Rockwater
PROPRIETARY LIMITED

AUSTRALIAN PREMIUM IRON JV
HARDEY PROJECT

HYDROSTRATIGRAPHIC DRILLING, BORE COMPLETION, AND GROUNDWATER MODELLING REPORT

AUGUST 2011

REPORT FOR
API MANAGEMENT PTY LTD

371.0/11/02

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1 INTRODUCTION

API Management Pty Ltd (API) is planning to develop, on behalf of the Australian Premium Iron Joint Venture, open-cut mines at its Hardey Project iron ore deposits, located about 45 km northwest of Paraburdoo in the Pilbara region of Western Australia. A locality map is provided in Figure 1. API holds mineral lease E 17/1413 covering two separate parcels of land. The locations are shown on the topographical map presented in Figure 2. The eastern lease covers the Hardey Project, which contains two separate iron ore deposits: the Brockman and Marra Mamba deposits. Locations of the deposits are shown in Figure 3.

During January 2010, Rockwater investigated the groundwater resources on the API leases for ore-processing and the potential dewatering requirements for the project (Rockwater 2010a). The report provided the assessment, together with recommendations for a hydrostratigraphic drilling and testing programme. One of the main conclusions of the initial assessment was that the planned Marra Mamba open pit will not be mined below the water table and will therefore not require dewatering.

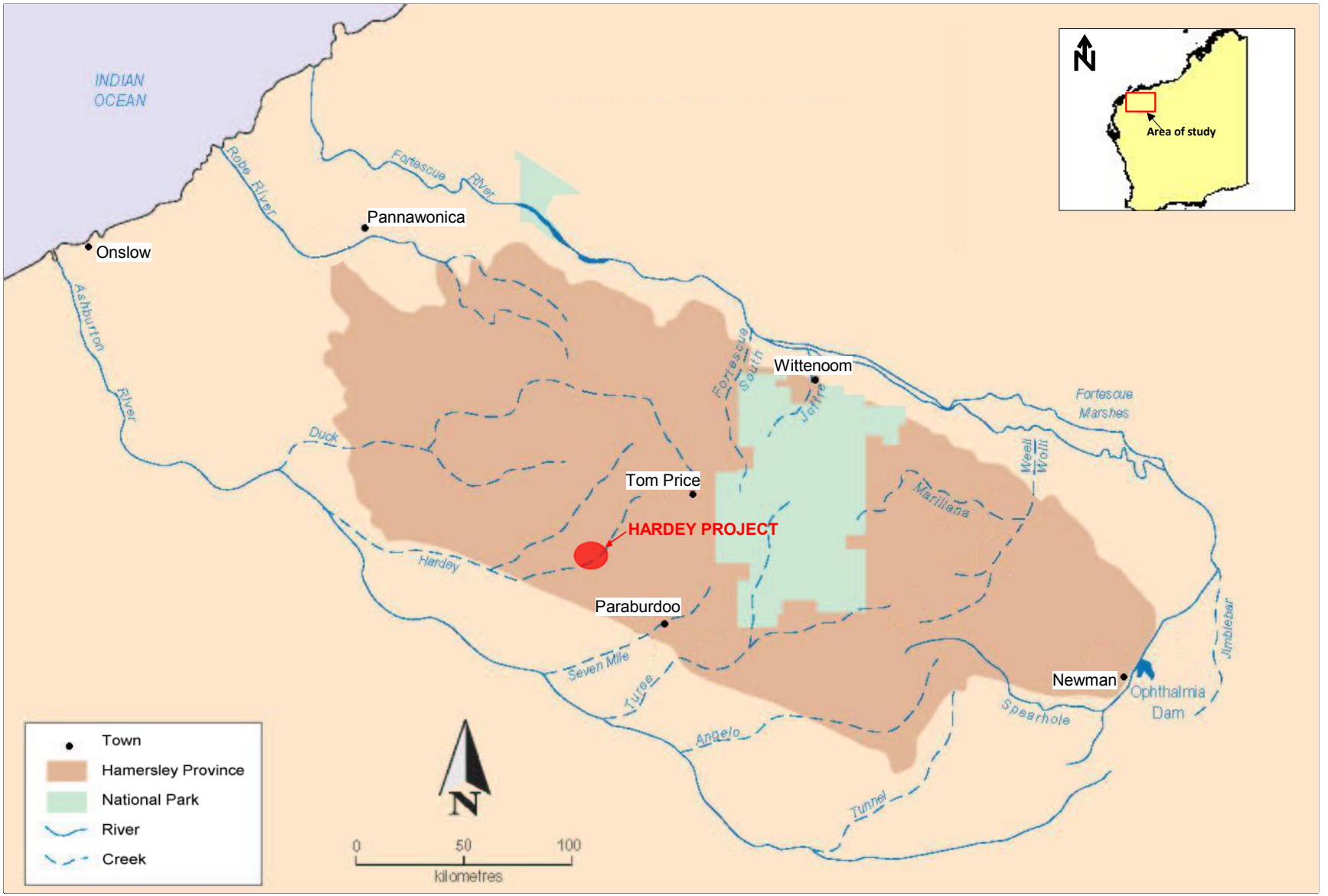
A hydraulic-testing programme using airlift-recovery and slug-test methods was conducted in March 2010 on uncased, reverse circulation (RC) holes and cased production and monitoring bores. The results were used to better understand the aquifers in the project area and to help refine targets for a proposed hydrostratigraphic drilling programme (Rockwater, 2010b).

API commissioned Rockwater to undertake and supervise a hydrostratigraphic drilling programme, which was conducted from May to July 2010. Nine holes were drilled and constructed as monitoring bores and three test-production bores were drilled, constructed, and test pumped. The results of the drilling programme are presented in this report along with the results from a numerical groundwater model, which focused on assessing the dewatering requirements of the Brockman deposit and the availability of groundwater as a source of water for the Hardey Project.

2 GEOLOGICAL SETTING

The geology of the area has been described in a previous report (Rockwater 2010a) and is summarised below.

API plans to mine two iron ore deposits within sedimentary rocks of the Hamersley Group: a bedded hematite iron deposit in the Brockman Iron Formation (Brockman deposit), and limonite and goethite in the Marra Mamba Iron Formation (Marra Mamba deposit), which is lower in the sequence of strata.



371-0/Surfer/10-003/Figure 1 Regional Map Central Pilbara.srf

API Hardey Project - Bore Completion Report

Figure 1; Page 2

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PROJECT: Hardey Project Dewatering and Water Supply

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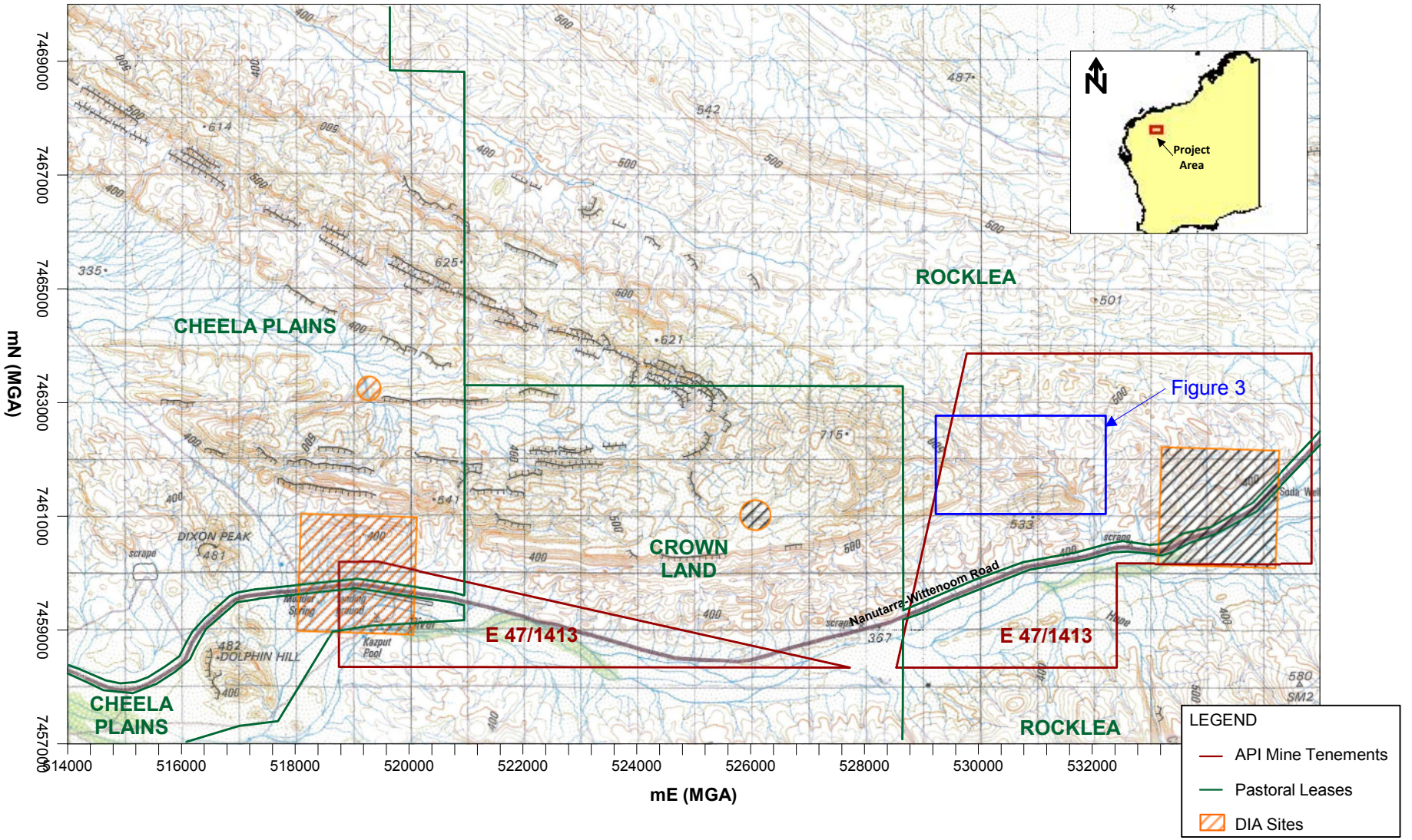
REGIONAL MAP
CENTRAL PILBARA - HAMERSLEY PROVINCE



371-0/Surfer/10-003/Figure 2 Lease Boundaries.srf

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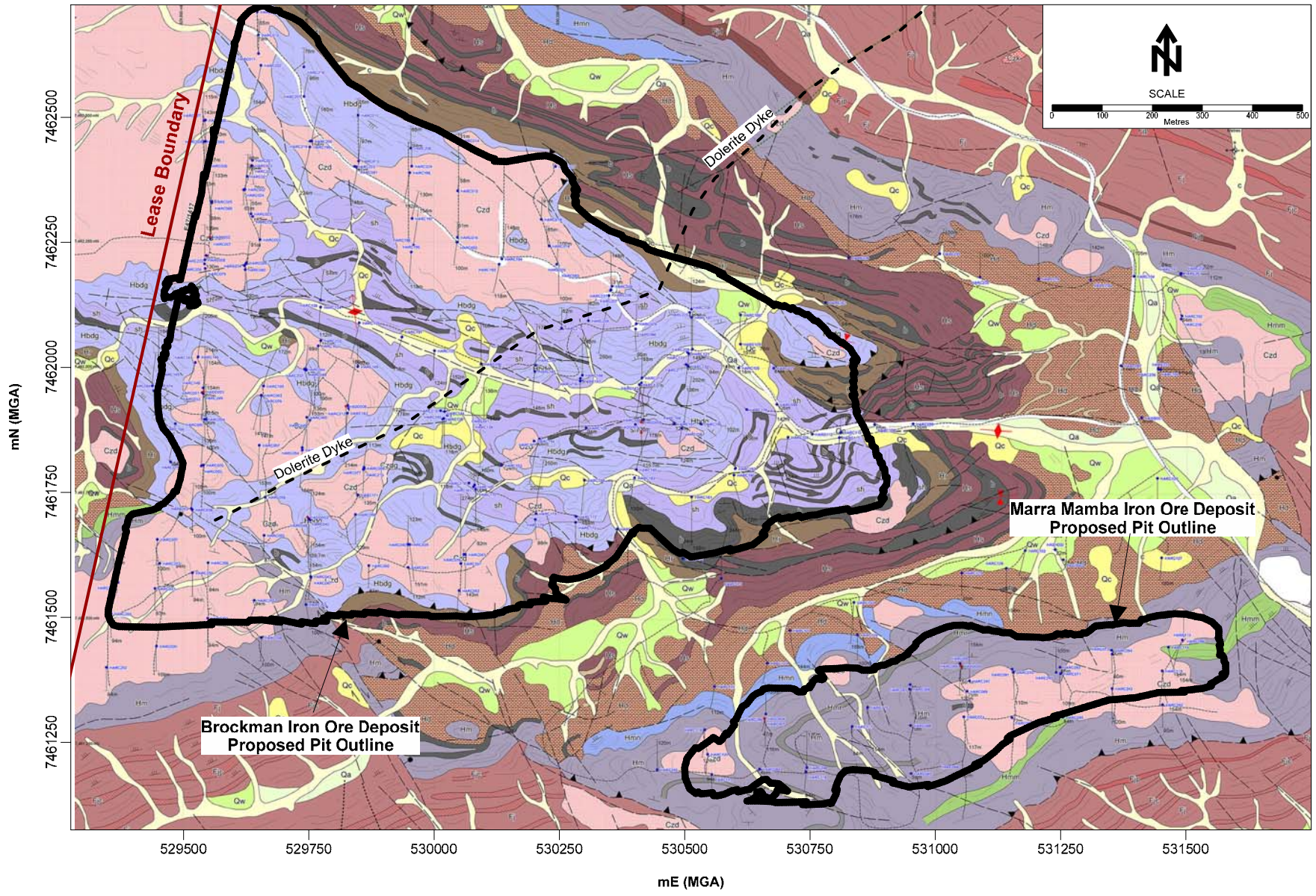
TOPOGRAPHIC MAP WITH API MINERAL LEASES



LEGEND

- Proposed Pit Area
- Dolerite Dyke (approximate location)
- c — Alluvium in active drainage
- Qa — Alluvium in broad, ephemeral channels and levee banks
- Qc — Colluvium; sand, silt and gravel in scree and outwash fans
- Qw — Low angle sheetwash deposits; sand, silt, pebbbles
- Czd — Massive and pisolitic, ferruginous, mostly residual duricrust deposits - relict texture and structure locally preserved, developed on undulating, Early Cainozoic Hamersley weathering surface extensively preserved on topographically prominent Brockman Formation and Marra Mamba Formation BIF outcrops.
- sh — Photogeologically recessive shale, ironstone; uncertain stratigraphic status, mostly Dales Gorge Member but may include some Mount Sylvia Formation and Mount McRae Formation
- b — Photogeologically prominent BIF units within Mt Sylvia Formation, Mt McRae Shale, Dales George Member; includes Tram Tracks and Bruno's Band within Mt Slyvia Formation
- Hbdg — Brockman Iron Formation, Dales Gorge Member; Undivided ironstone, shale
- Hr — Mount McRae Shale; Undivided shale, dolomitic shale, chert, BIF
- Hs — Mount Sylvia Formation; Undivided shale, dolomitic shale, chert, BIF
- Hd — Wittenoom Dolomite; Undivided dolomite, chert, shale
- Mappable chert band within Hd
- **Marra Mamba Iron Formation:** Undivided basaltic volcanic rocks, undivided BIF; minor chert, musdstone and siltstone
- Hmn — Mount Newman Member: BIF, shale
- Hmm — McLeod Member: Chert, shale, BIF, podded ('potato') chert
- Hmr — Photogeologically recessive sub-unit within Hm
- Fj — **Fortesue Group, Jerrinah Formation:** Undivided basaltic volcanic rocks, dolerite, minor sedimentary bands
- Fjc — Interpreted chert unit within FJ
- Fjp — Photogeologically prominent sub-unit within FJ

371-0/Surfer/10-003/Figure 3 Geological Map.srf

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HARDEY PROJECT GEOLOGICAL MAP

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Shale and other sedimentary strata of the Mt McRae Shale and Mt Silvia Formations, and dolomite of the Wittenoom Formation, separate the two iron deposits. The footwall of the Marra Mamba Iron Formation consists of metavolcanic and metasedimentary rocks of Archaean age.

The project area lies at the eastern end of the Hardey syncline, an asymmetrical feature striking roughly east–west with steeply-dipping sediments to the north of the synclinal axis and gently-dipping sediments to the south. A geological map prepared by Nick Lockett and Associates (Nick Lockett 2009) using Quickbird photographic interpretation is presented in Figure 3. The map also shows the API mineral holes drilled during exploration campaigns during 2006 – 2009. Also shown on Figure 3 are the proposed pit perimeters for the Brockman and Marra Mamba deposits.

A summary stratigraphic column compiled by Rockwater for the Hardey project is given in Table 1.

Table 1: Stratigraphic Column of the Southwest Hamersley Province–Hardey Project

Age	Group		Formation	Member	Description
Phanerozoic			Quaternary sediments	undifferentiated	Alluvium and colluvium
			Cainozoic sediments	undifferentiated	Calcrete, laterite and duricrust deposits
Proterozoic	Mount Bruce Supergroup	Hamersley Group	Brockman Iron Formation	*Yandicoogina Shale Member	Interbedded shale and chert
				Joffre Member	BIF with minor shale
				Mt Whaleback Shale Member	Interbedded chert and shale with two BIF bands at the base
				Dales Gorge Member	Sequence of BIF and shale
Archaean			Mt McRae Shale		Interbedded shale and chert
			Mt Silvia Formation		Dolomitic shale and BIF
			Wittenoom Formation	undifferentiated	Dolomite and chert
			Marra Mamba Iron Formation	Mt Newman Member	BIF minor chert
				Macleod Member	Shale, chert BIF
				Nammuldi Member	Goethite, limonite and chert
		Fortescue Group	Jeerinah Formation	undifferentiated	Metabasalt metasediments

*Absent at the Hardey Project

3 DRILLING PROGRAMME RESULTS

The drilling programme was carried out by Welldrill of Henderson, WA, using a Fraste FS-500 rig. The programme, which was undertaken from 19 May 2010 to 6 July 2010, was supervised by Rockwater hydrogeologists.

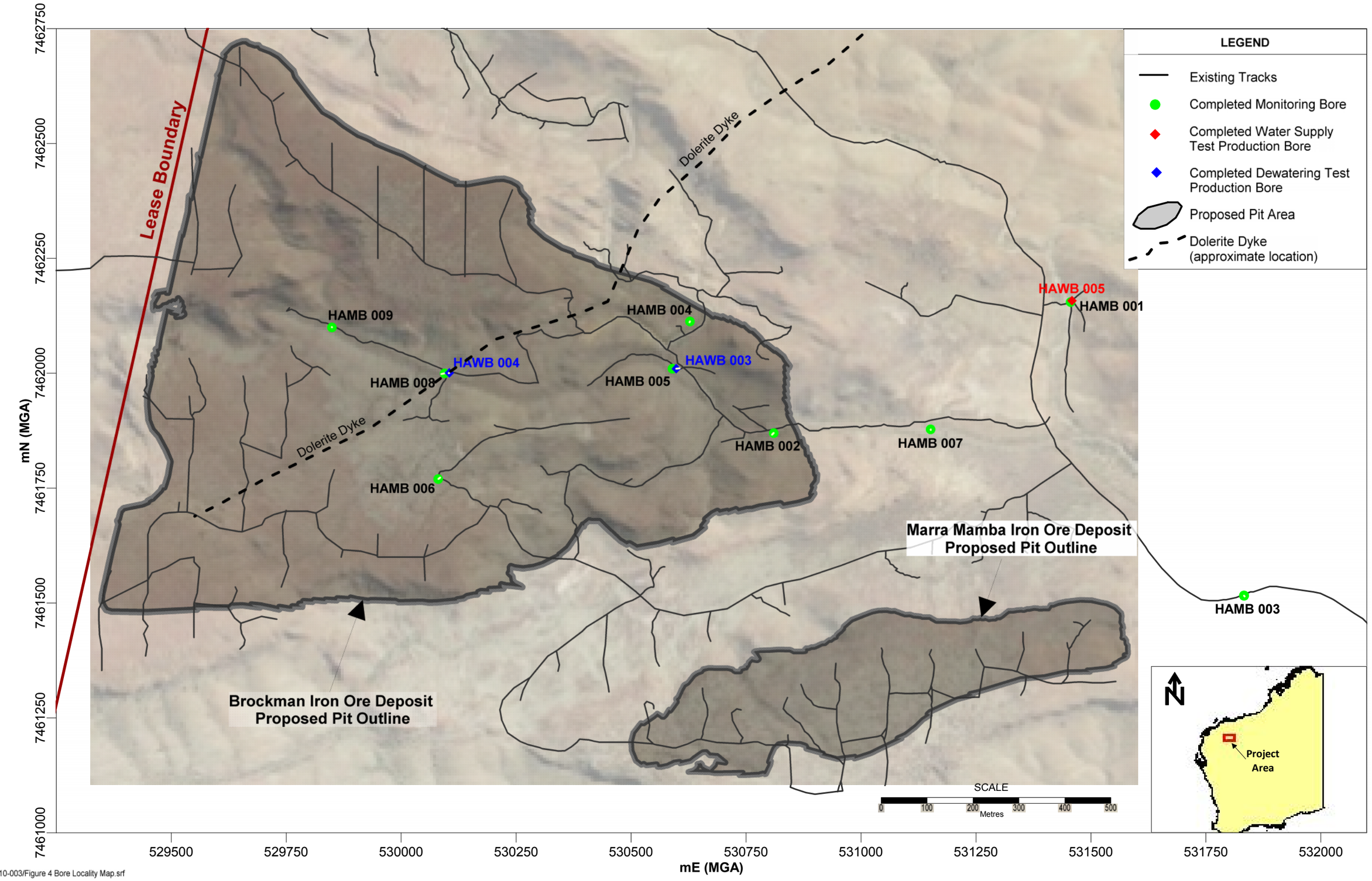
There were 16 sites selected across the Hardey project as potential drilling targets; nine were selected to assess the dewatering requirements of the main ore body (Dale Gorge Member of the Brockman Formation) and seven were chosen to target potential water supplies in the Wittenoom, Marra Mamba and Jeerinah Formations. Hydrostratigraphic holes were drilled and completed as monitoring bores at nine of the sites. Large diameter production bores were drilled and constructed at three of the hydrostratigraphic sites.

3.1 HYDROSTRATIGRAPHIC DRILLING AND MONITORING BORE CONSTRUCTION

A total of 1,147 metres were drilled in the hydrostratigraphic programme. The holes were drilled using air-hammer methods at 167 mm diameter and lined with 79 mm ID, 90 mm OD, class 12 uPVC casing with 3 mm aperture slotted casing set across the main aquifer zones. Bore locations are shown in Figure 4.

Bores HAMB 001 and HAMB 003 were drilled to investigate possible water supply sources for the proposed mine camp and mining support facilities and bores HAMB 002, and HAMB 004 to 009 were drilled to assess the dewatering requirements of the Brockman deposit.

A summary of the drilling details are shown in Table 2, composite bore diagrams are shown in Figures 5 to 12, and bore completion data are provided in Appendix I. Results of individual bores are discussed below. Field salinity values are reported as milligrams per litre (mg/L) total dissolved solids (TDS) based on electrical conductivity (EC) measurements.



371-0/Surfer/10-003/Figure 4 Bore Locality Map.srf

API Hardey Project - Bore Completion Report

Figure 4; Page 7

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HARDEY PROJECT
BORE LOCALITY MAP

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Table 2: Hydrostratigraphic Drilling Results

Hole No	MGA coordinates		Collar RL[1]	Depth drilled	Cased depth	Slotted interval	Airlift Rate	Salinity	SWL	SWL	Aquifer[6]
	mE	mN	(m AHD[2])	(m)	(m)	(m bgl[3])	(L/s)	(mg/l TDS[4])	(m btc[5])	(m AHD[2])	
HAMB 001	531455	7462155	393.2	132	89	17-23, 29-35, 41-53, 59-65, 71-77, and 83-89	12	650	19.8	374.1	MM
HAMB 002	530810	7461870	394.8	179	178.5	58.5-64.5, 76.5-82.5, 94.5-100.5, 148.5-154.5, and 166.5-178.5	10	640	24.6	370.8	DG
HAMB 003	531833	7461516	385.3	20	17	11-17	4	600	12.7	373.3	J
HAMB 004	530628	7462113	398	156	107.8	59.8-107.8	3	775	30.8	371.1	MSS
HAMB 005	530590	7462010	397.9	132	71.5	17.5-23.5, 29.5-35.5	10	610	27.5	370.4	DG
HAMB 006	530081	7461770	431.1	98	73.7	55.7-73.7	-	530	61.9	369.9	DG
HAMB 007	531151	7461878	392.0	132	131.2	35.2-41.2, 113.2-131.2	3	550	21.8	370.6	MSS
HAMB 008	530095	7462000	407.2	145	143	77-83, 89-95, 101-119, 125-143	13	560	38.0	369.9	DG
HAMB 009	529850	7462100	410.8	154	152	98-152	7	450	47.0	364.3	DG

[1]Collar RL = estimated from digital terrain model

[2]AHD = Australian Height Datum

[3]bgl = below ground level

[4]TDS = Total Dissolved Solids; calculated from field electrical conductivity (EC) measurements using the relationship: TDS (mg/L) = 0.5*EC(µS/cm) and corrected to 25°C

[5]btc = below top of collar

[6]Aquifers; MM = Marra Mamba; DG = Dales Gorge; MSS = Mt Silvia Shale, J = Jeerinah

3.1.1 HAMB 001

A composite bore diagram for HAMB 001 is shown in Figure 5.

Bore HAMB 001 was drilled to investigate the Marra Mamba Iron Formation as a possible source of groundwater. The bore was drilled to 132 m depth and intersected banded iron formation (BIF), goethite/limonite, and shale of the Marra Mamba Iron Formation. The bore yielded about 12 L/sec of fresh water (650 mg/L TDS) with the majority of the flow from aquifers below 50 m depth.

A blockage in the hole prevented the casing being installed below 89 m depth. The static water level at HAMB 001 was 19.75 m below top of collar (btc) (374.15 m AHD) on 4 June 2010.

3.1.2 HAMB 002

A composite bore diagram for HAMB 002 is shown in Figure 6.

Bore HAMB 002, which was drilled to 179 m depth, produced up to 10 L/s of low salinity groundwater (640 mg/L TDS). About half the supply was obtained from the Brockman Iron Formation, Dales Gorge aquifer and the remainder was from chert/iron beds within the Mount McRae Shale and the Bruno's Band of the Mount Silvia Formation.

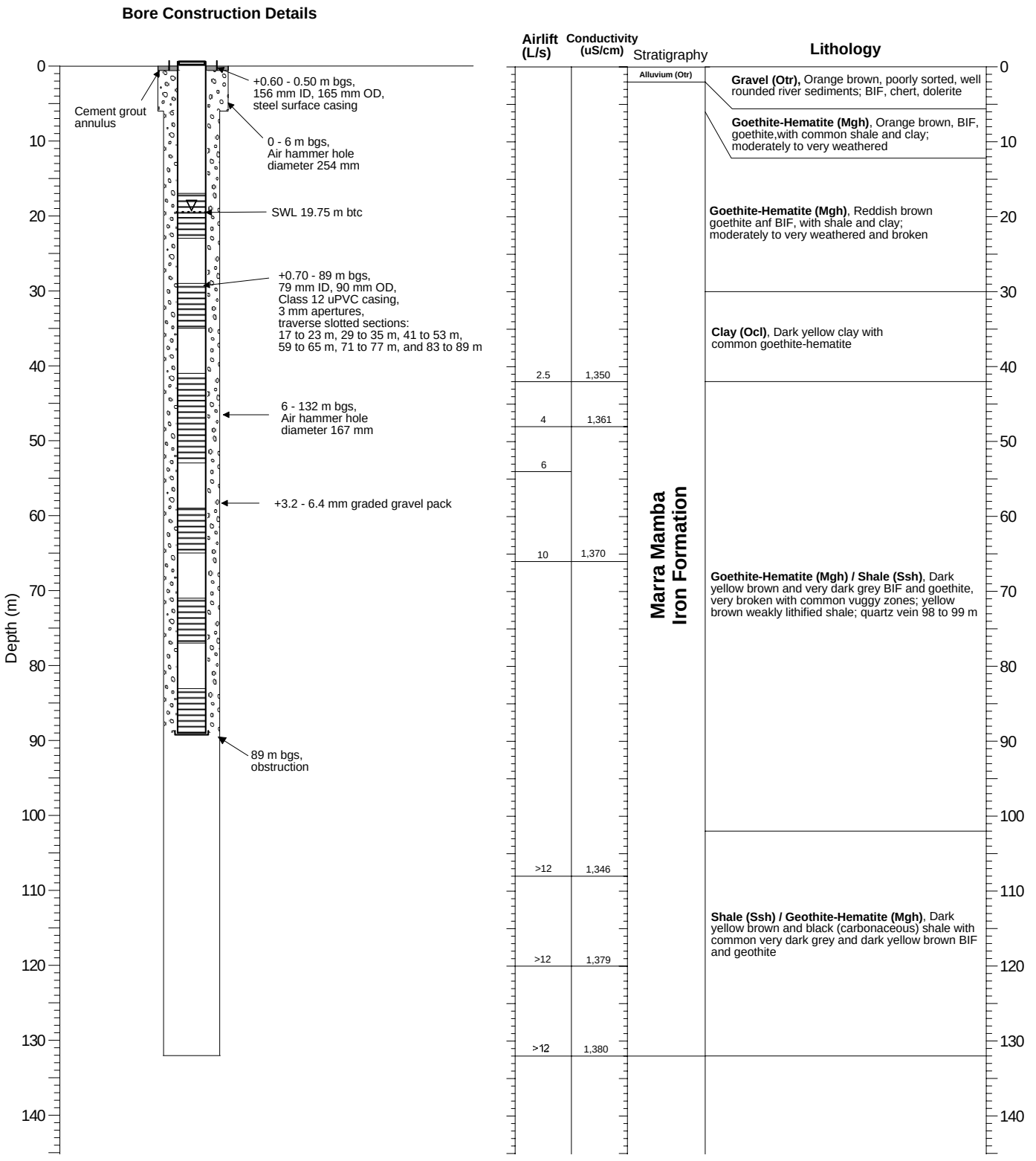
HAMB 002 was cased to 178.5 m depth and had a static water level of 24.61 m btc (370.79 m AHD) on 28 June 2010.

3.1.3 HAMB 003

A composite bore diagram for HAMB 003 is shown in Figure 7.

Bore HAMB 003 was drilled to investigate the Jeerinah Formation as a potential groundwater source. The bore had to be terminated at 20 m depth due to collapsing strata and the risk of bogging the drill string. The bore intersected broken chert and dolerite of the Jeerinah Formation and yielded about 4 L/sec of fresh water (600 mg/L TDS).

HAMB 003 was cased to 17 m depth with slotted casing from 11 to 17 m depth. The static water level was 12.70 m btc (373.30 m AHD) on 4 June 2010.



