17/9/12

1. AS SUBMITTED TO DoP
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SINCLAIR KNIGHT MERZ
SKM

New Paper Mill - Matraville

WATER SUPPLY STRATEGY

- Final
- September 2012

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- Final
- September 2012

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1. Water Supply Strategy

1.1. Overview

As part of Schedule 3- Minister's Condition of Approval (MCoA) : 9, Amcor are required to prepare:

A Water Supply Strategy for the site including a report on the sustainability of groundwater extraction from the Snape Park borefield and the impact on the Botany Sands Aquifer. The Strategy should also assess options for alternative water supply and should be undertaken in consultation with DWE.

The information contained in this report addresses the requirements of this MCoA. Consultation has been ongoing with the NSW Office of Water (the department in which the water licensing functions of DWE are now vested) in relation the groundwater extraction and the new water access licences under the water sharing plan for the Botany Sands aquifer.

1.2. Water requirements

On average the New Paper Mill will use about 70ML/day of water to produce about 1000 tonnes of paper. Most of this water is used to prepare the waste paper pulp slurry and for steam generation require for the papermaking process and is able to be treated and reused. However contaminants such as salts and microorganisms gradually accumulate in the process water. This is undesirable as it may cause corrosion, generate odours and reduce the efficiency of the papermaking process. Therefore a proportion (up to 12 Ml/day) of the process water needs to be replaced with fresh water to prevent the accumulation of contaminants.

This replacement process water does not need to be of potable standard but needs to be of reasonable quality preferably with a low level of salts and suspended particulates.

Another 0.5 ML/day of high quality water is required for critical process requirements and for potable use in the New Paper Mill.

1.3. Current water supply

AMCOR currently operates a borefield at Snape Park, a recreational area about 3.5km north of the New Paper Mill. The borefield consists of 6 operational bores which extract water from the Botany Sands aquifer and discharge the groundwater into a stormwater canal that runs adjacent to the park. This stormwater canal eventually discharges into Long Dam, a small reservoir about 180m from the north western edge of the New Paper Mill site. AMCOR directly extracts water from Long Dam which is used as process water for the paper making process. The water in Long Dam is a combination of groundwater and stormwater, the proportions of each dependent upon antecedent

rainfall. The operation of the Snape Park borefield is controlled by a level sensor at Long Dam so that in wet periods groundwater extraction at Snape Park ceases or is reduced as stormwater inflows are sufficient to meet the paper mill's process water demands.

1.4. Water supply options

A number of options were considered to supply process water for the New Paper Mill and these are summarised in **Table 1-1**. Only Options 1, 3 and 6 were considered feasible. Using potable water from the existing water reticulation network is very costly and the quality of water is in excess of what is required. However water would be sourced from the water reticulation network for domestic and critical process requirements and as a backup if the preferred source of process water failed for some reason.

Discussions have been held with Orica on a number of occasions regarding the use of water from their Reverse Osmosis groundwater treatment plant (GTP). However, as the GTP has not been designed to supply water, it has frequent downtimes for maintenance and breakdowns and the security of supply cannot be guaranteed which is critical for the New Paper Mill. Also in the longer term the GTP may be decommissioned once the groundwater in the aquifer has been treated to EPA's satisfaction. The cost of treated water from the GTP is high in comparison to other options.

The existing water supply option of using groundwater from AMCOR's Snape Park borefield and stormwater from the Long Dam catchment is the preferred option as it is the most sustainable (providing there are no impacts on the aquifer) and cost effective. AMCOR holds existing licences under the Water Act 1912 for groundwater extraction from the Snape Park borefield so would not require any additional approvals.

- **Table 1-1: Comparison of water supply**

No.	Option	Advantages	Disadvantages
1	Potable water from water supply network	High security of supply Water pipelines existing High quality water	High cost May require augmentation of water reticulation network Potable standard water not required for process water
2	On-site stormwater harvesting	No pumping costs	Would only be able to meet a very small proportion of process water requirements and alternative source would be required High costs for on-site storages
3	Product water from the Orica Reverse Osmosis groundwater treatment plant	Using water that is currently discharged Relatively close proximity to site	High cost RO standard of water not required for process water Low security of supply due to RO plant downtime and longer term operation of RO plant

No.	Option	Advantages	Disadvantages
4	Treated effluent from Malabar STP	Using water that is currently discharged	Malabar wastewater only undergoes primary treatment so significant additional treatment would be required High cost – additional treatment & pipeline Perception issue – paper produced often used for food packaging
5	Groundwater from site	Low cost High degree of control	Site partially in Groundwater Exclusion Zone Possible saline intrusion from Botany Bay Sustainability of groundwater extraction
6	Groundwater from Snape Park and stormwater from Long Dam catchment	Partial use of stormwater Infrastructure and approvals already in place Quality of water demonstrated to be sufficient Low cost	Sustainability of groundwater extraction

1.5. Approvals for groundwater extraction

AMCOR currently hold 6 licences for individual bores used for groundwater extraction at Snape Park. An example of one of the licences is presented in Appendix A.

As part of the NSW water reform process, water sharing plans are being developed and implemented for key water resources in the State. The Botany Sands aquifer in which the Snape Park borefield is located has been identified as a water resource requiring a water sharing plan. After background studies and consultation, a water sharing plan for Greater Metropolitan Sydney Groundwater resources which includes the Botany Sands Aquifer came into force in July 2011. As part of the development of the water sharing plan, AMCOR was consulted and provided information on the sustainability of its groundwater extraction at Snape Park. This report is presented in Appendix B.

AMCOR is currently negotiating with the NSW Office of Water for water access licences under the new water sharing plan to replace its existing groundwater extraction licences. These new licences would be high security licences and would provide sufficient water to meet the New Paper Mill requirements. At the time of preparing this report, the negotiations were ongoing and the new licences had yet to be issued.

Appendix A – Copy of Groundwater Licences

VIE Solutions

TAX INVOICE #1044

TAX INVOICE TO:
AMCOR Packaging
(Australia) Pty Ltd
Botany Mill
NSW

FROM :
VIE Solutions
Supplier No: 046 766

Mobile : 0403 865 377

Start Date	End Date	Description	Total
Sep-12	Sep-12	**Per VIE Solutions Quotation #222** PURCHASE ORDER NO: B9S000850 Parts/Antenna Bracket & Mounting Kit Labour	 680 420

Total Invoice	1,100.00
GST (10%)	110.00
Total Invoice (incl GST)	1,210.00

Payment Details :
Commonwealth Bank BSB 062124 Account No 11018998
INVOICE TO BE PAID WITHIN 14 DAYS OF RECEIPT

65/26219

License No. 16020

License in respect of a Bore other than an Artesian Bore issued under Part V of the Water Act, 1912, as amended by subsequent Act

Application No. 16082

Name, Address and Occupation of Licensee or Licensees	Location of Work			Nature and Description of Work	Purposes for which the Licensee or Lice may utilise the water
	Portion	Parish	County		
AUSTRALIAN PAPER MANUFACTURERS LIMITED, McCauley Street, Matraville, New South Wales.	690 (Boyce Road, Maroubra)	Botany	Cumber-land	Construction of a bore from the surface.	The manufacture of paper

THE work described hereon, and referred to in the application and statement of the purposes for which it is proposed to utilise the water, deposited on behalf of the above-named, and subject to and under the terms, limitations and conditions endorsed **on the back hereof,** as finally approved b Water Conservation and Irrigation Commission, is hereby declared to be a licensed work under the Water Act, 1912, as amended by subsequent Acts.

DATED this Fifteenth day of November 1965.

By direction of the Water Conservation and Irrigation Commission

Water Conservation and Irrigation Commission

MI 2484 GOVERNMENT PRINTER.

67/7536

License No. 19783

License in respect of a Bore other than an Artesian Bore issued under Part V of the Water Act, 1912, as amended by subsequent Acts

Application No. 19845

Name, Address and Occupation of Licensee or Licensees	Location of Work			Nature and Description of Work	Purposes for which the Licensee or Licensees may utilise the water
	Portion	Parish	County		
AUSTRALIAN PAPER MANUFACTURERS LIMITED, McCauley Street, Matraville, New South Wales.	Snape Park, Maroubra Junction	Botany	Cumberland	Construction of a bore from the surface.	Water supply for industrial (paper manufacturing) purposes and to water playing areas of Snape Park.

THE work described hereon, and referred to in the application and statement of the purposes for which it is proposed to utilise the water, deposited by or on behalf of the above-named, and subject to and under the terms, limitations and conditions endorsed **on the back hereof,** as finally approved by the Water Conservation and Irrigation Commission, is hereby declared to be a licensed work under the Water Act, 1912, as amended by subsequent Acts.

DATED this Eighteenth day of July 1967.

By direction of the Water Conservation and Irrigation Commission

Water Conservation and Irrigation Commission

MI 2484 V.C.N. Blight, Government Printer

(OVER

67/7537

License No. 19784

License in respect of a Bore other than an Artesian Bore issued under Part V of the Water Act, 1912, as amended by subsequent Acts

Application No. 19846

Name, Address and Occupation of Licensee or Licensees	Location of Work			Nature and Description of Work	Purposes for which the Licensee or Licensees may utilise the water
	Portion	Parish	County		
AUSTRALIAN PAPER MANUFACTURERS LIMITED, McCauley Street, Matraville, New South Wales.	Snape Park, Maroubra Junction	Botany	Cumberland	Construction of a bore from the surface.	Water supply for industrial (paper manufacturing) purposes and to water playing areas of Snape Park.

THE work described hereon, and referred to in the application and statement of the purposes for which it is proposed to utilise the water, deposited by or on behalf of the above-named, and subject to and under the terms, limitations and conditions endorsed **on the back hereof,** as finally approved by the Water Conservation and Irrigation Commission, is hereby declared to be a licensed work under the Water Act, 1912, as amended by subsequent Acts.

DATED this Eighteenth day of July 1967.

By direction of the Water Conservation and Irrigation Commission

Water Conservation and Irrigation Commission

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67/7538

License No. 19785

License in respect of a Bore other than an Artesian Bore issued under Part V of the Water Act, 1912, as amended by subsequent Acts

Application No. 19847

Name, Address and Occupation of Licensee or Licensees	Location of Work			Nature and Description of Work	Purposes for which the Licensee or Licensees may utilise the water
	Portion	Parish	County		
AUSTRALIAN PAPER MANUFACTURERS LIMITED, McCauley Street, Matraville, New South Wales.	Snape Park, Maroubra Junction	Botany	Cumberland	Construction of a bore from the surface.	Water supply for industrial (paper manufacturing) purposes.

THE work described hereon, and referred to in the application and statement of the purposes for which it is proposed to utilise the water, deposited by or on behalf of the above-named, and subject to and under the terms, limitations and conditions endorsed **on the back hereof,** as finally approved by the Water Conservation and Irrigation Commission, is hereby declared to be a licensed work under the Water Act, 1912, as amended by subsequent Acts.

DATED this Eighteenth day of July 1967.

By direction of the Water Conservation and Irrigation Commission

Water Conservation and Irrigation Commission

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67/7539

License No. 19786

License in respect of a Bore other than an Artesian Bore issued under Part V of the Water Act, 1912, as amended by subsequent Acts

Application No. 19848

Name, Address and Occupation of Licensee or Licensees	Location of Work			Nature and Description of Work	Purposes for which the Licensee or Licensees may utilise the water
	Portion	Parish	County		
AUSTRALIAN PAPER MANUFACTURERS LIMITED, McCauley Street, Matraville, New South Wales.	Snape Park, Maroubra Junction	Botany	Cumberland	Construction of a bore from the surface.	Water supply for industrial (paper manufacturing) purposes.

THE work described hereon, and referred to in the application and statement of the purposes for which it is proposed to utilise the water, deposited by or on behalf of the above-named, and subject to and under the terms, limitations and conditions endorsed **on the back hereof,** as finally approved by the Water Conservation and Irrigation Commission, is hereby declared to be a licensed work under the Water Act, 1912, as amended by subsequent Acts.

DATED this Eighteenth day of July 1967.

By direction of the Water Conservation and Irrigation Commission

Water Conservation and Irrigation Commission

MI 2484 V.C.N. Blight, Government Printer

(OVER

REPORT BY

HERITAGE COMPUTING

HYDROGEOLOGICAL ASSESSMENT OF THE SNAPE PARK BOREFIELD, MAROUBRA NSW

FOR

AMCOR FIBRE PACKAGING PTY LTD

1891 BOTANY ROAD, PO BOX 95

MATRAVILLE. NSW 2036

By

Dr N. P. Merrick

Report Number: HC2007/5
Date: 18 December 2007

DOCUMENT REGISTER

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EXECUTIVE SUMMARY

One of the bores in the Snape Park borefield at Maroubra has failed and needs to be replaced. AMCOR Fibre Packaging Pty Ltd is required by the Department of Water and Energy to provide an hydrogeological assessment of the Snape Park borefield to provide an assurance that groundwater abstraction from the new bore will be sustainable, and that impacts on the aquifer, the local environment and other users will be acceptable.

The original bore licences in the 1950s and 1960s were issued in perpetuity with no stipulated allocation. This practice is out of kilter with current licensing arrangements. The replacement of a bore has provided an opportunity to rectify the situation for this one bore, or preferably for the entire borefield which consists of six operational production bores.

In support of the hydrogeological assessment, a 24 hour pumping test has been done on the test bore at the north-western corner of the park, and each bore in the network has been surveyed for position and elevation. A comprehensive chemical analysis of bore waters shows the groundwater to be very fresh and to be free of the contaminants that beset groundwater closer to Botany Bay.

A bore census has revealed nearly 100 registered bores within a 1 km radius of Snape Park. Most are expected to be backyard bores of low yield, with a few larger Local Government production bores servicing playing fields. As the Snape Park borefield has been operating since the late 1960s, initially at rates roughly double those of recent years, it is apparent that the neighbouring bores have always been operating in the context of background borefield pumping. That is, any drawdown effects that the borefield might be having on other users have been present for many decades. The replacement of one operating bore by another will not alter the operational situation. Hence, unacceptable impacts on other users are not to be expected.

Long-term extraction of groundwater for use in the Botany mill is believed to be around 9 ML/day, derived from two borefields (Snape Park and Laporte / Solvay-Interox). Estimates are based on paper production with only occasional meter measurements. There is evidence of pumping from the Snape Park borefield alone at 12 ML/day in the late 1960s. The groundwater level monitoring record is weak. There used to be a diagnostic monitoring bore in Snape Park which had been recording water levels since 1975, but this bore failed in 1984 and was not replaced. The nearest government monitoring bores are 400 m to the north-west of the park, and 1 km south of the most southerly production bore. The monitoring record suggests that the drawdown due to the Snape Park borefield is no more than 0.25 m at the nearer monitoring bore. The farther monitoring bore has a higher drawdown of 0.5 m, but this bore is in the proximity of Heffron Park Council production bores.

Use has been made of an existing regional numerical groundwater model to anticipate the drawdown

magnitude and extent for a range of borefield production levels from 3 ML/day to 12 ML/day. The model calibration was focussed on the Botany Industrial Park during development of the model, and had the benefit of very little data from the Snape Park area. Model-predicted drawdowns at the government monitoring bores suggest that the model is overestimating drawdowns there for likely borefield production rates. The model requires better calibration in the Snape Park area, but this cannot be done without better production and monitoring records. For the time being, the model will give exaggerated drawdowns. An alternative analytical model suggests that the numerical model is overestimating drawdown by a factor of 2 approximately.

The monitoring bores show a very strong correlation with rainfall. In particular, the partial monitoring record within the park from 1975 to 1984 shows drawdowns of 4 m to 7 m due to pumping, with very rapid recovery and return to natural levels when the pumps are turned off.

The nearest surface water body of environmental significance is 1 km to the west of Snape Park. The intervening monitoring bore in Rowland Park provides evidence that the borefield pumping impacts will not extend and have not extended that far.

The impact of off-site and far-field drawdowns should be considered in the context of substantial natural water level variations of 4-5 metres due to climate variations.

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1.0 INTRODUCTION

This report provides an hydrogeological assessment of the Snape Park borefield at Maroubra, operated by AMCOR Fibre Packaging Pty Ltd (AMCOR). In seeking conversion of a test bore licence (10BL600682) to a production bore licence, AMCOR was advised by the NSW Government Department of Water and Energy (DWE) that a comprehensive hydrogeological assessment would be required. DWE needs to be satisfied that groundwater abstraction from the new bore will be sustainable, and that impacts on the aquifer, the local environment and other users will be acceptable.

The Snape Park borefield lies within that part of the Botany Sandbeds Water Shortage Zone GWMA 018 that was embargoed on 23 May 2007. The rest of the sandbeds were embargoed from 22 August 2003. The embargos mean that no further applications for sub-surface water licences will be received, subject to some exceptions. One of the exceptions is for conversion of a test bore to a production bore where the test bore licence was held prior to 1 May 2007, subject to application being made by 23 November 2007.

The latest embargo does not apply to a licence for a replacement bore. This is the situation at Snape Borefield, where one of the production bores installed in 1967 has failed and is being replaced. The original licence, however, was issued in perpetuity without a stipulated annual allocation. The replacement of this bore offers an opportunity to bring the licensing for this bore into line with current practices. The other bores in the Snape Park borefield have the same licensing inconsistency.

AMCOR has always been highly dependant on groundwater, with city water use of only 21±12% over the period 1980 to 2007. The company plans to replace the two existing papermaking machines in the next few years, with an increase in production over the next decade in the vicinity of 60%. A corresponding increase in water is required.

2.0 HYDROGEOLOGICAL SETTING

The Snape Park borefield (Figure 1) is situated about 4 km north of Botany Bay and lies within the Botany Sands aquifer within the Botany Basin, the only significant source of groundwater near Sydney. The northern rim of the Botany Basin occurs a further 5 km to the north, marked by sandstone outcrops bordering Centennial Park.

The Botany sands aquifer has the distinction of being the oldest producing groundwater system in Australia which is still in active use. Prior to 1930, water was withdrawn from open dams, timbered shafts and brick wells. Around the time of the Second World War, the borehole pump was introduced and groundwater was exploited intensively from that time, particularly for industrial use. Usage rose rapidly in the late 1960s (Merrick, 1998).

The Botany Basin is designated as Groundwater Management Area (GWMA) 018. It is divided into northern, southern and western zones. Only the northern zone is relevant to this study. The aquifer is classified as a "high risk resource" in terms of groundwater quality (Bish *et al.*, 2000), due to the presence of a large number of contaminated sites.

Groundwater occurs in unconsolidated sediments of Quaternary age which overlie a bedrock surface consisting of Hawkesbury Sandstone. These sediments comprise the Botany Sands aquifer

and are made up of river, beach and dune sands interbedded with clay and peat lenses. This sequence can be separated into three zones:

- an upper, predominantly sandy section with occasional peat and silt stringers;
- a middle section of sand with interbedded peat layers;
- a basal section of interbedded clays, peats and sands above the bedrock.

Discontinuous peat beds and indurated sand-rock layers, termed "Waterloo Rock" up to a few metres thick, can occur in the upper section. An extensive area of saline peat underlies Banksmeadow to the north of the Botany Foreshore and west of the Botany Industrial Park.

The most important dynamic stresses on the Botany Sands aquifer are rainfall and groundwater abstraction. The main recharge area is in Centennial Park. Substantial recharge also occurs in green space areas (parks and golf courses). Groundwater levels are controlled by Alexandra Canal, the Lachlan Lakes and Swamps, Cooks River and Botany Bay.

Long term median rainfall is 1073 mm per annum at Sydney Airport (Mascot). There is a strong correlation between rainfall and groundwater fluctuations. Merrick (1994), based on calibration of an earlier groundwater model, estimated that rainfall infiltration varies from 6 percent on estuarine sediments to 37 percent on sand.

The Botany Sands aquifer has been an important source of water for more than a century. Estimates of groundwater abstraction have varied from about 20 ML/day to about 55 ML/day in the last 50 years (Merrick, 1998). In 1992, usage was reported as 30 ML/day. Since then, there has been no official check on usage due to an absence of meters on most production bores. It is likely that usage declined significantly over the next 10 years, as industrial users close to the bay shut down pumping operations (due to pollution), moved their businesses elsewhere or closed down their operations. Total usage of groundwater during 2000-2002 in the northern part of the Botany Basin was estimated (D. McKibbin, pers. comm.) to be about 20 ML/day. Since then, the Solvay-Interox Borefield that was producing about 2-3 ML/day closed down early in 2004 (C. Koch, pers. comm.), and the Orica pump-and-treat scheme commenced in late 2004 in an interim way, with the full groundwater treatment plant operational from late 2005 (at 6-8 ML/day).

Until the Macro Water Sharing Plan is released, the official government estimate of the long-term abstraction limit for that part of the Botany Sands aquifer to the north of Botany Bay is 39 ML/day (14.3 GL/year) (Bish *et al.*, 2000). The official licensed allocation is 11.5 ML/day (4.2 GL/year), but this excludes pre-1972 licences held by major industrial users (particularly AMCOR) and pre-dates the Orica pump-and-treat extraction. Nobody knows how much groundwater is being abstracted from the aquifer, as there is no compliance system in place and few bores are metered. However, it is likely to be around 25 ML/day, about the same as was drawn from the Botany Swamps scheme more than a hundred years ago.

Groundwater levels in the middle aquifer are shown in Figure 1 at October 2004, prior to Orica's pump-and-treat commencement. This diagram indicates that groundwater flow is generally south-westerly towards Botany Bay, with a hydraulic gradient in the order of 4 m/km (1:250). Depth to the water table is typically about 10 m (Figure 2) throughout much of the aquifer, including Snape Park, but becomes shallower (about 2 m) close to the bay and the Lachlan Lakes. The total thickness of unconsolidated sediments between ground surface and bedrock is typically about 30 m.

Higher aquifer thicknesses occur at remnant sand dunes and along palaeochannels. Snape Park, where the aquifer thickness is about 35 m, overlies one of the palaeochannels that trends south-west and then turns south to pass through the Botany Industrial Park and emerges beneath Botany Bay.

The nearest environmentally sensitive area to Snape Park is 1.2 km distant. This is the northern end of the Lachlan Swamps (Figure 1), bordered by Eastlake Golf Course, known to have a high degree of surface water – groundwater interaction.

Figure 4 gives an indication of the groundwater salinity pattern throughout the entire northern zone of the Botany Basin, in terms of electrical conductivity of water samples taken in 1970-1974. Snape Park lies within one of the freshest zones of the aquifer, with conductivity a little less than 200 µS/cm. Individual bore water samples will be discussed in Section 4.

3.0 BORE CENSUS

Many hundreds of bores have been drilled in the Botany Basin, but most have been lost with time or have ceased to be used. In addition, there are expected to be many backyard bores that have never been licensed.

The New South Wales Ground Water Data Archive 2006 (Version 1.1 produced by the Department of Natural Resources) has been examined to locate all registered bores within 1 km of any bore within the Snape Park borefield. The distribution of registered bores, classified according to date of construction, is shown in Figure 5.

Most bores were put down in the period 1960-1980, as shown in Table 1. This includes the Snape Park bores. In all, 94 bores were found within 1 km of Snape Park. Of these, 30 were classified as "spearpoints". Most bores are privately owned, with only 11 designated as "government". The median completed depth was 10 m, which suggests that most bores reach the local water table and go no farther. The maximum completed depth was 41.5 m.

Table 1. Temporal classification of bores within 1 km of Snape Park

	1919-1940	1940-1960	1960-1980	1980-2000	2000-2006
Number of bores / spears	1	10	47	18	18
Percentage (%)	1	11	50	19	19

The database does not include Bore GW107404 in Snape Park which was drilled for Randwick City Council in March 2005 (Licence 10BL165185). This bore reached 32 m with the water table at 12.4 m below top of casing.

Nor does the database include government monitoring bores. The nearest such bores to Snape Park are GW75025 in Rowland Park and GW75020 in Heffron Park, as shown in Figure 1.

Currently operational Snape Park bores are highlighted in Figure 5 and designated with local bore numbers (#13, #30, #33, #34, #35, #36). Figure 5 shows two locations for each bore based on coordinates in the database, and corrected locations that were surveyed by AAMHatch Pty Ltd in September 2007. The corrected location for the Randwick City Council bore is an estimate based on a site inspection.

The amount and direction of each correction for the Snape Park bores are shown more clearly in Figure 6. This diagram also shows the official location of an old government monitoring bore (GW42165) in the south-eastern corner of the park. There is no longer any evidence of this bore at the park.

4.0 SNAPE PARK BOREFIELD

4.1 BORE DETAILS

Currently there are six (6) operational production bores in the Snape Park borefield. Known details of all bores are listed in Tables 2 and 3. Bores within the park proper were licensed in 1967; bores outside the park in residential areas were licensed in 1957 and 1965. In the past AMCOR (as APM) had a number of other bores but they are no longer in use.

Table 2. Location and elevation details of bores within the Snape Park borefield

Local ID	Licence ID	Work ID	GROUND ELEVATION [mAHD]	EASTING [MGA]	NORTHING [MGA]	BORE DEPTH [m]	PUMP DEPTH [m]
Bore 13	6753	GW13436	25.73	336591	6243560	34.3	
Bore 30	16020	GW23983	22.68	336547	6243259	38.6	29.0
Bore 33	19783	GW27615	25.20	336701	6243542	36.3	
Bore 34	19784	GW27616	26.39	336813	6243719	32.6	
Bore 35	19785	GW29354	25.64	336918	6243506	37.8	
Bore 36	19786	GW29355	25.28	336661	6243735	29.0	

Table 3. Licensing and water details of bores within the Snape Park borefield

Local ID	Licence ID	Work ID	SCREEN FROM [m]	SCREEN TO [m]	INITIAL SWL [m]	INITIAL WL [mAHD]	INITIAL YIELD [L/s]	DRILLED DATE	LICENCE DATE
Bore 13	6753	GW13436					18.9	1957	27-Sep-57
Bore 30	16020	GW23983	29.4	38.6	6.1	16.6	31.6	24-Nov-65	15-Nov-65
Bore 33	19783	GW27615	27.1	36.3	6.1	19.1	31.6	27-Jul-67	18-Jul-67
Bore 34	19784	GW27616	23.5	32.6	7.0	19.4	31.6	02-Aug-67	18-Jul-67
Bore 35	19785	GW29354	28.7	37.8	8.5	17.1		05-Aug-68	18-Jul-67
Bore 36	19786	GW29355	21.6	29.0	9.4	15.9		25-Jul-68	18-Jul-67

There has been some confusion over the years between bores #35 and #36. The convention adopted in this report is that #36 is the bore in the north-western corner of the park, and it is this bore that is being replaced. This view is supported by a painted number inside the concrete pit, which presumably was placed there at the time of construction. This view also accords with government records articulated in a letter dated 27 September 1978 and on the original graticule chart reproduced in Figure 7.

Site inspections were conducted on 5 September 2007 to confirm the status of each bore, and again on 25 October 2007 to locate the Randwick City Council bore. A photograph of the test bore adjacent to bore #36 (within the open concrete pit) is shown in Figure 8(a).

The water from the Snape Park bores is pumped into a stormwater channel for gravity drainage to Long Dam at the company's plant at Matraville. The channel is open for part of its length along Walsh Street (see photograph Figure 8(b)). The dam has a capacity of about 3 ML. Overflow from the dam, estimated as 2.8±0.8 ML/day between 1980 and 2007, discharges into Bunnerong Canal. Long Dam is also a recipient of stormwater and effluent from Orica's Groundwater Treatment Plant.

Copies of the original Form A for "Particulars of Completed Bore" are included in Appendix A. The driller's logs show fairly uniform sand in each hole, with only rare mentions of clay and peat.

4.2 Production Record

AMCOR has always been recognised as the largest single user of groundwater in the Botany Sands aquifer. Merrick (2004) estimated AMCOR's use from the Snape Park borefield as 34 percent of all groundwater usage in the northern part of the basin, plus another 12 percent from the Solvay-Interox borefield. The relativities will be different now with the commencement of the Orica pump-and-treat scheme.

AMCOR has estimated the groundwater extraction record for financial years 1980-81 to 2006-07 from paper production tonnage based on waste water discharge, with allowances for city water usage, water loss due to machine drying, evaporation, and Long Dam weir overflow (see Appendix E). The estimates have been "calibrated" against occasional mill reports that cite current borewater usage. The record is displayed in Figure 9(a). The bar graph shows total groundwater extraction generally in the range 7-12 ML/day, being on average 9.3±2.3 ML/day. The line graph shows groundwater consumed in the mill as 6.5±2.7 ML/day with median 7.0 ML/day. The difference between the bar graph and the line graph figures is due to Long Dam weir overflow. The decline from 1994 coincides with the introduction by Sydney Water of much higher prices for sewer discharge. In addition, Solvay-Interox borefield contributions ceased in early 2001.

In an earlier assessment of groundwater resources for APM, Knight *et al.* (1992) cited a "current extraction rate of 631 kL/hr" which converts to 15.1 ML/day if operated for 24 hours per day.

Instantaneous groundwater production figures for individual bores in the Snape Park borefield are available for a limited number of dates, as listed in Table 4 and illustrated in Figure 9(b). In the early years, production seems to have been in the range 8-12 ML/day. In the last few years, production has been generally 5-7 ML/day.

The bore that is to be replaced (#36) shows a clear decline in performance over time, from initial production of 2.8 ML/day down to about 0.6 ML/day before it was decommissioned.

Table 4. Snapshots of groundwater production (ML/day) from the Snape Park borefield

DATE	Total(ML/d)	#36	#34	#13	#33	#35	#30
Jun-69	12.09	2.8	2.0	2.0	2.1	1.4	1.8
Jun-70	10.35	2.4	1.4	1.8	1.7	1.4	1.6
Aug-71	7.57	2.3	0.9	1.4	1.5	0.0	1.4
Mar-73	9.35	2.3	1.0	1.3	1.6	1.5	1.6
20/12/2005	7.18	1.1	1.8	1.7	0.0	1.0	1.6
12/04/2006	9.50	0.3	1.3	2.2	2.6	1.3	1.8
17/07/2006	7.40	0.6	1.5	2.2	0.0	1.3	1.8
20/02/2007	7.37	0.0	1.0	2.1	1.6	1.0	1.7
28/06/2007	3.33	0.0	0.0	1.7	1.6	0.0	0.0
7/08/2007	0.89	0.0	0.0	0.0	0.0	0.9	0.0
4/09/2007	5.36	0.0	1.3	0.0	1.5	0.9	1.7

The Council bore GW107404 has an allocation of 20 ML/year (that is 0.055 ML/day). It is expected to be using about 15 ML over six months of the year to irrigate the park. Prior to installation of this bore, the Council used some of the water abstracted from bore #33 and in earlier years from bore #35 as well.

4.3 Groundwater Monitoring Record

Currently, there is no effective monitoring of water levels in the vicinity of Snape Park. The nearest monitoring bores are 400 m to the north-west of bore #36 in Rowland Park (GW75025) and 1000 m south of bore #30 in Heffron Park (GW75020). There used to be a bore within Snape Park (GW42165) which gathered data from 1975 to 1981, with one reading in 1984.

