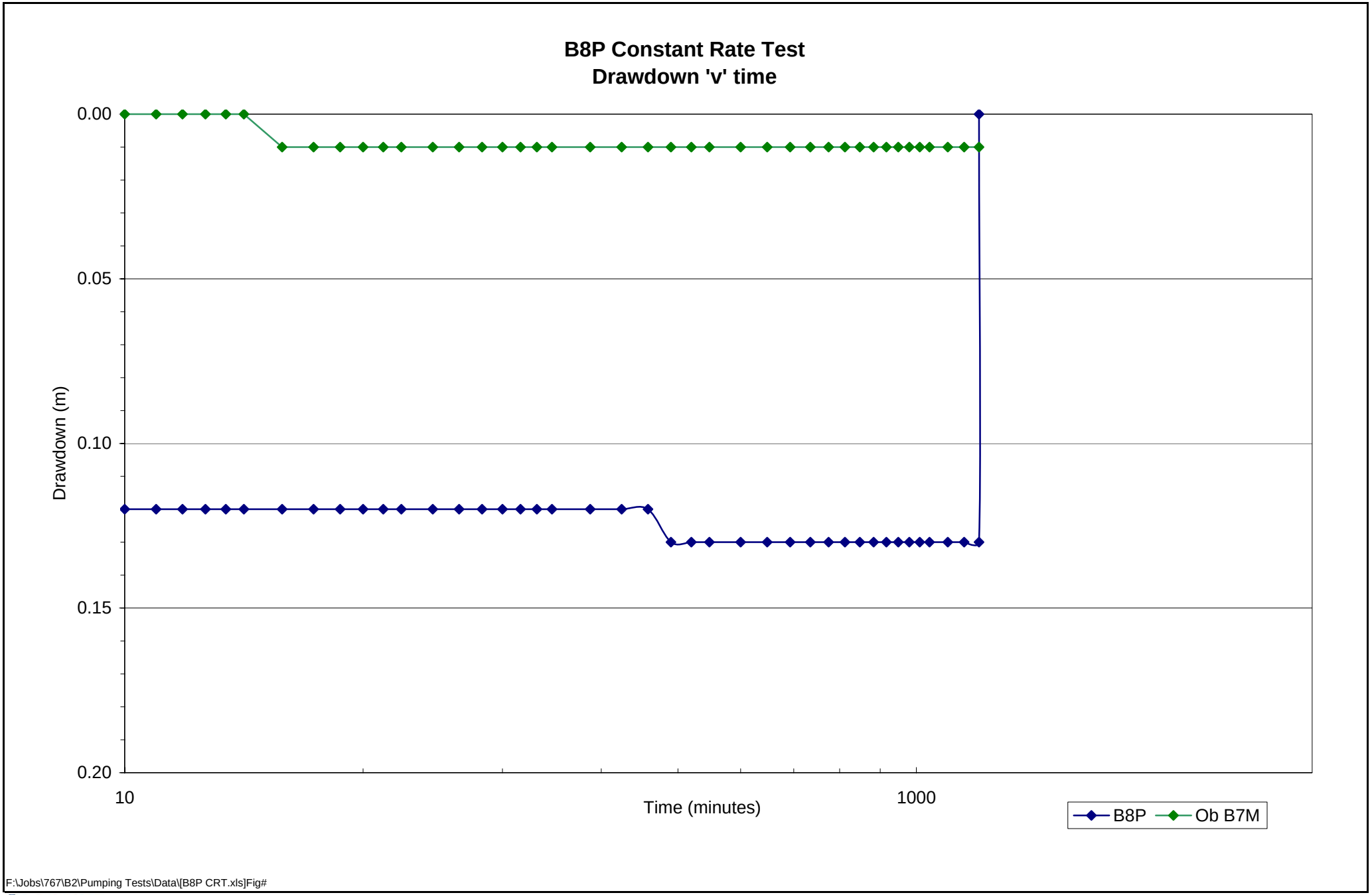
Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 4/10/2007 Time: 6pm

Details	Pumping Bore	Observation Bore	Comments
Bore No.	B8P	B7M	B9M SWL=4.28
Discharge rate (L/s)	20.5	-	Start and end of CRT
Reference point (magl)	0.75	0.21	
Static water level (mbrp)	5.64	5.1	
Dist. from PB (m)	-	25	

Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	0.5	5.74	0.1	5.1	0	
	1.0	5.75	0.11	5.1	0	
	1.5	5.76	0.12	5.1	0	
	2.0	5.76	0.12	5.1	0	
	2.5	5.76	0.12	5.1	0	
	3.0	5.76	0.12	5.1	0	
	4.0	5.76	0.12	5.1	0	
	5.0	5.76	0.12	5.1	0	
	6.0	5.76	0.12	5.1	0	
	7.0	5.76	0.12	5.1	0	
	8.0	5.76	0.12	5.1	0	
	9.0	5.76	0.12	5.1	0	
	10	5.76	0.12	5.1	0	
	12	5.76	0.12	5.1	0	
	14	5.76	0.12	5.1	0	
	16	5.76	0.12	5.1	0	
	18	5.76	0.12	5.1	0	
	20	5.76	0.12	5.1	0	
	25	5.76	0.12	5.11	0.01	EC=3.92ms at 22.7 degrees C
	30	5.76	0.12	5.11	0.01	
	35	5.76	0.12	5.11	0.01	
	40	5.76	0.12	5.11	0.01	
	45	5.76	0.12	5.11	0.01	
	50	5.76	0.12	5.11	0.01	
	60	5.76	0.12	5.11	0.01	71555 Litres
	70	5.76	0.12	5.11	0.01	
	80	5.76	0.12	5.11	0.01	
	90	5.76	0.12	5.11	0.01	
	100	5.76	0.12	5.11	0.01	122649 Litres
	110	5.76	0.12	5.11	0.01	
	120	5.76	0.12	5.11	0.01	
	150	5.76	0.12	5.11	0.01	183819 Litres
	180	5.76	0.12	5.11	0.01	

Constant Rate (Pump and Observation)

