APPENDIX B

East Rockingham industrial park (IP14 Area): Groundwater hydrology (JDA Consultant Hydrologists, 2006)

Landcorp

East Rockingham Industrial Park (IP14 Area)

Groundwater Hydrology

October 2006

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1. INTRODUCTION

The IP14 area is located 4.5 km north-east of Rockingham. The site is 1150 ha in total with about 640 ha planned for development (Figure 1). Landcorp are planning the IP14 area and a Strategic Environmental Assessment (SEA) has been requested by the EPA. The objective of the SEA is to obtain environmental approval for a development footprint in which future industries can be located.

The IP14 area contains a series of wetlands at the southern end. A vegetation survey completed by ATA in 2004 identified significant assemblages of wetland plant species in areas not previously mapped as wetlands. The assemblages of the plant species around the wetlands are ecologically significant with wetland species and dryland species occurring together.

The groundwater investigations described in this report have been undertaken to better understand the groundwater hydrology of the IP14 area and the influence of the groundwater hydrology on the presence of the wetlands. The investigation includes mapping the groundwater flow direction, a preliminary assessment of groundwater quality and identifying seasonal groundwater levels in the wetlands.

This report provides a summary of the drilling _results from the groundwater monitoring bore installation, and water level and water quality analysis.

2. HYDROLOGIC SETTING

2.1 Superficial Geology

The East Rockingham area has a generalised geomorphology of relic foredune plains and Quindalup Dunes, and a topography of 0 - 25 m AHD. The generalised surface geology is Safety Bay sand, which unconformably overlies Tamala Limestone (Davidson 1995). Regional environmental geology mapping presented in Gozzard (1983) indicates that the Tamala Limestone is at a depth of approximately 15 m below natural surface. The Superficial Aquifer underlaying the site is an unconfined aquifer within the Superficial Formations of Safety Bay Sands and Tamala Limestone. The watertable is the upper surface of the unconfined Superficial Aquifer.

2.2 Superficial Groundwater Flow

The hydrogeology of the Superficial Aquifer in the Perth region is described and mapped in Davidson (1995). The Study Area is located near the boundary of 2 Superficial groundwater areas; the southern part of the Jandakot Mound and the northern part of the Safety Bay Mound (Figure 2).

Just south of the Study Area is Lake Cooloongup described by Davidson (1995) as a groundwater discharge lake, which forms the eastern boundary of the Safety Bay Mound groundwater system along with Lake Walyungup. The salts from the groundwater discharge into the lake are concentrated by evaporation, creating a saline lake system.

Regional mapping of groundwater salinities presented in Davidson (1995) shows a high salinity plume immediately west of Lake Cooloongup, with salinity greater than 2000 mg/L TDS (Figure 3). The plume is consistent with groundwater through-flow from the Jandakot Mound interacting with the northern part of Lake Cooloongup. Further south were the Safety Bay Mound discharges to the lake, no plume is mapped and salinity is approximately 1000 mg/L TDS.

2.3 Regional Watertable

The IP14 Area is located in the southern boundary of the Jandakot Mound. Mapping of maximum watertable levels in WRC (1997) show regional groundwater flow direction is east to west towards the ocean. The groundwater gradient due to seasonal variation in groundwater levels (mounding) over the Study Area is very low, generally less than 0.5 m, owing to the high hydraulic conductivity of the underlying Tamala Limestone.

3. BORE INSTALLATION

Between 18 March and 20 March, 2005 JOA supervised the installation of 21 monitoring bores in 15 locations within the IP14 boundary. The locations of the bores are shown in Figure 4 with the details presented in Table 1. The monitoring bore network is designed to provide information of regional groundwater flow directions and the hydrology of the wetlands in the southern portion of the IP14 Area. To address these two objectives;

- 6 bores were spatially distributed around the northern part of the Study Area and
- A transect of 15 bores established in a north-west direction through the wetlands in the southern part of the Study Area.

For the wetland bores (ERGM 7,9, 10, 12, 13, 15) one bore was installed to the depth of the regional water table (labelled deep) and a second shallow bore was installed to a total depth of 1 metre. The deep bores were constructed by hollow auger rig generally to a depth of 6 m below natural surface with 2 metres of screen. The shallow bores were installed by JOA using a hand auger. The drilled bores were developed following construction making the bores suitable for groundwater sampling.

Table 1: Groundwater Monitoring Bore Details

Bore	Bore Location (GDA Co-ordinates)		Natural Surface	Top of Casing	Screen Depth
	Easting	Northing	(m AHD)	(m AHD)	(m BNS)
ERGM1	0383827	6430506	3.92	4.62	4.0 - 6.0
ERGM2	0385213	6431025	3.93	4.58	4.0 - 6.0
ERGM3	0384474	6430572	4.21	4.95	4.0 - 6.0
ERGM4	0384288	6431078	4.19	4.83	4.0 - 6.0
ERGM5	0383002	6429297	4.10	4.79	4.0 - 6.0
ERGM6	0385021	6429727	4.40	5.05	4.0 - 6.0
ERGM7d	0384378	6428951	2.90	3.56	3.5- 5.5
ERGM7s	0384381	6428949	2.93	3.54	0.5 - 1.0
ERGM8	0383419	6429912	4.13	4.78	2.5 - 6.0
ERGM9d	0383605	6429735	3.67	4.31	4.0 - 6.0
ERGM9s	0383605	6429737	3.65	2.67	0.5-1.0
ERGM10d	0383714	6429578	3.44	3.99	4.0 - 6.0
ERGM10s	0383712	6429580	3.27	4.17	0.5-1.0
ERGM11	0383847	6429474	4.05	4.71	4.0 - 6.0
ERGM12d	0383876	6429393	3.26	3.92	4.0 - 6.0
ERGM12s	0383873	6429392	3.27	3.79	0.5-1.0
ERGM13d	0383945	6429360	3.62	4.28	4.0 - 6.0
ERGM13s	0383946	6429354	3.36	3.94	0.5-1.0
ERGM14	0384035	6429290	3.74	4.43	4.0 - 6.0
ERGM15d	0384152	6429167	2.98	3.67	4.0 - 6.0
ERGM15s	0384149	6429168	3.10	3.54	0.5-1.0

4. LITHOLOGY

A lithological log was recorded for each bore during drilling (Appendix A). The first hole drilled was wetland bore ERGM7. This hole was used as a pilot hole to identify the lithology to a depth considered relevant to the hydrology of the wetlands. Drilling in this hole continued to a depth of 8 m below natural surface and confirmed Safety Bay Sands to this depth with Tamala Limestone not encountered in the hole.

In general the lithology of the boreholes was dominated by grey to cream, fine to medium grain size sands. Of particular interest from the logs is the fine silt encountered in the first 1 m of the soil profile. The silt was cemented in places with the strength and thickness of cemented layers varying. Generally within the wetlands (ERGM bores 7, 9, 10, 12, 13 and 15) the cemented layers were harder and thicker (0.5 - 1m thick). A hardpan layer will have a low hydraulic conductivity, creating the potential for a 'perched' watertable to form within the wetlands over the winter period.

5. WATERTABLE LEVELS

Water levels were recorded in all of the bores on 6 May 2005, two weeks after bore installation, and then at later intervals on 6 July 2005, 27 September and 4 January 2006 (Appendix 8). Levels were also measured in the nearby Department of Environment and Conservation (DEC) monitoring bore T230(O) on each date.

5.1 Watertable Contours

The water levels presented in Figure 5 show the watertable over the Study Area is very flat. The levels were plotted by JOA to determine groundwater contours, however only one contour could be derived. The flow direction based on this contour was considered quite subjective and as such the regional flow direction according to Davidson (1995) and WRC (1997) has been adopted and is presented as Figure 5, along with the groundwater levels recorded by JOA on 27 September 2005.

The lack of contours derived is due to the very flat watertable owing to the high hydraulic conductivity of the underlying Tamala Limestone. The very subtle natural groundwater gradient is likely to be disrupted by local factors such as variations in rainfall recharge (groundcover, lithology) and groundwater abstractions in the vicinity, resulting in the slight variation in water levels observed between the bores.

5.2 Seasonal Watertable Fluctuations

The seasonal difference, as shown in Figure 9, between the lowest (May) and highest (September) groundwater levels range between 0.77 m and 0.89 m, with an average annual seasonal fluctuation of 0.83 m. The seasonal fluctuation in the DEC bore T230(0) between 6 May and 27 September 2005 was 0.72 m. Levels in this bore have been recorded from 1975 onwards and show an average annual seasonal fluctuation of 0.60 m (Figure 6). We consider the average annual seasonal fluctuation of the Study Area is likely to be approximately 0.7 m.

5.3 Wetland Watertable Levels

5.3.1 Groundwater Levels in 2005

The highest level of the watertable recorded for the monitoring period was 27 September 2005 (Figure 9), with the levels recorded in the wetland bores shown in Table 2. The levels range from 1.11 m to 1.91 m below natural surface.

Table 2: Wetlands watertable leve127 Septem ber 2005

Bore	Natural Surface Level (m AHD)	Water level 27September 2005 (mAHD)	Water Level depth below Natural Surface Cm)
ERGM7d	2.90	1.79	1.11
ERGM9d	3.67	1.76	1.91
ERGM10d	3.44	1.81	1.63
ERGM12d	3.26	1.83	1.43
ERGM13d	3.62	1.81	1.81
ERGM15d	2.98	1.82	1.16

A transect through the wetland monitoring bores is presented in Figure 7. The transect shows the groundwater levels are on average 2.60 m below natural surface on 6 May 2005, and on average 1.5 m below natural surface on 27 September 2005.

5.3.2 Perched Watertable

During construction of the monitoring bores within the wetlands a silty hard cemented layer was identified. It was expected that over the winter period the infiltration of rainfall through this hardpan would be slow, creating a 'perched' watertable within the wetlands. To monitor for a 'perched 'watertable, shallow bores were installed to a maximum depth of 1 m below natural surface at each of the 6 wetland monitoring sites.

The watertable measured on the 6 May was approximately 1 m below the hardpan layer. The watertable rose approximately 0.8 m over winter, to the maximum level measured on the 27 September, where it was approximately 0.2 m below the hardpan layer, and on average 1.50 m below the ground level of the wetland.

Water was not recorded in any of the shallow wetland monitoring bores on the 4 monitoring occasions. For the monitoring period May 2005 to January 2006 there was no evidence of a 'perched' watertable forming in the wetlands.

5.3.3 Long-Term Groundwater Levels

Rainfall recorded at Bureau of Meteorology site 009064 (Kwinana) for 2005 was 786.6 mm against a long-term average of 758.5 mm for this station since records commenced in 1956 (Figure 8). The rainfall in 2005 was above average and this is reflected by the higher water level recorded in bore T230(O) compared to the previous 4 years (Figure 6).

The times series plot of water levels in DEC bore T230(O) shows a declining trend in the annual high water level from 1991 to 2004, falling steadily by approximately 0.90 m (Figure 6). This trend coincides with reduced rainfall over this period, but also a reduction in the ·monitoring frequency of this bore. Figure 6 shows the comparison between the calculated Average Annual Maximum Groundwater Level (AAMGL) for the periods 1975 to 1992 and 1993 to 2005.

Average rainfall has only been recorded on 3 occasions in the period 1993 to 2005, including 2005 (Figure 8). On this basis we consider the groundwater levels for the period 1975 to 1992 would have ranged from 0.50 to 0.90 m above current levels. Therefore, prior to 1992, the groundwater levels would have been much closer to the surface of the wetlands than is currently evident, possibly supporting the presence of the wetlands in this area.

6. GROUNDWATER QUALITY

Coinciding with the water level monitoring in May, July, September 2005 and January 2006, electrical conductivity, pH and temperature was measured in each of the bores on site by JOA. Results are plotted in Figures 10, 11 and 12.

6.1 Total Dissolved Salts (TDS)

The TDS results are calculated using electrical conductivity values measured by JOA multiplied by a factor of 550 to convert EC mS/cm to TDS mg/L.

The TDS.results shown in Figure 10, range between 150 - 900 mg/L for most bores. Bore ERGM7 was an exception, with TDS varying between approximately 2500 mg/L on 6 May 2005 and 4000 mg/L on 6 July 2005. Laboratory results from 6 May 2005 for this bore show the sodium and chloride ion levels are also high, with the ions appropriately balanced to be attributable to salt water. The higher salinity in this bore is most likely due to this bore being deeper than the other bores, and the location of the bore relative to Lake Cooloongup (Figure 3).