The hydrograph for bore GW42165 is shown in Figure 10. This is the best information available for observing the impact that the Snape Park borefield has had on groundwater levels. The hydrograph shows a very strong correlation with rainfall residual mass, which indicates long-term climatic behaviour by charting the cumulative deviation from mean monthly rainfall. The residual mass curve climbs during wet periods and falls during dry periods. This indicates that the aquifer dynamics are controlled by rainfall. The low points on the hydrograph are evidence of pumping effects. There appear to be drawdowns of 4.5 m in June 1975, 4 m in February 1977, and 7 m in February 1979. Unfortunately, we do not have pumping records at the same time to establish a relationship between drawdown and pumping rate. As GW42165 is charted as being very close to bore #35, the observed drawdowns are expected to be due almost entirely to this bore.

The hydrographs for more distant monitoring bores GW75020 and GW75025 (Figure 11) also show a strong correlation with long-term rainfall. The reason for displaying the residual mass curve is that groundwater hydrographs should follow the same pattern if an aquifer's performance is dominated by rainfall. The pronounced declines in water levels from 1999 to 2006 are due clearly to dry conditions. The short-term fluctuations in water levels that give the curves a banded appearance are due mostly to pumping effects. Clearly there is more effect at GW75020 where the pumping

induced drawdown appears to be in the order of 0.5 m, with more scatter generally in summer months. Most of this effect is due probably to production bores in Heffron Park, that are used for park irrigation. Randwick City Council has four (4) bores in Heffron Park with a combined allocation of 276 ML/year (that is 0.8 ML/day) and one (1) bore with no specified limit. Some of the drawdown could be due to the Snape Park borefield.

The monitoring bore closest to Snape Park (GW75025) shows very little drawdown, in the order of 0.25 m. There is no obvious seasonal dependence. This is consistent with the drawdown being due to Snape Park pumping which is not expected to have any seasonal pattern, as the water is used for continuous paper production.

4.4 PUMPING TEST

A 24 hour pumping test was conducted on 13 September 2007 by Michael Barrett of B&B Drilling. A near-constant pumping rate of 3.33 L/s (0.29 ML/day) was maintained. Water levels were measured in the pumped bore and in an observation bore 80 cm away from the test bore. Copies of the original pumping test data sheets are in Appendix B.

The field data for drawdown with time in Figure 12 show that nearly all of the drawdown occurred suddenly, within the first 5 minutes. After this time, the water levels stabilised. The maximum drawdown in the pumped bore was 3.6 m, while the maximum drawdown 80 cm away was 0.8 m.

Analytical modelling using a leaky aquifer conceptual model is able to reproduce the observed behaviour quite well, on the assumption that some well loss occurred in the pumped well (Figure 12). The model suggests the following aquifer properties:

- Hydraulic conductivity 18 m/day;
- Transmissivity 330 m^2/day;
- Storage coefficient (short-term) 1×10^{-5};
- Leakage coefficient 3×10^{-3} d^{-1};
- Well loss coefficient 1.4×10^{-5}.

4.5 WATER QUALITY

Comprehensive chemical analyses were undertaken by Envirolab Services Pty Ltd (a registered NATA facility) on water samples taken from each bore on 9 February 2007, and from the stormwater channel and Long Dam on 19 March 2007. The channel sample is effectively a composite of all bore waters, with some possible stormwater. It is upstream of the confluence with Orica's point of discharge for surplus water output from the Groundwater Treatment Plant. The dam sample includes the water discharged by Orica.

The results are summarised in Table 5. The highlighted TDS (total dissolved solids) row shows a range from 120 to 190 mg/L in the bores. This is very fresh water. The major cations are chloride (Cl) and sulphate (SO4), while the major anions are sodium (Na) and calcium (Ca). In the metals there are no causes for concern, apart from an elevated iron concentration in bore #35.

The median EC value in 1973 (Knight et al., 1992) was 180 µS/cm, compared to a current value of around 230 µS/cm at the bores.

A copy of the Certificate of Analysis and the full chemical analysis report for the bore and dam waters is at Appendix D. Where reference is made to "Bore 36", this should read "Bore 35". No sample was possible from the failed bore (#36) at the time of sampling.

Table 5. Chemical analyses for bore, channel and dam waters.

		GW13436	GW23983	GW27616	GW29354	All Bores	& Orica
ELEMENT	**UNIT**	Bore 13	Bore 30	Bore 34	Bore 36	Channel	Long Dam
pH		5.6	5.0	6.0	5.9	6.8	6.8
TDS	mg/L	150	190	190	120	160	200
EC	µS/cm	230	230	260	210	240	240
Ions:							
NO3	mg/L	6.1	6.1	4.6	0.2	4.0	1.2
Cl	mg/L	33	33	38	30	63	40
SO4	mg/L	25	25	24	16	8	24
HCO3	mg/L	2	1	23	25	12	6
Na	mg/L	17	17	22	15	45	19
K	mg/L	2.8	2.9	2.8	4.0	1.2	3.8
Ca	mg/L	13	12	17	3.7	13	3.5
Mg	mg/L	3.2	3.0	3.0	2.9	3.5	1.0
Metals:							
Al	mg/L	0.18	0.14	0.18	0.019	0.12	0.045
Ag	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
As	mg/L	<0.001	<0.001	<0.001	0.0024	<0.001	<0.001
Ba	mg/L	0.036	0.037	0.017	0.037	0.037	0.012
B	mg/L	0.03	0.01	0.01	0.03	0.03	0.16
Cd	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cr	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	mg/L	<0.001	0.0023	0.0025	<0.001	0.0034	0.0056
Fe	mg/L	0.016	0.011	0.058	4.3	0.065	0.046
Hg	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Li	mg/L	<0.001	<0.001	<0.001	<0.001	0.0011	0.0013
Mn	mg/L	0.0074	0.0066	0.0110	0.0180	0.0097	0.0055
Ni	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.0024
Pb	mg/L	<0.001	0.0010	0.0046	0.0020	<0.001	0.0012
Sb	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	mg/L	0.008	0.055	0.051	0.085	0.011	0.160

5.0 GROUNDWATER MODELLING

To assess the degree of impact that the borefield might have, at various levels of production, a regional groundwater model has been used. This model was developed by Merrick (2004) and

Laase (2005), building upon an earlier model by Merrick (1994). The model uses MODFLOW software with cell sizes varying from 10 m to 100 m. The model has been calibrated in steady-state mode against the water level measurements at October 2004 that were used to generate the contour map in Figure 1. As most of the calibration data are concentrated near the Botany Industrial Park, the model will be most accurate there. There are hardly any data points in the vicinity of Snape Park. Hence, model reliability there is low. In addition, the assumed continuous pumping rate at the Snape Park borefield was assumed to be 3 ML/d during calibration. As the real pumping rate is known now to be roughly double, the model as it stands will overestimate drawdown, perhaps by a factor of 2 close to the pumping bores. Nevertheless, the model is the best tool currently available for assessing impact.

The earlier model, developed with AQUIFEM finite element software, was used in an assessment of groundwater resources for the APM Botany Mill, derived from the Snape Park borefield and the Laporte (Solvay-Interox) borefield (Knight *et al.*, 1992; Merrick, 1994).

5.1 Model Properties

The current MODFLOW model is subdivided into five (5) layers:

- Upper aquifer – Layer 1;
- Middle aquifer – Layers 2, 3 and 4;
- Lower aquifer – Layer 5.

In contrast, the previous AQUIFEM model considered the aquifer as a single layer. AMCOR pumping is allocated to Layer 3 in the new model.

In the model, the Layer 3 hydraulic conductivity at the north-western corner of the park (at #36) is 18 m/d. This agrees with the value found by analytical modelling applied to the pumping test data. Layers 2 and 4, however, are 20 m/d and 25 m/d respectively.

5.2 Model Scenarios

The model has been run in steady-state mode (continuous pumping) for a number of production scenarios:

- Scenario A: no pumping (benchmark);
- Scenario B: pumping 3 ML/d total;
- Scenario C: pumping 4 ML/d total;
- Scenario D: pumping 5 ML/d total;
- Scenario E: pumping 6 ML/d total;
- Scenario F: pumping 7 ML/d total;

- Scenario G: pumping 8 ML/d total;
- Scenario H: pumping 10 ML/d total;
- Scenario I: pumping 12 ML/d total.

In each case, water is distributed between the bores in the ratio observed in the limited production record from 1969 to 2007. The shares are listed in Table 6, along with the assumed pumping rates (in m^3/d) at each bore for each scenario.

Table 6. Assumed shares and pumping rates for individual bores in various borefield production scenarios.

	(m^3/day)	3000	4000	5000	6000	7000	8000	10000	12000
BORE	SHARE	Scen.B	Scen.C	Scen.D	Scen.E	Scen.F	Scen.G	Scen.H	Scen.I
36	0.15	450	600	750	900	1050	1200	1500	1800
34	0.15	450	600	750	900	1050	1200	1500	1800
13	0.20	600	800	1000	1200	1400	1600	2000	2400
33	0.18	540	720	900	1080	1260	1440	1800	2160
35	0.13	390	520	650	780	910	1040	1300	1560
30	0.19	570	760	950	1140	1330	1520	1900	2280

The earlier model (Knight *et al.*, 1992) investigated four (4) production scenarios: 5, 10, 15 and 20 ML/day from two borefields. As the Laporte borefield was set at 25% of the total, the effective production levels for the Snape Park borefield were: 3.75, 7.5, 11.25 and 15 ML/day. At this time there were seven (7) active production bores in the vicinity of Snape Park. Each scenario included background pumping by other users.

5.3 Benchmark Scenario A

In this scenario, all Snape Park production is off. However, all other known production bores to the east of the Lachlan Lakes and between the bay and Gardeners Road (northing 6244500) are assumed active at 11.2 ML/d.

The resulting simulated groundwater levels are contoured in Figure 13. The expected natural water levels range from 18 to 20 mAHD across Snape Park, at a time of prolonged average rainfall. The natural levels at Rowland Park (15-18 mAHD) and Heffron Park (11-14 mAHD) are predicted quite well.

5.4 Scenario E (6 ML/day)

In this scenario, borefield production is assumed to be 6 ML/d. This scenario has been chosen for illustration as the production rate best matches the long-term average from the limited production record. The total groundwater production from all bores in the model is 17.2 ML/d.

Figure 14 shows the groundwater level contours in the upper aquifer (Layer 1) and the middle aquifer (Layer 3). There is very little difference between the two. The minimum water level is about 9 mAHD with a broad cone of depression around bores #13 and #33, and an isolated cone around bore #30.

The simulated drawdowns from the benchmark levels, shown in Figure 15, are much the same in the upper aquifer and the middle aquifer. The maximum drawdown is 10 m between bore #33 and the Council bore. Close to bore #35 the predicted drawdown is more than 9 m; however, the worst drawdown observed at bore GW42165 was 7 m. At the south-eastern corner of Rowland Park, the predicted drawdown is 3 m, but observations at GW75025 are no more than 0.3 m. At Heffron Park, the predicted drawdown is 2 m near GW75020, but the observed drawdown is likely to be no more than 0.5 m, and most of this is due probably to pumping from Heffron Park bores.

Hence, the model is overestimating drawdown or the effective continuous long-term pumping rate is considerably less than 6 ML/d. The former is more likely. Section 5.0 foreshadowed the likelihood of overestimation by a factor of 2 because the MODFLOW model was calibrated on 3 ML/day borefield extraction rather than a value closer to 6 ML/day.

Figure 16(a) shows how the water level pattern would appear if bore #36 alone is deactivated. An obvious difference in the order of 2 m can be seen in the north-western corner of the park. Figure 16(b) shows the marginal drawdown that would be caused by operating bore #36 alone at 0.9 ML/d. The local drawdown is about 2.5 m. The predicted drawdowns at the two distant monitoring bores are 0.5 m (Rowland Park) and 0.25 m (Heffron Park). However, both drawdowns will be overestimates.

5.5 SCENARIO I (12 ML/DAY)

In this scenario, borefield production is assumed to be 12 ML/d. This scenario has been chosen for illustration as the maximum recorded production rate in the past (as shown in Table 4). With the inclusion of background production bores, the total groundwater production from all bores in the model is 23.2 ML/d.

Figure 17 shows the groundwater level contours in the upper aquifer (Layer 1) and the middle aquifer (Layer 3). While there is very little difference between the two, there is cause for concern as the model predicts water levels lower than sea level. The minimum water level is about -4 mAHD.

The simulated drawdowns from the benchmark levels are so severe that the upper aquifer is dewatered around Snape Park; this is indicated by an absence of contour lines in Figure 18(a). In the deeper aquifer (Figure 18(b)), drawdowns are reported to reach a maximum of 22 m. At the south-eastern corner of Rowland Park, the predicted drawdown is 6 m, but observations at GW75025 are no more than 0.3 m. At Heffron Park, the predicted drawdown is 4-5 m near GW75020, but the observed drawdown is likely to be no more than 0.5 m.

It has already been noted in Section 5.0 and Section 5.4 that the MODFLOW model is overestimating drawdown by close to a factor of 2. Hence, the real maximum drawdown in the deeper aquifer is more likely to be around 11 m. However, the spatial drawdown pattern portrayed in Figure 18(b) will be valid. For a similar scenario (11.25 ML/day), the Knight *et al.* (1992) model predicted a maximum drawdown of 11-12 m.

Figure 19(a) shows how the water level pattern would appear if bore #36 alone is deactivated. An obvious difference in the order of 2 m can be seen in the north-western corner of the park. Figure 19(b) shows the marginal drawdown that would be caused by operating bore #36 alone at 0.9 ML/d. The local drawdown is about 2.5 m. The predicted drawdowns at the two distant monitoring bores are 0.5 m (Rowland Park) and 0.25 m (Heffron Park). However, both drawdowns will be overestimates.

5.6 Transient Simulation

In order to assess the ability of the aquifer to recover from Snape Park borefield pumping, the MODFLOW model has been run in transient mode for a month of pumping, followed by a month off, then another month of pumping, then no pumping for the rest of the year. Although this is an unrealistic pumping schedule, it will give an insight into whether various levels of production might cause permanent depletion of the groundwater resource.

Figure 20 displays the time-varying water levels for production rates 6 ML/day and 12 ML/day. After a month of pumping, followed by a month of rest, the aquifer has recovered to 90% of its initial water level for 12 ML/day production, and 95% for 6 ML/day. After a further month of pumping followed by 9 months of rest, the aquifer recovery is 97% for 12 ML/day production, and 98% for 6 ML/day. It is clear that the drawdown effects on the aquifer are temporary and the aquifer will be replenished by rainfall infiltration and lateral flow.

5.7 Other Scenarios

The model outputs for Scenarios B-I are displayed in Appendix C in Figure C1 to C16. For each scenario, the following graphics are provided:

- Simulated groundwater level;
- Simulated drawdown;
- Simulated groundwater level with bore #36 inactive;
- Simulated marginal drawdown due to bore #36 alone.

For borefield production of 3 ML/d, the predicted drawdowns at both distant monitoring bores is 1 m. However, this is a little in excess of what has been observed. Hence, far-field drawdown is being overestimated by the regional model.

The expected maximum drawdown of 7 m at GW42165 near bore #35 is honoured by Scenario D for 5 ML/day. In this scenario, bore #35 is assumed to be pumping 0.65 ML/d.

5.8 Analytical Model

As a check on the likely levels of drawdown for different production rates, a simplified analytical model has been developed using *HotSpots* software (Merrick and Merrick, 2002). This software is

based on a dual aquifer model which consists of a shallow aquifer and a deep aquifer, with an intervening aquitard. Scheduled pumping can occur from multiple bores pumping from either aquifer or both aquifers simultaneously, with drawdowns computed in both aquifers. Rainfall recharge is simulated as a percentage of rainfall scheduled in time. Uniform properties are allocated to each layer for thickness, hydraulic conductivity and storage coefficient. The model cannot handle spatial variability.

The anticipated drawdown patterns for 6 ML/day and 12 ML/day are illustrated in Figures 21 and 22 respectively. Unlike the MODFLOW model, this model suggests that the drawdown in the upper aquifer will be about half the drawdown in the deeper aquifer. Furthermore, the maximum drawdowns in the deeper aquifer are a little less than half what has been estimated with the MODFLOW model. This supports the earlier warning that the MODFLOW model is expected to overestimate drawdowns by a factor of 2.

Time-varying drawdowns at key monitoring sites are displayed in Figure 23 for 6 ML/day and 12 ML/day production. For 6 ML/day, negligible drawdown is observed at the Heffron Park bore, as expected. The drawdown at the Rowland Park bore is about 1 m after a year, and this is a little more than expected. The drawdown across Snape Park is about 4 m, which accords with observed reductions in water level in the historical data set for bore GW42165 (as shown in Figure 10).

Figure 24 compares the analytical and numerical models for the same time-varying production schedule considered in Section 5.6. The analytical model gives a much faster drawdown and a much faster recovery from pumping. This is consistent with the very rapid drawdown observed in the pumping test discussed in Section 4.4. After a year, the rest water levels exceed the initial levels. This indicates that the applied rainfall recharge of 22 percent of rainfall provides a greater volume of water to the aquifer system than has been abstracted over the same period.

A major difference between the two models is the presence of a permeability boundary upgradient of Snape Park in the MODFLOW model. This can be seen in Figure 14 (for example) where the contour lines stop. As this will limit the availability of lateral flow from an upgradient direction, computed drawdowns will be greater. The analytical model has no such boundary and hence no impediment to a supply of water from that direction. The earlier AQUIFEM model had a significant inflow of water into the model near this boundary, which is not in the MODFLOW model.

6.0 CONCLUSION

The key findings of this assessment of groundwater conditions in the vicinity of the Snape Park borefield are:

1. The borefield consists of six (6) operational bores that have produced about 9 ML/day groundwater on average; however, production up to 12 ML/day was achieved in the late 1960s;

2. The natural groundwater level at the site is expected to be about 18-20 metres above sea level during prolonged periods of average rainfall (with no pumping);

3. The current groundwater level at the site is about 15 metres above sea level (in the north-western corner);

4. Groundwater levels are very responsive to rainfall infiltration and can fluctuate by 4-5 metres;

5. There is an inadequate groundwater level monitoring record in the vicinity of Snape Park; the government monitoring bore inside the park operated from 1975 but failed in 1984 and was not replaced;

6. Due to inadequate monitoring data and patchy production records, the current regional groundwater model (MODFLOW) is not sufficiently well calibrated in the Snape Park area to give reliable predictions of drawdown magnitude; however, the drawdown pattern will be reliable;

7. MODFLOW model drawdowns are overestimates, probably by a factor of around 2;

8. The government monitoring bore in Rowland Park suggests that the drawdown at 400 metres from the borefield is no more than 0.25 metres;

9. Drawdown effects will not propagate to the nearest surface water feature of environmental importance which is 1 km to the west of the borefield;

10. There are almost 100 bores within 1 km of the Snape Park borefield, mostly backyard bores of low yield;

11. Existing neighbouring bores have always been subject to any drawdown caused by the borefield, which has been in operation for 40 years; there is no record that the operational impacts have been unacceptable or will become unacceptable to other users;

12. The partial monitoring record within the park from 1975 to 1984 shows drawdowns of 4 m to 7 m due to pumping, with very rapid recovery and return to natural levels when the pumps are turned off;

13. The groundwater is very fresh and shows no evidence of contamination.

The analytical model used in this study gives the most reliable drawdown magnitudes, but the drawdown patterns are best indicated by the numerical MODFLOW model. Off-site and far-field drawdowns should be considered in the context of substantial natural water level variations of 4-5 metres due to climate variations.

7.0 REFERENCES

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Merrick, N. P., 1994, A groundwater flow model of the Botany Basin. IAH/IEA Water Down Under '94 Conference, Adelaide, 21-25 Nov., Proceedings Vol. 2A, 113-118.

Merrick, N. P., 1998, Glimpses of history: The evolution of groundwater levels and usage in the Botany Basin. In McNally, G., and Jankowski, J. (eds.) : Collected Case Studies in Engineering Geology, Hydrogeology and Environmental Geology (Fourth Series): Environmental Geology of the Botany Basin. Conference Publications, Springwood, 230-242.

Merrick, N. P. and Merrick, D. P., 2002, A dual aquifer analytical model with rain and river recharge. CD Proceedings of the IAH International Groundwater Conference, Darwin, Australia, 12-17 May, 2002.

Merrick, N. P., 2004, Optimal groundwater abstraction rates for hydraulic containment of contaminant plumes and source areas, Botany NSW. AccessUTS report for Orica Australia Pty Ltd, Project C04/44/001, October 2004.

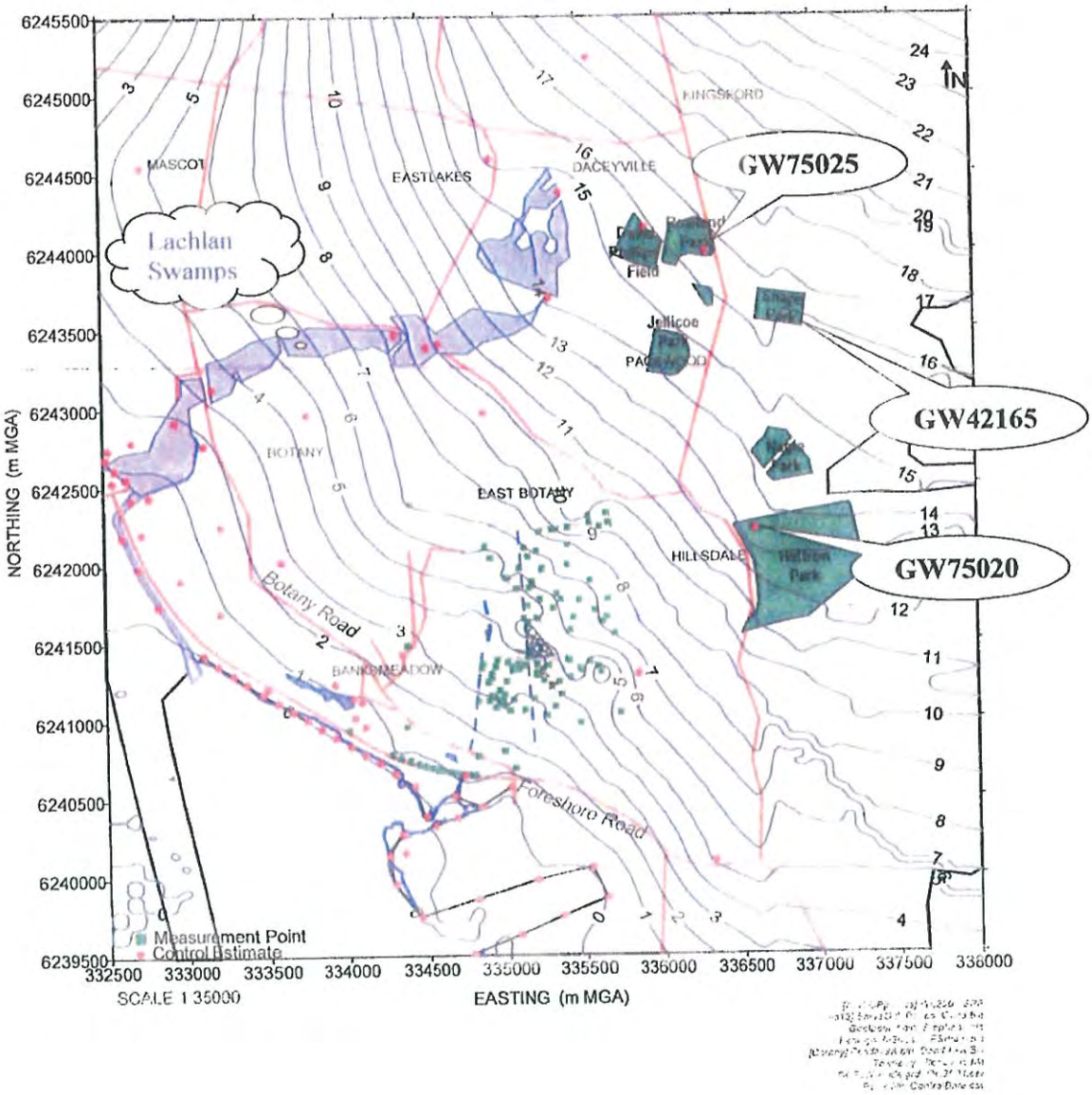

Figure 1. Groundwater levels (mAHD) measured and estimated at October 2004.

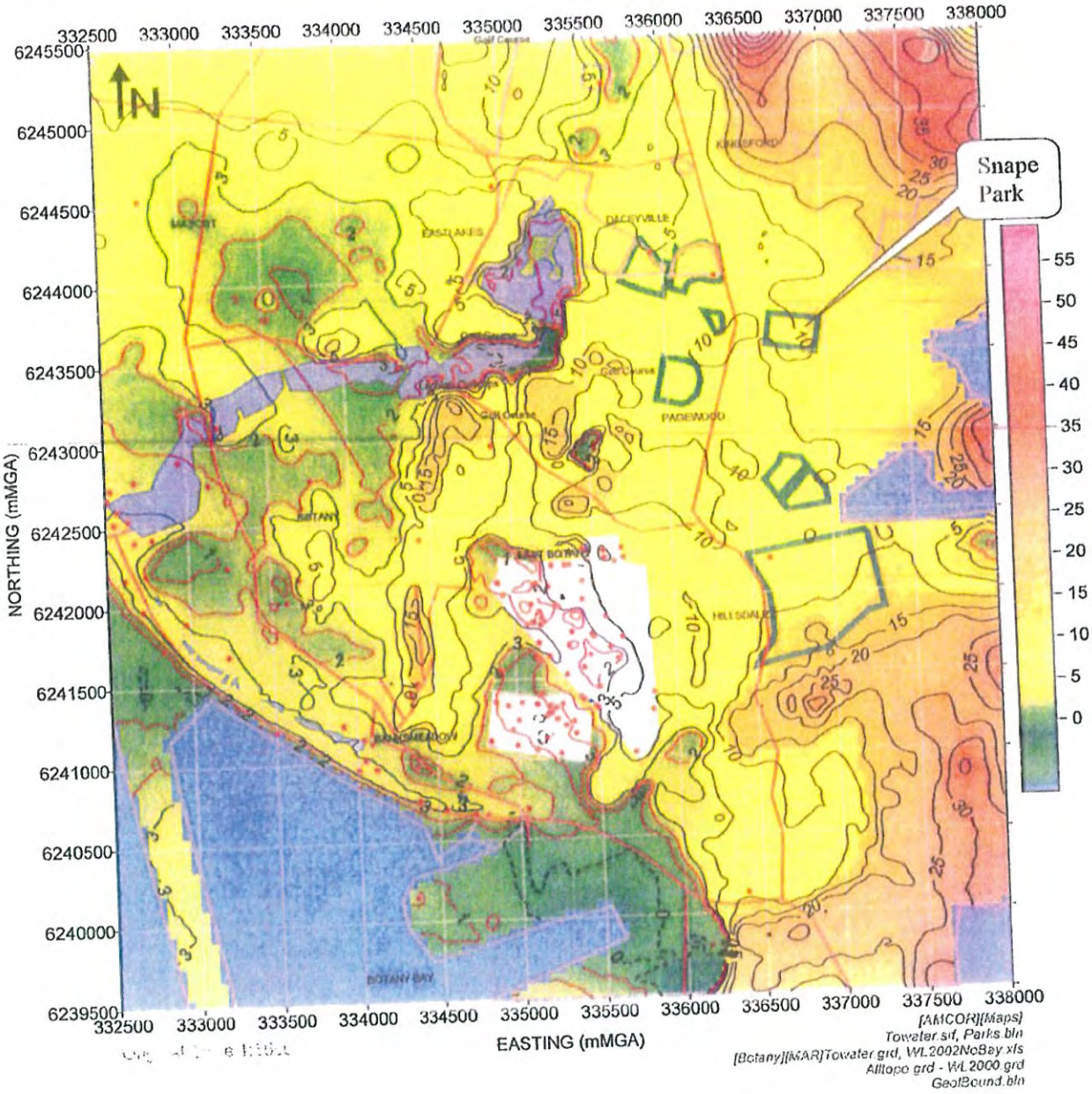

Figure 2. Approximate depth to the water table (m).