Bore No. B8P		Job No.: 767				Job Name: Barrambie
Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	210	5.76	0.12	5.11	0.01	
	240	5.77	0.13	5.11	0.01	294488 L/EC=3.74m/s at 28.3 degrees c
	270	5.77	0.13	5.11	0.01	
	300	5.77	0.13	5.11	0.01	368270 Litres
	360	5.77	0.13	5.11	0.01	442000 Litres
	420	5.77	0.13	5.11	0.01	515680 Litres
	480	5.77	0.13	5.11	0.01	EC=3.68ms at 31.4 Degrees
	540	5.77	0.13	5.11	0.01	663000 Litres
	600	5.77	0.13	5.11	0.01	736537 Litres
	660	5.77	0.13	5.11	0.01	
	720	5.77	0.13	5.11	0.01	
	780	5.77	0.13	5.11	0.01	
	840	5.77	0.13	5.11	0.01	1032100 3.79ms 25.7 Degrees
	900	5.77	0.13	5.11	0.01	
	960	5.77	0.13	5.11	0.01	
	1020	5.77	0.13	5.11	0.01	1253758 Litres
	1080	5.77	0.13	5.11	0.01	EC=3.93ms at 21.5 Degrees C
	1200	5.77	0.13	5.11	0.01	
	1320	5.77	0.13	5.11	0.01	1623200 Litres
	1440	5.77	0.13	5.11	0.01	EC=3.80ms at 21.6 degrees
	1440.5	5.64	0	0		Recovery too fast to be monitored
	1560					
	1680					Total Litres= 1770777
	1800					
	1920					
	2040					
	2160					
	2280					
	2400					
	2520					
	2640					
	2760					
	2880					
	3120					
	3360					
	3600					
	3840					
	4080					
	4320					



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Water Level Drawdown

Constant Rate (Pump and Observation)

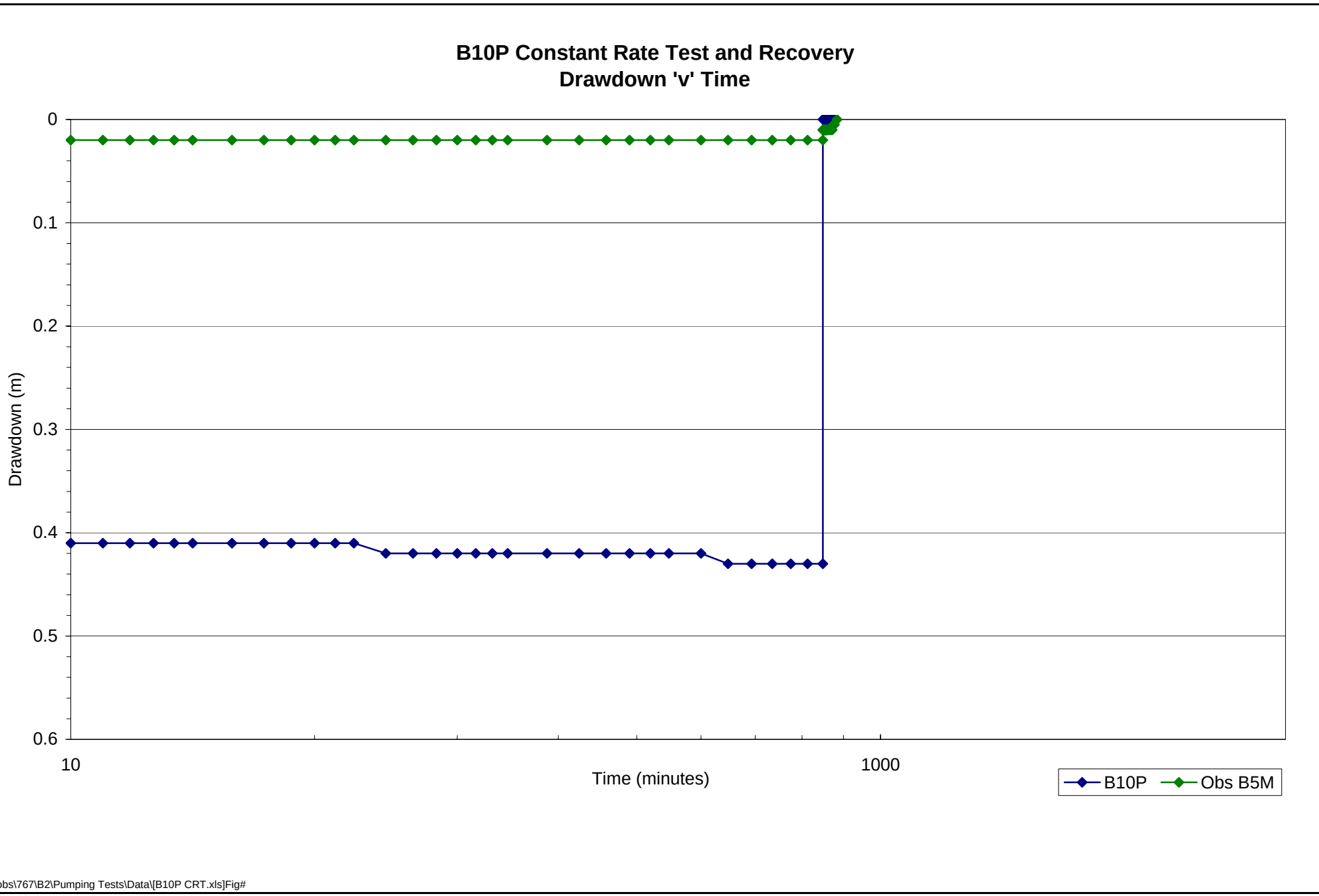
Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 5/10/2007 Time: 6pm

Details	Pumping Bore	Observation Bore	Comments
Bore No.	B10P	B5M	B9M SWL=4.28
Discharge rate (L/s)	20	-	Start and end of CRT
Reference point (magl)	0.8	0.2	
Static water level (mbrp)	5.94	5.18	
Dist. from PB (m)	-	25	

Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	0.5	6.35	0.41	5.18	0	
	1.0	6.35	0.41	5.19	0.01	
	1.5	6.35	0.41	5.19	0.01	
	2.0	6.35	0.41	5.2	0.02	
	2.5	6.35	0.41	5.2	0.02	
	3.0	6.35	0.41	5.2	0.02	
	4.0	6.35	0.41	5.2	0.02	
	5.0	6.35	0.41	5.2	0.02	
	6.0	6.35	0.41	5.2	0.02	
	7.0	6.35	0.41	5.2	0.02	
	8.0	6.35	0.41	5.2	0.02	
	9.0	6.35	0.41	5.2	0.02	
	10	6.35	0.41	5.2	0.02	EC=12.05ms at 28.1 degrees C
	12	6.35	0.41	5.2	0.02	
	14	6.35	0.41	5.2	0.02	
	16	6.35	0.41	5.2	0.02	
	18	6.35	0.41	5.2	0.02	
	20	6.35	0.41	5.2	0.02	
	25	6.35	0.41	5.2	0.02	
	30	6.35	0.41	5.2	0.02	
	35	6.35	0.41	5.2	0.02	
	40	6.35	0.41	5.2	0.02	
	45	6.35	0.41	5.2	0.02	
	50	6.35	0.41	5.2	0.02	
	60	6.36	0.42	5.2	0.02	71555 Litres
	70	6.36	0.42	5.2	0.02	
	80	6.36	0.42	5.2	0.02	
	90	6.36	0.42	5.2	0.02	
	100	6.36	0.42	5.2	0.02	
	110	6.36	0.42	5.2	0.02	
	120	6.36	0.42	5.2	0.02	
	150	6.36	0.42	5.2	0.02	EC=12.36ms at 25.7 dC
	180	6.36	0.42	5.2	0.02	215189 Litres

Constant Rate (Pump and Observation)

Bore No. B10P		Job No.: 767				Job Name: Barrambie
Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	210	6.36	0.42	5.2	0.02	
	240	6.36	0.42	5.2	0.02	287472 L
	270	6.36	0.42	5.2	0.02	
	300	6.36	0.42	5.2	0.02	
	360	6.36	0.42	5.2	0.02	EC=12.44 ms at 23.5 dC
	420	6.37	0.43	5.2	0.02	503280 L
	480	6.37	0.43	5.2	0.02	
	540	6.37	0.43	5.2	0.02	646988 L
	600	6.37	0.43	5.2	0.02	EC=12.28 ms at 22.3 dC
	660	6.37	0.43	5.2	0.02	
	720	6.37	0.43	5.2	0.02	EC=12.52 ms at 21.2 dC
	780					
	840					Total Litres=863649
	900					
	960					
	1020					
	1080					
	1200					
	1320					
	1440					
	1560					
	1680					
	1800					
	1920					
	2040					
	2160					
	2280					
	2400					
	2520					
	2640					
	2760					
	2880					
	3120					
	3360					
	3600					
	3840					
	4080					
	4320					



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Water Level Drawdown

Constant Rate (Pump and Observation)

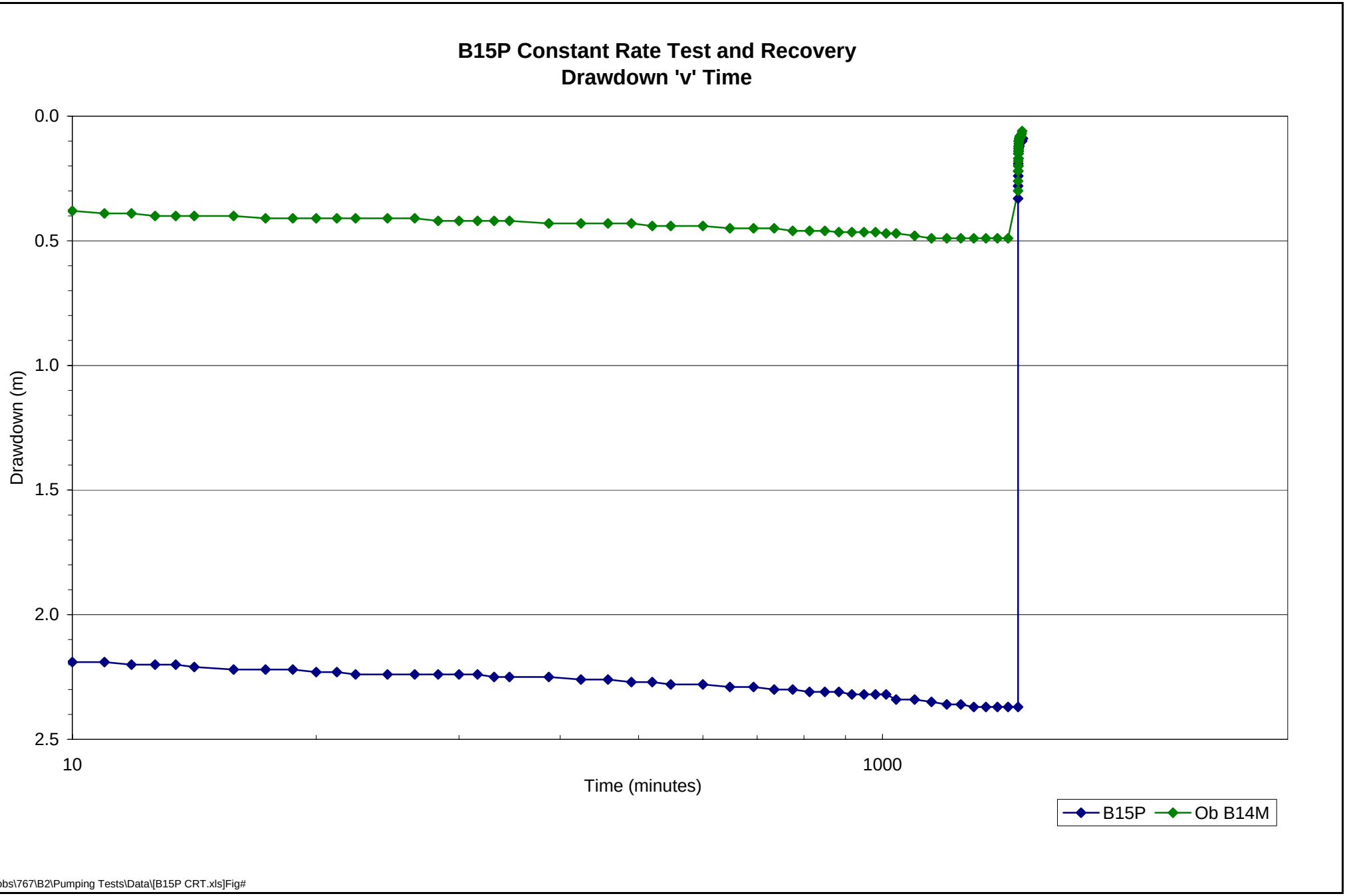
Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 6/10/2007 Time: 6pm