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 5 HAMB001 Composite Log.grf

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Monitoring Bore HAMB001
Composite Log

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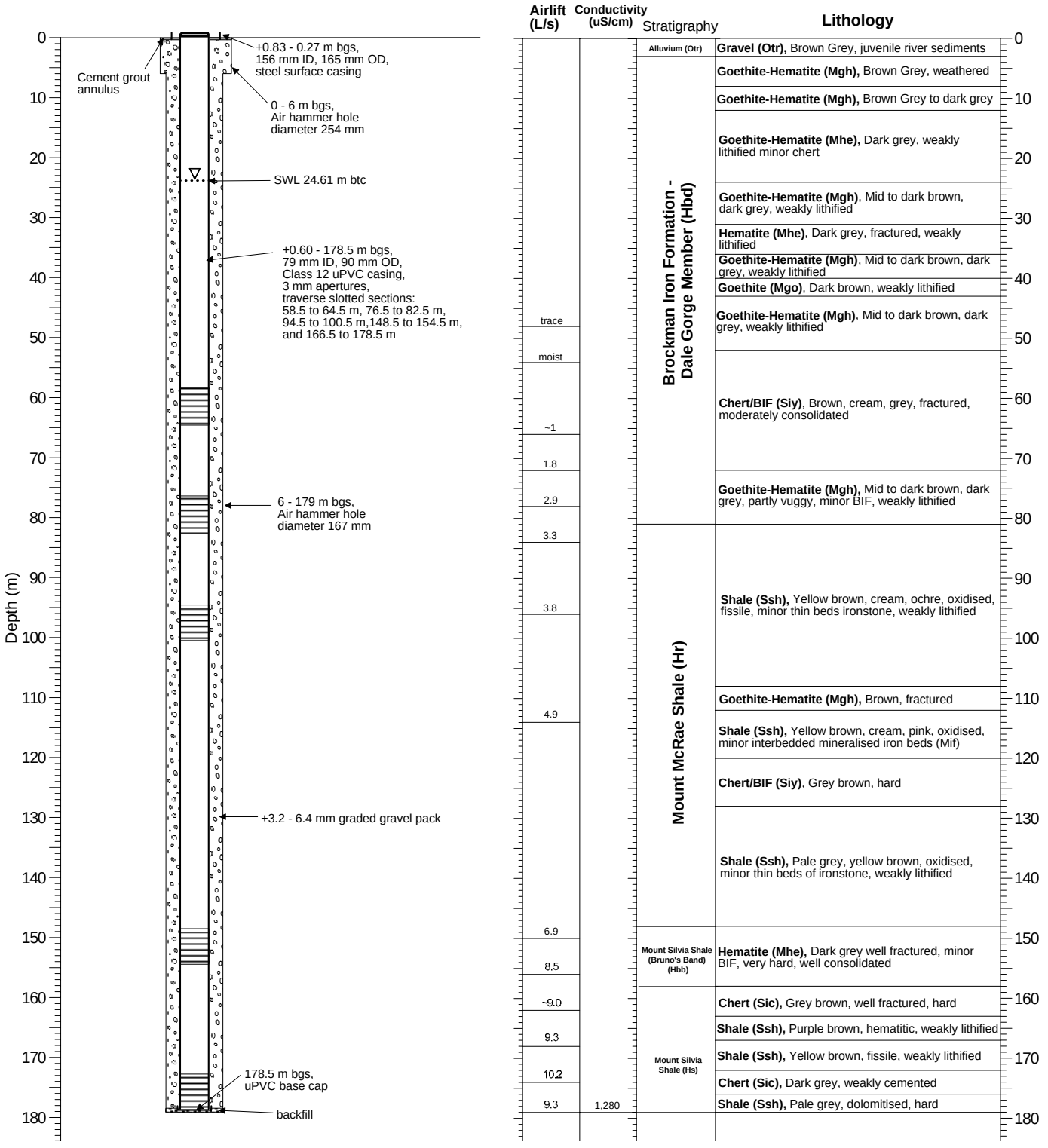
Bore Construction Details



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 6 HAMB002 Composite Log.grf

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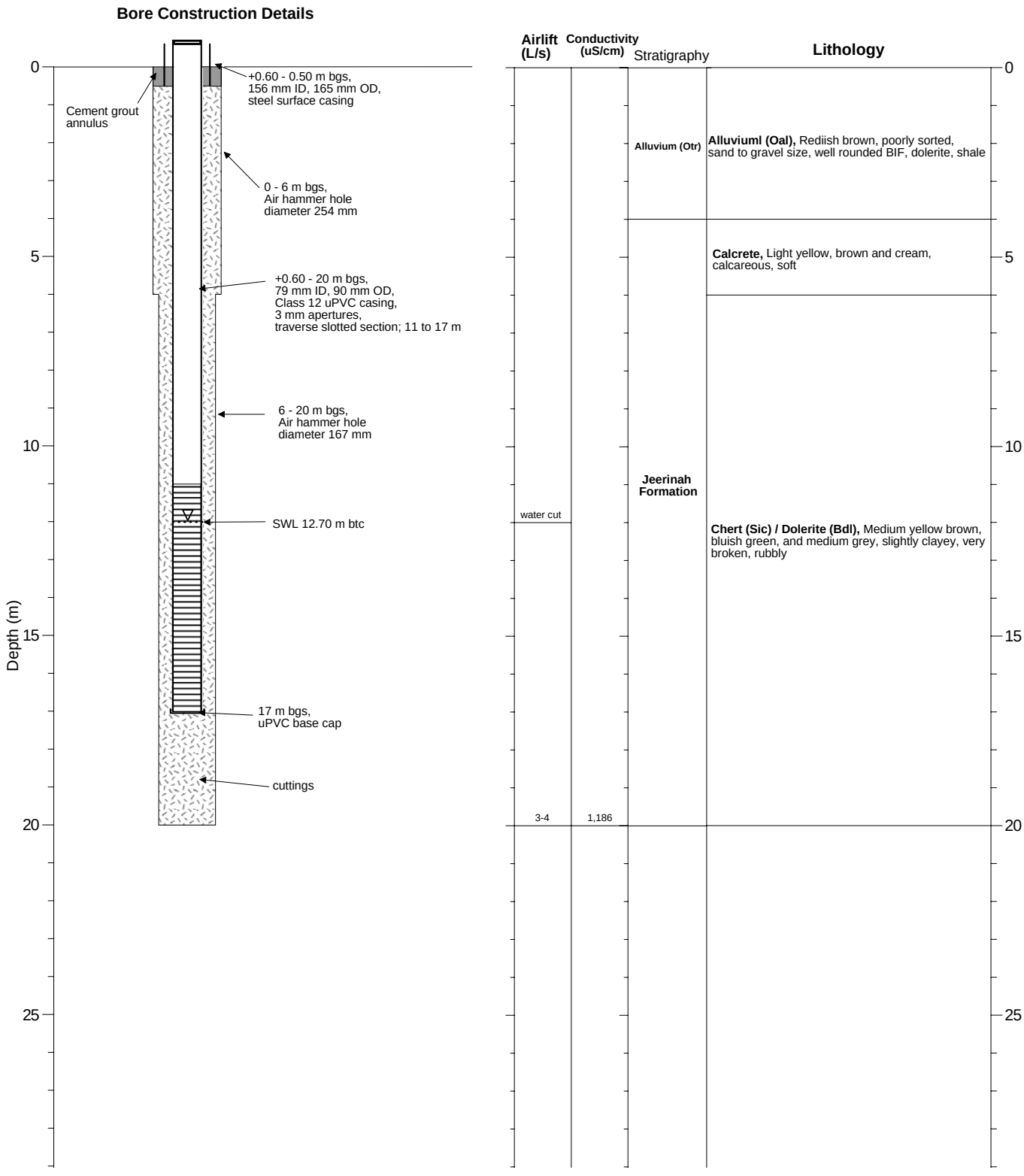
Monitoring Bore HAMB002 Composite Log

Rockwater



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 7 HAMB003 Composite Log.grf

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Monitoring Bore HAMB003 Composite Log

Rockwater

3.1.4 HAMB 004

A composite bore diagram for HAMB 004 is shown in Figure 8.

Bore HAMB 004 was drilled to 156 m depth. The bore intersected clay/shale and goethite/hematite of the Dales Gorge Member to 30 m depth and shale of the Mount McRae Shale from 30 to 156 m depth with carbonaceous-pyritic shale from 96-156 m. The bore yielded 3 L/sec primarily from pyrite rich strata below 140 m depth. The water was fresh with a salinity of 775 mg/L TDS.

A blockage in the hole prevented the casing being installed below 108 m depth. The static water level was 30.77 m btc (371.13 m AHD) on 27 June 2010.

3.1.5 HAMB 005

A composite bore diagram for HAMB 005 is shown in Figure 9.

Bore HAMB 005 was drilled to 132 m depth. The bore intersected goethite/hematite and minor chert of the Dale Gorge Member aquifer. During drilling, the bore yielded over 10L/sec of fresh water (615 mg/L TDS) mainly from aquifers below 75 m depth.

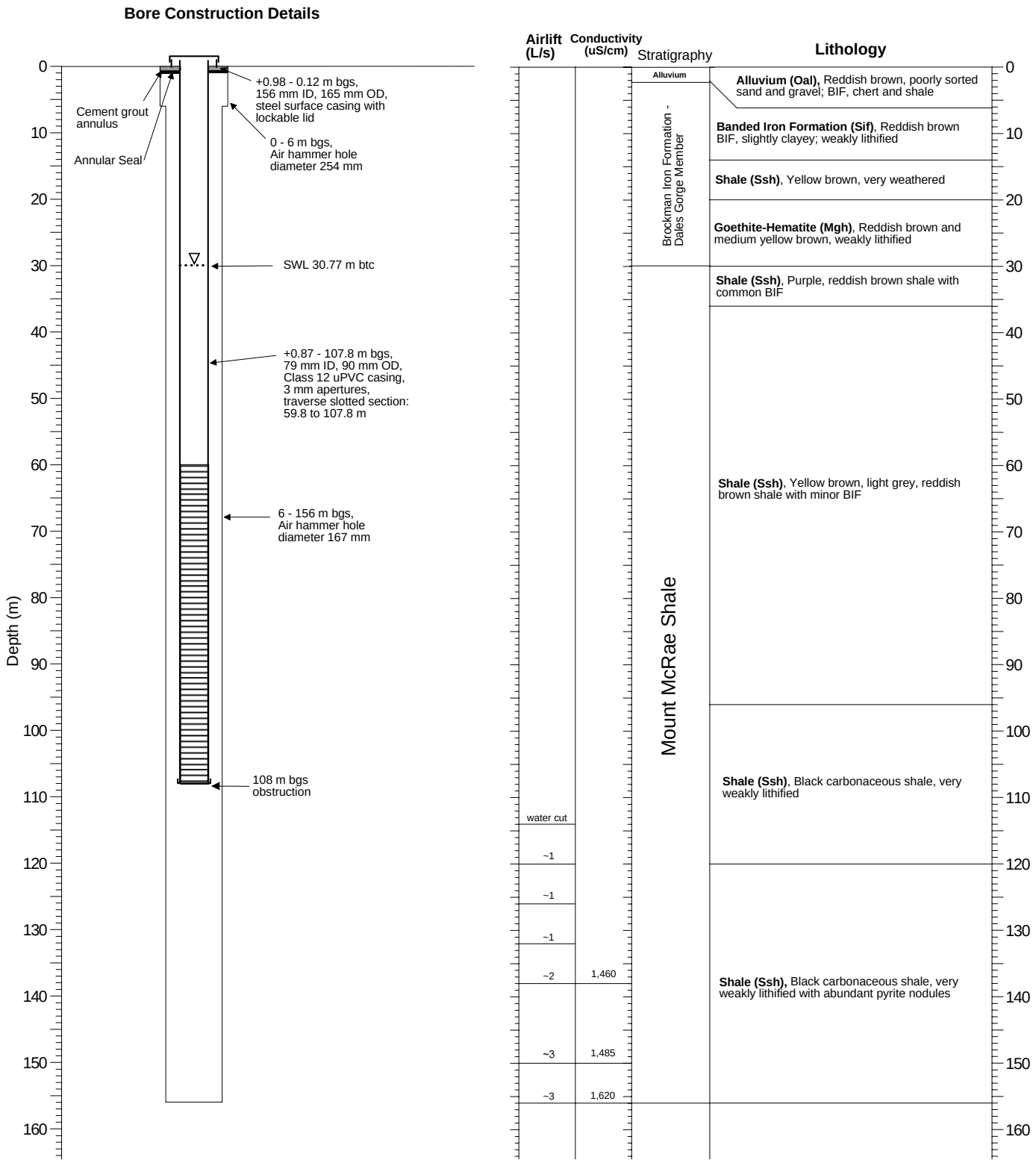
A blockage in the hole prevented the casing being installed below 71.5 m depth. The static water level was 28.22 m btc (369.68 m AHD) on 28 June 2010.

3.1.6 HAMB 006

A composite bore diagram for HAMB 006 is shown in Figure 10.

Bore HAMB 006 was drilled to 98 m and intersected very weakly lithified and cavernous BIF of the Brockman Iron Formation Dales Gorge Member. At 80 m depth, circulation was lost and there was no return of air or drill cuttings to the surface; this resulted in the drill rods jamming during their retrieval from the hole. The drill string was eventually freed and then drilling continued to 98 m where circulation was again lost and it was decided to terminate the hole due the high risk of bogging the drill string.

A blockage in the hole prevented the casing being installed below 74 m depth. The bore produced 0.25 L/sec of fresh water (515 mg/L TDS) during development. The static water level was 61.89 m btc (369.81 m AHD) on 27 June 2010.



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 8 HAMB004 Composite Log.grf

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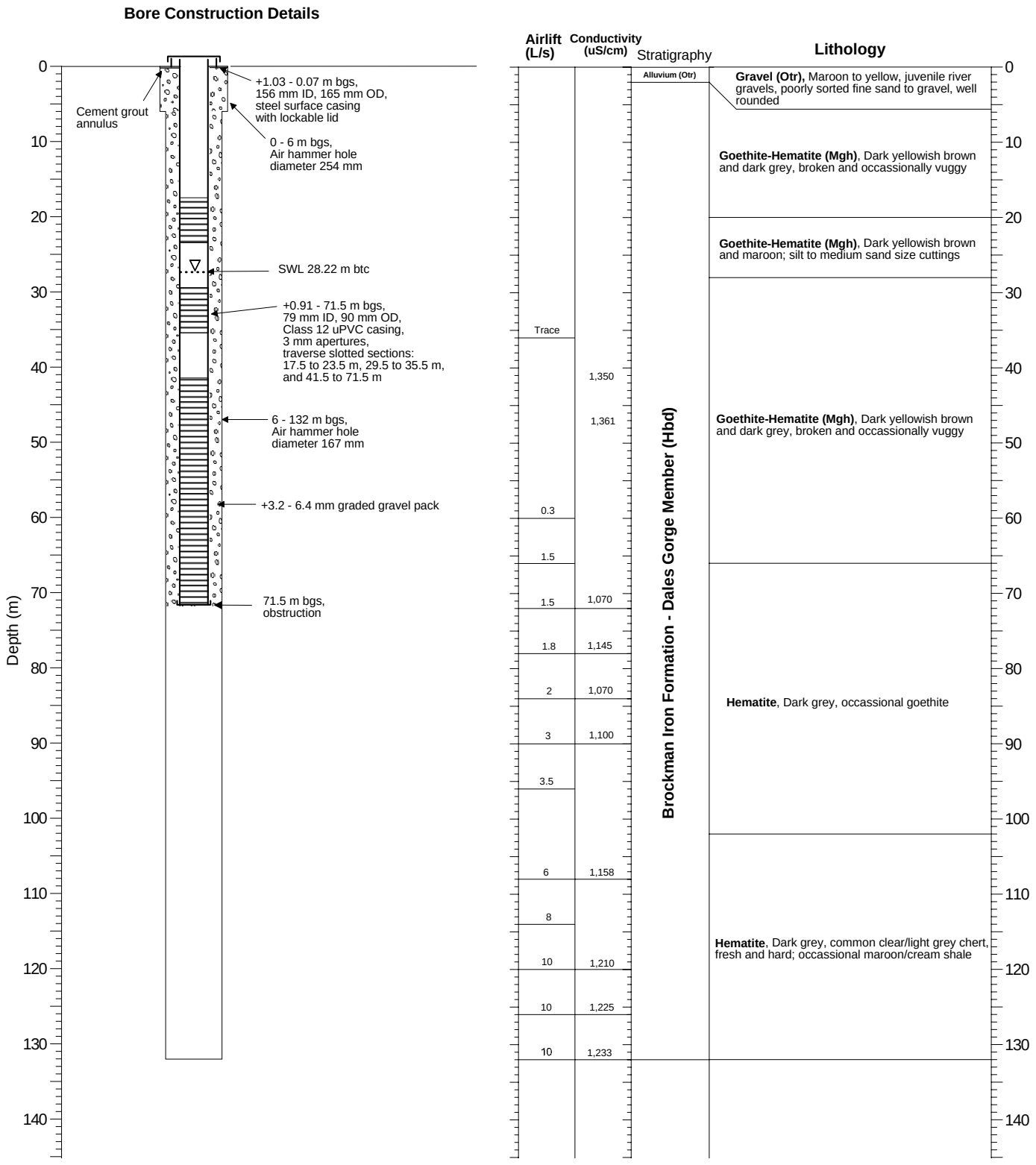
Monitoring Bore HAMB004 Composite Log



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 9 HAMB005 Composite Log.grf

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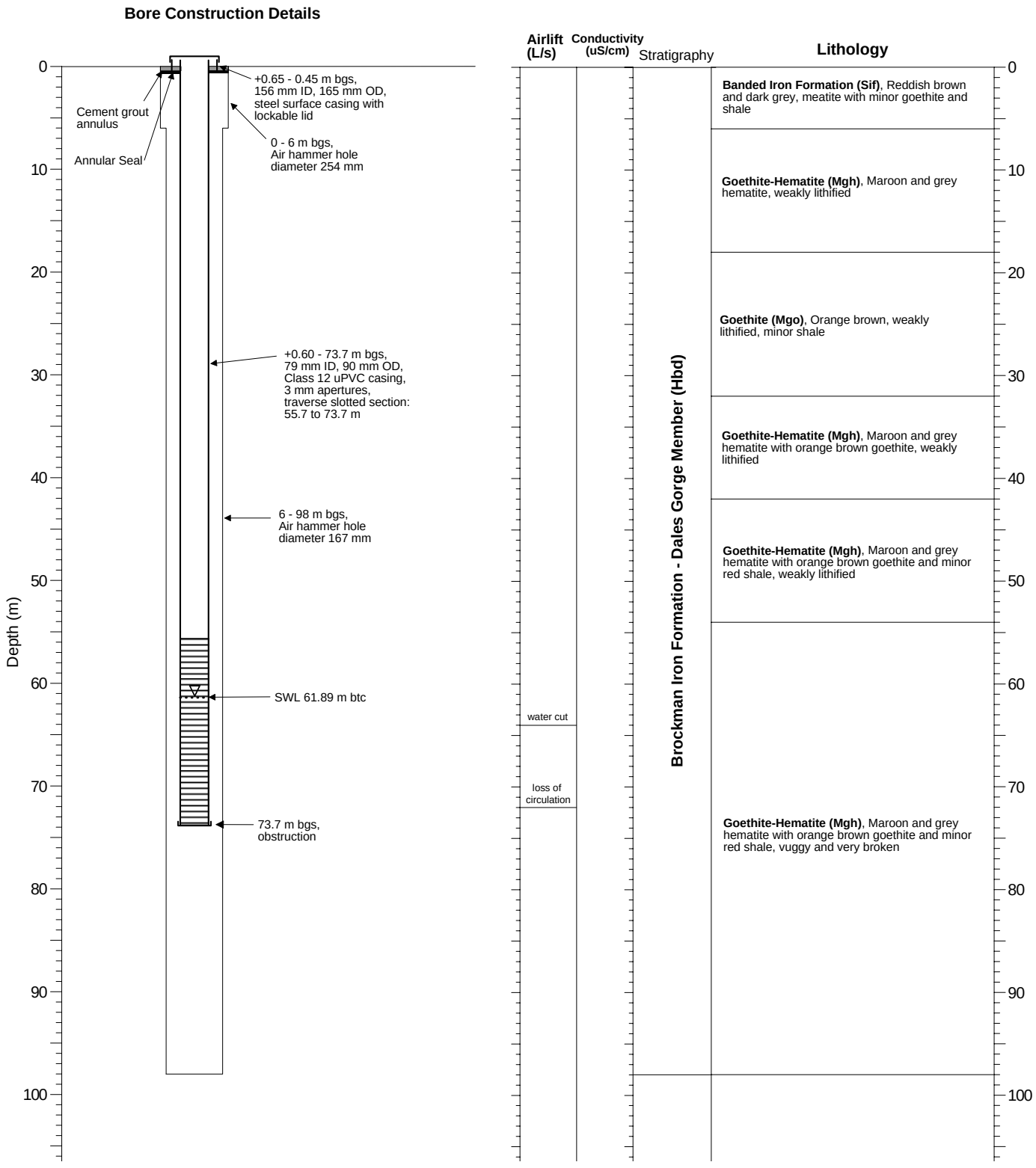
Monitoring Bore HAMB005
Composite Log



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 10 HAMB006 Composite Log.grf

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Monitoring Bore HAMB006 Composite Log

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3.1.7 HAMB 007

A composite bore diagram for HAMB 007 is shown in Figure 11.

HAMB 007 was drilled to 132 m depth to target the Wittenoom Formation; however, it intersected only shale of the Mt Silvia Formation. Water was cut at 36 m depth with a flow of 3 L/sec and a salinity of 550 mg/L TDS. No additional flows were encountered deeper. The bore was cased to 131 m depth and had a static water level of 21.80 m btc (370.3 m AHD) on 27 June 2010.

3.1.8 HAMB 008

A composite bore diagram for HAMB 008 is shown in Figure 12.

Bore HAMB 008 was drilled to 145 m depth within the Brockman Iron Ore Formation. It intersected clay/shale and goethite/hematite of the Mount Whaleback Shale Member to 66 m and goethite/hematite/shale of Dales Gorge Member to 144 m depth. The bore yielded about 13 L/sec with the majority of the water derived from aquifers below 90 m depth. The hole was cased to 143 m depth.

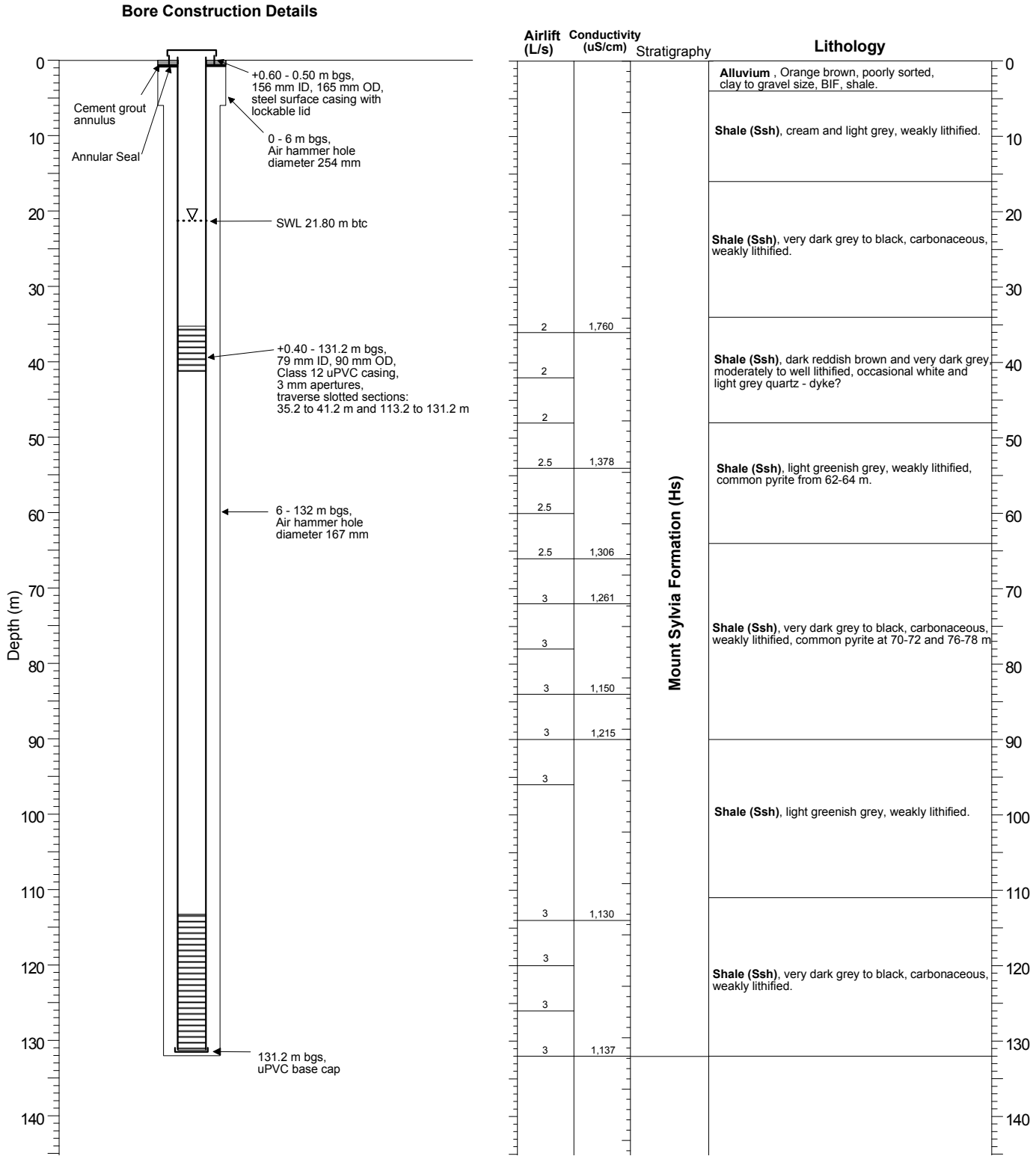
During gravel installation a bridge is thought to have occurred somewhere between 50 and 70 m depth; this was the depth at which obstructions occurred during the casing installation. Attempts to dislodge the gravel by airlifting the bore were unsuccessful and therefore the slotted section of HAMB 008 is unlikely to be gravel-packed. HAMB 008 static water level was 38.18 m btc (369.72 m AHD) on 26 June 2010.

3.1.9 HAMB 009

A composite bore diagram for HAMB 009 is shown in Figure 13.

Bore HAMB 009 was drilled to 154 m depth within the Brockman Iron Ore Formation. It intersected shale/clay and BIF of the Mount Whaleback Shale Member to 70 m depth and BIF, chert, and shale of the Dales Gorge Member from 70 m to 154 m depth. The hole produced an airlift rate of about 7 L/sec, mainly from aquifers below 114 m depth. The water was fresh with a salinity of about 450 mg/L TDS.

Bore HAMB 009 was cased to 152 m depth. The static water level was 46.95 m btc (364.35 m AHD) on 28 June 2010.



I:/371-0/Grapher/10-003/Bore Composite Logs/Fig 11 HAMB007 Composite Log.grf

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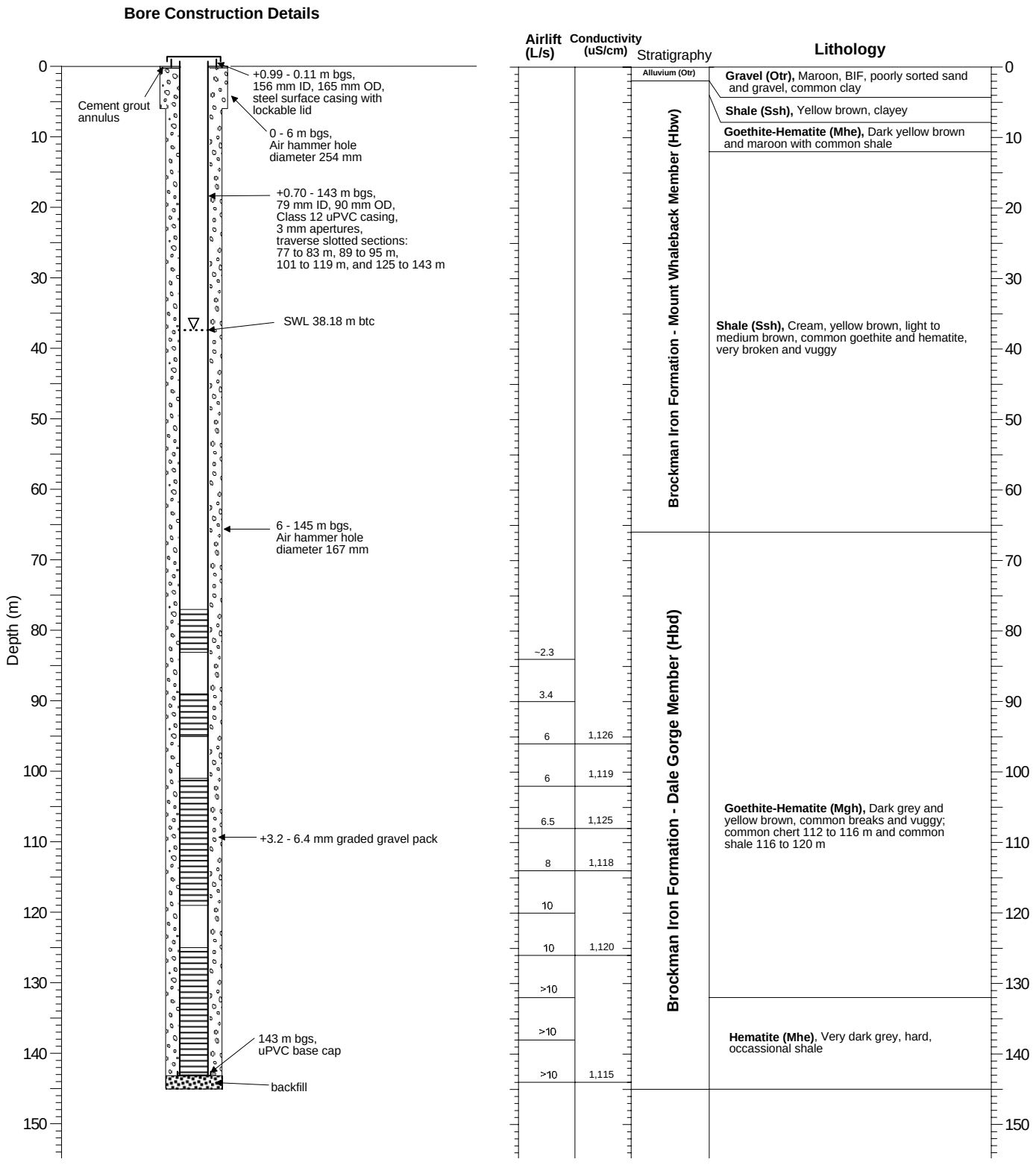
Monitoring Bore HAMB007
Composite Log



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 12 HAMB008 Composite Log.grf

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Monitoring Bore HAMB008 Composite Log

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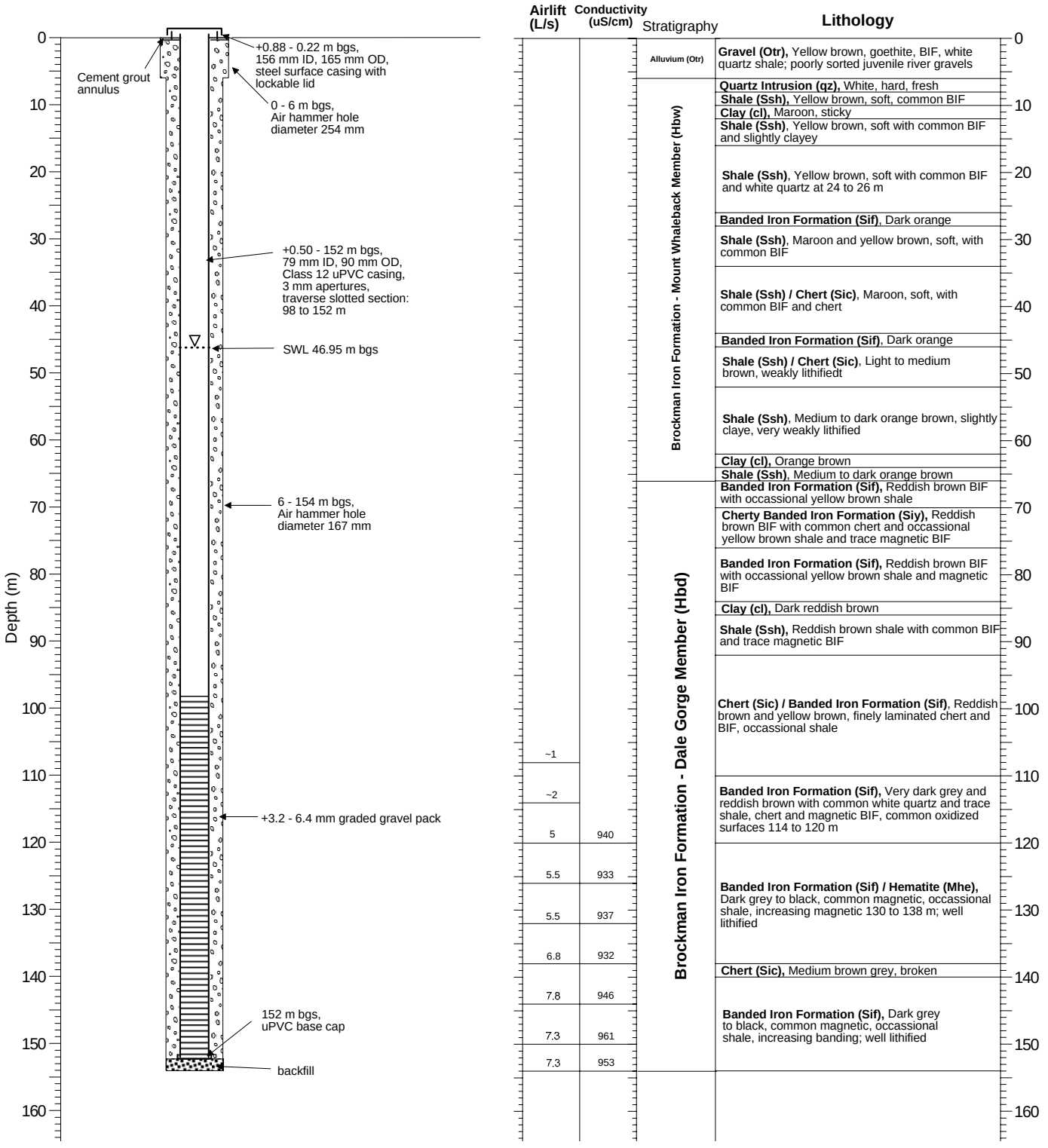
Bore Construction Details



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Monitoring Bore HAMB009 Composite Log

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3.2 LARGE DIAMETER PRODUCTION BORES

Three additional large diameter production bores were drilled and constructed to further assess the hydrogeology at the Hardey site. Bores HAWB 003 and HAWB 004 were drilled to asses the Brockman aquifer and the potential dewatering requirements needed for mining below the water table, and are located within about 10 m from monitoring bores HAMB 005, and HAMB 008, respectively. Bore HAWB 005 was drilled to investigate the Marra Mamba Formation as a potential source of water for the proposed mine camp and support facilities, and is located near bore HAMB 001. Bore locations are shown on Figure 4 (page 7), and bore completion data are presented in Appendix II and summarised in Table 3.