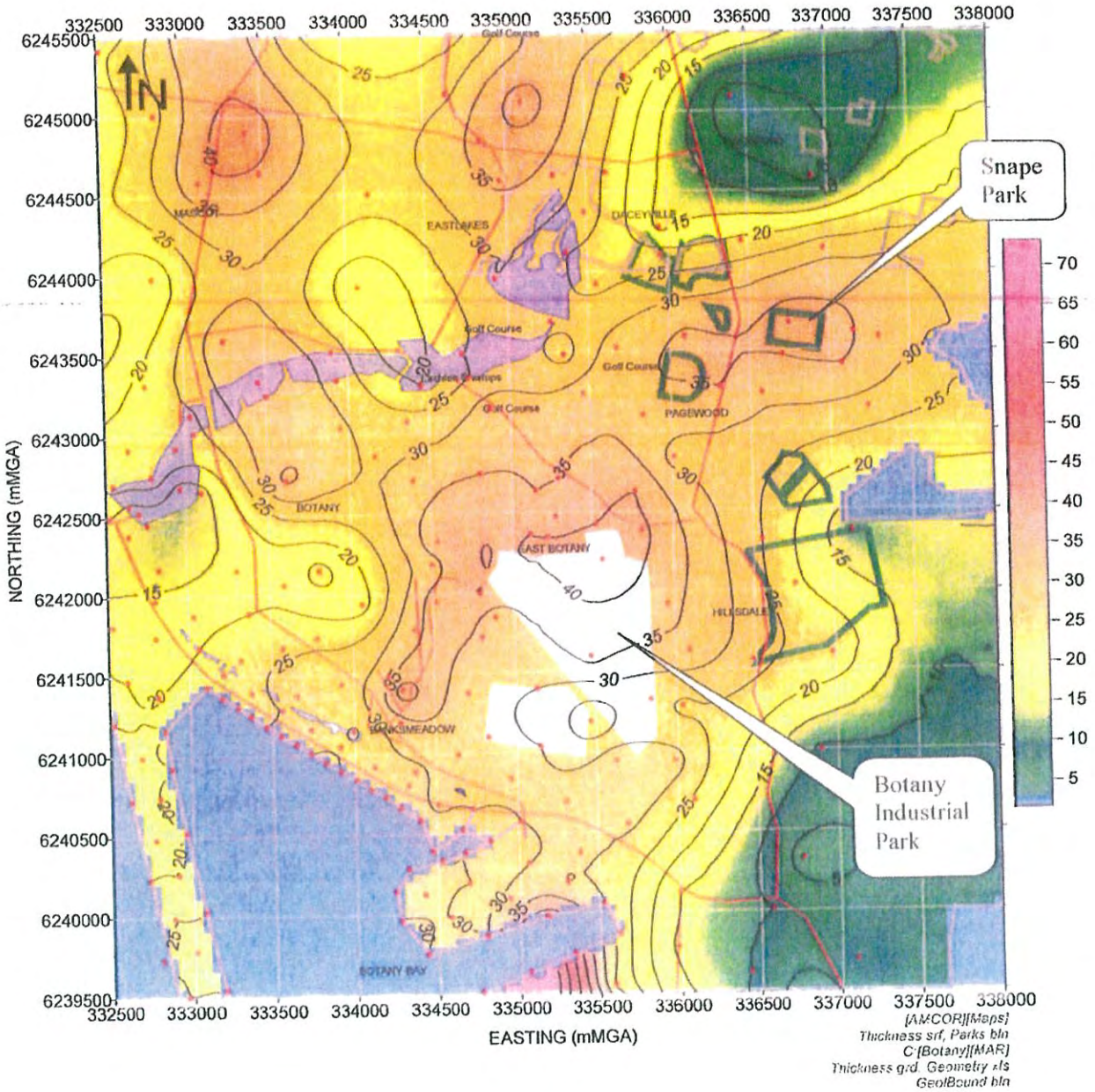

Figure 3. Total aquifer thickness (m) [from ground surface to bedrock]

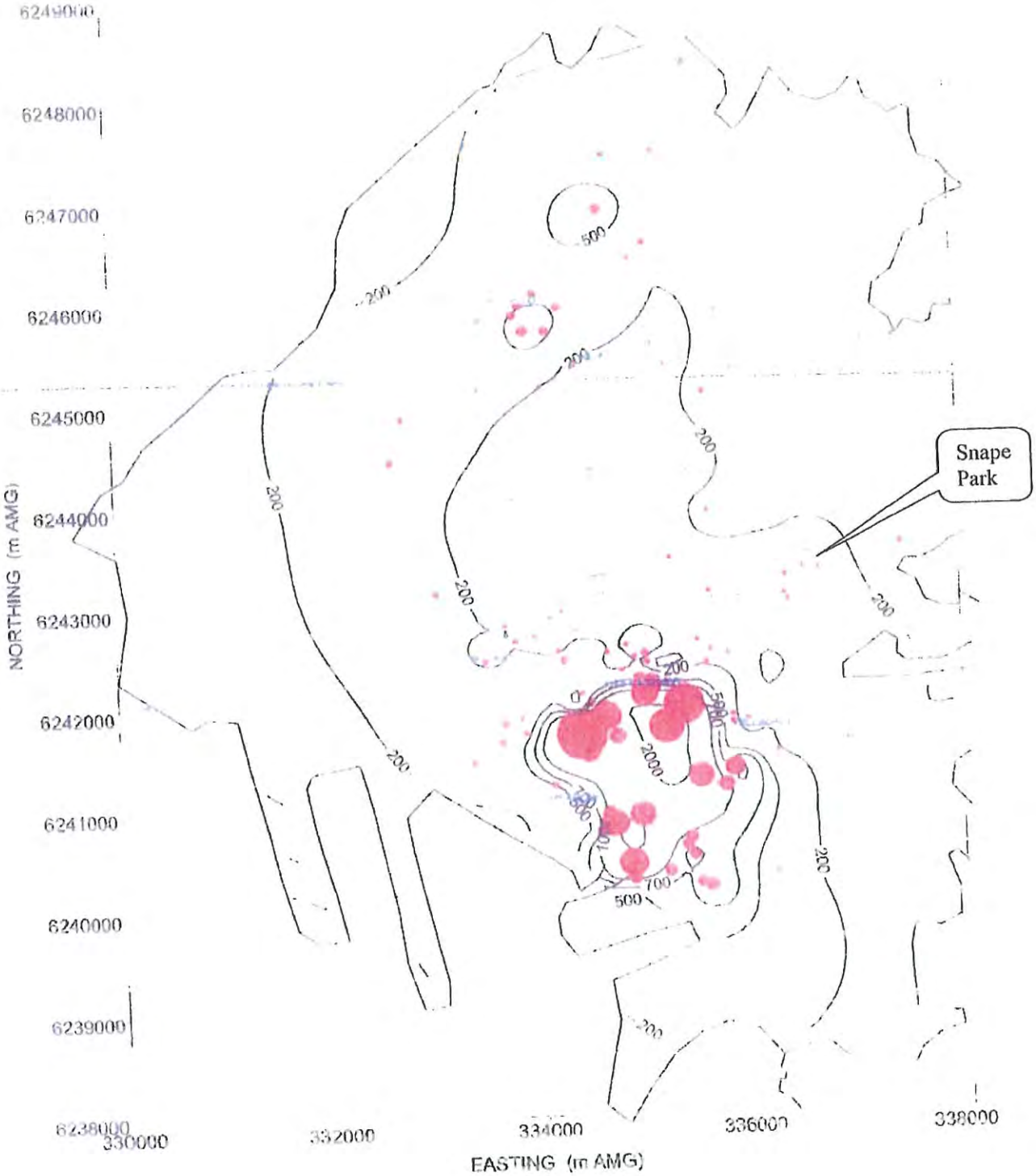

Figure 4. Groundwater electrical conductivity (µS/cm) pattern (based on 1970-1974 data)

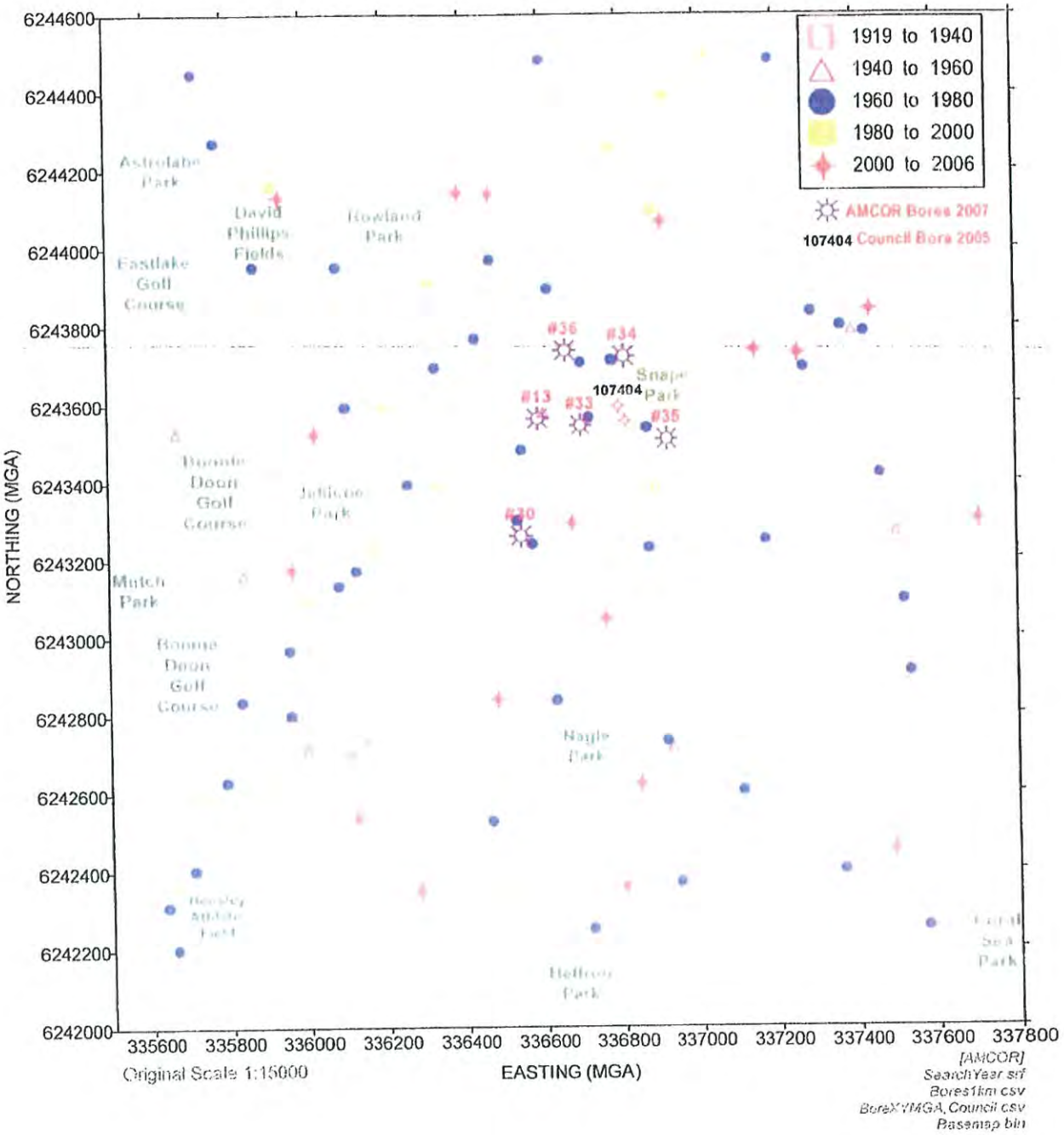

Figure 5. Registered bores within 1 km of Snape Park (at 2006).

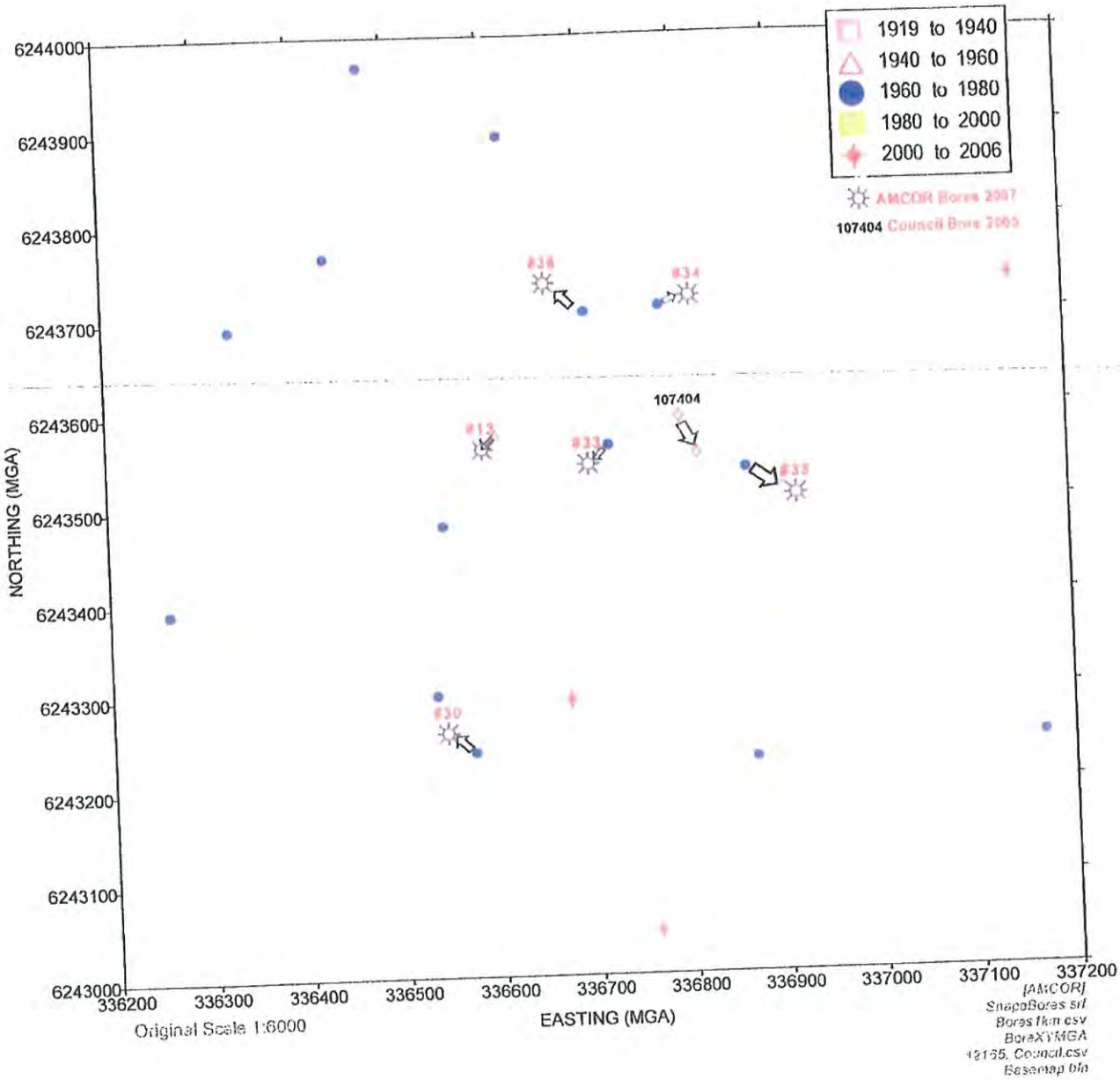

Figure 6. Corrected locations for the bores in the Snape Park borefield.

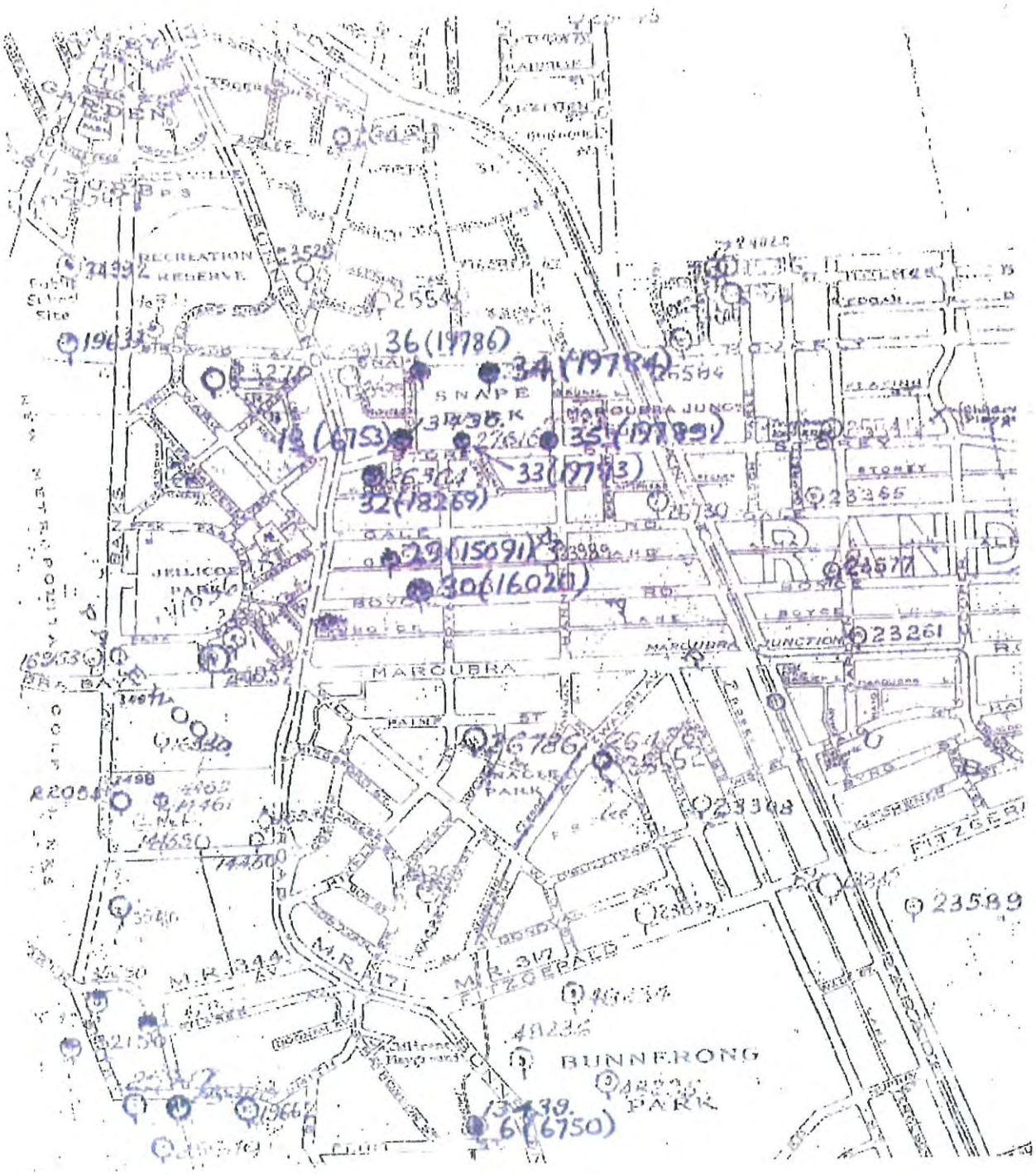

Figure 7. Original charted locations of bores surrounding Snape Park.

(a)

(b)

Figure 8. Photographs taken on 5 September 2007
(a) Failed bore #36 (in concrete pit) and adjacent test bore (exposed temporary casing);
(b) Stormwater channel water flowing south along Walsh Street towards Heffron Park.

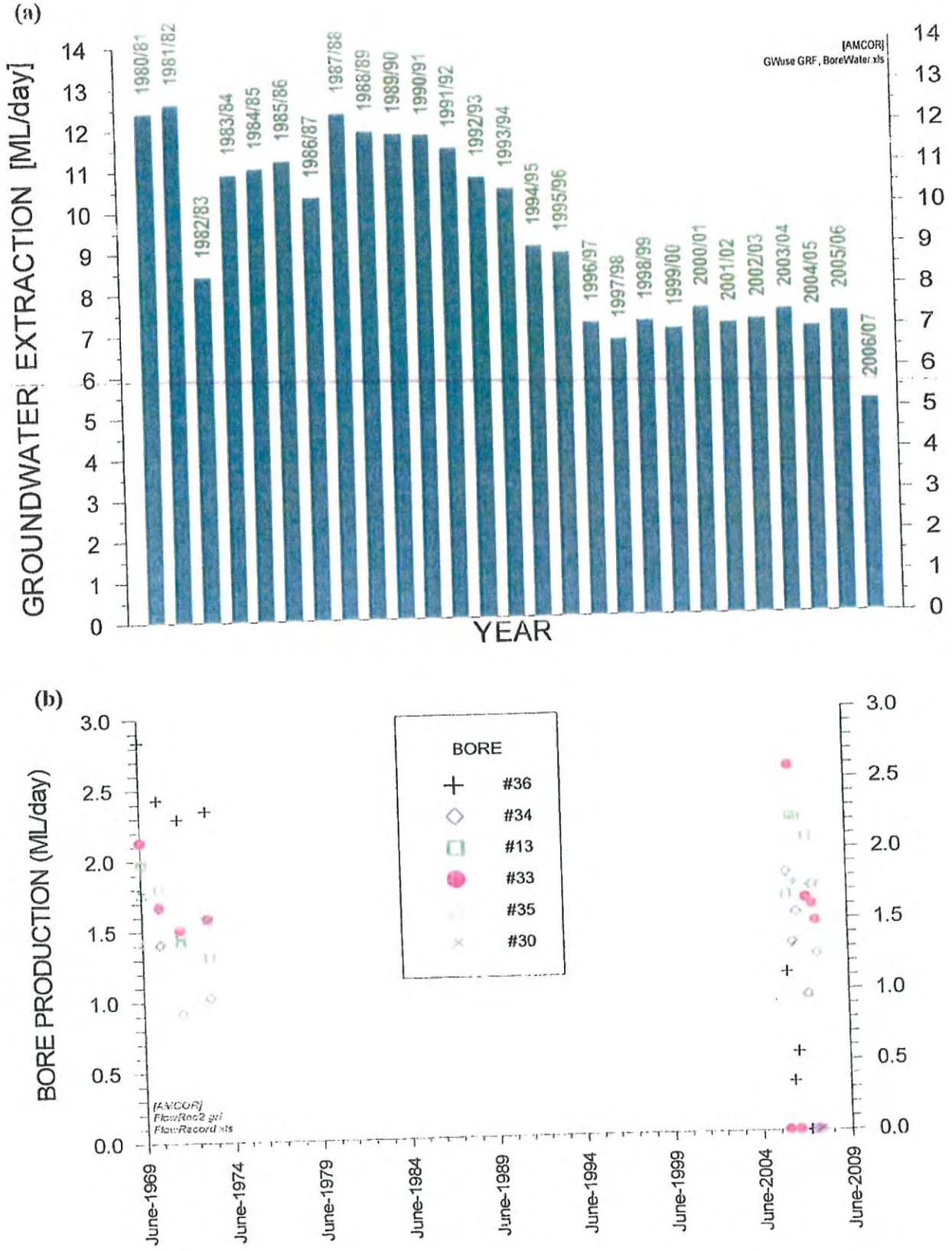

Figure 9. Borefield production records (ML/day)
(a) Total; (b) Individual bores.

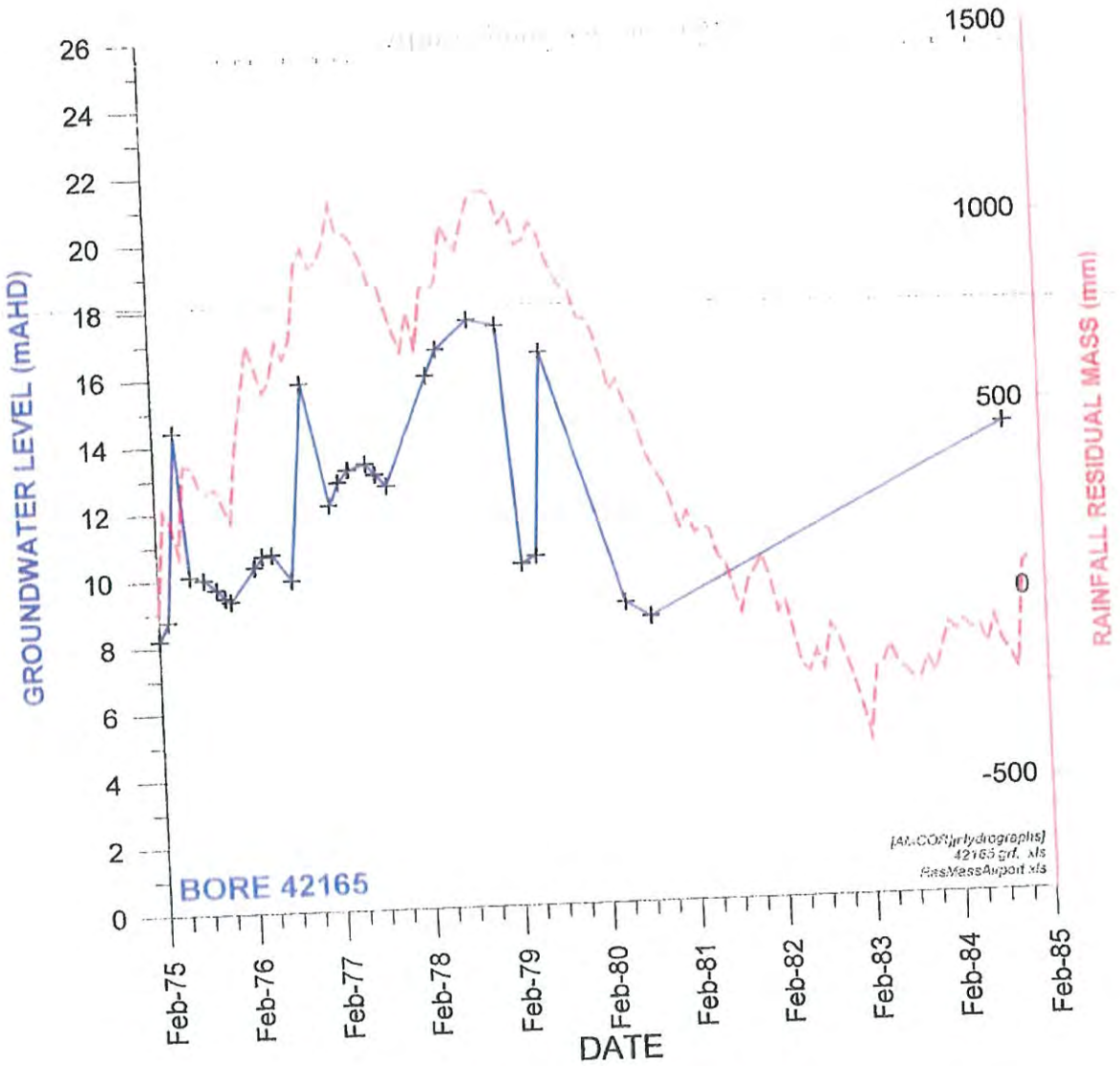

Figure 10. Groundwater hydrograph for bore GW42165 in Snape Park.

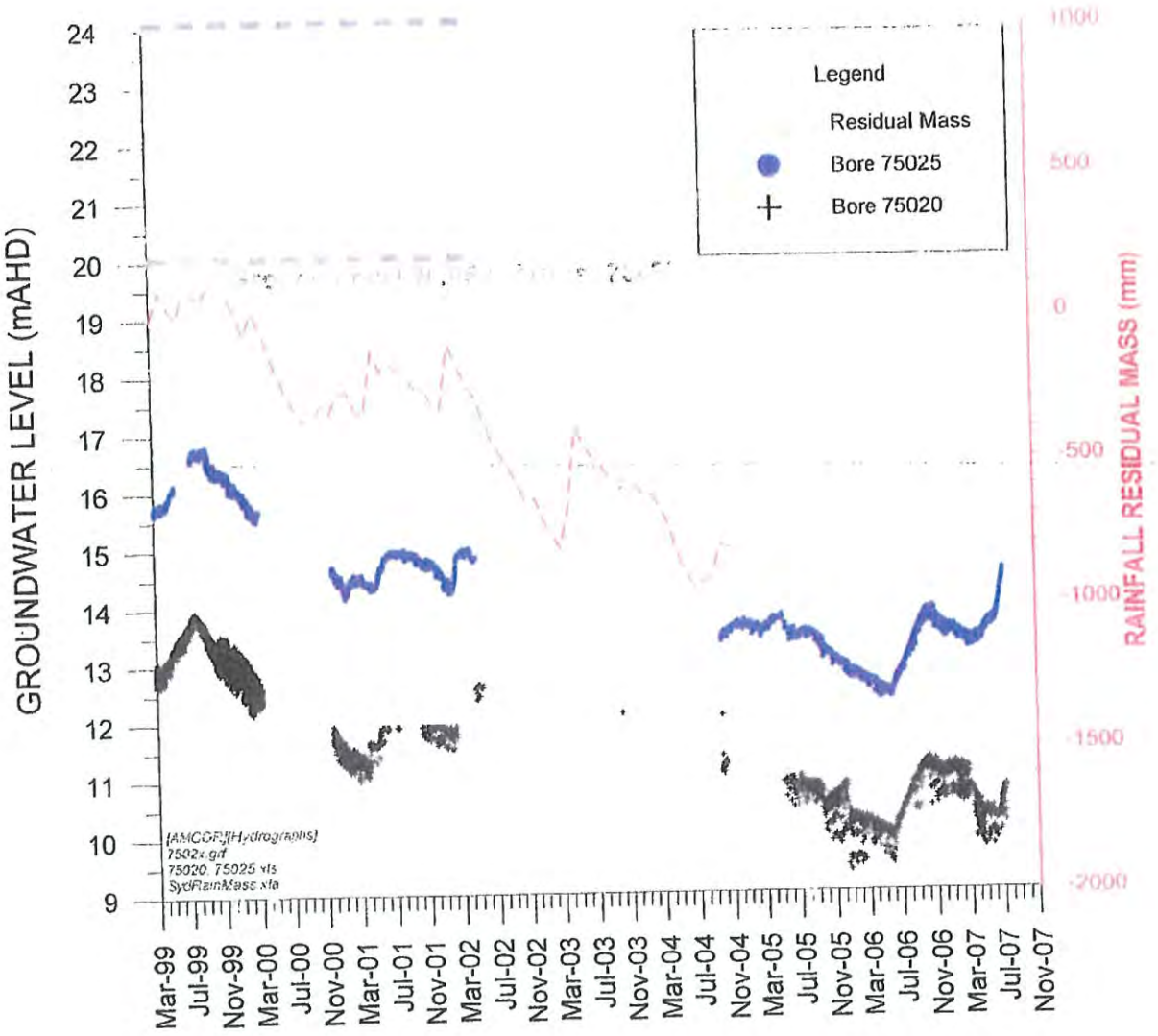

Figure 11. Groundwater hydrographs for bores GW75020 in Heffron Park and GW75025 in Rowland Park.

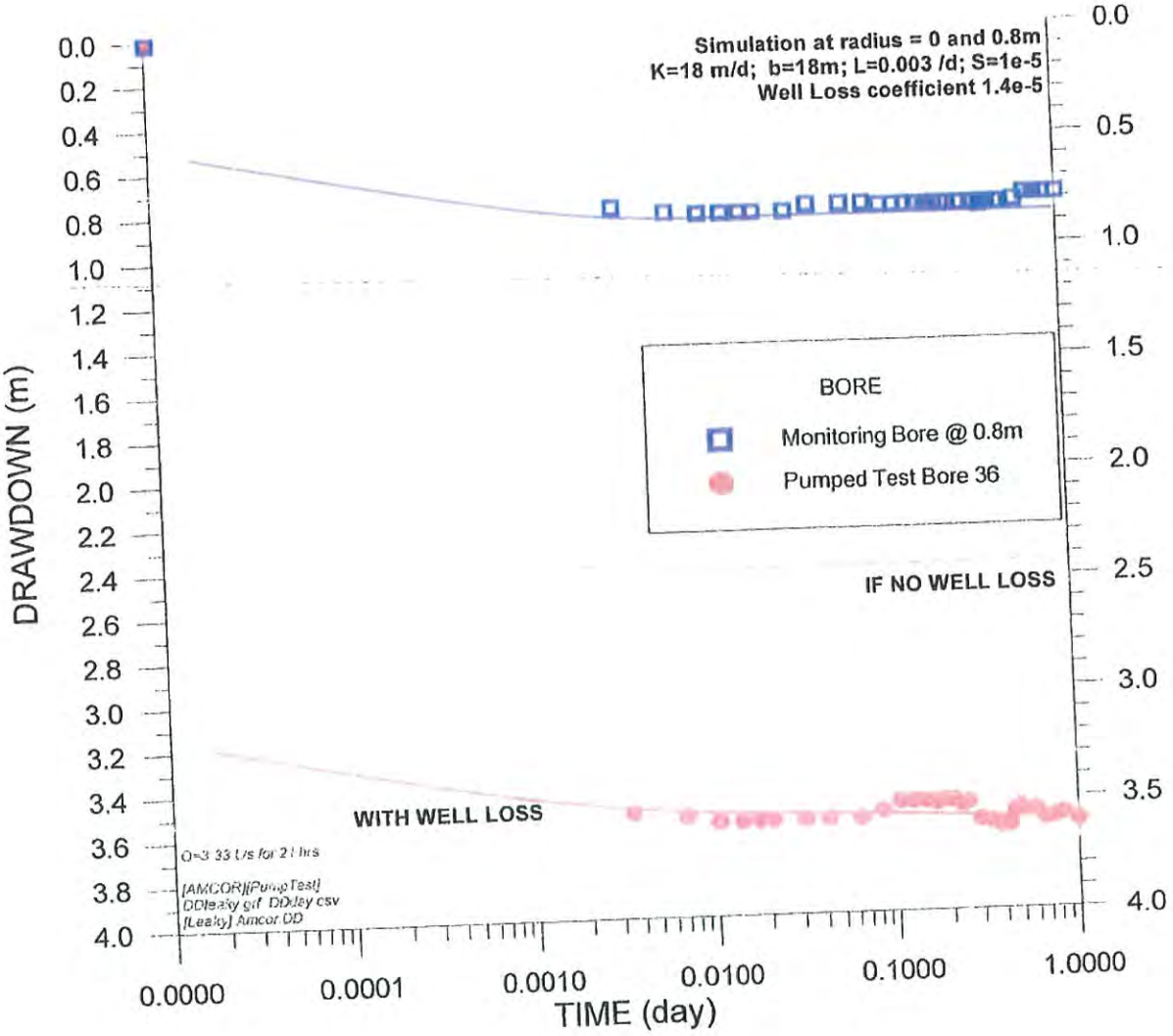

Figure 12. 24 hour pumping test data and interpretation at test bore #36.