Details	Pumping Bore	Observation Bore	Comments
Bore No.	B15P	B14M	Nickyloo- SWL=2.43 at start of CRT
Discharge rate (L/s)	12	-	SWL=2.43 at end of CRT
Reference point (magl)	0.7	0.1	B6M- SWL=4.86 at start of CRT
Static water level (mbrp)	3.69	2.83	SWL=4.86 at end of CRT
Dist. from PB (m)	-	10	

Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	0.5	5.63	1.94			
	1.0	5.71	2.02	3.02	0.19	
	1.5	5.75	2.06	3.07	0.24	
	2.0	5.78	2.09	3.09	0.26	
	2.5	5.79	2.1	3.12	0.29	
	3.0	5.8	2.11	3.14	0.31	
	4.0	5.83	2.14	3.16	0.33	
	5.0	5.84	2.15	3.17	0.34	
	6.0	5.85	2.16	3.18	0.35	
	7.0	5.86	2.17	3.19	0.36	
	8.0	5.87	2.18	3.2	0.37	
	9.0	5.87	2.18	3.21	0.38	
	10	5.88	2.19	3.21	0.38	
	12	5.88	2.19	3.21	0.38	
	14	5.89	2.2	3.22	0.39	
	16	5.89	2.2	3.22	0.39	
	18	5.89	2.2	3.23	0.4	
	20	5.9	2.21	3.23	0.4	
	25	5.91	2.22	3.23	0.4	
	30	5.91	2.22	3.23	0.4	
	35	5.91	2.22	3.24	0.41	
	40	5.92	2.23	3.24	0.41	
	45	5.92	2.23	3.24	0.41	
	50	5.93	2.24	3.24	0.41	EC=4.07ma at 25.8 dC
	60	5.93	2.24	3.24	0.41	43317 Litres
	70	5.93	2.24	3.24	0.41	
	80	5.93	2.24	3.24	0.41	
	90	5.93	2.24	3.25	0.42	
	100	5.93	2.24	3.25	0.42	
	110	5.94	2.25	3.25	0.42	
	120	5.94	2.25	3.25	0.42	86737 L
	150	5.94	2.25	3.25	0.42	
	180	5.95	2.26	3.26	0.43	130100 L

Constant Rate (Pump and Observation)

Bore No. B15P		Job No.: 767				Job Name: Barrambie
Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	210	5.95	2.26	3.26	0.43	
	240	5.96	2.27	3.26	0.43	173482 L
	270	5.96	2.27	3.26	0.43	
	300	5.97	2.28	3.27	0.44	
	360	5.97	2.28	3.27	0.44	
	420	5.98	2.29	3.27	0.44	303468 L
	480	5.98	2.29	3.28	0.45	EC=4.09ms at 20.9 dC
	540	5.99	2.3	3.28	0.45	
	600	5.99	2.3	3.28	0.45	
	660	6.00	2.31	3.29	0.46	
	720	6.00	2.31	3.29	0.46	EC=4.00ms at 21.8 dC
	780	6.00	2.31	3.29	0.46	565723 L
	840	6.01	2.32	3.295	0.465	609303 L
	900	6.01	2.32	3.295	0.465	
	960	6.01	2.32	3.295	0.465	
	1020	6.01	2.32	3.295	0.465	EC=3.95 ms at 26.3 dC
	1080	6.03	2.34	3.3	0.47	783500 L
	1200	6.03	2.34	3.3	0.47	
	1320	6.04	2.35	3.31	0.48	EC=4.02 ms at 26.6 dC
	1440	6.05	2.36	3.32	0.49	1043630 L
	1560	6.05	2.36	3.32	0.49	
	1680	6.06	2.37	3.32	0.49	
	1800	6.06	2.37	3.32	0.49	EC= 4.04 ms at 20.9 dC
	1920	6.06	2.37	3.32	0.49	1391762 L
	2040	6.06	2.37	3.32	0.49	
	2160	6.06	2.37	3.32	0.49	EC=3.94 ms at 21.2 dC
	2280					
	2400					Total Litres= 1566297
	2520					
	2640					
	2760					
	2880					
	3120					
	3360					
	3600					
	3840					
	4080					
	4320					



F:\Jobs\767\B2\Pumping Tests\Data\[B15P CRT.xls]Fig#

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Water Level Drawdown

Constant Rate (Pump and Observation)

Job No.: 767	Job Name: Barrambie	Client: Reed Resources
Location: Cogla Downs	Logged by: MDP	Date: 8/10/2007 Time: 5pm

