REPORT

Corunna Downs H2 Hydrogeological Study

PREPARED FOR **ATLAS IRON LIMITED**

15 May 2018

MWH now part of Stantec

Stantec Australia Pty Ltd undertook the work, and prepared this document, in accordance with specific instructions from Atlas Iron Limited to whom this document is addressed, within the time and budgetary requirements of Atlas Iron Limited. The conclusions and recommendations stated in this document are based on those instructions and requirements, and they could change if such instructions and requirements change or are in fact inaccurate or incomplete.

Stantec Australia Pty Ltd has prepared this document using data and information supplied to Stantec Australia Pty Ltd by Atlas Iron Limited and other individuals and organisations, most of whom are referred to in this document. Where possible, throughout the document the source of data used has been identified. Unless stated otherwise, Stantec Australia Pty Ltd has not verified such data and information. Stantec Australia Pty Ltd does not represent such data and information as true or accurate, and disclaims all liability with respect to the use of such data and information. All parties relying on this document, do so entirely at their own risk in the knowledge that the document was prepared using information that Stantec Australia Pty Ltd has not verified.

This document is intended to be read in its entirety, and sections or parts of the document should therefore not be read and relied on out of context.

The conclusions and recommendations contained in this document reflect the professional opinion of Stantec Australia Pty Ltd, using the data and information supplied. Stantec Australia Pty Ltd has used reasonable care and professional judgment in its interpretation and analysis of the data. The conclusions and recommendations must be considered within the agreed scope of work, and the methodology used to carry out the work, both of which are stated in this document.

This document was intended for the sole use of Atlas Iron Limited and only for the use for which it was prepared, which is stated in this document. Any representation in the document is made only to Atlas Iron Limited. Stantec Australia Pty Ltd disclaims all liability with respect to the use of this document by any third party, and with respect to the use of and reliance upon this document by any party, including Atlas Iron Limited for a purpose other than the purpose for which it was prepared.

Stantec Australia Pty Ltd has conducted environmental field monitoring and/or testing for the purposes of preparing this document. The type and extent of monitoring and/or testing is described in the document.

Subject to the limitations imposed by the instructions and requirements of Atlas Iron Limited, the monitoring and testing have been undertaken in a professional manner, according to generally-accepted practices and with a degree of skill and care which is ordinarily exercised by reputable environmental consultants in similar circumstances. Stantec Australia Pty Ltd makes no other warranty, express or implied.

Maps produced by Stantec Australia Pty Ltd may be compiled from multiple external sources and therefore Stantec Australia Pty Ltd does not warrant that the maps provided are error free. Stantec Australia Pty Ltd does not purport to represent precise locations of cadastral corners or the surveyed dimensions of cadastral boundaries. Stantec Australia Pty Ltd gives no warranty in relation to mapping data (including accuracy, reliability, completeness or suitability) and accepts no liability for any loss, damage or costs relating to any use of the data.

PERTH
41 Bishop Street, JOLIMONT, WA 6014
TEL +61 (08) 9388 8799

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
Tracy Schwinkowski	David Thomson

PREPARED BY		
David Thomson	.....	15/ 5 /18.....
CHECKED BY		
J van Rensburg	.....	15/ 5 /18
REVIEWED BY		
David Thomson	.....	15/ 5 /18
APPROVED FOR ISSUE BY		
J van Rensburg	.....	15/ 5 /18

REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
A	06/09/17	Progress Draft	P Hedley		D Thomson	
B	03/10/17	Draft	P Hedley/ D Thomson		D Thomson	
C	15/5/18	Final	P Hedley/ D Thomson	J van Rensburg	D Thomson	J van Rensburg

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. Introduction

This H2 Hydrogeological Assessment report has been prepared by MWH (now part of Stantec) to document field work and findings from hydrogeological investigations carried out on behalf of Atlas Iron Limited (Atlas), for the purpose of identifying groundwater resources for use in road construction and mining operations. The field work was carried out in two field campaigns between April and August 2017, and in November 2017.

The report is to be submitted to the Department of Water and Environmental Regulation (DWER) in support of an application for a 5C Licence to Take Water under the Rights in Water and Irrigation Act 1914 (RIWI Act), for the purpose of abstracting groundwater for road construction and mining operations.

The groundwater investigations included the drilling of, construction and hydraulic testing of 12 pilot drill holes and 8 production bores.

1.1 Background

The Corunna Downs mining project (Corunna) is located approximately 237 km by road, southeast of Port Hedland and 33 km south southwest from Marble Bar (Figure 1-1). The project has the potential to deliver 4 Mtpa of lump and fines direct shipping iron ore (DSO) over an initial mine life of five to six years. In order to achieve this target a 22 km public road upgrade and 13 km mine access road construction is required.

Groundwater abstraction is currently authorised under two 5C licences to take water, GWL184565(1) for 100,000 kL/annum for road construction purposes, and GWL176960(4) for 100,000 kL/annum construction, campsite and potable water supply purposes (Appendix 1). In March 2017, Atlas applied to amend GWL176960, seeking 1,100,000 kL/annum for all mining purposes on the Corunna mining leases. DWER specified that additional information was required before they could assess the application:

- H2 – basic hydrogeological assessment including drilling and test pumping
- Groundwater Operating Strategy

This H2 report constitutes the reporting component of DWERs request for additional information. (Figure 1-2).

1.1 Scope of Work

The overarching objective of the groundwater investigation was to identify groundwater resources and construct production bores that can provide a sustainable groundwater resource for the six year life of the Atlas Iron Corunna Downs project.

The specific tasks completed to meet the objectives include:

- Management and supervision of hydrogeological drilling and aquifer testing, including:
    - Drilling of twelve (12) water exploration pilot holes located along the proposed Corunna Downs haul road and pit areas;
    - Drilling, construction and testing of eight (8) production bores along the proposed haul road and within the ROM areas; and
- Hydrogeological reporting in support for an application for a 5C licence to abstract groundwater.

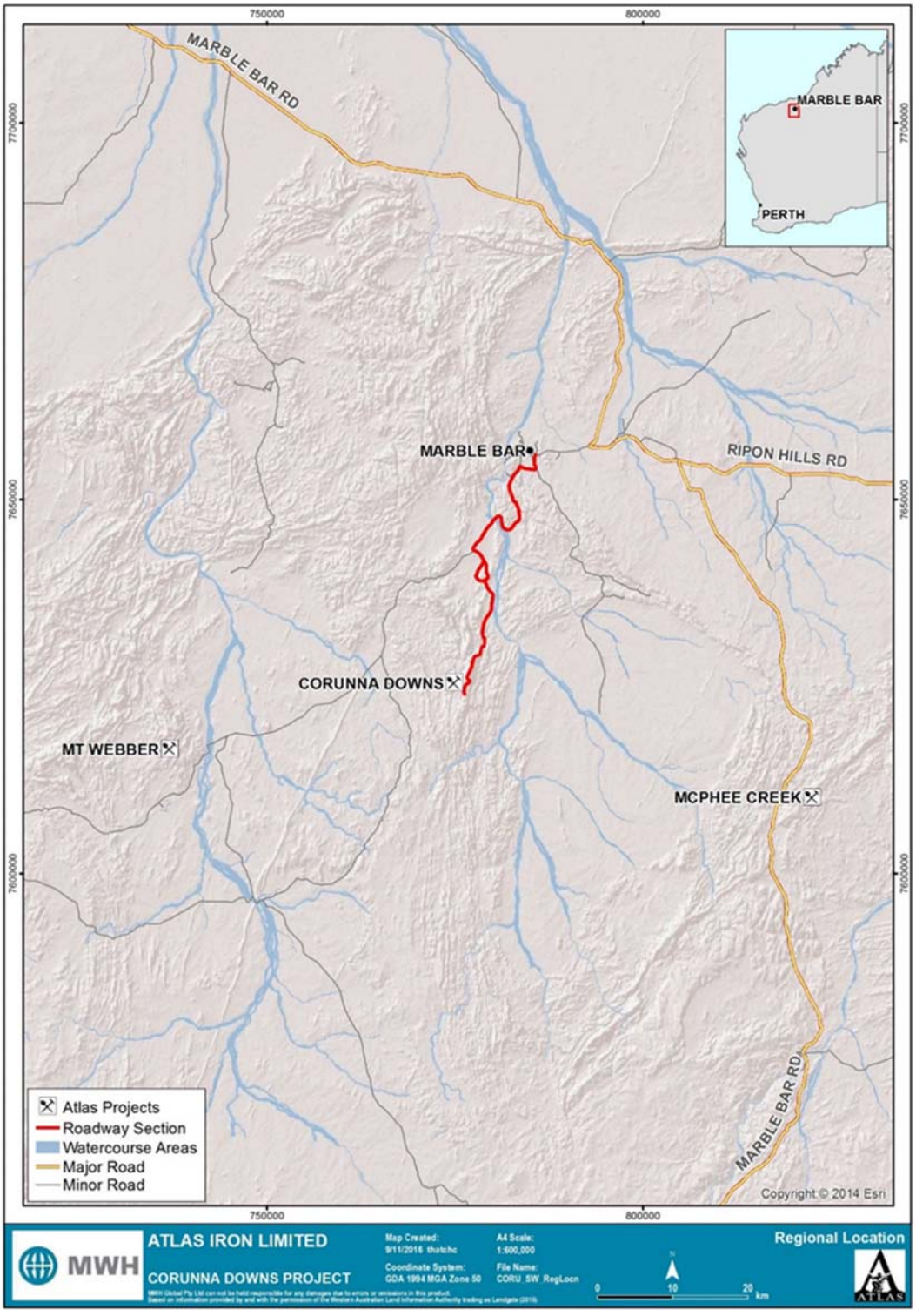


Figure 1-1: Location of proposed haul road alignment

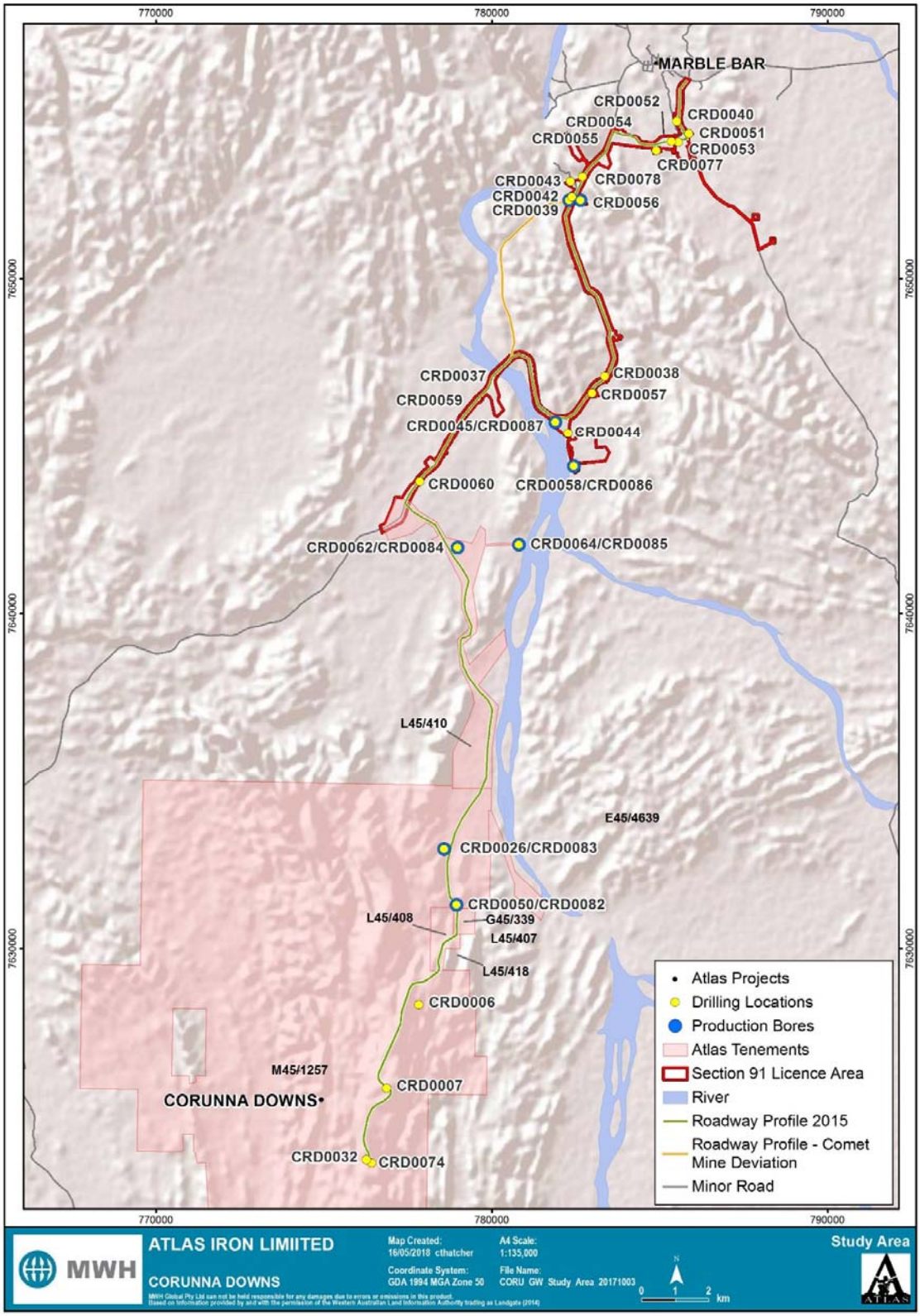


Figure 1-2: Corunna Downs hydrogeological investigation – drilling target locations

1.3 Previous work

Stantec completed a review of the water supply targets for the Section 91 area of the proposed haul road (MWH, 2017). This comprised a desktop study to review each proposed exploration drilling location and provide a location ranking based on geological lithology, geological structure, likely groundwater recharge characteristics, and drill pad access.

The study supported the proposed hydrogeological drilling targets provided by Atlas and characterised them as logical and well-founded based on the available knowledge base. Fractured rock aquifers (basalt, chert and dolerite dykes) were identified to be the primary targets for groundwater exploration.

2. Physical setting

1.2 Topography

The prevalent landforms around the project area are steep-sided ridges and hills (Figure 2-1). They are associated with outcrops of greenstone, chert and, in some locations, sandstone and dolomite.

Steep slopes are associated with ridges formed by hard rock outcrops comprising predominantly banded iron lithologies. Well-developed drainage lines incised into the ridge areas form gorges and gullies. Away from the ridge areas, ground surface changes to gentle to undulating slope surfaces in valley areas and river floodplains, typically underlain by basalt.

Figure 2-1: Example of the landscape in the Corunna Downs area

2.1 Climate

The climate of the Pilbara region is classified as semi-arid to arid and is characterised by hot summers and warm winters. The area experiences a climate of extremes, where severe droughts and major floods can occur at close intervals. Tropical cyclones can occur between January and April, bringing sporadic, high-intensity, rainfall events.

The closest Bureau of Meteorology (BOM) weather station to the project is located at Marble Bar (station number 004106, previously station number 004020), located 25 km to the northeast (BOM 2016a). During the summer months of November to February, the mean maximum temperature for Marble Bar is 40.7 °C and the mean minimum temperature is 25.3 °C (Figure 2-1). Marble Bar averages 104 days above 40°C per year (BOM 2016a). During the winter months of June to August, the mean maximum temperature for Marble Bar is 27.8 °C and the mean minimum temperature is 12.7 °C (BOM 2016a)

Annual rainfall at Marble Bar is shown as the red bar in Figure 2-2. Rainfall within the Project area can be highly localised and unpredictable with substantial fluctuations occurring from year to year. Mean annual rainfall is around 362 mm, with minimum and maximum annual rainfall of 71 mm (1924) and 798 mm (1980), respectively. Approximately 70% of the rainfall in the area occurs from December to March, and is generally associated with the passage of tropical cyclones. Most of the rainfall events occur as scattered thunderstorms, producing heavy localised falls over short periods. Tropical lows, usually originating off the Pilbara coast, can also bring widespread rain to the region.

Average annual pan evaporation (based on Marble Bar evaporation data) is around 3,300 mm/year, which is an order of magnitude higher than the average annual rainfall (Figure 2-3).

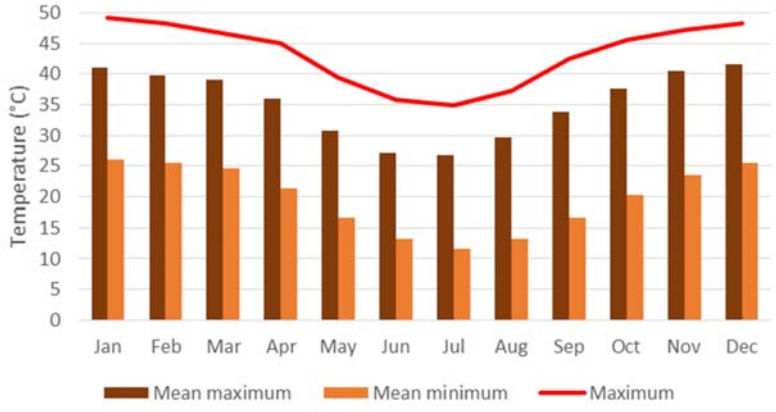


Figure 2-1: Marble Bar mean monthly rainfall and temperature

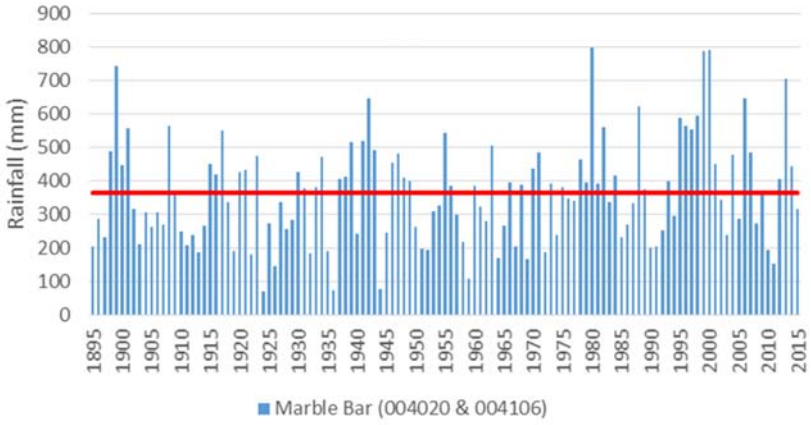


Figure 2-2: Marble Bar annual rainfall

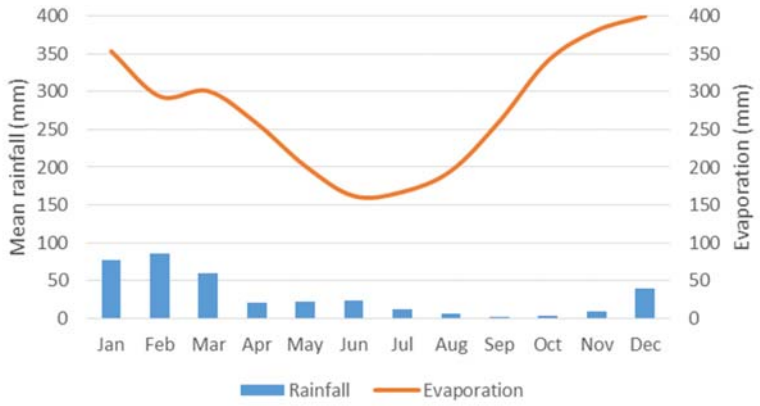


Figure 2-3: Marble Bar mean monthly rainfall and evaporation

2.2 Catchments and Drainage

The Project area lies within the middle reaches of the Coongan River catchment which sits within the De Grey River Basin (Figure 2-4). The De Grey River Basin covers an area of 56,890 km^2 (Ruprecht et al. 2000) with its major tributaries being the Strelley, Shaw, Coongan, Oakover and Nullagine Rivers. The Coongan River system has a total catchment area of around 7,090 km^2 and lies between the Chichester Ranges in the south and minor ranges on the west and east. The Coongan River has a number of tributaries, including: Budjen Creek, Triberlar Creek, Boobina Creek, Emu Creek and Camel Creek. The Coongan River joins the De Grey River at Mulyie Pool, about 41 km upstream of the confluence with the Shaw River.

Rivers in the Pilbara region are typically ephemeral in nature; however, surface water is present throughout the year in pools along the main rivers and creeks. These pools are most likely surface expressions groundwater within the alluvium.

The local catchments generally drain from west to east across the Project area towards the Coongan River. Gradients along the elevated areas are steep, reducing to flatter gradients along the valley floor. Incised drainage paths along the ridge and hill areas within the Project area are indicative of high flows occurring within well-defined channels. The flat areas spreading out from the ridges provide evidence of sheet flow with lower gradient drainage paths. In these areas finer material settles out as flow energy decreases after a rainfall event.

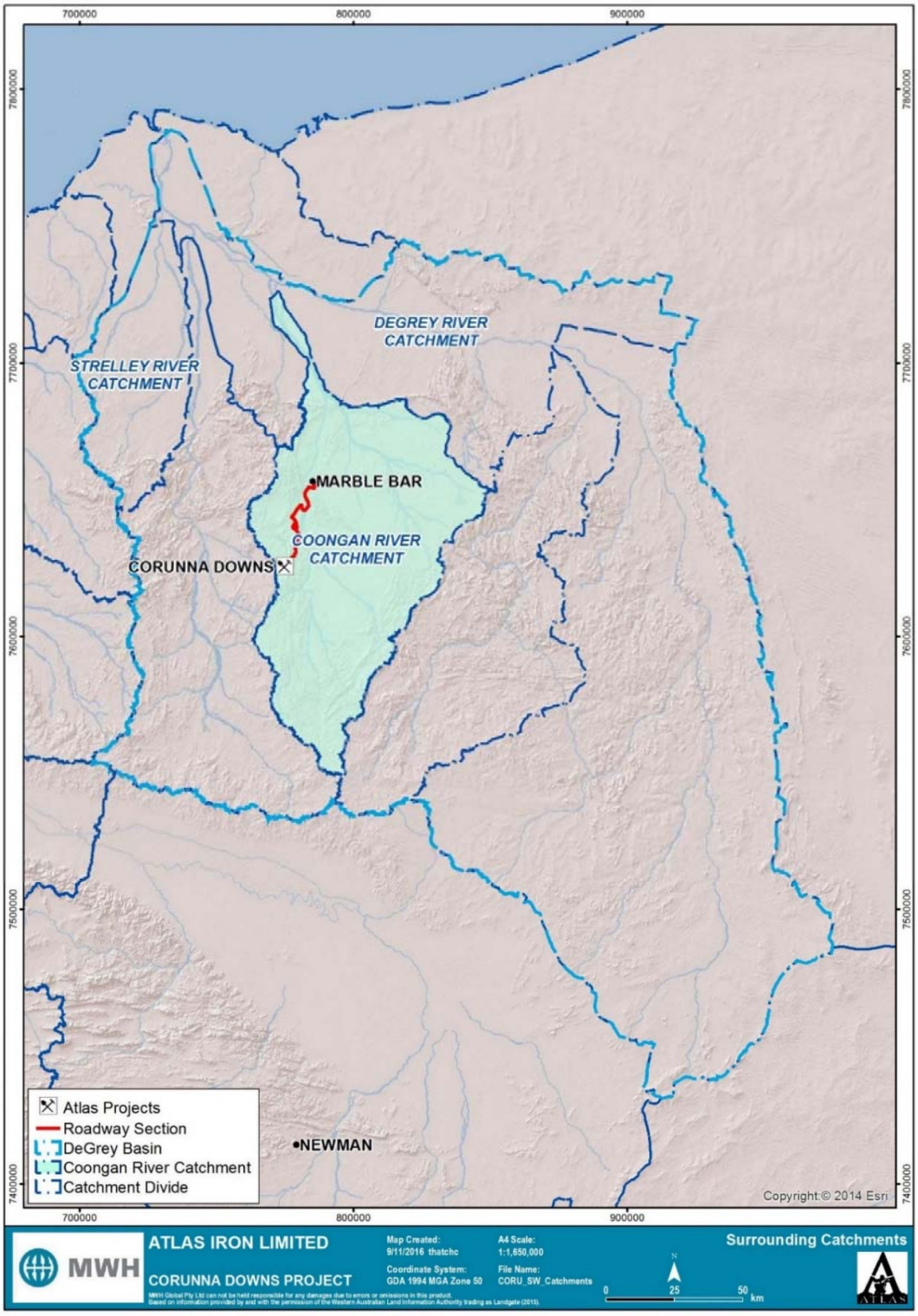


Figure 2-4: Regional surface water catchments

3. Regional Geology

The Corunna Downs Project and proposed haul road lie predominantly within Archaean greenstone belt rocks of the Coongan Syncline, located between the Shaw Batholith and Corunna Downs Batholith; all major structural units on the Pilbara Craton (Hickman 2010, and Hickman and Lipple, 1978).

The key formations underlying the haul road alignment belong to the Pilbara, De Grey and Mount Bruce Supergroups as presented in Table 3-1.

Table 3-1: Alignment stratigraphy

Supergroup	Group	Formation	Lithologies
Mount Bruce	Fortescue	Hardey	Sedimentary and felsic volcanics, local intrusives
		Mount Roe Basalt	Basaltic volcanic rock, local voclaniclastic and siliciclastic rocks
De Gray	Gorge Creek	Cleaverville	Metamorphosed banded iron formation (BIF), sandstone, siltstone and shale, chert and felsic volcaniclastic rocks
Pilbara	Warrawoona	Duffer	Metamorphosed felsic volcanic rock, local basalt, chert and felsic schist

The rocks of the Pilbara and De Grey Supergroups have experienced four deformation periods resulting in a strongly and complexly folded terrain. The Mount Bruce Supergroup has experienced a single period of open folding. Faulting is extremely common.

The rocks of the Pilbara and De Grey Supergroups are affected by pervasive greenstone facies metamorphism, but rocks from lower structural levels have attained amphibolite facies.

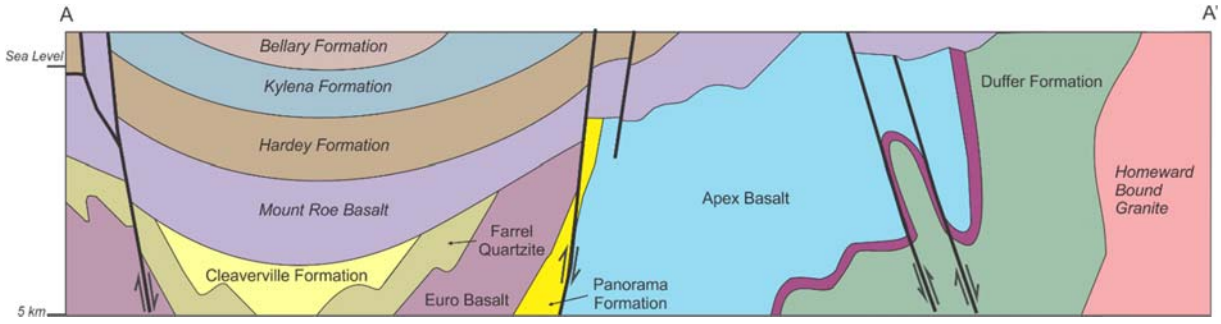


Figure 3-1: Cross section of regional geology (see Figure 4-1 for section location).

4. Regional Hydrogeology

The hydrogeology of the northern Pilbara is typified by faulted granitoid rocks and folded Archaean greenstone belt rocks, predominantly providing a fractured rock setting in which groundwater storage and transmission is structurally controlled. Aquifers types range from unconfined to confined, with the fractured rock setting typically unconfined to semi confined. Groundwater is predominantly recharged on the regional scale by episodic intense tropical low and cyclonic rainfall events, plus intense thunderstorm events on the local scale.

Groundwater may also occur in the upper weathered zones of all rocktypes, and where storage and transmission may be enhanced in secondary porosity associated with extensive weathering along zones, geological contacts and quartz veining.

The regional groundwater likely flows to the north consistent with the drainage direction of the major surface drainage features (rivers), while local groundwater flow directions will be driven by the interaction of topography, the elevation of the water table, and the interconnectivity of the structural elements of the rock mass.

Groundwater quality is likely to be fresh to brackish, but is directly coupled with recharge processes and the history of the water along individual flowlines, such that the presence of saline water cannot be discounted.

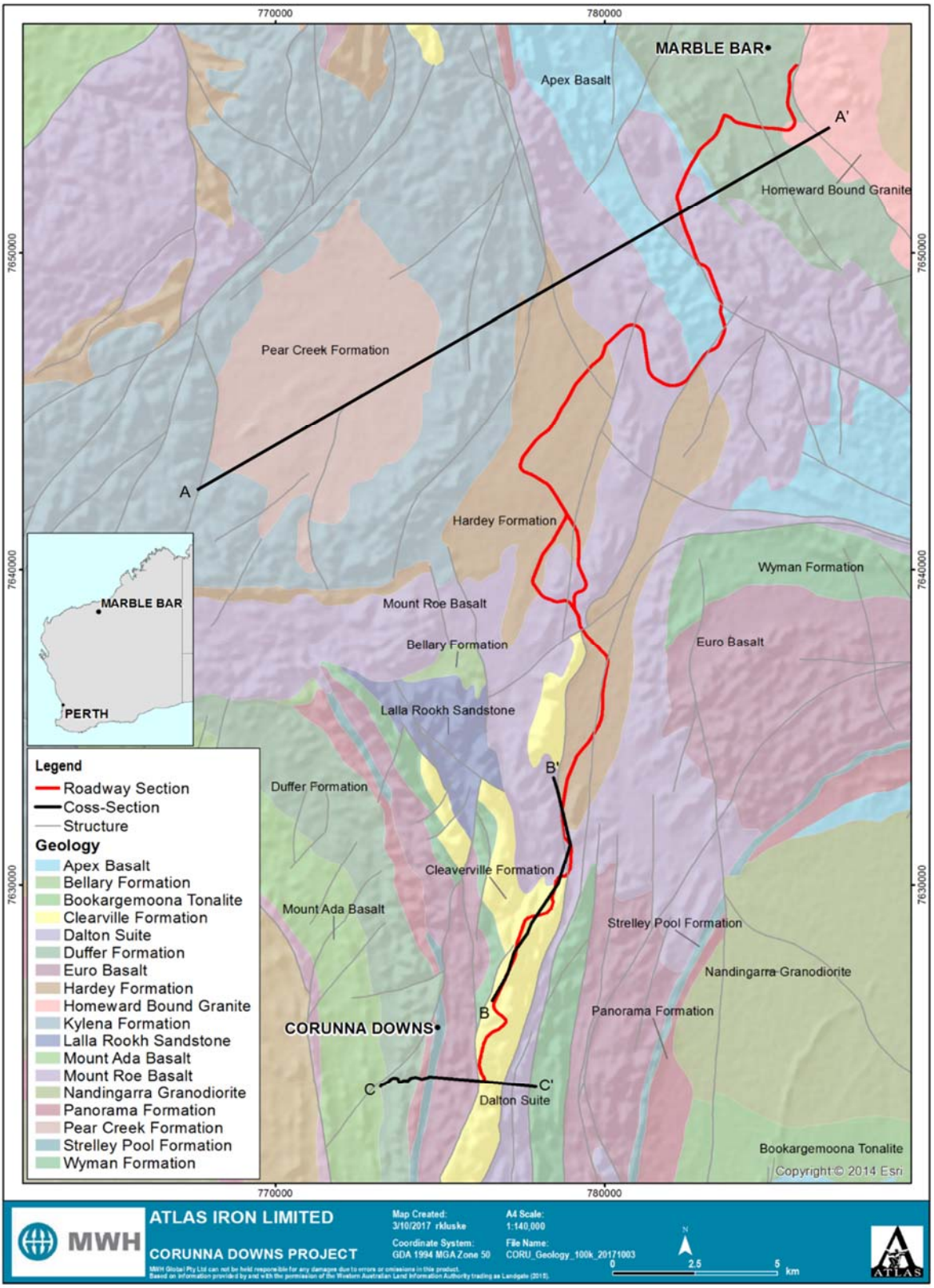


Figure 4-1: Simplified geological map of the Corunna Downs area

5. Drilling investigations

Groundwater exploration and production bore drilling was undertaken in the Corunna Downs study area between April and May 2017, and again in November 2017. Drillhole locations were selected by Atlas Pty Ltd and were reviewed by MWH (now part of Stantec). Drilling locations targeted, fractures (shear or fault zones), geological contact zones, areas of alluvial or calcrete cover, in relatively close proximity to drainage lines to provide recharge potential. Pilot holes were initially drilled before the final locations of the production bores were chosen.

Drilling was undertaken by drilling contractor Foraco using a KWL 700 drilling rig. The drilling was carried out under Licences to Construct or Alter Wells (Table 5-1), approved by the Department of Water in accordance with the Rights in Water and Irrigation Act 1914.

Table 5-1: Details of regulatory approvals

Licence	Approval Date	Expiry Date
CAW183385(1)	22 September 2016	19 September 2018
CAW184294(1)	21 April 2017	31 January 2019

The intersected geology was entirely consistent with the anticipated lithologies (**Table 3-1**). Photos of type examples are illustrated in the Appendix A.

5.1 Pilot Bores

All pilot bores were pre-collared to 6 m, drilling with a 190 mm tri-cone drill bit, and installing a 6 m length of ND150 mm ID uPVC surface casing, secured in place with AB foam. Each hole was then drilled open hole with conventional rotary air, down-the-hole hammer techniques, utilising a 6" (152.4 mm) bit on a 5" (127 mm) hammer. After drilling, the bore was airlifted for approximately 2 hours to determine water quality and discharge yield. **Table 5-2** provides a summary of pilot bore drilling, while summary drill hole logs are presented in Appendix C.

5.2 Production Bores

All production bores were initially drilled to 6 mbgl with a 305 mm (12") tri-cone bit, then reamed out with a 380mm (15") bit before installing a 300mm (12") steel surface collar, and cement grouting the annulus. The holes were then drilled with conventional rotary air, down-the-hole hammer techniques to depth utilising a 254mm (10") bit. The holes were completed with blank and slotted 8" Class 18 PVC casing and gravel packed to within a metre of the surface, where a bentonite seal was installed. **Table 5-3** provides a summary of production bore details, while summary drill hole logs are presented in Appendix C.

Table 5-2: Summary of Pilot Bores

Hole ID	Date started	Date completed	Easting	Northing	Total depth (mbgl)	Water Strike Depths (mbgl)	Lithology/Formation	Max airlift yield whilst drilling (L/s)	pH	EC (µS/cm)
CRD0038	9/04/2017	10/04/2017	783368	7647094	60	From 19	Weathered granite and basalt	0.5	8.1	310.0
CRD0057	10/04/2017	10/04/2017	782993	7646586	72	N/A		0.0	dry	dry
CRD0044	11/04/2017	11/04/2017	782273	7645380	66	5 16	Alluvials Weathered Basalt	2.6	7.65	2,670
CRD0058	11/04/2017	12/04/2017	782443	7644390	66	10	Weathered Basalt	1.0 - 1.5	7.37	2,965
CRD0045	12/04/2017	13/04/2017	781895	7645717	72	16 46	Weathered Basalt Weathered Basalt	4.5	8.01	1,003
CRD0078	9/05/2017	9/05/2017	782700	7653040	84	34	Duffer Formation	0.8	NS	NS
CRD0043	4/11/2017	4/11/2017	782275	7652340	84	4	Weathered Basalt	2.2	NS	1,136
CRD0039	5/11/2017	6/11/2017	782368	7652870	102	10	Weathered Basalt	4.8	NS	1,118
CRD0056	6/11/2017	7/11/2017	782732	7652279	102	30	Weathered Basalt	2.5	NS	1,209
CRD0040	9/11/2017	10/11/2017	785602	7654390	102	13	Fractured and Weathered Basalt	1.6	NS	1,894
CRD0051	10/11/2017	11/11/2017	785884	7654307	102	24	Fractured and Weathered Basalt	1.8	NS	1,961
CRD0081	11/11/2017	12/11/2017	785348	7654094	102	24	Weathered Basalt	0.3	NS	1,216

Notes: mbgl = metres below ground level, NS = Not Sampled

Table 5-3: Summary of Production Bores

Hole ID	Date started	Date finish	Easting	Northing	Depth (m)	Screened Interval (mbgl)	Water Strike Depths (mbgl)	Lithology/Formation	Max airlift yield whilst drilling (L/s)	pH	EC (µS/cm)
CRD0082	13/04/2017	17/04/2017	778953	7631289	88	10 to 88	6 33 approx..46 74 to 82	Hardey Formation Weathered Basalt Weathered Basalt Weathered Basalt	50-70 (Dev. 35)	7.2	850
CRD0083	17/04/2017	23/04/2017	778579	7632984	82	6 to 78	20 approx. 40	Weathered Basalt, quartz vein Weathered Basalt	18.8 – 20	7.79	763.1
CRD0084	24/04/2017	27/04/2017	778981	7641952	64	6 to 60	24 26	Weathered Basalt Fractured Zone	2.9 – 5.5	7.94	1,330
CRD0085	27/04/2017	30/04/2017	780809	7642040	64	6 to 64	14 40	Weathered Basalt Weathered Basalt	4.9	7.88	1,454
CRD0086	1/05/2017	4/05/2017	782443	7644390	70	4 to 70	11 60	Weathered Basalt Weathered Basalt	3	8.16	2,800
CRD0087	5/05/2017	7/05/2017	781895	7645717	64	4 to 64	8 38	Weathered Basalt Weathered Basalt	15 (Dev. 6.8)	8.01	947
CRD0088	14/11/2017	17/11/2017	782285	7652335	102	9 to 99	24 to 98	Weathered and Fractured Basalt	10.3	7.85	880
CRD0089	18/11/2017	21/11/2017	782719	7652280	100	12.3 to 96.3	26 to 94	Weathered and Fractured Basalt	10.3	7.79	925

Notes: mbgl = metres below ground level,

6. Hydraulic Testing

Hydraulic testing (test pumping) was carried out to assess the availability of water for the proposed development, to determine hydraulic properties of the geological materials intersected by drilling, and assess the potential long-term impacts from the proposed abstraction on the source aquifers, the environment, and other groundwater users. The test pumping was undertaken in accordance with Australian Standards (AS 2368–1990 Test pumping of water wells).

The testing was carried out by Airwell Group Pty Ltd on all new production bores. Testing comprised a calibration test, a step rate test (four 100 minute steps at increasing rates), a 72 hour constant rate test (CRT), and a recovery test. Test details are summarised in Table 6-1.

The pump used was a Shakti QF100 (156 mm diameter). The flow rate was measured with two Danfoss EM-Flowmeters and controlled by a VSD (variable speed drive) system. Water level measurements were collected both manually, and with Druck 1930 vented pressure transducer loggers which were installed in the pumping bore and adjacent monitoring bore. The groundwater level data was recorded manually and also via a SCADA software system which enabled real time viewing of flow rate, water level, electrical conductivity and temperature data.

Step rate test data was analysed with the Beirschenk & Wilson method utilising in-house spreadsheets, while CRT and Recovery Test results were analysed both manually (spreadsheet based), and using proprietary hydraulic test analysis software AQTESOLV Pro Version 4.5.002.

6.1 Data Analysis

Analysis of CRT data was often confounded by the non-standard drawdown response in the fractured rock settings, where the basic assumptions of classical hydraulic test data analysis methods, including efficient hydraulic connection between pumping bore and monitoring bore, do not apply. When this occurs, derived hydraulic properties such a transmissivity and specific yield must be treated with appropriate caution, depending upon the specific purpose for which they are used. Nevertheless, the analysis methods of Theis, Cooper Jacob and Moench were applied assuming unconfined conditions. Analysis using various fractured aquifer analysis techniques was unsuccessful due to the failure of the solutions to converge.

Individual step rate test results are presented in Appendix C. CRT test results and interpretations are provided in Appendix D, while a summary of the pumping test results is present in Table 6-2.

6.2 Discussion of Test Results

Referring to the individual pumping test drawdown curves presented in Appendix D and Table 6-2, the key findings from the hydraulic test work are as follows:

- The production bores are all hydraulically inefficient and none will be able to maintain the pumping rates selected for the CRTs. This is common when hydraulically testing bores in fractured rock settings, so operational abstraction rates will typically be lower than the CRT rates.

- Sustainability at any selected pumping rate for individual bores will be a function or balance between recharge (rainfall), available storage, and the rate of pumping. Accordingly the time of the year when the six month water supply is required will affect the operational sustainability of supply.

Table 6-1: Summary of Pumping Test Details

Pumping Bore	Test Dates	Static water level (mbtoc)	Pump setting depth (mbtoc)	Step Test Rates (L/s)	Constant Rate (L/s)	Total Drawdown in pumping bore (m)	Monitoring Bore	Monitoring Bore Static water level (mbtoc)	Drawdown observed (m)	Distance from pumping bore (m)	Time for 95% Recovery (mins)
CRD0082	27/06/2017 03/07/2017	4.65	52.05	10, 15, 20, 25	25	6.1	CRD0050 No_ID CRD0048	4.1 2.67 2.09	3.6 NR NR	10 700 1000	2800
CRD0083	05/07/2017 09/07/2017	3	42.05	10, 15, 20, 25	20	13.3	CRD0026 CRD0071 CRD0027 CRD0050	2.94 2.81 4.3 3.9	10.3 1.64 0.06 0.0	8.35 432 1162 1729	390 mins to 89%
CRD0084	10/07/2017 16/07/2017	4.31	41.735	3, 4, 5, 6	6	14.9	CRD0062 CRD0064	4.25 7.83	14.1 0.0	10 1750	20
CRD0085	16/07/2017 21/07/2017	NR	47.05	3, 5, 7, 9	5	16.6	CRD0064	9.74	2.03	10	66
CRD0086	23/07/2017 27/07/2017	3.5	61.83	2, 3, 4, 5	4	8.14	CRD0058	3	0.87	8	107
CRD0087	28/07/2017	4.86	51.82	10, 15, 20, 25	15	31.61	CRD0044	2.91	25.53	700	94 % 15 mins 95% 110 mins
CRD0088	19/11/2017 23/11/2017	6.79	49.8	4, 8, 12, 16	12	16.2	CRD0039	5.73	1.5	11	2
CRD0089	24/11/2017 27/11/2017	11.47	59.8	5, 10, 15, 20	12	21.5	CRD0056	10.8	15.5	13	NA, 85% in 360 mins

Notes: mbtoc = metres below top of casing. Mins = minutes.

- Analytically estimating the drawdowns for individual production wells utilising their derived well equations, will be inaccurate due to the inability of honouring the aquifer assumptions required for classical hydraulic test analysis, in fractured rock aquifers.

- All bores will require close operational monitoring to identify declines in bore performance. If drawdown in a particular bore becomes critical (approaches pump intake level), then abstraction duty should be given to another production bore. Alternation of production bores will be necessary during the duration of the haul road construction.

Table 6-2: Summary of Pumping Test Results

Pumped Bore	Well Efficiency* (%)	CRT Pumping Rate (L/s)	Transmissivity (m^2/day)	Drawdown response in terms of classical drawdown curve analysis
CRD0082	53 (25 L/s)	25	190 to 210	Poor fit, strong strip aquifer (strip) response
CRD0083	22 (25 L/s)	20	200 to 220	Poor fit, delayed yield then strip response
CRD0084	9 (6L/s)	6	47 to 237	Poor fit, delayed yield then strip response
CRD0085	20 (7 L/s)	5	100 to 165	Poor fit, delayed yield then strip response
CRD0086	9 (5 L/s)	4	395	Very noisy data, poor fit, possible compaction
CRD0087	28 (25 L/s)	15	593	Poor fit, strong strip aquifer (strip) response
CRD0088	15 (16 L/s)	12	300 to 440	Reasonable fit
CRD0089	26 (20 L/s)	12	22 to 54	Poor fit, delayed yield then strip response

Notes: * Well efficiency for highest interpretable step test pumping rate (flow rate in brackets).

7. Groundwater and Surface Water Chemistry

Groundwater samples were collected during development of each drill hole and also during test pumping. The samples were then submitted to MPL Laboratories for major ions and trace metals analysis. The results and laboratory analytical reports are presented in Appendix F.

Groundwater in the study area is fresh to brackish, with total dissolved solids (TDS) ranging from 410 to 1,800 mg/L. The key major ions include sodium (43 to 630 mg/L), chloride (19 to 500 mg/L), and bicarbonate (300 to 700 mg/L). Potassium concentrations are relatively low (0.5 to 2.5 mg/L).

With the exception of fluoride, arsenic, manganese and nickel, all groundwater sample concentrations for analytes listed in the Australian Drinking Water Guidelines (NHMRC, NRMMC, 2011) are below guideline concentrations.

Fluoride was detected at or above the guideline concentration of 1.5 mg/L in CRD0086 on 3 samples collected to date (maximum concentration 2.0 mg/L), and in CRD0058 once at 1.8 mg/L.

Arsenic was detected in CRD0086 on 3 occasions (maximum concentration 0.014 mg/L), twice in CRD0040 (0.01 mg/L), and once in CRD0038 (0.013 mg/L), CRD0058 ((0.012 mg/L) and CRD0073 (0.010 mg/L).

Manganese was detected twice in CRD0003 (maximum 0.87 mg/L), and once in CDRC0334 (4.2 mg/L), CRD0027 (1.4 mg/L), CRD0031 (3.2 mg/L), and CRD0033 (0.96 mg/L).

Nickel was detected in in CRD0062 (0.410 mg/L) and CRD0071 (0.022 mg/L).

CRD0086 is the only production bore in which criteria were exceeded and given the groundwater will be used for road construction, the exceedances are not considered to be a risk to livestock or the environment.

Surface water TDS ranges from 33 to 2,800 mg/L, and is generally characterised by the same major ions, although in differing relative concentrations. A Schoeller diagram illustrating the relative major ion concentrations of surface water compared to the range observed in groundwater is shown in Figure 7-1

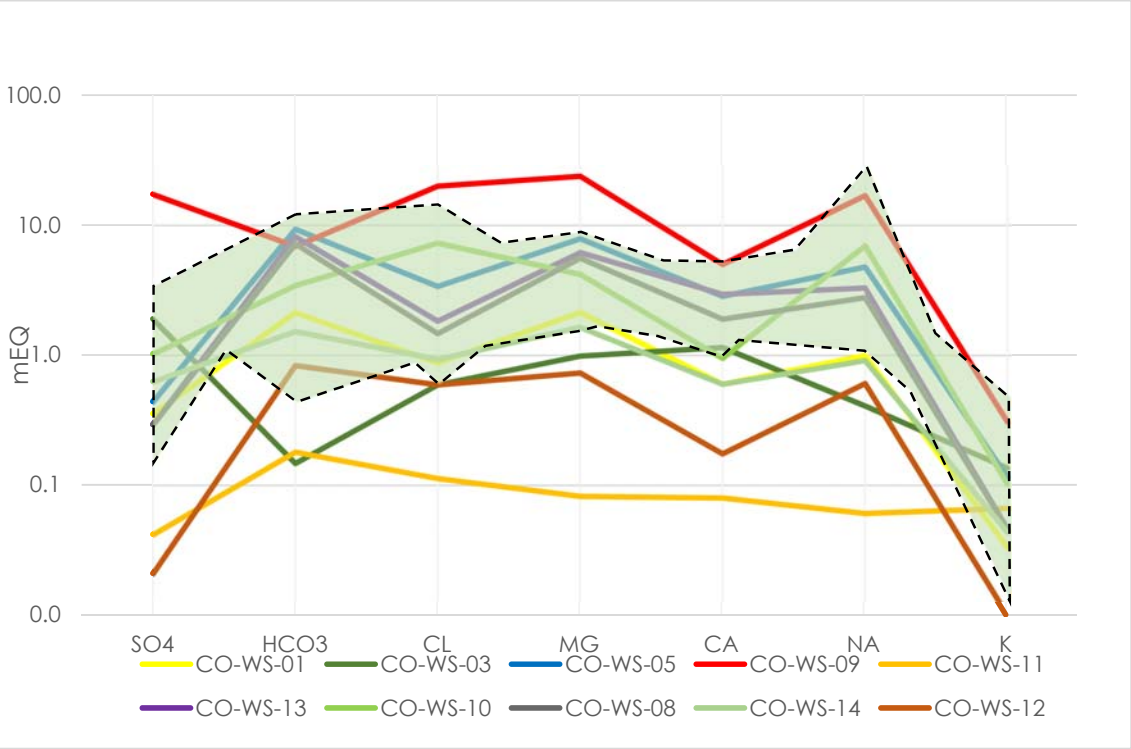


Figure 7-1: Schoeller diagram illustrating the range of major ion concentration in groundwater and the ionic concentration of surface water samples collected from the Corunna Downs mining area on 24/07/2017.

Figure 7-2 presents a Piper plot of all available groundwater chemistry data currently available from the project site. Reference to the figure shows a broad distribution of groundwater types (hydrochemical facies) with the dominant anionic species being bicarbonate (bicarbonate type water) but with no overwhelmingly dominant cation. The broad distribution indicates a broad range of histories for the individual groundwater samples, with mixing of groundwaters with differing

histories of aquifer residence time or exposure to recent recharge, and interaction with differing rock types.

The groundwater samples indicate marginal sodium enrichment in northerly direction accompanied also by slight chloride enrichment suggesting groundwater chemistry evolution from south to north as evidenced in spatial distribution of hydrochemical signatures presented in Figure 7-3 and Figure 7-4 for groundwater and surface water respectively. The total dissolved solid concentrations also have a tendency to increase in northerly direction.

Several samples (e.g. CRD0003, CRD0031, and CRD0041) indicate sulphate enrichment (Figure 7-3) at the expense of bicarbonate and chloride possibly suggesting the presence of sulphide oxidation in parts of the aquifer system.

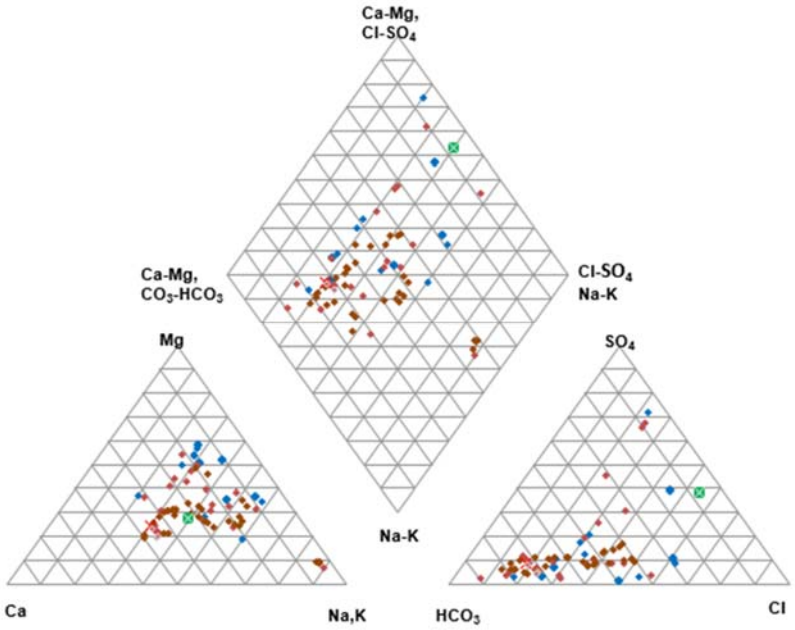


Figure 7-2: Piper diagram of surface water (blue) and groundwater (red) samples from Corunna Downs area. The green symbol represents rainfall.

Hydrochemical signatures of surface water samples are inconsistent with the groundwater samples (Figure 7-2 and Figure 7-4), suggesting that in surface water bodies, the water is affected by evapoconcentration and biological processes.

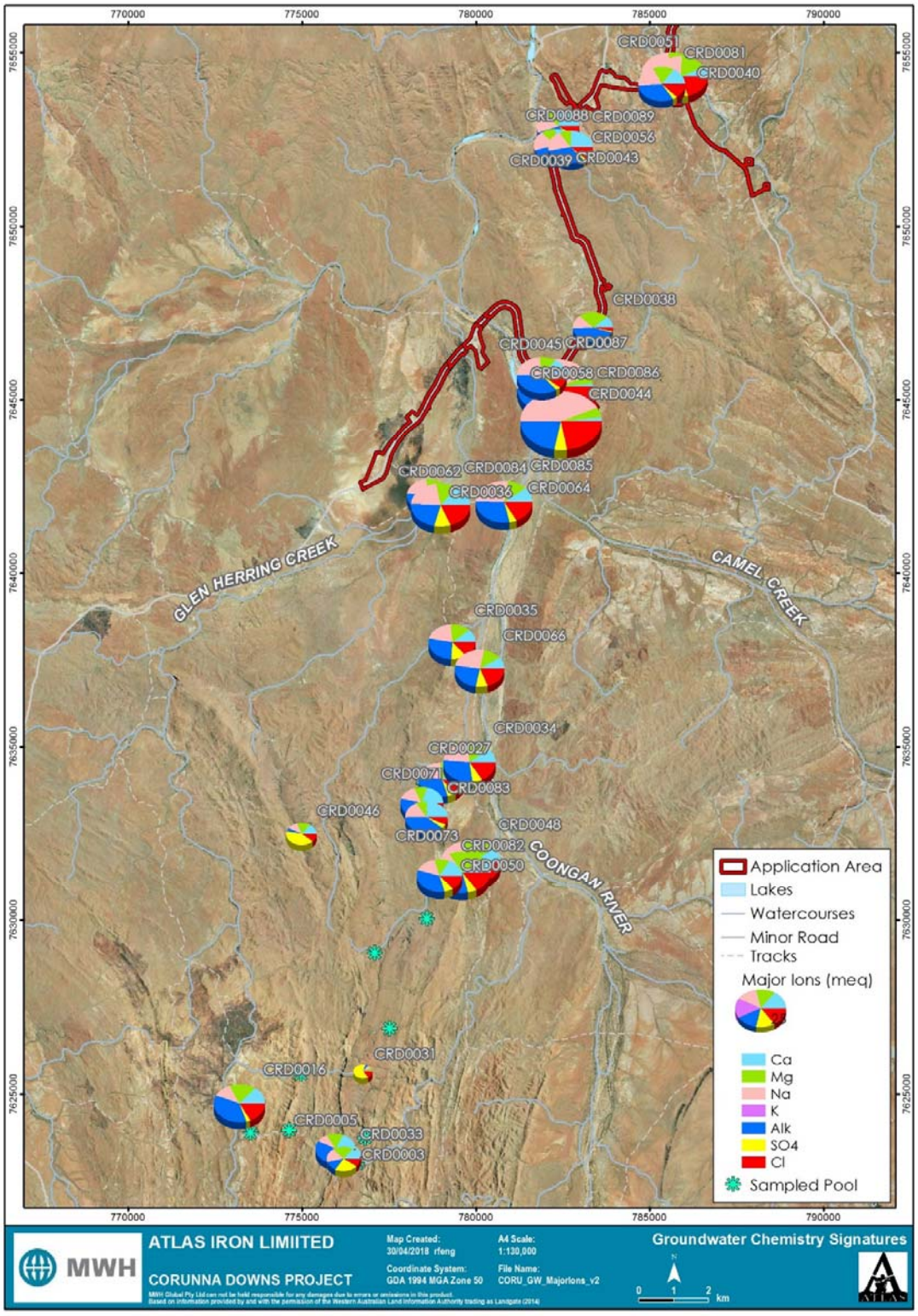


Figure 7-3: Major ion chemistry – groundwater samples

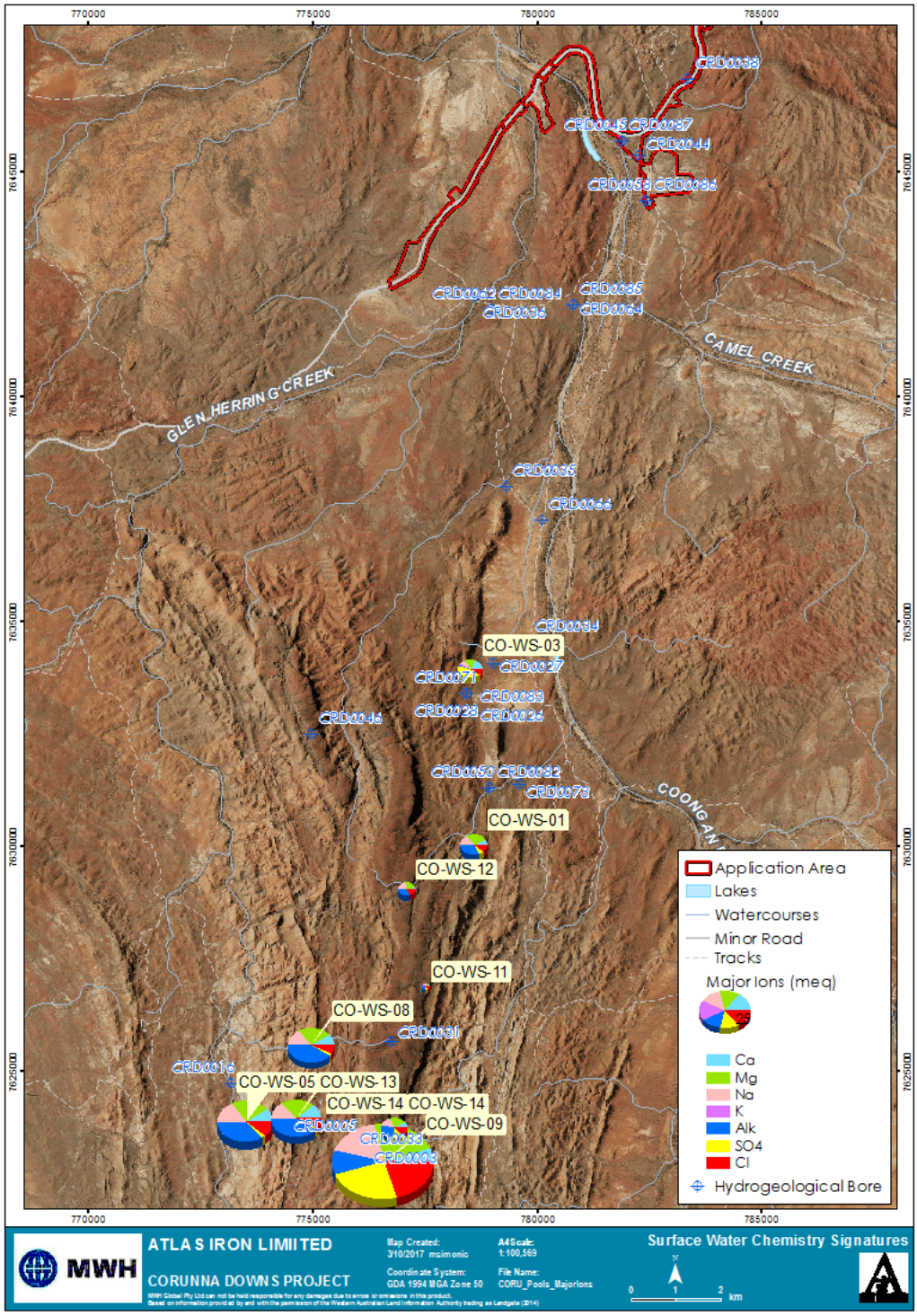


Figure 7-4: Major ion chemistry – surface water (pools)

8. Conceptual Hydrogeology

Conceptually, the hydrogeological setting for the region comprises predominantly fractured rock within a package of crystalline and sedimentary rocks that have been exposed to significant structural deformation and metamorphism. With the exception of weathered and mineralised zones, groundwater storage and transmission principally occurs in joints, fractures and other defects in the rock mass. Colluvial and alluvial deposits may have developed in the vicinity of high relief or major drainage features, although the amount of groundwater stored in such settings is thought to be minor. The highly faulted nature of the fractured rock setting may hydraulically compartmentalise individual blocks of rock mass such that the phreatic surface (water table) may not form a continuum across geological boundaries.

