HEATHGATE

BEVERLEY MINE REPORT

Aquifer test analysis at the Beverley Four Mile East Ore Zone

Final Report–V2

November 2008

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1 EXECUTIVE SUMMARY

1.1 Introduction

Heathgate Resources Pty Ltd (Heathgate) on behalf of Quasar Resources Pty Ltd (Quasar) has been commissioned to examine the potential for mining of a newly discovered uranium deposit, hosted within the Tertiary age Eyre Formation sediments beneath the plains east of the Northern Flinders Ranges located approximately 10 km north-west of the Beverley Uranium Mine. The deposit, known as Beverley Four Mile, comprises two separate ore bodies, Four Mile West and Four Mile East (Figure 2). The deposit was discovered by Joint Venture Partners Quasar Resources (75%) and Alliance Resources (25%). The JV partners have lodged a mining lease application over both deposits, and are expected to commission Heathgate to undertake mining of the deposit using In-Situ Recovery (ISR) methods.

First stage mining will be undertaken in the Beverley Four Mile East (BFME) ore zone. First Stage mining will entail operation of a number of wellfield patterns which will essentially serve as a comprehensive Field Leach Trial. First Stage Mining is expected to comprise 60 wellfield 7-spot patterns, comprising a total of approximately 300 mining wells. The location targeted for aquifer testing and First Stage mining (the First Stage Mining Area within the BFME ore zone) has been selected as one of the sites more amenable to ISL mining. At this location uranium mineralisation is hosted within a more permeable sand unit of the aquifer.

This report documents the analysis of aquifer testing data, hydrogeochemical data and aquifer pressure data from the mineralised aquifer at the BFME First Stage Mining Area.

1.2 Conceptual Hydrogeological Model

Mineralisation at Four Mile East is hosted within the Eyre Formation. At the BFME ore zone, the Eyre Formation comprises an aquifer of some 70 m thickness. The aquifer is comprised of very fine to coarse gained unconsolidated sands deposited in a number of sedimentary cycles. The sedimentary unit hosting mineralisation targeted for mining is named the S-1c unit extending from approximately 200 to 205 mBGL. This unit is comprised of particularly coarse grained sands. There are no marked confining layers within the aquifer, though thin clay and silt zones and cemented pyritic layers observed in drillcore may vertically confine fluids on a small scale. A silcrete horizon towards the top of the formation will confine fluids on a small scale, however this horizon is shown to leak, presumably due to fracturing hence it does not form a confining layer on a large scale. The aquifer is confined above by the Namba Formation which is a predominately clay / siltstone formation with minor thin sand lenses. The aquifer is bounded below by a consolidated diamictite comprising cobbles cemented within a clay matrix. This sedimentary package overlies the hard rock of the Adelaidean sequence.

Aquifer pressure within the Eyre Formation ranges around 56 mAHD, with a slight vertical gradient converging toward the S-1c unit, indicating that this unit may be a pathway for preferential flow. Aquifer pressure in the Namba formation is significantly higher at around 78 mAHD, which indicates that the two formations are hydraulically separate, and that the potential for any natural flow is from the Namba Formation down to the Eyre Formation. Aquifer Pressure in the fractured rock aquifer underlying the Eyre Formation is also higher at 59 mAHD, which indicates that the basal diamictite is an effective confining layer, and that the potential for any natural flow is from the Fractured Rock aquifer up into the Eyre Formation. The aquifer exhibits a lateral pressure gradient from west to east of 0.0025 indicating lateral groundwater flow toward the east.

The measured salinity of the Eyre Formation aquifer averages 3000 mg/L TDS, whilst chloride concentration averages 1200 mg/L. Natural radionuclide concentrations average 0.021 mg/L and 57 Bq/L for uranium and radium 226 respectively.

1.3 Aquifer Testing

Hydraulic testing of the aquifer was undertaken at the BFME ore zone. Three tests were undertaken:

1. Step test from well screening target mineralised zone
2. Constant rate test from well screening target mineralised zone
3. Constant rate test from well screening fractured rock aquifer.

Analysis of hydraulic testing data indicates the following:

- The Eyre Formation is highly permeable and production well yields in excess of 5L/s can be expected with very little drawdown (approximately 4.5 m). The well equation describing drawdown in the pumped well for varying flow rates is:

$$S = 0.006\,(Q) + 7.9 \times 10^{-4}.(Q)\,.\log\,(t) + 2.6 \times 10^{-6}.Q^2$$

  Where:

  S = drawdown (m)
  Q = flow rate (m^3/day)
  t = time of pumping (days)

- The Eyre Formation behaves as one hydraulically connected aquifer, as evidence by the similar slope of drawdown over time, for all wells completed in this formation. Some vertical flow restriction is evidence by reduced drawdown in wells completed above and below the pumped well, particularly 4M0002 (Figure 1).
- The silcrete layer at approx 180 mBGL does not serve as a competent aquitard. Leakage through this unit is demonstrated by drawdown in the observation well completed above the Silcrete layer.
- The Eyre Formation is confined by the low vertical hydraulic conductivity of the Namba Formation. The drawdown response to pumping in the Eyre Formation does not indicate significant leakage. The absence of drawdown in the observation well completed in the Namba Formation provides further evidence that this unit is in poor hydraulic connection with the Eyre Formation. In addition, the natural 20 mH_2O pressure difference between the two formations indicates hydraulic separation.
- The Basal Diamictite layer forms a competent underlying hydraulic boundary at the BFME ore zone. This is evidenced by the absence of drawdown in the underlying fractured rock aquifer in response to pumping from the Eyre Formation.
- The calculated Transmissivity of the Eyre Formation is approximately 350 m^2/day.
- The calculated Storativity of the Eyre Formation ranges from 6.8×10^{-5} to 1×10^{-4}.
- The aquifer does not exhibit marked anisotropy on the horizontal plane on the scale of the test. This is evidenced by the radial distribution of distance-drawdown data.
- A recharge boundary reports at a distance of about 2500 m from the pumped well. This may be due to either:
  1. recharge via faulting in the basement, or
  2. recharge from laterally abutting fractured rock aquifers at the range front of the Flinders Ranges; or
  3. A thickening of the Eyre Formation to yield a total transmissivity of approximately 550 m^2/day as indicated by the slope of drawdown over time after t = 0.5 days.

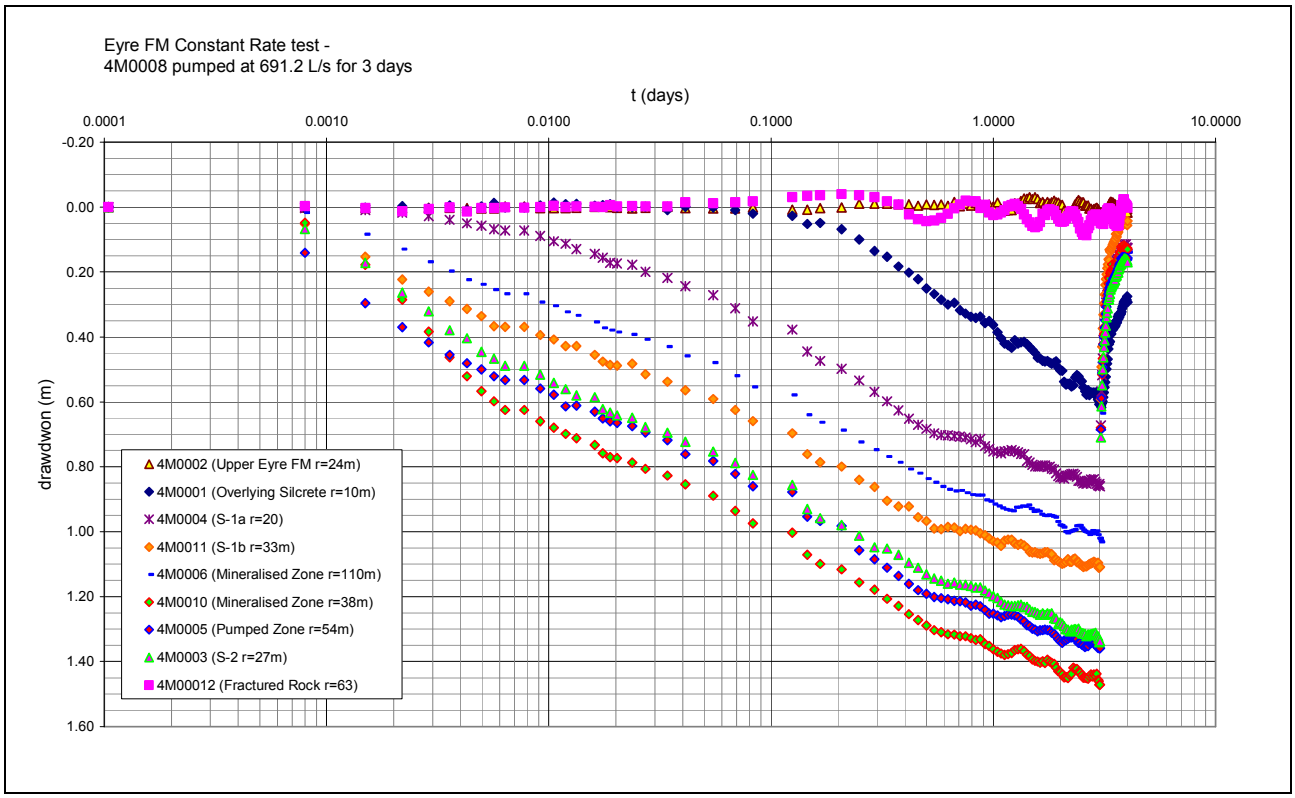

Figure 1: Constant rate aquifer testing drawdown. Time plotted on a log scale.

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1 INTRODUCTION

Heathgate Resources (Heathgate) has been commissioned to undertake an investigation into mining of a newly discovered uranium deposit, hosted within the Tertiary age Eyre Formation sediments beneath the plains east of the Northern Flinders Ranges located approximately 10 km north-west of the Beverley Uranium Mine. The deposit, known as Beverley Four Mile, comprises two separate ore bodies, Beverley Four Mile West and Beverley Four Mile East (BFME) (Figure 2) . The deposit was discovered by Joint Venture Partners Quasar Resources (75%) and Alliance Resources (25%). The JV partners have lodged a mining lease application over both deposits, and are expected to commission Heathgate to undertake mining of the deposit using In-Situ Recovery (ISR) methods.

This report documents the analysis of aquifer testing data, hydrogeochemical data and aquifer pressure data from the mineralised aquifer at the BFME First Stage Mining Area (within the BFME ore zone). The aim of this work is to use the aquifer testing data to elucidate:

- Aquifer structure - whether the aquifer is bounded or unbounded, leaky or completely confined
- Aquifer properties of transmissivity and storage
- Hydraulic connection with overlying and underlying aquifer units
- Anisotropy of aquifer hydraulic conductivity (permeability) on the horizontal to vertical plane. This factor is crucial in determining vertical flare of mining solution during ISR mining.

Analytical solutions to well drawdown are used to calculate aquifer properties. These aquifer property data are then used to construct a numerical groundwater model, which is further calibrated to observed drawdown responses to pumping.

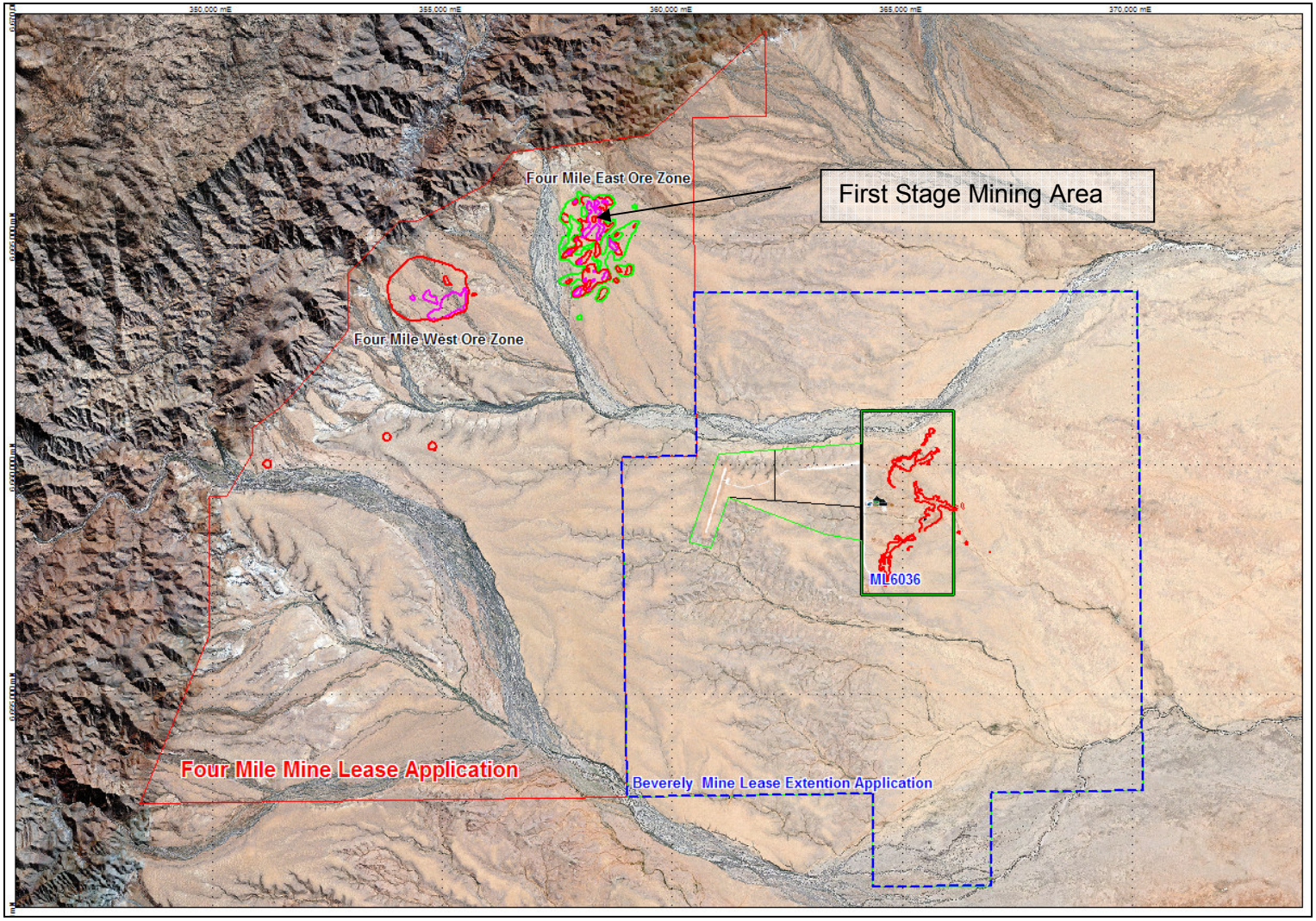


Figure 2: Location – 5000m grid

2 HYDROSTRATIGRAPHY

The conceptual hydrogeological model at the BFME ore zone is comprised of 11 hydrostratigraphic units. The interpretation of these units is based on detailed core logging, and geophysical borehole log analysis. The continuity of each of these units across the BFME ore zone is being established by interpretive work undertaken by Quasar Resources (Packer, 2008 pers. Com.). These units are reported to be relatively consistent in thickness and lithology across the BFME ore zone.

The hydrostratigraphy of the BFME ore zone is shown in type section in Figure 3. Broadly, the hydrogeological structure at the BFME ore zone comprises a fractured rock aquifer basement, overlaid by a diamictite confining layer, which is in turn overlaid by approximately 70 m thickness of permeable sands of the Eyre Formation. This sand unit hosts uranium mineralised horizons of approximately 5 m thickness. The aquifer sediments are silicified towards the top of the aquifer, forming a silcrete layer up to 10 m thick. Where intact and continuous, this layer would serve as an effective confining layer; however, being brittle it is likely that fracturing at faults would result in secondary permeability. The silcrete is overlaid by another sand unit of some 20 m thickness.

The Eyre Formation sand units are overlaid by interbedded silts and clays of the Tertiary age Namba Formation which hosts some thin gravel and sand beds. The unit serves as a hydraulic confining unit over the Eyre Formation.

The Quaternary age Willawortina Formation is relatively thin and is unsaturated.

The unconsolidated sedimentary units and underlying basement unconformity exhibit a shallow dip towards the south east.

Eyre Formation aquifer units comprise cycles of sedimentary units. The layered lithology is expected to result in some degree of vertical anisotropy in hydraulic conductivity, where the horizontal hydraulic conductivity is higher than the vertical hydraulic conductivity. This vertical anisotropy is examined and confirmed through the aquifer hydraulic testing and modelling work described later. Hydrostratigraphic units are described below from bottom to top.

2.1.1 Fractured Rock Basement – Aquifer

Basement hard rock of the Adelaidean (Proterozoic) age sequence (Mount Painter Group) underlies BFME. Core samples of this rock unit indicate significant fracturing. Fractures show evidence of chemical weathering, with chlorite weathering residue present on fracture walls, suggestive of active water movement.

2.1.2 Basal Diamictite - Aquiclude

The hard rock basement is overlain by a diamictite of boulders and cobbles cemented in a clayey indurated matrix. Based on inspection of core samples, this unit is likely to act as an effective aquiclude.

2.1.3 Eyre Formation Sand Unit (S-2) - Aquifer

The basal Eyre Formation sand unit comprises fine to coarse sand deposited in two fining upwards units at the BFME ore zone. The upper interval of this unit is host to mineralisation in the south eastern section of the BFME ore zone.

2.1.4 Eyre Formation Sand Unit (S-1c) – Mineralised Zone - Aquifer.

The middle sand unit of the Eyre Formation comprises a fine to coarse unit deposited in several fining upward and fining downward units. The lower boundary of this unit is marked by a reduced neutron count indicative of a fine grained silty bed. This silt boundary is present at 205.5 to 206 mBGL in Hole 4M0012. This unit hosts mineralisation which is the main target for ISR in the central and northern section of the BFME ore zone.

2.1.5 Eyre Formation Sand Unit (S-1b and S-1a) – Aquifer

The upper sand units of the Eyre Formation comprises a fine to coarse unit deposited in several fining upward and fining downward units. The S-1b unit exhibits fine to medium grained sands at the BFME ore zone. The unit hosts mineralisation in the eastern section of the BFME ore zone. The S-1a unit exhibits very fine sands to silt. This unit hosts some mineralisation to the west of the BFME ore zone.

2.1.6 Silcrete Layer (S)

A layer of hard, indurated “Silcrete” is present across the BFME ore zone. This feature is not a true silcrete, but comprises hard cemented sand, which in some areas resembles a quartzite. This unit is a very hard and “porcelain-like material”. Where movement occurs through faulting, this unit is likely to fracture rather than deform.

2.1.7 Overlying Silcrete (OL)

A silty fine to coarse sand unit overlies the Silcrete layer to a depth of approximately 150 mBGL in the BFME ore zone. The unit is broadly fining upwards

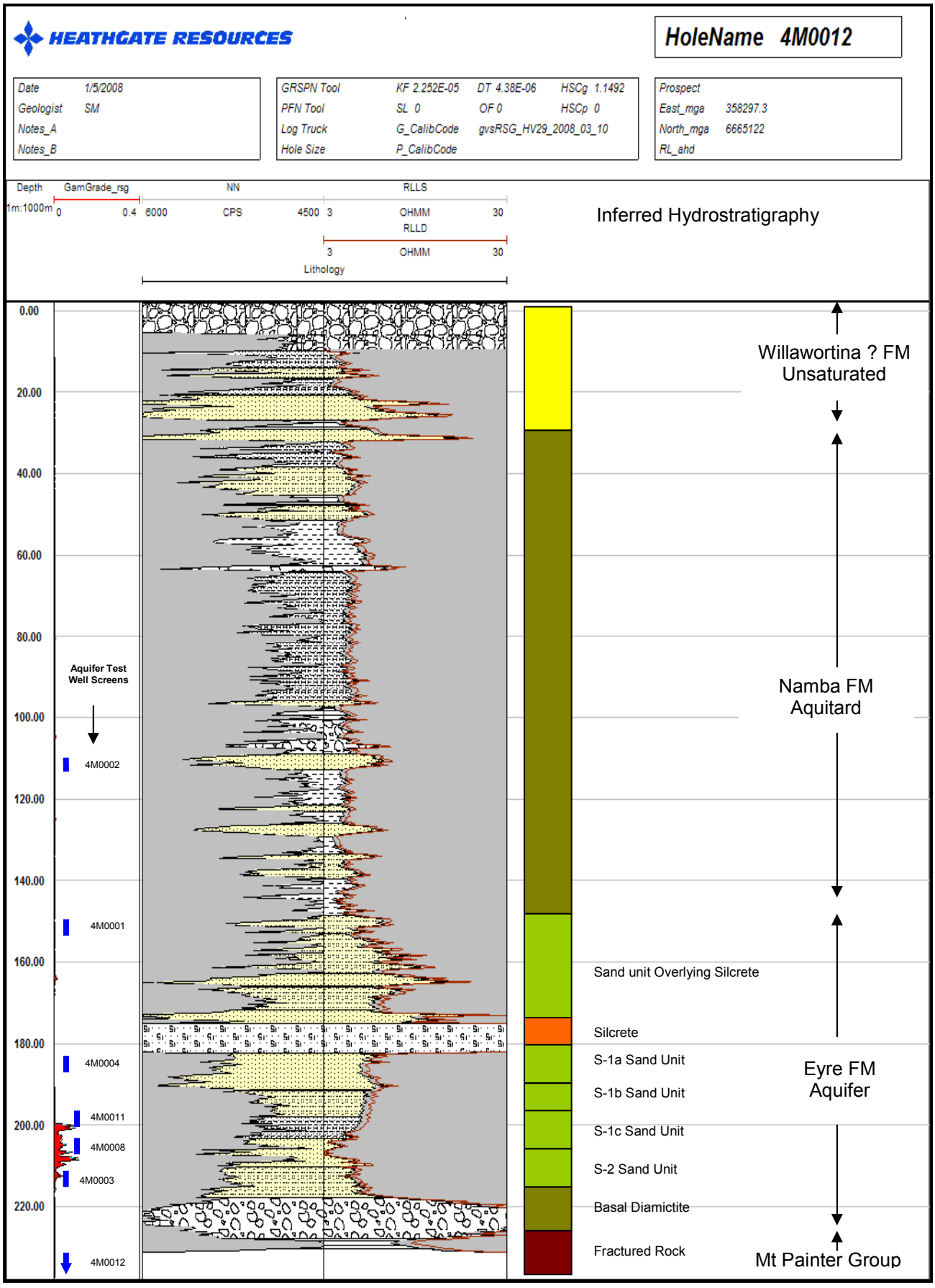
2.1.8 Namba Formation

The Namba Formation comprises mainly low permeability silts and clays with some thin gravel and sand units. The vertical permeability of this unit is likely to be low due to the dominance of clay and silt units. A monitor well completed in the Namba Formation at a depth of 109 to 116.5 mBGL exhibited very low yield (<0.1 L/s),

2.1.9 Quaternary (Willawortina Formation)

Two fining upwards sedimentary packages, possibly remnant stream beds are present at 20 to 30 m depth. These possibly represent Quaternary sediment at this site. These permeable units almost certainly above the water table and unsaturated under current climatic conditions. The presence of old hand dug wells with derelict windmills, in Four Mile creek approximately 1 km south of the BFME ore zone indicate that this Quaternary unit may host a perched aquifer after significant creek flows, however, these wells are currently observed to be dry.