Bores HAWB 001 and HAWB 002 were drilled and constructed during a previous drilling programme under the direction and supervision of API personnel to obtain water supplies for mineral resource drilling operations. API data indicate that HAWB 001 was drilled to 96 m depth and intersected dolomite of the Wittenoom Formation. Based on the drilling results and hydraulic testing conducted by Rockwater (Rockwater, 2010b), the yield of the bore was found to be very low. Bore HAWB 002 was completed to a depth of 40 m and intersected diorite of the Jeerinah Formation. Drilling and hydraulic testing results indicate that HAWB 002 intersected highly transmissive strata and the bore was subsequently equipped with a submersible pump and used to obtain water for drilling operations.

3.2.1 HAWB 003

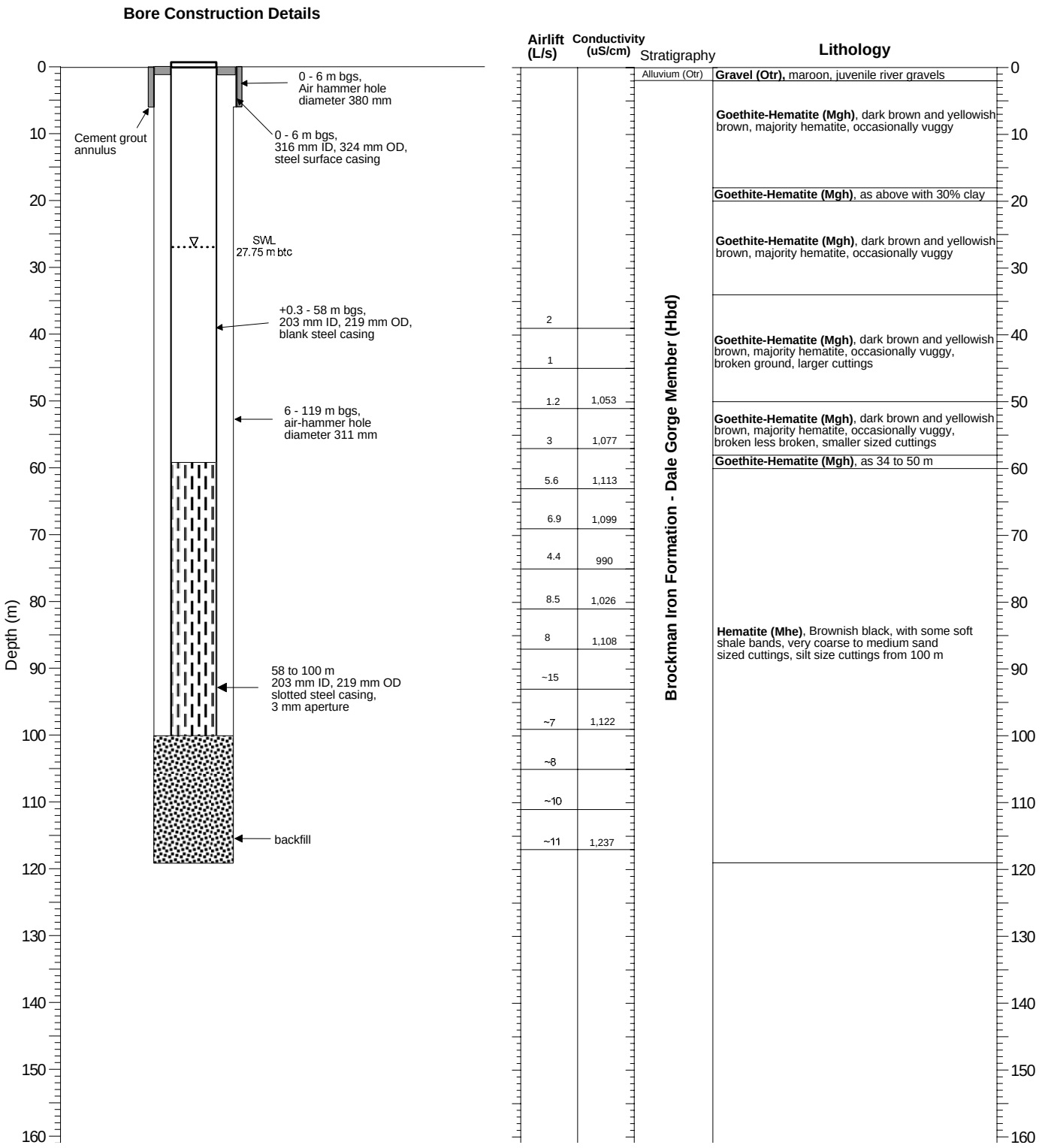
A composite bore diagram for HAWB 003 is shown in Figure 14.

HAWB 003 is located about 7 m east of HAMB 005 and was drilled to target the Brockman Iron Formation Dales Gorge Member aquifer. A 381 mm diameter hole was first drilled to 6 m depth and lined with 314 mm ID, 324 mm OD, steel surface casing. A 308 mm diameter hole was then drilled to 119 m depth using air-hammer methods. It intersected BIF and hematite of the Dales Gorge Member. During drilling, the strata from 100 to 119 m depth were found to be very unstable and the hole continually collapsed after the air supply was shut off. The hole was therefore terminated at 119 m depth and was lined with 203 mm ID, 219 mm OD, schedule 40 steel casing to 100 m depth, with 3 mm aperture slotted casing installed from 58 to 100 m.

Table 3: Large Diameter Test Bore Construction Details

Hole No	MGA coordinates[1]		Collar RL[2]	Depth drilled	Cased depth	Slotted interval	Airlift Rate	SWL	SWL	Salinity	Aquifer[7]
	mE	mN	(m AHD[3])	(m bgl[4])	(m bgl[4])	(m bgl[4])	(L/s)	(m btc[5])	(m AHD[3])	(mg/L TDS[6])	
HAWB 001*	531409	7461901	390.9	96	NA#	NA#	trace	18.8	372.1	NA#	WIN
HAWB 002*	532052	7461479	384.0	40	NA#	NA#	3	14.4	396.6	758	J
HAWB 003	530598	7462010	397.4	119	100.0	58-100	12	27.8	369.8	668	DG/MSS
HAWB 004	530105	7462001	407.5	152.8	150.8	89.1-101.1 and 107.1-149.1	11	38.3	370.0	645	DG
HAWB 005	531458	7462158	393.6	138	132.6	53.16-77.16, 95.16-113.16, 119.16-131.16	>12	20.5	373.9	818	MM

[1]MGA coordinates = Map Grid of Australia; determined from hand held GPS
[2]Collar RL = estimated from digital terrain model
[3]AHD = Australian Height Datum
[4]bgl = below ground level
[5]btc = below top of collar
[6]TDS = Total Dissolved Solids; by gravimetric filtration at 180°C
[7]Aquifers; WIN = Wittenoom; MM = Marra Mamba; DG = Dales Gorge Member; MSS = Mt Silvia Shale, J = Jeerinah
*Drilled under the direction and supervision of API.
#NA = Not available.



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 14 HAWB003 Composite Log.grf

Client:	API Managment Pty Ltd
Project:	Hardey Project Dewatering and Water Supply
Date:	August 2011
Drg. No.:	371-0/11/02-14

Water Bore HAWB003 Composite Log

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Bore HAWB 003 was developed by airlifting and produced about 10 to 15 L/s (based on visual estimate) of water with a salinity of 680 mg/L TDS. A static water level of 27.75 m btc (369.85 m AHD) was measured on 26 May 2010.

3.2.2 HAWB 004

A composite bore diagram for HAWB 004 is shown in Figure 15.

Due to collapsing boreholes encountered during the hydrostratigraphic drilling programme and also with HAWB 003, it was decided to drill HAWB 004 using mud-rotary drilling techniques.

HAWB 004 is located about 10 m from HAMB 008 and was drilled to target the Dales Gorge Member aquifer within the Brockman Iron Formation. A 381 mm diameter hole was first drilled to 6 m depth and lined with 314 mm ID, 324 mm OD, steel surface casing. A 194 mm diameter pilot hole was then drilled with a tri-cone roller bit to 150 m depth using mud rotary methods. The hole intersected shale and goethite/hematite.

The 194 mm diameter pilot hole was then reamed to 311 mm diameter to 152.8 m depth using mud-rotary methods and lined with 203 mm ID, 219 mm OD, steel casing to 149.15 m depth with 3 mm aperture slotted sections from 89.15 m to 101.15 m and from 107.15 m to 149.15 m depth.

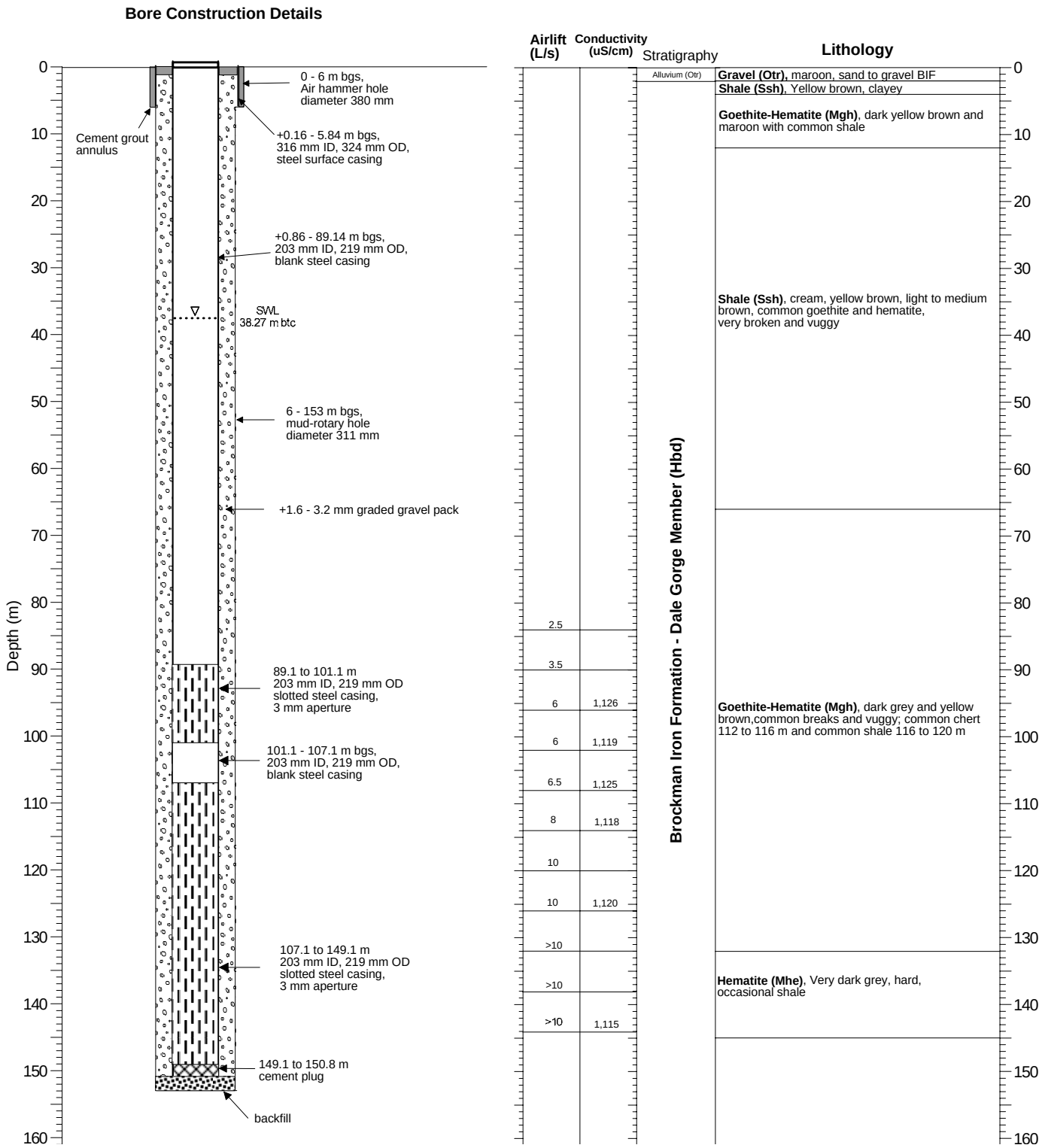
During development the bore produced more than 11 L/s of water with a salinity of 635 mg/L TDS and had a static water level of 38.27 m btc (370.03 m AHD) on 26 June 2010.

3.2.3 HAWB 005

A composite bore diagram for HAWB 005 is shown in Figure 16.

HAWB 005 is located about 4 m from HAMB 001 and was drilled to target the Marra Mamba aquifer as a potential source of water. A 381 mm diameter hole was first drilled to 6 m depth and lined with 316 mm ID, 314 mm OD, steel surface casing. A 194 mm diameter pilot hole was then drilled to 135 m depth using a mud-rotary roller bit. The hole intersected weathered goethite and BIF with common shale and chert bands.

The pilot hole was then reamed to 311 mm diameter to 138 m depth, and lined with 203 mm ID, 219 mm OD, schedule 40 steel casing with 3 mm aperture slotted sections from 53.16 to 77.16 m, 95.16 m to 113.16 m, and 119.16 m, and 131.16 m depth.

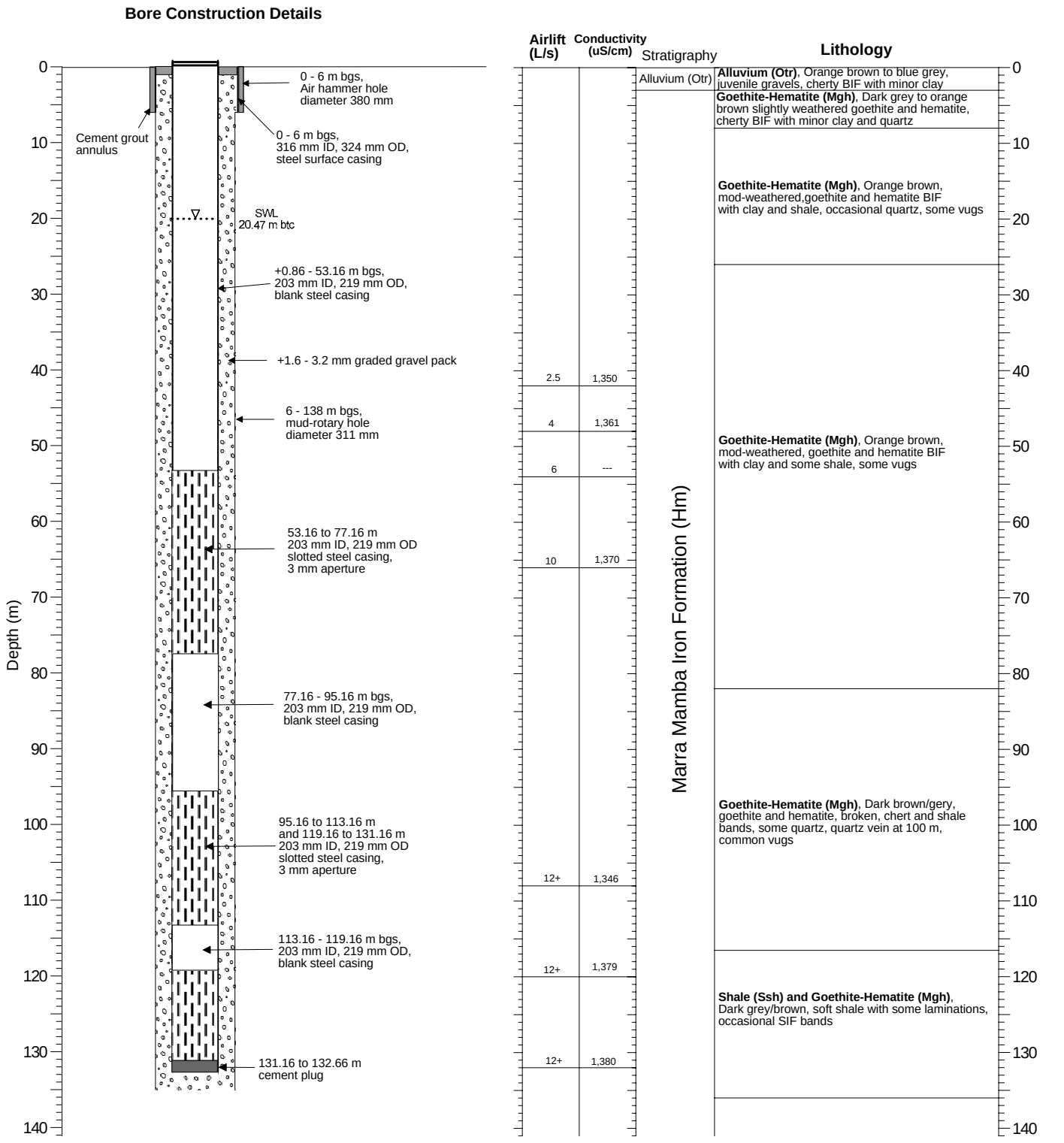


I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 15 HAWB004 Composite Log.grf

Client:	API Managment Pty Ltd
Project:	Hardey Project Dewatering and Water Supply
Date:	August 2011
Drg. No.:	371-0/11/02-15

Water Bore HAWB004 Composite Log

Rockwater PROPRIETARY LIMITED



I:/371-0/Grapher/11-003/Bore Composite Logs/Fig 16 HAWB005 Composite Log.grf

Client:	API Management Pty Ltd
Project:	Hardey Project Dewatering and Water Supply
Date:	August 2011
Drg. No.:	371-0/11/02-16

Water Bore HAWB005
Composite Log

Rockwater

During development the bore produced greater than 12 L/sec of water with a salinity of about 820 mg/L TDS and had a static water level of 20.47 m btc (369.85 m AHD) on 26 June 2010.

4 PUMPING TEST RESULTS

Pumping tests were conducted on the three test bores, HAWB 003, HAWB 004 and HAWB 005 from 7 July to 18 July 2010. The test pumping equipment was installed and operated by Welldrill and the tests were supervised by a Rockwater hydrogeologist.

A step-rate test was first conducted in the each of the bores. Each test comprised incrementally increasing one-hour steps at rates of 8, 15, 20, and 25 L/sec. They were undertaken to determine a duty pumping rate for a 48-hour constant-rate pumping test and to assess the bore efficiencies. The results of the step-rate tests are presented in Appendix III and results of the constant rate tests are summarised in Table 4.

Water levels were measured manually in the pumping bores and the nine recently constructed monitoring bores during the pumping tests. Pressure transducer/data logger instruments were also used in several of the bores during the tests to measure water levels at ten-minute intervals.

The data logger water level measurements were first corrected for changes in barometric pressure. A transducer/data logger, which was installed in HAMB 007 about 10 m above the water table, measured variations in atmospheric pressure during the test. Barometer-corrected water levels in all bores monitored showed fluctuations in the water level with periods of about 12 hours and amplitudes of about 3 to 4 cm. These changes in water level are attributed to earth tides acting on the aquifer. An example of the water level fluctuations in bore HAMB 007 is shown in Figure 17.

The pumping produced relatively small drawdown cones, and only the closest monitoring bore to each pumping bore (within 10 m) exhibited any observable drawdown. The water level changes that were observed in most of the monitoring bores are attributed to the earth tide effects on water levels, and water level recovery occurring after previous tests, rather than changes due to pumping.

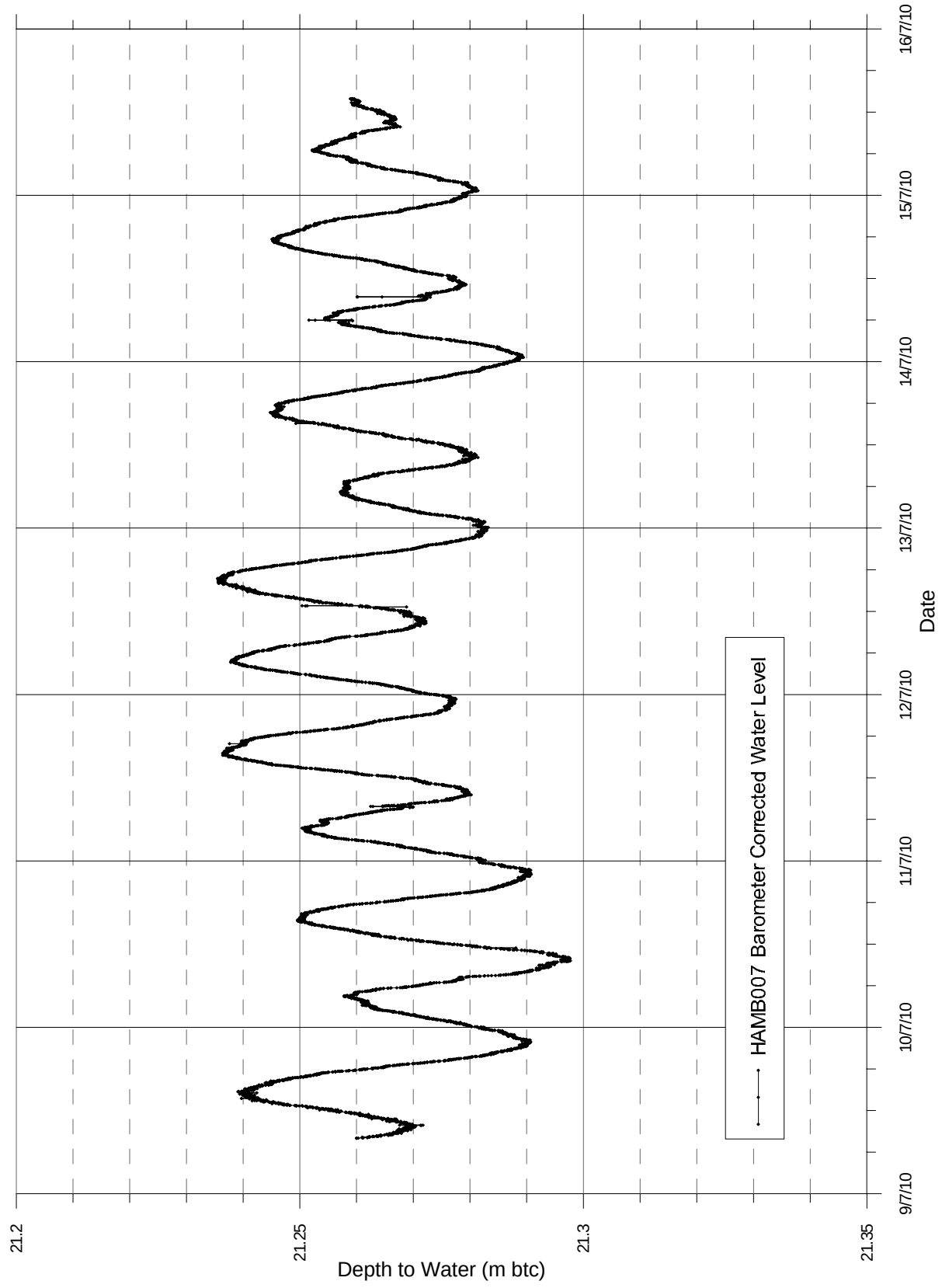
4.1 HAWB 003

The 48-hour constant-rate pumping test was conducted on HAWB 003 at 20 L/sec. The drawdown curves for HAWB 003 and monitoring bore HAMB 005, which is located seven metres from HAWB 003, are shown in Figure 18.

Table 4: Summary of Test Pumping Results

Hole No	Type of bore	Distance from Pumping Bore (m)	Pumping Rate (L/sec)	Drawdown after 48 hours (m)	Effective Transmissivity (m^2/day)	Aquifer Thickness (m)	Hydraulic Conductivity (m/day)	Comments
HAWB 003	Pumping	--	20	11.7	455	73	5.5	---
HAMB 005	Obs for HAWB 003	7	--	4.0	398	73	6.2	---
HAWB 004	Pumping	--	20	19.2	84	84	1.0	Test affected by aquifer boundaries
HAMB 008	Obs for HAWB 004	10	--	9.5	64	84	0.8	Test affected by aquifer boundaries
HAWB 005	Pumping	--	25	4.6	105	95	1.1	Test affected by aquifer boundaries
HAMB 001	Obs for HAWB 005	4	--	3.6	124	95	1.3	Test affected by aquifer boundaries

[#]Effective Transmissivity – estimated transmissivity taking into account aquifer boundary effects observed during 48-hour constant rate pumping test.



371.0/Grapher/11-003/Pumping Tests/Fig 17 HAMB007 Water Level.grf

Client: API Managment Pty Ltd

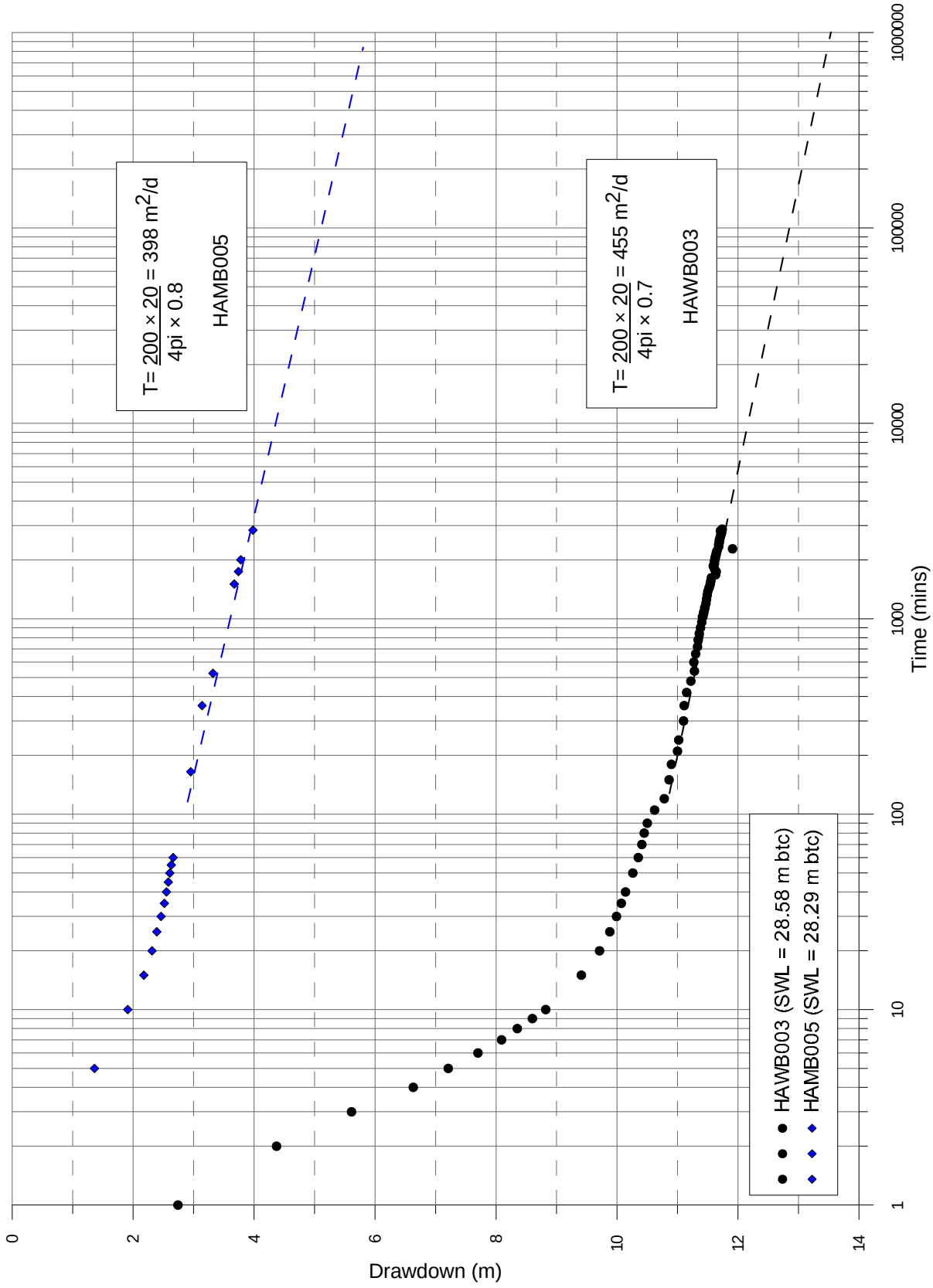
Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-17

HAMB007
Barometer Corrected
Water Level During Test Pumping

Rockwater



371-0/Grapher/11-003/Pumping tests/HAWB003/Fig 18 Constant Rate HAWB003.grf

Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371.0/11/02-18

HAWB003 Constant Rate Pumping Test Results

Test Started 07:00 hrs 16/7/10

Average Pumping Rate = 20.0 L/s=1,728 m^3/day

The drawdown curve for HAMB 003 shows a relatively steep drop in the water level during about the first 20 minutes of pumping, followed by straight line trend for the remainder of the test. Bore HAMB 005 showed a drawdown curve of similar shape to that for HAWB 003.

The final drawdown at HAWB 003 was 11.74 m and based on the straight line trend of the late time data and calculated transmissivity is about 455 m^2/day. The final drawdown in HAMB 005 was 3.98 m, and a transmissivity of 398 m^2/day has been estimated.

4.2 HAWB 004

The 48-hour constant rate pumping test was conducted at HAWB 004 at 20 L/sec. The drawdown curve for HAWB 004 and monitoring bore HAMB 008, which is located 10 m from HAWB 004, are shown in Figure 19.

Each bore had a relatively large amount of drawdown due to bore losses during the first minute of pumping: 4 m at HAMB 008 and 15 m at HAWB 004. This was followed by about four metres of drawdown in each of the bores for the remainder of the 48-hour test. This rapid early time drawdown, which was also observed in HAWB 003, is attributed to bore inefficiency.