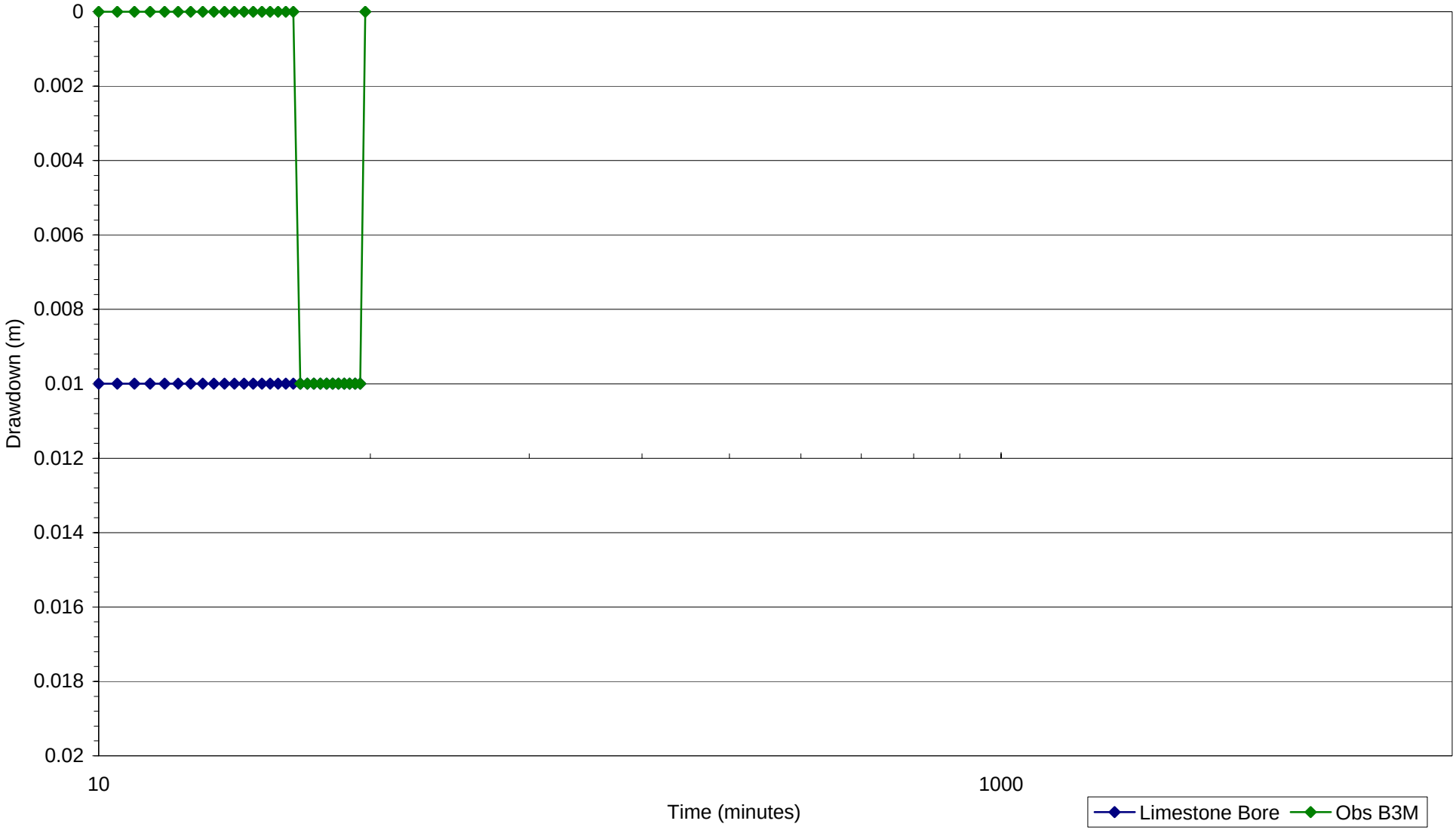
Details	Pumping Bore	Observation Bore	Comments
Bore No.	Limestone Bore	B3M	B1M-SWL= 6.06 No Drawdown
Discharge rate (L/s)	12.3	-	
Reference point (magl)	0.84	-	B11X-SWL= 4.11 No Drawdown
Static water level (mbrp)	5.11	4.63	
Dist. from PB (m)	-	50	

Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	0.5	5.12	0.01	4.63	0	
	1.0	5.12	0.01	4.63	0	
	1.5	5.12	0.01	4.63	0	
	2.0	5.12	0.01	4.63	0	
	2.5	5.12	0.01	4.63	0	
	3.0	5.12	0.01	4.63	0	
	4.0	5.12	0.01	4.63	0	
	5.0	5.12	0.01	4.63	0	
	6.0	5.12	0.01	4.63	0	
	7.0	5.12	0.01	4.63	0	
	8.0	5.12	0.01	4.63	0	
	9.0	5.12	0.01	4.63	0	
	10	5.12	0.01	4.63	0	
	12	5.12	0.01	4.63	0	
	14	5.12	0.01	4.63	0	
	16	5.12	0.01	4.63	0	
	18	5.12	0.01	4.63	0	
	20	5.12	0.01	4.63	0	EC=3.34ms at 25.3 dC
	25	5.12	0.01	4.63	0	
	30	5.12	0.01	4.63	0	
	35	5.12	0.01	4.63	0	
	40	5.12	0.01	4.63	0	
	45	5.12	0.01	4.63	0	
	50	5.12	0.01	4.63	0	
	60	5.12	0.01	4.63	0	44634 L
	70	5.12	0.01	4.63	0	
	80	5.12	0.01	4.63	0	
	90	5.12	0.01	4.64	0.01	
	100	5.12	0.01	4.64	0.01	
	110	5.12	0.01	4.64	0.01	
	120	5.12	0.01	4.64	0.01	89300 L
	150	5.12	0.01	4.64	0.01	
	180	5.12	0.01	4.64	0.01	

Constant Rate (Pump and Observation)

Bore No. Limestone Bore		Job No.: 767				Job Name: Barrambie
Time		Pumping Bore		Observation Bore		Comments
Real Time	Elapsed Time (mins)	Reading (mbrp)	Drawdown (m)	Reading (mbrp)	Drawdown (m)	
	210	5.12	0.01	4.64	0.01	
	240	5.12	0.01	4.64	0.01	
	270	5.12	0.01	4.64	0.01	
	300	5.12	0.01	4.64	0.01	EC=3.19ms at 23.9 dC
	360	5.12	0.01	4.64	0.01	Total Litres Pumped=267743
	361	5.11	0	4.63	0	
	420					Bores Recovered in less than one minute.
	480					
	540					
	600					
	660					
	720					
	780					
	840					
	900					
	960					
	1020					
	1080					
	1200					
	1320					
	1440					
	1560					
	1680					
	1800					
	1920					
	2040					
	2160					
	2280					
	2400					
	2520					
	2640					
	2760					
	2880					
	3120					
	3360					
	3600					
	3840					
	4080					
	4320					