The significant difference in salinity between bore ERGM 7 and the other monitoring bores indicates that the fresh groundwater lens in the Superficial Aquifer is only several metres in thickness. This will need to be considered if groundwater abstraction is required as part the proposed development. Abstraction of fresh groundwater would have to be carefully managed to ensure salt water intrusion does not occur from the underlying more saline groundwater.

6.2 pH

The pH results presented in Figure 11 show pH dropped considerably from May to July 2005, ranging from 8.30 and 8.70 in May, and 7.00 and 7.80 in July 2005. The July results were repeated for the following monitoring occasions in September and January. Generally the pH results are above pH 7, which is expected in the calcareous sediments around Rockingham. The observed drop in pH between May and July 2005 is most likely a result of groundwater recharge (rainfall), with the recent rainfall recharge having a lower pH than groundwater that has been in contact with the calcareous soils for a period of time.

6.3 Temperature

Temperature results, shown in Figure 12, vary from 17.1 to 19.5 $^{\circ}$C measured on 27 September 2005 to 20.4 to 23.0 $^{\circ}$C measured on 4 January 2006. This range in temperature is consistent with groundwater of the Superficial Aquifer (Davidson, 1995).

6.4 Laboratory Analysis

To provide additional detail of baseline water quality, samples were taken from 8 bores selected to provide a good spatial coverage of the Study Area, namely; ERGM1, ERGM2, ERGM4, ERGM5, ERGM6, ERGM7, ERGM10 and ERGM15. The samples were taken on 6 May 2005 and delivered to MPL Laboratories for analysis of a range of parameters including nutrients, metals and major ions. A copy of the laboratory report is attached as Appendix B.

Table 3 shows the sulphate and chloride ion concentrations, with the ion ratio calculated. The ion ratio varies from 0.21 to 2.15, with four of the bores showing a ratio over 1. Discussion of sulphate/chloride ratios in Davidson (1995) indicates a normal ratio for rainfall is 0.05 to 0.1. In areas impacted by industry, as would be expected for the IP14 area, a ratio of >1 is not uncommon as this results from the input of sulphate from industrial activities (Careeg *et al.,* 1987).

Table 3: Groundwater Sulphate to Chloride Ratio

Bore	504 (mg/L)	Cl (mg/L)	SOJCL Ratio
ERGM1	87	69	1.26
ERGM2	79	140	0.56
ERGM4	72	66	1.09
ERGM5	84	39	2.15
ERGM6	49	150	0.33
ERGM7(d)	490	2300	0.21
ERGM10(d)	81	190	0.43
ERGM15(d)	220	180	1.22

7. CONCLUSIONS

Based on the results from the drilling and monitoring undertaken between May 2005 and January 2006 we conclude:

- The lithology of the boreholes was dominated by sands of the generalised Safety Bay Sands Formation (Appendix A).
- The lithological logs identified a silty cemented hardpan layer generally within 1 m depth of the natural surface of the wetlands (Appendix A). It was thought that the hardpan could impede rainfall recharge to the regional watertable creating a perched watertable over the winter period. Monitoring of shallow bores showed that there was no perched watertable between May 2005 and January 2006.
- An average seasonal fluctuation in the watertable of 0.83 m was observed between May and September 2005. This is thought to be slightly higher than the average annual fluctuation estimated to be 0.70 m.
- Watertable levels measured on 27 September 2005 do not show a consistent groundwater flow gradient. Groundwater contours could not be derived from the data, with the regional flow direction as presented in Davidson (1995) and WRC (1997) adopted (Figure 5).
- Watertable levels in the wetlands were on average 2.60 m below natural surface on 6 May 2005 and 1.50 m below natural surface on 27 September 2005. Rainfall records from BoM site 009064 indicate that 2005 was an above average rainfall year in Kwinana.
- Based on rainfall records for Kwinana (BoM 009064) and water level records for DEC bore T230(O), it is estimated that during the period from 1975 to 1992 peak winter groundwater levels for the Study Area would have ranged from 0.5 to 0.90 m above the levels measured in 2005.
- Groundwater salinity measurements indicate a fresh groundwater lens of only several metres thickness from the watertable. This will need to be considered if groundwater abstraction is required as part of the proposed development.
- Analysis of the sulphate to chloride ion ratio of the groundwater indicates the groundwater is affected by the surrounding industrial landuses.

8. REFERENCES

Davidson W.A. (1995) Hydrogeology and Groundwater Resources of the Perth Region Western Australia: Bulletin 147. Geological Survey of Western Australia

Water & Rivers Commission (1997) *Perlh Groundwater At/as.*

FIGURES

JDA Consultant Hydrologists

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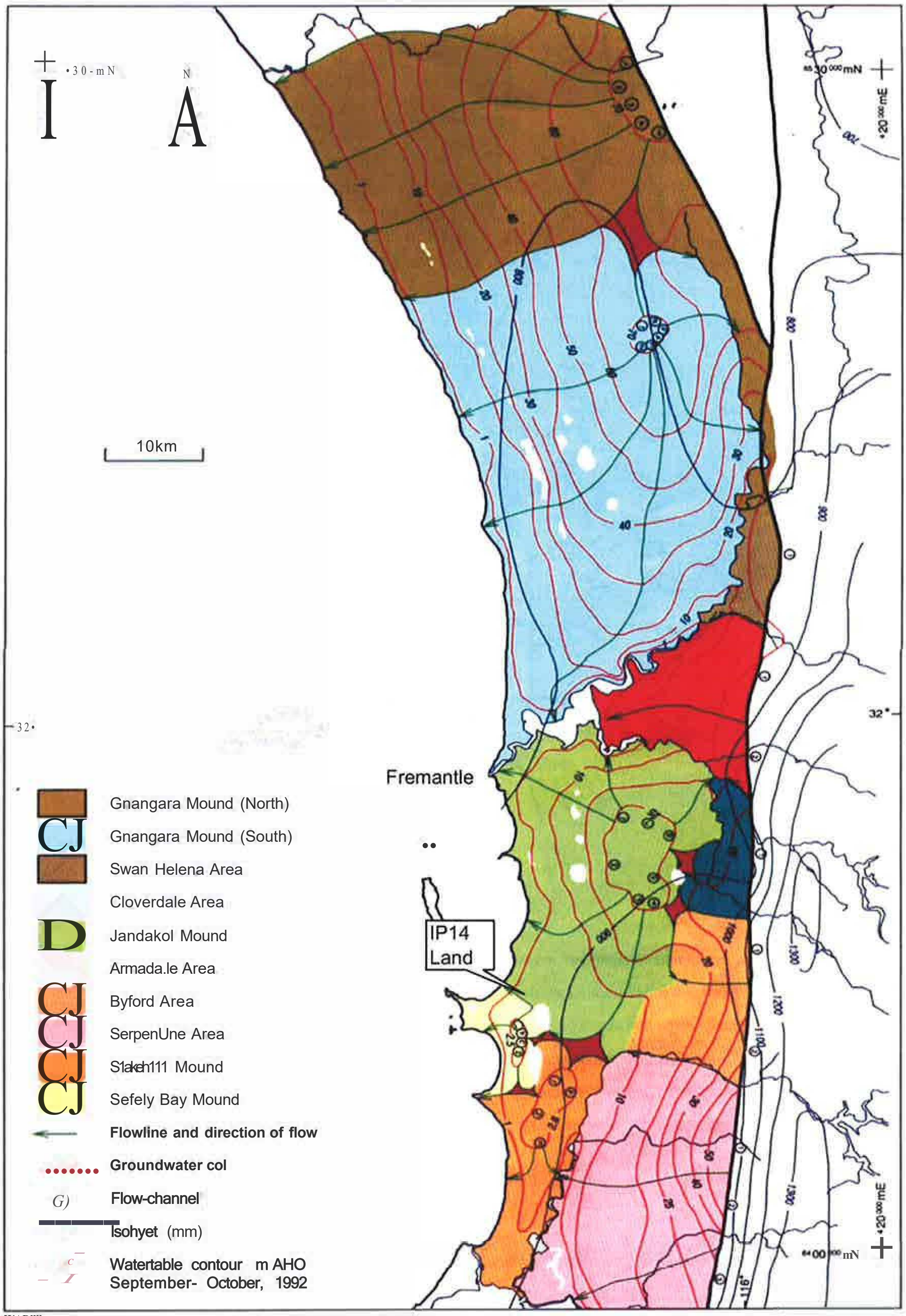
East Rockingham Industrial Park Groundwater Hydrology

Figure 1: Location of Study Area



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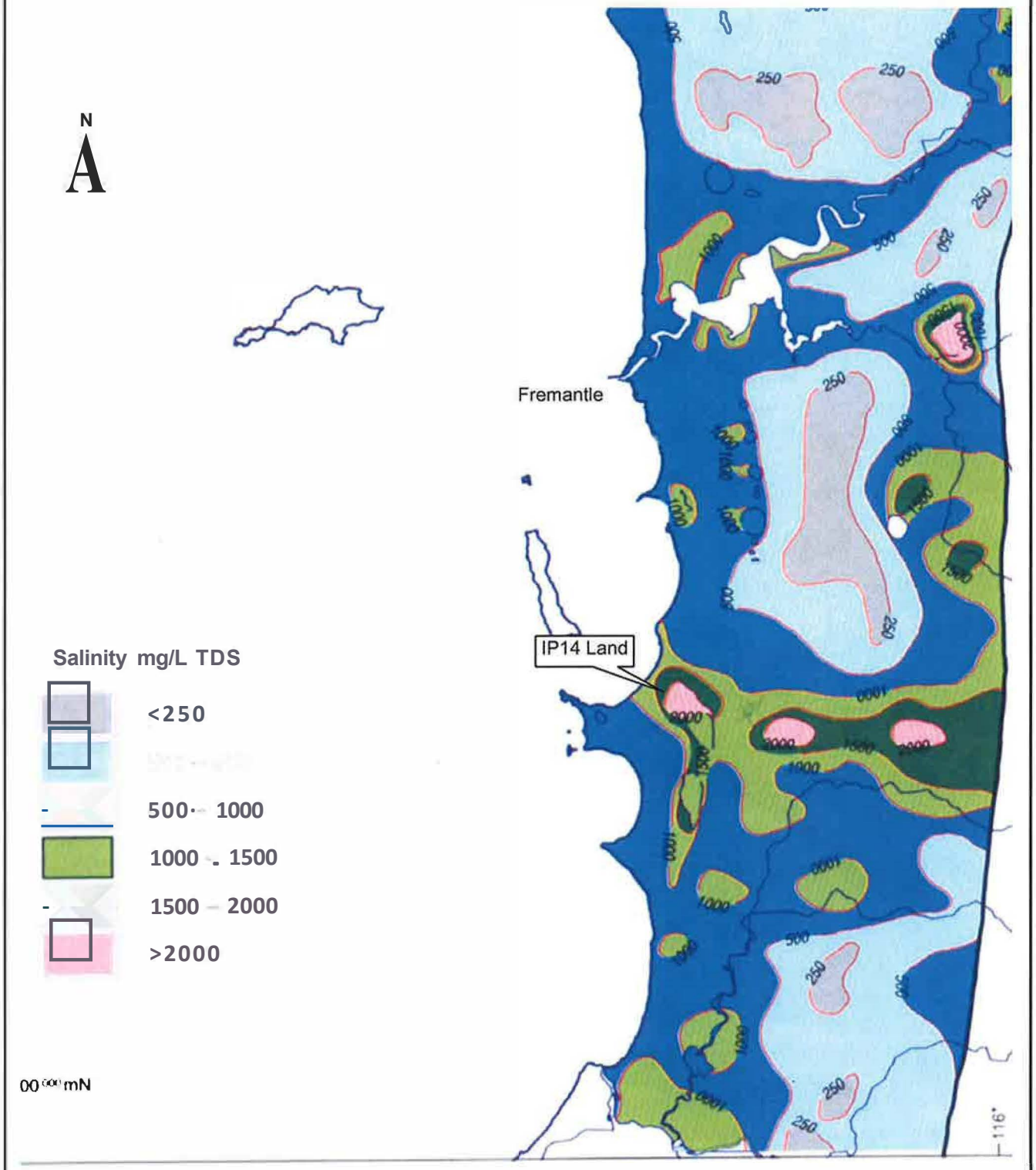
Data Source: Davidson (1995)

JD•,\ Con,ull•nl 1-Jydrolo♦Li.lt:1	Job No. J3477 Scale 1 : 600 000	Landcorp East Rockingham Industrial Park Groundwater Hydrology **Figure 2: Superficial groundwater flow from Davidson (1995)**