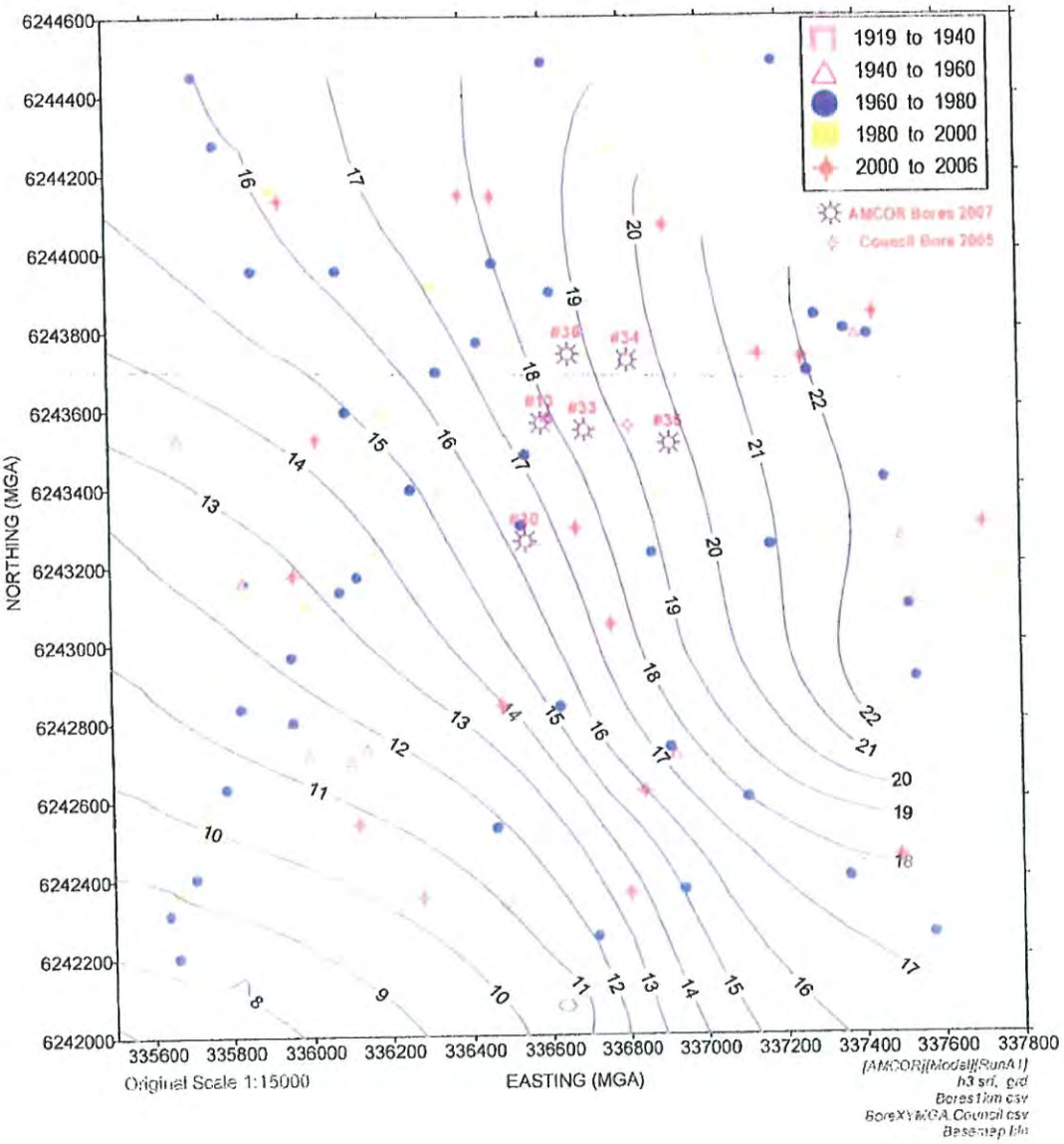

Figure 13. Simulated groundwater levels with no AMCOR pumping (Benchmark Scenario A).

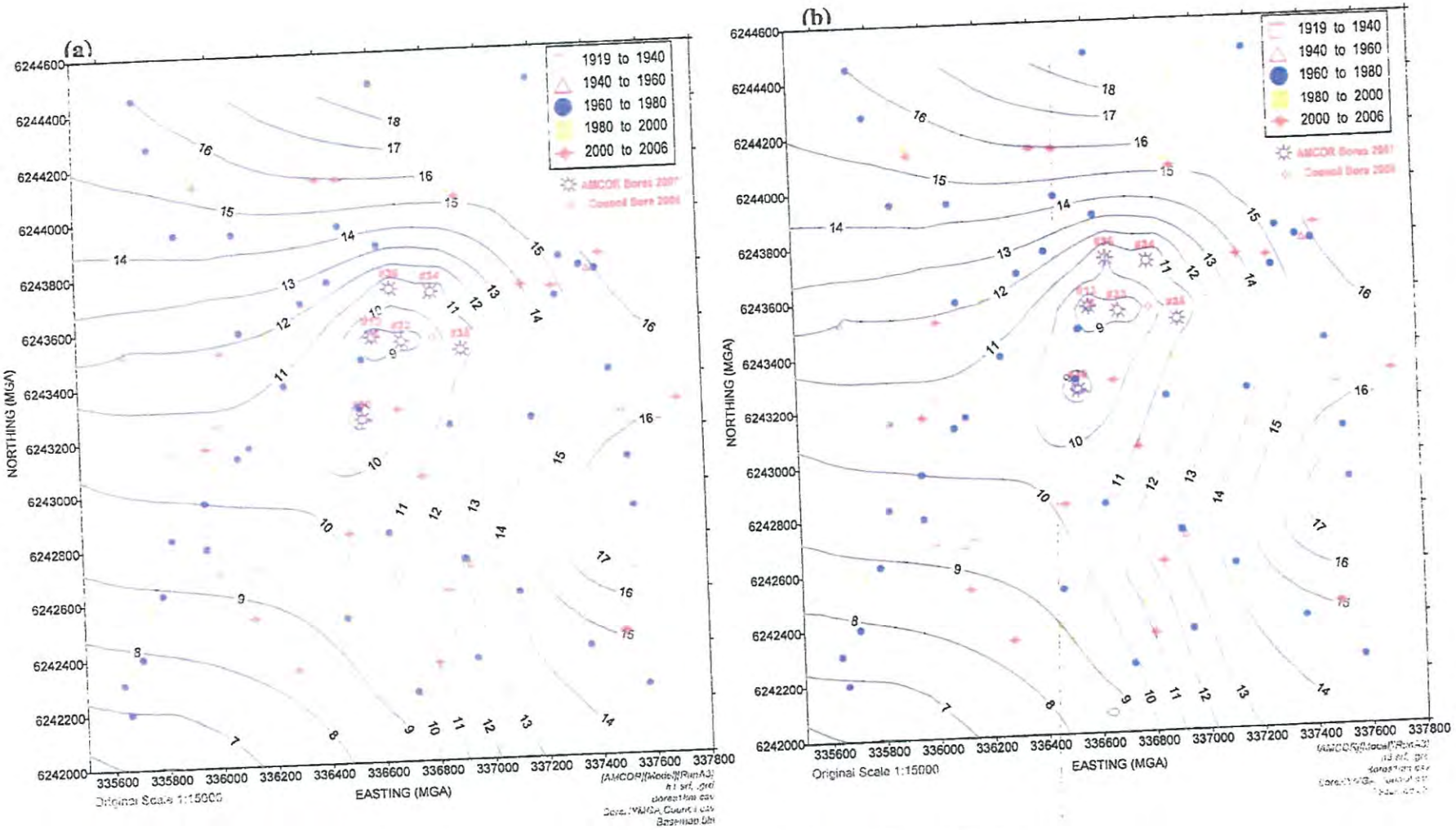

Figure 14. Simulated groundwater levels (mAHD) for borefield production 6 ML/day (Scenario E)
(a) Upper aquifer (Layer 1); (b) Middle aquifer (Layer 3).

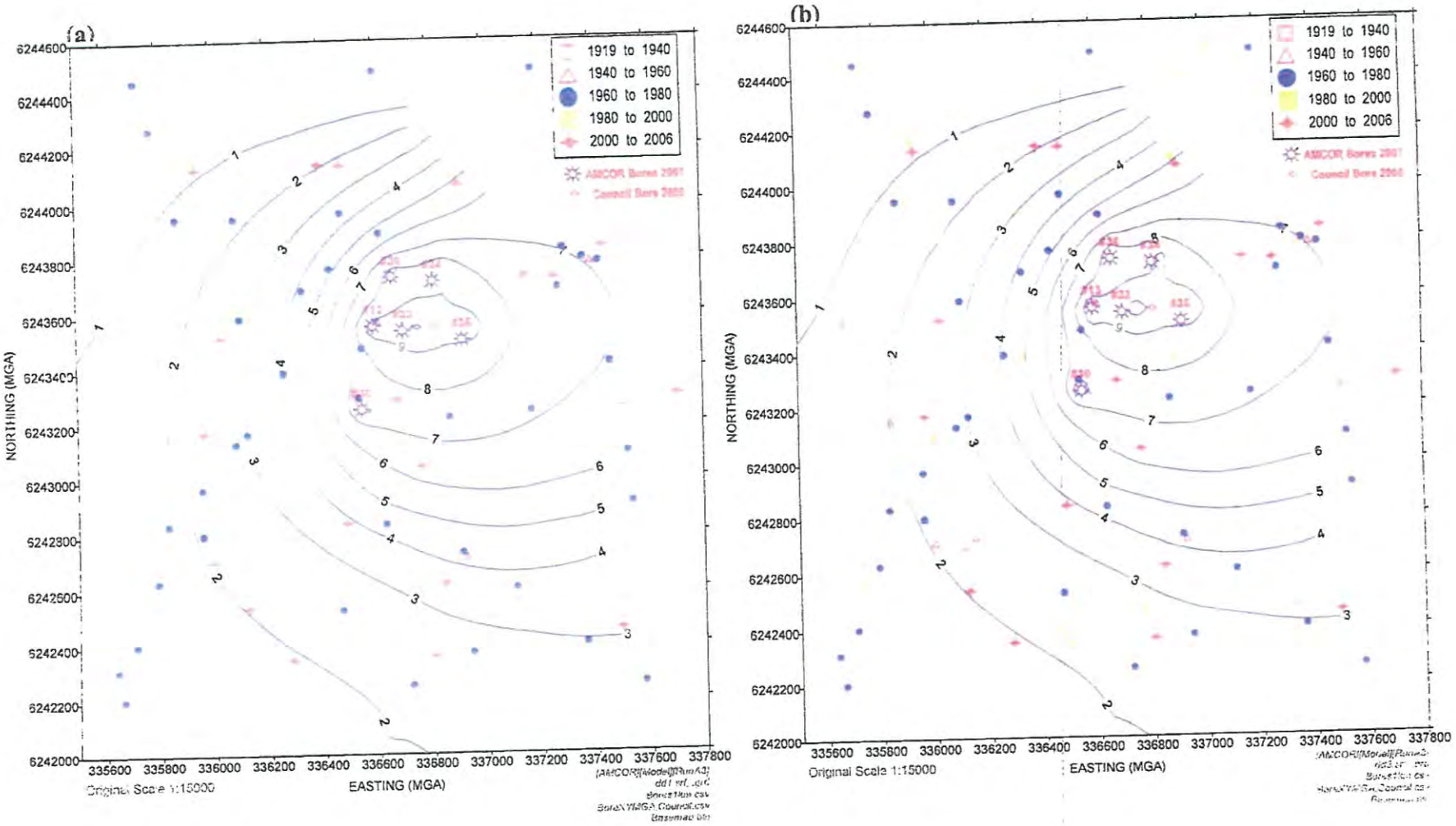

Figure 15. Simulated drawdown (m) levels for borefield production 6 ML/day (Scenario E)
(a) Upper aquifer (Layer 1); (b) Middle aquifer (Layer 3).

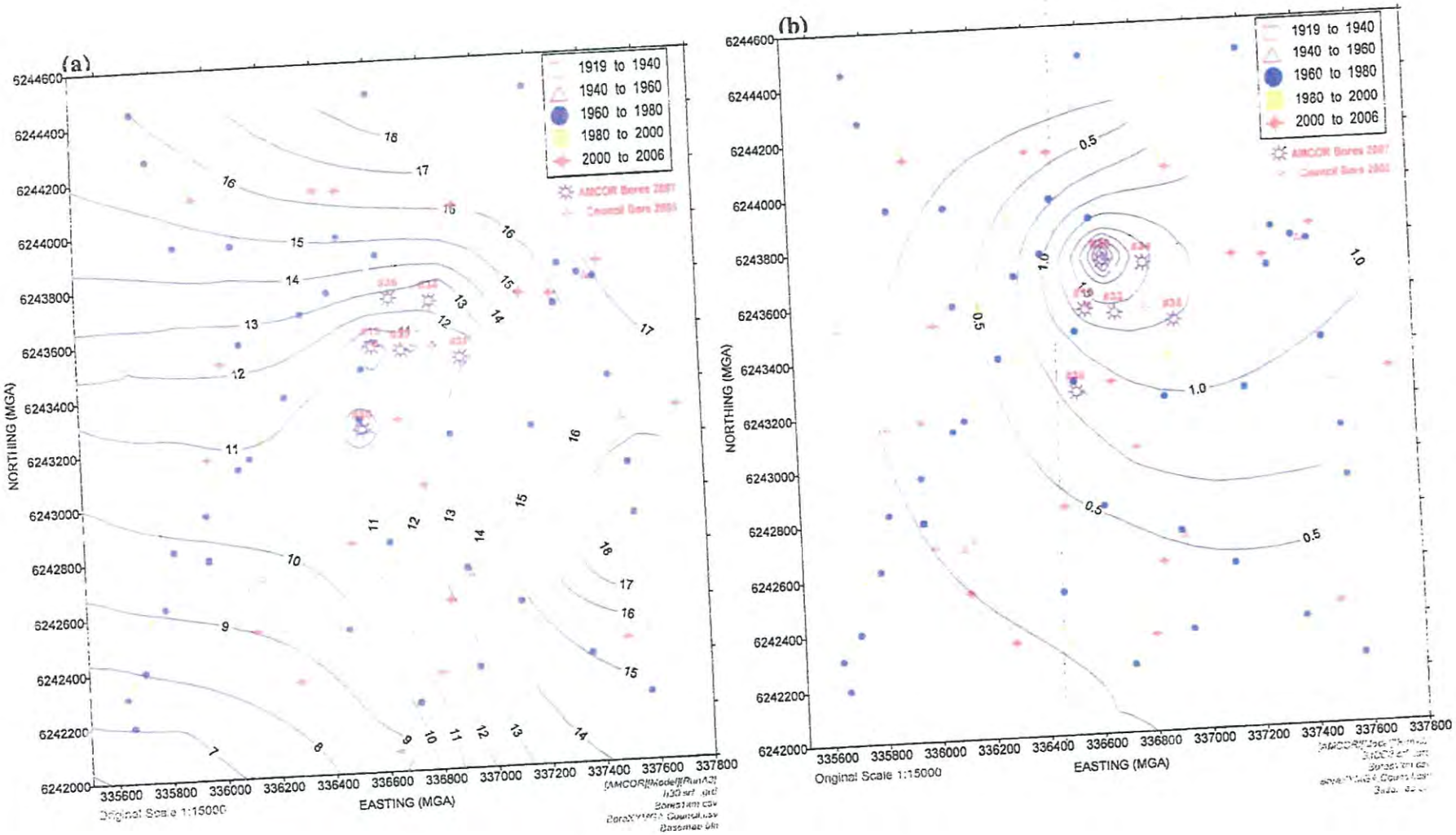

Figure 16. Simulated responses in the middle aquifer for Scenario E
(a) Groundwater level (mAHD) for borefield production 5.1 ML/day with #36 off;
(b) Marginal drawdown due to pumping bore #36 alone at 0.9 ML/day.

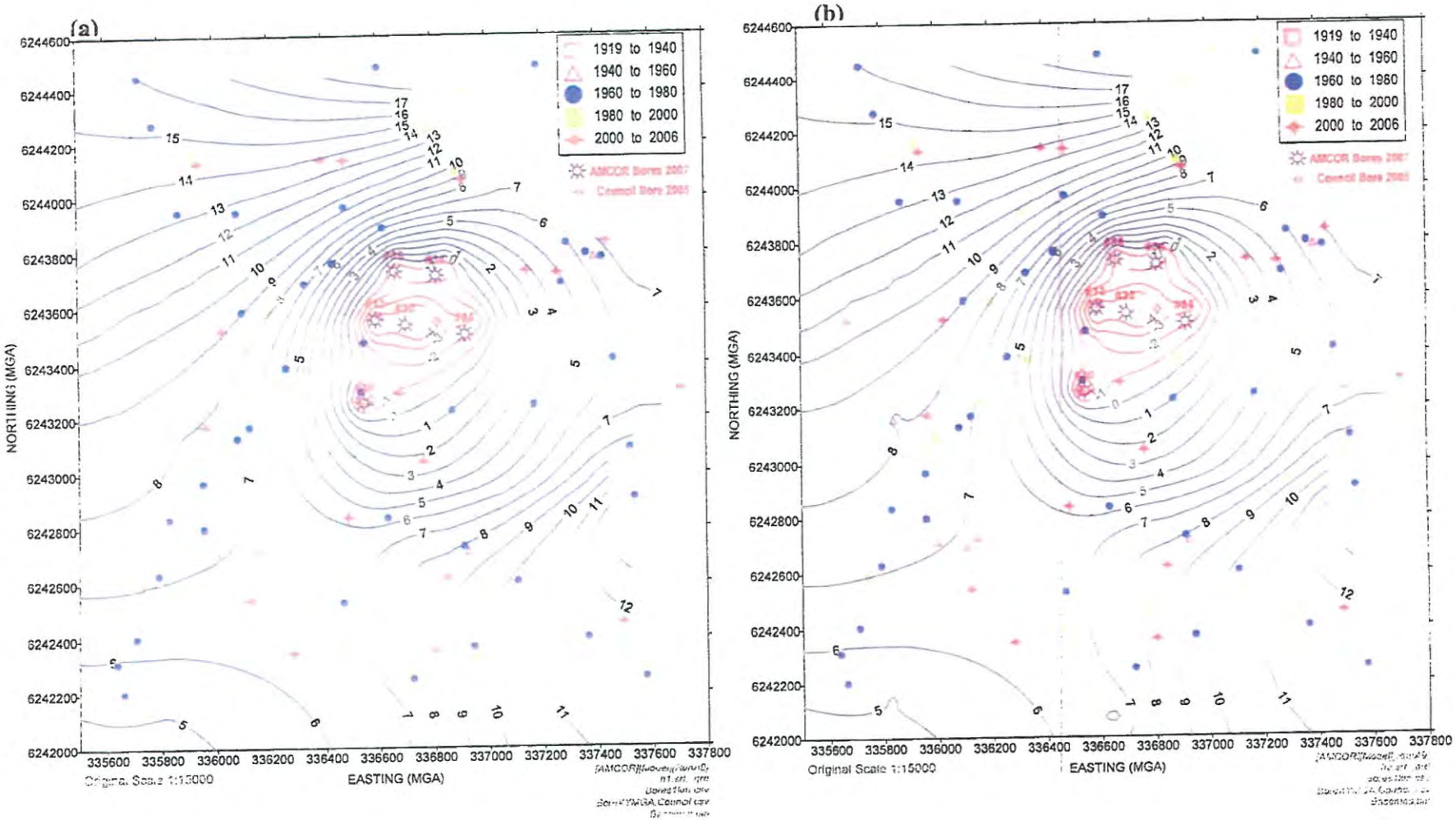

Figure 17. Simulated groundwater levels (mAHD) for borefield production 12 ML/day (Scenario I)
(a) Upper aquifer (Layer 1); (b) Middle aquifer (Layer 3).

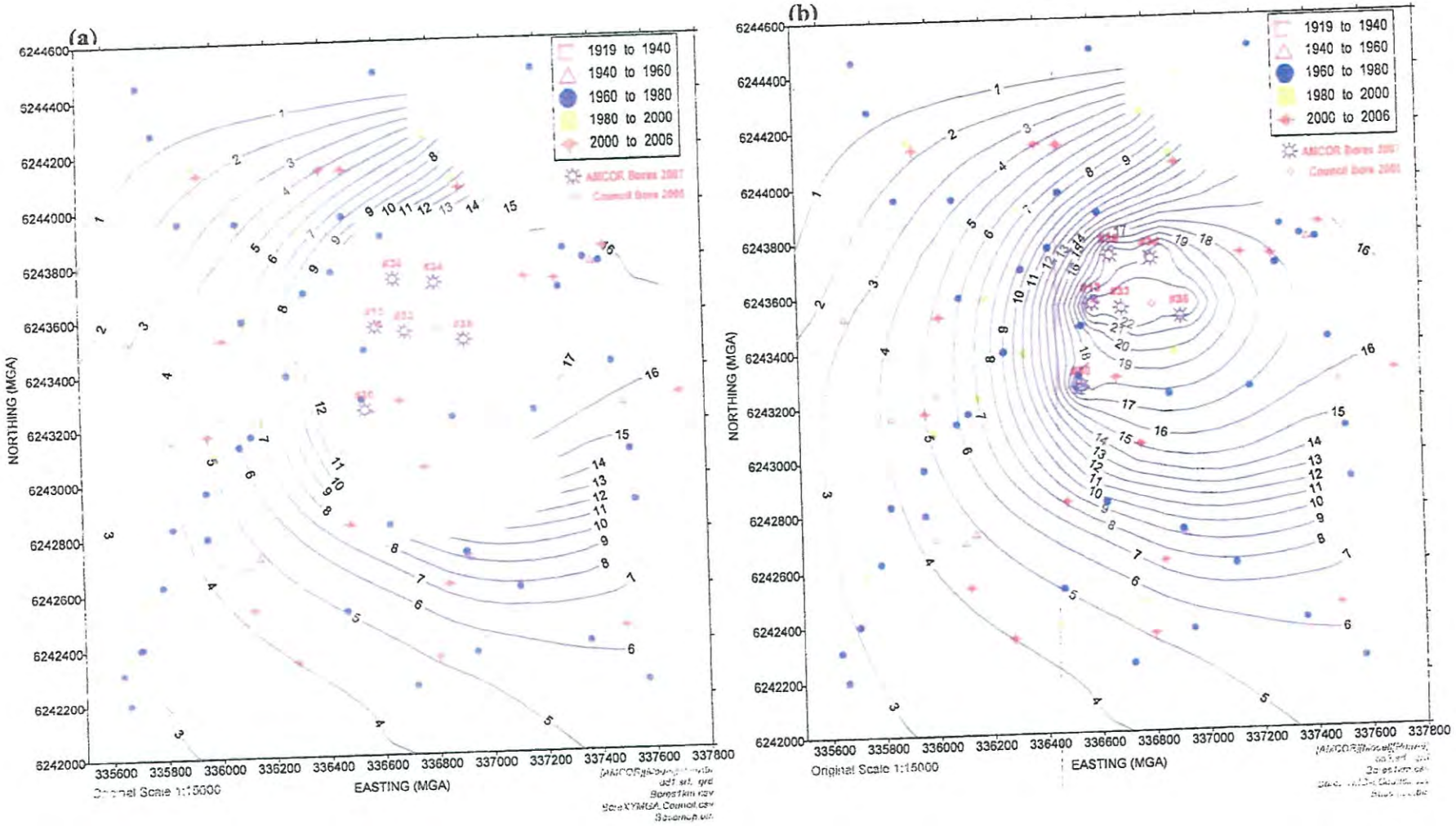

Figure 18. Simulated drawdown (m) levels for borefield production 12 ML/day (Scenario I)
(a) Upper aquifer (Layer 1); (b) Middle aquifer (Layer 3).

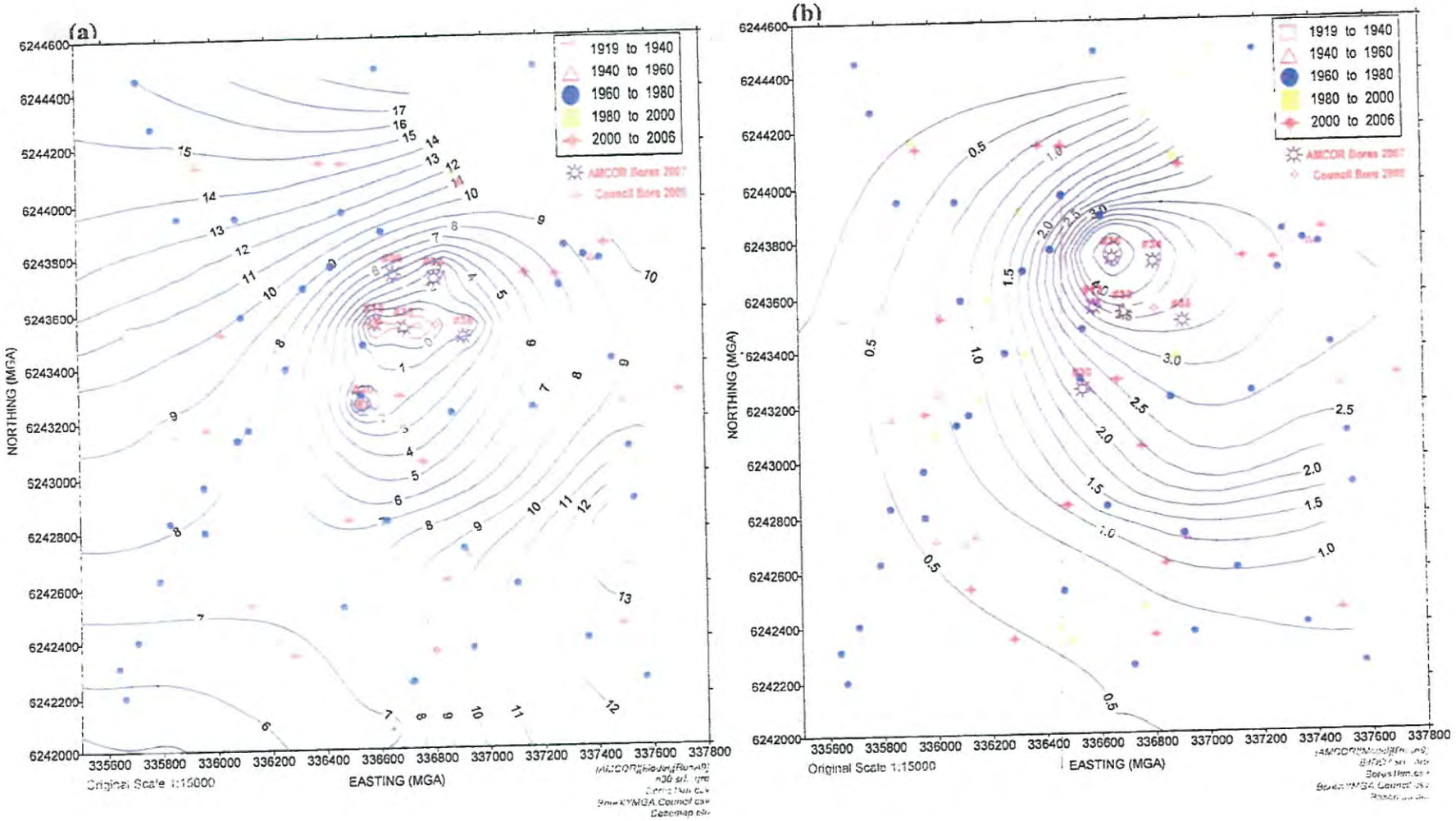

Figure 19. Simulated responses in the middle aquifer for Scenario I
(a) Groundwater level (mAHD) for borefield production 10.2 ML/day with #36 off;
(b) Marginal drawdown due to pumping bore #36 alone at 1.8 ML/day.

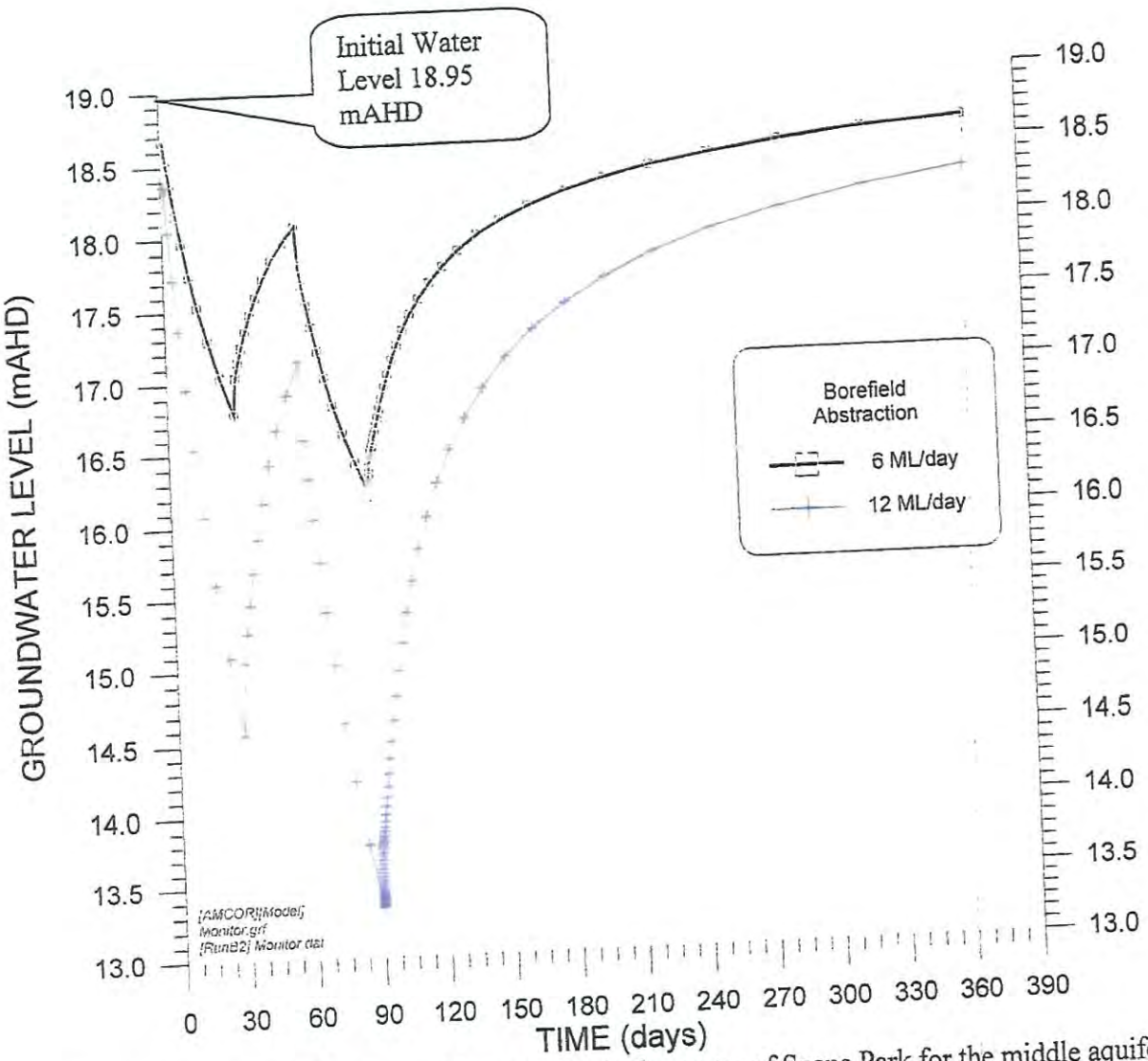

Figure 20. Simulated hydrographic responses in the centre of Snape Park for the middle aquifer for (a) Scenario E (6 ML/day) and (b) Scenario I (12 ML/day) with pumping on for month 1, off for month 2, on for month 3, then off for 9 months.