Figure 3: Conceptual Hydrostratigraphy. Drill hole 4M0012 provided as a Reference Log.



2.2 Aquifer Pressure.

2.2.1 Vertical Distribution of Aquifer Pressure at BFME Ore Zone.

A nest of 7 test wells was constructed at the BFME ore zone to examine the vertical distribution of hydrogeological properties. Well Details are presented in Appendix A

Aquifer pressure data measured on 1/6/2008 is presented in Table 1 and Figure 4.
Reference elevations for this data were surveyed manually using a dumpy level. All well collar elevations were referenced to the collar elevation of well 4M0008 to within 0.01 m. The collar elevation of 4M0008 was, in turn, derived from a LIDAR ground surface survey (FUGRO, 2007).

These data show that aquifer pressure is notably higher in the Namba Formation aquifer, compared to the deeper Eyre Formation. This indicates that there is an effective low permeability barrier between the Namba Formation aquifer and the deeper Eyre Formation aquifer, and that the potential for any flow is downwards from the water table aquifer to the Eyre Formation aquifer.

Aquifer pressure in the underlying fractured rock aquifer is also higher than the Eyre Formation aquifer. This indicates that the basal diamictite serves as an aquitard at the location tested, and that the potential for flow is upward, from the fractured rock aquifer into the Eyre Formation aquifer.

Table 1: Vertical Aquifer pressure survey data.

Aquifer Unit	Well_ID	Aquifer pressure (mAHD)
Namba Formation	4M0002	77.93
Eyre Formation Overlying Silcrete	4M0001	56.86
Eyre Formation S-1a	4M0004	56.52
Eyre Formation S-1b	4M0011	56.49
Eyre Formation S-1c Mineralised	4M0008	56.29
Eyre Formation S-2	4M0003	56.57
Fractured Rock Basement	4M0012	59.10

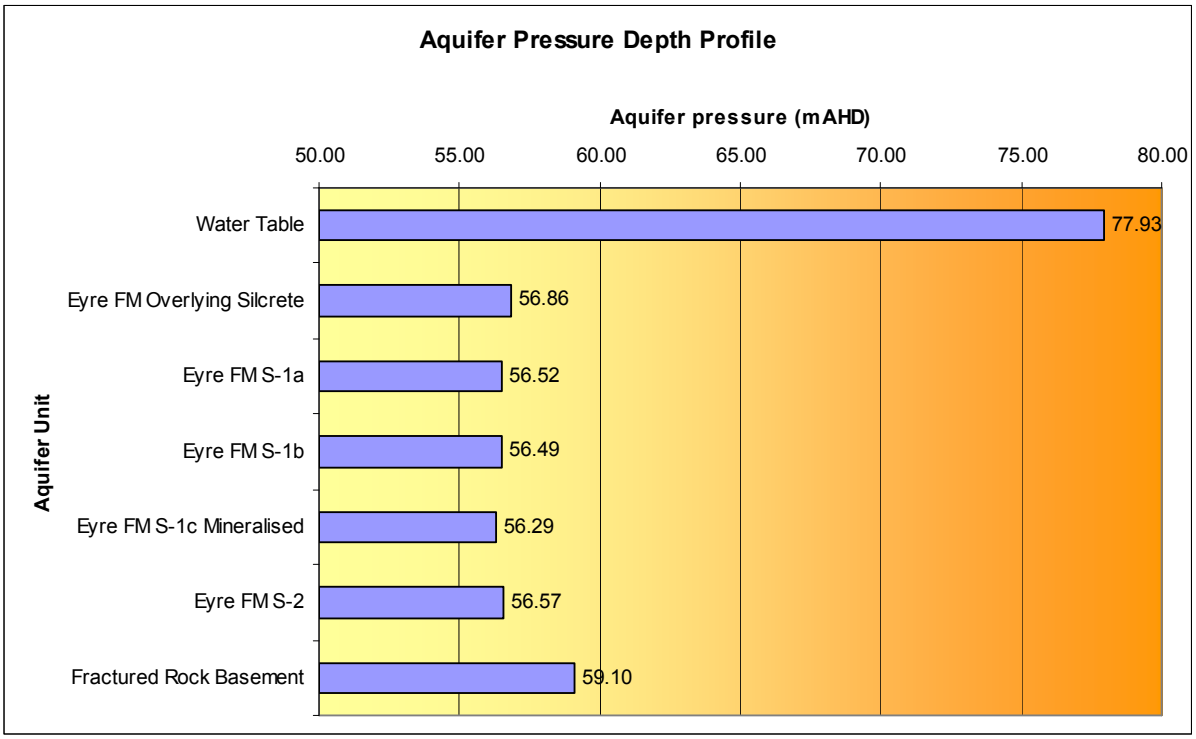


Figure 4: Aquifer pressure depth profile.

2.2.2 Lateral Aquifer Pressure Gradient across the BFME Ore Zone

Eyre Formation aquifer pressure at wells across the BFME ore zone was determined from water level measurements at wells completed in the Eyre Formation. Aquifer pressure was determined as the average pressure reading over 10 days from 2 to 12/5/2008. This data is presented in Table 2 and Figure 5. The data shows that, across the BFME re zone, aquifer pressure exhibits a gradient of 0.0025 towards the east. This indicates that there is potential for flow from the west to the east across the BFME ore zone.

Table 2: Eyre Formation aquifer pressure

WellID	Easting	Northing	Avg SWL (mAHD) 2/52008 to 12/5/2008
AKMW006	358200	6665802	57.61
AKMW007	358698	6665701	56.89
AKMW008	358198	6664000	60.04
AKMW009	358718	6664816	54.33
AKMW011	359048	6664200	57.92
AKMW012	357920	6664923	57.65
4MRMW001	356719	6664521	58.88
4MRMW007	359988	6665248	51.14
4M0008	358244	6665155	56.32

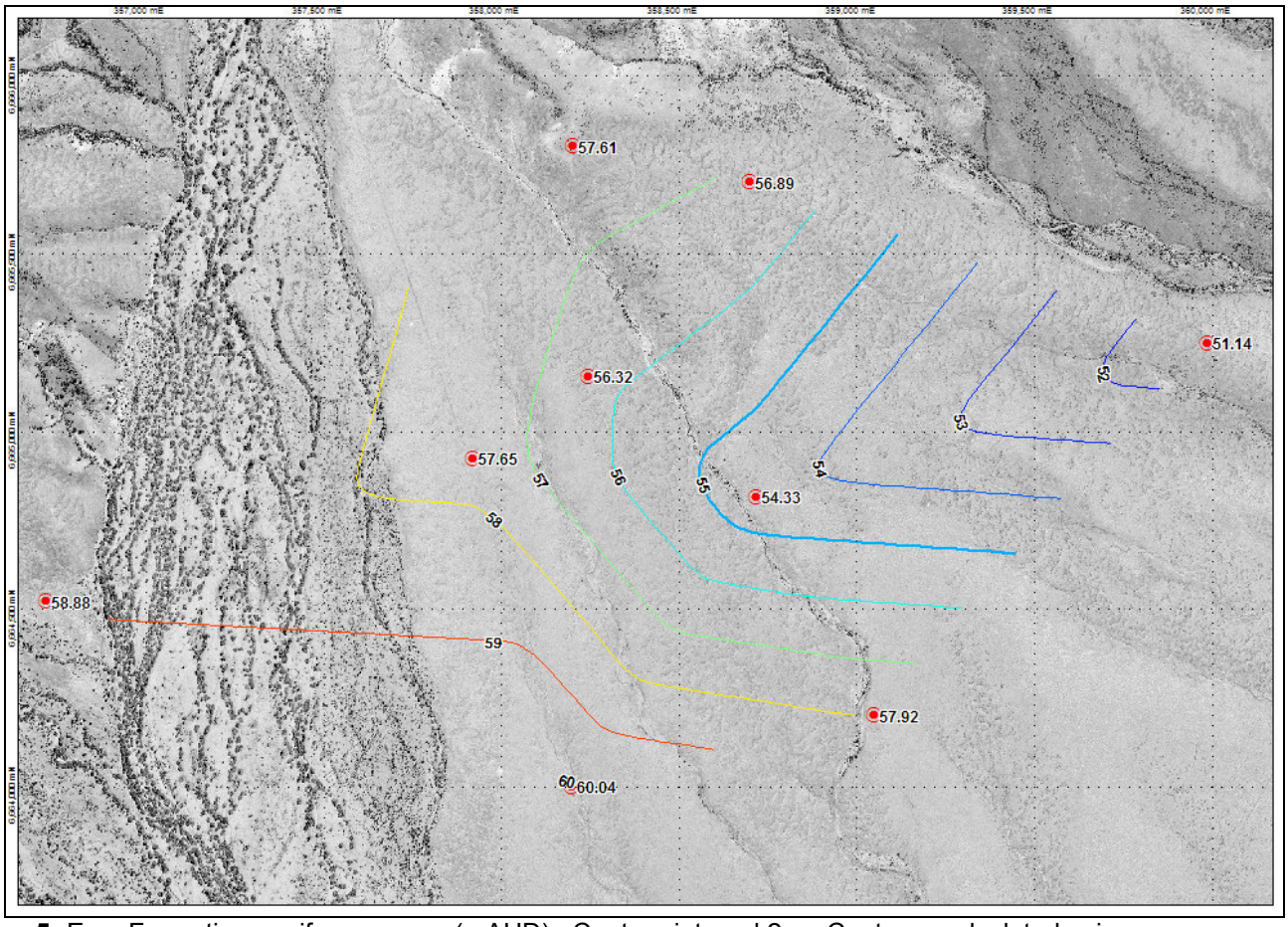


Figure 5: Eyre Formation aquifer pressure (mAHD). Contour interval 2m. Contours calculated using triangulation of presented data points. 500m map grid.

2.3 Groundwater Chemistry

2.3.1 Chemical Data

Chemical Data for wells completed in the Eyre Formation are summarised in Table 3 and presented in detail in Appendix F.

Salinity in the Eyre Formation is moderately low at around 2200 to 3600 mg/L TDS. Chloride concentrations are also moderately low at 900 to 1500 mg/L. Natural dissolved uranium concentrations range from <0.005 to 0.035 mg/L, whilst natural radium 226 activity ranges from 1.2 to 239 Bq/L.

Table 3: Chemical Data for Eyre Formation – Data from 16 Wells

	EC	TDS	pH	Na	Ca	Mg	K	Cl	SO_4	Alk	U	Ra-226
	uS/cm	mg/L	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/l
Min	3900	2200	7.1	639	87	21.5	28	900	232	190	0.005	2.41
max	6630	3630	8.6	909	411	79	53	1500	808	400	0.035	268
Average	4930	2970	7.9	806	157	58	40	1217	484	280	0.021	57

3 AQUIFER TESTING

3.1 Overview

A series of 3 aquifer tests were undertaken at Beverley Four Mile East. These tests were located at the BFME ore zone, centred on well 4M0008. The testing program aimed to determine aquifer structure (confinement, leakance, boundary conditions); and aquifer properties of Transmissivity (T) and Storativity (S).

Wells were completed across the mineralised interval of the S1c sand unit of the Eyre Formation and in the overlying and underlying sand units, as well as the underlying fractured rock basement and overlying Namba Formation. Well details are presented in Table 4. Aquifer test layout is presented in Figure 7 whilst a conceptual cross section of the aquifer test well layout is presented in Figure 6.

Table 4: Aquifer test well details.

WellID	Collar North[1]	Collar East[1]	Screen North[1,2]	Screen East[1,2]	Collar rL (mAHD) [3]	Screen Top (mBTOC)	Screen Bottom (mBTOC)	SWL (mAHD)[4]
4M0001	6665158.0	358250.0	6665162.9	358249.5	138.49	150.0	156.0	56.86
4M0002	6665133.7	358254.5	6665134.1	358255.6	138.44	109.0	116.5	77.93
4M0003	6665150.8	358274.2	6665149.0	358270.6	138.13	213.5	216.5	56.57
4M0004	6665143.6	358233.6	6665138.5	358232.0	138.49	184.0	190.0	56.52
4M0005	6665203.9	358263.8	6665204.4	358266.0	138.76	204.5	208.5	56.55
4M0006	6665255.9	358273.8	6665260.0	358275.6	139.02	199.0	204.0	56.51
4M0008	6665157.9	358259.7	6665154.6	358243.8	138.50	201.0	206.0	56.29
4M0009	6665185.2	358251.5	6665187.1	358253.9	138.52	203.0	206.5	56.55
4M0010	6665134.1	358273.7	6665131.0	358274.0	138.11	201.5	205.5	56.57
4M0011	6665173.3	358269.4	6665174.7	358269.5	139.16	196.0	200.0	56.49
4M0012	6665122.0	358297.3	6665120.3	358296.3	138.13	238.0	268.0	59.10

Notes
1 Gda 94 Zone 54
2 Screen coordinates corrected for borehole drift
3 Referenced to 4M0008 well collar through manual survey. 4M0008 reference level from LIDAR dataset (FUGRO, 2007)
4 SWL measured 1 June 2007

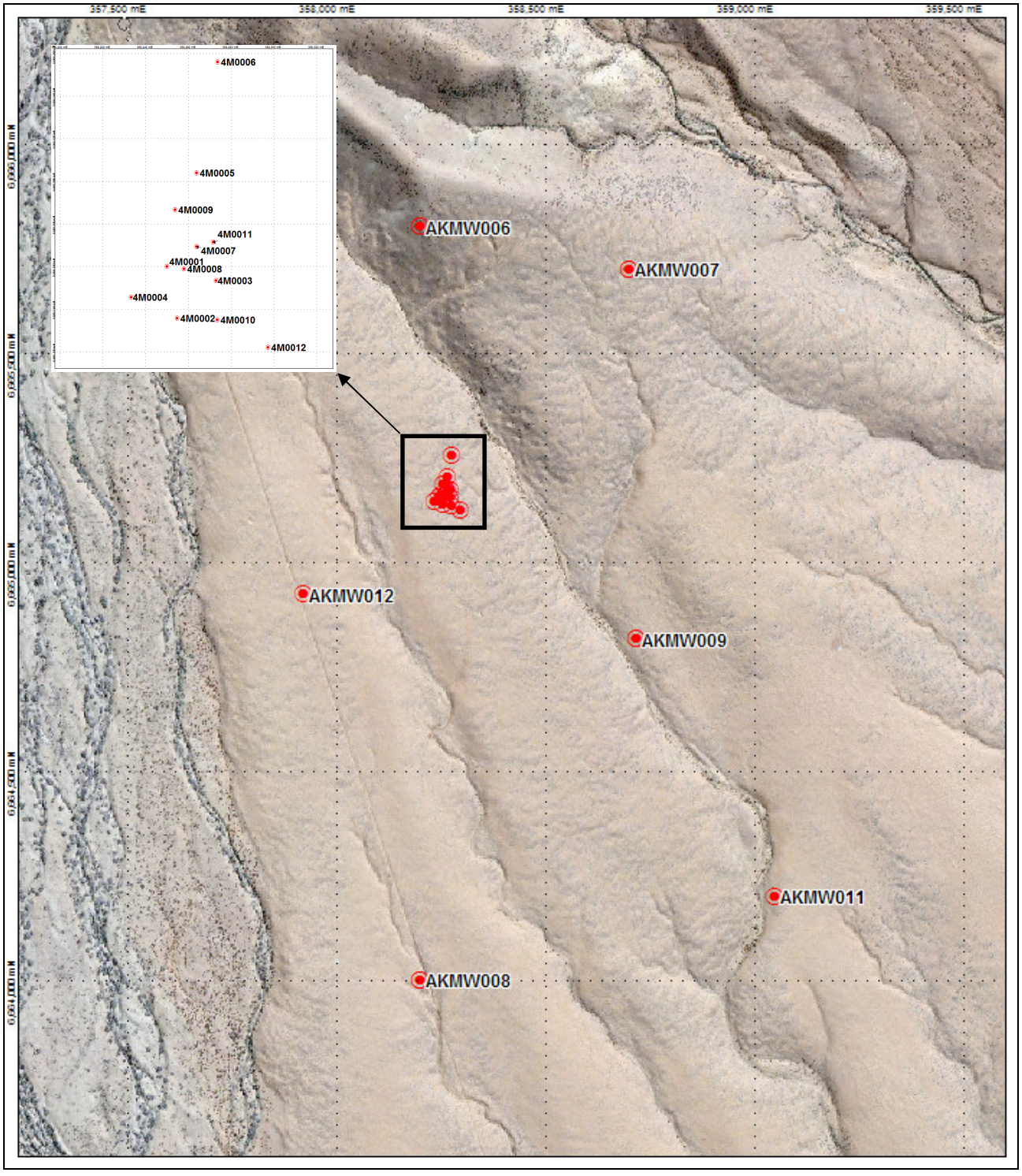


Figure 6: Aquifer test well layout. Main Map – 500m grid. Inset – 20m Grid.

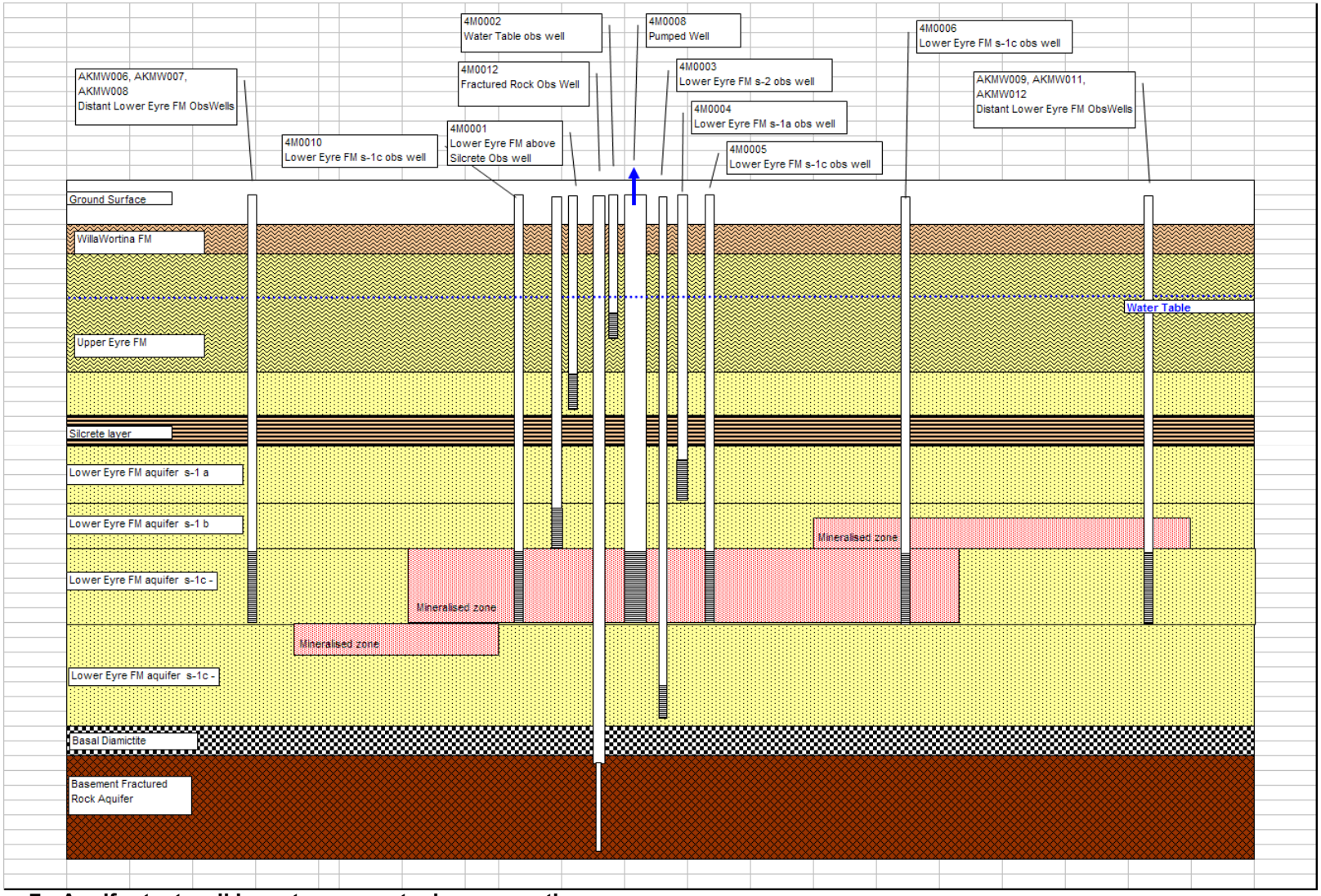


Figure 7: Aquifer test well layout – conceptual cross section

Three tests were undertaken. Test details are summarised in Table 5 and are described below.

Table 5: Aquifer Test Details

Test	Pumped well	Date Commenced	Rate (L/s)	Duration	Comments
1 – Step Test	4M0008	16/5/2008 9:30	2, 4, 6, and 8	100 minute steps	
2 - CRT	4M0008	17/5/2008 11:00	8	3 days	1 day of recovery data was collected
3 - CRT	4M0012	29/5/2008 9:00		8 hours	

3.2 Test 1- 4M0008 Eyre Formation Step Test

A step test was undertaken pumping from well 4M0008 which is screened across the mineralised interval of the S-1c aquifer unit. Reporting was undertaken separately and is presented as Appendix B. Potential yields are high as demonstrated by only 4.6 m drawdown resulting from pumping at 8 L/s for 100 minutes.

Pumping rates during mining will be restricted by well screen open area, and by the capacity of pumps selected for mining. A conservative target flow rate which is hydraulically most efficient and unlikely to result in screen clogging through chemical precipitation is 7.5 L/s. Higher flow rates may be achievable if pumps with sufficient capacity are employed.

3.3 Test 2- 4M0008 Eyre Formation Constant Rate Test

A 3-day constant rate pumping test was undertaken pumping from Well 4M0008. The test was undertaken by The South Australian Department of Water, Land and Biodiversity (DWLBC) Technical Services and commenced on 17/5/2008. Pumping rate was 691.2 m^3/day (8 L/s). Flow rate was maintained using a variable speed drive Grunfoss pump and gate valve. Flow rate was monitored using a Magflow meter. Drawdown was monitored in all available observation wells using digital pressure loggers and backed up with less frequent manual water level measurements. Water level recovery was monitored for at least 24 hours following pump shutdown. Pressure transducer data was found to be satisfactory and used for all analysis.