Data Source: Davidson (1995)

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East Rockingham Industrial Park Groundwater Hydrology
Figure 3: Superficial groundwater salinity from Davidson (1995)

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East Rockingham Industrial Park Groundwater Hydrology

Figure 4: Monitoring bore location plan

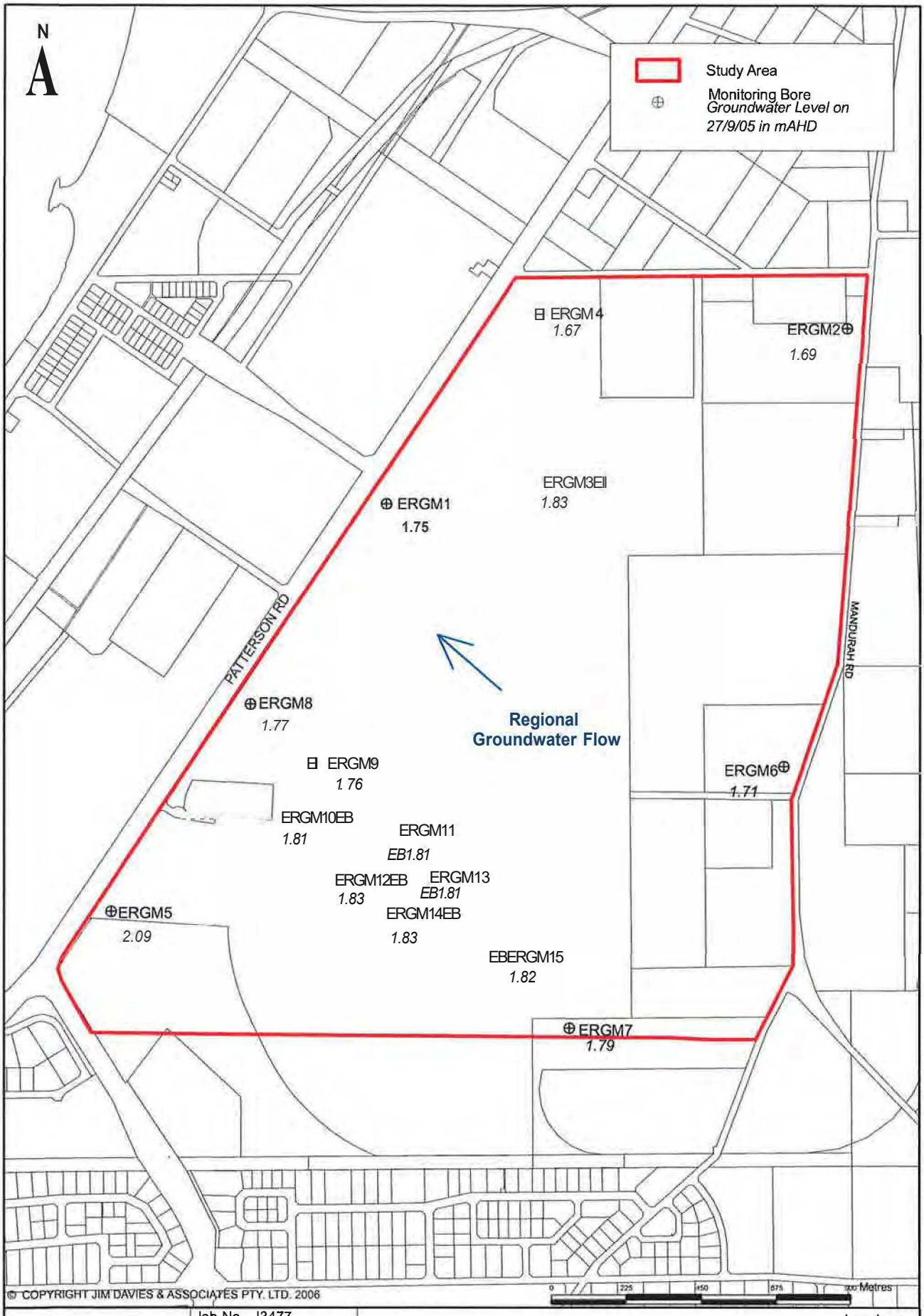

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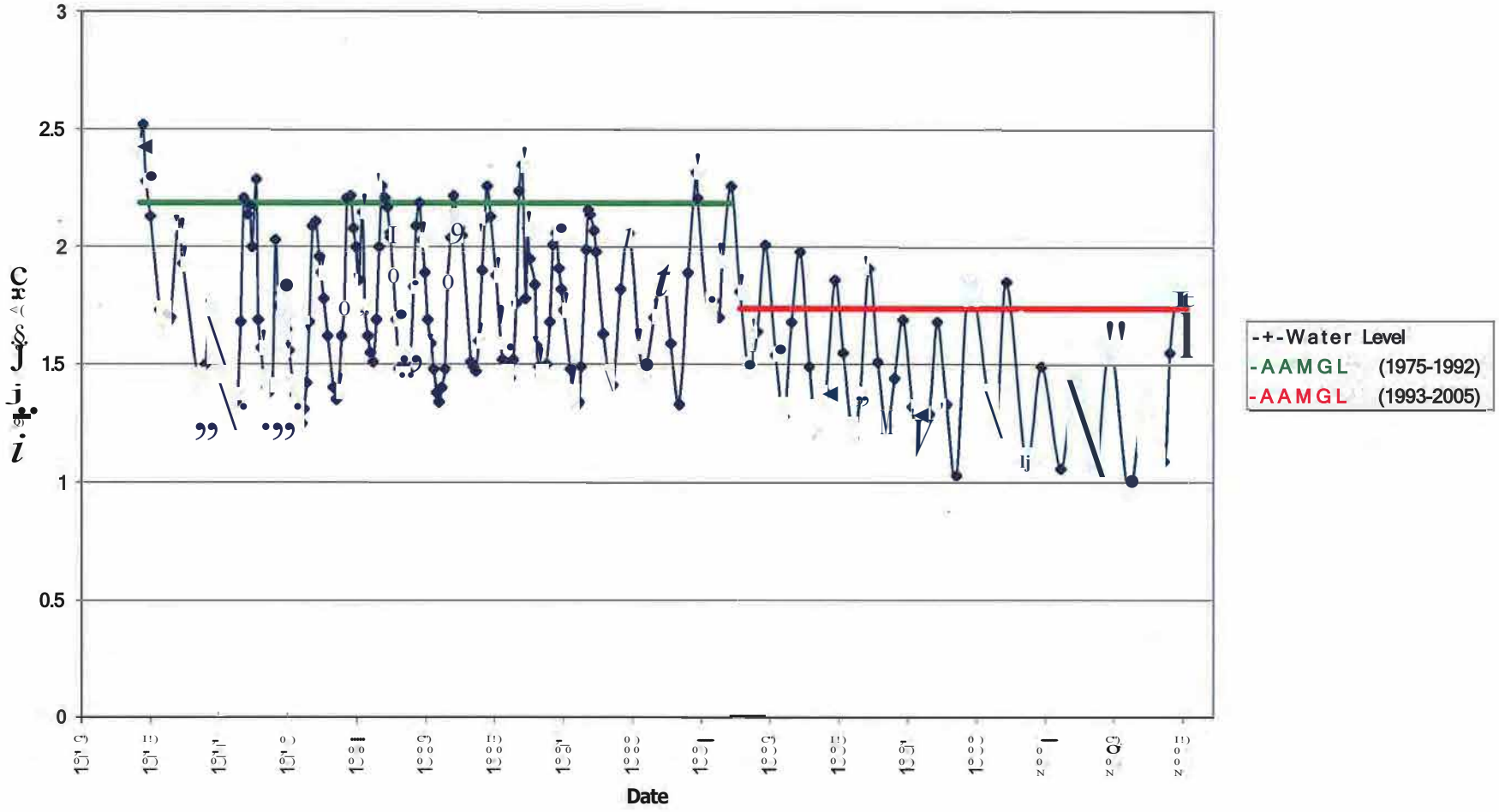
Figure 5: Watertable Levels 27 September 2005

Monitoring Bore T230(O)



Data Source: Department of Environment (2005)

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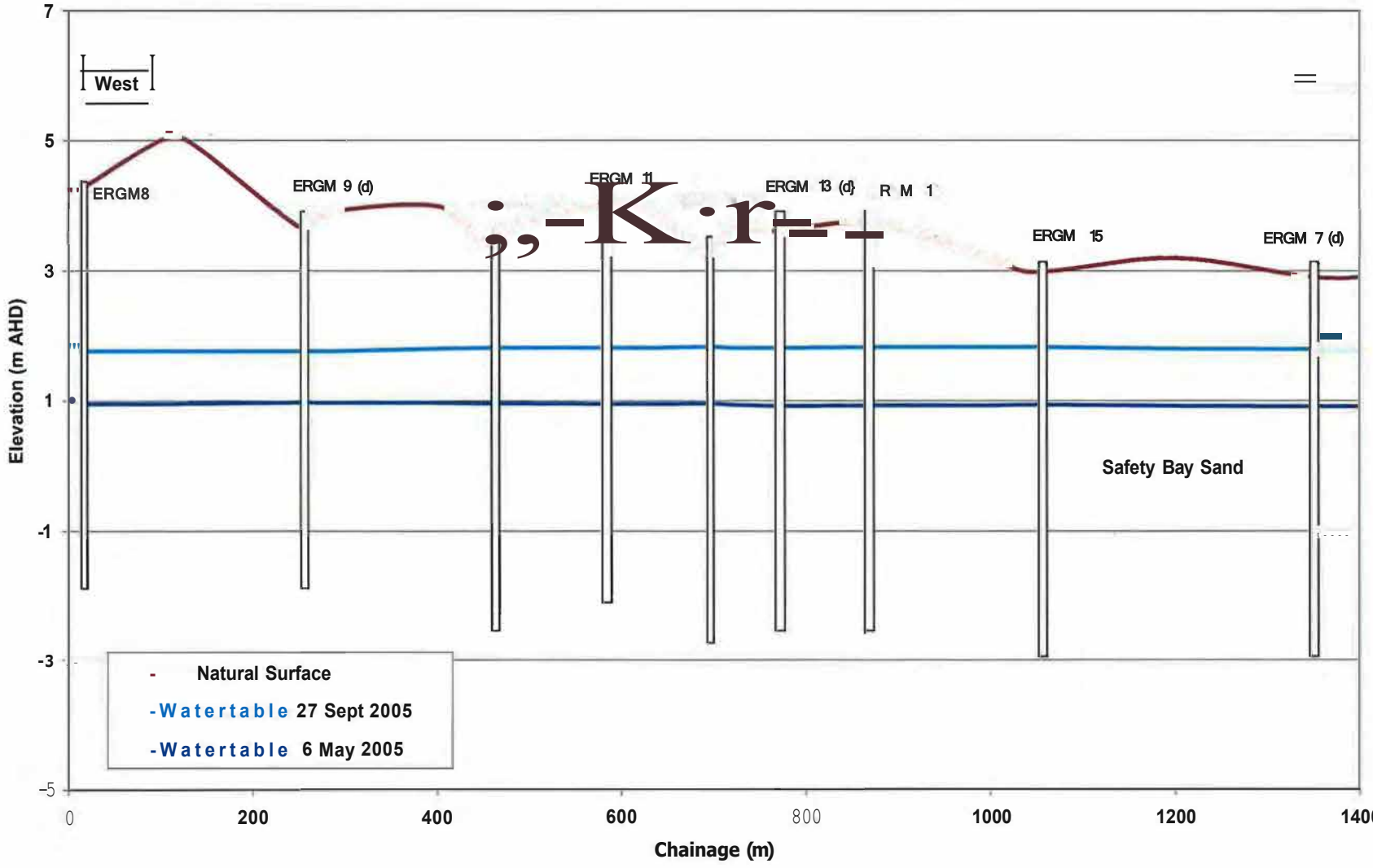
Figure 6: DEC Bore T230(O) time series plot of recorded water levels