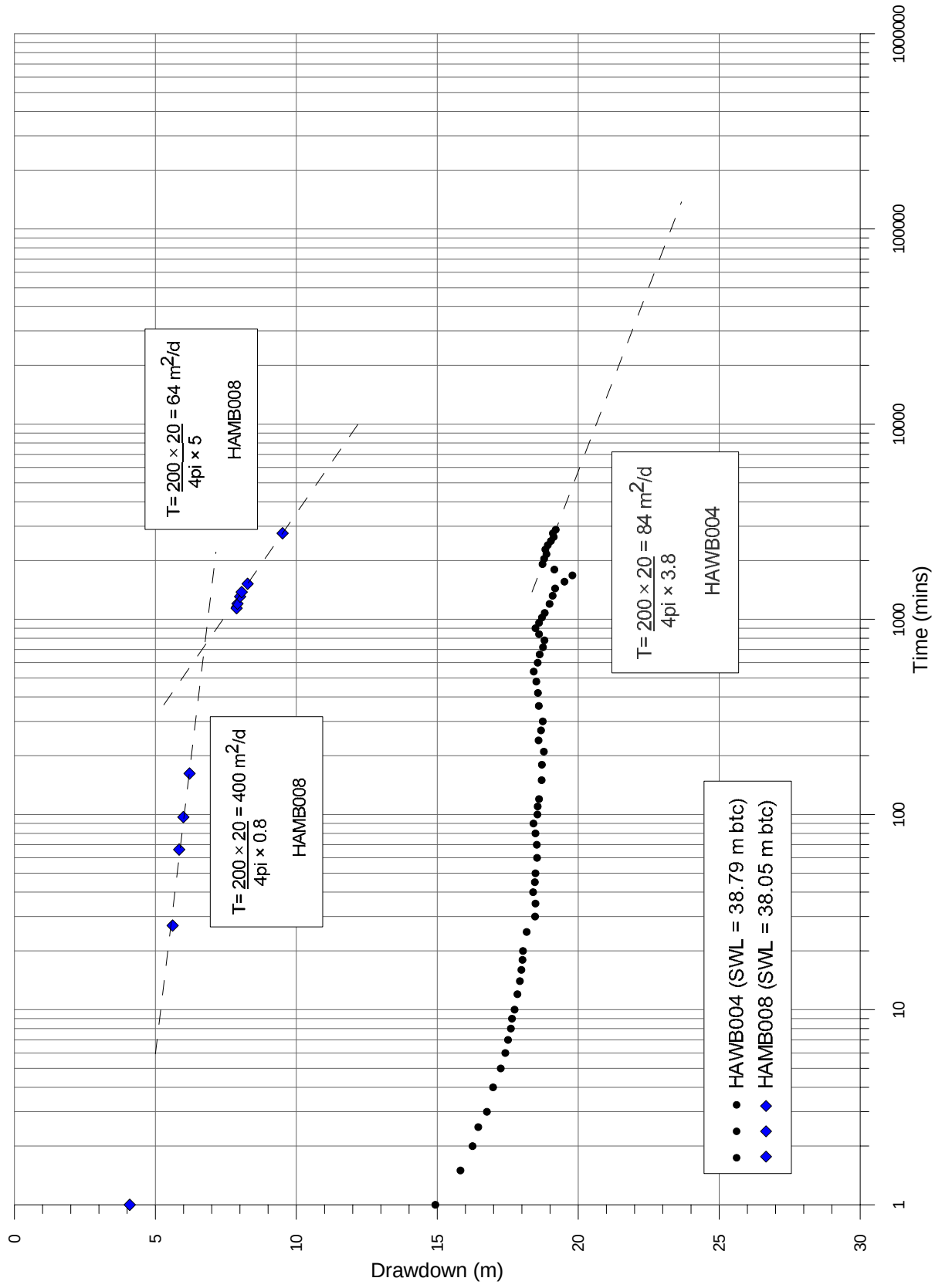
The drawdown curves for both bores begin to show a slight steepening of the drawdown curve near the end of the test, particularly HAMB 008, indicating limited aquifer extent (i.e. the drawdown cone of depression is starting to reach less permeable strata). Some of the irregularities in the drawdown curve for HAWB 004 are likely the result of small changes in the pumping rate.

A transmissivity of 400 m^2/day is calculated using the intermediate time (20 to 180 min) data at HAMB 008. Effective transmissivities for HAWB 004 and HAMB 008 using the late time drawdown curves and accounting for the boundary effects are less at 84 and 64 m^2/day, respectively.

4.3 HAWB 005

The 48-hour constant rate pumping test at 25 L/sec was conducted at HAWB 005. The drawdown curves for HAWB 005 and monitoring bore HAMB 001, which is located 4 m from HAWB 005, are shown in Figure 20.

HAWB 005 is considerably more efficient then bores HAWB 003 and HAWB 004 as there was only about 2 m of drawdown in HAWB 005 in the first 10 minutes compared to 9 m and 18 m in the other two bores, respectively.



371-0/Grapher/11-003/Pumping Tests/HAWB004/Fig 19 Constant Rate HAWB004.grf

Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

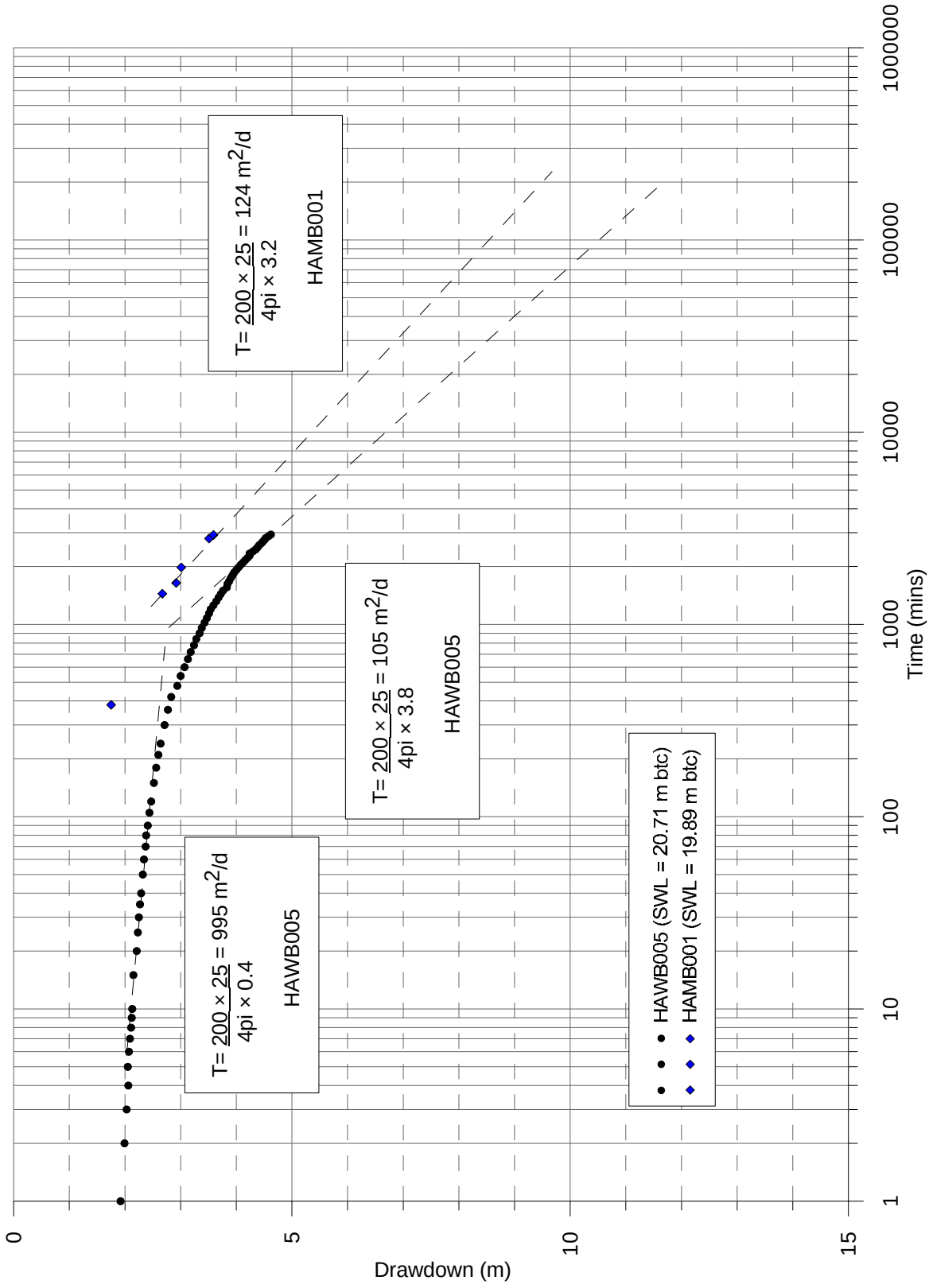
Dwg. No: 371-0/11/02-19

HAWB004 Constant Rate Pumping Test Results

Test Started 14:00 hrs 08/7/10

Average Pumping Rate = 20.0 L/s = 1,728 m^3/day

Rockwater



371-0/Grapher/Pumping Tests/HAWB005/Fig 20 Constant Rate HAWB005.grf

Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-20

HAWB005 Constant Rate Pumping Test Results

Test Started 07:00 hrs 12/07/10

Average Pumping Rate = 25.0 L/s = 2,160 m^3/day

The drawdown curve for HAWB 005 follows a straight-line trend for about the first 100 minutes after which the rate of drawdown begins to increase. The change in the rate of drawdown is attributed to a limited aquifer extent, and more specifically to the extent of cavities and vuggy strata which were encountered during drilling.

The transmissivity calculated for HAWB 005 using the first 100 minutes of data is very high at about 1,000 m^2/d; while the effective transmissivity using late time data is less at about 105 m^2/day. It is possible that additional barrier boundaries will be intersected by the drawdown cone of depression as the pumping continues, resulting in lower yields.

5 WATER QUALITY

Water samples were collected at the start and end of the 48-hour constant rate pumping tests from the three production bores HAWB 003, 004 and 005, and were sent to ASL laboratories in Perth. A sample was also collected via pumping from the previously constructed bore HAWB 002 which is completed to a depth of 40 m in the Jeerinah Formation and was used as a source of water for the drilling programme.

Water samples were also collected using a bailer from bores HAWB 003 to 005 and analysed for Coliforms and Escherichia coli (E. coli).

The water-chemistry results are presented in Table 5 and plotted as a piper diagram in Figure 21. Laboratory certificates are presented in Appendix IV.

The groundwater from all aquifers tested is neutral to slightly alkaline with pH values ranging from 7.38 to 8.01. The water was fresh with salinity ranging from 645 to 818 mg/L TDS which is less than the 2004 Australian Drinking Water Guideline (ADWG) limit of 1,000 mg/L, but above the recommended aesthetic limit of 500 mg/L (NHMRC, 2004).

The analytical results (Fig. 21) show a mixed chemistry with most data plotted within the centre of each trilinear plot. The groundwater from all aquifers tested at the project, have a bicarbonate rich composition with slightly elevated concentrations of sulphate, chloride and sodium.

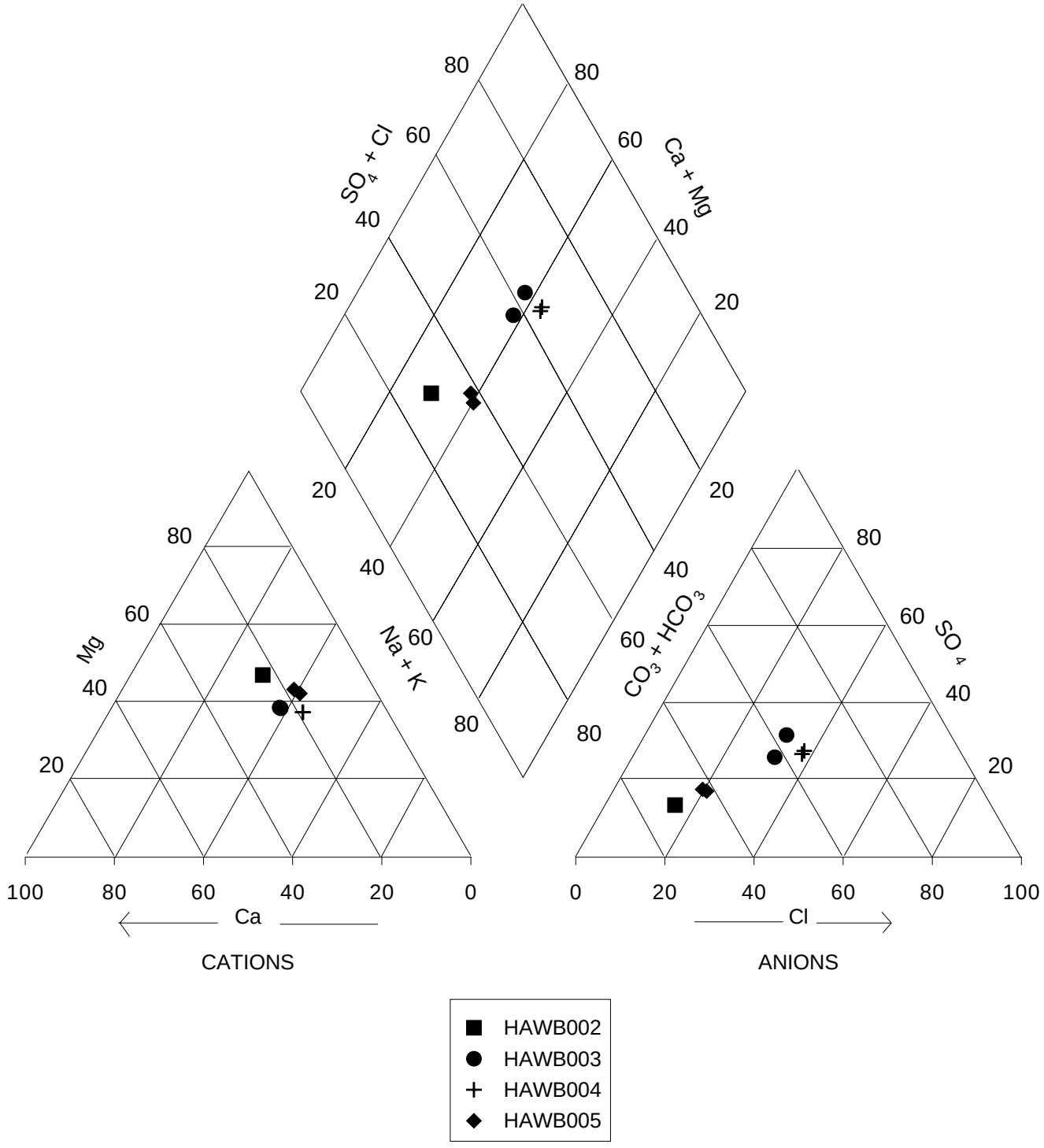
Sulphate (SO_4^{2-}) concentrations from all samples were slightly elevated; 86 mg/L in HAWB 002 and 124 to 192 mg/L in bores HAWB 003 to 005. These concentrations are however still well below both the 2004 ADWG limit of 500 mg/L and below the recommended aesthetic limit of 250 mg/L.

All other constituents analysed were below the 2004 ADWG limits. There were no Coliforms or E.Coli detected.

Table 5: Laboratory Water Quality Results

Analyte	Units	LOR#	HAWB 002 (28/6/2010)	HAWB 003 (16/7/2010)	HAWB 003 (18/7/2010)	HAWB 004 (8/7/2010)	HAWB 004 (10/7/2010)	HAWB 005 (12/7/2010)	HAWB 005 (10/14/2010)	2004 ADWGL*
pH	pH Unit	0.01	7.91	7.38	7.44	8.01	7.92	7.84	7.8	6.5 to 8.5
Electrical Conductivity @ 25°C	µS/cm	1	1,100	1,330	1,320	1,080	1,090	1,460	1,450	-
Total Dissolved Solids @180°C	mg/L	1	758	709	668	651	645	781	818	1,000 (500)*
Total Hardness as $CaCO_3$	mg/L	1	480	410	417	357	370	504	528	-
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1	<1	-
Carbonate Alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1	<1	-
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	470	233	264	212	210	467	454	-
Sulphate as SO4 2-	mg/L	1	86	192	155	152	159	126	124	500 (250)*
Sulphur as S	mg/L	1	29	64	52	51	53	42	41	-
Chloride	mg/L	1	73	141	140	157	160	104	111	250
Calcium	mg/L	1	63	62	63	48	50	58	62	-
Magnesium	mg/L	1	78	62	63	58	60	87	91	-
Sodium	mg/L	1	93	110	113	122	126	157	153	180
Potassium	mg/L	1	<1	7	8	9	9	<1	<1	-
Aluminium	mg/L	0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	-
Arsenic	mg/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007
Cadmium	mg/L	0.0001	<0.0001	0.0001	<0.0001	0.0006	0.0003	0.0007	0.0002	0.002
Chromium	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Manganese	mg/L	0.001	<0.001	0.004	0.002	0.081	0.02	0.013	0.002	0.5 (0.1)*
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Zinc	mg/L	0.005	0.006	0.026	0.016	0.038	0.052	0.01	0.007	-
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
Reactive Silica	mg/L	0.10	67.3	5.4	19.9	18.2	15.0	64.1	65.8	-
Ammonia as N	mg/L	0.01	0.03	0.01	0.02	0.03	0.03	0.02	0.02	-
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.01	0.01	0.02	0.18	0.02	3
Nitrate as N	mg/L	0.01	4.18	0.75	1.01	1.23	1.26	6.19	7.04	50
Nitrite + Nitrate as N	mg/L	0.01	4.18	0.75	1.01	1.25	1.28	6.36	7.06	-
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.4	0.3	0.2	0.4	0.1	<0.5	0.6	-
Total Nitrogen as N	mg/L	0.1	4.6	1	1.2	1.6	1.4	6.4	7.7	-
Total Phosphorus as P	mg/L	0.01	0.06	0.07	0.04	0.04	0.08	<0.05	<0.05	-
Reactive Phosphorus as P	mg/L	0.01	0.02	0.04	0.03	0.01	0.01	<0.01	<0.01	-
Total Anions	meq/L	0.01	13.2	12.6	12.4	11.8	12.0	14.9	14.8	-
Total Cations	meq/L	0.01	13.6	13.2	13.5	12.7	13.1	16.9	17.2	-
Ionic Balance	%	0.01	1.45	2.04	3.91	3.43	4.38	6.33	7.59	-
#Coliforms	CFU/100ml				<10		<10		<10	
#E. Coli	CFU/100ml				<10		<10		<10	

***2004 ADWGL = 2004 Australian Drinking Water Guideline limit (aesthetic value in parenthesis); #Coliforms/E.Coli = samples collected on 30/7/10**



371-0/Grapher/11-003/Fig 21 Hardey Piper.grf

Client:	API Managment Pty Ltd
Project:	Hardey Project Dewatering and Water Supply
Date:	August 2011
Drg. No.:	371-0/11/02-21

PIPER DIAGRAM OF HARDEY BORE WATER CHEMISTRY

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6 HYDROGEOLOGY

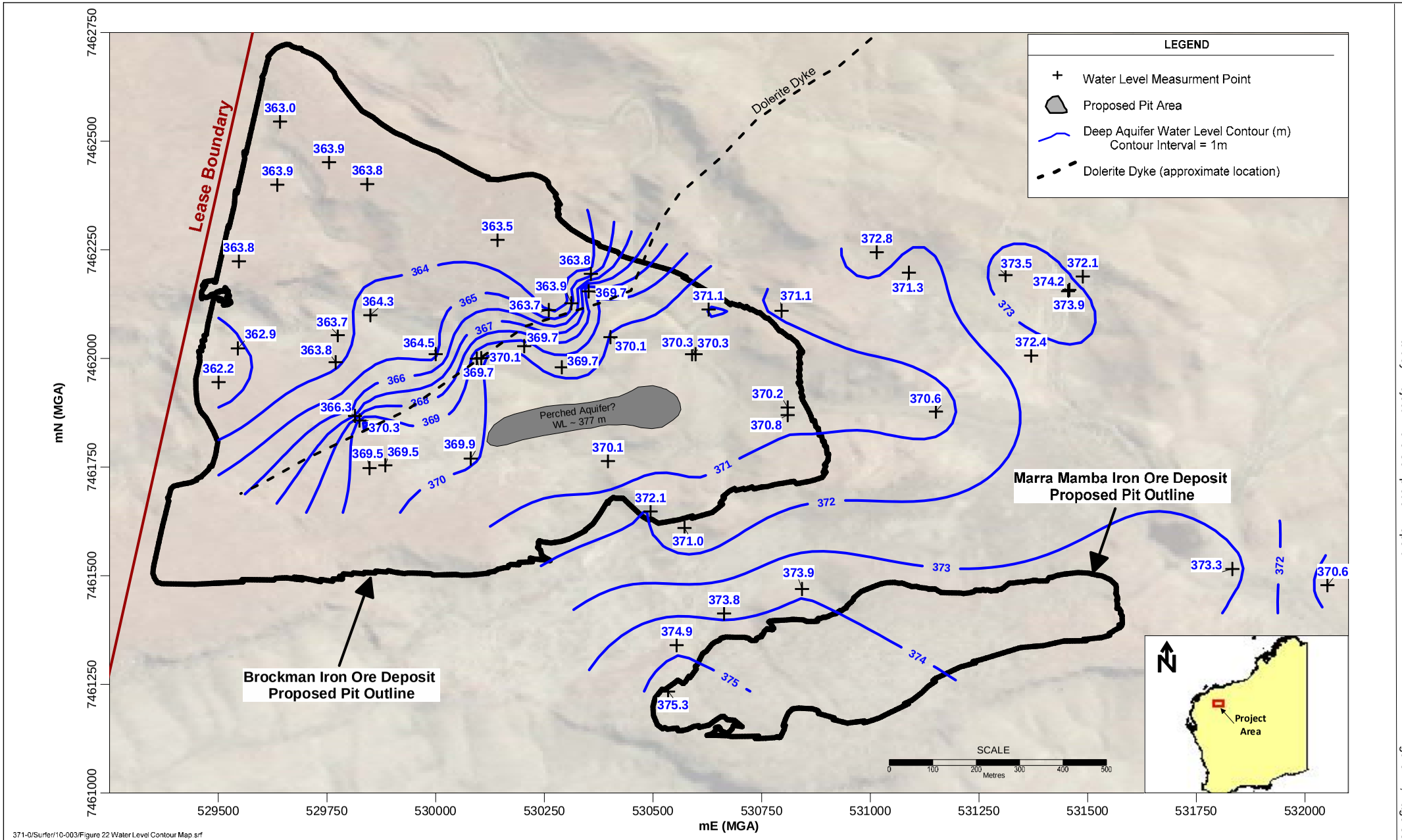
A water level contour map of the deep aquifers is presented in Figure 22; based on the recently-constructed monitoring bores and test bores, and selected existing mineral exploration holes. The water table lies between 363 and 375 m AHD, and it slopes downwards to the northwest, suggesting that recharge is via infiltration below the Hardey River and direct infiltration. Several perched aquifers may exist due to the presence of less permeable clay/shale layers, with the most prominent perched aquifer occurring along a ridgeline in the eastern part of the Brockman deposit (ex. holes HARC 153, 154, 155, 157, 159, 168, and 177) where water levels are between 377 and 378 m AHD, about 7 to 8 m above the regional water table.

Figure 22 also shows a relatively abrupt change in water levels near the centre of the Brockman deposit with water levels at about 364 m to the west and 370 m to the east. This change in water level is interpreted to be the result of a low permeability dolerite dyke that strikes NE-SW and that is impeding groundwater flow to the northwest. The estimated surface expression of the dolerite dyke based on geological mapping is shown on Figure 22.

Results of the drilling programme have shown that the Brockman deposit contains moderate to large supplies of groundwater with the majority of high-permeability material occurring below a depth of about 50 m. Pumping test results from HAWB 003 and HAWB 004 indicate that dewatering bores completed in the Brockman will sustain pumping rates of the order of 20 to 25 L/sec in the short to medium term but as the drawdown cone extends radially and intersects less permeable strata and or faults, the yields may decrease.

Bores HAMB 004 and HAMB 007 intersected lower permeability strata of the Mount McRae Shale and Mount Sylvia Formations, respectively, indicating that the Brockman deposit may be bordered by lower permeability strata. However, the permeability and connection between the Brockman aquifers and the Wittenoom Formation are not known.

Based on the current life of mine plan depicted in Figure 23 and the water level contours shown in Figure 22, the areas where the proposed pit is to be mined below about 370 m RL will need to be dewatered. The 370 m RL of the proposed pit design is shown in Figure 23 providing an estimate of the approximate area that will need to be dewatered. Water levels will need to be drawn down by as much as 90 m to lower the water table to the deepest part of the proposed pit at about 280 m RL. To achieve this scale of dewatering, in-pit bores will be needed. A numerical groundwater model has been prepared to assess the level of dewatering needed and is presented in Section 7 of this report.



371-0/Surfer/10-003/Figure 22 Water Level Contour Map.srf

API Hardey Project - Bore Completion Report

Figure 22; Page 38

CLIENT: API Management Pty Ltd

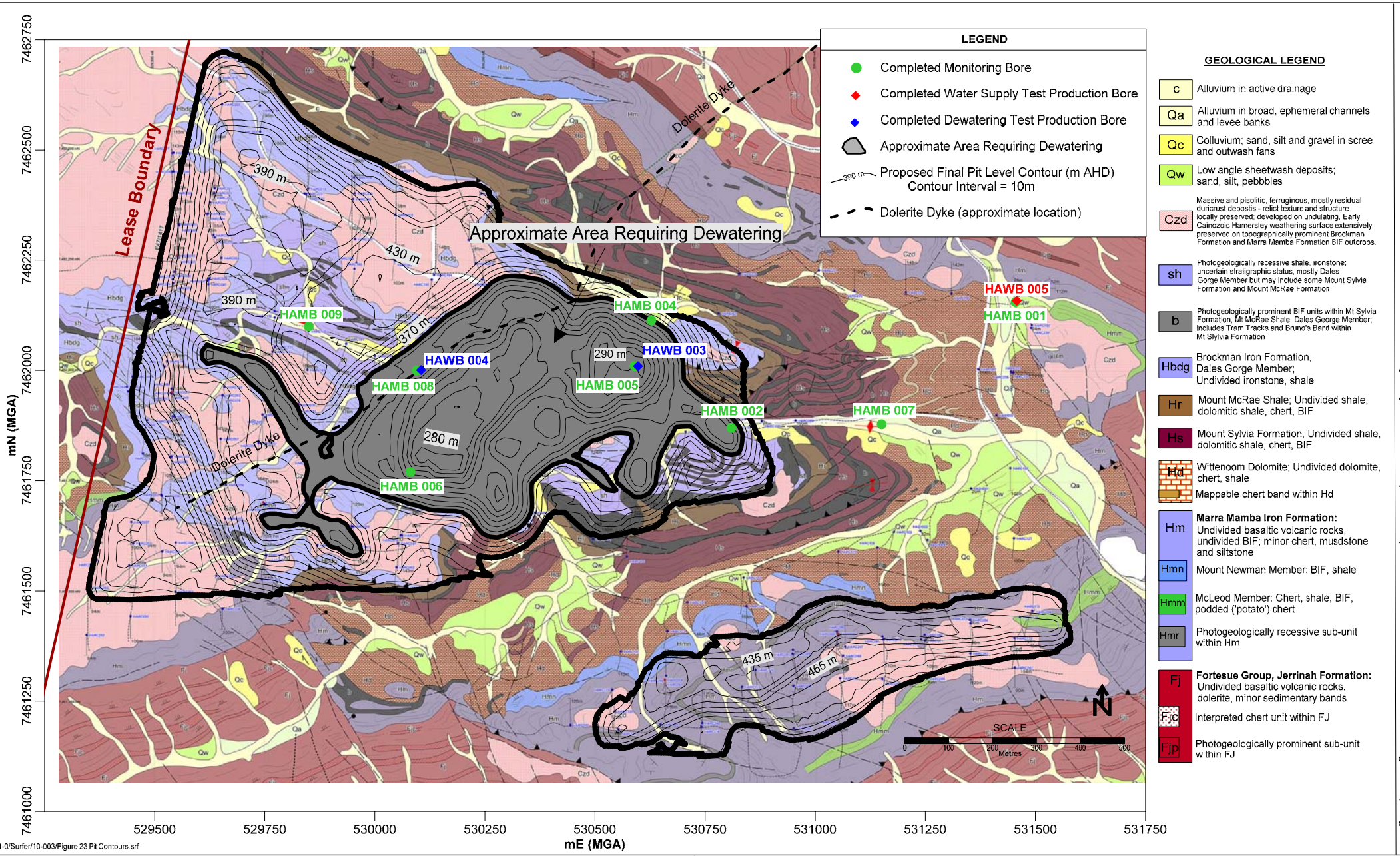
PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-22

DEEP AQUIFER GROUNDWATER LEVEL CONTOUR MAP

Rockwater



API Hardey Project - Bore Completion Report

Figure 23; Page 39

CLIENT: API Management Pty Ltd

PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-23

PROPOSED PIT DESIGNS (VER. 3a)
LIFE OF MINE PLAN

Rockwater

7 NUMERICAL MODELLING

7.1 MODEL DESCRIPTION

The numerical modelling utilised Processing Modflow Pro, the industry-standard finite-difference groundwater model designed by the US Geological Survey (McDonald and Harbaugh, 1988). It was set up using aquifer parameters derived from the drilling and test-pumping programmes, and calibrated to static water levels and to individual pumping tests.

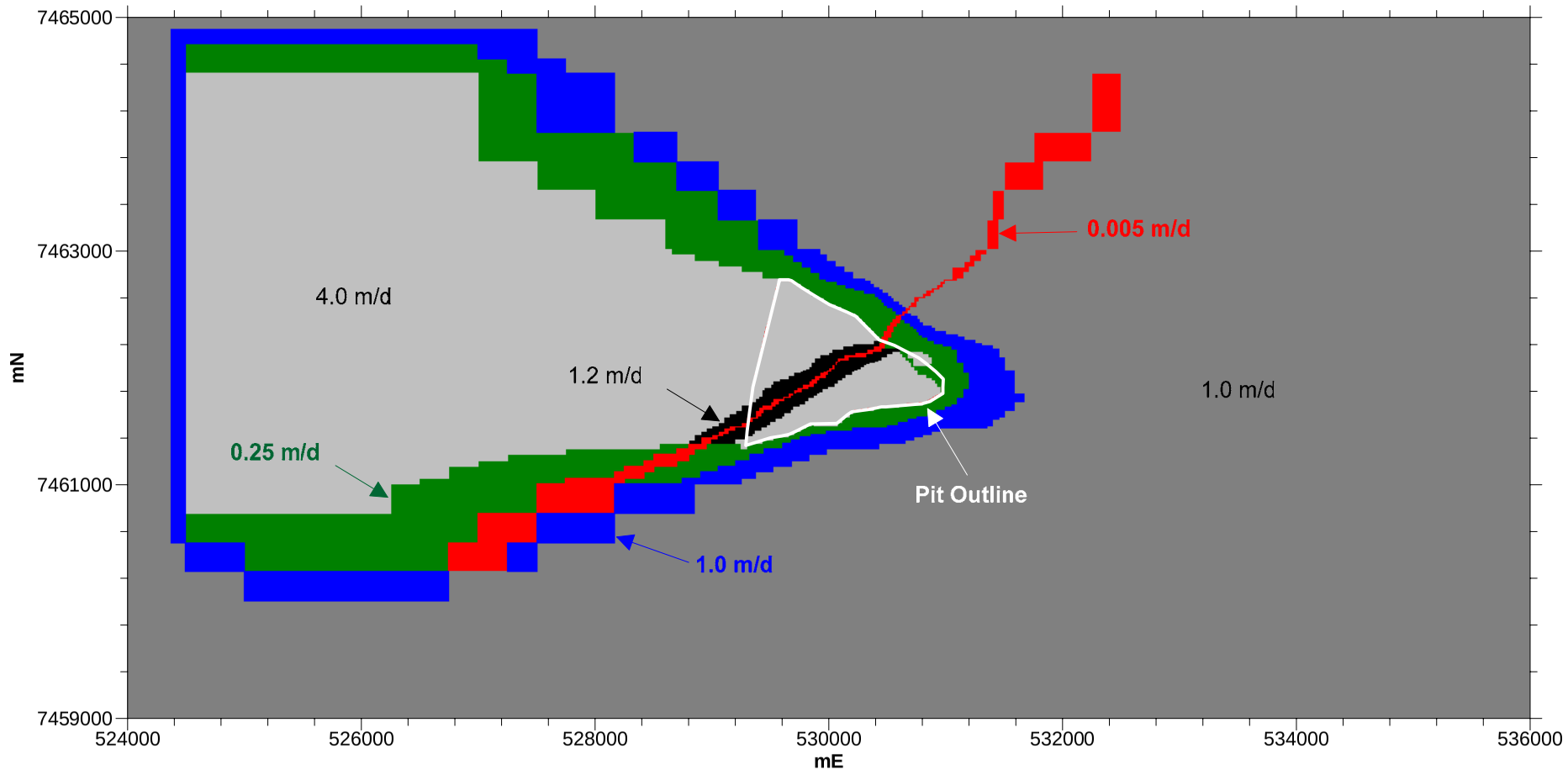
The model domain is comprised of a 6 x 12 km rectangle aligned in an east-west direction, approximately parallel to the regional groundwater flow direction, and sub-divided into 119 rows and 169 columns. The grid cell size ranges from 5 x 5 m in the area of the Hardey project area to 500 x 500 m at the model periphery. The model domain is shown in Figure 24.