Limestone Bore Constant Rate Test
Drawdown 'v' Time



F:\Jobs\767\B2\Pumping Tests\Data\[Limestone Bore CRT.xls]Fig#

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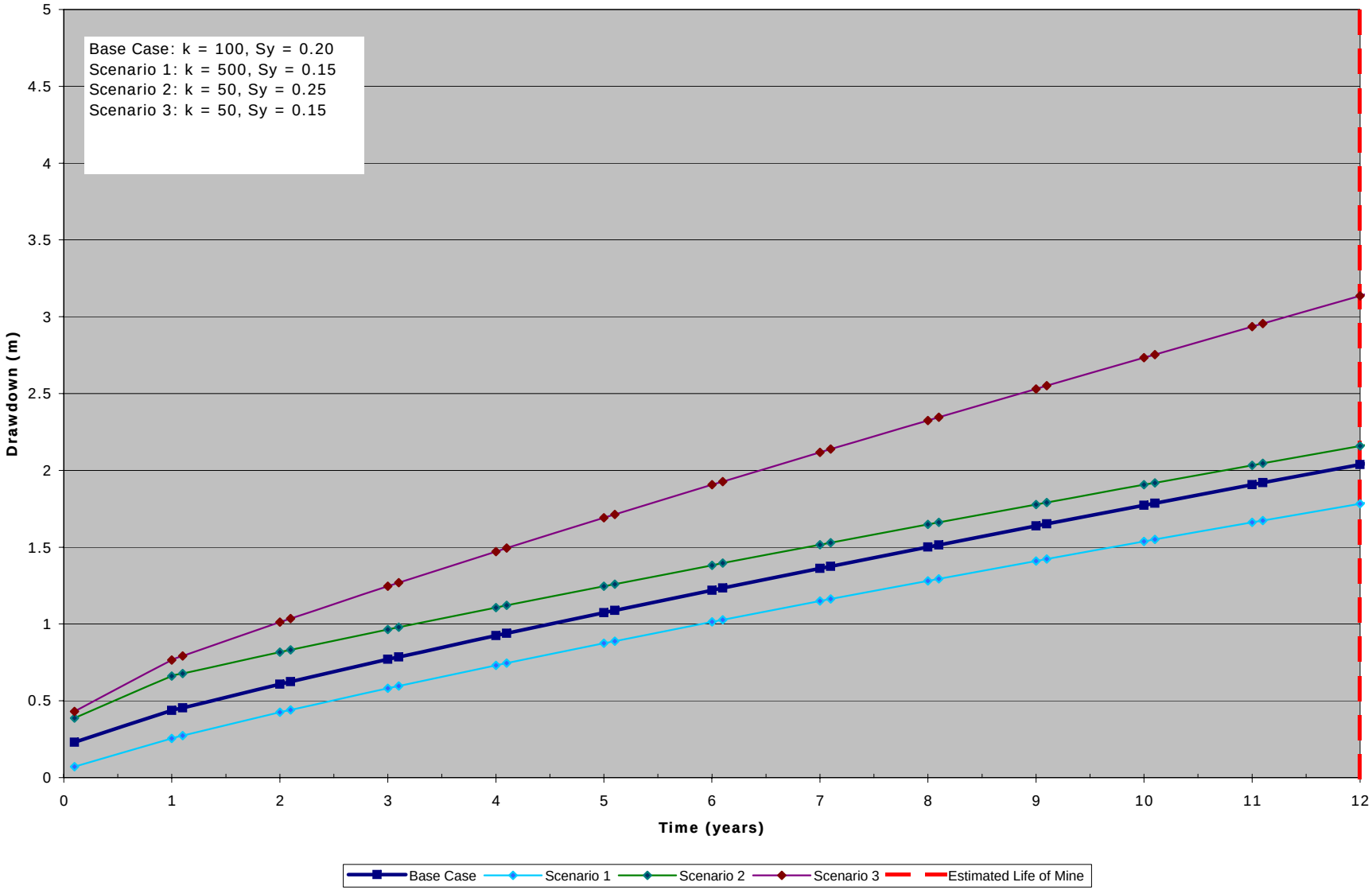
Water Level Drawdown