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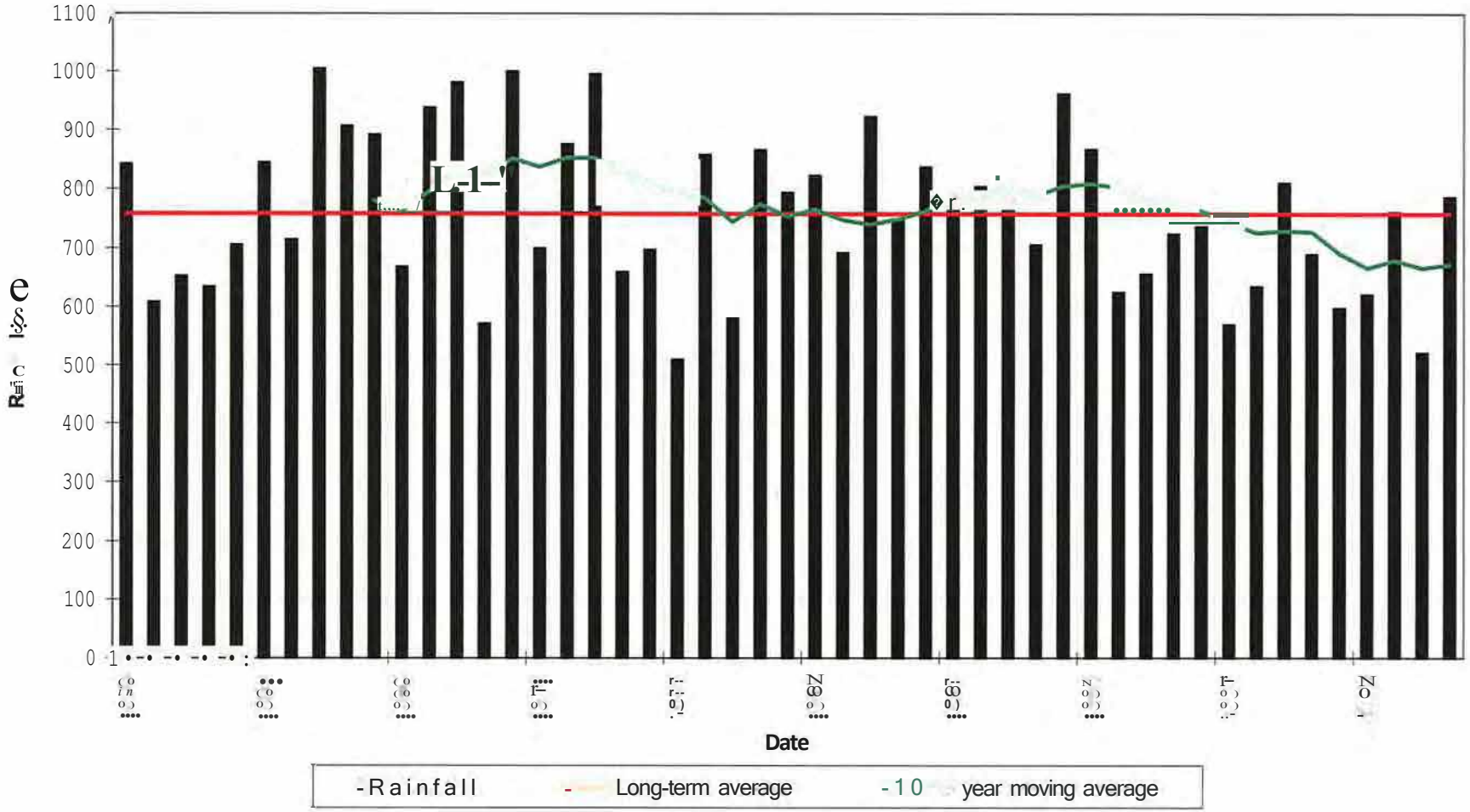
East Rockingham Industrial Park Groundwater Hydrology
Figure 7: Transect of seasonal watertable levels in the wetlands for 2005

Rainfall at Kwinana Station 009064



Data Source : Bureau of Meteorology (2006)

JDA Hywvlo	Job No. J3477	Landcorp East Rockingham Industrial Park Groundwater Hydrology Figure 8: Annual rainfall for Bureau of Meteorology station 009064

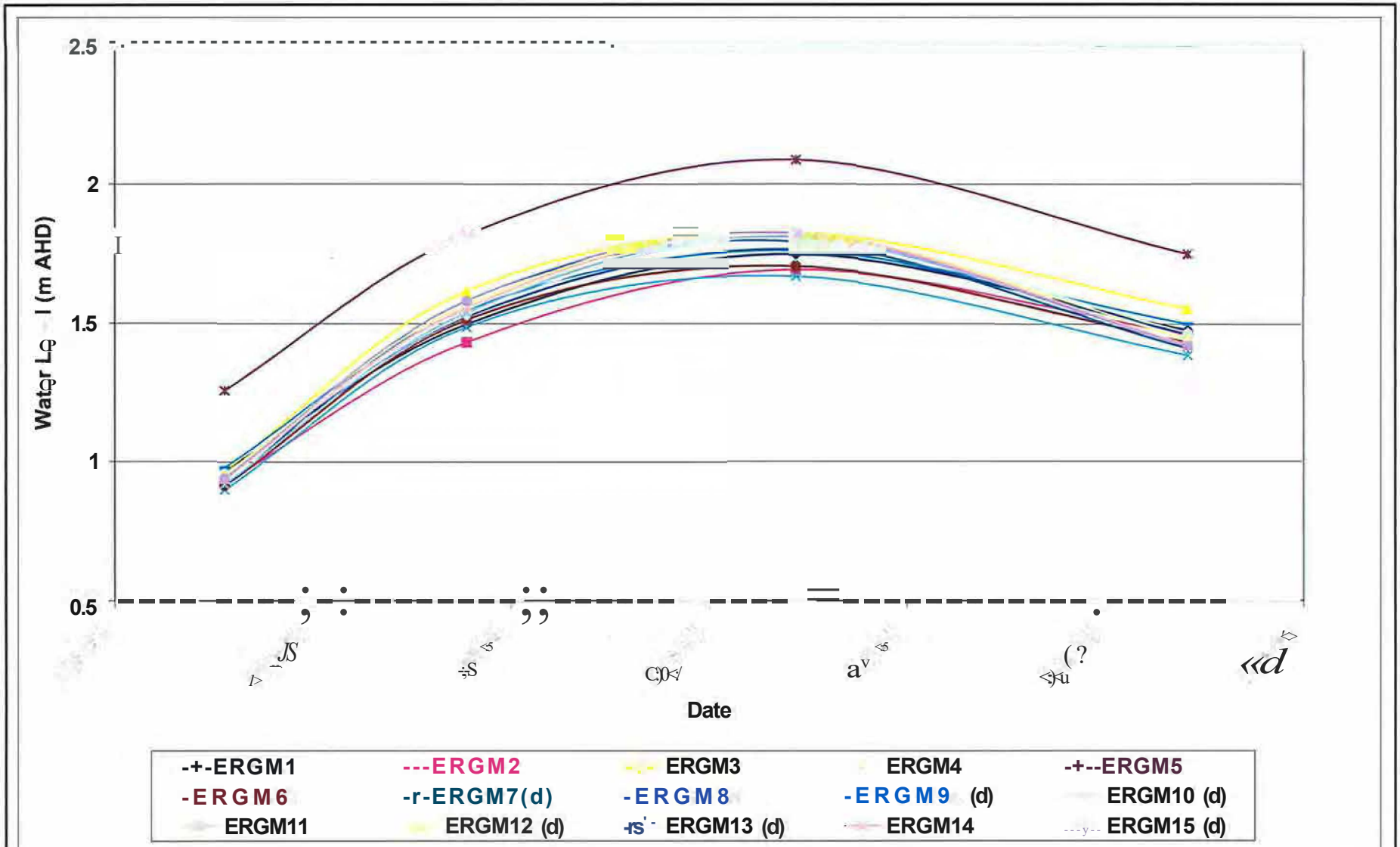


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Figure 9: ERGM series monitoring bores time series plot of water levels

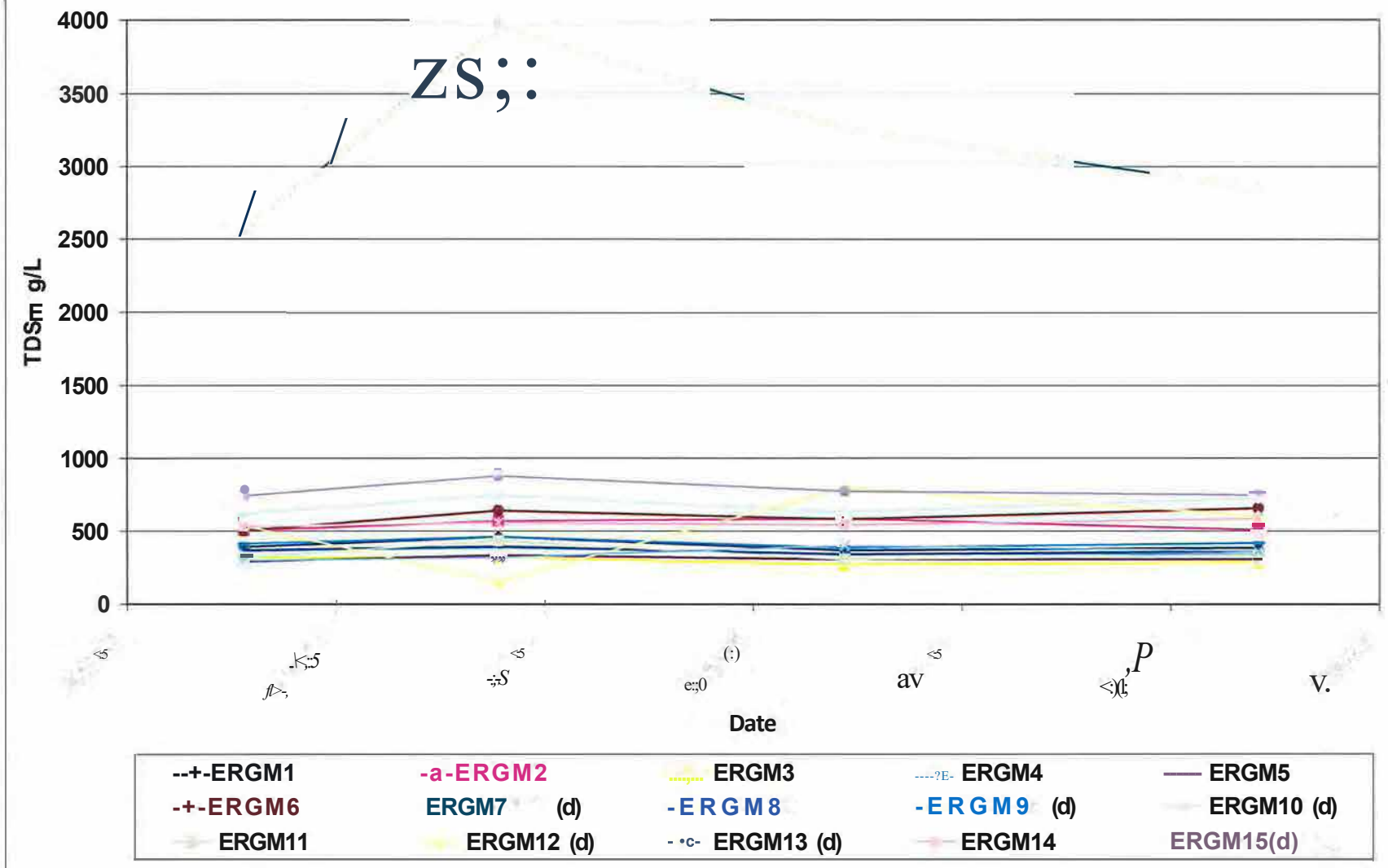

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Figure 10: ERGM series monitoring bores time series plot of total dissolved salts