Drawdown data is presented in Appendix H, Figure 8 and Figure 9. This second plot, with time on a logarithmic scale, shows that:

1. All wells completed in the Eyre Formation exhibit a drawdown response, which plots with a similar slope, on a log-linear scale. This indicates that the entire thickness of the Eyre Formation behaves as one aquifer unit, with reduced vertical conductivity between horizons indicated by the delayed or muted response of some wells (particularly 4M0001 completed in the Eyre Formation sand unit overlying the silcrete horizon.
2. There is no drawdown response observed in monitoring wells completed in the Namba Formation aquifer (4M0002) or the underlying fractured rock aquifer (4M00012) This indicates that these aquifers are in poor hydraulic connection with the Eyre Formation aquifer at the pumping test site. Rhythmic pressure fluctuations at these wells are likely to be barometric pressure effects.
3. Drawdown measured at all Eyre Formation wells exhibits a slope reduction commencing at t=0.5 to 0.6 days. This is indicative of a recharge boundary at some distance from the pumped well or may be due to limited vertical leakage.

Drawdown data was analysed using a range of methods. These are outlined below. Results are summarised in Table 6. Drawdown and recovery plots are presented on Figure 11 to Figure 24.

- Firstly, Hantush's modification of the Jacob Straight-line Method (Kruseman and Deridder 1994, pp 167) was employed. This method is appropriate for partially penetrating wells when the time of pumping is relatively long. At the aquifer test site this condition is met when the time of pumping exceeds approximately 0.00016 days (0.25 minutes). Drawdown data is free of well storage effects after approximately t = 0.005 (8 min). The calculated transmissivity of the aquifer ranges from 316 to 421 m^2/day.

- Secondly Theis' Recovery method (Kruseman and Deridder, 1994, pp194) was used to analyse recovery data. This analysis produced aquifer transmissivity estimates ranging from 263 to 395 m^2/day. Recovery plots exhibit a decrease in slope at approximately t/t' < 11 (equivalent to t' > 0.3 days) indicative of a recharge boundary at some distance from the pumped well.

- Thirdly, Hantush-Jacob's distance drawdown method (Krusemann and Deridder, 1994 pp 77) was used. Drawdown data at t = 0.5 was plotted for all monitoring wells completed in the Eyre Formation aquifer sand unit consistent with the pumped well (S-1c sand unit). These data show that drawdown at all wells plots quite nicely on a straight line on a log-linear plot. This is indicative of radial flow across the aquifer and a fairly homogenous aquifer, with no marked anisotropy on the horizontal plane. Analysis of the slope of drawdown over distance indicates a transmissivity of 301 m^2/day.

- As a fourth analysis, the Clark (1988) suite of pumping test analysis software was used to determine the analytical model which best approximates the observed drawdown at observation wells. This analysis was applied to data from observation wells completed in the aquifer unit consistent with the pumped well (S-1c sand unit) at distances less than 110 m from the pumped well. The analytical model which produces the best match with the observed data is a confined aquifer with a recharge boundary that reports at a distance of around 2500 m from the pumped well. Calculated transmissivity ranges from 351 to 386 m^2/day. Calculated Storativity ranges from 6.8 x 10^{-5} to 1 x 10^{-4}. Calculated leakance values ranged above approximately 20,000 m. Leakance values greater than approximately 2500 m are considered to indicate a confined rather than a leaky aquifer (Clark, 1988).

Table 6: 4M0008 CRT calculated aquifer parameters

Observation Well	Aquifer Unit	Analysis	T (m^2/day)	Comments
4M0001	Overlying	Drawdown	316	drawdown delayed by 0.1 d
		Recovery	351	recovery delayed at t/t' = 30
4M0003	S-2	Drawdown	361	boundary at t = 0.6 d
		Recovery	395	early time data
4M0004	S-1a	Drawdown	421	boundary at t = 0.5 d
		Recovery	287	early time data
4M0005	S-1c	Drawdown	351	boundary at t = 0.5 d
		Recovery	341	early time data
		Clark	351	S = 7.5 x 10^{-5}; Recharge boundary at 2500m
4M0006	S-1c	Drawdown	496	boundary at t = 0.6 d
		Recovery	332	early time data
		Clark	386	S = 1 x 10^{-4}; Recharge boundary at 2250m
4M0010	S-1c	Drawdown	361	boundary at t = 0.6 d
		Recovery	263	early time data
		Clark	386	S = 6.8 x 10^{-5}; Recharge boundary at 2250m
4M0011	S-1b	Drawdown	361	boundary at t = 0.5 d
		Recovery	308	early time data
All S-1c	Eyre Formation	Distance Drawdown	301	
		Average Transmissivity	**346**	**Average Storativity = 8.**1 x 10^{-5}

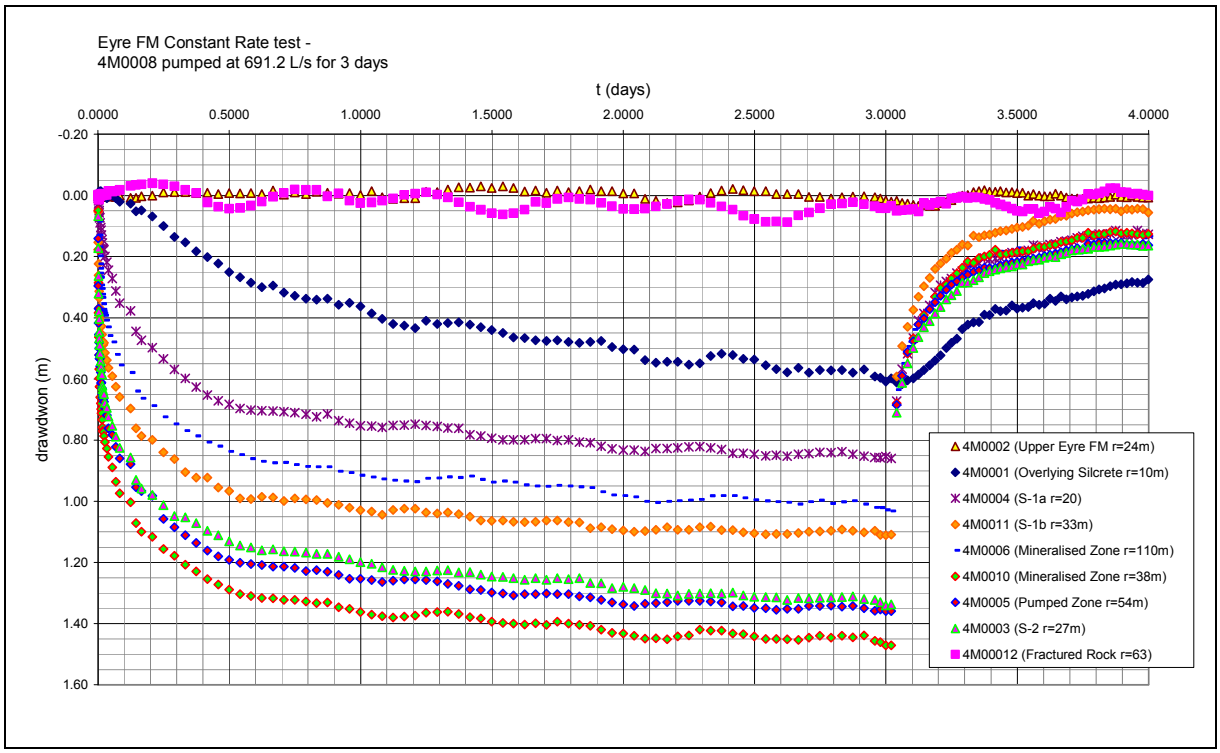


Figure 8: Test 2 Drawdown data - natural scale

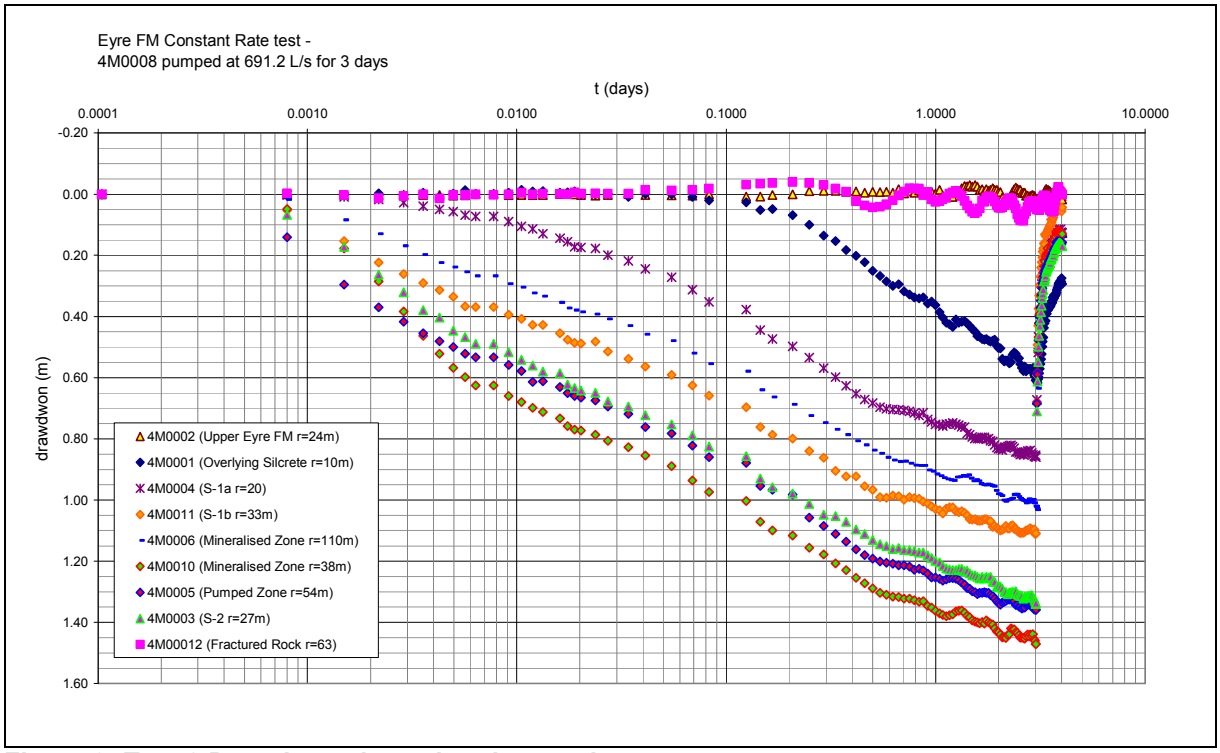


Figure 9: Test 2 Drawdown data – log time scale

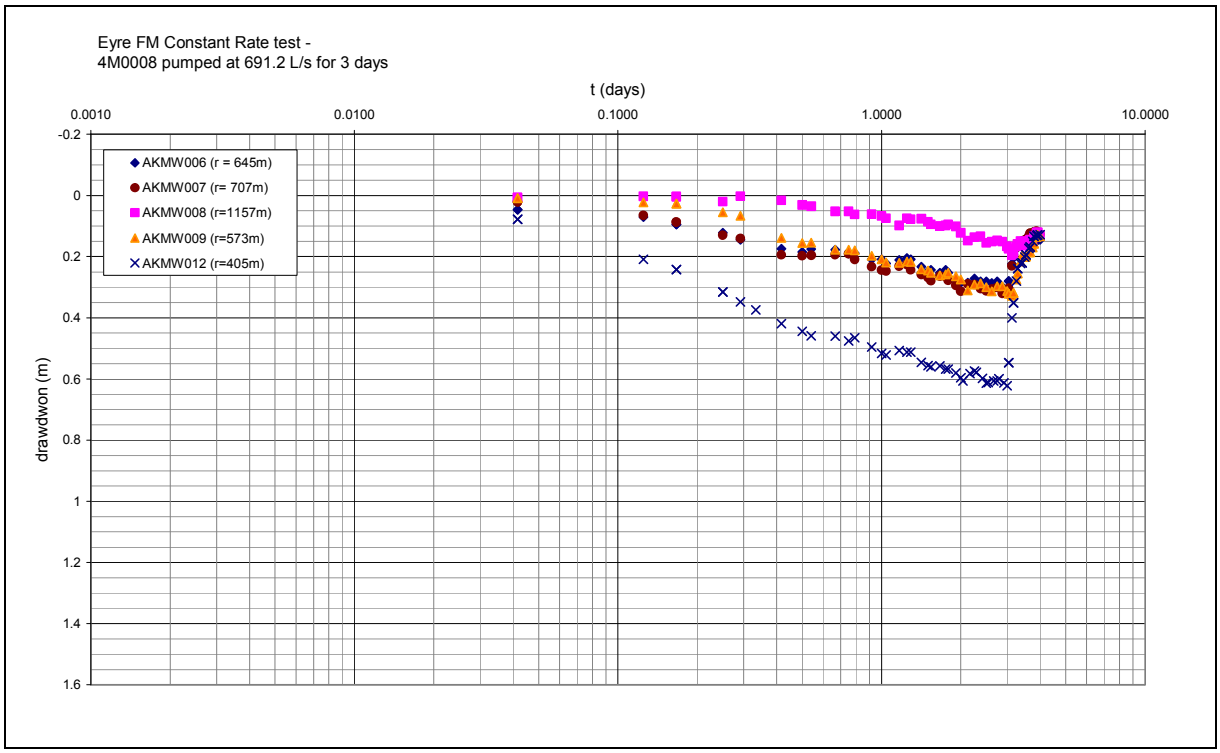


Figure 10: Test 2 Drawdown data –distant observation wells– log time scale

3.4 Test 3 4M0012 fractured rock aquifer test

An 8 hour constant rate test was undertaken pumping from well 4M0012 at 0.3 L/s. This well is completed in the fractured rock aquifer underlying the Eyre Formation at the BFME ore zone. Water level drawdown in the pumped well was measured using an air-line and Druck pressure gauge. Results are plotted in Appendix E. The Jacob Straight-Line analysis (Kruseman and Deridder 1994) was used to analyse this data to estimate a transmissivity of 1.44 m^2/day. The open-hole section of this well is 30 m in length, which translates to a bulk conductivity of 0.05 m/day for this aquifer at the BFME ore zone. The recovery plot indicates an open aquifer system with the recovery plot intersecting at t/t' >1.

3.5 Summary of Hydraulic Testing Results

The hydraulic testing indicates the following:

- The Eyre Formation is highly permeable and production well yields in excess of 5 L/s can be expected with very little drawdown
- The Eyre Formation behaves as one hydraulically connected aquifer.
- The silcrete layer at approx 180 mBGL does not serve as a competent aquitard. Leakage through this unit is demonstrated by drawdown in the observation well completed above the Silcrete layer.
- The Eyre Formation is confined by the low hydraulic conductivity of the overlying Namba Formation. The drawdown response to pumping in the Eyre Formation does not indicate significant leakage. The absence of drawdown in the observation well completed in the Namba Formation provides further evidence that this unit is not in good hydraulic connection to the Eyre Formation. In addition, the 20 mH_2O natural pressure difference between the two formations demonstrates hydraulic separation.
- The Basal Diamictite layer forms a competent underlying hydraulic boundary at the BFME ore zone. This is evidenced by the absence of drawdown in the underlying fractured rock aquifer in response to pumping from the Eyre Formation.
- The calculated Transmissivity of the Eyre Formation is approximately 350 m^2/day.
- The calculated Storativity of the Eyre Formation ranges from 6.8 $x10^{-5}$ to 1 $x10^{-4}$.
- The aquifer does not exhibit marked anisotropy on the horizontal plane on the scale of the tests. This is evidenced by the radial distribution of distance-drawdown data to a maximum distance of approximately 1000 m.
- A recharge boundary reports at a distance of about 2500 m from the pumped well. This may be due to either:
    - recharge via faulting in the underlying basement aquifer, or
    - recharge from laterally abutting fractured rock aquifers at the range front of the Flinders Ranges; or
    - A thickening of the Eyre Formation to yield a total transmissivity of approximately 550 m^2/day as indicated by the slope of drawdown over time after t = 0.5 days.

4 REFERENCES

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5 APPENDIX A: WELL DETAILS

Hole ID	rl	Total Depth	Screen From	Screen To	Comp. Type	GDA94_North	GDA94_East	A/L Rate l/sec
4M0001	139.10	164	150	156	4" two stage	6665160.00	358250.00	0.25
4M0002	138.86	120	109	116.5	4" single	6665135.70	358254.80	0
4M0003	138.91	222	213.5	216.5	4" single	6665153.30	358272.90	1
4M0004	139.11	198	184	190	4" single	6665145.60	358233.20	1.5
4M0005	139.30	188	204.5	208.5	4" single	6665203.90	358263.80	2.5
4M0006	139.50	210	199	204	4" single	6665255.90	358273.80	2
4M0008	139.02	212	201	206	6" two stage	6665158.90	358258.00	4
4M0009	139.10	206	203	206.5	6" two stage	6665186.60	358253.80	4
4M0010	138.80	228	201.5	205.5	4" single stage	6665135.00	358273.50	-
4M0011	139.07	212	196	200	4" single	6665171.40	358271.60	0
4M0012	138.60	268	238	268	6"	6665122.00	358297.30	-

6 APPENDIX B: 4M0008 STEP TEST ANALSYIS

MEMORANDUM

To: 4 Mile Team

CC:

From: Ben Jeuken

Date: 19/5/2008

Subject: Production Well Testing at Four Mile East

Summary

Test pumping of Well 4M0008 was undertaken at Four Mile East Ore Zone on 16/5/2008.

This well is screened for 5 m across the mineralised aquifer interval in the ore zone targeted for stage 1 mining.

Standing water level was 83.10 mBTOC (below top of casing).

A conservative flow rate which maximizes hydraulic efficiency and is not likely to result in chemical screen clogging is **7.5 L/s**. This would result in a pumping water level of **89 mBTOC**. This flow rate can be achieved with a grundfos pump that fits inside a 162 mm ID Class 10 PVC casing.

Flow rates of 20 L/s may be achievable with the following considerations:

- Increased pump and hence well casing diameter would be required.
- There is a possibility of chemical precipitation on screens due to pressure drop through the well screen. This could result in clogging.
- Pumping water level at 20 L/s would be approximately 96 mBTOC.

Introduction

This note outlines the well performance observed during test pumping at Four Mile East Ore Zone. This information can be used for flow rate specification, pump specification, and well casing internal diameter specification.

Method

Well 4M0008 was used as the test well. This well is completed as a single stage, 6 inch well. Production casing is nominal 6 inch Class 10 PVC (ID of 162 mm), pressure cemented in place. The screen is nominal 4 inch diameter proprietary TDC[1] slotted and grooved PVC, wrapped with 249 micron geotextile fabric. A 1.5 m sump is added. The screened interval is 5 m from 201.3 to 206.3 mBGL (meters below ground level). The well is screened across the main mineralised aquifer interval adjacent to exploration core hole AKC029.

At this site. the aquifer extends from 179 to 216 mBGL for a total thickness of 37 m. The main mineralised zone is approximately 5 m thick.

[1] Thompson Drilling Company

Test pumping was undertaken on 16/5/2008 for four steps each 100 minutes in duration. Flow rate was increased from 2, to 4, to 6, to 8 L/s for each subsequent step. Flow control was maintained using a variable speed drive pump and gate valve. Flow was monitored using a mag-flow flow meter. Drawdown in the pumped well was measured manually using an electric water level probe inside a small pvc conductor tube.

Results

Standing water level prior to pumping was 83.10 mBTOC. Drawdown during pumping is shown in Figure 1 and Appendix 1. Maximum drawdown following pumping the final step at 8 L/s for 100 min was 4.6 m resulting in a pumping water level of 87.7 mBTOC. This small drawdown indicates an efficient well and a relatively high transmissivity[2]. Derived aquifer transmissivity is 231 m^2/day.

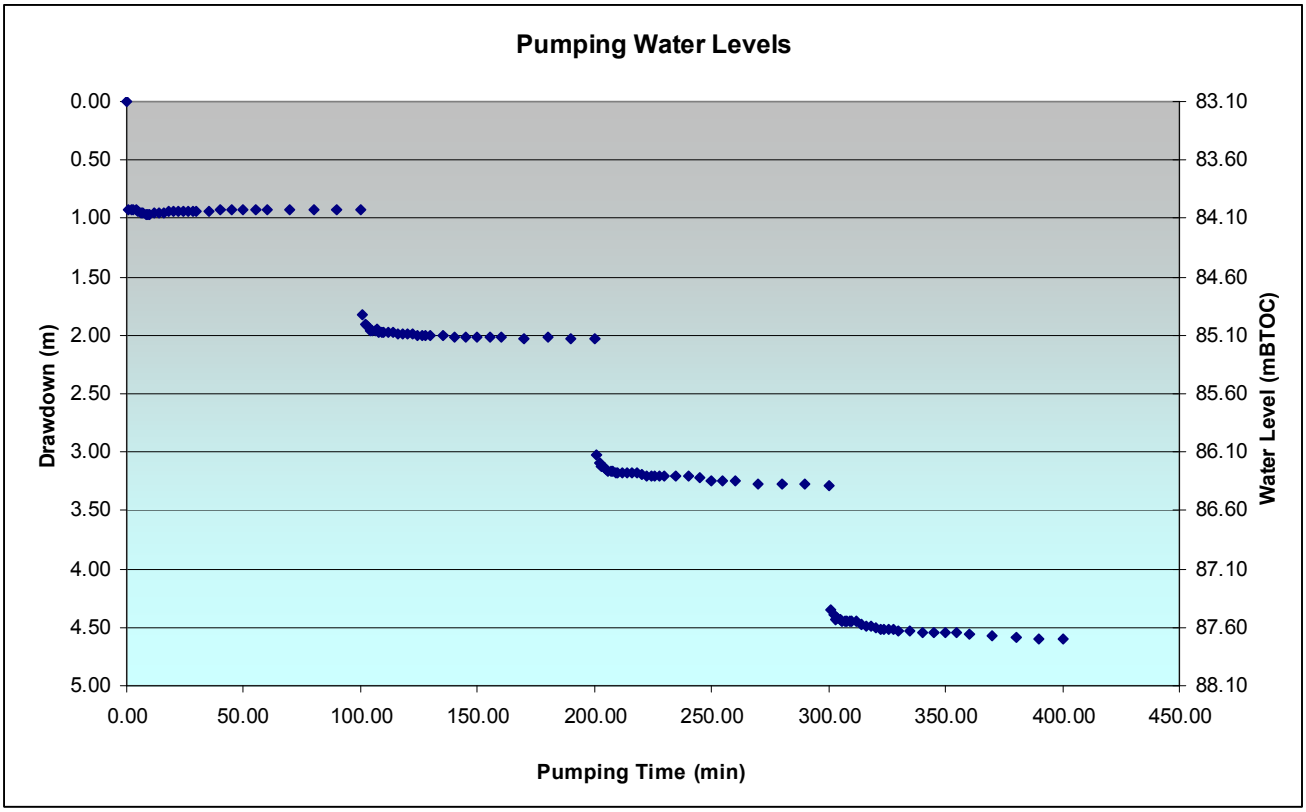


Figure 1: Step Test drawdown data. Flow rates were 2, 4, 6 and 8 L/s for 100 minute steps.