APPENDIX E 1.24GL/ANNUM DEMAND SCENARIO DRAWDOWN WITH TIME CURVES



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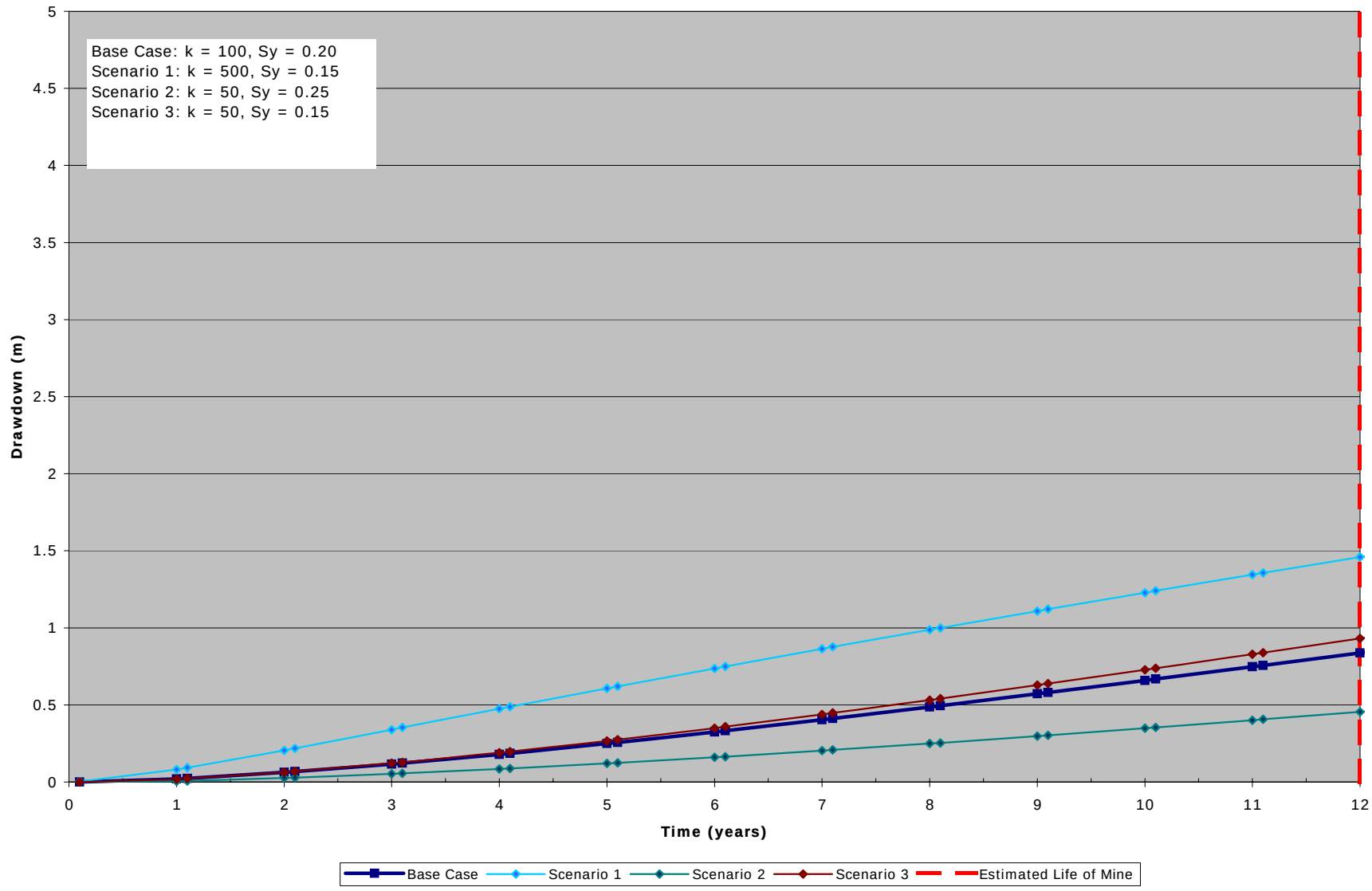
PREDICTED DRAWDOWN AT OBSERVATION POINT A (BORE 3 - PUMPING BORE) FIGURE E1

F:\Jobs\767\B12\233 App\[E1.xls]Sheet1



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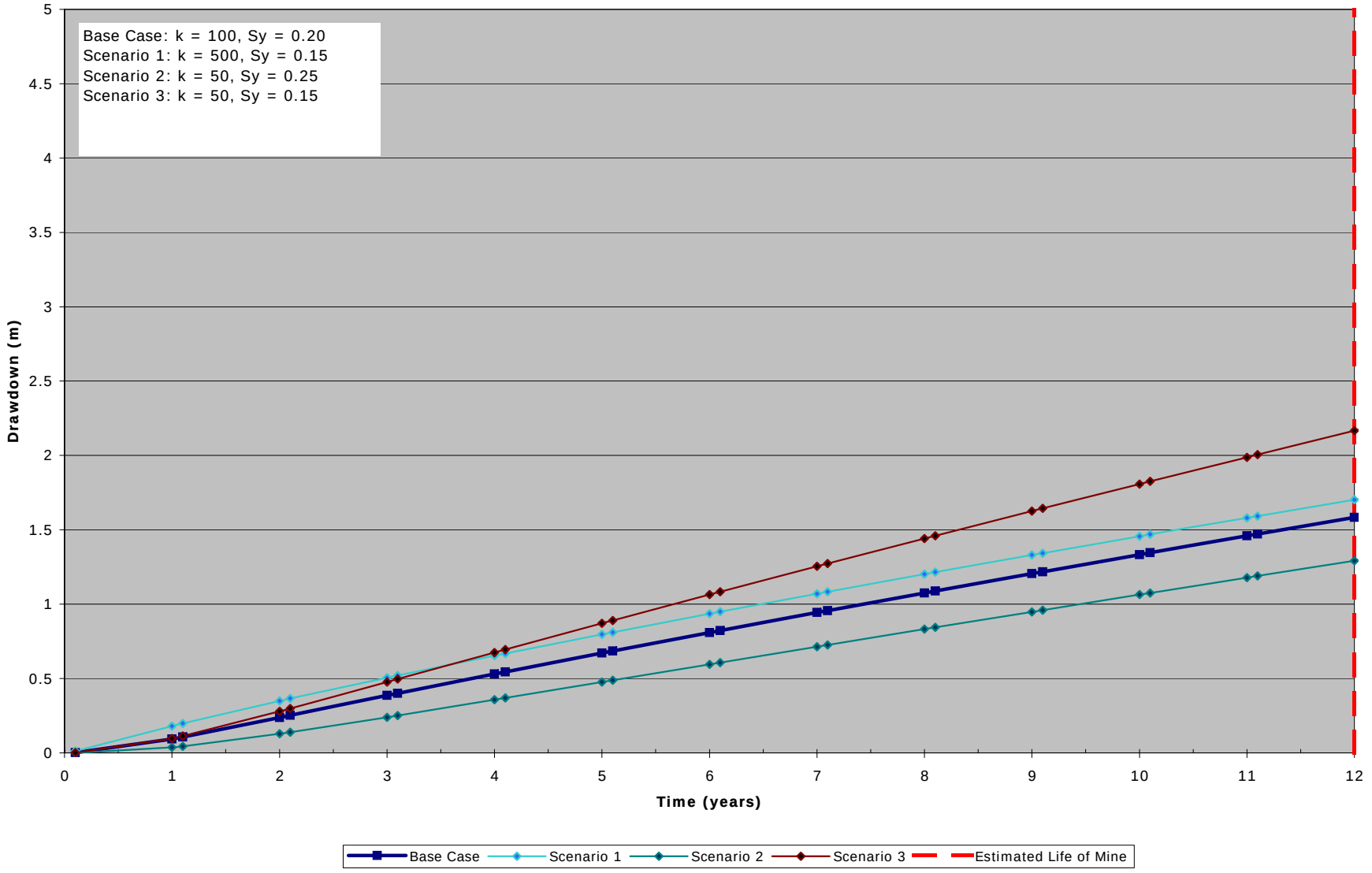
PREDICTED DRAWDOWN AT OBSERVATION POINT B FIGURE E2

