

Figure 2 Mesa H Hydrogeological drilling locations north

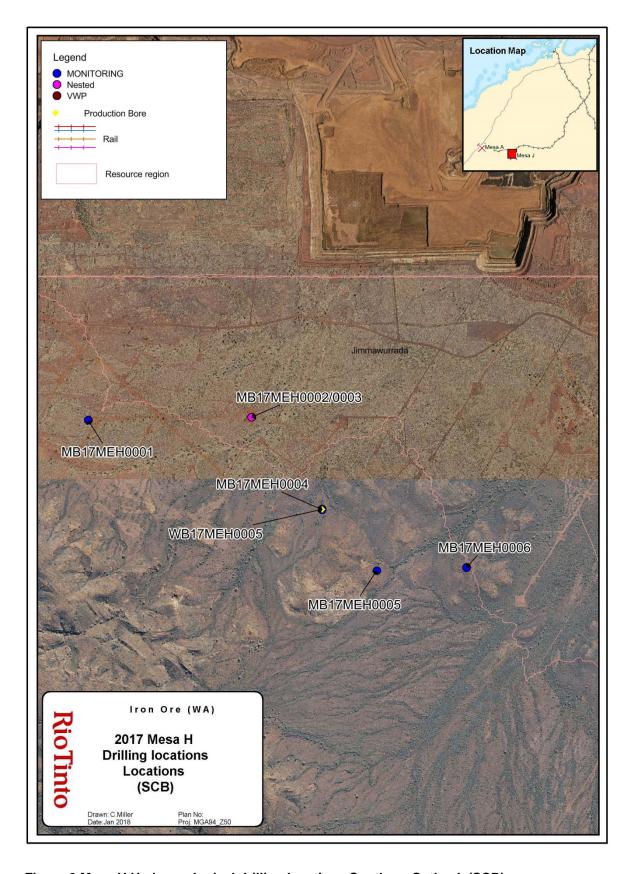


Figure 3 Mesa H Hydrogeological drilling locations Southern Cutback (SCB)

### 1.2 Approvals

Before earthworks and drilling commenced, the following Approvals Requests (AR) and 26D Licenses were obtained.

### Approvals Requests (ARs)

- AR-16-14020 Mesa H FS Hydrogeological Program (Heritage Areas)
- AR-16-14023 Mesa H FS Hydro Drilling (Off Mining Lease)
- AR-16-14024 Mesa H FS Hydro Drilling
- AR-17-14272 Mesa H Robe River Discharge Trial
- AR-17-14444 -Water Supply Mesa H Construction Camp

### 26D Licenses

- CAW183351(1)
- CAW183352(1)

### Section 2 - Mesa H Project Setting

Mesa H is a channel iron deposit (**CID**) deposit that forms part of a sinuous chain of mesas which define the palaeochannel of the Robe River and its associated tributaries. The deposit contains high grade and low grade mineralisation, with a combined Mineral Resource of 207 Mt at 54.3% Fe. Approximately 34% of the reported resource occurred below the pre-mining water table, however due to the lowering of the water table caused by dewatering activities at the adjacent Mesa J operation, the reported resource at Mesa H is approximately 13% below the present-day water table.

The project site is located downstream from the confluence of the Robe River and Jimmawurrada Creek. Along the river are permanent and semi-permanent pools which support environmental sensitive ecosystems and are of cultural significance in the area. Due to the close proximity of Mesa H to Robe River and a number of significant surface water pools, this investigations objective is focused on understanding potential impacts that future dewatering activities at Mesa H may have on these areas.

### 2.1 Geology and Hydrogeology

Geological units and hydro-stratigraphic components in the Mesa H area are well understood. Areas where hydrogeological conceptual uncertainties were identified during the PFS were targeted in this investigation to clarify modelling scenarios based on the understating of geological units in the area.

### 2.1.1 Mesa H Conceptualisation

Key areas where conceptual uncertainties for the Mesa H FS included the Yeera Bluff location (MB17MEH0011 and MB17MEH0012) where limited drilling and hydrogeological investigations could clarify a groundwater throughflow boundary between CID aquifer and the Robe River Alluvial aquifer which supports what is considered a permanent surface water pool (KM-RR16) directly west of the Mesa H deposit. As such, drilling and bore development suggests the basement geology (unmineralised BIF) in this area causes a groundwater throughflow boundary. Further evidence of this groundwater boundary is suggested by very low airlift yields which shortly after commencing bore development became dry. Water samples were not collected as a result and a production bore to test hydrogeological parameters and hydraulic connectivity between CID and basement were deemed unnecessary.

The uncertainty of basement aquifer continuity in the north of the Mesa H was addressed by drilling at several locations including MB17MEH0007 - MB17MEH0010, MB17MEH0013, MB17MEH00014 in this program and an additional location MB17MEK0001 (RTIO-PDE-0156788) to determine the regional Wittenoom Aquifer throughflow direction north the Robe River. The results are reflected as water level contours shown in Figure 3. Additional information on geological units in the north area can be found in the borehole logs in Appendix A.

Geological and hydrostratigraphic unit uncertainties remain in areas where drilling requests could not be approved or where rig mobilisation was deemed unsafe. These areas are the Robe River alluvial and Jimmawurrada Creek locations.

### 2.1.2 Water supply

Areas drilled in for the purpose of water supply exploration and construction camp water supply had found varying results and success. In similar geological units, variations in hydrostratigraphic properties were found. As a result, drilling and test pumping was unable to clarify the suitability of the locations for water supply. For example exploration bores in the Southern Cutback (SCB) area of Mesa H (Otherwise known as Jimmawurrada deposit) encountered thick sequences of black, lignitic shale (McRae Shale) overlayed by a thick sequence of clay. While it was found to be largely impermeable, fractured and interbedded zones of chert layers had higher permeability allowing for yields during drilling. Where lost circulation occurred, the yields were at its highest however it is not known how extensive these fractures and cavities are in the area. A large fracture and lost circulation zone was intersected only at one drill pad location MB17MEH0004 and WB17MEH0005. Bore locations which did not encounter lost circulation in the SCB area were dry (MB17MEH0001 and MB17MEH0003) and or yielding very low or had issues developing due to the amount of fines in the sample (MB17MEH0002, MB17MEH0005 and MB17MEH0006). These bore locations were not recommended for production bore construction.

Bores in the north of the Mesa H close to the rail line (MB17MEH0013 & 14) had varying degrees of success for water supply potential for the Mesa H construction camp. The monitoring bores and production bores encountered similar geology with varying degrees of fracturing and weathering profiles within the alluvium and Wittenoom Formation. This suggests that continuous water supply may be at risk due to varying yield performance between the two production bores drilled here (WB17MEH0002 and WB17MEH0004).

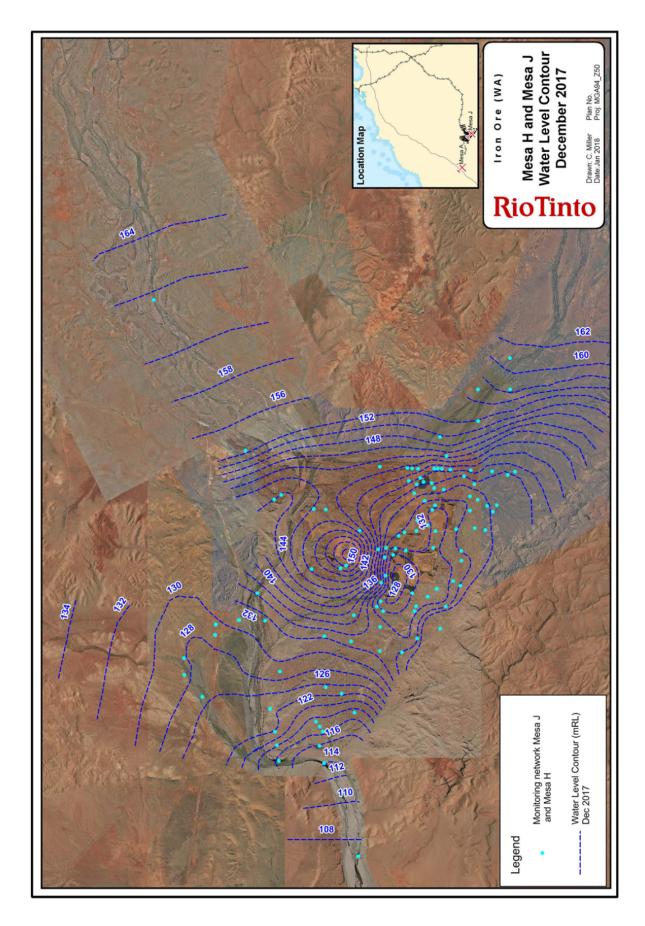


Figure 4 Groundwater level RL post drilling at Mesa C

### Section 3 - Drilling Program

### 3.1 Drilling

Bunbury Drilling Pty Ltd (BDC), were commissioned to carry out the 2017 Mesa H Hydrogeological Drilling Program. A combination of Mud Rotary and Conventional Air Hammer drilling techniques were employed by BDC to ensure successful and timely completion of the project. Where it was deemed necessary, a combination of both techniques were used on the same hole, where mud rotary was used to seal the upper less stable sections, while the rest of the hole was completed using the quicker conventional air drilling technique. Post drilling and construction geophysical surveys were also completed on all production Bores between October 2017 and December 2017 by Kinetic. Installation of VWPs was carried out Foraco Fluid Potential

Drilling, Test Pumping and Geophysical surveys were managed by the Rio Tinto Water Resource Evaluation and Services group (WRE&S). During the field campaign, project logistics and safety oversight was provided by Project Field Coordinators, whilst Technical hydrogeological supervision was provided by Feld Hydrogeologists.

### 3.2 Mesa H Bore Construction

Bore construction was completed by BDC as per Scope of Works (SoW). Headworks for all bores were completed in accordance with the Rio Tinto Design Specification for Water and Monitoring Bore Headworks (RTIO-PDE-0089729). Complete details of all bore locations, drilling and construction and hydrogeological information collected during drilling and construction activities is provided in Tables 1, 2, 3, and 4 respectively. A summary of construction details for each bore type are below:

### **Production Bores:**

- 12" threaded steel casing stick-up <u>150mm</u> above the top of the plinth;
- Lockable steel lid with handle;
- Concrete plinth measuring 1 m<sub>2</sub> by 300 mm high (100 mm set below natural ground level).

### Monitoring bores (includes dual nested monitoring bores)

- o 50mm PVC Class 18 casing, fitted with a PVC cap
- o Steel casing stick-up 500 mm above the top of the plinth;
- Lockable steel lid with handle;
- o Concrete plinth measuring 1 m<sup>2</sup> by 300 mm high (100 mm set below natural ground level).
- Dual nested monitoring bores were constructed with bentonite seal to separate deep and shallow formations between slotted sections of PVC within the parent hole.
- All bores were gravel packed with graded gravel 3.2 6.4 mm in size, except the <u>3mm aperture</u> monitoring bore which used 6.4-10mm graded gravel.

### Vibrating Wire Piezometer (VWPs)

Grouting and instrumentation of VWPs was carried out by Foraco Fluid Potential in November 2017. Table 3 summarises the VWP installation details including depths and formations. All VWPs were sleeved using 50mm PVC by BDC. The multiple sensors were installed post drilling and sleeving activities and grouted up to the surface. A Quattro logger and tripod standard headworks were installed for downloading VWP data. Sensors recording frequency was set to record every 6 hours.

### 3.3 Geophysics

Gamma and Gyro geophysical surveys were conducted by BDC using the Driller Operated Gamma and Gyro Survey (DOGGS) tools provided by Reflex. Post drilling and construction, geophysical surveys were completed on all production bores in casing. Production bore geophysical surveys were carried out by Kinetic as outlined in the Scope of Works. The geophysics survey reports are presented in Appendix C.

### 3.4 Water quality

Water quality samples were collected after the end of airlifting activities for all monitoring and production bores. VWP locations were not developed and were not sampled. Any bores not sampled during the program were dry after a short period of airlifting. Sampled were tested for the hydro-geochemical parameters as per the Scope of Works. Hydro-geochemical analysis was completed by ALS environment Laboratory. Certificate of analysis are presented in Appendix D.

### 3.5 Summary of Field Program Learnings

While the field campaign was executed safely and successfully, a key number of learnings can be taken away from the program. Detailed below are some of the key learnings from Mesa H.

### Mesa H Key Learnings

- MB17MEH0012 was planned as a nested piezo but was only constructed as a single piezo due to surfacing casing going to 40m and hence sealing off the CID unit Also, the CID is largely unsaturated. This was due to a large cavity encountered the adjacent monitoring bore.
- MB17MEH0011 was not drilled to planned depth of 110m due to a large cavity between 28 and 62 mbgl and 100% circulation loss. As this location is on the edge of the cliff, it can be assumed this cavity may have external lateral extents to the cliff face. Drilling further away from the cliff face showed there was no cavity there.
- MB17MEH0015 was installed as a 3mm 50mm PVC aperture and course gravel (6.4-10mm) to enable stygofauna surveys. Consequently, airlift had to be abandoned due to excessive silt and due to fear of clogging up the hole. Large aperture bores will allow elevated silt inflow during airlift, especially along the creek bed.
- WB17MEH0005 produced significantly more water than anticipated and was airlifted at 36 L/s. Despite the presence of black shale in the water, the bore was able so sufficiently clean up.

- HM17MEH0003 (17MEH\_VW01) encountered significant fallback to 37 mbgl from the drilled depth of 110m. It fell back to approximately the top of the clay sequence. The PVC casing was installed to depth using hollow rods. The PVC stayed open for the subsequent installation of the VWP and grouting.
- HM17MEH0001 (17MEH\_VW01) and a number of other holes were drilled 16m shorter as basement
  which was fresh crystalline dolomite was encountered earlier than expected. Other basement
  contacts included Marra Mamba BIFs and shales.
- Significant clay bands of up to <u>12m</u> thick were encountered at Mesa H. However these did not pose hole stability issues during mud drilling. Holes stayed open and there were no installation issues.
- Monitoring Bore MB17MEH0011 encountered significant circulation loss (29-62 mbgl), yet it took significantly less gravel than expected given the cavity. This indicates that most lost circulation at Warramboo is more likely a result of fractures and smaller voids, rather than "large cavities".
- Drilling exploratory monitoring bores with mud limited ability to accurately measure yields and hence make it difficult to pick the best locations for production bores.
- A few locations where dual nested bores were planned have been changed to single installation due to lithology and lack of saturated aquifer thickness. This highlights geological uncertainties within Mesa H.
- Slow penetration rates in fresh basement rocks, especially dolomite. Penetration rates were as low as 2.5m/hr.
- Although the area was classified as fibrous likely, there were no fibrous materials intercepted.
- The use of threaded casing was successfully trailed at Mesa H.
- Deep water crossings and steep terrain posed significant hazards but were managed as per existing procedures and no safety incidents were reported.
- Exploratory monitoring holes/targets for production bores need to be drilled with CH or RC to accurately measure yields and select the best possible target for PBs
- PB bores installations, need to install slots well below water table to stop air getting into the hole and reduce turbulence during test pumping.
- Threaded casing was trialled successful
- Drilling in the pit posed challenges due to operational constraints. Time was lost due to waiting for escorts into and out of the pit.
- Incorporate terrain and discharge management plan into sump designs for potentially high yielding areas.

### Section 4 - Test Pumping

### 4.1 Test Pumping Plan and Methods

Test pumping was conducted by McArthur Drilling and Test Pumping (MDP). The program consisted of a step rate test (SRT) and constant rate test (CRT) for 5 production bores within Mesa H in November 2017. All 5 production bores had 12" diameters. Figure 5 show the location of the production bores tested.

Test pumping objectives consisted of:

- Observe local drawdown in groundwater levels resulting from test pumping to further understand aquifer parameters to support Mesa J / H aquifer water supply capacity in the Southern Cutback borefield area; and
- Access aquifer parameters and bore hydraulics to support the Mesa H construction provisory camp water supply.

To measure water levels within the production bore, two dip tubes attached to the rising main in the pumping bore were utilised. Water levels in monitoring bores were measured with a combination of manual dipping and automated data loggers.

Test pumping involved the following:

- A calibration test to ensure all equipment was functional and to provide an indication of possible flow rates.
- Step drawdown rate test (SRT): Consisting of 5 x 60 or 100 minute tests with increasing yield rates to provide data for bore efficiency assessment and to determine an appropriate pumping rate for the constant rate test.
- Constant rate test (CRT): Consisting of a 24 hour test to provide data for estimation of aquifer properties. WB17MEH0001 had a 30 day test.
- Water sampling after one hour of pumping during the CRT for water quality analysis.
- At CRT cessation, water levels in the production bore were monitored until water level recovery reached 90% of the pre CRT water level.

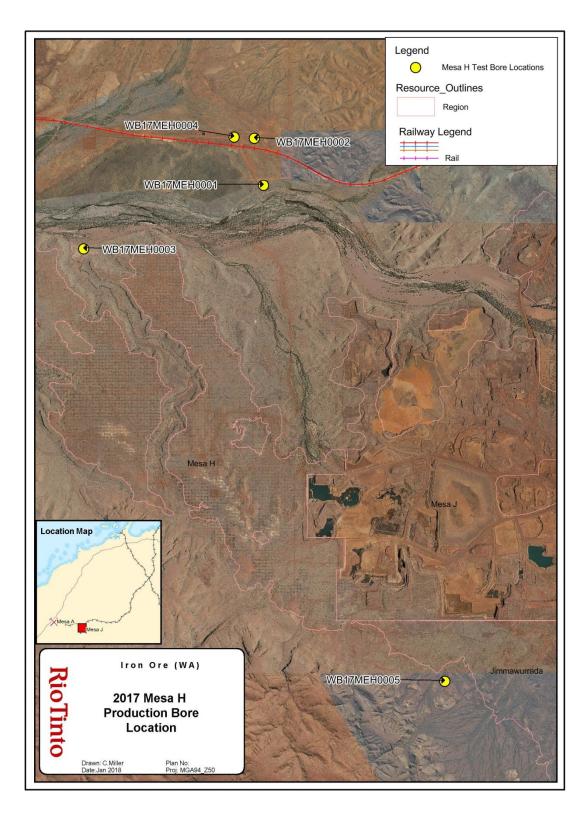


Figure 5: Mesa H production test bore locations

### 4.1 Aquifer Test Summary

The Hantush-Bierschenk analysis was used to analyse the step rate test data to determine the apparent well efficiency. The step test pumping rates were used to determine the pumping rate for the constant rate test.

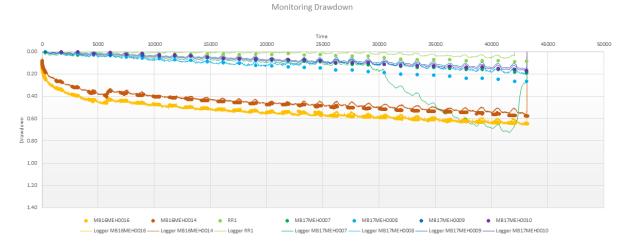
The Constant Rate test drawdown results presented a combination of unconfined and semi-confined (leaky) aquifer response. In order to analyse the drawdown response and obtain aquifer parametes the Moench (unconfined) and the Hantush-Jacob (leaky) solutions were chosen to match the curves.

A review of the test pumping results indicates the following:

- All bores presented a relatively low well loss ranging between 1x10<sup>-4</sup> and 2x10<sup>-7</sup>.
- Hydraulic conductivity of the Alluvium ranges between 10.54 and 71.49 m/day.
- Hydraulic conductivity and storage coefficient of Dolomite was 44.9 m/day 6.39E<sup>-5</sup>.
- Hydraulic conductivity and storage coefficient of fractured BIF was 568 m/day 6.203E<sup>-5</sup>.
- No bores were screened exclusively within CID and therefore CID hydraulic conductivity and storage coefficient can't be estimated.
- WB15MEH0005 displayed accelerated drawdown towards the later portion of the test that indicates
  a boundary response most likely due to outcropping unmineralised Brockman Formation in the
  south.

A 30 days CRT test was carried out for WB17MEH0001 to access boundary conditions and for the purpose of a discharge trial to support drawdown mitigation strategies of the Robe River Pools. Although the bore was showing signs of development during the initial stages of the test (at 18 L/s and reduced later to 16 L/s); results indicates:

- hydraulic conductivity of ~70 m/day with a max drawdown lesser than 3m after 30 days, and an associated specific yield of 33%;
- A boundary response was displayed in MB17MEH0007 after 30000 minutes that resulted in an sharp drop in the water level as can be observed in Figure 6.



### Figure 6: WB17MEH0001 CRT drawdown curves

Table 4 and Table 5 shows the summary of the step drawn-down test and constant rate test results. CRT drawdown curves and analysis using AQTSOLVE is presented in Appendix B.

### Section 5 - Conclusions and Recommendations

The 2017 Mesa H hydrogeological program was executed within the approved budget and without incident. A combination of drilling techniques was successfully used to complete drilling activities including Air hammer and mud rotary methods. Through drilling and test pumping an increased understanding of the Mesa H Conceptualisation has been achieved. Conceptual gaps identified in the PFS in 2016 have been addressed with positive conceptualisation outcomes regarding areas of significant cultural and environmental value. Drilling and test pumping will be used to update and refine the Mesa H Conceptual and numerical model as part of the Mesa H FS requirements.

Water supply exploration had varying success for identifying potential future production supply locations. This is largely due to varying presence of fractured and weathered geology profiles which influenced yields in locations of similar geology. This variance and discontinuity in the geology will make it difficult to target future supply locations to meet water supply requirements.

The Robe River discharge trial confirmed an inferred aquifer boundary to the north of the Robe River, and will be valuable to assess hydraulic and engineering designs for the Robe River pools impact and associated mitigation strategy.

**Table 1 Bore Locations Mesa H** 

Bore ID	Peg ID	Surveyed Easting (MGA)	Surveyed Northing (MGA)	Surveyed Ground Level mRL (m AHD)	Surveyed TOC mRL (m AHD)
Monitoring Bores					
MB17MEH0001	17MEH_MB06	420764.006	7591282.880	178.376	179.090
MB17MEH0004	17MEH_MB08	421705.351	7590918.035	174.947	175.681
MB17MEH0005	17MEH_MB09	421909.743	7590687.074	177.221	177.934
MB17MEH0006	17MEH_MB10	422272.376	7590689.111	178.401	179.201
MB17MEH0007	17MEH_MB04	417658.827	7600422.641	134.828	135.714
MB17MEH0008	17MEH_MB02	417119.022	7600417.544	134.784	135.477
MB17MEH0009	17MEH_MB01	416434.642	7599847.256	131.526	132.316
MB17MEH0010	17MEH_MB16	416447.194	7599849.354	131.704	132.466
MB17MEH0011	17MEH_MB05	414868.454	7596153.963	165.542	166.313
MB17MEH0012	17MEH_MB17	414881.979	7596152.854	165.589	166.430
MB17MEH0013	17MEH_MB12	418380.559	7599440.612	135.787	136.493
MB17MEH0014	17MEH_MB11	418723.950	7599428.420	136.890	137.609
MB17MEH0015	17MEH_MB015	416044.945	7597712.125	132.166	132.935
Nested Piezometres					
MB17MEH0002	17MEK_MB01	421409.959	7591295.997	173.672	174.158
MB17MEH0003	17MEK_MB01	421409.925	7591295.954	173.672	174.25
Vibrating Wire Piezometres (VW	P)				
HM17MEH0001	17MEH_VW02	416034.012	7597714.217	TBC	132.378
HM17MEH0003	17MEH_VW01	414982.062	7596143.524	ТВС	165.239
Production Bores					
WB17MEH0001	17MEH_PB02	418857.053	7598693.336	138.982	139.413
WB17MEH0002	17MEH_PB06	418711.747	7599423.723	136.836	137.194
WB17MEH0003	17MEH_PB03	416059.508	7597705.964	132.067	132.438
WB17MEH0004	17MEH_PB05	418388.056	7599451.981	135.829	136.356
WB17MEH0005	17MEH_PB04	421699.218	7590927.611	174.871	175.267
** Key: D = Deep F	Piezometre. S: Shallo	ow Piezometre. NA: No	t Applicable		

Table 2 Mesa H Water levels and Yields

Bore ID	Peg ID	Initial SWL (mBTOC)	Initial SWL (mAHD)	Peak Bore Development Airlift Yield (L/s)
Monitoring Bores				
MB17MEH0001	17MEH_MB06	44.510	134.580	TBC
MB17MEH0004	17MEH_MB08	41.080	134.601	1.000
MB17MEH0005	17MEH_MB09	40.800	137.134	1.500
MB17MEH0006	17MEH_MB10	41.540	137.661	0.500
MB17MEH0007	17MEH_MB04	7.620	128.094	TBC
MB17MEH0008	17MEH_MB02	7.150	128.327	0.500
MB17MEH0009	17MEH_MB01	5.910	126.406	1.200
MB17MEH0010	17MEH_MB16	6.000	126.466	1.100
MB17MEH0011	17MEH_MB05	49.850	116.463	TBC
MB17MEH0012	17MEH_MB17	49.950	116.480	TBC
MB17MEH0013	17MEH_MB12	7.030	129.463	TBC
MB17MEH0014	17MEH_MB11	8.090	129.519	2.000
MB17MEH0015	17MEH_MB015	8.830	124.105	TBC
Nested Piezometres				
MB17MEH0002	17MEH_MB07	38.180	135.978	0.25
MB17MEH0003	17MEH_MB07	39.840	134.410	0.1
Vibrating Wire Piezometres (VWP)				
HM17MEH0001	17MEH_VW02	NA	NA	NA
HM17MEH0003	17MEH_VW01	NA	NA	NA
Production Bores				
WB17MEH0001	17MEH_PB02	8.880	130.533	10
WB17MEH0002	17MEH_PB06	7.360	129.834	5
WB17MEH0003	17MEH_PB03	8.460	123.978	6
WB17MEH0004	17MEH_PB05	6.860	129.496	12
WB17MEH0005	17MEH_PB04	40.600	134.667	36
** Key: D = Deep F	Piezometre. S: Sh	nallow Piezometre. NA: I	Not Applicable	



Start Date	Completion Date	Drilled Depth	Cased Depth	Casing Details	Bore Type	Drilling Method	Collar Casing Diameter (mm)	Cased Collar Depth (m bgl)	Hole Diameter (mm)	Slotted Interval (r bgl)
20/08/2017	22/08/2017	104.000	95.000	PVC 50mm	1 40 Ci 1	MR	254.000	12.000	215.900	29-95
23/08/2017	26/08/2017	90.000	87.500	PVC 50mm	MB: Single MB: Single	CH/MR	254.000	18.000	215.900	51.5-87.5
26/08/2017	27/08/2017	86.000	81.000	PVC 50mm	MB: Single	MR/CH	254.000	18.000	215.900	69-81
26/08/2017	28/08/2017	80.000	XX	PVC 50mm	MB: Single	MR/CH	254.000	18.000	215.900	XX
28/08/2017	29/08/2017	30.000	30.000	PVC 50mm	MB: Single	MR/CH	254.000	6.000	215.900	12-30.0
28/08/2017	29/08/2017	18.000	18.000	PVC 50mm	MB: Single	CH	254.000	6.000	215.900	12-18.0
29/08/2017	30/08/2017	43.000	41.000	PVC 50mm	MB: Single	CH	254.000	5.000	215.900	29-41
30/08/2017	31/08/2017	30.000	30.000	PVC 50mm	MB: Single	CH	254.000	xx	215.900	9-30.0
24/10/2017	29/10/2017	62.000	59.000	PVC 50mm	MB: Single	CH	254.000	4.000	215.900	47-59
25/10/2017	28/10/2017	116.000	80.000	PVC 50mm	MB: Single	CH	254.000	40.000	215.900	56-80
30/10/2017	1/11/2017	43.000	42.000	PVC 50mm	MB: Single	CH/MR	254.000	12.000	215.900	12-42.0
27/10/2017	29/10/2017	43.000	42.000	PVC 50mm	MB: Single	CH	254.000	18.000	215.900	18-42
2/11/2017	3/11/2017	37.000	30.000	PVC 50mm (3mm)	MB: Single	MR	254.000	3.000	215.900	12-30.0
2711/2011	0/11/2017	07.000	00.000	. ve semm (emm)	IVID. SHIGIE		201.000	0.000	210.000	12 00:0
20/08/2017	22/08/2017	80	79	PVC 50mm	MB: Nested	-CH	203.2mm	18	215.9	61-79
20/08/2017	22/08/2017	00	48	PVC 50mm	MB: Nested	СП	203.211111	10	215.9	36-48
18/08/2017	19/08/2017	44.000	44.000	PVC 50mm	VWP: Multi Sensor	MR	254	xx	xx	39-44
28/08/2017	30/10/2017	110.000	110.000	PVC 50mm	VWP: Multi Sensor	СН	203.2	5	190.5	14-104
	23, 10,2017	10.000			vvvi. iviuiti seilsül					11.10
23/08/2017	26/08/2017	46.00	40.000	Threaded Steel 304.80mm	РВ	СН	xx	xx	444.5	10-28.0
31/10/2017	3/11/2017	50.00	40.000	Threaded Steel 304.80mm	РВ	MR	473.075	16	444.5	16-34
4/11/2017	11/11/2017	36.00	36.000	Threaded Steel 304.80mm	РВ	MR	558.8	2	444.5	18-30
711/2011	11/11/2017	55.00	55.000	Threaded Steel	15	IVIIX	550.0		444.5	10-30
7/11/2017	10/11/2017	50.00	46.000	304.80mm	PB	MR	508	7	444.5	10-40.0
				Threaded Steel						
14/11/2017	19/11/2017	106.00	104.000	304.80mm	PB	MR	558.8	2	444.5	74-98

Table 4 Summ	ary step ra	te testing at Mesa ト	ł		
Bore ID	Number of steps	Step Duration (minutes)	Discharge Rates (L/s)	Bore Apparent Well Loss	Bore Equation
WB17MEH0001	5	100 each, 20 mins @ 20L/s	12, 14, 16, 18, 20		
WB17MEH0002	5	60 each, 20 mins @ 6.5L/s	4.5, 5, 5.5, 6, 6.5	1.304E-04	y = 1.304E-04x 2.547E-02
WB17MEH0003	5	60	4, 6, 8, 10, 12	6.148E-06	y = 6.148E-06x · 4.626E-03
WB17MEH0004	5	60	10, 12, 14, 16, 18	8.651E-06	y = 8.651E-06x 4.253E-03
WB17MEH0005	5	60	29, 34, 39, 44, 49	2.134E-07	y = 2.134E-07x · 3.475E-06

Table 5 Mesa H CRT summary

Test Bore	Diameter	Observation Bore	Distance from test bore	Discharge Rate (L/s)	CRT Duration (min)	Screened Unit	Aquifer Type	Max Drawdown (m)	Transmissivity (m²/day)	Hydraulic Conductivity (m/day)	Storage Coefficient/ Specific Yield
	12"	WB17MEH0001	•			Alluvium		4.1m @ 18L/s, 2.7m @ 16L/s	1013.2	52.77	3.843E-8
	50mm	МВ16МЕН0016	10.7m			Alluvium & CID		0.5m @ 18L/s, 0.7m @ 16L/s	1649.7	109.54	1.938E-5
	50mm	MB16MEH0014	14m	18L/s until		CID & Dolomite		0.4m @ 18L/s, 0.6m @ 16L/s	2027.6	36.79	3.011E-3
WB17MEH0001	50mm	MB17MEH0007	2105m	changed to	43200	Dolomite	Unconfined	0.7m @18L/s by 1440mins	NA	NA	NA
	50mm	MB17MEH0008	2457m	43200 mins		Dolomite		0.2m @ 18L/s by 1440mins	NA	NA	NA
	50mm	МВ17МЕН0009	m289Z		\ \	Dolomite		0.2m @ 18L/s by 1440mins	NA	NA	NA
	50mm	МВ17МЕН0010	2671m			CID & Clay		0.2m @ 18L/s by 1440mins	NA	NA	NA
	12"	WB17MEH0002				Alluvium & Conglomerate		16.8	9.418	0.523	6.448E-3
WB17MEH0002	50mm	MB17MEH0014	13m	5.5	1440	Alluvium, CID & Dolomite	Leaky	0.5	220.7	6.49	1.931E-3
	50mm	MB17MEH0013	333m			BIF	4	0		1	
W/B47AAEU0003	12"	WB17MEH0003	•	7	27	Alluvium	- Francisco	8.9	227.1	10.54	1.294E-6
WELVINEHOUS	50mm	MB17MEH0015	15m	OT	1440	Alluvium	Olicollilled	0.8	1513.4	71.49	1.012E-5
WB17MEH0004	12"	WB17MEH0004	•	15	1440	Dolomite	Unconfined	10.8	44.9	1.35	6.39E-5
WB17MEH0005	12"	WB17MEH0005		45	1440	BIF	Unconfined	4.2	568	17.14	6.203E-5





HM17MEH0001

PROJECT: MESA H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Luke Wallace

**GRID NAME:** MGA94\_50 **EASTING:** 416034.012

DATE COMMENCED: 18/08/2017

DATE COMPLETED: 19/08/2017

**DRILLING METHOD:** Mud Drilling

**HYDROGEOLOGIST:** Y. Alaak

**NORTHING:** 7597714.217 **ELEVATION:** 132.378 mRL TOC

Well Notes: Collar Mud Rotary 0-1m using 12 1/4" drill bit, collar installed 8" steel casing 0-3m. Mud drilling 0-44m using 8 1/2" drill bit

			Dit.			
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
	Alluvium		ALLUVIUM: Alluvials composed of rounded to sunrounded gravels with sand and clay infills. trace tragments of cherts, shales and pisolites present	y wy my		50mm Blank PVC (0-3 mbgl)
15   20 			TPM: Moderately weathered red clayey and yellow orcherous goethite with 40% vitreous goethite, red brown sand and silts, angular to sub angular	Josh Johnson Johnson	SWL = 19 mbgl	VW17MEH0001 (15 mbgl)
25   30   	CID		TPB: Weathered tertiary orcherous goethite and vitrous goethite, yellow, brown and white plastic clays with pislotic clasts of goethite. Increasing plasticity towards end of interval. clay content @ 20-30%			50mm Slotted PVC (3-39 mbgl)
- 35   40   	Whitnoom Dolomite		DOLOMITE: Fresh chrystaline dolomite. light to dark blue, angular to sub-angular, hard to very hard hard. weathered zone at 40-42 mbgl			VW17MEH0002 (37 mbgl)  VW17MEJ0003 (40 mbgl)