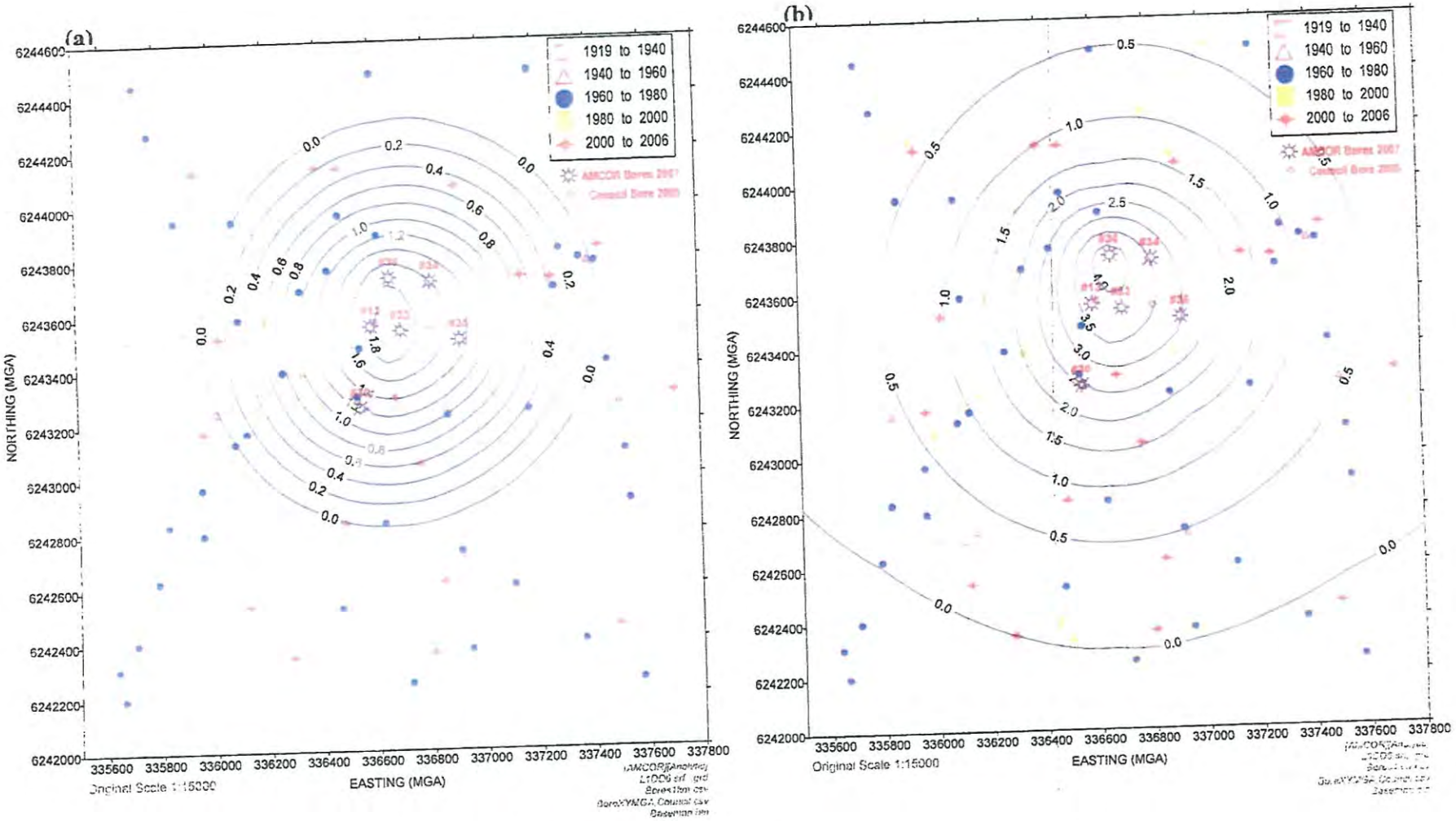

Figure 21. Analytical model simulated drawdown (m) levels for borefield production 6 ML/day (Scenario E)
(a) Upper aquifer (Layer 1); (b) Middle aquifer (Layer 3).

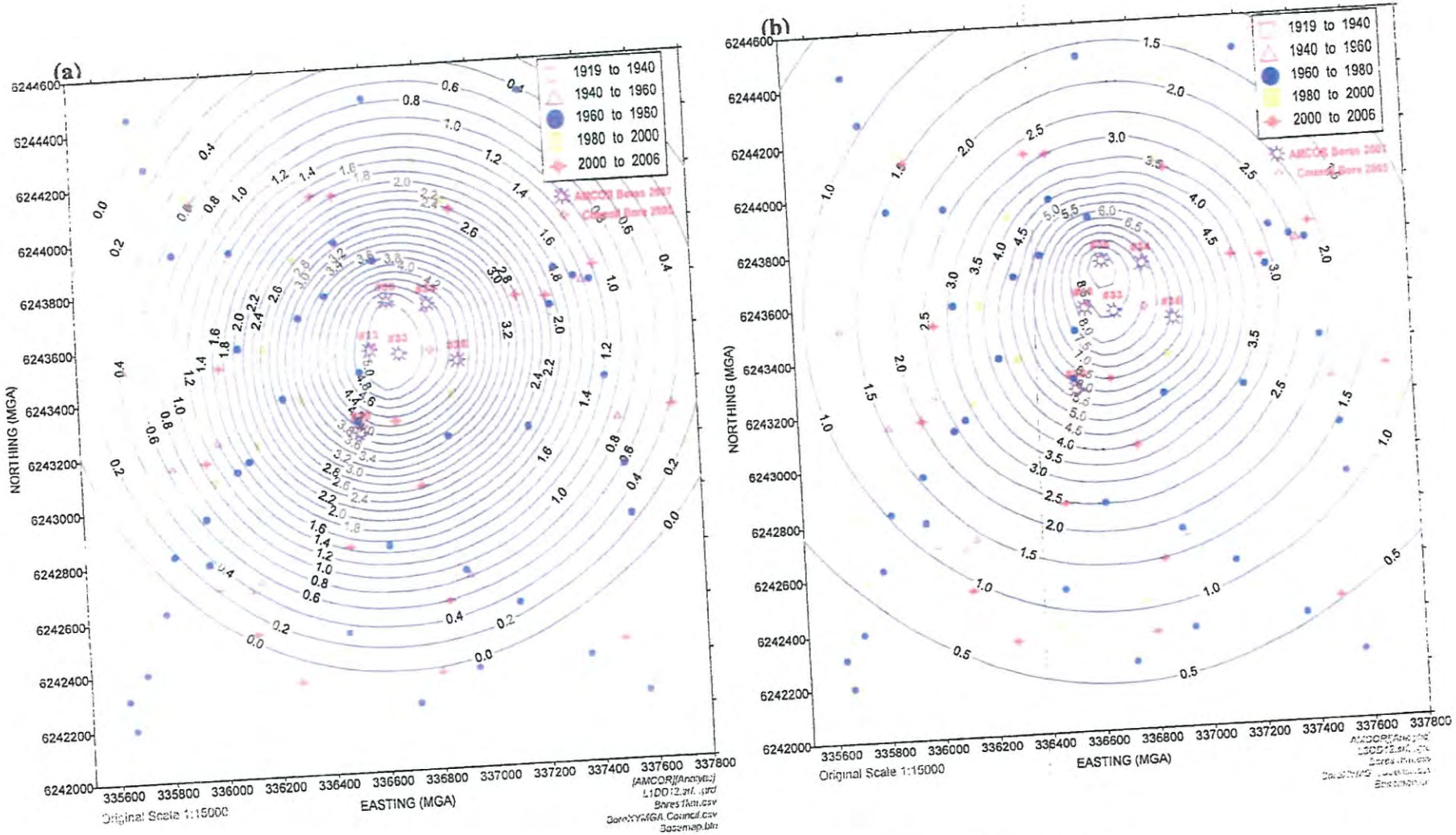

Figure 22. Analytical model simulated drawdown (m) levels for borefield production 12 ML/day (Scenario I)
(a) Upper aquifer (Layer 1); (b) Middle aquifer (Layer 3).

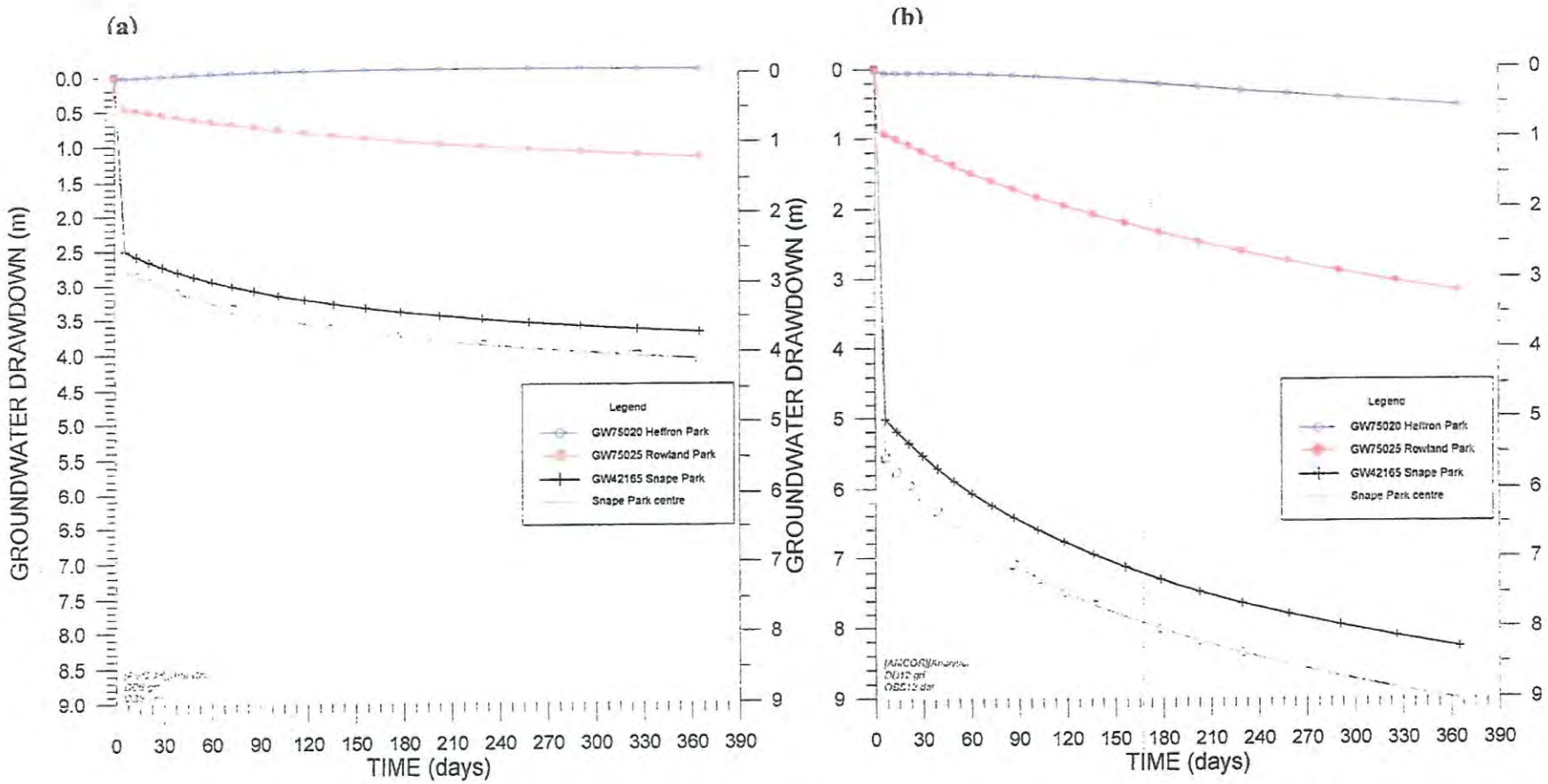

Figure 23. Analytical model simulated hydrographic responses for the middle aquifer for (a) Scenario E (6 ML/day) and (b) Scenario I (12 ML/day) with continuous pumping for 12 months

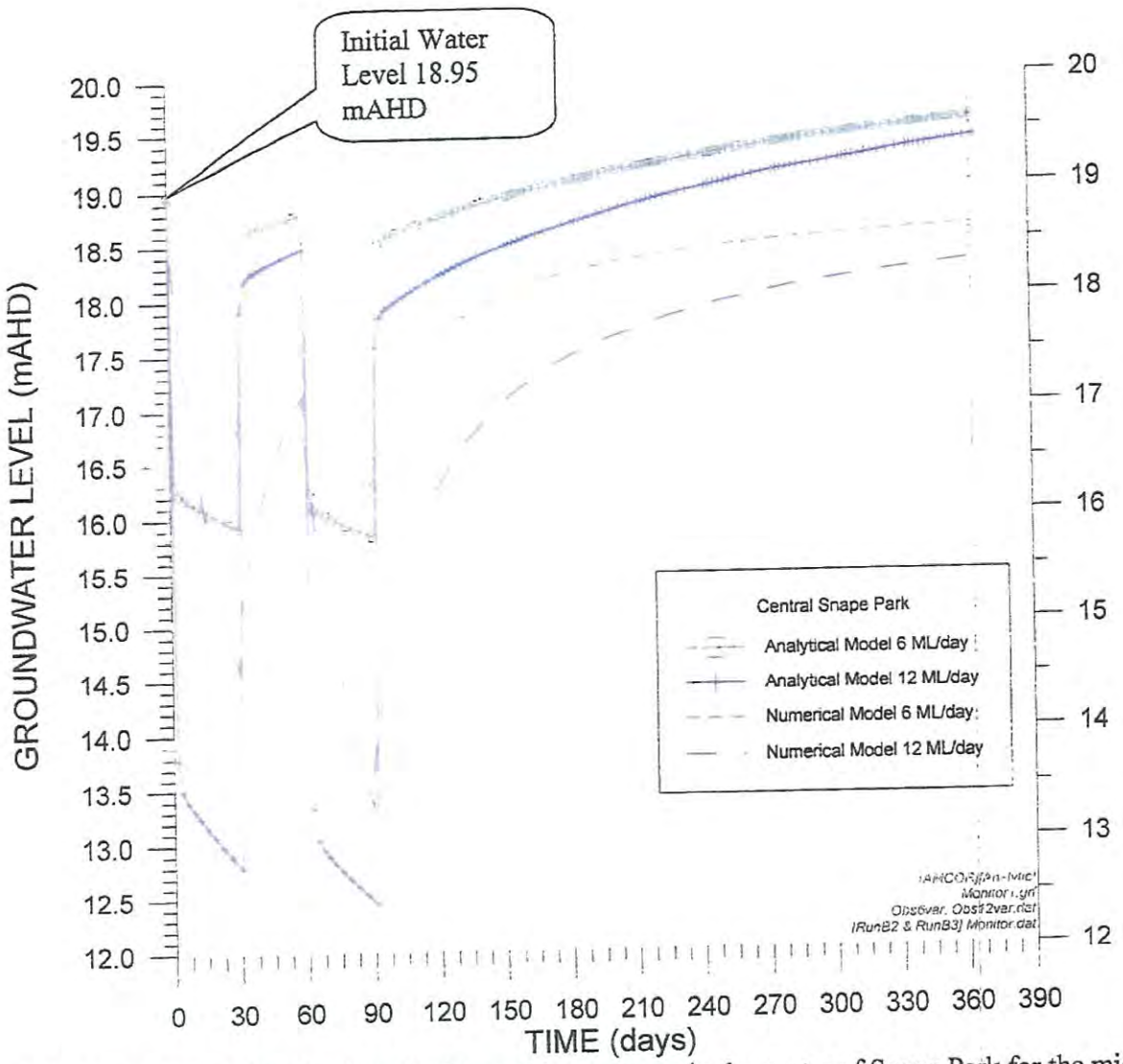

Figure 24. Analytical model simulated hydrographic responses in the centre of Snape Park for the middle aquifer for (a) Scenario E (6 ML/day) and (b) Scenario I (12 ML/day) with pumping on for month 1, off for month 2, on for month 3, then off for 9 months.

APPENDIX A

FORM A : PARTICULARS OF COMPLETED BORES

FORM "A"

WATER CONSERVATION AND IRRIGATION COMMISSION, N.S.W.

PARTICULARS OF COMPLETED BORE

#30

In respect of License issued under Part V of the Water Act, 1912, as amended by subsequent Acts

Name of Licensee Australian Paper Manufacturers Ltd., Bore License No. 16020

Particulars of Strata.

From feet.	To feet	Thickness.	Strata
0'	1'	1'	Grey sand
1'	2'	1'	White sand
2'	20'	18'	Yellow sand
20'	26'	6'	Yellow sand W/B
26'	26'1	1'	Peat seam
26'1	33'	6'11	Brown sand GW/B
33'	45'	12'	Yellow white sand GW/B
45'	52'	7'	Brown sand GW/B
52'	56'	4'	White sand "
56'	57'	1'	Grey clay
57'	60'	3'	Brown sand W/B
60'	61'	1'	Grey clay
61'	83'	22'	Yellow sand with small clay bands
83'	121'	38'	Yellow sand GW/B
121'	123'	2'	Light brown sand W/B
123'	126'6	3'6	Dark Brown sand (clay seams)
126'6			Sandstone

Total Depth 126'6"

General Particulars.

Date commenced	14th November 1965
Date completed	24th November 1965
Contractor	Alan Royle Pty. Ltd.
Address	287 King Street
"	Mascot
Driller	T. Ryan
Address	C/o A. Royle Pty. Ltd
"	287 King St. Mascot.

Net Length of Casing in Bore: 8-in. diam. feet; 6-in. diam. feet; 5-in. diam. feet; 4-in. diam. feet

For Office Use Only: File No. ; App. No. ; Grat. ; Regd. No. ; Index No. ; Card No.

Height of Casings above surface level (each size) Nil

Brand of Casing :

Method of fixing each size of Casing in bore i.e.—Suspended in Clamps : Driven into small hole : Welded

Seated on bottom : Cemented :

Particulars of slots or perforations in Casings stating depth or depths at which placed :

Screen Slotted Length 30' Diam. 8"

Make Material

Water Bearing Beds

Depth struck	20'
Thickness	100'
Depth from surface to which water rose (if any)	Nil
Pumping Supply G.P.H.	25,000
Artesian Flow G.P.D.	
Quality	Good

Total Artesian Flow at completion G.P.D.

Pumping Test on Completion

Standing W.L. from surface.	Depth Pump Inserted	Gallons per hour	Duration of test hours	Draw down W.L. during pumping.
20 feet	85 feet	25,000	Not known	To feet from surface.

State method of raising supply : Submerged 6" Pamona Pump.

Show location of Bore site by sketch on back hereof :

Has Bore Water been tested for Analysis ? Ph5.2 NaCe65 T.H. 30 PO.03 F.D.H.

Total charge including Casing $3,000

Signature

Address

Date 4th August, 1966

FORM "A"

WATER CONSERVATION AND IRRIGATION COMMISSION, N.S.W.

37/1536

PARTICULARS OF COMPLETED BORE

#33

In respect of License issued under Part V of the Water Act, 1912, as amended by subsequent Acts

Name of Licensee ..... Bore License No. 19783

Particulars of Strata.

From feet.	To feet	Thickness.	Strata
0'0	3'0	3'0	Sand & Waterloo rock
3'0	30'0	27'0	Brown Sand
30'0	37'0	7'0	Grey Sand
37'0	45'0	8'0	Yellow Sand
45'0	50'0	5'0	White Sand
50'0	53'0	3'0	Clayey Peaty San
53'0	63'0	10'0	Gray Sand
63'0	64'0	1'0	Clayey Sand
64'0	84'0	20'0	Brown Sand
84'0	117'0	33'0	White Sand
117'0	119'0	2'0	Sand with traces of Clay
119'0	—	—	Clay

For Depth 119'0"

General Particulars.

Date commenced	17.7.67
Date completed	27.7.67
Contractor	ALLAN ROYLE DRILLING
Address	287 KING STREET,
"	MASCOT. N.S.W.
Driller	P. Barrett
Address	As Above
Net Length of Casing in Bore	8-in. diam. 89'0" feet.
	6-in. diam. feet.
	5-in. diam. feet.
	4-in. diam. feet.

For Office Use Only.

File No. ...
App. No. ...
Crat. ...
Regd No. ...
Index No. ...
Card No. ...

Height of Casings above surface level (each size) :

Brand of Casing :

Method of fixing each size of Casing in bore, i.e.—Suspended in Clamps :

Driven into small hole :

Seated on Bottom : Yes Cemented .

Particulars of slots or perforations in Casings stating depth or depths at which placed :

8" Kon. x .020" between 89'0" and 119'0"

Screen Length Diam.

Make Suresscreen Material Stainless Steel

Water Bearing Beds.

Depth struck ...					
Thickness					
Depth from surface to which water rose (ft.)					
Pumping Supply G.P.H.					
Artesian flow G.P.D.					
Quality					

Total Artesian Flow on completion G.P.D.

Pumping Test on Completion

Standing W.L. from surface	Depth Pump lowered.	Gallons per hour.	Duration of test hours.	Draw down W.L. during pumping.
20'0" feet	feet.			To feet from surface.

Force overhead of existing supply

Show location of Bore site by sketch on back hereof :

Has Bore Water been sent for Analysis ?

Total charge including Casing :

Signature

Address

Date.....

... 2330 — F. C. N. Blight, Government Printer

FORM "A"

WATER CONSERVATION AND IRRIGATION COMMISSION, N.S.W.

PARTICULARS OF COMPLETED BORE #34

In respect of License issued under Part V of the Water Act, 1912, as amended by subsequent Acts.

Name of Licensee ...BOWRALLIK PAPER [illegible] LTD. Bore License No. 19784

Particulars of Strata.

From feet.	To feet.	Thickness	Strata
0'0	3'0	3'0	Sand & Gill
3'0	6'0	3'0	Waterlog Rock
6'0	12'0	6'0	White Sand
12'0	18'0	6'0	White sand with Slight Clay
18'0	27'0	9'0	Fresh Sand
27'0	33'0	6'0	Slightly Dusty Slight Water Bearing
33'0	40'0	7'0	Yellow sand with Slight Clay Water Bearing
40'0	52'0	12'0	White Sand Water Bearing
52'0	90'0	38'0	White Sand Highly Water Bearing
90'0	105'0	15'0	Brown Sand Highly Water Bearing
105'0	107'0	2'0	Decomposed Sandstone

Total Depth 107'0

General Particulars.

Date commenced	28.7.47
Date completed	2.3.47
Contractor	Allan Doyle Drilling Co.
Address	207 King St., Newcastle.
Driller	R. Bennett
Address	as above
Nett Length of Casing in Bore	8-in. diam. 77'0" feet; 6-in. diam. feet; 5-in. diam. feet; 4-in. diam. feet

Height of Casings above surface level (each size) :

Brand of Casing :

Method of fixing each size of Casing in bore. i.e.—Suspended in Clamps :

Driven into small hole :

Seated on bottom :

Cemented :

Particulars of slots or perforations in Casings stating depth or depths at which placed :

Screen Sunscreen Length 3'0" Diam. [illegible] in.

Make Sunscreen Material Grain [illegible]

Water Bearing Beds.

Depth struck				
Thickness				
Depth from surface to which water rose (ft.)				
Pumping Supply G.P.H.				
Artesian flow G.P.D.				
Quality				

Total Artesian flow on completion G.P.D.

Pumping Test on Completion

Standing W.L. from surface.	Depth Pump Inserted.	Gallons per hour.	Duration of test hours.	Draw down W.L. during pumping
feet	feet			to feet from surface.

State method of testing supply :

Show location of Bore site by sketch on back hereof :

Has Bore Water been sent for Analysis ?

Total charge including Casing :

Signature

Address.

Date.

[illegible] W.C. & I. Printer, Government Printer

WATER CONSERVATION AND IRRIGATION COMMISSION

#35

PARTICULARS OF COMPLETED BORE

In respect of License issued under Part V of the Water Act, 1912, as amended by subsequent Acts.

Name of Licensee: AUSTRALIAN PAPER MANUFACTURERS LIMITED

Bore License No.

Particulars of Strata.

From feet.	To feet	Thickness	Strata
0'0	5'0	5'0	Sand
5'0	8'0	3'0	Waterloo Rock
8'0	22'0	14'0	Brown Sand
22'0	25'0	3'0	Slightly Peaty Sand
25'0	48'0	23'0	Brown Sand Water Bearing
48'0	56'0	8'0	White Sand Highly Water Bearing
56'0	60'0	4'0	Clay & Sand
60'0	77'0	17'0	Yellow Sand Highly Water Bearing
77'0	108'0	31'0	White Sand Highly Water Bearing
108'0	112'0	4'0	Yellow Sand Water Bearing
112'0	114'0	2'0	Sand & Yellow Clay
114'0	120'0	6'0	Yellow Sand Water Bearing
120'0	124'0	4'0	Yellow Clayey Sand

General Particulars

Date commenced: 29/7/68

Date completed: 5/8/68

Contractor: Allan Royle Drilling Engineering Company,

Address: 287 King Street, MASCOT.

Driller: R. Barrett.

Address: As above.

Net length of Casing in Bore:
8 in. diam. 94'0 I.D. feet.
6-in. diam. feet
5-in. diam. feet
4-in. diam. feet

For Office Use Only.
File No.
Aqu. No.
Grat.
Regd. No.
Index No.
Card No.

Height of Casings above surface level (each size):

Brand of Casing:

Method of fixing each size of Casing in bore: Suspended from Clamp; Driven into small hole; Cemented; Sented on bottom:

Particulars of slots or perforations in Casings stating depth at which placed.
Bore equipped with 30' of gravel packed 10" Nom. x .020" Surescreen stainless steel bore scr
Screen Length Diam.

Make Material

Water Bearing Beds

Depth struck
Thickness
Depth from surface to which water rose (ft.)
Pumping Supply G.P.H.
Artesian flow G.P.H.
Quality

Total Artesian Flow on completion G.P.H.

Pumping Test on Completion

Standing W.L. from surface	Depth Pump inserted	Gallons per hour	Duration of test hours	Drawdown W.L. during pumping.
28'0 feet	feet			feet from surface

State method of testing supply:

Show location of Bore site by sketch on back hereof:

Purpose of Bore (Irrigation, Stock, etc.)

FORM "A."

WATER CONSERVATION AND IRRIGATION COMMISSION, N.S.W.

#36

PARTICULARS OF COMPLETED BORE

In respect of License issued under Part V of the Water Act, 1912, as amended by subsequent Acts. S.A.N.W.

Name of Licensee AUSTRALIAN PAPER MANUFACTURERS LIMITED Bore License No.

Particulars of Strata.

From feet.	To feet.	Thickness.	Strata
0'0	8'0	8'0	Brown Sand
8'0	9'0	1'0	Clay & Sand
9'0	10'6	1'6	Waterloo Rock
10'6	37'0	26'6	Brown Sand
37'0	46'0	9'0	Clayey Sand
46'0	47'0	1'0	Brown Sand Slightly Water Bearing
47'0	50'0	3'0	White Sand Slightly Water Bearing
50'0	65'0	15'0	Brown Sand Slightly Water Bearing
65'0	75'0	10'0	Brown Sand Water Bearing
75'0	95'0	20'0	Brown Sand Water Bearing
95'0			Sandstone

General Particulars.

Date commenced	20/7/68
Date completed	25/7/68
Contractor	Allan Royle Drilling Engineering Company,
Address	287 King Street, MASCOT.
Driller	R. Barrett.
Address	As above.

Nett Length of Casing in Bore: 8-in. diam. I.D. 71'0" feet; 6-in. diam. feet; 5-in. diam. feet; 4-in. diam. feet.

Height of Casings above surface level (each size):

Brand of Casing:

Method of fixing each size of Casing in bore: i.e.—Suspended in Clamps:

Driven into stout hole:

Cemented:

Seated on bottom:

Particulars of slots or perforations in Casings stating depth or depths at which placed: Bore equipped with 24' of gravel packed 10" Non x .020" Surescreen stainless steel bore screen.

Screen: Length: Diam.

Make: Material:

Water Bearing Beds.

Depth struck					
Thickness					
Depth from surface to which water rose (ft.)					
Pumping Supply G.P.H.					
Artesian flow G.P.D.					
Quality					

Total Artesian Flow on completion G.P.D.

Pumping Test on Completion

Standing W.L. from surface.	Depth Pump inserted	Gallons per hour.	Duration of test hours.	Draw down W.L. during pumping.
30' 10" feet	feet			To feet from surface

State method of testing supply:

Show location of Bore site by sketch on back hereof:

Has Bore Water been sent for Analysis?

For Office Use Only

File No.

App. No.

Grat.

Regd. No.

Index No.

Card No.