[2] For comparison; at Beverley Mine in Deep South, Dragon ore zone, pumping at 4 L/s for 60 min resulted in 30 m drawdown.

Well Equation

The step test drawdown data was analyzed using Clarke Groundwater Software (Clark, 1988) to determine the well equation constants for this well.

The derived equation is:

$$S = 0.006\ (Q) + 7.9\ e^{-4}.(Q)\ .\log\ (t) \times 2.6e^{-6}.Q^2$$

Where:

Derived Aquifer transmissivity = 231 m^2/day.

S = drawdown (m)
Q = flow rate (m^3/day)
t = time of pumping (days)

The drawdown for various flow rates predicted using this equation is plotted on Figure 2. This figure also presents observed data.

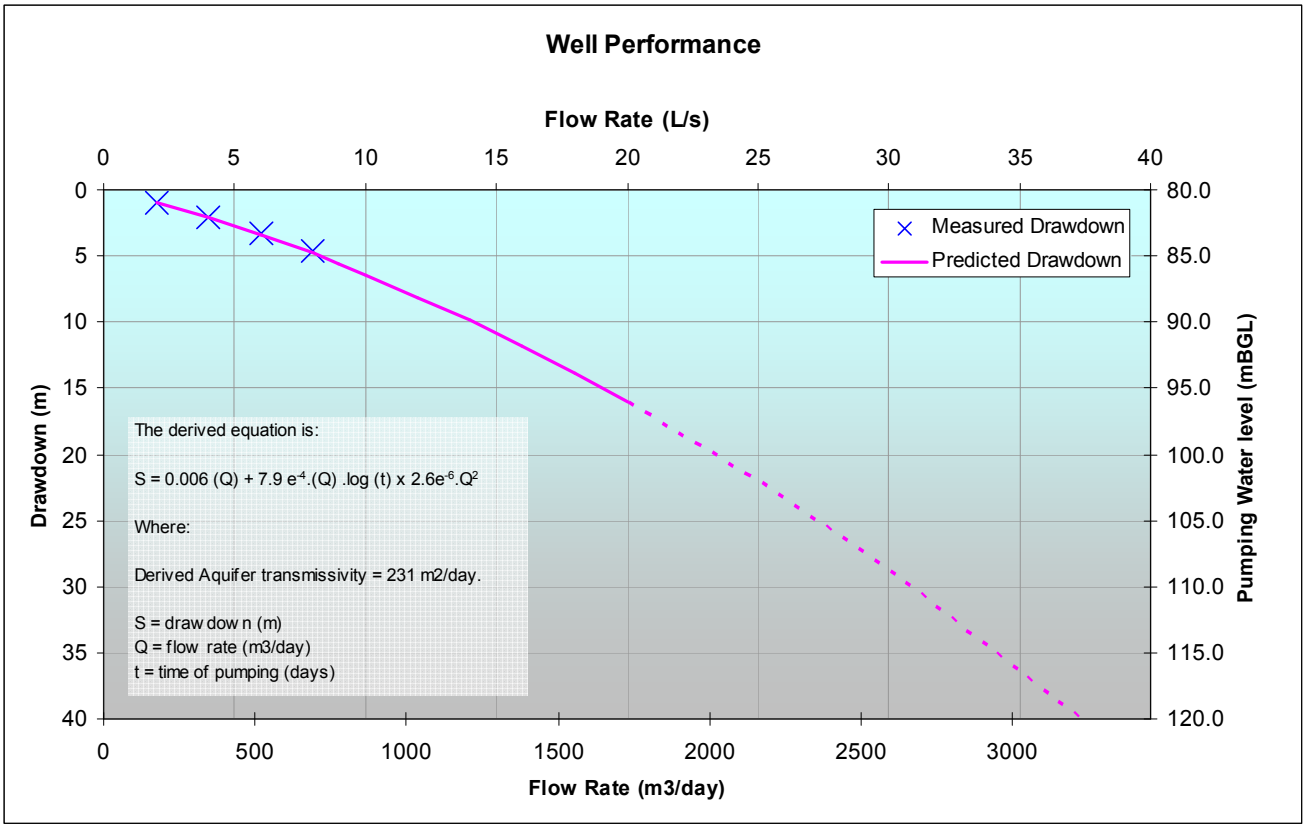


Figure 2: Well Performance. Water levels following pumping for 100 minutes are plotted. Well equation is derived from step s\test pumping data using Clarke (1988).

Production Capacity

Production capacity of a well is constrained by three factors:

- Well Capacity
- Rising velocity
- Well Screen Entrance velocity.

Well Capacity
The available drawdown in this aquifer is around 100 m (SWL = 80 mBGL, pump setting 180 mBGL) The calculated well equation indicates that wells completed in this aquifer unit could achieve flow rates far exceeding 35 L/s if all the available drawdown were utilized (Figure 1).

Rising Velocity
The rising velocity of water in the well casing and screen should ideally be less than 1.5 m/s (Driscoll, 2008)[3]. For the nominal 100 mm ID screen this equates to a maximum flow of roughly 10 L/s. At higher flow rates, friction and turbulent flow will result in reduced well efficiency.

Well Screen Entrance Velocity
One area of some controversy has to do with the recommended flow velocity through the screen. In normal water well design, flow velocity through the well screen and its associated pressure drop, is an issue of throughput and pumping costs. While these are also important in in-situ mining, minimization of pressure drop through the screen may also be important due to kinetics of the fluid chemistry, where higher entrance velocity, and hence pressure drop, may lead to precipitation of solids from the ion-saturated lixiviant in the area near the well.

Driscoll (2008)[3], published by the manufacturer of Johnson Screens, recommends a maximum entrance velocity of 0.03 m /s. In contrast, the American Water Works Association (AWWA, 1973)[4], recommends a much higher maximum entrance velocity of 0.5 m/s.

The slotted and grooved 4 inch PVC screens sourced from TDC, in conjunction with geotextile fabric, yields an effective screen open area of 16% (Aquaterra, not dated). Table 1 and Figure 3 present the calculated maximum flow rates achievable for varying screen lengths using the two threshold values for entrance velocity (Driscoll, 2008 and AWWA, 1973). This figure demonstrates the large variation between the two specifications of entrance velocity. Based on this information, maximum efficient flow rates for a 5 m screen are between 7.5 and 125 L/s.

Table 1: Maximum flow rate (L/s) for varying screen lengths using two entrance velocity thresholds.

Length	Max Flow. (0.03 m/sec entrance velocity)	Max Flow (0.5m/sec entrance velocity)
2	3	50
3	4.5	75
4	6	100
5	7.5	125
6	9	150

[3] Driscoll 2008, Groundwater and Wells. Published by Johnson Screens Pty Ltd Minnesota USA
[4] American Water Works Association (Manual M21 (1973)

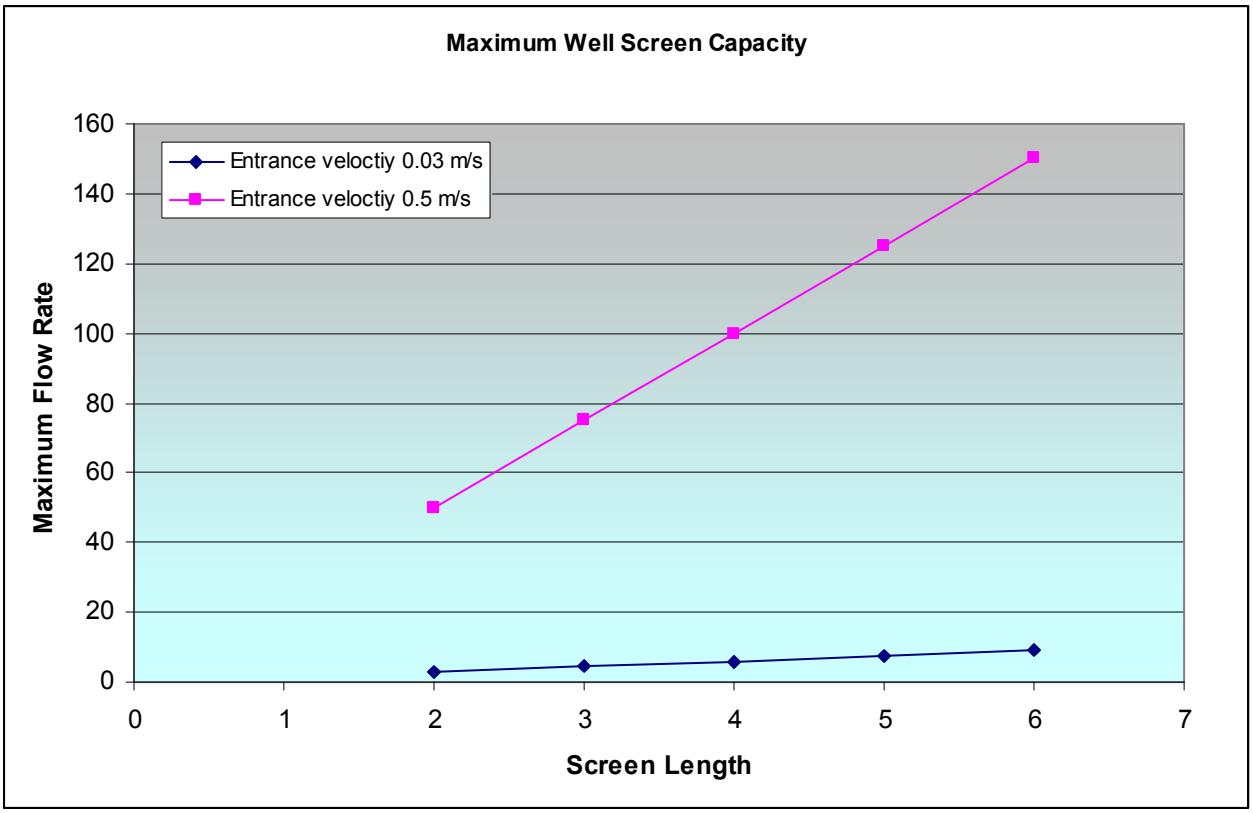


Figure 3: Maximum well screen capacity. Estimates are based on two maximum screen entrance velocities; 0.03 m/s (Driscoll, 2008); and 0.5 m/s (AWWA, 1973).

Recommended Flow Rates

A summary of the factors constraining well flow rate is presented in Table 2.

Table 2: Factors constraining well flow rate.

Constraining Factor	Max Flow Rate
Well Capacity	>35 L/s
Rising Velocity	< 10L/s
Well Screen Entrance Velocity	7.5 to 125 L/s

The flow rate which is most efficient in terms of drawdown, and associated pumping and power costs, and is most unlikely to result in chemical precipitation on the well screens is 7.5 L/s. This pumping rate would result in drawdown of around 6.0 m. Further drawdown over time would not occur in an ISR situation due to balancing injection of lixiviant at adjacent wells.

It would be worthwhile trialling higher pumping rates in the order of 20 L/s given that the well capacity is available, and the increase power consumption resulting from friction and turbulence effects would be relatively low. The main constraint to implementing higher flow rates would be chemical precipitation around well screens which might occur due to a significant pressure drop across the screen at higher flow rates. However the occurrence of encrustation due to high flow rates not confirmed.

Another factor impacting on selection of flow rate is the diameter of the pump (And hence bore diameter) required to achieve the desired flow rate. Flow rates greater than 10 L/s will require an 8 inch diameter production casing, whilst flow rates greater than 20 L/s will most likely require a 10 inch diameter production casing.

Appendix B.A.1: Step Test Data

t (min)	t (days)	SWL (mBTOC)	Flow Rate (m3/day)	drawdown (m)
0.00	0.00000	83.10	0	0.00
1.00	0.00069	84.03	172.8	0.93
2.00	0.00139	84.03	172.8	0.93
3.00	0.00208	84.03	172.8	0.93
4.00	0.00278	84.03	172.8	0.93
5.00	0.00347	84.04	172.8	0.94
6.00	0.00417	84.05	172.8	2.00
7.00	0.00486	84.05	172.8	0.95
8.00	0.00556	84.06	172.8	0.96
9.00	0.00625	84.06	172.8	0.96
10.00	0.00694	84.07	172.8	0.97
12.00	0.00833	84.05	172.8	0.95
14.00	0.00972	84.05	172.8	0.95
16.00	0.01111	84.05	172.8	0.95
18.00	0.01250	84.04	172.8	0.94
20.00	0.01389	84.04	172.8	0.94
22.00	0.01528	84.04	172.8	0.94
24.00	0.01667	84.04	172.8	0.94
26.00	0.01806	84.04	172.8	0.94
28.00	0.01944	84.04	172.8	0.94
30.00	0.02083	84.04	172.8	0.94
35.00	0.02431	84.04	172.8	0.94
40.00	0.02778	84.03	172.8	0.93
45.00	0.03125	84.02	172.8	0.92
50.00	0.03472	84.02	172.8	0.92
55.00	0.03819	84.02	172.8	0.92
60.00	0.04167	84.03	172.8	0.93
70.00	0.04861	84.03	172.8	0.93
80.00	0.05556	84.02	172.8	0.92
90.00	0.06250	84.02	172.8	0.92
100.00	0.06944	84.02	172.8	0.92
101.00	0.07014	84.93	345.6	1.83
102.00	0.07083	85.00	345.6	1.90
103.00	0.07153	85.02	345.6	1.92
104.00	0.07222	85.06	345.6	1.96
105.00	0.07292	85.06	345.6	1.96
106.00	0.07361	85.06	345.6	1.96
107.00	0.07431	85.05	345.6	1.95
108.00	0.07500	85.07	345.6	1.97
109.00	0.07569	85.08	345.6	1.98
110.00	0.07639	85.08	345.6	1.98
112.00	0.07778	85.08	345.6	1.98
114.00	0.07917	85.08	345.6	1.98
116.00	0.08056	85.09	345.6	1.99
118.00	0.08194	85.09	345.6	1.99
120.00	0.08333	85.09	345.6	1.99
122.00	0.08472	85.09	345.6	1.99
124.00	0.08611	85.10	345.6	2.00
126.00	0.08750	85.10	345.6	2.00
128.00	0.08889	85.10	345.6	2.00
130.00	0.09028	85.10	345.6	2.00
135.00	0.09375	85.10	345.6	2.00
140.00	0.09722	85.11	345.6	2.01
145.00	0.10069	85.12	345.6	2.02
150.00	0.10417	85.12	345.6	2.02
155.00	0.10764	85.11	345.6	2.01
160.00	0.11111	85.11	345.6	2.01
170.00	0.11806	85.13	345.6	2.03
180.00	0.12500	85.12	345.6	2.02
190.00	0.13194	85.13	345.6	2.03
200.00	0.13889	85.13	345.6	2.03
201.00	0.13958	86.12	518.4	3.02
202.00	0.14028	86.19	518.4	3.09
203.00	0.14097	86.22	518.4	3.12
204.00	0.14167	86.23	518.4	3.13
205.00	0.14236	86.25	518.4	3.15
206.00	0.14306	86.26	518.4	3.16
207.00	0.14375	86.26	518.4	3.16
208.00	0.14444	86.26	518.4	3.16
209.00	0.14514	86.27	518.4	3.17
210.00	0.14583	86.27	518.4	3.17
212.00	0.14722	86.27	518.4	3.17
214.00	0.14861	86.28	518.4	3.18
216.00	0.15000	86.28	518.4	3.18
218.00	0.15139	86.28	518.4	3.18
220.00	0.15278	86.29	518.4	3.19
222.00	0.15417	86.30	518.4	3.20
224.00	0.15556	86.30	518.4	3.20
226.00	0.15694	86.30	518.4	3.20
228.00	0.15833	86.30	518.4	3.20
230.00	0.15972	86.30	518.4	3.20
235.00	0.16319	86.31	518.4	3.21
240.00	0.16667	86.31	518.4	3.21
245.00	0.17014	86.32	518.4	3.22
250.00	0.17361	86.34	518.4	3.24
255.00	0.17708	86.34	518.4	3.24
260.00	0.18056	86.35	518.4	3.25
270.00	0.18750	86.37	518.4	3.27

280.00	0.19444	86.37	518.4	3.27
290.00	0.20139	86.38	518.4	3.28
300.00	0.20833	86.39	518.4	3.29
301.00	0.20903	87.45	691.2	4.35
302.00	0.20972	87.49	691.2	4.39
303.00	0.21042	87.53	691.2	4.43
304.00	0.21111	87.52	691.2	4.42
305.00	0.21181	87.54	691.2	4.44
306.00	0.21250	87.55	691.2	4.45
307.00	0.21319	87.55	691.2	4.45
308.00	0.21389	87.55	691.2	4.45
309.00	0.21458	87.55	691.2	4.45
310.00	0.21528	87.55	691.2	4.45
312.00	0.21667	87.55	691.2	4.45
314.00	0.21806	87.58	691.2	4.48
316.00	0.21944	87.59	691.2	4.49
318.00	0.22083	87.59	691.2	4.49
320.00	0.22222	87.60	691.2	4.50
322.00	0.22361	87.61	691.2	4.51
324.00	0.22500	87.61	691.2	4.51
326.00	0.22639	87.62	691.2	4.52
328.00	0.22778	87.62	691.2	4.52
330.00	0.22917	87.63	691.2	4.53
335.00	0.23264	87.63	691.2	4.53
340.00	0.23611	87.64	691.2	4.54
345.00	0.23958	87.65	691.2	4.55
350.00	0.24306	87.65	691.2	4.55
355.00	0.24653	87.65	691.2	4.55
360.00	0.25000	87.66	691.2	4.56
370.00	0.25694	87.67	691.2	4.57
380.00	0.26389	87.68	691.2	4.58
390.00	0.27083	87.70	691.2	4.60
400.00	0.27778	87.70	691.2	4.60
420.00	0.29167	87.72	691.2	4.62
440.00	0.30556	87.74	691.2	4.64
460.00	0.31944	87.73	691.2	4.63
480.00	0.33333	87.75	691.2	4.65