### **HM17MEH0002**

PROJECT:MESA HDRILLING COMPANY:BDCGRID NAME:MGA94\_50LOCATION:Mesa HDRILLER:Joe MasonEASTING:421409.959DATE COMMENCED:20/08/2017DRILLING METHOD:ROTARY HAMMER - AIRNORTHING:7591295.997DATE COMPLETED:22/08/2017HYDROGEOLOGIST:YUOT ALAAKELEVATION:174.158 mRL

Well Notes: Mud Rotary Collar 0-18m using 12 1/2" drill bit and installed 10" casing 0-17m. Mud drilled with 8 1/2" drill bit 18 - 80m (EOH). Deep piezometer MB17MEH0002, Shallow piezometer MB17MEH0003

Depth mbgl	deology	Lithology	Lithological Description	Gamma 0-300cps	Field Notes		struction etails
			CID: Weathered vitrous geothite and red clays. weathered pisloites. CID largely unsaturated			X X X X X X X X X X X X X X X X X X X	Bentonite (0 - 0.5 mbgl)
- 10 - 10 15 	CID					KA K	8" Blank Steel (0- 17 mbgl)
- 20 - - - - - 25 - -						K. K	
— 30 - - - - - - 35		0-10-0	CLAY: Highly weathered white tertiary clays,	man from the second		XXXXXXXXXXXXXXXXXXXX	50mm Blank PVC (0-36, 0-61 mbgl)
- - - - - - - - - - -	Clay		resembling calcrete. Unsaturated and highly powdery. Highly plastic when saturated.	) Vmmmmm	SWL Deep - (38.18 mbgl) SWL Shallow - (39.84 mbgl)		50mm Slotted PVC (36 - 48 mbgl)
- - - - - 50			WITTENOOM DOLOMITE: Fresh cyrstalline dolomite,	mola	Final Airlift - Yield - 0.25 L/s pH - 8.4 EC - 964 uS/cm Temp - 30.5 0C		End Cap (48 mbgl)  Bentonite Seal (48-52 mbgl)
- 55 - - - - - 60	Jolomite)		sub-angular to angular, slightly fractured horizon from 60-65 but no significant increase in yields. evidence of contamination from overlaying CID in the chips. Very slow penetration through competent dolomite		FWS = 53 mbgl		
60    65 	Whitnoom Formation (Paraburdoo Dolomite)				Field Chem ( @60 mbgl EC=1021, pH=8.2, Temp = 32.8) Field Chem ( @66 mbgl		
- - 70 - - -	Whitnoom Formati				EC=1118, pH=8.6, Temp = 32.8) Field Chem ( @72 mbgl EC=1098, pH=8.2, Temp		50mm Slotted PVC (61-79 mbgl)
- 75 	>				= 32.8)		End Cap (79 mbgl)
- - - 80				<b>\</b>			Fallback (79 - 80 mbgl))

### **Bore Completion Details**

MB17MEH0001

PROJECT: MESA H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Manu Rekena

**GRID NAME:** MGA94\_50 **EASTING:** 420764.006

DATE COMMENCED: 20/08/2017

DATE COMPLETED: 22/08/2017

**DRILLING METHOD:** ROTARY HAMMER - AIR **HYDROGEOLOGIST:** Y. Alaak

**NORTHING:** 7591282.880 **ELEVATION:** 179.090 mRL TOC

Mud drilled using 12 1/2" drill bit 0 - 16m and installed 8" surface casing 0-16 mbgl. Mud drilled 16-104 (EOH) using 8 1/2" bit

Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-210cps	Field Notes	Construction Details
0    5 			CID: Tertiary mixed pisolites, red to to reddish brown. 80% vitrous goethite with 10% sand and silts infill. trace orcherous goethite, angular to sub-angular and medium hard, slightly weathered			Bentonite (0 - 0.5 mbgl)
- 10    15						8" Blank Steel (0- 12 mbgl)
- 13 - - - - 20 -				Maraham		50mm Blank PVC (0-29 mbgl)
25 25 30	CID			- more more	SWL = 25 mbgl Final Airlift -	
- - - - 35 - - -			CID: TPB: Tertiary mixed piolites, red to reddish brown. Increased clay content.	M V V	Yield - 3 L/s pH - 8.6 EC - 1108 uS/cm Temp - 8.6 0C	Gravel (3.2- 6.4mm) (0.5 - 95 mbgl)
— 40    45 				W Amma		
- - - - - - - - - - - 55		<ul><li>(2)</li><li>(2)</li><li>(3)</li><li>(4)</li><li>(4)</li><li>(5)</li><li>(6)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li><li>(7)</li></ul>	SHALE/BIF: Weathered shales, dark to blue with 20-30% clay content. angular to sub-angular clay, medium hard. Fragments of BIF mostly composed of cherts and some quartz trace.	month of the	Field Chem ( @86 mbgl EC=1001, pH=7.8, Temp = 34)	50mm Slotted PVC (29-95 mbgl)
- - 60  	nation (Bee Gorge)			John Martin Jang Cang	Field Chem ( @92 mbgl EC=1209, pH=8.2, Temp = 34)	
65    70 	Wittenoom Form			WWW MAN	Field Chem ( @98 mbgl EC=1108, pH=8.6, Temp	
- 75 - - - 80				Land Markage	= 34)	
- - - - - - - - - - - - - - - - - - -	Vittenoom Formation (Paraburdoo Dolomite		WITTENOOM DOLOMITE: Fresh chrstalline dolomite, light to dark blue, angular to sub-angular, hard to medium hard. Slightly fractured towards end of hole		FWS = 81 mbgl	
- - - - 95 - -	ormation (Pa					End Cap (95 mbgl)
- - - 100	Vittenoom F					Fallback (95 - 104 mbgl))

### **Bore Completion Details**

### MB17MEH0004

PROJECT: MESA H DRILLING COMPANY: BDC LOCATION: Mesa H DRILLER: Luke Wallace

DRILLING COMPANY:BDCGRID NAME:MGA94\_50DRILLER:Luke WallaceEASTING:421705.351DRILLING METHOD:ROTARY HAMMER - AIRNORTHING:7590918.035

**DATE COMMENCED:** 23/08/2017 **DATE COMPLETED:** 25/08/2017

HYDROGEOLOGIST: C. Miller ELEVATION: 175.681

Mud rotary with 12 1/4" drill bit 0-18m for 8" Collar, Air hammer 6 1/2" drill bit from 18-90m (EOH)

Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-200cps	Field Notes	Construction Details
0 	Alluvium		ALLUVIUM: Mixed unconsolidated clasts of GOV pisolith, Chert, BIF, red brown ferrugenous silts/ sands	March		
— 10 - - - - - - 15	CID		CID: Vitreous goethite pisoliths	Manage of the second of the se		8" Blank Steel (0- 18 mbgl)
_ - - 20				~\\\~~\\\~~\\\\\\\\\\\\\\\\\\\\\\\\\\\		50mm Blank PVC (0-51.5 mbgl)
- - 25 - - -			CLAY: Yellow, soft clay and shale, highly weathered, swelling clay, slight-moderate plasticity	Junear Mary		Gravel (3.2- 6.4mm) (0 - 32mbgl)
30    35				Marchan	FWS = 30 mbgl  SWL = 33.88 mbgl	Bentonite (32 - 34 mbgl)
_ - - 40 -			SHALE: Dark blue grey shale (95%), minor interbedded dolomite and cherty BIF	Alson West	Final Airlift - Yield - 1 L/s pH - 8.2 EC - 982 uS/cm Temp - 29.2 0C	
- 45 - - - -	Member)			Mondopolis		
50    55	ion (Bee Gorge Member)		WITTENOOM DOLOMITE: Dark grey blue Shale (~70%) interbedded with dark grey/blue dolomite, white/grey cherty BIF and partially mineralised BIF-		Yields during drilling up to 5L/s from 50mbgl	
- - 60 -	Wittenoom Formatio		Hard-medium hematite fractures- dark brown-grey.	And my		50mm Slotted PVC (51.5-87.5 mbgl)
- 65 - - - - 70	Wit			my for	Fast penetration rates throughout ~5 rods/hr	Gravel (3.2- 6.4mm) (34 - 87.5 mbgl)
70    75				Mary many for the state of the		
- - - - 80 - -				What		
- 85 - - -			LOST CIRCULATION: 100% lost circulation- Cavities/ Fractures. No air / water or sample return			End Cap (87.5 mbgl)  Fallback (87.5 - 90 mbgl)

# Depth mbgl

### **Bore Completion Details**

MB17MEH0005

PROJECT: Mesa H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Luke Wallace

**GRID NAME:** MGA94\_50 **EASTING:** 421909.743

**DATE COMMENCED:** 26/08/2017 **DATE COMPLETED:** 27/08/2017

**DRILLING METHOD:** ROTARY HAMMER - AIR

**NORTHING:** 7590687.074 **ELEVATION:** 177.934 mRL TOC

Mud rotary with 12 1/4" drill bit 0-18m for 8" Collar, Air hammer 6 1/2" drill bit from 18-86m (EOH)

HYDROGEOLOGIST: C. Miller

epth nbgl	Geology	Lithology	Lithological Description	Gamma 0-250cps	Field Notes		struction stails
0 5	Alluvium		ALLUVIUM: mixed pisolith, weathered detrital materials and ferrugenous sediments, limonite, GOV and silt and sileous material	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			Bentonite (0-2 mbgl)
10	CID		CID: weathered, limonitic goethite, fine limonite throughout, GOV clasts, weathered limonitic coatings	*			
15			CLAY: Yellow/white clay, highly weathered Shale, competent soapy fragments throughout	Laurent Callery Value of L		× N×N×N× × N×O×O×	8" Blank Steel (0- 18mbgl)
25			BLACK SHALE: Fresh saturated black shale with some pyrite, minor chert bands interbedded	A Verter Just	FWS = 20 mbgl		
35							Gravel (3.2- 6.4mm) (2 - 86mbgl)
40 45	le			Wy	SWL = 40.8 mbgl		
50	Mt. McRae Shale				Final Airlift -		50mm Blank PV( (0-69 mbgl)
55	_			Mary har	Yield - 0.3 L/s pH - 8.1 EC - 839uS/cm Temp - 31.7 C Yields during drilling up		
60			<i>,</i>		to 3L/s from 62mbgl		
65			CHERT: Chert Band- Black/grey hard  BLACK SHALE: Fresh saturated black shale with some pyrite, minor chert bands interbedded, increased fracturing from 70mbgl, larger fragmentation and sample returns with white/ yellow	from hims	Fast penetration rates throughout ~5 rods/hr		
70 75			weathered shale clasts				50mm Slotted PVC (69-81 mbg
30				W. W			PVC endcap (81 mbgl)
85					No reported drilling issues		Fallback (81-86 mbgl)

### **Bore Completion Details**

### **MB17MEH0006**

PROJECT:Mesa HDRILLING COMPANY: BDCGRID NAME:MGA94\_Z50LOCATION:Mesa HDRILLER: Luke WallaceEASTING:422272.376DATE COMMENCED:26/08/2017DRILLING METHOD: Mud Rotary and Air Hammer NORTHING:7590689.111

**DATE COMPLETED:** 28/08/2017 **HYDROGEOLOGIST:** C. Miller **ELEVATION:** 179.201

0-18m Mud Rotary for Collar installation, Air Hammer to EOH 80m

Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-250cps	Field Notes	Construction Details
			CID: Dark grey, medium hard vitreous goethite chip matrix with goethite pisolith and yellow brown limonite clay  TPB: Predominantly highly weathered ochreous and white clay matrix with vitreous goethite pisolith clasts with a property and the leasts with a property and the least section of the le			Bentonite (0-2 mbgl)  8" Blank Steel (0-18mbgl)
- - - 25 - -	Robe Pisolite		mixed with angular- sub angular chert and dolomite fragments thoughout			50mm Blank PVC (0-41 mbgl)
- 30 - - - - 35 -						Gravel (3.2- 6.4mm) (2 - 54mbgl)
- - - - - - - - - - - - - - - - - - -				And the second s	FWS = 38 mbgl  SWL= 41.574 mbgl  Final Airlift - Yield - 3 L/s pH - 8.4 EC - 935 uS/cm	50mm Slotted PVC (41-53 mbgl)
- - - - - - - - - - 55			BLACK SHALE: soft- competent saturated black shale, possibly pyritic with minor chert	Jam Jam Jam	Temp - 30.3 0C Yields during drilling up to 2L/s	PVC endcap (53 mbgl)  Bentonite (54-56 mbgl)
- - - - - - - - - - - - - - - - - - -	Mt Mc Rae Shale			- A hard	Fast penetration rates	Gravel (3.2- 6.4mm) (56-80 mbgl)
- - - - - - - - - - - - - -	Mŧ				throughout ~5 rods/hr	
- - - 80					No reported drilling issues	

### **Bore Completion Details**

MB17MEH0007

PROJECT: Mesa H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Luke Wallace

**GRID NAME:** MGA94\_Z50 **EASTING:** 417658.827 **NORTHING:** 7600422.641

**DATE COMMENCED:** 28/08/2017 **DATE COMPLETED:** 29/08/2017

HYDROGEOLOGIST: C. Miller

**DRILLING METHOD:** Air Hammer

**ELEVATION:** 135.714 mRL TOC

Air Hammer 0-30m Drill bit 6 1/2" from 0-31m. Collar 12 1/4" drill bit from 0-6m.

				_	T	ı
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
0 			COLLUVIUM: red brown ferrugenous silt and sands, with minor clasts of chert, pisolith and dolomite			Bentonite (0-2 mbgl)
- - - -5	) }		ALLUVIUM: increased GOV matrix clasts chips with sub rounded white and grey chert and dolomite			8" Blank Steel (0-6mbgl)
-	· ·		WITTENOOM DOLOMITE: Fractured, slightly weathered crystalline dolomite		SWL = 7.62 mbgl	
— 10 - -					FWS = 12 mbgl	50mm Blank PVC (0-12 mbgl)
15  			WITTENOOM DOLOMITE: Hard fresh crystalline dolomite		Final Airlift - Yield - 1.2 L/s pH - 7.56 EC - 1288 uS/cm Temp - 25 0C	50mm Slotted PVC (12-30 mbgl)
- 20 					Yields during drilling up to 10L/s	Gravel (3.2-
- 25 					Drilling difficult at fracture zone from 10- 14mbgl	6.4mm) (2 - 30mbgl)
- - -30					Drilling in fresh Basement 12m/hr	PVC endcap (30 mbgl)

### **Bore Completion Details**

### **MB17MEH0008**

PROJECT: Mesa H

DRILLING COMPANY: BDC

DOCATION: Mesa H

DRILLER: Luke Wallace

DATE COMMENCED:28/08/2017

DRILLING METHOD: Air Hammer

**EASTING:** 417119.022 **NORTHING:** 7600417.544

**GRID NAME:** MGA94\_Z50

**DATE COMPLETED:** 29/08/2017 **HYDROGEOLOGIST:** C. Miller

**ELEVATION:** 135.477 mRL TOC

Air Hammer drilled 0-6m and installed 8" collar. Air Drilled 6-18 (EOH) using 8 1/2" drill bit

25	≥		1		
Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
		COLLUVIUM: red brown ferrugenous silt and sands, with minor clasts of chert, pisolith and dolomite			Bentonite (0-2 mbgl)
		DOLOMITE: Hard fresh crystalline dolomite			
				SWL = 7.15 mbgl	8" Blank Steel (0-6mbgl)
				Yields during drilling up to 0.5L/s	50mm Blank PVC (0-12 mbgl)
				FWS = 11 mbgl	
				Final Airlift - Yield - 0.5 L/s pH - 7.41 EC - 1288 uS/cm Temp - 24.40C	50mm Slotted PVC (12-18 mbgl) Gravel (3.2- 6.4mm) (2 - 18mbgl)
					PVC endcap (18 mbgl)
	5		COLLUVIUM: red brown ferrugenous silt and sands, with minor clasts of chert, pisolith and dolomite	COLLUVIUM: red brown ferrugenous silt and sands, with minor clasts of chert, pisolith and dolomite	COLLUVIUM: red brown ferrugenous silt and sands, with minor clasts of chert, pisolith and dolomite  DOLOMITE: Hard fresh crystalline dolomite  SWL = 7.15 mbgl  Yields during drilling up to 0.5L/s  FWS = 11 mbgl  Final Airlift - Yield - 0.5 L/s pH - 7.288 uS/cm

# Depth mbgl

### **Bore Completion Details**

**MB17MEH0009** 

PROJECT:Mesa HDRILLING COMPANY:BDCGRID NAME:MGA94\_Z50LOCATION:Mesa HDRILLER:Hayden KentEASTING:416434.642DATE COMMENCED:29/08/2017DRILLING METHOD:Air HammerNORTHING:7599847.256

DATE COMPLETED: 30/08/2017 HYDROGEOLOGIST: C. Miller ELEVATION: 132.316 mRL TOC

Air Hammer drilled 0-5m and installed 8" collar. Air Drilled 5-43 (EOH) using 8 1/2" drill bit

epth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes		struction etails
0 [			COLLUVIUM: red brown ferrugenous silt and sands, with minor clasts of chert, pisolith and dolomite				Bentonite (0-2 mbgl)
5	,				Yields during drilling up to 1.2 L/s SWL = 5.92 mbgl		8" Blank Steel (0-6mbgl)
10					FWS = 11 mbgl		
15				W ***	Final Airlift - Yield - 1.2 L/s pH - 7.27 EC - 1266 uS/cm Temp - 25.80C		
20	\ \ \ \ \					X DX DX DX	
25			DOLOMITE: Hard fresh crystalline dolomite				50mm Blank PVC (0-29 mbgl)
30	* * * * * * * * * * * * * * * * * * * *		DOLOMITE. Hard fresh crystalline dolomite				Gravel (3.2- 6.4mm) (2 - 41mbgl)
35	**************************************						50mm Slotted PVC (29-41 mbgl
40							PVC endcap (41mbgl)
	\$						Fallback (41- 43mbgl)



MB17MEH0011

PROJECT: Mesa H DRILLING COMPANY: BDC LOCATION: Mesa H DRILLER: Hayden Kent

**EASTING:** 414868.454 **NORTHING:** 7596153.963

**GRID NAME:** MGA94\_50

DATE COMMENCED: 24/10/2017
DATE COMPLETED: 29/10/2017

DRILLING METHOD: Air HammerNORTHING:7596153.963HYDROGEOLOGIST: Yuot AlaakELEVATION:166.313 mRL

Air hammer drilled 0-4m with 12 1/4" drill bit, 8" steel collar installed 0-3m. Air hammer drilled 0-62m with 7 1/2" drill bit. Fallback 59-62m.

Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes		struction etails
0  		00000	CID: TPH- Vitreous goethite with limonitic goethite, blue and brown, medium hardness, moderate weathering, angular to sub angular, fine gravel. Infilled with goethitic silt and sand.	May Cont			Bentonite Seal (0-2 mbgl)  Blank Steel (0-4
-5 - - - - - 10 - -				January Marina		KXKXKXKXKX KXKXXXXXXXXXXXXXXXXXXXXXXXX	mbgl)
15     20 	CID			La Morando Maria			Gravel (3.2- 6.4mm)(2-59mbgl)
- - - 25 - - -		000000000000000000000000000000000000000	CID: Same as above with massive ocherous goethite 20-26m, less weathered 26-30 with large goethite pisolites in silt. 20-26m is predominantly silt and sand at 70%.			N N N N N N N N N N N N N N N N N N N	
- 30 - - - - - - 35			VOID: Cavity, no sample return from 30m.				50mm Blank PVC (0-47 mbgl)
- - - 40 - - -							
45   	Cavity						50mm Slotted PVC (47-59 mbgl)
50    55					SWL = 49.85mbgl		SWL = 49.85mbgl
							End Cap (59mbgl)
- 60 -							Fallback (59- 62mbgl)

### **Bore Completion Details**

MB17MEH0012

PROJECT: MESA H DRILLING COMPANY: BDC LOCATION: Mesa H DRILLER: Hayden Kent

**GRID NAME:** MGA94\_50 **EASTING:** 414881.979

**DATE COMMENCED:**25/10/2017 **DATE COMPLETED:** 28/10/2017

**DRILLING METHOD:** Rotary Hammer - Air

**NORTHING:** 7596152.854 **ELEVATION:** 166.430 mRL TOC

DATE COMPLETED: 28/10/2017 HYDROGEOLOGIST: Yuot Alaak ELEVATION: 166.430 mRL

Air drilled 0-40m using a 13 3/4" drill bit and 10" collar installed 0-40m. Air drilled 0-116m (EOH) using a 8 1/2" drill bit.

	Geology	Lithology	Lithological Description	Gamma 0-50cps	Field Notes	Construction Details
0 5 10	)		TPH: Bright to darkish yellow predominantly orcherous goethite, medium weathered and medium hardness, angular to sub-angular, 10-20% sand infills	What water was		Headworks  C  10" Blank Steel (0-40mbgl)
15 20 25 30	CID			Manyorana		WAXAXAXAX XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
- 35 - 35 - 40	CID		TPM: Moderately weathered yellow orcheous goethite at 70%, with trace limnonite towards end of interval, slighly less weathered than interval above.  5 %vitreous goethite fine gravel and silt towards end of hole	W. J. Hally J. M. J. C.		50mm Blank PVC (0-56 mbgl)
- - - - - - - - - - - - 50 - - - - - - -			MARRA MAMBA: Cherty marra mamba bifs with 20% silt infill, slightly weathered, angular to sub-angular, moderately fractured, hard to medium hard rock. 54-72 as above but more fractured and slightly less weathered, can be described as fresh marra mamba bif	Annual May hallowayer son	SWL = 49.95 mbgl FWS = 55 mbgl	(40-44mbgl)
- - - - - - - - - - - - - - - - - - -	BIF			Marin Mayor Marin	1 W3 = 33 mbgi	6.4mm) (0 - 40, 44 - 116 mbgl)
70  75 		*** *** *** ***	MARRA MAMBA: Shalley marra mamba bifs with chert bands and trace goethite with sand and silts infills	Jamy Jamy Am		50mm Slotted PVC (56-80 mbgl)
80 85 85 90	BIF	**************************************		Mummond more	Airlift Yield - 2 L/s	PVC endcap (80 mbgl)
95 - - - - - - - 100				Warmy Now Apple		
105 - 110 - 110	BIF		MARRA MAMBA: Fresh marra mamba bif composed mostly of cherts and shales, with predominantly high and silt content and trace quartz. highly fractured with angular to sub-angular ships upto 3.5cm	The street of th		
115						



MB17MEH0013

PROJECT: MESA H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Hayden Kent

**GRID NAME:** MGA94\_50 **EASTING:** 418380.559

DATE COMMENCED: 30/10/2017
DATE COMPLETED: 1/11/2017

DRILLING METHOD: Rotary Hammer - Air
HYDROGEOLOGIST: Yuot Alaak

**NORTHING:** 7599440.612 **ELEVATION:** 136.493 mRL

Air rotary drilled 0-12m using a 13 3/4" drill bit and 8" collar installed 0-12m. Air Rotary drilled 0-43m (EOH) using a 6 1/2" drill bit.

		drill	DIL.			
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
	/IALS		FILL: Tertiary alluvials composed of gravels@90 and silts and sands at 10%. Gravel size to 30 cm, moderately weathered.			Bentonite (0-2 mbgl)  8" Blank Steel (0-12mbgl)
- - - 10 - -	ALLUVIALS				SWL = 7.03 mbgl FWS = 12 mbgl	50mm Blank PVC (0-12 mbgl)
— 15 - - -			DOLOMITE: Whitnoom dolomite, largely chrstalline with interbedded layers of moderately fractured zones. 18-22m moderately fractured zone with significant water strike @ 6-8 L/s, 32-36 moderately fractured but no visible increase in water flow			
20 - - - - - 25	* - * - * - * - * - * - *				Airlift Yield - 3.5 L/s pH - 7.59 EC - 1167 uS/cm Temp - 26.7 C	Gravel (3.2- 6.4mm) (2 - 43mbgl)
- - - 30 -	DOLOMITE					50mm Slotted PVC (12-42 mbgl)
- - 35 - -						
- 40 - -	* - * - * - * - *					PVC endcap (42 mbgl)  Fallback (42-43 mbgl)

### **Bore Completion Details**

MB17MEH0014

PROJECT: MESA H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Luke Wallace

**GRID NAME:** MGA94\_50 **EASTING:** 418723.950

**DATE COMMENCED:**27/10/2017 **DATE COMPLETED:** 29/10/2017

**DRILLING METHOD:** Rotary Hammer - Air

**HYDROGEOLOGIST:** Yuot Alaak

**NORTHING:** 7599428.420 **ELEVATION:** 137.609 mRL TOC

Mud drilled 0-18m using a 13 3/4" drill bit and 8" collar installed 0-18m. Air Rotary drilled 18-43m (EOH) using a 6 1/2" drill bit.

<u> </u>						
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
0  			ALLUVIUM: Tertiary alluvials (gravels) upto 3cm. Medium weathered with silt and clay infills			Bentonite (0-2 mbgl)  8" Blank Steel (0-
- 5 -	ALLUVIALS					18mbgl)
- 10 					SWL = 8.09 mbgl	50mm Blank PVC (0-18 mbgl)
- - - - 15 - -	ALLUVIALS		ALLUVIUM: Tertiary gravels in 50% clay matrix. medium plasticity with trace tertiary clays		FWS = 12 mbgl	A S S S S S S S S S S S S S S S S S S S
- 20		000	CID: Vitrous goethite CID with silt infill upto 30%, blue		Airlift Yield - 2 L/s pH - 8.75	Gravel (3.2- 6.4mm)
-	CID		to brown, with a medium weathered profile		EC - 1375 uS/cm Temp - 27 C	(2 - 43mbgl)
— 25 - - -			DOLOMITE: Whitnoom dolomite 22-24 is fractured slightly. slightly weathered sequence to end od hole, tiny particle sizes, more competent during drilling from 39m but no evidence of freash chrstalline doomite in the chips samples. Angular to Sub-angular			
— 30 – –	ITE					50mm Slotted PVC (18-42 mbgl)
- - 35 - - -	DOLOMITE					
- 40				}		PVC endcap (42 mbgl)
						Fallback (42-43 mbgl)

### **MB17MEH0015**

PROJECT: Mesa H LOCATION: Mesa H

DATE COMMENCED:2/11/2017

**DRILLING COMPANY: BDC** DRILLER: Manu Rekena **DRILLING METHOD:** Mud

**EASTING:** 416044.945 **NORTHING:** 7597712.125

**GRID NAME:** MGA94\_50

HYDROGEOLOGIST: Nik Adam DATE COMPLETED: 3/11/2017

**ELEVATION:** 132.935

Mud Drilled 0-3m with 12 1/4" drill bit, collar installed 0-3m. Mud drilled 0-37m with 8 1/2" drill bit.

				1		
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
			ALLUVIUM: Dark red ferrugenous sand and clay with brown, sub rounded chert fine gravel.  40% Dark red ferrugenous fine to medium grain sand, completely weathered. 40% Brown and yellow chert, fine gravel, sub rounded and very hard. 20% red clay.		SWL = 8.7mbgl EC: 1130uS/cm	Blank Steel (0-3 mbgl)  Blank PVC (0-12 mbgl)
_ - - - 15 - - - -	Alluvium		ALLUVIUM: Dark red ferrugenous clay and sand with minor sub rounded chert. Clay content decreases with depth.  60% red ferrugenous clay, highly weathered and high plasticity. 20% red fine grain sand. 20% sub rounded brown chert, very hard, highly weathered.		pH: 7.92 Temperature: 34.2C	Slotted PVC (12-30 mbgl)
- - - - - 25 - -			ALLUVIUM: Dark red ferrugenous sand with a reduction in clay content.			Gravel (2-37 mbgl)
- 30 - 30 35	BIF		BIF: Slightly weathered bedrock cherty BIF, dark blue, magnetic, very hard.			No End Cap

# Depth mbgl

### **Bore Completion Details**

WB17MEH0001

PROJECT: MESA H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Hayden Kent

**GRID NAME:** MGA94\_50 **EASTING:** 418857.053 **NORTHING:** 7598693.336

DATE COMMENCED: 23/08/2017

DATE COMPLETED: 25/08/2017

**DRILLING METHOD:** Mud Rotary **HYDROGEOLOGIST:** C. Miller

**ELEVATION:** 139.413

Mud rotary with 17 1/2" Drill bit from 0-46m, No collar installed.

Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-25cps	Field Notes	Construction Details
-0			ALLUVIUM: Mixture of Red brown ferrugenous silts and sands (0-4m) decreasing content with depth. Sub-rounded vitreous goethite and goethitic pisolith, increasing content with depth. Chert and white quartz up to 15mm, angular and sub-rounded jasperlite. BIF and dolomite moderately weathered, unconsolidated throughout.		SWL = 8.8 mbgl	No collar- too shallow  12" Blank Steel threaded casing (0-10 mbgl)
- 15 - 20	Alluvium		DETRITALS: Detritals pisolith, predominantly vitreous goethite content as above with less Chert, BIF, Dolomite content with increased weathering.		Final Airlift - Yield - 10 L/s pH - 8.0 EC - 969 uS/cm Temp - 31.8 0C	12"Slotted Steel Threaded Casing (10-28 mbgl)  Gravel (3.2- 6.4mm)
- 25			ALLUVIUM: As above, with increased white, yellow clay content 20-30% and less vitreous goethite, mixed with chips of moderately to highly weathered Dolomite, BIF and chert.			(0 - 30mbgl) and (33-46 mbgl)
- 30			CLAY: >80% white, yellow clay, highly plastic, with clasts of BIF, Dolomite, chert and goethite.  WITTENOOM DOLOMITE: Grey mudstone, with white, yello clay pods, minor interbedded content of moderate to highly weathered, angular to subrounded dolomite.	M		Bentonite (30 - 32 mbgl)
- 35	ormation		WITTENOOM DOLOMITE: As above, contaminated with Alluvials			12" Blank Steel threaded casing (28-40 mbgl)
- 40	Wittenoom Formation		WITTENOOM DOLOMITE: hard - slightly weathered, sub-angular crystalline dolomite and chert.			End Cap (40 mbgl)
- 45 -			Contaminated with Alluvials. Slow drilling			No fallback

**WB17MEH0002** 

**ELEVATION:** 139.413 mRL TOC

PROJECT: Mesa H **DRILLING COMPANY: BDC** LOCATION: Mesa H

GRID NAME: MGA94\_50 **DRILLER:** Joe Mason **EASTING:** 418711.747

**DATE COMMENCED:**31/10/2017

DRILLING METHOD: Mud 0-30m, Air 30-50m. NORTHING: 7599423.723

**DATE COMPLETED:** 3/11/2017 HYDROGEOLOGIST: Nik Adam/Casey Miller

Mud drilled using 22" drill bit from 0-30m, collar installed 0-16m. Air Drilled from 30 -50m EOH.

pth bgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
			ALLUVIUM: 90% Chert and BIF, blue, red and brown, rounded, medium to coarse gravel grain size, very hard hardness, highly weathered. 10% Goethite, red, fine grain sand, completely weathered.  ALLUVIUM: 95% Chert and BIF with minor Goethite	W.\~\		Bentonite (0 - 2 mbgl)
	,		and Vitreous Goethite, blue, red and brown, angular to sub angular, fine to medium gravel, hard hardness, highly weathered. 5% Goethite, red brown, fine grain sand, completely weathered.		SWL = 7.36 mbgl	15 5/8" Blank Steel (0-16 mbgl
0	Alluvium			~~~~~~	Final Airlift - 2-5L/s, surging with 3 to 4 seconds break between surges. pH - 8.75 EC - 1350uS/cm Temp - 27C	Blank Steel (0-16 mbgl)
5	A				Tomp 170	Slotted Steel (16: 34 mbgl)
0			ALLUVIUM: 70% Chert and BIF with minor Goethite and Vitreous Goethite, white, red brown, blue, angular to sub angular, fine to medium gravel, hard hardness, highly weathered. 10%Goethite, red brown, fine grain sand, completely weathered. 10% White clay and 10% Limonitic Goethite clay.	Jay May May May May		
5			CONGLOMERATE: Chert and BIF, blue, red brown, medium to coarse gravel, well rounded, very hard,			
0			highly weathered.  CONGLOMERATE: Chert, Quartz and BIF, blue, red brown, sub angular to well rounded, fine to medium gravel, hard, highly weathered.			
5	Conglomerate		DOLOMITE: 55% Cherty Dolomite, dark blue, fine grain gravel, angular to sub angular, very hard. 30% Chert and BIF, blue, red brown, sub angular to well rounded, fine to medium gravel. 15% Black shale, black coating over all the grains. Black water discharged from air drilling.	A Alama		Bentonite Seal (34-36 mbgl)  Blank Steel (34- 40mbgl)
0						End Cap (40 mb)
5	ite		DOLOMITE: 70% Cherty Dolomite, dark blue, angular, very hard, fine gravel. 20% Black shale that coats all of the grains.10% Quartz, blue and white, angular to sub angular, fine to medium gravel, hard (Probably contamination).	~~A		
	Cherty Dolomite		DOLOMITE: Fresh Cherty Dolomite bedrock, dark blue, no shale present.			

# **Bore Completion Details**

**WB17MEH0003** 

PROJECT: Mesa H **DRILLING COMPANY: BDC** LOCATION: Mesa H DRILLER: Manu Rekena

**GRID NAME:** MGA94\_50 **EASTING:** 416059.508

**DATE COMMENCED:**04/11/2017 **DATE COMPLETED:** 11/11/2017

DRILLING METHOD: Mud Rotary 0-36m **HYDROGEOLOGIST:** Nik Adam

NORTHING: 7597705.964 ELEVATION: 132.438 mRL

Mud drilled using 22" drill bit from 0-2m, collar installed 0-2m. Mud Drilled using 17 1/2" drill bit from 0-36m EOH.