DEPARTMENT OF NATURAL RESOURCES

FORM A

PARTICULARS OF COMPLETED BORE

(This form MUST be completed and returned to the Department)

BORE NO

Test Bore #36

LICENCE NO 10BL600682

1 NAME OF LICENSEE AMCOR FIBRE PACKAGING

2 **DRILLER**

Licence No	DL1649
Name	MICHAEL BARRETT
Contractor	B & B DRILLING
Rig Type	CABLE TOOL

TEST BORE

3 **DRILLING SUMMARY**

Depth (m) From	Depth (m) To	Hole Diam (mm)	Method	Fluid used Air, Mud etc
0	30	150	PERCUSSION	WATER

4 **MAIN SUMMARY** New Bore ☐ Replacement Bore ☐ Deepening ☐ Enlarging ☐ Reconditioning ☐

Date Completed 13-9-07 Final Depth 30 m Intended Use

Final Salinity* GOOD mg/L or taste Temperature C If abandoned state procedure

*If water analysis available please supply copy of report

5 **PUMPING TESTS ON COMPLETION** If 3-stage and single-rate tests available, enter in this order

Date	Duration (hours)	S.W.L. ↑ (m)	D.W.L. ↑ (m) at end of period	Yield (L/s)	Pump Intake Depth (m)
1 13-9-07	24	10.6	14.10	3.33	22
2					
3					
4					

Testing Equipment Used		
Method	To Measure Water Level	To Measure Discharge
SUBMERSIBLE PUMP	DRAW DOWN GAUGE	WATER METER

Tested by: M BARRETT

* Please supply copy of data ↑ If artesian flow, please supply static and dynamic pressures (kPa) respectively

SWL-Standing Water Level
DDL Drawdown Water Level when pumped
L/s -litres/second

IF NOT DRILLED BY BORING PLANT PLEASE GO TO SECTION 12

6 **AQUIFERS** Depths from natural surface level to nearest 0.1 m

Water Bearing From (m)	Water Bearing To (m)	S.W.L. ↑ (m)	D.D.L. ↑ (m)	Yield (L/s)	Hole Depth at Test (m)	Test Method	Duration (Hrs)	Salinity* mg/L or Taste	Remarks
1 10.6	30	10.6	14.10	3.33	30	SUBMERSIBLE PUMP	24	GOOD	
2									
3									
4									

7 **CASING** Depths from natural surface level to nearest 0.1 m. If above surface level 0 m above surface

Type and Thickness	Outside Diameter (mm)	From (m)	To (m)	Welded Screwed Glued etc	How Fixed: Held in clamp	Seated on bottom	Driven into small hole	Other	Cemented From (m)	Cemented To (m)	Casing Shoe Yes	No
1 MILD STEEL	150	0	28	SCREWED		✓						
2 5mm												
3												

8 **COMPLETION DETAILS**

SUMMARY

Open hole	☐
Open ended casing	☐
Slotted casing	☐
Slotted liner	☐
Screen	☑
Gravel pack	☐

Type of Bottom Cap ☑ Plug ☐

SLOTTED CASING:- oxy cut ☐ sawn ☐ slotted in hole ☐ stamped slot ☐

Material	Outer Diameter (mm)	Slotted From (m)	Slotted To (m)	Length (m)	Slot size Width (mm)	Direction eg Vertical

SCREEN:- wire wound ☑ gauze ☐ plastic ☐ other

Brand / Material	Outer Diameter (mm)	From (m)	To (m)	Aperture (mm)	Method of Fixing eg Packer Screwed etc
1 JOHNSON	125	28	30	0.15	PACKER
2 STAINLESS					
3 STEEL					
4					
5					

APPENDIX B

PUMPING TEST AT TEST BORE #36

TESTING YIELD OF BORES AND WELLS FOR IRRIGATION, TOWN SUPPLY, ETC.

SHEET 2a TEST BORE SINGLE RATE TEST

BORE NO. 35 TEST BORE LICENSE NO..... DEPTH 30 METRES m

OWNER AMCOR ADDRESS.....

DATE OF TEST 13-9-07 REFERENCE POINT .....

HEIGHT OF REFERENCE POINT ABOVE SURFACE 0.35 METRES m

DEPTH TO TOP OF SCREENS OR SLOTS 28 METRES m

METHOD OF MEASURING DISCHARGE WATER METER DEPTH PUMP INTAKE 22 METRES m

Time Hrs. Mins.	Time Since Test Commenced Hrs.	or Mins.	Depth to Water From Reference Point m	Pumping Rate l/s	Remarks
*	0	0	10.99 METRES	3.33 LITRES PER SECOND	Standing Water Level
		5	14.02		
		10	14.04		
		15	14.07		
		20	14.07		
		25	14.07		
		30	14.07		
		45	14.07		
	1	60	14.07		
		90	14.07		
	2	120	14.04		
		150	14.00		
	3	180	14.00		
		210	14.00		
	4	240	14.01		
		270	14.00		
	5	300	14.00		
		330	14.02		
	6	360	14.01		
	7	420	14.09		
	8	480	14.10		
	9	540	14.12		
	10	600	14.12		
	11	660	14.05		
	12	700	14.04		
	14	840	14.05		
	16	960	14.09		
	18	1080	14.06		
	20	1200	14.07		
	24	1440	14.10		

* Water level must be read immediately before the start of test

0·9 METRES FROM TEST BORE 35

TESTING YIELD OF BORES AND WELLS FOR IRRIGATION, TOWN SUPPLY, ETC.

SHEET 2a MONITORING WELL

SINGLE RATE TEST

BORE NO. 35 LICENSE NO. ..... DEPTH 30 METRES m

OWNER AMCOR ADDRESS .....

DATE OF TEST 13·9·97 REFERENCE POINT .....

HEIGHT OF REFERENCE POINT ABOVE SURFACE METRES 0·20 BELOW REFERENCE POINT m

DEPTH TO TOP OF SCREENS OR SLOTS 29 METRES m

METHOD OF MEASURING DISCHARGE WATER METER DEPTH PUMP INTAKE ..... m

Time Hrs. Mins.	Time Since Test Commenced Hrs.	or Mins.	Depth to Water From Reference Point m	Pumping Rate l/s	Remarks
*	0	0	9·94 METRES	-	Standing Water Level
		5	10·74		
		10	10·77		
		15	10·78		
		20	10·78		
		25	10·78		
		30	10·78		
		45	10·78		
	1	60	10·75		
		90	10·75		
	2	120	10·75		
		150	10·76		
	3	180	10·76		
		210	10·76		
	4	240	10·76		
		270	10·76		
	5	300	10·76		
		330	10·76		
	6	360	10·76		
	7	420	10·76		
	8	480	10·76		
	9	540	10·77		
	10	600	10·76		
	11	660	10·76		
	12	720	10·76		
	14	840	10·75		
	16	960	10·72		
	18	1080	10·72		
	20	1200	10·72		
	24	1440	10·72		
*			Water level must be read immediately before the start of test		

APPENDIX C

GROUNDWATER MODELLING SCENARIOS

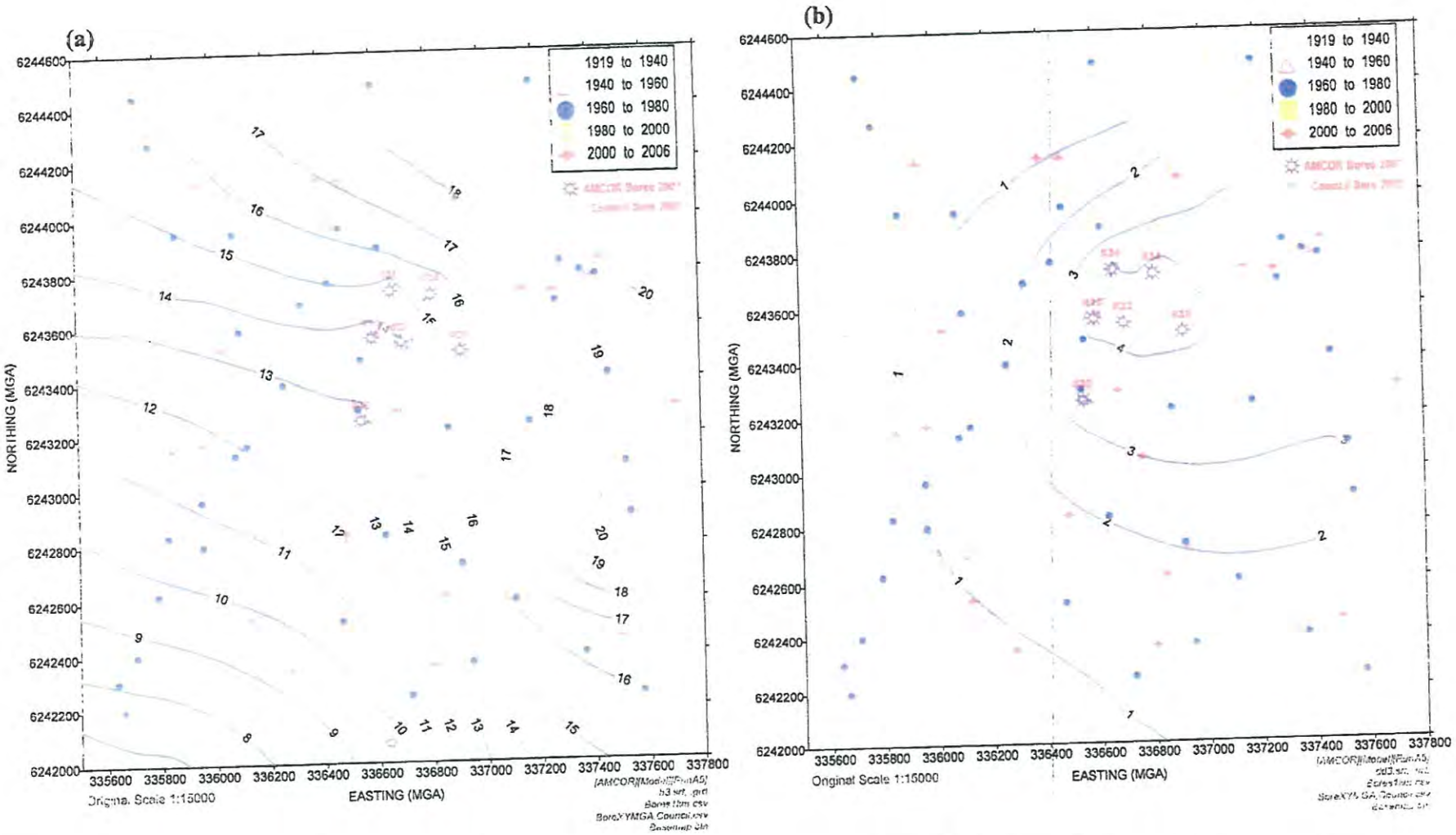

Figure C1. Scenario B for 3 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

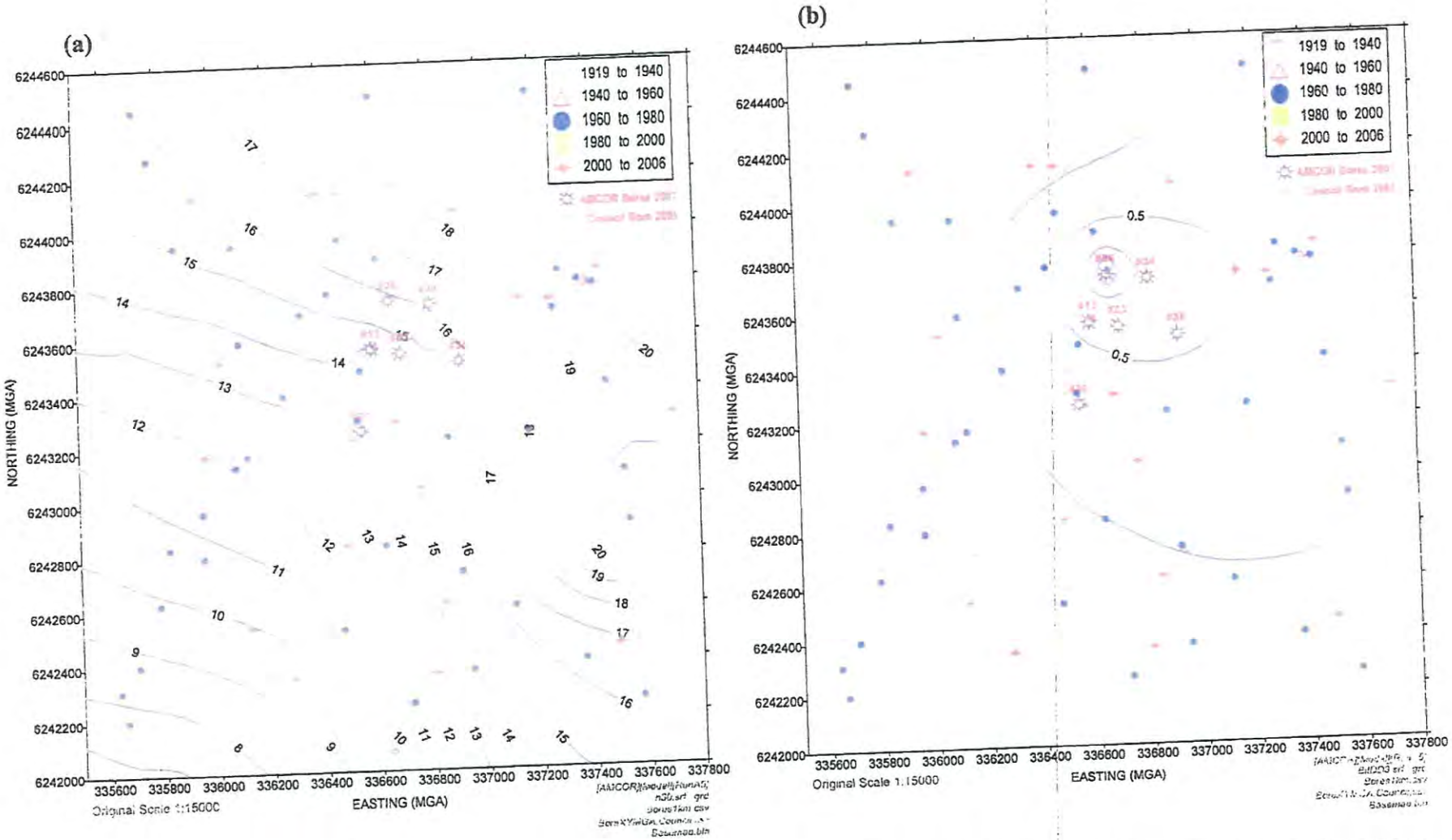

Figure C2. Scenario B for 3 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

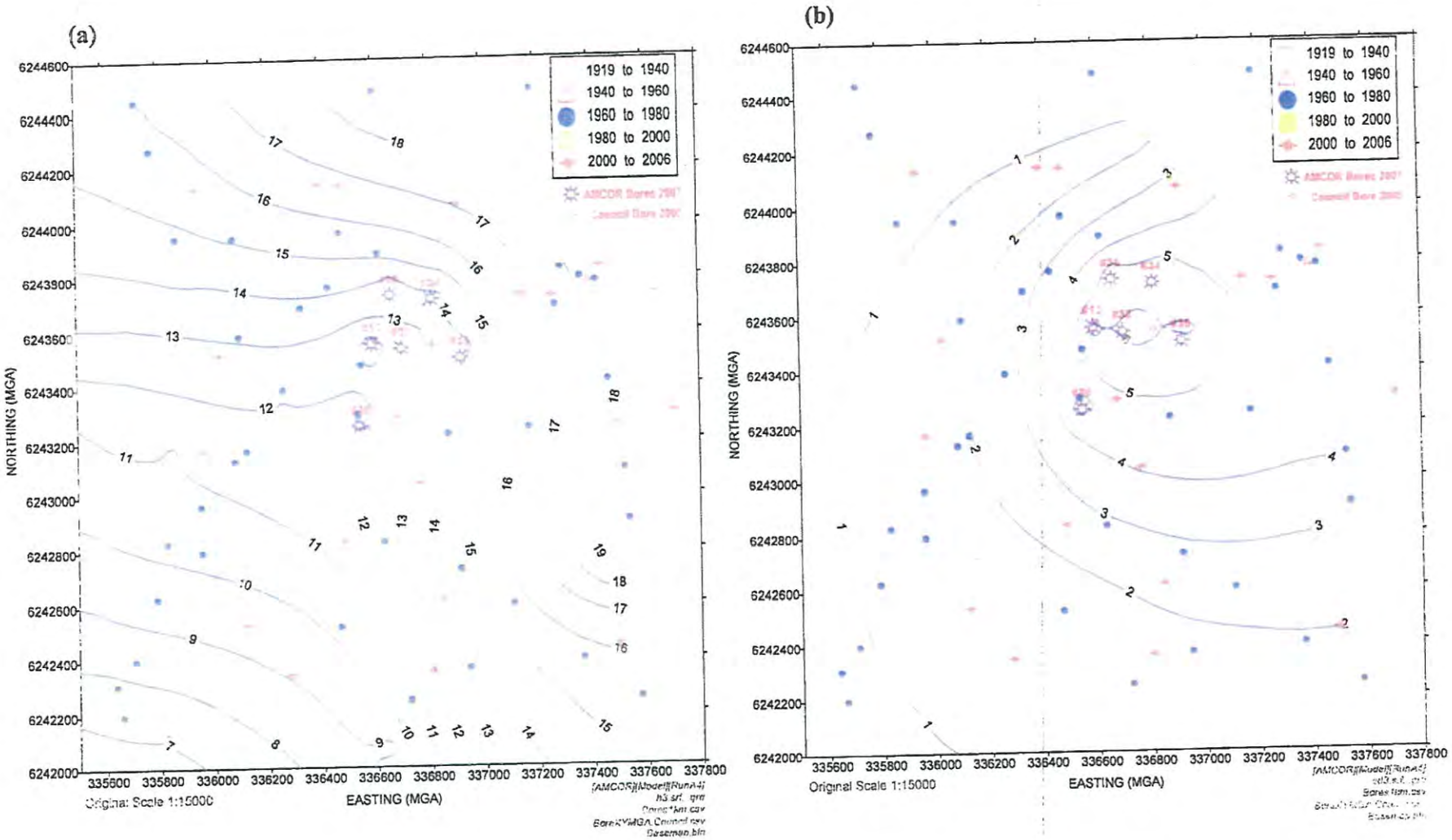

Figure C3. Scenario C for 4 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

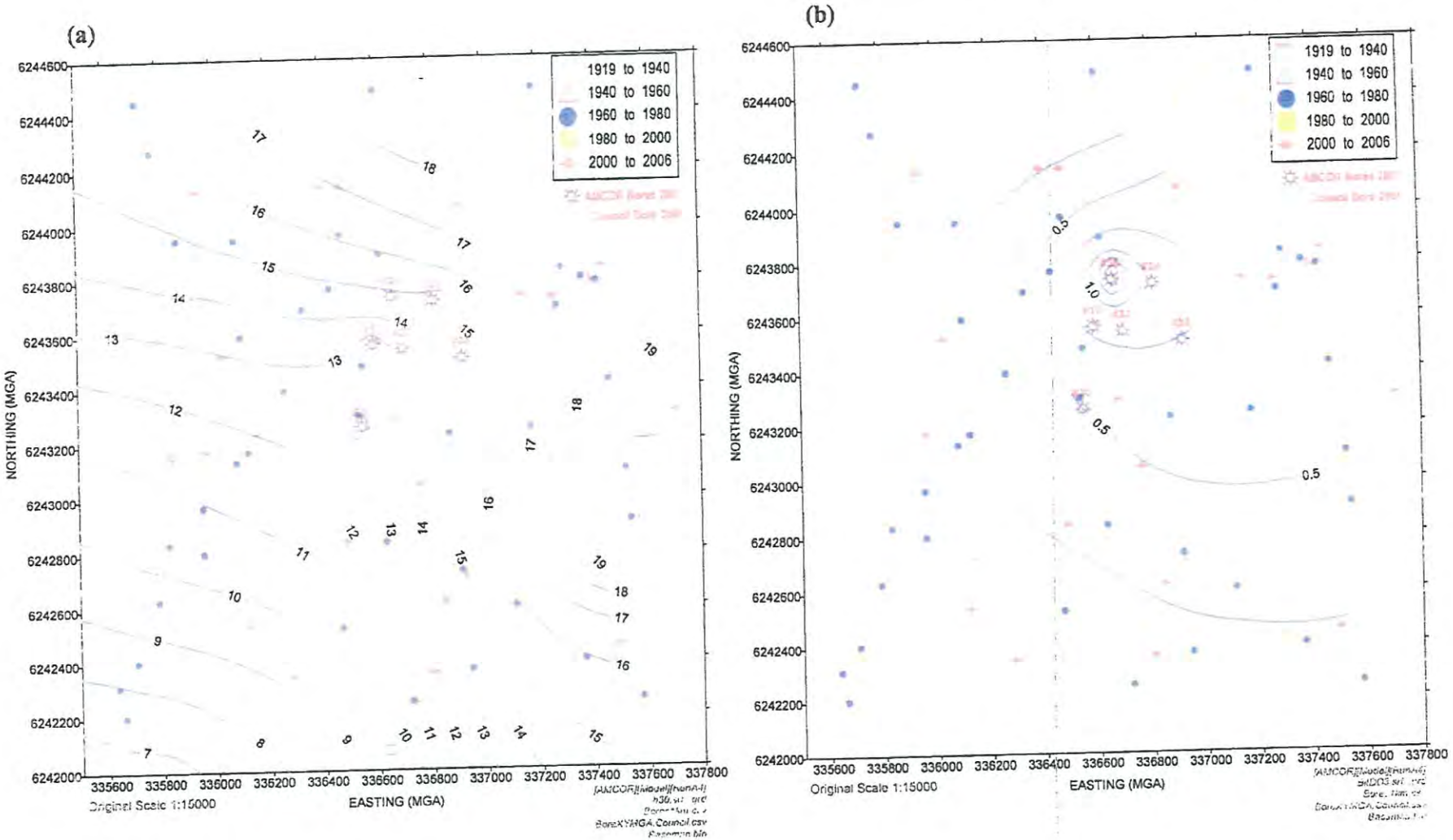

Figure C4. Scenario C for 4 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

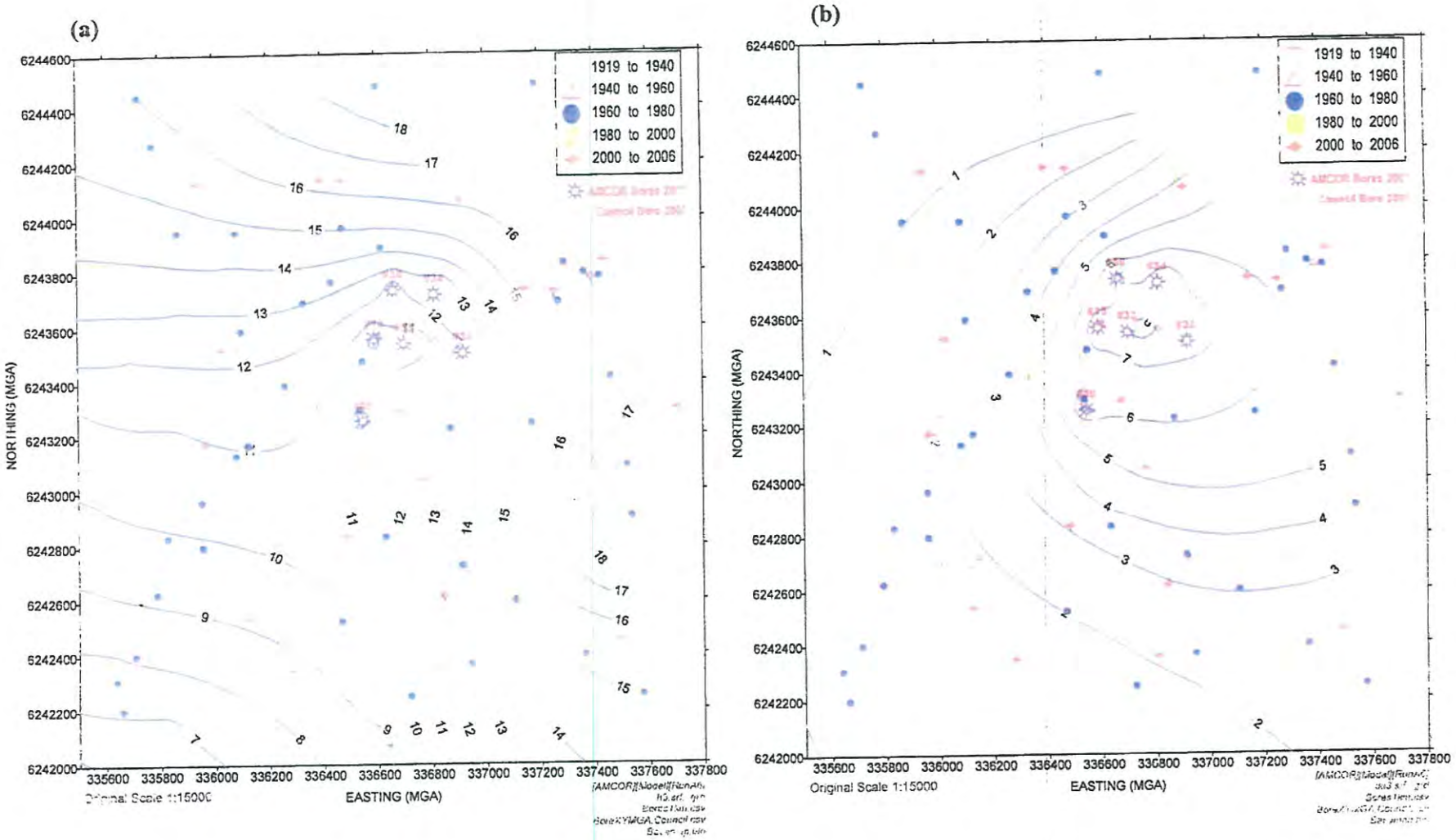

Figure C5. Scenario D for 5 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

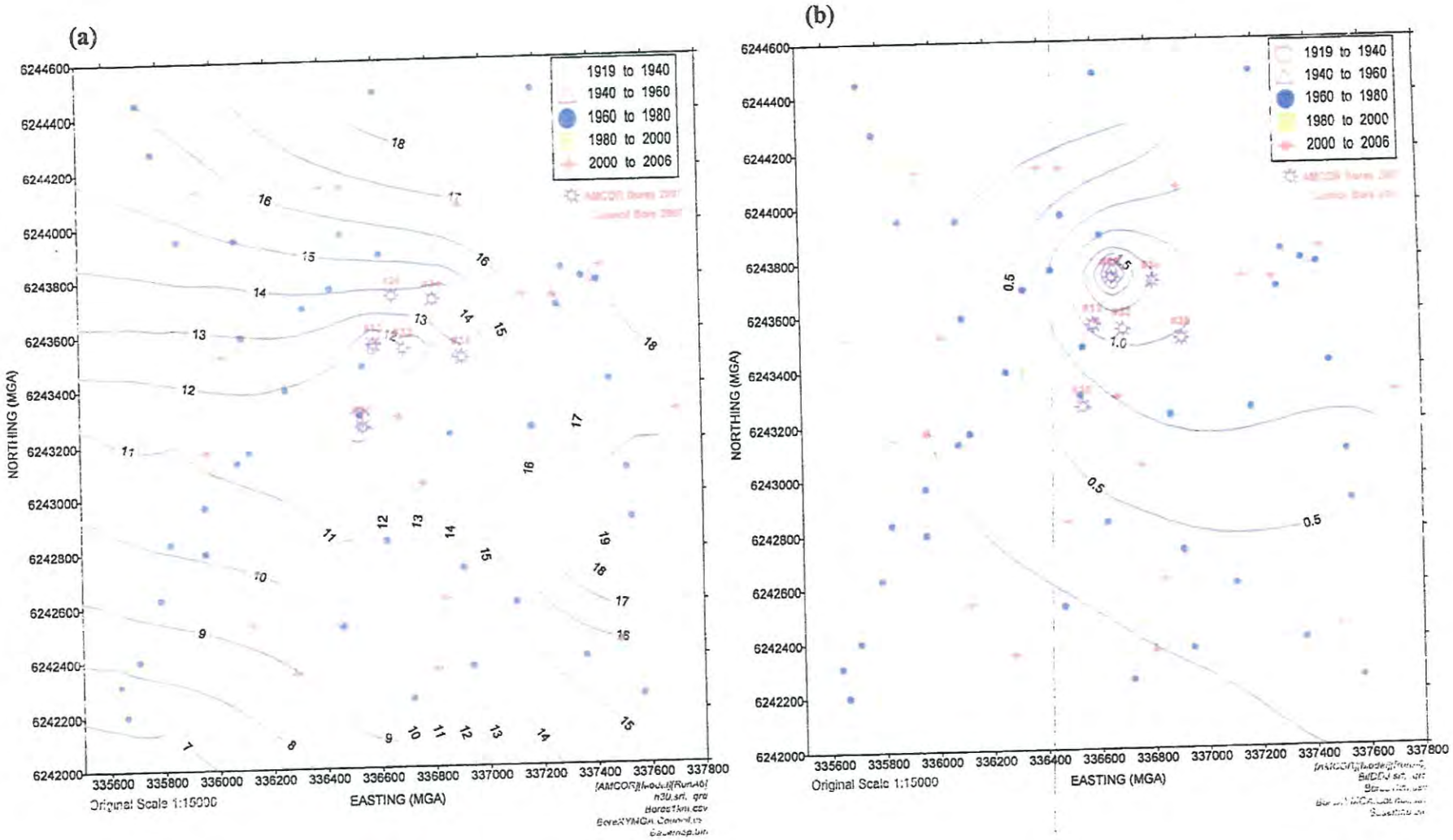

Figure C6. Scenario D for 5 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