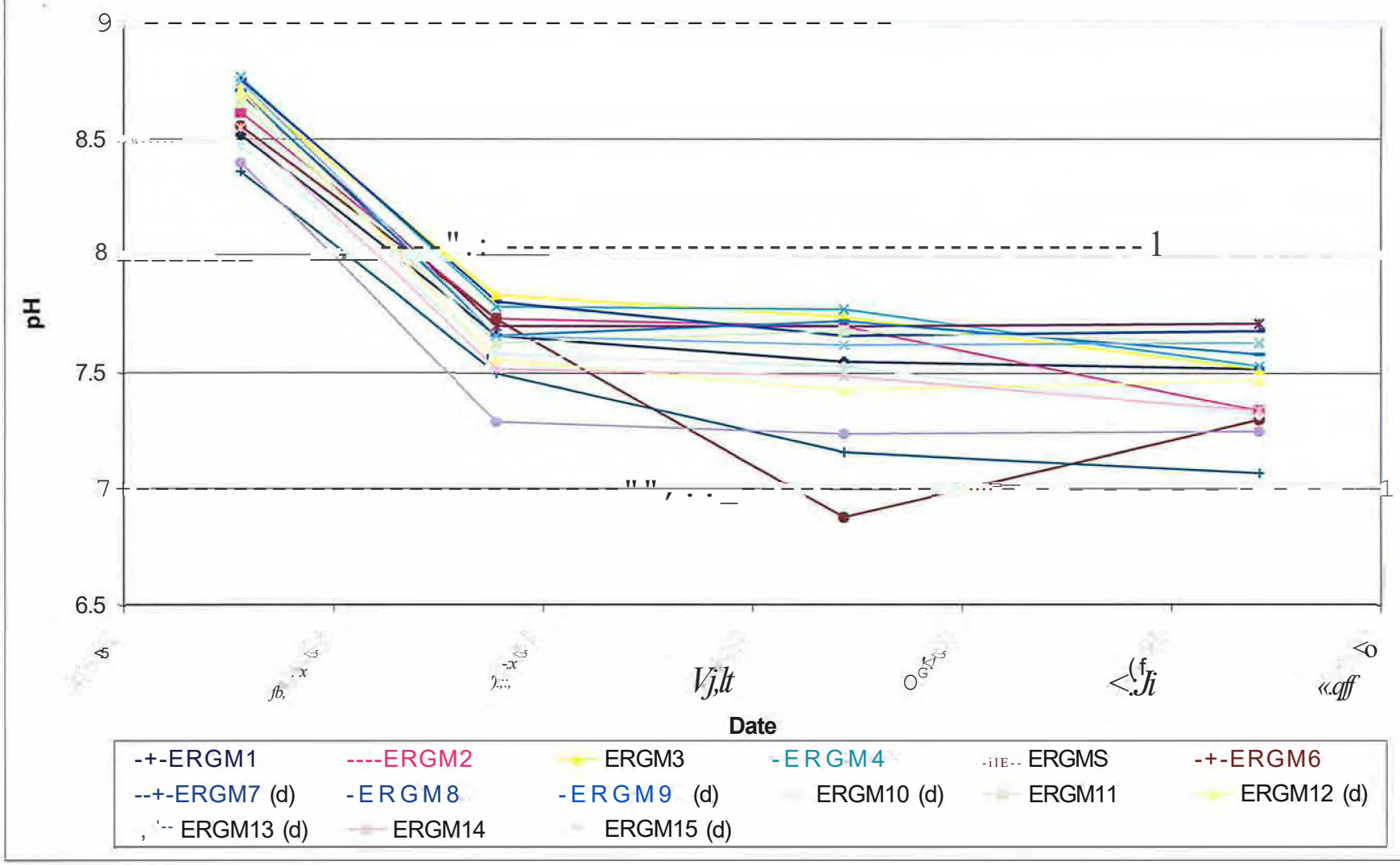

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Figure 11: ERGM series monitoring bores time series plot of pH

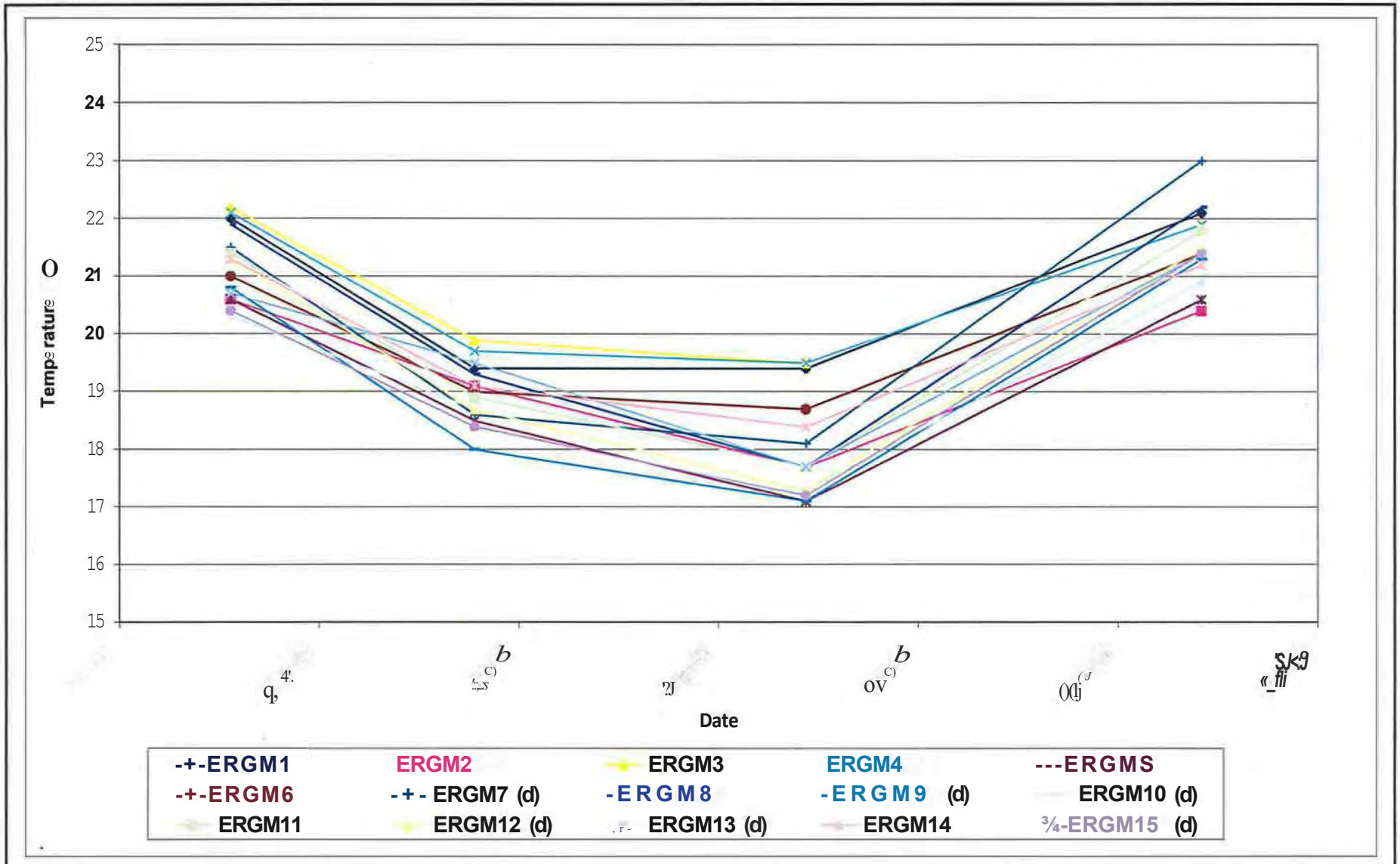

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Figure 9: ERGM series monitoring bores time series plot of temperature

APPENDIX A

Lithological Logs of ERGM Series Monitoring Bores

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Subiaco WA
Tel: 9J88 2436
Fax:93111'1279

LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	]3477
Project:	East Rockingham Industrial Park	Hole commenced:	**18/04/05**
Bore location:	0383826E, 6430506N	Hole completed:	**18/04/05**
Datum,	**MG/194/AHO**	Logged by:	**SW**
Bore Name:	ERGM 1	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TDC:	4.62 m AHD
Hole diameter:	75mm	Natural Surface:	3.92 m AHD

method	penetration 1 2 3	support	water	Slot/ Screen Ocplb	Depth (m,tres)	SOfL CIIARACTF.RISTICS COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (g ass'l:			0lm	Black	fliC	Sill	High	D,y	
						G ny/Brown			Low		
					1.Or1	Crc;im		Sand			
					1,lm						
					2.0m						
					Um		Mo:lium/Finc	Loamy Sand		Moisl	
			∇		10l11						
					1lm					Sa1ur:1td	
				screen	4.0m						
					4.5m						
					5.0m						
					5.5m	GrY		L1mcs1011c' Loamy S11J1t			
					6.0m						A'D//

NO'rF.S ON OOW:LcG

COLOUIIS; SohJrolou"'"'oBl.ACK. WIIITf, BEJO.E
o:in: Brown, Ret Orange, Yellow, Grey, Blue   Toucs: solid colour, blemish or moUlc
Mt:ilhun: Brown, Red, Or.u1gc, Yellow, Grey, Blue
Up'n: Brow11 Red, Oraugt; YcUuw, Grey, Blue

PAllTICI£SIZE: P;ir1id arec.ilho- FINE, MEDIUM or COARSE

''t.\"llJJU\: Smul, Loamy Sam\, Clayey Sand
Sill, Loam, Sandy Loam, Clay Loam
Clay, Samly Cl,ty

ORGA>IC: CONTENT, VOLUME: High, Medium, Low
SIZ£: Fine, Mo:lium, Coi,rsc

MOI.STIJR.E.: Soil Monfu.rctllll bel,dttr. 01(Y, 'SUOIITt.Y MOIST, MOl!i.r or SA ruA:o1\TO

,-ATIC WA1'1'R U;\'EL
Date: 06/05/05
Wl. below TUC: 161 m
Stickup above NS: 0.69 m
WL: 2.96 m below NS

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Fax: 9381 9279

LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	18/04/05
Bore location:	0385212E, 6431025N	Hole completed:	18/04/05
Datum,	MGA94 AKD	Logged by:	SW
Bore Name:	ERGM 2	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	4.58 m AHD
Hole diameter:	75mm	Natural Surface:	3.93 m AHD

Method: HA. Support: PVC (Class 9). Slot/Screen Depth: screened from approx. 4.0 m to 6.0 m. Water level symbol (▽) at approx. 3.0 m.

SOIL CHARACTERISTICS

Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
0.0–1.5 m	Grey	fine	Silt	High	Dry	Partly Cemented
1.5–2.0 m	Creamy White	fine	Sand	Low	Dry	
2.0–2.8 m	Cream	Medium/Fine	Limestone/ Sand	Low	Moist	
2.8–4.0 m	Cream	Medium	Limestone/ Sand	Low	Moist	
4.0–6.0 m	Cream	Medium	Limestone/ Sand	Low	Saturated	EOH

Depth scale: 0.5m, 1.0m, 1.5m, 2.0m, 2.5m, 3.0m, 3.5m, 4.0m, 4.5m, 5.0m, 5.5m, 6.0m

NOTES ON LOG

COLOUR: Soil colours are BLACK, WHITE, BEIGE:
Dark: Brown, Red, Orange, Yellow, Grey, Blue   Tones: solid colour, blemish or mottle
Medium: Brown, Red, Orange, Yellow, Grey, Blue
Light: Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE: Particles are classed as FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil texture is described as: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 06/05/05

WL below TOC: 3.66 m

Stickup above NS: 0.65 m

WL: 3.01 m below NS

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Subiaco WA6008
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Fax:93R19279

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LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	)3477
Project:	East Rockingham Industrial Park	Hole commenced:	18/04/05
Bore location:	0384475E, 64305705N	Hole completed:	18/04/05
Datum:	MGA94/AHD	Logged by:	SW
Bore Name:	ERGM 3	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	4.95 m AHO
Hole diametl?,r:	75mm	Natural Surface:	4,2.1. mAHD

Method	1 2 3 Penetration	Support	Water	Slot/ Screen Depth	Depth (metres)	SOIL CHARACTERISTICS COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0m	Black		Sll	High		Shells at surface
					1.0m	Grey	Fine	Silty Sand	Low	Dry	Part with lyccmcnlal rl lop of layer
					1.5m		Fine/Medium				
					2.0m						
					2.5m	Light Brown/Cream	Medium/ Course	Sand		Saturated	Limestone Gravel
					4.0m						
					4.5m						
					5.0m						
					5.5m						
					6.0m						

NOTES ON DOLOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE:
Dirt: Brown, Red, Orange, Yellow, Grey, Blue — Tones: solid colour, blemish or mottle
MOULD: Brown, Red, Orange, Yellow, Grey, Blue
CLAY: Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE: Particle; are either FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be Either: DRY, SLIGHTLY MOIST, MOIST, SATURATED