7 APPENDIX C: 4M0008 CONSTANT RATE TEST DRAWDOWN AND RECOVEREY PLOTS

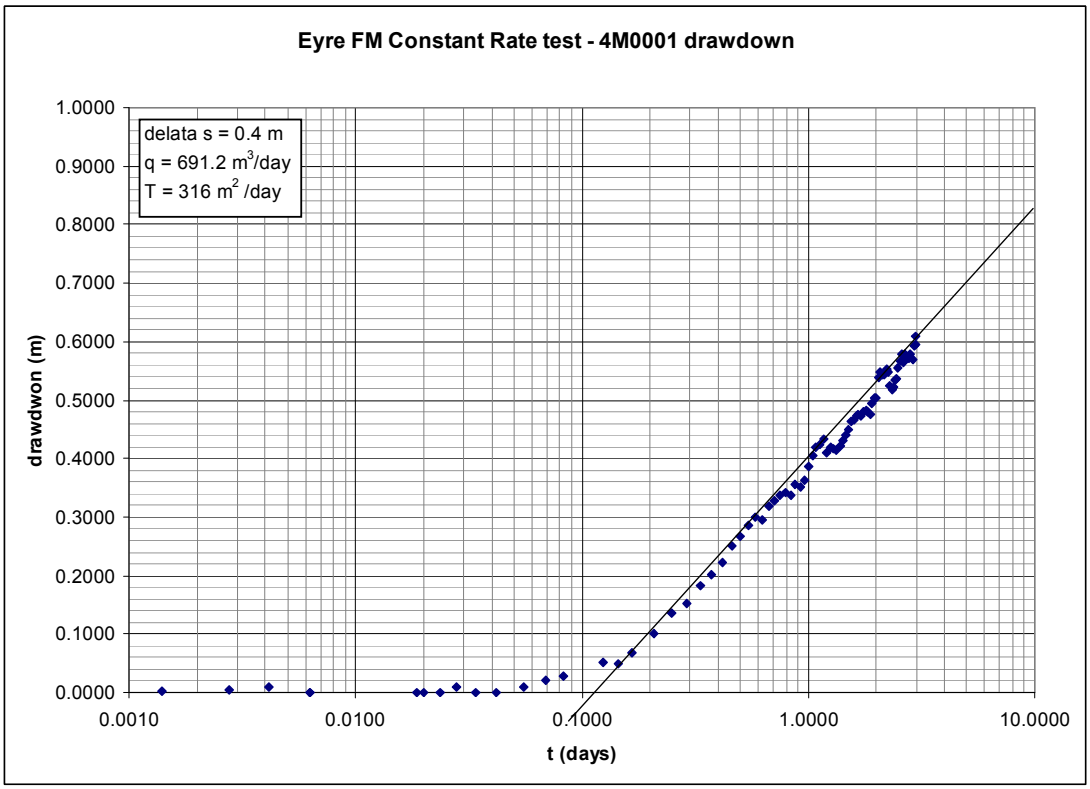


Figure 11: Test 2 4M0001 Drawdown Data

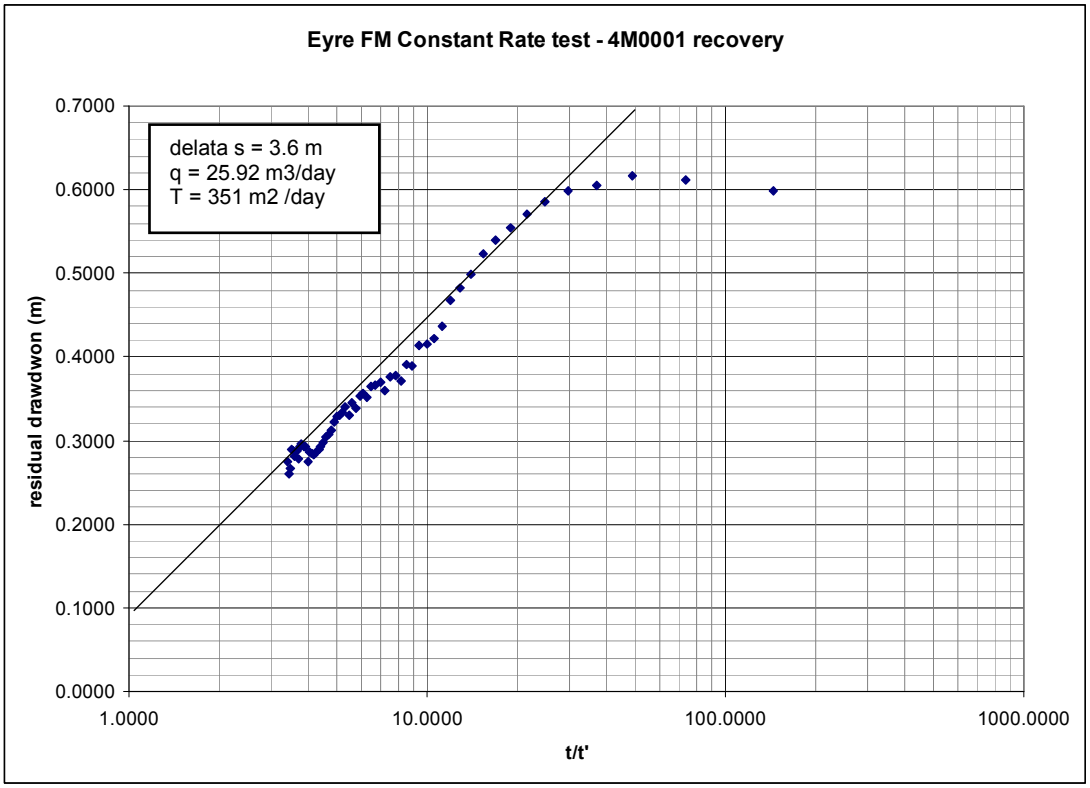


Figure 12: Test 2 4M0001 Recovery Data

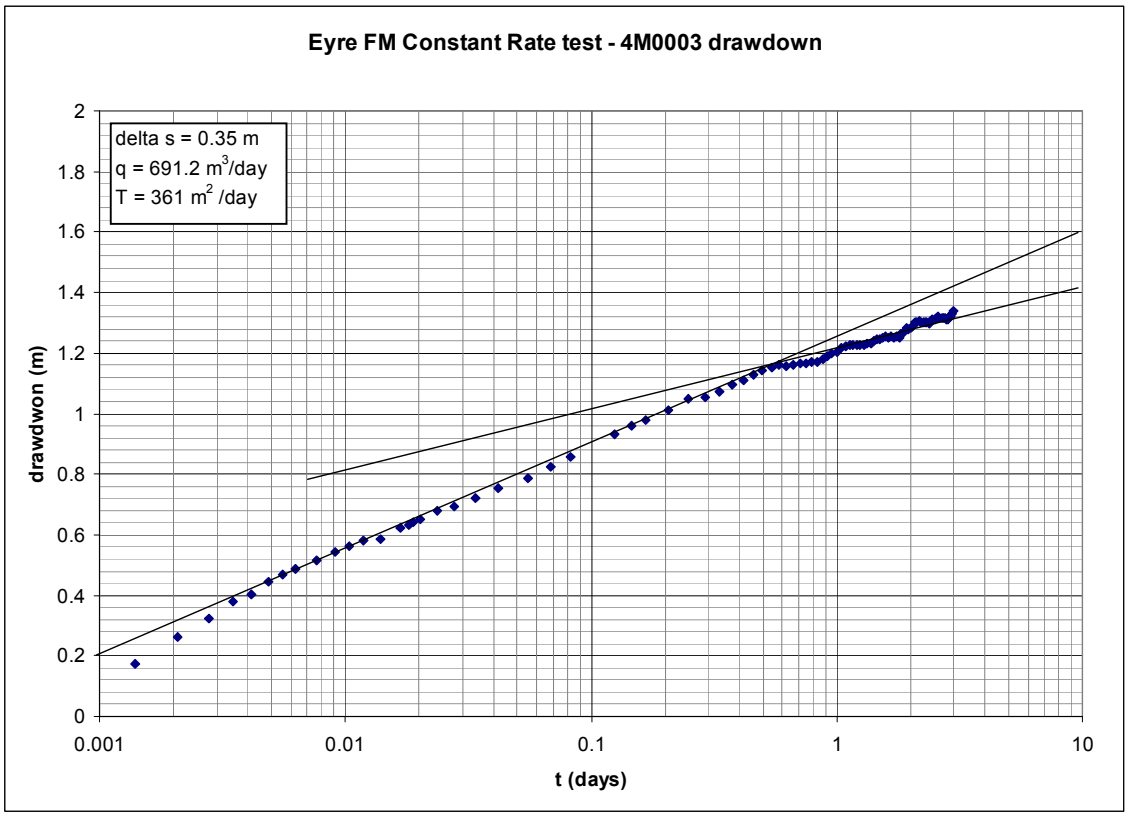


Figure 13: Test 2 4M0003 Drawdown Data

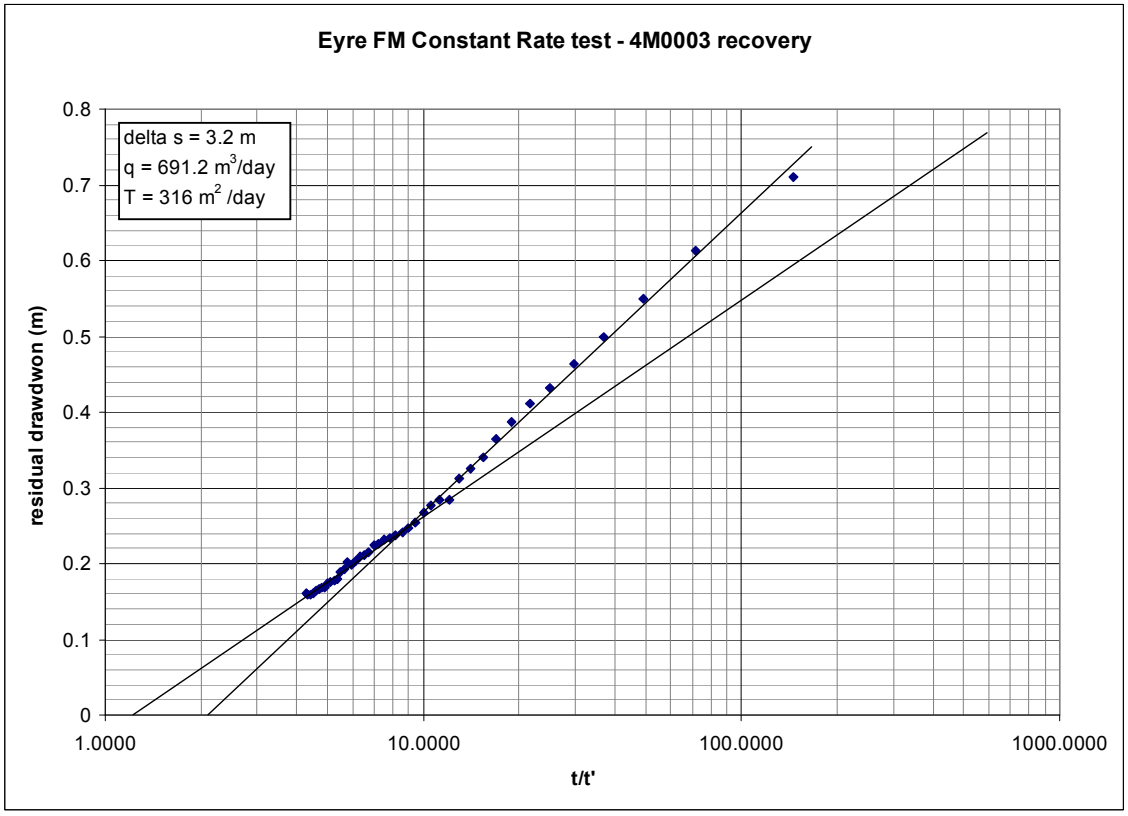


Figure 14: Test 2 4M0003 Recovery Data

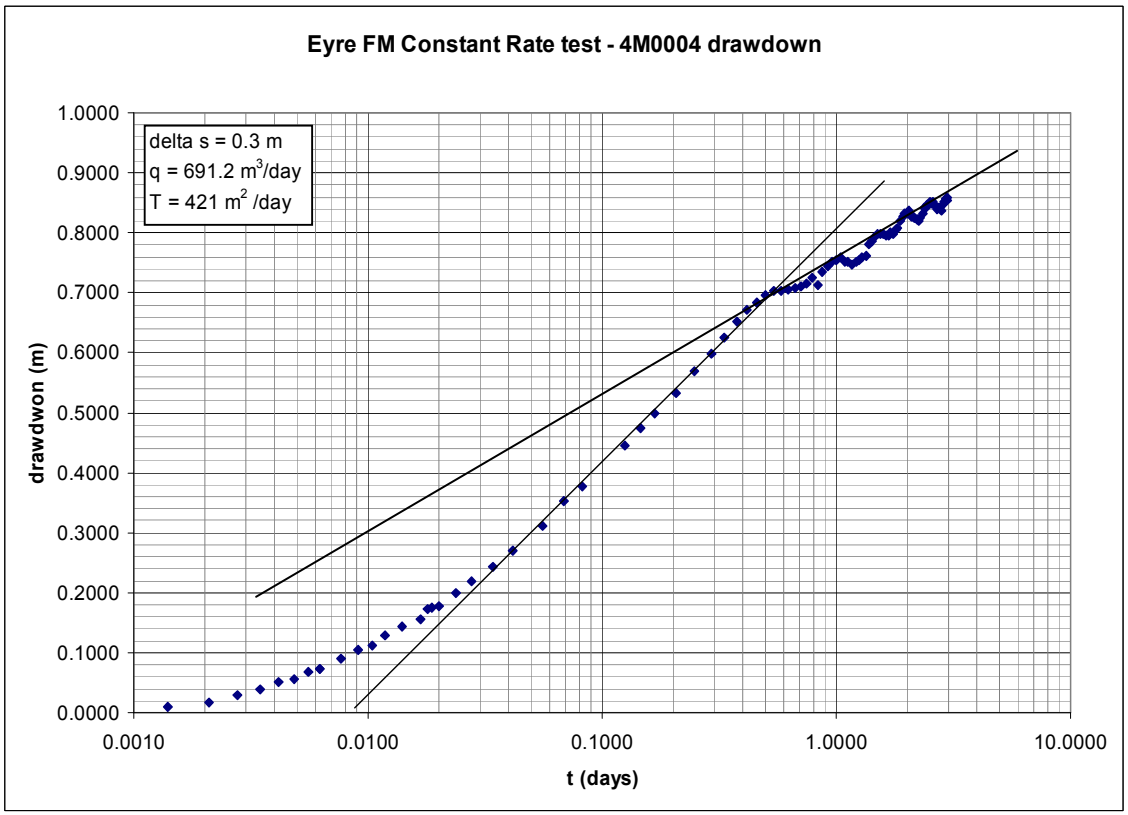


Figure 15: Test 2 4M0004 Drawdown Data

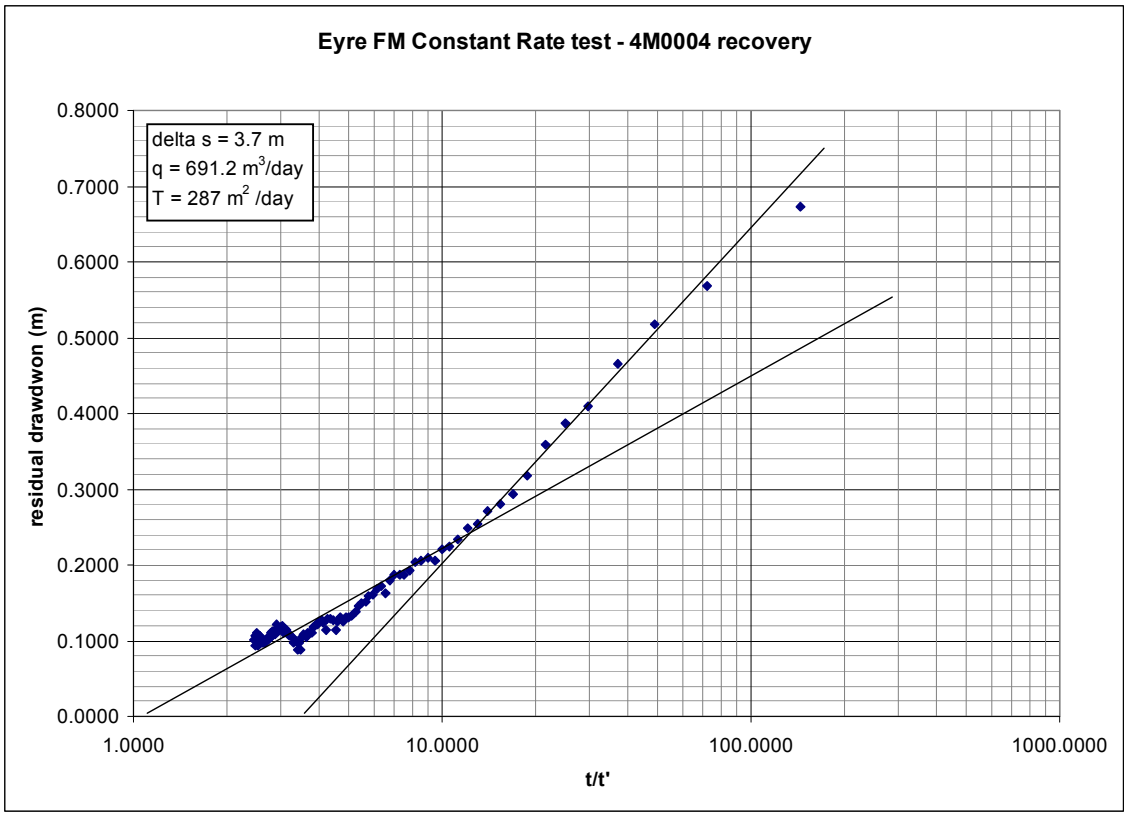


Figure 16: Test 2 4M0004 Recovery Data

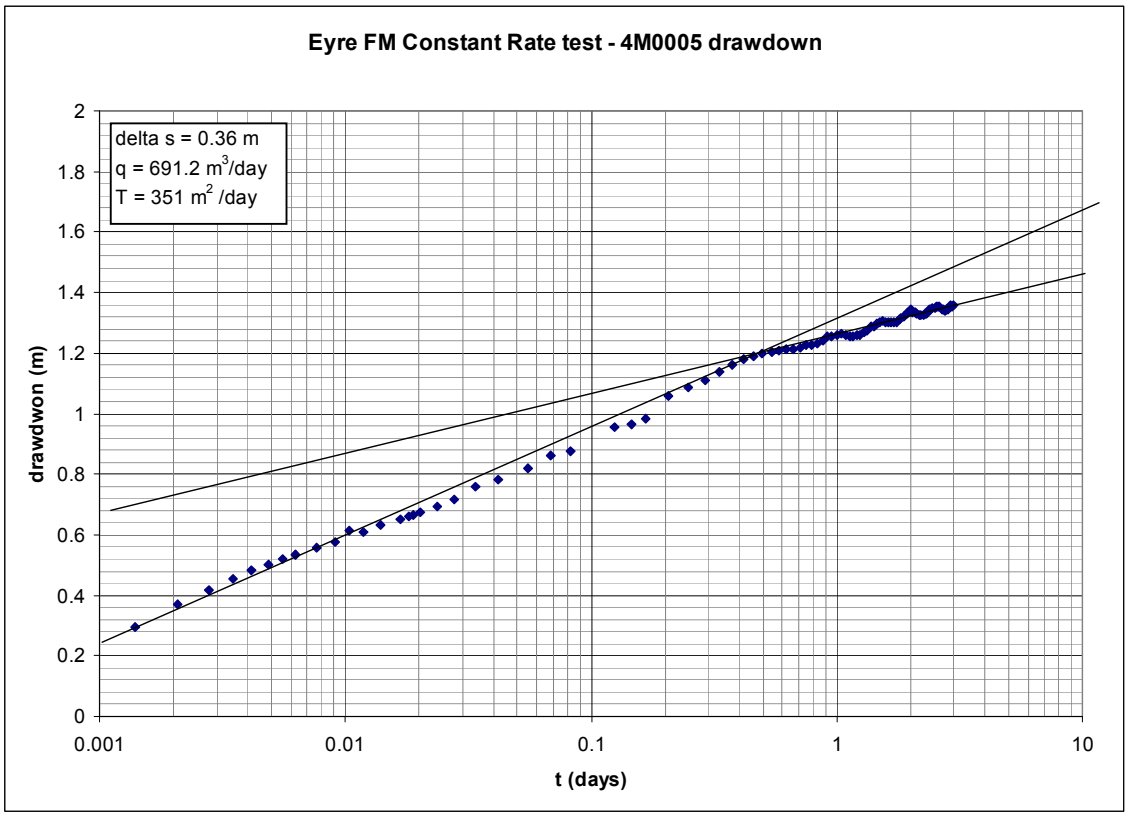


Figure 17: Test 2 4M0005 Drawdown Data

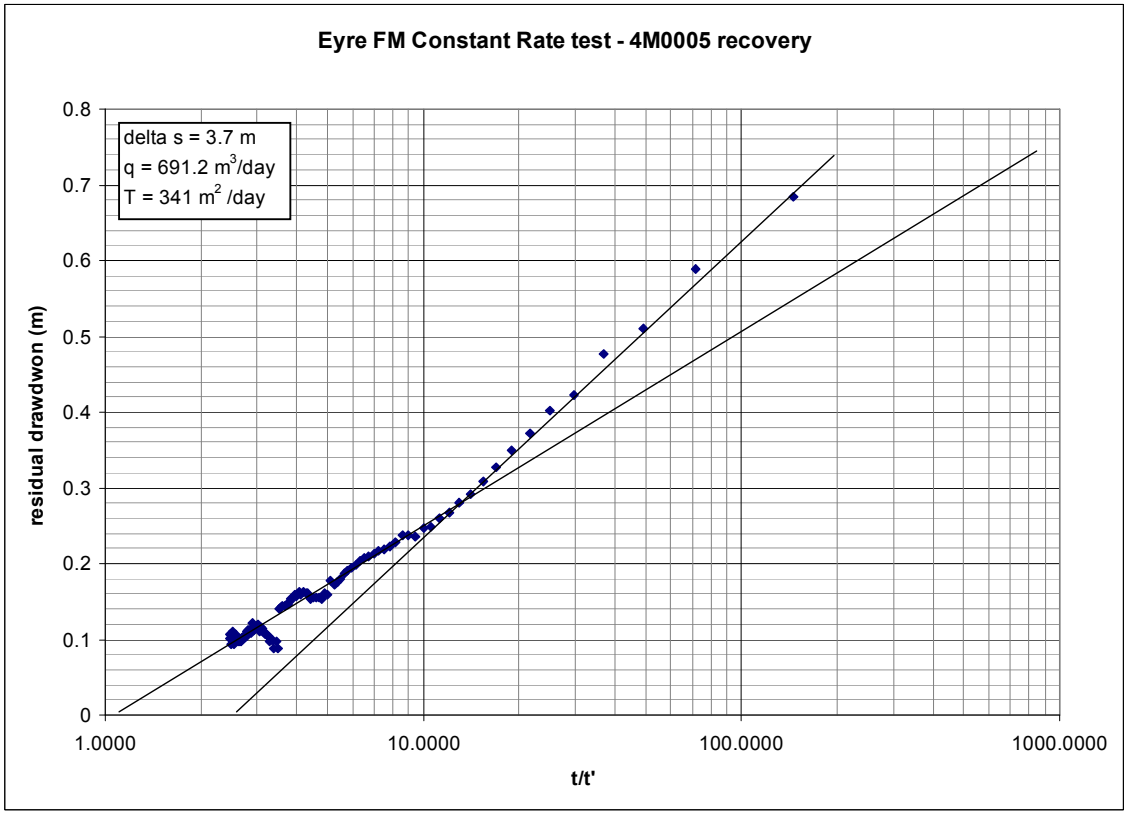