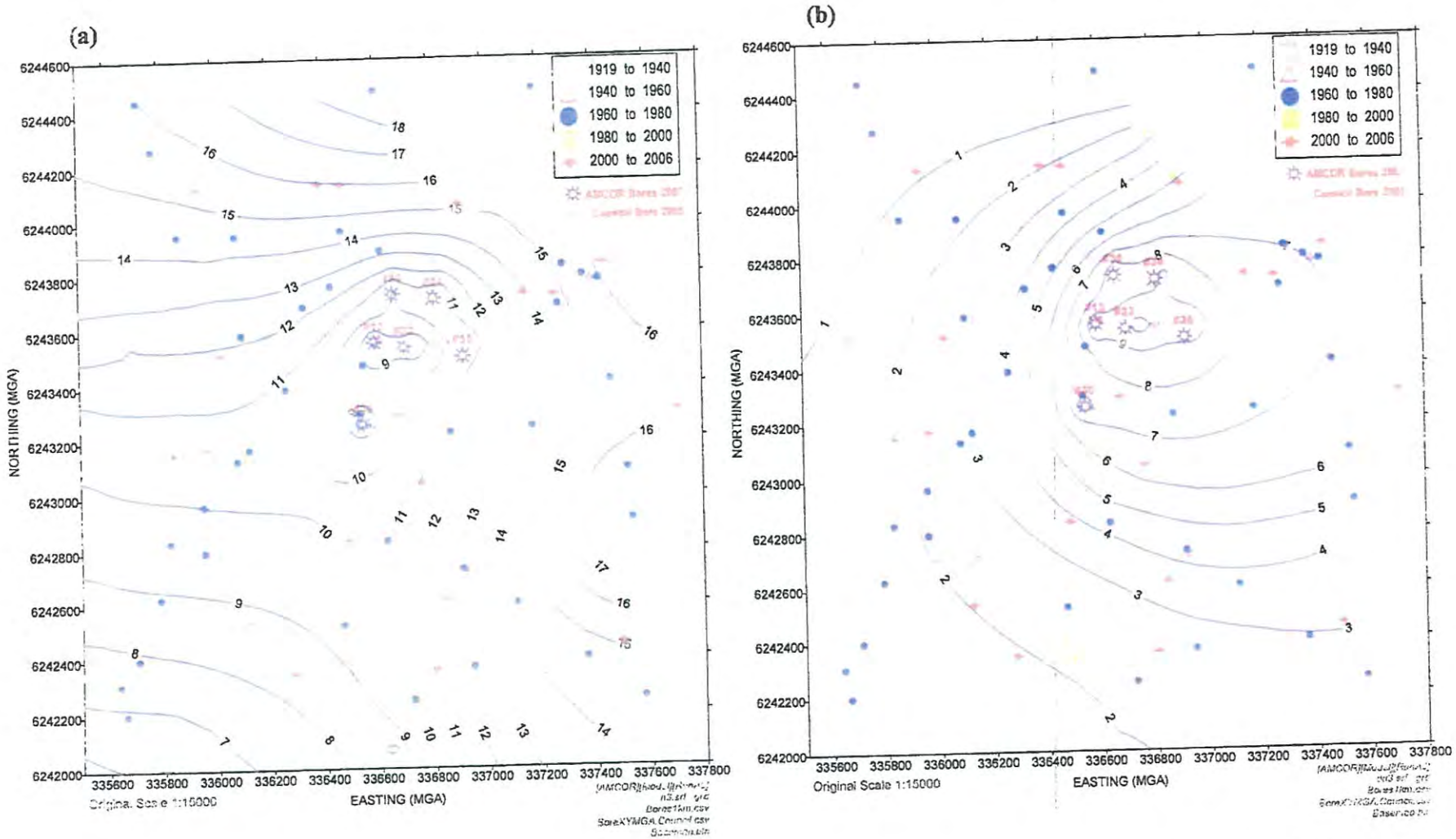

Figure C7. Scenario E for 6 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

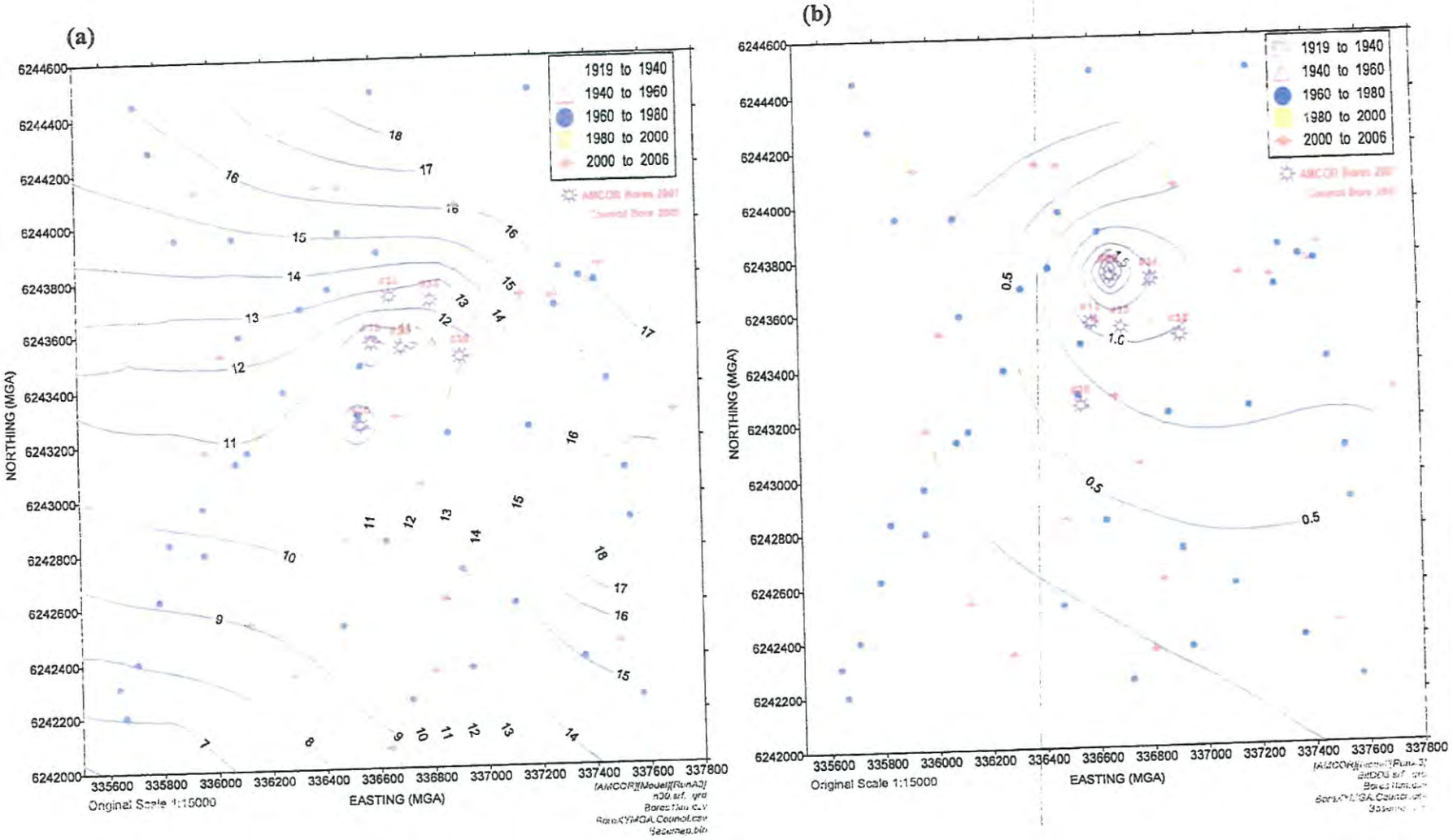

Figure C8. Scenario E for 6 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

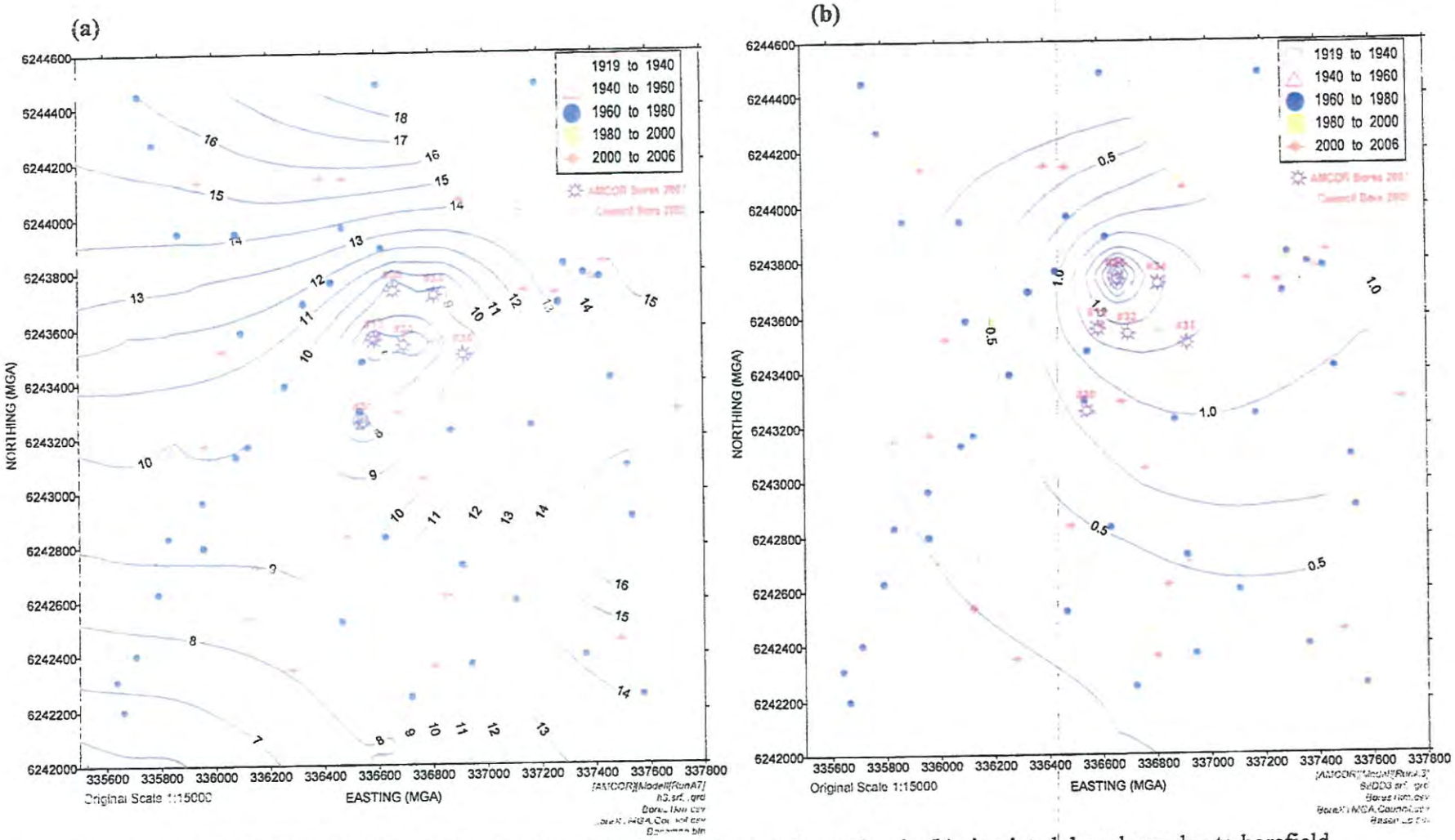

Figure C9. Scenario F for 7 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

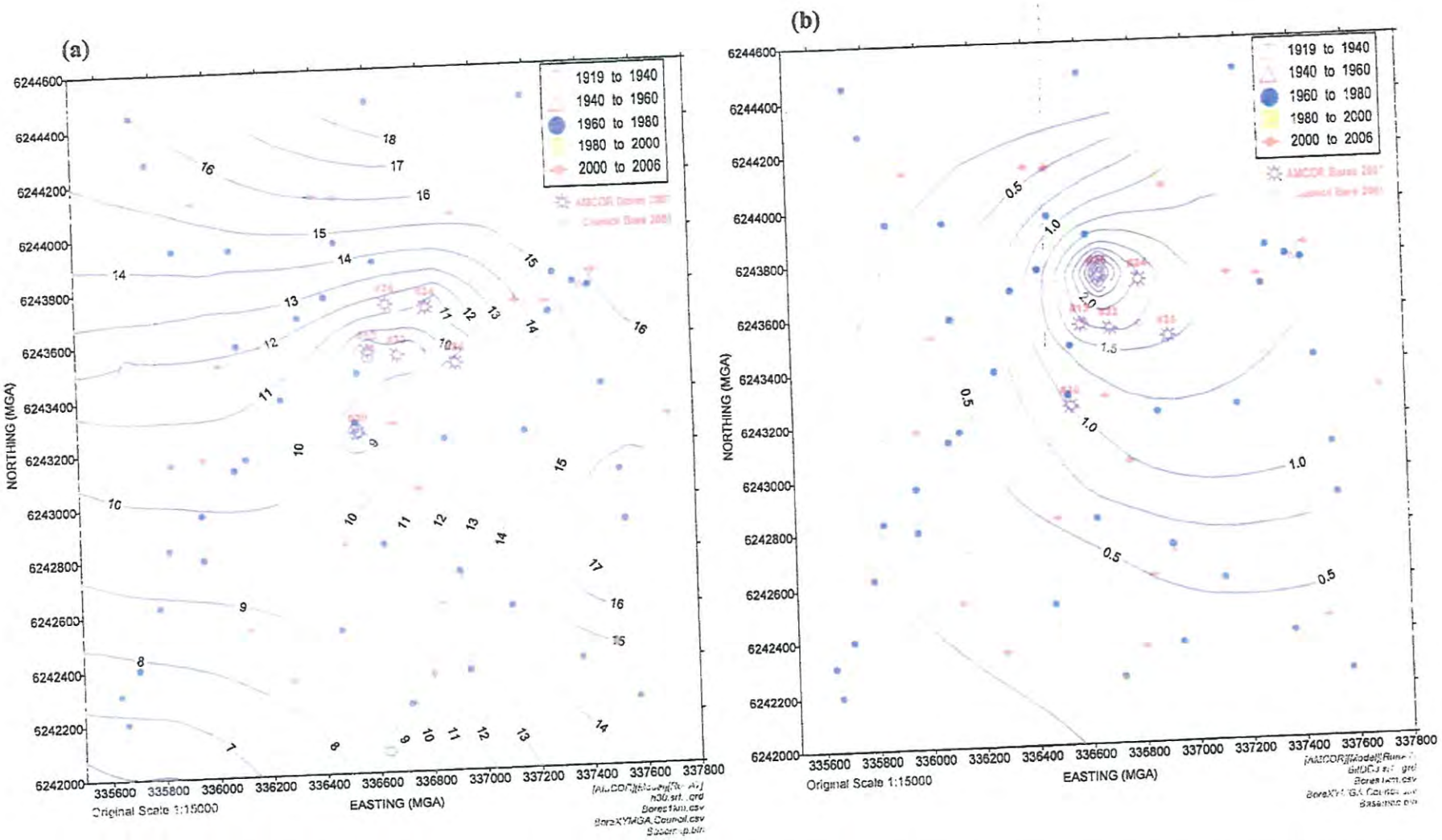

Figure C10. Scenario F for 7 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

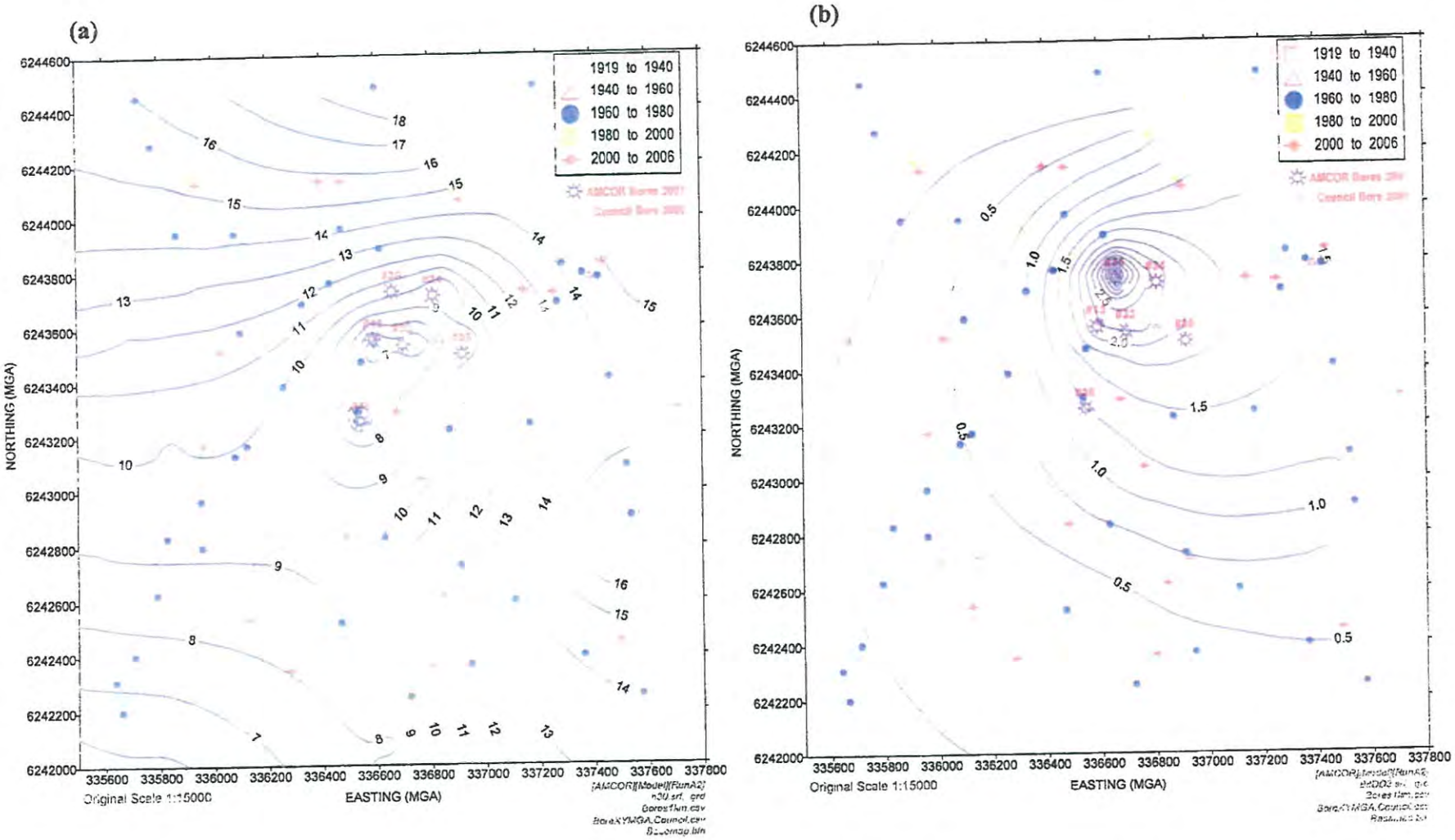

Figure C12. Scenario G for 8 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

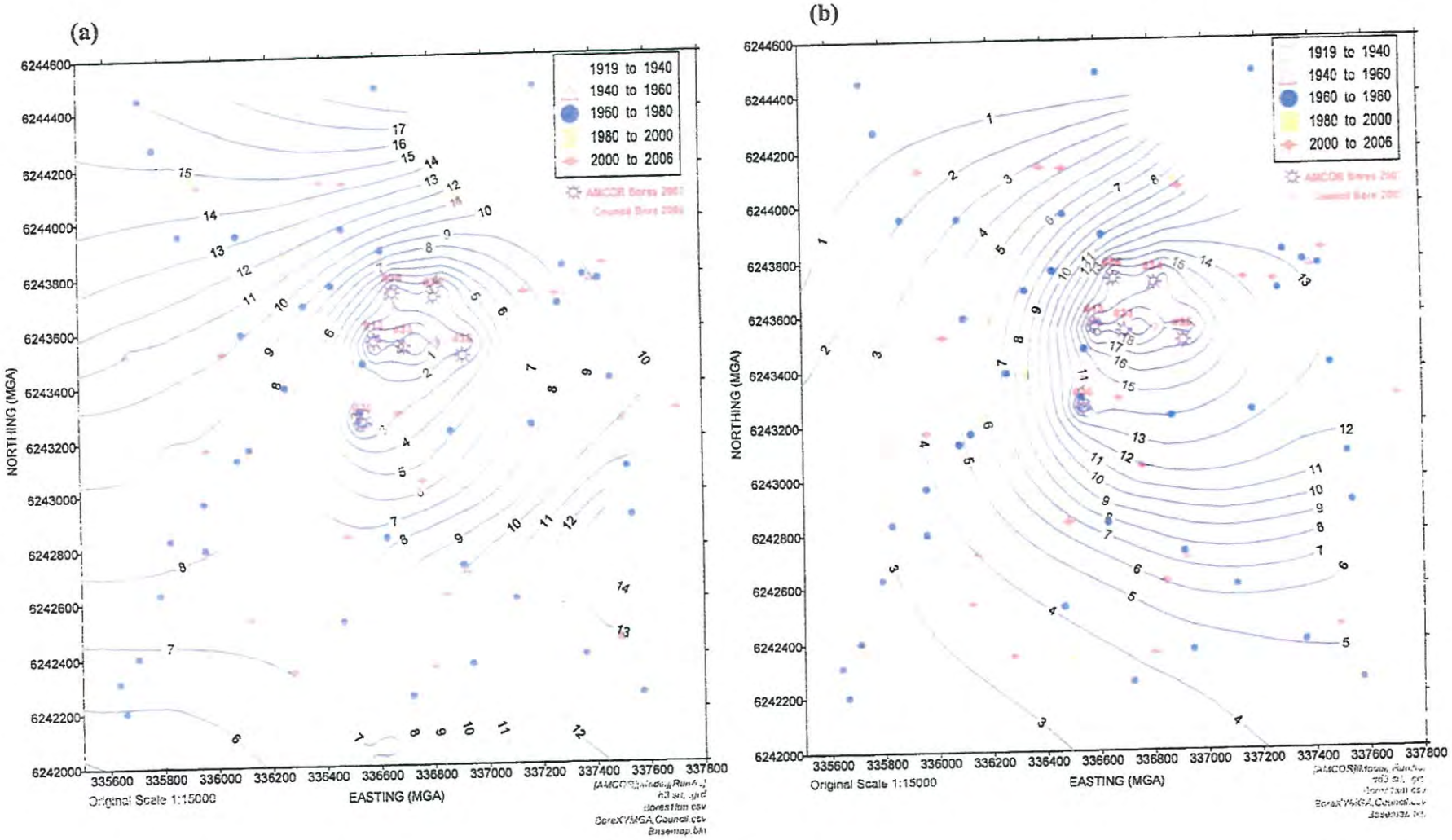

Figure C13. Scenario H for 10 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

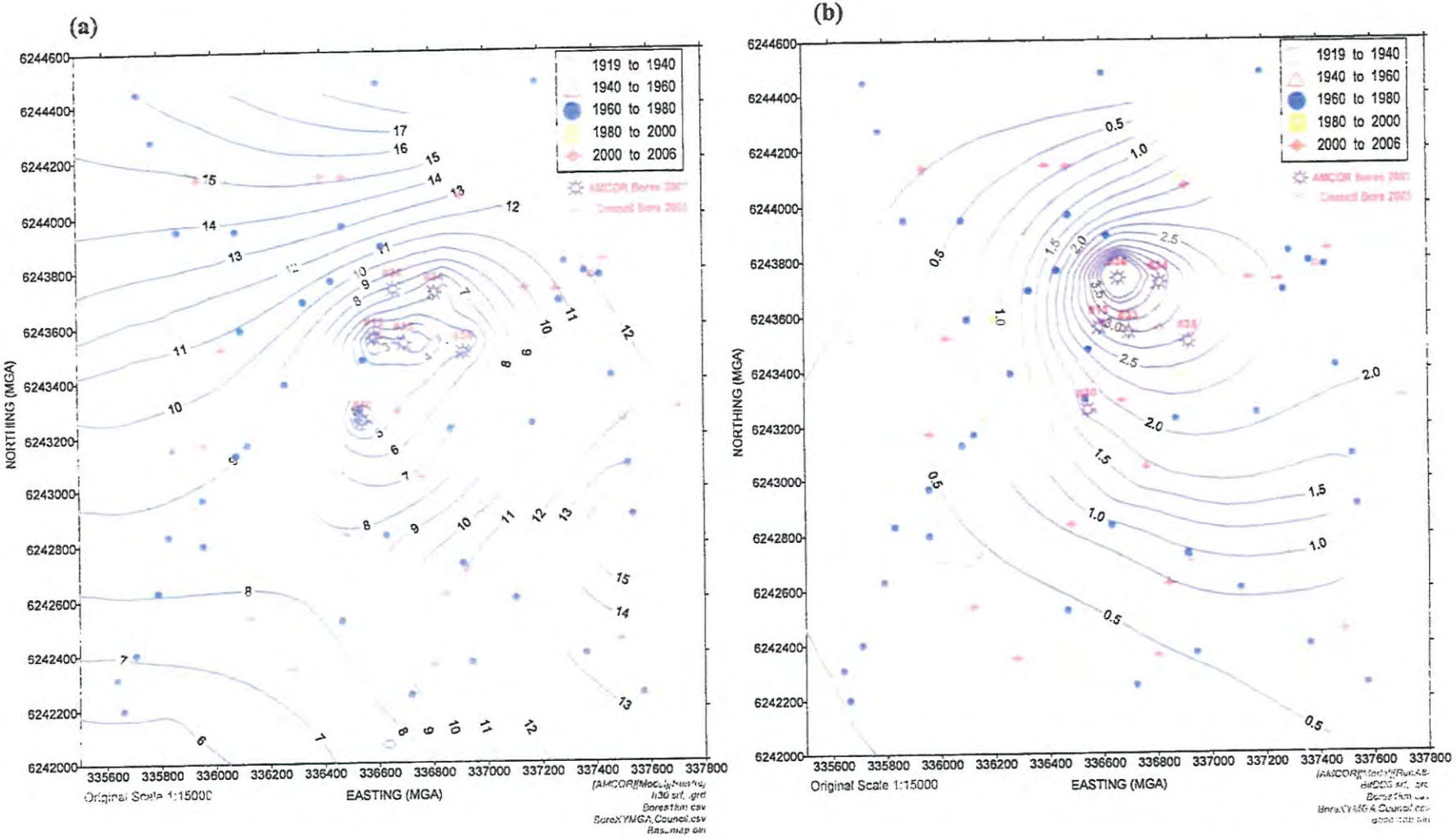

Figure C14. Scenario H for 10 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

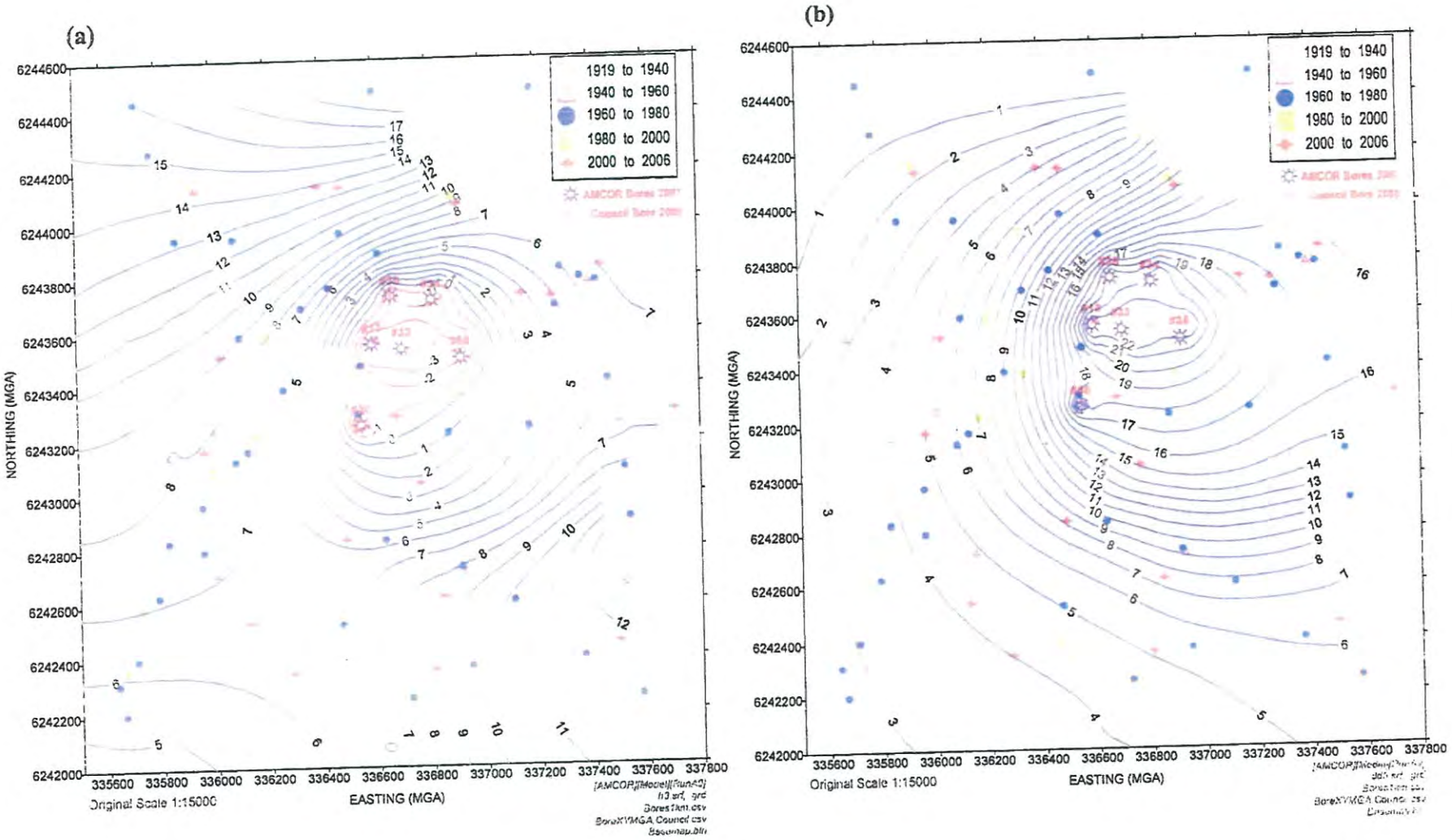

Figure C15. Scenario I for 12 ML/day borefield extraction: (a) Simulated groundwater level; (b) simulated drawdown due to borefield

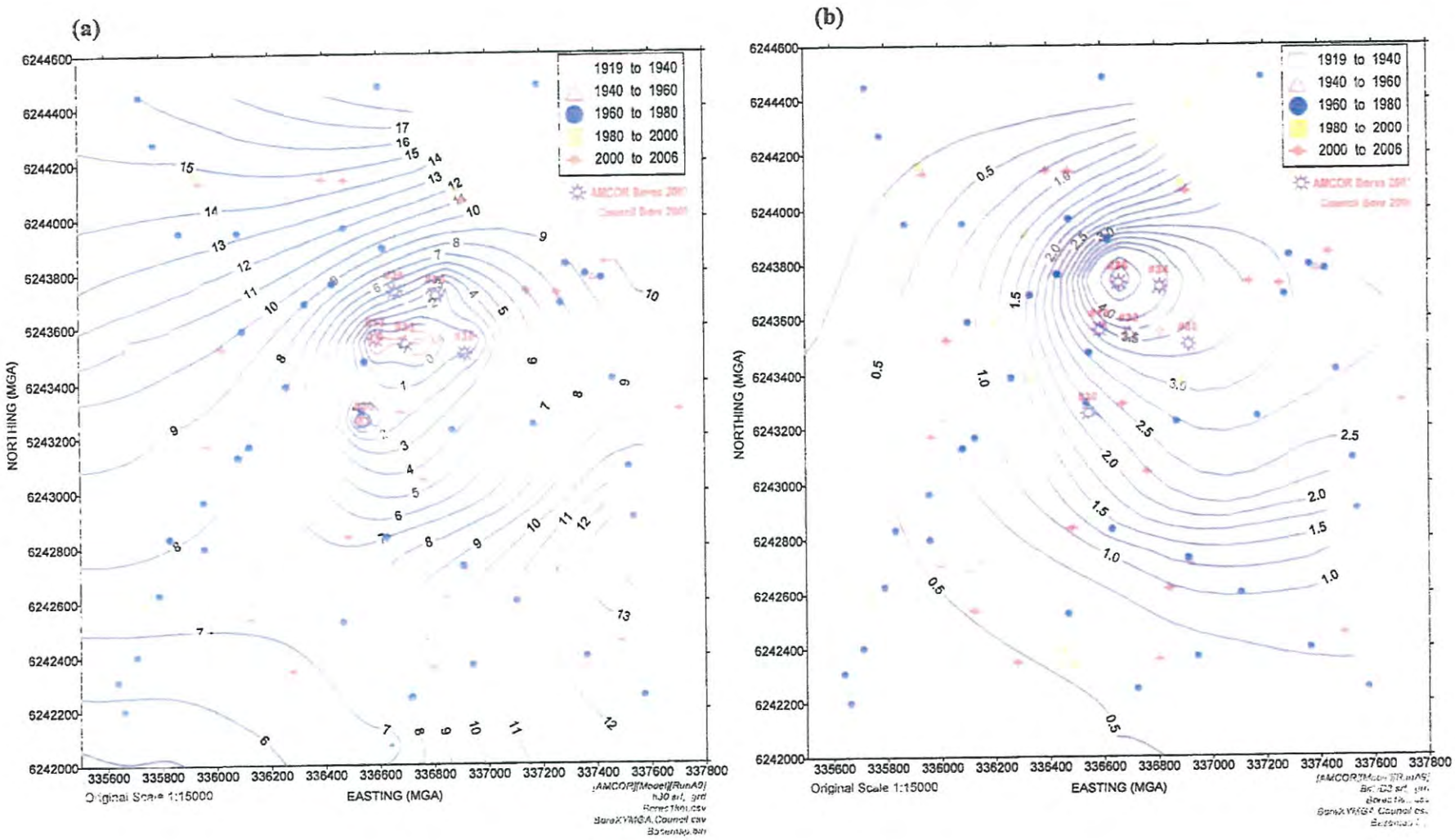

Figure C16. Scenario I for 12 ML/day borefield extraction: (a) Simulated groundwater level with #36 inactive; (b) simulated marginal drawdown due to #36 alone

APPENDIX D

CHEMICAL ANALYSIS

Envirolab Services Pty Ltd
ABN 37 112 535 645
54 Frenchs Rd Willoughby NSW 2068
ph 02 9958 5801 fax 02 9958 5803
email: tnotaras@enviroiabservices.com.au

CERTIFICATE OF ANALYSIS 9488

Client:
AMCOR Fibre Packaging
PO Box 95
Matraville
NSW 2036

Attention: Peter Nystrom

Sample log in details:

Your Reference:	**Bore Water Analysis**
No. of samples:	5 Waters
Date samples received:	09/02/07
Date completed instructions received:	09/02/07

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	20/02/07
Date of Preliminary Report:	Not Issued
Issue Date:	20/02/07

NATA accreditation number 2901. This document shall not be reproduced except in full.
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
Tests not covered by NATA are denoted with *.