Figure 8-1 presents two geological cross sections that provide hydrogeological context for project. The locations of the cross sections are provided on Figure 4-1, a regional geological base-map showing the extent of the project within a geological context.

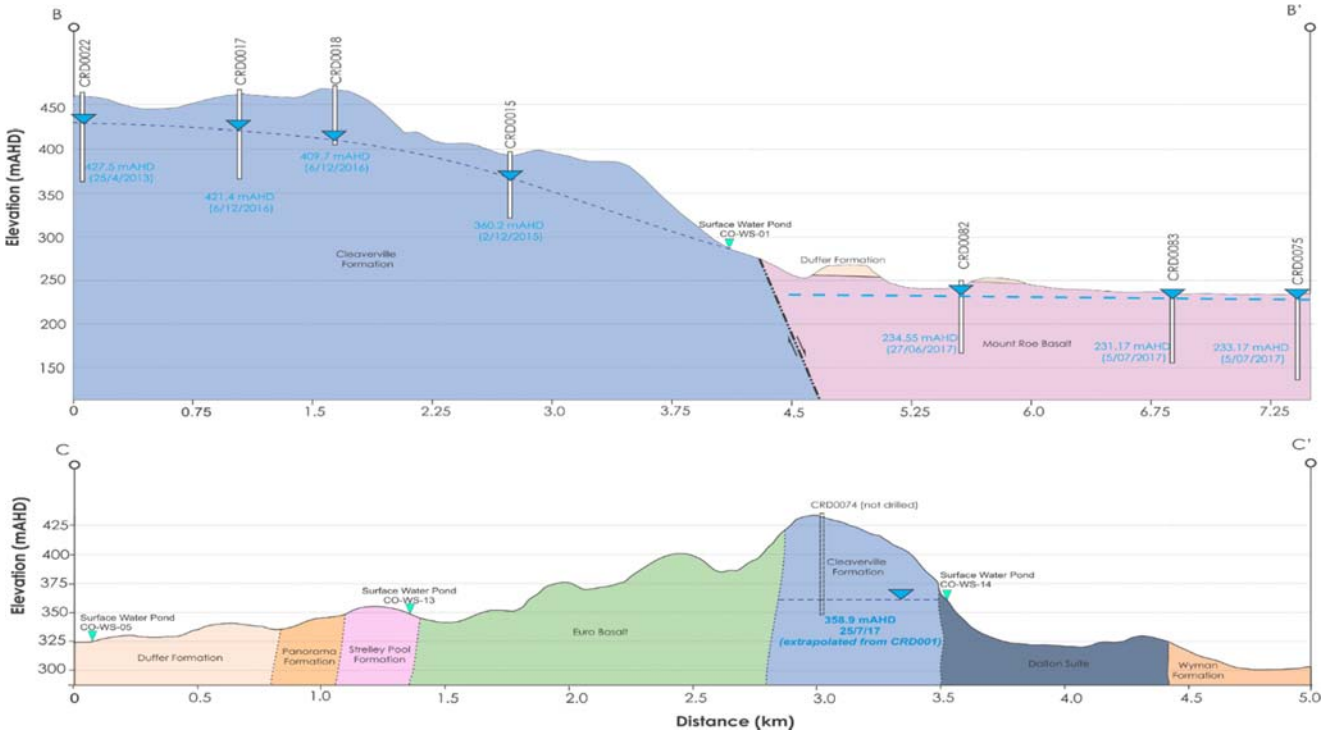


Figure 8-1: Approximately south to north, hydrogeological long section along the project alignment (B to B', looking west) and west to east section (C to C', looking north)

Reference to Figure 8-1 shows a number of hydrogeological concepts thought to active in the study area:

- A northerly water table gradient within the Cleaverville Formation (banded iron formation)groundwater flow direction (Section B to B")

- Compartmentalisation at the fault separating the Cleaverville Formation (Cleaverville) from the Mount Roe Basalt, such that saturated conditions exist within Cleaverville causing groundwater to discharge where the water table daylights against the fault, conceptually overflowing into the different hydrogeological domain within the Mt Roe Basalt.
- Groundwater levels within the Mt Roe Basalt being uncoupled with levels in the Cleaverville, and constrained by discharge processes elsewhere. Accordingly transient groundwater levels are a balance between recharge and discharge processes, with a primary constraint being the topographic level of the ground surface.

Groundwater has been classified into two key zones for the purpose of this study. The zones are separated based on groundwater elevation and hydraulic connection, as follows:

- Corunna Mining area (CORU): Groundwater exists on the elevated Corunna Down mining area plateau within the Cleaverville Formation and adjacent igneous intrusions. Groundwater level ranges between 430 to 360 mAHD (Figure 8-1 and Figure 8-3) and TDS ranges from 280 to 710 mg/L.
- Coongan River Valley (CRV): Groundwater is hosted within alluvial sediments and fractured Mount Roe Basalt. Groundwater levels range from 230 to 190 mAHD with a hydraulic gradient of 0.0037 which follows the Coongan River valley topography in a northerly direction. TDS ranges from 290 to 1,800 mg/L, the higher values are a result increased evapotranspiration of shallow groundwater and/or mixing with older groundwater.

8.1 Local recharge and discharge areas.

Groundwater recharge across the study area will occur primarily during and after intense rainfall events, which are generally associated with tropical lows and cyclonic weather systems. Regional groundwater levels typically rise significantly during and after these major recharge events, then commence recession until the next major recharge event, which may be some years later. Figure 8-2 shows the longest continual groundwater hydrograph available for the Corunna area, from CRD0003 at the southern extent of the project. The hydrograph shows a four year overall groundwater level recession, interspersed with occasional recharge events correlating with the wet season.

After rainfall, recharge will be enhanced along alluvial filled drainage lines and where surface water collects allowing infiltration to occur directly into outcropping or subcropping fractured rock.

During the wet season the Coongan River is likely to act as a losing system, contributing recharge to groundwater environment.

Groundwater discharge also occurs from a number of springs that are located around the Corunna Downs mining area plateau (Figure 8-3).

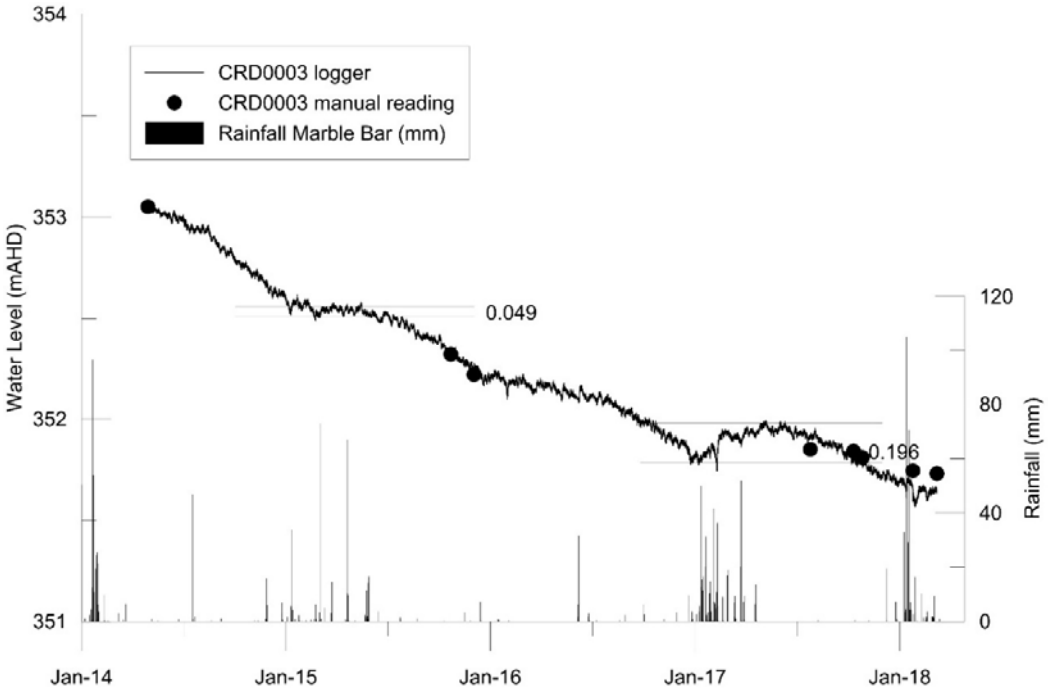


Figure 8-2: Groundwater hydrograph showing overall groundwater level recession, with occasional recharge events.

.

8.2 Local groundwater occurrence

Drilling in the Coongan River valley was undertaken after the wet season when water levels were relatively high. The first groundwater strike was often encountered within the unconfined alluvial sediments. This aquifer is thought to support the vegetation that line the drainage lines, and is likely to exhibit a large seasonable variation.

Holes drilled further away from the drainage lines didn't strike groundwater until drilling proceeded into the underlying Mount Roe Basalt, the upper few metres were generally hard and dry with low apparent permeability. As drilling continued into the basalt, water strikes were noted at multiple depth horizons, and the groundwater level often rose 5-10 m after the initial water strike. Groundwater strikes in the Mount Roe basalt was generally associated with increases in quartz (silica) concentration, which may indicate the local lithology is actually more rhyodacitic (i.e. technically not the basalt), and the lithology is more conducive to secondary porosity than the surrounding basalt. Note silica-rich pillow lavas have been identified in Archaean basalts to the west of the Shaw Batholith (Lipple, date unknown).

Drilling and testing of the Mount Roe Basalt illustrated that hydraulic performance varied significantly within the rocktype with airlift yields ranging from 0 (dry) to 4.5 L/s being obtained from holes in the same formation. This highlights the importance of intersecting structural or secondary porosity features in fractured rock settings.

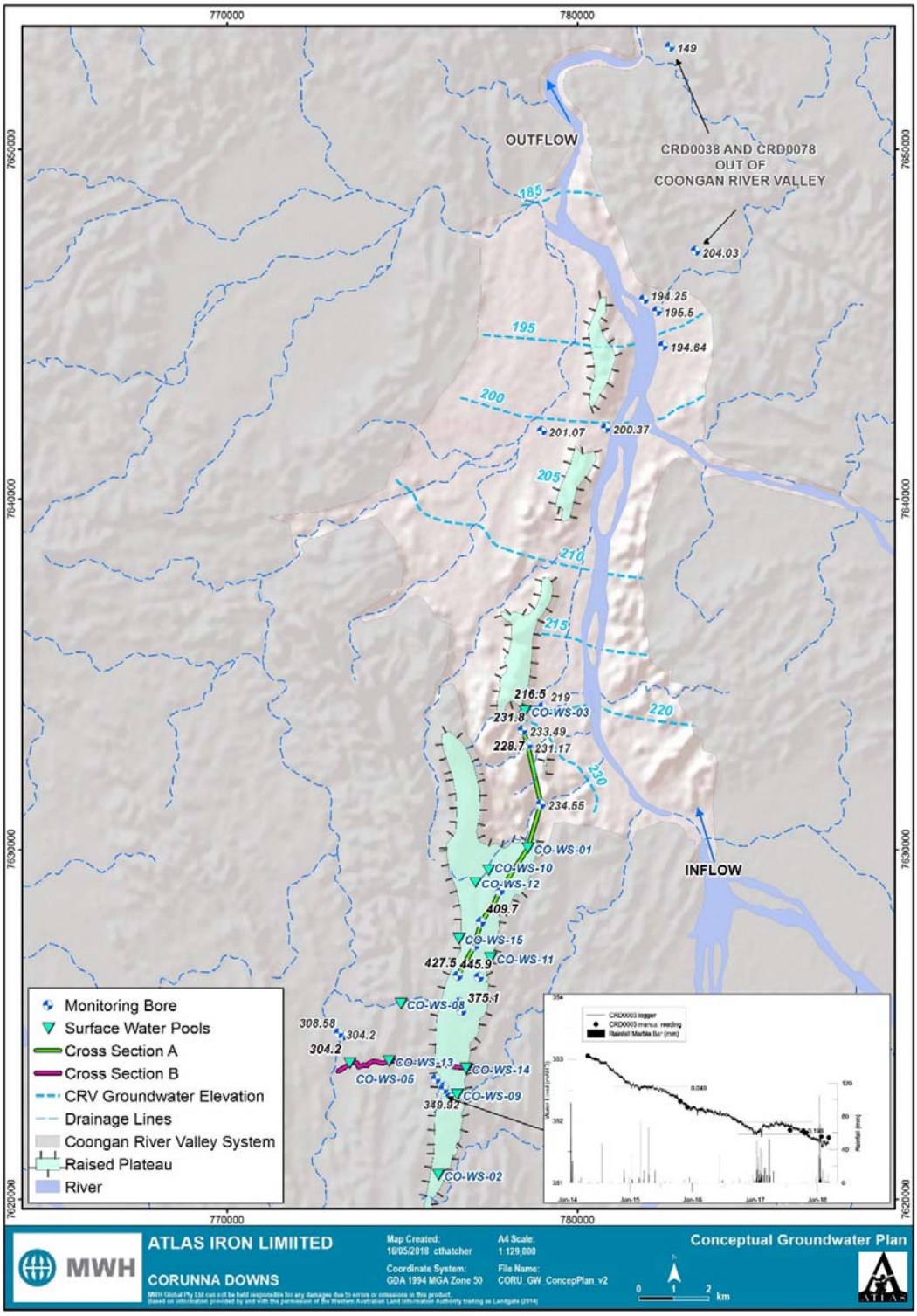


Figure 8-3: Conceptual hydrogeology of Corunna Downs area showing surface water pond locations

8.3 Corunna Downs mining area surface water features

A number of pools, seeps and springs are situated around the Corunna Downs mining area, the mode of occurrence of these features are likely from one of three mechanisms (Figure 8-4):

1. Where the local groundwater level intersects topography, mostly occurring in incised gullies where groundwater is shallow. This may also support groundwater dependant vegetation. The hydrochemical signature of these pools are dependent on the amount of evaporation that has occurred.
2. Infiltrated groundwater may discharge before reaching the saturated zone due to geological structures or perched aquifers. The short aquifer residence time minimises the effect of rock-water interaction on the hydrochemical signature of these surface water features.
3. Pools may exist where the morphology allows rainwater to collect in locations where evaporation is minimal. The hydrochemical signature of these surface water features will be similar to that of the regional groundwater, but may be modified by subsequent evaporation after discharge.

Analysis of hydrochemical signatures, elevation and aerial photography has been used to delineate the mode of occurrence of each pool, this is detailed below and in Table 9-3.

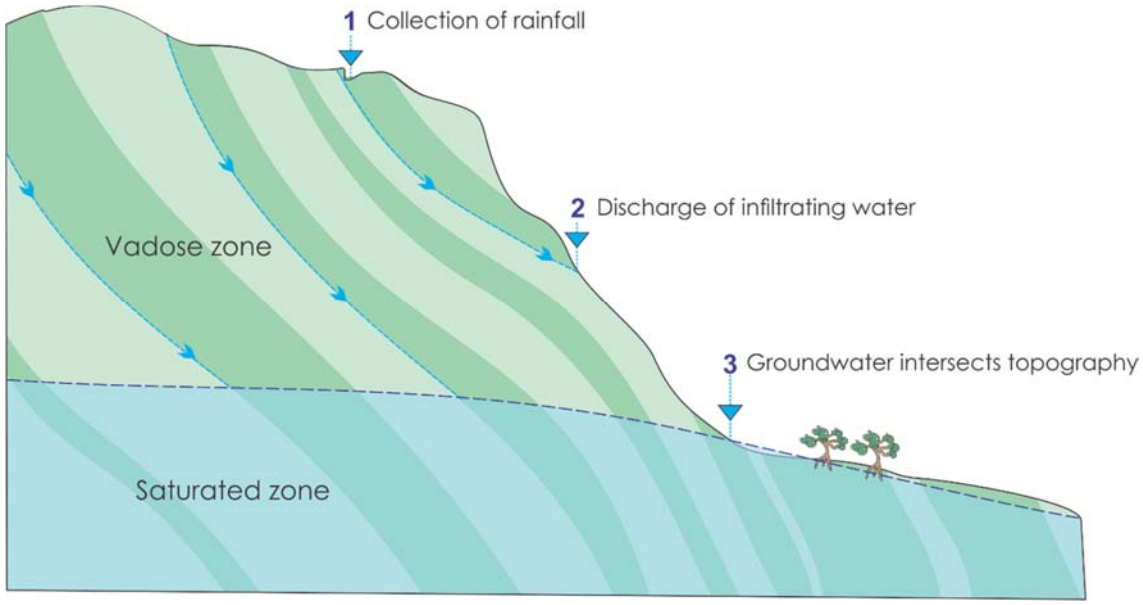


Figure 8-4: Conceptual mode of occurrence of surface features located around the Corunna Downs mining area

9. Assessment of Potential Impacts

9.1 Numerical Modelling of Mining Area

A simple numerical model was constructed to allow assessment of drawdown impacts due to pumping groundwater for site water requirements. The model was constructed in the numerical groundwater modelling code MODFLOW-2005 using the Upstream Weighting Package. The Groundwater Vistas graphical user interface (Version 6.96) was used to develop the model input files and process the model output. Technical details of the model are summarised in Appendix G.

The Class 1 model (*Australian groundwater modelling guidelines*, 2012) was constructed to incorporate structural elements such as major faults and key geological formations, in recognition of the fractured rock nature of the groundwater environment in the project area. Compartmentalisation is common in structurally complex terrains so the model gave some flexibility in exploring the implications of structure on groundwater movement and drawdown. The model domain has dimensions of 39 km (north to south) by 25.4 km (east to west), and has 3 layers with the top layer incorporating a digital terrain model of actual topography (Figure 9-1).

Key features of interest were incorporated into the model, such as abstraction bores and environmental features such as known rock pools and seepage locations (soaks). This was to allow assessment of the drawdown impacts that abstraction would have on these key features.

Model zone hydraulic properties in the key areas of interest were based upon actual parameters determined from hydraulic testing carried out at production bores installed during groundwater exploration programs. The model was calibrated to the available groundwater level data set, by adjusting until a reasonable calibration was achieved Appendix G.

The best calibrated model was used to evaluate various pumping schedules for the available production bores and two proposed production bore locations, with the objective of minimising the amount of drawdown at the end of the life of the mine (LoM), equivalent to 2190 days of mining, whilst meeting the mine's operational need for water over the LoM. The operational mine requires 30.5 L/s over its 6 year life. This is equivalent to an annual abstraction rate of 962,000 kL/annum.

The abstraction schedule that provided the least drawdown at sensitive locations is presented in Table 9-1

Table 9-1: Mine Site Operational Abstraction Rates

Bore ID	Proposed Pumping Rate (L/s)
CRD0071	8.0
CRD0074	5.0
CRD0082	5.0
CRD0083	6.5
CRD0084	3.0
CRD0085	3.0

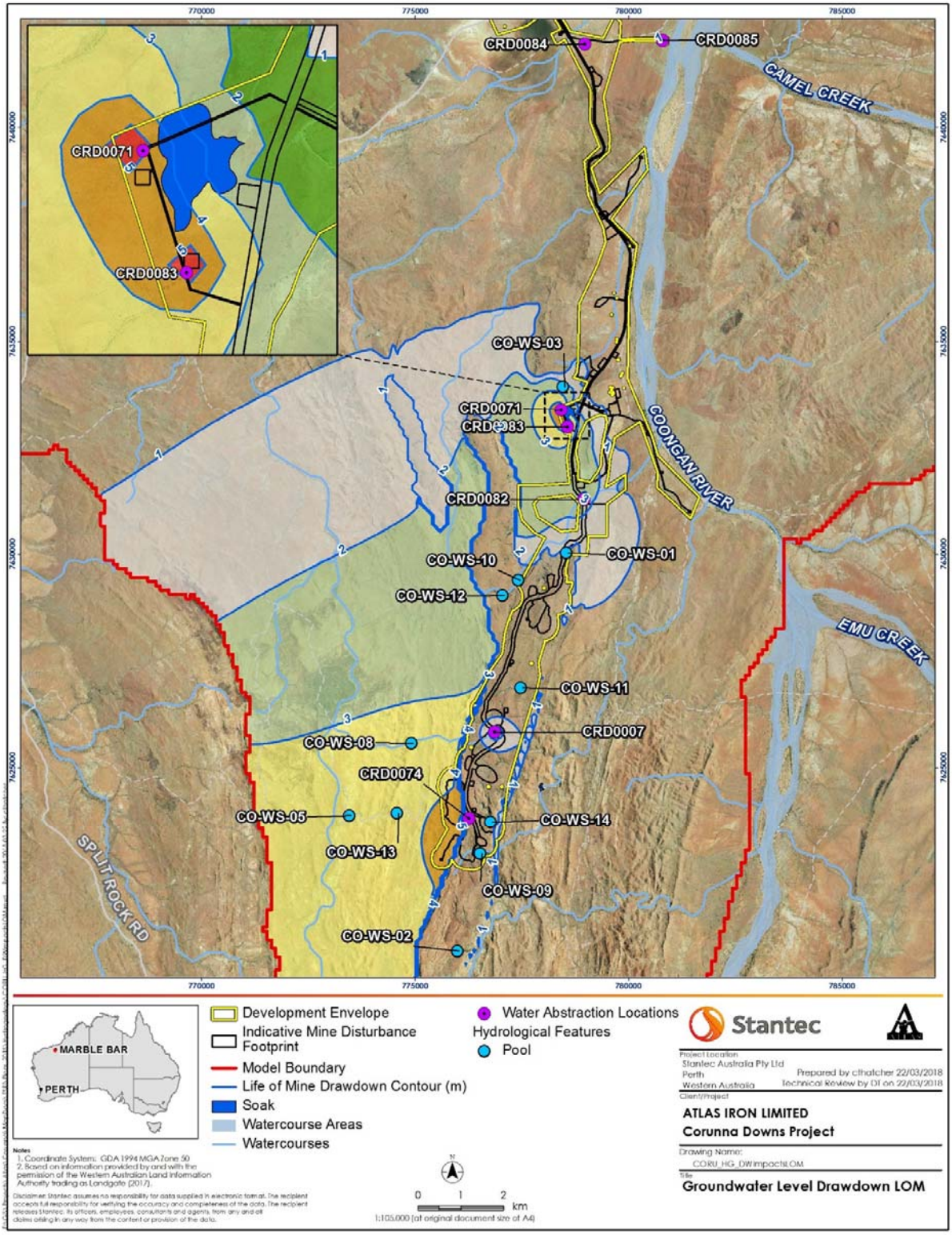


Figure 9-1: Drawdown estimate at end of the life of mine (LOM)

9.2 Drawdown and Radius of Influence

9.2.1 Mine Site Operational Water Supply

The maximum predicted drawdown at the end of LOM is presented on Figure 9-1, for the production schedule outlined in Table 9-1. This is the operational abstraction schedule, numerically modelled to minimise likely drawdown impacts at sensitive environmental locations (refer Section 9.3).

While drawdown contours in the southern cluster (associated with water abstraction at CRD0074 and CRD0007) may be considered to be tentative given no test pumping has been conducted in this area, available information from testing in other areas and from exploration bores (including the nature of water level distribution) suggests that aquifer permeability may be low and/or the aquifer geometry may be affected by compartmentalisation.

Future drilling and test pumping on the range will provide useful information to better understand the hydrogeological environment/connectivity in this area and can be used to revise the numerical model and associated drawdown estimations at the key environmental features.

9.2.2 Road Construction Water Supply

Prior to the commencement of mining, construction water will be needed to construction and upgrading of public and private roads. Pairs of production bores will supply Turkeys Nest (TN) storages along the road alignment, such that the requirement for 8 L/s per TN, will be shared by the two bores closest to each TN.

Cones of depression have been analytically calculated for all production bores operating at their proposed maximum abstraction rates for construction of the haul road (Table 9-2). As noted previously, the production bores will only operate for the duration of time that road construction is in their vicinity. Accordingly 2 months continuous operation has been modelled, using the transmissivities derived from the hydraulic testing.

Table 9-2: Summary of Modelled Operational Drawdown for Road Construction

Bore ID	CRT Pumping Rate (L/s)	Transmissivity Range (m^2/day)	Proposed Pumping Rate (L/s)	Aquifer Drawdown at Bore (m)	Aquifer Drawdown at 1 km radius (m)	Aquifer Drawdown at 5 km radius (m)
CRD0082	25	190 to 210	4.0	3.00	0.40	0.10
CRD0083	20	200 to 220	4.0	2.86	0.45	0.05
CRD0084	6	47 to 237	4.0	4.16	0.60	0.00
CRD0085	5	100 to 165	4.0	4.52	0.60	0.00
CRD0086	4	395.00	3.0	1.17	0.22	0.04
CRD0087	15	593.00	5.0	1.33	0.29	0.08
CRD0088	12	300 to 440	4.0	1.67	0.30	0.06
CRD0089	12	22 to 54	4.0	14.58	0.13	0.00

Fractured rock settings are very difficult to analytically model and hydraulic properties derived from hydraulic testing are typically imprecise as the primary assumptions used in classical methods of pumping test analysis, do not apply in fractured rock settings. In particular, fractured rock settings are not homogeneous, isotropic, nor of infinite extent. Compartmentalisation is common and drawdown

distribution and magnitude depends upon how the fractured fabrics and structural features in the rock are connected.

Reference to Table 9-2 shows that for the pumping scenario examined, drawdown impacts 1 km from the bore are generally less than a 0.6 m, and by 5 km radius, they are negligible to zero m.

9.3 Groundwater Dependant Ecosystems

Eleven (11) small permanent or ephemeral pools have been identified in the upper (southern) reaches of the catchment, in the vicinity of the proposed mining areas (Table 9-3 and Figure 9-2). Four of the features have been identified as likely to be supported to some extent by groundwater contributions. In response to hydrogeological queries (received 20/09/2017) raised by the Department of Mines, Industry Regulation and Safety (DMIRS) and DWER on review of the Corunna Downs mining proposal, studies have been undertaken on the nature of these pools in the context of groundwater dependent ecosystems (Stantec, 2018). While a number of pools were identified as being potentially at risk at the operational mine abstraction rates (approximately 30.5 L/s), these combined operational abstraction rates greatly exceed the requirements of abstraction for haul road construction: 8 L/s per TN over 6 months. It is unlikely that abstraction for haul road construction will affect the pools or soak.

Table 9-3: Summary of surface water feature details.

Location ID	Easting	Northing	Elevation (mAHD)	TDS (mg/L)	Groundwater Source
CO-WS-01	778586	7630030	255.627	210	Likely
CO-WS-02	776034	7620690	371.100	No sample	Unlikely
CO-WS-03	778506	7633950	227.531	180	Unlikely (dry)
CO-WS-05	773504	7623870	313.184	690	Likely
CO-WS-08	774961	7625570	321.721	510	Unlikely
CO-WS-09	776568	7622980	344.725	2800	Unlikely (dry)
CO-WS-10	777461	7629400	297.225	No sample	Unlikely
CO-WS-11	777517	7626870	398.728	33	Unlikely
CO-WS-12	777092.2	7629040	373.970	100	Likely
CO-WS-13	777092	7629040	327.170	550	Unlikely
CO-WS-14	774623	7623940	320.990	190-210	Likely

Notes: Coordinates are GDA94

The operational raw water requirements were numerically modelled for the life of mine as outlined in (Section 9.1). Table 9-4 lists the drawdown results at specified time steps for each of the key environmental features. Four of the pools CO-WS's 3, 5, 8,and 13 were identified as having drawdowns of over 1 m after a year of abstraction at 30.5 L/s. By the end of mining the model indicated that these same features had been impacted between 2.3 and 3.73 m.

Woodman Environmental Consultants (WEC, 2018a) conducted an assessment of groundwater drawdown impacts to vegetation over the Project area. This assessment evaluated the presence of groundwater dependent vegetation (GDV), both on a landscape scale (VTs) and growing in association with key surface water features (pools), and the project's risk of groundwater drawdown related impact on this vegetation over the life of mine. The assessment identified the following potentially groundwater dependent features that may be at Moderate to High risk of impact and therefore require site specific assessment and potentially monitoring of impacts:

- Moderate risk of impact: 0.15 ha of GDV mapped as VT 3 (vegetation may provide a role as a refuge);
- High risk of impact: 48.79 ha of GDV (VTs classified as being obligate (VT 15) or facultative and may provide a role as a refuge (VT 3);
- Surface water features: CO-WS-05, CO-WS-08 and CO-WS13; due to a combination of GDV presence, groundwater dependence of the pool areas and potential impact on groundwater levels in these areas (as reported by Stantec 2018a).

Given the short project life, the relatively small areas of the VTs at risk of impact and their broader distributions in the project area, the potential impacts are not considered to be significant in a regional context.

Two other important hydrological features have been identified in the vicinity by previous surveys:

- A freshwater wetland system was identified by Golder Associates Pty Ltd (2010). This feature corresponds to identified important surface water features CO-WS-05 and CO-WS-13 already discussed; and
- A feature referred to as a "freshwater soak" has been investigated separately in the context of potential impacts of groundwater abstraction (WEC, 2018b), and has been determined to not represent groundwater dependent vegetation. This site is characterized as VT 8.

Table 9-4: Drawdown estimates for key environmental locations, at specified time steps

Key Environmental Feature	Drawdown estimations over the Life of Mine (m)						
	0.5 Yr	1 Yr	2 Yr	3 Yr	4 Yr	5 Yr	6 Yr
CO-WS-01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
CO-WS-02	0.01	0.04	0.12	0.22	0.33	0.45	0.56
CO-WS-03	0.91	1.34	1.79	2.01	2.15	2.24	2.30
CO-WS-05*	0.69	1.25	2.07	2.63	3.02	3.31	3.52
CO-WS-08*	0.75	1.27	2.01	2.51	2.86	3.12	3.31
CO-WS-09*	0.01	0.02	0.04	0.07	0.09	0.10	0.11
CO-WS-10	0.00	0.00	0.01	0.01	0.01	0.02	0.02
CO-WS-11*	0.01	0.03	0.09	0.15	0.21	0.26	0.29
CO-WS-12	0.00	0.01	0.02	0.03	0.03	0.04	0.05
CO-WS-13*	0.91	1.48	2.30	2.85	3.24	3.52	3.73
CO-WS-14*	0.02	0.04	0.06	0.07	0.08	0.09	0.10

* Subject to further hydrogeological characterisation (i.e. drilling and test pumping of proposed water abstraction bores on the range.

While haul road construction is unlikely significantly impact on any of the pools, the numerical model output indicates that there may be significant drawdown impacts and a strict monitoring program will need to be put in place to monitor all the pools and the soak, immediately before operational abstraction begins. The proposed monitoring program is outlined in the Operating Strategy (Appendix H)

Note that studies for the operational impacts for mining are ongoing in consultation with DMIRS and DWER.

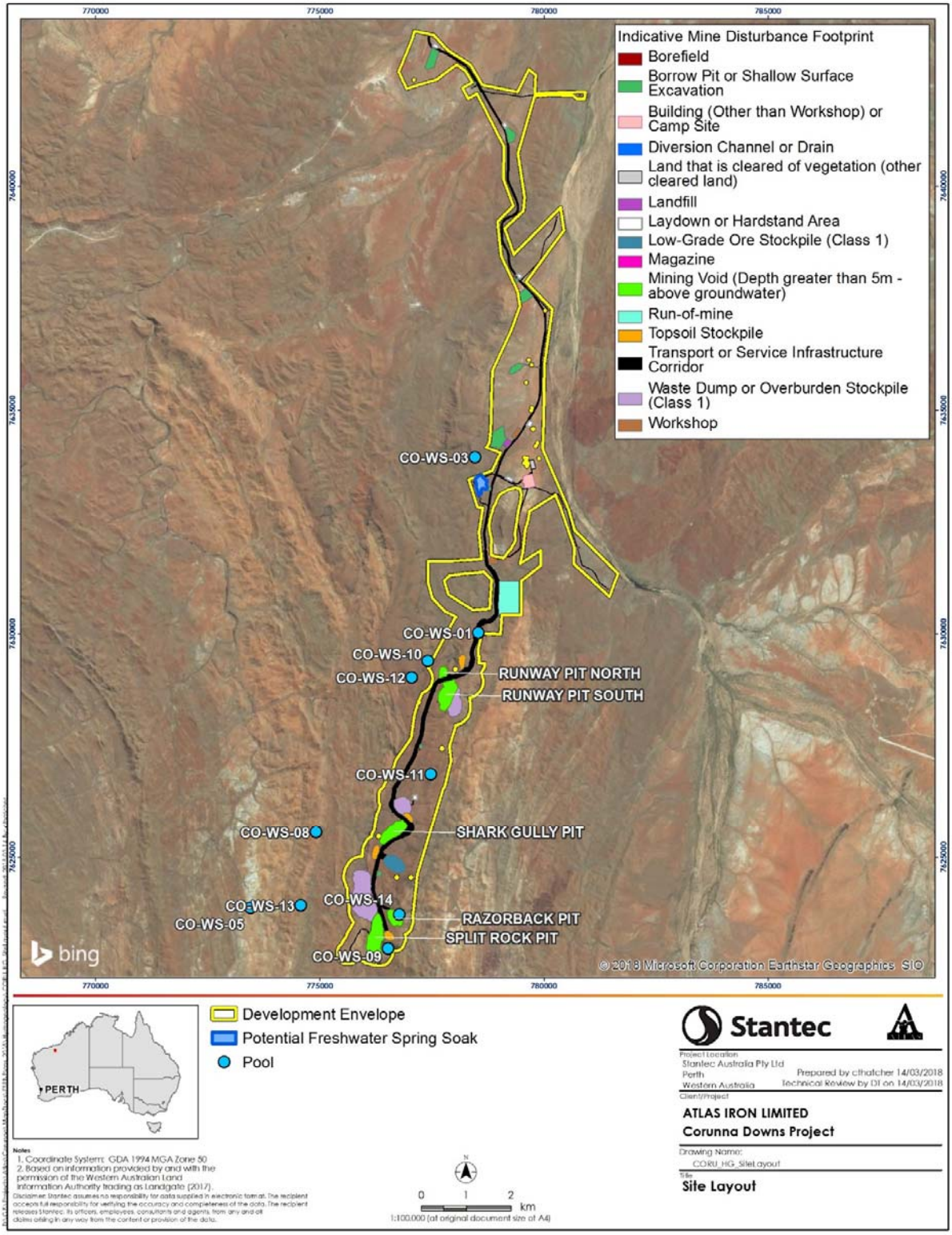


Figure 9-2: Location of Possible Groundwater Dependant Ecosystems

9.4 Other Groundwater Users

A search of DWER borehole databases revealed no other groundwater users along the haul road alignment, close enough to be impacted by abstraction for haul road construction. The closest significant other users production bore is Bore 1/99 (DWER Site Reference 71012155) located in the Marble Bar township water supply borefield, approximately 3.2 km north northwest of CRD0088. The location of the Marble Bar borefield is adjacent to the Coongan River and across the geological strike of the country rock between the borefield and CRD0088. It is unlikely that abstraction of 4 L/s from CRD0088 for a portion of the 6 month construction period, will impact upon the borefield.

No other groundwater users have been identified with 5 km of the haul road construction water supply bores or the mining area. Registered bores within 5 km of the production bores are all either abandoned or belong to Atlas.

9.5 Groundwater Quality

Groundwater pumping induced changes groundwater quality was investigated through test pumping on each new production bore. Electrical conductivity was monitored throughout the step and constant rate testing. There were no significant changes observed due to different pumping rates or prolonged pumping for the duration of the tests. A groundwater sample was also collected at the start and the end of testing, these showed no significant changes in any ion concentration.

10. Operating Strategy

A Groundwater Operating Strategy for the Project, prepared in a standalone format to facilitate operational utilisation, and in accordance with DWER's Operational policy 5.08 - Use of operating strategies in the water licensing process (DoW, 2011), is attached in Appendix H.

11. Summary/Recommendations

The key findings from the hydrogeological investigation are as follows:

- Twelve (12) pilot groundwater exploration holes have been drilled along the proposed haul road alignment.
- Eight (8) production bores have been constructed adjacent to the best performing pilot holes, using ND 200 mm (8") Class 12 UPVC blank and slotted casing.
- All production bores have been hydraulically tested by step rate testing (four 100 minute steps at increasing rates), a 72 hour constant rate test (CRT), and a recovery test. Test details are summarised in Table 6-1.
- Groundwater in the study area is fresh to brackish, with TDS ranging from 410 to 1,800 mg/L. The key major ions include sodium (43 to 630 mg/L), chloride (19 to 500 mg/L), and bicarbonate (300 to 700 mg/L). Potassium concentrations are relatively low (0.5 to 2.5 mg/L).
- With the exception of fluoride, arsenic, manganese and nickel, all groundwater sample concentrations for analytes listed in the Australian Drinking Water Guidelines (NHMRC, NRMMC, 2011) are below guideline concentrations.

- CRD0086 is the only production bore in which Australian Drinking Water Guidelines criteria were exceeded and given the groundwater will be used for road construction, the exceedances are not considered to be a risk to livestock or the environment.

- Surface water TDS ranges from 33 to 2,800 mg/L, and is generally characterised by the same major ions as in the groundwater, although in differing relative concentrations.

- The production bores are all hydraulically inefficient to various degrees and they are not likely to be able to sustain the pumping rates selected for the CRTs. The proposed operational pumping rates the production bores are presented in Table 9-2.

- Sustainability at any selected pumping rate for individual bores will be a function or balance between recharge (rainfall), available storage, and the rate of pumping. Accordingly, the time of the year when the six month water supply is required, will affect the operational sustainability of supply.

- There are no other groundwater users along the proposed haul road alignment that could be impacted by abstraction for construction water supply.

- There are a number of surface water pools that may be temporarily impacted by abstraction from nearby production bores. However, the short duration of the haul road construction (6 months) and the even shorter duration of abstraction from individual production bores along the alignment (assumed maximum 2 months), means impacts if any, are likely to be minimal and of short duration. Nevertheless, monitoring of individual pools located near production bores will be carried out. Production bores where this will apply are CRD0082 and CRD0083.

- Abstraction for the mine site operational water requirements over the life of mining may impact upon surface water pools CO-WS-03, CO-WS-05, CO-WS-08, and CO-WS-13, and these features will be the focus of stringent monitoring during the life of mine operations.

- This report is to be submitted to the Department of Water and Environmental Regulation, in support of an application for a 5C Licence to Take Water, for an annual allocation of 1,100,000 kL.

12. References

ANZECC, 2000. Australian and New Zealand Guidelines for Fresh and Marine Waters.

Bureau of Meteorology (BOM), 2016a. Climate Data Online [online]. Available at: http://www.bom.gov.au/climate/data/. Accessed October 2016.

DoW, 2011: Operational policy 5.08 - Use of operating strategies in the water licensing process. Government of Western Australia, Department of Water. June 2011.

DoW 2009: Operational policy 5.12: Hydrogeological reporting associated with a groundwater well licence.

Hem, J. (1985). "Study and Interpretation of the Chemical Characteristics of Natural Water."U.S Geological Survey Water-Supply Paper, 2254.

Hickman, AH and Lipple, SL, 1978: Marble Bar, Western Australia, 1:250 000 Geological Series Explanatory Notes, Sheet SF50-8 International Index.

Hickman, AH, 2010: Marble Bar, WA Sheet SF 50-8 (3rd edition). Geological Survey of Western Australia, 1:250 000 Geological Series.

Johnson, S. L. and A. H. Wright (2001). "Central Pilbara Groundwater Study." Water and Rivers Commission, Perth.

MWH, 2017. Review of water supply targets Corunna Downs haul road Section 91 Area. Prepared for Atlas Iron Limited

NHMRC, NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra

Ruprecht et al, 2000. Surface Hydrology of the Pilbara Region, Summary Report. Water and Rivers Commission, Surface Water Hydrology Report Series, Report No SWH 32.

Stantec, 2018: Corunna Downs Project, Hydrogeological Investigation, prepared for Atlas Iron.

WEC, (2018a) Corunna Downs Project – Assessment of Groundwater Drawdown Impacts to Vegetation. Unpublished report prepared for Atlas Iron Limited. May, 2018

Appendices

Appendix A Groundwater Licences

Government of **Western Australia**
Department of **Water**

Your Ref: App13211
Our ref: RF10954; wrd352780
Enquiries: Stephanie Pham
(08) 6364 6874

securing Perth and Australia's water future

Corunna Downs

David Nyquest
Atlas Iron
PO Box 7071
Cloisters Square WA 6850

Dear David,

Re: Issue of a licence under the *Rights in Water and Irrigation Act 1914*

Property*:* L45/408, G45/339, L45/418, E45/4639, L45/407, M45/1257, L45/410 - *Corunna Downs Project*

Please find enclosed your licence to take groundwater – GWL176960(4).

Please take time to read this document as it contains important information about your rights and responsibilities.

In addition, please note the following:

There are Clearing Regulations Schedule 1 Areas within the tenements. Please be advised that if you wish to undertake any clearing of vegetation within these areas you will need to do so in consultation with the Department of Environment Regulation (DER). Please contact the DER on (08) 6467 5000 for further information.

If you have any queries about this matter please contact Stephanie Pham on (08) 6364 6874.

Yours sincerely,

Kevin Hopkinson
Program Manager – Pilbara District
North West Region
Department of Water

29 May 2017

168 St Georges Terrace Perth Western Australia 6000
PO Box K822 Perth Western Australia 6842
Telephone (08) 6364 7600 Facsimile (08) 6364 7601
www.water.wa.gov.au

File No: RF10954

Government of **Western Australia**
Department of **Water**

Instrument No. GWL176960(4)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Atlas Iron Limited		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	100000 kL
Location of Water Source	L45/408, G45/339, L45/418, L45/410, L45/407, M45/1257, E45/4639		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes Exploratory drilling operations General campsite purposes Potable Water Supply purposes Road construction purposes Road maintenance purposes	L45/408, G45/339, L45/418, L45/410, L45/407, M45/1257, E45/4639

Duration of Licence	From 29 May 2017 to 28 May 2027

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

End of terms, conditions and restrictions

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

Government of **Western Australia**
Department of **Water**

Your Ref: App13998
Our ref: RF10954; wrd358426
Enquiries: Stephanie Pham
(08) 6364 6874
Securing Western Australia's water future

David Nyquest
Atlas Iron
PO Box 7071
Cloisters Square WA 6850

Dear David,

Re: Issue of a licence under the *Rights in Water and Irrigation Act 1914*

Property*:* Section 91 Lic 869-2016_A6435862 - *Corunna Downs Project*

Please find enclosed your licence to take groundwater – GWL184565.

Please take time to read this document as it contains important information about your rights and responsibilities.

In addition, please note the following:

There are registered sites of Aboriginal Heritage Significance within the project area. Please be advised that it is your responsibility to ensure appropriate consultation with any affected Traditional Owners and adequate referral to the Department of Aboriginal Affairs (DAA) is made, to ensure full compliance with the *Aboriginal Heritage Act 1972*.

Clearing Regulations Schedule 1 Areas are within your project area. Please be advised that if you wish to undertake any clearing of vegetation within these areas you will need to do so in consultation with the Department of Environment Regulation (DER). Please contact the DER on (08) 6467 5000 for further information.

Contaminated site ID1335 near Halse Road/Limestone Marble Bar Road has been identified as near or within your project area. The site is listed as "possibly contaminated – investigation required" under the Department of Environment Regulation (DER) contaminated sites classification system. Please consult the DER for additional information and advice and/or any relevant approvals. The DER Contaminated Sites hotline number is **1300 762 982.**

Priority fauna are located within the project area. If you have any queries, please contact the Department of Parks and Wildlife's Species and Communities Branch on (08) 9219 9511 for further information.

The Marble Bar Water Reserve was proclaimed in 1972 under the *Country Areas Water Supply Act 1947 (CAWS)*.

168 St Georges Terrace Perth Western Australia 6000
PO Box K822 Perth Western Australia 6842
Telephone (08) 6364 7600 Facsimile (08) 6364 7601
www.water.wa.gov.au

A Drinking Water Source Protection Plan was prepared for the Marble Bar Water Reserve in 2000, and updated in 2010. Groundwater is drawn from the Coongan well-field 2-3km west of the town and adjacent to the Coongan River. The Coongan wellfield draws from fractured volcanic rock on the Coongan Rivers eastern bank. Significant recharge occurs during high rainfall events and the direction of groundwater flow is closely related to surface drainage, in a north to north westerly direction.

Given the unconfined nature of the aquifer, it is vulnerable to contamination. Land and water based uses and activities within the catchment can directly affect water quality and treatment. It should be noted that protecting a drinking water supply to provide a safe drinking water source is a cheaper option than both treatment and remediation; furthermore treatment is not 100% reliable.

It is therefore important to ensure any bores are appropriately located to avoid drawdown and constructed to prevent contamination of the public drinking water source. All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

Existing and future mining proposals within the water reserve are compatible with conditions, and should adhere to the Department of Water's *Water Quality Protection Guidelines for Mining and Mineral Processing 1- 11* and other relevant Water Quality Protection Notes published by the Department of Water

If you have any queries about this matter please contact Stephanie Pham on (08) 6364 6874.

Yours sincerely,

Kevin Hopkinson
Program Manager – Pilbara District
North West Region
Department of Water

30 May 2017

File No: RF10954

Government of Western Australia
Department of Water

Instrument No. GWL184565(1)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Atlas Iron Limited		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	100000 kL
Location of Water Source	Section 91 of the LAA Lic 00869-2016_A6435862		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes Exploratory drilling operations Road construction purposes Road maintenance purposes	Section 91 of the LAA Lic 00869-2016_A6435862

Duration of Licence	From 31 May 2017 to 31 January 2019

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

End of terms, conditions and restrictions

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

Appendix B Type lithology examples

The table below illustrates the different lithology's that were encountered during the Corunna Downs hydrogeological drilling investigation. The table acts as a type example of geological descriptions used in the drill logs presented Appendix C.

Formation	Type/Weathering	Photo	Description
Mt Roe Basalt	Extremely Weathered		Extremely weathered, cream/grey powder and clay material. No visible texture or grain size. *Photo: CRD0058 4 – 12 mbgl*
Mt Roe Basalt	Highly Weathered		Highly weathered, red/yellow/purple colour, chips 1-20 mm. *Photo: CRD0050 33 mbgl*
Mt Roe Basalt	Weathered		Weathered, black/grey/brown, very hard and angular, chips 1-5 mm. *Photo: CRD0050 30 mbgl*
Mt Roe Basalt	Fresh		Fresh dark grey/black basalt *Photo: CRD0026 74 mbgl*
Mt Roe Basalt	Doleritic		Doleritic basalt, dark grey, 40% mafic, 60% quartz. *Photo: CRD0026 36 mbgl*

Duffer Formation	Moderately weathered		Photo: CRD0078 32 mbgl

Appendix C Drillhole Graphic Logs

EXPLORATION BORE
CRD0038 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 9/4/17 **COMPLETED** 10/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 18.00 m bgl
LOGGED BY DN, Atlas Iron **CHECKED BY** PH, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0038 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
0	Steel: +0.2 m; Inclination: -90 (deg); 12" Surface Steel Casing [0.2 - 6 mbgl]				
		ALLUVIUM			ALLUVIALS: Sub-rounded, silty sand and clay.. *[6 m]*
6.0					
					ALLUVIALS: Sub-rounded, silty sand and clay, some calcrete.. *[10 m]*
16.0					
		ROE BASALT			GRANITE: Highly weathered with clay. Water at 18m.. *[10 m]*
26.0					GRANODIORITE/GRANITE: Moderately weathered, quartz. *[16 m]*
42.0					BASALT: Moderately fresh, possible granodiorite and lots of quartz. *[18 m]*
50	6" Air Hammer Drilling Method [6-60 mbgl]				

DISCH. drilling (L/s): 1, 2, 3, 4
EC drilling (µS/cm): 320, 440, 560, 680
pH drilling: 8.2, 8.4, 8.6, 8.8
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE

CRD0038 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 9/4/17 **COMPLETED** 10/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 18.00 m bgl
LOGGED BY DN, Atlas Iron **CHECKED BY** PH, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

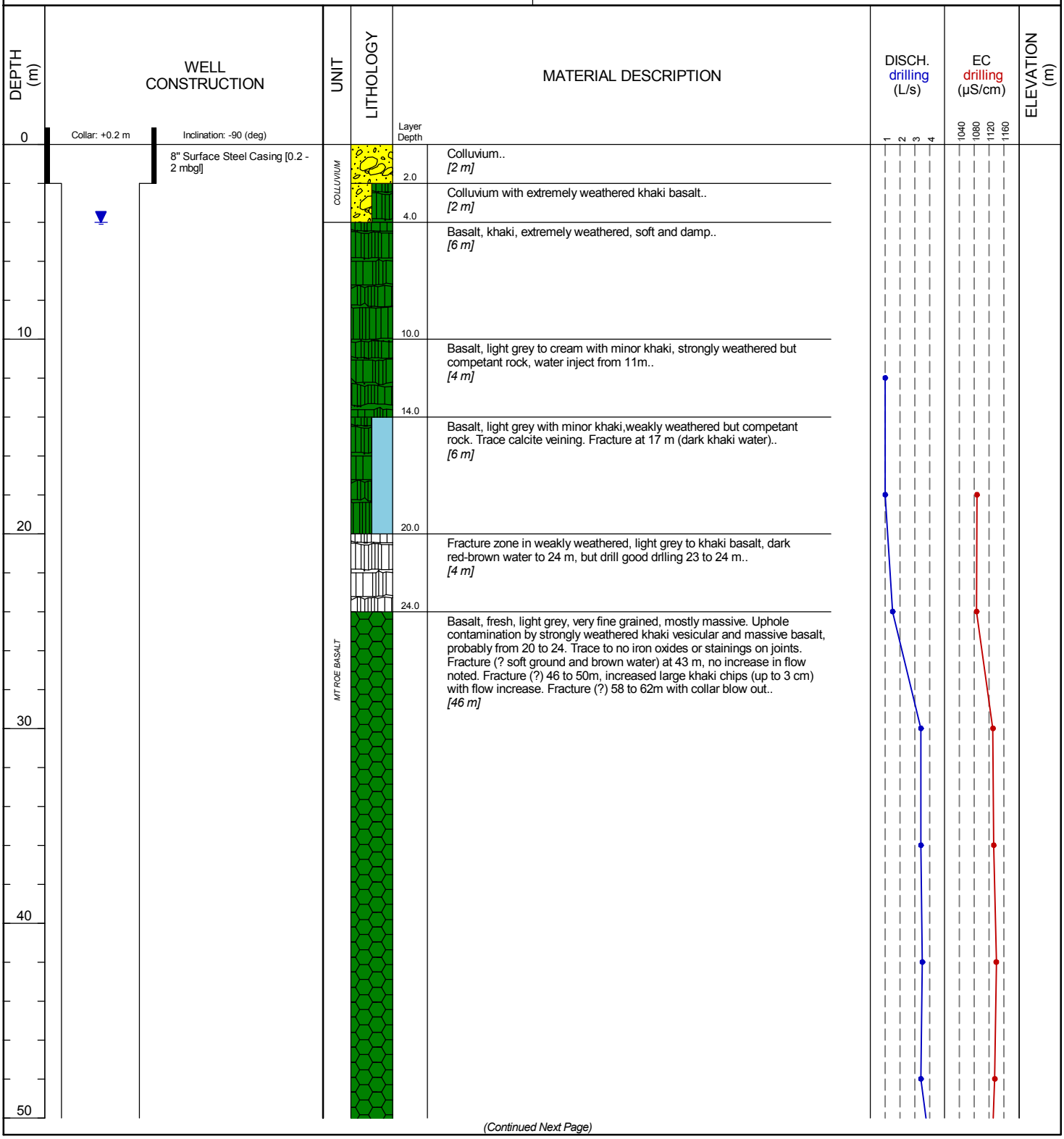
Comments:
No construction as CRD0038 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	pH drilling	ELEVATION (m)
50	Inclination: -90 (deg)	ROE BASALT			BASALT: Moderately fresh, possible granodiorite and lots of quartz. *[18 m]* (continued)	1 2 3 4	320 440 560 680	8.2 8.4 8.6 8.8	
60				60.0	**Bottom of borehole at 60.0 m.**				

EXPLORATION BORE
CRD0039

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 5/11/17 **COMPLETED** 6/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 4.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782275 **NORTHING** 7652340
GROUND ELEVATION **DATUM**

Comments:
Water inject from 11 m due dust. Lots of water at 12 m rod change, no water inject from 13 m - free flowing. Collar blew out due water erosion. No construction as CRD0039 is a pilot hole.