Two horizontal model layers were used. Layer 1 represents the variably-fractured fresh bedrock of the Brockman Iron Formation and the surrounding strata i.e. Mt McRae Shale, Wittenoom Formation, and the adjoining country rocks. Layer 2 represents low permeability fresh bedrock. The model was built with constant-head boundaries to simulate the wider extent of the aquifer. No-flow cells were placed around the model boundary and the initial water levels were assigned constant-heads ranging from 351 to 380 m AHD.

Aquifer parameters were assigned according to six spatial zones defined within each model layer. The zones represented the Brockman Iron Formation, a low-permeability zone associated with a dolerite dyke which crosses the deposit in a northeast-southwest direction, shale and other sedimentary strata of the Mt McRae Shale and Mt Silvia Formations, dolomite of the Wittenoom Formation, and the adjoining country rocks.

Details of the aquifer parameters are presented in Table 6 and the domains of hydraulic conductivity for Layer 1 are shown in Figure 24. The permeability domains reflect the values estimated from test-pumping, the drilling programme, and the static water levels.

Adjustment of these values was required to achieve a satisfactory calibration. It should be noted that the permeability distribution was defined on the basis of limited regional geological information, particularly with respect to the hydrogeological properties of the Wittenoom Formation.



Brockman Formation = 4.0 m/d

Dolerite Dyke = 0.005 m/d

Wittenoom Dolomite = 2.0 m/d

Mt McRae and Mt Silva = 0.25 m/d

Brockman Formation Adjacent to Dolerite Dyke = 1.2 m/d

Country Rocks = 1.0 m/d

371-0/Surfer/10-003/Gwtr Model/Figure 24 Permeability Distribuiton.srf

CLIENT: API Management Pty Ltd

PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-24

MODELLED HORIZONTAL PERMEABILITY VALUES LAYER 1 (m/day)

Rockwater

Table 6: Model Parameters

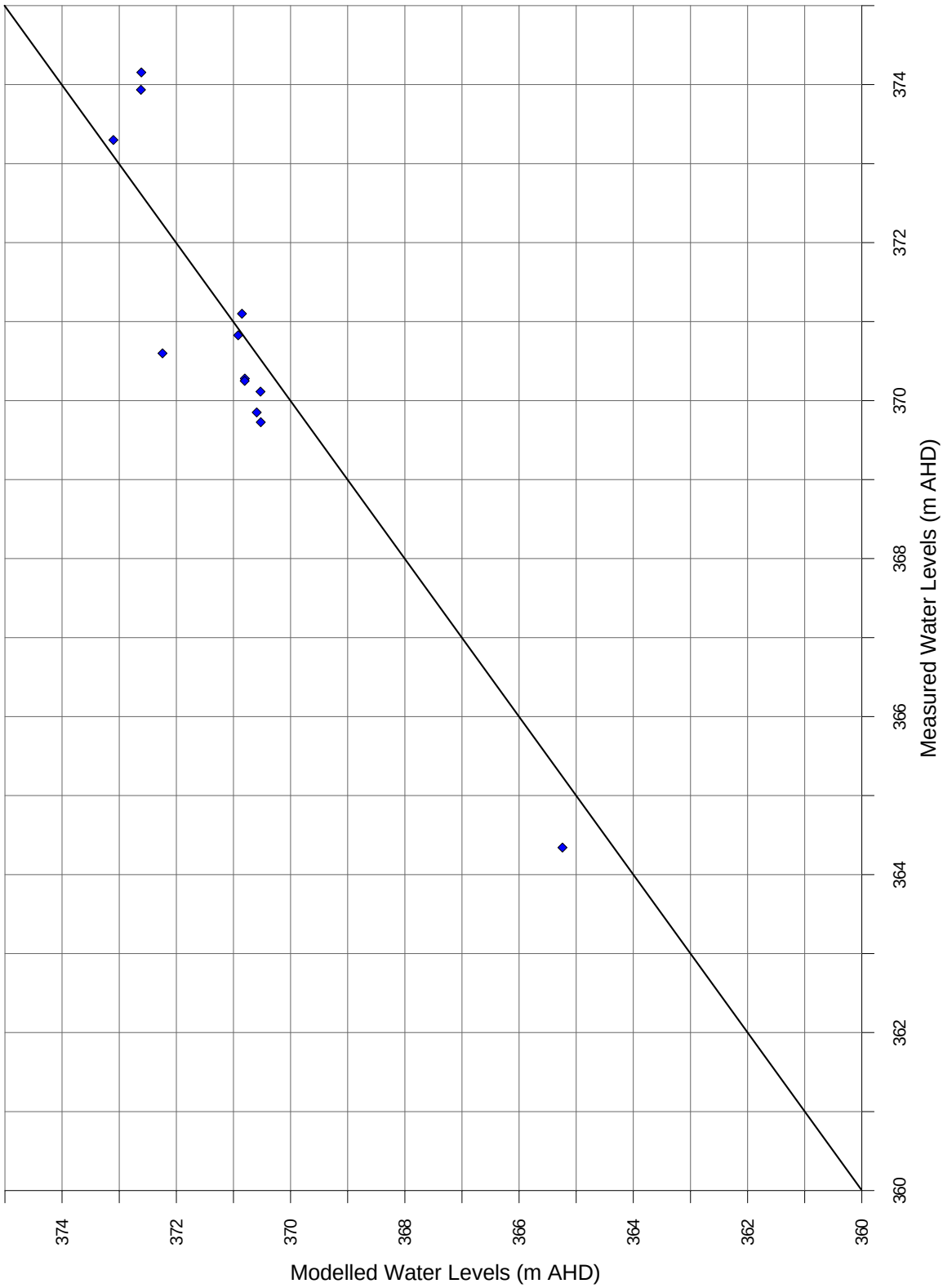
Parameter	Brockman Iron Formation	Brockman Iron Formation adjacent to dolerite dyke	Dolerite Dyke	Mt McRae Shale and Mt Silvia Formation	Wittenoom Formation	Country Rocks
Top Layer 1 Elevation (m AHD)	400	400	400	400	400	400
Top Layer 2 Elevation (m AHD)	250 to 340	250 to 340	250 to 340	340	340	340
Bottom Layer 2 Elevation (m AHD)	100 to 190	100 to 190	100 to 190	190	190	190
Initial Water Level (m AHD)	380	380	380	380	380	380
Kh* Layer 1 (m/d)	4.0	1.2	0.005	0.25	2.0	1.0
Kv# Layer 1 (m/d)	0.8	0.24	0.001	0.1	0.4	0.2
Kh* Layer 2 (m/d)	0.1	0.1	0.005	0.1	1.3	0.1
Kv# Layer 2 (m/d)	0.02	0.02	0.001	0.02	0.26	0.02
Specific Yield; Layer 1	0.009	0.0065	0.0005	0.004	0.01	0.005
Specific Storage (1/m); Layer 2	0.00001	0.00001	0.00001	0.00001	0.001	0.00001
Recharge from rainfall (m/d)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001

* horizontal hydraulic conductivity
\# vertical hydraulic conductivity

7.2 MODEL CALIBRATION

The model was first calibrated by matching the simulated water levels to static water levels in monitoring and production bores measured in July 2010. This was achieved by varying the values of hydraulic conductivity and the amount of aquifer recharge from rainfall.

A comparison between groundwater levels measured in July 2010 and those calculated by the calibrated model are shown in Figure 25 and a contour map of modeled initial water levels is shown in Figure 26. There is a reasonable agreement between the modeled and measured water levels, which portray a relatively abrupt change in water levels near the centre of the Brockman deposit with water levels at about 364 m to the west and 370 m to the east. This change in water level is interpreted to be the result of a low permeability dolerite dyke that strikes NE-SW, impeding groundwater flow to the northwest.



371-0/Grapher/11-003/GwtrModel/Fig 25 Comparison measured vs modelled SWL.grf

Client: API Managment Pty Ltd

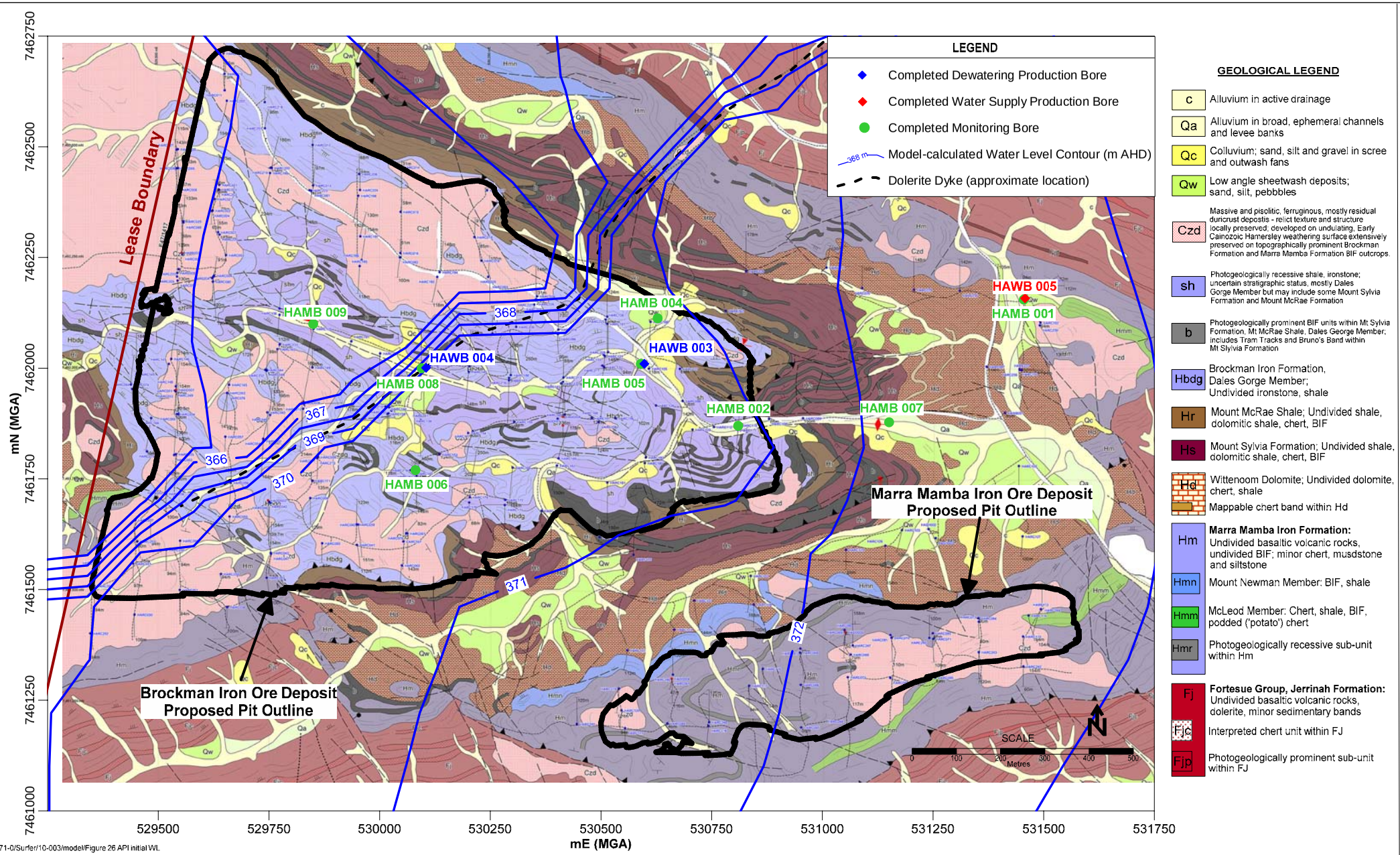
Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-25

MEASURED VS MODELLED STATIC WATER LEVELS

Rockwater



CLIENT: API Management Pty Ltd

PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-26

MODELLED INITAL WATER LEVELS (m AHD)

Rockwater

To replicate the steep water level gradient, a line of low-permeability cells was incorporated into the model.

The modeled water-levels were also calibrated to the water-level drawdowns produced during the 48-hour pumping tests conducted on the three production bores HAWB 003, HAWB 004 and HAWB 005 in July 2010 (test-pumping results were described in Section 4). The calculated water-level drawdowns and measured drawdowns in the monitoring bores are presented in Figures 27 to 29. The calibration results indicate that the simulated water-level drawdowns are similar to the measured drawdowns. Calculated drawdowns at the pumping bores are less than those measured because the latter include the 'well losses' (frictional/turbulence) inside the bores, and because the modelled water levels are averaged for each cell, which have minimum sizes 5 m x 5 m, whereas the bores provide point-measurements. Calculated water level drawdowns in monitoring bores adjacent to the production bores provide a more accurate representation of the surrounding aquifer than those in the production bores.

7.3 MODELLING RESULTS

The model was run to simulate the rate of dewatering that will be required to maintain dry mining conditions as the pit is deepened to its final elevation of 284 m AHD after 12 years of mining.

Pumping from four production bores was simulated: from the two existing production bores HAWB 003 and HAWB 004 and two additional hypothetical production bores (#1 and #2) each constructed 150 m depth and located about 200 m east from HAWB 004 and 150 m north-east from HAMB 006, respectively. For modelling purposes, bore HAWB 003 has been extended from its current depth of 100 m to 150 m. Locations of the pumping bores are presented in Figure 30.

Pumping operations were modelled to commence in year 5 of mining (i.e. at the beginning of the first quarter of the fifth year) and continue for the remaining eight years of the proposed mining schedule. Based on the proposed mining schedule #3a, provided by API in November 2010, the pit floor elevation at Year 6 will be at 372 m AHD, which is approximately the depth in the pit area where saturated ground will be encountered (Figure 23). To ensure that water levels are lowered ahead of mining it will be necessary to commence dewatering operations at least one year before (i.e. year 5 of mining operations).

The results of the modelling scenario are presented in Table 7 and plots of predicted water-levels after 40 days, 1, 5, and 8 years of pumping are shown in Figures 31 to 34.

During the first 40 days of pumping, the simulated pumping rates range from 25 to 30 L/s for each of the four production bores, and total 115 L/sec (9,940 m^3/d). The modelled water level in production bore HAWB 004 would have drawn-down close to the pump

inlet (about 280 m AHD) after 40 days and therefore the simulated pumping rate was reduced from 25 L/s to about 9 L/s to maintain a constant head. Water level contours after 40 days of pumping are shown in Figure 31. They do not show the water levels in the pumped dewatering bores.

For the next 24 days (i.e. day 64 since the start of pumping), the pumping rates simulated from the four pumping bores range between 9 and 30 L/s, totalling 99 L/s (8,550 m^3/d). The water level in hypothetical bore #1 is expected to be drawdown close the pump inlet (about 278 m AHD) and therefore, the pumping rate is reduced from 30 L/s to about 19 L/s to maintain a constant head in the bore.

For the following 10 days (i.e. day 74 since the start of pumping), the pumping rates simulated at the four pumping bores were reduced to a total rate of 85 L/s (7,340 m^3/d). The water levels in the production bore HAWB 003 and the second additional production bore (ie bore site 2) would have drawn down close to the pump inlets (about 280 and 275 m AHD, respectively).

For the next eight years of dewatering, the pumping rates were subsequently reduced as the water levels in the aquifer declined. The combined pumping rate ranged from about 50 L/s at the end of year one to about 40 L/s at the end of year eight and the total cumulative volume of pumped water (after eight years of pumping) is approximately 11.5 GL (Table 7). Modelled drawdowns after one year, five years and eight years are presented in Figures 32, 33, and 34 respectively.

A time-series plot of water levels at five locations in the deepest part of the pit is presented in Figure 35, together with the planned minimum elevations of the pit at the end of each mining year. The modelling results indicate that water levels will be kept below the deepest pit floor elevation (i.e. 284 m AHD) if dewatering is undertaken with four bores pumping for a period of eight years (assuming starting dewatering at year 5 of mining operations). Additionally, minor in-pit pumping will be required to allow dry mining conditions.

In summary, the modelling indicates that the total dewatering pumping rate will decline from about 115 L/s (9,940 m^3/d), in the early stages of dewatering, to about 40 L/s (3,450 m^3/d) after eight years.

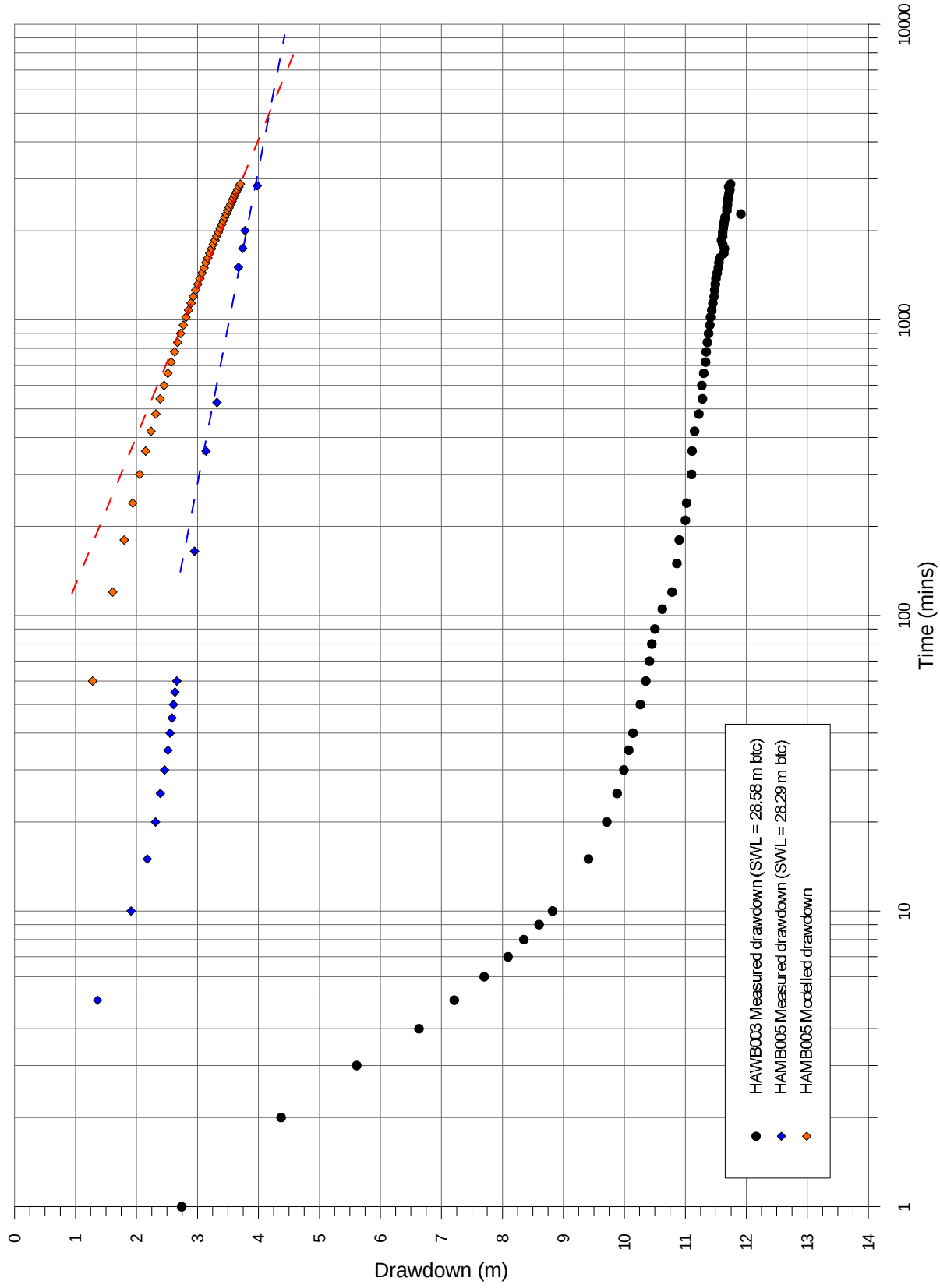
The pumping rates and water levels calculated by modelling should be regarded as approximate only, because the aquifers are heterogeneous, and the parameters used in the model are predominantly estimates supported by a small number of measured values.

Table 7: Dewatering Modelling Results

Bore ID			Year 1				Year 2		Year 5 [2]	Year 8 [2]
		Day	40	64	74	360	540	720	1800	2880
	Planned Pit elevation (minimum)	m AHD				376		364		284
HAWB 003	Pumping Rate	L/s	30	30	30	17	16	16	14	13
	Water Level in Cell	m AHD	314.4	287.8	276.7	280	279.8	279.7	279.4	279.3
HAWB 004	Pumping Rate	L/s	25	9	6	4	4	4	4	4
	Water Level in Cell	m AHD	282.0	280.5	278.1	277.8	277.7	277.7	277.6	277.6
Bore 1 [1]	Pumping Rate	L/s	30	30	19	14	13	13	12	12
	Water Level in Cell	m AHD	307.8	278.6	277.3	276.4	276.3	276.2	267.1	276
Bore 2 [1]	Pumping Rate	L/s	30	30	30	16	15	15	14	13
	Water Level in Cell	m AHD	310.6	282.8	273.2	276.6	276.6	276.5	276.3	276.2
HAMB 006	Water Level in Cell	m AHD	322.7	299.3	291.1	286.5	286.1	285.9	285.2	284.7
HAMB 009	Water Level in Cell	m AHD	362.4	361.3	360.7	355.7	353.9	352.7	349.7	348.3
Total Combined Pumping Rate		L/s	**115**	**99**	**85**	**51**	**49**	**47**	**43**	**41**
Annual Pumped Volume		GL	**1.94**				**1.51**		**1.37**	**1.30**
Cummulative Pumped Volume			**1.94**				**3.44**		**7.54**	**11.45**

1 = hypothetical bore

2 = the same pumping rate has been applied for the preceeding two years



371-0/Grapher/11-003/Gwtr Model/Fig 27 DD Comparison measured vs modelled HAWB03.grf

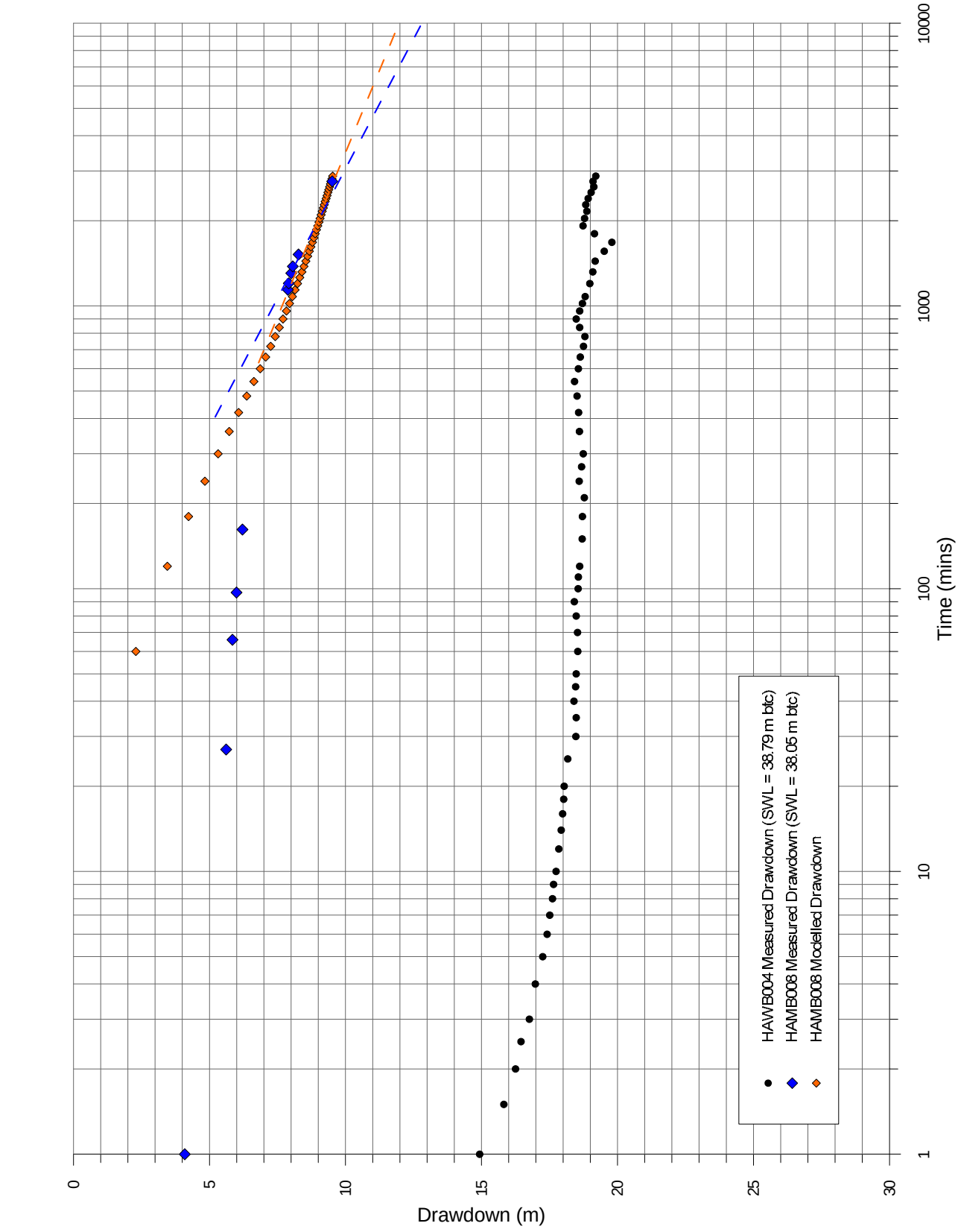
Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-27

HAWB003
Measured vs. Modelled drawdown after 48 hours of pumping



371-0/Grapher/11-003/Gwtr Model/Fig 28 DD Comparison measured vs modelled HAWB04.grf

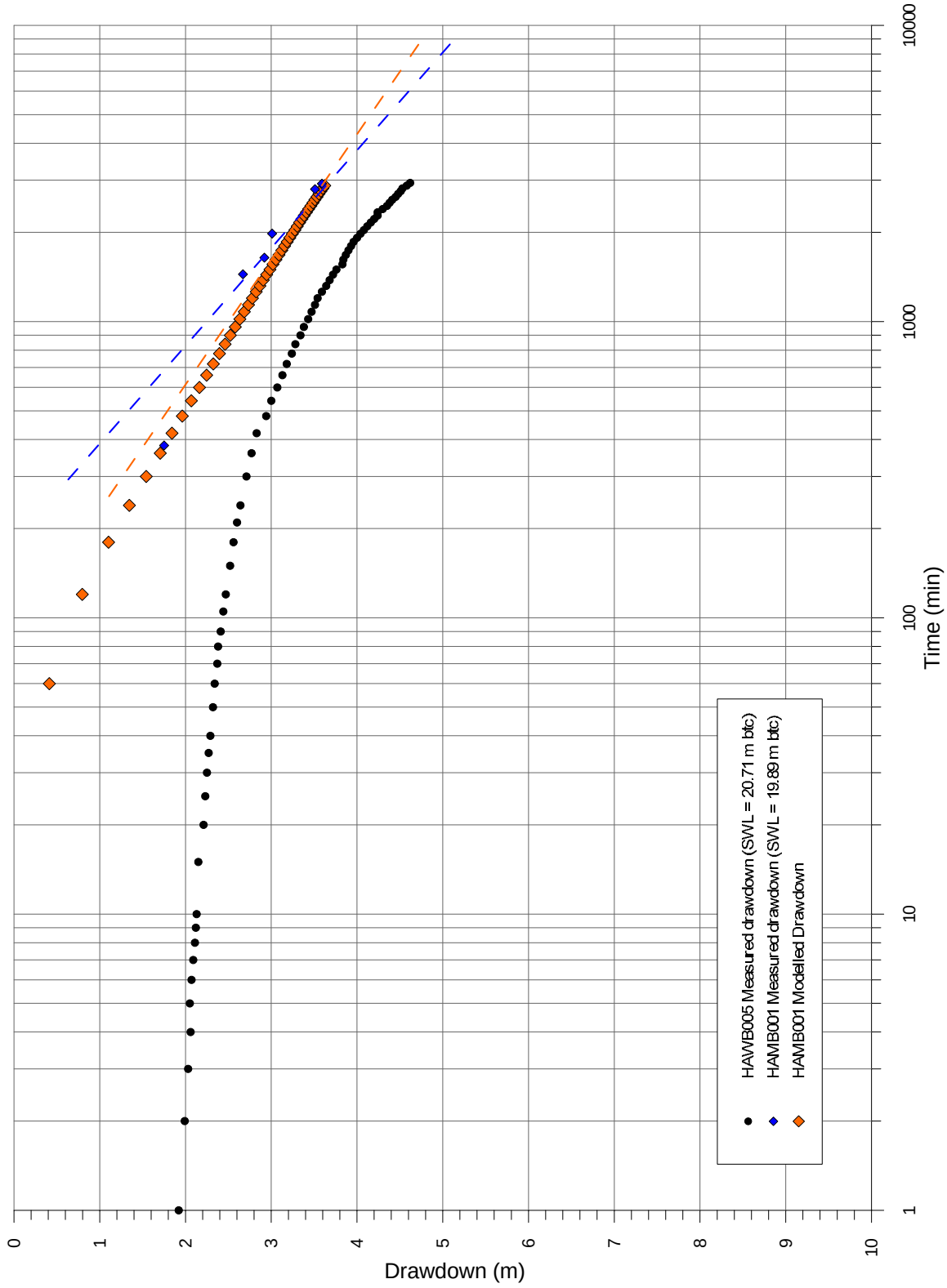
Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-28

HAWB004
Measured vs. Modelled drawdown after 48 hours of pumping



371-0/Grapher/11-003/Gwtr Model/Fig 29 DD Comparison measured vs modelled HAWB05.grf