0		IVIUO	d drilled using 22" drill bit from 0-2m, collar installed	0-2m. Mud D	rilled using 17 1/2" drill	DIT From 0-36m EOH.
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
-0			ALLUVIUM: Predominantly highly weathered red brown chert with minor quartz and goethite.  75% chert, red brown, angular to sub rounded, fine to medium gravel, hard, highly weathered. 15% Goethite, yellow, angular to sub angular, fine to medium gravel, hard. 10% quartz, white, angular to sub angular to sub angular to sub angular.	Cylling Live		Blank Steel (0-2 mbgl)  Bentonite (0 - 2 mbgl)
10			sub angular, fine to medium gravel, hard.	m hay yang m	SWL = 8.46 mbgl	
15	Alluvium		ALLUVIUM: Highly weathered, dark red brown clay and sand with minor chert and goethite clasts.  40% Clay, red brown, high plasticity, soft. 40% red brown, fine grain sand. 10% chert, dark green and blue, angular to sub angular, fine gravel, hard. 10% vitreous goethite, dark blue and red, angular to sub angular, fine gravel, hard.	MMW Joyn John John	Final Airlift - 6L/s pH - 7.82 EC - 1108 mS/cm Temperature - 30.2C	Blank PVC (0-18 mbgl)
20			ALLUVIUM: Highly weathered red brown clay with a high proportion of chert, goethite and quartz clasts.  50% clay, red brown, medium plasticity. 50% alluvium consisting of quartz, chert and goethite, white, dark blue and red, angular to sub angular, fine gravel, hard.	Leany Arrive		Slotted PVC (18- 30 mbgl)
25			ALLUVIUM: Moderately weathered chert, goethite and quartz, dark blue and white, angular to sub angular, fine to medium gravel, hard.	W WWW. MW DW.		
30	Cherty BIF		BIF: Slightly weathered cherty BIF, magnetic, fractured, dark blue, platy, very hard. Problems drilling past 32m with the drill stopping on numerous occassions.	Maryhamy		Blank PVC (30-36 mbgl)
· 35						End Cap (36 mbg



# **Bore Completion Details**

WB17MEH0004

**GRID NAME:** MGA94\_50

PROJECT: MESA H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Joe Mason

**EASTING:** 418388.056 **NORTHING:** 7599451.981

**DATE COMMENCED:** 7/11/2017 **DATE COMPLETED:** 10/11/2017

DRILLING METHOD: Mud Rotary
HYDROGEOLOGIST: Yuot Alaak

**ELEVATION:** 136.356 mRL BTOC

Mud rotary with 22" Drill bit from 0-7m, Installed 20" collar 0-7m. Mud drilled 7-50m using 17 1/2" drill bit. Threaded casing used by BDC.

	used by BDC.							
Depth mbgl	Geology	Lithology	Lithological Description	Lithological Description  Gamma 0-100cps  Field Notes				
	CID		CID: channel iron deposits composed largely of geothite, moderartely weathered with 10% silt infills	M	SWL = 6.86 mbgl	Bentonite Seal (0 2mbgl)  20" Collar (0-7m)  12" Blank Steel		
- 10 - 10 15	Wittenoom Formation		DOLOMITE: blue to light blue whitnoom formation dolomite with chert interbeds, moderately weathered with visible clay in the chips, most probably from a thin clay band	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Final Airlift - Yield - 12 L/s pH - 7.92 EC - 1180 uS/cm Temp - 24 0C	threaded casing (0-10mbgl)		
- - - - - - 20	Witten		DOLOMITE: moderately weathered whitnoom			12" Slotted Steel Threaded Casing (10-40 mbgl)  Gravel (3.2-6.4mm)		
- - - 25 - -			formation dolomite, light blue to dark blue with chrystalline interbeds, moderately fractured 20-24m			6.411111) (2 - 50mbgl)		
- 30 	Wittenoom Formation							
- - - 40 - -	Witte					12" Blank Steel threaded casing		
- 45 - - - - - - 50						End Cap (46mbg)		

# RioTinto

# **Bore Completion Details**

**WB17MEH0005** 

PROJECT: Mesa H

DRILLING COMPANY: BDC

LOCATION: Mesa H

DRILLER: Hayden Kent

**GRID NAME:** MGA94\_50 **EASTING:** 421699.218

DATE COMMENCED: 14/11/2017

DATE COMPLETED: 19/11/2017

DRILLING METHOD: Mud Rotary 0-106m

**NORTHING:** 7590927.611 **ELEVATION:** 175.267 mRL TOC

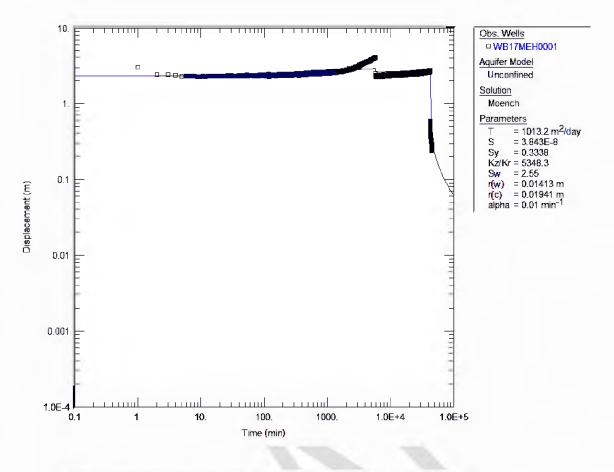
Mud drilled using 22" drill bit from 0-2m, collar installed 0-2m. Mud Drilled using 17 1/2" drill bit from 0-106m EOH.

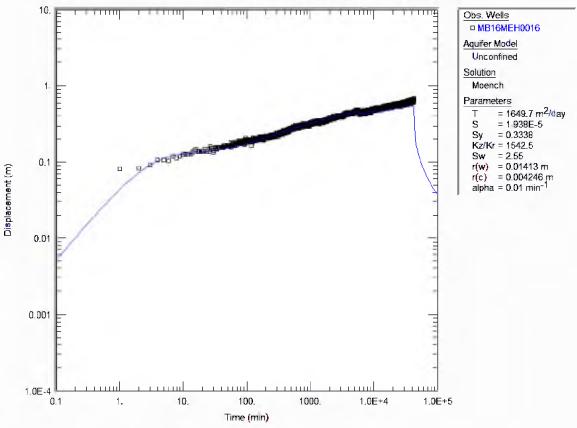
**HYDROGEOLOGIST:** Nik Adam

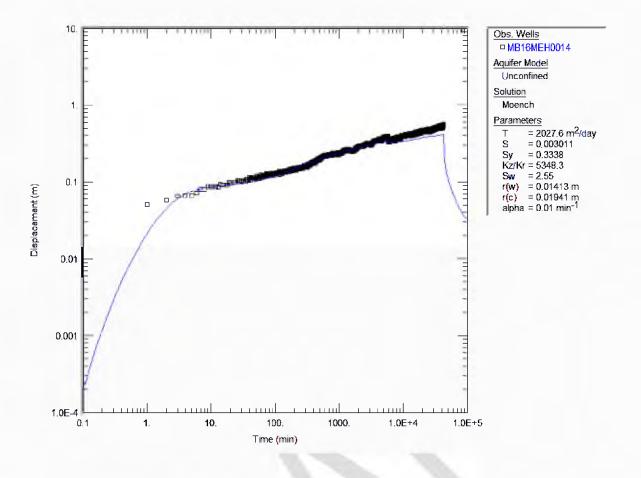
<u> </u>						
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-200cps	Field Notes	Construction Details
0     5  			CID: Highly weathered CID comprised of red brown vitreous goethite, yellow brown goethite, white quartz, dark blue chert, angular to sub angular, fine gravel, hard. Minor red clay.	All Jahrana		Bentonite (0 - 2 mbgl) 20" Blank Steel (0-2 mbgl)
10 10 	CID		CID: Moderately weathered CID with higher vitreous goethite % and lower quartz and chert, than above.			
15 15 		000	CID: Moderately weathered yellow orcherous goethite with red brown vitreous goethite and yellow brown goethite.	7		
— 20 - - - - - - - 25			40% orcherous goethite clay with high plasticity. 30% Goethite, yellow brown, angular to sub angular, fine gravel, medium hardness. 20% Vitreous goethite, red brown, angular to sub angular, fine gravel.	WW V Property		
30			CID: Moderately weathered CID with higher vitreous goethite % than above.	M. A.		Gravel (2-
- - - - 35 - -			CLAY: Modertaely weathered white clay with high plasticity. Minor vitreous goethite, red brown, angular to sub angular, fine gravel.	American COMM-M	Final Airlift - 36L/s	104mbgl)
- 40  	ıale		SHALE: Black shale with high plasticity and minor white clay.		SWL = 40.6 mbgl	
- 45 - -	Black Shale			May A		
50 				~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		12" Blank Steel (0- 74 mbgl)
55  				The state of the s		
-    				Supple of the second		
 65  			BIF: Fresh cherty BIF interbedded wtih black shale.  85% Cherty BIF, dark blue, angular, very hard,	A MANA		
- 70  -	BIF		magnetic. 15% Black shale with high plasticity.	J.W.J.w.A		
- 75 - -	Cherty			W. W.		
- - - - -				100 Jay		12" Slotted Steel (74-98 mbgl)
- 85 	avit		VOID: Cavity	\$ A		
- - - 90 -			LOST CIRCULATION: No sample returns after cavity intersected.	Monday		
- - 95 - -	Circulation			\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		
_ 100 	Loss (			Japan Jan		12" Blank Steel (98-104 mbgl)
_ _ 105				7	Fall Back 104-106mbgl	End Cap 104mbgl

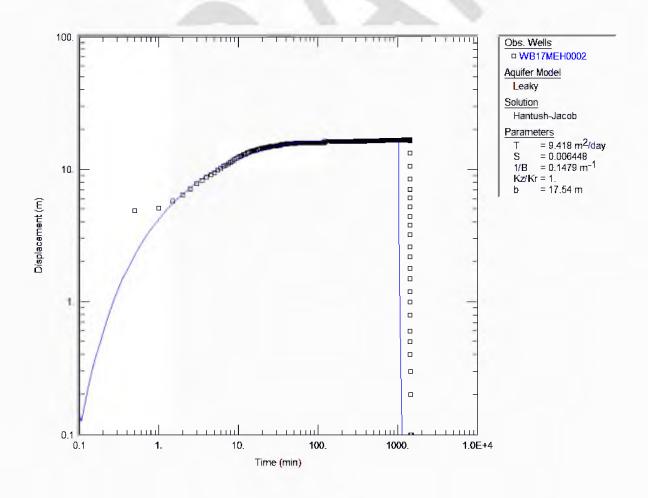
# **Appendix B - Constant Rate Test Analysis**

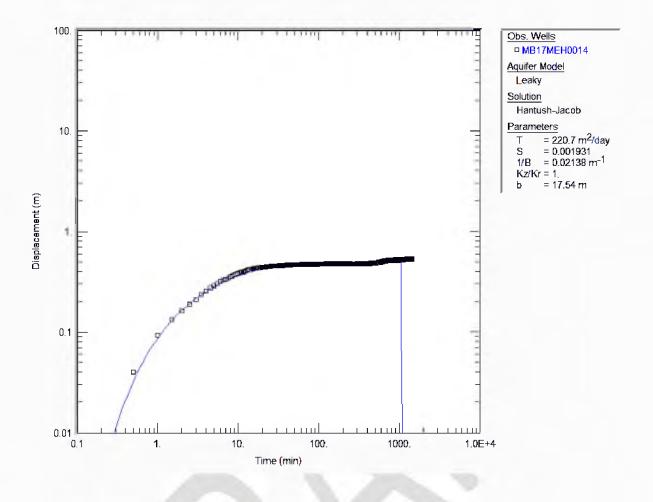


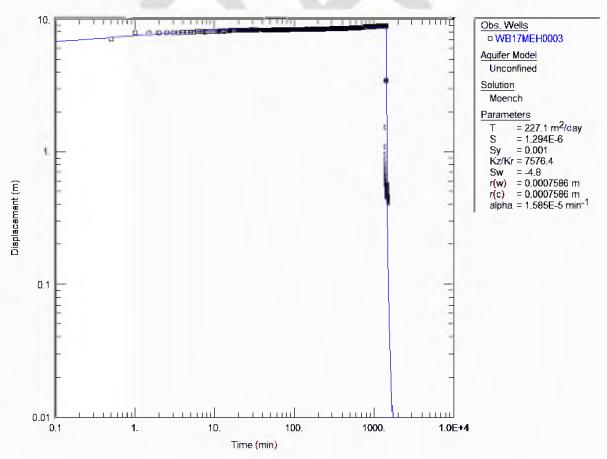


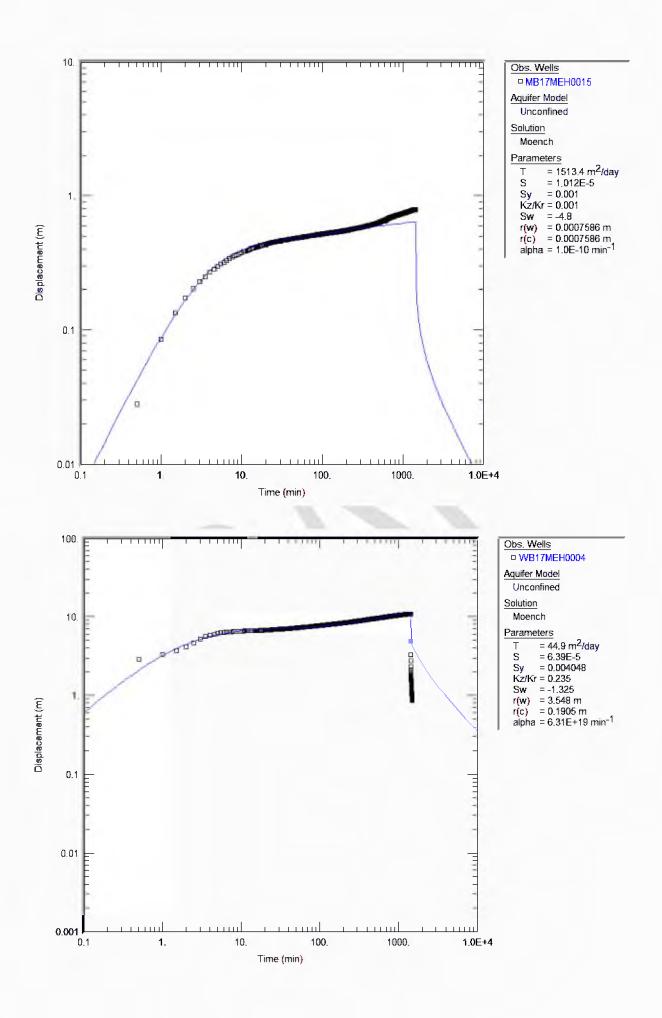


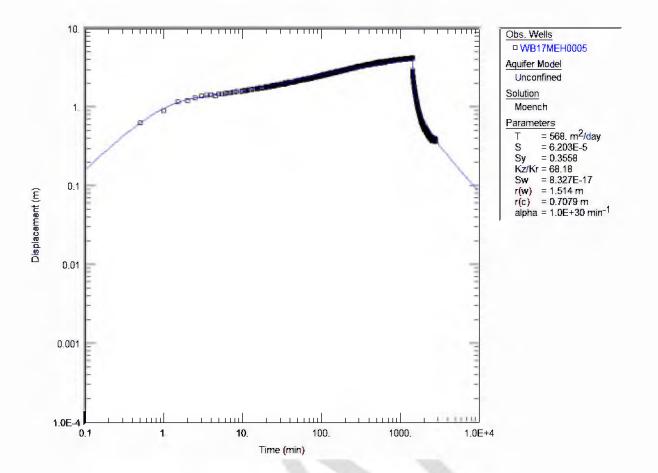














# Rio Tinto Iron Ore Hydrogeology – Mesa J Mine Site

Mesa H 2016 Pre-Feasibility Study Hydrogeological Drilling Program Completion Report

May 2016



## **EXECUTIVE SUMMARY**

This report presents drilling and construction details for works completed as part of the Mesa H Pre-Feasibility Study (PFS). The works were carried out by Bunbury Drilling, Ranger Drilling and McArthur Drilling and Test Pumping between the 8<sup>th</sup> of February and the 25<sup>th</sup> of March 2016.

Four production bores were drilled using mud rotary drilling techniques and constructed with 12" blank and slotted steel casing. The production bores were subsequently test pumped including a step test, a constant rate test and a recovery test.

A total of three nested monitoring bores and twelve single monitoring bores were constructed. All monitoring bores were cased with 50 mm blank and slotted Class 18 PVC. The nested monitoring bores and one of the monitoring bores were drilled using the air-hammer method, with all remaining monitoring bores drilled using reverse circulation (RC). All holes were logged by a supervising Hydrogeologist and a downhole geophysical survey was conducted on each bore. Water samples were collected from each production bore at the completion of the test pumping and submitted for laboratory chemical analysis.

Drilling results helped define the extent of the Robe Pisolite (CID) underneath the Robe River alluvium, identify the Paraburdoo Member and the Bee Gorge Member of the Wittenoom Formation as local aquifers and at the same time classify the unmineralised BIF (whenever underlying the CID) as an aquitard.

The basal CID has horizontal continuity throughout the deposit, with an average thickness of 20 metres and continuing underneath the Robe River alluvium (Robe River Aquifer) to the north and potentially works as a partial boundary limiting the hydraulic connection between the CID and Wittenoom aquifer.

The Robe River aquifer has a saturated thickness of approximately 20 meters consisting of highly permeable and low storage quaternary sediments with a shallow water table. Drawdown response during the long term test pumping suggests potential hydraulic connection between this aquifer and the CID aquifer.

This work aimed to support the development of a conceptual model to predict the dewatering requirements and impacts of future dewatering activities, particularly in relation to the pools and riparian vegetation associated with the Robe River.

# **Project Details**

Project Name:	Mesa H 2016 Pre-Feasibility Study Hydrogeological Drilling Program
Business Unit:	Orebody Knowledge and Planning
Project Sponsor:	Darren Sharp
Project Manager:	Alexandre Russo

# **Document Version Control**

Document Name:	Mesa H 2016 Pre-Feasibility Study Hydrogeological Drilling Program Completion Report					
D						
Document Status:	Draft					
Version No.:	Rev 3					
File Name:						
Date:	April 2016					

# **Revision History**

Version	Revision Date	Author(s)	Revision Notes
0	20/03/16	Ashley Price	preliminary drilling report
1	15/04/16	Alexandre Russo	factual data and findings
2	25/04/16	Cally Sibley	added test pumping results
3	17/05/16	Shane Trott	1 <sup>st</sup> revision
4	18/05/16	Wade Dodson	2 <sup>nd</sup> revision

# **Document Acceptance**

Name	Title	Date	Signature
Shane Trott	Superintendent Hydrogeology		
Wade Dodson	Principal Hydrogeology		
Darren Sharp	Manager WRE&S		

# **Document Distribution**

Name	Title	Date
Jeremy English	Mesa H Study Manager	
Keith Brown	Superintendent Numerical Models	
Eddie Lee	Specialist Numerical Models	

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### **APPENDICES**

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APPENDIX F WATER TABLE CONTOUR MAP

### SECTION 1 - INTRODUCTION

### 1.1 PROGRAM DESCRIPTION

Hydrogeological drilling works were required at Mesa H in 2016 as part of the Pre-Feasibility Study (PFS) for the development of the proposed mine. Approximately 13% of the orebody occurs below the current water table (already depressed due to dewatering activities at the nearby Mesa J mine). As such, work is required to determine the likely dewatering requirements and impacts of future dewatering activities, particularly in relation to the pools and riparian vegetation associated with the Robe River.

The original program scope comprised:

- Drilling, installation and testing of four production bores to enable advancement of the conceptual hydrogeological model;
- Drilling and installation of ten single monitoring bores and six nested monitoring bores (comprising one shallow and one deep installation) across the site;
- Test pumping of all installed production bores including step drawdown test, constant rate test and recovery; and
- Groundwater sampling of all installed production bores.

Before earth works and drilling commenced Approvals Requests (AR-15-13678A and AR-15-13678B) were authorised to carry out the work, as part of this process a 26D license (CAW182227) was obtained to install four production bores during the drilling program.

### SECTION 2 - DRILLING & BORE CONSTRUCTION

### 3.1 DRILLING CONTRACTS

Bunbury Drilling Pty Ltd (BDC) and Ranger Drilling Pty Ltd (Ranger) were commissioned to carry out the 2016 Mesa H PFS Hydrogeological Drilling Program. Drilling was managed by the Rio Tinto Water Resource Evaluation and Services group (WRE&S). The program was undertaken between February and March 2016.

### 3.3 DRILLING AND CONSTRUCTION

Single well monitoring bores were drilled using reverse circulation (RC) drilling methods, nested monitoring bores were drilled using air-hammer and production bores were drilled using mud rotary techniques. Production bores were constructed with 12" blank steel and slotted steel casing.

Monitoring bores were constructed using blank and slotted 50mm Class 18 PVC casing with bentonite seals placed to isolate the deep and shallow installations. All bores were gravel packed using graded 3.2 - 6.4 mm gravel with headworks completed as per the Rio Tinto Design Specification for Water and Monitoring Bore Headworks (RTIO-PDE-0089729), as follows:

### Production bores:

- o 12" steel casing stick-up above the top of the plinth;
- Lockable steel lid with handle;
- Stick up and lid painted white;
- Concrete plinth measuring 1 m<sup>2</sup> by 300 mm high (100 mm set below natural ground level).

### Monitoring bores:

- Steel casing stick-up 500 mm above the top of the plinth;
- o PVC stick-up 350 mm above the top of the plinth and fitted with a PVC cap;
- Lockable steel lid with handle;
- o Concrete plinth measuring 1 m<sup>2</sup> by 300 mm high (100 mm set below natural ground level).

Bore details are provided in Tables 1 (locations), 2 (construction details) and 3 (water levels/airlift yields), and Figure 1 shows the bore locations in relation to the Order of Magnitude (OoM) pit design (mesa\_h\_opt2\_pit\_rev4\_mga). Bore logs and individual bore completion reports are presented in Appendices A and B respectively.

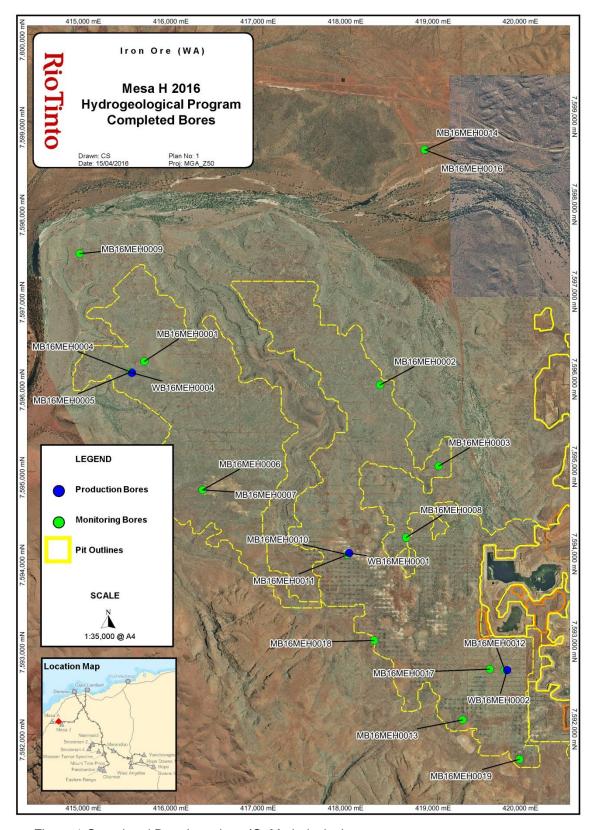


Figure 1 Completed Bore Locations (OoM pit design)

Table 1 Bore Locations

Bore ID	Peg ID	Surveyed Easting (MGA)	Surveyed Northing (MGA)	Surveyed TOC m RL (m AHD)	Surveyed GL m RL (m AHD)
			Monitoring Bores		
MB16MEH0001	16MEH_M16	415648.30	7596263.24	166.52	166.06
MB16MEH0002	16MEH_M08	418342.63	7595994.38	167.57	167.11
MB16MEH0003	16MEH_M07	419013.90	7595067.08	175.67	175.09
MB16MEH0008	16MEH_M06	418640.88	7594248.67	160.24	159.49
MB16MEH0009	16MEH_M09	414906.39	7597496.70	161.91	161.12
MB16MEH0012	16MEH_M01	419768.32	7592737.21	165.22	164.50
MB16MEH0013	16MEH_M04	419286.91	7592165.60	183.13	182.45
MB16MEH0014	16MEH_M11	418861.54	7598680.02	139.33	138.77
MB16MEH0015	16MEH_M11	Hole aba	andoned and not constructed d	ue to surface casing blowout and h	ole collapse
MB16MEH0016	16MEH_M11	418854.63	7598682.99	139.435	138.88
MB16MEH0017	16MEH_M13	419597.88	7592744.90	165.684	165.03
MB16MEH0018	16MEH_M05	418273.51	7593072.81	168.337	167.55
MB16MEH0019	16MEH_M03	419938.38	7591715.26	178.53	177.85
		Ne	ested Monitoring Bores		
S: MB16MEH0004 D: MB16MEH0005	16MEH_M15	415490.51	7596140.85	S: 165.24 D: 165.31	164.50
S: MB16MEH0006 D: MB16MEH0007	16MEH_M02	416312.82	7594795.87	S: 170.5 D: 170.11	169.46
S: MB16MEH00010 D: MB16MEH00011	16MEH_M14	417971.10	7594055.67	S: 174.96 D: 175.08	174.40
			Production Bores		
WB16MEH0001	16MEH_P02	417990.96	7594070.94	175.24	174.93
WB16MEH0002	16MEH_P01	419797.07	7592735.16	165.03	164.52
WB16MEH0003	16MEH_P03	416321.85	7594781.07	170.06	169.69
WB16MEH0004	16MEH_P04	415504.09	7596133.77	164.90	164.49

Key: S: shallow monitoring bores, D: deep monitoring bores

Table 2 Construction Details

Bore ID	Peg ID	Actual Start Date	Completion Date	Actual Drilled Depth	Cased Depth	Casing Details	Bore Type	Drilling Method	Collar Casing Diameter (mm)	Cased Collar Depth (m bgl)	Hole Diameter (mm)	Slotted Interval (m bgl)
					Monitor	ing Bores				, J		
MB16MEH0001	16MEH_M16	8/02/2016	10/02/2016	64	64	50mm PVC	MB: Single	RC	150	5	140	52 - 64
MB16MEH0002	16MEH_M08	10/02/2016	11/02/2016	80	74	50mm PVC	MB: Single	RC	150	5	140	56 - 74
MB16MEH0003	16MEH_M07	12/02/2016	14/02/2016	84	84	50mm PVC	MB: Single	RC	150	5	140	66 - 84
MB16MEH0008	16MEH_M06	15/02/2016	16/02/2016	58	58	50mm PVC	MB: Single	RC	150	5	140	40 - 58
MB16MEH0009	16MEH_M09	16/02/2016	17/02/2016	52	82	50mm PVC	MB: Single	RC	150	5	140	34 - 52
MB16MEH0012	16MEH_M01	18/02/2016	22/02/2016	49	47	50mm PVC	MB: Single	MR	250	8	216	35 - 47
MB16MEH0013	16MEH_M04	22/02/2016	23/02/2016	76	76	50mm PVC	MB: Single	RC	150	4	140	64 - 76
MB16MEH0014	16MEH_M11	18/02/2016	18/02/2016	64	64	50mm PVC	MB: Single	RC	150	5	140	40 - 64
MB16MEH0015	16MEH_M11	19/02/2016	19/02/2016	40		Hole abandon	ed and not o	constructed du	e to surface c	asing blowout	and hole colla	pse
MB16MEH0016	16MEH_M11	19/02/2016	20/02/2016	30	30	50mm PVC	MB: Single	RC	150	5	140	6 - 24
MB16MEH0017	16MEH_M13	20/02/2016	22/02/2016	76	50	50mm PVC	MB: Single	RC	150	8	140	32 - 50
MB16MEH0018	16MEH_M05	23/02/2016	23/02/2016	52	48	50mm PVC	MB: Single	RC	150	5	140	36 - 48
MB16MEH0019	16MEH_M03	23/02/2016	24/02/2016	70	64	50mm PVC	MB: Single	RC	150	5	140	40 - 64
				Ne	ested Mon	itoring Bores						
S: MB16MEH0004 D: MB16MEH0005	16MEH_M15	15/02/2016	16/02/2016	76	S: 60 D: 78	50mm PVC	MB: Nested	СН	250	6	216	S: 48 – 60 D: 66 – 78
S: MB16MEH0006 D: MB16MEH0007	16MEH_M02	14/02/2016	29/02/2016	74	S: 40 D: 76	50mm PVC	MB: Nested	СН	250	6	216	S: 28 - 40 D: 59 - 70
S: MB16MEH00010 D: MB16MEH00011	16MEH_M14	17/02/2016	18/02/2016	78	S: 58 D: 77	50mm PVC	MB: Nested	СН	250	6	216	S: 46 – 58 D: 65 - 77
	<u> </u>	1	<u> </u>		Product	ion Bores			1			

Bore ID	Peg ID	Actual Start Date	Completion Date	Actual Drilled Depth	Cased Depth	Casing Details	Bore Type	Drilling Method	Collar Casing Diameter (mm)	Cased Collar Depth (m bgl)	Hole Diameter (mm)	Slotted Interval (m bgl)
WB16MEH0001	16MEH_P02	20/02/2016	27/02/2016	84	84	Steel 305mm	РВ	MR	473	2	432	45 - 81
WB16MEH0002	16MEH_P01	24/02/2016	02/03/2016	57	56	Steel 305mm	РВ	MR	473	6	432	38 - 50
WB16MEH0003	16MEH_P03	01/03/2016	08/03/2016	70	70	Steel 305mm	РВ	MR	473	2	432	46 - 70
WB16MEH0004	16MEH_P04	04/03/2016	13/03/2016	79	76	Steel 305mm	РВ	MR	473	5	432	46 - 64

Key: MB - Monitoring Bore, PB - Production Bore, RC - Reverse Circulation, MR - Mud Rotary, CH - Conventional Hammer

Table 3 Water Levels and Airlift Yields

Bore ID	Peg ID	Initial SWL (m BTOC)	Initial SWL (m AHD)	Peak bore development airlift yield (L/s)					
Monitoring Bores									
MB16MEH0001	16MEH_M16	46.94	132.93	0					
MB16MEH0002	16MEH_M08	34.64	134.55	1					
MB16MEH0003	16MEH_M07	41.12	132.22	0.1 - 0.2					
MB16MEH0008	16MEH_M06	28.03	119.40	0.7					
MB16MEH0009	16MEH_M09	42.52	131.28	0					
MB16MEH0012	16MEH_M01	33.94	131.33	0.25					
MB16MEH0013	16MEH_M04	51.80	129.89	<0.25					
MB16MEH0014	16MEH_M11	9.44	132.93	2.5					
MB16MEH0016	16MEH_M11	9.50	129.94	0.35					
MB16MEH0017	16MEH_M13	34.10	131.58	0					
MB16MEH0018	16MEH_M05	36.01	132.33	0					
MB16MEH0019	16MEH_M03	43.50	135.03	0					
		Nested Monitoring	g Bores						
S: MB16MEH0004 D: MB16MEH0005	16MEH_M15	S: 45.89 D: 45.92	S: 119.35 D: 119.39	S: 0.2 D: 0.5					
S: MB16MEH0006 D: MB16MEH0007	16MEH_M02	S: NA D: 44.62	S: NA D: 125.49	S: N/A D: 0.7 - 1					
S: MB16MEH00010 D: MB16MEH00011	16MEH_M14	S: 42.12 D: 42.00	S: 132.96 D: 132.96	S: <0.25 D: 1.5					
Production Bores									
WB16MEH0001	16MEH_P02	42.36	132.88	8 – 10					
WB16MEH0002	16MEH_P01	33.86	131.17	1.25					
WB16MEH0003	16MEH_P03	40.92	129.14	<0.1					
WB16MEH0004	16MEH_P04	45.55	119.35	1.8					

<sup>\*</sup> No yield achieved

### 3.4 GEOPHYSICS

Surtron Technologies (Australia) PTY Ltd (Surtron) was commissioned to carry out the downhole geophysics, including: gamma, gyro and density.

Geophysical survey results are provided in Appendix C with gamma survey results also presented on the bore logs in appendix **A COMPOSITE BORE LOGS** A.

### 3.5 PROGRAM LEARNINGS

Overall, the program was completed successfully, on time, within the budget and with no injury, however there were some minor difficulties encountered which should be considered for future drilling, including:

- Varying degrees of lost circulation occurred in several drill holes within the CID, resulting in significant mud loss on occasion. In one instance, complete circulation loss was experienced in both the production bore (WB16MEH0002) and the adjacent monitoring bore (MB16MEH0012). Attempts were made to grout up the mud loss zone during drilling of WB16MEH0002 as it was above the water table, however, this was unsuccessful and the remainder of the hole was drilled blind;
- Several of the monitoring bores could not be developed due to inadequate yield and likely low submergence;
- Difficulties were encountered during construction of nested piezometer MB15MEH0005/006. The
  bore was initially drilled with air, however, a swelling clay zone restricted the installation of casing. As
  a result, the driller sourced some RC rods to enable casing to be run in-rod. The bore was
  successfully constructed;
- One production bore could not be properly developed due to inadequate yield and minimal submergence. Attempts were made to flush water down the annulus and inside the casing to break down the mud, however, the flow did not increase as the mud was cleared out.

### SECTION 3 - TEST PUMPING

### 4.1 TEST PUMPING PLAN AND METHODS

Test pumping of the production bores was conducted in March 2016. The objective of the test pumping was to provide information on bore efficiency and yield, and to assess aquifer properties and test groundwater flow boundaries.

The test pumping was carried out by McArthur Drilling and Test Pumping (MDP). Two dip tubes attached to the rising main in the pumping bore was utilised to record water levels during the test. Water levels in monitoring bores were measured using a combination of manual dipping and automated level loggers (data loggers).