F:\Jobs\767\B12\233 App\[E2.xls]Sheet1



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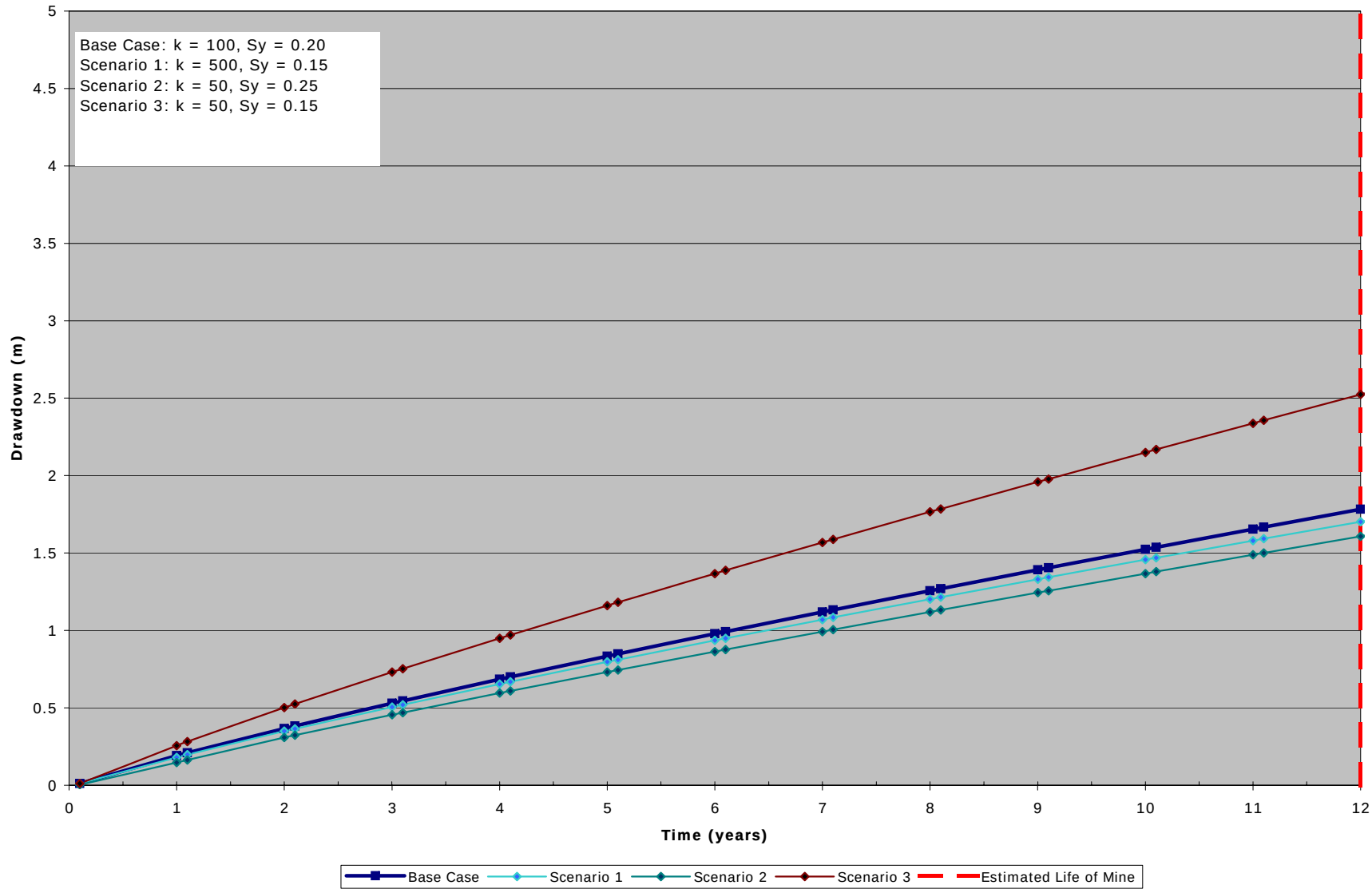
PREDICTED DRAWDOWN AT OBSERVATION POINT C FIGURE E3

F:\Jobs\767\B12\233 App\[E3.xls]Sheet1



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PREDICTED DRAWDOWN AT OBSERVATION POINT D FIGURE E4

F:\Jobs\767\B12\233 App\[E4.xls]Sheet1

In Australia

Perth
Suite 4
125 Melville Parade
Como WA 6152
Tel +61 8 9368 4044
Fax +61 8 9368 4055
perth@aquaterra.com.au

Adelaide
Ground Floor
15 Bentham Street
Adelaide SA 5000
Tel +61 8 8410 4000
Fax +61 8 8410 6321
adelaide@aquaterra.com.au

Sydney
Suite 9
1051 Pacific Highway
Pymble NSW 2073
Tel +61 2 9440 2666
Fax +61 2 9449 3193
sydney@aquaterra.com.au

Echuca
Unit 1
213 Anstruther Street
Echuca VIC 3564
Tel +61 3 5480 3140
Fax +61 3 5480 3140
echuca@aquaterra.com.au

In Europe

Lewes
Cobbe Barns
Beddingham, Lewes
East Sussex BN8 6JU
United Kingdom
Tel +44 1273 858 223
Fax +44 1273 858 229
lewes@aquaterra.uk.com

Dublin
Sandyford
PO Box 11580
Dublin 18
Ireland
Tel +35312069920
Fax +35312069920
dublin@aquaterra.ie

In Mongolia

Ulaanbaatar
701 San Business Center
8th khoroo
Sukhbaatar District
Ulaanbaatar
Mongolia
Tel +976 95854921
ub@aquaterra.mn

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Water and Environment