STATIC WATER LEVEL

Date: 06/05/05

WL: 3.24 m below NS

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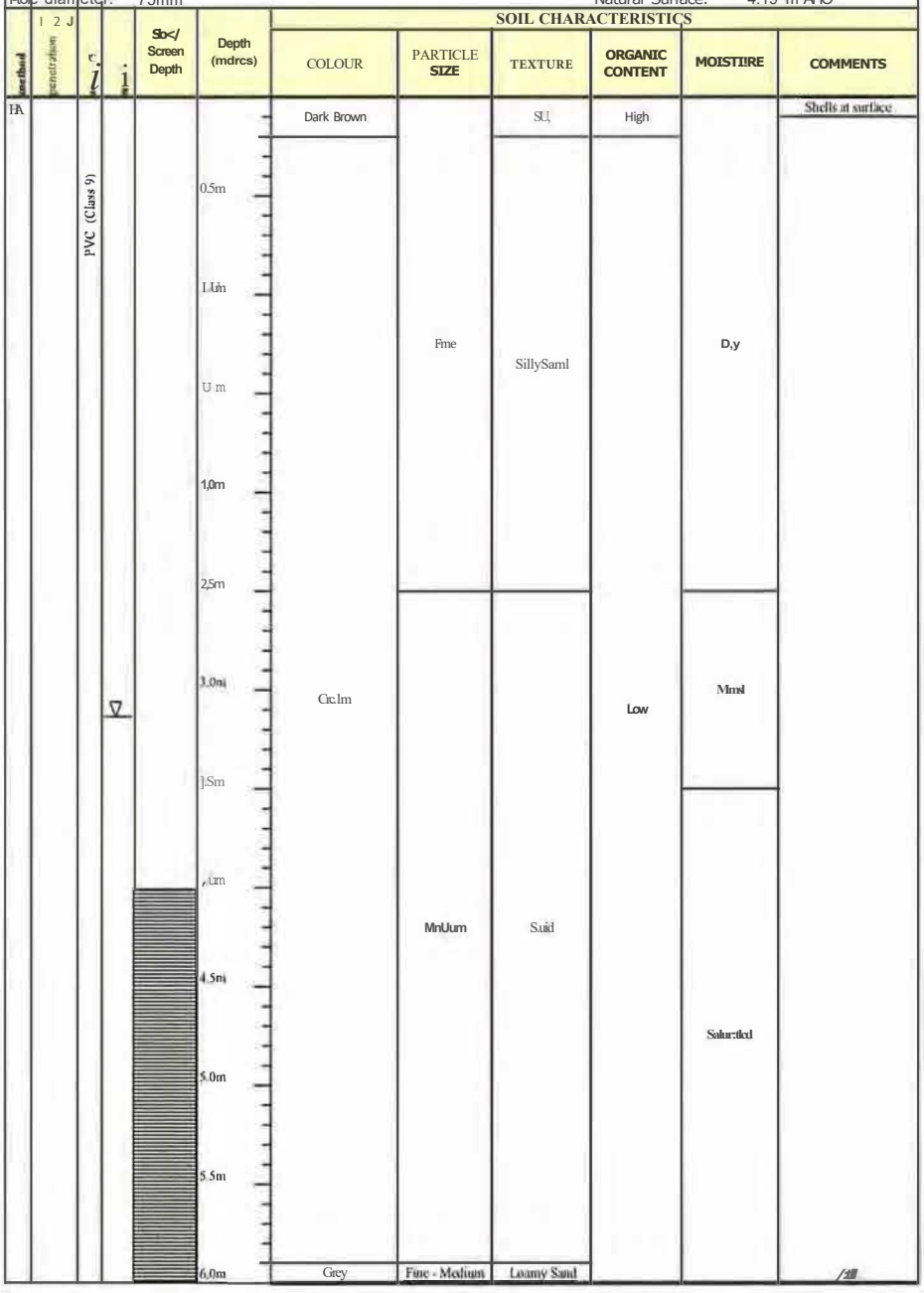
LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/04/05
Bore location:	0385212E, 6431025N	Hole completed:	19/04/05
Datum:	MGA94/AHO	Logged by:	SW
Bore Name:	ERGM 4	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	4.83 m AHO
Hole diameter:	75mm	Natural Surface:	4.19 m AHO



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COLOURS: Solid colours art: BLACK. WHITE. 0Ef(if.
JJJrti:: Brown, Re<l Orauge, Yellow, Gn;Y, Blue
Midwm Brown, Rtxl Orange, Yellow, Grey, Blue
Uf!I;:: Brown, RCJl Orange. Yellow, Grey, Blue

Toucs ; soli<t cnlour, blmtish ur mottle

P,\RTICt.t:.SrZE: Parlic!Cl arc citha- FINE. MEDIUM or COARSE

TEXTURE: Saml, Loamy Sand, Clayey Smid
Sill, Loam, SalHly Loam, Clay Loilm
Clay, Sandy Clay

OHCANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE:Sc\llMtJt,1m:v llllbel'l1her: DRY, LIGH'ILYMOiSf. MOISf1ir ATUMATliD

STATIC WATF;U UV f L
Date: 06/05/05
WL h<lnw TOC: J./J rl
Stickup above NS: 0.74 m
WL: 3.19 m below NS

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·ax: 9381 9279

J D Coruultml Hydrologl.sh

LITHOLOGICAL LOG

Client:	ATA Environmental	Joo No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/04/05
8ore location:	0383002E, 6429297N	Hole completed:	19/04/05
Datum:	MGA94 AHD	Logged by:	SW
Bore Name:	ERGM 5	Total Depth:	6.0 m BN5
Drill type:	Hand Auger	RL TDC:	4.79 m AHD
Hole diameter:	75mm	Natural Sutface:	4.10 m AHD

method	penetration 1 2 3	support	f	Slot/ Screen Depth	Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)			0–0.4 m	Grey/Dark Brown		Slit	High	Dry	Weakdy ccmculcd jus1 below urfacc
					0.4–1.5 m (05m, 10m)	Gn,y	Ftne	Silly Saul	Low	Dry	Some slightly !:Cnunlt1l L1yers
			∇		1.5–3.6 m (15m, !0m, !1m,)0m, Hm)	Gn,y	Ftne	Silly Saul	Low	Dry	
					3.6–4.1 m (4.0m)	Cream	Medium/Fi11e	Saud	Low	Moisl	
				Screen 4.05–6.0 m	4.1–6.0 m (4.5m, 5.0m, 5.5m, 6.0m)	Cream	Medium/Fi11e	Saud	Low	Snlurnled	EOH

NO'fl'.$ ON UORELOG

COl..OURS: Sntl1 ooloun are BLACK, WHITE. BEIGE

l>Nt:	Brown, Red. Orange, Yellow, Grey, Blue	Tones : solidoolour, blcrnih or mulllc
lalUIU•:	Brown, Red, Ornnsc, Yellow, Grey, Blue:	
L41lf_:	Brown, Rec Or.loge, Yellow, Grey. Blue	

l"A"11CLESTZE: P;irtidl.!'l **are** ci1hcr FINE. MEDIUM or COARSE

TEXTURE : S;md, Loamy Saud, Clayey Sam!
Silt, Lorun, Snndy Lu;1m, Clay Loam
Cl;iy, Sanely Clay

OHC,\NIC CONTENT1 VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 06/05/05

WL below TOC: 3.53 m

Stickup above NS: 0.69 m

WL: 2.84 m below NS

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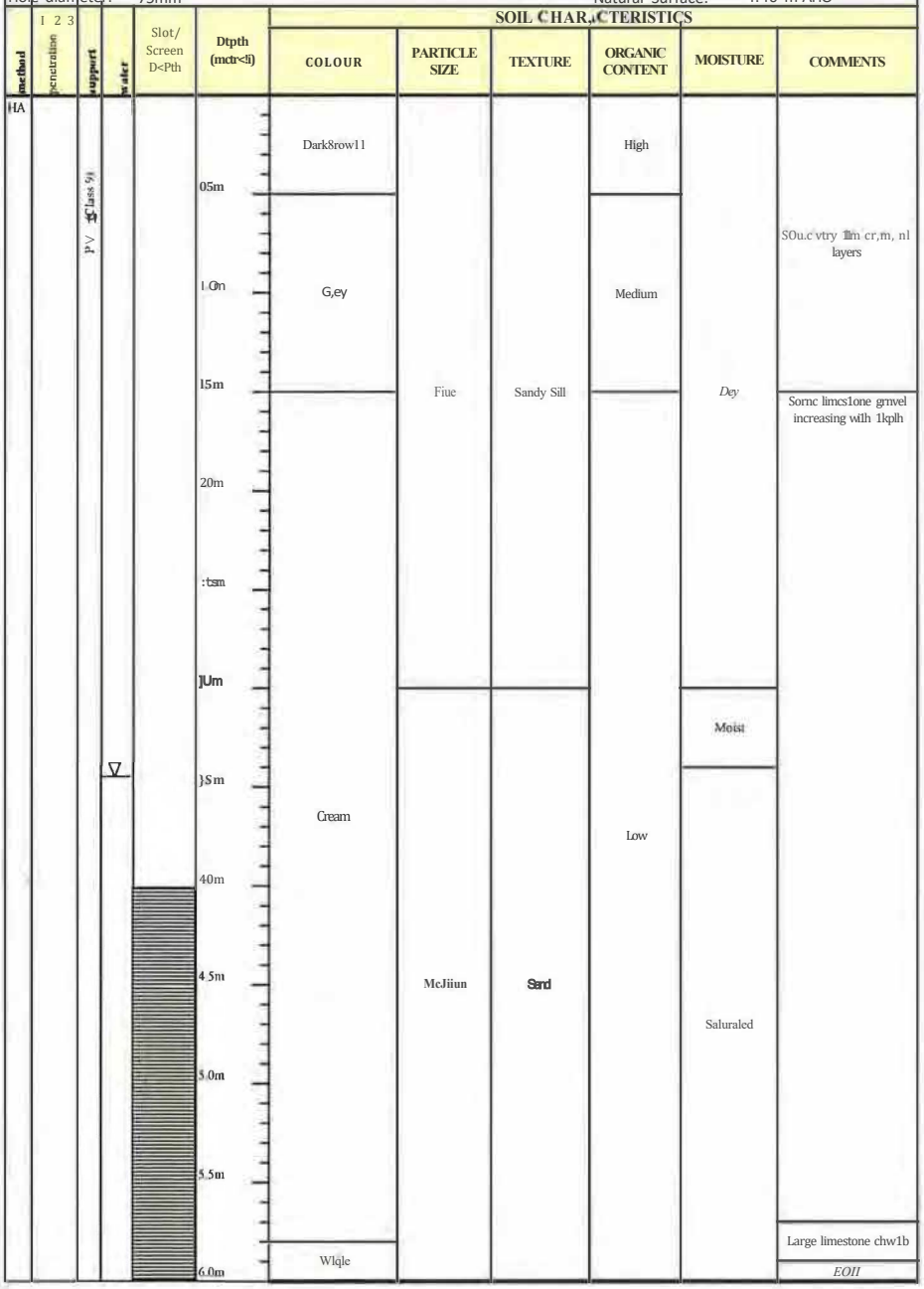
Hydmlogliit9

LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	)3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/D4/D5
Bore locatlon:	D385D21E, 6429727N	Hole completed:	19/D4/D5
Datum:	MGA9♦/AHO	Lo♦ed by:	SW
Bore Name:	ERGM 6	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TDC:	5.05 m AHO
Hole diameter:	75mm	Natural Surface:	4.40 m AHO



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COl.OURS; Sohil coloun arc SLACK, WRITE, "8El0t

D:wli, **Brown, ROI Orauge, Yellow, Grey, Blue** Tones ; solid colour, blemish or mull le
Mafluw: **Brown, Red,** Orange, **Yellow, Grey, Blue**
Ysfl;1 Brown, Rccl Orang'-', Yellow, **Grey, Blue**

PA{ffICU:SIZE: Par1iclo; arc cilha- FINE, MEDIUM or COARSE

TE!TURE: SaHd, Lo;miy Sm1ll Clayey Sand
Sill, Loam, SillKly Lm1m, Clay Lo.im
Clay, Sandy Clfty

OIIG,\-SIC CONTENT: VOLUME: High, Medium, Low
SIZE: **Fine,** Medium, Coarse

MULSTUl:<.E: &1ll Mws1un:cwt he ci1hcr. DRY, SLIGHTLY MOIST, MOIST .s.\TUkATiiO

STATIC WATER LEV&L
Date: 06/05/05
WL II<._ TOC: . ₱,n
Stickup above NS: 0.65 m
WL: 3.48 m bclow NS

jl)A. Coosulld11I Hy)11>1ϕi;'5
Soilc I, 'I'IYorLSlr'<-1
S11hbro WA60(ti
Tcl:93882 36
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LITHOLOGICAL LOG