Test pumping comprised the following:

- A calibration test to ensure all equipment was functional and to provide an indication of possible flow rates;
- Step drawdown rate test (SRT): Five steps (60 minute duration) of increasing discharge rate to
  provide data for bore efficiency assessment and to determine an appropriate pumping rate for the
  constant rate test.
- Constant rate test (CRT): Pumping at a constant discharge rate for periods between 1 and 7 days to provide data for estimation of aquifer properties.
- Water sampling after one hour of pumping during the CRT for water quality analysis.
- Throughout the CRT, a logger with attached flow cell was used to record physiochemical parameters including; dissolved oxygen (DO), electrical conductivity (EC), oxygen reduction potential (ORP) and pH of the discharge water for WB16MEH002 and WB16MEH004.
- At the end of the CRT, recovering water levels in the production bore were monitored until recovery inside the bore reached at least 90% of the original water level.

### 4.3 STEP TEST ANALYSIS

The Hantush-Bierschenk analysis was used to analyse the step rate test data to determine the apparent well efficiency (see Appendix D). The data was also used to determine the pumping rates for the constant rate tests. A summary of the completed SRT is provided in **Table 4.** 

Table 4: Summary of completed test pumps

Bore ID	Number of Steps	Step Duration (minutes)	Discharge Rates (L/s)	Bore Apparent Well Loss	Bore Equation
WB16MEH0001	5	60	5, 8, 11, 15, 18	4.2E <sup>-06</sup>	Sw= 0.0056Q + 4e-6Q2
WB16MEH0002	4	60	1.5, 2, 2.5, 3	1.66E <sup>-04</sup>	Sw= 0.0082Q + 1e-4Q2
WB16MEH0003			Bore could not be tested do	ue to yield lower than 1.5	5 L/s
WB16MEH0004	3	60	1.5, 2.5, 3.5	3.4E <sup>-05</sup>	Sw= 0.015Q + 8e-5Q2

### 4.4 CONSTANT RATE AND RECOVERY TEST ANALYSIS

### WB16MEH0001

WB16MEH0001 was constructed with slots over both the CID and Paraburdoo Member, and was pumped at 18 L/s, drawing the water level down a total of 20.67 m in 72 hours. WB16MEH0001 is located directly west of Mesa J Pit 11 Sump, a large source of water (Figure 2); in order to represent this water source in the pumping test analysis, a constant head boundary was entered.

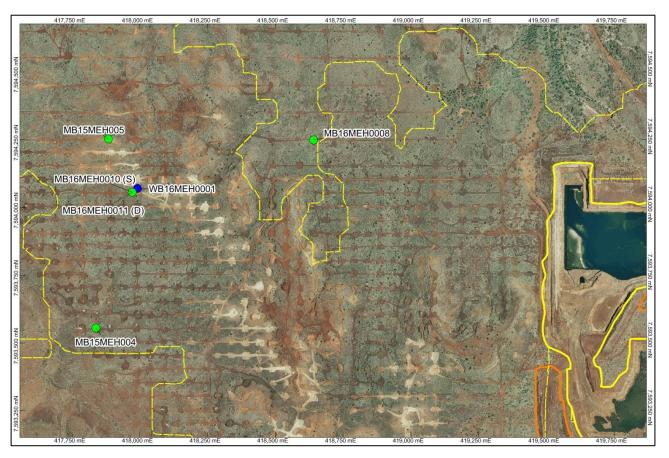


Figure 2: WB16MEH0001 CRT observation bores

The Newman-Witherspoon (1969) solution for a leaky, two aquifer system was fitted to the drawdown data for WB16MEH0001, producing a transmissivity (T) value of 61.8 m<sup>2</sup>/day, a hydraulic conductivity (K) of 1.6 m/day and storage coefficient (S) of 8E<sup>-3</sup> (Figure 3).

The closest adjacent bore was nested (HM16MEH0003), with a shallow piezometer (MB16MEH0010) slotted over the CID and a deep piezometer (MB16MEH0011) slotted over the Paraburdoo Member dolomite. The water level prior to pumping was similar in both the shallow (42.19 m) and deep (42.24 m) piezometers. However, MB16MEH0011 showed a much greater response to pumping, with 5.54 m of drawdown, compared to only 0.685 m of drawdown in the shallow bore MB16MEH0010.

The Cooley-Case (1973) solution for a leaky aquifer overlain by a water table aquitard was used to attempt to fit a curve to the drawdown data for MB16MEH0010 (Figure 4) producing a T of 323.30 m<sup>2</sup>/day,

corresponding K of 20.21 m/day and S of 7.3E<sup>-4</sup>. The Hantush-Jacob (1955) / Hantush (1964) solution for unsteady flow in a leaky aquifer was used to fit a curve to the drawdown data for MB16MEH0011, producing a T of 63.16 m<sup>2</sup>/day, and corresponding K of 5.26 m/day and S of 3.3E<sup>-4</sup> (Figure 5).

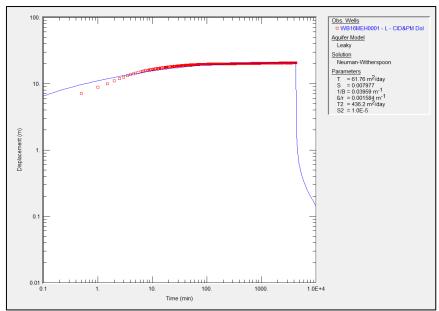


Figure 3: WB16MEH0001 CRT drawdown data with Neuman-Witherspoon solution

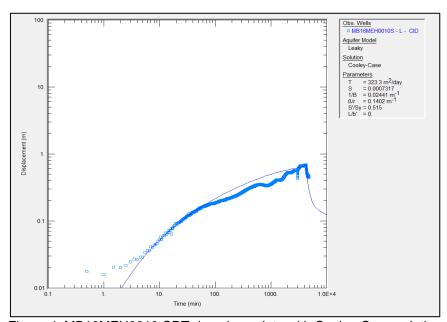


Figure 4: MB16MEH0010 CRT drawdown data with Cooley-Case solution

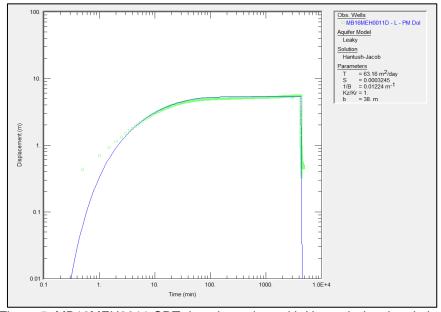


Figure 5: MB16MEH0011 CRT drawdown data with Hantush-Jacob solution

### WB16MEH0002

WB16MEH0002 was slotted over the CID and pumped at a rate of 2.5 L/s, with a final drawdown of 11.05 m after 24 hours. WB16MEH0002 is located directly south of Mesa J Pit 11 Sump, a large source of water (Figure 6); in order to represent this water source in the pumping test analysis, a constant head boundary was entered. The drawdown data observed in WB16MEH0002 could not be analysed due to the lack of early data points with the steady state reached very early in the test (Figure 7).

The closest adjacent bore was MB16MEH0012, slotted over the CID and had a final drawdown of 1.41 m. The Hantush-Jacob (1955) / Hantush (1964) solution for unsteady flow in a leaky aquifer was used to fit the drawdown data for MB16MEH0012, producing a T of 19.5 m²/day, and corresponding K of 1.5 m/day and S of 1.4E<sup>-4</sup> (Figure 8).

Dissolved Oxygen (DO) and pH were stable during the CRT at respectively 1.6mg/L and 7.7. The electrical conductivity (EC) increased from  $800~\mu\text{S/cm}$  to  $860~\mu\text{S/cm}$  during the CRT , then declining to  $780~\mu\text{S/cm}$  during the recovery test (Figure 9), this change in the EC is possibly associated with the increased contribution from a slightly more saline deeper aquifer as the test progresses.

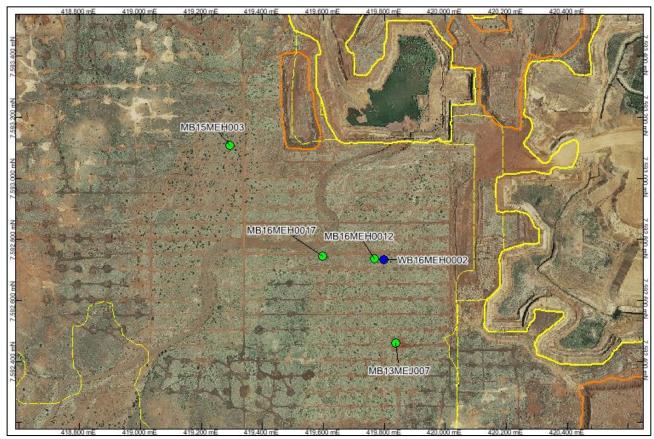


Figure 6: WB16MEH0002 CRT observation bores

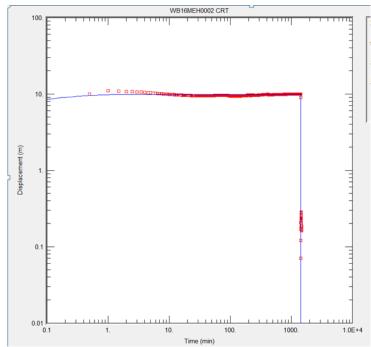


Figure 7: WB16MEH0002 CRT drawdown

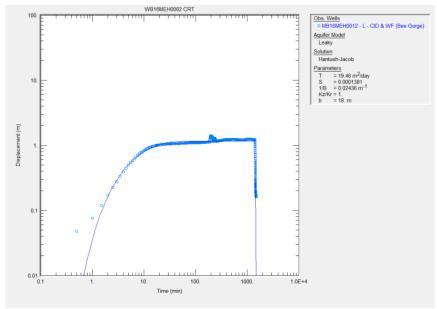


Figure 8: MB16MEH0012 CRT drawdown data with Hantush-Jacob solution

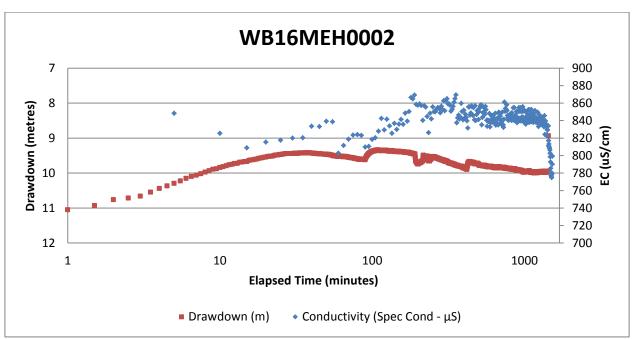


Figure 9: WB16MEH0002 drawdown and EC response during pumping test

### WB16MEH0004

WB16MEH0004 was slotted over both the CID and Paraburdoo Member and pumped at 3.5 L/s for 2 days before the rate was lowered to 2.5 L/s for the remaining 8 days of the test. The water level was drawn down a total of 17.40 m over the 10 day period. WB16MEH0004 is in the northeast section of the proposed Mesa H mining area and approximately 1 km to the east of Yeera Bluff, one of the Robe River Pools (Figure 10); in order to represent this water source in the pumping test analysis, a constant head boundary was entered.

There is a dual nested monitoring bore close to the production bore, with the shallow piezometer MB16MEH0004 slotted over the CID and the deep piezometer, MB16MEH0005, slotted over the Paraburdoo Member. MB16MEH0005 showed a greater response to pumping, with 2.40 m of drawdown, compared to MB16MEH0004 with 1.20 m of drawdown.

The Newman-Witherspoon (1969) solution for a leaky, two aquifer system was fitted to the drawdown data for WB16MEH0004, producing a low T value of 10.23 m²/day, a corresponding K of 0.43 m/day and S of 8.6E<sup>-6</sup> (

### Figure 11).

The Moench (Case 1) (1985) solution, for a leaky confined aquifer, was used fit a curve to the drawdown data for MB16MEH0004, calculating a T of 51.07 m²/day, a corresponding K of 3.65 m/day and S of 2.7E<sup>-3</sup> (Figure 12). The Neuman-Witherspoon (1969) solution was used to fit a curve to the drawdown data for MB16MEH0005, producing a T of 23.34 m²/day, a corresponding K of 0.73 m/day and S of 1.8E<sup>-4</sup> (Figure 13).

DO increased from 1 mg/L at 10 minutes, then to 2 mg/L at 650 minutes, and remained at this level until 2,880 minutes when the flow rate was decreased, and the DO declined to 1.75 mg/L until 6,000 minutes, where it levelled out for the duration of the test.

EC dropped from 940  $\mu$ S/cm to 800  $\mu$ S/cm at 720 minutes where it stabilised until the rate was changed, then rose to 860  $\mu$ S/cm with the drawdown recovery of 7 metres in the bore until 4,000 minutes, where it started decreasing again to 800  $\mu$ S/cm, and stabilising at this reading until 7,000 minutes, where the EC began to slowly increase to 850  $\mu$ S/cm at the end of the test (Figure 14). ORP increased to 50 mV over the first 1,500 minutes, and then plateaued until dropping to 0 mV at 2,890 minutes, when the flow rate was dropped, with ORP increasing exponentially to 184 mV at 4,200 minutes, then at a slower rate to 231 mV until 5,700 minutes, where there was a slight decrease to 229 mV. For the rest of the test, the ORP continued to increase slowly, reaching a maximum of 248 mV by 11,410 minutes (Figure 15). Further analysis of ORP and EC change over time during the CRT test are not conclusive.

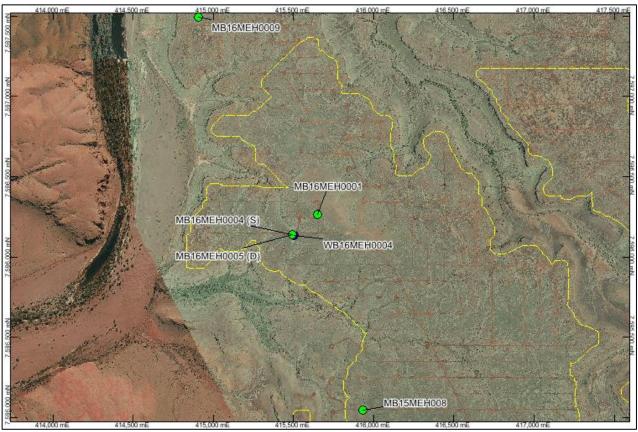


Figure 10: WB16MEH0004 CRT observation bores (Scale 1:15,000)

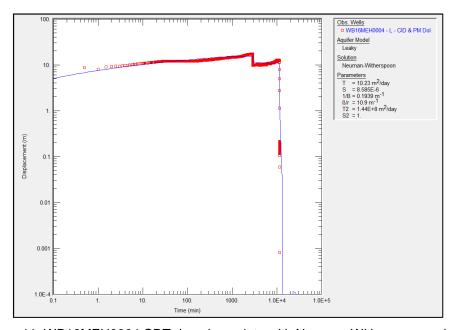


Figure 11: WB16MEH0004 CRT drawdown data with Neuman-Witherspoon solution

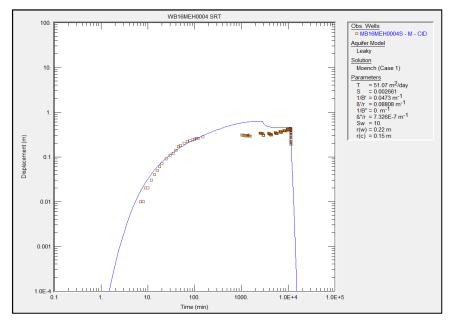


Figure 12: MB16MEH0004 CRT drawdown data with Moench solution

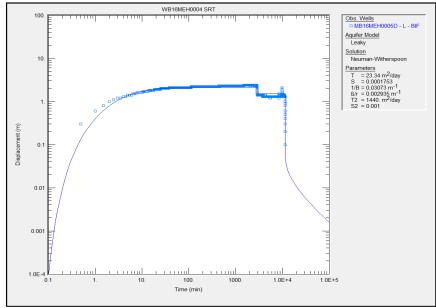


Figure 13: MB16MEH0005 CRT drawdown data with Neuman-Witherspoon solution

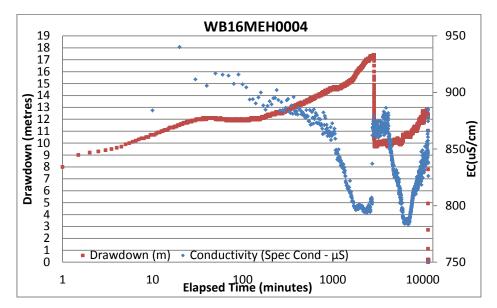


Figure 14: WB16MEH0004 CRT drawdown and EC response during pumping test

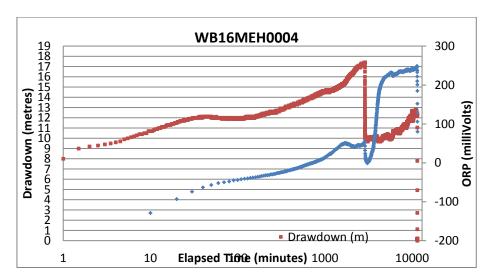


Figure 15: WB16MEH0004 CRT drawdown and ORP response during pumping test

A summary of the constant rate test analyses is presented in Table 5.

Table 5: Summary of CRT results and analysis

Test Site	Bore ID	Distance From Water Bore (m)	Discharge Rate (L/s)	CRT Duration (min)	Screened Unit	Aquifer Type	Max Drawdown (m)	Transmissivity (m2/day)	Hydraulic Conductivity (m/day)	Storage Coefficient / Specific Yield
	WB16MEH0001 RECOVERY	0	18	4,320	CID & Paraburdoo Member		20.7	61.8	1.6	7.98 x 10-3
	MB16MEH0010	23			CID	Leaky	0.7	323.3	20.2	7.32 x 10-4
WB16MEH0001	MB16MEH0011	23			Paraburdoo Member CID &		5.5	63.2	5.3	3.25 x 10-4
	MB15MEH005	202			Paraburdoo Member		Could not be analysed due to negligible drawdown			
	MB15MEH004	537			CID		Could not be analysed due to negligible drawdown			
	MB16MEH0008	620			Paraburdoo Member		Could not be analysed due to negligible drawdown			
	WB16MEH0001 RECOVERY	0	2.5	1,440	CID		11.1	19.2	1.2	4.21 x 10-6
WB16MEH0002	MB16MEH0012	36			Paraburdoo Member	Leaky	1.4	19.5	1.5	1.38 x 10-4
WB10WE110002	MB16MEH007	275			CID		Could not be analysed due to negligible drawdown			
	MB16MEH0017	195			CID		Could not be analysed due to negligible drawdown			
	MB15MEH003	630			CID		Could not be analysed due to negligible drawdown			
	WB16MEH0004	0	3.5, 2.5	11,460	CID & Paraburdoo		17.4	10.2	0.4	8.59 x 10-6
	RECOVERY	0			Member		17.4	10.2	0.4	6.59 X 10-6
	MB16MEH0004	17			CID		1.2	51.1	3.7	2.66 x 10-3
WB16MEH0004	MB16MEH0005	17			Paraburdoo Member	Leaky	2.4	23.3	0.7	1.75 x 10-4
	MB16MEH0001	190			Marra Mamba Iron Formation CID &		Could not be analysed due to negligible drawdown			
	MB15MEH008	1,170			Paraburdoo Member		Could not be analysed due to negligible drawdown			
	MB16MEH0009	1,490			Wittenoom Formation	_	Could not be ana	alysed due to negligil	ble drawdown	

### 4.5 AQUIFER TESTING SUMMARY

A review of the pumping test results suggests the following:

- Hydraulic conductivity and storage coefficient of the CID ranges between 1.2 and 20.2 m/day and 2.6E<sup>-3</sup> and 4.2E<sup>-6</sup> respectively.
- Hydraulic conductivity of the Paraburdoo Member dolomite ranges between 0.7 and 5.3 m/day with a storage coefficient of approximately 2E<sup>-4</sup>.
- The bulk average hydraulic conductivity of the CID and Wittenoom aquifer has been calculated as 2.5 m/day with a storage coefficient of 5.5 E<sup>-3</sup>.
- Basal CID works as a partial boundary to the vertical flow between the CID and the Wittenoom
  Formation aquifers observed by the difference in drawdown between the shallow and deep
  monitoring bores associated with the WB16MEH001 and WB16MEH004 test;
- The Robe Alluvium aquifer seems to be in hydraulic connection with the CID aquifer as suggested by the WB16MEH0004 drawdown, EC and ORP analysis.

# SECTION 4 - WATER QUALITY ANALYSIS

Water quality parameters (pH, electrical conductivity (EC) and temperature) were measured on site at the end of air development with a TSP WP-81 water quality meter. Field water quality results are presented in Table 6.

Table 6 Field Water Quality

Bore ID	Peg ID	рН	EC (µS/cm)	Temp (°C)					
Monitoring Bores									
MB16MEH0001	16MEH_M16	No yield achieved							
MB16MEH0002	16MEH_M08	8.04	683	32.7					
MB16MEH0003	16MEH_M07	8.36	606	32.8					
MB16MEH0008	16MEH_M06	8.38	606	31.8					
MB16MEH0009	16MEH_M09		No yield achieved						
MB16MEH0012	16MEH_M01	8.65	32.3						
MB16MEH0013	16MEH_M04	8.77	725	29.0					
MB16MEH0014	16MEH_M11	8.08	1096	31.6					
MB16MEH0016	16MEH_M11	8.33	957	30.4					
MB16MEH0017	16MEH_M13		No yield achieved						
MB16MEH0018	16MEH_M05	No yield achieved							
MB16MEH0019	MB16MEH0019 16MEH_M03 No yield achieved								
	Neste	d Monitoring Bo	res						
S: MB16MEH0004 D: MB16MEH0005	16MEH_M15	S: 8.47 D: 5.31	S: 675 D: 609	S: 32.4 D: 31.9					
S: MB16MEH0006 D: MB16MEH0007	16MEH_M02	S: No yield D: 8.60	S: No yield D: 1009	S: No yield D: 32.6					
S: MB16MEH00010 D: MB16MEH00011	16MEH_M14	S: No yield D: 8.16	S: No yield D: 630	S: No yield D: 31.9					
Production Bores									
WB16MEH0001	16MEH_P02	8.42	642	33.0					
WB16MEH0002	16MEH_P01	8.76	550	32.5					
WB16MEH0003	16MEH_P03	8.55	774	32.4					
WB16MEH0004	16MEH_P04	8.66	677	31.7					
		Pools							
Yeera Bluff	Yeera Bluff	7.12	1350	28.5					

Five samples were collected from the production bores at the beginning of each test (WB16MEH0004 also had a sample collected at the end of the test) and sent to the laboratory for analysis. The full hydrochemical

analysis results are provided in Appendix E.appendix **C SURTRON GEOPHYSICS RESULTS** 

Sample WB16MEH0003 returned a significant number of anomalous and conflicting results which suggests that due to very low yield (lesser then 1L/s) the bore could not be properly developed after construction.

The results of the remaining four samples reflect the hydraulic interconnection between the CID and the Wittenoom aquifers. All the analysed parameters returned with values within the Australian Drinking Water Guidelines (2011), including:

- pH between 7.1 7.75
- Total Dissolved Solids between 497 663 mg/L
- Total Alkalinity as CaCO3 between 160 194 mg/L
- Sulphate as SO<sub>4</sub> between 24 38 mg/L
- Chloride between 60 76 mg/L
- Total Nitrate between 0.54 0.86 mg/L

# SECTION 5 - PROGRAM FINDINGS

The PFS Hydrogeological Drilling Program at Mesa H enabled the improvement of several conceptual aspects of the hydrogeological system of the deposit. Below is a list of key findings:

- The Paraburdoo Member and the Bee Gorge Member of the Wittenoom Formation are a local aquifer with an approximate thickness of 25 metres associated with the weathered zone;
- The production bore installed outside the OoM pit shell (WB16MEH0003) and slotted across the CID and the Wittenoom Formation could not be tested or developed properly due to very low yield (<1L/s), suggesting the weathering zone of the Wittenoom Fm. is potentially associated with the mineralisation of the CID, and where the mineralisation is absent, the weathering of this stratigraphic unit is less pronounced.</li>
- The unmineralised BIF when underlying the CID is an aquiclude, hence presenting no permeability;
- The groundwater table sits at the CID and flows from southeast to northwest ranging between 132 and 118 mRL, with a hydraulic gradient of 0.002 along the deposit area. The interpreted water table contour map is presented on Appendix F.
- The basal CID, consisting mostly of a clayish pisolite (waste) has horizontal continuity throughout the
  deposit, with an average thickness of 20 metres and continues underneath the Robe River alluvium
  towards Mesa I to the north; its hydraulic properties could not be tested but test pumping analysis
  suggests it works as a partial boundary reducing, but not removing, the hydraulic connection
  between aquifers;
- The Robe River alluvium has a thickness of approximately 20-25 meters consisting of highly
  permeable and low storage quaternary sediments with a shallow water table (2-10 mbgl). The long
  term test pumping carried out on WB16MEH0004 suggests the hydraulic connection between this
  aquifer and the CID aquifer;
- Test pumping results indicate an average transmissivity of 160 m<sup>2</sup>/day, with an associated K of 2.5 m/day and storage coefficient of 5.5E<sup>-3</sup>;
- Water samples collected from the production bores suggest the hydraulic interconnection between the CID and the Wittenoom aquifers.

# SECTION 6 - MEASURE OF SUCCESS

As described in the original scope, the success of the project was measured against the following drivers:

# HSE:

All drilling and clearances were contained within approved AR;

- Program was completed with one single incident: heat stress; the patient notified his supervisor immediately upon feeling unwell and was transported to the medic who advised some rest in a cool place;
- The single incident was reported and acted upon within minimal time.

# **Technical drivers:**

- Installation and testing of 4 production bores;
- Installation of 18 monitoring bores;
- Water sampling of selected bores;

# **Project management drivers:**

- · Completion of the program free of incidents;
- Completion of the program within the schedule duration;
- Completion of the program within budget;
- · Provision of accurate drilling and test pumping data;
- Maintained / enhanced relationship with site Study Manager;
- Enhanced conceptual model for dewatering planning and understanding risks of mining related impacts to groundwater levels in the Rights Reserve in support of Mesa H PFS.

APPENDIX A COMPOSITE BORE LOC	GS	



Depth

# **WB16MEH0001**

# **HOLE DETAILS**

LOCATION: Mesa H

# **DRILLING DETAILS**

# LOCATION

PROJECT: Mesa H PFS 2016

DRILLING COMPANY: Bunbury Drilling Company GRID NAME: MGA94 Zone 50

**DRILLER:** John Nesbitt

**EASTING:** 417990.96 **NORTHING:** 7594070.94

**Well Design** 

DATE COMMENCED:20/02/2016

**DRILLING METHOD:** Mud Rotary

ELEVATION: 175.24 mRL (TOC)

Well

DATE COMPLETED: 27/02/2016

HYDROGEOLOGIST: Marisa Mochizuki

Gamma

**Field Notes** 

Peg ID: 16MEH\_P02

logy

Mud Rotary Tricone Bit: 171/2" diameter 0 - 86 mbgl. 0 - 2 mbgl reamed to 22" diameter.

**Lithological Description** 

(mbgl)	Geolog	Litholog	Littiological Description	Gaiiiiia	rieid Notes	Well Design	Construction
	Ğ	Ĕ		( 0-150cps)			
- 0 - 5 - 10 - 15 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60	Gorge) Robe Pisolite		from 18-26m, minor hematite and red staining.  CID: (26 - 40 mbgl): Weathered grey, brown and red goethite and hematite,, fragments of cemented pisolites (to 1 mm) and minor individual pisolites, moderate yellow limonitic and grey clay reducing to minor with trace multi-coloured fine to coarse quartz sands from 36-40m  CID: (40 - 48 mbgl): Well weathered grey, brown and red 1 mm goethite and hematite pisolites in a vitreous goethite matrix, minor to moderate yellow limonitic clay, increasing amounts of massive vitreous goethite from 44 - 46 mbgl.  CID: (48 - 56 mbgl): Weathered grey, vitreous goethite with minor pisolite chips as described above, moderate yellow and grey clay with increased amounts from 48 - 50 mbgl.  CID: (56 - 58 mbgl): Weathered grey, vitreous goethite with minor chert, shale and quartz.  SHALE: (58 - 86 mbgl): Moderately weathered and fractured grey and black shale, chert and	(0-150cps)  (0-150cps)	pH = 8.42 EC = 642 µS/cm Temp = 33.0 ℃ Final airlift yield: 8-10 L/s 30-40% lost circulation at 34 mbgl. SWL: 42.04 mbgl (42.36 mbtoc)		12" steel stick up 0.35 magl, fitted with cap. Concrete plinth 1m x 1m x 300 mm (200 mm above ground level). 0 - 2 mbgl, 18 5/8" steel collar cemented in place. 2 - 84 mbgl, 3.2 - 6.4 mm graded gravel pack.  0 - 45 mbgl, 12" blank steel casing.
- 70 - - - 75 - - - 80	Wittenoom Formation (Bee		clay, minor brown shale increasing with depth, minor green chert, minor BIF and white quartz after 60m, chips up to 5 mm, becoming fresher after 78m.	4 150			81 - 84 mbgl, blank steel
<u> </u>						.1.1.1.1.1.1.1.1.1	casing with steel end cap.

# **WB16MEH0002**

**HOLE DETAILS** 

**DRILLING DETAILS** 

**DRILLER:** Dave Usher

**LOCATION** 

PROJECT: Mesa H PFS 2016

DRILLING COMPANY: Bunbury Drilling Company GRID NAME: MGA94 Zone 50

**EASTING:** 419797.07

LOCATION: Mesa H

**DRILLING METHOD: Mud Rotary** 

NORTHING: 7592735.16

**DATE COMMENCED:**24/02/2016 **DATE COMPLETED:** 02/03/2016

HYDROGEOLOGIST: A. Price/ M. Mochizuki

**ELEVATION:** 165.03 mRL (TOC)

Peg ID: 16MEH\_P01

Mud Rotary Tricone Bit: 171/2" diameter 0 - 57 mbgl. 0 - 6 mbgl reamed to 22" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
(IIIDGI)	Gec	Lith		( 0-120cps)			
			ALLUVIUM: (0 - 6 mbgl): Reddish-brown, sand and silt, sub-rounded to sub-angular gravel to 3 cm of chert, shale and BIF, vuggy goethite, minor round to sub-round goethite and hematite pisolites.	The state of the s			12" steel stick up 0.35 magl, fitted with cap. Concrete plinth 1m x 1m x 300 mm (200 mm above ground
- - - - 10			CID: (6 - 8 mbgl): Weathered grey, red and brown goethite and hematite pisolites and chips of vitreous goethite minor yellow limonitic clay/mudstone, moderate fall-back/contamination.	the many the same			level).  0 - 6 mbgl, 18 5/8" steel collar
- 15 -			CLAY: (8 - 10 mbgl): Grey, silty clay with gravel (to 3 cm) of chert, shale, BIF, goethite and hematite.				cemented in place.
- 20	_		CID: (10 - 12 mbgl): Weathered grey vitreous and yellow ochreous goethite, minor pisolites, hematite and grey and yellow limonitic clay.	60 0	Final airlift WQ: pH = 8.76		2 - 57 mbgl, 3.2 - 6.4 mm graded gravel pack.
- - 25	Robe Pisolite		CLAY: (12 - 14 mbgl): Grey and yellow clay with weathered vitreous to earthy goethite and minor hematite.	60 0 0	EC = 550 μS/cm Temp = 32.5 °C		0 - 38 mbgl, 12"
- - - - - <b>30</b>	X	00000	CID: (14 - 18 mbgl): Moderately weathered vitreous and mildly vuggy hematite and goethite, minor yellow ochreous goethite, grey and yellow clay, trace hematite pisolites.	Why My May My	Final airlift yield: 1.25 L/s		blank steel casing.
- - - - 35			CID: (16 - 20 mbgl): Weathered yellow ochreous goethite and grey vitreous to siliceous goethite, minor hematite and cemented fine (to 1mm) yellow and brown individual pisolites and pisolite clasts.	Mondy the ordinary	SWL: 33.36 mbgl (33.86 mbtoc)	<b>*</b>	
- 40			CID: (20 - 32 mbgl): Red hematite and yellow ochreous to grey goethite, clasts of fine (to 1 mm) cemented pisolites, minor vitreous to highly vitreous goethite. Driller notes slightly harder ground.	80 80 00 00 00 00 00 00 00 00 00 00 00 0	Complete lost circulation at 32 mbgl. Completed two cement jobs to seal up. Continued to drill then		38 - 50 mbgl, 12" slotted steel (1mm aperture).
- 45 -			NO SAMPLE: (32 - 62 mbgl): No sample, lost circ.	MAN MAN	lost full circulation at 34 mbgl. Drilled blind for remainder of hole.		
_ <b>50</b>	Wittenoom Fm			Transal windless	Hard ground from ~48 mbgl.		50 - 56 mbgl, blank steel casing with steel
<b>55</b> 	Witten						end cap.

# **WB16MEH0003**

**HOLE DETAILS** 

# **DRILLING DETAILS**

# LOCATION

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY:** Bunbury Drilling Company **GRID NAME:** MGA94 Zone 50

GITTE TO THE TOTAL CONTROL

**LOCATION:** Mesa H

**DRILLER:** John Nesbitt

**EASTING:** 416321.85 **NORTHING:** 7594781.07

Well Design

**DATE COMMENCED:**01/03/2016 **DATE COMPLETED:** 08/03/2016

**DRILLING METHOD:** Mud Rotary

HYDROGEOLOGIST: Marisa Mochizuki

Gamma

**Field Notes** 

ELEVATION: 170.06 mRL (TOC)

Well

Peg ID: 16MEH\_P03

Depth ති

g

Mud Rotary Tricone Bit: 171/2" diameter 0 - 70 mbgl. 0 - 2 mbgl reamed to 22" diameter.

**Lithological Description** 

hard ground and slow penetration rates.