(Continued Next Page)

EXPLORATION BORE
CRD0039

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 5/11/17 **COMPLETED** 6/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 4.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782275 **NORTHING** 7652340
GROUND ELEVATION **DATUM**

Comments:
Water inject from 11 m due dust. Lots of water at 12 m rod change, no water inject from 13 m - free flowing. Collar blew out due water erosion. No construction as CRD0039 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
50	Inclination: -90 (deg) 6" Air Hammer Drilling Method [2-102 mbgl]	MT ROE BASALT			Basalt, fresh, light grey, very fine grained, mostly massive. Uphole contamination by strongly weathered khaki vesicular and massive basalt, probably from 20 to 24. Trace to no iron oxides or stainings on joints. Fracture (? soft ground and brown water) at 43 m, no increase in flow noted. Fracture (?) 46 to 50m, increased large khaki chips (up to 3 cm) with flow increase. Fracture (?) 58 to 62m with collar blow out.. *[46 m]* (continued)	1 2 3 4	1040 1080 1120 1160	
60								
70				70.0	Fracture zone / joint zone in fresh basalt (as above), Iron oxide coats and stains on planar joints. Water brown green.. *[4 m]*			
				74.0	Basalt, fresh, light grey, mostly very fine grained and massive. Uphole contamination by strongly weathered khaki vesicular and massive basalt. Increased flow between 78 and 84 m not discernable lithologically.. *[28 m]*			
80								
90								
100								

(Continued Next Page)

EXPLORATION BORE
CRD0039

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 5/11/17 **COMPLETED** 6/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 4.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782275 **NORTHING** 7652340
GROUND ELEVATION **DATUM**

Comments:
Water inject from 11 m due dust. Lots of water at 12 m rod change, no water inject from 13 m - free flowing. Collar blew out due water erosion. No construction as CRD0039 is a pilot hole.

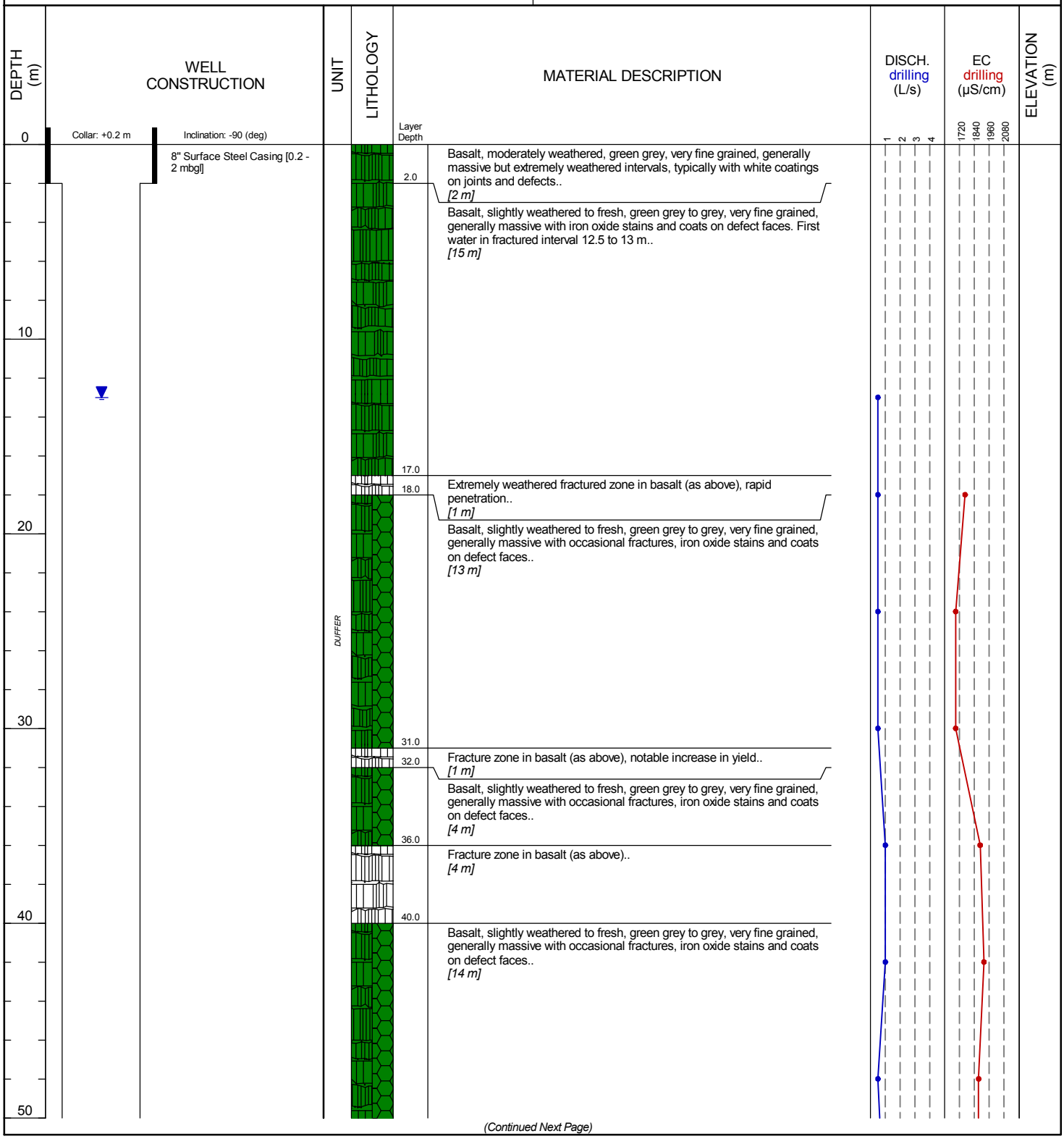
DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
100	Inclination: -90 (deg)			102.0		1 2 3 4	1040 1080 1120 1160	

Bottom of borehole at 102.0 m

EXPLORATION BORE
CRD0040

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 9/11/17 **COMPLETED** 10/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 13.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785602 **NORTHING** 7654390
GROUND ELEVATION **DATUM**

Comments:
Issues with hammer during drilling. No construction as CRD0040 is a pilot hole.



(Continued Next Page)

EXPLORATION BORE
CRD0040

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 9/11/17 **COMPLETED** 10/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
AT TIME OF DRILLING (Water Cut) 13.00 m bgl
DRILLING METHOD Air Hammer
AFTER DRILLING ---
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
EASTING 785602 **NORTHING** 7654390
GROUND ELEVATION **DATUM**

Comments:
Issues with hammer during drilling. No construction as CRD0040 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
50	Inclination: -90 (deg) 6" Air Hammer Drilling Method [2-102 mbgl]				Basalt, slightly weathered to fresh, green grey to grey, very fine grained, generally massive with occasional fractures, iron oxide stains and coats on defect faces.. *[14 m]* (continued)
				54.0	Fracture zone in basalt (as above).. *[2 m]*
				56.0	Basalt, slightly weathered to fresh, green grey to grey, very fine grained, generally massive with occasional fractures, iron oxide stains and coats on defect faces.. *[2 m]*
				58.0	Fracture zone in basalt (as above). Airlift returned numerous large (up to 3 cm) chips - uphole contamination?. *[2 m]*
60				60.0	Basalt, slightly weathered to fresh, green grey to grey, very fine grained, generally massive with occasional fractures, iron oxide stains and coats on defect faces.. *[14 m]*
70					
		DUFFER		74.0	Fracture zone in basalt (as above).. *[2 m]*
				76.0	Basalt, slightly weathered to fresh, green grey to grey, very fine grained, generally massive with occasional fractures, iron oxide stains and coats on defect faces.. *[4 m]*
80				80.0	Fracture zone in basalt (as above).. *[2 m]*
				82.0	Basalt, variously weathered to fresh, green grey to grey, very fine grained, generally massive with occasional fractures, iron oxide stains and coats on defect faces. Difficult to differentiate whether weathered material is in-situ or contamination.. *[20 m]*
90					
100					

DISCH. drilling (L/s): 1, 2, 3, 4
EC drilling (µS/cm): 1720, 1840, 1960, 2080
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE
CRD0040

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 9/11/17 **COMPLETED** 10/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 13.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785602 **NORTHING** 7654390
GROUND ELEVATION **DATUM**

Comments:
Issues with hammer during drilling. No construction as CRD0040 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
100	Inclination: -90 (deg)	DUFFER		102.0		1 2 3 4	1720 1840 1960 2080	

Bottom of borehole at 102.0 m

EXPLORATION BORE
CRD0043

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 3/11/17 **COMPLETED** 4/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 10.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782368 **NORTHING** 7652870
GROUND ELEVATION **DATUM**

Comments:
Delays due to rod handler and hammer sub. No construction as CRD0043 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
0	Collar: +0.2 m; Inclination: -90 (deg); 8" Surface Steel Casing [0.2 - 2 mbgl]	COLLUVIUM		1.5	Colluvium with weathered and fresh basalt lithics.. *[1.5 m]*
				5.0	Extremely weathered basalt with white clayey (when crushed) calcrete.. *[3.5 m]*
				8.0	Extremely weathered basalt, fresh chips are light blue grey, very fine grained, massive basalt.. *[3 m]*
10				10.0	Extremely weathered basalt, khaki, appears vesicular but hard to confirm given drilling technique.. *[2 m]*
					Weathered basalt, light blue grey, massive, iron oxide coatings on defects (joints and fractures).. *[8 m]*
		MT ROE BASALT		18.0	Basalt, occassionally weathered and occasional iron oxide stains and coats on joints and defects. Uphole contamination from weathered khaki vesicular basalt.. *[34 m]*
20					
30					
40	6" Air Hammer Drilling Method [2-84 mbgl]				
50					

DISCH. drilling cased (L/s) — 1, 2, 3, 4
EC drilling cased (µS/cm) — 1040, 1080, 1120, 1160
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE
CRD0043

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 3/11/17 **COMPLETED** 4/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 10.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782368 **NORTHING** 7652870
GROUND ELEVATION **DATUM**

Comments:
Delays due to rod handler and hammer sub. No construction as CRD0043 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
50	Inclination: -90 (deg)	MT ROE BASALT		52.0	
				53.0	Fractured zone in basalt (as above), water turned khaki over interval and large khaki vesicular basalt chips (>4 cm) recovered (contamination?).. *[1 m]*
60					Basalt, fresh, light blue grey, with khaki weathered basalt uphole contamination throughout. Trace iron oxide coatings, also possibly contamination.. *[31 m]*
70					
80				84.0	

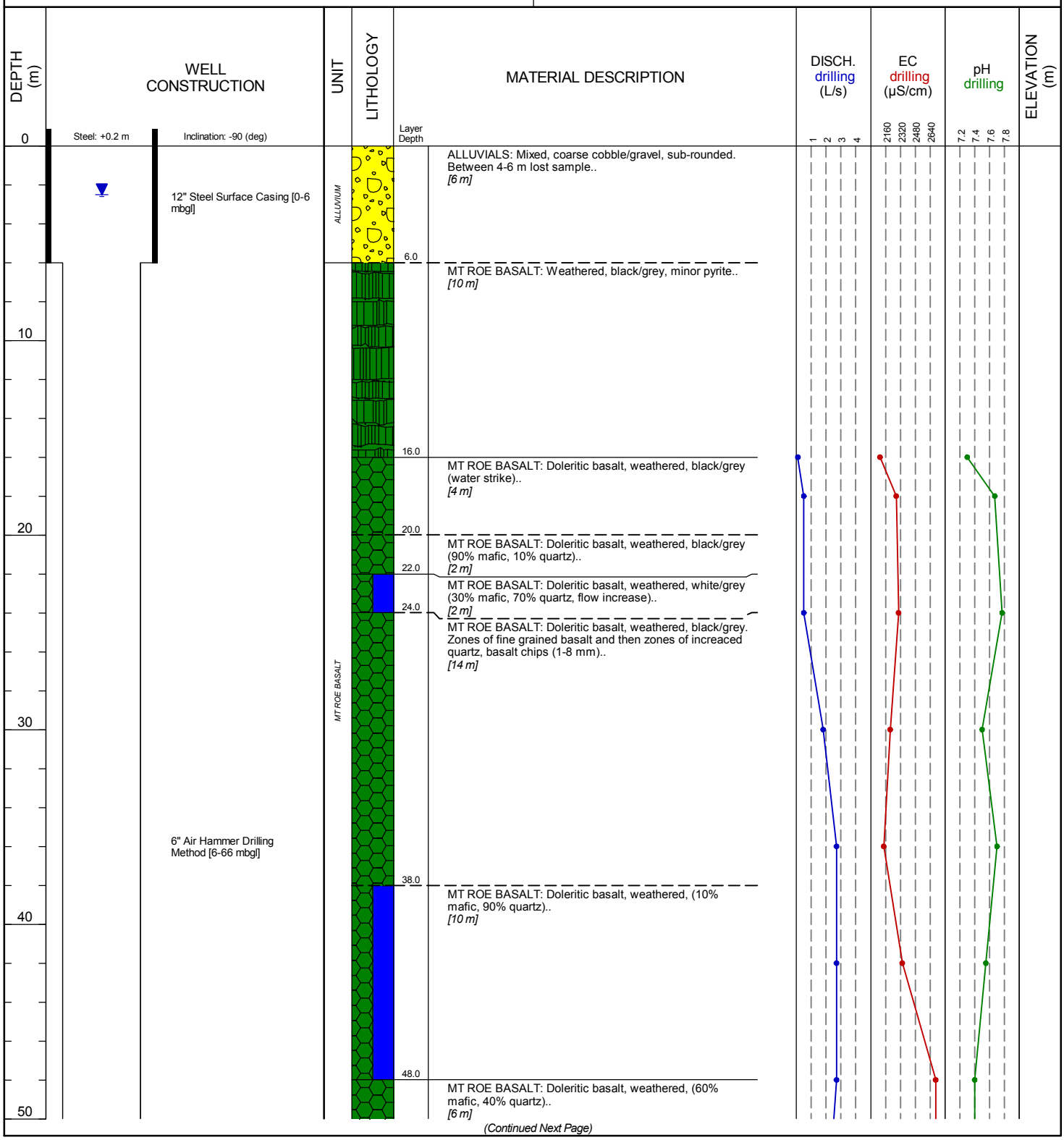
DISCH. drilling cased (L/s): 1, 2, 3, 4
EC drilling cased (µS/cm): 1040, 1080, 1120, 1160
ELEVATION (m)

Bottom of borehole at 84.0 m

EXPLORATION BORE
CRD0044 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/4/17 **COMPLETED** 11/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 2.50 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
The first 6m was mixed alluvials and an Initial water strike was measured at 2.5mbgl.

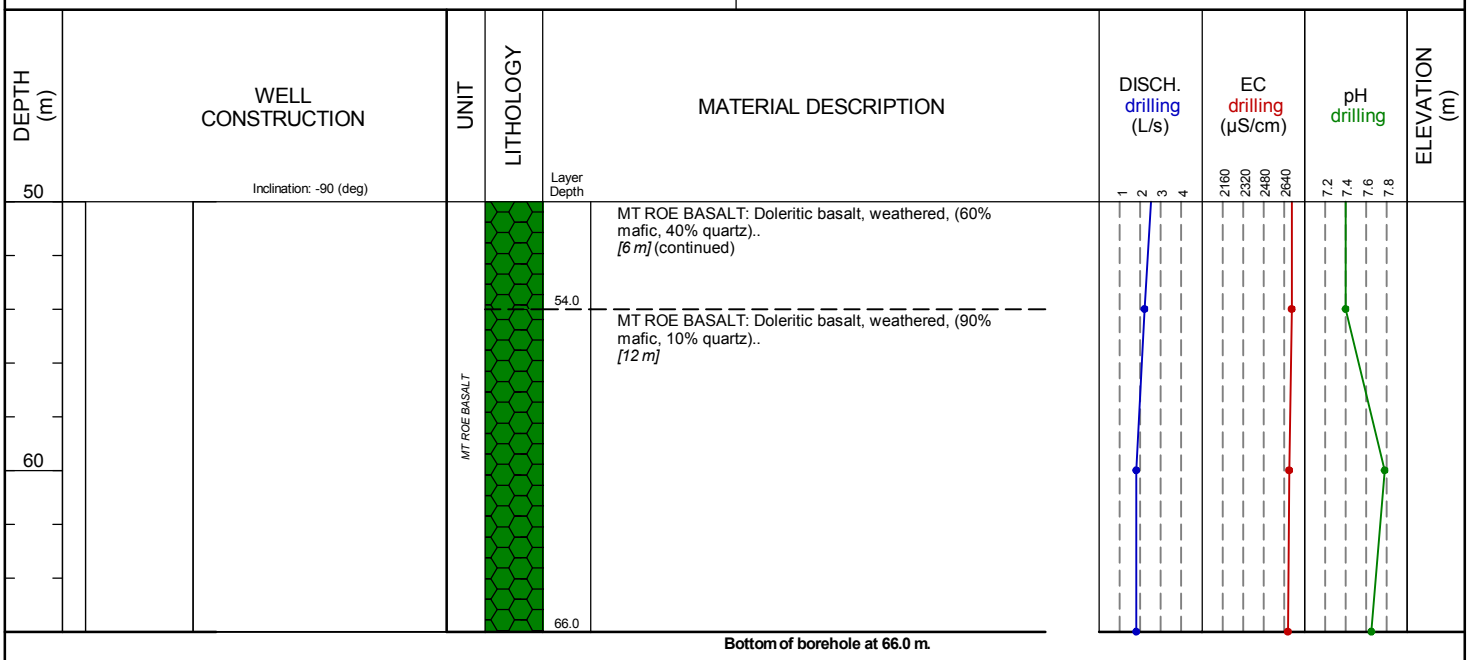


(Continued Next Page)

EXPLORATION BORE
CRD0044 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/4/17 **COMPLETED** 11/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 2.50 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FS, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
The first 6m was mixed alluvials and an Initial water strike was measured at 2.5mbgl.



Bottom of borehole at 66.0 m.

EXPLORATION BORE
CRD0045 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 12/4/17 **COMPLETED** 12/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0045 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
0	Steel: +0.2 m; Inclination: -90 (deg); 12" Surface Steel Casing [0.2 - 6 mbgl]	ALLUVIUM			ALLUVIALS: Mixture of basalts, shales, clay stones, sandstones,cherts, red/grey/brown colour, poorly sorted, angular and subrounded.. *[4 m]*
				4.0	
		ROE BASALT			Mt. Roe Basalt: Dark Grey/Black, coarse sand cuttings, 80% mafic minerals.. *[30 m]*
				34.0	
					Mt. Roe Basalt: Weathered 30% Brown/Red Chips.. *[4 m]*
				38.0	
	6" Air Hammer Drilling Method [6-72 mbgl]				Very consistent fresh Basalt, Grey/white, 100% Mafic, No QTZ, chip size varied from sand - 5mm.. *[34 m]*

DISCH. drilling (L/s): 1, 2, 3, 4
EC drilling (µS/cm): 880, 960, 1040, 1120
pH drilling: 7.4, 7.8, 8.2, 8.6
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE

CRD0045 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 12/4/17 **COMPLETED** 12/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING 7645380 **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0045 is a pilot hole.

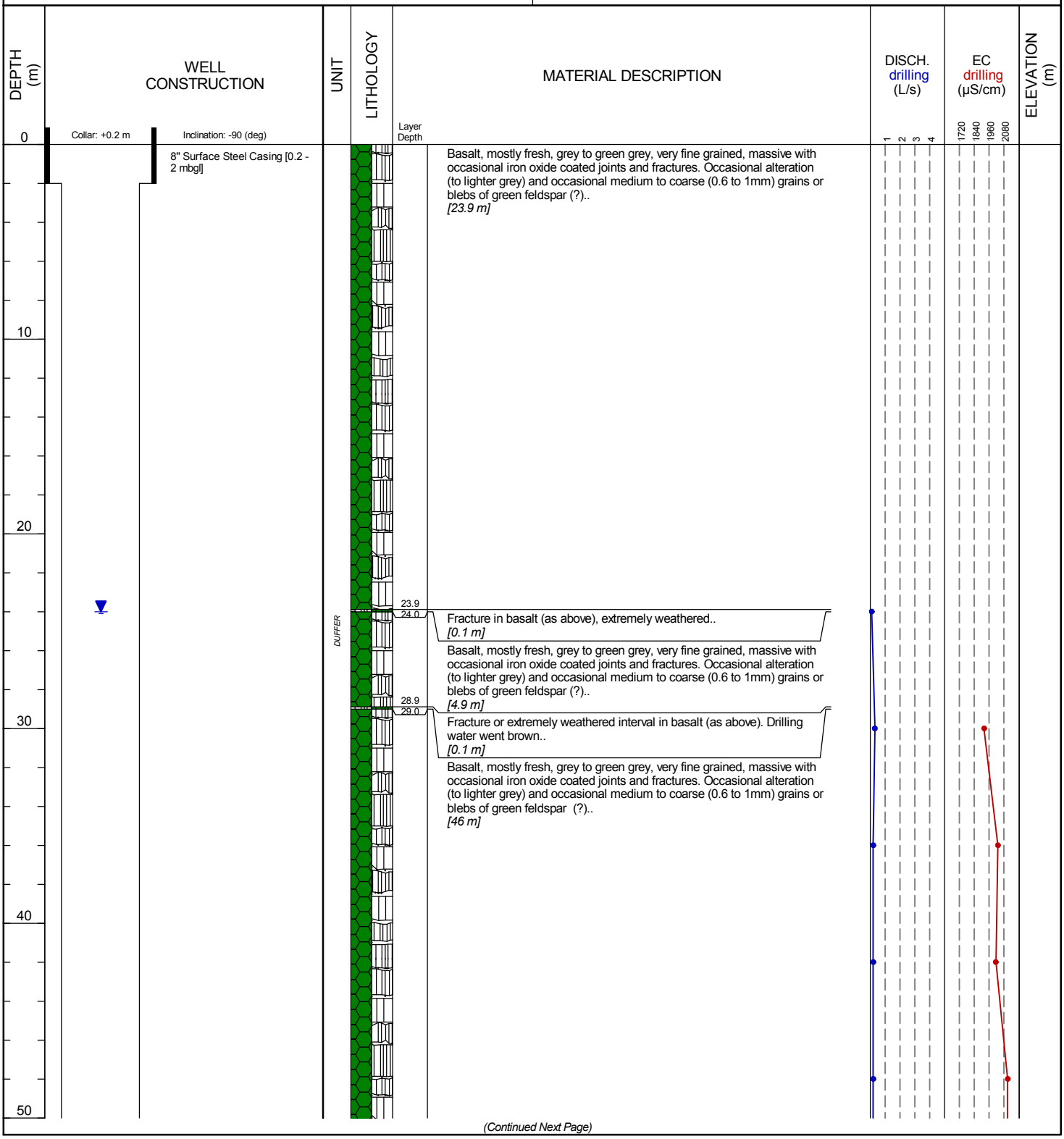
DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	pH drilling	ELEVATION (m)
50	Inclination: -90 (deg)	ROE BASALT			Very consistent fresh Basalt, Grey/white, 100% Mafic, No QTZ, chip size varied from sand - 5mm.. *[34 m]* (continued)	1 2 3 4	880 960 1040 1120	7.4 7.8 8.2 8.6	
60									
70				72.0					

Bottom of borehole at 72.0 m.

EXPLORATION BORE
CRD0051

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/11/17 **COMPLETED** 11/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785884 **NORTHING** 7654307
GROUND ELEVATION **DATUM**

Comments:
Water inject until 24m rod change. No construction as CRD0051 is a pilot hole.



(Continued Next Page)

EXPLORATION BORE
CRD0051

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/11/17 **COMPLETED** 11/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785884 **NORTHING** 7654307
GROUND ELEVATION **DATUM**

Comments:
Water inject until 24m rod change. No construction as CRD0051 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
50	Inclination: -90 (deg) 6" Air Hammer Drilling Method [2-102 mbgl]				Basalt, mostly fresh, grey to green grey, very fine grained, massive with occasional iron oxide coated joints and fractures. Occasional alteration (to lighter grey) and occasional medium to coarse (0.6 to 1mm) grains or blebs of green feldspar (?).. *[46 m]* (continued)
60					
70					
80					
90					
100					
		DUFFER		75.0 75.5	Fracture or extremely weathered interval in basalt (as above). Drilling water went very dark green and quality thereafter improved - different hydrogeological domain (?).. *[0.5 m]*
					Basalt, mostly fresh, grey to green grey, very fine grained, massive with occasional iron oxide coated joints and fractures. Occasional alteration (to lighter grey) and occasional medium to coarse (0.6 to 1mm) grains or blebs of green feldspar (?). Minor pink alteration and/or veining (feldspar?) 82 to 84 m.. *[9 m]*
				84.5 85.0	Fracture zone (driller described "broken gravel") with increased penetration rate.. *[0.5 m]*
					Basalt, mostly fresh, grey to green grey, very fine grained, massive with occasional iron oxide coated joints and fractures. Occasional alteration (to lighter grey) and occasional medium to coarse (0.6 to 1mm) grains or blebs of green feldspar (?). Minor pink alteration and/or veining (feldspar?) 90 to 92 m.. *[17 m]*

DISCH. drilling (L/s): 1, 2, 3, 4
EC drilling (µS/cm): 1720, 1840, 1960, 2080
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE
CRD0051

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/11/17 **COMPLETED** 11/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785884 **NORTHING** 7654307
GROUND ELEVATION **DATUM**

Comments:
Water inject until 24m rod change. No construction as CRD0051 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
100	Inclination: -90 (deg)	DUFFER		102.0		1 2 3 4	1720 1840 1960 2080	

Bottom of borehole at 102.0 m

EXPLORATION BORE
CRD0056

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 6/11/07 **COMPLETED** 7/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 30.50 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782732 **NORTHING** 7652279
GROUND ELEVATION **DATUM**

Comments:
Inject from surface as in competant rock from start. No construction as CRD0056 is a pilor hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
0	Collar: +0.2 m; Inclination: -90 (deg); 8" Surface Steel Casing [0.2 - 2 mbgl]	MT ROE BASALT			Basalt,variable highly weathered to fresh, light to dark grey and green grey, very fine to fine grained, pillow textured, massive to highly jointed/fractured (difficult to characterise with hammered chips). Common iron oxide coats and staining on joints and fractures. Fractures 30.5 to 31 m and 33 to 34 m, brown water. *[36 m]*
				36.0	Fracture zone in basalt (as above). Iron oxide coats on fracture faces and increased weathering, drilling water dark brown grey to black (manganese?).. *[6 m]*
				42.0	Basalt, highly weathered to fresh, light to dark grey and green grey, very fine to fine grained, pillow textured, massive to highly jointed/fractured. Iron oxide coats and stainings on joints and fractures.. *[4 m]*
				46.0	
				47.0	Fracture zone within basalt (as above), red brown drilling water.. *[1 m]*
					Basalt, weathered to fresh, light to dark grey and green grey, very fine to fine grained, massive to highly jointed/fractured. Iron oxide coats and staining on joints and fractures. Striated quartz in airlift sample from 48m
50				50.0	

DISCH. drilling (L/s): 1, 2, 3, 4
EC drilling (µS/cm): 1080, 1160, 1240, 1320
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE
CRD0056

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 6/11/07 **COMPLETED** 7/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 30.50 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782732 **NORTHING** 7652279
GROUND ELEVATION **DATUM**

Comments:
Inject from surface as in competant rock from start. No construction as CRD0056 is a pilor hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
50	Inclination: -90 (deg) 6" Air Hammer Drilling Method [2-102 mbgl]	MT ROE BASALT			(fault?).. *[3 m]* Fracture zone within basalt (as above) but with manganese joint and fracture coatings, dark brown drilling water.. *[4 m]*
				54.0	Basalt, fresh, light to dark grey and green grey, very fine to fine grained, massive to highly jointed/fractured. Occasional iron oxide coats and staining on joints and fractures.. *[26 m]*
60					
70					
80				80.0	
				81.0	Fracture zone in basalt (as above), driller repotered very crumbly ground, drilling water brown.. *[1 m]*
					Basalt, fresh, light to dark grey and green grey, very fine to fine grained, massive to highly jointed/fractured. Occasional iron oxide coats and staining on joints and fractures. Drilling water brown to 84m.. *[21 m]*
90					
100					

DISCH. drilling (L/s): 1, 2, 3, 4
EC drilling (µS/cm): 1080, 1160, 1240, 1320
ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE
CRD0056

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 6/11/07 **COMPLETED** 7/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 30.50 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782732 **NORTHING** 7652279
GROUND ELEVATION **DATUM**

Comments:
Inject from surface as in competant rock from start. No construction as CRD0056 is a pilor hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
100	Inclination: -90 (deg)			102.0		1 2 3 4	1080 1160 1240 1320	

Bottom of borehole at 102.0 m

EXPLORATION BORE
CRD0057 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/4/17 **COMPLETED** 10/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
LOGGED BY DN, Atlas Iron **CHECKED BY** PH, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0057 is a pilot hole. No water cut.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. (L/s)	EC (µS/cm)	pH	ELEVATION (m)
0	Steel: +0.2 m; Inclination: -90 (deg); 12" Surface Steel Casing [0.2 - 6 mbgl]	ALLUVIUM			ALLUVIALS: Silty clay.. *[8 m]*		0 0 0 0		
8.0		MT ROE BASALT			MT ROE BASALT: Highly weathered, some iron staining, quartz, clay.. *[16 m]*				
24.0					MT ROE BASALT: Weathered, hard, light grey (no water).. *[48 m]*				
10									
20									
30									
40	6" Air Hammer Drilling Method [6-72 mbgl]								
50									

(Continued Next Page)

EXPLORATION BORE
CRD0057 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 10/4/17 **COMPLETED** 10/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
LOGGED BY DN, Atlas Iron **CHECKED BY** PH, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0057 is a pilot hole. No water cut.

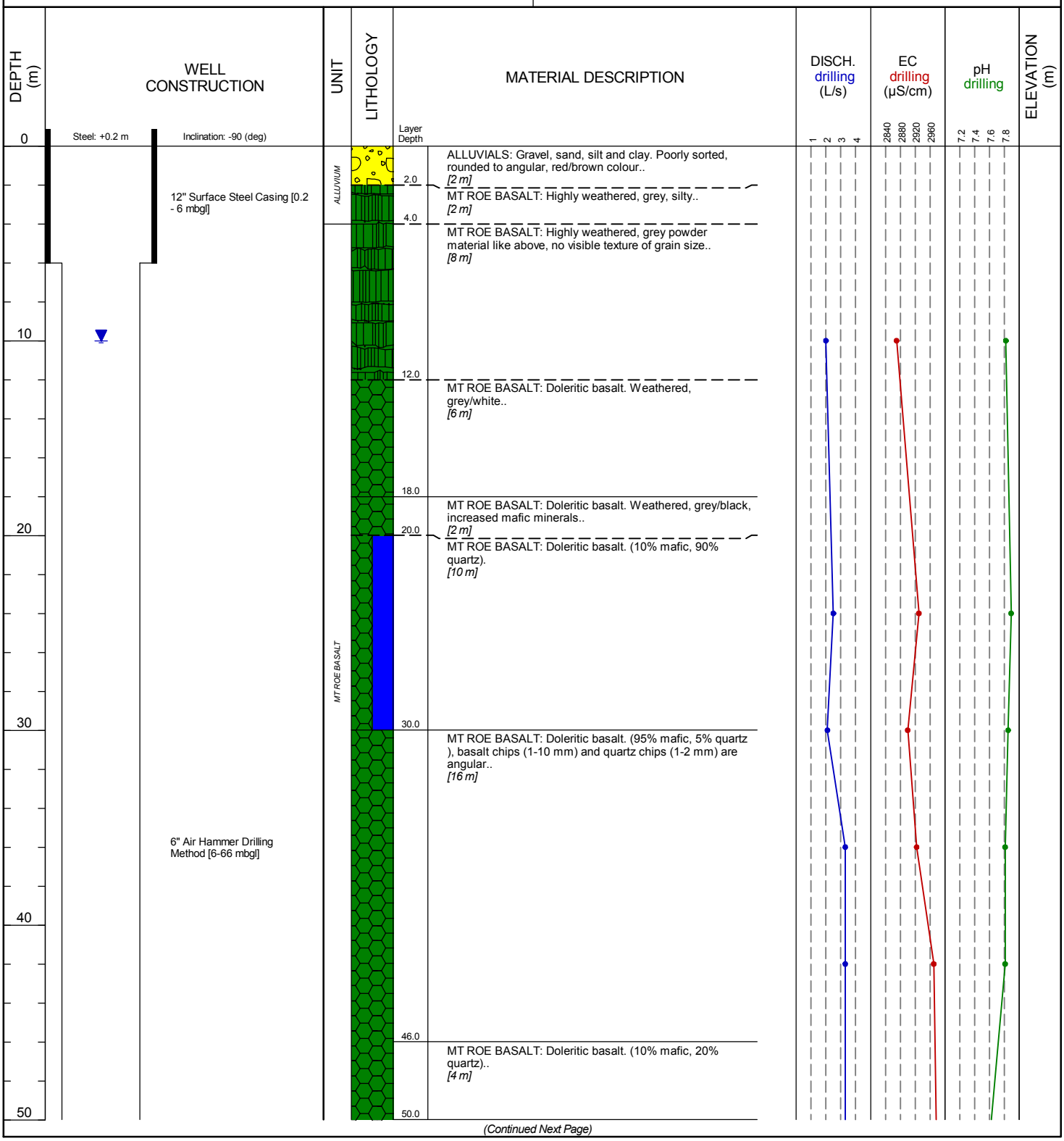
DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. (L/s)	EC (µS/cm)	pH	ELEVATION (m)
50	Inclination: -90 (deg)	MT ROE BASALT			MT ROE BASALT: Weathered, hard, light grey (no water).. *[48 m]* (continued)		0 0 0 0		
60									
70				72.0					

Bottom of borehole at 72.0 m.

EXPLORATION BORE
CRD0058 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 11/4/17 **COMPLETED** 12/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 10.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0058 is a pilot hole.



(Continued Next Page)

EXPLORATION BORE
CRD0058 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 11/4/17 **COMPLETED** 12/4/17
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 10.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0058 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	pH drilling	ELEVATION (m)
50	Inclination: -90 (deg)	MT ROE BASALT		66.0	MT ROE BASALT: Doleritic basalt. (10% mafic, 40% quartz).. *[16 m]*	1 2 3 4	2840 2880 2920 2960	7.2 7.4 7.6 7.8	
60									

Bottom of borehole at 66.0 m.

EXPLORATION BORE
CRD0078 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 8/5/17 **COMPLETED** 8/5/14
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 36.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0078 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION
0	Steel: +0.2 m; Inclination: -90 (deg); 12" Surface Steel Casing [0.2 - 6 mbgl]				
		DETRITALS		6.0	DETRITAL SEDIMENTS: Grey silt powder (90%), highly weathered yellow/white/brown angular claystones/mudstones chips (10%).. *[6 m]*
10		DETRITALS		14.0	DETRITAL SEDIMENTS: Light brown silt powder. *[8 m]*
		DUFFER FORMATION		16.0	DUFFER FORMATION: Grey silt powder (90%), red/white angular jasperlitic chert chips (10%).. *[2 m]*
		DUFFER FORMATION		20.0	DUFFER FORMATION: Red silt powder (90%), highly weathered, grey, pitted volcanic rock (10%).. *[4 m]*
20		DUFFER FORMATION		30.0	DUFFER FORMATION: Red/brown silt powder (95%), highly weathered, grey, pitted volcanic rock (50%) (SEE PHOTO).. *[10 m]*
30		DUFFER FORMATION		44.0	DUFFER FORMATION: Red clay powder (98%), grey/green fine grained, very well sorted with minor red fleck (2%) (SEE PHOTO).. *[14 m]*
40	6" Air Hammer Drilling Method [6-82 mbgl]	DUFFER FORMATION			DUFFER FORMATION: Grey powder, no solid cuttings.. *[20 m]*
50					

DISCH. drilling (L/s) 1 2 3 4 | EC (µS/cm) 0 0 0 0 | pH | ELEVATION (m)

(Continued Next Page)

EXPLORATION BORE
CRD0078 (Complete)

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 8/5/17 **COMPLETED** 8/5/14
HOLE DIAMETER 304.8/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 36.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
No construction as CRD0078 is a pilot hole.

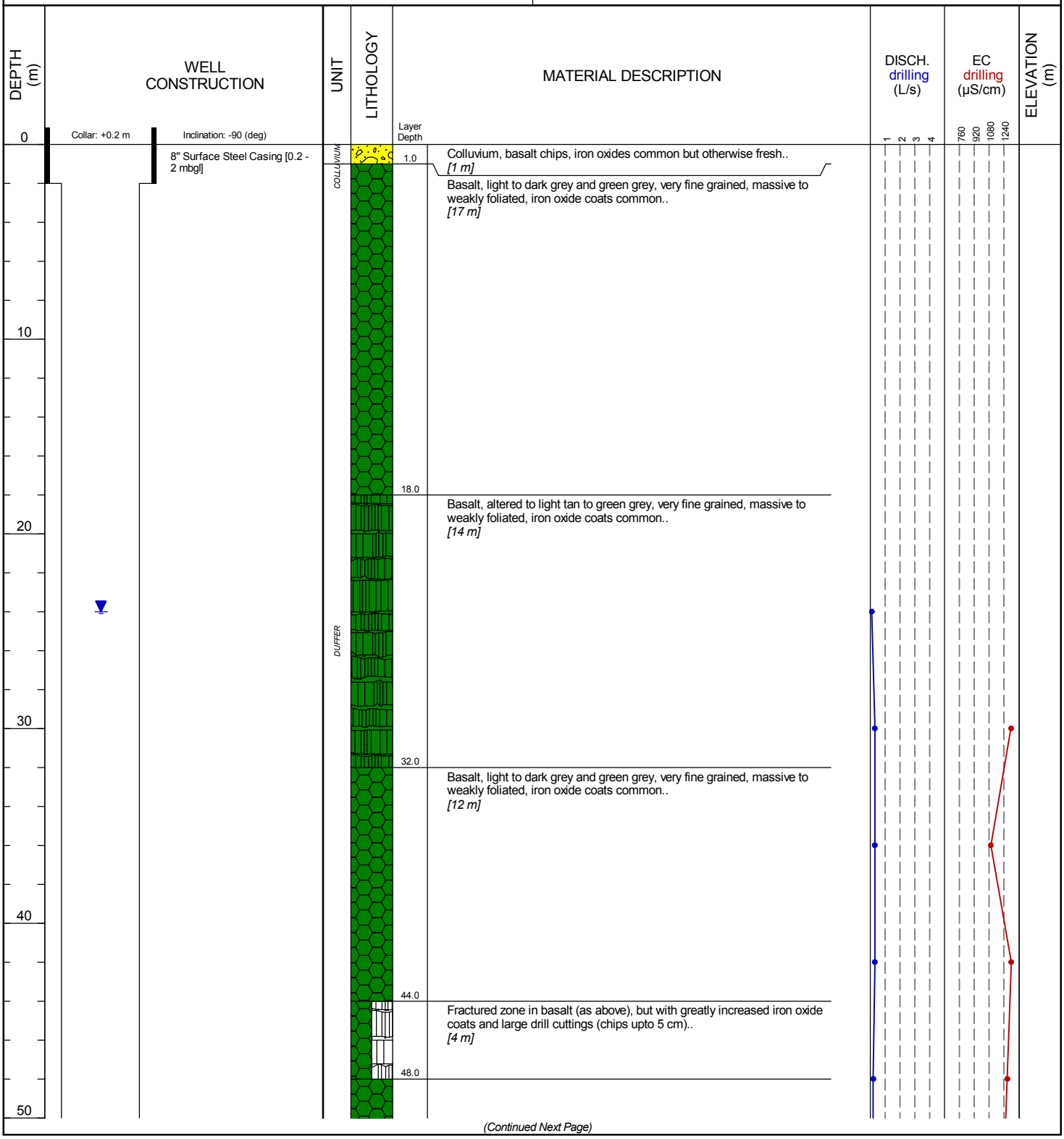
DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC (µS/cm)	pH	ELEVATION (m)
50	Inclination: -90 (deg)					1 2 3 4	0 0 0 0		
		DUFFER FORMATION			DUFFER FORMATION: Grey powder, no solid cuttings.. *[20 m]* (continued)				
60				64.0					
		MOUNT ADA BASALT			MOUNT ADA BASALT: Fresh, angular chips (1% quartz).. *[18 m]*				
70									
80				82.0					

Bottom of borehole at 82.0 m.

EXPLORATION BORE
CRD0081

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 11/11/17 **COMPLETED** 12/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785348 **NORTHING** 7654094
GROUND ELEVATION **DATUM**

Comments:
Water Injection necessary for large component of the drilling. No construction as CRD0081 is a pilot hole.



(Continued Next Page)

EXPLORATION BORE
CRD0081

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 11/11/17 **COMPLETED** 12/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785348 **NORTHING** 7654094
GROUND ELEVATION **DATUM**

Comments:
Water Injection necessary for large component of the drilling. No construction as CRD0081 is a pilot hole.

DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
50	Inclination: -90 (deg) 6" Air Hammer Drilling Method [2-102 mbgl]	DUFFER			Basalt, light to dark grey and green grey, very fine grained, massive to weakly foliated, iron oxide coats common. Water injection while drilling throughout. Fracture zones at 50 to 52 m and 54 to 56 m, but no increase in yields . Trace large chips of vesicular basalt with iron oxide coats throughout but likely to be uphole contamination, and no increase in yields.. *[54 m]* (continued)	1 2 3 4	760 920 1080 1240	
60								
70								
80								
90								
100								

(Continued Next Page)

EXPLORATION BORE
CRD0081

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 11/11/17 **COMPLETED** 12/11/17
HOLE DIAMETER 203.2/152.4 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY DT,Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 785348 **NORTHING** 7654094
GROUND ELEVATION 785348 **DATUM**

Comments:
Water Injection necessary for large component of the drilling. No construction as CRD0081 is a pilot hole.

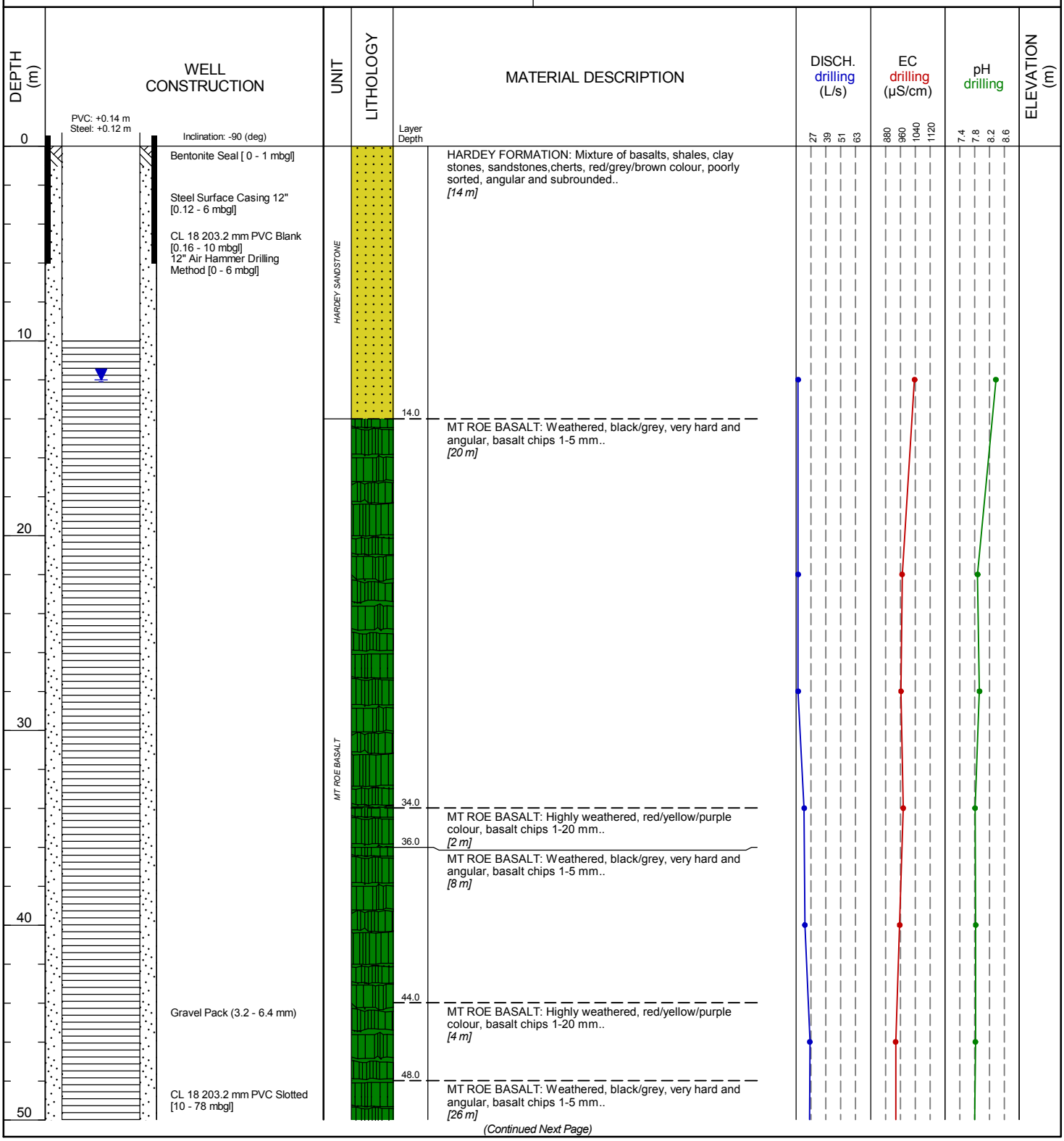
DEPTH (m)	WELL CONSTRUCTION	UNIT	LITHOLOGY	Layer Depth	MATERIAL DESCRIPTION	DISCH. drilling (L/s)	EC drilling (µS/cm)	ELEVATION (m)
100	Inclination: -90 (deg)	DUFFER		102.0	Basalt, light to dark grey and green grey, very fine grained, massive to weakly foliated, iron oxide coats common. Water injection while drilling throughout. Fracture zones at 50 to 52 m and 54 to 56 m, but no increase in yields . Trace large chips of vesicular basalt with iron oxide coats throughout but likely to be uphole contamination, and no increase in yields.. *[54 m]* (continued)	1 2 3 4	760 920 1080 1240	

Bottom of borehole at 102.0 m

PRODUCTION BORE
CRD0082

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 13/4/17 **COMPLETED** 16/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 12.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING 778961.442 **NORTHING** 7631290.621
DATUM 234.438 m
SWL REF. POINT ELEV. ()

Comments:
The V-notch overflowed, it is estimated the flow was ~70L/s.

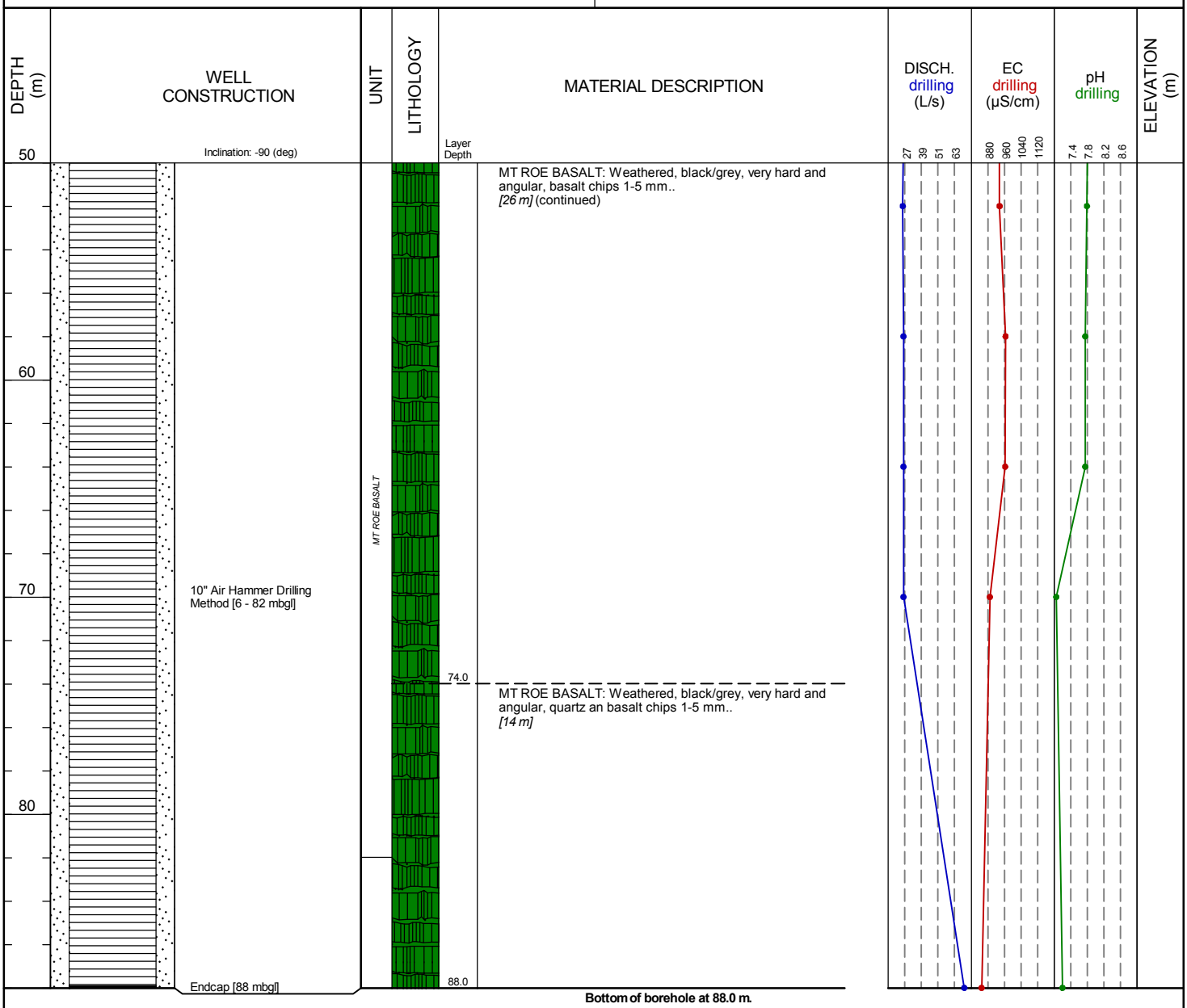


(Continued Next Page)

PRODUCTION BORE
CRD0082

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 13/4/17 **COMPLETED** 16/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 12.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING 778961.442 **NORTHING** 7631290.621
DATUM 234.438 m
SWL REF. POINT ELEV. ()

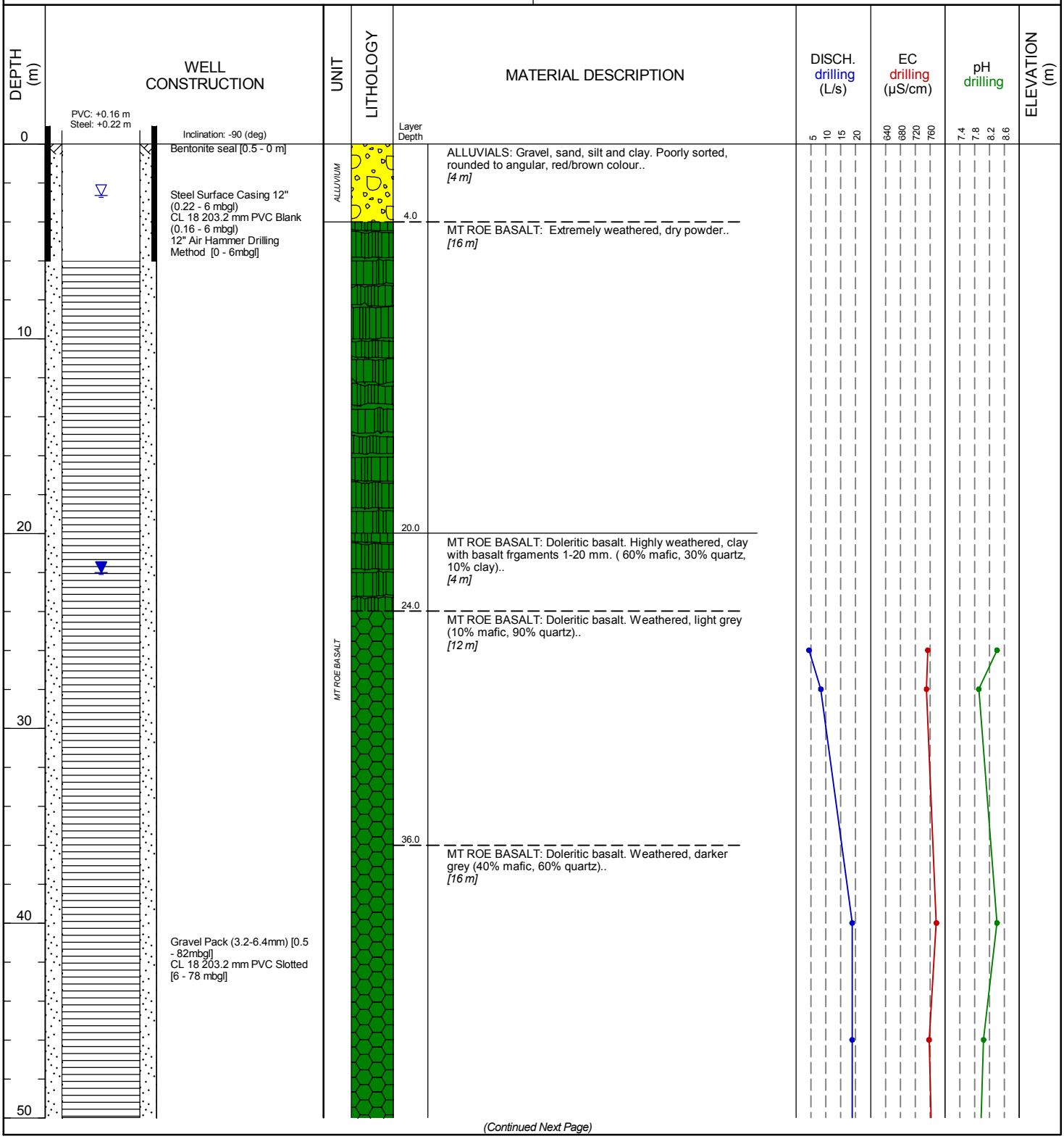
Comments:
The V-notch overflowed, it is estimated the flow was ~70L/s.



PRODUCTION BORE
CRD0083

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 17/4/17 **COMPLETED** 23/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 22.00 m bgl
LOGGED BY PH/FC, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING 2.81 m brp = RL 228.20 m (25/04/2017 2:58:00 PM)
EASTING 778575.622 **NORTHING** 7632987.081
DATUM 231 m
SWL REF. POINT ELEV. (0.16)

Comments:
Delays due to damaged spacer on drill bit and two early stoppages for lightning.