Figure 18: Test 2 4M0005 Recovery Data

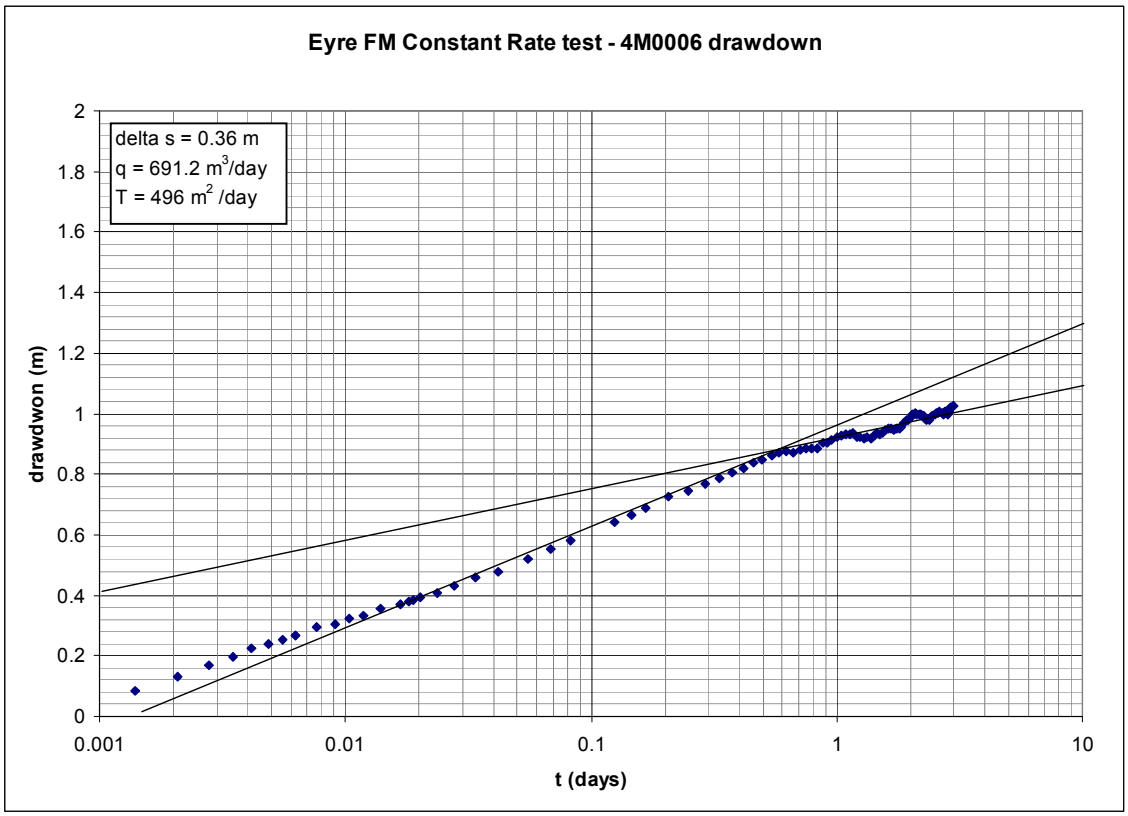


Figure 19: Test 2 4M0006 Drawdown Data

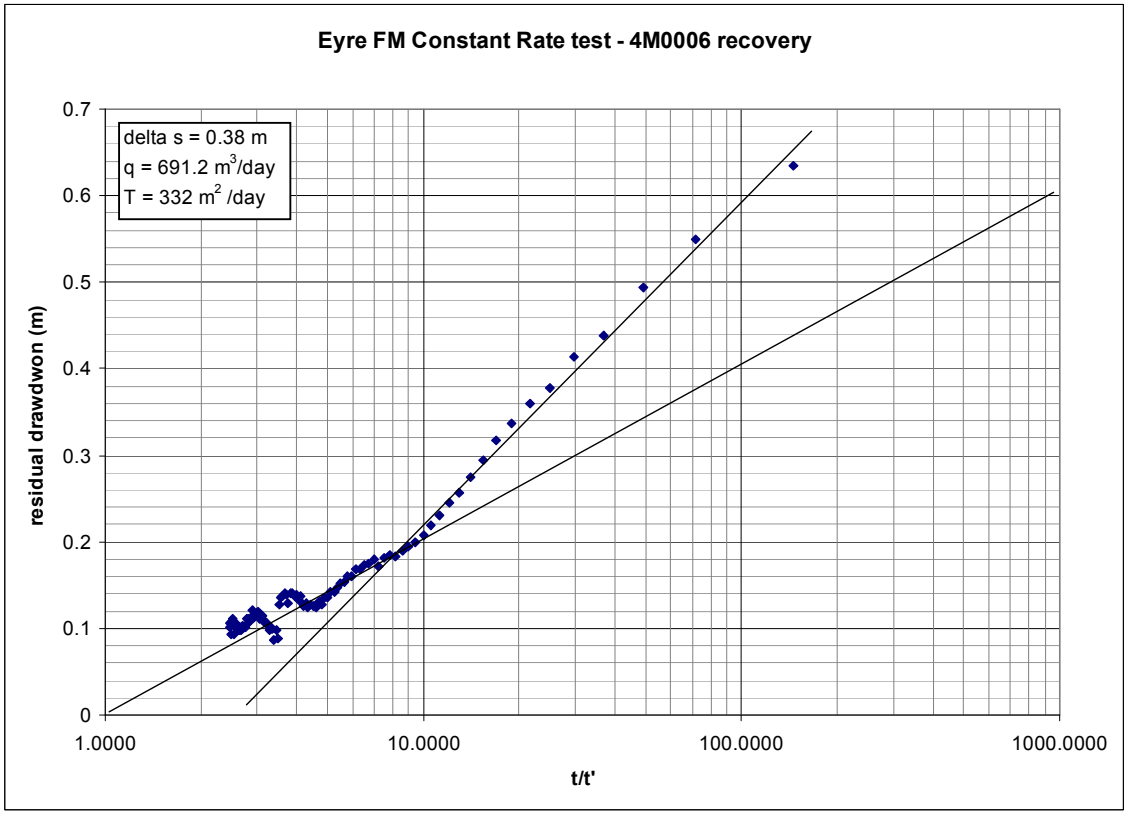


Figure 20: Test 2 4M0006 Recovery Data

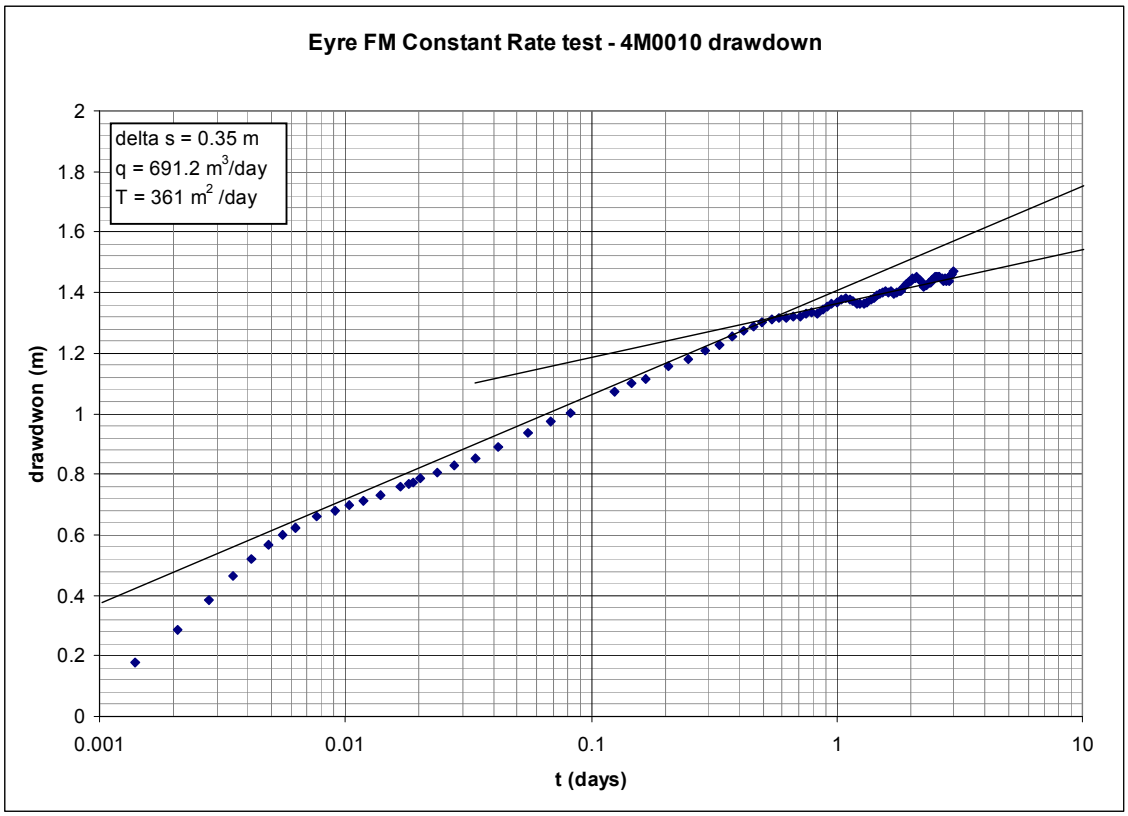


Figure 21: Test 2 4M0010 Drawdown Data

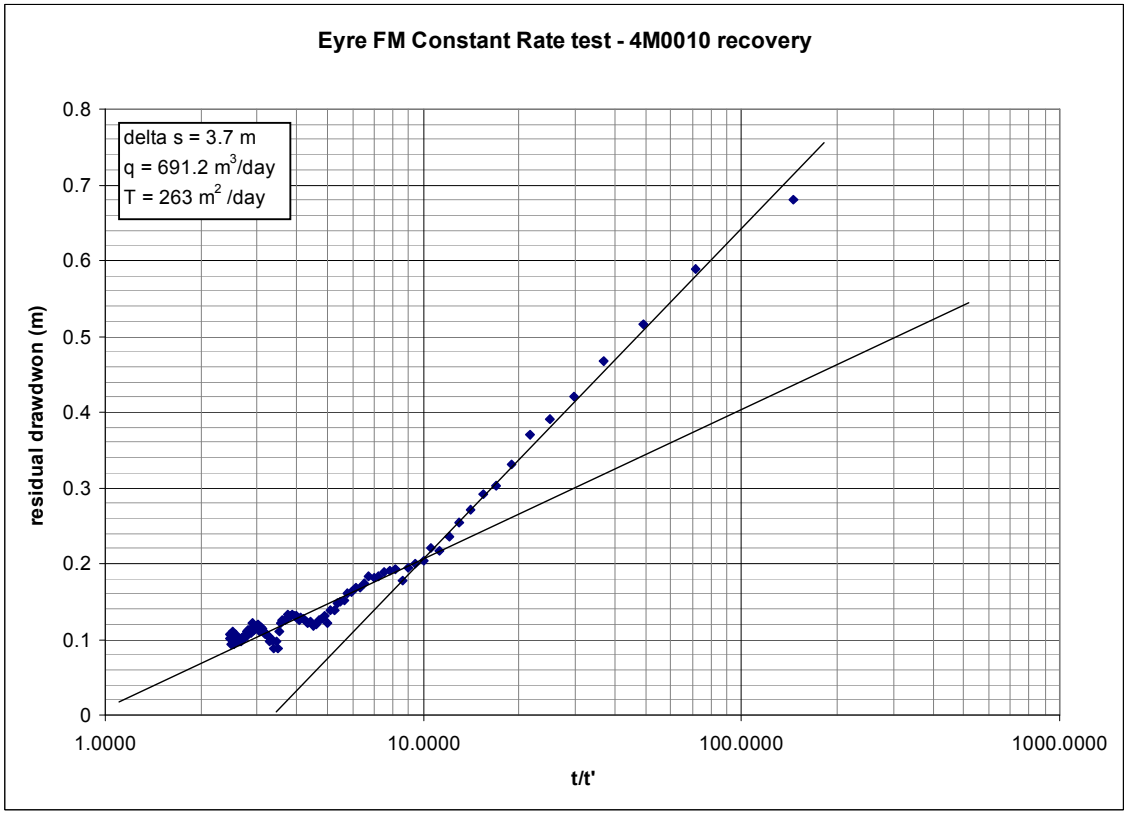


Figure 22: Test 2 4M0010 Recovery Data

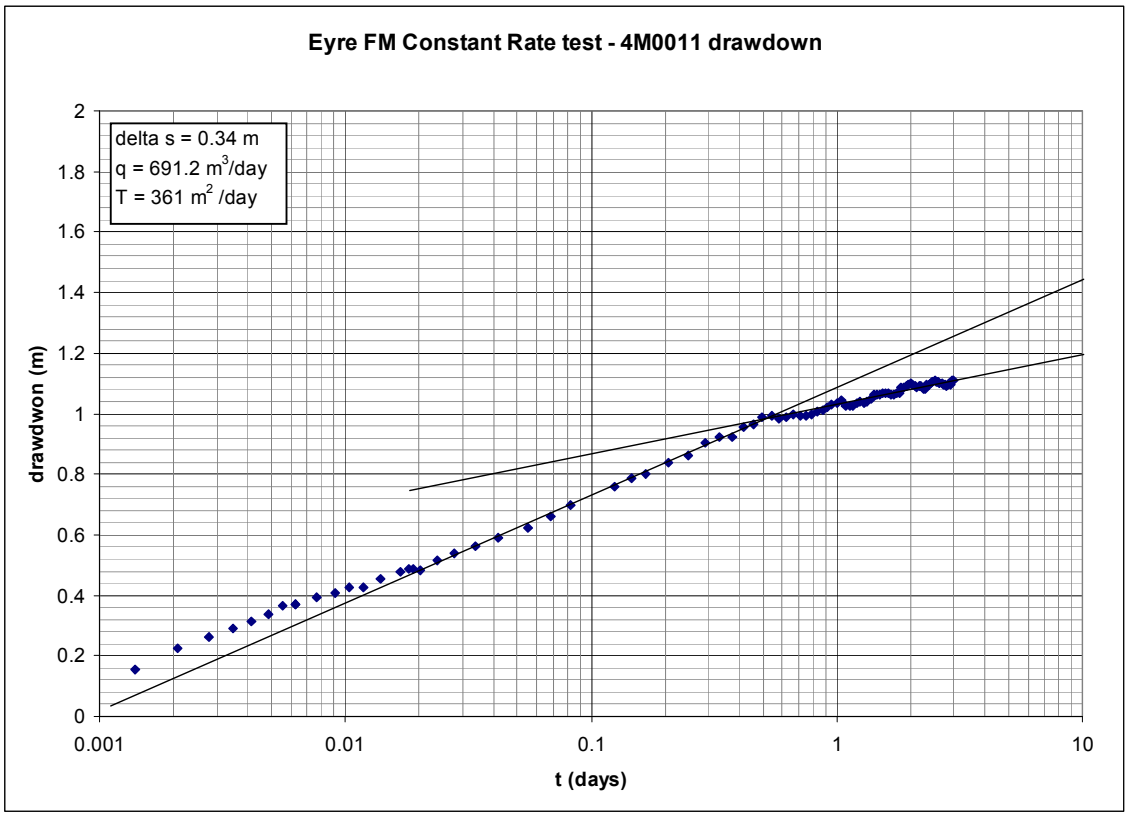


Figure 23: Test 2 4M0001 Drawdown Data

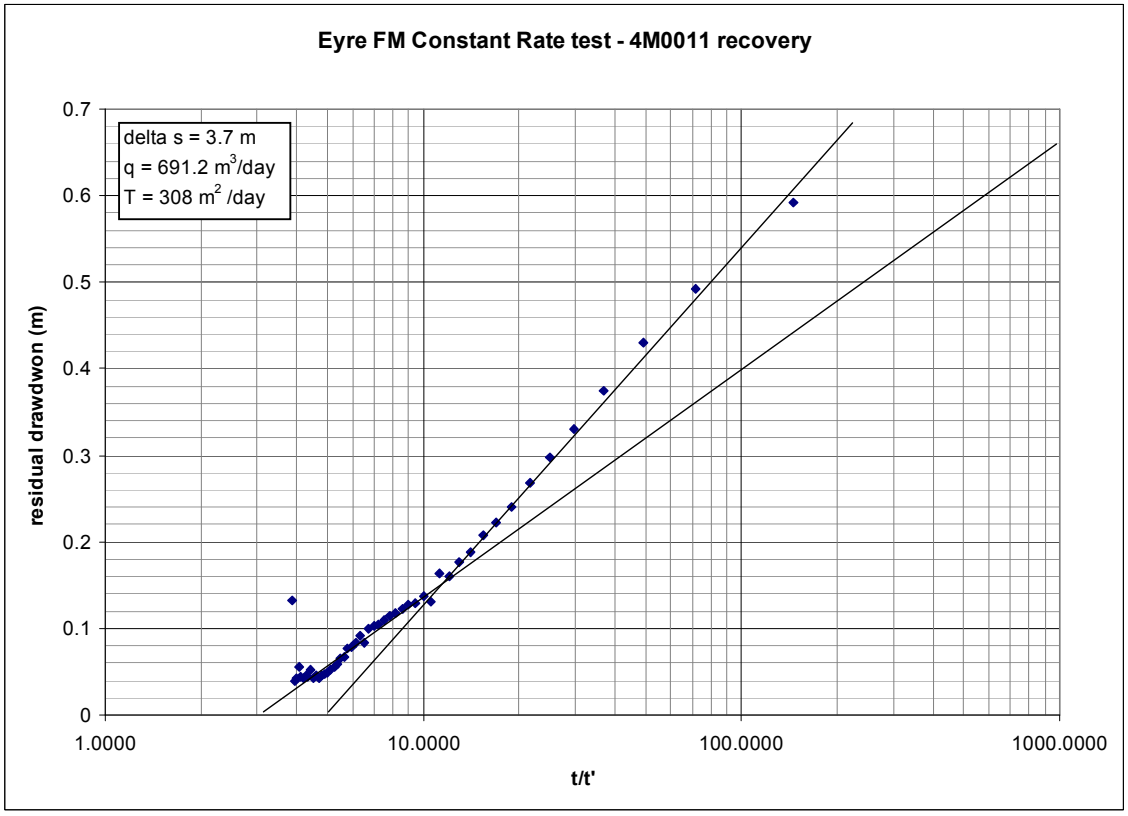


Figure 24: Test 2 4M0011 Recovery Data

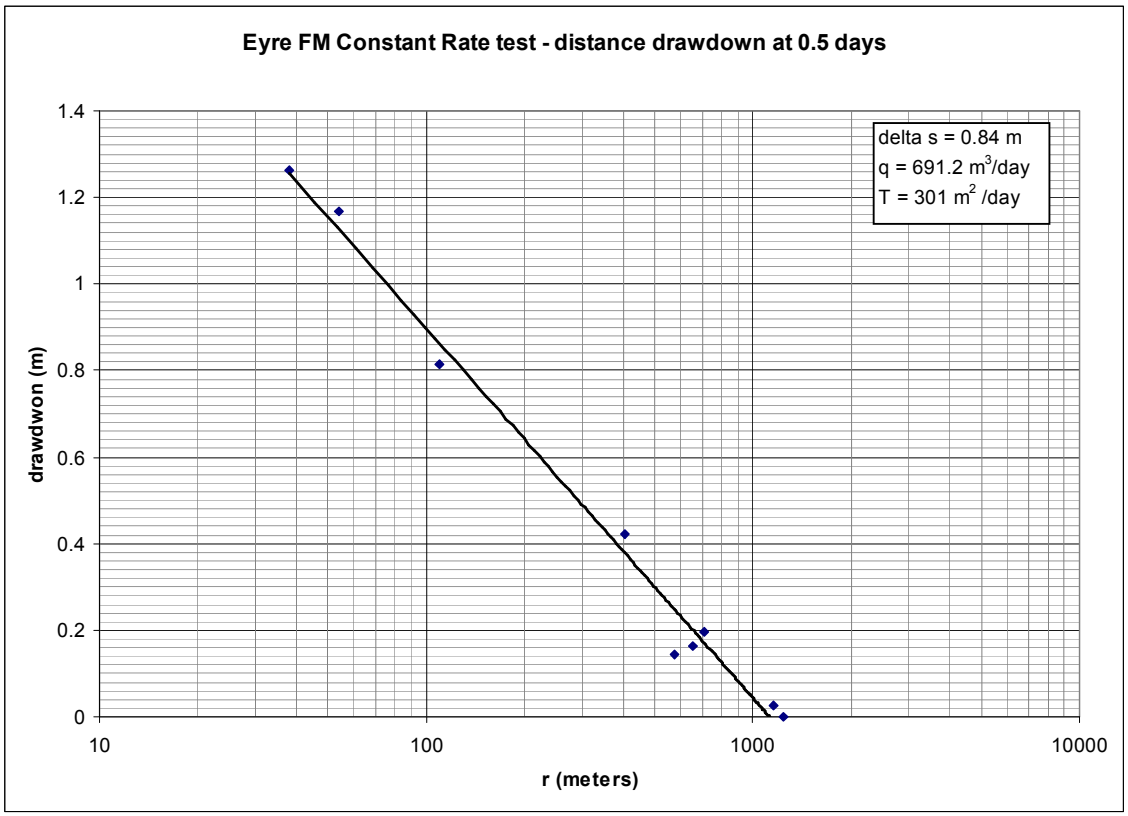
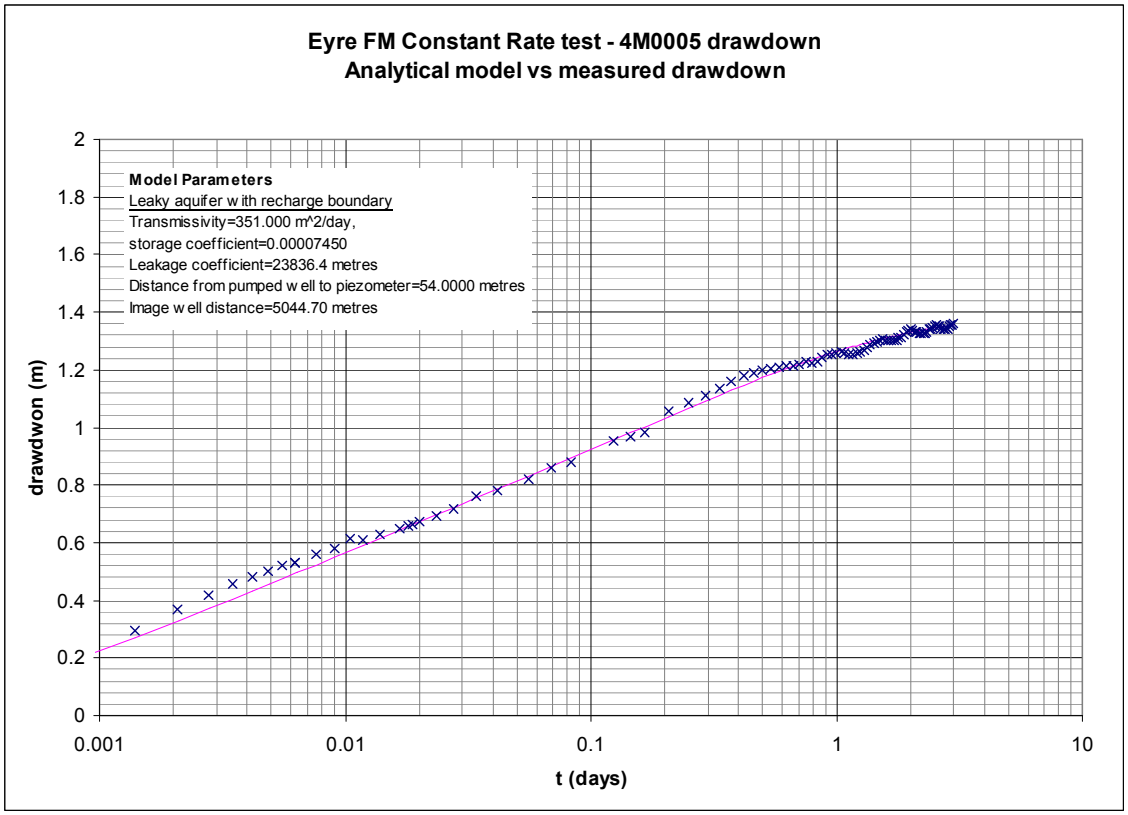
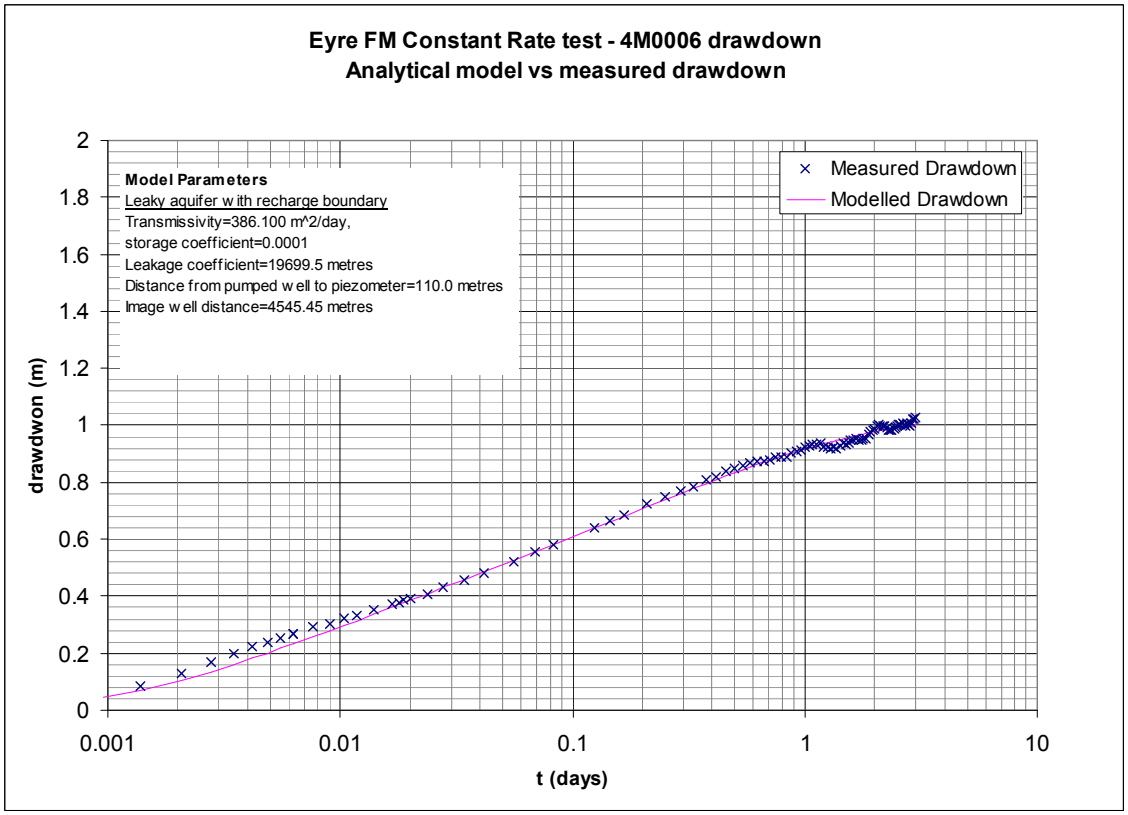
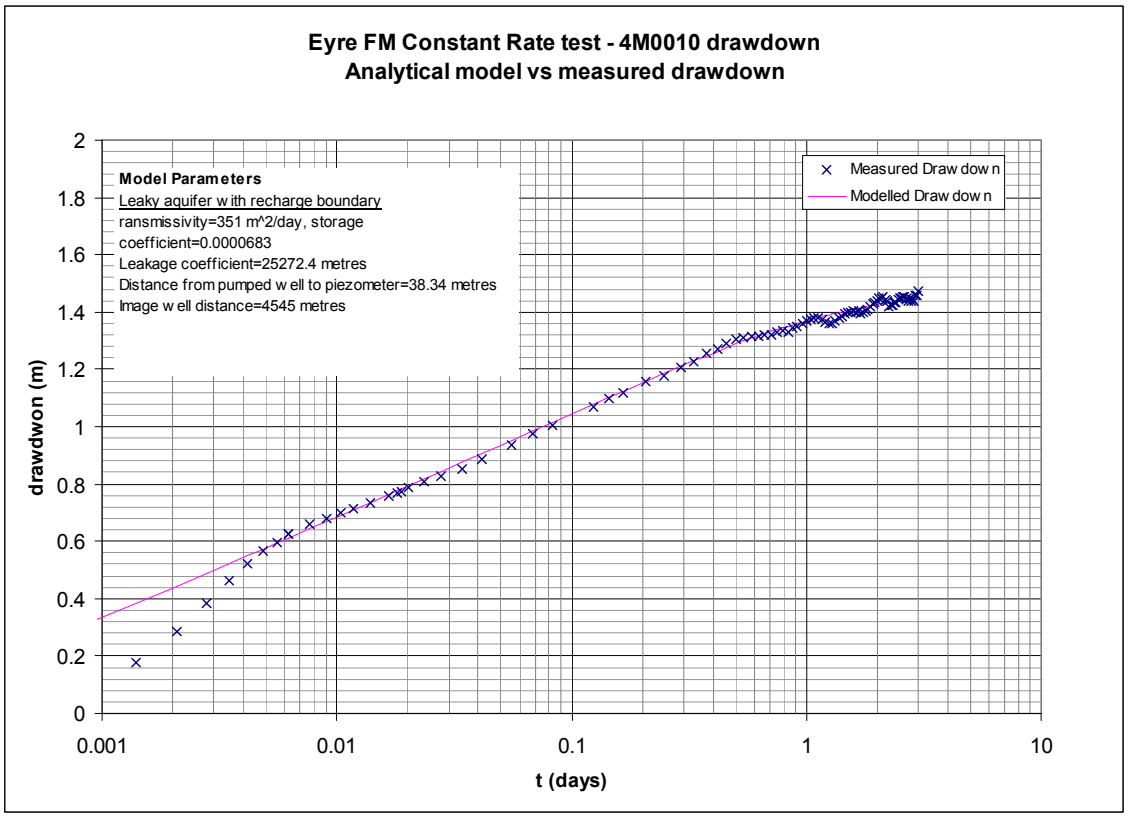