O1ent:	ATA Envrronment;,t	lob No:	I3477
reject:	East Rockingham Industrial Park	Hole commenced:	19/04/05
ore location:	0384377E, 6428951N	Hole completed:	19/04/05
Datum:	MGA94/AHO	Logged by:	SW
Bore Name:	1RGM 7	Tocal Depen:	8.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	3.56 m AHD
Hnlle diam&er:	75mm	Natural Surface;	2.90 m AHD

SOIi, CIIARAt'TERISTICS

method	penetration	support	water	Slot/ Scre,cn Drplh	D,pth (ntclrcs)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOJSTURE	COMMENTS
HA		': (Class 9')			0–05m	Lighl Brown/Cream	Very Fine	S,,	Low	Dry	Hartl ccmmlcd laycrs
					Him	Crc.l ln/Wllitc	Frro	Sand			Jlclc-110aocre.l'lu1.
					11m	Bmwl1/Crclm					
			▽		11)n	Blue/Grey		Lo;,mySand		MolSl	
					25m–8.0m	Grey	Fine/Medium	Snnd		S11tunlW	ore COllSmCIUI 0 5.S m RNS
											E\lt1Mikd-hllai rd Tamala Limcslonc
											I.Uinkmr110t'1lt1'u1llcm liJ.)//

Depth scale: 05m, Him, 11m, 11)n, 25m, 3,0m, J.Sm, 4,0:n, 45m, S0m, Slm, 60m, 6Sm, 1,0m, 7,Sm, 8.0m

NOTES 0I1 BORELOO

COLOURS1,;,\lIJ. . .11'"p,ollLA "K, IVHITI; trlll<:;I!
OJJk: Brown, R Omoi;o.. Yellow, Grey, Blue Tum :solit!oolonr, blemish or monl
li,k\lmnr: Brown. Red, Omoge. YC,low,1 Gn.y, Bhl!
Lld,11: Browl1, Red, Orl1ltgc, Ycltow, Grey, Blue

Pf\RTIC:t..lt SIZE: Pntliclcs are d1hcr FINE, MEDIUM or COARSE

TE."'C'fUltE: Snlc Loamy Sall(I, Clayey Sand
Sill, Loam, Sandy Loam, Clay Loam
Clay, Sal1lly Clay

OHCJNNIC CONTENT: VOLUME: High, Medium, Low
StZE: Fine, Malium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATEE

S't\TIC WATI:IU.&Vt:L

Date: 06/05/05

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Stickup above NS: 0.66 m

WL: 1.99 m below NS

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JDA Consultant Hydrologists

LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/04/05
Bore location:	0383419E, 6429912N	Hole completed:	19/04/05
Datum:	MGA94/AHO	Lagged bY:	S W
Bore Name:	ERGM 8	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	4,78 m AHO
Hole diameter:	75mm	Natural Surface:	4.13 m AHO

Method: HA
Support: PVC (Class 9)
Slot/screen depth: 2.5m – 6.0m

SOIL CHARACTERISTICS

Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
0.0m – 0.2m	Light brown/Cream	Fine/very fine	Silty sand	Low	Dry	Shells at suiface
0.2m – 1.5m	Light brown/Cream	Fine/very fine	Silty sand	Low	Dry	Sand particle size mcreasmg
1.5m – 2.0m	Cream	Medium/ very fine	Silty sand	Low	Dry	Sand particle size mcreasmg
2.0m – 4.0m	Cream	Medium/Fine	Sand	Low	Dry	Quartz and broken shell fragments
4.0m – 5.7m	Cream	Medium/Fine	Sand	Low	Saturated	Quartz and broken shell fragments
5.7m – 6.0m	Grey	Medium/Fine	Sand	Low	Saturated	EOH

Non::, ON UOR!-LOG

CO1,OUKS: SolNl colows are Ill.ACK. \\111TE, nEIGk
Oi11: Brown, Red, Orange, Yellow, Grey, Blue
M.tdiuw: Brown, Red, Orange, Yellow, Grey, Blue
LI.du: Brown, Red, Orange, Yellow, Grey, Blue
Tones : solid co\ou-, blemish or mollle

rARTitl.t SJZE: Particles are either FINE. MEDIUM or COARSE

'rF.\'TURE, Sand, Loamy Sand, Clayey Sand
Sill, Lorun, Sandy Loam, Clay Loam
Clay, Sandy Clay

OIIGAI'I'C C01.'T:1'T: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISClIllE, Soll /,1<11111e<11tb<iUG: DRY, LIOHI LV MOIS1. MOIST r S,,71/RA'IRI

STATIC WATER LEVEL

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WL below TOC: 3 82 m

'51ickdp atxive NS: 0.65 m

WL: J l7mbelowNS

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LITHOLOGICAL LOG

Client:	ATA Environmental	lob No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/04/05
Bore location:	0383604E, 6429735N	Hole completed:	19/04/05
Datum:	MGA94/AHD	Logged by:	SW
Bore Name:	ERGM 9	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	4.31 m AHD
Hole di.ameter:	75mm	Natural Surface:	3.67 m AHD

S011. CIIARACTERISTICS

method	penetration (1 2 3)	support	water	Slot/ Screen Depth	Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class a)			0.0–0.3m	Dark grey	Fine	Sandy silt	High	Dry	
					0.3–1.2m	Grey	Fine	Sandy silt	Low	Dry	.\\ofoun wdl 00·lt[li1l.'d m!hick
			∇ (2.7m)		1.2–3.0m	Cream	Medium/Fine.	Sand	Low	Moist	
				4.0–6.0m	3.0–6.0m	Grey	Medium	Sand	Low	Moist / Saturated (from 3.5m)	EOH

Depth scale: 0,5m; 1.0m; 1.5m; 2.0m; 2.5m; 3.0m; 3.5m; 4.0m; 4.5m; 5.0m; 5.5m; 6.0m

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, **WHITE**, BEIGE
Dark: Brown, Red, Orange, Yellow, Grey, Blue — Tones: solid colour, blemish or mottle
Medium: Brown, Red, Orange, Yellow, Grey, Blue
Light: Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE **SIZE:** Particles **are** either FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATERLEVEL

Date: 06/05/05

W t below TOC: 3.33 m

Stickup above NS: 0.64 m

WL 2.69 m below NS

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LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/04/05
Bore location:	0383714E, 6429578N	Hole completed:	19/04/05
Datum:	MGA94/AHD	Logged by:	SW
Bore Name:	ERGM 10	Total Depth:	**6.0 m** BNS
Drill type:	Hand Auger	R.L. TOC:	3.99 m AHD
Hole diameter:	75mm	Natural Surface:	3.44 m AHD

SOIL CHARACTERISTICS

method	penetration 1 2 3	support	wa	Slot/Screen Depth	Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA					0.0–0.7 m	Dark grey	Fine	s,l l	High	Dry	Medium well cemented
					0.7–1.6 m	Grey	Fine	Sandy sill	Medium	Dry	
			▽ (2.4 m)		1.6–3.0 m	Grey	Fine	Sand	Low	Moist (1.6–3.5 m)	
				Screen 4.0–6.0 m	3.0–6.0 m	Grey/Blue	Medium	Sand	Low	Saturated (3.5–6.0 m)	

Depth scale: 0.5m, 1.0m, 1.5m, 2.0m, 2.5m, 3.0m, 3.5m, 4.0m, 4.5m, 5.0m, 5.5m, 6.0m

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NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, GREY
Dark: Brown, Red, Orange, Yellow, Grey, Blue — Tones : solid colour, blemish or mottle
Medium: Brown, Red, Orange, Yellow, Grey, Blue
Light: Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE: Particles are either FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil moisture is either DRY, SUFFICIENTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL
Date: 06/05/05
WL below TOC: 3.03 m
Stick-up above NS: 0.55 m
WL: 2.48 m below NS

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LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	)3477
Project:	East Rockingham Industrial Park	Hole commenced:	19/04/05
Bore location:	0383847E,6429474N	Hole completed:	19/04/05
Datum:	MGA94 / AHD	Logged by:	SW
Bore Name:	ERGM 11	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TDC:	4.71 m AHD
Hole diameter:	75mm	Natural Surface:	4.05 m AHD

Method: HA. Support: PVC (Class ...). Water level marker (▽) at approx. 3.1 m. Slot/Screen depth: 4.0m – 6.0m.

SOIL CHARACTERISTICS

Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
0 – 0.5m	Dark grey	Fine	Sandy silt	High	Dry	
0.5m – 3.0m	Grey	Fine	Sandy silt	Low	Dry	Some limestone gravel
3.0m – 3.5m	Cream	Fine	Sand	Low	Moist	
3.5m – 5.0m	Cream	Fine	Sand	Low	Saturated	
5.0m – 6.0m	Grey/Blue	Fine	Sand	Low	Saturated	EOH

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, UEIGI
Dark: Brown, Red, Orange, Yellow, Grey, Blue — Tones ; solid colour, blemish or mottle
Medium: Brown, Red, Orange, Yellow, Grey, Blue
Light: Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE: Particles are either FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil lotSlmcanbeotba; DI>\ SUGIITI.\' MOIST, MOIST -U fu.\TUftATH"

STATIC WATER LEVEL
o,ic, 06/05105
\Vl below TOC: 3.16 m
ShGloip above NS: 0.66 m
Wt.: 3.10 m below NS

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LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	20/04/05
Bore location:	0383876E, 6429393N	Hole completed:	20/04/05
Datum:	MGA94 / AHD	Logged by:	SW
Bore Name:	ERGM 12	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	3.92 m AHD
Hole diameter:	75mm	Natural Surface:	3.26 m AHD

Method: HA; Support: (Class : :); Water level ▽ at approx. 2.3 m; Slot/Screen depth: 4.0 m – 6.0 m

SOIL CHARACTERISTICS

Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
0.0 – 0.5m	Dark grey	Fine	Silt	High	Dry	
0.5 – 1.0m	Light grey	Fine	Silt	Low	Dry	Well Cemented
1.0 – 1.5m	White	Fine	Silt	Low	Dry	
1.5 – 2.0m	Cream	Medium/Fine	Silty sand	Low	Dry	
2.0 – 3.0m	Cream	Medium	Sand	Low	Moist	
3.0 – 3.6m	Blue/grey	Medium	Sand	Low	Moist	
3.6 – 6.0m	Blue/grey	Medium	Sand	Low	Saturated	EOH

SOILS ON BORELOG

COLOURS, Solid colours are BLACK, WHITE, BEIGE
Dark: Brown, Red, Orange, Yellow, Grey, Blue
Medium: Brown, Red, Orange, Yellow, Grey, Blue
Light: Brown, Red, Orange, Yellow, Grey, Blue
Tones : solid colour, blemish or mottle

PARTICLE SIZE: Particles are either FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT, VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE Soil Moisture can be either, DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 06/05/05

WL below TOC: 2.93 m

Stick up above NS: 0.66 m

WL: 2.30 m below NS

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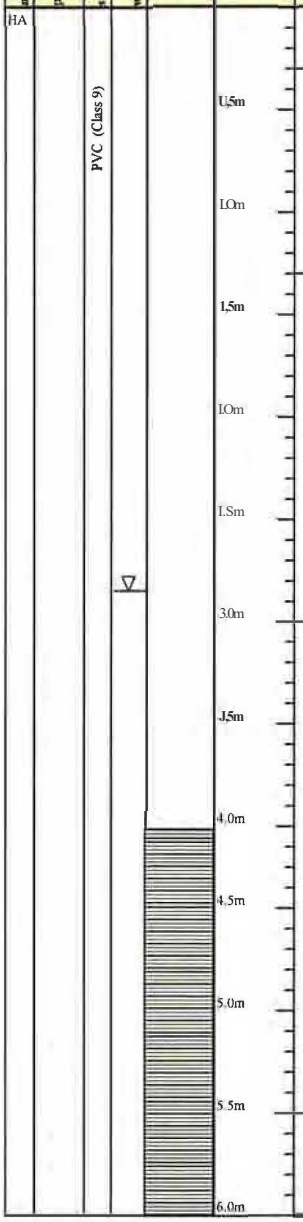
LITHOLOGICAL LOG

Client:	ATA Envlronmentijl	**Job No:**	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	20/04/05
Bore location:	0383873E, 6429392N	Hole completed:	20/04/05
Datum:	MGA94/AHO	Logged by:	SW
Bore Name:	**ERGM 13**	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	**R.L.** TOC:	3.79 m AHO
Hole diameter:	7.5mm	Natural Surface:	3.27 m AHO