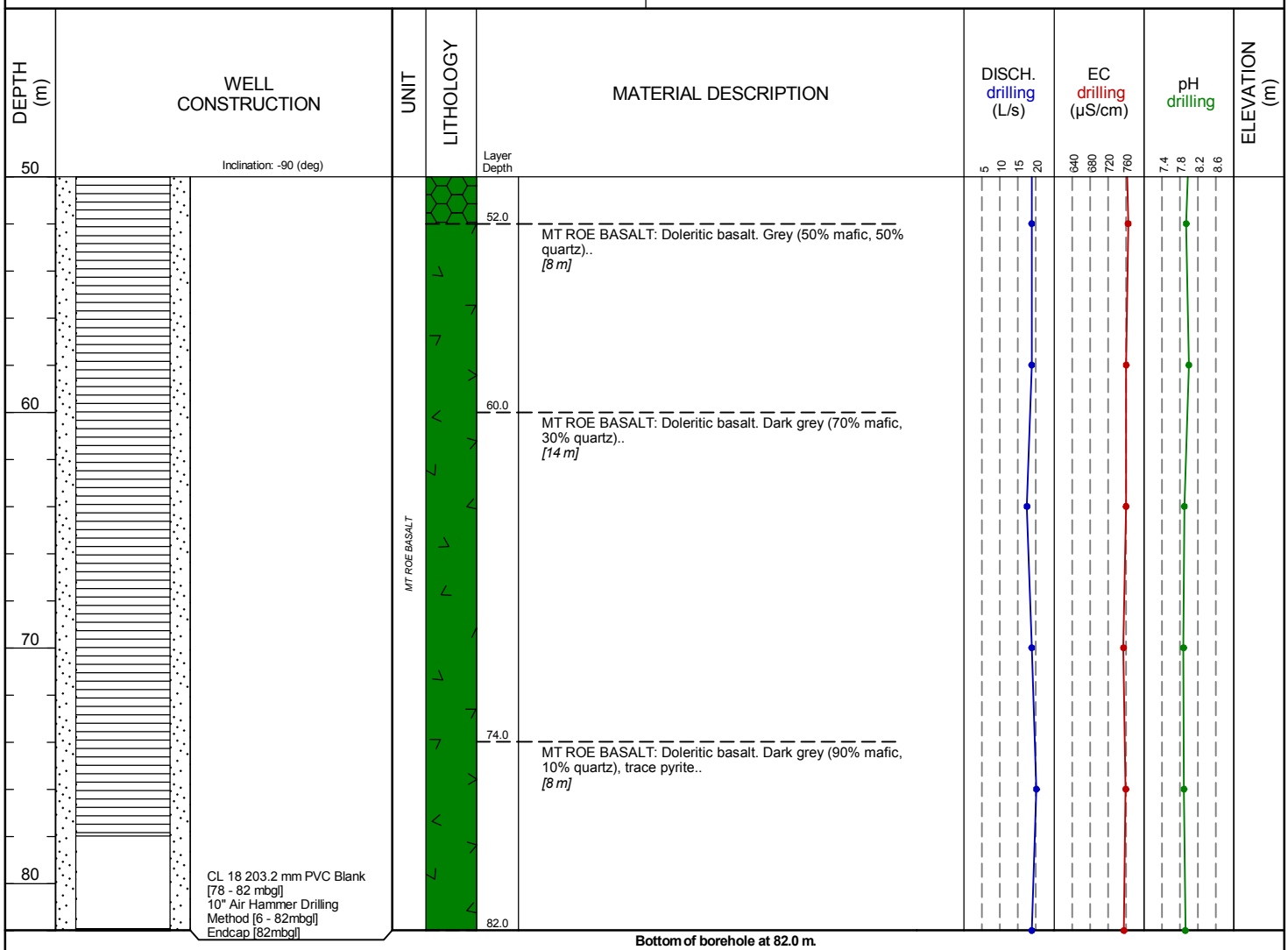


(Continued Next Page)

PRODUCTION BORE
CRD0083

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 17/4/17 **COMPLETED** 23/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 22.00 m bgl
LOGGED BY PH/FC, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING 2.81 m brp = RL 228.20 m (25/04/2017 2:58:00 PM)
EASTING 778575.622 **NORTHING** 7632987.081
DATUM 231 m
SWL REF. POINT ELEV. (0.16)

Comments:
Delays due to damaged spacer on drill bit and two early stoppages for lightning.

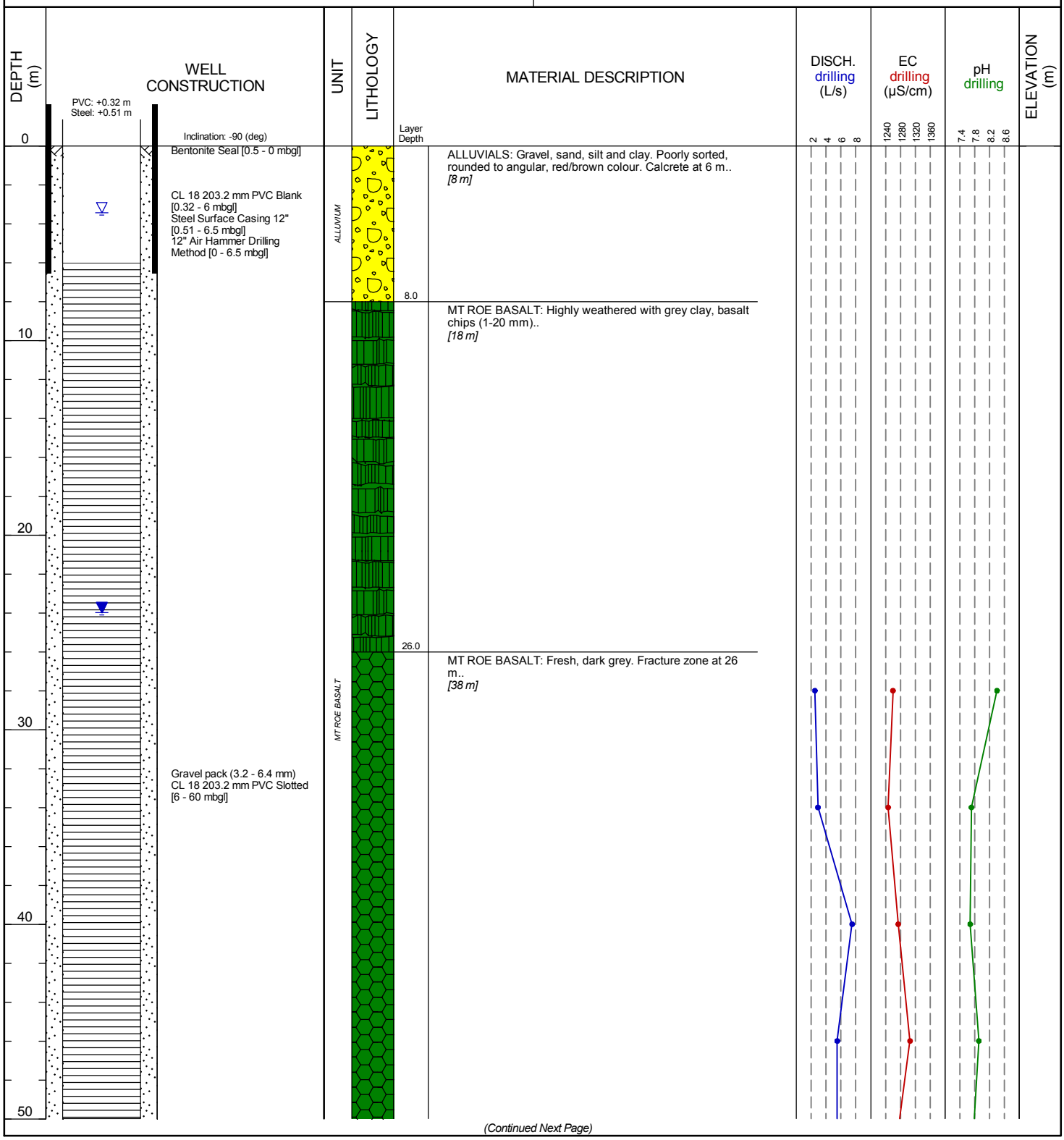


Bottom of borehole at 82.0 m.

PRODUCTION BORE
CRD0084

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 24/4/17 **COMPLETED** 26/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY FC, Stantec **CHECKED BY** PH, Stantec
AFTER DRILLING 3.77 m brp= RL 199.37 m (30/04/2017 7:30:00 AM)
EASTING 778983.549 **NORTHING** 7641951.676
DATUM 203.135 m
SWL REF. POINT ELEV. (0.32)

Comments:
At 26m hit possible fractured zone as the water came out from the monitoring bore on the same pad.

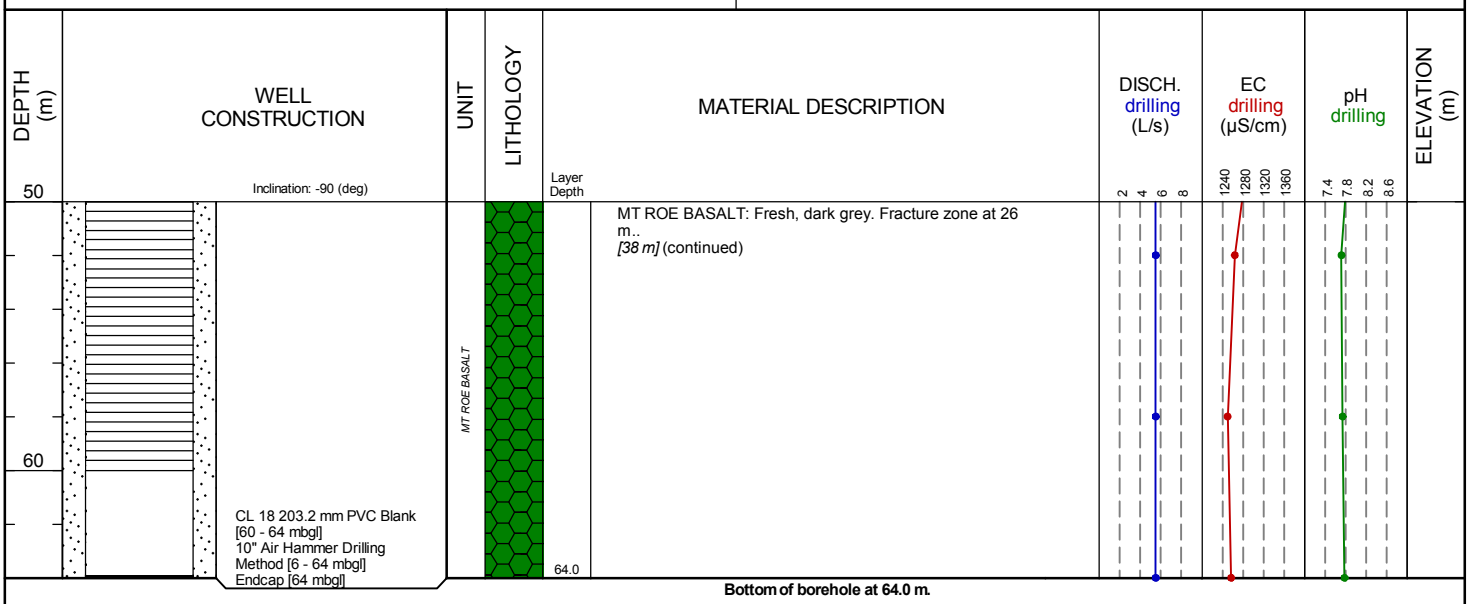


(Continued Next Page)

PRODUCTION BORE
CRD0084

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 24/4/17 **COMPLETED** 26/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.00 m bgl
LOGGED BY FC, Stantec **CHECKED BY** PH, Stantec
AFTER DRILLING 3.77 m brp= RL 199.37 m (30/04/2017 7:30:00 AM)
EASTING 778983.549 **NORTHING** 7641951.676
DATUM 203.135 m
SWL REF. POINT ELEV. (0.32)

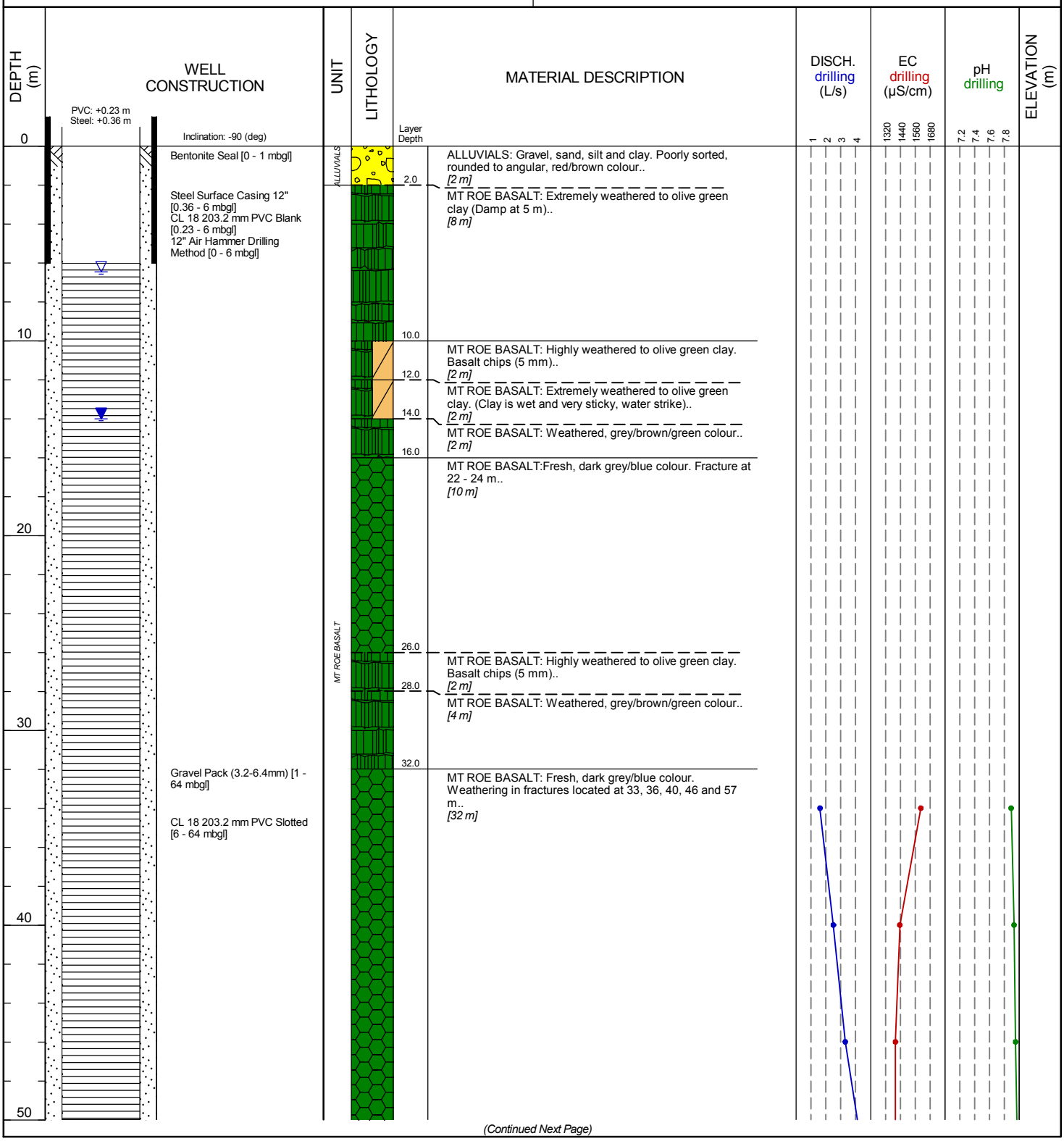
Comments:
At 26m hit possible fractured zone as the water came out from the monitoring bore on the same pad.



PRODUCTION BORE
CRD0085

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 27/4/17 **COMPLETED** 30/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 14.00 m bgl
LOGGED BY RK2, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING 6.70 m brp= RL 198.217 m (01/05/2017 7:44:00 AM)
EASTING 780807.982 **NORTING** 7642040.047
DATUM 204.917 m
SWL REF. POINT ELEV. (0.23)

Comments:
During gravel packing the casing join came apart at the first join (6 m BGL) without realising. the gravel inside the casing was dipped at 30 m (down from 17 m). Removed gravel pack from inside the casing.

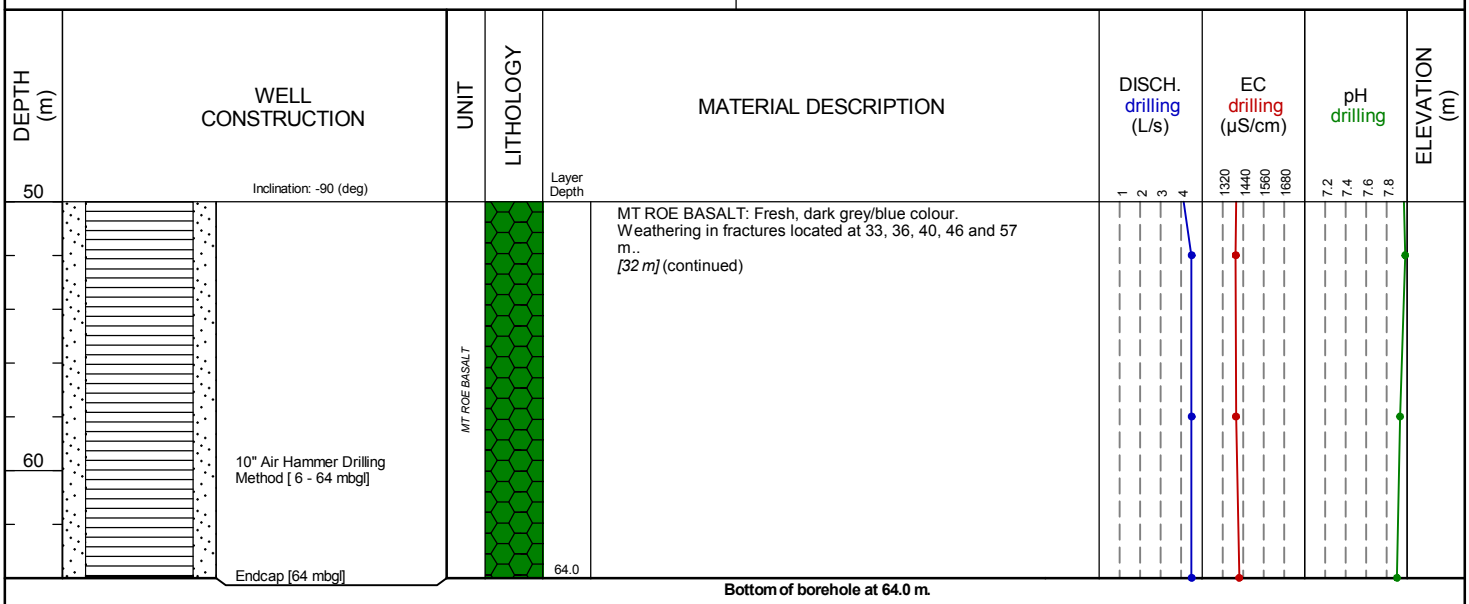


(Continued Next Page)

PRODUCTION BORE
CRD0085

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 27/4/17 **COMPLETED** 30/4/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 14.00 m bgl
LOGGED BY RK2, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING 6.70 m brp= RL 198.217 m (01/05/2017 7:44:00 AM)
EASTING 780807.982 **NORTHING** 7642040.047
DATUM 204.917 m
SWL REF. POINT ELEV. (0.23)

Comments:
During gravel packing the casing join came apart at the first join (6 m BGL) without realising. the gravel inside the casing was dipped at 30 m (down from 17 m). Removed gravel pack from inside the casing.

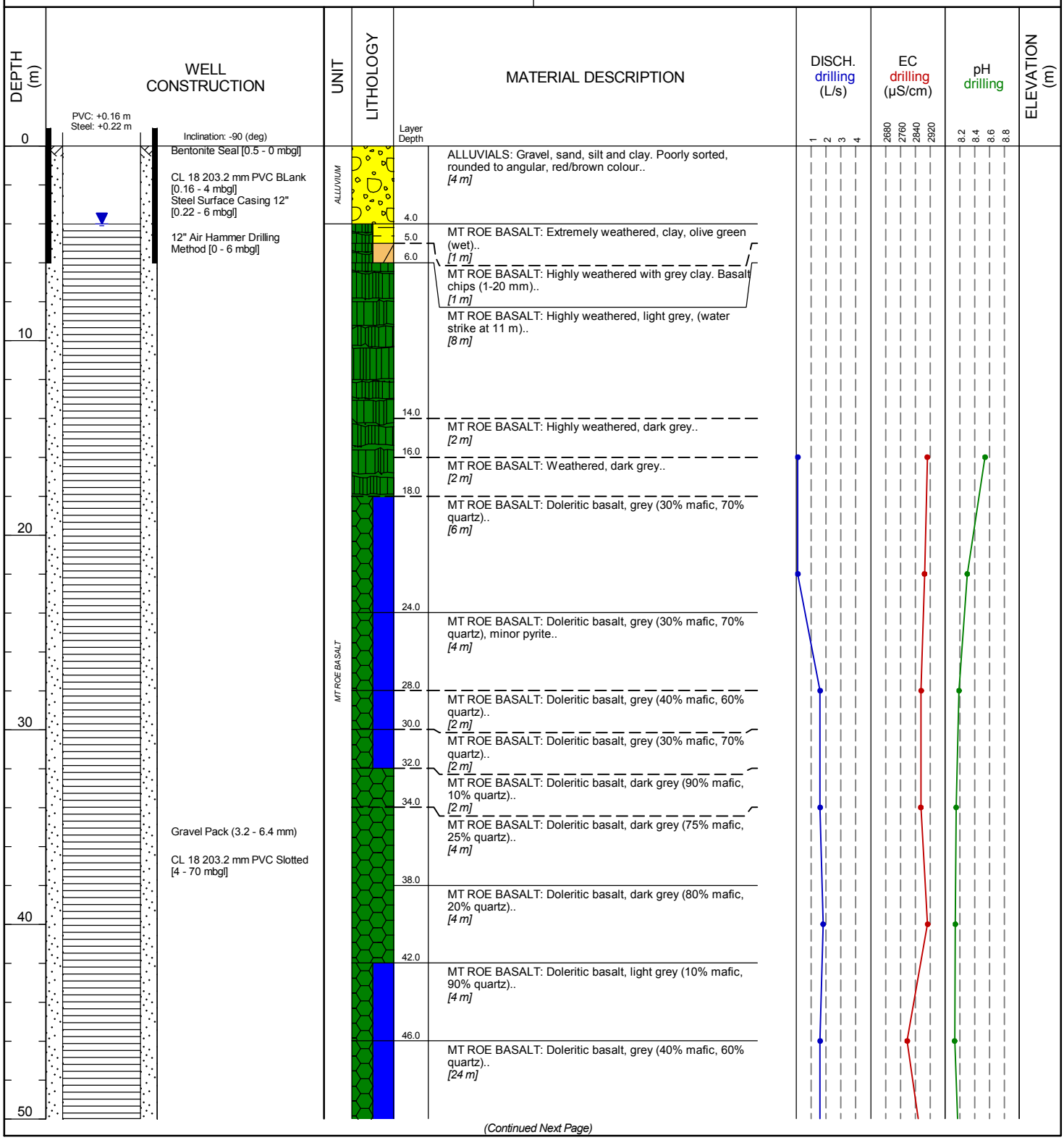


Bottom of borehole at 64.0 m.

PRODUCTION BORE
CRD0086

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 2/5/17 **COMPLETED** 4/5/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 4.00 m bgl
LOGGED BY RK2, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
Delays due to running out of quick set cement and maintenance.

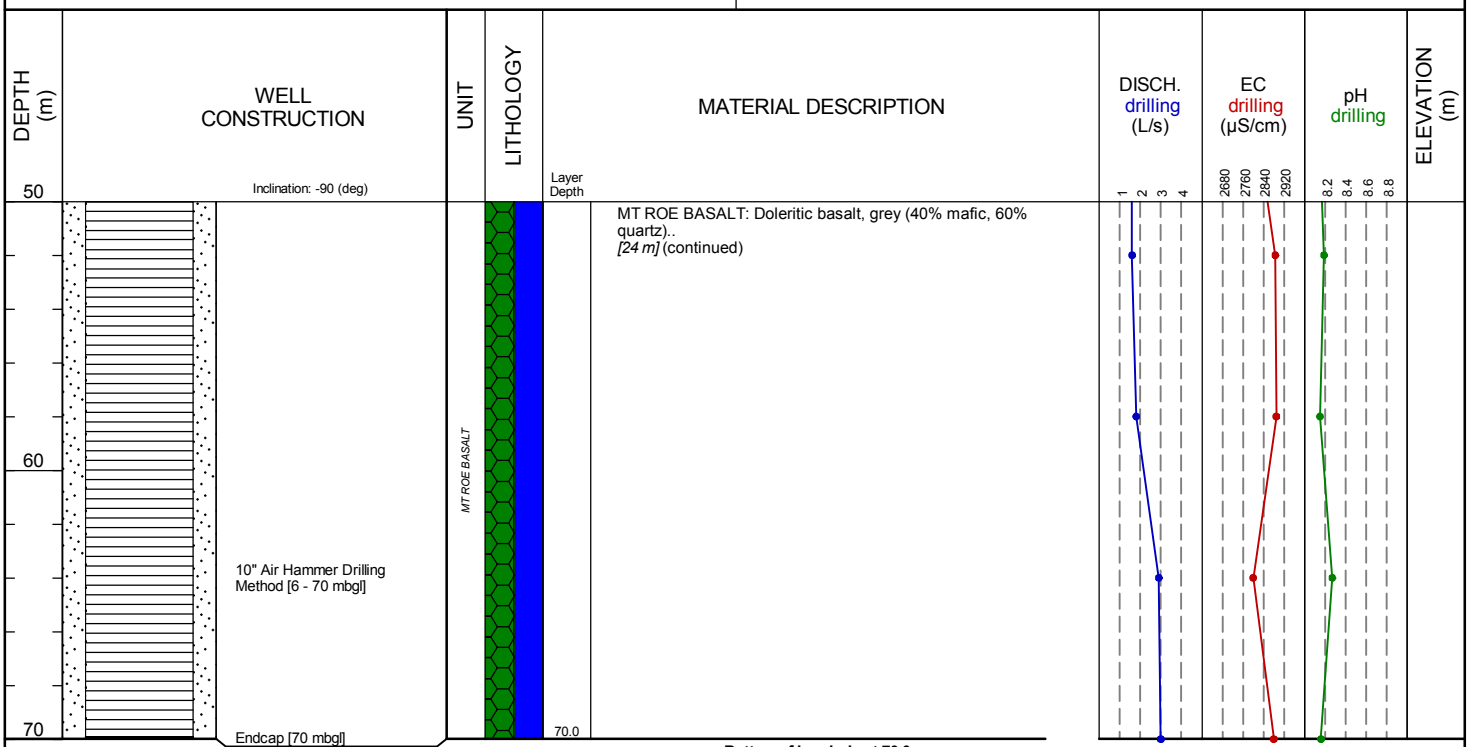


(Continued Next Page)

PRODUCTION BORE
CRD0086

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 2/5/17 **COMPLETED** 4/5/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 4.00 m bgl
LOGGED BY RK2, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
Delays due to running out of quick set cement and maintenance.

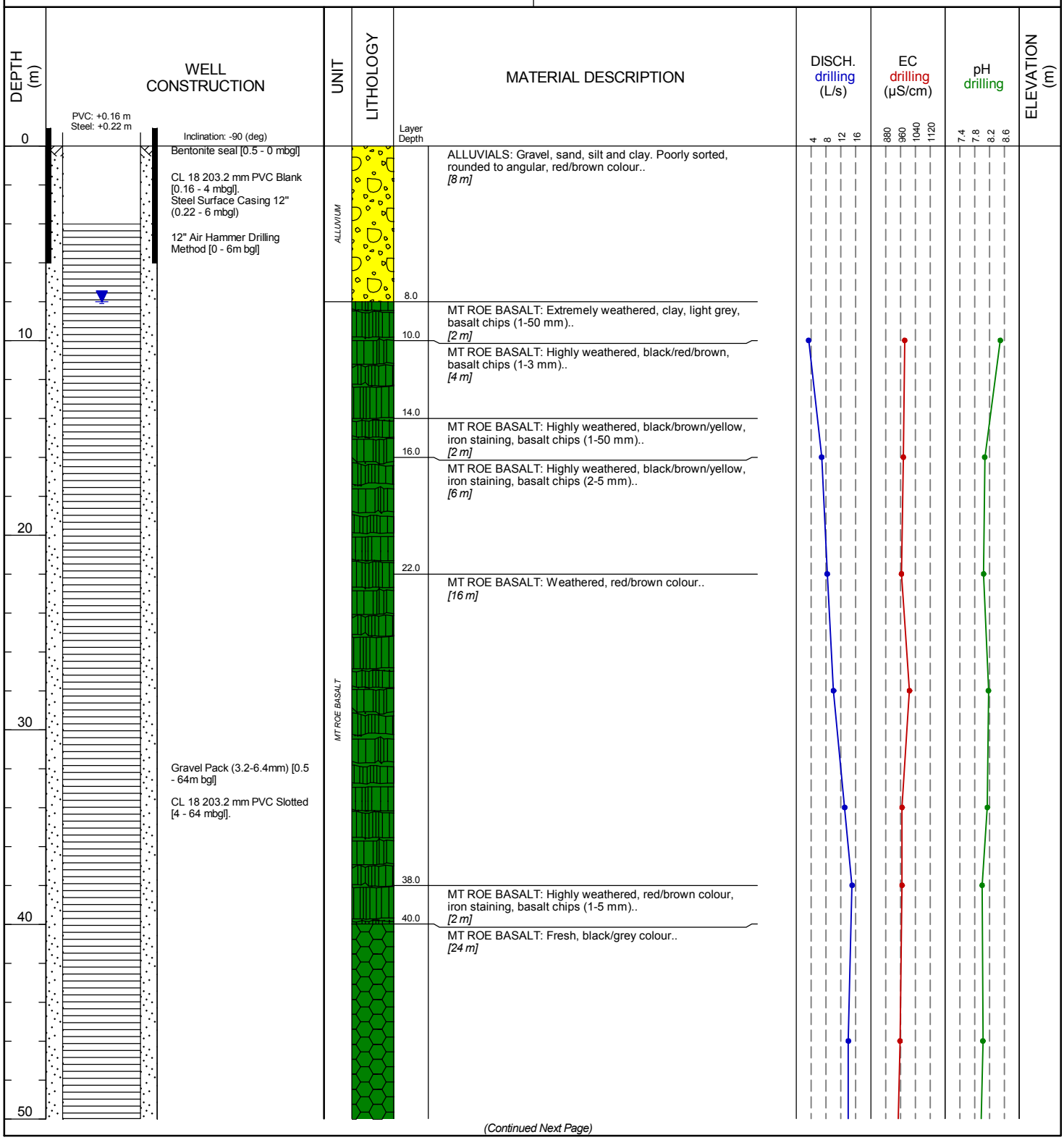


Bottom of borehole at 70.0 m.

PRODUCTION BORE
CRD0087

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 5/5/17 **COMPLETED** 8/5/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 8.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

Comments:
First water strike was at 8mbgl when the in a weathered Basalt section with a flow rate of >1L/s.

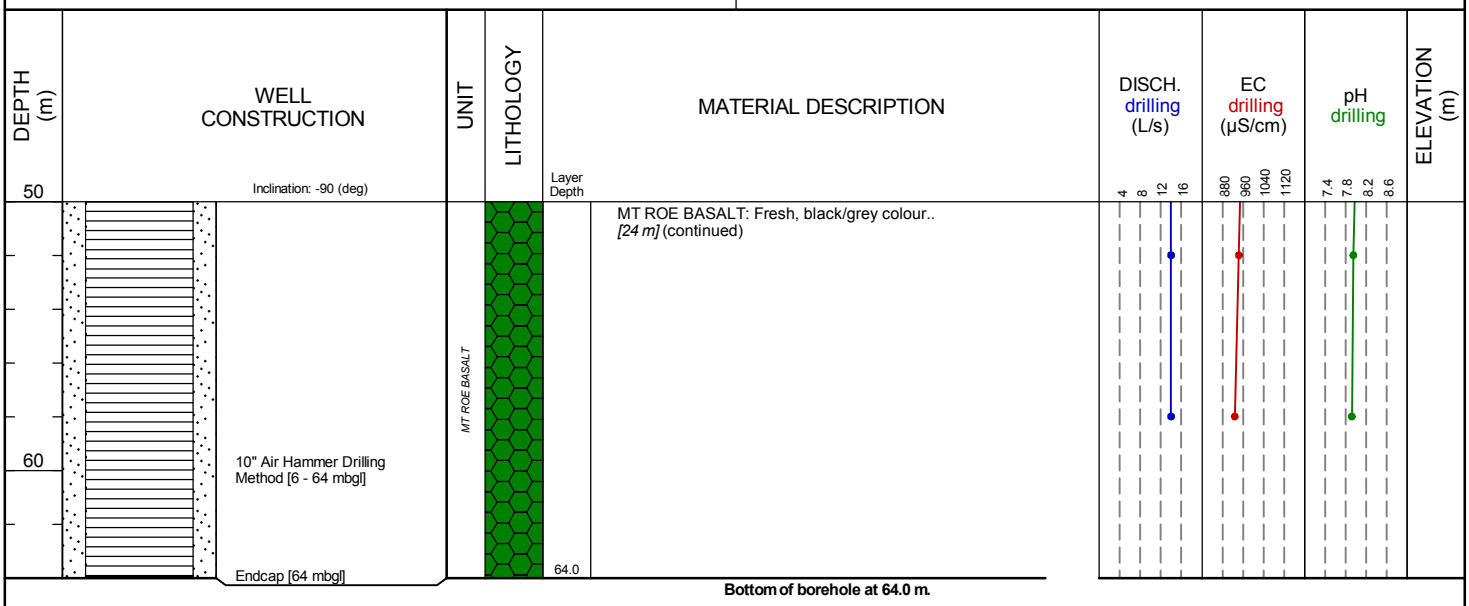


(Continued Next Page)

PRODUCTION BORE
CRD0087

CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 5/5/17 **COMPLETED** 8/5/17
HOLE DIAMETER 304.8/254 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 8.00 m bgl
LOGGED BY PH, Stantec **CHECKED BY** FC, Stantec
AFTER DRILLING ---
EASTING **NORTHING**
DATUM
SWL REF. POINT ELEV. ()

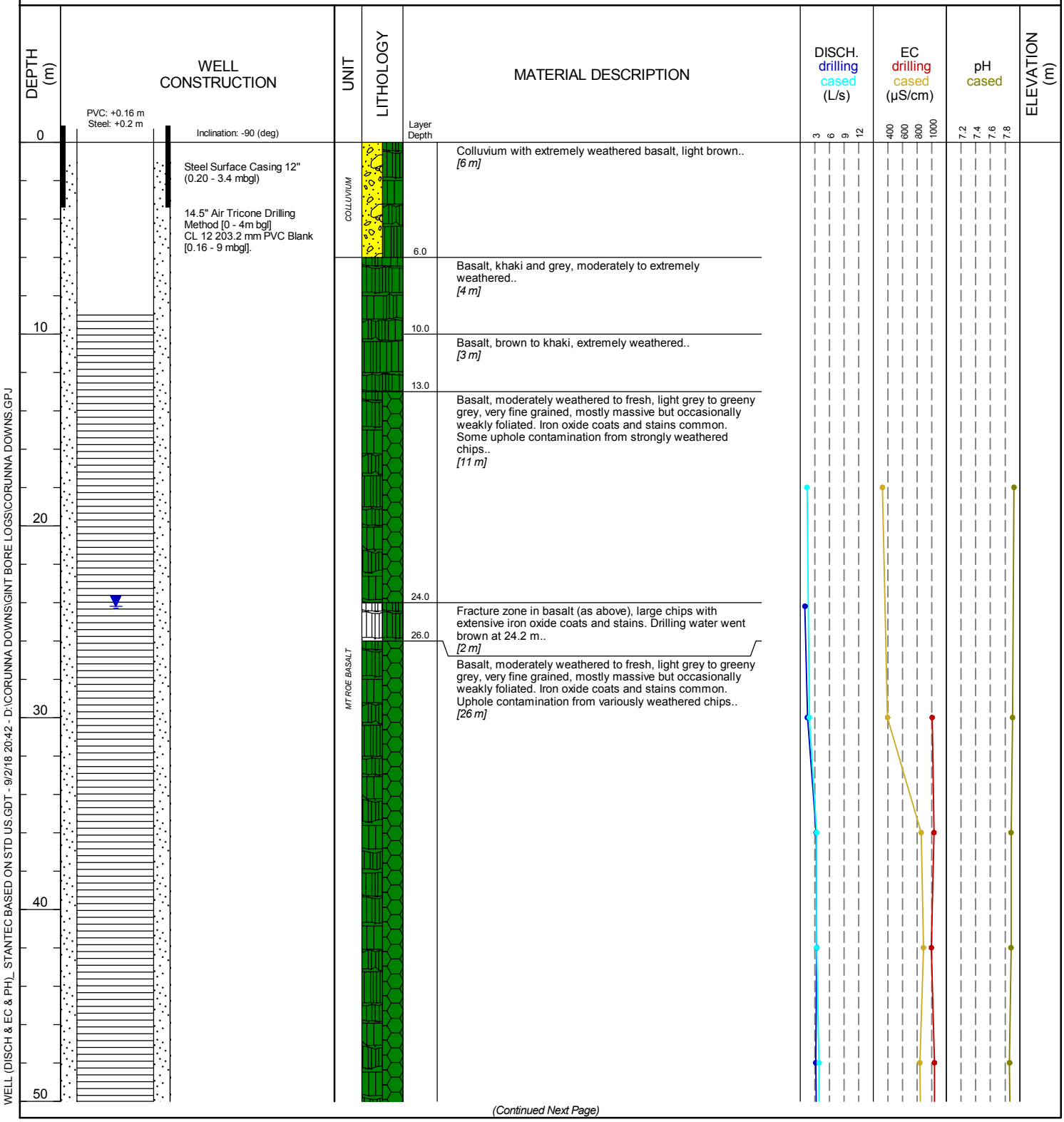
Comments:
First water strike was at 8mbgl when the in a weathered Basalt section with a flow rate of >1L/s.



Bottom of borehole at 64.0 m.

PRODUCTION BORE
CRD0088

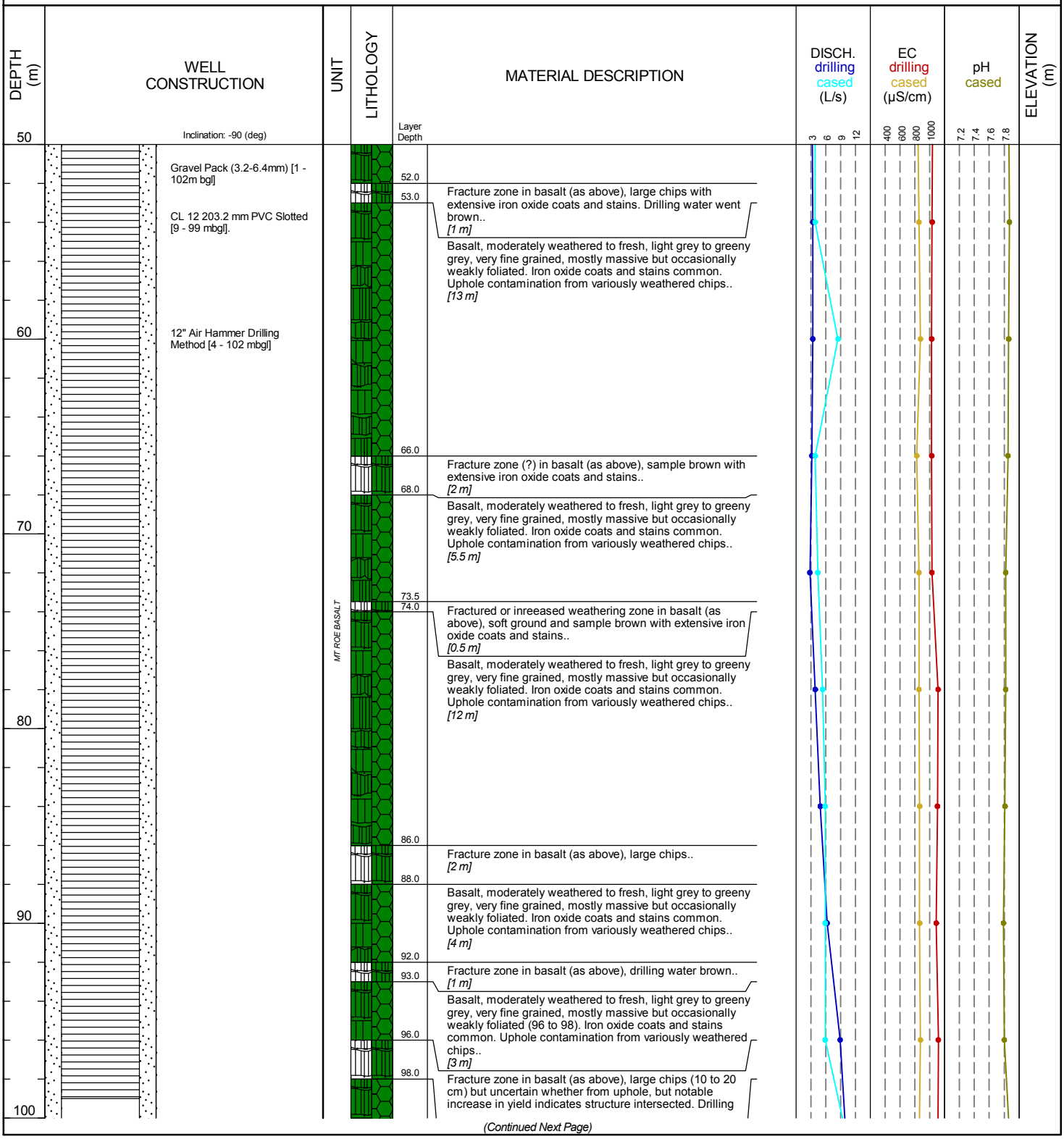
CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 14/11/17 **COMPLETED** 17/11/17
HOLE DIAMETER 368.3/304.8 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.20 m bgl
LOGGED BY DT, Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING **782285** 7652335 **NORTHING** 7652335
DATUM
SWL REF. POINT ELEV. ()m



(Continued Next Page)

PRODUCTION BORE
CRD0088

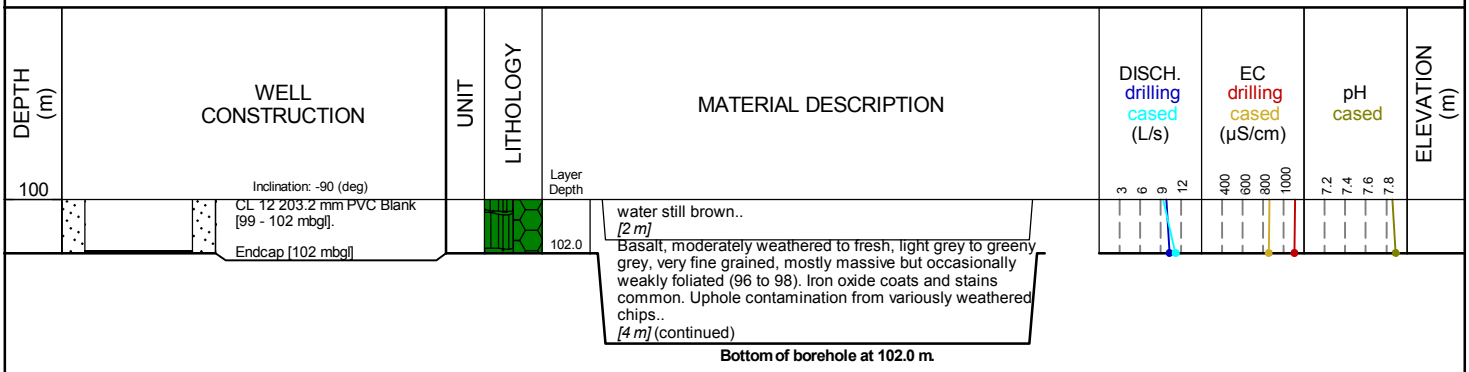
CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 14/11/17 **COMPLETED** 17/11/17
HOLE DIAMETER 368.3/304.8 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.20 m bgl
LOGGED BY DT, Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782285 **NORTHING** 7652335
DATUM
SWL REF. POINT ELEV. ()m



(Continued Next Page)

PRODUCTION BORE
CRD0088

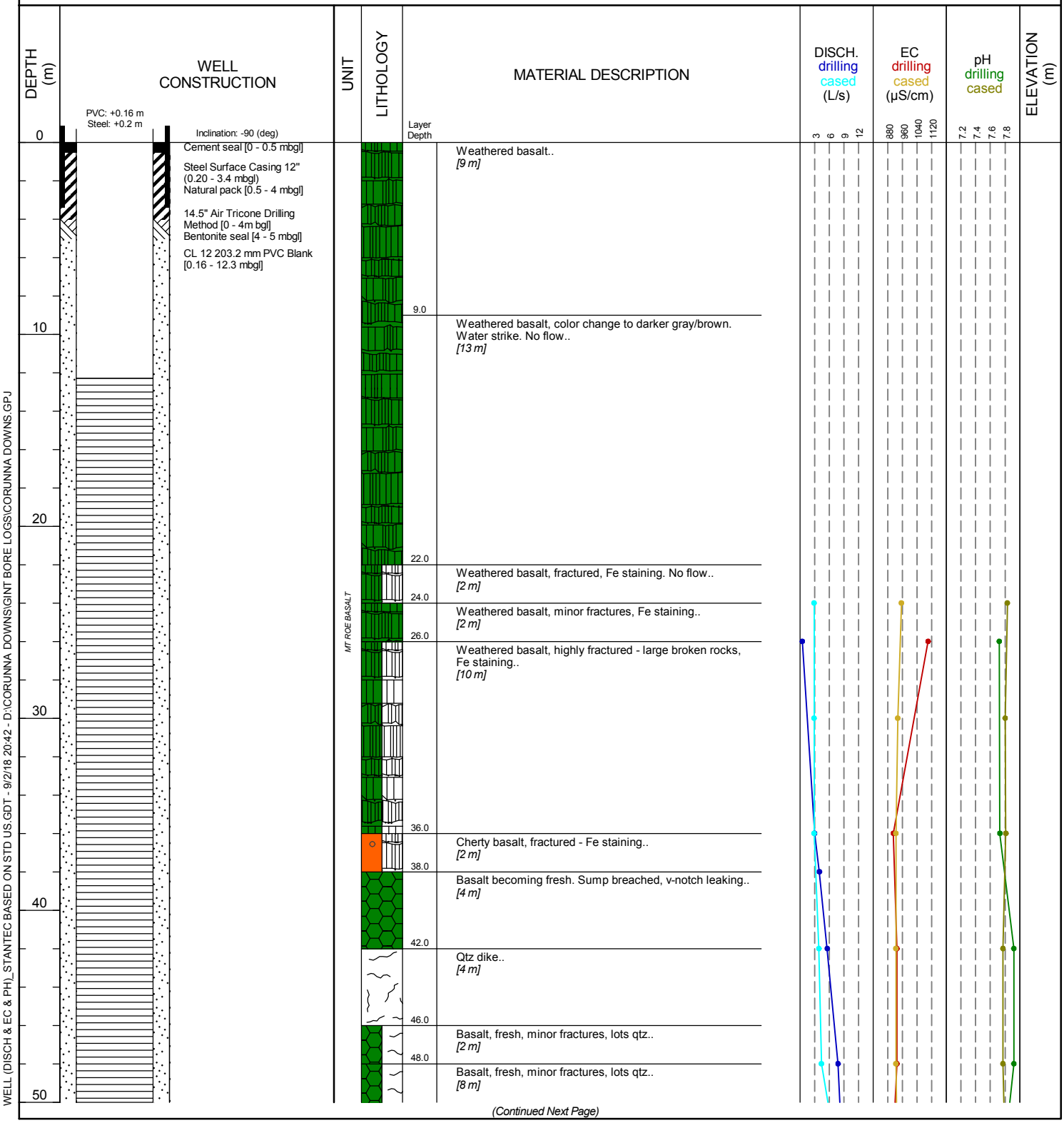
CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 14/11/17 **COMPLETED** 17/11/17
HOLE DIAMETER 368.3/304.8 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
AT TIME OF DRILLING (Water Cut) 24.20 m bgl
LOGGED BY DT, Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782285 **NORTHING** 7652335
DATUM
SWL REF. POINT ELEV. ()m



Bottom of borehole at 102.0 m.

PRODUCTION BORE
CRD0089

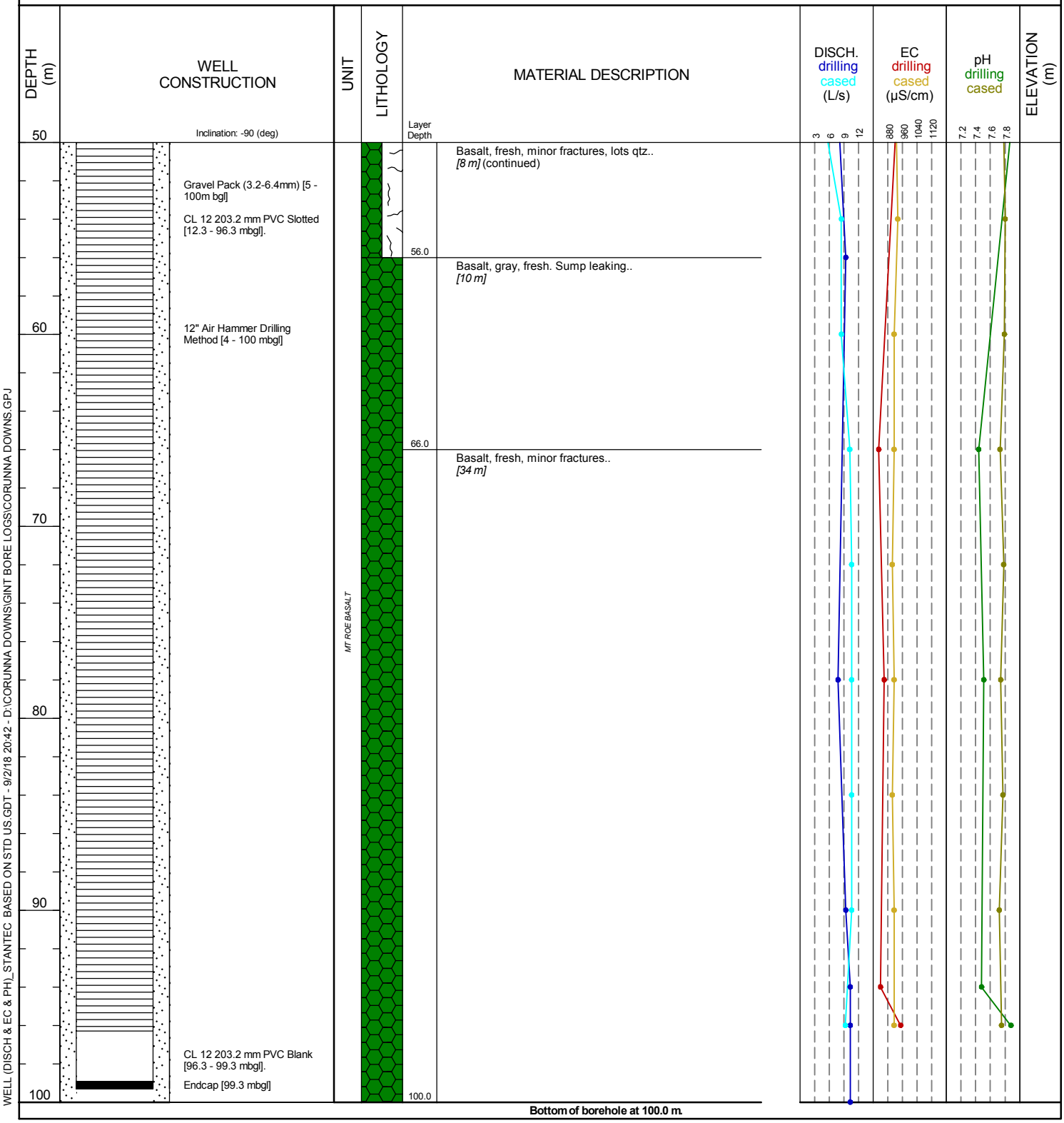
CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 18/11/17 **COMPLETED** 21/11/17
HOLE DIAMETER 368.3/304.8 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
LOGGED BY DT, Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782719 **NORTHING** 7652280
DATUM
SWL REF. POINT ELEV. ()m



(Continued Next Page)

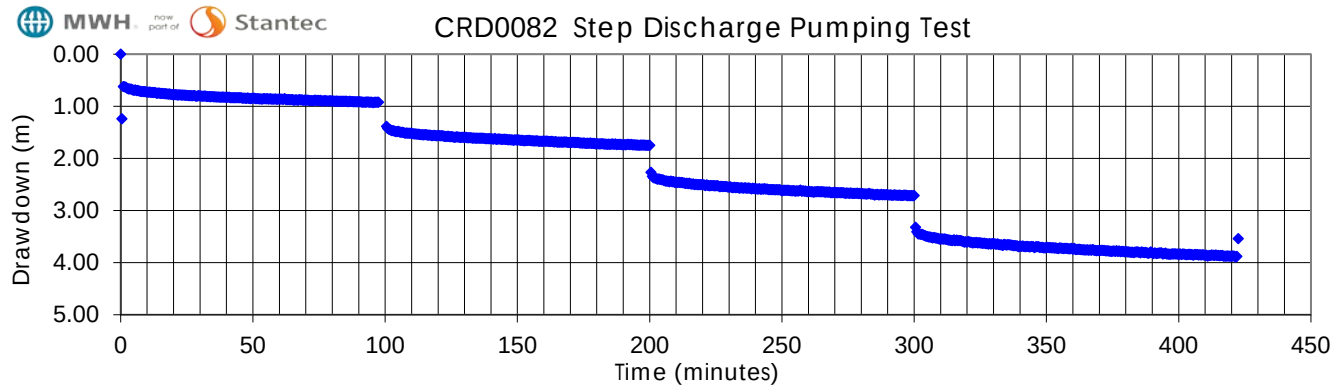
PRODUCTION BORE
CRD0089

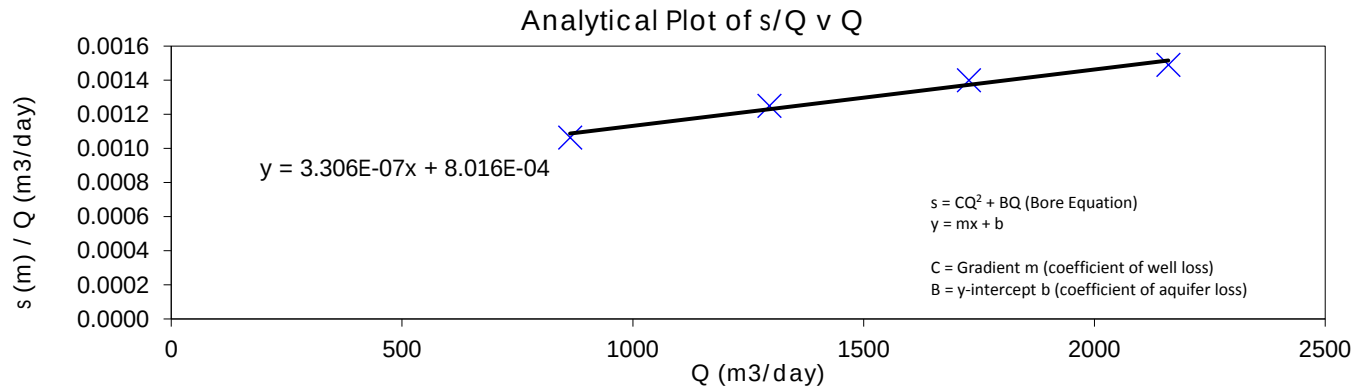
CLIENT Atlas Iron Limited
PROJECT NAME Corunna Downs Hydrogeological Investigations
PROJECT NUMBER 83503916
LOCATION Corruna Downs
DATE STARTED 18/11/17 **COMPLETED** 21/11/17
HOLE DIAMETER 368.3/304.8 mm
DRILLING CONTRACTOR (DRILLED BY) Foraco (Rig 8)
GROUND WATER LEVELS:
DRILLING METHOD Air Hammer
LOGGED BY DT, Stantec **CHECKED BY** FC,Stantec
AFTER DRILLING ---
EASTING 782719 **NORTHING** 7652280
DATUM
SWL REF. POINT ELEV. ()m



Bottom of borehole at 100.0 m.