(mbgl)	Geolog	Litholog	Lithological Description	( 0-120cps)	Field Notes	well Design	Construction
- <b>o</b>		<i>O:</i> -::0	CID: (0 - 6 mbgl): Moderately weathered grey				12" steel stick up 0.35 magl,
5 5			and brown vitreous goethite, minor calcrete, and yellow ochreous goethite. Most chips are 3mm with some rare 5mm chips.  CID: (6 - 22 mbgl): Moderately weathered grey and brown vitreous goethite, minor	A HAMANA AND AND AND AND AND AND AND AND AND	Final airlift WQ: pH = 8.55 EC = 774 µS/cm Temp = 32.4 °C		fitted with cap. Concrete plinth 1m x 1m x 300 mm (200 mm above ground level).
- 10 - - - - 15 - - - - 20			yellow ochreous goethite, minor yellow ochreous goethite, calcrete, hematite, trace yellow and grey clay, increase in ochreous goethite from 16m, trace individual (to 1mm) pisolites and pisolites in a vitreous goethite matrix from 18-22m.	120 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	Final airlift yield: <0.1 L/s Hard ground, slow penetration rates (1 m/hr) from 0 - 14 mbgl.		0 - 6 mbgl, 18 5/8" steel collar cemented in place. 2 - 70 mbgl, 3.2 - 6.4 mm graded
- - - - 25	Robe Pisolite	8-1	CID: (22 - 28 mbgl): Pisolite as above with significant yellow and grey clay and hematite, trace red clay from 26-28 mbgl.		SWL: 40.56 mbgl (40.92 mbtoc)		gravel pack.  0 - 46 mbgl, 12" blank steel casing.
- 30 - 35 - 40			CID: (28 - 42 mbgl): Mix of hematite, yellow ochreous and grey vitreous goethite, minor pisolites in a vitreous goethite matrix, minor grey, yellow and red clay, significant grey and yellow clay at 40-42m and chips of highly weathered/decomposed pisolite (pisolites and brecciated clasts of goethite (to 1mm) in a yellow orange and grey clay matrix, soft and friable).		Very low developing	<b>*</b>	casnig.
- 45 		D::::0 O:y.C D::::0	CLAY: (42 - 44 mbgl): Grey and yellow clay with minor hematite, ochreous and vitreous goethite, and highly weathered pisolite.	CPPC-WAPATA	yield, well clean was used, the well was surged with water and water was injected into the annulus to help		
50 - - - - - - - 55	(Bee Gorge)	0.9.5	CID: (44 - 50 mbgl): Mix of hematite, ochreous and vitreous goethite, significant grey and yellow clay and chips of highly weathered pisolite.  CLAY: (50 - 56 mbgl): Sandy olive grey	May May May May May	breakup and remove the mud and fines.		46 - 70 mbgl, 12" slotted steel (1mm aperture), with steel end cap.
60	_		dolomitic clay from highly weathered dolomite and minor hematite, ochreous goethite and highly weathered pisolite.	120 60			
- 65 - - - -	Wittenoom Formatio		DOLOMITE: (56 - 62 mbgl): Olive grey chips (to 10mm) of soft and friable, highly weathered dolomite, minor sub rounded chips (to 5mm) of hematite, ochreous and vitreous goethite and dolomitic clay. Driller notes ground becoming harder.	ndywygytupytum.	Very hard ground, slow penetration rates (1-3 m/hr) from 62.5 - 70 mbgl.		
70   75 			DOLOMITE: (62 - 70): Olive grey angular chips (to 3mm) of fresh microcrystalline dolomite and dark grey chert. becoming darker and harder from 66m. Driller notes very hard ground and slow poperation rates				

# **WB16MEH0004**

# **HOLE DETAILS**

LOCATION: Mesa H

# **DRILLING DETAILS**

# LOCATION

PROJECT: Mesa H PFS 2016

DRILLING COMPANY: Bunbury Drilling Company GRID NAME: MGA94 Zone 50

**DRILLER:** Tom Massey

**EASTING:** 415504.09 **NORTHING:** 7596133.77

**Well Design** 

**DATE COMMENCED:**04/03/2016

**DRILLING METHOD:** Mud Rotary

ELEVATION: 164.90 mRL (TOC)

Well

**DATE COMPLETED:** 13/03/2016

HYDROGEOLOGIST: Marisa Mochizuki

Gamma

**Field Notes** 

Peg ID: 16MEH\_P04

logy

Depth

logy

Mud Rotary Tricone Bit: 171/2" diameter 0 - 79 mbgl. 0 - 6 mbgl reamed to 22" diameter.

**Lithological Description** 

(mbgl)	Geold	Lithol					Construction
	Ğ	=		( 0-120cps)	1		
				•			
	Robe Pisolite		CID: (0 - 2): Weathered grey, and red angular chips (to 20mm) of mildly vuggy goethite and vitreous goethite minor yellow ochreous goethite.  CID: (2 - 18): Mild to moderately weathered chips (to 10mm) of grey vitreous goethite with limonitic clay often coating vughs and fracture planes, minor yellow ochreous goethite (becoming majority from 12m), hematite and trace calcrete and siliceous infill significant calcrete and white and yellow clay 4 -6 m, minor pisolite; hematite pisolites (to 1mm) in a vitreous goethite matrix from 16-18m.  CID: (18 - 22): Weathered pisolite, significant yellow ochreous and grey vitreous goethite, minor hematite.  CID: (22 - 30): Yellow and brown ochreous goethite and limonite, minor grey vitreous goethite and pisolite as above.  CID: (30 - 32): Weathered clayey pisolite; friable pisolite often weathered to clay, minor yellow ochreous goethite.  CID: (32 - 42): Ochreous goethite and limonitic clay, minor weathered pisolite and vitreous goethite with significant grey clay from 40-42m.  CID: (42 - 46): Weathered clayey pisolite, extensive clay and ochreous goethite.	Manual Jacob All Manual Manual Androne	120 120	Final airlift WQ: pH = 8.66 EC = 677 μS/cm Temp = 31.7°C  Final airlift yield: 1.8 L/s  SWL: 45.15 mbgl (45.55 mbtoc)	12" steel stick up 0.35 magl, fitted with cap. Concrete plinth 1m x 1m x 300 mm (200 mm above ground level).  0 - 6 mbgl, 18 5/8" steel collar cemented in place.  2 - 79 mbgl, 3.2 - 6.4 mm graded gravel pack.  0 - 46 mbgl, 12" blank steel casing.
-50 -55 -60 -70 -75	Wittenoom Fm (Bee Gorge)	00000000000000000000000000000000000000	CLAY: (46 - 54): Grey and yellow clay with extensive weathered pisolite and ochreous goethite, increase in vitreous goethite from 50m and brown clay from 52m.  CID: (54 - 62): Yellow and brown ochreous goethite, minor weathered pisolite, vitreous goethite, white and yellow clay, more clay from 58-60m.  CLAY: (62 - 64): Grey and brown clay, trace pisolite and vitreous goethite chips, 80% lost circulation, chips may not be coming up in sample.  NO SAMPLE: (64 - 79): No sample, lost circulation.	A THE THE PART OF	120	Water loss (to 70-80%) was experienced between 54-62 mbgl. Complete lost circulation from 62 mbgl.	46 - 64 mbgl, 12" slotted steel (1mm aperture).



**Lithological Description** 

# **HOLE DETAILS**

PROJECT: Mesa H PFS 2016

LOCATION: Mesa H

DATE COMMENCED:22/02/16

DATE COMPLETED: 23/02/16

# **DRILLING DETAILS**

**DRILLING COMPANY: Ranger Drilling** 

**DRILLER:** Adam Mennell **DRILLING METHOD: RC** 

HYDROGEOLOGIST: Marisa Mochizuki

Gamma

**Field Notes** 

# **LOCATION**

GRID NAME: MGA 94, Zone 50

**EASTING:** 415648.30 NORTHING: 7596263.24

**Well Design** 

**ELEVATION:** 166.52 mRL (TOC)

Well

logy

Depth

Peg ID: 16MEH\_M16 RC: 7½" diameter 0 - 5 mbgl. 5 - 76 mbgl 5½" diameter.

(mbgl)	Geolog	Litholog	Lithological Description	( 0-80cps)	Field Notes	well besign	Construction
				( 0 000 po)			
0 	Alluvium		ALLUVIUM: (0 - 4 mbgl): Reddish-brown, angular to sub-round gravel (to 3cm), brown sand and silt.				6" PVC collar grouted, 0 - 6 mbgl. Steel stick up 700 mm above natural
- 10 - 15 - 20	Robe Pisolite	00000000000000000000000000000000000000	CID: (4 - 24 mbgl): Brown and grey with yellow ocherous goethite, moderately weathered in places (particularly btwn 4 and 8 mbgl). Minor limonitic clay, rare calcrete and hematite.	O O O O O O O O O O O O O O O O O O O	No airlift yield.		surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).  0 - 2 mbgl, bentonite seal.  50mm blank PVC casing, - 0.50 - 52 mbgl.
		-Z-2 -Z-2 -Z-2 -Z-2	BIF: (24 - 28 mbgl): Weathered BIF. Yellow, red and grey chert. Minor grey shale, rare quartz. Strongly weathered and fractured.  BIF: (28 - 40 mbgl): Brownish-red and yellow chert, yellow ocherous goethite. Metallic grey BIF. Rare quartz. Some fracturing and minor weathering.	My My May May And And May			2 - 64 mbgl, 3.2 - 6.4 mm graded gravel pack.
- - - - - - - - - - - - - - - - - - -	Marra Mamba	-Z- <u>-</u> Z <u>-</u> ZZ	BIF/CLAY: (40 - 42 mbgl): Stiff green, grey and red clay (banded). Softer yellow clay, minor dark grey and yellow chert and quartz.  BIF: (42 - 44 mbgl): Black, grey and yellow chert. BIF and rare quartz.  CLAY: (44 - 52 mbgl): Soft reddish-brown clay.	40 AMALANA MARINA MARIN	SWL: 46.49 mbgl (46.94 mbtoc)		
- - - - 55 - - - - - - - - - - -		-7-7	BIF: (52 - 58 mbgl): Dark grey BIF, grey yellow and greenish chert.  SHALE: (58 - 64 mbgl): Black shale, moderately weathered, friable.	Ally John Many Many Ago Ago			52 - 64 mbgl, 50mm slotted PVC casing.



# **HOLE DETAILS**

# **DRILLING DETAILS**

# **LOCATION**

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

LOCATION: Mesa H

**DRILLER:** Adam Mennell

**DATE COMMENCED: 10/2/2015** DATE COMPLETED: 11/2/2015 **DRILLING METHOD: RC HYDROGEOLOGIST:** A.Price **GRID NAME:** MGA 94, Zone 50

**EASTING:** 418342.63 **NORTHING:** 7595994.38

**ELEVATION:** 167.57 mRL (TOC)

Peg ID: 16MEH\_M08 RC: 7½" diameter 0 - 5 mbgl. 5 - 82 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
	ၓၟ	Lit		( 0-300cps)			
	Robe Pisolite	00000000000000000000000000000000000000	CID: (0 - 6 mbgl): Blue-grey metallic and brown chips, some pitting in places. Minor hematite and yellow ocherous goethite.  CID: (6 - 15 mbgl): Grey and brown, minor yellow goethite, grey vitreous goethite.  Moderate weathering, some limonitic clay.	Application of the Abbush of the Application of the			6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).
15		): 0:	CLAY: (15 - 22 mbgl): Mottled brown, red and	WALL TO SERVICE STREET			0 - 2 mbgl, bentonite seal.
20			white clay.	0	Final airlift yield: 1L/s.		50mm blank PVC casing, - 0.50 - 56 mbgl.
25			CALCRETE: (22 - 28 mbgl): Off white calcrete, some sub-round brown gravel to 2mm.		pH: 8.04 EC: 683 μS/cm Temp: 32.7 ℃		J
30	je)		CLAY: (28 - 35 mbgl): Sticky, off white clay.				2 - 74 mbgl, 3.2 - 6.4 mm graded gravel pack.
- 35	Wittenoom Formation (Bee Gorge)		CLAY: (35 - 38 mbgl): Very dense, sticky dark grey to black clay.	WATER TO THE PARTY OF THE PARTY	SWL: 34.18 mbgl (34.64 mbtoc)	<b>*</b>	
40	ormatio		CLAY: (38 - 42 mbgl): Sticky mottled white, dark grey and red clay.	150	3		
_ 45	noom F		CLAY: (42 - 44 mbgl): Sticky brown clay.		First water strike at 42 mbgl - very little flow (<0.1L/s).		
	Witte		CLAY: (44 - 46 mbgl): Soft red clay with chips of hematite, red, purple and yellow shale.	Thubs: april	(<0.12/5).		
<u> </u>			SHALE: (46 - 48 mbgl): As above but only minor clay.				
_ 55			CLAY: (48 - 50 mbgl): Sticky purple clay.				56 - 74 mbgl
- 60			CLAY: (50 - 52 mbgl): Off white and grey clay.				,50mm slotted PVC casing.
- 60 -			CLAY: (52 - 54 mbgl): Dark grey to black sticky clay.	150	300		
65			CLAY: (54 - 56 mbgl): Dark grey and brown sticky clay.		Second water strike at 64 mbgl, 2.5L/s increasing to 3L/s by		
70	Wittenoom Dolomite		CLAY: (56 - 58 mbgl): Grey, white and brown sticky clay.		70 mbgl.		
- 75	moom		CLAY: (58 - 64 mbgl): Sticky dark grey clay.				Hole collapsed
80	Witter		DOLOMITE: (64 - 80 mbgl): Bluish grey dolomite. Strongly weathered in places. Abundant quartz btwn 70 and 72 mbgl.	150	900		from 74 to 82 mbgl.



# **HOLE DETAILS**

**DRILLING DETAILS** 

GRID NAME: MGA 94, Zone 50

PROJECT: Mesa H PFS 2016 LOCATION: Mesa H

**DRILLING COMPANY: Ranger Drilling** 

**EASTING:** 419013.90 **NORTHING:** 7595067.08

**LOCATION** 

**DATE COMMENCED: 12/2/2015** DATE COMPLETED: 14/2/2015 **DRILLER:** Ben Smith **DRILLING METHOD: RC HYDROGEOLOGIST:** A.Price

**ELEVATION:** 175.67 mRL (TOC)

Peg ID: 16MEH\_M07 RC: 7½" diameter 0 - 5 mbgl. 5 - 84 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma ( 0-300cps)	Field Notes	Well Design	Well Construction
	Robe Pisolite		CID: (0 - 6 mbgl): Dark grey and brown, vitreous goethite, round to sub-round pisolites to 2mm.  CID: (6 - 12 mbgl): Grey vitreous goethite, yellow ocherous goethite, moderately weathered.  CID: (12 - 31 mbgl): Yellow limonitic clay, yellow ocherous goethite, grey vitreous goethite, rare hematite.  CID: (31 - 34 mbgl): Pisolite with red hematite and yellow goethite pisolites in grey vitreous goethite matrix. Yellow ocherous goethite, brown clay.  CLAY: (34 - 45 mbgl): Brown clay with minor yellow ocherous and grey vitreous goethite.	300  150  150  150  150	Final airlift yield: 0.1 - 0.2L/s. pH: 8.36 EC: 606 µS/cm Temp: 32.8 ℃  SWL: 40.54 mbgl (41.12 mbtoc)		6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).  0 - 2 mbgl, bentonite seal.  2 - 84 mbgl, 3.2 - 6.4 mm graded gravel pack.
50	: Gorge)		light grey and light yellow chert.  CLAY: (47 - 58 mbgl): Brown clay.  QUARTZ: (58 - 65 mbgl): Weathered and	The state of the s	First water strike approx 40 mbgl - very little flow (<0.1L/s). No further increase during drilling.		50mm blank PVC casing, - 0.50 - 66 mbgl.
60 65 70 75 80	Wittenoom Formation (Bee		unweathered quartz. Strongly fractured and broken.  CLAY: (65 - 70 mbgl): Off white clay.  CLAY: (70 - 74 mbgl): Brown and grey clay.  CLAY: (74 - 76 mbgl): Strongly weathered dark grey shale and grey clay.  CLAY: (76 - 84 mbgl): Sticky grey clay.	150 150 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0			66 - 84 mbgl ,50mm slotted PVC casing.



# MB16MEH0004/ MB16MEH0005

**HOLE DETAILS** 

**DRILLING DETAILS** 

GRID NAME: MGA 94, Zone 50

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY:**Bunbury Drilling

LOCATION: Mesa H

DRILLER: Luke Wallace

**EASTING:** 415490.51 **NORTHING:** 7596140.85

Well Design

**LOCATION** 

DATE COMMENCED: 15/2/2016

DATE COMPLETED: 16/2/2016

**DRILLING METHOD:** Air Hammer **HYDROGEOLOGIST:** Ashley Price

Gamma

(0-200 cps)

**Field Notes** 

**ELEVATION S:** 165.24 mRL TOC **ELEVATION D:** 165.31 mRL TOC

Well Construction

0.50 - 66 mbgl. 50mm slotted

PVC casing, 66

- 78 mbgl.

Peg ID: 16MEH\_M15

Geology

Depth

(mbgl)

-ithology

Hammer Bit: 143/4" diameter 0 - 6 mbgl . 81/2" diameter 0 - 78 mbgl.

**Lithological Description** 

BIF: (76 - 78 mbgl): Strongly weathered and

fractured BIF, grey chert and shale.

Shallow piezometer - MB16MEH0004, deep piezometer - MB16MEH0005. Parent hole - HM16MEH0001

	U					
<b></b> □0						10" steel collar
5			ALLUVIUM: (0 - 2 mbgl): Reddish-brown, sub- round to sub-angular gravel to 3cm. Dark grey angular gravel to 1 cm. Minor yellow ocherous goethite.	who was made and the was a state of the stat	Shallow Piezo	grouted, 0 - 6 mbgl. Steel stick up 500 mm above natural surface. 1 m x 1
10			CID: (2 - 10 mbgl): Hard cap. Dark grey vitreous goethite, minor red hematite and rare yellow ocherous goethite. Minor white clay btwn 4 and 6 mbgl.	MINIMAN CANADA PARILIPA	Final airlift yield - ~10 L/min pH - 8.47 EC - 675 μS/cm Temp - 32.4 °C	m x 300 mm concrete plinth (200 mm above ground level).
- 15 - - - - 20			CID: (10 - 24 mbgl): Yellow ocherous goethite and limonitic clay. Pisolite, red pisolites in brown matrix. Minor dark grey vitreous goethite.	MAN MANUTANTANTANTANTANTANTANTANTANTANTANTANTANT	·	Bentonite seal, 0 - 2 mbgl.
-		0:-:4		TAN I		
<b>25</b>	<u>i</u>		CID: (24 - 28 mbgl): Fractured and weathered grey vitreous goethite. Vughy pisolite.			
30	Robe Pisolite		CID: (28 - 50 mbgl): Pisolite, strongly weathered to clay in places. Yellow ocherous goethite and limonitic clay. Vughy pisolite, red and yellow pisolites in brown and grey matrix.	The state of the s		3.2 - 6.4 mm graded gravel pack, 0 - 60
35			,	May hay a franch		mbgl and 64 - 78 mbgl.
<b>40</b>				THAM D-17 Man		
45  				THE PARTY OF THE P	SWL Shallow - 45.15 m bgl (45.89 m btoc)	
- 50 - - - - 55 -			CID: (50 - 60 mbgl): Strongly weathered vitreous goethite and pisolite. Yellow ocherous goethite and rare off-white clay.		Deep - 45.11 m bgl (45.92 m btoc)	50mm blank PVC casing, - 0.50 - 48 mbgl. 50mm slotted PVC casing, 48 - 60 mbgl.
<b>60</b>		-\\ -\\	BIF: (60 - 64 mbgl): Strongly weathered red- purple BIF. White and pink clay.		Deep Piezo Final airlift yield -	Bentonite seal, 60 - 64 mbgl.
- 65 - -	om Fm		CLAY: (64 - 69 mbgl): Dark greenish-grey clay.		0.5 L/s pH - 5.31 EC - 609 μS/cm Temp - 31.9 °C	
<b>70</b>	Wittenoom Fm		SHALE: (69 - 76 mbgl): Strongly weathered dark grey shale.			50mm blank PVC casing, -



Depth

(mbgl)

# MB16MEH0006 / MB16MEH0007

**HOLE DETAILS** 

**DRILLING DETAILS** 

GRID NAME: MGA 94, Zone 50

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY:**Bunbury Drilling

Gamma

**EASTING:** 416312.82

**LOCATION** 

**Field Notes** 

LOCATION: Mesa H

**DRILLER:** Dan Morris

**NORTHING:** 7594795.87

Well Design

**DATE COMMENCED:**14/02/2016 **DATE COMPLETED:** 29/02/2016

**DRILLING METHOD:** Air Hammer **HYDROGEOLOGIST:** Ashley Price

**ELEVATION S:** 170.5 mRL TOC **ELEVATION D:** 170.11 mRL TOC

Well

Construction

Hole collapsed from 77 to 80

mbgl.

Peg ID: 16MEH\_M02

Wittenoom Fr

- 7 ---- 75

80

nology

Hammer Bit: 143/4" diameter 0 - 6 mbgl . 81/2" diameter 0 - 80 mbgl.

**Lithological Description** 

Shallow piezometer - MB16MEH0006, deep piezometer - MB16MEH0007. Parent hole HM16MEH0002

(mbgi)	Gec	Lit		( 0-120 cps)		
-0 - - - -5 -			CID: (0 - 12 mbgl): Grey vitreous goethite, moderately weathered. Minor calcrete and yellow ocherous goethite.	MAN PART MAN	Shallow Piezo- No water	10" steel collar grouted, 0 - 6 mbgl. Steel stick up 500 mm above natural surface. 1 m x 1 m x 300 mm
— 10 - - -			CID: (12 - 14 mbgl): Yellow ocherous goethite, minor grey vitreous goethite, rare hematite.			concrete plinth (200 mm above ground level).
— 15 - - -	lte.		CID: (14 - 16 mbgl): Grey vitreous goethite, minor yellow ocherous goethite.			Bentonite seal, 0 - 2 mbgl.
— 20 - - -	Robe Pisolite		CID: (16 - 20 mbgl): Light grey clay with grey vitreous goethite. Minor yellow ocherous goethite.			50mm blank PVC casing, - 0.50 - 28 mbgl.
25   			CID: (20 - 22 mbgl): Yellow ocherous goethite. Pisolite with small pisolites in grey vitreous goethite matrix.			50mm slotted PVC casing, 28 - 40 mbgl.
- 30 - - - - - - 35			CID: (22 - 36 mbgl): Mostly hematite, minor yellow ocherous goethite. Brown clay btwn 28 and 30 mbgl. Rare grey clay throughout.			3.2 - 6.4 mm graded gravel pack, 0 - 40 mbgl and 45 - 77 mbgl.
40			CID: (36 - 43 mbgl): Soft yellow ocherous goethite.			, ,g.
- - - - - - - - - 50	se Gorge)		CLAY: (43 - 62 mbgl): Brown clay, very sticky btwn 54 and 62 mbgl.		SWL Shallow - No water Deep - 43.97 m bgl (44.62 m btoc)	Bentonite seal, 40 - 45 mbgl.
- - - - - - - -	Wittenoom (Bee Gorge)					
60			DOLOMITE (CO. 90 mbs/). Freedowed and		Deep Piezo Final airlift yield -	50mm blank PVC casing, -
- 65 	Æ		DOLOMITE: (62 - 80 mbgl): Fractured and weathered, light to medium grey dolomite. Rare quartz.		0.7-1 L/s pH - 8.60 EC - 1009 μS Temp - 32.6 ℃	0.50 - 59 mbgl. 50mm slotted PVC casing, 59 - 77 mbgl.



# **HOLE DETAILS**

**DRILLING DETAILS** 

GRID NAME: MGA 94, Zone 50

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

LOCATION: Mesa H **DATE COMMENCED:**15/2/2015 **DRILLER:** Ben Smith **DRILLING METHOD: RC**  **EASTING:** 418640.88 **NORTHING:** 7594248.67

**LOCATION** 

**DATE COMPLETED:** 16/2/2015

**HYDROGEOLOGIST:** A.Price

**ELEVATION:** 160.25 mRL (TOC)

Peg ID: 16MEH\_M06 RC: 7½" diameter 0 - 4 mbgl. 5 - 58 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
	ge	Ę		( 0-200cps)			
- <b>0</b>			ALLUVIUM: (0 - 2 mbgl): Reddish-brown silt, sand and gravel to 2cm. Sub-angular to subround.	WANTED THE MAN			6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural
-5 - - - -			CID: (2 - 10 mbgl): Yellow ocherous goethite, grey vitreous goethite. Yellow limonitic clay. Some grey and white quartz btwn 8 and 10 mbgl.	Managaman Marangan Managan Man			surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).
- 10 - - - - - - 15	Robe Pisolite		CID: (10 - 20 mbgl): Pisolite, red and yellow pisolites in reddish-brown matrix. Minor yellow ocherous goethite, minor grey vitreous goethite. Vughy in places.	MANA MANA MANA			0 - 2 mbgl, bentonite seal.
- 20 			CID: (20 - 24 mbgl): As above but with yellow limonitic clay.	WYWWY WWWY WWWYWW			50mm blank PVC casing, - 0.50 - 40 mbgl.
<b>25</b>			CID: (24 - 28 mbgl): As above but with brown clay.	my my my	SWL: 27.27 mbgl	<u>.</u>	2 - 54 mbgl, 3.2
- 30 - -	rge)		CLAY: (28 - 34 mbgl): Sticky yellow clay.	Atherna Maria	(28.03 mbtoc) Final airlift yield: 0.7 L/s. pH: 8.38		- 6.4 mm graded gravel pack.
- 35 - -	noom Formation (Bee Gorge)		CLAY: (34 - 44 mbgl): Light grey clay.	) the production	EC: 606 µS/cm Temp: 31.8 ℃		
<b> 40</b>	Wittenoom Forr			100			50mm slotted PVC casing, 40- 58 mbgl.
- 45 - -	>		CLAY: (44 - 48 mbgl): Yellow clay.		First water strike approx 44 mbgl - very little flow (<0.1L/s). Flow increased to 1.5 -		
- <b>50</b> - -	Wittenoom Dolomite		SHALE: (48 - 58 mbgl): Black shale with grey dolomite.		2 L/s by 58 mbgl.		
- 55 -	Wittenoo						



**HOLE DETAILS** 

**DRILLING DETAILS** 

**GRID NAME:** MGA 94, Zone 50

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

LOCATION: Mesa H

**DRILLER:** Ben Smith **DRILLING METHOD: RC**  **EASTING:** 414906.39 **NORTHING:** 7597496.70

**LOCATION** 

**DATE COMMENCED: 15/2/2015 DATE COMPLETED:** 16/2/2015

**HYDROGEOLOGIST:** A.Price

**ELEVATION:** 161.92 mRL (TOC)

Peg ID: 16MEH\_M09. RC: 7½" diameter 0 - 4 mbgl. 5 - 52 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
	ge	Lif		( 0-200cps)			
- -0		D					6" PVC collar grouted, 0 - 4
- - -			CID: (0 - 2 mbgl): Pisolite, yellow ocherous goethite, red hematite. Grey vitreous goethite.  Minor Quartz.	Mary Market			mbgl. Steel stick up 700 mm above natural surface. 1 m x 1
5 - - -			CID: (2 - 6 mbgl): Weathered pisolite, red and yellow clay, rare white clay. Vitreous goethite, hematite.				m x 300 mm concrete plinth (200 mm above ground level).
- 10			CID: (6 - 10 mbgl): Vitreous goethite matrix, red hematite and yellow goethite pisolites.  CID: (10 - 16 mbgl): As above but with pale	hyhmadow Marin			,
- - 15 -	isolite		yellow limonitic clay and more weathered.	AND MAN PER			0 - 2 mbgl, bentonite seal.
_ _ 20	Robe Pisolite		CLAY: (16 - 19 mbgl): Dense white clay.  CID: (19 - 34 mbgl): Brown and grey, weathered. Limonitic clay.	100	2000		50mm blank PVC casing, - 0.50 - 34 mbgl.
- - - <b>25</b>			would but I amount out.	MILL WILL			
- - - - - 30				My May frankly M	First water strike approx 28 mbgl - very little flow (<0.1L/s). No flow increase during drilling.		2 - 52 mbgl, 3.2 - 6.4 mm graded gravel pack.
_ 35 - -			CLAY: (34 - 38 mbgl): Red and white clay. Grey shale and weathered BIF. Rare quartz.	A My My M	No airlift yield during attempted development.		50mm slotted PVC casing, 34- 52 mbgl.
- 40	rmation		BIF: (38 - 52 mbgl): BIF. Brown, yellow and red. Minor white clay and grey to black shale.	0	SWL: 41.72 mbgl		
- - <b>45</b> -	Brockman Formation			WYDAWAYNY.	(42.52 mbtoc)		
- - <b>50</b>		-7-7					

# MB16MEH0010 / MB16MEH0011

**HOLE DETAILS** 

**DRILLING DETAILS** 

GRID NAME: MGA 94, Zone 50

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY:** Bunbury Drilling

**EASTING:** 417971.10

**LOCATION** 

LOCATION: Mesa H

DRILLER: John Nesbitt

**NORTHING:** 7594055.67

DATE COMMENCED: 17/2/2016

DATE COMPLETED: 18/02/2016

DRILLING METHOD: Air Hammer
HYDROGEOLOGIST: Marisa Mochizuki

ELEVATION S: 175.08 mRL (TOC)

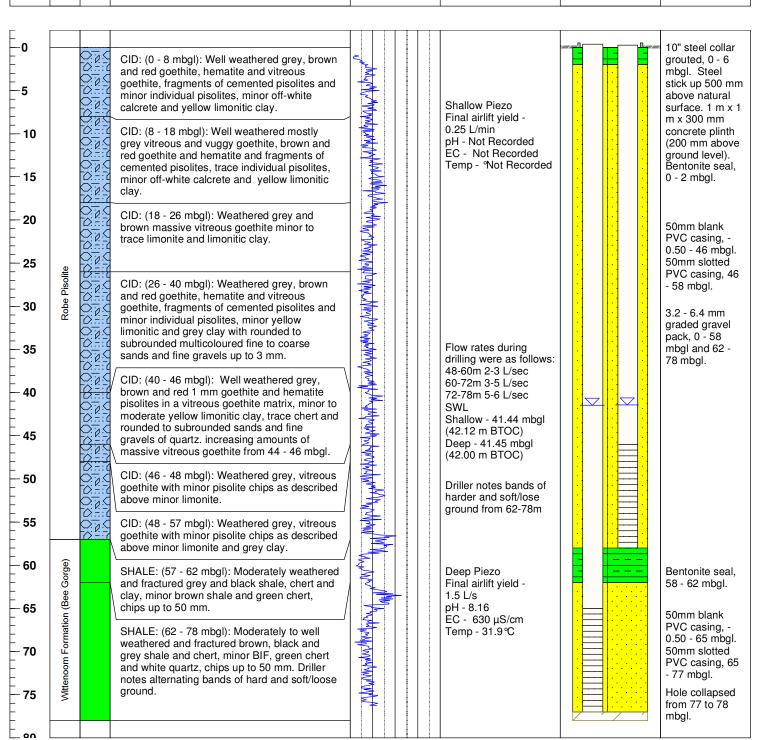
ELEVATION D: 174.96 mRL (TOC)

Peg ID: 16MEH\_M14

Hammer Bit:  $14\frac{3}{4}$ " diameter 0 - 6 mbgl .  $8\frac{1}{2}$ " diameter 0 - 78 mbgl.

Shallow piezometer - MB16MEH0010, deep piezometer - MB16MEH0011. Parent hole - HM16MEH0003

	epth	0		Lithological Description	Gamma	Field Notes	Well Design	Well
(r	nbgl)	Geol	Litho		( 0-80 cps)			Construction





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# MB16MEH0012

**HOLE DETAILS** 

**DRILLING DETAILS** 

LOCATION

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY:** Bunbury Drilling

GRID NAME: MGA 94, Zone 50

LOCATION: Mesa H

**DRILLER:** Dave Usher

**EASTING:** 419768.32

DATE COMMENCED: 19/2/2016

**DRILLING METHOD:** Air Hammer

NORTHING: 7592737.21

DATE COMPLETED: 22/02/2016

HYDROGEOLOGIST: Marisa Mochizuki

ELEVATION: 165.22 RL (GL)

Peg ID: 16MEH\_M01

Mud Rotary Tricone Bit: 143/4" diameter 0 - 8 mbgl . 81/2" diameter 8 - 49 mbgl.

Failed nested piezometer

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma ( 0-200cps)	Field Notes	Well Design	Well Construction
	ALLUVIUM		ALLUVIUM: (0 - 6 mbgl): Reddish-brown, sand and silt, sub-rounded to sub-angular gravel to 3 cm of chert, shale and BIF, vuggy goethite, minor round to sub-round goethite and hematite pisolites.	A MANAMAN AND AND AND AND AND AND AND AND AND A			10" steel collar grouted, 0 - 8 mbgl. Steel stick up 500 mm above natural surface. 1 m x 1 m x 300 mm
- - - - 10		0.00	CID: (6 - 8 mbgl): Weathered grey, red and brown goethite and hematite pisolites and chips of vitreous goethite minor yellow limonitic clay/mudstone, moderate fallback/contamination.	Apayland Mardylo	Significant mud loss btwn 0 and 6 mbgl.		concrete plinth (200 mm above ground level).
- - - - - 15	PISOLITE	0.7 C	CLAY: (8 - 10 mbgl): Grey, silty clay with gravel (to 3 cm) of chert, shale, BIF, goethite and hematite.  CID: (10 - 12 mbgl): Weathered grey vitreous and yellow ochreous goethite, minor pisolites,	Mary Thankart			Bentonite seal, 0 - 2 mbgl.
- - - - 20	ш	0 0 C	hematite and grey and yellow limonitic clay.  CLAY: (12 - 14 mbgl): Grey and yellow clay with weathered vitreous to earthy goethite and minor hematite.	100 May 121 May May 100	Lost circulation from ~26 mbgl with		
		0.7.	CID: (14 - 16 mbgl): Moderately weathered	MA I	complete lost circ from		

Land And Land Land Market Land And And Land

3

CID: (14 - 16 mbgl): Moderately weathered vitreous and mildly vuggy hematite and goethite, minor yellow ocherous goethite, grey and yellow clay, trace hematite pisolites.