Depth (metres)	SOIL CHARACTERISTICS					
	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
0.0–0.5m	Dark grey	Fine	Silt	High	Dry	
0.5–1.0m	Grey		Sandy silt	Medium		
1.0–1.5m						Well cemented layer
1.5–3.0m	Grey/Cream	Medium/Fine	Silty sand	Low	Moist	
3.0–4.5m	Cream	Course/ Medium	Sand		Saturated	Limestone gravel
4.5–5.5m						
5.5–6.0m	Blue/Grey	Medium				

NOtE@ ON UOR@LOC

COLOUIlSt Solid colours are BLACK, WATTE, BEIGE
D,11I': Brown, Red, Orange, Yellow, Grey, Blue
Mttlium: Brown, Red, Orange, Yellow, Grey, Blue
l.l&ht: Brown, Red, Orange, Yellow, Grey, Blue
Tones : solid colour, blemish or mottle

PARTICLE SIZE : Particles are eithei- FINE, MEDIUM or COARSE

TT.lo/'TIJRE: **Sand, loamy Sar<sl, Clayey Sar<sl**
Sill. loam, Sarxiy loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, **Coarse**

ltl01 7'U"E: Mlil Mr:u101rct:m\Cdlltcl: DRY, :SLIGIITI.Y MOIST. M01£T ot SATIJR.ATEt

STATIC WATER LEVEL

P.1IC 06/05/05

WI. below TOC: 3.J6 m

Sll•IM••bo1'c NS: 0.52 m

WL: 2.84 m below NS

E{IH

JDA Consultant Hydrologists
Suite 1,27 York Street
Subiaco WA 6008
Tel: 9388 2466
Fax: 9388 2479

LITHOLOGICAL LOG

Client:	ATA Environmental	Job No:	J3477
Project:	East Rockingham Industrial Park	Hole commenced:	20/04/05
Bore location:	0384035E, 6429290N	Hole completed:	20/04/05
Datum:	MGA94/AHD	Logged by:	SW
Bore Name:	ERGM 14	Total Depth:	6.0 m BNS
Drill type:	Mand Auger	R.L. TOC:	4.43 m AMD
Mole diameter:	75mm	Natural Surface:	3,74 m AHD

method	penetration	support	water	Slot/ Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC	▽		U,Sm	Dark brown	Flne	Slt	High	Dry	Shells alfflrfiKci
					1,Om						Very thin, weakly cemented layer
					1,Sm	Grey		Sandvsilt			
					LOm						
					2m						
					J.Om	Cream				Moisl	
					,15m				Low		
					4.0m		Mediwn	Sarai		Saturated	
					4.5m	Bluo'Grey					
					5,0m						
					5,5m						
					6.0m						EDfl

NOTES ON BORELOG

COLOURS; Solid colours are BIACK., WffiTE; ffEl OE
O;u\: Brown, Red, Orange, Yellow, Grey, Blue
Mcdnim: Brown, Red, Orange, Yellow, Grey, Blue
Ll,thl: Brown, Red, Orange, Yellow, Grey, Blue
Tones: solid colour, blemish or mottle

PAIITICL t SIZE : Particles are either F(NE, MEDIUM or COARSE

TR◆"TJRE, Sand, LOamy Sand, Clayey Sand
Silt, Lorun, Sandy Loam, Clay Loam
Clay, Sandy Clay

O!IGt\NIC CONTENT, VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATEI

STATIC WATER LEVEL

o,◆ 06105105

WL below TOC:] .49 m

S11dwp above NS: 0.69 m

\VJ: 2,80 m below NS

JDA Consultant Hydrologists
JDA <:nnsullanl Hyirol ISk
Suite 1, 27 YorkSlrcel
Subia'O WA 6008
Tel: 9358 2.136
Fax: 9381 9279

LITHOLOGICAL LOG

Client:	ATA Envlronmentill	Job No:	]3477
Project:	East Rockingham Industrial Park	Hole commenced:	20/04/05
Bore location:	0384152E, 6429166N	Hole completed:	20/04/05
Datum:	MGA94/AHD	Logged by:	SW
Bore Name:	ERGM 15	Total Depth:	6.0 m BNS
Drill type:	Hand Auger	R.L. TOC:	3.67 m AHO
Hole diameter:	75mm	Natural Surface:	2.98 m AHD

Method	I 2 J penetration	Support	Water	Slot/ Screeq Depth	Drpth (mctrc,)	SOIL CHARACTERISTICS					
						COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
11A		PVC (Class	1			Dark brown			High		
					USm	Grey	Fine	Sill	Modlum	D,y	Well cemented
					1.0m						
					1.Sm	C,cam	Mcdiwn/Fine			Moist	
			▽		20m						
					2Sm						
					3.0m						
					.1.Sm	Grey/Blue	Medium	Sand	Low	Saturated	
					4.0m						
					4.5m						
					5.0m						
					5.5m						
					6.0m						W/

I<O T:5 ON DORF.LOG

C:01.0Ul<S: Solid colou,s a,e 1ll.ACK. WIIITE. DE.IOI

01tk:	Brown, Red, Orange, Yellow, Grey, Blue	Tones: solid colour, blemish or mottle
Mahum:	Brown, Red, Orange, Yellow, Grey, Blue	
L.Jd.t:	Brown, Red, Orange, Yellow, Grey, Blue	

VAlf.rJ€LJ! SIZE: Particles are eilhcr FINE, MEDIUM or COARSE

T&XTUllE: Sand, Loamy Saod, Clayey Sand
Sill, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTUR.1!1 SaUM•i•1Utecn1hc:01lh<r. OR\', SWCllrrt,Y MOIST, MOl!:1' u, SATIIRA'IEI

STATIC:WATER LEVEL

D.,1e: 06105105

WLbclow TOC: 2.7J m

Sllthup 1[N/1 NS: 0.69 m

WL: 2.0t m below NS

APPENDIX B

Groundwater Analysis Laboratory Report

fmpl

e.:., J'etJ/fjcatl? of Analysis

Testing Facility: Perlh

Job No: **51255**
Client: JDA CONSULTANT HYD
Address: PO BOX 117
SUBIACO WA 6904

Client Reference: J3477C1
Date Received: 6/05/2005
Date Sampled: 6/05/2005
Test Method: Water samples submitted basis. Metals analysis on perfonned in accordance

Sampled By: CLIENT

IDENT UNITS	External Ident	Tot-P mg/L	TKN mg/L	Tot-N mg/L	NH4_N mg/L	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Hard mg/L	Al mg/L	Cd mg/L
M001	JDA J3477 ERGM1	0.06	0.47	0.5	0.18	31	2.1	57	21	230	0 012	<0.001
M002	JDA J3477 ERGM2	0.04	0.17	0.2	<0.05	62	1.5	55	33	270	0.009	<0.001
M003	JDA J3477 ERGM10	0.07	0.45	0.5	0.24	83	1.3	64	43	340	0.006	<0.001
M004	JDA J3477 ERGM4	0.04	<0.05	1.2	<0.05	29	1.3	51	20	210	0.014	<0.001
MOOS	JDA J3477 ERGM5	0-04	0.08	0.4	0.08	20	0.8	39	20	180	0.010	<0.001
M006	JDA J3477 ERGM6	0.12	2.1	13	0.3	80	4.8	98	19	320	0.032	<0.001
M007	JDA J3477 ERGM7	0.06	1.9	2.5	1.9	1200	20	150	220	1300	0.005	<0.001
M008	JDAJ3477 ERGM15	0.14	0.82	0.8	0.37	89	1.5	120	40	470	0.007	<0.001
M001 Lab Dup	JOA J3477 ERGM1	0.06	0.51	0.5	0.18	33	2.1	62	22	250	0.008	<0.001
LQL		0.01	0.05	0.1	0.05	1	0.1	0.1	0.1	1	0.005	0.001

Checked: ♦

Approved Signatory: r_-

Date: 19/05/2005

MPL Laboratories: 16-18 Nineteenth Court Myaree WA 6154 • Tel: (08) 9317 2505 / Fax: (08) 93[illegible] 163 / Email: [illegible] • www.mpl.com.au

mpl Laboratories

Certificate of Analysis

Testing Facility: Perth

Job No: 51255
Client: JDA CONSULTANT HYDROLOGISTS
Address: PO BOX 117
SUBIACO WA 6904

Client Reference: J3477C1
Date Received: 6/05/2005
Date Sampled: 6/05/2005
Test Method: Water samples submitted by clients are analysed on an as received basis. Metals analysis on acidified samples as received. Analysis performed in accordance with MPL Laboratories WILAB 5, 6, 8 and 17.

Sampled By: CLIENT

IDENT	External Ident	TDS	C03	HC03	Cl	504	N03	N03_N	N02	N02_N	P04_P	OrgP
UNITS		mg/L	mg/L	mgfl	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
M001	JDA J3477 ERGM1	490	<1	290	69	87	<0.1	<0.05	<0.1	<0.05	0.06	<0.01
M002	JDA J3477 ERGM2	660	<1	340	140	79	<0.1	<0.05	<0.1	<0.05	0.04	<0.01
M003	JOA J3477 ERGM10	820	<1	400	190	81	<0.1	<0.05	<0.1	<0.05	0.06	0.01
M004	JDA J3477 ERGM4	440	<1	240	66	72	7.8	1.8	5.3	1.6	0.04	<0.01
MOOS	JDA J3477 ERGM5	350	<1	240	39	84	1.0	0.23	0.2	<0.05	0.04	<0.01
M006	JOA J3477 ERGM6	660	<1	290	150	49	42	9.5	4.6	1.4	0.02	0.10
M007	JDA J3477 ERGM7	4900	<1	670	2300	490	0.4	0.09	1.6	0.48	0.06	<0.01
MOOS	JDA J3477 ERGM15	910	<1	440	180	220	<0.1	<0.05	<0.1	<0.05	0.09	0.05
M001 Lab Dup	JDA J3477 ERGM1	490	--	--	64	88	<0.1	<0.05	<0.1	<0.05	0.05	0.01
LQL		1	1	1	1	1	0.1	0.05	0.1	0.05	0.01	0.01

Checked: .)

Approved Signatory:

Date: 19/05/2005

MPL Laboratories [illegible] Myaree WA 6154 • Tel 08 9317 2505 / Fax 08 9311 [illegible] 63 / Email [illegible] • www.mpl.com.au
MPL Group Pty Ltd ABN [illegible]

[illegible] and Environmental Risk Solutions

fn;pl•_ n_a!ysis

Testing Facility: Perth

Job No:	51255
Client:	JOA CONSULTANT HYO
Address:	PO BOX 117 SUBIACO WA 6904
Client Reference:	J3477C1
Date Received:	6/05/2005
Date Sampled:	6/05/2005
Test Method:	Water samples submitted basis. Metals analysis on performed in accordance
Sampled By:	CLIENT

IDENT UNITS	External Ident	Cr mg/L	Cu mg/L	Mn_D mg/L	NI mg/L	Zn mg/L	As mg/L	Pb mg/L	Hg mg/L	Se mg/L	Fe_D mg/L	Fe (Tot) mg/L
M001	JOA J3477 ERGM1	<0.001	0.007	0.047	<0.005	0.03	0.061	0.003	<0.0001	<0.001	0.09	0.11
M002	JOA J34TT ERGM2	<0.001	<0.005	0.007	<0.005	0.02	0.16	0.001	<0.0001	<0.001	0.06	0.10
M003	JOA J3477 ERGM10	<0.001	<0.005	<0.001	<0.005	0.024	0.01	<0.001	<0.0001	<0.001	0.08	0.08
M004	JOA J3477 ERGM4	<0.001	<0.005	<0.001	<0.005	0.036	0.021	0.003	<0.0001	<0.001	0.03	0.04
MCOS	JOA J3477 ERGM5	<0.001	<0.005	0.002	<0.005	0.024	0.027	0.001	<0.0001	<0.001	0.02	0.02
M006	JOA J3477 ERGM6	0.001	<0.005	0.004	<0.005	0.025	<0.001	0.003	<0.0001	<0.001	0.06	1.2
M007	JOA J3477 ERGM7	<0.001	<0.005	0.010	<0.005	0.024	0.073	0.005	<0.0001	<0.005	0.65	0.65
MCOS	JOA J3477 ERGM15	<0.001	<0.005	0.003	<0.005	0.024	0.02	0.002	<0.0001	<0.001	0.11	0.11
M001 Lab Dup	JDA J3477 ERGM1	<0.001	<0.005	0.051	<0.005	0.019	0.06	0.002	<0.0001	<0.001	0.09	0.09
LQL		0.001	0.005	0.001	0.005	0.005	0.001	0.001	0.0001	0.001	0.01	0.01

Checked: ____________ Approved Signatory: ____________ Date: 19/05/2005

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