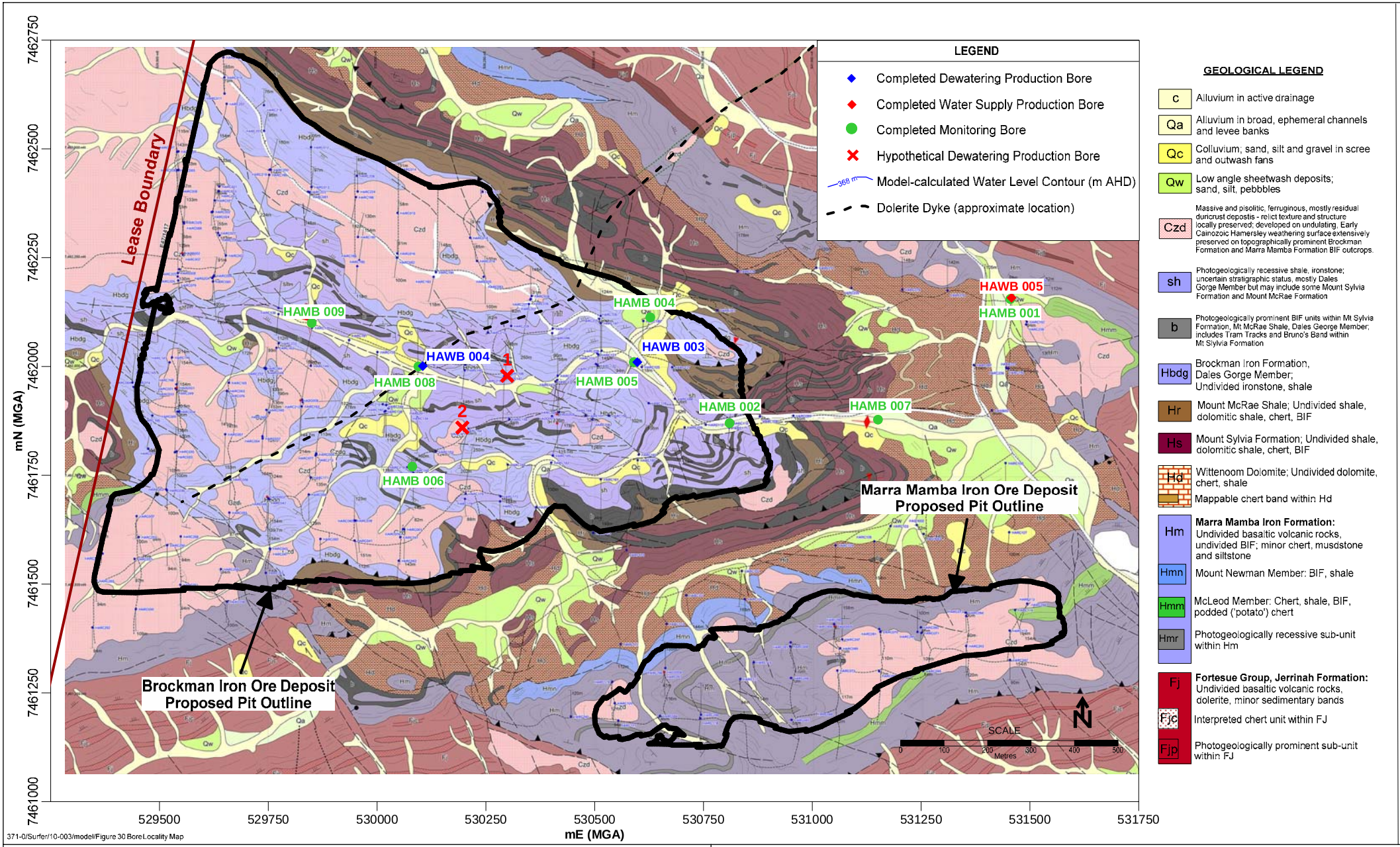
Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-29

HAWB005
Measured vs. Modelled drawdown after 48 hours of pumping



CLIENT: API Management Pty Ltd

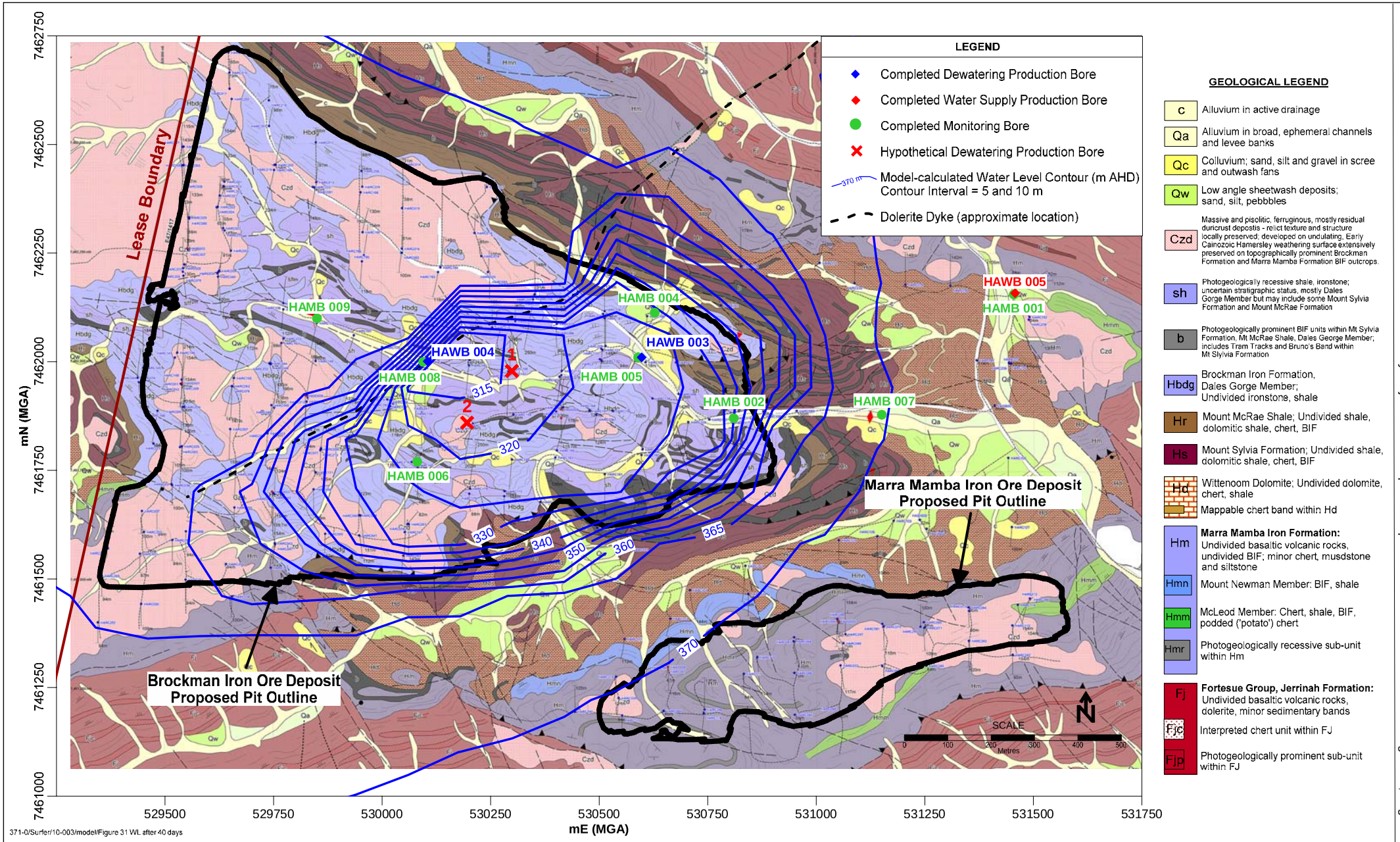
PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-30

DEWATERING BORE LOCALITY MAP

Rockwater



CLIENT: API Management Pty Ltd

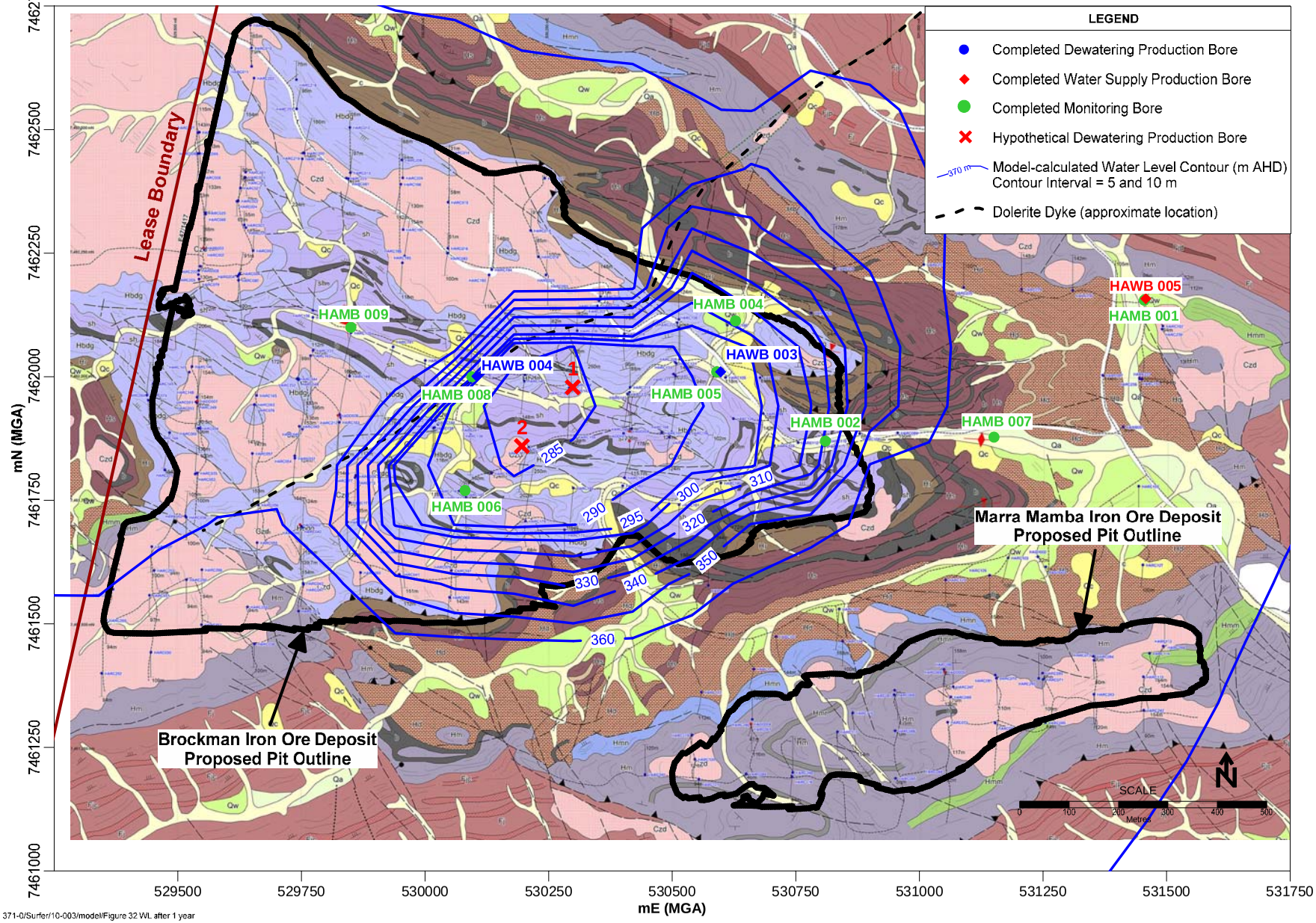
PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-31

MODELLED WATER LEVELS (m AHD) AFTER 40 DAYS OF DEWATERING

Rockwater



371-0/Surfer/10-003/model/Figure 32 WL after 1 year

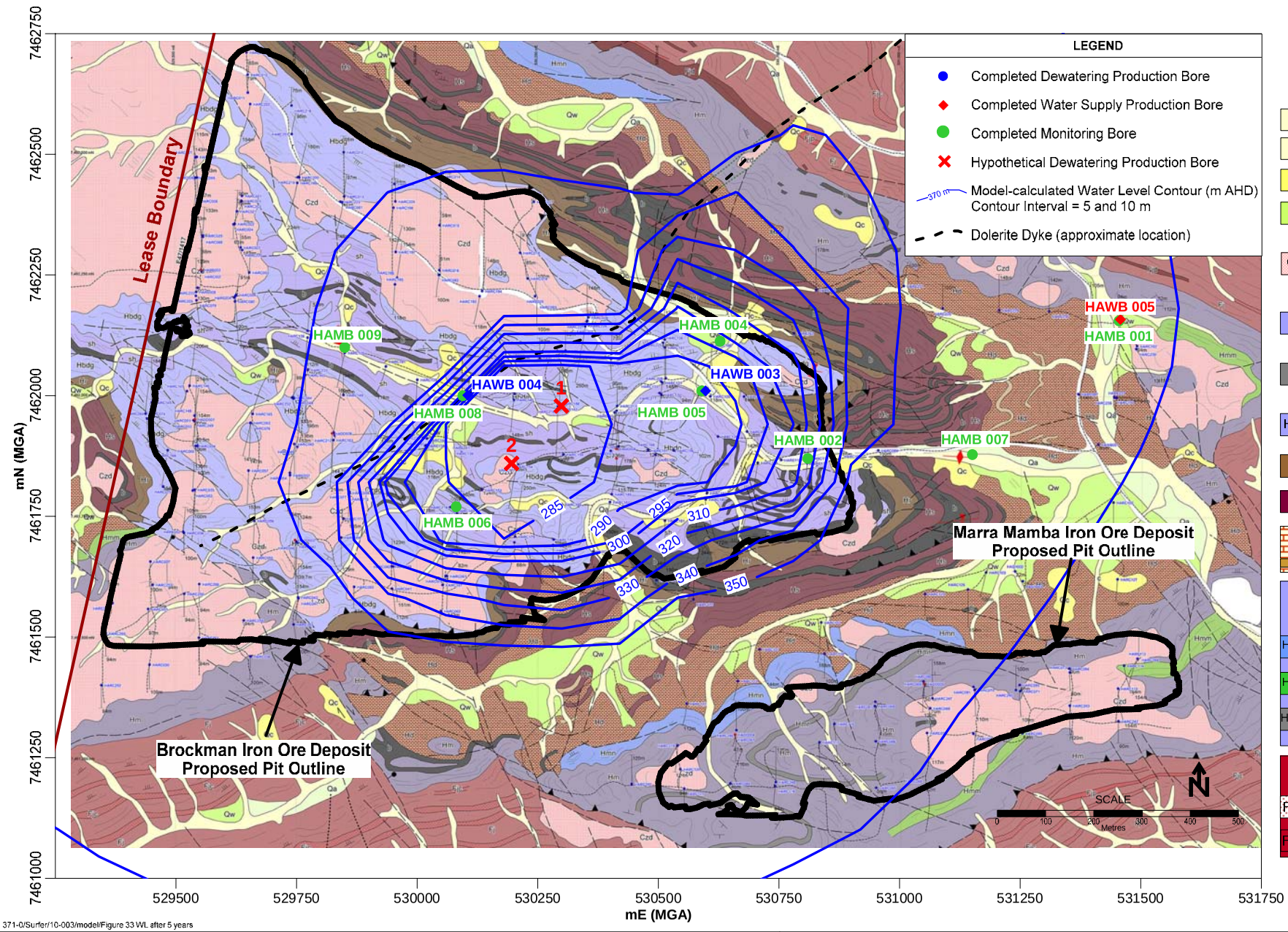
GEOLOGICAL LEGEND

- c — Alluvium in active drainage
- Qa — Alluvium in broad, ephemeral channels and levee banks
- Qc — Colluvium; sand, silt and gravel in scree and outwash fans
- Qw — Low angle sheetwash deposits; sand, silt, pebbbles
- Czd — Massive and pisolitic, ferruginous, mostly residual duricrust depostis - relict texture and structure locally preserved; developed on undulating, Early Cainozoic Hamersley weathering surface extensively preserved on topographically prominent Brockman Formation and Marra Mamba Formation BIF outcrops.
- sh — Photogeologically recessive shale, ironstone; uncertain stratigraphic status, mostly Dales Gorge Member but may include some Mount Sylvia Formation and Mount McRae Formation
- b — Photogeologically prominent BIF units within Mt Sylvia Formation, Mt McRae Shale, Dales George Member; includes Tram Tracks and Bruno's Band within Mt Slylvia Formation
- Hbdg — Brockman Iron Formation, Dales Gorge Member; Undivided ironstone, shale
- Hr — Mount McRae Shale; Undivided shale, dolomitic shale, chert, BIF
- Hs — Mount Sylvia Formation; Undivided shale, dolomitic shale, chert, BIF
- Hd — Wittenoom Dolomite; Undivided dolomite, chert, shale
  - Mappable chert band within Hd
- Hm — **Marra Mamba Iron Formation:** Undivided basaltic volcanic rocks, undivided BIF; minor chert, musdstone and siltstone
- Hmn — Mount Newman Member: BIF, shale
- Hmm — McLeod Member: Chert, shale, BIF, podded ('potato') chert
- Hmr — Photogeologically recessive sub-unit within Hm
- Fj — **Fortesue Group, Jerrinah Formation:** Undivided basaltic volcanic rocks, dolerite, minor sedimentary bands
- Fjc — Interpreted chert unit within FJ
- Fjp — Photogeologically prominent sub-unit within FJ

CLIENT:	API Management Pty Ltd
PROJECT:	Hardey Project Dewatering and Water Supply
DATE:	August 2011
Dwg. No:	371-0/11/02-32

MODELLED WATER LEVELS (m AHD) AFTER 1 YEAR (360 DAYS) OF DEWATERING

Rockwater



371-0/Surfer/10-003/model/Figure 33 WL after 5 years

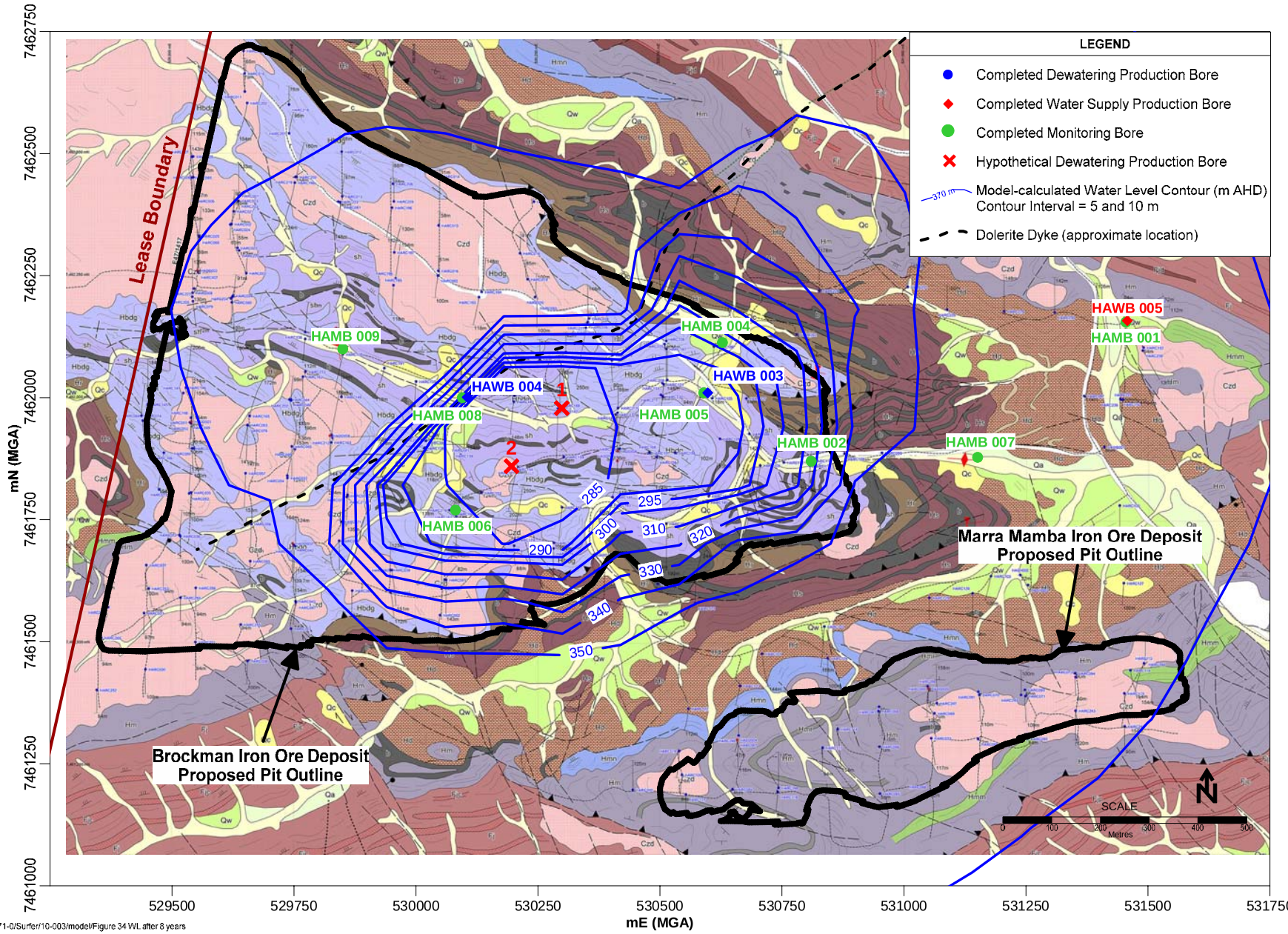
GEOLOGICAL LEGEND

- c — Alluvium in active drainage
- Qa — Alluvium in broad, ephemeral channels and levee banks
- Qc — Colluvium; sand, silt and gravel in scree and outwash fans
- Qw — Low angle sheetwash deposits; sand, silt, pebbles
- Czd — Massive and pisolitic, ferruginous, mostly residual duricrust deposits - relict texture and structure locally preserved; developed on undulating, Early Cainozoic Hamersley weathering surface extensively preserved on topographically prominent Brockman Formation and Marra Mamba Formation BIF outcrops.
- sh — Photogeologically recessive shale, ironstone; uncertain stratigraphic status, mostly Dales Gorge Member but may include some Mount Sylvia Formation and Mount McRae Formation
- b — Photogeologically prominent BIF units within Mt Sylvia Formation, Mt McRae Shale, Dales George Member; includes Tram Tracks and Bruno's Band within Mt Sylvia Formation
- Hbdg — Brockman Iron Formation, Dales Gorge Member; Undivided ironstone, shale
- Hr — Mount McRae Shale; Undivided shale, dolomitic shale, chert, BIF
- Hs — Mount Sylvia Formation; Undivided shale, dolomitic shale, chert, BIF
- Hd — Wittenoom Dolomite; Undivided dolomite, chert, shale
  - Mappable chert band within Hd
- Hm — **Marra Mamba Iron Formation:** Undivided basaltic volcanic rocks, undivided BIF; minor chert, musdstone and siltstone
- Hmn — Mount Newman Member: BIF, shale
- Hmm — McLeod Member: Chert, shale, BIF, podded ('potato') chert
- Hmr — Photogeologically recessive sub-unit within Hm
- Fj — **Fortesue Group, Jerrinah Formation:** Undivided basaltic volcanic rocks, dolerite, minor sedimentary bands
- Fjc — Interpreted chert unit within FJ
- Fjp — Photogeologically prominent sub-unit within FJ

CLIENT:	API Management Pty Ltd
PROJECT:	Hardey Project Dewatering and Water Supply
DATE:	August 2011
Dwg. No:	371-0/11/02-33

MODELLED WATER LEVELS (m AHD) AFTER 5 YEARS (1800 DAYS) OF DEWATERING

Rockwater



GEOLOGICAL LEGEND

- c — Alluvium in active drainage
- Qa — Alluvium in broad, ephemeral channels and levee banks
- Qc — Colluvium; sand, silt and gravel in scree and outwash fans
- Qw — Low angle sheetwash deposits; sand, silt, pebbles
- Czd — Massive and pisolitic, ferruginous, mostly residual duricrust deposits - relict texture and structure locally preserved; developed on undulating, Early Cainozoic Hamersley weathering surface extensively preserved on topographically prominent Brockman Formation and Marra Mamba Formation BIF outcrops.
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- b — Photogeologically prominent BIF units within Mt Sylvia Formation, Mt McRae Shale, Dales George Member; includes Tram Tracks and Bruno's Band within Mt Slylvia Formation
- Hbdg — Brockman Iron Formation, Dales Gorge Member; Undivided ironstone, shale
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- Hs — Mount Sylvia Formation; Undivided shale, dolomitic shale, chert, BIF
- Hd — Wittenoom Dolomite; Undivided dolomite, chert, shale
- Mappable chert band within Hd
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- Hmn — Mount Newman Member: BIF, shale
- Hmm — McLeod Member: Chert, shale, BIF, podded ('potato') chert
- Hmr — Photogeologically recessive sub-unit within Hm
- Fj — **Fortesue Group, Jerrinah Formation:** Undivided basaltic volcanic rocks, dolerite, minor sedimentary bands
- Fjc — Interpreted chert unit within FJ
- Fjp — Photogeologically prominent sub-unit within FJ

371-0/Surfer/10-003/model/Figure 34 WL after 8 years

CLIENT: API Management Pty Ltd

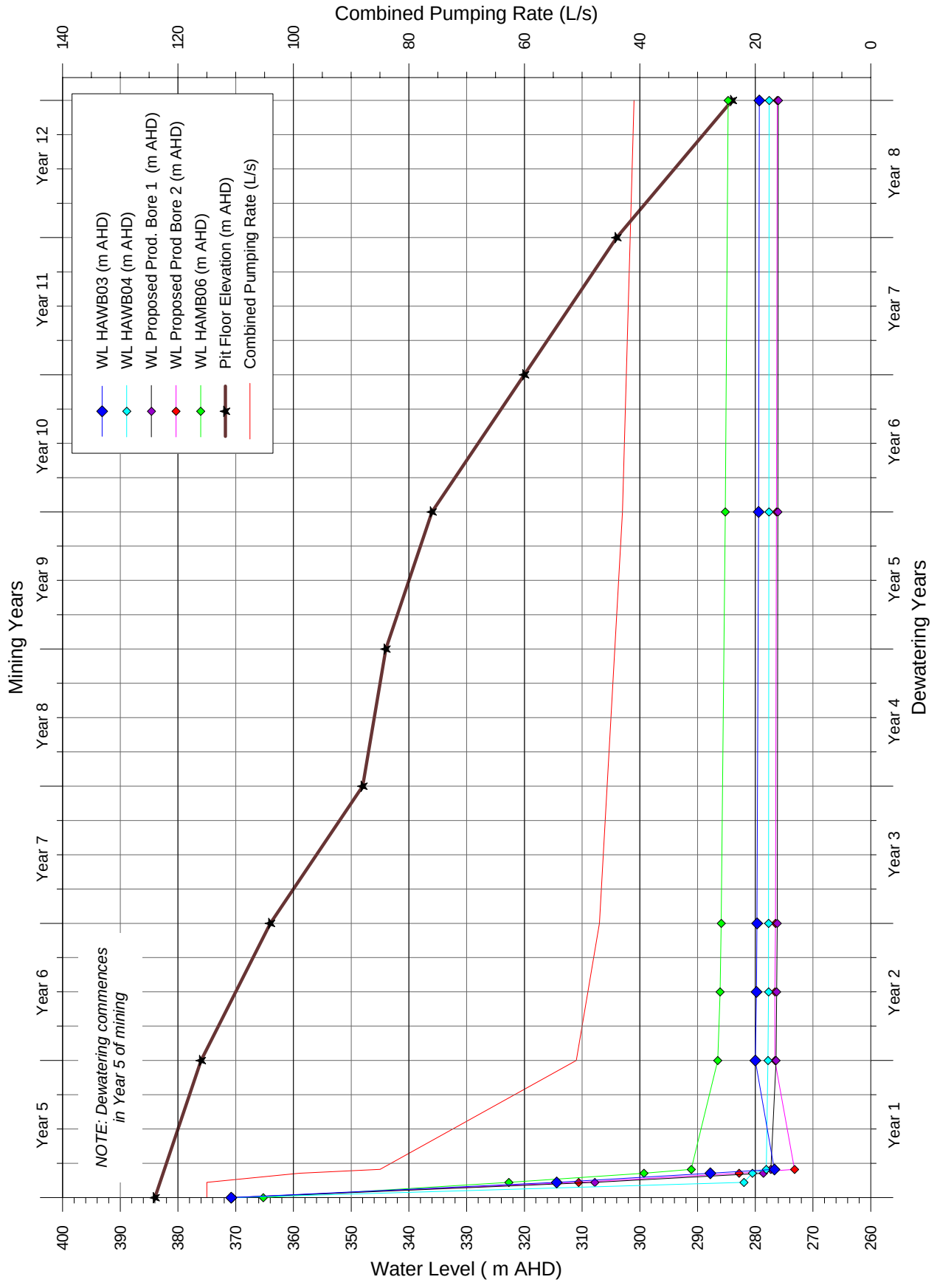
PROJECT: Hardey Project Dewatering and Water Supply

DATE: August 2011

Dwg. No: 371-0/11/02-34

MODELLED WATER LEVELS (m AHD) AFTER 8 YEARS (2880 DAYS) OF DEWATERING

Rockwater



371-0/Grapher/10-003/Gwtr Model/Fig 35 pit floor versus wl .grf

Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371-0/11/02-35

Water Level vs. Pit Floor Elevation with Proposed and Existing Bores

Rockwater

8 DEWATERING STATEGY

Mining at Hardey is scheduled to occur over a twelve year period. To ensure that water levels are lowered ahead of mining operations it will be necessary to conduct a dewatering programme for a period of about 8 years commencing prior to the fifth year of mining operations.

Succesful implementation of the dewatering programme will require the construction of at least two additional production bores; (ie hypothetical bores #1 and #2). Their proposed locations are roughly 530250 mE, 7461955 mN for bore #1 and 530200 m E, 7461855 mN for bore #2. The bores would need to be drilled below the base of the Brockman aquifer, to approximately 260 m AHD. Additional bores may also be needed as contingency to allow for standby dewatering capacity if one or more bores are lost to mining.

It is also anticipated that existing bore HAWB 003 will need to be deepened because adverse ground conditions prevented the casing from being installed below 100 m depth and the proposed pit depth at HAWB 003 will be about 150 m. Alternatively, a replacement bore could be constructed near HAWB 003, depending on the initial results of the dewatering programme.

Based on the results of the test pumping and groundwater modelling, it is likely that most of the 1 GL/annum (32 L/sec) water requirements could be provided from the dewatering infrastructure (bores and in-pit sumps). However, as mining progresses, the dewatering bores will produce less, and bore HAWB 005 will probably need to be commissioned or another source of water investigated. HAWB 005 could supply 20 to 25 L/sec for the short to medium term; the yield will likely decrease in the long term because the aquifer has a limited extent as was observed during the test pumping programme.

9 SUMMARY AND CONCLUSIONS

A drilling, bore construction, and test pumping programme was carried out at the Hardey project during May to July 2010 to assess the hydrogeological conditions of the Brockman Iron Formation deposit and adjacent strata for dewatering and water supply purposes. Nine hydrostratigraphic holes were drilled and constructed as monitoring bores and three large diameter test bores were drilled, constructed, and test pumped. A numerical groundwater model was developed based on the results of the drilling and test-pumping programme to assess the dewatering requirements needed to lower the water table ahead of mining operations.

The following conclusions have been drawn from the investigations:

- Groundwater flow in the deep aquifers is generally from east to west across the Brockman deposit with localised, perched aquifers occurring in the eastern part of the deposit due to shale/clay strata impeding the infiltration of groundwater.

- The Dales Gorge Member of the Brockman Iron Formation, where drilled, was found to be moderately to highly permeable. Estimated yields of individual dewatering bores are 20 to 30 L/sec for short to medium term time frames based on test pumping results from HAWB 003 and HAWB 004.

- The Mt. McRae Shale and Mt. Sylvia shale, which border the Brockman deposit, were found to be low yielding and will therefore likely assist in the dewatering of the Brockman deposit as well as reduce the yields of dewatering bores in the long term as cones of depression spread out laterally and intersects the two units.

- The hydrogeology of the Wittenoom Formation and its hydraulic connection with the Brockman and Marra Mamba deposits are currently not well known.

- Bore HAWB 005, which is screened within the Marra Mamba Formation, should be able to produce 20 to 25 L/sec for short to medium time frames although a limited aquifer extent will likely limit its production in the long term.

- It is anticipated that the eastern part of the proposed pit that will be mined below RL 370 m will need to be dewatered. Water levels will need to be lowered by up to 90 m to the ultimate planned pit depth of about 280 m RL. To achieve this scale of dewatering, in-pit bores will be required.

- A steep change in groundwater levels in the central part of the Brockman deposit is interpreted to be the result of a low permeability NE-SW striking dolerite dyke that forms an aquifer boundary and that impedes groundwater flow to the northwest. This dyke could be an important factor in influencing the extent of drawdown and yield of bores during dewatering operations.

- A numerical groundwater model was constructed to estimate the dewatering requirements needed to lower the water table ahead of mining operations. The model indicates that the existing dewatering bores, HAWB 003 and HAWB 004, and two additional production bores would be sufficient for lowering the water levels ahead of mining operations, assuming pumping commences at the start of year 5 of the proposed mining schedule and based on the current understanding of the hydrogeology of the area. It is predicted that the four bores would cumulatively yield about 115 L/sec during the first 40 days of dewatering programme and that

the yield would decrease to about 50 L/sec after one year of continuous pumping, and the long term yield would be about 40 L/sec. At these pumping rates and after eight years of pumping the total cumulative volume of pumped water is approximately 11.5 GL

- Groundwater samples collected from the project area were of good quality with none of the constituents analysed exceeding the current drinking water guidelines; it is fresh with salinity values ranging from 645 to 818 mg/L total dissolved solids. Groundwater from all aquifers tested at the project have a neutral to slightly alkaline pH and have a bicarbonate rich composition with slightly elevated concentrations of sulphate, chloride and sodium. The water is likely to be of suitable quality for mining, processing, and potable uses.