CID: (16 - 20 mbgl): Weathered yellow ochreous goethite and grey vitreous to siliceous goethite, minor hematite and cemented fine (to 1mm) yellow and brown individual pisolites and pisolite clasts.

CID: (20 - 24 mbgl): Red hematite and yellow ochreous to grey goethite, clasts of fine (to 1 mm) cemented pisolites, minor vitreous to highly vitreous goethite. Driller notes slightly harder ground.

NO SAMPLE: (26 - 49 mbgl): No sample, lost circ.

~26 mbgl with complete lost circ from 32 mbgl (cavaties or fractures). No sample return from 32 mbgl for remainder of hole.

Minor fractures noted from 30 - 40 mbgl with bands of harder and softer ground btwn 40 and 47 mbgl.

SWL: 33.22 mbgl (33.94 mbtoc)

Final airlift yield -0.25 L/sec pH - 8.65 EC - 583 µS/cm Temp - 32.3 ℃ 3.2 - 6.4 mm graded gravel pack, 0 - 47

mbgl.

 $\nabla$ 

50mm blank PVC casing, -0.50 - 35 mbgl. 50mm slotted PVC casing, 35 - 47 mbgl.



# **HOLE DETAILS**

PROJECT: Mesa H PFS 2016

LOCATION: Mesa H

DATE COMMENCED:22/02/16

DATE COMPLETED: 23/02/16

# **DRILLING DETAILS**

**DRILLING COMPANY: Ranger Drilling** 

**DRILLER:** Andrew McPherson

**DRILLING METHOD: RC** 

HYDROGEOLOGIST: Marisa Mochizuki

# **LOCATION**

**GRID NAME:** MGA 94, Zone 50

**EASTING:** 419286.91 **NORTHING:** 7592165.60

**ELEVATION:** 183.13 mRL (TOC)

Peg ID: 16MEH\_M04 RC: 7½" diameter 0 - 5 mbgl. 5 - 76 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
( '3')	Ğ	Lif		( 0-200cps)			
-0 -5 -10 -15 -20	Robe Pisolite		CID: (0 - 2 mbgl): Weathered brown and grey chips (to 15 mm) of cemented, fine (to 1 mm) hematite and goethite pisolites, minor linonite and vitreous goethite, minor quartz.  CID: (2 - 4 mbgl): Brown and grey vitreous goethite, and clasts of cemented pisolites, moderate limonite.  CID: (4 - 13 mbgl): Yellow limonite and grey, highly vitreous and mildly vuggy goethite, minor hematite.  CLAY: (13 - 17 mbgl): Red and yellow clay, stiff dark grey clay, minor vitreous goethite and pisolite clasts.  CID: (20 - 26 mbgl): Chips (to 20 mm) of	100	200		6" PVC collar grouted, 0 - 5 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).  0 - 2 mbgl, bentonite seal.  50mm blank PVC casing, - 0.50 - 64 mbgl.
25   30 			vitreous gothite, chert, BIF, and shale, minor grey and yellow clay increasing from 24 - 26 mbgl.  CID: (26 - 28 mbgl): Dark chert, goethite, BIF, and shale chips (to 15 mm), substantial yellow and grey clay.	W What was many minima was	Final airlift yield: <0.25 L/s. pH: 8.77		2 - 40 mbgl, 3.2 - 6.4 mm graded gravel pack.
- 35 - - - 40 - - - 45	Clay		CID: (28 - 32 mbgl): Dark chert, goethite, BIF, and shale chips (to 15 mm), minor yellow and grey clay.  CLAY: (32 - 42 mbgl): Grey and yellow sticky clay.  CLAY: (42 - 50 mbgl): Grey, yellow and white clay with minor purple clay from 44 - 46 mbgl.	100 אין איין איין איין איין איין איין איי	First water strike approx 50 mbgl - no		40 - 44 mbgl, bentonite seal.
_ <b>50</b>			CLAY: (52 - 54 mbgl): Yellow, grey and purple clay.	rvm.hallahallo	significant flow.  SWL: 51.12 mbgl (51.80 mbtoc)	<u> </u>	40 - 44 mbgl, 3.2 - 6.4 mm graded gravel
55 - - - - 60		- <u></u>	BIF: (54 - 58 mbgl): Reddish purple shale and chert, minor yellow and grey clay, minor hematite.	ty My			pack.
60  -  -  -  -  - 65	Wittenoom Formation	-7/-7	BIF: (58 - 64 mbgl): Red and grey BIF, hematite, red and brown shale and chert. SHALE: (64 - 70 mbgl): Black shale, minor	100			
- 70	Wittenoom		hematite and goethite, trace secondary silicification along fracture planes, trace to minor brown and red shale.				04. 70 mh
- - - - - 75			SHALE: (70 - 76 mbgl): Black shale, magnetic, minor hematite and goethite, trace secondary silicification along fracture planes, trace to minor brown and red shale, increase	the Amount			64 - 76 mbgl ,50mm slotted PVC casing.

Depth

# **MB16MEH0014**

**Lithological Description** 

# **HOLE DETAILS**

# **DRILLING DETAILS**

# **LOCATION**

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

Gamma

**Field Notes** 

LOCATION: Mesa H

**DRILLER:** Andrew McPherson

**DATE COMMENCED:**18/02/2016

**DRILLING METHOD: RC** 

**DATE COMPLETED:** 18/02/2016 HYDROGEOLOGIST: Marisa Mochizuki **GRID NAME:** MGA 94, Zone 50

**EASTING:** 418861.54

**NORTHING:** 7598680.02

Well Design

**ELEVATION:** 139.33 mRL (TOC)

Well

Peg ID: 16MEH\_M11 RC: 7½" diameter 0 - 5 mbgl. 5 - 64 mbgl 5½" diameter.

(mbgl)	Geolo	Litholo				1 1014 110100	200.g	Construction
	5	֓֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞֞		( 0-200cps)				
	Alluvium		ALLUVIUM: (0 - 18 mbgl): Strongly weathered reddish-brown, sub-rounded to sub-angular gravel to 30mm of chert and BIF, sand and silt, minor clay 10 - 12 and 16 - 18 mbgl.	Later Commenter Part Miller Comment		SWL: 8.88 mbgl (9.44 mbtoc)	<b>■</b>	6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).
_ 15 			ALLUVIUM: (18 - 19 mbgl): Strongly weathered reddish-brown, sub-round to sub-angular gravel to 30 mm of chert and BIF, sand and silt, minor red clay, vitreous goethite and pisolites.	mad hall delt				0 - 2 and 34-38 mbgl, bentonite seal.
<b>20</b>			CID: (19- 21 mbgl): Reddish-brown, silt and clay with grey vitreous goethite, cemented pisolites minor angular chert and BIF.	100	200			PVC casing, - 0.50 - 40 mbgl.
<b>25</b> - - - -			CLAY: (21- 26 mbgl): Brown and grey clay with fragments (to 10 mm) of vuggy vitreous goethite and hematite, cherts and shale.  CLAY: (26- 31 mbgl): Pale brown and grey					2 - 34 and 38-64 mbgl, 3.2 - 6.4
- <b>30</b>	Robe Pisolite	0.7.0	clay with minor weathered fragments of shale, chert, quartz and weathered goethite.	My wash		Final airlift yield: 2.5 L/s. pH: 8.08		mm graded gravel pack.
35    40	R		CID: (31- 45 mbgl): Strongly weathered reddish brown shale, chert, massive, vuggy goethite becoming more grey and enriched with depth, moderate limonitic clay that increases with depth, trace to minor botryoidal goethite and pisolites.	MAN 100 MAN 100 MAN		EC: 1096 µS/cm Temp: 31.6 ℃		50mm slottedPVC casing, 40-64
- - - - - -			CLAY: (45- 48 mbgl): Brown to yellow clay transition zone, minor shale chert and goethite.			First water strike approx 12 mbgl - very little flow (<0.1L/s). flow increased to		mbgl.
50	ation		DOLOMITE: (48- 52 mbgl): Fresh bluish grey, crystalline, silicified dolomite.	March Market		1L/sec at 30 m then to 2.5 L/sec around 40 - 50 m.		
- - 55	Wittenoom Formation		DOLOMITE: (52- 54 mbgl): Mildly weathered bluish grey, crystalline, silicified dolomite, minor red shale and pale brown clay.	يود-ماليوسد				
- - - - 60	Witten		DOLOMITE: (54- 64 mbgl): Fresh bluish grey, crystalline, silicified dolomite, minor red shale and pale brown clay from 60 - 62 mbgl.	100 مالاسح	200			
_ 65								



**HOLE DETAILS** 

# **DRILLING DETAILS**

**LOCATION** 

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

LOCATION: Mesa H

**DRILLER:** Andrew McPherson

**DATE COMMENCED:**19/02/2016 **DATE COMPLETED:** 19/02/2016 **DRILLING METHOD: RC** 

HYDROGEOLOGIST: Marisa Mochizuki

GRID NAME: MGA 94, Zone 50

**EASTING:** Not Surveyed NORTHING: Not Surveyed

**ELEVATION: Not Surveyed** 

Peg ID: 16MEH\_M11 RC: 7½" diameter 0 - 5 mbgl. 5 - 40 mbgl 5½ diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
( 3,	ğ	를		( 0-200cps)			
ΓΙ					T		
- - - - -			ALLUVIUM: (0 - 18 mbgl): Strongly weathered reddish-brown, sub-rounded to sub-angular gravel to 30mm of chert and BIF, sand and silt, minor clay 10 - 12 and 16 - 18 mbgl.				
5 - - - - - - 10 -	Alluvium				First water strike		Hole not constructed and abandoned due to surface casing blow out and hole collapse.
- - - 15 - -					approx 12 mbgl. Flow increased to 0.75L/sec at ~20m.		
- 20 - -			CID: (18 - 24 mbgl): A mix of alluvium as above with minor to moderate brown and red clay, vitreous, vuggy goethite with botryoidal formation and pisolites.				
- <b>25</b> - - -	Pisolite		CLAY: (24 - 30 mbgl): Pale yellow, brown to grey, silty clay with minor chert and quartz, vuggy vitreous goethite and red to brown shale. Clay content decreases from 28 - 30 mbgl.				
<b>— 30</b>	Robe	0:::0 0:::0 0:::0	CID: (30 - 32 mbgl): Well weathered brown shale and vuggy goethite trace limonite and silty clay.		Surface casing blew out and broke. The hole collapsed and		
- - - <b>35</b>			CLAY: (32 - 34 mbgl): Pale brown and grey clay with minor weathered fragments of shale and weathered goethite.		could not be stabilised. It was then back filled and abandoned.		
- - -			PISOLITE: (34- 40 mbgl): Well weathered reddish brown shale, vuggy goethite, some botryoidal goethite and hematite, white quartz vein at 36 - 38 mbgl and increased limonitic clay from 38 - 40 mbgl.				
<b> 40</b>							



**HOLE DETAILS** 

**DRILLING DETAILS** 

**GRID NAME:** MGA 94, Zone 50

**LOCATION** 

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

**EASTING:** 418854.63

LOCATION: Mesa H **DATE COMMENCED: 19/02/2016**  **DRILLER:** Andrew McPherson **DRILLING METHOD: RC** 

**NORTHING:** 7598682.99

**DATE COMPLETED: 19/02/2016** 

HYDROGEOLOGIST: Marisa Mochizuki

**ELEVATION:** 139.44 mRL (TOC)

Peg ID: 16MEH\_M11 RC: 7½" diameter 0 - 5 mbgl. 5 - 30 mbgl 5½ diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma ( 0-200cps	s)	Field Notes	Well Design	Well Construction
- -0 - - -5 - - -10 - - - 15	Alluvium		ALLUVIUM: (0 - 18 mbgl): Strongly weathered reddish-brown, sub-rounded to sub-angular gravel to 30mm of chert and BIF, sand and silt, minor clay 10 - 12 and 16 - 18 mbgl.	June James J		SWL: 8.94 mbgl (9.5 mbtoc)  Gamma tool could not penetrate past 12m  First water strike approx 12 mbgl. Flow increased to 0.75L/sec at ~20 m.		6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).  50mm blank PVC casing, - 0.50 - 6 mbgl.  0 - 2 mbgl, bentonite seal.  2 - 30 mbgl, 3.2 - 6.4 mm graded gravel pack.
- - <b>20</b> - -	Pisolite	00000000000000000000000000000000000000	CID: (18 - 24 mbgl): A mix of alluvium as above with minor to moderate brown and red clay, vitreous, vuggy goethite with botryoidal formation and pisolites.	100	200			
- <b>25</b> - - -	Robe Pis		CLAY: (24 - 30 mbgl): Pale yellow, brown to grey, silty clay with minor chert and quartz, vuggy vitreous goethite and red to brown shale. Clay content decreases from 28 - 30 mbgl.			Final airlift yield: 0.35 L/s. pH: 8.33 EC: 957 µS/cm Temp: 30.4 ℃		50mm blank PVC casing, 24 - 30 mbgl.
- <b>30</b>							<u>.'</u>	

# **MB16MEH0017**

**Lithological Description** 

# **HOLE DETAILS**

# **DRILLING DETAILS**

# **LOCATION**

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

Gamma

**Field Notes** 

LOCATION: Mesa H

**DRILLER:** Andrew McPherson

**DATE COMMENCED:**19/02/2016

**DRILLING METHOD: RC** 

**DATE COMPLETED: 21/02/2016** HYDROGEOLOGIST: Marisa Mochizuki **GRID NAME:** MGA 94, Zone 50

**EASTING:** 419597.88 **NORTHING:** 7592744.90

**Well Design** 

**ELEVATION:** 165.68 mRL (TOC)

Well

logy

Depth

logy

Peg ID: 16MEH\_M13 RC: 7½" diameter 0 - 8 mbgl. 8 - 76 mbgl 5½ diameter.

(mbgl)	Geolog	Litholog	Littiological Description	Gaiiilia	Field Notes	well besign	Construction
	Ğ	Ľ		( 0-100cps)			
-0 -5 -10 -15	Alluvium		ALLUVIUM: (0 - 6 mbgl): Reddish-brown, sub-rounded to sub-angular gravel to 30 mm of chert, shale and BIF, sand and silt, rounded to subrounded pisolites of goethite and hematite, minor brown clay btwn 4 - 6 mbgl.  CLAY: (6 - 10 mbgl): Brown, yellow and grey, silty clay with yellow ochreous goethite and chips of weathered hematite and goethite pisolites.  CID: (12- 18 mbgl): Weathered yellow and red to brown ochreous goethite, hematite and cemented pisolites clasts, minor yellow and grey mudstone, minor vitreous goethite,	50 Sin May My My Charles And May			6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level).
	Robe Pisolite	3(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$(\$	increasing clay btwn 12 - 14 and 16 - 18 mbgl.  CID: (18 - 36 mbgl): Red hematite and yellow ochreous to grey goethite, clasts of fine cemented pisolites, minor vitreous to highly vitreous goethite, minor to trace clays.  CID: (36- 42 mbgl): Grey vitreous and yellow ochreous goethite and red to brown hematite, substantial yellow and brown clay btwn 36 and 38 mbgl, only trace chips showing pisolitic texture.  CID: (42- 44 mbgl): An even mix of grey clay,	50 50 50 50 50 50 50 50 50 50 50 50 50 5	Loose ground near surface. Cavities noted at 22 - 23 mbgl and 30-31 mbgl with smaller cavities/fractures between.  SWL: 33.44 mbgl (34.10 mbtoc)  First water strike approx 40 mbgl. No significant flow during		2 - 50 and 54-76 mbgl, 3.2 - 6.4 mm graded gravel pack.  32 - 50mbgl, 50mm slotted PVC casing.
- 45 - - - - 50	WF (Bee Gorge)		yellow ochreous and grey vitreous goethite, minor chert and white quartz.  CLAY: (44- 46 mbgl): White and pale yellow silty clay with minor chips (to 5 mm) of chert, white quartz and pisolites.		drilling or airlifting.		Š
	WF (Dolomite)		CLAY: (46- 52 mbgl): Brown silty clay with minor chips (to 30 mm) of chert, BIF, shale, earthy goethite and minor pisolites.  DOLOMITE: (52- 60 mbgl): Bluish grey highly crystalline to siliceous Dolomite, some ships have weak, darker grey to black and white bands and veins, minor manganese along fracture planes, minor clay btwn 58 and 60 mbgl.  DOLOMITE: (60- 64 mbgl): Hard dark grey to purple highly crystalline to siliceous dolomite to chert, trace black and white bands and veins, minor manganese along fracture planes, minor clay btwn 58 and 60 mbgl.	50			0 - 2 and 50 - 54 mbgl, bentonite seal.
L L				<del> </del>	I.		



# **HOLE DETAILS**

# **DRILLING DETAILS**

# **LOCATION**

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

LOCATION: Mesa H

**DRILLER:** Andrew McPherson

**DATE COMMENCED:**23/02/2016

**DRILLING METHOD: RC** 

**DATE COMPLETED: 23/02/2016** HYDROGEOLOGIST: Marisa Mochizuki **GRID NAME:** MGA 94, Zone 50

**EASTING:** 418273.51 NORTHING: 7593072.81

**ELEVATION:** 168.34 mRL (TOC)

Peg ID: 16MEH\_M05 RC: 7½" diameter 0 - 5 mbgl. 5 - 52 mbgl 5½ diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
	Ğ	Ĭ		( 0-150cps)			
[ _ <b>0</b> ]							6" PVC collar
- - - - -5	Robe Pisolite		CID: (0 - 6 mbgl): Weathered red and grey hematite and goethite pisolites and chips of pisolite clasts, red silt, minor shale and sands decreasing with depth.	A way had			grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm
- - - - - 10	Robe		CID: (6 - 10 mbgl): As above but with minor shale, minor limonite and yellow and grey clay and increasing amounts of vitreous goethite from 6- 10 mbgl.	mand my Mandalan Mandalan			concrete plinth (200 mm above ground level).
-		-72-7. -72-7.	BIF: (10 - 14 mbgl): Even mix of silty yellow and grey clay, multi coloured chert and BIF, minor vitreous goethite.	Manny M			0 - 2 mbgl, bentonite seal.
— 15 - -		-\-\-\-\-\-\-\-\-\-\-\-\-\-\-\-\-\-\-\	BIF: (14- 16 mbgl): Pale and multi coloured chert and minor shale/siltstone/silty yellow and grey clay.	Mahama			
<b>20</b>		-72-7 -72-7	BIF: (16 - 24 mbgl): Pale and multi coloured chert and minor shale/siltstone/silty white with minor yellow clay.	75			50mm blank PVC casing, - 0.50 - 36 mbgl.
_		-77		M			
— <b>25</b> -		-7/-7	BIF: (24- 28 mbgl):Yellow red, and grey chert, minor shale and clay.				
- - - - 30	Marra Mamba Formation	/	SHALE: (28- 29 mbgl): Black shale, significant black yellow and red chert.	3			2 - 52 mbgl, 3.2 - 6.4 mm graded gravel pack.
- 30 - -	amba F	_7/_7	BIF: (29- 31 mbgl): Black yellow and red chert, minor black shale.				
- - 35	Marra M		SHALE: (31- 36 mbgl): Mildly weathered black shale, dark red, black and orange chert, minor grey and yellow clay.		SWL: 35.22 mbgl		
-			SHALE: (36- 38 mbgl): Black shale dark red and black chert, minor grey clay.		(36.01 mbtoc)		
- - - -			CHERT: (38 - 42 mbgl): Fresh black and dark grey chert with significant shale, minor colourless quartz.	75 75	First water strike approx 40 mbgl. No significant flow during		36 - 48 mbgl, 50mm slotted PVC casing.
- 45 -			SHALE: (42- 47 mbgl): Black and dark grey shale with significant chert.		drilling or airlifting.		
- - <b>50</b>			CHERT: (47- 52 mbgl): Black and dark grey chert with minor shale.	MAN A			
L [							



# **HOLE DETAILS**

# **DRILLING DETAILS**

# **LOCATION**

**EASTING:** 

PROJECT: Mesa H PFS 2016

**DRILLING COMPANY: Ranger Drilling** 

HYDROGEOLOGIST: Marisa Mochizuki

LOCATION: Mesa H

**DRILLER:** Andrew McPherson

**DATE COMMENCED:**23/02/2016 **DATE COMPLETED: 24/02/2016**  **DRILLING METHOD: RC** 

**NORTHING:** 7591715.26

**ELEVATION:** 178.53 mRL (TOC)

GRID NAME: MGA 94, Zone 50

419938.38

Peg ID: 16MEH\_M03 RC: 7½" diameter 0 - 5 mbgl. 5 - 70 mbgl 5½ diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma	Field Notes	Well Design	Well Construction
	Ğ	Ë		( 0-150cps)			
	Robe Pisolite		CID: (0 - 2 mbgl): Well weathered clasts of cemented red and grey fine (to 1mm) pisolites and goethite, red silt.  CID: (2 - 4 mbgl): Weathered grey and brown vitreous goethite, minor limonite and yellow clay.  CID: (4 - 7 mbgl): Weathered grey and brown vitreous goethite, minor limonite and yellow clay with substantial yellow chert.  SHALE: (7 - 9 mbgl): Yellow shale, minor chert, vitreous goethite and grey clay.  CID: (9 - 14 mbgl): Weathered massive vitreous goethite, minor grey and trace yellow and red clay and limonite. Increased red clay from 8 - 10 mbgl. Becoming slightly more weathered from 12 - 14 mbgl.  CID: (14- 16 mbgl): Grey and yellow clay with significant weathered vitreous goethite and hematite.	WWW. W. C. W			6" PVC collar grouted, 0 - 4 mbgl. Steel stick up 700 mm above natural surface. 1 m x 1 m x 300 mm concrete plinth (200 mm above ground level). 0 - 2 mbgl, bentonite seal.  50mm blank PVC casing, - 0.50 - 40 mbgl.  2 - 70 mbgl, 3.2 - 6.4 mm graded gravel pack.
_ - - - 35 -			CLAY: (16- 21 mbgl): Stiff grey clay with minor silty red clay, trace to minor vitreous goethite and hematite.	Arrado Art	First water strike		
- - - - - - - - - - - - - - - - - - -	(Bee Gorge)		CID: (21- 23 mbgl): Weathered vitreous goethite and hematite with significant stiff grey and silty red to purple clay.  CLAY: (23- 26 mbgl): Stiff dark grey clay, minor silty red clay.	75	approx 40 mbgl. No significant flow during drilling or airlifting.  SWL: 42.82 mbgl (13.50 mbtoc)		40 - 64 mbgl, 50mm slotted PVC casing.
- - - - - 50	Clay		CID: (26- 28 mbgl): Stiff grey and silty red and yellow clay, minor vitreous goethite.  CID: (28 - 35 mbgl): Weathered vitreous to yellow and brown ocherous goethite, minor hematite and limonite, minor clasts of hematite and goethite pisolites in a vitreous				
_ 55			goethite matrix, minor grey and yellow clay from 30 - 36 mbgl.				
- - - - - - - -	Wittenoom Formation		CLAY: (36 - 53 mbgl):Off white clay, minor red silty clay from 38 - 42 mbgl, minor yellow silty clay from 42 - 48 mbgl, trace silty purple clay from 48 - 50 mbgl, trace red silty clay 50 - 52 mbgl.	0 0			
65  -  -  -  -	Witte		SHALE: (53 - 70 mbgl): Soft black shale, pulverized with only trace chips (to 3 mm)				



# WIRELINE SERVICES

LOG MEASURED FROM: GL

DRL MEASURED FROM: GL

MATRIX DELTA T : 177

LOGGING UNIT

FIELD OFFICE

RECORDED BY

RM

BOREHOLE FLUID

# WB16MEH0001

: RTIO COMPANY

WELL

: WB16MEH000

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : **TOWNSHIP** RANGE:

DATE : 03/13/16 PERMANENT DATUM : GL

DEPTH DRILLER : 84

LOG BOTTOM : 83.50

: -0.80

LOG TOP CASING DIAMETER: 10.

: STEEL CASING TYPE

CASING THICKNESS:

BIT SIZE : 31 MAGNETIC DECL. : 1.438

MATRIX DENSITY : 2.65

**NEUTRON MATRIX**: SANDSTONE

OTHER SERVICES:

PEG#

16MEH P02

KΒ

DF

GL

: SV10

: SURTRON

: CJ

RM TEMPERATURE :

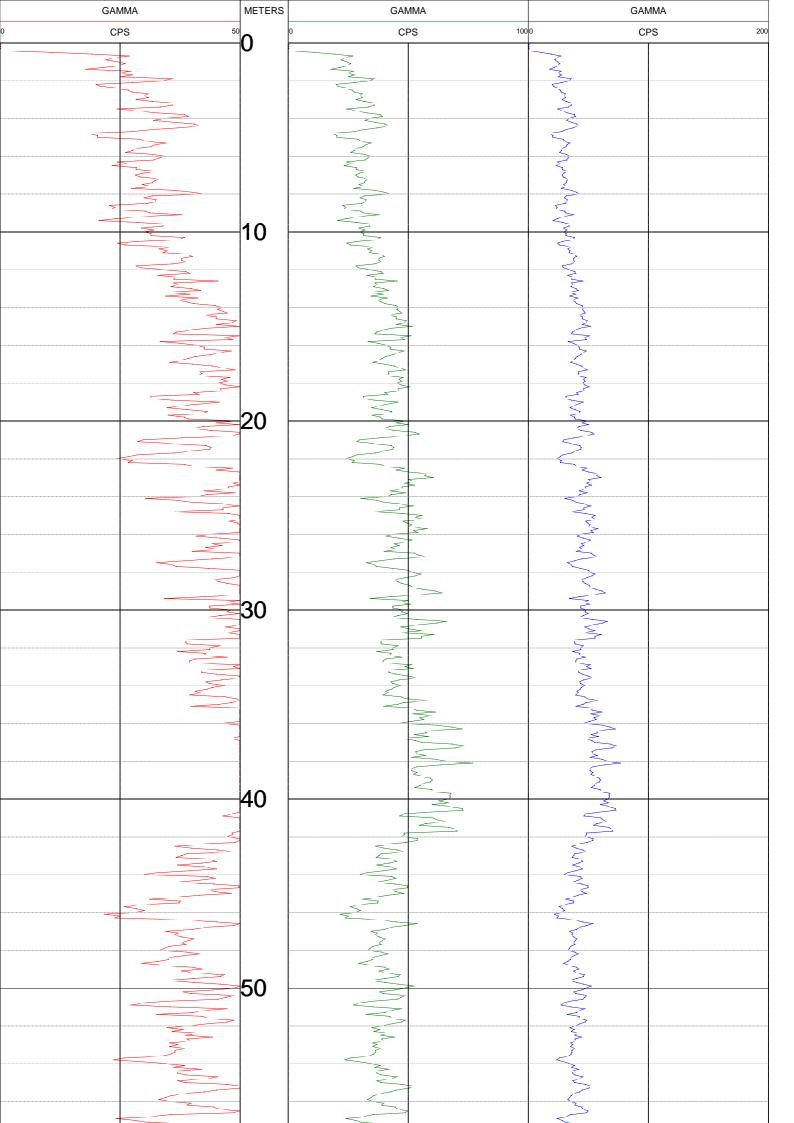
TYPE : 9238AA

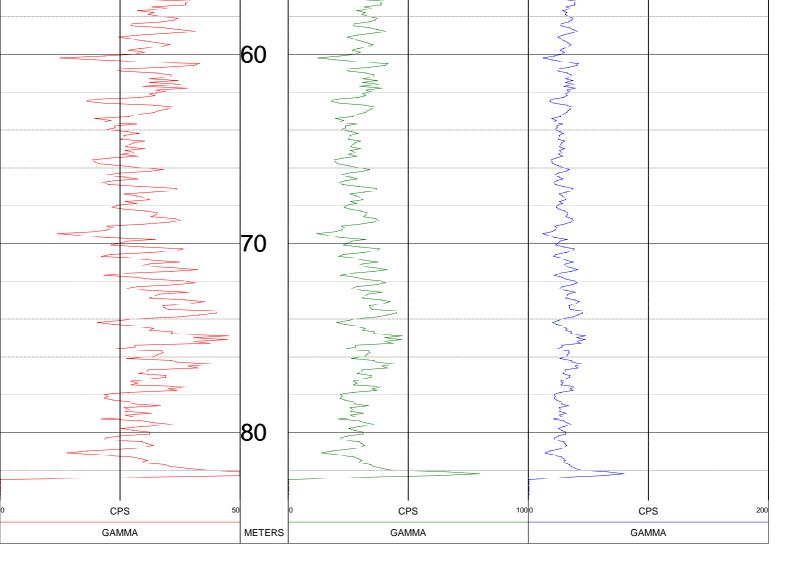
LGDATE: 03/13/16

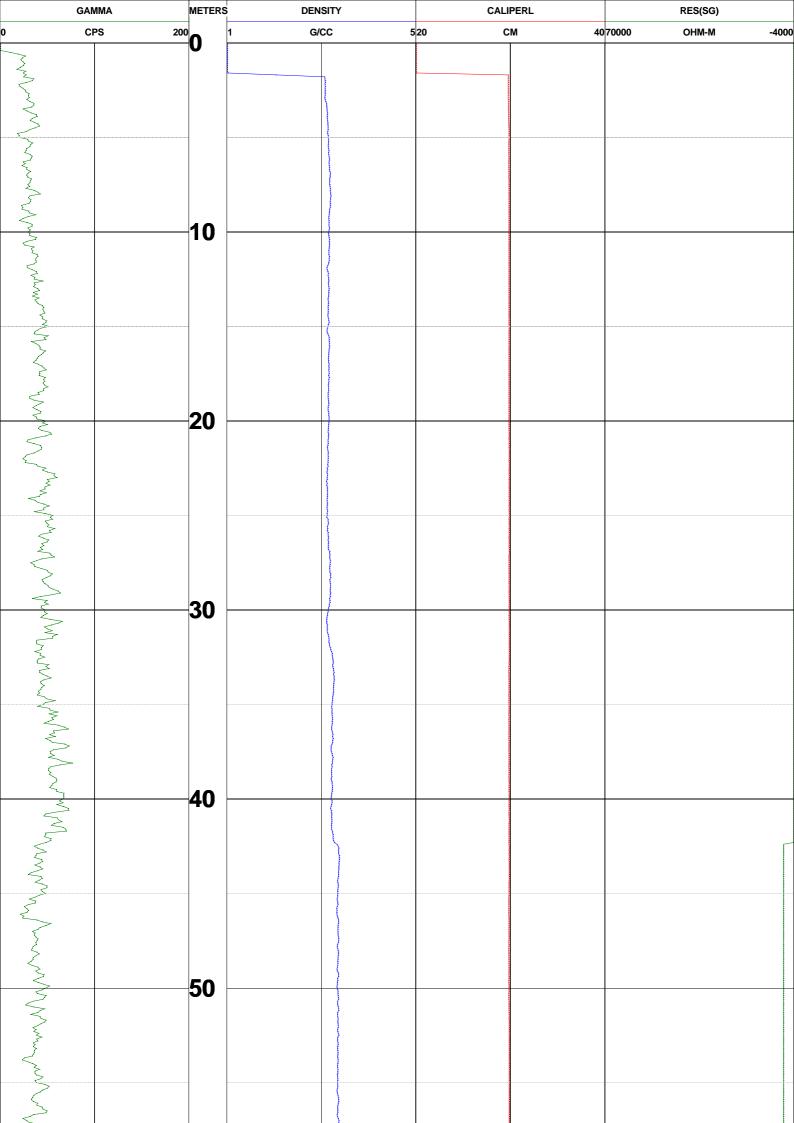
FILE : PROCESSED

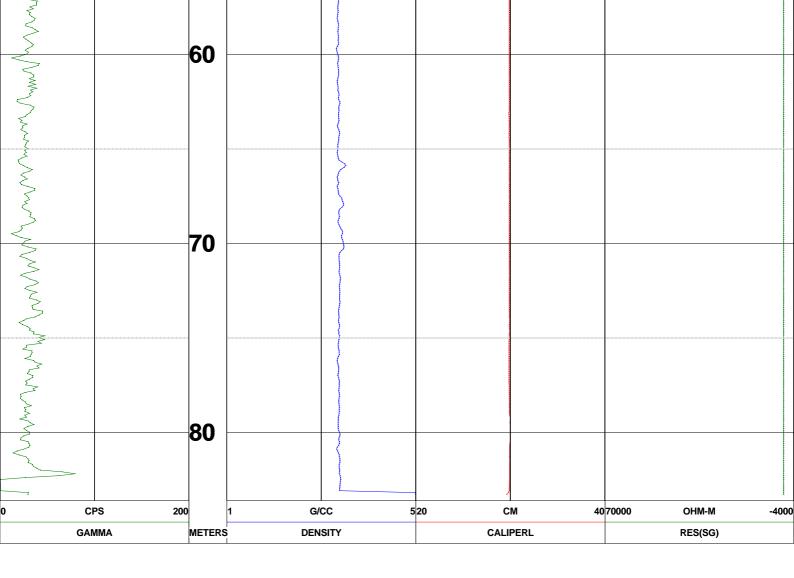
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS











# WIRELINE SERVICES

# WB16MEH0002

OTHER SERVICES:

PEG#

P01

16-MEH

COMPANY : RTIO

WELL

: WB16MEH000

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

LOG BOTTOM

SECTION : TOWNSHIP : RANGE :