Figure 25: Test 2 Distance-drawdown Data

8 APPENDIX D: 4M0008 CONSTANT RATE TEST - CLARK ANALYTICAL MODEL DATA






Eyre FM Constant Rate test - 4M0010 drawdown
Analytical model vs measured drawdown
Model Parameters
Leaky aquifer with recharge boundary
ransmissivity=351 m^2/day, storage
coefficient=0.0000683
Leakage coefficient=25272.4 metres
Distance from pumped well to piezometer=38.34 metres
Image well distance=4545 metres
Measured Drawdown
Modelled Drawdown
drawdwon (m)
t (days)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0.001
0.01
0.1
1
10

9 APPENDIX E: 4M0012 FRACTURED ROCK AQUIFER CONSTANT RATE TEST DRAWDOWN AND RECOVERY PLOTS

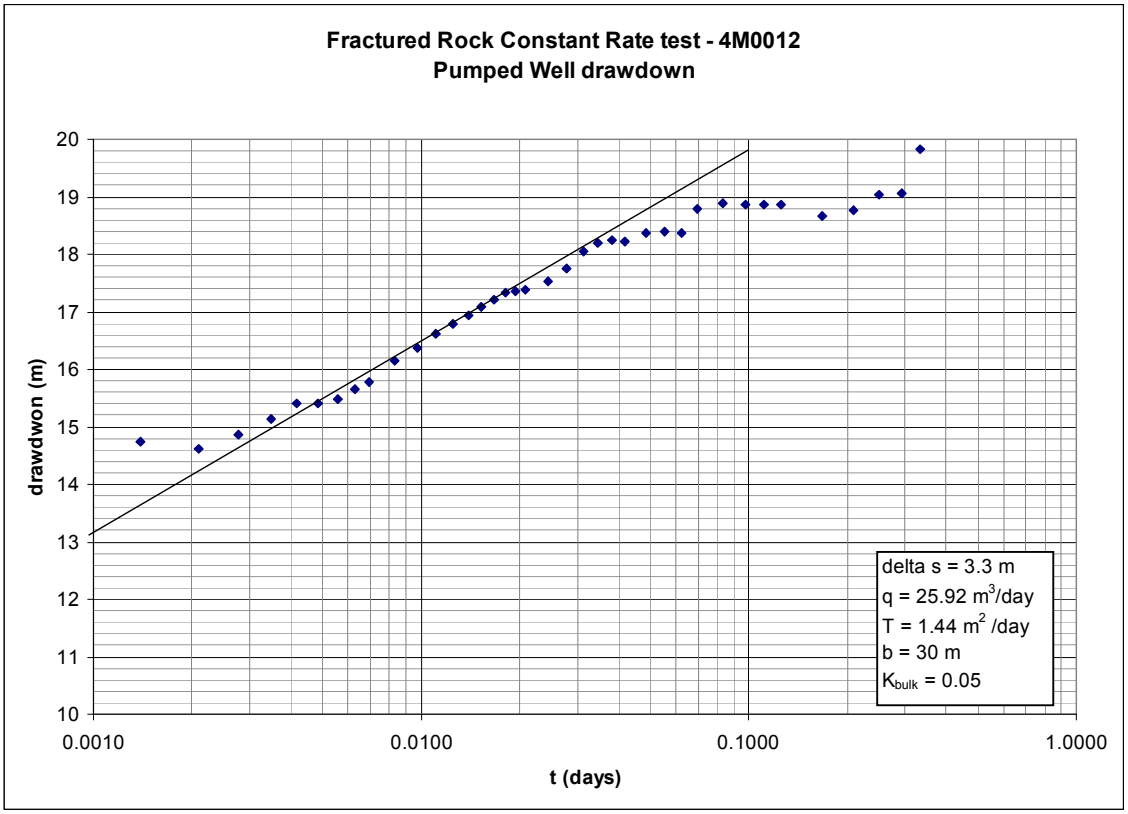


Figure 26: Test 3 4M0012 Drawdown Data

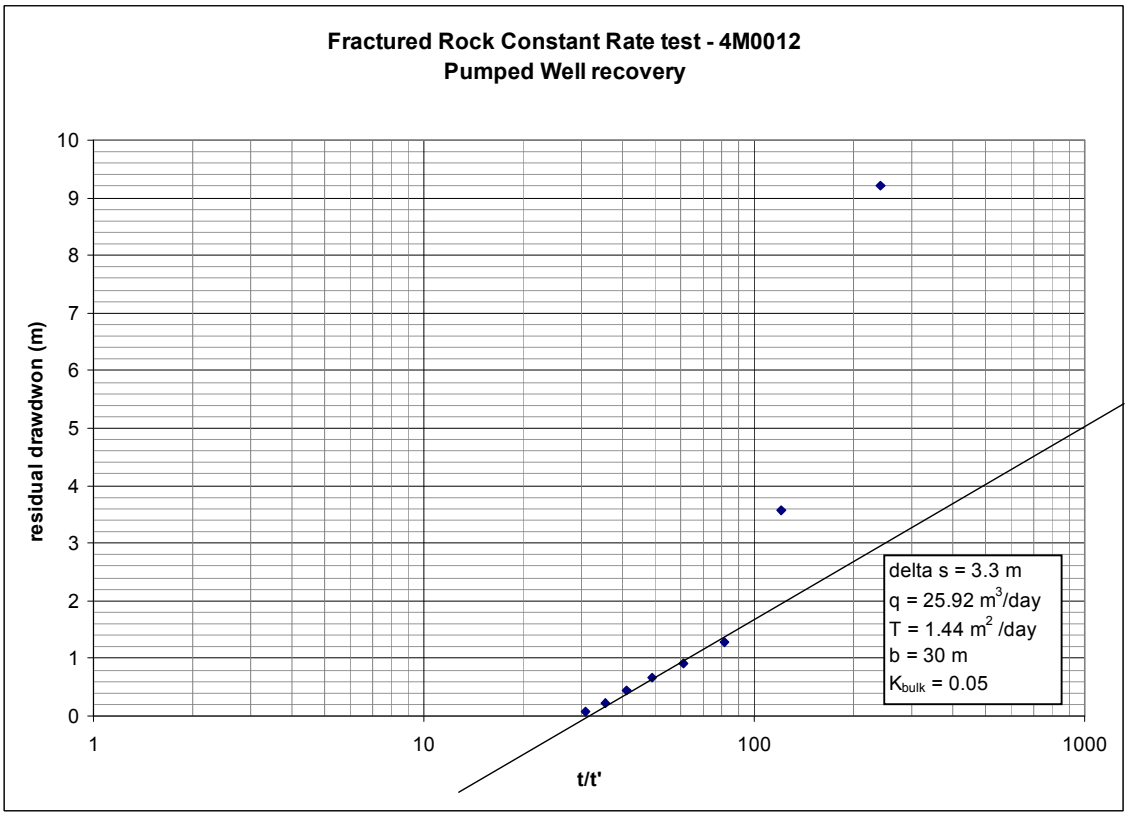


Figure 27: Test 3 4M0012 Recovery Data

10 APPENDIX F: HYDROGEOCHEMICAL DATA

Well ID	Sample Date	Ra-226 (Gamma Spectrometry)	Ra-226 Error (Gamma Spectrometry)	Al	As	B	Ba	Br	Ca	Cd	Cl	CO3	Co	Cr	Cu	F	Fe	EC	Hardness	HCO3 Alkalinity	Hg	K	Mg	Mn	Mo	Na	Ni	Pb	TDS	pH	Se	SiO2	SO4	Sr	V	Zn	NO3	ALK	U
		Bq/l	Bq/l	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AKMW006	13/11/2007	2.97	0.84	0.2	-0.1	1.4	0.05	2.5	124	-0.05	1150	100	-0.01	0.01	0.02	18	-0.1	4780	402	90	-5	53	21.5	-0.01	-0.01	834	-0.01	-0.05	2860	8.4	-0.5	53	414	2.1	-0.1	-0.01	-20	190	
AKMW007	12/11/2007	28.3	3.3	0.1	-0.1	0.9	0.02	2.7	157	-0.05	1300	-10	-0.01	0.01	0.02	16	-0.1	5380	679	270	-5	38	69	-0.01	-0.01	877	0.02	-0.05	3250	8.2	-5	24	544	2	-0.1	-0.01	-20	270	
AKMW008	11/11/2007	2.1	0.59	-0.1	-0.1	1	0.07	2.2	87	-0.05	900	-10	-0.01	0.02	0.01	12	-0.1	3900	356	360	-5	38	35.5	-0.01	-0.01	652	-0.01	-0.05	2200	7.7	-0.5	22	232	1.7	-0.1	0.01	-20	360	
AKMW011	11/11/2007	239	16	-0.1	-0.1	0.8	0.28	0.6	411	-0.05	1150	-10	0.04	0.04	-0.01	12	-0.1	4340	1220	250	-5	28	47	0.11	-0.01	639	0.06	-0.05	3630	7.6	1	39	808	2.7	-0.1	0.09	-20	250	
AKMW012	12/11/2007	12.8	1.6	1.6	-0.1	0.9	0.13	2.2	122	-0.05	950	-10	-0.01	0.02	-0.01	12	0.9	4270	535	370	-5	37	53	0.06	-0.01	707	0.04	-0.05	2620	8.1	-0.5	35	394	1.7	-0.1	0.01	-20	370	
AKMW014	05/12/2007	1.2	0.53	1.3	-0.1	0.9	0.05	2.3	120	-0.05	1050	-10	-0.01	0.01	0.02	12	0.8	4500	514	400	-5	42	49.5	-0.01	-0.01	744	0.01	-0.05	2670	8.2	-0.5	27	358	1.7	-0.1	0.05	-20	400	
4M0004	08/03/2008	2.62	0.57																																				
4M0003	18/02/2008	1.53	0.5																																				
4M0005	12/04/2008			0.2	<0.1	0.8	0.02	2.1	153	<0.05	1100	20	0.02	<0.02	<0.02	6	0.22	5100	650	220	<5	40	64	0.09	<0.01	834	<0.02	<0.05	3050	8.4	<0.5	22	555	1.9	<0.05	0.02	<20	240	0.015
4M0006	13/04/2008			0.9	<0.1	0.8	0.03	2.6	143	<0.05	1300	20	0.04	<0.02	<0.02	6	0.74	5440	685	240	<5	38	73.5	0.08	<0.01	909	0.02	<0.05	3150	8.5	<0.5	22	510	1.8	0.05	0.04	<20	260	0.035
4M0009	27/04/2008			0.9	<0.1	0.8	0.02		176	<0.05	1300	20	<0.02	0.02	0.06	6	0.5	5170	770	220	<5	42	79	0.06	0.01	894	<0.02	<0.05	3400	8.3	<0.5	24	610		<0.05	<0.02	<1	240	0.03
4M0010	29/04/2008			3.8	<0.1	1.1	1.1		157	<0.05	1200	20	0.02	<0.02	0.08		2.1	5010	710	230	<5	42	71	0.07	0.01	867	<0.02	<0.05	3150	8.6	<0.5	34	535		<0.05	<0.02	<1	250	<0.005
4M0003	23/05/2008	17.9	1.9	0.1	<0.1	1	0.05	2.2	123	<0.05	1260	<10	<0.02	<0.02	0.02	6	0.2	4.45	445	280	<5	44	33	0.12	0.01	796	<0.02	<0.05	2600	7.3	<0.5	28	438	1.86	<0.05	<0.02	<20	280	<0.005
4M0004	25/05/2008	7.25	78	0.05	<0.1	0.8	0.05	2.5	129	<0.05	1420	<10	0.02	0.02	<0.02	4	0.05	4.84	610	270	<5	40.5	69.5	0.12	<0.01	814	<0.02	<0.05	2850	7.1	<0.5	17.5	412	1.64	<0.05	0.02	<20	270	<0.005
4M0008	20/05/2008	65.4	5.6	<0.05	<0.1	0.75	0.03	2.5	152	<0.05	1500	<10	<0.02	0.02	0.02	4	<0.05	5.13	695	260	<5	41	76.5	0.08	<0.01	878	<0.02	<0.05	3200	7.1	<0.5	18.5	528	1.82	<0.05	0.32	<20	260	<0.005
4M0011	27/05/2008	14.1	1.6	0.05	<0.1	0.75	0.03	2.5	131	<0.05	1460	<10	0.02	<0.02	<0.02	4	0.1	4.95	620	280	<5	38.5	70	0.11	<0.01	844	<0.02	<0.05	2950	7.1	<0.5	17.5	432	1.65	<0.05	<0.02	<20	280	0.005
Min		1.2	0.5	-0.1	-0.1	0.75	0.02	0.6	87	-0.05	900	-10	-0.01	0.01	-0.01	4	-0.1	4.45	356	90	-5	28	21.5	-0.01	-0.01	639	-0.01	-0.05	2200	7.1	-5	17.5	232	1.64	-0.1	-0.01	-20	190	0.005
max		239	78	3.8	-0.1	1.4	1.1	2.7	411	-0.05	1500	100	0.04	0.04	0.08	18	2.1	5440	1220	400	-5	53	79	0.12	0.01	909	0.06	-0.05	3630	8.6	1	53	808	2.7	0.05	0.32	-20	400	0.035
Average		32.93	9.25	0.69	-0.10	0.91	0.14	2.24	156.50	-0.05	1217.14	13.00	0.01	0.02	0.02	9.08	0.40	3464.36	635.07	267.14	-5.00	40.21	58.00	0.06	0.00	806.36	0.02	-0.05	2970.00	7.90	-1.00	27.33	483.57	1.88	-0.08	0.05	-20.00	280.00	0.02

11 APPENDIX H: AQUIFER TEST DATA

t = time in days since pumping started, s = drawdown in metres. Pumping was 8L/s from 4M0008. Pumping stopped at t = 3 days.

4M0001		4M0002		4M003		4M0004		4M0005		4M0006		4M00010		4M00011		4M00012	
t	s	t	s	t	s	t	s	t	s	t	s	t	s	t	s	t	s
0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
0.0007	0.00	0.0007	0.00	0.0007	0.07	0.0007	0.00	0.0007	0.14	0.0007	0.02	0.0007	0.05	0.0007	0.05	0.0001	0.00
0.0014	0.00	0.0014	0.00	0.0014	0.17	0.0014	0.01	0.0014	0.30	0.0014	0.08	0.0014	0.18	0.0014	0.15	0.0008	0.00
0.0021	0.00	0.0021	0.00	0.0021	0.26	0.0021	0.02	0.0021	0.37	0.0021	0.13	0.0021	0.28	0.0021	0.22	0.0015	0.00
0.0028	0.00	0.0028	0.00	0.0028	0.32	0.0028	0.03	0.0028	0.42	0.0028	0.17	0.0028	0.38	0.0028	0.26	0.0022	0.01
0.0035	0.00	0.0035	0.00	0.0035	0.38	0.0035	0.04	0.0035	0.45	0.0035	0.20	0.0035	0.46	0.0035	0.29	0.0029	0.01
0.0042	0.01	0.0042	0.00	0.0042	0.40	0.0042	0.05	0.0042	0.48	0.0042	0.22	0.0042	0.52	0.0042	0.31	0.0036	0.00
0.0049	0.00	0.0049	0.01	0.0049	0.45	0.0049	0.06	0.0049	0.50	0.0049	0.24	0.0049	0.57	0.0049	0.34	0.0043	0.01
0.0056	-0.01	0.0056	0.00	0.0056	0.47	0.0056	0.07	0.0056	0.52	0.0056	0.25	0.0056	0.60	0.0056	0.37	0.0050	0.00
0.0063	0.00	0.0063	0.00	0.0063	0.49	0.0063	0.07	0.0063	0.53	0.0063	0.27	0.0063	0.63	0.0063	0.37	0.0057	0.00
0.0063	0.00	0.0063	0.00	0.0063	0.49	0.0063	0.07	0.0063	0.53	0.0063	0.27	0.0063	0.63	0.0063	0.37	0.0064	0.00
0.0076	0.00	0.0076	0.00	0.0076	0.52	0.0076	0.09	0.0076	0.56	0.0076	0.29	0.0076	0.66	0.0076	0.39	0.0077	0.00
0.0090	-0.01	0.0090	0.00	0.0090	0.54	0.0090	0.10	0.0090	0.58	0.0090	0.30	0.0090	0.68	0.0090	0.41	0.0091	0.00
0.0104	-0.01	0.0104	0.00	0.0104	0.56	0.0104	0.11	0.0104	0.61	0.0104	0.32	0.0104	0.70	0.0104	0.43	0.0105	0.00
0.0118	-0.01	0.0118	0.00	0.0118	0.58	0.0118	0.13	0.0118	0.61	0.0118	0.33	0.0118	0.71	0.0118	0.43	0.0119	0.00
0.0139	0.00	0.0139	0.00	0.0139	0.58	0.0139	0.14	0.0139	0.63	0.0139	0.35	0.0139	0.73	0.0139	0.45	0.0133	0.00
0.0167	-0.01	0.0167	0.00	0.0167	0.62	0.0167	0.16	0.0167	0.65	0.0167	0.37	0.0167	0.76	0.0167	0.48	0.0161	0.00
0.0181	-0.01	0.0181	0.00	0.0181	0.63	0.0181	0.17	0.0181	0.66	0.0181	0.38	0.0181	0.77	0.0181	0.49	0.0175	0.00
0.0188	0.00	0.0188	0.00	0.0188	0.64	0.0188	0.17	0.0188	0.66	0.0188	0.39	0.0188	0.77	0.0188	0.49	0.0189	-0.01
0.0201	0.00	0.0201	0.01	0.0201	0.65	0.0201	0.18	0.0201	0.67	0.0201	0.39	0.0201	0.79	0.0201	0.48	0.0202	0.00
0.0236	0.00	0.0236	0.00	0.0236	0.68	0.0236	0.20	0.0236	0.69	0.0236	0.41	0.0236	0.81	0.0236	0.52	0.0237	0.00
0.0278	0.01	0.0278	0.00	0.0278	0.69	0.0278	0.22	0.0278	0.72	0.0278	0.43	0.0278	0.83	0.0278	0.54	0.0272	0.00
0.0340	0.00	0.0340	0.00	0.0340	0.72	0.0340	0.24	0.0340	0.76	0.0340	0.46	0.0340	0.85	0.0340	0.56	0.0341	0.00
0.0417	0.00	0.0417	0.00	0.0417	0.75	0.0417	0.27	0.0417	0.78	0.0417	0.48	0.0417	0.89	0.0417	0.59	0.0411	-0.01
0.0556	0.01	0.0556	0.01	0.0556	0.79	0.0556	0.31	0.0556	0.82	0.0556	0.52	0.0556	0.94	0.0556	0.63	0.0550	-0.01
0.0688	0.02	0.0688	0.00	0.0688	0.83	0.0688	0.35	0.0688	0.86	0.0688	0.55	0.0688	0.97	0.0688	0.66	0.0689	-0.01
0.0826	0.03	0.0826	0.01	0.0826	0.86	0.0826	0.38	0.0826	0.88	0.0826	0.58	0.0826	1.00	0.0826	0.70	0.0827	-0.02
0.1243	0.05	0.1243	0.01	0.1243	0.93	0.1243	0.44	0.1243	0.95	0.1243	0.64	0.1243	1.07	0.1243	0.76	0.1244	-0.03
0.1451	0.05	0.1451	0.00	0.1451	0.96	0.1451	0.47	0.1451	0.97	0.1451	0.66	0.1451	1.10	0.1451	0.79	0.1452	-0.03
0.1667	0.07	0.1667	0.00	0.1667	0.98	0.1667	0.50	0.1667	0.98	0.1667	0.69	0.1667	1.12	0.1667	0.80	0.1661	-0.04
0.2076	0.10	0.2076	-0.01	0.2076	1.01	0.2076	0.53	0.2076	1.06	0.2076	0.72	0.2076	1.16	0.2076	0.84	0.2076	-0.04
0.2493	0.14	0.2493	-0.01	0.2493	1.05	0.2493	0.57	0.2493	1.08	0.2493	0.75	0.2493	1.18	0.2493	0.86	0.2493	-0.04
0.2917	0.15	0.2917	-0.01	0.2917	1.05	0.2917	0.60	0.2917	1.11	0.2917	0.77	0.2917	1.21	0.2917	0.91	0.2917	-0.03
0.3326	0.18	0.3326	-0.01	0.3326	1.07	0.3326	0.63	0.3326	1.14	0.3326	0.79	0.3326	1.23	0.3326	0.92	0.3326	-0.02
0.3743	0.20	0.3743	-0.01	0.3743	1.10	0.3743	0.65	0.3743	1.16	0.3743	0.81	0.3743	1.25	0.3743	0.92	0.3743	-0.01
0.4167	0.22	0.4167	0.00	0.4167	1.11	0.4167	0.67	0.4167	1.18	0.4167	0.82	0.4167	1.27	0.4167	0.95	0.4167	0.02
0.4576	0.25	0.4576	-0.01	0.4576	1.13	0.4576	0.68	0.4576	1.19	0.4576	0.84	0.4576	1.29	0.4576	0.97	0.4576	0.04
0.4993	0.27	0.4993	-0.01	0.4993	1.14	0.4993	0.70	0.4993	1.20	0.4993	0.85	0.4993	1.30	0.4993	0.99	0.4993	0.04
0.5417	0.28	0.5417	-0.01	0.5417	1.15	0.5417	0.70	0.5417	1.21	0.5417	0.86	0.5417	1.31	0.5417	0.99	0.5417	0.04
0.5826	0.30	0.5826	0.00	0.5826	1.16	0.5826	0.70	0.5826	1.21	0.5826	0.87	0.5826	1.32	0.5826	0.98	0.5826	0.03
0.6243	0.30	0.6243	-0.02	0.6243	1.16	0.6243	0.70	0.6243	1.21	0.6243	0.87	0.6243	1.32	0.6243	0.99	0.6243	0.02
0.6667	0.32	0.6667	0.00	0.6667	1.16	0.6667	0.71	0.6667	1.21	0.6667	0.87	0.6667	1.32	0.6667	1.00	0.6667	0.00
0.7076	0.33	0.7076	-0.01	0.7076	1.16	0.7076	0.71	0.7076	1.22	0.7076	0.88	0.7076	1.32	0.7076	0.99	0.7076	-0.01
0.7493	0.34	0.7493	0.00	0.7493	1.17	0.7493	0.72	0.7493	1.23	0.7493	0.89	0.7493	1.33	0.7493	0.99	0.7493	-0.02
0.7917	0.34	0.7917	-0.01	0.7917	1.17	0.7917	0.72	0.7917	1.22	0.7917	0.89	0.7917	1.33	0.7917	1.00	0.7917	-0.02