10 RECOMMENDATIONS

Based on the above conclusions and the general requirements for approvals from government regulators, the following actions are recommended:

- Conduct additional hydrostratigraphic drilling to target the Wittenoom Formation.
- Construct a test production bore in the Wittenoom Formation to assess its permeability and hydraulic connection with the Brockman Iron Formation.
- Conduct additional hydrostratigraphic drilling near the deepest part of the proposed pit and where suitable aquifers are encountered; construct at least two additional dewatering bores.
- Undertake long term pumping tests on any newly constructed bores.
- Analyse data and re-run the numerical model and reassess the dewatering strategy.
- Prepare a final void numerical model to assess water quality and water variations after mining and processing ceases.
- Measure water levels regularly from the newly constructed bores and selected mineral holes to develop a baseline of the seasonal/natural variability in groundwater levels prior to the commencement of mining operations.

Finalised: 01 August 2011 **Rockwater Pty Ltd**

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Drafted: 10 December 2010 **Rockwater Pty Ltd**

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APPENDIX I

MONITORING BORE COMPLETION DATA

COMPLETION DATA
BORE HAMB 001

STATUS:	Monitoring Bore
MGA COORDINATES:	531455 mE 7462155 mN
REDUCED LEVEL OF COLLAR:	393.21m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	30/05/10 to 31 /05/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 132 m, 167 mm air-hammer
SURFACE CASING:	+0.6 to 0.5 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.7 to 89 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 17 to 23 m, 29 to 35 m, 41 to 53 m, 59 to 65 m, 71 to 77 m, and 83 to 89 m.
BASE PLATE:	89 m uPVC base cap
GRAVEL PACK:	+3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (4 June 10):	19.75 m below datum (ie top of uPVC casing) 374.15 m above AHD
SALINITY/pH/TEMPERATURE:	690 mg/L TDS/ pH 7.4 /Temperature 29.0°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
42	2.5	1,350	27.8	675	7.4	
48	4	1,361	28.7	680	7.4	
54	6	--	--		--	
66	10	1,370	--	685	7.4	
108	12+	1,346	29.6	673	7.4	
120	12+	1,379	29.0	689	7.4	
132	12+	1,380	--	690	7.4	

BORE HAMB 001 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 2	Alluvium (otr)	Gravel (Otr)	Orange brown, poorly sorted, well rounded river sediments; BIF, chert, dolerite
2 to 6	Marra Mamba Iron Formation	Goethite-Hematite (Mgh)	Orange brown, BIF, goethite, with common shale and clay; moderately to very weathered
6 to 30		Geothite-Hematite (Mgh)	Reddish brown goethite and BIF, with shale and clay; moderately to very weathered and broken.
30 to 42		Clay (Ocl)	Dark yellow brown clay with common goethite-hematite
42 to 102		Geothite- Hematite (Mgh) / Shale (Ssh)	Dark yellow brown and very dark grey BIF and goethite, very broken with common vuggy zones; yellow brown weakly lithified shale; quartz vein 98 to 99 m
102 to 132		Shale (Ssh) / Geothite – Hematite (Mgh)	Dark yellow brown and black (carbonaceous) shale with common very dark grey and dark yellow brown BIF and goethite

COMPLETION DATA
BORE HAMB 002

STATUS:	Monitoring Bore
MGA COORDINATES:	530810 mE 7461870 mN
REDUCED LEVEL OF COLLAR:	394.84 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	20/05/10 to 21/05/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 179 m, 167 mm air-hammer
SURFACE CASING:	+0.83 to 0.27 m, 154 mm ID, 168 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.60 to 178.5 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 58.5 to 64.5 m, 76.5 to 82.5 m, 94.5 to 100.5 m, 148.5 to 154.5 m, and 166.5 to 178.5 m.
BASE PLATE:	178.5 m uPVC base cap
GRAVEL PACK:	+3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (28 June 10):	24.61 m below datum (ie top of uPVC casing) 370.79 m above AHD
SALINITY/pH/TEMPERATURE	820 mg/L TDS/ pH 7.6 /Temperature °C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
48 to 50						moist
54	trace					cut water
66	~1					
72	1.8					
78	2.9					
84	3.3					
96	3.8					
114	4.9					
150	6.9					
156	8.5					
162	~9.0					
168	9.3					
174	10.2					
179	9.3	1,280	18.1	820	7.6	Very clean and clear

BORE HAMB 002 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 3	Alluvium (otr)	Gravel (Otr)	Brown grey, very poorly sorted, juvenile river sediments, fine grained sand to large pebbles
3 to 8	Brockman Iron Formation – Dales Gorge Member (Hbd)	Goethite-Hematite (Mgh)	Brown grey, weathered, weakly fractured.
8 to 10		Hematite (Mhe)	Dark grey, minor chert, moderately consolidated.
10 to 12		Goethite-Hematite (Mgh)	Mid to dark brown, dark grey, weakly lithified.
12 to 14		Hematite (Mhe)	Dark grey, minor chert, moderately consolidated.
14 to 18		Goethite-Hematite (Mgh)	Mid to dark brown, dark grey, weakly lithified.
18 to 24		Hematite (Mhe)	Dark grey, weakly lithified.
24 to 31		Goethite-Hematite (Mgh)	Mid to dark brown, dark grey, weakly lithified.
31 to 36		Hematite (Mhe)	Dark grey, fractured, weakly lithified.
36 to 40		Goethite-Hematite (Mgh)	Mid to dark brown, dark grey, weakly lithified.
40 to 43		Goethite (Mgo)	Dark brown, weakly lithified.
43 to 52		Goethite-Hematite (Mgh)	Mid to dark brown, dark grey, weakly lithified.
52 to 54		Shale (Ssh)	Red brown, hematitic, fissile, weakly lithified.
54 to 56		Chert/BIF (Siy)	Brown, cream, grey, fractured.
56 to 58		Goethite (Ssh)	Red brown, argillaceous, very weakly lithified.
58 to 72		Chert/BIF (Siy)	Brown, cream, grey, fractured, moderately consolidated.
72 to 81		Goethite-Hematite (Mgh)	Mid to dark brown, dark grey, partly vuggy, minor BIF, weakly lithified.
81 to 108	Mount McRae Shale (Hr)	Shale (Ssh)	Yellow brown, cream, ochre, oxidised, fissile, minor thin beds ironstone, weakly lithified.
108 to 112		Goethite-Hematite (Mgh)	Brown, dark grey, minor vughs, fractured, weakly lithified.
112 to 120		Shale (Ssh)	Yellow brown, cream, pink, oxidised, minor interbedded mineralised iron beds (Mif).
120 to 128		Chert/BIF (Siy)	Grey brown, hard.
128 to 148		Shale (Ssh)	Pale grey, yellow brown, oxidised, fissile, minor thin beds ironstone, weakly lithified.
148 to 150		Shale (Ssh)	Purple brown, hematitic, fissile, weakly lithified.
150 to 158	Mount Silvia Shale (Bruno's Band) (Hbb)	Hematite (Mhe)	Dark grey well fractured, minor BIF, very hard, well consolidated.
158 to 160		Shale (Ssh)	Purple brown, hematitic, fissile, weakly lithified.
160 to 163		Chert (Sic)	Grey brown, well fractured, hard.
163 to 167	Mount Silvia Shale (Hs)	Shale (Ssh)	Purple brown, hematitic, fissile, weakly lithified.
167 to 172		Shale (Ssh)	Yellow brown, grey, fissile, weakly lithified.
172 to 176		Chert (Sic)	Dark grey, hard minor shale, weakly cemented.
176 to 179		Shale (Ssh)	Pale grey, dolomitised, hard

COMPLETION DATA
BORE HAMB 003

STATUS:	Monitoring Bore
MGA COORDINATES:	531833 mE 741516 mN
REDUCED LEVEL OF COLLAR:	385.3 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	1/06/10 to 1/06/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 20 m, 167 mm air-hammer
SURFACE CASING:	+0.6 to 0.5 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.7 to 17 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 11 to 7 m.
BASE PLATE:	17 m uPVC base cap
GRAVEL PACK:	drill cuttings
STATIC WATER LEVEL (4 June 10):	12.70 m below datum (ie top of uPVC casing) 373.3 m above AHD
SALINITY/pH/TEMPERATURE:	590 mg/L TDS/ pH 8.0 /Temperature 28.4°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
12	cut water					
20	3-4	1186	28.4	590	8.0	

BORE HAMB 003 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 4	Alluvium	Alluvium (Oal)	Reddish brown, poorly sorted, sand to gravel size, well rounded BIF, dolerite, shale
4 to 6	Alluvium?	Calcrete?	Light yellow brown and cream, calcareous (very strong reaction to acid), soft
6 to 20	Jeerinah Formation	Chert (Sic) / Dolerite (Bdl)	Medium yellow brown, bluish green, and medium grey, slightly clayey, very broken, rubbly

COMPLETION DATA
BORE HAMB 004

STATUS:	Monitoring Bore
MGA COORDINATES:	530628 mE 7462113 mN
REDUCED LEVEL OF COLLAR:	397.99 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	1/06/10 to 3/06/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 156 m, 167 mm air-hammer
SURFACE CASING:	+0.98 to 0.12 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.87 to 107.8 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 59.8 to 107.8 m.
BASE PLATE:	107.8 m uPVC base cap
GRAVEL PACK:	none
STATIC WATER LEVEL (27 June 10):	30.77 m below datum (ie top of uPVC casing) 371.13 m above AHD
SALINITY/pH/TEMPERATURE:	775 mg/L TDS/ pH 7.4/ Temperature 30.1°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
114	cut water					very muddy
120	~1					very muddy
126	~1					very muddy
132	~1					very muddy
138	~2	1,460	29.0	700	7.1	
150	~3	1,485	29.3	710	7.1	
156	~3	1,620	30.1	775	7.4	

BORE HAMB 004 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 2	Alluvium	Alluvium (Oal)	Reddish brown, poorly sorted sand and gravel; BIF, chert, and shale
2 to 14	Brockman Iron Formation – Dales Gorge Member (Hbd)	Banded Iron Formation (Sif)	Reddish brown BIF, slightly clayey; weakly lithified
14 to 20		Shale (Ssh)	Yellow brown, very weathered
20 to 30		Goethite-Hematite (Mgh)	Reddish brown and medium yellow brown, weakly lithified
30 to 36	Mount McRae Shale (Hr)	Shale (Ssh)	Purple, reddish brown shale with common BIF
36 to 96		Shale (Ssh)	Yellow brown, light grey, reddish brown shale with minor BIF
96 to 120		Shale (Ssh)	Black carbonaceous shale, very weakly lithified
120 to 156		Shale (Ssh)	Black carbonaceous shale, very weakly lithified, with abundant pyrite nodules

COMPLETION DATA
BORE HAMB 005

STATUS:	Monitoring Bore
MGA COORDINATES:	530590 mE 7462010 mN
REDUCED LEVEL OF COLLAR:	397 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	22/05/10 to 24 /05/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 132 m, 167 mm air-hammer
SURFACE CASING:	+1.03 to 0.07 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.91 to 71.5 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 17.5 to 23.5 m, 29.5 to 35.5 m, and 41.5 to 71.5 m.
BASE PLATE:	71.5 m uPVC base cap
GRAVEL PACK:	+3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (28 June 10):	28.22 m below datum (ie top of uPVC casing) 369.68 m above AHD
SALINITY/pH/TEMPERATURE:	575 mg/L TDS/ pH 7.4 /Temperature 30.3°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
36	Trace					
60	0.3					
66	1.5					
72	1.5	1,070	26.3		7.4	
78	1.8	1,145	29.3		7.4	
84	2	1,070	28.6		7.4	
90	3	1,100	28.9		7.4	
96	3.5					
102	--					
108	6	1,158	29.8		7.4	
114	8					
120	10	1,210	30.2		7.4	
126	10	1,225	29.9		7.4	
132	10	1,233	30.3		7.4	

BORE HAMB 005 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 2	Alluvium (otr)	Gravel (Otr)	Maroon and yellow brown, juvenile river gravels, poorly sorted fine sand to gravel, well rounded
2 to 20	Brockman Iron Formation – Dales Gorge Member (Hbd)	Goethite-Hematite (Mgh)	Dark yellowish brown and dark grey, broken and occasionally vuggy
20 to 28		Goethite-Hematite (Mgh)	Dark yellowish brown and maroon; silt to medium sand size cuttings
28 to 66		Goethite-Hematite (Mgh)	Dark yellowish brown and dark grey, broken and occasionally vuggy
66 to 114		Hematite (Mhe)	Dark grey, occasional goethite
114 to 132		Hematite (Mhe)	Dark grey, common clear/light grey chert, fresh and hard; occasional maroon/cream shale

COMPLETION DATA
BORE HAMB 006

STATUS:	Monitoring Bore
MGA COORDINATES:	530081 mE 7461770 mN
REDUCED LEVEL OF COLLAR:	431.09 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	4/06/10 to 6/06/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 98 m, 167 mm air-hammer
SURFACE CASING:	+0.65 to 0.45 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.6 to 73.7 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 55.7 to 73.7 m.
BASE PLATE:	73.7 m uPVC base cap
GRAVEL PACK:	none
STATIC WATER LEVEL (27 June 10):	61.89 m below datum (ie top of uPVC casing) 369.81 m above AHD
SALINITY/pH/TEMPERATURE:	515 mg/L TDS/ pH 7.1/ Temperature 25.9°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
64	cut water					
72 to 98	lost circulation, poor return to surface, only trace mud					

BORE HAMB 006 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 6	Brockman Iron Formation – Dales Gorge Member (Hbd)	Banded Iron Formation (Sif)	Reddish brown and dark grey, hematite with minor goethite and shale
6 to 18		Goethite-Hematite (Mgh)	Maroon and grey hematite, weakly lithified
18 to 32		Goethite (Mgo)	Orange brown, weakly lithified, minor shale
32 to 42		Goethite-Hematite (Mgh)	Maroon and grey hematite with orange brown goethite, weakly lithified
42 to 54		Goethite-Hematite (Mgh)	Maroon and grey hematite with orange brown goethite and minor red shale, weakly lithified
54 to 98		Goethite-Hematite (Mgh)	Maroon and grey hematite with orange brown goethite and minor red shale, vuggy and very broken

COMPLETION DATA
BORE HAMB 007

STATUS:	Monitoring Bore
MGA COORDINATES:	531151 mE 7461878 mN
REDUCED LEVEL OF COLLAR:	392 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	6/06/10 to 7/06/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 132 m, 167 mm air-hammer
SURFACE CASING:	+0.6 to 0.5 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.4 to 131.2 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 35.2 to 41.2 and 113.2 to 131.2 m.
BASE PLATE:	131.2 m uPVC base cap
GRAVEL PACK:	none
STATIC WATER LEVEL (27 June 10):	21.8 m below datum (ie top of uPVC casing) 370.6 m above AHD
SALINITY/pH/TEMPERATURE:	575 mg/L TDS/ pH 7.1/ Temperature 29.4°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
36	2	1,760	29.3	880	7.1	
42	2					
48	2					
54	2.5	1,378	29.0	689	7.1	
60	2.5					
66	2.5	1,306	28.9	653	7.1	
72	3	1,261	29.0	630	7.1	
78	3					
84	3	1,150	29.1	575	7.1	
90	3	1,215	28.5	607	7.1	
96	3					
114	3	1,130	29.2	565	7.1	
120	3					
126	3					
132	3	1,137	29.6	568	7.1	

BORE HAMB 007 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 4	Mount Sylvia Formation (Hs)	Alluvium	Orange brown, poorly sorted, clay to gravel size, BIF, shale
4 to 16		Shale (Ssh)	Cream and light grey, weakly lithified.
16 to 34		Shale (Ssh)	Very dark grey to black, carbonaceous, weakly lithified.
34 to 48		Shale (Ssh)	Dark reddish brown and very dark grey, moderately to well lithified, occasional white and light grey quartz - dyke?
48 to 64		Shale (Ssh)	Light greenish grey, weakly lithified, common pyrite from 62-64 m.
64 to 90		Shale (Ssh)	Very dark grey to black, carbonaceous, weakly lithified, common pyrite at 70-72 and 76-78 m
90 to 111		Shale (Ssh)	Light greenish grey, weakly lithified.
111 to 132		Shale (Ssh)	Very dark grey to black, carbonaceous, weakly lithified.

COMPLETION DATA
BORE HAMB 008

STATUS:	Monitoring Bore
MGA COORDINATES:	530095 mE 7462000 mN
REDUCED LEVEL OF COLLAR:	407.21 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	27/05/10 to 29 /05/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 145 m, 167 mm air-hammer
SURFACE CASING:	+0.99 to 0.11 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.7 to 143 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 77 to 83 m, 89 to 95 m, 101 to 119 m, and 125 to 143 m.
BASE PLATE:	143 m uPVC base cap
GRAVEL PACK:	+3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (26 June 10):	38.18 m below datum (ie top of uPVC casing) 369.72 m above AHD
SALINITY/pH/TEMPERATURE:	557 mg/L TDS/ pH 6.8 /Temperature 29.2°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
84	~2-3					
90	3.4					
96	6	1,126	27.2	563	6.8	
102	6	1,119	27.7	559	6.8	
108	6.5	1,125	28.0	562	6.8	
114	8	1,118	28.1	559	6.8	
120	10					
126	10	1,120	28.2	560	6.8	
132	10+					
138	10+					
144	10+	1,115	29.2	557	6.8	

BORE HAMB 008 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 2	Alluvium (otr)	Gravel (Otr)	Maroon, BIF, poorly sorted sand to gravel, common clay
2 to 4	Brockman Iron Formation – Mount Whaleback Member (Hbw)	Shale (Ssh)	Yellow brown, clayey
4 to 12		Goethite-Hematite (Mgh)	Dark yellow brown and maroon with common shale
12 to 66		Shale (Ssh)	Cream, yellow brown, light to medium brown, common goethite and hematite, very broken and vuggy
66 to 132	Brockman Iron Formation – Dales Gorge Member (Hbd)	Goethite-Hematite (Mgh)	Dark grey and yellow brown, common breaks and vuggy; common chert 112-116 m and common shale 116 to 120 m.
132 to 145		Hematite (Mhe)	Very dark grey, hard, occasional shale

COMPLETION DATA
BORE HAMB 009

STATUS:	Monitoring Bore
MGA COORDINATES:	529850 mE 7462100 mN
REDUCED LEVEL OF COLLAR:	410.79 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	25/05/10 to 27 /05/10
DRILLING DETAILS:	0 to 6 m, 254 mm air-hammer 6 to 154 m, 167 mm air-hammer
SURFACE CASING:	+0.88 to 0.22 m, 156 mm ID, 165 mm OD, galvanised steel standpipe with lockable lid.
CASING:	+0.5 to 152 m, 79 mm ID, 90 mm OD, class 12 uPVC, 3 mm aperture, transverse slotted sections: 98 to 152 m.
BASE PLATE:	152 m uPVC base cap
GRAVEL PACK:	+3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (28 June 10):	46.95 m below datum (ie top of uPVC casing) 364.35 m above AHD
SALINITY/pH/TEMPERATURE:	475 mg/L TDS/ pH 7.1 /Temperature 29.3°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
108	~1					
114	~2					
120	5	940	28.0	470	7.1	
126	5.5	933	27.4	466	7.1	
132	5.5	937	27.8	468	7.1	
138	6.8	932	30.3	466	7.1	
144	7.8	946	29.6	473	7.1	
150	7.3	961	29.1	480	7.1	
154	7.3	953	29.3	476	7.1	

BORE HAMB 009 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 6	Alluvium (otr)	Gravel (Otr)	Yellow brown, goethite, BIF, white quartz, shale; poorly sorted juvenile river gravels
6 to 8	Brockman Iron Formation – Mount Whaleback Member (Hbw)	Quartz intrusion (qz)	White, hard and fresh
8 to 10		Shale (Ssh)	Yellow brown, soft, with common BIF
10 to 12		Clay (cl)	Maroon, sticky
12 to 16		Shale (Ssh)	Yellow brown, soft, with common BIF and slightly clayey
16 to 26		Shale (Ssh)	Yellow brown, soft, with common BIF and white quartz at 24 to 26 m.
26 to 28		Banded Iron Formation (Sif)	Dark orange brown, weakly lithified
28 to 34		Shale (Ssh)	Marron and yellow brown, soft, with common BIF
34 to 44		Shale (Ssh) / Chert (Sic)	Marron, soft, with common BIF and chert
44 to 46		Banded Iron Formation (Sif)	Dark orange brown, weakly lithified
46 to 52		Chert (Sic) / Shale (Ssh)	Light to medium orange brown, weakly lithified
52 to 62		Shale (Ssh)	Medium to dark orange brown, slightly clayey, very weakly lithified
62 to 64		Clay (cl)	Orange brown
64 to 66		Shale (Ssh)	Medium to dark orange brown, slightly clayey, very weakly lithified
66 to 70	Brockman Iron Formation – Dales Gorge Member (Hbd)	Banded Iron Formation (Sif)	Reddish brown BIF with occasional yellow brown shale
70 to 76		Cherty Banded Iron Formation (Siy)	Reddish brown BIF with common chert and occasional yellow brown shale and trace magnetic BIF
76 to 84		Banded Iron Formation (Sif)	Reddish brown BIF with occasional yellow brown shale and magnetic BIF
84 to 86		Clay (cl)	Dark reddish brown
86 to 92		Shale (Ssh)	Reddish brown shale with common BIF and trace magnetic BIF
92 to 110		Chert (Sic) / Banded Iron Formation (Sif)	Reddish brown and yellow brown, finely laminated chert and BIF, occasional shale
110 to 120		Banded Iron Formation (Sif)	Very dark grey and reddish brown with common white quartz and trace shale, chert, and magnetic BIF, common oxidized surfaces 114-120
120 to 138		Banded Iron Formation (Sif) / Hematite (Mhe)	Dark grey to black, common magnetic, occasional shale, increasing magnetic 130 to 138 m; well lithified
138 to 140		Chert (Sic)	Medium brownish grey, broken, oxidized surfaces
140 to 148		Banded Iron Formation (Sif)	Dark grey to black, common magnetic, occasional shale, increasing banding (marron and dark grey); well lithified
148 to 149		Shale (Ssh) / Chert	Yellow brown and orange brown, banded
149 to 154		Banded Iron Formation (Sif)	Dark grey to black, common magnetic, occasional shale, increasing banding (marron and dark grey); well lithified

APPENDIX II

LARGE-DIAMETER TEST BORE COMPLETION DATA

COMPLETION DATA
BORE HAWB 003

STATUS:	Test Production Bore
MGA COORDINATES:	530598 mE 7462010 mN
REDUCED LEVEL OF COLLAR:	397.37 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	08/06/10 to 14 /06/10
DRILLING DETAILS:	0 to 6 m, 380 mm air-hammer 6 to 119 m, 308 mm air-hammer
SURFACE CASING:	0 to 6 m, 316 mm ID, 324 mm OD, steel
CASING:	+0.3 to 58 m, 203 mm ID, 219 mm OD, blank steel casing, 58 m to 100 m, 203 mm ID, 219 mm OD, 3 mm aperture, slotted steel casing, open end
GRAVEL PACK:	Not gravel packed
STATIC WATER LEVEL (26 May 10):	27.75 m below datum (ie top of steel casing) 369.85 m above AHD
SALINITY/pH/TEMPERATURE:	681 mg/L TDS/ pH 6.8 /Temperature 30.8°C

HYDROGEOLOGICAL DATA

Depth (m)	Airlift Rate (L/s)	Electrical Conductivity (µS/cm)	Temperature (ºC)	Total Dissolved Solids (from EC/Temp) (mg/L)	pH	Comments
39	2					
45	1					
51	1.2	1053	23.7		6.8	Foam
57	3	1077	23.8		7.1	Foam
63	5.6	1113	24.6		7.1	Foam
69	6.9	1099	24.9		6.8	Foam
75	4.4	990	26.8		6.8	Foam
81	8.5	1026	27.2		6.8	Foam
87	8	1108	29.6		6.8	Foam
93	~15	-	-		-	No more v-notch, foam
99	~7	1122	29.3		6.8	Foam
105	~8	-	-		-	Foam
111	~10	-	-		-	Foam
117	~11	1237	26.5		7.4	Foam

BORE HAWB 003 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 2	Alluvium (otr)	Gravel (Otr)	Maroon and yellow brown, juvenile river gravels, poorly sorted fine sand to gravel, well rounded
2 to 18	Brockman Iron Formation – Dales Gorge Member (Hbd)	Goethite-Hematite (Mgh)	Dark brown and yellowish brown, majority hematite, occasionally vuggy
18 to 20		Goethite-Hematite (Mgh), Clay (Ocy)	Dark brown and yellowish brown, majority hematite, occasionally vuggy, 30% clay, soft
20 to 34		Goethite-Hematite (Mgh)	Dark brown and yellowish brown, majority hematite, occasionally vuggy
34 to 50		Goethite-Hematite (Mgh)	Dark brown and yellowish brown, majority hematite, occasionally vuggy, broken ground, larger chips
50 to 58		Goethite-Hematite (Mgh)	Dark brown and yellowish brown, majority hematite, occasionally vuggy, ground less broken smaller sized chips
58 to 60		Goethite-Hematite (Mgh)	Dark brown and yellowish brown, majority hematite, occasionally vuggy, broken ground, larger chips
60 to 119		Hematite (Mhe)	Brownish black, with some soft shale bands, very coarse to medium sand sized cutting, finer powdery cuttings from 100 m

COMPLETION DATA
BORE HAWB 004

STATUS:	Test Production Bore
MGA COORDINATES:	530105 mE 7462001 mN
REDUCED LEVEL OF COLLAR:	407.52 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	14/06/10 to 25/06/10
DRILLING DETAILS:	0 to 6 m, 380 mm air-hammer 6 to 150 m, 194 mm mud-rotary roller bit, reamed out to 152.8 m with 311 mm with mud-rotary roller bit
SURFACE CASING:	+0.16 m to 5.84 m, 316 mm ID, 324 mm OD, steel
CASING:	+0.86 m to 89.14 m, 203 mm ID, 219 mm OD, blank steel casing, 89.14 m to 101.14 m, 203 mm ID, 219 mm OD, 3 mm aperture, slotted steel casing, 101.14 m to 107.14 m, 203 mm ID, 219 mm OD, blank steel casing, 107.14 m to 149.14 m, 203 mm ID, 219 mm OD, 3 mm aperture, slotted steel casing, 149.14 m to 150.84 m, cement plug
GRAVEL PACK:	+3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (26 June 10):	38.27 m below datum (ie top of steel casing) 370.03 m above AHD
SALINITY/pH/TEMPERATURE:	632.25 mg/L TDS/ pH 7.2 /Temperature 30.6°C

BORE HAWB 004 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 2	Alluvium (Otr)	Gravel (Otr)	Maroon, BIF, poorly sorted sand to gravel, common clay
2 to 4	Brockman Iron Formation – Dales Gorge Member (Hbd)	Sif	Brownish yellow, highly weathered, ironstone and clay
4 to 8		Goethite-Hematite (Mgh)	Maroon, highly weathered, Sif and clay, very broken
8 to 12		Goethite-Hematite (Mgh)	Brown, Sif and clay, hematite, goethite, weathered, broken
12 to 20		Clay (Ocy) and Goethite-Hematite (Mgh)	Yellow and cream, mostly clay with hematite, goethite, weathered, some shale
20 to 72		Goethite-Hematite (Mgh)	Brown, hematite with some goethite, clay, and some shale, broken, increased clay at 42-48 m, 54-56 m
132 to 152.8		Hematite (Mhe)	Very dark brown/grey, fractured surfaces, broken ground, small amount clay/shale

COMPLETION DATA
BORE HAWB 005

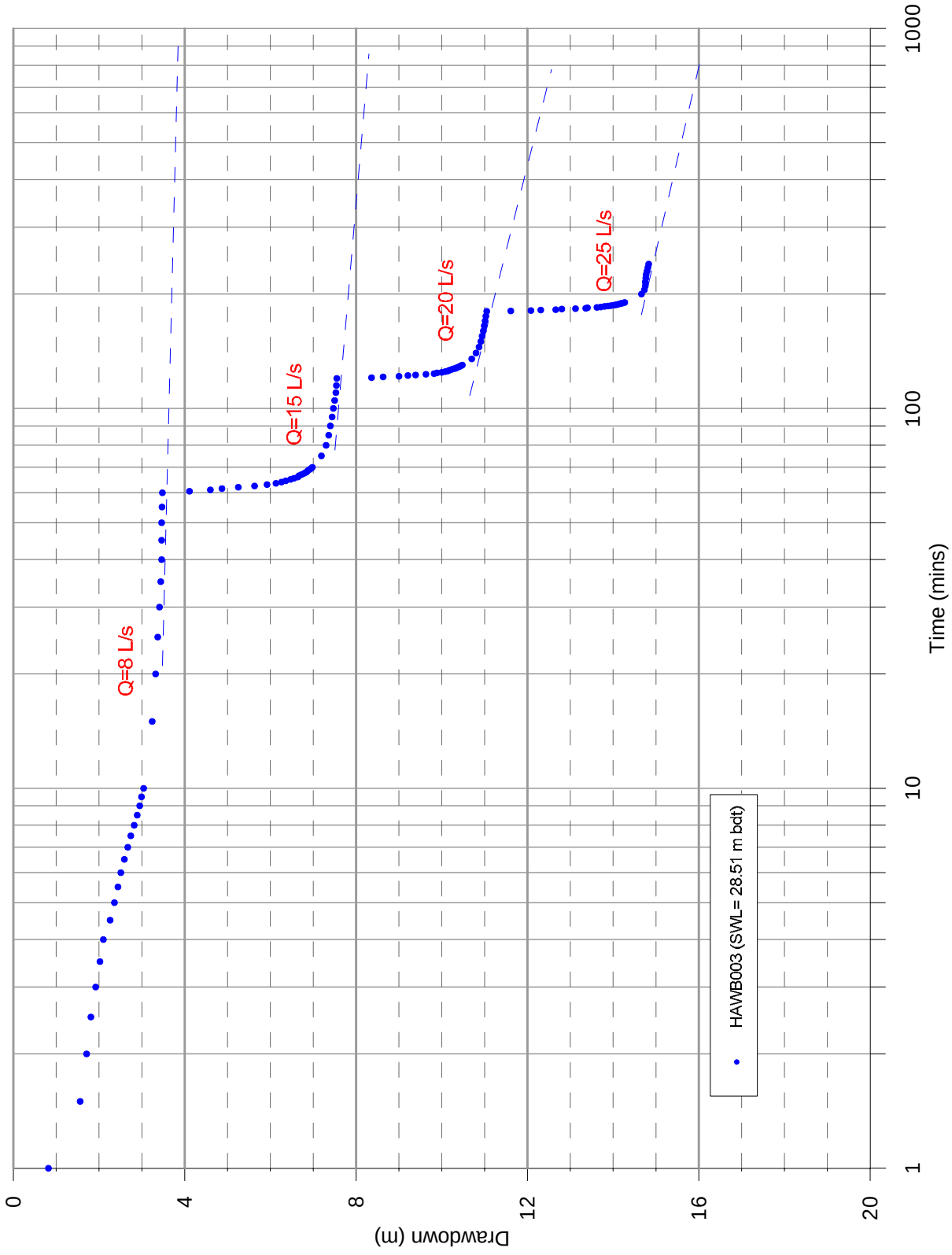
STATUS:	Test Production Bore
MGA COORDINATES:	531458 mE 7462158 mN
REDUCED LEVEL OF COLLAR:	393.57 m AHD
DRILLING CONTRACTOR:	Welldrill
DRILLING RIG:	Fraste FS-500 Rig
DATE CONSTRUCTED:	26/06/10 to 09/07/10
DRILLING DETAILS:	0 to 6 m, 380 mm roller bit 6 to 135 m, 194 mm mud-rotary roller bit, reamed out to 138 m with 311 mm with mud-rotary roller bit
SURFACE CASING:	0.0 m to 6.0 m, 316 mm ID, 324 mm OD, steel
CASING:	+0.84 m to 53.16 m, 203 mm ID, 219 mm OD, blank steel casing, 53.16 m to 77.16 m, 203 mm ID, 219 mm OD, 3 mm aperture, slotted steel casing, 77.16 m to 95.16 m, 203 mm ID, 219 mm OD, blank steel casing, 95.16 m to 113.16 m, 203 mm ID, 219 mm OD, 3 mm aperture, slotted steel casing, 113.16 m to 119.16 m, 203 mm ID, 219 mm OD, blank steel casing, 119.16 m to 131.16 m, 203 mm ID, 219 mm OD, 3 mm aperture, slotted steel casing, 131.16 m to 132.66 m, cement plug
GRAVEL PACK:	6 m to 138 m, +3.2 -6.4 mm diameter, graded quartz
STATIC WATER LEVEL (26 May 10):	20.47 m below datum (ie top of steel casing) 373.93 m above AHD
SALINITY/pH/TEMPERATURE:	1435 uS/cm /pH 7.1 /Temperature 29.9°C