Results Approved By:

Jacinta Hurst
Operations Manager

Client Reference: **Bore Water Analysis**

VHC's in water Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	–	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	–	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Dichlorodifluoromethane	µg/L	<10	<10	<10	<10	<10
Chloromethane	µg/L	<10	<10	<10	<10	<10
Vinyl Chloride	µg/L	<10	<10	<10	<10	<10
Bromomethane	µg/L	<10	<10	<10	<10	<10
Chloroethane	µg/L	<10	<10	<10	<10	<10
Trichlorofluoromethane	µg/L	<10	<10	<10	<10	<10
1,1-Dichloroethene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Trans-1,2-dichloroethene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-dichloroethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Cis-1,2-dichloroethene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Bromochloromethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroform	µg/L	<1.0	<1.0	1.2	<1.0	<1.0
2,2-dichloropropane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-dichloroethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-trichloroethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-dichloropropene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon tetrachloride	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromomethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-dichloropropane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Bromodichloromethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,3-dichloropropene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,3-dichloropropene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2-trichloroethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,3-dichloropropane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromochloromethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-dibromoethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	µg/L	8.4	<1.0	4.3	<1.0	<1.0
1,1,1,2-tetrachloroethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chlorobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Bromoform	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2,2-tetrachloroethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,3-trichloropropane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Bromobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2-chlorotoluene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
4-chlorotoluene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,3-dichlorobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-dichlorobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-dichlorobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0

Client Reference: Bore Water Analysis

VHC's in water Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
1,2-dibromo-3-chloropropane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,4-trichlorobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Hexachlorobutadiene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,3-trichlorobenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Surrogate Dibromofluoromethane	%	91	90	89	94	93
Surrogate toluene-d8	%	84	84	83	86	82
Surrogate 1-bromo-4-fluorotoluene	%	65	71	66	66	66

Client Reference: Bore Water Analysis

vTPH & BTEX in Water Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
TPH C_6 - C_9	µg/L	<10	<10	<10	<10	<10
Benzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
m+p-xylene	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
o-xylene	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Surrogate Dibromofluoromethane	%	91	90	89	94	93
Surrogate toluene-d8	%	84	84	83	86	82
Surrogate 1-bromo-4-fluorotoluene	%	65	71	66	66	66

Client Reference: Bore Water Analysis

sTPH in Water (C10-C36) Our Reference: Your Reference Type of sample	UNITS ——— ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	--	13/02/2007	13/02/2007	13/02/2007	13/02/2007	13/02/2007
TPH C_{10} - C_{14}	µg/L	<50	<50	<50	<50	<50
TPH C_{15} - C_{28}	µg/L	<100	<100	<100	<100	<100
TPH C_{29} - C_{36}	µg/L	<100	<100	<100	<100	<100
Surrogate o-Terphenyl	%	102	103	102	96	79

Client Reference: Bore Water Analysis

PAHs in Water Our Reference: Your Reference Type of sample	UNITS ——— ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Naphthalene	µg/L	<1	<1	<1	<1	<1
Acenaphthylene	µg/L	<1	<1	<1	<1	<1
Acenaphthene	µg/L	<1	<1	<1	<1	<1
Fluorene	µg/L	<1	<1	<1	<1	<1
Phenanthrene	µg/L	<1	<1	<1	<1	<1
Anthracene	µg/L	<1	<1	<1	<1	<1
Fluoranthene	µg/L	<1	<1	<1	<1	<1
Pyrene	µg/L	<1	<1	<1	<1	<1
Benzo(a)anthracene	µg/L	<1	<1	<1	<1	<1
Chrysene	µg/L	<1	<1	<1	<1	<1
Benzo(b,k)fluoranthene	µg/L	<2	<2	<2	<2	<2
Benzo(a)pyrene	µg/L	<1	<1	<1	<1	<1
Indeno(1,2,3-c,d)pyrene	µg/L	<1	<1	<1	<1	<1
Dibenzo(a,h)anthracene	µg/L	<1	<1	<1	<1	<1
Benzo(g,h,i)perylene	µg/L	<1	<1	<1	<1	<1
Surrogate p-Terphenyl-d_{14}	%	104	100	104	100	80

Client Reference: Bore Water Analysis

Organochlorine Pesticides in water Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	--	13/02/2007	13/02/2007	13/02/2007	13/02/2007	13/02/2007
HCB	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
alpha-BHC	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
gamma-BHC	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
beta-BHC	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Heptachlor	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
delta-BHC	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Aldrin	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Heptachlor Epoxide	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
gamma-Chlordane	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
alpha-Chlordane	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan I	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
pp-DDE	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Dieldrin	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
pp-DDD	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan II	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
DDT	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin Aldehyde	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan Sulphate	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Methoxychlor	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Surrogate TCLMX	%	102	74	98	138	118

Client Reference: Bore Water Analysis

PCBs in Water Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	--	13/02/2007	13/02/2007	13/02/2007	13/02/2007	13/02/2007
Arochlor 1016	µg/L	<2	<2	<2	<2	<2
Arochlor 1232	µg/L	<2	<2	<2	<2	<2
Arochlor 1242	µg/L	<2	<2	<2	<2	<2
Arochlor 1248	µg/L	<2	<2	<2	<2	<2
Arochlor 1254	µg/L	<2	<2	<2	<2	<2
Arochlor 1260	µg/L	<2	<2	<2	<2	<2
Surrogate TCLMX	%	102	74	98	138	115

Client Reference: Bore Water Analysis

SVOC's in water Our Reference: Your Reference Type of sample	UNITS	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Date extracted	--	12/02/2007	12/02/2007	12/02/2007	12/02/2007	12/02/2007
Date analysed	--	13/02/2007	13/02/2007	13/02/2007	13/02/2007	13/02/2007
Phenol	µg/L	<10	<10	<10	<10	<10
Bis (2-chloroethyl) ether	µg/L	<10	<10	<10	<10	<10
2-Chlorophenol	µg/L	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	µg/L	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	µg/L	<10	<10	<10	<10	<10
2-Methylphenol	µg/L	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	µg/L	<10	<10	<10	<10	<10
bis-(2-Chloroisopropyl) ether	µg/L	<10	<10	<10	<10	<10
3/4-Methylphenol	µg/L	<20	<20	<20	<20	<20
N-nitrosodi-n-propylamine	µg/L	<10	<10	<10	<10	<10
Hexachloroethane	µg/L	<10	<10	<10	<10	<10
Nitrobenzene	µg/L	<10	<10	<10	<10	<10
isophorone	µg/L	<10	<10	<10	<10	<10
2,4-Dimethylphenol	µg/L	<10	<10	<10	<10	<10
2-Nitrophenol	µg/L	<10	<10	<10	<10	<10
bis (2-Chloroethoxy) methane	µg/L	<10	<10	<10	<10	<10
2,4-Dichlorophenol	µg/L	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	µg/L	<10	<10	<10	<10	<10
Naphthalene	µg/L	<10	<10	<10	<10	<10
4-Chloroaniline	µg/L	<10	<10	<10	<10	<10
Hexachlorobutadiene	µg/L	<10	<10	<10	<10	<10
2-Methylnaphthalene	µg/L	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	µg/L	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	µg/L	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol	µg/L	<10	<10	<10	<10	<10
2-Chloronaphthalene	µg/L	<10	<10	<10	<10	<10
2-Nitroaniline	µg/L	<10	<10	<10	<10	<10
Dimethyl phthalate	µg/L	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	µg/L	<10	<10	<10	<10	<10
Acenaphthylene	µg/L	<10	<10	<10	<10	<10
3-Nitroaniline	µg/L	<10	<10	<10	<10	<10
Acenaphthene	µg/L	<10	<10	<10	<10	<10
2,4-Dinitrophenol	µg/L	<100	<100	<100	<100	<100
4-Nitrophenol	µg/L	<100	<100	<100	<100	<100
Dibenzofuran	µg/L	<10	<10	<10	<10	<10
Diethylphthalate	µg/L	<10	<10	<10	<10	<10
4-Chlorophenylphenylether	µg/L	<10	<10	<10	<10	<10
4-Nitroaniline	µg/L	<10	<10	<10	<10	<10
Fluorene	µg/L	<10	<10	<10	<10	<10

Client Reference: Bore Water Analysis

SVOC's in water Our Reference: Your Reference Type of sample	UNITS	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
2-methyl-4,6-dinitrophenol	µg/L	<100	<100	<100	<100	<100
Azobenzene	µg/L	<10	<10	<10	<10	<10
4-Bromophenylphenylether	µg/L	<10	<10	<10	<10	<10
Hexachlorobenzene	µg/L	<10	<10	<10	<10	<10
Pentachlorophenol	µg/L	<100	<100	<100	<100	<100
Phenanthrene	µg/L	<10	<10	<10	<10	<10
Anthracene	µg/L	<10	<10	<10	<10	<10
Carbazole	µg/L	<10	<10	<10	<10	<10
Di-n-butylphthalate	µg/L	<10	<10	<10	<10	<10
Fluoranthene	µg/L	<10	<10	<10	<10	<10
Pyrene	µg/L	<10	<10	<10	<10	<10
Butylbenzylphthalate	µg/L	<10	<10	<10	<10	<10
Bi(2-ethylhexyl) phthalate	µg/L	<10	<10	<10	<10	<10
Benzo(a)anthracene	µg/L	<10	<10	<10	<10	<10
Chrysene	µg/L	<10	<10	<10	<10	<10
Di-n-octylphthalate	µg/L	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	µg/L	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	µg/L	<10	<10	<10	<10	<10
Benzo(a)pyrene	µg/L	<10	<10	<10	<10	<10
Indeno(1,2,3-c,d)pyrene	µg/L	<10	<10	<10	<10	<10
Dibenzo(a,h)anthracene	µg/L	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene	µg/L	<10	<10	<10	<10	<10
Ethylmethanesulfonate	µg/L	<10	<10	<10	<10	<10
Aniline	µg/L	<10	<10	<10	<10	<10
Pentachloroethane	µg/L	<10	<10	<10	<10	<10
Benzyl alcohol	µg/L	<10	<10	<10	<10	<10
Acetophenone	µg/L	<10	<10	<10	<10	<10
N-nitrosomorpholine	µg/L	<10	<10	<10	<10	<10
3-methylphenol	µg/L	<10	<10	<10	<10	<10
N-nitrosopiperidine	µg/L	<10	<10	<10	<10	<10
2,6-Dichlorophenol	µg/L	<10	<10	<10	<10	<10
Hexachloropropene-1	µg/L	<10	<10	<10	<10	<10
N-nitroso-n-butylamine	µg/L	<10	<10	<10	<10	<10
Safrole	µg/L	<10	<10	<10	<10	<10
1,2,4,5-Tetrachlorobenzene	µg/L	<10	<10	<10	<10	<10
Trans-iso-safrole	µg/L	<10	<10	<10	<10	<10
1,3-Dinitrobenzene	µg/L	<10	<10	<10	<10	<10
Pentachlorobenzene	µg/L	<10	<10	<10	<10	<10
1-Naphthylamine	µg/L	<10	<10	<10	<10	<10
2,3,4,6-Tetrachlorophenol	µg/L	<10	<10	<10	<10	<10
2-Naphthylamine	µg/L	<10	<10	<10	<10	<10
5-Nitro-o-toluidine	µg/L	<10	<10	<10	<10	<10

Client Reference: Bore Water Analysis

Metals in water - low level Our Reference: Your Reference Type of sample	UNITS --- ---	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Aluminium-filtered	µg/L	180	19	180	140	25
Antimony-filtered	µg/L	<1	<1	<1	<1	<1
Arsenic-filtered	µg/L	<1	2.4	<1	<1	<1
Barium-filtered	µg/L	36	37	17	37	22
Boron-filtered	µg/L	30	31	13	5.5	65
Cadmium-filtered	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-filtered	µg/L	<1	<1	<1	<1	<1
Copper-filtered	µg/L	<1	<1	2.5	2.3	1.8
Iron-filtered	µg/L	16	4,300	58	11	30
Lead-filtered	µg/L	<1	2.0	4.6	1	<1
Lithium-filtered	µg/L	<1	<1	<1	<1	<1
Manganese-filtered	µg/L	7.4	18	11	6.6	6.0
Mercury-filtered	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel-filtered	µg/L	<1	<1	<1	<1	<1
Selenium-filtered	µg/L	<1	<1	<1	<1	<1
Silver-filtered	µg/L	<1	<1	<1	<1	<1
Zinc-filtered	µg/L	7.6	85	51	55	25

Client Reference: Bore Water Analysis

Ion Balance Our Reference: Your Reference Type of sample	UNITS --- ---	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Calcium	mg/L	13	3.7	17	12	8.2
Potassium	mg/L	2.8	4.0	2.8	2.9	1.7
Magnesium	mg/L	3.2	2.9	3.0	3.0	1.3
Sodium	mg/L	17	15	22	17	31
Carbonate Alkalinity as $CaCO_3$	mg/L	0.0	0.0	0.0	0.0	0.0
Bicarbonate Alkalinity as $CaCO_3$	mg/L	2	25	23	1	8
Sulphate, SO4	mg/L	25	16	24	25	16
Chloride (titration) - water	mg/L	33	30	38	33	54

Client Reference: Bore Water Analysis

Miscellaneous Inorganics Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Electrical Conductivity	µS/cm	230	210	260	230	260
pH	pH Units	5.6	5.9	6.0	5.0	6.6
Total Dissolved Solids (grav)	mg/L	150	120	190	190	170
Hardness by calculation	mgCaCO3 /L	45	21	56	42	28
Ammonia as N in water	mg/L	<0.1	4.6	<0.1	<0.1	0.50
Nitrate as N in water	mg/L	6.1	0.2	4.6	6.1	2.9
Nitrite as N in water	mg/L	<0.01	0.01	0.02	<0.01	<0.01
Total Kjeldahl Nitrogen	mg/L	0.7	4.0	0.4	0.3	0.7
Total Nitrogen in water	mg/L	6.8	4.2	5.0	6.4	3.6
Total Phosphorus	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05

Client Reference: Bore Water Analysis

Microbiologocal Testing Our Reference: Your Reference Type of sample	UNITS ——— ———	9488-1 Bore 13 Water	9488-2 Bore 36 Water	9488-3 Bore 34 Water	9488-4 Bore 30 Water	9488-5 Long Dam Water
Faecal Coliforms	CFU/100 mL	<1	<1	<1	<1	<1
Faecal Streptococci	CFU/100 mL	<1	<1	<1	<1	<10
E. Coli	CFU/100 mL	<1	<1	<1	<1	<1

Client Reference: Bore Water Analysis

Method ID	Methodology Summary
GC.13	Water samples are analysed directly by purge and trap GC-MS.
GC.16	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS.
GC.3	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID.
GC.12	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS.
GC-5	Soil samples are extracted with hexane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
GC-6	Soil samples are extracted with hexane/acetone and waters with dichloromethane and analysed by GC-ECD.
LAB.30	Total Phenolics - determined colorimetrically following disitillation.
Ext-020	Analysis subcontracted to Australian Government - National Measurement Institute. NATA Accreditation No: 198
Metals.20	Determination of various metals by ICP-AES.
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.9	Sulphate determined turbidimetrically.
LAB.11	Chloride determined by argentometric titration.
LAB.2	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED and Rayment & Higginson.
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.16	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.57	Ammonia water extractable - determined colourimetrically based on EPA103A.
LAB.55	Nitrate water extractable - determined colourimetrically based on EPA114A.
LAB.56	Nitrite water extractable - determined colourimetrically based on EPA116A.
LAB.66	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Ext-006	Subcontracted to Barratt & Smith Pathlogy. NATA Accreditation No. 2178.

Client Reference: Bore Water Analysis

QUALITY CONTROL VHC's in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	--			[NT]	[NT]	[NT]	[NR]	[NR]
Date analysed	--			[NT]	[NT]	[NT]	[NR]	[NR]
Dichlorodifluoromethane	µg/L	10	GC.13	<10	[NT]	[NT]	[NR]	[NR]
Chloromethane	µg/L	10	GC.13	<10	[NT]	[NT]	[NR]	[NR]
Vinyl Chloride	µg/L	10	GC.13	<10	[NT]	[NT]	[NR]	[NR]
Bromomethane	µg/L	10	GC.13	<10	[NT]	[NT]	[NR]	[NR]
Chloroethane	µg/L	10	GC.13	<10	[NT]	[NT]	[NR]	[NR]
Trichlorofluoromethane	µg/L	10	GC.13	<10	[NT]	[NT]	[NR]	[NR]
1,1-Dichloroethene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Trans-1,2-dichloroethene	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	86%
1,1-dichloroethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Cis-1,2-dichloroethene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Bromochloromethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	95%
Chloroform	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
2,2-dichloropropane	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	86%
1,2-dichloroethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	86%
1,1,1-trichloroethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,1-dichloropropene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Carbon tetrachloride	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Dibromomethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,1-dichloropropane	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	110%
Trichloroethene	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	121%
Bromodichloromethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
trans-1,3-dichloropropene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
cis-1,3-dichloropropene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,1,2-trichloroethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,3-dichloropropane	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	120%
Dibromochloromethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,2-dibromoethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	LCS	116%
Tetrachloroethene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,1,1,2-tetrachloroethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Chlorobenzene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Bromoform	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,1,2,2-tetrachloroethane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,2,3-trichloropropane	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
Bromobenzene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
2-chlorotoluene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
4-chlorotoluene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,3-dichlorobenzene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]
1,4-dichlorobenzene	µg/L	1	GC.13	<1.0	[NT]	[NT]	[NR]	[NR]

Client Reference: Bore Water Analysis

QUALITY CONTROL Organochlorine Pesticides in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Surrogate TCLMX	%		GC-5	[NT]	[NT]	[NT]	LCS	96%
QUALITY CONTROL PCBs in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	–			[NT]	[NT]	[NT]	[NR]	[NR]
Date analysed	–			[NT]	[NT]	[NT]	[NR]	[NR]
Arochlor 1016	µg/L	2	GC-6	<2	[NT]	[NT]	[NR]	[NR]
Arochlor 1232	µg/L	2	GC-6	<2	[NT]	[NT]	[NR]	[NR]
Arochlor 1242	µg/L	2	GC-6	<2	[NT]	[NT]	[NR]	[NR]
Arochlor 1248	µg/L	2	GC-6	<2	[NT]	[NT]	[NR]	[NR]
Arochlor 1254	µg/L	2	GC-6	<2	[NT]	[NT]	LCS	115%
Arochlor 1260	µg/L	2	GC-6	<2	[NT]	[NT]	[NR]	[NR]
QUALITY CONTROL SVOC's in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	–			[NT]	[NT]	[NT]	[NR]	[NR]
Date analysed	–			[NT]	[NT]	[NT]	[NR]	[NR]
Phenol	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	40%
Bis (2-chloroethyl) ether	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Chlorophenol	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	102%
1,3-Dichlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
1,4-Dichlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	74%
2-Methylphenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
1,2-Dichlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
bis-(2-Chloroisopropyl) ether	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
3/4-Methylphenol	µg/L	20	GC.12	<20	[NT]	[NT]	[NR]	[NR]
N-nitrosodi-n-propylamine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Hexachloroethane	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Nitrobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Isophorone	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2,4-Dimethylphenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Nitrophenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
bis (2-Chloroethoxy) methane	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2,4-Dichlorophenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
1,2,4-Trichlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Naphthalene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
4-Chloroaniline	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Hexachlorobutadiene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Methylnaphthalene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Hexachlorocyclopentadiene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]

Client Reference: Bore Water Analysis

QUALITY CONTROL SVOC's in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
2,4,6-Trichlorophenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2,4,5-Trichlorophenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Chloronaphthalene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Nitroaniline	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Dimethyl phthalate	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	85%
2,6-Dinitrotoluene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Acenaphthylene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
3-Nitroaniline	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Acenaphthene	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	92%
2,4-Dinitrophenol	µg/L	100	GC.12	<100	[NT]	[NT]	[NR]	[NR]
4-Nitrophenol	µg/L	100	GC.12	<100	[NT]	[NT]	LCS	20%
Dibenzofuran	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Diethylphthalate	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	125%
4-Chlorophenylphenylether	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
4-Nitroaniline	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Fluorene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-methyl-4,6-dinitrophenol	µg/L	100	GC.12	<100	[NT]	[NT]	[NR]	[NR]
Azobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
4-Bromophenylphenylether	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Hexachlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Pentachlorophenol	µg/L	100	GC.12	<100	[NT]	[NT]	[NR]	[NR]
Phenanthrene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Anthracene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Carbazole	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Di-n-butylphthalate	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Fluoranthene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Pyrene	µg/L	10	GC.12	<10	[NT]	[NT]	LCS	62%
Butylbenzylphthalate	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Bi(2-ethylhexyl) phthalate	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Benzo(a)anthracene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Chrysene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Di-n-octylphthalate	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Benzo(b)fluoranthene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Benzo(k)fluoranthene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Benzo(a)pyrene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Indeno(1,2,3-c,d)pyrene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Dibenzo(a,h)anthracene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Benzo(g,h,i)perylene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Ethylmethanesulfonate	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Aniline	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]

Client Reference: Bore Water Analysis

QUALITY CONTROL SVOC's in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Pentachloroethane	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Benzyl alcohol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Acetophenone	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
N-nitrosomorpholine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
3-methylphenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
N-nitrosopiperidine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2,6-Dichlorophenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Hexachloropropene-1	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
N-nitroso-n-butylamine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Safrole	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
1,2,4,5-Tetrachlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Trans-iso-safrole	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
1,3-Dinitrobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Pentachlorobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
1-Naphthylamine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2,3,4,6-Tetrachlorophenol	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Naphthylamine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
5-Nitro-o-toluidine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Diphenylamine	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Phenacetin	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Pentachloronitrobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Dinoseb	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Methapriline	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
p-Dimethylaminoazobenzene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
2-Acetylaminofluorene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
7,12-Dimethylbenz(a)anthracene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
3-Methylcholanthrene	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
a-BHC	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
b-BHC	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
g-BHC	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
d-BHC	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Heptachlor	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Aldrin	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Heptachlor Epoxide	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
g-Chlordane	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
a-Chlordane	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Endosulfan I	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
p,p'-DDE	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Dieldrin	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Endrin	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]

Client Reference: Bore Water Analysis

QUALITY CONTROL SVOC's in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
p,p'-DDD	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Endosulfan II	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Endrin Aldehyde	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
p,p'-DDT	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulphate	µg/L	10	GC.12	<10	[NT]	[NT]	[NR]	[NR]
Surrogate 2-fluorophenol	%		GC.12	[NT]	[NT]	[NT]	LCS	65%
Surrogate Phenol-ds	%		GC.12	[NT]	[NT]	[NT]	LCS	24%
Surrogate Nitrobenzene-ds	%		GC.12	[NT]	[NT]	[NT]	LCS	70%
Surrogate 2-fluorobiphenyl	%		GC.12	[NT]	[NT]	[NT]	LCS	71%
Surrogate 2,4,6-Tribromophenol	%		GC.12	[NT]	[NT]	[NT]	LCS	115%
Surrogate p-Terphenyl-d_{14}	%		GC.12	[NT]	[NT]	[NT]	LCS	84%
QUALITY CONTROL Total Phenolics in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Total Phenolics (as Phenol)	mg/L	0.05	LAB.30	<0.050	9488-1	<0.050 || <0.050	LCS	94%
QUALITY CONTROL Metals in water - low level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Aluminium-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Antimony-filtered	µg/L	0.15	Ext-020	<0.1	[NT]	[NT]	[NR]	[NR]
Arsenic-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Barium-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Boron-filtered	µg/L	0.2	Ext-020	<0.2	[NT]	[NT]	[NR]	[NR]
Cadmium-filtered	µg/L	0.1	Ext-020	<0.1	[NT]	[NT]	[NR]	[NR]
Chromium-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Copper-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Iron-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Lead-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Lithium-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Manganese-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Mercury-filtered	µg/L	0.1	Ext-020	<0.1	[NT]	[NT]	[NR]	[NR]
Nickel-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Selenium-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]
Silver-filtered	µg/L	0.02	Ext-020	<0.020	[NT]	[NT]	[NR]	[NR]
Zinc-filtered	µg/L	1	Ext-020	<1	[NT]	[NT]	[NR]	[NR]

Client Reference: Bore Water Analysis

QUALITY CONTROL Ion Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Calcium	mg/L	0.03	Metals.20	<0.030	9488-1	13 || [N/T]	LCS	101%
Potassium	mg/L	0.03	Metals.20	<0.030	9488-1	2.8 || [N/T]	LCS	105%
Magnesium	mg/L	0.03	Metals.20	<0.030	9488-1	3.2 || [N/T]	LCS	101%
Sodium	mg/L	0.03	Metals.20	<0.030	9488-1	17 || [N/T]	LCS	101%
Sulphate, SO4	mg/L	5	LAB.9	<5.0	9488-1	25 || 24 || RPD: 4	LCS	96%
Chloride (titration) - water	mg/L	20	LAB.11	<20	9488-1	33 || 30 || RPD: 10	LCS	105%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Electrical Conductivity	µS/cm	1	LAB.2	<1.0	9488-1	230 || 230 || RPD: 0	[NR]	[NR]
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	9488-1	150 || 170 || RPD: 12	[NR]	[NR]
Hardness by calculation	mgCaCO3/L	1	Metals.20	<1	9488-1	45 || [N/T]	[NR]	[NR]
Ammonia as N in water	mg/L	0	LAB.57	0.00	9488-1	<0.1 || <0.1	[NR]	[NR]
Nitrate as N in water	mg/L	0.1	LAB.55	<0.1	9488-1	6.1 || 6.1 || RPD: 0	[NR]	[NR]
Nitrite as N in water	mg/L	0.01	LAB.56	<0.01	9488-1	<0.01 || <0.01	LCS	100%
Total Kjeldahl Nitrogen	mg/L	0.05	Ext-020	<0.05	9488-1	0.7 || [N/T]	LCS	93%
Total Nitrogen in water	mg/L	0.6	LAB.66	<0.6	9488-1	6.8 || [N/T]	[NR]	[NR]
Total Phosphorus	mg/L	0.05	Metals.20	<0.05	9488-1	<0.05 || [N/T]	[NR]	[NR]

QUALITY CONTROL Microbiologocal Testing	UNITS	PQL	METHOD	Blank
Faecal Coliforms	CFU/100 mL		Ext-008	[NT]
Faecal Streptococci	CFU/100 mL		Ext-008	[NT]
E. Coli	CFU/100 mL		Ext-008	[NT]

QUALITY CONTROL Total Phenolics in Water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Total Phenolics (as Phenol)	mg/L	[NT]	[NT]	9488-2	96%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Electrical Conductivity	µS/cm	[NT]	[NT]	[NR]	[NR]
Total Dissolved Solids (grav)	mg/L	[NT]	[NT]	[NR]	[NR]
Hardness by calculation	mgCaCO3/L	[NT]	[NT]	[NR]	[NR]
Ammonia as N in water	mg/L	[NT]	[NT]	[NR]	[NR]
Nitrate as N in water	mg/L	[NT]	[NT]	[NR]	[NR]
Nitrite as N in water	mg/L	[NT]	[NT]	[NR]	[NR]
Total Kjeldahl Nitrogen	mg/L	[NT]	[NT]	9488-1	90%

Client Reference: Bore Water Analysis

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Total Nitrogen in water	mg/L	[NT]	[NT]	[NR]	[NR]
Total Phosphorus	mg/L	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Electrical Conductivity	µS/cm	[NT]	[NT]	LCS	102%
Total Dissolved Solids (grav)	mg/L	[NT]	[NT]	LCS	101%
Hardness by calculation	mgCaCO3/L	[NT]	[NT]	LCS	101%
Ammonia as N in water	mg/L	[NT]	[NT]	LCS	99%
Nitrate as N in water	mg/L	[NT]	[NT]	LCS	105%
Nitrite as N in water	mg/L	[NT]	[NT]	LCS	105%
Total Kjeldahl Nitrogen	mg/L	[NT]	[NT]	[NR]	[NR]
Total Nitrogen in water	mg/L	[NT]	[NT]	[NR]	[NR]
Total Phosphorus	mg/L	[NT]	[NT]	LCS	84%