Appendix D Step Rate Test Results





From plot of s/Q v Q (trend line equation):

Gradient (C)	3.306E-07
Intercept (B)	8.016E-04

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	Analysed incremental drawdown (m)	Cumulative Analysed drawdown (m)	Predicted drawdown using Bore Equation (m)	Actual total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	10.0	864	0.92	0.92	0.94	0.92	0.0011	73.7
2	15.0	1296	0.70	1.62	1.59	1.75	0.0013	65.2
3	20.0	1728	0.80	2.42	2.37	2.71	0.0014	58.4
4	25.0	2160	0.80	3.22	3.27	3.54	0.0015	52.9

ANALYSIS COMMENTS:

Analysis Date: 14/07/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

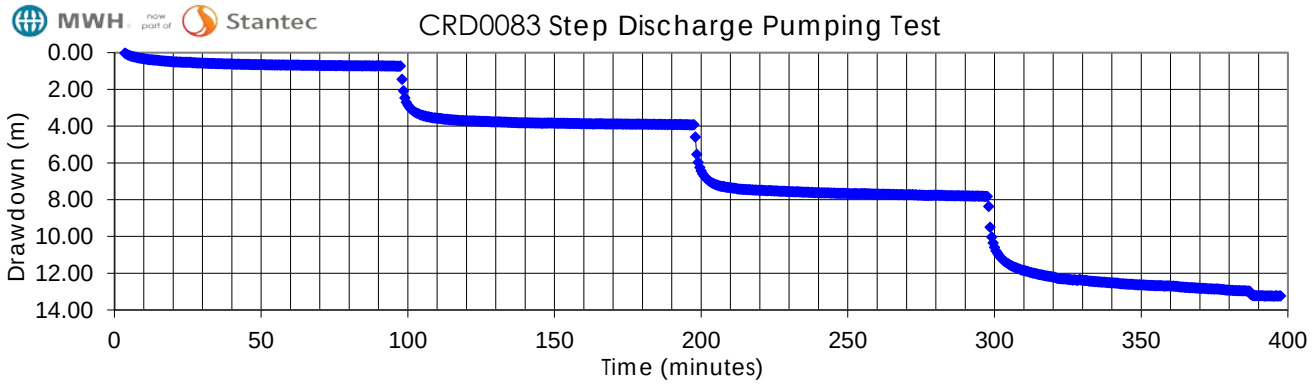
Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

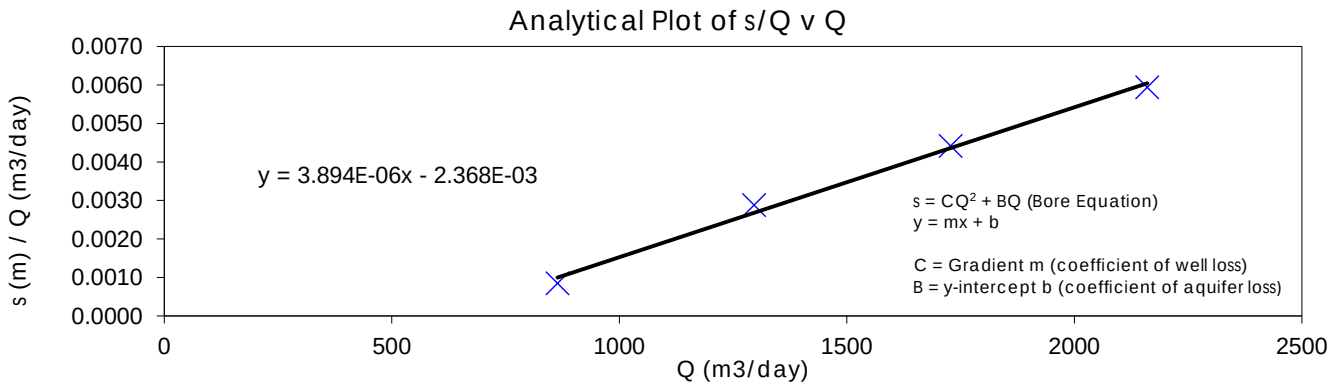
Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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





From plot of s/Q v Q (trend line equation):

Gradient (C)	3.894E-06
Intercept (B)	2.368E-03

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	Analysed incremental drawdown (m)	Cumulative Analysed drawdown (m)	Predicted drawdown using Bore Equation (m)	Actual total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	10.0	864	0.73	0.73	4.95	0.73	0.0008	41.3
2	15.0	1296	3.00	3.73	9.61	3.92	0.0029	31.9
3	20.0	1728	3.90	7.63	15.72	7.82	0.0044	26.0
4	25.0	2160	5.20	12.83	23.28	13.24	0.0059	22.0

ANALYSIS COMMENTS: First step was 97.5 mins.

Analysis Date: 13/07/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

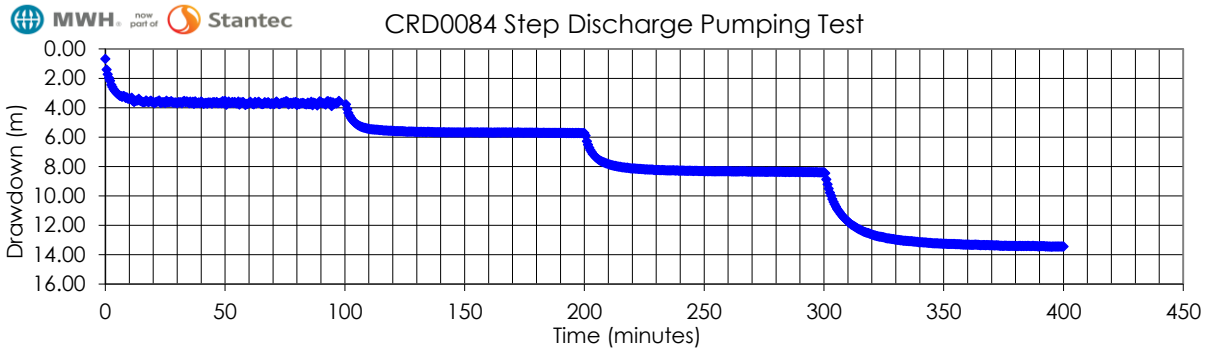
Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

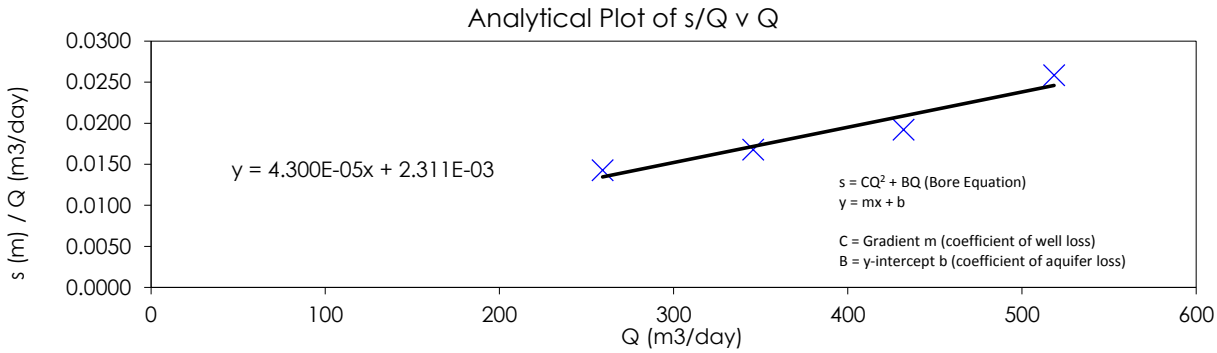
Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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





From plot of s/Q v Q (trend line equation):

Gradient (C)	4.300E-05
Intercept (B)	2.311E-03

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	**Analysed incremental** drawdown (m)	Cumulative **Analysed** drawdown (m)	**Predicted** drawdown using Bore Equation (m)	**Actual** total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	3.0	259	3.70	3.70	3.49	3.70	0.0143	17.2
2	4.0	346	2.10	5.80	5.93	5.73	0.0168	13.5
3	5.0	432	2.50	8.30	9.02	8.40	0.0192	11.1
4	6.0	518	5.10	13.40	12.75	13.45	0.0258	9.4

ANALYSIS COMMENTS:

Analysis Date: 25/07/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

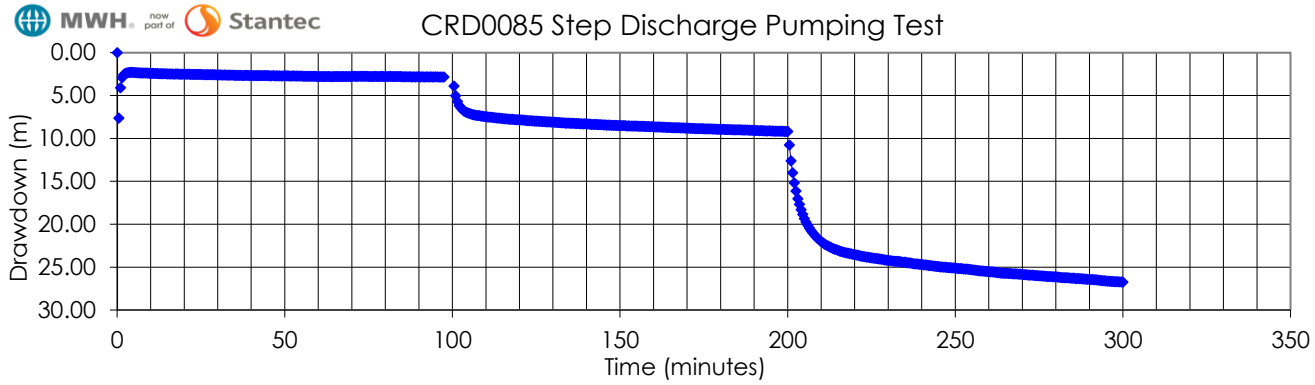
Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

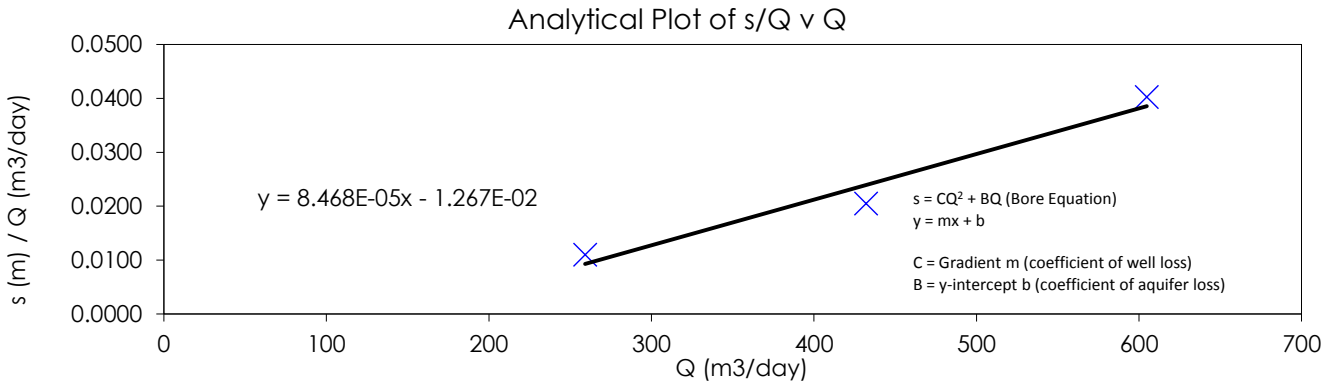
Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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





From plot of s/Q v Q (trend line equation):

Gradient (C)	8.468E-05
Intercept (B)	1.267E-02

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	**Analysed incremental** drawdown (m)	Cumulative **Analysed** drawdown (m)	**Predicted** drawdown using Bore Equation (m)	**Actual** total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	3.0	259	2.85	2.85	8.97	0.92	0.0110	36.6
2	5.0	432	6.00	8.85	21.28	1.75	0.0205	25.7
3	7.0	605	15.50	24.35	38.64	2.71	0.0403	19.8

ANALYSIS COMMENTS:

Analysis Date: 25/07/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

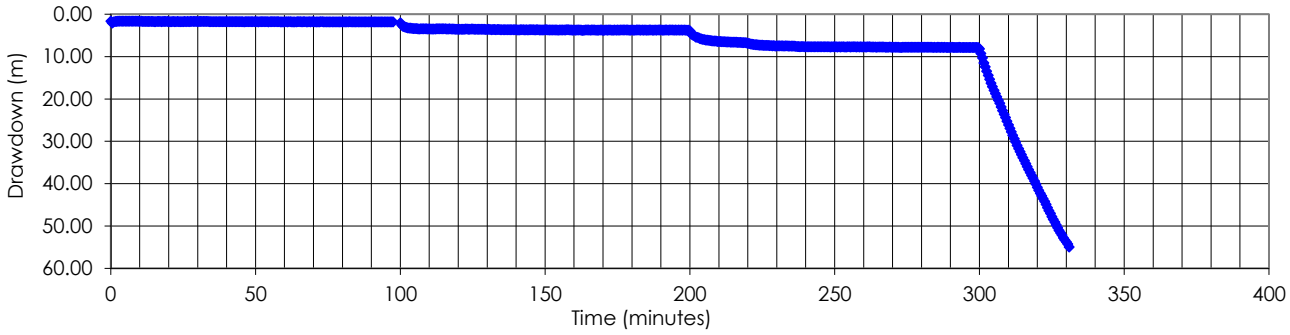
2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

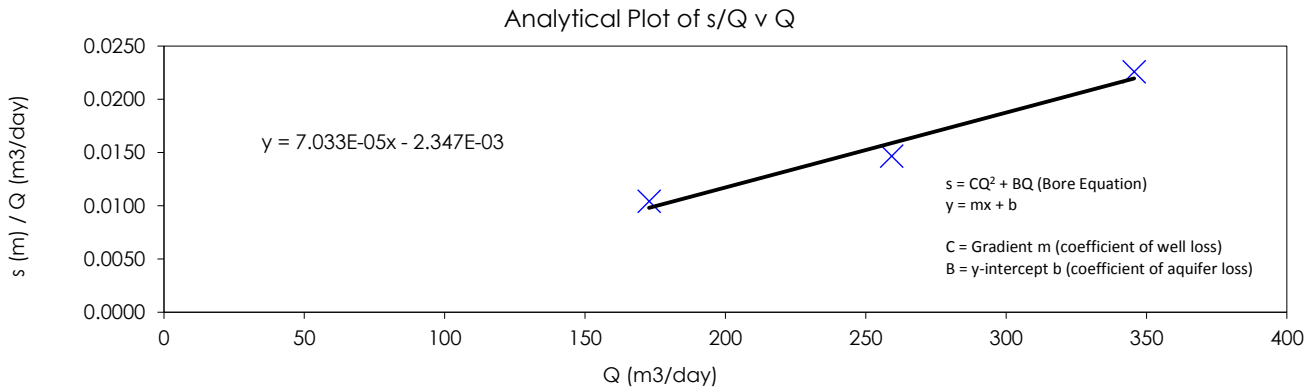
Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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

MWH now part of Stantec

CRD0086 Step Discharge Pumping Test





From plot of s/Q v Q (trend line equation):

Gradient (C)	7.033E-05
Intercept (B)	2.347E-03

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	**Analysed incremental** drawdown (m)	Cumulative **Analysed** drawdown (m)	**Predicted** drawdown using Bore Equation (m)	**Actual** total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	2.0	173	1.80	1.80	2.51	1.80	0.0104	16.2
2	3.0	259	2.00	3.80	5.33	3.75	0.0147	11.4
3	4.0	346	4.00	7.80	9.21	7.85	0.0226	8.8
4	5.0	432	46.00	53.80	14.14	54.93	0.1245	7.2

ANALYSIS COMMENTS: Last step was 31 minutes

Analysis Date: 03/08/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

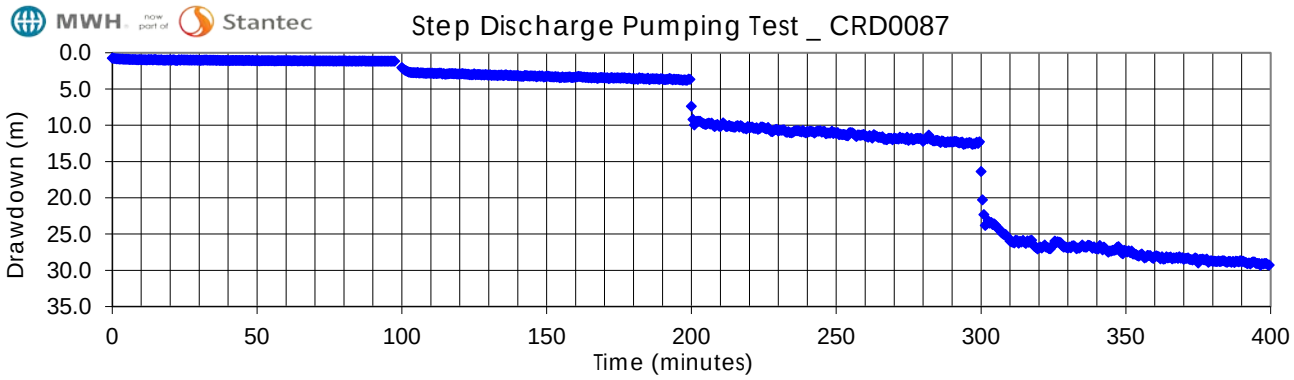
Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

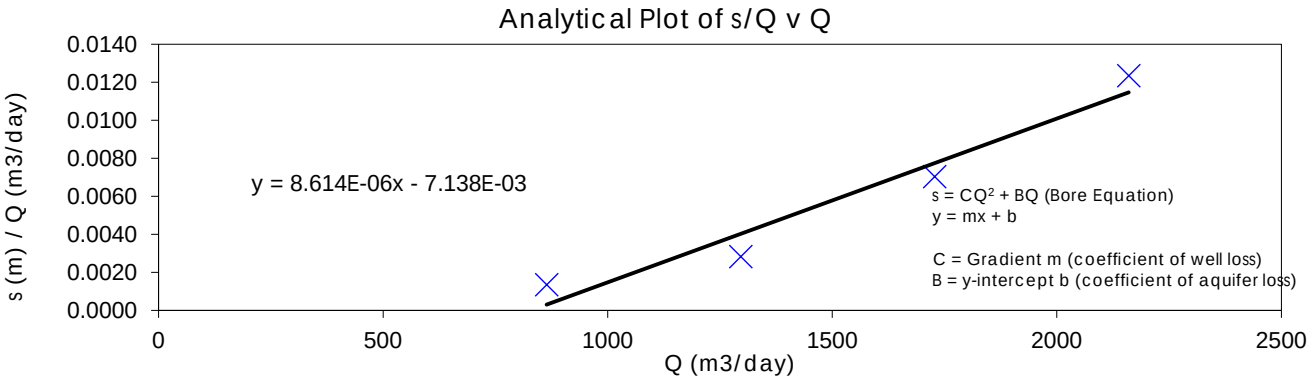
Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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





From plot of s/Q v Q (trend line equation):

Gradient (C)	8.614E-06
Intercept (B)	7.138E-03

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	Analysed incremental drawdown (m)	Cumulative Analysed drawdown (m)	Predicted drawdown using Bore Equation (m)	Actual total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	10.0	864	1.16	1.16	12.60	1.16	0.0013	49.0
2	15.0	1296	2.50	3.66	23.72	3.66	0.0028	39.0
3	20.0	1728	8.50	12.16	38.06	12.27	0.0070	32.4
4	25.0	2160	14.50	26.66	55.61	29.28	0.0123	27.7

ANALYSIS COMMENTS:

Analysis Date: 03/08/2017 By Hydro: F Cronjé

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

Where: B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

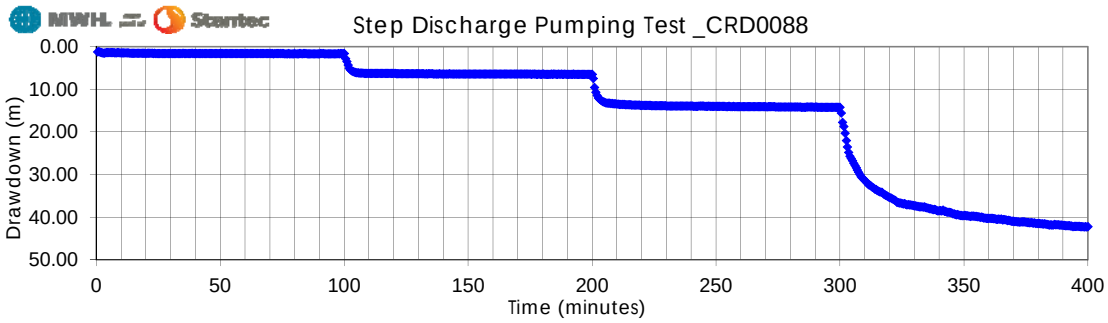
Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

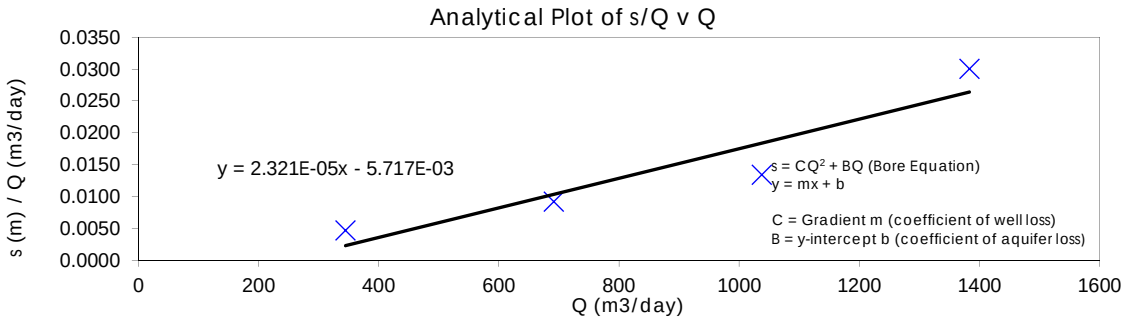
Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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





From plot of s/Q v Q (trend line equation):

Gradient (C)	2.321E-05
Intercept (B)	5.717E-03

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	Analysed incremental drawdown (m)	Cumulative Analysed drawdown (m)	Predicted drawdown using Bore Equation (m)	Actual total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	4.0	345	1.61	1.61	4.73	1.61	0.0047	41.7
2	8.0	691	4.76	6.37	15.04	6.46	0.0092	26.3
3	12.0	1038	7.57	13.94	30.92	14.17	0.0134	19.2
4	16.0	1383	27.64	41.58	52.32	42.24	0.0301	15.1

ANALYSIS COMMENTS: First step was 97.5 mins.

Analysis Date: 13/07/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

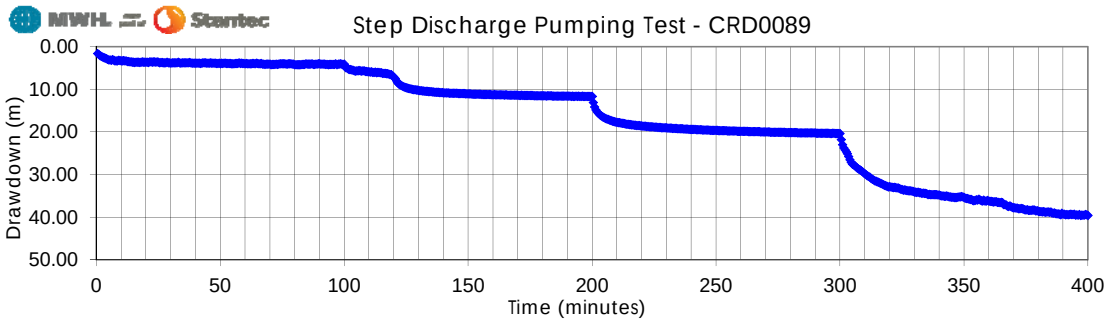
Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

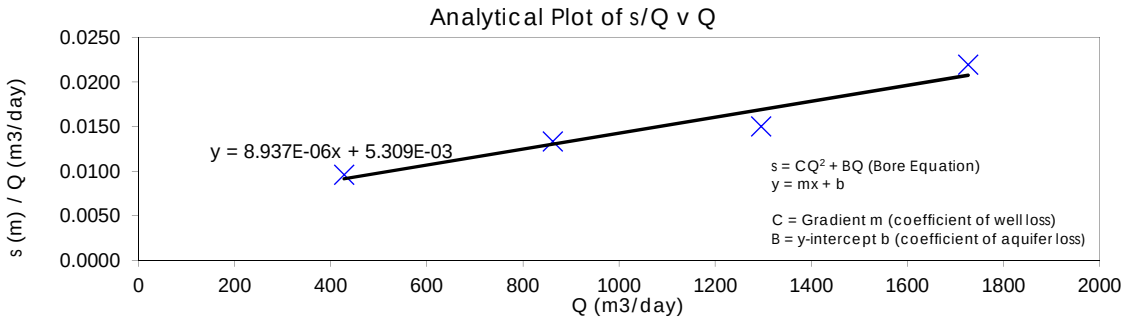
Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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





From plot of s/Q v Q (trend line equation):

Gradient (C)	8.937E-06
Intercept (B)	5.309E-03

ANALYSIS TABLE Bierschenk & Wilson (1961)

Calculation of well efficiency and comparison of observed and predicted drawdowns

Step (100 minute duration)	Discharge (l/s)	Discharge (Q) (m^3/d)	Analysed incremental drawdown (m)	Cumulative Analysed drawdown (m)	Predicted drawdown using Bore Equation (m)	Actual total pump-test drawdown (m)	Analysed cumulative s/Q	Apparent Efficiency (Ew) %
1	5.0	428	4.10	4.10	3.91	4.10	0.0096	58.1
2	10.0	862	7.37	11.47	11.22	11.67	0.0133	40.8
3	15.0	1296	7.96	19.43	21.88	20.36	0.0150	31.4
4	20.0	1727	18.40	37.83	35.81	39.60	0.0219	25.6

ANALYSIS COMMENTS: First step was 97.5 mins.

Analysis Date: 13/07/2017 By Hydro: F Cronjé

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

Where:
B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

Components of Jacob's (1947) equation BQ and CQ^2 are the drawdown due aquifer loss and drawdown due to apparent well loss.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

Please note: 1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.

2 In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow.
A high percent efficiency indicates a larger proportion of drawdown is due to the aquifer properties rather than the well construction.

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

Appendix E Constant Rate Pumping Test Results

CRD0082

Test pumping of CRD0082 was undertaken between 27/6/2017 and 4/7/2017. A calibration test indicated the maximum pumping rate the pump could achieve was 28 L/s. Therefore four 100 minute steps at 10, 15, 20 and 25 L/s were selected. The total drawdown observed in the pumping bore after the test was 3.8 m. Analysis of the test results yielded coefficients of aquifer loss (B) and apparent well loss (C) of 8.01 x 10^{-4} and 3.3 x 10^{-7} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 74% at 10 L/s to 53% at 25 L/s.

The constant rate test was conducted at a rate of 25 L/s, resulting in a maximum drawdown of 6.13 m. The drawdown did not reach steady state conditions with groundwater levels continuing to fall at an increasing rate, similar to a strip aquifer response, but in a fractured rock setting. Hydraulic analysis yielded best estimates for transmissivity values of around 200 m^2/day (190 to 211) while derived specific yield values are not considered reliable.

Electrical conductivity remained steady throughout the test oscillating diurnally (due to temperature change) between 1035 – 1307 µS/cm.

Following the CRT, the groundwater level took 2800 minutes to achieve 95% recovery.

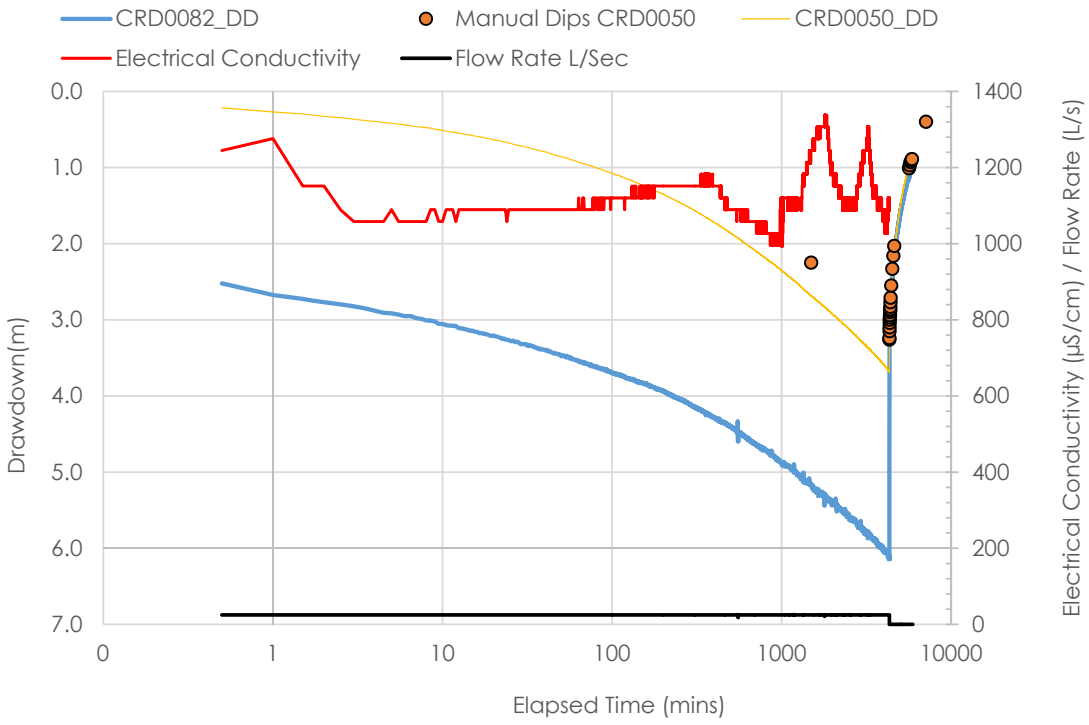


Figure D1: Observations of water level and electrical conductivity during the constant rate test of CRD0082

CRD0083

Test pumping of CRD0083 was undertaken between 5/7/2017 and 9/7/2017. A calibration test indicated the bore was capable of a pumping rate of 20 L/s and four 100 minute steps at 10, 15, 20, 25 L/s were selected for the step rate test. The total drawdown observed in the pumping bore after the test was 13.24 m. The test results yielded coefficients of aquifer loss (B) and apparent well loss (C) of 2.368 x 10^{-3} and 3.89 x 10^{-6} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 41% at 10 L/s to 22% at 20 L/s.

The constant rate test was conducted at a rate of 20 L/s. The shape of the drawdown plot suggests an unconfined aquifer response in the pumping bore. The water level throughout the pumping test did not reach steady state conditions, but showed a plateauing around the middle of the test, consistent with a delayed yield response, before the drawdown commenced increasing at an increasing rate, similar to a strip aquifer response, but in a fractured rock setting. Hydraulic analysis yielded best estimates for transmissivity values of around 200 m^2/day (170 to 220 m^2/day). Derived specific yield values ranged from 7 x 10^{-3} to 7 x 10^{-6} but are not considered reliable..

Electrical conductivity fluctuated with diurnal temperature change and there was a slight reduction in throughout the test from 995 to 710 µS/cm.

Following the CRT water level recovery was monitored for 390 minutes, during which time 89% recovery was observed.

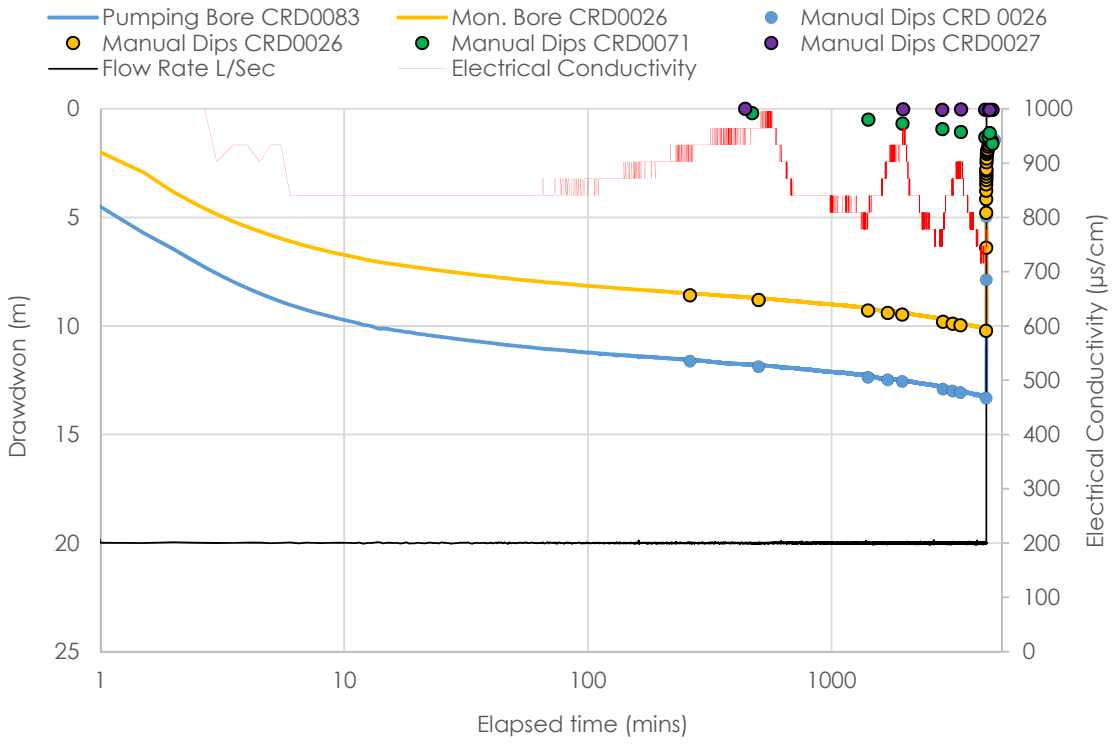


Figure D2: Observations of water level and electrical conductivity during the constant rate test of CRD0083

CRD0084

Test pumping of CRD0084 was undertaken between 10/7/2017 and 16/7/2017. A calibration test indicated a pumping rate of 8 L/s was unsustainable for the bore. Therefore four 100 minute steps at 3, 4, 5, and 6 L/s were selected. The total drawdown observed in the pumping bore after the test was 13.45 m. The test

results yielded coefficients of aquifer loss (B) and apparent well loss (C) of 2.311 x 10^{-3} and 4.30 x 10^{-5} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 17.2% at 3 L/s to 9% at 6 L/s.

The constant rate test was conducted at a rate of 6 L/s. The drawdown response was unsteady, showing a plateauing around the middle of the test, consistent with a delayed yield response, before the drawdown commenced increasing at an increasing rate, similar to a strip aquifer response, but in a fractured rock setting. Hydraulic analysis yielded best estimates for transmissivity values of around 200 m^2/day (155 to 237 m^2/day). A good curve fit was achieved using Moench's analysis method, but the derived transmissivity was relatively low at 47 m^2/day. The derived specific yield was 5 x 10^{-3} but it is not considered reliable.. Electrical conductivity fluctuated with diurnal temperature change but remained steady ranging between 1867 and 1338 µS/cm. Following the CRT, a water level recovery of 95% was achieved in 20 minutes.

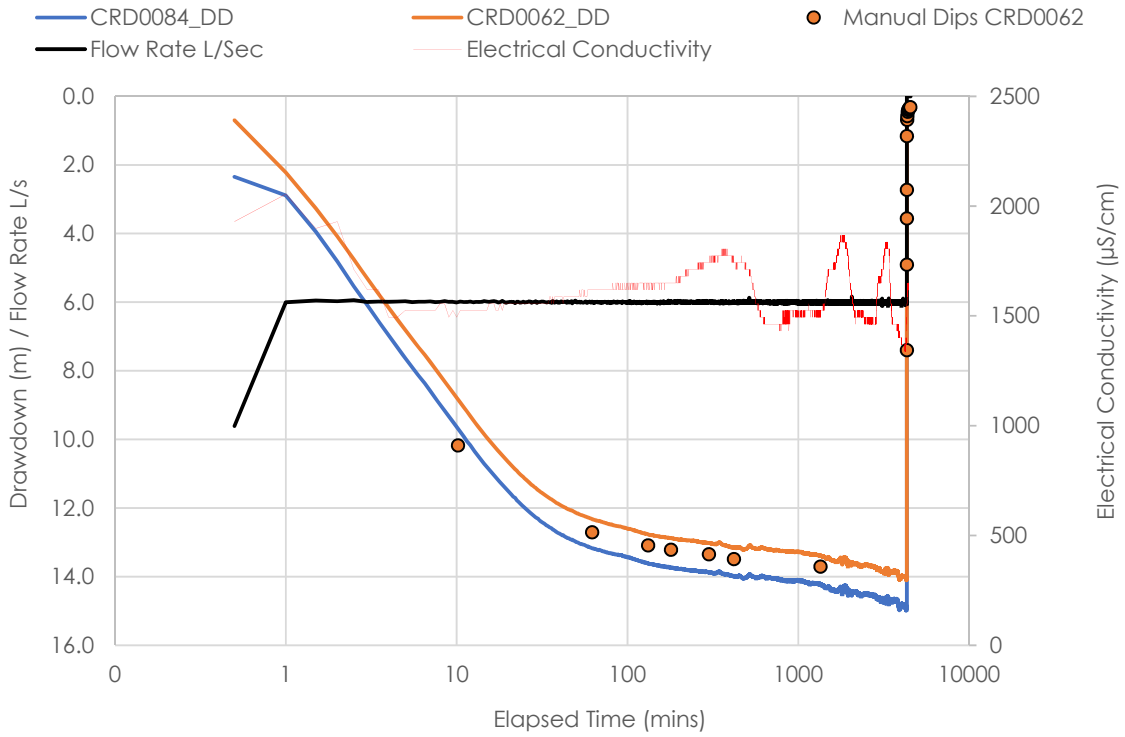


Figure D3: Observations of water level and electrical conductivity during the constant rate test of CRD0084

CRD0085 Test

Test pumping of CRD0085 was undertaken between 16/7/2017 and 21/7/2017. The calibration indicated that a pumping rate of 17 L/s was significantly too high for the bore. Four 100 minute steps at 3, 5, 7, and 9 L/s were selected, however during the final step the drawdown was excessive and the test was abandoned after 306 minutes.

The results of the first three steps yielded coefficients of aquifer loss (B) and apparent well loss (C) of 1.267 x 10^{-2} and 8.468 x 10^{-5} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 37% at 3 L/s to 20% at 7 L/s.

The constant rate test was conducted at a rate of 5 L/s, for a maximum drawdown of 16.6 m. The drawdown response was unsteady, showing a slight plateauing about ten minutes into the test, consistent with a delayed yield response, before the drawdown commenced increasing at an increasing rate, similar to a strip aquifer response, but in a fractured rock setting. Hydraulic analysis yielded best estimates for transmissivity values of around 100 m^2/day.

Electrical conductivity fluctuated with diurnal temperature change and there was a slight reduction throughout the test from 1617 to 1281 µS/cm. Following the CRT, the water level recoveredto 95% in 66 mins.

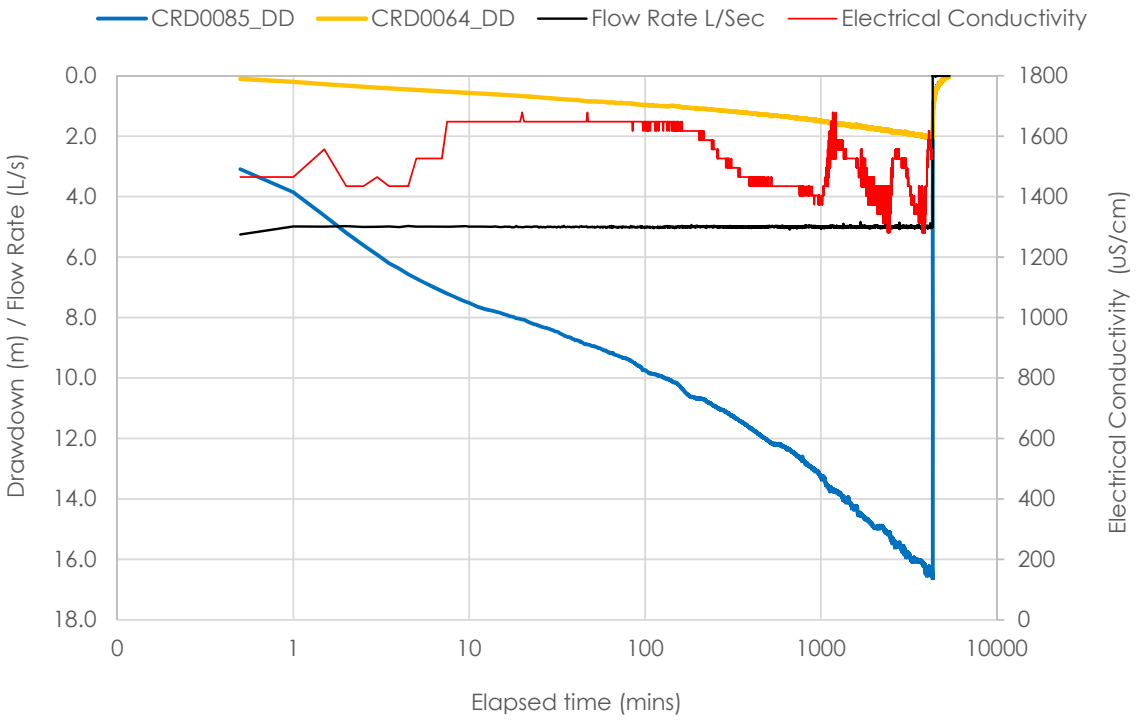


Figure D4: Observations of water level and electrical conductivity during the constant rate test of CRD0085

CRD0086 Test

Test pumping of CRD0086 was undertaken between 23/7/2017 and 27/7/2017. No calibration test was undertaken before the step test. Four 100 minute steps at 2, 3, 4, and 5 L/s were selected, however during the final step the drawdown was excessive and the test was abandoned after 330 minutes.

The results of the first three steps yielded coefficients of aquifer loss (B) and apparent well loss (C) of 2.34 x 10^{-3} and 7.033 x 10^{-5} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 16 % at 2 L/s to 9 % at 4 L/s.

The constant rate test was conducted at a rate of 4 L/s. The drawdown response in the pumping bore was erratic, with s intervals of apparent recovery (up to 0.6 m over 6.5 minutes). Maximum drawdown was 8.27m. Given the pumping rate was measured as constant for the duration of the test, the cause of these recoveries is not known but could be due to development effects such as when saturated fractures suddenly drain as the differential head between the water level in the well and the water in the fracture, increases to a point where hydraulic connection with the well is established (i.e. developing). Alternatively and/or simultaneously, the recoveries could be due to the aquifer material settling in response to reducing heads during the test (storage reducing). Hydraulic analysis yielded unreliable estimates for transmissivity values of around 400 m^2/day.

The drawdown response in the monitoring bore indicates poor connectivity with the pumping bore as the drawdown curve was smooth and almost linear, but with a slowly increasing rate of drawdown. The maximum drawdown in the monitoring bore was 0.88 m.

Electrical conductivity fluctuated with diurnal temperature change but remained steady ranging between 3143 and 2899 µS/cm.

Following the CRT recovery to 95% was achieved within 107mins.

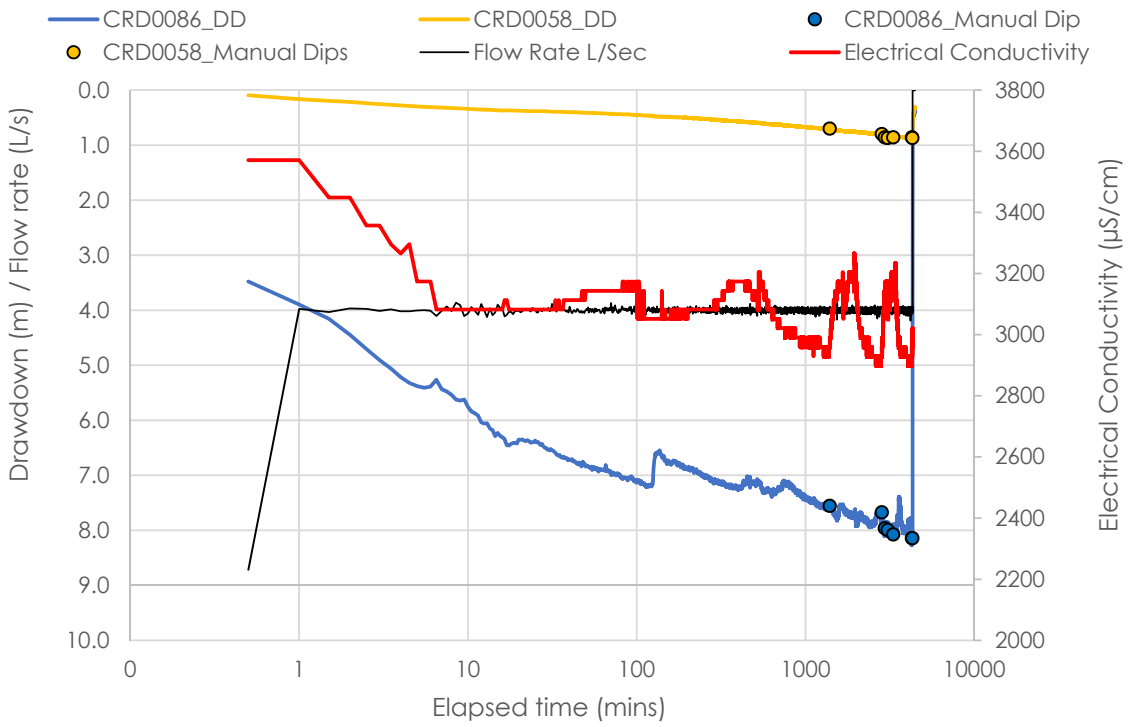


Figure D5: Observations of water level and electrical conductivity during the constant rate test of CRD0086

CRD0087 Test

Test pumping of CRD0087 was undertaken between 28/7/2017 and 1/8/2017. A calibration test indicated that a pumping rate of 27 L/s was unsustainable for the bore. Therefore four 100 minute steps at 10, 15 , 20 and 25 L/s were selected. The total drawdown observed in the pumping bore after the test was 29.3 m. The test results yielded coefficients of aquifer loss (B) and apparent well loss (C) of 7.138 x 10^{-3} and 8.61 x 10^{-6} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 49% at 10 L/s to 28% at 25 L/s. In the fourth step Airwell reported they were struggling to keep a constant pumping rate (25 L/s)

The constant rate test was conducted at a rate of 15 L/s, for a maximum drawdown of 31.3 m. The drawdown did not reach steady state conditions with groundwater levels continuing to fall at an increasing rate, similar to a strip aquifer response, but in a fractured rock setting. Hydraulic analysis yielded poor estimates for transmissivity due to the nature of the drawdown curve while no specific yield values could be determined.

Electrical conductivity fluctuated with diurnal temperature change and there was a slight reduction throughout the test from 1250 to 730 µS/cm

Following the CRT, recovery was rapid, achieving 94% in 15 mins and 95% in 110 mins. . Recovery analysis gave an unreliably high transmissivity value of around 600 m^2/day,

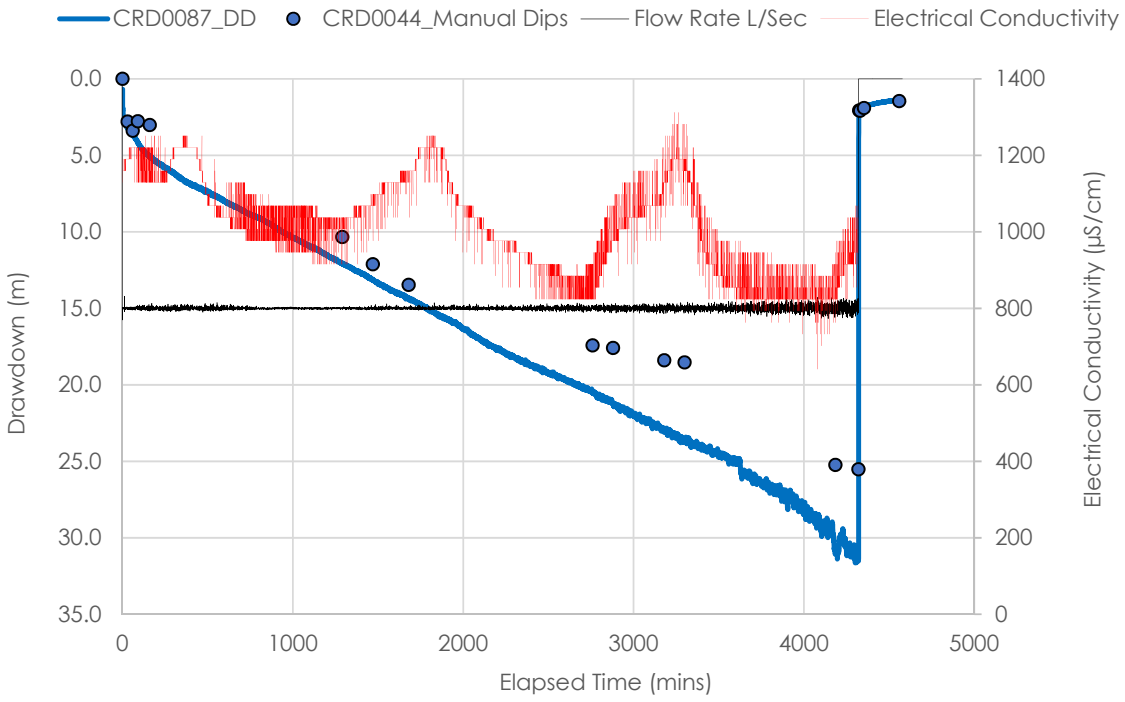


Figure D6: Observations of water level and electrical conductivity during the constant rate test of CRD0087

CRD0088 Test

Test pumping of CRD0088 was undertaken between 19/11/2017 and 23/11/2017. A Step Rate Test was undertaken for four 100 minute steps at 4, 8, 12 and 16 L/s were selected. The total drawdown observed in the pumping bore after the test was 41.58 m. The test results yielded coefficients of aquifer loss (B) and apparent well loss (C) of 5.717 x 10^{-3} and 2.32 x 10^{-5} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 42% at 4 L/s to 15.1% at 16 L/s.

The constant rate test was conducted at a rate of 12 L/s, for a maximum drawdown of 16.2 m. The drawdown did not reach steady state conditions with the water level in pumping well linear after about 101 minutes and 12 m drawdown. The curve remains essentially linear until about 2000 minutes, where it begins to increase in gradient, not quite "falling over" during the test but indicating the commencement of a strip aquifer response, but in a fractured rock setting. Hydraulic analysis indicated transmissivities around 300 m^2/day while storage properties could not be determined due to non-classical theory (porous media) water level responses in the monitoring bore.

Recovery of 95% was achieved in 2 minutes, followed by a small rebound then linear recovery back to 99% in 13 hours, indicating high head losses during pumping, and some mining of water as storage was depleted during the constant rate test.

Electrical conductivity fluctuated with diurnal temperature change between 534 and 840 µS/cm.

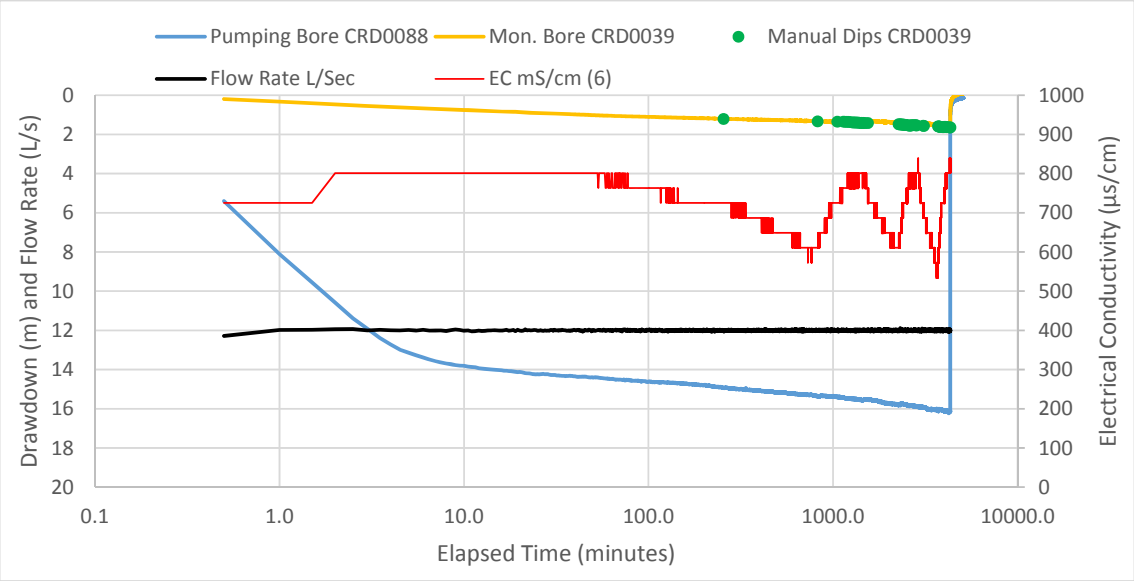


Figure D7: Observations of water level and electrical conductivity during constant rate test of CRD0088

CRD0089 Test

Test pumping of CRD0089 was undertaken between 23/11/2017 and 27/11/2017. A Step Rate Test was undertaken for four 100 minute steps at 5, 10, 15 and 20 L/s were selected. The total drawdown observed in the pumping bore after the test was 37.83 m. The test results yielded coefficients of aquifer loss (B) and apparent well loss (C) of 5.309 x 10^{-3} and 8.937 x 10^{-6} respectively. The apparent efficiency of the bore operating at these flow rates ranged from 58% at 5 L/s to 25.61% at 20 L/s.

The constant rate test was conducted at a rate of 12 L/s, for a maximum drawdown of 21.50 m. The drawdown did not reach steady state conditions with groundwater levels plateauing off between 10 and about 1000 minutes, in a delayed yield style of response, before continuing to fall at an increasing rate, similar to a strip aquifer response, but in a fractured rock setting. Hydraulic analysis yielded poor estimates for transmissivity of around 50 m^2/day, due to the nature of the drawdown curve while no specific yield values could be determined.

Recovery of 84% was achieved in approximately 6 hours, indicating high head losses during pumping, and some mining of water as storage was depleted during the constant rate test.

Electrical conductivity fluctuated with diurnal temperature change and there was a slight reduction throughout the test from 880 to 610 µS/cm.