BORE HAWB 005 LITHOLOGY

Depth (m)	Stratigraphy	Lithology	Description
0 to 3	Alluvium (otr)	Gravel (Otr)	Orange brown to blue grey, poorly sorted, rounded to angular, juvenile gravels, river deposit, cherty BIF with minor clay
3 to 8	Marra Mamba Iron Formation	Geothite-Hematite (Mgh)	Dark grey to orange brown, slightly weathered goethite and hematite, cherty BIF with minor clay and quartz
8 to 26		Geothite-Hematite (Mgh)	Orange brown, mod-weathered, goethite and hematite BIF with clay and shale, occasional quartz, some vugs
26 to 82		Geothite-Hematite (Mgh)	Orange brown, mod-weathered, goethite and hematite BIF with clay and some shale, some vugs
82 to 120		Geothite-Hematite (Mgh)	Dark brown/grey, Goethite and Hematite, broken, chert and shale bands, some quartz, quartz vein at 100 m, common vugs
120 to 136 EOH		Shale (Ssh) / Geothite – Hematite (Mgh)	Dark grey/brown soft shale with some laminations, occasional SIF bands

APPENDIX III

STEP-RATE PUMPING TEST PLOTS



I: 371.0\Grapher\Report003\Pumping Tests\HAWB003 Step Test.grf

Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

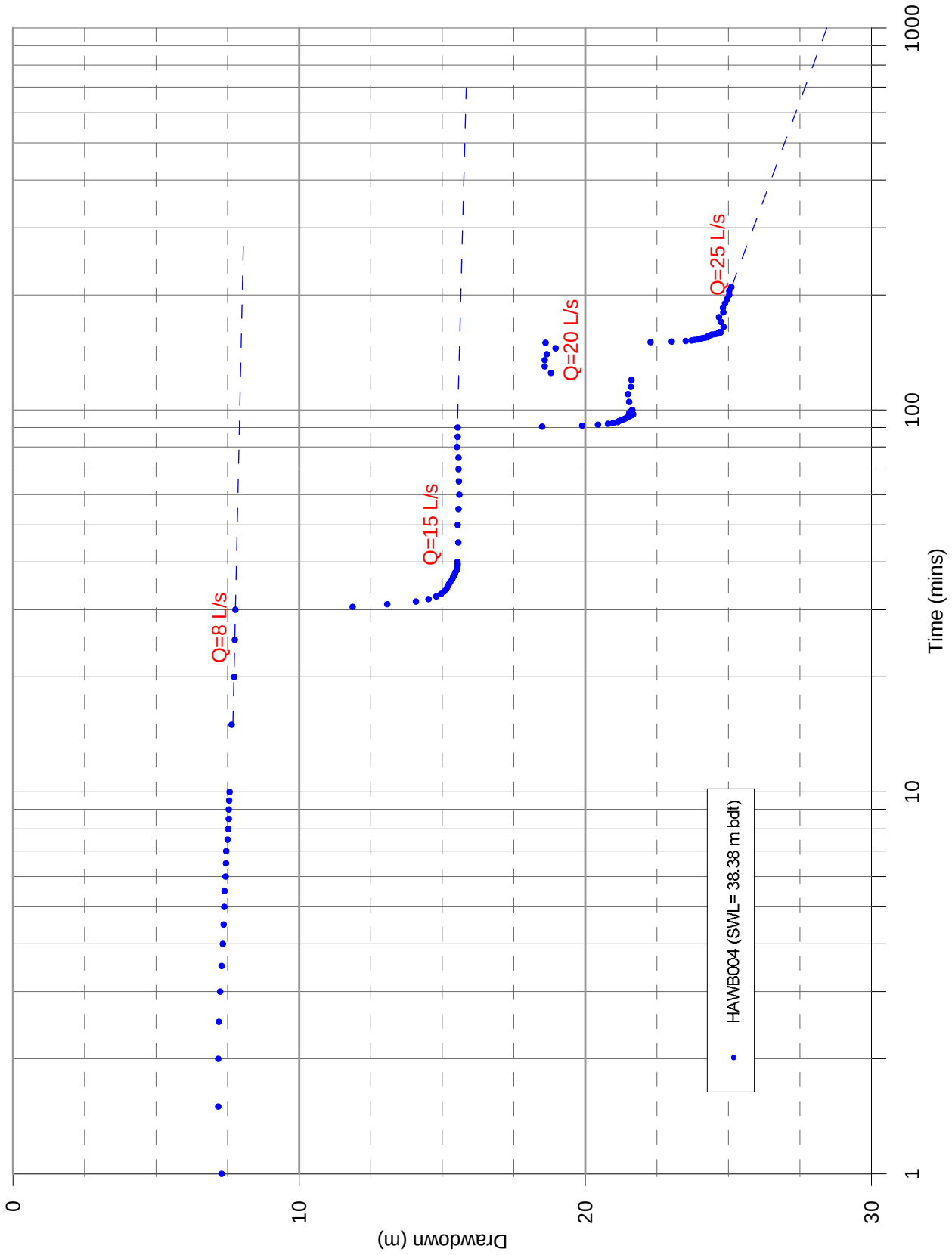
Dwg. No: 371.0/11/02/App III-1

Bore HAWB003 Step Rate Test

Test Started 6:30 15/07/10

Average Pumping Rate = 8, 15, 20, 25 L/s

Rockwater



I: 371.0\Grapher\Report3\Pumping Tests\HAWB004 Step Test.grf

Client: API Management Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

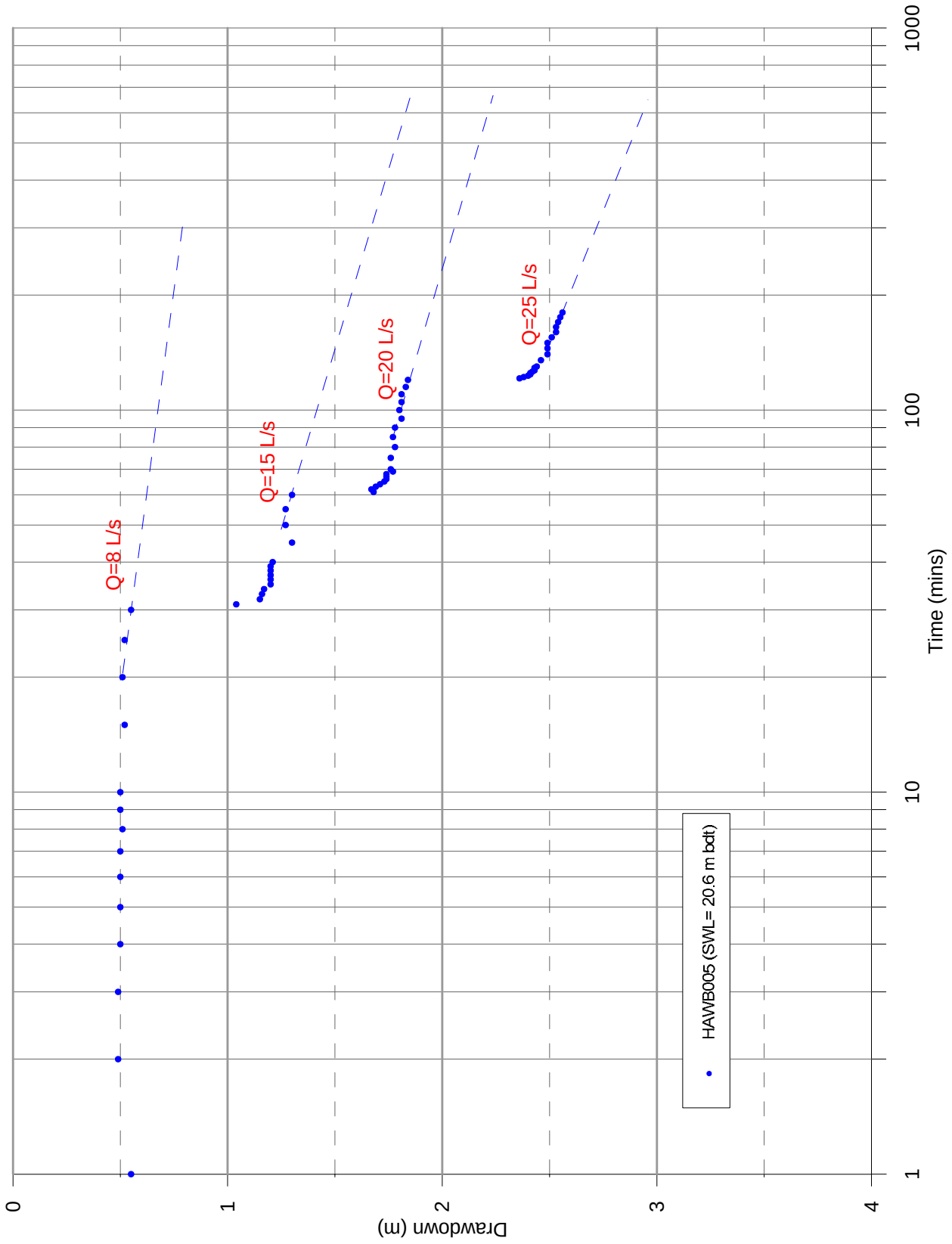
Dwg. No: 371.0/11/02/APPIII-2

Bore HAWB004 Step Rate Test

Test Started 7:10 8/07/10

Average Pumping Rate = 8, 15, 20, 25 L/s

Rockwater



I: 371.0\Data\Pumping Tests\HAWB005\HAWB005 Step Test.grf

Client: API Managment Pty Ltd

Project : Hardey Project Dewatering and Water Supply

Date : August 2011

Dwg. No: 371.0/11/02/App III-3

Bore HAWB005 Step Rate Test

Test Started 14:15 11/07/10

Average Pumping Rate = 8, 15, 20, 25 L/s

Rockwater

APPENDIX IV

WATER QAULITY LABORATORY CERTIFICATES

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP1003809**	Page	: 1 of 5
Client	: **ROCKWATER PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: CONSULT	Contact	: Scott James
Address	: 1ST FLOOR, 76 JERSEY ST WEMBLEY WA, AUSTRALIA 6014	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: consult@rockwater.com.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9284 0222	Telephone	: +61-8-9209 7655
Facsimile	: +61 9284 1785	Facsimile	: +61-8-9209 7600
Project	: HARDEY PROJECT 371 0	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 01-JUL-2010
Sampler	: M.P	Issue Date	: 09-JUL-2010
Site	: ----		
		No. of samples received	: 1
Quote number	: EP-001-09	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrea Vaughan-Taylor	Non-Metallic Instrument Chemist	Perth Inorganics
Ankit Joshi	Inorganic Chemist	Inorganics
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
ChasTucker	Non-metallic Instrument Chemist	Perth Inorganics
Cicelia Bartels	Metals Instrument Chemist	Perth Inorganics
Kim McCabe	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG0035F: Poor matrix spike recovery for Hg due to sample heterogeneity. Confirmed by re-extraction and re-analysis.**
- **LCS recovery for Ammonia fall outside ALS dynamic control limits. However, they are within the acceptance criteria based on ALS DQO. No further action is required.**

Analytical Results

Sub-Matrix: GROUNDWATER				Client sample ID	API-HAWB02	----	----	----	----
				Client sampling date / time	28-JUN-2010 12:10	----	----	----	----
Compound	CAS Number	LOR	Unit		EP1003809-001	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.91**	----	----	----	----
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1100**	----	----	----	----
EA015: Total Dissolved Solids									
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L		**758**	----	----	----	----
EA065: Total Hardness as CaCO3									
^ Total Hardness as CaCO3	----	1	mg/L		**480**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**470**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**470**	----	----	----	----
ED040F: Dissolved Major Anions									
Sulfate as SO4 2-	14808-79-8	1	mg/L		**86**	----	----	----	----
^ Sulfur as S	63705-05-5	1	mg/L		**29**	----	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**73**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**63**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**78**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**93**	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.001**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.006**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG052G: Silica by Discete Analyser									
Reactive Silica	----	0.10	mg/L		**67.3**	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER				Client sample ID	API-HAWB02	----	----	----	----
				Client sampling date / time	28-JUN-2010 12:10	----	----	----	----
Compound	CAS Number	LOR	Unit		EP1003809-001	----	----	----	----
EG055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
^ Nitrate as N	14797-55-8	0.01	mg/L		**4.18**	----	----	----	----
EK059G: NOX as N by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**4.18**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	0.1	mg/L		**4.6**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	----	0.01	mg/L		**0.02**	----	----	----	----
EN055: Ionic Balance									
^ Total Anions	----	0.01	meq/L		**13.2**	----	----	----	----
^ Total Cations	----	0.01	meq/L		**13.6**	----	----	----	----
^ Ionic Balance	----	0.01	%		**1.45**	----	----	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP1004189**	Page	: 1 of 5
Client	: **ROCKWATER PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: DANAE RONEY	Contact	: Scott James
Address	: 1ST FLOOR, 76 JERSEY ST WEMBLEY WA, AUSTRALIA 6014	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: droney@rockwater.com.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9284 0222	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: 371-0 HARDEY S RANGE API	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 19-JUL-2010
Sampler	: ND	Issue Date	: 23-JUL-2010
Site	: ----		
		No. of samples received	: 2
Quote number	: EP-001-09	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

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Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
ChasTucker	Non-metallic Instrument Chemist	Perth Inorganics
Cicelia Bartels	Metals Instrument Chemist	Perth Inorganics
Hillary Kyio	Intrument Operator	Perth Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

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Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: WATER			Client sample ID	HAWB003S	HAWB003F	----	----	----
			Client sampling date / time	16-JUL-2010 08:00	18-JUL-2010 06:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1004189-001	EP1004189-002	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.38**	**7.44**	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1330**	**1320**	----	----	----
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	**709**	**668**	----	----	----
EA065: Total Hardness as CaCO3								
^ Total Hardness as CaCO3	----	1	mg/L	**410**	**417**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**233**	**264**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**233**	**264**	----	----	----
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	**192**	**155**	----	----	----
^ Sulfur as S	63705-05-5	1	mg/L	**64**	**52**	----	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**141**	**140**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**62**	**63**	----	----	----
Magnesium	7439-95-4	1	mg/L	**62**	**63**	----	----	----
Sodium	7440-23-5	1	mg/L	**110**	**113**	----	----	----
Potassium	7440-09-7	1	mg/L	**7**	**8**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.001**	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.004**	**0.002**	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.026**	**0.016**	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG052G: Silica by Discete Analyser								
Reactive Silica	----	0.10	mg/L	**5.40**	**19.9**	----	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: HAWB003S	HAWB003F	----	----	----
				Client sampling date / time: 16-JUL-2010 08:00	18-JUL-2010 06:00	----	----	----
				EP1004189-001	EP1004189-002	----	----	----
EG055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	**0.02**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.75**	**1.01**	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.75**	**1.01**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**0.2**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	0.1	mg/L	**1.0**	**1.2**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.07**	**0.04**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	**0.04**	**0.03**	----	----	----
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	**12.6**	**12.4**	----	----	----
^ Total Cations	----	0.01	meq/L	**13.2**	**13.5**	----	----	----
^ Ionic Balance	----	0.01	%	**2.04**	**3.91**	----	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP1004159**	Page	: 1 of 5
Client	: **ROCKWATER PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: DANAE RONEY	Contact	: Scott James
Address	: 1ST FLOOR, 76 JERSEY ST WEMBLEY WA, AUSTRALIA 6014	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: droney@rockwater.com.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9284 0222	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: 371-0 API HARDEYS RANGE	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 16-JUL-2010
Sampler	: NIKKI DAVEY	Issue Date	: 22-JUL-2010
Site	: ----		
		No. of samples received	: 2
Quote number	: EP-001-09	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
ChasTucker	Non-metallic Instrument Chemist	Perth Inorganics
Cicelia Bartels	Metals Instrument Chemist	Perth Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EK061/67G: LOR for samples raised due to the high amount of NOx present.**

Analytical Results

Sub-Matrix: WATER			Client sample ID	HAWB005S A+B+C	HAWB005F A+B+C	----	----	----
			Client sampling date / time	12-JUL-2010 08:00	14-JUL-2010 06:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1004159-001	EP1004159-002	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.84**	**7.80**	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1460**	**1450**	----	----	----
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	**781**	**818**	----	----	----
EA065: Total Hardness as CaCO3								
^ Total Hardness as CaCO3	----	1	mg/L	**504**	**528**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**467**	**454**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**467**	**454**	----	----	----
ED040F: Dissolved Major Anions								
Sulfate as SO4 2-	14808-79-8	1	mg/L	**126**	**124**	----	----	----
^ Sulfur as S	63705-05-5	1	mg/L	**42**	**41**	----	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**104**	**111**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**58**	**62**	----	----	----
Magnesium	7439-95-4	1	mg/L	**87**	**91**	----	----	----
Sodium	7440-23-5	1	mg/L	**157**	**153**	----	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0007**	**0.0002**	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.013**	**0.002**	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.010**	**0.007**	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG052G: Silica by Discete Analyser								
Reactive Silica	----	0.10	mg/L	**64.1**	**65.8**	----	----	----

Analytical Results

Sub-Matrix: WATER			Client sample ID	HAWB005S A+B+C	HAWB005F A+B+C	----	----	----
			Client sampling date / time	12-JUL-2010 08:00	14-JUL-2010 06:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1004159-001	EP1004159-002	----	----	----
EG055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**0.02**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	**0.18**	**0.02**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**6.19**	**7.04**	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**6.36**	**7.06**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.5	**0.6**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	0.1	mg/L	**6.4**	**7.7**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.05	<0.05	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	----	----	----
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	**14.9**	**14.8**	----	----	----
^ Total Cations	----	0.01	meq/L	**16.9**	**17.2**	----	----	----
^ Ionic Balance	----	0.01	%	**6.33**	**7.59**	----	----	----

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SILLIKER AUSTRALIA
PERTH LABORATORY
181 Claisebrook Road
Perth, WA 6000
08-9227-6499 Fax 08-9227-6455

CERTIFICATE OF ANALYSIS

COA No:	PER-50227429-0
Supersedes:	None
COA Date:	02/08/2010
Page 1 of 1	

TO:
Scott James
ALS Environmental
10 Hod Way
Malaga, WA 6090

Received From:	Malaga, WA
Received Date:	30/07/2010
P.O.#:	290330

Location of Test: (except where noted)
Perth, WA

Analytical Results

Desc. 1:	Work Order: EP1004475			**Sample Number:**	450941483
Desc. 2:	Sample No: 1			**Condition Rec'd:**	NORMAL
Desc. 3:	Sample ID: HAWB003			**Temp Rec'd (°C):**	6.0
Desc. 4:	Sample Date: 29/07/10			**Date Started:**	30/07/2010

Analyte	Result	Units	Method Reference	Result Date	Loc.
Coliforms	<10	CFU/100mL	M12.1	31/07/2010	
E.coli	<10	CFU/100mL	M12.2	31/07/2010	

Desc. 1:	Work Order: EP1004475			**Sample Number:**	450941485
Desc. 2:	Sample No: 2			**Condition Rec'd:**	NORMAL
Desc. 3:	Sample ID: HAWB004			**Temp Rec'd (°C):**	6.0
Desc. 4:	Sample Date: 29/07/10			**Date Started:**	30/07/2010

Analyte	Result	Units	Method Reference	Result Date	Loc.
Coliforms	<10	CFU/100mL	M12.1	01/08/2010	
E.coli	<10	CFU/100mL	M12.2	31/07/2010	

Desc. 1:	Work Order: EP1004475			**Sample Number:**	450941487
Desc. 2:	Sample No: 3			**Condition Rec'd:**	NORMAL
Desc. 3:	Sample ID: HAWB005			**Temp Rec'd (°C):**	6.0
Desc. 4:	Sample Date: 29/07/10			**Date Started:**	30/07/2010

Analyte	Result	Units	Method Reference	Result Date	Loc.
Coliforms	<10	CFU/100mL	M12.1	31/07/2010	
The presence of high numbers of non-coliform bacteria may have caused an underestimation in the count of coliform bacteria					
E.coli	<10	CFU/100mL	M12.2	31/07/2010	
The presence of high numbers of non-coliform bacteria may have caused an underestimation in the count of E.coli					

MARJANA SILJANOSKA
LABORATORY MANAGER, MICROBIOLOGY

NATA
WORLD RECOGNISED
ACCREDITATION

NATA Corporate Accreditation Number: 2020
Site Microbiology No: 10653. Site Chemistry No: 5081
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ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP1004026**	Page	: 1 of 5
Client	: **ROCKWATER PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: DANAE RONEY	Contact	: Scott James
Address	: 1ST FLOOR, 76 JERSEY ST WEMBLEY WA, AUSTRALIA 6014	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: droney@rockwater.com.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9284 0222	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: 371-0	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 12-JUL-2010
Sampler	: ----	Issue Date	: 19-JUL-2010
Site	: HARDEYS RANGE		
		No. of samples received	: 2
Quote number	: EP-001-09	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
ChasTucker	Non-metallic Instrument Chemist	Perth Inorganics
Cicelia Bartels	Metals Instrument Chemist	Perth Inorganics
Daniel Fisher	Inorganics Analyst	Perth Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: WATER				Client sample ID	HAWB004SA	HAWB004FA	----	----	----
				Client sampling date / time	08-JUL-2010 15:00	10-JUL-2010 07:00	----	----	----
Compound	CAS Number	LOR	Unit		EP1004026-001	EP1004026-002	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.01	7.92	----	----	----
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		1080	1090	----	----	----
EA015: Total Dissolved Solids									
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L		651	645	----	----	----
EA065: Total Hardness as CaCO3									
^ Total Hardness as CaCO3	----	1	mg/L		357	370	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		212	210	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		212	210	----	----	----
ED040F: Dissolved Major Anions									
Sulfate as SO4 2-	14808-79-8	1	mg/L		152	159	----	----	----
^ Sulfur as S	63705-05-5	1	mg/L		51	53	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		157	160	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		48	50	----	----	----
Magnesium	7439-95-4	1	mg/L		58	60	----	----	----
Sodium	7440-23-5	1	mg/L		122	126	----	----	----
Potassium	7440-09-7	1	mg/L		9	9	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		0.0006	0.0003	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		0.081	0.020	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		0.038	0.052	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EG052G: Silica by Discete Analyser									
Reactive Silica	----	0.10	mg/L		18.2	15.0	----	----	----

Analytical Results

Sub-Matrix: WATER			Client sample ID	HAWB004SA	HAWB004FA	----	----	----
			Client sampling date / time	08-JUL-2010 15:00	10-JUL-2010 07:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1004026-001	EP1004026-002	----	----	----
EG055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.03	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	0.01	0.02	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	1.23	1.26	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	1.25	1.28	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.1	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	0.1	mg/L	1.6	1.4	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.04	0.08	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	0.01	0.01	----	----	----
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	11.8	12.0	----	----	----
^ Total Cations	----	0.01	meq/L	12.7	13.1	----	----	----
^ Ionic Balance	----	0.01	%	3.43	4.38	----	----	----

APPENDIX V

GLOSSARY OF HYDROGEOLOGICAL TERMS

Term	Meaning
AHD	Australian Height Datum
Airlifting	The process of abstracting water from a bore using a submerged high pressure air-line
Alluvium	Stream deposits consisting of sand, silt, clay and gravel
Analytical Groundwater Model	A mathematical representation of an aquifer system which can be solved using analytical methods. Analytical models are highly dependent upon simplifying assumptions
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water
Aquifer Boundary Effects	Changes in the rate of drawdown created as the pumping cone of depression reaches the lateral extents of an aquifer and intersects strata with different permeability
Aquitard	A saturated unit of low hydraulic conductivity that can store and slowly transmit groundwater either upward or downward depending on the vertical hydraulic gradient
Barrier Boundary	Boundaries that inhibit groundwater flow. Examples are faults, bedrock, dykes, or thinning of an aquifer unit
Bedrock	Solid rock exposed at the surface or overlain by palaeodrainage deposits or alluvium
bgl	Below ground level
Bore	Drilled small diameter well usually lined with steel or plastic casing for the purpose of obtaining or monitoring groundwater
Bore Losses	Amount of drawdown produced in a pumping bore due to inefficiencies in transmitting water from an aquifer to a bore
Boundary conditions	The physical conditions at the boundaries of a groundwater system. Examples in a groundwater model are no-flow boundaries at the lateral aquifer terminus, fixed flux boundaries representing a fixed inflow or outflow of water across that boundary cell, and fixed head boundaries representing potentiometric head that is held constant by some external force such as a river or lake
Brackish Water	Water containing between 1,000 and 5,000 mg/L of total dissolved solids, tasting slightly salty
Calcrete	A form of limestone deposited in lakes and along river systems interbedded with and replacing alluvium
Cone of Depression	The shape of the water table in the area immediately surrounding a pumping bore. The water draws down in a radial cone-shape around the pumping bore, with the deepest drawdown immediately at the well, tapering off with distance from the pumping bore
Confined Aquifer	An aquifer which is overlain by a confining bed of significantly lower hydraulic conductivity which retards the vertical movement of water
Drawdown	The change in potentiometric head caused by the pumping of groundwater
Dyke	A tabular intrusive igneous rock that is discordant or cut across existing rocks
Electrical Conductivity (EC)	The measure of a solution's ability to conduct electricity. EC units are used to express salinity levels in water. When salt is dissolved in water the conductivity increases, so the more salt, the higher the EC value
Falling-head Test	An aquifer permeability test in which a slug, typically a volume of water, is instantaneously placed below the static water level in a bore, displacing the water upward. Measurements of the falling water levels back to the static level are recorded over time. In a falling-head test groundwater is entering the formation from the bore
Ferricrete	A residual ferruginous deposit, commonly sandy or silty, cemented with iron oxides

Term	Meaning
Fresh Water	Water containing less than 1,000 mg/L of total dissolved solids, and generally suitable for drinking
Groundwater	Water occurring below the land surface in pores or fissures, generally in motion and part of the hydrological cycle
Groundwater Model Grid	The discretized model domain. The model grid is the physical model area normally overlain by a rectangular grid which defines the model boundaries and model cells
Groundwater Well Licence	A licence issued by the Department of Water giving permission to undertake exploratory drilling and testing, or permitting groundwater extraction for a fixed period with stated quantity of water and usually with attached conditions
Heterogeneous	A porous medium which has different physical characteristics in different locations
Homogeneous	A porous medium which has uniform physical characteristics everywhere
Hydraulic Conductivity	The capacity of a porous medium to transmit water through a unit cross-sectional area. Hydraulic conductivity is dependent upon the physical properties of the porous medium and the viscosity of the water and is expressed in units of length/time, typically m/d
Hydrograph	A graph showing changes in flow or stage of a stream, river or lake over time
Hypersaline	Water of salinity substantially greater than sea water (35,000 mg/L Total Dissolved Solids)
L/sec	Litres per second
Laterite	A residual ferruginous deposit within clay alluvium
Leakage	Vertical flow of groundwater from one aquifer to another, generally through a less permeable layer
m/d	Metres per day
m^2/d	Square metres per day
m^3	Cubic metre of water; equal to 1,000 litres
m^3/d	Cubic metres per day
mg/L	Milligrams per litre
mg/L TDS	Milligrams per litre of total dissolved solids
m^3/yr	Cubic metres per year
mm/yr	Millimetres per year
Model Calibration	The process of adjusting estimates of aquifer characteristics used in numerical ground water models. The calibration usually attempts to minimize differences between simulated and measured characteristics such as aquifer water levels
MODFLOW	A numerical ground water flow model code developed by the U.S. Geological Survey. The code has been widely applied to aquifers throughout the world
Numerical Modelling	A discretized representation of aquifers and their contained groundwater which is solved iteratively using a computer
Observation Bore	A bore located some distance from a pumping bore which is used to measure changes in water levels during an applied aquifer stress
pH	Measure of the acidity or basicity of an aqueous solution; pure water is said to be neutral, with a pH close to 7.0 at a temperature of 25 °C. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline
Perched Water	A localized zone of water which sits on top of an aquitard. A perched zone is typically unconfined and at a higher elevation than the regional aquifer system. Unsaturated conditions exist below a perched unit

Term	Meaning
Permeability	The ability of a porous medium to transmit water under a given gradient
Piper Diagram	A graphical representation of the chemistry of a water sample or samples. The cations and anions are shown by separate ternary plots. The apexes of the cation plot are calcium, magnesium and sodium plus potassium cations. The apexes of the anion plot are sulphate, chloride and carbonate plus hydrogen carbonate anions. The two ternary plots are then projected onto a diamond. The diamond is a matrix transformation of a graph of the anions (sulfate + chloride/ total anions) and cations (sodium + potassium/total cations).
Porosity	A measure of the void or pore space within rocks and sediments (the ratio of the volume of void spaces to the total volume)
Potentiometric Surface	The two-dimensional surface which describes the elevation of the water table. In an unconfined aquifer, the potentiometric surface is at the top of the water level. In a confined aquifer, the potentiometric surface is above the top of the water level because the water is under confining pressure
Production Bore	A bore used for removal of water from an aquifer
Recharge	Mechanisms of inflow to the aquifer. Typical sources of recharge are precipitation, applied irrigation water, underflow from tributary basins and seepage from surface water bodies
Rising-head Test	An aquifer permeability test in which a slug, typically a volume of water, is instantaneously extracted from the bore, displacing the static water level downward. Measurements of the rising water levels back to the static level are recorded over time. In a rising-head test groundwater is entering the bore from the formation.
Runoff	Overland flow in channels or as sheet flow originating from rainfall
Saline Water	Water containing more than 5,000 mg/L of dissolved salts
Saturated Thickness (b)	The saturated depth of an aquifer. For a confined aquifer, the saturated thickness at any point in the aquifer is equal to the aquifer thickness. For an unconfined aquifer, the saturated thickness at any point is the distance from the top of the water table to the bottom of the aquifer
Specific Storage (Ss)	The volume of water that will yield due to compression of the mineral skeleton and decompression of water in a confined aquifer
Specific Yield (Sy)	The ratio of the volume of water which will drain from a porous medium by gravity to the volume of the porous medium
Steady State Model	A numerical groundwater model in which model stresses do not vary over time. A steady state model is run until the modelled area is in equilibrium and no more changes in potentiometric head are calculated
Stress Period	An increment of time in a transient simulation during which aquifer recharges and discharges are held constant
Storativity (S)	The volume of water an aquifer releases from an aquifer per unit surface area of the aquifer and per unit change in head
Total Dissolved Solids (TDS)	The total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water, typically expressed in units of milligrams per litre of water (mg/L)
Transient Model	A numerical model in which the model stresses (inflows and outflows) and aquifer heads vary over time

Term	Meaning
Transmissivity (T)	The rate of flow of water through a vertical strip of aquifer which is one unit wide and which extends the full saturated depth of the aquifer. Transmissivity is related to Hydraulic Conductivity by the relationship: T = Kb where T = Transmissivity, K = Hydraulic Conductivity and b = the saturated thickness of the aquifer. Transmissivity is expressed in units of length^2/time, typically m^2/d.
Unconfined Aquifer	An aquifer whose upper surface is at atmospheric pressure
Water Table	The elevation of the water in an unconfined aquifer