0.8326	0.34	0.8326	-0.01	0.8326	1.17	0.8326	0.71	0.8326	1.23	0.8326	0.89	0.8326	1.33	0.8326	1.01	0.8326	-0.02
0.8743	0.36	0.8743	-0.01	0.8743	1.18	0.8743	0.74	0.8743	1.24	0.8743	0.90	0.8743	1.35	0.8743	1.01	0.8743	0.00
0.9167	0.35	0.9167	-0.01	0.9167	1.19	0.9167	0.74	0.9167	1.25	0.9167	0.91	0.9167	1.35	0.9167	1.02	0.9167	-0.01
0.9576	0.36	0.9576	0.00	0.9576	1.20	0.9576	0.75	0.9576	1.25	0.9576	0.92	0.9576	1.36	0.9576	1.03	0.9576	0.02
0.9993	0.39	0.9993	-0.01	0.9993	1.20	0.9993	0.75	0.9993	1.26	0.9993	0.92	0.9993	1.37	0.9993	1.03	0.9993	0.03
1.0417	0.40	1.0417	0.01	1.0417	1.22	1.0417	0.76	1.0417	1.26	1.0417	0.93	1.0417	1.38	1.0417	1.04	1.0417	0.02
1.0826	0.42	1.0826	0.01	1.0826	1.22	1.0826	0.75	1.0826	1.26	1.0826	0.93	1.0826	1.38	1.0826	1.03	1.0826	0.02
1.1243	0.42	1.1243	0.01	1.1243	1.23	1.1243	0.75	1.1243	1.26	1.1243	0.93	1.1243	1.38	1.1243	1.02	1.1243	0.01
1.1667	0.43	1.1667	0.01	1.1667	1.23	1.1667	0.75	1.1667	1.26	1.1667	0.94	1.1667	1.37	1.1667	1.02	1.1667	0.00
1.2076	0.41	1.2076	-0.01	1.2076	1.23	1.2076	0.75	1.2076	1.26	1.2076	0.93	1.2076	1.36	1.2076	1.04	1.2076	-0.01
1.2493	0.42	1.2493	-0.01	1.2493	1.23	1.2493	0.75	1.2493	1.26	1.2493	0.92	1.2493	1.36	1.2493	1.04	1.2493	-0.01
1.2917	0.42	1.2917	-0.02	1.2917	1.22	1.2917	0.76	1.2917	1.27	1.2917	0.92	1.2917	1.36	1.2917	1.04	1.2917	0.00
1.3326	0.42	1.3326	-0.03	1.3326	1.23	1.3326	0.76	1.3326	1.28	1.3326	0.92	1.3326	1.37	1.3326	1.04	1.3326	0.01
1.3743	0.42	1.3743	-0.03	1.3743	1.23	1.3743	0.78	1.3743	1.29	1.3743	0.92	1.3743	1.38	1.3743	1.05	1.3743	0.02
1.4167	0.43	1.4167	-0.03	1.4167	1.24	1.4167	0.79	1.4167	1.29	1.4167	0.93	1.4167	1.38	1.4167	1.06	1.4167	0.04
1.4576	0.44	1.4576	-0.02	1.4576	1.25	1.4576	0.79	1.4576	1.30	1.4576	0.94	1.4576	1.39	1.4576	1.06	1.4576	0.05
1.4993	0.45	1.4993	-0.03	1.4993	1.25	1.4993	0.80	1.4993	1.30	1.4993	0.93	1.4993	1.40	1.4993	1.06	1.4993	0.06
1.5417	0.46	1.5417	-0.02	1.5417	1.25	1.5417	0.80	1.5417	1.31	1.5417	0.94	1.5417	1.40	1.5417	1.07	1.5417	0.06
1.5826	0.47	1.5826	-0.01	1.5826	1.26	1.5826	0.80	1.5826	1.30	1.5826	0.95	1.5826	1.40	1.5826	1.07	1.5826	0.06
1.6243	0.47	1.6243	-0.02	1.6243	1.25	1.6243	0.80	1.6243	1.30	1.6243	0.95	1.6243	1.40	1.6243	1.07	1.6243	0.05
1.6667	0.48	1.6667	-0.01	1.6667	1.26	1.6667	0.80	1.6667	1.30	1.6667	0.95	1.6667	1.40	1.6667	1.06	1.6667	0.02
1.7076	0.47	1.7076	-0.02	1.7076	1.25	1.7076	0.80	1.7076	1.30	1.7076	0.95	1.7076	1.39	1.7076	1.06	1.7076	0.03
1.7493	0.48	1.7493	-0.01	1.7493	1.25	1.7493	0.80	1.7493	1.30	1.7493	0.95	1.7493	1.40	1.7493	1.07	1.7493	0.01
1.7917	0.48	1.7917	-0.02	1.7917	1.25	1.7917	0.81	1.7917	1.31	1.7917	0.95	1.7917	1.40	1.7917	1.07	1.7917	0.01
1.8326	0.48	1.8326	-0.02	1.8326	1.27	1.8326	0.81	1.8326	1.31	1.8326	0.95	1.8326	1.41	1.8326	1.09	1.8326	0.01
1.8743	0.48	1.8743	-0.02	1.8743	1.27	1.8743	0.82	1.8743	1.32	1.8743	0.97	1.8743	1.42	1.8743	1.09	1.8743	0.01
1.9167	0.50	1.9167	-0.01	1.9167	1.28	1.9167	0.83	1.9167	1.33	1.9167	0.98	1.9167	1.43	1.9167	1.09	1.9167	0.02
1.9576	0.50	1.9576	-0.01	1.9576	1.28	1.9576	0.83	1.9576	1.34	1.9576	0.98	1.9576	1.43	1.9576	1.10	1.9576	0.04
1.9993	0.50	1.9993	-0.01	1.9993	1.28	1.9993	0.83	1.9993	1.34	1.9993	0.99	1.9993	1.44	1.9993	1.10	1.9993	0.04
2.0417	0.54	2.0417	0.01	2.0417	1.29	2.0417	0.84	2.0417	1.33	2.0417	1.00	2.0417	1.45	2.0417	1.10	2.0417	0.05
2.0826	0.55	2.0826	0.02	2.0826	1.30	2.0826	0.83	2.0826	1.33	2.0826	1.00	2.0826	1.45	2.0826	1.09	2.0826	0.04
2.1243	0.54	2.1243	0.03	2.1243	1.30	2.1243	0.83	2.1243	1.33	2.1243	1.00	2.1243	1.45	2.1243	1.09	2.1243	0.04
2.1667	0.54	2.1667	0.02	2.1667	1.31	2.1667	0.83	2.1667	1.33	2.1667	1.00	2.1667	1.44	2.1667	1.09	2.1667	0.03
2.2076	0.55	2.2076	0.02	2.2076	1.30	2.2076	0.82	2.2076	1.32	2.2076	1.00	2.2076	1.44	2.2076	1.09	2.2076	0.02
2.2493	0.55	2.2493	0.00	2.2493	1.30	2.2493	0.82	2.2493	1.32	2.2493	0.99	2.2493	1.42	2.2493	1.08	2.2493	0.01
2.2917	0.53	2.2917	-0.01	2.2917	1.30	2.2917	0.83	2.2917	1.33	2.2917	0.98	2.2917	1.42	2.2917	1.08	2.2917	0.01
2.3326	0.52	2.3326	-0.02	2.3326	1.30	2.3326	0.83	2.3326	1.33	2.3326	0.98	2.3326	1.42	2.3326	1.09	2.3326	0.02
2.3743	0.52	2.3743	-0.02	2.3743	1.30	2.3743	0.84	2.3743	1.34	2.3743	0.98	2.3743	1.43	2.3743	1.09	2.3743	0.04
2.4167	0.53	2.4167	-0.02	2.4167	1.31	2.4167	0.84	2.4167	1.34	2.4167	0.99	2.4167	1.43	2.4167	1.10	2.4167	0.05
2.4576	0.54	2.4576	-0.02	2.4576	1.31	2.4576	0.85	2.4576	1.35	2.4576	1.00	2.4576	1.44	2.4576	1.11	2.4576	0.07
2.4993	0.56	2.4993	-0.02	2.4993	1.31	2.4993	0.85	2.4993	1.35	2.4993	1.00	2.4993	1.45	2.4993	1.11	2.4993	0.08
2.5417	0.57	2.5417	0.00	2.5417	1.31	2.5417	0.85	2.5417	1.35	2.5417	1.00	2.5417	1.45	2.5417	1.11	2.5417	0.09
2.5826	0.58	2.5826	0.00	2.5826	1.32	2.5826	0.85	2.5826	1.35	2.5826	1.00	2.5826	1.45	2.5826	1.11	2.5826	0.09
2.6243	0.56	2.6243	0.00	2.6243	1.32	2.6243	0.85	2.6243	1.35	2.6243	1.01	2.6243	1.45	2.6243	1.10	2.6243	0.09
2.6667	0.58	2.6667	0.01	2.6667	1.32	2.6667	0.84	2.6667	1.34	2.6667	1.00	2.6667	1.45	2.6667	1.10	2.6667	0.07
2.7076	0.57	2.7076	0.01	2.7076	1.32	2.7076	0.84	2.7076	1.34	2.7076	1.00	2.7076	1.44	2.7076	1.10	2.7076	0.06
2.7493	0.57	2.7493	0.01	2.7493	1.31	2.7493	0.84	2.7493	1.34	2.7493	1.01	2.7493	1.45	2.7493	1.10	2.7493	0.04
2.7917	0.57	2.7917	0.01	2.7917	1.31	2.7917	0.84	2.7917	1.34	2.7917	1.00	2.7917	1.44	2.7917	1.09	2.7917	0.03
2.8326	0.58	2.8326	0.00	2.8326	1.31	2.8326	0.85	2.8326	1.34	2.8326	1.00	2.8326	1.45	2.8326	1.10	2.8326	0.03
2.8743	0.57	2.8743	0.00	2.8743	1.32	2.8743	0.85	2.8743	1.35	2.8743	1.01	2.8743	1.44	2.8743	1.10	2.8743	0.02
2.9167	0.59	2.9167	0.01	2.9167	1.32	2.9167	0.86	2.9167	1.36	2.9167	1.02	2.9167	1.46	2.9167	1.10	2.9167	0.03
2.9576	0.60	2.9576	0.01	2.9576	1.33	2.9576	0.86	2.9576	1.35	2.9576	1.02	2.9576	1.46	2.9576	1.11	2.9576	0.04
2.9792	0.61	2.9792	0.02	2.9792	1.34	2.9792	0.85	2.9792	1.36	2.9792	1.03	2.9792	1.47	2.9792	1.11	2.9792	0.04
3.0000	0.60	2.9993	0.02	2.9993	1.34	2.9993	0.86	2.9993	1.36	2.9993	1.03	2.9993	1.47	2.9993	1.11	2.9993	0.04

3.0201	0.61	3.0201	0.02	3.0201	0.71	3.0201	0.67	3.0201	0.68	3.0201	0.64	3.0201	0.68	3.0201	0.59	3.0201	0.03
3.0417	0.62	3.0417	0.03	3.0417	0.61	3.0417	0.57	3.0417	0.59	3.0417	0.55	3.0417	0.59	3.0417	0.49	3.0417	0.05
3.0618	0.61	3.0618	0.03	3.0618	0.55	3.0618	0.52	3.0618	0.51	3.0618	0.49	3.0618	0.52	3.0618	0.43	3.0618	0.05
3.0826	0.60	3.0826	0.03	3.0826	0.50	3.0826	0.47	3.0826	0.48	3.0826	0.44	3.0826	0.47	3.0826	0.37	3.0826	0.05
3.1042	0.59	3.1042	0.03	3.1042	0.46	3.1042	0.41	3.1042	0.42	3.1042	0.41	3.1042	0.42	3.1042	0.33	3.1042	0.05
3.1243	0.57	3.1243	0.03	3.1243	0.43	3.1243	0.39	3.1243	0.40	3.1243	0.38	3.1243	0.39	3.1243	0.30	3.1243	0.05
3.1451	0.56	3.1451	0.03	3.1451	0.41	3.1451	0.36	3.1451	0.37	3.1451	0.36	3.1451	0.37	3.1451	0.27	3.1451	0.03
3.1667	0.54	3.1667	0.03	3.1667	0.39	3.1667	0.32	3.1667	0.35	3.1667	0.34	3.1667	0.33	3.1667	0.24	3.1667	0.03
3.1868	0.52	3.1868	0.02	3.1868	0.36	3.1868	0.29	3.1868	0.33	3.1868	0.32	3.1868	0.30	3.1868	0.22	3.1868	0.03
3.2076	0.50	3.2076	0.02	3.2076	0.34	3.2076	0.28	3.2076	0.31	3.2076	0.30	3.2076	0.29	3.2076	0.21	3.2076	0.02
3.2292	0.48	3.2292	0.02	3.2292	0.33	3.2292	0.27	3.2292	0.29	3.2292	0.28	3.2292	0.27	3.2292	0.19	3.2292	0.03
3.2493	0.47	3.2493	0.01	3.2493	0.31	3.2493	0.25	3.2493	0.28	3.2493	0.26	3.2493	0.25	3.2493	0.18	3.2493	0.01
3.2701	0.44	3.2701	0.00	3.2701	0.28	3.2701	0.25	3.2701	0.27	3.2701	0.25	3.2701	0.24	3.2701	0.16	3.2701	0.01
3.2917	0.42	3.2917	0.00	3.2917	0.28	3.2917	0.23	3.2917	0.26	3.2917	0.23	3.2917	0.22	3.2917	0.16	3.2917	0.00
3.3118	0.42	3.3118	-0.01	3.3118	0.28	3.3118	0.22	3.3118	0.25	3.3118	0.22	3.3118	0.22	3.3118	0.13	3.3118	0.01
3.3326	0.41	3.3326	-0.02	3.3326	0.27	3.3326	0.22	3.3326	0.25	3.3326	0.21	3.3326	0.20	3.3326	0.14	3.3326	0.01
3.3542	0.39	3.3542	-0.02	3.3542	0.25	3.3542	0.20	3.3542	0.24	3.3542	0.20	3.3542	0.20	3.3542	0.13	3.3542	0.01
3.3743	0.39	3.3743	-0.01	3.3743	0.25	3.3743	0.21	3.3743	0.24	3.3743	0.20	3.3743	0.19	3.3743	0.13	3.3743	0.01
3.3951	0.37	3.3951	-0.01	3.3951	0.24	3.3951	0.21	3.3951	0.24	3.3951	0.19	3.3951	0.18	3.3951	0.12	3.3951	0.02
3.4167	0.38	3.4167	-0.02	3.4167	0.24	3.4167	0.20	3.4167	0.23	3.4167	0.18	3.4167	0.19	3.4167	0.12	3.4167	0.02
3.4368	0.38	3.4368	-0.01	3.4368	0.23	3.4368	0.19	3.4368	0.22	3.4368	0.18	3.4368	0.19	3.4368	0.12	3.4368	0.03
3.4576	0.36	3.4576	-0.01	3.4576	0.23	3.4576	0.19	3.4576	0.22	3.4576	0.18	3.4576	0.19	3.4576	0.11	3.4576	0.04
3.4792	0.37	3.4792	-0.01	3.4792	0.23	3.4792	0.19	3.4792	0.22	3.4792	0.17	3.4792	0.18	3.4792	0.11	3.4792	0.04
3.4993	0.37	3.4993	-0.01	3.4993	0.22	3.4993	0.19	3.4993	0.21	3.4993	0.18	3.4993	0.18	3.4993	0.10	3.4993	0.05
3.5201	0.36	3.5201	0.00	3.5201	0.22	3.5201	0.18	3.5201	0.21	3.5201	0.18	3.5201	0.18	3.5201	0.10	3.5201	0.05
3.5417	0.35	3.5417	0.00	3.5417	0.21	3.5417	0.16	3.5417	0.21	3.5417	0.17	3.5417	0.17	3.5417	0.08	3.5417	0.04
3.5618	0.36	3.5618	0.00	3.5618	0.21	3.5618	0.17	3.5618	0.20	3.5618	0.17	3.5618	0.17	3.5618	0.09	3.5618	0.04
3.5826	0.35	3.5826	0.00	3.5826	0.20	3.5826	0.17	3.5826	0.20	3.5826	0.17	3.5826	0.17	3.5826	0.08	3.5826	0.06
3.6042	0.34	3.6042	0.00	3.6042	0.20	3.6042	0.16	3.6042	0.19	3.6042	0.16	3.6042	0.16	3.6042	0.08	3.6042	0.05
3.6243	0.34	3.6243	-0.01	3.6243	0.20	3.6243	0.16	3.6243	0.19	3.6243	0.16	3.6243	0.16	3.6243	0.08	3.6243	0.04
3.6451	0.33	3.6451	0.00	3.6451	0.19	3.6451	0.15	3.6451	0.19	3.6451	0.15	3.6451	0.15	3.6451	0.07	3.6451	0.04
3.6667	0.34	3.6667	0.01	3.6667	0.19	3.6667	0.15	3.6667	0.18	3.6667	0.15	3.6667	0.15	3.6667	0.07	3.6667	0.06
3.6868	0.33	3.6868	0.01	3.6868	0.18	3.6868	0.15	3.6868	0.18	3.6868	0.15	3.6868	0.15	3.6868	0.06	3.6868	0.04
3.7076	0.33	3.7076	0.01	3.7076	0.18	3.7076	0.14	3.7076	0.17	3.7076	0.14	3.7076	0.14	3.7076	0.06	3.7076	0.02
3.7292	0.33	3.7292	0.01	3.7292	0.17	3.7292	0.13	3.7292	0.18	3.7292	0.14	3.7292	0.14	3.7292	0.05	3.7292	0.02
3.7493	0.32	3.7493	0.01	3.7493	0.17	3.7493	0.13	3.7493	0.16	3.7493	0.14	3.7493	0.12	3.7493	0.05	3.7493	0.01
3.7701	0.31	3.7701	0.01	3.7701	0.17	3.7701	0.13	3.7701	0.16	3.7701	0.14	3.7701	0.13	3.7701	0.05	3.7701	0.00
3.7917	0.31	3.7917	0.01	3.7917	0.17	3.7917	0.13	3.7917	0.15	3.7917	0.13	3.7917	0.13	3.7917	0.05	3.7917	0.00
3.8118	0.30	3.8118	0.01	3.8118	0.17	3.8118	0.13	3.8118	0.16	3.8118	0.13	3.8118	0.13	3.8118	0.04	3.8118	-0.01
3.8326	0.30	3.8326	0.01	3.8326	0.16	3.8326	0.13	3.8326	0.16	3.8326	0.13	3.8326	0.12	3.8326	0.05	3.8326	-0.01
3.8542	0.29	3.8542	0.00	3.8542	0.16	3.8542	0.11	3.8542	0.16	3.8542	0.13	3.8542	0.12	3.8542	0.04	3.8542	-0.02
3.8743	0.29	3.8743	0.01	3.8743	0.16	3.8743	0.13	3.8743	0.15	3.8743	0.13	3.8743	0.12	3.8743	0.05	3.8743	-0.02
3.8951	0.29	3.8951	0.01	3.8951	0.16	3.8951	0.13	3.8951	0.16	3.8951	0.13	3.8951	0.12	3.8951	0.04	3.8951	-0.01
3.9167	0.28	3.9167	0.00	3.9167	0.16	3.9167	0.13	3.9167	0.16	3.9167	0.13	3.9167	0.12	3.9167	0.05	3.9167	-0.01
3.9368	0.28	3.9368	0.01	3.9368	0.16	3.9368	0.11	3.9368	0.16	3.9368	0.13	3.9368	0.13	3.9368	0.04	3.9368	0.00
3.9576	0.29	3.9576	0.01	3.9576	0.17	3.9576	0.12	3.9576	0.16	3.9576	0.14	3.9576	0.13	3.9576	0.04	3.9576	-0.01
3.9792	0.28	3.9792	0.01	3.9792	0.16	3.9792	0.13	3.9792	0.16	3.9792	0.13	3.9792	0.13	3.9792	0.06	3.9792	0.00
3.9993	0.29	3.9993	0.02	3.9993	0.17	3.9993	0.13	3.9993	0.16	3.9993	0.14	3.9993	0.13	3.9993	0.04	3.9993	0.00
4.0201	0.29	4.0201	0.02	4.0201	0.17	4.0201	0.12	4.0201	0.16	4.0201	0.14	4.0201	0.13	4.0201	0.04	4.0201	0.00