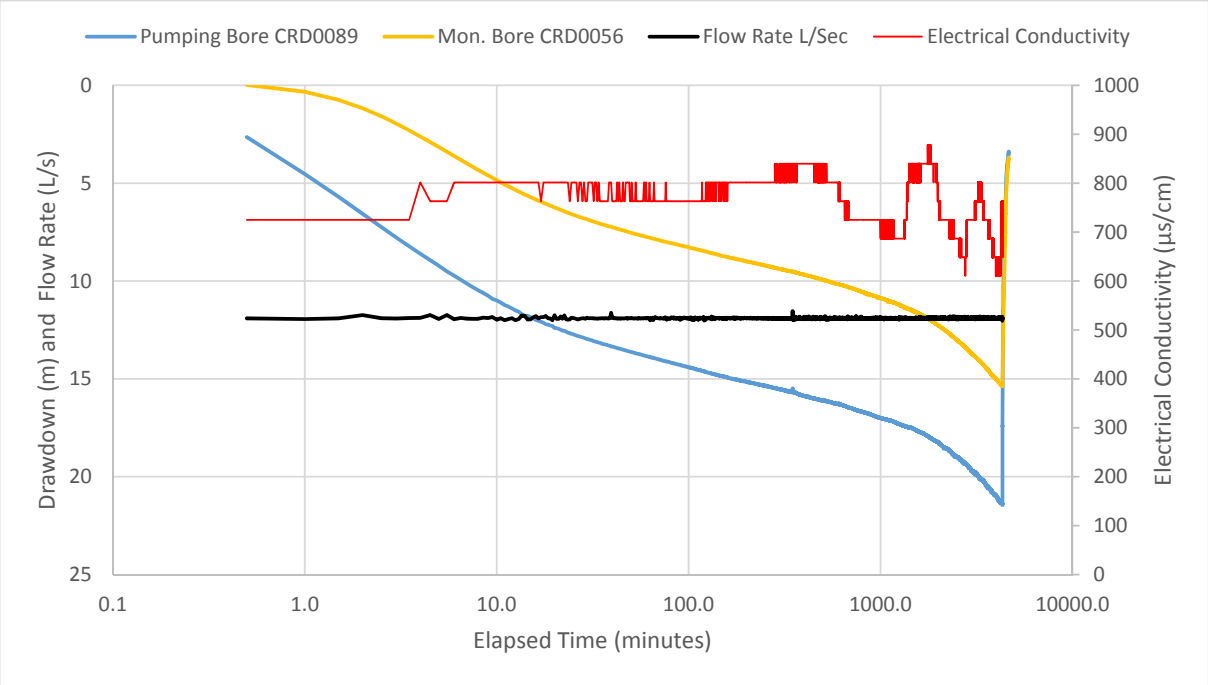


Figure D8: Observations of water level and electrical conductivity during constant rate test of CRD0089

Appendix F Water Chemistry Database and Laboratory Analysis Reports

Groundwater and Surface Water Chemistry Database

			Analyte	Type	pH	EC	TDS	TSS	Fluoride	Nitrate	Nitrite	NOx	Calcium	Potassium	Magnesium	Sodium	Silica	Bicarbonate HCO3	Carbonate CO32	Hydroxide OH	Total Alkalinity	Chloride
			Type				grav			as N	as N	as N	Dissolved	Dissolved	Dissolved	Dissolved		as CaCO3	as CaCO3	as CaCO3	as CaCO3	
			Units	SW/GW	pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			PQL			1	5	5	0.1	0.005	0.005	0.005	0.5	0.5	0.5	0.5	0.2	5	5	5	5	1
Sample ID	**X**	**Y**	**Date Sampled**	**Type**	**pH**	**EC**	**TDS**	**TSS**	**Fluoride**	**Nitrate**	**Nitrite**	**NOx**	**Calcium**	**Potassium**	**Magnesium**	**Sodium**	**Silica**	**Bicarbonate HCO3**	**Carbonate CO32**	**Hydroxide OH**	**Total Alkalinity**	**Chloride**
CO-WS-01	778586	7630030	24/07/2017	SW	7.9	350	210	<5	0.2	0.022	<0.005	0.022	12	1.3	26	23	16	130	<5	<5	130	31
CO-WS-01	778586	7630030	20/12/2017	Water	7.9	390	240	<5	0.2	<0.005	<0.005	0.013	12	0.9	29	25	18	140	<5	<5	140	34
CO-WS-03	778506	7633950	24/07/2017	SW	6.4	300	180	<5	0.1	<0.005	<0.005	<0.005	23	5.3	12	9.4	14	9	<5	<5	9	21
CO-WS-05	773504	7623870	25/07/2017	SW	8.1	1300	690	<5	0.4	0.066	<0.005	0.066	57	4.5	96	110	42	570	<5	<5	570	120
CO-WS-09	776568	7622980	25/07/2017	SW	8.3	4000	2800	<5	0.9	0.008	<0.005	0.008	100	12	290	390	27	420	13	<5	430	710
CO-WS-10	777455	7629434	25/10/2017	Water	7.9	670	400	<5	0.2	<0.005	<0.005	0.008	13	2.4	33	92	32	130	<5	<5	130	160
CO-WS-10	777455	7629434	19/12/2017	Water	7.9	1300	700	<5	0.3	<0.005	<0.005	0.019	19	4	51	160	37	210	<5	<5	210	260
CO-WS-10	777455	7629434	19/12/2017	Water	[NT]	[NT]	[NT]	[NT]	0.3	<0.005	<0.005	[NT]	19	4	51	160	[NT]	[NT]	[NT]	[NT]	[NT]	260
CO-WS-11	777517	7626870	25/07/2017	SW	6.7	55	33	<5	0.1	0.35	<0.005	0.35	1.6	2.6	1	1.4	4.7	11	<5	<5	11	4
CO-WS-11	777517	7626870	20/12/2017	Water	6.8	210	120	11	<0.1	<0.005	<0.005	0.016	5.8	19	3.1	7.7	13	39	<5	<5	39	29
CO-WS-12	777069	7629034	19/12/2017	Water	6.5	150	91	26	0.1	<0.005	<0.005	0.014	5.3	<0.5	6.4	16	29	38	<5	<5	38	22
CO-WS-13	774623	7623940	25/07/2017	SW	8.2	1000	550	<5	0.3	<0.005	<0.005	<0.005	59	1.8	75	76	61	500	<5	<5	500	65
CO-WS-14	776816	7623730	2/08/2017	SW	8	320	190	<5	0.3	<0.005	<0.005	<0.005	12	1	22	21		87	<5	<5	87	32
CO-WS-14	776816	7623730	19/12/2017	Water	7.8	340	210	<5	0.2	<0.005	<0.005	0.009	13	1.4	23	22	20	97	<5	<5	97	32
CDRC0334			30/04/2014	GW	6.8	420	310		0.1				10	2.2	16	43	20	140	<5		110	40
CRD0003	776206	7623203	29/04/2014	CORU	7.1	560	360		0.2				23	4.1	30	34	17	150	<5		120	63
CRD0003 (CDRC0014)			26/10/2017	Water	6.5	430	260	150	0.2	0.009	<0.005	0.009	20	2.8	31	35	18	100	<5	<5	100	64
CRD0004 (CDWB0001 Camp Bore)			26/10/2017	Water	7.8	1300	780	5	0.4	0.021	<0.005	0.022	60	4.4	67	120	49	540	<5	<5	540	150
CRD0005	775962	7623420	29/04/2014	CORU	7.5	800	470		0.3				56	1.8	30	33	27	430	<5		360	46
CRD0016	773188	7624730	30/04/2014	CORU	7.8	1300	710		0.5				65	2.2	61	69	55	560	<5		460	150
CRD0024			26/10/2017	Water	5.5	59	36	23	<0.1	1.3	<0.005	1.3	2.1	0.6	3.6	8.2	17	14	<5	<5	14	12
CRD0026	778579	7632984	13/12/2016	COON	7.7	670	400	200	0.4	1.3	<0.005	1.3	70	0.5	20	62	29	310	<5	<5	310	35
CRD0026	778579	7632984	24/04/2017	Water	7.7	690	410	<5	0.4	1.1	<0.005	1.1	56	<0.5	17	52		300	<5	<5	300	37
CRD0027	779020	7634060	30/11/2015	COON	8.2	950	550	31000		0.9	0.22	1.12	58	15	33	93		420	<1		340	98
CRD0028	778440	7633400	1/12/2015	COON	8.2	740	430	40		<0.05	<0.05	<0.05	59	1.5	28	51		360	<1		300	46
CRD0028	778440	7633400	7/08/2016	COON	7.9	720	430	250	0.3	0.25	<0.005	0.25	65	1.1	33	63	30	320	<5	<5	320	45
CRD0031	776754	7625643	30/11/2015	CORU	7	240	180	23000		<0.05	<0.05	<0.05	1.2	0.6	2.1	6.8		12	<1		10	19
CRD0033	776181	7623126	31/10/2015	CORU	7.8	400	280	37000		<0.05	<0.05	<0.05	30	4.2	30	39		78	<1		64	34
CRD0034	779813	7634552	23/11/2016	Water	7.8	1200	650	130	0.6	1.2	<0.005	1.2	57	2.3	53	130	42	390	<5	<5	390	150
CRD0035	779316	7638017	23/11/2016	Water	7.9	950	570	930	0.2	0.29	<0.005	0.29	46	3.2	41	100	31	290	<5	<5	290	100
CRD0036	778631	7642234	23/11/2016	Water	7.9	880	530	13000	0.2	0.05	<0.005	0.051	44	6.7	33	86	21	260	<5	<5	260	110
CRD0038	783368	7647094	10/04/2017	COON	8	700	420	2400	0.1	1.2	<0.005	1.2	34	1.5	52	43	53	350	<5	<5	350	19
CRD0039	782368	7652870	6/11/2017	Water	7.6	800	480	310	0.4	1.4225806	<0.005	1.7	88	<0.5	30	72	33	360	<5	<5	360	56
CRD0039	782368	7652870	06/11/2017	Water	7.6	800	480	310	0.4	1.4	<0.1	1.7	88	<0.5	30	72	33	360	<5	<5	360	56
CRD0040	785602	7654390	10/11/2017	Water	8.1	1600	970	110	1.2	1.1516129	<0.005	1.4	62	<0.5	67	190	64	450	<5	<5	450	240
CRD0040	785602	7654390	10/11/2017	Water	8.1	1600	970	110	1.2	1.1	<0.1	1.4	62	<0.5	67	190	64	450	<5	<5	450	240
CRD0043	782275	7652340	4/11/2017	Water	7.5	820	490	140	0.5	1.3548387	<0.005	1.5	88	<0.5	26	75	31	360	<5	<5	360	66
CRD0043	782275	7652340	4/11/2017	Water	7.5	810	480	[NT]	0.5	1.3548387	<0.005	[NT]	88	<0.5	26	74	30	370	<5	<5	370	66
CRD0043	782275	7652340	04/11/2017	Water	7.5	820	490	140	0.5	1.3	<0.1	1.5	88	<0.5	26	75	31	360	<5	<5	360	66
CRD0043	782275	7652340	04/11/2017	Water	7.5	810	480	[NT]	0.5	1.3	<0.1	[NT]	88	<0.5	26	74	30	370	<5	<5	370	66
CRD0044	782273	7645380	11/04/2017	COON	8.4	2700	1500	780	1.4	1.2	<0.005	1.2	18	1	23	570	50	650	22	<5	670	400
CRD0045	781895	7645717	13/04/2017	COON	8.1	970	580	1300	0.7	1.5	0.017	1.5	41	<0.5	28	120		390	<5	<5	390	77
CRD0046	774980	7632501	3/11/2015	COON	7.4	400	290	2500		<0.05	<0.05	<0.05	24	3.3	19	22		24	<1		19	32
CRD0048	779844	7631676	9/12/2016	COON	8	1600	800	180	0.4	0.26	<0.005	0.26	63	5.4	97	140	46	480	<5	<5	480	200
CRD0050	778953	7631289	12/12/2016	COON	8.1	820	490	<5	0.2	0.024	<0.005	0.026	66	1.9	36	70	45	310	<5	<5	310	73
CRD0050	778953	7631289	16/04/2017	Water	8	850	510	<5	0.2	<0.005	<0.005	<0.005	56	1.8	31	63		310	<5	<5	310	72
CRD0051	785884	7654307	11/11/2017	Water	8.1	1500	890	21	1.2	1.0387097	<0.005	1.3	39	1.1	61	190	53	420	<5	<5	420	200
CRD0051	785884	7654307	11/11/2017	Water	8.1	1500	890	21	1.2	1	<0.1	1.3	39	1.1	61	190	53	420	<5	<5	420	200
CRD0056	782732	7652279	7/11/2017	Water	7.5	860	520	440	0.5	1.6709677	<0.005	1.9	81	<0.5	25	82	30	400	<5	<5	400	75
CRD0056	782732	7652279	07/11/2017	Water	7.5	860	520	440	0.5	1.7	<0.1	1.9	81	<0.5	25	82	30	400	<5	<5	400	75
CRD0058	782443	7644390	12/04/2017	COON	8.3	3000	1600	950	1.8	1.5	<0.005	1.5	23	1.9	32	610	50	690	7	<5	700	460
CRD0062	778985	7641957	23/11/2016	Water	7.8	1200	630	350	0.2	0.88	0.033	0.92	65	1.5	48	110	36	300	<5	<5	300	170
CRD0064	780806	7642050	23/11/2016	Water	7.9	1200	620	1100	0.7	0.66	<0.005	0.66	41	2.7	38	150	37	340	<5	<5	340	170
CRD0066	780109	7637261	23/11/2016	Water	8	1100	640	7500	0.5	0.43	<0.005	0.43	40	6	39	140	34	290	<5	<5	290	160
CRD0071	778435	7633394	6/08/2016	COON	8	560	330	<5	0.2	0.18	0.015	0.19	69	1.3	33	63	27	320	<5	<5	320	47
CRD0071	778435	7633394	2/09/2016	COON	7	690	420	<5	0.2	0.022	<0.005	0.023	62	1.2	26	52		320	<5	<5	320	45
CRD0071	778435	7633394	5/09/2016	COON	7	760	460	<5	0.3	0.75	0.011	0.76	70	0.7	25	55		350	<5	<5	350	46
CRD0071	778435	7633394	26/10/2017	Water	6.9	480	290	<5	0.3	0.008	<0.005	0.009	60	1.6	30	59	27	300	<5	<5	300	50
CRD0073	779603	7631387	11/12/2016	COON	8	1400	750	19	0.4	0.74	<0.005	0.74	64	5.3	93	110	48	470	<5	<5	470	170
CRD0081	785348	7654094	12/11/2017	Water	7.9	980	590	1400	0.7	1.8290323	<0.005	2.2	65	<0.5	45	92	45	430	<5	<5	430	92
CRD0081	785348	7654094	12/11/2017	Water	7.9	980	590	1400	0.7	1.8	<0.1	2.2	65	<0.5	45	92	45	430	<5	<5	430	92
CRD0082	778953	7631289	16/04/2017	COON	8	850	510	<5	0.2	<0.005	<0.005	<0.005	56	1.8	31	63		310	<5	<5	310	72
CRD0082	778953	7631289	29/06/2017	COON	7.1	840	510	<5	0.3	<0.5	<0.5	0.007	61	1.6	31	66	41	330	<5	<5	330	71
CRD0082	778953	7631289	2/07/2017	COON	7	950	570	<5	0.4	<0.5	<0.5	0.086	66	1.3	32	72	36	340	<5	<5	340	95
CRD0083	778579	7632984	24/04/2017	COON	7.7	690	410	<5	0.4	1.1	<0.005	1.1	56	<0.5	17	52		300	<5	<5	300	37
CRD0083	778579	7632984	6/07/2017	COON	7	790	480	<5	0.4	4.6	<0.5	0.98	79	0.5	19	56	28	360	<5	<5	360	40
CRD0083	778579	7632984	9/07/2017	COON	7	770	460	<5	0.4	0.82	0.017	0.83	88	0.5	22	61	31	350	<5	<5	350	42
CRD0084	778985	7641957	26/04/2017	COON	7.9	1300	660	<5	0.3	1.4	0.008	1.4	63	1	44	110		310	<5	<5	310	180
CRD0084	778985	7641957	12/07/2017	COON	7.2	1300	800	<5	0.3	1.4	0.019	1.4	89	1.2	52	130	41	350	<5	<5	350	190
CRD0084	778985	7641957	15/07/2017	COON	7.2	1500	930	<5	0.4	1.7	0.008	1.8	97	1.1	57	160	43	360	<5	<5	360	220
CRD0085	780806	7642050	30/04/2017	COON	8	1400	720	21	0.7	0.81	0.008	0.82	58	2.5	43	160		390	<5	<5	390	200
CRD0085	780806	7642050	17/07/2017	COON	7.2	1400	820	<5	0.6	1.1	<0.005	1.1	61	2.5	47	200	44	460	<5	<5	460	180
CRD0085	780806	7642050	17/07/2017	COON			820	<5	0.6	1.1	<0.005	1.1										180
CRD0085	780806	7642050	20/07/2017	COON	7.2	1400	830	<5	0.6	1.1	<0.005	1.1	62	2.6	47	190	44	460	<5	<5	460	180
CRD0086	782443	7644390	4/05/2017	COON	8.1	2900	1700	200	2	<0.005	<0.005	<0.005	21	1.5	27	480		700	<5	<5	700	480
CRD0086	782443	7644390	24/07/2017	COON	7.5	2900	1700	<5	1.6	1.1	0.022	1.1	22	1.4	35	630	48	690	<5	<5	690	480
CRD0086	782443	7644390	27/07/2017	COON	7.5	3000	1800	<5	1.6	1.4	<0.005	1.4	22	1.3	35	630	51	700	<5	<5	700	500
CRD0087	781895	7645717	7/05/2017	COON	8	900	540	<5	0.7	1.2	<0.005	1.2	49	<0.5	26	100		390	<5	<5	390	60
CRD0087	781895	7645717	29/07/2017	COON	7.2	1100	650	<5	0.6	1.3	<0.005	1.3	64	0.5	35	120	44	440	<5	<5	440	84
CRD0087	781895	7645717	1/08/2017	COON	7.3	1100	650	<5	0.6	1.2	<0.005	1.2	67	0.5	37	120	44	440	<5	<5	440	84
CRD0087	781895	7645717	13/04/2017	Water	8.1	970	580	1300	0.7	1.5	0.017	1.5	41	<0.5	28	120		390	<5	<5	390	77
CRD0088	782285	7652335	19/11/2017	Water	7.1	960	570	13	0.4	1.6	<0.1	1.9	93	<0.5	30	71	32	380	<5	<5	380	56
CRD0088	782285	7652335	19/11/2017	Water	7.1	940	560	[NT]	[NT]	[NT]	[NT]	[NT]	94	<0.5	31	71	33	380	<5	<5	380	[NT]
CRD0088	782285	7652335	22/11/2017	Water	7	940	570	5	0.4	1.6	<0.1	1.9	93	<0.5	29	72	32	380	<5	<5	380	57
CRD0089	782719	7652280	24/11/2017	Water	7	1000	570	<5	0.7	1.8	<0.1	1.8	97	<0.5	25	83	31	400	<5	<5	400	77
CRD0089	782719	7652280	24/11/2017	Water	7	1000	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	97	<0.5	26	83	32	400	<5	<5	400	[NT]
CRD0089	782719	7652280	27/11/2017	Water	7	1000	550	<5	0.7	1.7	<0.1	1.7	94	<0.5	25	81	30	400	<5	<5	400	76
Rainfall				RAIN									1.2	0.4	0.6	1.4		0.9				4

Groundwater and Surface Water Chemistry Database

	Sulphate	Ionic Balance	Sum of Anions	Sum of Cations	Hardness	Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Strontium	Tin	Zinc
	as SO4				as CaCO3	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	mg/L	%	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	1		0	0	3	0.01	0.001	0.001	0.001	0.005	0.0001	0.001	0.001	0.001	0.01	0.001	0.005	0.00005	0.001	0.001	0.001	0.001	0.001	0.001
Sample ID	**Sulphate**	**Ionic Balance**	**Sum of Anions**	**Sum of Cations**	**Hardness**	**Aluminium**	**Antimony**	**Arsenic**	**Barium**	**Boron**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Strontium**	**Tin**	**Zinc**
CO-WS-01	17	-0.11	3.3	3.75	130	<0.01	<0.001	<0.001	0.019	0.07	<0.0001	<0.001	<0.001	<0.001	0.01	<0.001	0.008	<0.00005	<0.001	<0.001	<0.001	0.065	<0.001	<0.001
CO-WS-01	12	1.4	3.48	4.09	150	<0.01	<0.001	<0.001	0.017	0.1	<0.0001	<0.001	<0.001	<0.001	0.12	<0.001	0.062	<0.00005	<0.001	<0.001	<0.001	0.072	<0.001	0.005
CO-WS-03	91	-0.14	2.63	2.66	110	<0.01	<0.001	<0.001	0.034	0.02	<0.0001	<0.001	<0.001	0.002	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.15	<0.001	<0.001
CO-WS-05	21	0.56	13.3	15.5	540	<0.01	<0.001	0.001	0.21	0.26	<0.0001	<0.001	<0.001	<0.001	0.03	<0.001	0.046	<0.00005	<0.001	<0.001	<0.001	0.25	<0.001	<0.001
CO-WS-09	830	-0.32	44.8	45.8	1400	<0.01	<0.001	<0.001	0.032	0.36	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.019	<0.00005	<0.001	<0.001	<0.001	0.59	<0.001	<0.001
CO-WS-10	38	-3.1	7.47	7.47	170	<0.01	<0.001	<0.001	0.024	0.27	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.17	<0.001	<0.001
CO-WS-10	49	-1.1	11.7	12.2	260	<0.01	<0.001	<0.001	0.042	0.43	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.03	<0.00005	<0.001	<0.001	<0.001	0.25	<0.001	0.001
CO-WS-10	49	[NT]	[NT]	12.3	260	<0.01	<0.001	<0.001	0.042	0.45	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.031	<0.00005	<0.001	<0.001	<0.001	0.25	<0.001	0.001
CO-WS-11	2	-11	0.332	0.297	8	0.01	<0.001	<0.001	0.004	<0.02	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.01	<0.001	<0.001
CO-WS-11	2	-9.1	1.49	1.36	27	0.12	<0.001	0.001	0.02	0.1	<0.0001	<0.001	<0.001	0.005	6.9	<0.001	0.23	0.00023	<0.001	0.001	0.001	0.038	<0.001	0.004
CO-WS-12	<1	3.2	1.24	1.47	40	0.28	<0.001	<0.001	0.035	0.1	<0.0001	0.001	0.001	0.007	0.72	0.002	0.7	<0.00005	<0.001	0.002	<0.001	0.056	<0.001	0.037
CO-WS-13	14	1.7	10.2	12.5	450	<0.01	<0.001	0.005	0.1	0.2	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.19	<0.001	<0.001
CO-WS-14	29	0.83	120	2.94	3.31	<0.01	<0.001	<0.001	0.004	0.07	<0.0001	<0.001	<0.001	<0.001	0.03	<0.001	0.1	<0.00005	<0.001	<0.001	<0.001	0.046	<0.001	0.002
CO-WS-14	26	2.1	3.03	3.53	130	<0.01	<0.001	<0.001	0.005	0.1	<0.0001	<0.001	<0.001	<0.001	0.04	<0.001	0.15	<0.00005	<0.001	<0.001	<0.001	0.053	<0.001	0.001
CDRC0334	21					<0.02	<0.05	<0.02	0.096	0.2	<0.001	<0.005	<0.01	<0.005	0.32	<0.02	4.2	<0.00005	<0.01	0.014	<0.05	0.1	<0.05	0.23
CRD0003	70					<0.02	<0.05	<0.02	0.078	0.2	<0.001	<0.005	<0.01	0.006	<0.02	<0.02	0.67	<0.00005	<0.01	<0.005	<0.05	0.094	<0.05	0.04
CRD0003 (CDRC0014)	73	-2.3	4.97	5.1	180	<0.01	<0.001	<0.001	0.021	0.1	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.87	<0.00005	<0.001	0.001	<0.001	0.098	<0.001	0.006
CRD0004 (CDWB0001 Camp Bore)	14	-4.2	13.2	13.9	430	0.02	<0.001	0.001	0.11	0.31	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.12	<0.00005	0.001	<0.001	<0.001	0.36	<0.001	0.008
CRD0005	15					<0.02	<0.05	<0.02	0.048	0.2	<0.001	<0.005	<0.01	<0.005	<0.02	<0.02	0.15	<0.00005	<0.01	0.008	<0.05	0.12	<0.05	0.06
CRD0016	25					<0.02	<0.05	<0.02	0.084	0.3	<0.001	<0.005	<0.01	0.01	<0.02	<0.02	0.012	<0.00005	<0.01	<0.005	<0.05	0.26	<0.05	0.04
CRD0024	1	9.1	0.595	0.774	20	<0.01	<0.001	<0.001	0.006	0.05	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.028	<0.00005	<0.001	0.002	<0.001	0.024	<0.001	0.011
CRD0026	15	1.9	6	7.83	260	<0.01	<0.001	<0.001	0.004	0.2	<0.0001	<0.001		<0.001	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.41	<0.001	<0.001
CRD0026	19	-6.9	6	6.44	210	<0.01	<0.001	<0.001	0.007	0.1	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.4	<0.001	<0.001
CRD0027	48	-2.6				0.017		<0.001		0.23	<0.0001	<0.001		<0.001	<0.005	<0.001	1.4	<0.00005		0.001	<0.001	0.49	<0.001	<0.005
CRD0028	47	-4.3				0.006		<0.001		0.15	<0.0001	<0.001		<0.001	<0.005	<0.001	0.29	<0.00005		0.001	0.002	0.28	<0.001	<0.005
CRD0028	38	1.6	7	8.8	300	<0.01	<0.001	<0.001	0.05	0.17	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.096	<0.00005	<0.001	<0.001	<0.001	0.31	<0.001	<0.001
CRD0031	73					<0.005		<0.001		0.042	<0.0001	<0.001		<0.001	<0.005	<0.001	3.2	<0.00005		0.018	<0.001	0.024		<0.005
CRD0033	89					<0.005		<0.001		0.092	<0.0001	<0.001		0.004	0.011	<0.001	0.96	<0.00005		0.01	0.001	0.22		0.007
CRD0034	62	-2	12	12.8	360	0.01	<0.001	<0.001	0.043	0.29	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	0.004	<0.001	0.001		<0.001	<0.001
CRD0035	89	-1.3	9	10.2	280	0.02	<0.001	0.001	0.021	0.32	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.025	<0.00005	0.001	0.001	<0.001		<0.001	<0.001
CRD0036	36	-1.1	8	8.82	250	0.02	<0.001	<0.001	0.043	0.2	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.062	<0.00005	0.007	0.001	0.002		<0.001	<0.001
CRD0038	7	1.2	6	7.94	300	0.02	<0.001	0.013	0.008	0.1	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.078	<0.00005	0.006	0.002	<0.001	0.15	<0.001	<0.001
CRD0039	33	2.6	8.22	10	340	<0.01	<0.001	0.001	0.016	0.2	<0.0001	<0.001	0.006	<0.001	<0.01	<0.001	0.033	<0.00005	<0.001	<0.001	<0.001	0.64	<0.001	<0.001
CRD0039	33	2.6	8.22	10	340	<0.01	<0.001	0.001	0.016	0.2	<0.0001	<0.001	0.006	<0.001	<0.01	<0.001	0.033	<0.00005	<0.001	<0.001	<0.001	0.64	<0.001	<0.001
CRD0040	66	-0.75	15.6	17	430	<0.01	<0.001	0.01	0.11	0.39	<0.0001	<0.001	<0.001	<0.001	0.06	<0.001	0.033	<0.00005	0.006	0.002	0.002	0.91	<0.001	0.012
CRD0040	66	-0.75	15.6	17	430	<0.01	<0.001	0.01	0.11	0.39	<0.0001	<0.001	<0.001	<0.001	0.06	<0.001	0.033	<0.00005	0.006	0.002	0.002	0.91	<0.001	0.012
CRD0043	26	0.99	8.33	9.84	330	<0.01	<0.001	<0.001	0.007	0.2	<0.0001	<0.001	0.002	<0.001	<0.01	<0.001	0.017	<0.00005	<0.001	<0.001	<0.001	0.67	<0.001	0.013
CRD0043	26	-0.36	8.48	9.75	330	<0.01	<0.001	<0.001	0.007	0.2	<0.0001	<0.001	0.002	<0.001	<0.01	<0.001	0.017	<0.00005	<0.001	<0.001	<0.001	0.65	<0.001	0.012
CRD0043	26	0.99	8.33	9.84	330	<0.01	<0.001	<0.001	0.007	0.2	<0.0001	<0.001	0.002	<0.001	<0.01	<0.001	0.017	<0.00005	<0.001	<0.001	<0.001	0.67	<0.001	0.013
CRD0043	26	-0.36	8.48	9.75	330	<0.01	<0.001	<0.001	0.007	0.2	<0.0001	<0.001	0.002	<0.001	<0.01	<0.001	0.017	<0.00005	<0.001	<0.001	<0.001	0.65	<0.001	0.012
CRD0044	99	1.4	25	27.4	140	<0.01	<0.001	0.008	0.021	0.8	<0.0001	<0.001	<0.001	<0.001	0.01	<0.001	0.067	<0.00005	0.013	0.001	0.003	0.25	<0.001	<0.001
CRD0045	25	-5.9	9	9.42	220	0.01	<0.001	0.002	0.003	0.28	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	0.003	<0.001	0.001	0.36	<0.001	<0.001
CRD0046	120					<0.005		<0.001		0.08	<0.0001	<0.001		<0.001	<0.005	<0.001	0.27	<0.00005		0.002	0.002	0.079		<0.005
CRD0048	77	1.1	15	17.3	560	<0.01	<0.001	0.005	0.012	0.35	<0.0001	<0.001		<0.001	<0.01	<0.001	<0.005	<0.00005	0.002	<0.001	0.001	0.38	<0.001	<0.001
CRD0050	40	1.2	8	9.39	310	<0.01	0.002	0.003	0.069	0.22	<0.0001	<0.001		<0.001	<0.01	<0.001	0.29	<0.00005	<0.001	<0.001	0.001	0.3	<0.001	<0.001
CRD0050	44	-5.9	8	8.18	270	<0.01	0.003	0.004	0.084	0.23	<0.0001	<0.001	<0.001	0.001	<0.01	<0.001	0.076	<0.00005	<0.001	<0.001	<0.001	0.3	<0.001	<0.001
CRD0051	58	-0.47	13.9	15.3	350	<0.01	<0.001	0.006	0.04	0.36	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.03	<0.00005	0.007	0.003	0.002	0.52	<0.001	<0.001
CRD0051	58	-0.47	13.9	15.3	350	<0.01	<0.001	0.006	0.04	0.36	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.03	<0.00005	0.007	0.003	0.002	0.52	<0.001	<0.001
CRD0056	20	-4.4	9.09	9.64	300	0.01	<0.001	<0.001	0.002	0.21	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.022	<0.00005	<0.001	<0.001	<0.001	0.63	<0.001	0.032
CRD0056	20	-4.4	9.09	9.64	300	0.01	<0.001	<0.001	0.002	0.21	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.022	<0.00005	<0.001	<0.001	<0.001	0.63	<0.001	0.032
CRD0058	130	1.5	27	30.6	190	0.02	<0.001	0.012	0.031	0.91	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.018	<0.00005	0.026	<0.001	0.003	0.3	<0.001	<0.001
CRD0062	83	-1.1	11	12.2	360	0.03	<0.001	<0.001	0.041	0.2	<0.0001	<0.001	<0.001	<0.001	0.05	<0.001	0.051	<0.00005	0.002	0.001	0.001		<0.001	<0.001
CRD0064	50	-2.1	11	12	260	0.05	<0.001	0.001	0.013	0.25	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.013	<0.00005	0.007	<0.001	<0.001		<0.001	<0.001
CRD0066	72	-1.5	11	11.5	260	0.04	<0.001	<0.001	0.024	0.31	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.041	<0.00005	0.007	0.001	0.001		<0.001	<0.001
CRD0071	39	1.7	7	8.89	310	<0.01	<0.001	<0.001	0.1	0.17	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.19	<0.00005	<0.001	<0.001	<0.001	0.3	<0.001	<0.001
CRD0071	40	-5.9			260	<0.01	<0.001	<0.001	0.076	0.16	<0.0001	<0.001	<0.001	0.001	0.02	<0.001	0.24	<0.00005	<0.001	0.001	<0.001	0.28	<0.001	0.18
CRD0071	32	-5.7			280	<0.01	<0.001	<0.001	0.055	0.17	<0.0001	<0.001	<0.001	<0.001	0.05	0.001	0.17	<0.00005	<0.001	<0.001	<0.001	0.34	<0.001	0.049
CRD0071	39	-0.35	7.07	8.08	270	<0.01	<0.001	<0.001	0.1	0.2	<0.0001	<0.001	<0.001	<0.001	0.1	<0.001	0.36	<0.00005	<0.001	<0.001	<0.001	0.32	<0.001	0.005
CRD0073	61	1.1	14	15.8	540	<0.01	0.002	0.01	0.012	0.32	<0.0001	<0.001		<0.001	<0.01	<0.001	0.02	<0.00005	0.002	<0.001	0.003	0.3	<0.001	<0.001
CRD0081	36	-3.9	10.4	11	350	<0.01	<0.001	0.001	0.029	0.2	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.078	<0.00005	0.006	0.003	0.001	0.49	<0.001	0.002
CRD0081	36	-3.9	10.4	11	350	<0.01	<0.001	0.001	0.029	0.2	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.078	<0.00005	0.006	0.003	0.001	0.49	<0.001	0.002
CRD0082	44	-5.9	8	8.18	270	<0.01	0.003	0.004	0.084	0.23	<0.0001	<0.001	<0.001	0.001	<0.01	<0.001	0.076	<0.00005	<0.001	<0.001	<0.001	0.3	<0.001	<0.001
CRD0082	42	-5.2			280	<0.01	0.002	0.003	0.05	0.22	<0.0001	<0.001	<0.001	0.001	<0.01	<0.001	0.21	<0.00005	<0.001	0.017	<0.001	0.32	<0.001	0.016
CRD0082	49	-6.9			300	<0.01	0.001	0.002	0.044	0.23	<0.0001	<0.001	<0.001	0.001	<0.01	<0.001	0.21	<0.00005	<0.001	0.014	<0.001	0.38	<0.001	0.003
CRD0083	19	-6.9	6	6.44	210	<0.01	<0.001	<0.001	0.007	0.1	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	<0.001	<0.001	<0.001	0.4	<0.001	<0.001
CRD0083	22	-5			270	<0.01	0.001	<0.001	0.005	0.1	<0.0001	<0.001	<0.001	0.002	<0.01	<0.001	0.013	<0.00005	<0.001	0.022	<0.001	0.43	<0.001	0.021
CRD0083	22	1.1	7.42	8.88	310	<0.01	<0.001	<0.001	0.2	0.004	<0.0001	<0.001	<0.001	<0.001	0.05	<0.001	0.008	<0.00005	<0.001	0.014	<0.001	0.44	<0.001	0.034
CRD0084	91	-6.2	12	11.6	340	<0.01	<0.001	<0.001	0.046	0.24	<0.0001	<0.001	<0.001	0.001	<0.01	<0.001	0.016	<0.00005	0.002	<0.001	0.001	0.57	<0.001	<0.001
CRD0084	91	1.5	12.9	14.5	440	<0.01	<0.001	0.002	0.24	0.069	<0.0001	<0.001	<0.001	<0.001	0.03	0.002	0.19	<0.00005	0.002	0.41	0.002	0.62	<0.001	0.13
CRD0084	120	1.4	14.6	16.3	480	<0.01	<0.001	0.001	0.29	0.054	<0.0001	<0.001	<0.001	<0.001	<0.01	0.001	0.11	<0.00005	0.002	0.006	0.002	0.69	<0.001	0.012
CRD0085	56	-3.4	13	13.6	320	<0.01	<0.001	0.002	0.013	0.33	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.007	<0.00005	0.006	<0.001	<0.001	0.46	<0.001	<0.001
CRD0085	51	1.2	13.7	15.7	350	<0.01	<0.001	0.003	0.016	0.29	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.007	<0.00005	0.005	0.009	<0.001	0.46	<0.001	0.01
CRD0085	50					<0.01	<0.001	0.003	0.016	0.29	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	0.007		0.006	0.009	<0.001	0.47	<0.001	0.01
CRD0085	49	0.41	13.6	15.4	350	<0.01	<0.001	0.002	0.009	0.3	0.0004	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	0.005	0.005	<0.001	0.47	<0.001	0.008
CRD0086	140	-11	28	24.2	160	0.01	<0.001	0.012	0.038	0.97	<0.0001	<0.001	<0.001	<0.001	0.02	<0.001	0.013	<0.00005	0.027	<0.001	0.003	0.31	<0.001	0.003
CRD0086	130	2.1	27.6	31.3	200	<0.01	<0.001	0.012	0.054	0.84	0.0004	<0.001	<0.001	0.001	0.01	<0.001	0.086	<0.00005	0.024	0.016	0.003	0.35	0.001	0.077
CRD0086	130	1.2	28.2	31.5	200	<0.01	<0.001	0.014	0.035	0.82	<0.0001	<0.001	<0.001	0.001	<0.01	<0.001	<0.005	<0.00005	0.025	0.014	0.003	0.35	<0.001	0.014
CRD0087	20	-4	8	9.09	230	0.02	<0.001	0.002	0.009	0.27	<0.0001	<0.001	<0.001	<0.001	0.04	<0.001	<0.005	<0.00005	0.002	<0.001	<0.001	0.46	<0.001	0.008
CRD0087	25	-0.64	10.1	11.5	310	<0.01	<0.001	0.002	0.011	0.25	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	0.002	<0.001	<0.001	0.59	<0.001	0.007
CRD0087	24	0.089	10.1	11.8	320	<0.01	<0.001	0.002	0.007	0.25	<0.0001	<0.001	<0.001	0.002	<0.01	<0.001	<0.005	<0.00005	0.002	0.003	<0.001	0.6	<0.001	0.02
CRD0087	25	-5.9	9	9.42	220	0.01	<0.001	0.002	0.003	0.28	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.005	<0.00005	0.003	<0.001	0.001	0.36	<0.001	<0.001
CRD0088	35	1.5	8.51	10.2	360	<0.01	<0.001	0.002	0.017	0.2	<0.0001	<0.001	0.009	0.014	<0.01	<0.001	0.027	<0.00005	<0.001	0.015	0.001	0.69	<0.001	0.049
CRD0088	[NT]	[NT]	[NT]	10.3	360	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
CRD0088	34	1.7	8.48	10.2	350	<0.01	<0.001	0.001	0.011	0.2	<0.0001	<0.001	0.008	0.004	<0.01	<0.001	0.023	<0.00005	<0.001	0.008	0.001	0.71	<0.001	0.015
CRD0089	21	-0.43	9.2	10.6	350	<0.01	<0.001	<0.001	0.003	0.2	<0.0001	<0.001	<0.001	0.002	<0.01	<0.001	0.012	<0.00005	<0.001	<0.001	<0.001	0.66	<0.001	0.006
CRD0089	[NT]	[NT]	[NT]	10.6	350	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
CRD0089	20	-0.92	9.04	10.3	340	<0.01	<0.001	<0.001	0.003	0.2	<0.0001	<0.001	<0.001	0.004	<0.01	<0.001	0.014	<0.00005	<0.001	0.003	<0.001	0.63	<0.001	0.008
Rainfall	3.8																							

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 194600

Client:
Atlas Iron Limited
Level 18, 300 Murray Street
PERTH WA 6000

Attention: David Nyquest

Sample log in details:

Your Reference:	**Corunna Downs**
No. of samples:	3 Water
Date/Time samples received:	13/04/2017 / 15:20
Date completed instructions received:	13/04/2017
Location:	

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

Report Details:

Date results requested by:	21/04/17
Date of Preliminary Report:	Not issued
Issue Date:	21/04/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

Miscellaneous Inorganics				
Our Reference:	UNITS	194600-1	194600-2	194600-3
Your Reference	----------	CRD0038	CRD0044	CRD0058
Date Sampled	----------	10/04/2017	11/04/2017	12/04/2017
Type of sample		Water	Water	Water
Time Sampled		09:00	14:50	10:30
Date prepared	-	18/04/2017	18/04/2017	18/04/2017
Date analysed	-	18/04/2017	18/04/2017	18/04/2017
pH	pH Units	8.0	8.4	8.3
Electrical Conductivity (EC)	µS/cm	700	2,700	3,000
Total Dissolved Solids (grav)	mg/L	420	1,500	1,600
Total Suspended Solids	mg/L	2,400	780	950
Fluoride	mg/L	0.1	1.4	1.8
Nitrate as N	mg/L	1.2	1.2	1.5
Nitrite as N	mg/L	<0.005	<0.005	<0.005
NOx as N	mg/L	1.2	1.2	1.5

Ionic Balance				
Our Reference:	UNITS	194600-1	194600-2	194600-3
Your Reference	----------	CRD0038	CRD0044	CRD0058
Date Sampled	----------	10/04/2017	11/04/2017	12/04/2017
Type of sample		Water	Water	Water
Time Sampled		09:00	14:50	10:30
Date prepared	-	18/04/2017	18/04/2017	18/04/2017
Date analysed	-	18/04/2017	18/04/2017	18/04/2017
Calcium - Dissolved	mg/L	34	18	23
Potassium - Dissolved	mg/L	1.5	1	1.9
Magnesium - Dissolved	mg/L	52	23	32
Sodium - Dissolved	mg/L	43	570	610
Bicarbonate HCO_3 as $CaCO_3$	mg/L	350	650	690
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	22	7
Hydroxide OH^- as $CaCO_3$	mg/L	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	350	670	700
Chloride	mg/L	19	400	460
Sulphate	mg/L	7	99	130
Ionic Balance	%	1.2	1.4	1.5
Sum of Anions	meq/L	6.00	25.0	27.0
Sum of Cations	meq/L	7.94	27.4	30.6
Hardness as $CaCO_3$	mg/L	300	140	190

Dissolved Metals in Water				
Our Reference:	UNITS	194600-1	194600-2	194600-3
Your Reference	----------	CRD0038	CRD0044	CRD0058
Date Sampled	----------	10/04/2017	11/04/2017	12/04/2017
Type of sample		Water	Water	Water
Time Sampled		09:00	14:50	10:30
Date prepared	-	21/04/2017	21/04/2017	21/04/2017
Date analysed	-	21/04/2017	21/04/2017	21/04/2017
Silica*	mg/L	53	50	50
Aluminium-Dissolved	mg/L	0.02	<0.01	0.02
Antimony-Dissolved	mg/L	<0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	0.013	0.008	0.012
Barium-Dissolved	mg/L	0.008	0.021	0.031
Boron-Dissolved	mg/L	0.1	0.80	0.91
Cadmium-Dissolved	mg/L	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	<0.001	<0.001	<0.001
Iron-Dissolved	mg/L	0.02	0.01	<0.01
Lead-Dissolved	mg/L	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.078	0.067	0.018
Mercury-Dissolved	mg/L	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.006	0.013	0.026
Nickel-Dissolved	mg/L	0.002	0.001	<0.001
Selenium-Dissolved	mg/L	<0.001	0.003	0.003
Strontium-Dissolved	mg/L	0.15	0.25	0.30
Tin-Dissolved	mg/L	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	<0.001	<0.001	<0.001

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110 -B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
METALS-020	Metals in soil and water by ICP-OES.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-022	Determination of various metals by ICP-MS.
METALS-021	Determination of Mercury by Cold Vapour AAS.

Client Reference: Corunna Downs

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			18/04/2017	194600-1	18/04/2017 || 18/04/2017	LCS-1	18/04/2017
Date analysed	-			18/04/2017	194600-1	18/04/2017 || 18/04/2017	LCS-1	18/04/2017
pH	pH Units		INORG-001	[NT]	194600-1	8.0 || 8.0 || RPD: 0	LCS-1	102%
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	194600-1	700 || 700 || RPD: 0	LCS-1	106%
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	194600-1	420 || 420 || RPD: 0	LCS-1	88%
Total Suspended Solids	mg/L	5	INORG-019	<5	194600-1	2400 || [N/T]	LCS-1	97%
Fluoride	mg/L	0.1	INORG-081	<0.1	194600-1	0.1 || 0.1 || RPD: 0	LCS-1	98%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	194600-1	1.2 || 1.2 || RPD: 0	LCS-1	99%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	194600-1	<0.005 || <0.005	LCS-1	100%
NOx as N	mg/L	0.005	INORG-055	<0.005	194600-1	1.2 || 1.2 || RPD: 0	LCS-1	99%
QUALITY CONTROL Ionic Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			18/04/2017	194600-1	18/04/2017 || 18/04/2017	LCS-1	18/04/2017
Date analysed	-			18/04/2017	194600-1	18/04/2017 || 18/04/2017	LCS-1	18/04/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	194600-1	34 || [N/T]	LCS-1	101%
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	194600-1	1.5 || [N/T]	LCS-1	103%
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	194600-1	52 || [N/T]	LCS-1	101%
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	194600-1	43 || [N/T]	LCS-1	102%
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	194600-1	350 || [N/T]	LCS-1	101%
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	194600-1	<5 || [N/T]	LCS-1	101%
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	194600-1	350 || [N/T]	LCS-1	101%
Chloride	mg/L	1	INORG-081	<1	194600-1	19 || 19 || RPD: 0	LCS-1	92%
Sulphate	mg/L	1	INORG-081	<1	194600-1	7 || 7 || RPD: 0	LCS-1	94%
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	194600-1	300 || [N/T]	[NR]	[NR]

Client Reference: Corunna Downs

QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			21/04/2017	[NT]	[NT]	LCS-1	21/04/2017
Date analysed	-			21/04/2017	[NT]	[NT]	LCS-1	21/04/2017
Silica*	mg/L	0.2	METALS-020	<0.2	[NT]	[NT]	LCS-1	103%
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	[NT]	[NT]	LCS-1	99%
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	99%
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	100%
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	100%
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	[NT]	[NT]	LCS-1	89%
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	[NT]	[NT]	LCS-1	101%
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	103%
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	103%
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	99%
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	[NT]	[NT]	LCS-1	104%
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	100%
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	[NT]	[NT]	LCS-1	98%
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	[NT]	[NT]	LCS-1	99%
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	100%
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	98%
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	101%
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	105%
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	99%
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	[NT]	[NT]	LCS-1	101%

Report Comments:

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 195634

Client:
Atlas Iron Limited
Level 18, 300 Murray Street
PERTH WA 6000

Attention: D Nyquest

Sample log in details:

Your Reference:	**Water Analysis - Corunna Downs**
No. of samples:	7 Water
Date/Time samples received:	10/05/2017 / 11:10
Date completed instructions received:	11/05/2017
Location:	

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

Report Details:

Date results requested by:	17/05/17
Date of Preliminary Report:	Not issued
Issue Date:	17/05/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

Miscellaneous Inorganics						
Our Reference:	UNITS	195634-1	195634-2	195634-3	195634-4	195634-5
Your Reference	----------	CRD0045	CRD0050	CRD0026	CRD0062	CRD0064
Inviron ID	----------	1830977	1830978	1830979	1830980	1830981
Date Sampled		13/04/2017	16/04/2017	24/04/2017	26/04/2017	30/04/2017
Type of sample		Water	Water	Water	Water	Water
Time Sampled		10:00	14:00	11:00	15:40	11:40
Date prepared	-	12/05/2017	12/05/2017	12/05/2017	12/05/2017	12/05/2017
Date analysed	-	12/05/2017	12/05/2017	12/05/2017	12/05/2017	12/05/2017
pH	pH Units	8.1	8.0	7.7	7.9	8.0
Electrical Conductivity (EC)	µS/cm	970	850	690	1,300	1,400
Total Dissolved Solids (grav)	mg/L	580	510	410	660	720
Total Suspended Solids	mg/L	1,300	<5	<5	<5	21
Fluoride	mg/L	0.7	0.2	0.4	0.3	0.7
Nitrate as N	mg/L	1.5	<0.005	1.1	1.4	0.81
Nitrite as N	mg/L	0.017	<0.005	<0.005	0.008	0.008
NOx as N	mg/L	1.5	<0.005	1.1	1.4	0.82

Miscellaneous Inorganics			
Our Reference:	UNITS	195634-6	195634-7
Your Reference	----------	CRD0058	CRD0045
Inviron ID	----------	1830982	1830983
Date Sampled		04/05/2017	07/05/2017
Type of sample		Water	Water
Time Sampled		15:00	11:30
Date prepared	-	12/05/2017	12/05/2017
Date analysed	-	12/05/2017	12/05/2017
pH	pH Units	8.1	8.0
Electrical Conductivity (EC)	µS/cm	2,900	900
Total Dissolved Solids (grav)	mg/L	1,700	540
Total Suspended Solids	mg/L	200	<5
Fluoride	mg/L	2.0	0.7
Nitrate as N	mg/L	<0.005	1.2
Nitrite as N	mg/L	<0.005	<0.005
NOx as N	mg/L	<0.005	1.2

Ionic Balance						
Our Reference:	UNITS	195634-1	195634-2	195634-3	195634-4	195634-5
Your Reference	----------	CRD0045	CRD0050	CRD0026	CRD0062	CRD0064
Inviron ID	----------	1830977	1830978	1830979	1830980	1830981
Date Sampled		13/04/2017	16/04/2017	24/04/2017	26/04/2017	30/04/2017
Type of sample		Water	Water	Water	Water	Water
Time Sampled		10:00	14:00	11:00	15:40	11:40
Date prepared	-	12/05/2017	12/05/2017	12/05/2017	12/05/2017	12/05/2017
Date analysed	-	12/05/2017	12/05/2017	12/05/2017	12/05/2017	12/05/2017
Calcium - Dissolved	mg/L	41	56	56	63	58
Potassium - Dissolved	mg/L	<0.5	1.8	<0.5	1	2.5
Magnesium - Dissolved	mg/L	28	31	17	44	43
Sodium - Dissolved	mg/L	120	63	52	110	160
Bicarbonate HCO_3 as $CaCO_3$	mg/L	390	310	300	310	390
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	390	310	300	310	390
Chloride	mg/L	77	72	37	180	200
Sulphate	mg/L	25	44	19	91	56
Ionic Balance	%	-5.9	-5.9	-6.9	-6.2	-3.4
Hardness as $CaCO_3$	mg/L	220	270	210	340	320
Sum of Anions	meq/L	9.00	8.00	6.00	12.0	13.0
Sum of Cations	meq/L	9.42	8.18	6.44	11.6	13.6

Ionic Balance			
Our Reference:	UNITS	195634-6	195634-7
Your Reference	----------	CRD0058	CRD0045
Inviron ID	----------	1830982	1830983
Date Sampled		04/05/2017	07/05/2017
Type of sample		Water	Water
Time Sampled		15:00	11:30
Date prepared	-	12/05/2017	12/05/2017
Date analysed	-	12/05/2017	12/05/2017
Calcium - Dissolved	mg/L	21	49
Potassium - Dissolved	mg/L	1.5	<0.5
Magnesium - Dissolved	mg/L	27	26
Sodium - Dissolved	mg/L	480	100
Bicarbonate HCO_3 as $CaCO_3$	mg/L	700	390
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	700	390
Chloride	mg/L	480	60
Sulphate	mg/L	140	20
Ionic Balance	%	-11	-4.0
Hardness as $CaCO_3$	mg/L	160	230
Sum of Anions	meq/L	28.0	8.00
Sum of Cations	meq/L	24.2	9.09

Dissolved Metals in Water						
Our Reference:	UNITS	195634-1	195634-2	195634-3	195634-4	195634-5
Your Reference	----------	CRD0045	CRD0050	CRD0026	CRD0062	CRD0064
Inviron ID	----------	1830977	1830978	1830979	1830980	1830981
Date Sampled		13/04/2017	16/04/2017	24/04/2017	26/04/2017	30/04/2017
Type of sample		Water	Water	Water	Water	Water
Time Sampled		10:00	14:00	11:00	15:40	11:40
Date prepared	-	16/05/2017	16/05/2017	16/05/2017	16/05/2017	16/05/2017
Date analysed	-	16/05/2017	16/05/2017	16/05/2017	16/05/2017	16/05/2017
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic-Dissolved	mg/L	0.002	0.004	<0.001	<0.001	0.002
Barium-Dissolved	mg/L	0.003	0.084	0.007	0.046	0.013
Boron-Dissolved	mg/L	0.28	0.23	0.1	0.24	0.33
Cadmium-Dissolved	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	<0.001	0.001	<0.001	0.001	<0.001
Iron-Dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	0.02
Lead-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	<0.005	0.076	<0.005	0.016	0.007
Mercury-Dissolved	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.003	<0.001	<0.001	0.002	0.006
Nickel-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium-Dissolved	mg/L	0.001	<0.001	<0.001	0.001	<0.001
Antimony-Dissolved	mg/L	<0.001	0.003	<0.001	<0.001	<0.001
Tin-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium-Dissolved	mg/L	0.36	0.30	0.40	0.57	0.46
Zinc-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Dissolved Metals in Water			
Our Reference:	UNITS	195634-6	195634-7
Your Reference	----------	CRD0058	CRD0045
Inviron ID	----------	1830982	1830983
Date Sampled		04/05/2017	07/05/2017
Type of sample		Water	Water
Time Sampled		15:00	11:30
Date prepared	-	16/05/2017	16/05/2017
Date analysed	-	16/05/2017	16/05/2017
Aluminium-Dissolved	mg/L	0.01	0.02
Arsenic-Dissolved	mg/L	0.012	0.002
Barium-Dissolved	mg/L	0.038	0.009
Boron-Dissolved	mg/L	0.97	0.27
Cadmium-Dissolved	mg/L	<0.0001	<0.0001
Chromium-Dissolved	mg/L	<0.001	<0.001
Cobalt-Dissolved	mg/L	<0.001	<0.001
Copper-Dissolved	mg/L	<0.001	<0.001
Iron-Dissolved	mg/L	0.02	0.04
Lead-Dissolved	mg/L	<0.001	<0.001
Manganese-Dissolved	mg/L	0.013	<0.005
Mercury-Dissolved	mg/L	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.027	0.002
Nickel-Dissolved	mg/L	<0.001	<0.001
Selenium-Dissolved	mg/L	0.003	<0.001
Antimony-Dissolved	mg/L	<0.001	<0.001
Tin-Dissolved	mg/L	<0.001	<0.001
Strontium-Dissolved	mg/L	0.31	0.46
Zinc-Dissolved	mg/L	0.003	0.008

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110 -B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
METALS-020	Metals in soil and water by ICP-OES.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-022	Determination of various metals by ICP-MS.
METALS-021	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			12/05/2017	195634-1	12/05/2017 || 12/05/2017	LCS-1	12/05/2017
Date analysed	-			12/05/2017	195634-1	12/05/2017 || 12/05/2017	LCS-1	12/05/2017
pH	pH Units		INORG-001	[NT]	195634-1	8.1 || 8.1 || RPD: 0	[NR]	[NR]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	195634-1	970 || 970 || RPD: 0	[NR]	[NR]
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	195634-1	580 || 580 || RPD: 0	LCS-1	87%
Total Suspended Solids	mg/L	5	INORG-019	<5	195634-1	1300 || [N/T]	LCS-1	110%
Fluoride	mg/L	0.1	INORG-081	<0.1	195634-1	0.7 || 0.7 || RPD: 0	LCS-1	101%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	195634-1	1.5 || [N/T]	LCS-1	102%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	195634-1	0.017 || [N/T]	LCS-1	104%
NOx as N	mg/L	0.005	INORG-055	<0.005	195634-1	1.5 || [N/T]	LCS-1	103%
QUALITY CONTROL Ionic Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			12/05/2017	195634-1	12/05/2017 || 12/05/2017	LCS-1	12/05/2017
Date analysed	-			12/05/2017	195634-1	12/05/2017 || 12/05/2017	LCS-1	12/05/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	195634-1	41 || [N/T]	LCS-1	90%
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	195634-1	<0.5 || [N/T]	LCS-1	94%
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	195634-1	28 || [N/T]	LCS-1	90%
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	195634-1	120 || [N/T]	LCS-1	95%
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	195634-1	390 || 400 || RPD: 3	[NR]	[NR]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	195634-1	<5 || <5	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	195634-1	390 || 400 || RPD: 3	[NR]	[NR]
Chloride	mg/L	1	INORG-081	<1	195634-1	77 || 77 || RPD: 0	LCS-1	98%
Sulphate	mg/L	1	INORG-081	<1	195634-1	25 || 25 || RPD: 0	LCS-1	106%
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	195634-1	220 || [N/T]	[NR]	[NR]

QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			16/05/2017	195634-1	16/05/2017 || 16/05/2017	LCS-1	16/05/2017
Date analysed	-			16/05/2017	195634-1	16/05/2017 || 16/05/2017	LCS-1	16/05/2017
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	195634-1	0.01 || 0.01 || RPD: 0	LCS-1	92%
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	0.002 || 0.002 || RPD: 0	LCS-1	98%
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	0.003 || 0.003 || RPD: 0	LCS-1	102%
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	195634-1	0.28 || 0.28 || RPD: 0	LCS-1	97%
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	195634-1	<0.0001 || <0.0001	LCS-1	101%
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	93%
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	100%
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	97%
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	195634-1	<0.01 || <0.01	LCS-1	106%
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	98%
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	195634-1	<0.005 || <0.005	LCS-1	94%
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	195634-1	<0.00005 || <0.00005	LCS-1	98%
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	0.003 || 0.003 || RPD: 0	LCS-1	102%
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	94%
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	0.001 || 0.001 || RPD: 0	LCS-1	103%
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	101%
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	105%
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	0.36 || 0.34 || RPD: 6	LCS-1	94%
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	195634-1	<0.001 || <0.001	LCS-1	97%

QUALITY CONTROL Dissolved Metals in Water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	195634-2	15/05/2017
Date analysed	-	[NT]	[NT]	195634-2	15/05/2017
Aluminium-Dissolved	mg/L	[NT]	[NT]	195634-2	84%
Arsenic-Dissolved	mg/L	[NT]	[NT]	195634-2	94%
Barium-Dissolved	mg/L	[NT]	[NT]	195634-2	102%
Boron-Dissolved	mg/L	[NT]	[NT]	195634-2	#
Cadmium-Dissolved	mg/L	[NT]	[NT]	195634-2	101%
Chromium-Dissolved	mg/L	[NT]	[NT]	195634-2	86%
Cobalt-Dissolved	mg/L	[NT]	[NT]	195634-2	90%
Copper-Dissolved	mg/L	[NT]	[NT]	195634-2	84%
Iron-Dissolved	mg/L	[NT]	[NT]	195634-2	95%
Lead-Dissolved	mg/L	[NT]	[NT]	195634-2	91%
Manganese-Dissolved	mg/L	[NT]	[NT]	195634-2	86%
Mercury-Dissolved	mg/L	[NT]	[NT]	[NR]	[NR]
Molybdenum-Dissolved	mg/L	[NT]	[NT]	195634-2	103%
Nickel-Dissolved	mg/L	[NT]	[NT]	195634-2	83%
Selenium-Dissolved	mg/L	[NT]	[NT]	195634-2	97%
Antimony-Dissolved	mg/L	[NT]	[NT]	195634-2	98%
Tin-Dissolved	mg/L	[NT]	[NT]	195634-2	101%
Strontium-Dissolved	mg/L	[NT]	[NT]	195634-2	#
Zinc-Dissolved	mg/L	[NT]	[NT]	195634-2	89%

Report Comments:

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 198030

Client:
Atlas Iron Limited
Level 18, 300 Murray Street
PERTH
WA 6000

Attention: David Nyquest

Sample log in details:

Your Reference:	**Corunna Downs**
No. of samples:	3 waters
Date/Time samples received:	10/07/2017 / 08:00
Date completed instructions received:	11/07/2017
Location:	

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

Report Details:

Date results requested by:	18/07/17
Date of Preliminary Report:	Not issued
Issue Date:	18/07/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

ACCREDITED FOR TECHNICAL COMPETENCE

Miscellaneous Inorganics				
Our Reference:	UNITS	198030-1	198030-2	198030-3
Your Reference	----------	CRD0050	CRD0082	CRD0071
Date Sampled	----------	29/06/2017	2/07/2017	6/07/2017
Type of sample		water	water	water
Time Sampled		10:10		07:20
Date prepared	-	12/07/2017	12/07/2017	12/07/2017
Date analysed	-	12/07/2017	12/07/2017	12/07/2017
pH	pH Units	7.1	7.0	7.0
Electrical Conductivity (EC)	µS/cm	840	950	790
Total Dissolved Solids (grav)	mg/L	510	570	480
Total Suspended Solids	mg/L	<5	<5	<5
Fluoride	mg/L	0.3	0.4	0.4
Nitrate as NO_3	mg/L	<0.5	<0.5	4.6
Nitrite as NO_2	mg/L	<0.5	<0.5	<0.5
NOx as N	mg/L	0.007	0.086	0.98

Client Reference: Corunna Downs

Ionic Balance				
Our Reference:	UNITS	198030-1	198030-2	198030-3
Your Reference	----------	CRD0050	CRD0082	CRD0071
Date Sampled	----------	29/06/2017	2/07/2017	6/07/2017
Type of sample		water	water	water
Time Sampled		10:10		07:20
Date prepared	-	13/07/2017	13/07/2017	13/07/2017
Date analysed	-	13/07/2017	13/07/2017	13/07/2017
Calcium - Dissolved	mg/L	61	66	79
Potassium - Dissolved	mg/L	1.6	1.3	<0.5
Magnesium - Dissolved	mg/L	31	32	19
Sodium - Dissolved	mg/L	66	72	56
Bicarbonate HCO_3 as $CaCO_3$	mg/L	330	340	360
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	330	340	360
Chloride	mg/L	71	95	40
Sulphate	mg/L	42	49	22
Ionic Balance	%	-5.2	-6.9	-5.0
Hardness as $CaCO_3$	mg/L	280	300	270

Dissolved Metals in Water				
Our Reference:	UNITS	198030-1	198030-2	198030-3
Your Reference	----------	CRD0050	CRD0082	CRD0071
Date Sampled	----------	29/06/2017	2/07/2017	6/07/2017
Type of sample		water	water	water
Time Sampled		10:10		07:20
Date prepared	-	17/07/2017	17/07/2017	17/07/2017
Date analysed	-	17/07/2017	17/07/2017	17/07/2017
Silica*	mg/L	41	36	28
Aluminium-Dissolved	mg/L	<0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	0.002	0.001	0.001
Arsenic-Dissolved	mg/L	0.003	0.002	<0.001
Barium-Dissolved	mg/L	0.050	0.044	0.005
Boron-Dissolved	mg/L	0.22	0.23	0.1
Cadmium-Dissolved	mg/L	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.001	0.002
Iron-Dissolved	mg/L	<0.01	<0.01	<0.01
Lead-Dissolved	mg/L	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.21	0.21	0.013
Mercury-Dissolved	mg/L	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	<0.001	<0.001	<0.001
Nickel-Dissolved	mg/L	0.017	0.014	0.022
Selenium-Dissolved	mg/L	<0.001	<0.001	<0.001
Strontium-Dissolved	mg/L	0.32	0.38	0.43
Tin-Dissolved	mg/L	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.016	0.003	0.021

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110 -B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
METALS-020	Metals in soil and water by ICP-OES.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-022	Determination of various metals by ICP-MS.
METALS-021	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			12/07/2017	198030-1	12/07/2017 || 12/07/2017	LCS-1	12/07/2017
Date analysed	-			12/07/2017	198030-1	12/07/2017 || 12/07/2017	LCS-1	12/07/2017
pH	pH Units		INORG-001	[NT]	198030-1	7.1 || 7.1 || RPD: 0	LCS-1	101%
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	198030-1	840 || 840 || RPD: 0	LCS-1	99%
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	198030-1	510 || 500 || RPD: 2	[NR]	[NR]
Total Suspended Solids	mg/L	5	INORG-019	<5	198030-1	<5 || [N/T]	LCS-1	110%
Fluoride	mg/L	0.1	INORG-081	<0.1	198030-1	0.3 || 0.3 || RPD: 0	[NR]	[NR]
Nitrate as NO_3	mg/L	0.5	INORG-081	<0.5	198030-1	<0.5 || <0.5	[NR]	[NR]
Nitrite as NO_2	mg/L	0.5	INORG-081	<0.5	198030-1	<0.5 || <0.5	[NR]	[NR]
NOx as N	mg/L	0.005	INORG-055	<0.005	198030-1	0.007 || [N/T]	LCS-1	99%
QUALITY CONTROL Ionic Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			13/07/2017	198030-1	13/07/2017 || 13/07/2017	LCS-1	13/07/2017
Date analysed	-			13/07/2017	198030-1	13/07/2017 || 13/07/2017	LCS-1	13/07/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	198030-1	61 || [N/T]	LCS-1	103%
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	198030-1	1.6 || [N/T]	LCS-1	97%
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	198030-1	31 || [N/T]	LCS-1	99%
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	198030-1	66 || [N/T]	LCS-1	102%
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	198030-1	330 || 330 || RPD: 0	LCS-1	99%
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	198030-1	<5 || <5	LCS-1	99%
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	198030-1	330 || 330 || RPD: 0	LCS-1	99%
Chloride	mg/L	1	INORG-081	<1	198030-1	71 || 71 || RPD: 0	[NR]	[NR]
Sulphate	mg/L	1	INORG-081	<1	198030-1	42 || 42 || RPD: 0	[NR]	[NR]
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	198030-1	280 || [N/T]	[NR]	[NR]

Client Reference: Corunna Downs

QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			17/07/2017	198030-1	17/07/2017 || 17/07/2017	LCS-1	17/07/2017
Date analysed	-			17/07/2017	198030-1	17/07/2017 || 17/07/2017	LCS-1	17/07/2017
Silica*	mg/L	0.2	METALS-020	<0.2	198030-1	41 || [N/T]	LCS-1	110%
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	198030-1	<0.01 || <0.01	LCS-1	95%
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.002 || 0.002 || RPD: 0	LCS-1	80%
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.003 || 0.003 || RPD: 0	LCS-1	98%
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.050 || 0.050 || RPD: 0	LCS-1	97%
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	198030-1	0.22 || 0.22 || RPD: 0	LCS-1	103%
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	198030-1	<0.0001 || <0.0001	LCS-1	94%
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	<0.001 || <0.001	LCS-1	90%
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	<0.001 || <0.001	LCS-1	97%
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.001 || 0.001 || RPD: 0	LCS-1	92%
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	198030-1	<0.01 || 0.01	LCS-1	101%
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	<0.001 || <0.001	LCS-1	98%
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	198030-1	0.21 || 0.20 || RPD: 5	LCS-1	89%
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	198030-1	<0.00005 || <0.00005	LCS-1	112%
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	<0.001 || <0.001	LCS-1	93%
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.017 || 0.016 || RPD: 6	LCS-1	89%
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	<0.001 || <0.001	LCS-1	99%
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.32 || 0.31 || RPD: 3	LCS-1	89%
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	<0.001 || <0.001	LCS-1	94%
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	198030-1	0.016 || 0.016 || RPD: 0	LCS-1	99%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	198030-2	12/07/2017
Date analysed	-	[NT]	[NT]	198030-2	12/07/2017
pH	pH Units	[NT]	[NT]	[NR]	[NR]
Electrical Conductivity (EC)	µS/cm	[NT]	[NT]	[NR]	[NR]
Total Dissolved Solids (grav)	mg/L	[NT]	[NT]	[NR]	[NR]
Total Suspended Solids	mg/L	[NT]	[NT]	[NR]	[NR]
Fluoride	mg/L	[NT]	[NT]	198030-2	93%
Nitrate as NO_3	mg/L	[NT]	[NT]	198030-2	100%
Nitrite as NO_2	mg/L	[NT]	[NT]	198030-2	101%
NOx as N	mg/L	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL Ionic Balance	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	198030-2	13/07/2017
Date analysed	-	[NT]	[NT]	198030-2	13/07/2017
Calcium - Dissolved	mg/L	[NT]	[NT]	[NR]	[NR]
Potassium - Dissolved	mg/L	[NT]	[NT]	[NR]	[NR]
Magnesium - Dissolved	mg/L	[NT]	[NT]	[NR]	[NR]
Sodium - Dissolved	mg/L	[NT]	[NT]	[NR]	[NR]
Bicarbonate HCO_3 as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]
Chloride	mg/L	[NT]	[NT]	198030-2	99%
Sulphate	mg/L	[NT]	[NT]	198030-2	107%
Hardness as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]

Client Reference: Corunna Downs

QUALITY CONTROL Dissolved Metals in Water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	198030-2	17/07/2017
Date analysed	-	[NT]	[NT]	198030-2	17/07/2017
Silica*	mg/L	[NT]	[NT]	[NR]	[NR]
Aluminium-Dissolved	mg/L	[NT]	[NT]	198030-2	86%
Antimony-Dissolved	mg/L	[NT]	[NT]	198030-2	79%
Arsenic-Dissolved	mg/L	[NT]	[NT]	198030-2	103%
Barium-Dissolved	mg/L	[NT]	[NT]	198030-2	105%
Boron-Dissolved	mg/L	[NT]	[NT]	198030-2	#
Cadmium-Dissolved	mg/L	[NT]	[NT]	198030-2	99%
Chromium-Dissolved	mg/L	[NT]	[NT]	198030-2	99%
Cobalt-Dissolved	mg/L	[NT]	[NT]	198030-2	94%
Copper-Dissolved	mg/L	[NT]	[NT]	198030-2	86%
Iron-Dissolved	mg/L	[NT]	[NT]	198030-2	96%
Lead-Dissolved	mg/L	[NT]	[NT]	198030-2	93%
Manganese-Dissolved	mg/L	[NT]	[NT]	198030-2	84%
Mercury-Dissolved	mg/L	[NT]	[NT]	198030-2	106%
Molybdenum-Dissolved	mg/L	[NT]	[NT]	198030-2	101%
Nickel-Dissolved	mg/L	[NT]	[NT]	198030-2	84%
Selenium-Dissolved	mg/L	[NT]	[NT]	198030-2	106%
Strontium-Dissolved	mg/L	[NT]	[NT]	198030-2	82%
Tin-Dissolved	mg/L	[NT]	[NT]	198030-2	95%
Zinc-Dissolved	mg/L	[NT]	[NT]	198030-2	94%

Report Comments:

Percent recovery not available due to the analyte signal being much greater than the spike amount. An acceptable recovery was achieved for the LCS.

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 198330

Client:
Atlas Iron Limited
Level 18, 300 Murray Street
PERTH
WA 6000

Attention: David Nyquest

Sample log in details:

Your Reference:	**Corunna Downs**
No. of samples:	3 Water
Date/Time samples received:	17/08/2017 / 09:45
Date completed instructions received:	18/07/2017
Location:	

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

Report Details:

Date results requested by:	24/07/17
Date of Preliminary Report:	Not issued
Issue Date:	24/07/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

ACCREDITED FOR TECHNICAL COMPETENCE

Miscellaneous Inorganics				
Our Reference:	UNITS	198330-1	198330-2	198330-3
Your Reference	----------	CRD0026	CRD0062	CRD0062
Inviron ID	----------	1831016	1831019	1831020
Date Sampled		09/07/2017	12/07/2017	15/07/2017
Type of sample		Water	Water	Water
Time Sampled		07:30	08:40	08:25
Date prepared	-	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017
pH	pH Units	7.0	7.2	7.2
Electrical Conductivity (EC)	µS/cm	770	1,300	1,500
Total Dissolved Solids (grav)	mg/L	460	800	930
Total Suspended Solids	mg/L	<5	<5	<5
Fluoride	mg/L	0.4	0.3	0.4
Nitrate as N	mg/L	0.82	1.4	1.7
Nitrite as N	mg/L	0.017	0.019	0.008
NOx as N	mg/L	0.83	1.4	1.8

Ionic Balance				
Our Reference:	UNITS	198330-1	198330-2	198330-3
Your Reference	----------	CRD0026	CRD0062	CRD0062
Inviron ID	----------	1831016	1831019	1831020
Date Sampled		09/07/2017	12/07/2017	15/07/2017
Type of sample		Water	Water	Water
Time Sampled		07:30	08:40	08:25
Date prepared	-	18/07/2017	18/07/2017	18/07/2017
Date analysed	-	18/07/2017	18/07/2017	18/07/2017
Calcium - Dissolved	mg/L	88	89	97
Potassium - Dissolved	mg/L	<0.5	1.2	1.1
Magnesium - Dissolved	mg/L	22	52	57
Sodium - Dissolved	mg/L	61	130	160
Bicarbonate HCO_3 as $CaCO_3$	mg/L	350	350	360
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	350	350	360
Chloride	mg/L	42	190	220
Sulphate	mg/L	22	91	120
Ionic Balance	%	1.1	1.5	1.4
Sum of Anions	meq/L	7.42	12.9	14.6
Sum of Cations	meq/L	8.88	14.5	16.3
Hardness as $CaCO_3$	mg/L	310	440	480

Client Reference: Corunna Downs

Dissolved Metals in Water				
Our Reference:	UNITS	198330-1	198330-2	198330-3
Your Reference	----------	CRD0026	CRD0062	CRD0062
Inviron ID	----------	1831016	1831019	1831020
Date Sampled		09/07/2017	12/07/2017	15/07/2017
Type of sample		Water	Water	Water
Time Sampled		07:30	08:40	08:25
Date prepared	-	20/07/2017	20/07/2017	20/07/2017
Date analysed	-	20/07/2017	20/07/2017	20/07/2017
Silica*	mg/L	31	41	43
Aluminium-Dissolved	mg/L	<0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	<0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	<0.001	0.002	0.001
Boron-Dissolved	mg/L	0.2	0.24	0.29
Barium-Dissolved	mg/L	0.004	0.069	0.054
Cadmium-Dissolved	mg/L	<0.0001	<0.0001	<0.0001
Cobalt-Dissolved	mg/L	<0.001	<0.001	<0.001
Chromium-Dissolved	mg/L	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	<0.001	<0.001	<0.001
Iron-Dissolved	mg/L	0.05	0.03	<0.01
Lead-Dissolved	mg/L	<0.001	0.002	0.001
Manganese-Dissolved	mg/L	0.008	0.19	0.11
Mercury-Dissolved	mg/L	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	<0.001	0.002	0.002
Nickel-Dissolved	mg/L	0.014	0.41	0.006
Selenium-Dissolved	mg/L	<0.001	0.002	0.002
Strontium-Dissolved	mg/L	0.44	0.62	0.69
Tin-Dissolved	mg/L	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.034	0.13	0.012

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110 -B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
METALS-020	Metals in soil and water by ICP-OES.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-022	Determination of various metals by ICP-MS.
METALS-021	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			18/07/2017	198330-1	18/07/2017 || 18/07/2017	LCS-1	18/07/2017
Date analysed	-			18/07/2017	198330-1	18/07/2017 || 18/07/2017	LCS-1	18/07/2017
pH	pH Units		INORG-001	[NT]	198330-1	7.0 || [N/T]	LCS-1	101%
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	198330-1	770 || [N/T]	LCS-1	99%
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	198330-1	460 || [N/T]	LCS-1	104%
Total Suspended Solids	mg/L	5	INORG-019	<5	198330-1	<5 || <5	LCS-1	106%
Fluoride	mg/L	0.1	INORG-081	<0.1	198330-1	0.4 || 0.4 || RPD: 0	LCS-1	93%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	198330-1	0.82 || 0.82 || RPD: 0	LCS-1	104%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	198330-1	0.017 || 0.017 || RPD: 0	LCS-1	104%
NOx as N	mg/L	0.005	INORG-055	<0.005	198330-1	0.83 || 0.84 || RPD: 1	LCS-1	104%
QUALITY CONTROL Ionic Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			18/07/2017	198330-1	18/07/2017 || 18/07/2017	LCS-1	18/07/2017
Date analysed	-			18/07/2017	198330-1	18/07/2017 || 18/07/2017	LCS-1	18/07/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	198330-1	88 || [N/T]	LCS-1	105%
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	198330-1	<0.5 || [N/T]	LCS-1	105%
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	198330-1	22 || [N/T]	LCS-1	103%
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	198330-1	61 || [N/T]	LCS-1	112%
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	198330-1	350 || [N/T]	LCS-1	106%
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	198330-1	<5 || [N/T]	LCS-1	106%
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	198330-1	350 || [N/T]	LCS-1	106%
Chloride	mg/L	1	INORG-081	<1	198330-1	42 || 42 || RPD: 0	LCS-1	95%
Sulphate	mg/L	1	INORG-081	<1	198330-1	22 || 22 || RPD: 0	LCS-1	96%
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	198330-1	310 || [N/T]	[NR]	[NR]

Client Reference: Corunna Downs

QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			20/07/2017	198330-1	20/07/2017 || 20/07/2017	LCS-1	20/07/2017
Date analysed	-			20/07/2017	198330-1	20/07/2017 || 20/07/2017	LCS-1	20/07/2017
Silica*	mg/L	0.2	METALS-020	<0.2	198330-1	31 || [N/T]	LCS-1	110%
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	198330-1	<0.01 || <0.01	LCS-1	83%
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	109%
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	93%
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	198330-1	0.2 || 0.2 || RPD: 0	LCS-1	99%
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	0.004 || 0.004 || RPD: 0	LCS-1	98%
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	198330-1	<0.0001 || <0.0001	LCS-1	94%
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	96%
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	96%
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	93%
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	198330-1	0.05 || 0.05 || RPD: 0	LCS-1	95%
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	97%
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	198330-1	0.008 || 0.008 || RPD: 0	LCS-1	88%
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	198330-1	<0.00005 || [N/T]	LCS-1	98%
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	91%
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	0.014 || 0.014 || RPD: 0	LCS-1	91%
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	106%
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	0.44 || 0.45 || RPD: 2	LCS-1	89%
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	<0.001 || <0.001	LCS-1	98%
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	198330-1	0.034 || 0.037 || RPD: 8	LCS-1	94%

Report Comments:

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 199108

Client:
Atlas Iron Limited
Level 18, 300 Murray Street
PERTH
WA 6000

Attention: D Nyquest

Sample log in details:

Your Reference:	**Corunna Downs**
No. of samples:	6 Water
Date/Time samples received:	04/08/2017 / 14:00
Date completed instructions received:	07/08/2017
Location:	

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

Report Details:

Date results requested by:	11/08/17
Date of Preliminary Report:	Not issued
Issue Date:	10/08/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

ACCREDITED FOR TECHNICAL COMPETENCE

Miscellaneous Inorganics						
Our Reference:	UNITS	199108-1	199108-2	199108-3	199108-4	199108-5
Your Reference	----------	CRD00064	CRD00064	CRD00058	CRD00058	CRD00045
Inviron ID	----------	1831040	1831041	1831042	1831043	1831044
Date Sampled		17/07/2017	20/07/2017	24/07/2017	27/07/2017	29/07/2017
Time Sampled		14:10	13:50	09:00	08:30	10:10
Type of sample		GW	GW	GW	GW	GW
Date prepared	-	07/08/2017	07/08/2017	07/08/2017	07/08/2017	07/08/2017
Date analysed	-	07/08/2017	07/08/2017	07/08/2017	07/08/2017	07/08/2017
pH	pH Units	7.2	7.2	7.5	7.5	7.2
Electrical Conductivity (EC)	µS/cm	1,400	1,400	2,900	3,000	1,100
Total Dissolved Solids (grav)	mg/L	820	830	1,700	1,800	650
Total Suspended Solids	mg/L	<5	<5	<5	<5	<5
Fluoride	mg/L	0.6	0.6	1.6	1.6	0.6
Nitrate as N	mg/L	1.1	1.1	1.1	1.4	1.3
Nitrite as N	mg/L	<0.005	<0.005	0.022	<0.005	<0.005
NOx as N	mg/L	1.1	1.1	1.1	1.4	1.3

Miscellaneous Inorganics		
Our Reference:	UNITS	199108-6
Your Reference	----------	CRD00045
Inviron ID	----------	1831045
Date Sampled		01/08/2017
Time Sampled		09:50
Type of sample		GW
Date prepared	-	07/08/2017
Date analysed	-	07/08/2017
pH	pH Units	7.3
Electrical Conductivity (EC)	µS/cm	1,100
Total Dissolved Solids (grav)	mg/L	650
Total Suspended Solids	mg/L	<5
Fluoride	mg/L	0.6
Nitrate as N	mg/L	1.2
Nitrite as N	mg/L	<0.005
NOx as N	mg/L	1.2

Ionic Balance						
Our Reference:	UNITS	199108-1	199108-2	199108-3	199108-4	199108-5
Your Reference	----------	CRD00064	CRD00064	CRD00058	CRD00058	CRD00045
Inviron ID	----------	1831040	1831041	1831042	1831043	1831044
Date Sampled		17/07/2017	20/07/2017	24/07/2017	27/07/2017	29/07/2017
Time Sampled		14:10	13:50	09:00	08:30	10:10
Type of sample		GW	GW	GW	GW	GW
Date prepared	-	07/08/2017	07/08/2017	07/08/2017	07/08/2017	07/08/2017
Date analysed	-	07/08/2017	07/08/2017	07/08/2017	07/08/2017	07/08/2017
Calcium - Dissolved	mg/L	61	62	22	22	64
Potassium - Dissolved	mg/L	2.5	2.6	1.4	1.3	<0.5
Magnesium - Dissolved	mg/L	47	47	35	35	35
Sodium - Dissolved	mg/L	200	190	630	630	120
Bicarbonate HCO_3 as $CaCO_3$	mg/L	460	460	690	700	440
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	460	460	690	700	440
Chloride	mg/L	180	180	480	500	84
Sulphate	mg/L	51	49	130	130	25
Ionic Balance	%	1.2	0.41	2.1	1.2	-0.64
Sum of Anions	meq/L	13.7	13.6	27.6	28.2	10.1
Sum of Cations	meq/L	15.7	15.4	31.3	31.5	11.5
Hardness as $CaCO_3$	mg/L	350	350	200	200	310

Ionic Balance		
Our Reference:	UNITS	199108-6
Your Reference	----------	CRD00045
Inviron ID	----------	1831045
Date Sampled		01/08/2017
Time Sampled		09:50
Type of sample		GW
Date prepared	-	07/08/2017
Date analysed	-	07/08/2017
Calcium - Dissolved	mg/L	67
Potassium - Dissolved	mg/L	<0.5
Magnesium - Dissolved	mg/L	37
Sodium - Dissolved	mg/L	120
Bicarbonate HCO_3 as $CaCO_3$	mg/L	440
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5
Hydroxide OH^- as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	440
Chloride	mg/L	84
Sulphate	mg/L	24
Ionic Balance	%	0.089
Sum of Anions	meq/L	10.1
Sum of Cations	meq/L	11.8
Hardness as $CaCO_3$	mg/L	320

Dissolved Metals in Water						
Our Reference:	UNITS	199108-1	199108-2	199108-3	199108-4	199108-5
Your Reference	----------	CRD00064	CRD00064	CRD00058	CRD00058	CRD00045
Inviron ID	----------	1831040	1831041	1831042	1831043	1831044
Date Sampled		17/07/2017	20/07/2017	24/07/2017	27/07/2017	29/07/2017
Time Sampled		14:10	13:50	09:00	08:30	10:10
Type of sample		GW	GW	GW	GW	GW
Date prepared	-	10/08/2017	10/08/2017	10/08/2017	10/08/2017	10/08/2017
Date analysed	-	10/08/2017	10/08/2017	10/08/2017	10/08/2017	10/08/2017
Silica*	mg/L	44	44	48	51	44
Aluminium-Dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	0.003	0.002	0.012	0.014	0.002
Barium-Dissolved	mg/L	0.016	0.009	0.054	0.035	0.011
Boron-Dissolved	mg/L	0.29	0.30	0.84	0.82	0.25
Cadmium-Dissolved	mg/L	<0.0001	0.0004	0.0004	<0.0001	<0.0001
Chromium-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	<0.001	<0.001	0.001	0.001	<0.001
Iron-Dissolved	mg/L	<0.01	<0.01	0.01	<0.01	<0.01
Lead-Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.007	<0.005	0.086	<0.005	<0.005
Mercury-Dissolved	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.005	0.005	0.024	0.025	0.002
Nickel-Dissolved	mg/L	0.009	0.005	0.016	0.014	<0.001
Selenium-Dissolved	mg/L	<0.001	<0.001	0.003	0.003	<0.001
Strontium-Dissolved	mg/L	0.46	0.47	0.35	0.35	0.59
Tin-Dissolved	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.010	0.008	0.077	0.014	0.007

Dissolved Metals in Water		
Our Reference:	UNITS	199108-6
Your Reference	----------	CRD00045
Inviron ID	----------	1831045
Date Sampled		01/08/2017
Time Sampled		09:50
Type of sample		GW
Date prepared	-	10/08/2017
Date analysed	-	10/08/2017
Silica*	mg/L	44
Aluminium-Dissolved	mg/L	<0.01
Antimony-Dissolved	mg/L	<0.001
Arsenic-Dissolved	mg/L	0.002
Barium-Dissolved	mg/L	0.007
Boron-Dissolved	mg/L	0.25
Cadmium-Dissolved	mg/L	<0.0001
Chromium-Dissolved	mg/L	<0.001
Cobalt-Dissolved	mg/L	<0.001
Copper-Dissolved	mg/L	0.002
Iron-Dissolved	mg/L	<0.01
Lead-Dissolved	mg/L	<0.001
Manganese-Dissolved	mg/L	<0.005
Mercury-Dissolved	mg/L	<0.00005
Molybdenum-Dissolved	mg/L	0.002
Nickel-Dissolved	mg/L	0.003
Selenium-Dissolved	mg/L	<0.001
Strontium-Dissolved	mg/L	0.60
Tin-Dissolved	mg/L	<0.001
Zinc-Dissolved	mg/L	0.020

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110 -B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
METALS-020	Metals in soil and water by ICP-OES.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-022	Determination of various metals by ICP-MS.
METALS-021	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			07/08/2017	199108-1	07/08/2017 || 07/08/2017	LCS-1	07/08/2017
Date analysed	-			07/08/2017	199108-1	07/08/2017 || 07/08/2017	LCS-1	07/08/2017
pH	pH Units		INORG-001	[NT]	199108-1	7.2 || [N/T]	LCS-1	101%
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	199108-1	1400 || [N/T]	LCS-1	99%
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	199108-1	820 || 820 || RPD: 0	LCS-1	101%
Total Suspended Solids	mg/L	5	INORG-019	<5	199108-1	<5 || <5	LCS-1	97%
Fluoride	mg/L	0.1	INORG-081	<0.1	199108-1	0.6 || 0.6 || RPD: 0	LCS-1	101%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	199108-1	1.1 || 1.1 || RPD: 0	LCS-1	100%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	199108-1	<0.005 || <0.005	LCS-1	107%
NOx as N	mg/L	0.005	INORG-055	<0.005	199108-1	1.1 || 1.1 || RPD: 0	LCS-1	100%
QUALITY CONTROL Ionic Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			07/08/2017	199108-1	07/08/2017 || 07/08/2017	LCS-1	07/08/2017
Date analysed	-			07/08/2017	199108-1	07/08/2017 || 07/08/2017	LCS-1	07/08/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	199108-1	61 || [N/T]	LCS-1	106%
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	199108-1	2.5 || [N/T]	LCS-1	103%
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	199108-1	47 || [N/T]	LCS-1	104%
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	199108-1	200 || [N/T]	LCS-1	104%
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	199108-1	460 || [N/T]	LCS-1	98%
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	199108-1	<5 || [N/T]	LCS-1	98%
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	199108-1	460 || [N/T]	LCS-1	98%
Chloride	mg/L	1	INORG-081	<1	199108-1	180 || 180 || RPD: 0	LCS-1	99%
Sulphate	mg/L	1	INORG-081	<1	199108-1	51 || 50 || RPD: 2	LCS-1	101%
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	199108-1	350 || [N/T]	[NR]	[NR]

Client Reference: Corunna Downs

QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			10/08/2017	199108-1	10/08/2017 || 10/08/2017	LCS-1	10/08/2017
Date analysed	-			10/08/2017	199108-1	10/08/2017 || 10/08/2017	LCS-1	10/08/2017
Silica*	mg/L	0.2	METALS-020	<0.2	199108-1	44 || [N/T]	LCS-1	106%
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	199108-1	<0.01 || <0.01	LCS-1	94%
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	80%
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	0.003 || 0.003 || RPD: 0	LCS-1	96%
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	0.016 || 0.016 || RPD: 0	LCS-1	96%
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	199108-1	0.29 || 0.29 || RPD: 0	LCS-1	90%
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	199108-1	<0.0001 || <0.0001	LCS-1	97%
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	88%
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	97%
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	90%
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	199108-1	<0.01 || <0.01	LCS-1	100%
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	103%
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	199108-1	0.007 || 0.007 || RPD: 0	LCS-1	93%
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	199108-1	<0.00005 || [N/T]	LCS-1	96%
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	0.005 || 0.006 || RPD: 18	LCS-1	95%
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	0.009 || 0.009 || RPD: 0	LCS-1	92%
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	94%
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	0.46 || 0.47 || RPD: 2	LCS-1	96%
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	<0.001 || <0.001	LCS-1	99%
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	199108-1	0.010 || 0.010 || RPD: 0	LCS-1	94%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	199108-2	07/08/2017
Date analysed	-	[NT]	[NT]	199108-2	07/08/2017
pH	pH Units	[NT]	[NT]	[NR]	[NR]
Electrical Conductivity (EC)	µS/cm	[NT]	[NT]	[NR]	[NR]
Total Dissolved Solids (grav)	mg/L	[NT]	[NT]	[NR]	[NR]
Total Suspended Solids	mg/L	[NT]	[NT]	[NR]	[NR]
Fluoride	mg/L	[NT]	[NT]	[NR]	[NR]
Nitrate as N	mg/L	[NT]	[NT]	199108-2	105%
Nitrite as N	mg/L	[NT]	[NT]	199108-2	105%
NOx as N	mg/L	[NT]	[NT]	199108-2	105%

QUALITY CONTROL Dissolved Metals in Water	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	199108-2	08/08/2017
Date analysed	-	[NT]	[NT]	199108-2	08/08/2017
Silica*	mg/L	[NT]	[NT]	[NR]	[NR]
Aluminium-Dissolved	mg/L	[NT]	[NT]	199108-2	94%
Antimony-Dissolved	mg/L	[NT]	[NT]	199108-2	78%
Arsenic-Dissolved	mg/L	[NT]	[NT]	199108-2	106%
Barium-Dissolved	mg/L	[NT]	[NT]	199108-2	98%
Boron-Dissolved	mg/L	[NT]	[NT]	199108-2	#
Cadmium-Dissolved	mg/L	[NT]	[NT]	199108-2	108%
Chromium-Dissolved	mg/L	[NT]	[NT]	199108-2	89%
Cobalt-Dissolved	mg/L	[NT]	[NT]	199108-2	94%
Copper-Dissolved	mg/L	[NT]	[NT]	199108-2	85%
Iron-Dissolved	mg/L	[NT]	[NT]	199108-2	99%
Lead-Dissolved	mg/L	[NT]	[NT]	199108-2	98%
Manganese-Dissolved	mg/L	[NT]	[NT]	199108-2	93%
Mercury-Dissolved	mg/L	[NT]	[NT]	[NR]	[NR]
Molybdenum-Dissolved	mg/L	[NT]	[NT]	199108-2	109%
Nickel-Dissolved	mg/L	[NT]	[NT]	199108-2	86%
Selenium-Dissolved	mg/L	[NT]	[NT]	199108-2	104%
Strontium-Dissolved	mg/L	[NT]	[NT]	199108-2	111%
Tin-Dissolved	mg/L	[NT]	[NT]	199108-2	105%
Zinc-Dissolved	mg/L	[NT]	[NT]	199108-2	93%

Report Comments:

Percent recovery not available due to the analyte signal being much greater than the spike amount. An acceptable recovery was achieved for the LCS.

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 203451

Client Details

Client	Atlas Iron Limited
Attention	David Nyquest
Address	Level 18, 300 Murray Street, PERTH, WA, 6000

Sample Details

Your Reference	**Atlas / Corunna Downs**
Number of Samples	6 Water
Date samples received	20/11/2017
Date completed instructions received	20/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	27/11/2017
Date of Issue	24/11/2017

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Joshua Lim, Operations Manager

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorganics							
Our Reference			203451-1	203451-2	203451-3	203451-4	203451-5
Your Reference	UNITS	PQL	CRD0043	CRD0039	CRD0056	CRD0040	CRD0051
Date Sampled			04/11/2017	06/11/2017	07/11/2017	10/11/2017	11/11/2017
Type of sample			Water	Water	Water	Water	Water
Inviron ID			1831056	1831057	1831058	1831059	1831060
Date prepared	-		20/11/2017	20/11/2017	20/11/2017	20/11/2017	20/11/2017
Date analysed	-		20/11/2017	20/11/2017	20/11/2017	20/11/2017	20/11/2017
pH	pH Units		7.5	7.6	7.5	8.1	8.1
Electrical Conductivity (EC)	µS/cm	1	820	800	860	1,600	1,500
Total Dissolved Solids (grav)	mg/L	5	490	480	520	970	890
Total Suspended Solids	mg/L	5	140	310	440	110	21
Fluoride	mg/L	0.1	0.5	0.4	0.5	1.2	1.2
Nitrate as NO_3	mg/L	0.5	6.0	6.3	7.4	5.1	4.6
Nitrite as NO_2	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
NOx as N	mg/L	0.005	1.5	1.7	1.9	1.4	1.3

Miscellaneous Inorganics			
Our Reference			203451-6
Your Reference	UNITS	PQL	CRD0081
Date Sampled			12/11/2017
Type of sample			Water
Inviron ID			1831061
Date prepared	-		20/11/2017
Date analysed	-		20/11/2017
pH	pH Units		7.9
Electrical Conductivity (EC)	µS/cm	1	980
Total Dissolved Solids (grav)	mg/L	5	590
Total Suspended Solids	mg/L	5	1,400
Fluoride	mg/L	0.1	0.7
Nitrate as NO_3	mg/L	0.5	8.1
Nitrite as NO_2	mg/L	0.5	<0.5
NOx as N	mg/L	0.005	2.2

Ionic Balance							
Our Reference			203451-1	203451-2	203451-3	203451-4	203451-5
Your Reference	UNITS	PQL	CRD0043	CRD0039	CRD0056	CRD0040	CRD0051
Date Sampled			04/11/2017	06/11/2017	07/11/2017	10/11/2017	11/11/2017
Type of sample			Water	Water	Water	Water	Water
Inviron ID			1831056	1831057	1831058	1831059	1831060
Date prepared	-		20/11/2017	20/11/2017	20/11/2017	20/11/2017	20/11/2017
Date analysed	-		20/11/2017	20/11/2017	20/11/2017	20/11/2017	20/11/2017
Calcium - Dissolved	mg/L	0.5	88	88	81	62	39
Potassium - Dissolved	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	1.1
Magnesium - Dissolved	mg/L	0.5	26	30	25	67	61
Sodium - Dissolved	mg/L	0.5	75	72	82	190	190
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	360	360	400	450	420
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5	<5	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	360	360	400	450	420
Chloride	mg/L	1	66	56	75	240	200
Sulphate	mg/L	1	26	33	20	66	58
Ionic Balance	%		0.99	2.6	-4.4	-0.75	-0.47
Hardness as $CaCO_3$	mg/L	3	330	340	300	430	350
Sum of Anions	meq/L	0	8.33	8.22	9.09	15.6	13.9
Sum of Cations	meq/L	0	9.84	10.0	9.64	17.0	15.3

Ionic Balance			
Our Reference			203451-6
Your Reference	UNITS	PQL	CRD0081
Date Sampled			12/11/2017
Type of sample			Water
Inviron ID			1831061
Date prepared	-		20/11/2017
Date analysed	-		20/11/2017
Calcium - Dissolved	mg/L	0.5	65
Potassium - Dissolved	mg/L	0.5	<0.5
Magnesium - Dissolved	mg/L	0.5	45
Sodium - Dissolved	mg/L	0.5	92
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	430
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	430
Chloride	mg/L	1	92
Sulphate	mg/L	1	36
Ionic Balance	%		-3.9
Hardness as $CaCO_3$	mg/L	3	350
Sum of Anions	meq/L	0	10.4
Sum of Cations	meq/L	0	11.0

Dissolved Metals in Water							
Our Reference	UNITS	PQL	203451-1	203451-2	203451-3	203451-4	203451-5
Your Reference			CRD0043	CRD0039	CRD0056	CRD0040	CRD0051
Date Sampled			04/11/2017	06/11/2017	07/11/2017	10/11/2017	11/11/2017
Type of sample			Water	Water	Water	Water	Water
Inviron ID			1831056	1831057	1831058	1831059	1831060
Date prepared	-		21/11/2017	21/11/2017	21/11/2017	21/11/2017	21/11/2017
Date analysed	-		21/11/2017	21/11/2017	21/11/2017	21/11/2017	21/11/2017
Silica	mg/L	0.2	31	33	30	64	53
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01	0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	0.001	<0.001	0.001	<0.001	0.01	0.006
Barium-Dissolved	mg/L	0.001	0.007	0.016	0.002	0.11	0.040
Boron-Dissolved	mg/L	0.02	0.20	0.2	0.21	0.39	0.36
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	0.002	0.006	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron-Dissolved	mg/L	0.01	<0.01	<0.01	<0.01	0.06	0.02
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.005	0.017	0.033	0.022	0.033	0.030
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	0.006	0.007
Nickel-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	0.002	0.003
Selenium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	0.002	0.002
Strontium-Dissolved	mg/L	0.001	0.67	0.64	0.63	0.91	0.52
Tin-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.013	<0.001	0.032	0.012	<0.001

Dissolved Metals in Water			
Our Reference			203451-6
Your Reference	UNITS	PQL	CRD0081
Date Sampled			12/11/2017
Type of sample			Water
Inviron ID			1831061
Date prepared	-		21/11/2017
Date analysed	-		21/11/2017
Silica	mg/L	0.2	45
Aluminium-Dissolved	mg/L	0.01	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001
Arsenic-Dissolved	mg/L	0.001	0.001
Barium-Dissolved	mg/L	0.001	0.029
Boron-Dissolved	mg/L	0.02	0.20
Cadmium-Dissolved	mg/L	0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001
Iron-Dissolved	mg/L	0.01	<0.01
Lead-Dissolved	mg/L	0.001	<0.001
Manganese-Dissolved	mg/L	0.005	0.078
Mercury-Dissolved	mg/L	0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.001	0.006
Nickel-Dissolved	mg/L	0.001	0.003
Selenium-Dissolved	mg/L	0.001	0.001
Strontium-Dissolved	mg/L	0.001	0.49
Tin-Dissolved	mg/L	0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.002

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110-B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-020	Metals in soil and water by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203451-2
Date prepared	-			20/11/2017	1	20/11/2017	20/11/2017		20/11/2017	20/11/2017
Date analysed	-			20/11/2017	1	20/11/2017	20/11/2017		20/11/2017	20/11/2017
pH	pH Units		INORG-001	[NT]	1	7.5	7.5	0	101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	1	820	810	1	101	[NT]
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	1	490	480	2	102	[NT]
Total Suspended Solids	mg/L	5	INORG-019	<5	1	140	[NT]		99	[NT]
Fluoride	mg/L	0.1	INORG-081	<0.1	1	0.5	0.5	0	87	84
Nitrate as NO_3	mg/L	0.5	INORG-081	<0.5	1	6.0	6.0	0	100	96
Nitrite as NO_2	mg/L	0.5	INORG-081	<0.5	1	<0.5	<0.5	0	99	98
NOx as N	mg/L	0.005	INORG-055	<0.005	1	1.5	[NT]		113	[NT]

QUALITY CONTROL: Ionic Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203451-2
Date prepared	-			20/11/2017	1	20/11/2017	20/11/2017		20/11/2017	20/11/2017
Date analysed	-			20/11/2017	1	20/11/2017	20/11/2017		20/11/2017	20/11/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	88	88	0	101	75
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	<0.5	<0.5	0	99	99
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	26	26	0	104	98
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	75	74	1	99	88
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	1	360	370	3	100	[NT]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	1	<5	<5	0	100	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	1	360	370	3	100	[NT]
Chloride	mg/L	1	INORG-081	<1	1	66	66	0	99	99
Sulphate	mg/L	1	INORG-081	<1	1	26	26	0	99	100
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	1	330	330	0	[NT]	[NT]

QUALITY CONTROL: Dissolved Metals in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203451-2
Date prepared	-			21/11/2017	1	21/11/2017	21/11/2017		21/11/2017	21/11/2017
Date analysed	-			21/11/2017	1	21/11/2017	21/11/2017		21/11/2017	21/11/2017
Silica	mg/L	0.2	METALS-020	<0.2	1	31	30	3	102	107
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	<0.01	0	94	97
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	89	95
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	95	107
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.007	0.007	0	87	93
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	1	0.20	0.2	0	96	106
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	1	<0.0001	<0.0001	0	97	109
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	93	99
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.002	0.002	0	88	89
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	92	90
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	<0.01	0	95	98
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	94	96
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	1	0.017	0.017	0	97	97
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	1	<0.00005	<0.00005	0	95	94
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	93	103
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	92	92
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	91	116
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.67	0.65	3	102	#
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	93	97
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.013	0.012	8	95	97

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Percent recovery not available due to the analyte signal being much greater than the spike amount. An acceptable recovery was achieved for the LCS.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 203775

Client Details

Client	Atlas Iron Limited
Attention	David Nyquest
Address	Level 18, 300 Murray Street, PERTH, WA, 6000

Sample Details

Your Reference	**Atlas / Corunna Downs / Groundwater**
Number of Samples	2 Water
Date samples received	27/11/2017
Date completed instructions received	27/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	04/12/2017
Date of Issue	04/12/2017

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Joshua Lim, Operations Manager

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorganics				
Our Reference			203775-1	203775-2
Your Reference	UNITS	PQL	CRD0088	CRD0088
Inviron ID			1831072	1831074
Date Sampled			19/11/2017	22/11/2017
Type of sample			Water	Water
Time Sampled			04:30 PM	04:10 PM
Date prepared	-		27/11/2017	27/11/2017
Date analysed	-		27/11/2017	27/11/2017
pH	pH Units		7.1	7.0
Electrical Conductivity (EC)	µS/cm	1	960	940
Total Dissolved Solids (grav)	mg/L	5	570	570
Total Suspended Solids	mg/L	5	13	5
Fluoride	mg/L	0.1	0.4	0.4
Nitrate as NO_3	mg/L	0.5	7.3	7.0
Nitrite as NO_2	mg/L	0.5	<0.5	<0.5
NOx as N	mg/L	0.005	1.9	1.9

Ionic Balance				
Our Reference	UNITS	PQL	203775-1	203775-2
Your Reference			CRD0088	CRD0088
Environ ID			1831072	1831074
Date Sampled			19/11/2017	22/11/2017
Type of sample			Water	Water
Time Sampled			04:30 PM	04:10 PM
Date prepared	-		27/11/2017	27/11/2017
Date analysed	-		27/11/2017	27/11/2017
Calcium - Dissolved	mg/L	0.5	93	93
Potassium - Dissolved	mg/L	0.5	<0.5	<0.5
Magnesium - Dissolved	mg/L	0.5	30	29
Sodium - Dissolved	mg/L	0.5	71	72
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	380	380
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	380	380
Chloride	mg/L	1	56	57
Sulphate	mg/L	1	35	34
Ionic Balance	%		1.5	1.7
Hardness as $CaCO_3$	mg/L	3	360	350
Sum of Anions	meq/L	0	8.51	8.48
Sum of Cations	meq/L	0	10.2	10.2

Dissolved Metals in Water				
Our Reference	UNITS	PQL	203775-1	203775-2
Your Reference			CRD0088	CRD0088
Inviron ID			1831072	1831074
Date Sampled			19/11/2017	22/11/2017
Type of sample			Water	Water
Time Sampled			04:30 PM	04:10 PM
Date prepared	-		30/11/2017	30/11/2017
Date analysed	-		30/11/2017	30/11/2017
Silica	mg/L	0.2	32	32
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	0.001	0.002	0.001
Barium-Dissolved	mg/L	0.001	0.017	0.011
Boron-Dissolved	mg/L	0.02	0.2	0.2
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	0.009	0.008
Copper-Dissolved	mg/L	0.001	0.014	0.004
Iron-Dissolved	mg/L	0.01	<0.01	<0.01
Lead-Dissolved	mg/L	0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.005	0.027	0.023
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.001	<0.001	<0.001
Nickel-Dissolved	mg/L	0.001	0.015	0.008
Selenium-Dissolved	mg/L	0.001	0.001	0.001
Strontium-Dissolved	mg/L	0.001	0.69	0.71
Tin-Dissolved	mg/L	0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.049	0.015

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110-B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-020	Metals in soil and water by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			27/11/2017	1	27/11/2017	27/11/2017		27/11/2017	[NT]
Date analysed	-			27/11/2017	1	27/11/2017	27/11/2017		27/11/2017	[NT]
pH	pH Units		INORG-001	[NT]	1	7.1	7.1	0	101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	1	960	940	2	103	[NT]
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	1	570	560	2	98	[NT]
Total Suspended Solids	mg/L	5	INORG-019	<5	1	13	[NT]		[NT]	[NT]
Fluoride	mg/L	0.1	INORG-081	<0.1	1	0.4	[NT]		81	[NT]
Nitrate as NO_3	mg/L	0.5	INORG-081	<0.5	1	7.3	[NT]		98	[NT]
Nitrite as NO_2	mg/L	0.5	INORG-081	<0.5	1	<0.5	[NT]		99	[NT]
NOx as N	mg/L	0.005	INORG-055	<0.005	1	1.9	[NT]		112	[NT]

QUALITY CONTROL: Ionic Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203775-2
Date prepared	-			27/11/2017	1	27/11/2017	27/11/2017		27/11/2017	27/11/2017
Date analysed	-			27/11/2017	1	27/11/2017	27/11/2017		27/11/2017	27/11/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	93	94	1	104	86
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	<0.5	<0.5	0	104	104
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	30	31	3	108	105
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	71	71	0	102	92
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	1	380	380	0	96	[NT]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	1	<5	<5	0	96	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	1	380	380	0	96	[NT]
Chloride	mg/L	1	INORG-081	<1	1	56	[NT]		98	[NT]
Sulphate	mg/L	1	INORG-081	<1	1	35	[NT]		98	[NT]
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	1	360	360	0	[NT]	[NT]

QUALITY CONTROL: Dissolved Metals in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203775-2
Date prepared	-			30/11/2017	1	30/11/2017	29/11/2017		30/11/2017	29/11/2017
Date analysed	-			30/11/2017	1	30/11/2017	29/11/2017		30/11/2017	29/11/2017
Silica	mg/L	0.2	METALS-020	<0.2	1	32	33	3	107	#
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	[NT]		92	[NT]
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		98	[NT]
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.002	[NT]		100	[NT]
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.017	[NT]		109	[NT]
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	1	0.2	[NT]		102	[NT]
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	1	<0.0001	[NT]		99	[NT]
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		103	[NT]
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.009	[NT]		105	[NT]
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.014	[NT]		108	[NT]
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	[NT]		102	[NT]
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		106	[NT]
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	1	0.027	[NT]		100	[NT]
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	1	<0.00005	[NT]		94	[NT]
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		96	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.015	[NT]		106	[NT]
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.001	[NT]		111	[NT]
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.69	[NT]		97	[NT]
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		100	[NT]
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.049	[NT]		104	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Percent recovery not available due to the analyte signal being much greater than the spike amount. An acceptable recovery was achieved for the LCS.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 203908

Client Details

Client	Atlas Iron Limited
Attention	David Nyquest
Address	Level 18, 300 Murray Street, PERTH, WA, 6000

Sample Details

Your Reference	**Atlas / Corunna Downs / Groundwater**
Number of Samples	2 Water
Date samples received	29/11/2017
Date completed instructions received	29/11/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	06/12/2017
Date of Issue	06/12/2017

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Joshua Lim, Operations Manager

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorganics				
Our Reference			203908-1	203908-2
Your Reference	UNITS	PQL	CRD0089	CRD0089
Inviron ID			1831078	1831079
Date Sampled			24/11/2017	27/11/2017
Type of sample			Water	Water
Date prepared	-		29/11/2017	29/11/2017
Date analysed	-		29/11/2017	29/11/2017
pH	pH Units		7.0	7.0
Electrical Conductivity (EC)	µS/cm	1	1,000	1,000
Total Dissolved Solids (grav)	mg/L	5	570	550
Total Suspended Solids	mg/L	5	<5	<5
Fluoride	mg/L	0.1	0.7	0.7
Nitrate as NO_3	mg/L	0.5	7.9	7.7
Nitrite as NO_2	mg/L	0.5	<0.5	<0.5
NOx as N	mg/L	0.005	1.8	1.7

Ionic Balance				
Our Reference	UNITS	PQL	203908-1	203908-2
Your Reference			CRD0089	CRD0089
Environ ID			1831078	1831079
Date Sampled			24/11/2017	27/11/2017
Type of sample			Water	Water
Date prepared	-		29/11/2017	29/11/2017
Date analysed	-		29/11/2017	29/11/2017
Calcium - Dissolved	mg/L	0.5	97	94
Potassium - Dissolved	mg/L	0.5	<0.5	<0.5
Magnesium - Dissolved	mg/L	0.5	25	25
Sodium - Dissolved	mg/L	0.5	83	81
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	400	400
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	400	400
Chloride	mg/L	1	77	76
Sulphate	mg/L	1	21	20
Ionic Balance	%		-0.43	-0.92
Hardness as $CaCO_3$	mg/L	3	350	340
Sum of Anions	meq/L	0	9.20	9.04
Sum of Cations	meq/L	0	10.6	10.3

Dissolved Metals in Water				
Our Reference	UNITS	PQL	203908-1	203908-2
Your Reference			CRD0089	CRD0089
Inviron ID			1831078	1831079
Date Sampled			24/11/2017	27/11/2017
Type of sample			Water	Water
Date prepared	-		04/12/2017	04/12/2017
Date analysed	-		04/12/2017	04/12/2017
Silica	mg/L	0.2	31	30
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001
Barium-Dissolved	mg/L	0.001	0.003	0.003
Boron-Dissolved	mg/L	0.02	0.20	0.20
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.002	0.004
Iron-Dissolved	mg/L	0.01	<0.01	<0.01
Lead-Dissolved	mg/L	0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.005	0.012	0.014
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.001	<0.001	<0.001
Nickel-Dissolved	mg/L	0.001	<0.001	0.003
Selenium-Dissolved	mg/L	0.001	<0.001	<0.001
Strontium-Dissolved	mg/L	0.001	0.66	0.63
Tin-Dissolved	mg/L	0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.006	0.008

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110-B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-020	Metals in soil and water by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			29/11/2017	1	29/11/2017	29/11/2017		29/11/2017	[NT]
Date analysed	-			29/11/2017	1	29/11/2017	29/11/2017		29/11/2017	[NT]
pH	pH Units		INORG-001	[NT]	1	7.0	7.0	0	101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	1	1000	1000	0	103	[NT]
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	1	570	[NT]		101	[NT]
Total Suspended Solids	mg/L	5	INORG-019	<5	1	<5	[NT]		97	[NT]
Fluoride	mg/L	0.1	INORG-081	<0.1	1	0.7	[NT]		101	[NT]
Nitrate as NO_3	mg/L	0.5	INORG-081	<0.5	1	7.9	[NT]		100	[NT]
Nitrite as NO_2	mg/L	0.5	INORG-081	<0.5	1	<0.5	[NT]		104	[NT]
NOx as N	mg/L	0.005	INORG-055	<0.005	1	1.8	[NT]		112	[NT]

QUALITY CONTROL: Ionic Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203908-2
Date prepared	-			29/11/2017	1	29/11/2017	29/11/2017		29/11/2017	29/11/2017
Date analysed	-			29/11/2017	1	29/11/2017	29/11/2017		29/11/2017	29/11/2017
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	97	97	0	110	78
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	<0.5	<0.5	0	107	103
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	25	26	4	110	104
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	83	83	0	106	[NT]
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	1	400	400	0	110	[NT]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	1	<5	<5	0	110	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	1	400	400	0	110	[NT]
Chloride	mg/L	1	INORG-081	<1	1	77	[NT]		99	[NT]
Sulphate	mg/L	1	INORG-081	<1	1	21	[NT]		97	[NT]
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	1	350	350	0	[NT]	[NT]

QUALITY CONTROL: Dissolved Metals in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	203908-2
Date prepared	-			04/12/2017	1	04/12/2017	01/12/2017		04/12/2017	01/12/2017
Date analysed	-			04/12/2017	1	04/12/2017	01/12/2017		04/12/2017	01/12/2017
Silica	mg/L	0.2	METALS-020	<0.2	1	31	32	3	111	116
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	[NT]		89	[NT]
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		96	[NT]
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		98	[NT]
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.003	[NT]		99	[NT]
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	1	0.20	[NT]		99	[NT]
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	1	<0.0001	[NT]		102	[NT]
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		91	[NT]
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		93	[NT]
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.002	[NT]		92	[NT]
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	[NT]		92	[NT]
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		99	[NT]
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	1	0.012	[NT]		94	[NT]
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	1	<0.00005	[NT]		94	[NT]
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		99	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		93	[NT]
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		100	[NT]
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.66	[NT]		100	[NT]
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	[NT]		101	[NT]
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.006	[NT]		94	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 206060

Client Details

Client	Atlas Iron Limited
Attention	Esme Wink
Address	Level 18, 300 Murray Street, PERTH, WA, 6000

Sample Details

Your Reference	**Corunna Downs / 53276 / Groundwater**
Number of Samples	8 Water
Date samples received	29/01/2018
Date completed instructions received	29/01/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	05/02/2018
Date of Issue	05/02/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Todd Lee, Laboratory Manager, Perth

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorganics							
Our Reference			206060-1	206060-2	206060-3	206060-4	206060-5
Your Reference	UNITS	PQL	CRD0071	CRD0083	CRD0082	CRD0027	CRD0004 (CDWB0001-Camp Bore)
Inviron ID			1831102	1831103	1831104	1831105	1831106
Date Sampled			23/01/2018	23/01/2018	23/01/2018	23/01/2018	23/01/2018
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Time Sampled			10:45 AM	11:05 AM	11:30 AM	12:30 PM	02:20 PM
Date prepared	-		29/01/2018	29/01/2018	29/01/2018	29/01/2018	29/01/2018
Date analysed	-		29/01/2018	29/01/2018	29/01/2018	29/01/2018	29/01/2018
pH	pH Units		6.9	7.4	7.2	6.2	7.7
Electrical Conductivity (EC)	µS/cm	1	820	790	850	48	1,400
Total Dissolved Solids (grav)	mg/L	5	490	480	510	29	780
Total Suspended Solids	mg/L	5	<5	<5	<5	50	<5
Fluoride	mg/L	0.1	0.3	0.2	0.1	<0.1	0.3
Nitrate as N	mg/L	0.005	0.006	<0.005	0.025	1.1	0.29
Nitrite as N	mg/L	0.005	<0.005	<0.005	<0.005	0.027	1.9
NOx as N	mg/L	0.005	0.006	<0.005	0.026	1.1	2.2

Miscellaneous Inorganics					
Our Reference			206060-6	206060-7	206060-8
Your Reference	UNITS	PQL	CRD0005 (CDWB0002-Kasabian)	CRD0003 (CDRC0014)	CRD0024
Inviron ID			1831107	1831108	1831109
Date Sampled			23/01/2018	24/01/2018	24/01/2018
Type of sample			Groundwater	Groundwater	Groundwater
Time Sampled			02:45 PM	11:00 AM	12:20 PM
Date prepared	-		29/01/2018	29/01/2018	29/01/2018
Date analysed	-		29/01/2018	29/01/2018	29/01/2018
pH	pH Units		7.2	6.6	5.6
Electrical Conductivity (EC)	µS/cm	1	1,100	570	93
Total Dissolved Solids (grav)	mg/L	5	610	340	56
Total Suspended Solids	mg/L	5	35	120	19
Fluoride	mg/L	0.1	0.2	0.2	<0.1
Nitrate as N	mg/L	0.005	1.6	<0.005	1.1
Nitrite as N	mg/L	0.005	<0.005	<0.005	<0.005
NOx as N	mg/L	0.005	1.6	<0.005	1.1

Ionic Balance							
Our Reference			206060-1	206060-2	206060-3	206060-4	206060-5
Your Reference	UNITS	PQL	CRD0071	CRD0083	CRD0082	CRD0027	CRD0004 (CDWB0001-Camp Bore)
Inviron ID			1831102	1831103	1831104	1831105	1831106
Date Sampled			23/01/2018	23/01/2018	23/01/2018	23/01/2018	23/01/2018
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Time Sampled			10:45 AM	11:05 AM	11:30 AM	12:30 PM	02:20 PM
Date prepared	-		29/01/2018	29/01/2018	29/01/2018	29/01/2018	29/01/2018
Date analysed	-		29/01/2018	29/01/2018	29/01/2018	29/01/2018	29/01/2018
Calcium - Dissolved	mg/L	0.5	61	76	62	2.7	47
Potassium - Dissolved	mg/L	0.5	1.3	1.9	2.6	0.5	5.5
Magnesium - Dissolved	mg/L	0.5	30	24	32	1.2	51
Sodium - Dissolved	mg/L	0.5	60	66	62	3.5	94
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	320	320	340	12	510
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5	<5	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	320	320	340	12	510
Chloride	mg/L	1	47	41	46	3	120
Sulphate	mg/L	1	39	27	39	2	14
Sum of Anions	meq/L	0	7.29	6.98	7.69	0.304	12.0
Sum of Cations	meq/L	0	8.20	8.69	8.51	0.396	10.8
Ionic Balance	%		-1.4	3.3	-2.3	6.6	-12
Hardness as $CaCO_3$	mg/L	3	280	290	290	12	330

Ionic Balance					
Our Reference			206060-6	206060-7	206060-8
Your Reference	UNITS	PQL	CRD0005 (CDWB0002-Kasabian)	CRD0003 (CDRC0014)	CRD0024
Inviron ID			1831107	1831108	1831109
Date Sampled			23/01/2018	24/01/2018	24/01/2018
Type of sample			Groundwater	Groundwater	Groundwater
Time Sampled			02:45 PM	11:00 AM	12:20 PM
Date prepared	-		29/01/2018	29/01/2018	29/01/2018
Date analysed	-		29/01/2018	29/01/2018	29/01/2018
Calcium - Dissolved	mg/L	0.5	76	20	1.8
Potassium - Dissolved	mg/L	0.5	1.6	3.0	0.8
Magnesium - Dissolved	mg/L	0.5	56	31	3.4
Sodium - Dissolved	mg/L	0.5	59	35	7.9
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	450	100	16
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	450	100	16
Chloride	mg/L	1	64	60	11
Sulphate	mg/L	1	18	74	1
Sum of Anions	meq/L	0	9.49	4.93	0.591
Sum of Cations	meq/L	0	11.0	5.14	0.732
Ionic Balance	%		-0.33	-1.6	6.1
Hardness as $CaCO_3$	mg/L	3	420	180	18

Dissolved Metals in Water							
Our Reference			206060-1	206060-2	206060-3	206060-4	206060-5
Your Reference	UNITS	PQL	CRD0071	CRD0083	CRD0082	CRD0027	CRD0004 (CDWB0001-Camp Bore)
Inviron ID			1831102	1831103	1831104	1831105	1831106
Date Sampled			23/01/2018	23/01/2018	23/01/2018	23/01/2018	23/01/2018
Type of sample			Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Time Sampled			10:45 AM	11:05 AM	11:30 AM	12:30 PM	02:20 PM
Date prepared	-		31/01/2018	31/01/2018	31/01/2018	31/01/2018	31/01/2018
Date analysed	-		31/01/2018	31/01/2018	31/01/2018	31/01/2018	31/01/2018
Silica	mg/L	0.2	28	29	48	3.3	39
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01	<0.01	0.06	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001	<0.001	0.004	<0.001	0.002
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	0.006	<0.001	0.002
Barium-Dissolved	mg/L	0.001	0.10	0.088	0.070	0.004	0.084
Boron-Dissolved	mg/L	0.02	0.2	0.2	0.25	<0.02	0.25
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	0.002	<0.001	<0.001	0.001	0.002
Iron-Dissolved	mg/L	0.01	0.30	<0.01	<0.01	0.05	0.07
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.005	0.33	0.012	0.20	0.027	0.13
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.001	<0.001	0.002	<0.001	<0.001	0.001
Nickel-Dissolved	mg/L	0.001	0.001	<0.001	<0.001	<0.001	0.002
Selenium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium-Dissolved	mg/L	0.001	0.28	0.51	0.28	0.015	0.28
Tin-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.014	0.007	0.009	0.005	0.009

Dissolved Metals in Water					
Our Reference			206060-6	206060-7	206060-8
Your Reference	UNITS	PQL	CRD0005 (CDWB0002-Kasabian)	CRD0003 (CDRC0014)	CRD0024
Inviron ID			1831107	1831108	1831109
Date Sampled			23/01/2018	24/01/2018	24/01/2018
Type of sample			Groundwater	Groundwater	Groundwater
Time Sampled			02:45 PM	11:00 AM	12:20 PM
Date prepared	-		31/01/2018	31/01/2018	31/01/2018
Date analysed	-		31/01/2018	31/01/2018	31/01/2018
Silica	mg/L	0.2	39	18	17
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Arsenic-Dissolved	mg/L	0.001	0.002	<0.001	<0.001
Barium-Dissolved	mg/L	0.001	0.073	0.015	0.007
Boron-Dissolved	mg/L	0.02	0.23	0.1	0.05
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Iron-Dissolved	mg/L	0.01	<0.01	0.04	<0.01
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.005	<0.005	0.45	0.016
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	0.00008
Molybdenum-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Nickel-Dissolved	mg/L	0.001	<0.001	0.001	0.003
Selenium-Dissolved	mg/L	0.001	0.002	<0.001	<0.001
Strontium-Dissolved	mg/L	0.001	0.20	0.095	0.023
Tin-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.007	0.005	0.008

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110-B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-020	Metals in soil and water by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			29/01/2018	1	29/01/2018	29/01/2018		29/01/2018	[NT]
Date analysed	-			29/01/2018	1	29/01/2018	29/01/2018		29/01/2018	[NT]
pH	pH Units		INORG-001	[NT]	1	6.9	6.9	0	101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	1	820	820	0	109	[NT]
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	1	490	490	0	105	[NT]
Total Suspended Solids	mg/L	5	INORG-019	<5	1	<5	[NT]		105	[NT]
Fluoride	mg/L	0.1	INORG-081	<0.1	1	0.3	0.3	0	95	[NT]
Nitrate as N	mg/L	0.005	INORG-055	<0.005	1	0.006	0.006	0	94	[NT]
Nitrite as N	mg/L	0.005	INORG-055	<0.005	1	<0.005	<0.005	0	119	[NT]
NOx as N	mg/L	0.005	INORG-055	<0.005	1	0.006	0.006	0	103	[NT]

QUALITY CONTROL: Ionic Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	206060-2
Date prepared	-			29/01/2018	1	29/01/2018	29/01/2018		29/01/2018	29/01/2018
Date analysed	-			29/01/2018	1	29/01/2018	29/01/2018		29/01/2018	29/01/2018
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	61	61	0	98	[NT]
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	1.3	1.3	0	100	98
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	30	30	0	99	90
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	60	60	0	98	91
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	1	320	310	3	102	[NT]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	1	<5	<5	0	102	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	1	320	310	3	102	[NT]
Chloride	mg/L	1	INORG-081	<1	1	47	47	0	99	[NT]
Sulphate	mg/L	1	INORG-081	<1	1	39	39	0	108	[NT]
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	1	280	280	0	[NT]	[NT]

QUALITY CONTROL: Dissolved Metals in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	206060-2
Date prepared	-			31/01/2018	1	31/01/2018	31/01/2018		31/01/2018	31/01/2018
Date analysed	-			31/01/2018	1	31/01/2018	31/01/2018		31/01/2018	31/01/2018
Silica	mg/L	0.2	METALS-020	<0.2	1	28	28	0	106	89
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	<0.01	0	103	[NT]
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	99	[NT]
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	102	[NT]
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.10	0.10	0	99	[NT]
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	1	0.2	0.2	0	108	[NT]
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	1	<0.0001	<0.0001	0	102	[NT]
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	100	[NT]
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	99	[NT]
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.002	0.002	0	104	[NT]
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	1	0.30	0.31	3	103	[NT]
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	106	[NT]
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	1	0.33	0.34	3	104	[NT]
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	1	<0.00005	[NT]		110	[NT]
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	103	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.001	0.001	0	103	[NT]
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	103	[NT]
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.28	0.28	0	103	[NT]
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	103	[NT]
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.014	0.014	0	102	[NT]

QUALITY CONTROL: Dissolved Metals in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	4	31/01/2018	01/02/2018		[NT]	[NT]
Date analysed	-			[NT]	4	31/01/2018	01/02/2018		[NT]	[NT]
Silica	mg/L	0.2	METALS-020	[NT]	4	3.3	[NT]		[NT]	[NT]
Aluminium-Dissolved	mg/L	0.01	METALS-022	[NT]	4	0.06	[NT]		[NT]	[NT]
Antimony-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Arsenic-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Barium-Dissolved	mg/L	0.001	METALS-022	[NT]	4	0.004	[NT]		[NT]	[NT]
Boron-Dissolved	mg/L	0.02	METALS-022	[NT]	4	<0.02	[NT]		[NT]	[NT]
Cadmium-Dissolved	mg/L	0.0001	METALS-022	[NT]	4	<0.0001	[NT]		[NT]	[NT]
Chromium-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Cobalt-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Copper-Dissolved	mg/L	0.001	METALS-022	[NT]	4	0.001	[NT]		[NT]	[NT]
Iron-Dissolved	mg/L	0.01	METALS-022	[NT]	4	0.05	[NT]		[NT]	[NT]
Lead-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Manganese-Dissolved	mg/L	0.005	METALS-022	[NT]	4	0.027	[NT]		[NT]	[NT]
Mercury-Dissolved	mg/L	0.00005	METALS-021	[NT]	4	<0.00005	<0.00005	0	[NT]	[NT]
Molybdenum-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Selenium-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Strontium-Dissolved	mg/L	0.001	METALS-022	[NT]	4	0.015	[NT]		[NT]	[NT]
Tin-Dissolved	mg/L	0.001	METALS-022	[NT]	4	<0.001	[NT]		[NT]	[NT]
Zinc-Dissolved	mg/L	0.001	METALS-022	[NT]	4	0.005	[NT]		[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Appendix G Numerical Model Summary

Model Setup

Modelling Software and Interface

The numerical groundwater modelling code MODFLOW-2005 using the Upstream Weighting Package (UPW) was used to develop the groundwater flow model for Corunna Downs. The Groundwater Vistas graphical user interface (Version 6.96) was used to develop the model input files and process the model output.

Model Extent and Grid

The model domain has dimensions of 39km (north to south) by 25.4km (east to west), with corner coordinates specified in Table 1

Table 1: Model Extent - Corner Coordinates

Model Corner	Easting(m)	Northing(m)
North-East	790138	7656963
North-West	764738	7656963
South-West	764738	7617963
South-East	790138	7617963

The model grid consists of 3 layers, and 254 columns and has a uniform cell size of 100 by 100m. The model and all associated data have been plotted using the GDA 1994 MGA zone 50 coordinate system.

Model Layer Geometry

The elevation of the top of the uppermost layer, Layer 1, is equal to the ground surface elevation. A summary of model layers is presented in Table 2

Table 2: Model Layer Description

Model Layer	Thickness (m)	Description
1	2 - 220	Top is ground surface
2	3	Constant 3m thickness
3	80 - 211	Average thickness 113m

Groundwater Inflow and Outflow

Groundwater Throughflow

The general direction of groundwater flow in the model is from south to north. Groundwater throughflow occurs through three boundaries. Groundwater flows into the model through a constant head boundary in Layer 3 on the southern boundary of the model, representing inflow from fractured bedrock. Groundwater inflow also occurs through a general head boundary along the southeastern boundary in Layer 1 of the model, representing inflow from the alluvium of the Coongan River. Groundwater outflow occurs through a drain boundary on the northern model boundary in Layer 2.

Rainfall Recharge

Apart from groundwater inflow from upstream catchments, all other inflow to the groundwater model is from rainfall recharge. There are two zones of recharge in the model: one covering the area of the Cleaverville Formation and the other covering the remaining model area. Recharge to the Cleaverville

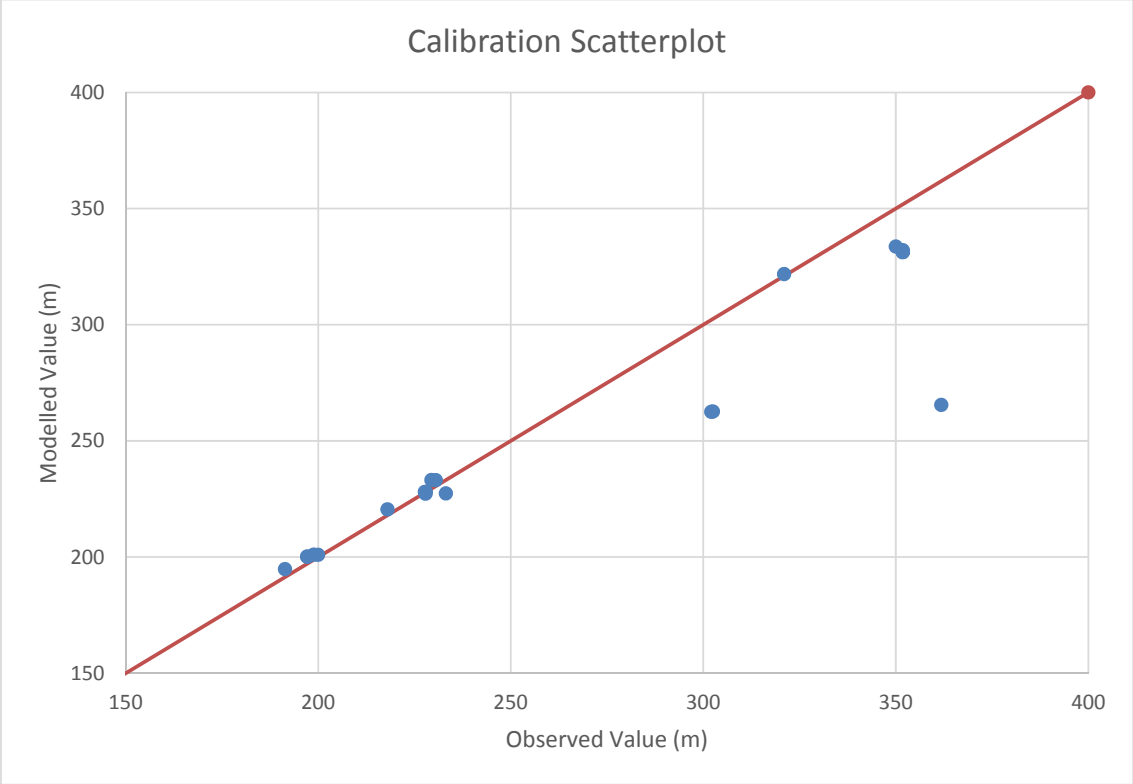
Formation is 9.86×10^{-5} m/d and recharge to the rest of the model area is 4.93×10^{-5} m/d. The recharge rate is constant throughout the entire simulation period.

Evapotranspiration

Evapotranspiration (ET) is simulated everywhere in the model with a maximum ET rate of 0.005 m/d and an extinction depth of 5m. The ET surface is set equal to the ground surface. The ET setup is the same for the entire simulation period.

Model Calibration

A steady state approach to model calibration was adopted due to a lack of long-term water level monitoring data. The steady state calibration provides a distribution of water levels that reflects the groundwater system prior to any development. The model was calibrated manually, by adjusting the hydraulic conductivity and storage parameters to find a best match between the observed and simulated values. A scatterplot of the modelled versus observed values is presented in Figure 1.



The scaled root mean square (SRMS) is 15.4% and the residual mean is 12.2m.

The calibrated steady state water levels were used as the initial conditions for the prediction model.

Calibrated aquifer parameters are presented in Table 3.

Table 3:Calibrated Aquifer Parameters

Zone	Kh (m/d)	Kz (m/d)	Ss	Sy
1	1	0.01	0.00001	.02
2	1	0.0001	0.00001	.02
3	1	0.01	0.00001	.02
4	0.0001	0.00005	0.00001	.02

5	0.01	0.001	0.00001	.02

Water Balance

The calibrated steady state water balance is presented in Table 4. The water balance indicates that inflows and outflows are dominated by recharge and evapotranspiration. Evapotranspiration accounts for more than 99% of the outflows from groundwater and recharge for more than 99% of the inflows.

Table 4: Calibrated Steady State Water Balance

Water Balance Component	Groundwater Inflow (kL/d)	Groundwater Outflow (kL/d)
General Head Boundary	290	0
Drain	0	142
Constant Head Boundary	10	0
Recharge	39,502	0
Evapotranspiration	0	39,659

Pumping Prediction

The LOM pumping prediction was implemented using the MNW1 (Multi-Node Well) package. A minimum pumping water level constraint was applied to the pumped wells. If the modelled water level in the casing of a pumped well reaches the minimum level, the pumping rate will be reduced so that the water does not drop below that level. Pumping rates for the LOM prediction are presented in Table 5.

Table 5: Pumping Rates for Life of Mine

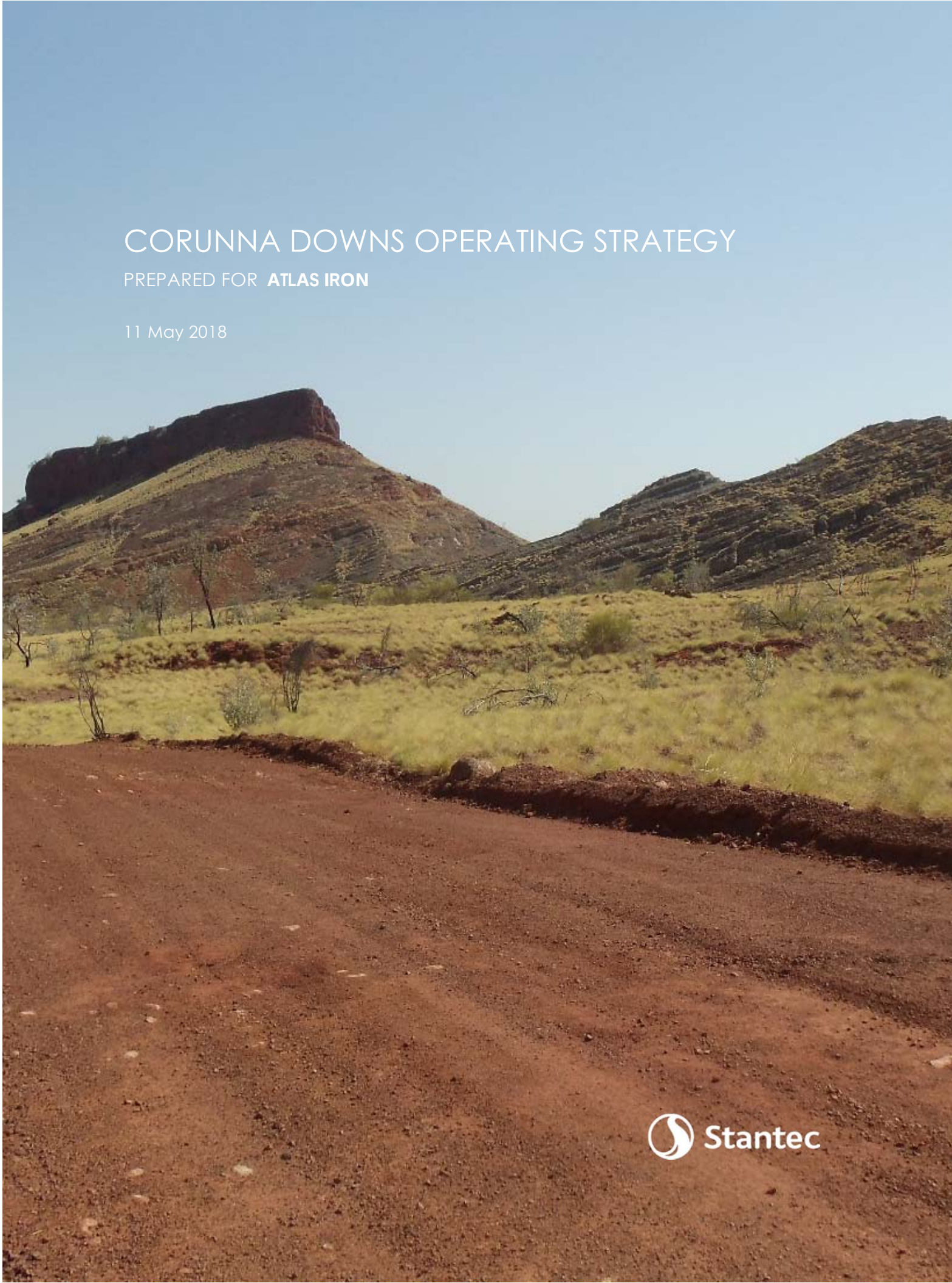
Pumping Bore	Specified Rate		Modelled Rate	
	(m^3/d)	litres/sec	(m^3/d)	litres/sec
CRD71	691.2	8.0	691.2	8.0
CRD74	432	5.0	432	5.0
CRD82	432	5.0	432	5.0
CRD83	561.6	6.5	562	6.5
CRD84	259.2	3.0	259	3.0
CRD85	259.2	3.0	259	3.0
CRD71	691.2	8.0	691.2	8.0
Total Pumping	2635.2	30.5	2635.2	30.5

Appendix H Operating Strategy

CORUNNA DOWNS OPERATING STRATEGY

PREPARED FOR **ATLAS IRON**

11 May 2018



Stantec

Atlas Iron

Corunna Downs Operating Strategy

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. INTRODUCTION

Atlas Iron Limited (Atlas) are currently undertaking a mining study for their Corunna Downs Project located approximately 237 km by road, southeast of Port Hedland and 33 km south southwest from Marble Bar.

Groundwater abstraction is currently authorised under two 5C licences to take water, GWL184565(1) for 100,000 kL/annum for road construction purposes, and GWL176960(4) for 100,000 kL/annum construction, campsite and potable water supply purposes (Appendix 1). On 21 March 2017, Atlas applied to amend GWL176960, seeking 1,100,000 kL/annum for all mining purposes on the Corunna mining leases. The Department of Water and Environmental Protection (DWER) specified that additional information was required before they could assess the application:

i. H2 – basic hydrogeological assessment including drilling and test pumping
ii. Groundwater Operating Strategy

This Groundwater Operating Strategy report has been prepared by Stantec on behalf of Atlas, in accordance with the guidelines provided in Operational Policy 5.08[1], and constitutes Item ii of the DWERs request for additional information.

Name of water licence applicant/licensee: **Atlas Iron Limited**

Name of Development project or purpose: **Corunna Downs Project**

Legal description and address of land where (a) water is taken, and (b) water is used (if different):

L45/408, G45/339, L45/418, E45/4639, L45/407, M45/1257, L45/410

"I understand that the commitments given in the attached operating strategy will be a condition of an associated water licence if approved and that a breach of a commitment or any licence condition may be an infringement of the Rights in Water and Irrigation Act 1914".

Signatures

Person legally responsible for water licence .....Date .....

Printed name:.....

Approved by delegated authority Department of Water .....Date .....

Printed name: .....

[1] Operational policy 5.08 - Use of operating strategies in the water licensing process. Government of Western Australia. Department of Water. June 2011.

2. ADMINISTRATIVE REQUIREMENTS

Number	Requirement
1.1	*List any other water licences already issued that are relevant to this operating strategy:* **GWL184565**(1) for 100,000 kL/annum for road construction purposes, and **GWL176960**(4) construction, campsite and potable water supply purposes.
1.2	*Does the water licence involve a staged development?* No staged development. Average monthly water demand is anticipated to be consistent upon commencement of ore processing.
1.3	*Has there been any investigation and reporting on the water source and/or environment involving the development?: -* ***YES*** **Stantec 2018a**: Corunna Downs Project Hydrogeological Investigation. Unpublished Report prepared for Atlas Iron. **Stantec 2018b:** Corunna Downs Project H2 Basic Hydrogeological Assessment. Unpublished Report prepared for Atlas Iron **WEC, (2018a)** Corunna Downs Project – Assessment of Groundwater Drawdown Impacts to Vegetation. Unpublished report prepared for Atlas Iron Limited. May, 2018
1.4	*Is the development within an area covered by a DoW water resource management/allocation plan?* No.
1.5	*Person responsible for implementing the Operating Strategy:* Corunna Registered Manager Telephone: 08 6228 8000, 300 Murry Street, PERTH WA 6000 PO Box 7071, Cloisters Square PO, WA 6850
1.6	*Reporting dates:* 1. Water use metering data - by 30 September every year. 2. Operating strategy compliance report - by 30 September every year. The "Water Year" is defined as the 12 month period commencing from the last day of the month in which the water license was issued. For the previous GWL the Water Year was from 29 May to 28 May [*sic*]
1.7	Date of major review of the Operating Strategy - three months prior to the expiry date on the water license.

3. WATER SOURCE DESCRIPTION

Water demand for the Project is proposed to be sourced from groundwater production bores drawing water from the fractured rock aquifer comprised predominantly within weathered to fresh basalt.

Groundwater quality at Corunna is classified as fresh to brackish (TDS <2 000 mg/L) according to Department of Water Operational Policy 5.08.

4. Water Sources

4.1 Groundwater Bores

The existing groundwater supply wells at Corunna are listed in Table 4-1. Potable water supplies for the camp are likely to be sourced from some of these bores.

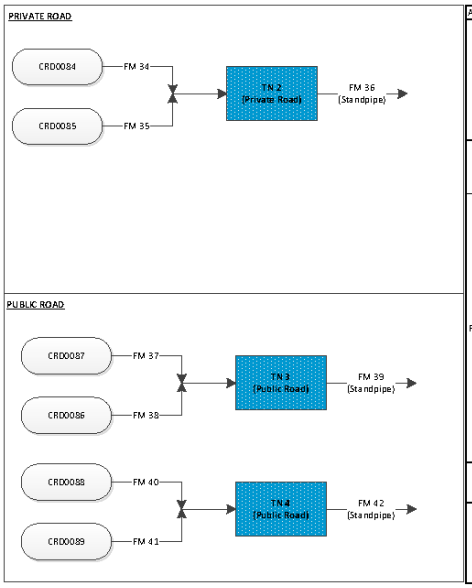
Table 4-1: Summary of Production Bores and Maximum Pumping Rates

Bore ID	Easting	Northing	Drilled Depth (m)	Screen (mbgl)	CRT Pumping Rate (L/s)	Proposed Maximum Pumping Rate (L/s)
CRD0007	TBA	TBA				
CRD0071	778429	7633394	96	10 - 96	24.0	8.0
CRD0074	TBA	TBA				5.0
CRD0082	778953	7631289	88	10 to 88	25.0	8.0
CRD0083	778579	7632984	82	6 to 78	20.0	8.0
CRD0084	778981	7641952	64	6 to 60	6.0	5.0
CRD0085	780809	7642040	64	6 to 64	5.0	4.0
CRD0086	782443	7644390	70	4 to 70	4.0	3.0
CRD0087	781895	7645717	64	4 to 64	15.0	8.0
CRD0088	782285	7652335	102	9 to 99	12.0	8.0
CRD0089	782719	7652280	100	12 to 96	12.0	8.0

4.2 Proposed Water Distribution Network

The proposed water distribution network comprises the utilisation of a series Turkeys Nests (TN) located as follows:

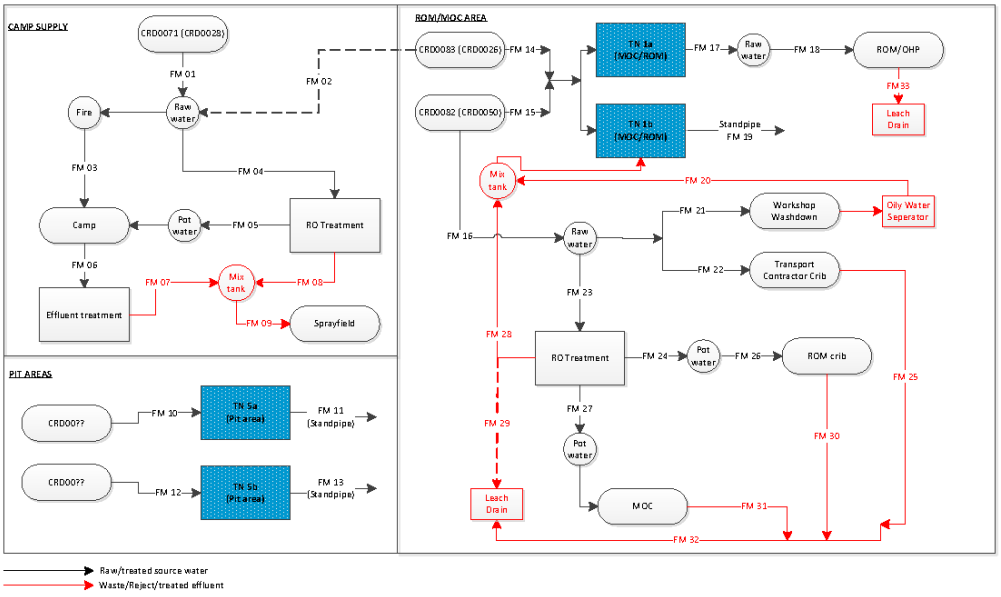
- TN's associated with haul road construction, two located along the along the public road section of the haul road alignment (Section 91 Licence area), with water sourced from production bores CRD0086 and CRD0087 supplying TN3, and CRD0088 and CRD0089 supplying TN4 (Figure 4-1);
- One TN (TN2) supplied by CRD0084 and CRD0085 (Figure 4-1);
- Two TNs (TN's 5a and 5b) located in the pit areas - source production bores yet to be identified (Figure 4-2); and
- Two TNs (TN's 1a and 1b) located in the ROM/MOC area, sourced from CRD0083 and CRD0084 (Figure 4-2).



AREA	Flowmeter ID	Description
Camp Supply	FM01	CRD0071 bore
	FM02	CRD0083 bore camp line/camp raw water input
	FM03	Fire tank output/ Camp input
	FM04	Raw water tank output/camp RO input
	FM05	Camp RO output/camp input
	FM06	Camp output/camp effluent treatment input
	FM07	Camp effluent treatment output/mix tank input
	FM08	Camp RO reject/mix tank input
	FM09	Mix tank output/sprayfield input
Pit Areas	FM10	CRD0077 Bore
	FM11	TN 5a standpipe
	FM12	CRD0077 bore
	FM13	TN 5b Standpipe
ROM / MOC Areas	FM14	CRD0083 bore ROM line/TN1a input and/or TN1b input
	FM15	CRD0082 bore output/TN1a input and/or TN1b input
	FM16	CRD0082 bore output/MOC Raw water tank
	FM17	TN 1a output to ROM OHP raw water tank
	FM18	MOC/ROM raw water tank output/ROM/OHP input
	FM19	TN 1b output Standpipe
	FM20	Workshop washdown oily water seperator output/ to TN1b input
	FM21	MOC/ROM water tank output/Workshop Washdown input
	FM22	MOC/ROM water tank output/Transport contractor crib input
	FM23	MOC/ROM water tank output/MOC RO treatment input
	FM24	MOC/ROM RO treatment output/ ROM potable tank
	FM25	Transport contractor crib effluent to leach drain
	FM26	ROM crib input
	FM27	MOC/ROM RO output to MOC potable water tank
	FM28	MOC/ROM reject water to TN1b input
	FM29	Optional MOC/ROM RO reject to Leach drain
	FM30	ROM crib output /input to MOC effluent treatment
	FM31	MOC wastewater/MOC Effluent treatment input
	FM32	MOC effluent treatment output/leach drain input
	FM33	ROM/OHP effluent output to leach drain
Private Road	FM34	CRD0084 (CRD0062)
	FM35	CRD0085 (CRD0064)
	FM36	TN2 Standpipe
Public Road	FM37	CRD0087 (CRD0045)
	FM38	CRD0086 (CRD0058)
	FM39	TN3 Standpipe
	FM40	CRD0007?
	FM41	CRD0074?
	FM42	TN4 Standpipe

02/05/2018

Figure 4-1: Proposed Haul Road Construction Turkeys Nests



17/07/2017

Figure 4-2: Proposed Mine Water Circuits

5. IDENTIFYING AND MANAGING IMPACTS

There are two water supply components, water supply for haul road construction, and water supply for the mining operations.

5.1 Other Users

No other groundwater users are likely to be affected by abstraction activities at Corunna.

5.2 Groundwater Dependent Ecosystems (GDEs)

Eleven (11) small permanent or ephemeral pools have been identified in the upper (southern) reaches of the catchment, in the vicinity of the proposed mining areas (Table 5-1). Four of the features have been identified as likely to be supported to some extent by groundwater contributions.

Abstraction for road construction activities is unlikely to impact upon the pools, however operational abstraction for the mining operations will likely impact upon the pools and they will require monitoring for the duration of abstraction.

The operational raw water requirements have been numerically modelled for the life of mine (LOM). The maximum drawdowns indicated by the modelling are shown on Table 5-1results at specified time steps for each of the key environmental features. Four of the pools CO-WS's 3, 5, 8, and 13 were identified as having drawdowns of over 1 m after a year of abstraction at 30.5 L/s. By the end of mining the model indicated that these same features had been impacted between 2.3 and 3.73 m.

Table 5-1: Summary of surface water feature details.

Location ID	Easting	Northing	Elevation (mAHD)	TDS (mg/L)	Groundwater Source	Modelled Drawdown at LOM (m)
CO-WS-01	778586	7630030	255.627	210	Likely	0.02
CO-WS-02	776034	7620690	371.100	No sample	Unlikely	0.56
CO-WS-03	778506	7633950	227.531	180	Unlikely (dry)	2.30
CO-WS-05	773504	7623870	313.184	690	Likely	3.52
CO-WS-08	774961	7625570	321.721	510	Unlikely	3.31
CO-WS-09	776568	7622980	344.725	2800	Unlikely (dry)	0.11
CO-WS-10	777461	7629400	297.225	No sample	Unlikely	0.02
CO-WS-11	777517	7626870	398.728	33	Unlikely	0.29
CO-WS-12	777092.2	7629040	373.970	100	Likely	0.05
CO-WS-13	777092	7629040	327.170	550	Unlikely	3.73
CO-WS-14	774623	7623940	320.990	190-210	Likely	0.10

Notes: Coordinates are GDA94

The main issues identified as requiring ongoing management are summarised in Table 5-2.

Table 5-2: Main issues requiring ongoing management

Issue	Management Objective	Measurement	Management Response
Groundwater Levels – Surface Water Features and Groundwater Dependant Vegetation (GDV).	Ensuring that the lowering of groundwater levels does not impact vegetation communities.	Monitor standing water levels monthly to ensure that water level does not drop significantly (>0.25 m) over life of mine.	If a significant change in water level is identified, review abstraction rates and use. Consider alternative water supply sources and increase in frequency of monitoring.
Groundwater Levels – Underestimation of drawdown on the local aquifer.	Ensuring that the lowering of groundwater levels does not impact upon bore yield.	Monitor standing water levels monthly to ensure that water level does not drop below primary aquifer zone/3 m above pump placement between monitoring events.	Do not exceed maximum pumping rates for individual bores. If water levels drop to within 3 m of pump placement, review abstraction rates and use. Consider resting individual bore and/or use of alternative sources.
Reliable water supply - Reduced bore yields.	Ensure water use does not exceed annual allocation.	Water meters installed and recorded monthly.	Review process and investigate options to reduce demand. Review licence abstraction limits and amend licence if required.
Groundwater salinity at production bores - Degradation of groundwater quality.	Maintain salinity (TDS) concentrations below 5 000 mg/L.	Monthly field pH and EC test. Ensuring results do not exceed 5 000 mg/L.	Review results and if bores are indicating an increase over a period of time, investigate options to reduce demand at a single bore and bring alternative bores online.
Reliable water supply - Mine footprint limits further water exploration.	Ensure water use does not exceed annual allocation.	Abstraction impact monitoring, all monitoring criteria.	Identify alternative supply options.

6. OPERATING RULES

6.1 Groundwater Production Bores

Existing groundwater supply production bores at Corunna are listed in Table 6-1. Additional production bores may be drilled in the pit areas when operations commence, and the Operating Strategy will then be updated to reflect these additions.

Table 6-1: Production Bores Abstraction Details

Bore ID	Proposed Maximum Abstraction Rate (L/s)	Estimated Annual Abstraction (kL/year)	Operating Protocol	Abstraction Strategy
CRD0007	tba		Backup Bore	Demand basis
CRD0071	8.0	252,300	Primary Bore	Demand basis

Bore ID	Proposed Maximum Abstraction Rate (L/s)	Estimated Annual Abstraction (kL/year)	Operating Protocol	Abstraction Strategy
CRD0074	5.0	157,700	Primary Bore	Demand basis
CRD0082	8.0	157,700	Primary Bore	Demand basis
CRD0083	8.0	205,000	Primary Bore	Demand basis
CRD0084	5.0	94600	Primary Bore	Demand basis
CRD0085	4.0	94600	Primary Bore	Demand basis
CRD0086	3.0	21000	Road construction water supply bores only	
CRD0087	8.0	21000		
CRD0088	8.0	21000		
CRD0089	8.0	21000		

7. MONITORING AND REPORTING

7.1 Purpose

The purpose of the monitoring programme is to obtain regular measurements of water use and basic groundwater chemistry parameters in order to provide comparison with baseline data, to assess whether the allocation has been exceeded, and to ensure that water use conforms to licensed conditions.

The "Water Year" is considered to be the period 1 July to 30 June for each year of operation.

One hard copy and one electronic copy of the 'annual groundwater monitoring summary' (in accordance with Operational Policy 5.12) will be submitted to DoW by 30 September for each year of operation.

All data will be supplied in graphical and tabular form (raw data).

A groundwater monitoring review is due every 3 years, the first one being 30 September 2021.

7.2 Water Use Measurement

Mechanical flow meters will be used to measure the water use for the project. Flow meters are proposed for installation at the locations shown on Figure 4-1 and Figure 4-2. Meter details will be provided to DWER in the annual groundwater monitoring summary, in the format presented in Table 7-1. Instantaneous flow rates and cumulative volumes will be recorded.

Table 7-1: Water Use Monitoring

Draw Point	Site Meter Number	Meter type/Serial No.	Meter Maintenance Calibration Schedule	Frequency of Recording Meter Data
CRD0007				Daily while operational, otherwise weekly.
CRD0071				
CRD0074				
CRD0082				
CRD0083				
CRD0084				

Draw Point	Site Meter Number	Meter type/Serial No.	Meter Maintenance Calibration Schedule	Frequency of Recording Meter Data
CRD0085				
CRD0086				
CRD0087				
CRD0088				
CRD0089				

Note: *Flowmeter serial numbers, calibration certificates and initial reading will be provided in the first annual monitoring report. If and when additional draw points are added to the water distribution system, this table will be updated.

7.3 Water Level Monitoring

Water level monitoring will be carried out according to the schedule shown in Table 7-2. Where automatic water level recorders with data loggers have been installed, they will be monitored quarterly.

Table 7-2: Water level monitoring locations and schedule

Location ID	Location Type	Easting	Northing	Monitoring Frequency
CRD0007	Production bore	TBA	TBA	Weekly
CRD0071	Production bore	778429	7633394	Weekly
CRD0074	Production bore	TBA	TBA	Weekly
CRD0082	Production bore	778953	7631289	Weekly
CRD0083	Production bore	778579	7632984	Weekly
CRD0084	Production bore	778981	7641952	Weekly
CRD0085	Production bore	780809	7642040	Weekly
CRD0086	Production bore	782443	7644390	Weekly
CRD0087	Production bore	781895	7645717	Weekly
CRD0088	Production bore	782285	7652335	Weekly
CRD0089	Production bore	782719	7652280	Weekly
CRD0001	Monitoring bore	776154	7623040	Monthly
CRD0003	Monitoring bore	776206	7623203	Monthly
CRD0016	Monitoring bore	773188	7624729	Monthly
CRD0017	Monitoring bore	777072	7627229	Monthly
CRD0018	Monitoring bore	777239	7627895	Monthly
CRD0021	Monitoring bore	776799	7625367	Monthly
CRD0022	Monitoring bore	776585	7626361	Monthly
CRD0023	Monitoring bore	777193	7626328	Monthly
CRD0026	Monitoring bore	778568	7632991	Monthly
CRD0027	Monitoring bore	779018	7634054	Monthly
CRD0028	Monitoring bore	778440	7633400	Monthly
CRD0031	Monitoring bore	776754	7625643	Monthly
CRD0033	Monitoring bore	776182	7623126	Monthly
CRD0039	Monitoring bore	782368	7652870	Monthly
CRD0043	Monitoring bore	782275	7652340	Monthly

Location ID	Location Type	Easting	Northing	Monitoring Frequency
CRD0044	Monitoring bore	782273	7645380	Monthly
CRD0045	Monitoring bore	781895	7645717	Monthly
CRD0050	Monitoring bore	778959	7631281	Monthly
CRD0056	Monitoring bore	782732	7652279	Monthly
CRD0058	Monitoring bore	782443	7644390	Monthly
CRD0062	Monitoring bore	778987	7641946	Monthly
CRD0064	Monitoring bore	780813	7642048	Monthly
CRD0075	Monitoring bore	778427	7633388	Monthly
CO-WS-01	Surface Pond	778586	7630030	Monthly
CO-WS-05	Surface Pond	773504	7623870	Monthly
CO-WS-08	Surface Pond	774961	7625570	Monthly
CO-WS-10	Surface Pond	777461	7629400	Monthly
CO-WS-12	Surface Pond	777092	7629040	Monthly
CO-WS-13	Surface Pond	777092	7629040	Monthly
CO-WS-14	Surface Pond	774623	7623940	Monthly

7.4 Water Quality Monitoring

The water quality monitoring schedule is presented on Table 7-3.

Table 7-3: Water quality monitoring schedule

Location	Frequency	Type of monitoring	Parameters
Production bores	Weekly	Field measurements	• Water Levels • Salinity • pH • Temperature
	Quarterly	Laboratory testing*	• Major ions • Metals • Total Petroleum Hydrocarbons • Total Suspended Solids
Monitoring Bores	Monthly	Field measurements	As for production bores
	Annually	Laboratory testing	As for production bores
Surface water values	Monthly	Field measurements	As for production bores
		Laboratory testing	As for production bores (excluding hydrocarbons for surface water sites)

Notes: *Laboratory tested of the Comprehensive Analytical Suite (Operational policy no. 5.12, ApendixC4)

8. ENVIRONMENTAL IMPACT MONITORING

Proposed environmental impact monitoring methodology is presented for assessment within the Mining Proposal submission to the Department of Mines, Industry Regulation and Safety. Within this submission,

Atlas has proposed a number of monitoring schedules and performance criteria (triggers) for groundwater monitoring for the GDE's and groundwater dependant vegetation (Atlas, 2018).

Atlas will comply with the groundwater abstraction licence conditions (RIWI Act 1914) and ensure that adequate mitigation measures are employed to demonstrate achievement of the final environmental outcomes and performance criteria outlined within the Mining Proposal, assessed under delegation of the Environmental Protection Act 1986 and approved in accordance with the Mining Act 1978. (

9. CONTINGENCY PROGRAMME

The project risks identified in Table 5-2 have been assessed in the context of contingency measures to ameliorate the risks. These measures are summarised in Table 10-1.

10. WATER USE EFFICIENCY

It will be to Atlas's benefit that an efficient water use practice is set up and maintained during the project, as environmental effects can be minimised and potential cost savings can be realised. In this regard, Atlas will implement inspection and maintenance systems aimed at ensuring that water use on-site is monitored, and issues identified that may result in more efficient water use.

Table 10-1: Contingency Plan

Risk	Risk Consideration	Reasoning	Contingency Measure
Environmental Impacts	Groundwater Levels – Surface Water Features and GDV.	Fractured rock aquifer performance is extremely difficult to characterise without long term operational monitoring data. Episodic climatic factors (rainfall) have a significant influence upon the extent of drawdown impacts on surface water features and GDV.	If a significant change in water level is identified, review abstraction rates and use, and cease abstraction from proximal water supply bores and use alternative bores. Consider increasing frequency of monitoring..
Groundwater supply	Groundwater Levels – Underestimation of drawdown on the local aquifer	Fractured rock aquifer performance is extremely difficult to characterise without long term operational monitoring data.	• Prior to finalising Site Water Operating Plan review drawdown assessment in consideration of completed drilling and testing program. • Alternative/additional supply bores may need to be constructed and reticulated to meet demand should dewatering reduce the local aquifer viability, degrade groundwater quality or adversely impact surface water values. • Target areas will be identified for future potential water exploration within the mine approvals footprint.
	Reliable water supply - Reduced bore yields		
	Groundwater salinity at production bores - Degradation of groundwater quality.		
	Reliable water supply - Mine footprint limits further water exploration.		
	Water meter failure. Monitoring and reporting commitments cannot be met.	Mechanical failure is common.	Keep at least one spare, calibrated water meter on site at all times. Inspect meters monthly. Inform DoW if a meter failure occurs and if a reporting commitment cannot be met.

11. SUMMARY LIST OF COMMITMENTS

The licensee will comply with this operating strategy as a condition of the Licence to Take Water, Instrument No. **GWL176960** for the taking of water from the Pilbara Water Region, at the Corunna Project.

The licensee will carry out and report to the department on the monitoring programme summarised in Table 11-1

Table 11-1: Summary Of Commitments

Location	Frequency	Type of monitoring	Parameters
Production bores	Weekly	Field measurements	• Water Levels • Salinity • pH • Temperature
	Quarterly	Laboratory testing*	• Major ions • Metals • Total Petroleum Hydrocarbons • Total Suspended Solids
Flow meters	Daily	Reading	Volume (kL) instantaneous and cumulative
Monitoring Bores	Monthly	Field measurements	As for production bores
	Annually	Laboratory testing	As for production bores
Surface water values	Monthly	Field measurements	As for production bores
		Laboratory testing	As for production bores (excluding hydrocarbons for surface water sites)

Notes: *Laboratory tested of the Comprehensive Analytical Suite (Operational policy no. 5.12, ApendixC4)

New bore details, locations and meter information will be supplied in the annual compliance report each year.

The licensee shall inform the DWER of any likely breach in the commitment of this operating strategy within 14 days of the licensee being aware of the possible breach. This also includes the implementation of a contingency response.

An annual water use (metering) report and the compliance (monitoring) report will be submitted by 30 September each year, respectively, in formats described in DoW (2009).

12. References

The following references were used during preparation of the Operating Strategy:

Atlas, 2018: Corunna Downs Hydrogeological Summary (pre-print)

DoW, 2009: Strategic policy 5.03: Metering the taking of water. June 2009. Government of Western Australia. Department of Water.

DoW, 2011: Operational policy 5.08 - Use of operating strategies in the water licensing process. Government of Western Australia, Department of Water. June 2011.

DoW 2009: Operational policy 5.12: Hydrogeological reporting associated with a groundwater well licence.

Golder Associates, 2010: *Corunna Downs Field Survey Report*. Unpublished report (087641274-004-R-Rev3), prepared for Gondwana Resources Ltd, February 2010.

Stantec 2018a: Corunna Downs Project, Hydrogeological Investigation, prepared for Atlas Iron

WEC, (2018a) Corunna Downs Project – Assessment of Groundwater Drawdown Impacts to Vegetation. Unpublished report prepared for Atlas Iron Limited. May, 2018.

WEC, (2018b). Corunna Downs Project, Investigation of Relationships Between Vegetation and Hydrology – "Soak" Area. Unpublished report prepared for Atlas Iron Limited, Perth, WA.

Appendices

Appendix A Groundwater Licences

Government of **Western Australia**
Department of **Water**

Your Ref: App13211
Our ref: RF10954; wrd352780
Enquiries: Stephanie Pham
(08) 6364 6874

Corunna Downs

David Nyquest
Atlas Iron
PO Box 7071
Cloisters Square WA 6850

Dear David,

Re: Issue of a licence under the *Rights in Water and Irrigation Act 1914*

Property: L45/408, G45/339, L45/418, E45/4639, L45/407, M45/1257, L45/410 - *Corunna Downs Project*

Please find enclosed your licence to take groundwater – GWL176960(4).

Please take time to read this document as it contains important information about your rights and responsibilities.

In addition, please note the following:

There are Clearing Regulations Schedule 1 Areas within the tenements. Please be advised that if you wish to undertake any clearing of vegetation within these areas you will need to do so in consultation with the Department of Environment Regulation (DER). Please contact the DER on (08) 6467 5000 for further information.

If you have any queries about this matter please contact Stephanie Pham on (08) 6364 6874.

Yours sincerely,

Kevin Hopkinson
Program Manager – Pilbara District
North West Region
Department of Water

29 May 2017

168 St Georges Terrace Perth Western Australia 6000
PO Box K822 Perth Western Australia 6842
Telephone (08) 6364 7600 Facsimile (08) 6364 7601
www.water.wa.gov.au

XDNAL001

File No: RF10954

Government of Western Australia
Department of Water

Instrument No. GWL176960(4)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Atlas Iron Limited		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	100000 kL
Location of Water Source	L45/408, G45/339, L45/418, L45/410, L45/407, M45/1257, E45/4639		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes Exploratory drilling operations General campsite purposes Potable Water Supply purposes Road construction purposes Road maintenance purposes	L45/408, G45/339, L45/418, L45/410, L45/407, M45/1257, E45/4639

Duration of Licence	From 29 May 2017 to 28 May 2027

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

End of terms, conditions and restrictions

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

Government of Western Australia
Department of Water

Your Ref: App13998
Our ref: RF10954; wrd358426
Enquiries: Stephanie Pham
(08) 6364 6874
Securing Western Australia's water future

David Nyquest
Atlas Iron
PO Box 7071
Cloisters Square WA 6850

Dear David,

Re: Issue of a licence under the *Rights in Water and Irrigation Act 1914*

Property: Section 91 Lic 869-2016_A6435862 - *Corunna Downs Project*

Please find enclosed your licence to take groundwater – GWL184565.

Please take time to read this document as it contains important information about your rights and responsibilities.

In addition, please note the following:

There are registered sites of Aboriginal Heritage Significance within the project area. Please be advised that it is your responsibility to ensure appropriate consultation with any affected Traditional Owners and adequate referral to the Department of Aboriginal Affairs (DAA) is made, to ensure full compliance with the *Aboriginal Heritage Act 1972*.

Clearing Regulations Schedule 1 Areas are within your project area. Please be advised that if you wish to undertake any clearing of vegetation within these areas you will need to do so in consultation with the Department of Environment Regulation (DER). Please contact the DER on (08) 6467 5000 for further information.

Contaminated site ID1335 near Halse Road/Limestone Marble Bar Road has been identified as near or within your project area. The site is listed as "possibly contaminated – investigation required" under the Department of Environment Regulation (DER) contaminated sites classification system. Please consult the DER for additional information and advice and/or any relevant approvals. The DER Contaminated Sites hotline number is **1300 762 982.**

Priority fauna are located within the project area. If you have any queries, please contact the Department of Parks and Wildlife's Species and Communities Branch on (08) 9219 9511 for further information.

The Marble Bar Water Reserve was proclaimed in 1972 under the *Country Areas Water Supply Act 1947 (CAWS)*.

168 St Georges Terrace Perth Western Australia 6000
PO Box K822 Perth Western Australia 6842
Telephone (08) 6364 7600 Facsimile (08) 6364 7601
www.water.wa.gov.au

XDWAL001

A Drinking Water Source Protection Plan was prepared for the Marble Bar Water Reserve in 2000, and updated in 2010. Groundwater is drawn from the Coongan well-field 2-3km west of the town and adjacent to the Coongan River. The Coongan wellfield draws from fractured volcanic rock on the Coongan Rivers eastern bank. Significant recharge occurs during high rainfall events and the direction of groundwater flow is closely related to surface drainage, in a north to north westerly direction.

Given the unconfined nature of the aquifer, it is vulnerable to contamination. Land and water based uses and activities within the catchment can directly affect water quality and treatment. It should be noted that protecting a drinking water supply to provide a safe drinking water source is a cheaper option than both treatment and remediation; furthermore treatment is not 100% reliable.

It is therefore important to ensure any bores are appropriately located to avoid drawdown and constructed to prevent contamination of the public drinking water source. All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

Existing and future mining proposals within the water reserve are compatible with conditions, and should adhere to the Department of Water's *Water Quality Protection Guidelines for Mining and Mineral Processing 1- 11* and other relevant Water Quality Protection Notes published by the Department of Water

If you have any queries about this matter please contact Stephanie Pham on (08) 6364 6874.

Yours sincerely,

Kevin Hopkinson
Program Manager – Pilbara District
North West Region
Department of Water

30 May 2017

File No: RF10954

Government of Western Australia
Department of Water

Instrument No. GWL184565(1)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Atlas Iron Limited		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	100000 kL
Location of Water Source	Section 91 of the LAA Lic 00869-2016_A6435862		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes Exploratory drilling operations Road construction purposes Road maintenance purposes	Section 91 of the LAA Lic 00869-2016_A6435862

Duration of Licence	From 31 May 2017 to 31 January 2019

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

End of terms, conditions and restrictions

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

Perth
41 Bishop Street,
JOLIMONT, WA 6014
Tel +61 (08) 9388 8799

www.stantec.com

Please visit **www.stantec.com** to learn more about how Stantec design with community in mind.

MWH® now part of Stantec