DATE : 02/29/16 PERMANENT DATUM : GL

DEPTH DRILLER : 57

: 57 KB : 55.60 LOG MEASURED FROM: GL DF

LOG TOP : 0.10 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV10

CASING TYPE : OPEN FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : RP

BIT SIZE : 31 BOREHOLE FLUID : FILE : PROCESSED

MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

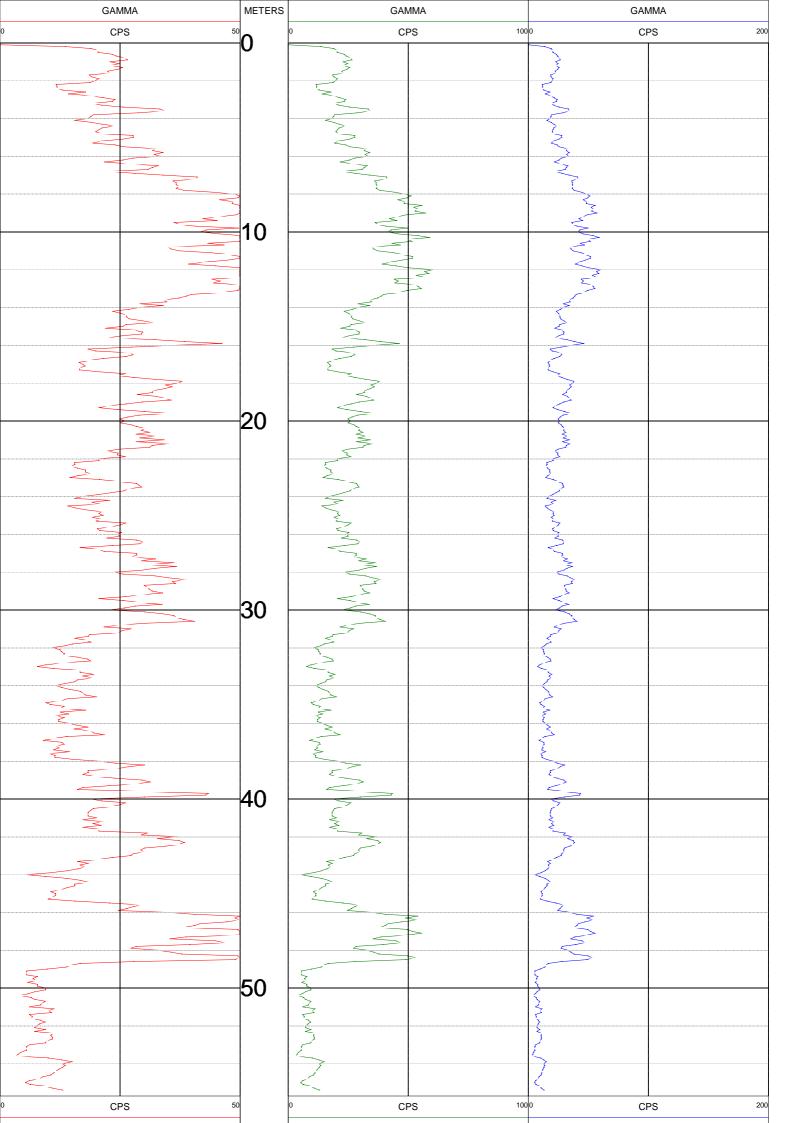
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/29/16

NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



GAMMA METERS GAMMA GAMMA



# WIRELINE SERVICES

# WB16MEH0002

OTHER SERVICES:

PEG#

16MEH

P01

: SV10

: RTIO COMPANY

WELL

: WB16MEH000

: 54.30

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : **TOWNSHIP** RANGE:

DATE : 03/04/16 PERMANENT DATUM : GL

DEPTH DRILLER : 57

LOG BOTTOM

KΒ LOG MEASURED FROM: GL

LOG TOP : -0.80 DRL MEASURED FROM: GL

CASING DIAMETER: 10. CASING TYPE

: STEEL FIELD OFFICE : SURTRON

LOGGING UNIT

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 31 BOREHOLE FLUID FILE : PROCESSED

MAGNETIC DECL. : 1.438 TYPE : 9238AA RM

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 03/04/16

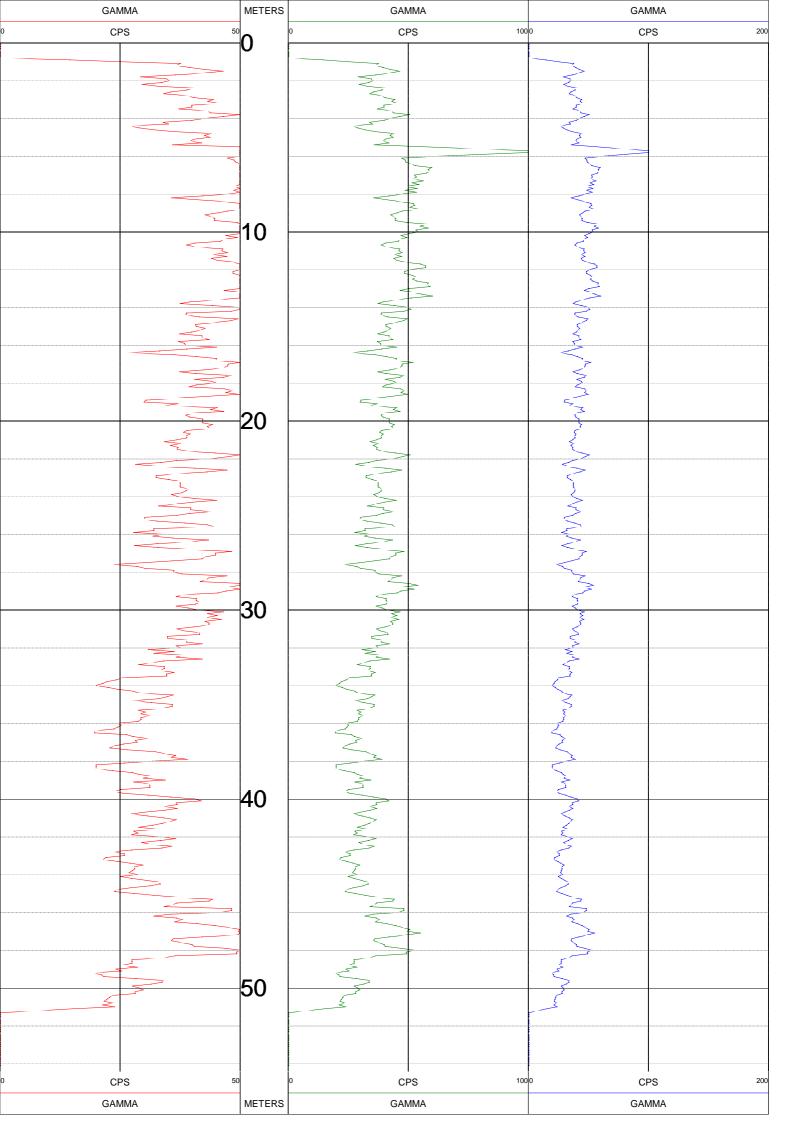
**NEUTRON MATRIX**: SANDSTONE MATRIX DELTA T : 177

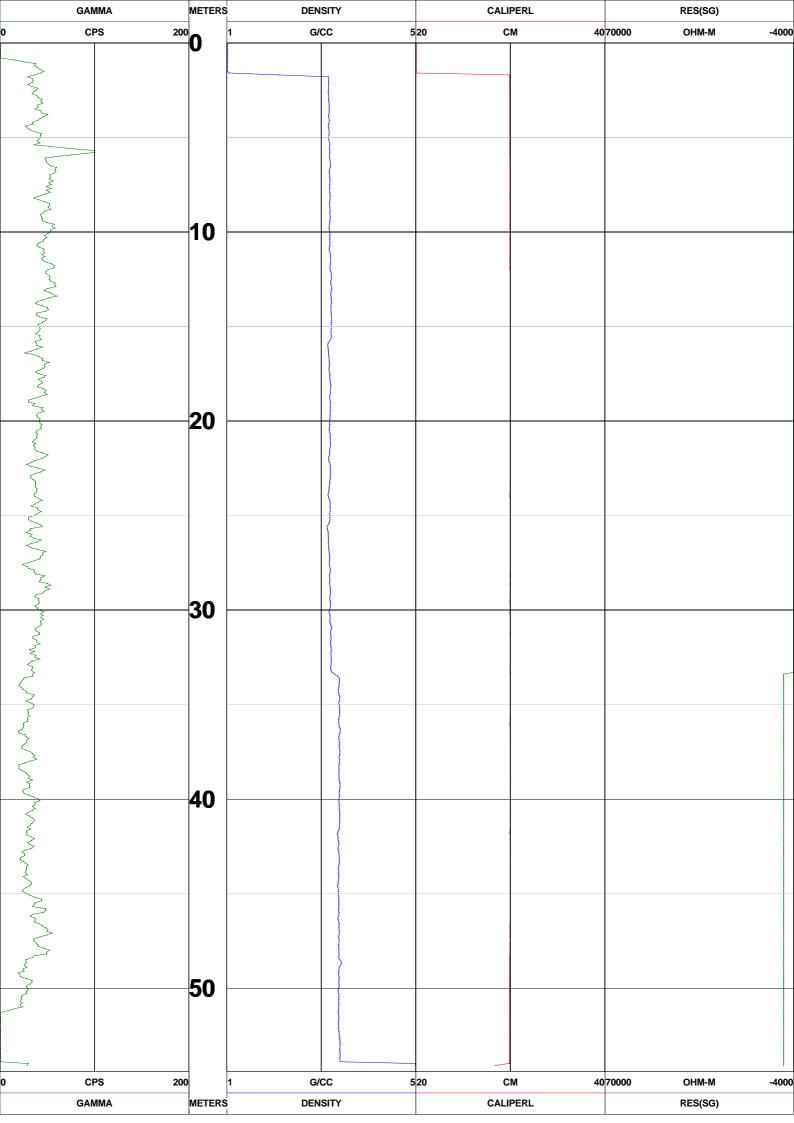
THRESH: 90000

DF

GL

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





# PLAN VIEW COMPU-LOG DEVIATION

CLIENT: RTIO LOCATION: MEH

HOLE ID: WB16MEH0002
DATE OF LOG: 03/04/16

PROBE: 9098C 1217

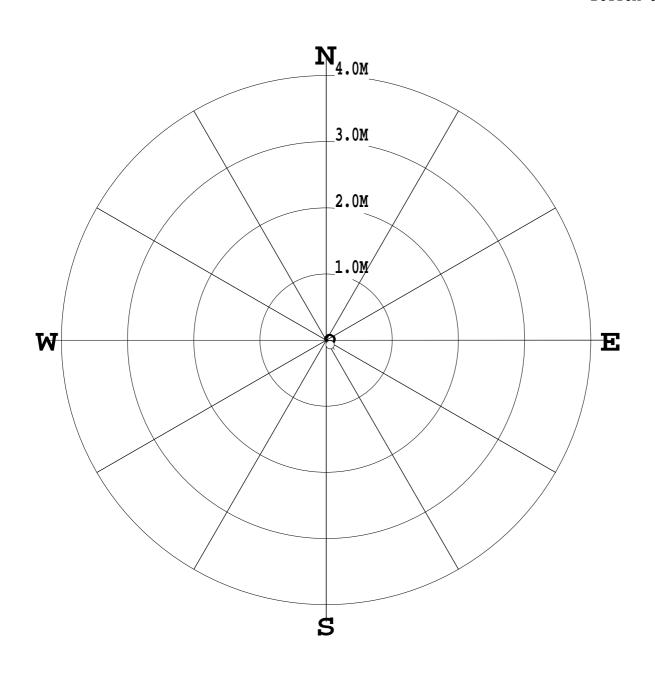
MAG DECL: 1.4

SCALE: 1 M/CM

TRUE DEPTH: 51.30 M

AZIMUTH: 137.6 DISTANCE: 0.1 M + = 50 M INCR

○ = BOTTOM OF HOLE



\* \* \* \* \* \* \* \* COMPU-LOG - VERTICAL DEVIATION \* \* \* \* \* \*

HOLE ID. : WB16MEH0002 DATE OF LOG : 03/04/16 PROBE : 9098C , 1217 DEPTH UNITS : METERS CLIENT : RTIO FIELD OFFICE : SURTRON
DATA FROM :
MAG. DECL. : 1.438
LOG: WB16MEH0002\_GYRO.log

ABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
0.50	0.70	0.00	-0.00	0.0	273.9	0.3	274.6
10.00	10.00	0.04	-0.01	0.0	341.2	0.3	23.1
20.00	20.00	0.07	0.02	0.1	15.8	0.3	54.3
30.00	30.00	0.08	0.07	0.1	42.0	0.3	121.0
40.00	40.00	0.02	0.12	0.1	78.5	0.6	171.1
50.00	50.00	-0.06	0.07	0.1	130.6	0.6	246.3
51.30	51.30	-0.07	0.06	0.1	137.6	0.6	254.4



# WB16MEH0003

COMPANY : RTIO

WELL: WB16MEH000

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : TOWNSHIP : RANGE :

DATE : 03/11/16 PERMANENT DATUM : GL

DEPTH DRILLER : 70

LER : 70

LOG BOTTOM : 69.50 LOG TOP : -0.80

: 69.50 LOG MEASURED FROM: GL : -0.80 DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : STEEL

: 31

: STEEL FIELD OFFICE : SURTRON

CASING THICKNESS:

BIT SIZE

BOREHOLE FLUID : FILE : PROCESSED

OTHER SERVICES:

PEG#

16MEH

P03

: SV10

: CJ

MAGNETIC DECL. : 1.438 RM : TYPE : 9238AA

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 03/11/16

LOGGING UNIT

RECORDED BY

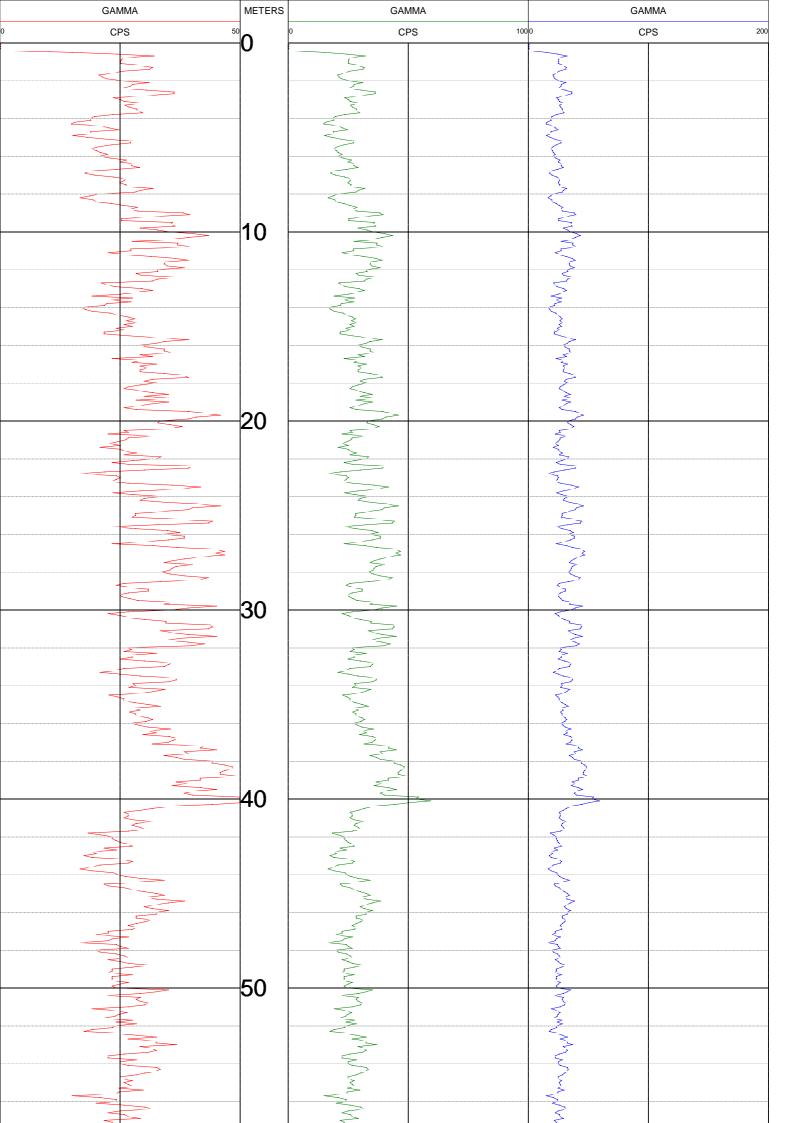
NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

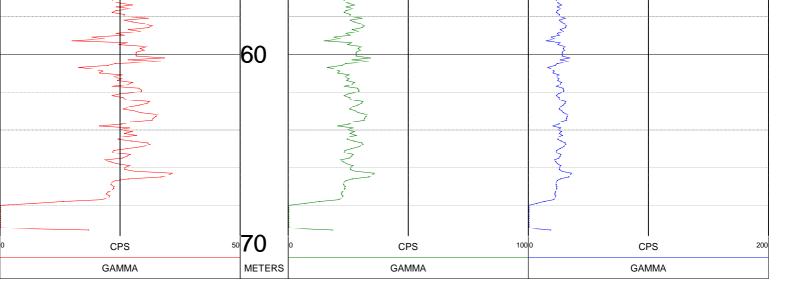
THRESH: 90000

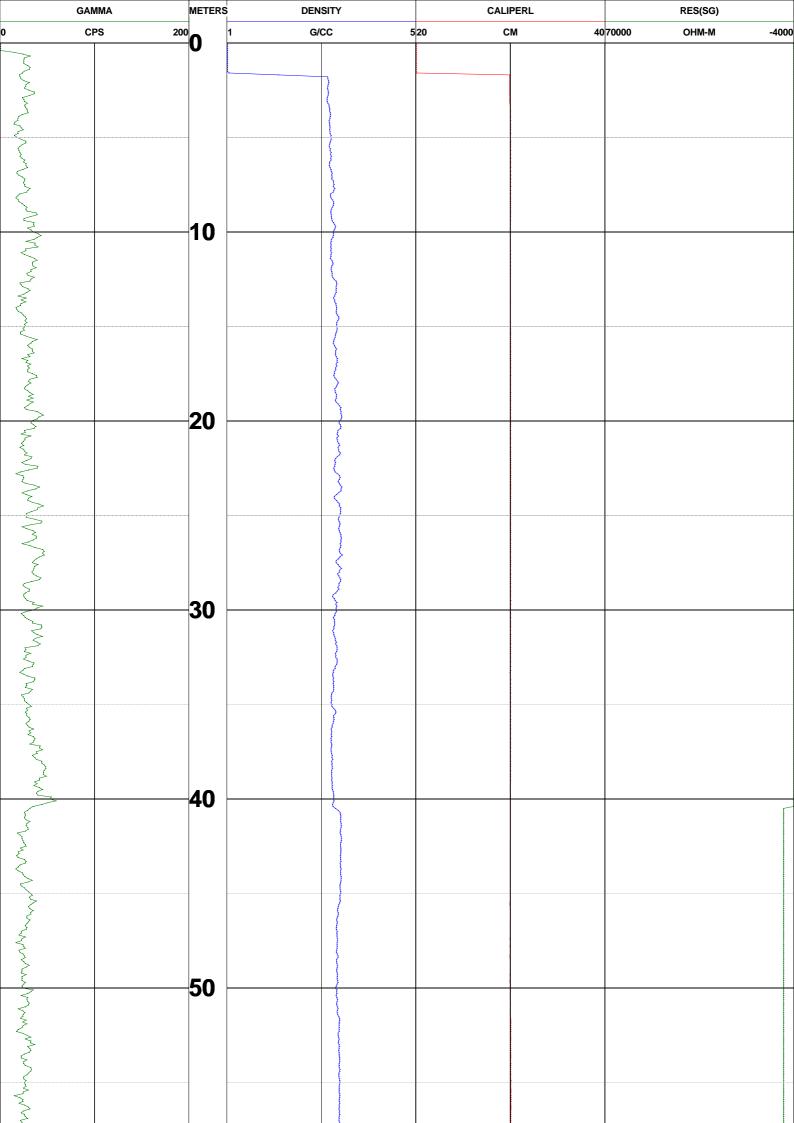
KΒ

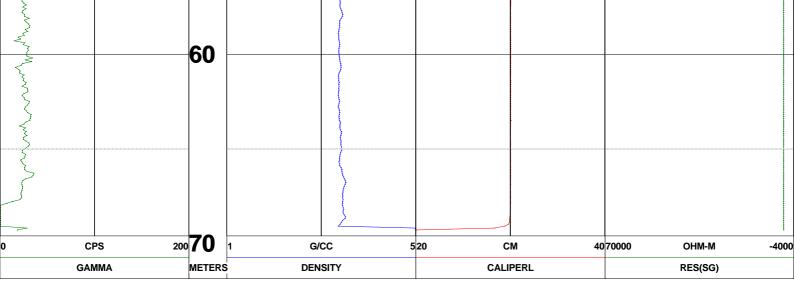
DF

GL











## WB16MEH0004

OTHER SERVICES:

PEG#

16MEH

P04

COMPANY : RTIO

: WB16MEH000

LOCATION/FIELD : MEH

WELL

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : TOWNSHIP : RANGE :

DATE : 03/14/16 PERMANENT DATUM : GL

DEPTH DRILLER : 76

76 KB

LOG BOTTOM : 75.00 LOG MEASURED FROM: GL
LOG TOP : -0.80 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV10
CASING TYPE: STEEL FIELD OFFICE: SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 31 BOREHOLE FLUID : FILE : PROCESSED

MAGNETIC DECL. : 1.438 RM : TYPE : 9238AA

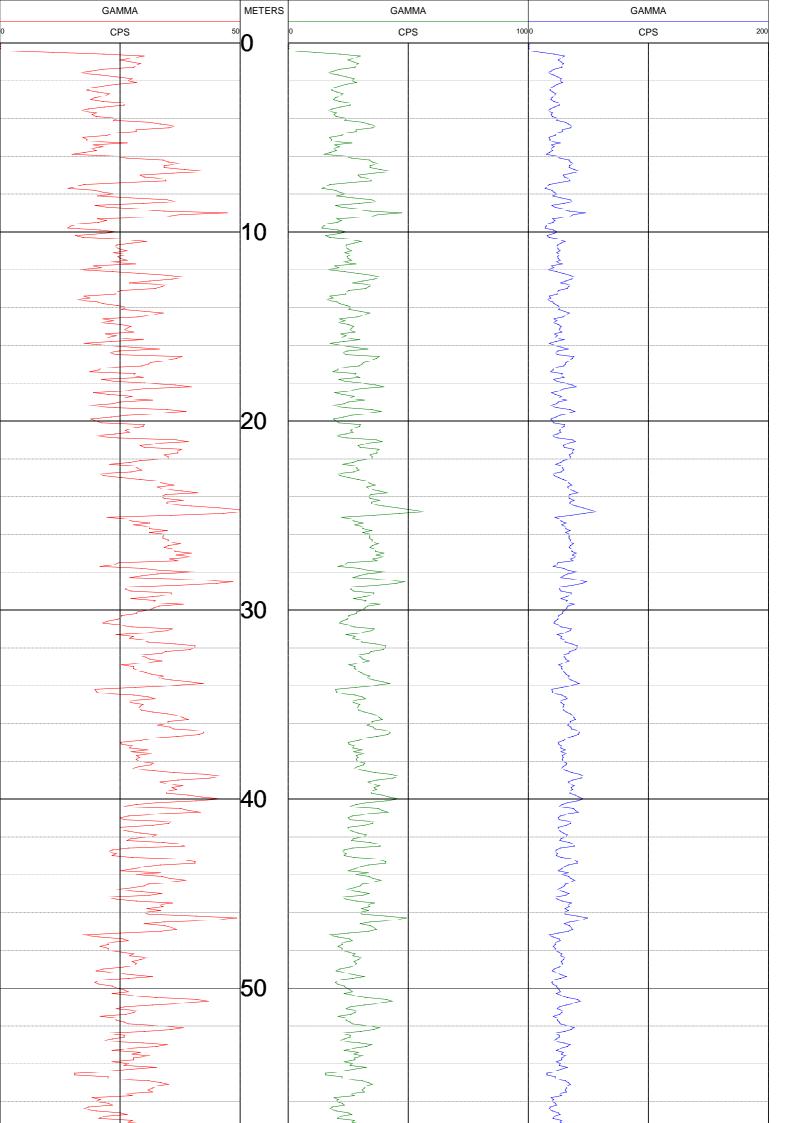
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 03/14/16

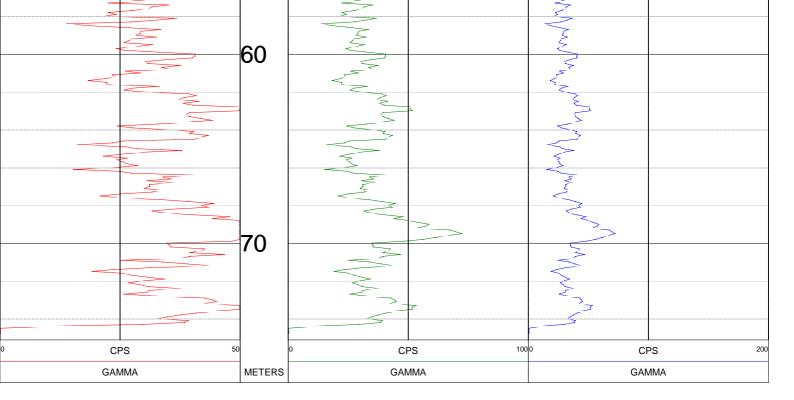
NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

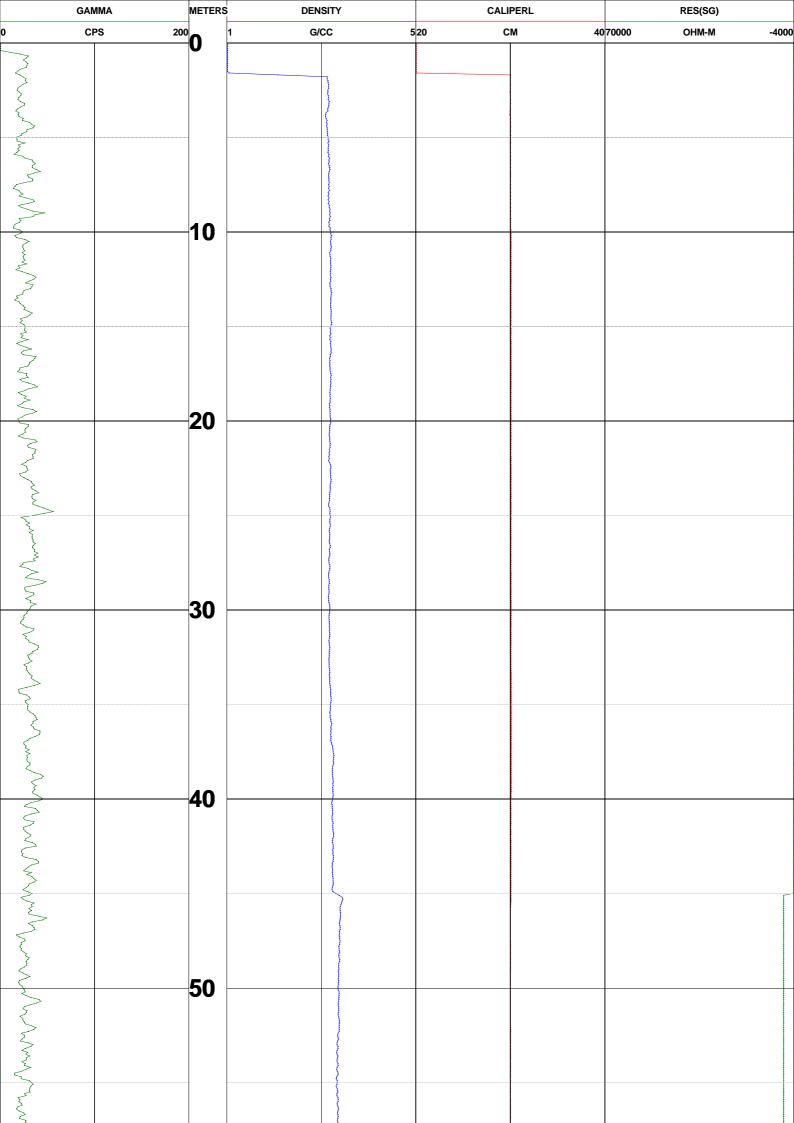
THRESH: 90000

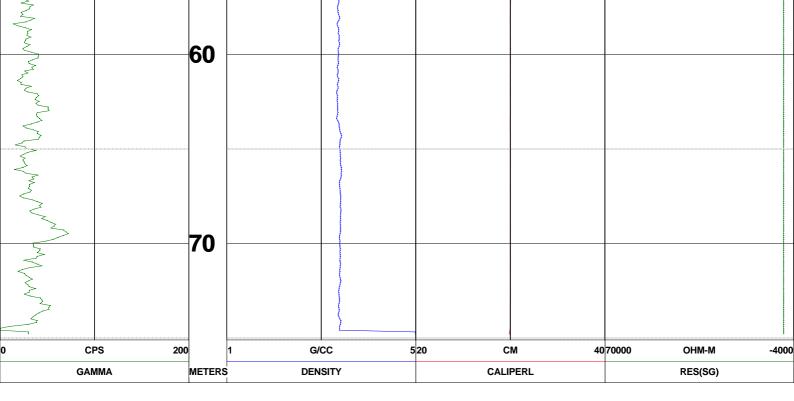
DF

GL











# HM16MEH0001

OTHER SERVICES:

PEG#

16MEH

M15

COMPANY : RTIO

WELL: HM16MEH000

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : TOWNSHIP : RANGE :

DATE : 03/04/16 PERMANENT DATUM : GL

DEPTH DRILLER : 78

78

LOG BOTTOM : 77.70

LOG MEASURED FROM: GL

: 0.10

DRL MEASURED FROM: GL

CASING DIAMETER: 10.

: 10. LOGGING UNIT : SV10 : PVC FIELD OFFICE : SURTRON

CASING TYPE : PVC CASING THICKNESS:

LOG TOP

RECORDED BY : CJ

BIT SIZE : 31

BOREHOLE FLUID :

FILE : ORIGINAL

KΒ

DF

GL

MAGNETIC DECL. : 1.438

RM :

TYPE : 9012C

MATRIX DENSITY : 2.65

RM TEMPERATURE :

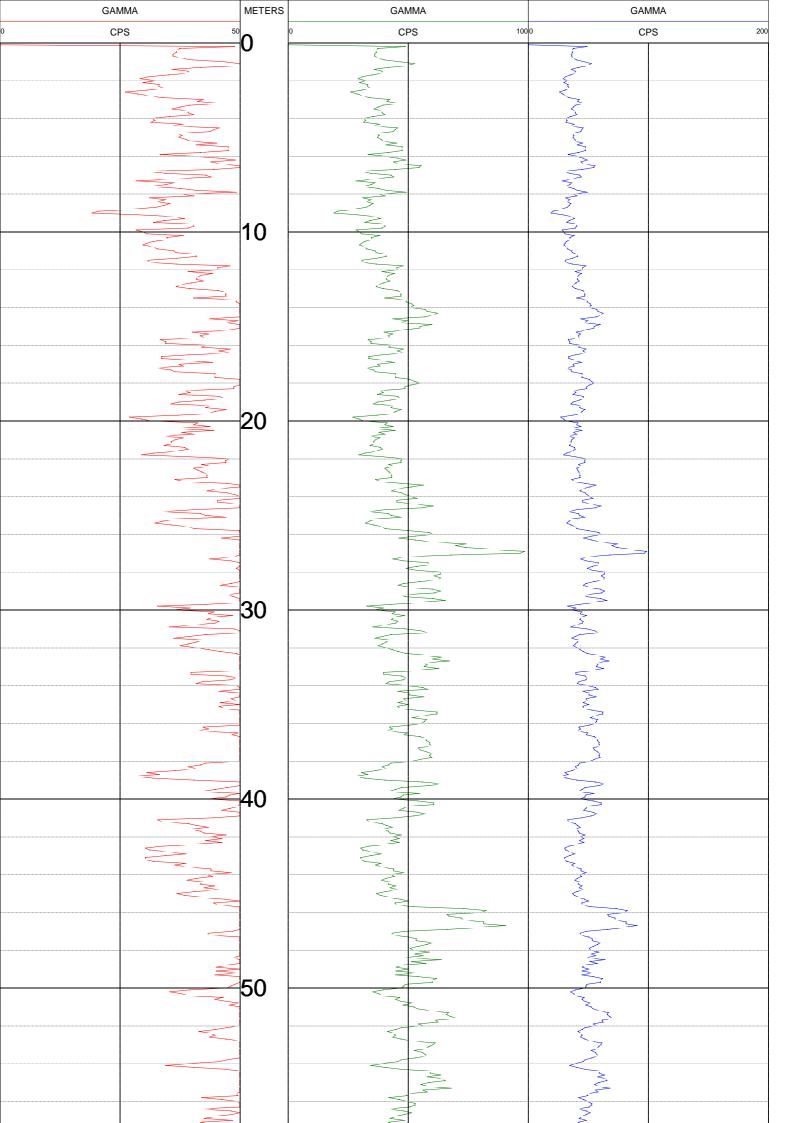
LGDATE: 03/04/16

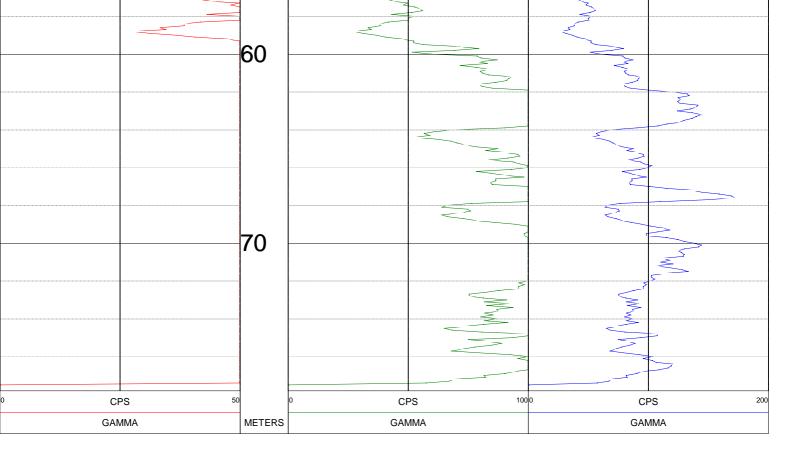
NEUTRON MATRIX : SANDSTONE

CANDOTONE

MATRIX DELTA T : 177

THRESH: 90000







# HM16MEH0001

OTHER SERVICES:

16MEH

\_M15

COMPANY : RTIO

WELL: HM16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION: MEH TOWNSHIP: RANGE:

DATE : 02/17/16 PERMANENT DATUM : GL

DEPTH DRILLER : 78

: 78 KB

LOG BOTTOM : 59.50 LOG MEASURED FROM: GL LOG TOP : 0.00 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV25
CASING TYPE: PVC: FIELD OFFICE: SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID : FILE : ORIGINAL

MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

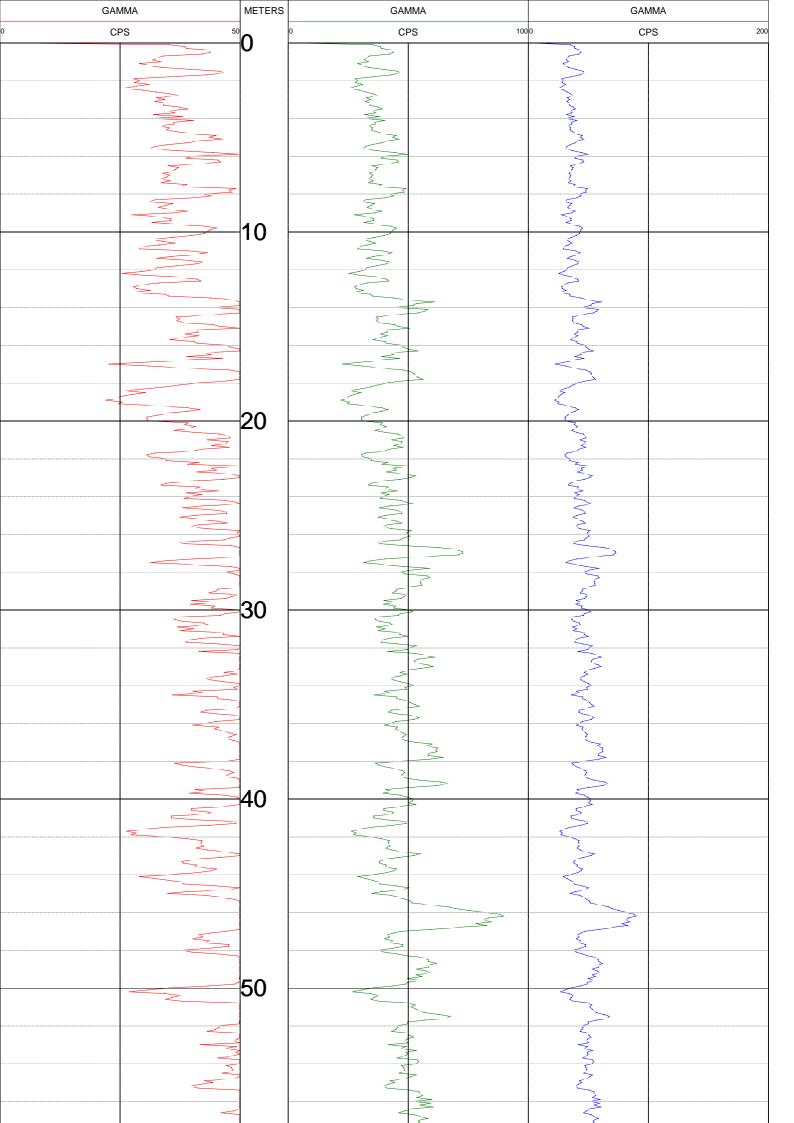
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/17/16

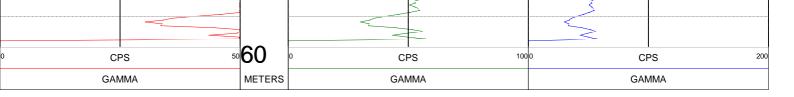
NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

DF

GL







# HM16MEH0002

OTHER SERVICES:

PEG#

16MEH

M02

COMPANY : RTIO

WELL: HM16MEH000

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : TOWNSHIP : RANGE :

DATE : 03/04/16 PERMANENT DATUM : GL

DEPTH DRILLER : 77

: 77

LOG BOTTOM : 43.40

0 LOG MEASURED FROM: GL

LOG TOP : -0.10 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV10

CASING TYPE : PVC FIELD OFFICE : SURTRON CASING THICKNESS: RECORDED BY : CJ

BIT SIZE

: 31 BOREHOLE FLUID : FILE : ORIGINAL

MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 03/04/16

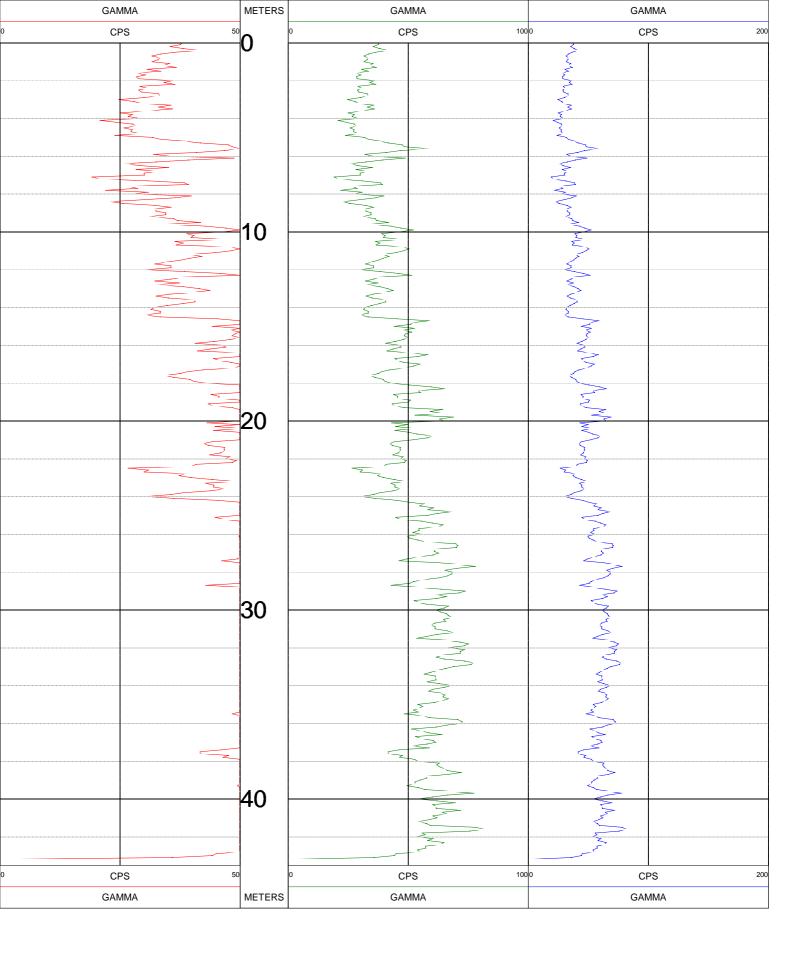
NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

KΒ

DF

GL





# HM16MEH0003

OTHER SERVICES:

16MEH \_M14

: RTIO COMPANY

WELL : HM16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH **TOWNSHIP** RANGE:

DATE : 02/18/16 PERMANENT DATUM : GL

DEPTH DRILLER : 77

KΒ LOG BOTTOM : 76.60 LOG MEASURED FROM: GL DF

LOG TOP : 0.80 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT : SV25

CASING TYPE : PVC FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID FILE : ORIGINAL

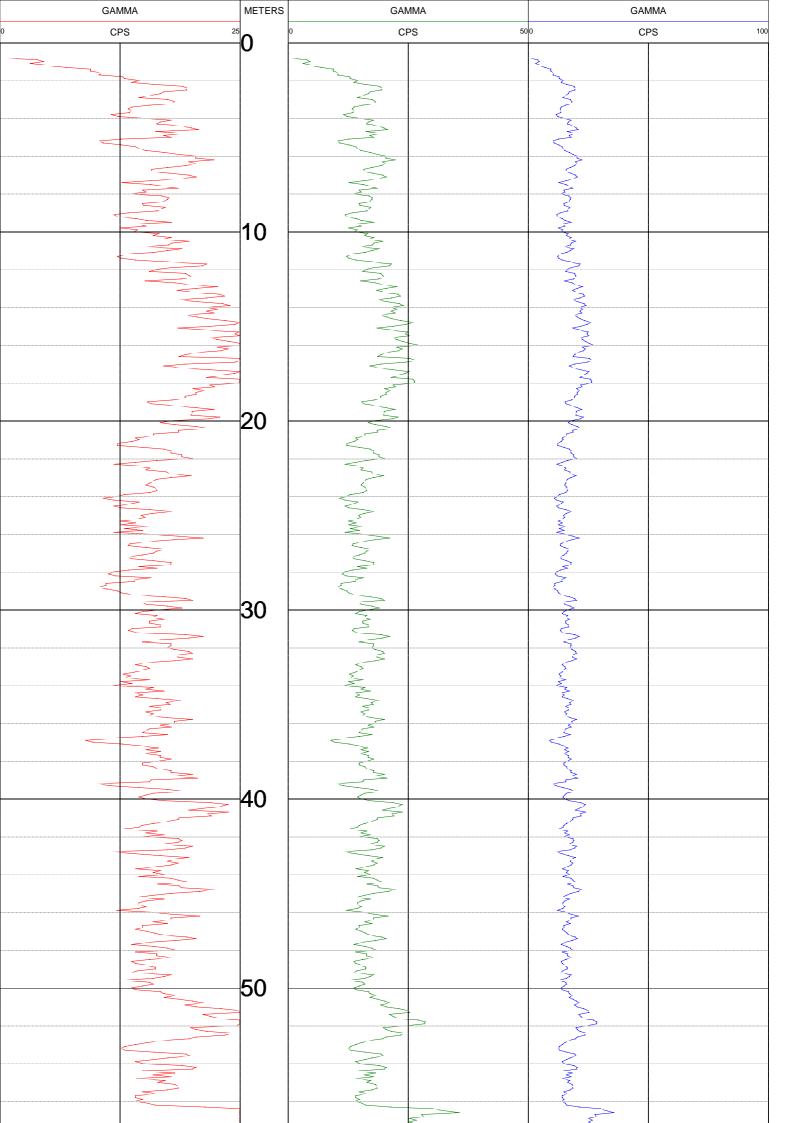
MAGNETIC DECL. : 1.438 TYPE : 9060C RM

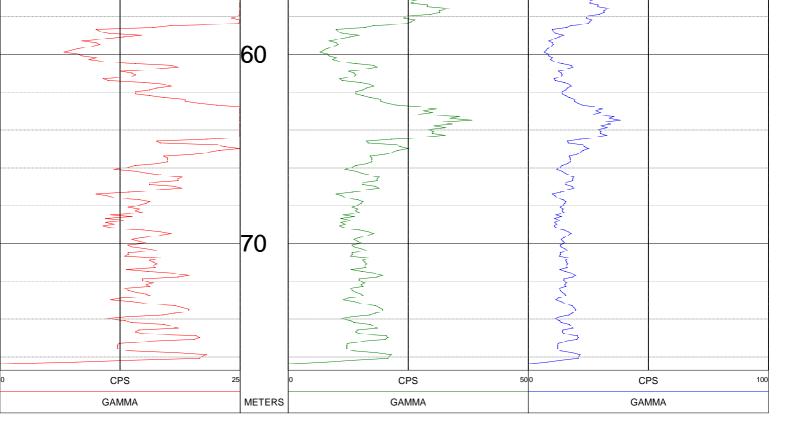
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/18/16

**NEUTRON MATRIX**: SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL







## MB16MEH0001

: RTIO COMPANY

: MB16MEH000

: 02/10/16

LOCATION/FIELD :

WELL

DATE

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH

DEPTH DRILLER : 64

LOG BOTTOM : 63.20 : -0.30 LOG TOP

CASING DIAMETER: 10. CASING TYPE : PVC

CASING THICKNESS:

BIT SIZE : 12.5 MAGNETIC DECL. : 1.438

MATRIX DENSITY : 2.65

**NEUTRON MATRIX**: SANDSTONE

OTHER SERVICES:

PEG#

16MEH\_

M16

RANGE:

KΒ

DF

GL

: SV10

: SURTRON

: DP

BOREHOLE FLUID :

RM

PERMANENT DATUM : GL

LOG MEASURED FROM: GL

DRL MEASURED FROM: GL

LOGGING UNIT

FIELD OFFICE

RECORDED BY

RM TEMPERATURE :

MATRIX DELTA T : 177

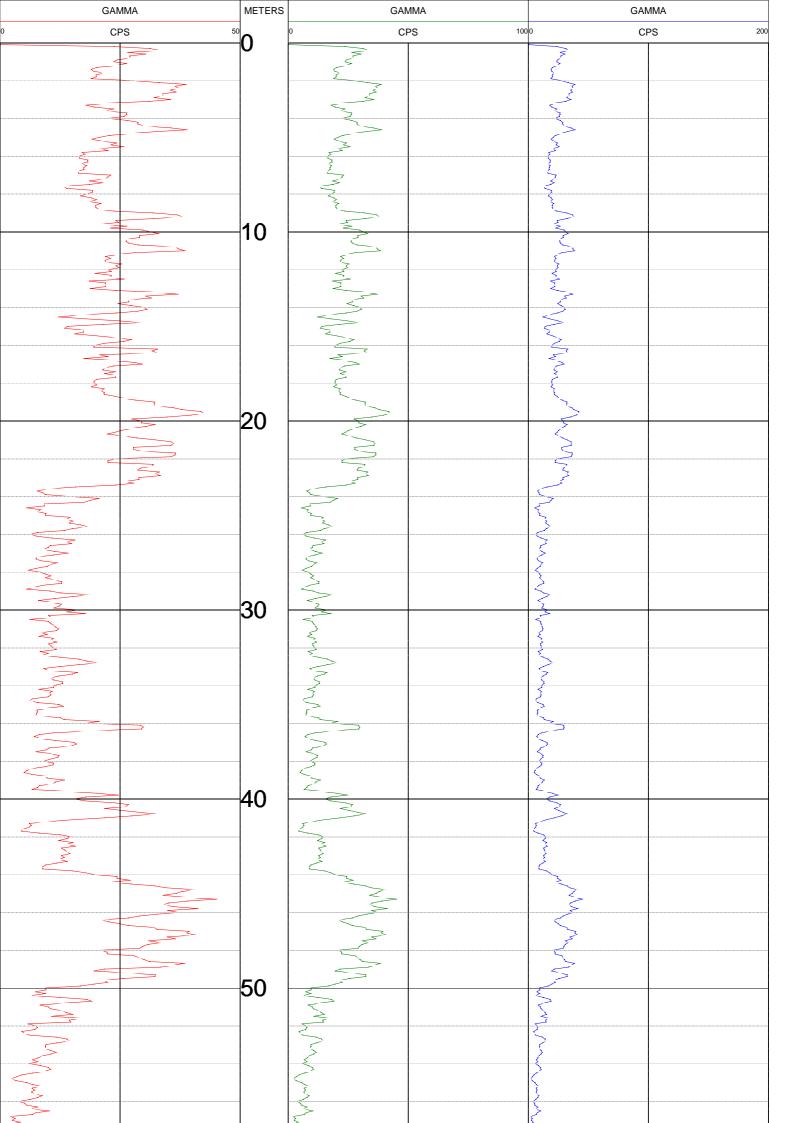
**TOWNSHIP** 

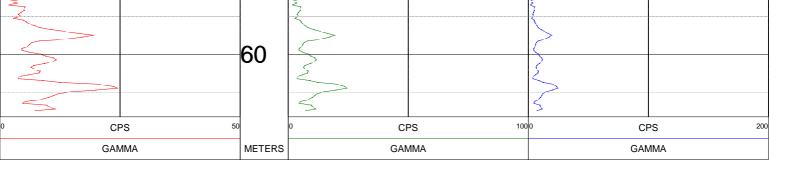
FILE : PROCESSED

TYPE : 9012C

LGDATE: 02/10/16

THRESH: 90000







# MB16MEH0002

OTHER SERVICES:

16MEH\_

M08

: RTIO COMPANY

WELL : MB16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH **TOWNSHIP** RANGE:

DATE : 02/12/16 PERMANENT DATUM : GL

DEPTH DRILLER : 80

KΒ LOG BOTTOM : 56.00 LOG MEASURED FROM: GL DF

LOG TOP : 0.50 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT : SV25

CASING TYPE : PVC FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID FILE : ORIGINAL

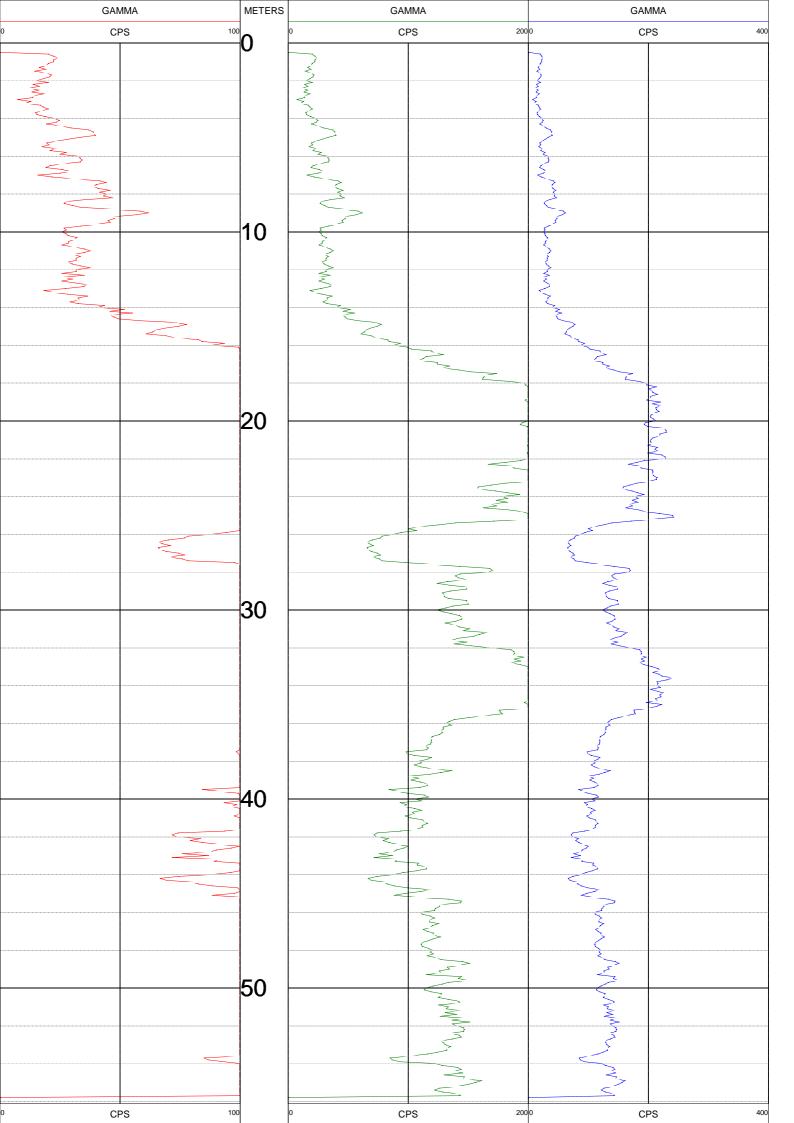
MAGNETIC DECL. : 1.438 TYPE : 9012C RM

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/12/16

**NEUTRON MATRIX**: SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL



GAMMA METERS GAMMA GAMMA



# MB16MEH0003

OTHER SERVICES:

16MEH

\_M07

COMPANY : RTIO

WELL : MB16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION: MEH TOWNSHIP: RANGE:

DATE : 02/15/16 PERMANENT DATUM : GL

DEPTH DRILLER : 84

LOG BOTTOM

: 84 KB : 66.00 LOG MEASURED FROM: GL DF

LOG TOP : 0.20 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV25

CASING TYPE : PVC FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID : FILE : ORIGINAL

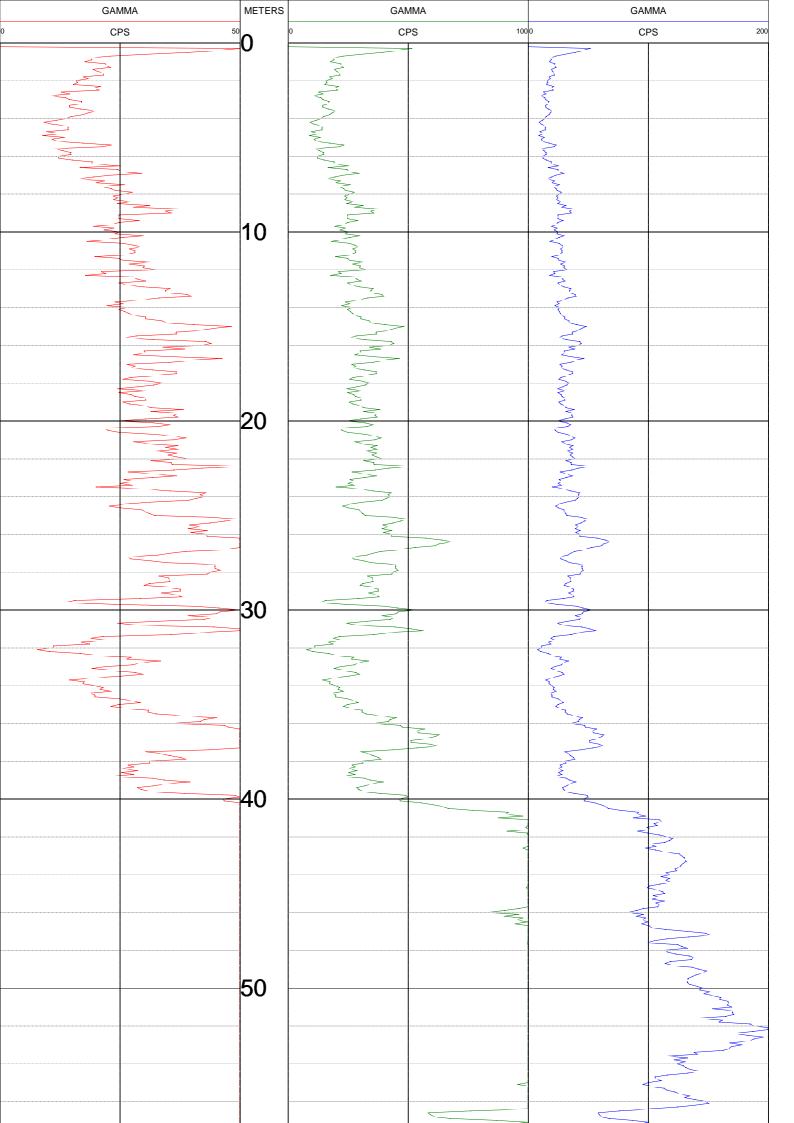
MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

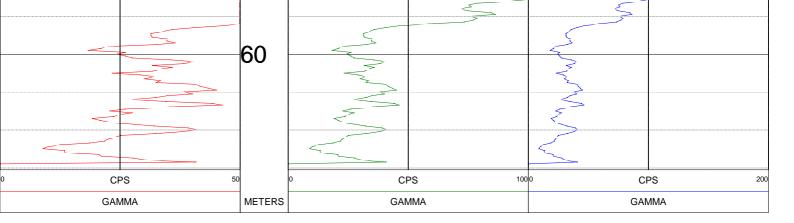
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/15/16

NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL







# MB16MEH0003

OTHER SERVICES:

16MEH

\_M07

COMPANY : RTIO

WELL : MB16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION: MEH TOWNSHIP: RANGE:

DATE : 02/13/16 PERMANENT DATUM : GL

DEPTH DRILLER : 84

LOG BOTTOM : 65.40 LOG MEASURED FROM: GL DF :

LOG TOP : 0.20 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV25
CASING TYPE: IROD: FIELD OFFICE: SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID : FILE : ORIGINAL

MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

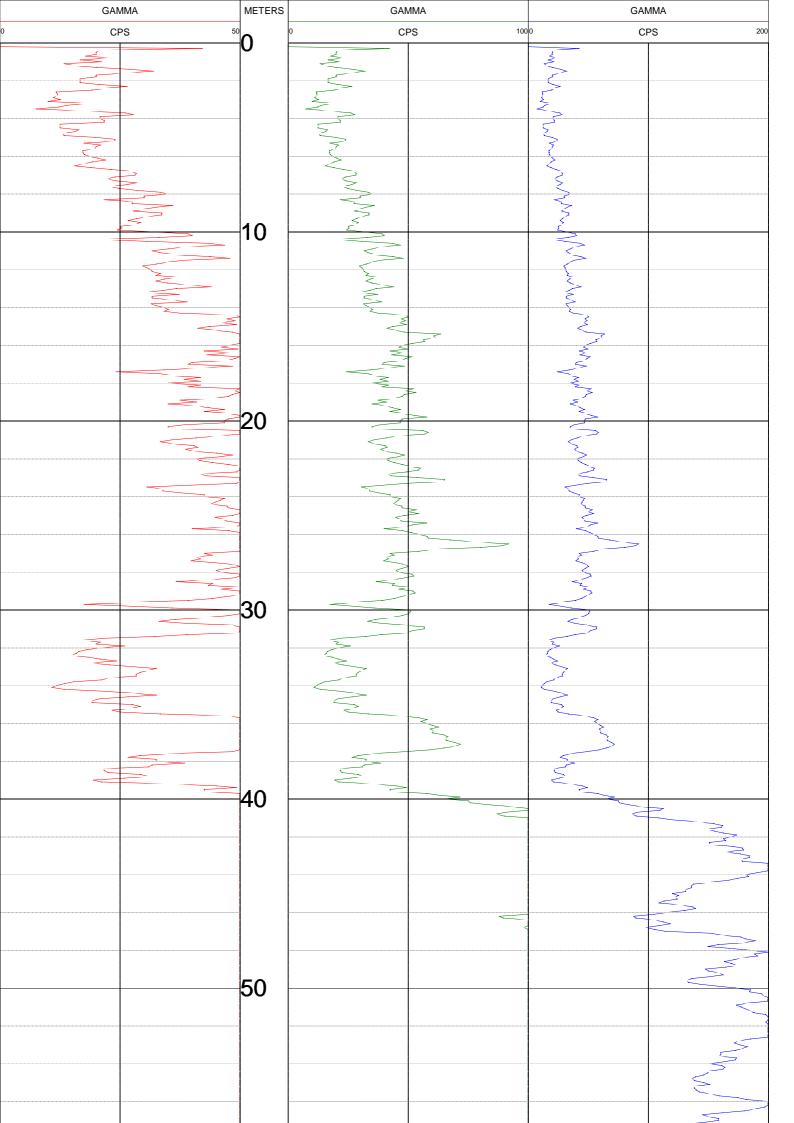
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/13/16

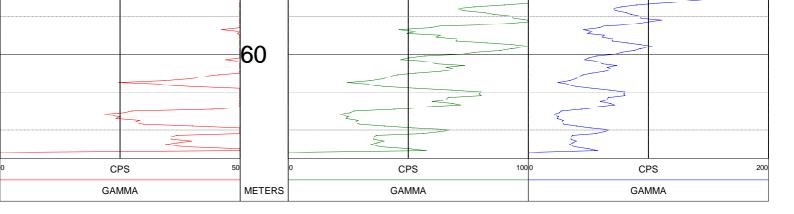
NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

KΒ

GL







# MB16MEH0008

OTHER SERVICES:

16MEH

\_M06

COMPANY : RTIO

WELL : MB16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION: MEH TOWNSHIP: RANGE:

DATE : 02/17/16 PERMANENT DATUM : GL

DEPTH DRILLER : 58

LOG BOTTOM : 40.00 LOG MEASURED FROM: GL DF : LOG TOP : 0.00 DRL MEASURED FROM: GL GL :

CASING DIAMETER: 10. LOGGING UNIT: SV25
CASING TYPE: PVC: FIELD OFFICE: SURTRON

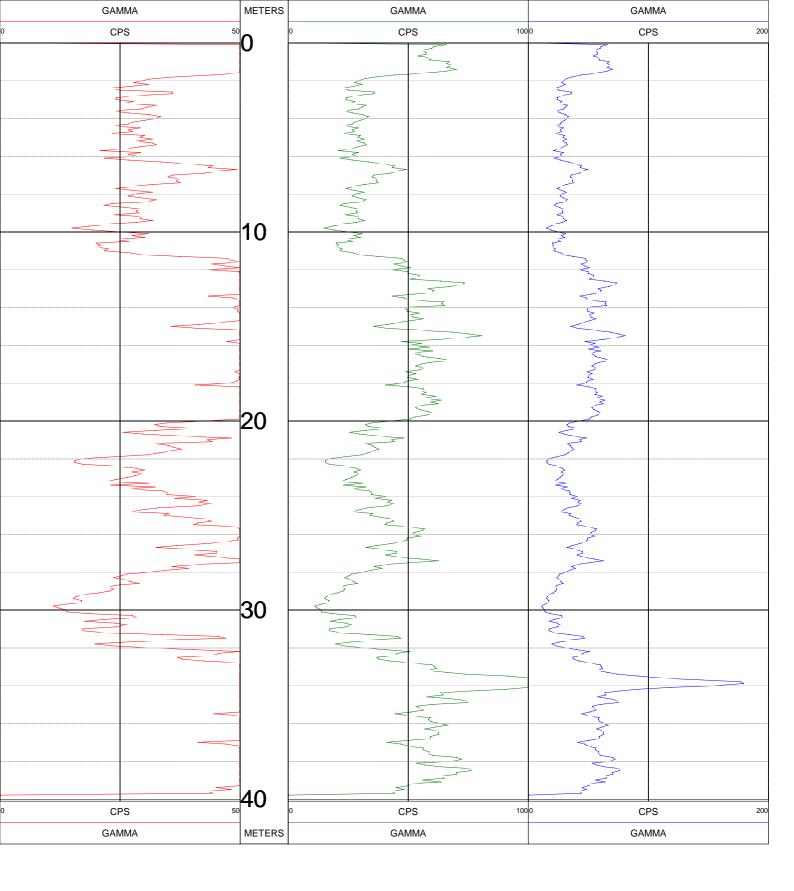
CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID : FILE : ORIGINAL MAGNETIC DECL. : 1.438 RM : TYPE : 9012C MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/17/16

NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

KΒ





# MB16MEH0008

OTHER SERVICES:

16MEH

\_M06

COMPANY : RTIO

WELL: MB16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION: MEH TOWNSHIP: RANGE:

DATE : 02/15/16 PERMANENT DATUM : GL

DEPTH DRILLER : 58

: 58 KB

LOG BOTTOM : 55.80 LOG MEASURED FROM: GL DF LOG TOP : 0.00 DRL MEASURED FROM: GL GL

CASING DIAMETER: 10. LOGGING UNIT: SV25
CASING TYPE: RODS: FIELD OFFICE: SURTRON

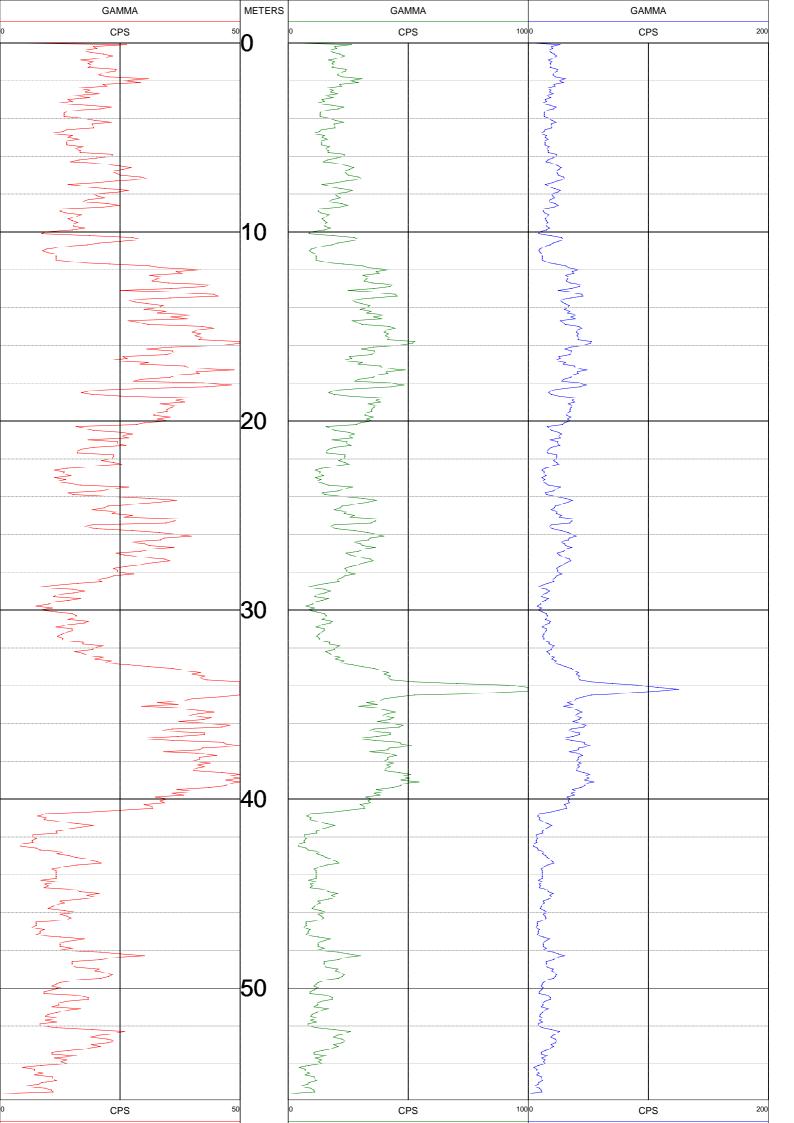
CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID : FILE : ORIGINAL MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/15/16

NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000



GAMMA METERS GAMMA GAMMA



## MB16MEH0009

: RTIO COMPANY

WELL : MB16MEH000

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : **TOWNSHIP** RANGE:

DATE : 03/03/16 PERMANENT DATUM : GL

DEPTH DRILLER : 52

CASING THICKNESS:

BIT SIZE

LOG BOTTOM : 51.20

LOG MEASURED FROM: GL

LOG TOP : 0.20

CASING DIAMETER: 10.

CASING TYPE : PVC

LOGGING UNIT

FIELD OFFICE

RECORDED BY

: 31

MAGNETIC DECL. : 1.438

MATRIX DENSITY : 2.65

**NEUTRON MATRIX**: SANDSTONE

DRL MEASURED FROM: GL

: SV10

: SURTRON

OTHER SERVICES:

PEG#

16MEH

M09

: CJ

BOREHOLE FLUID

RM

RM TEMPERATURE :

MATRIX DELTA T : 177

KΒ

DF

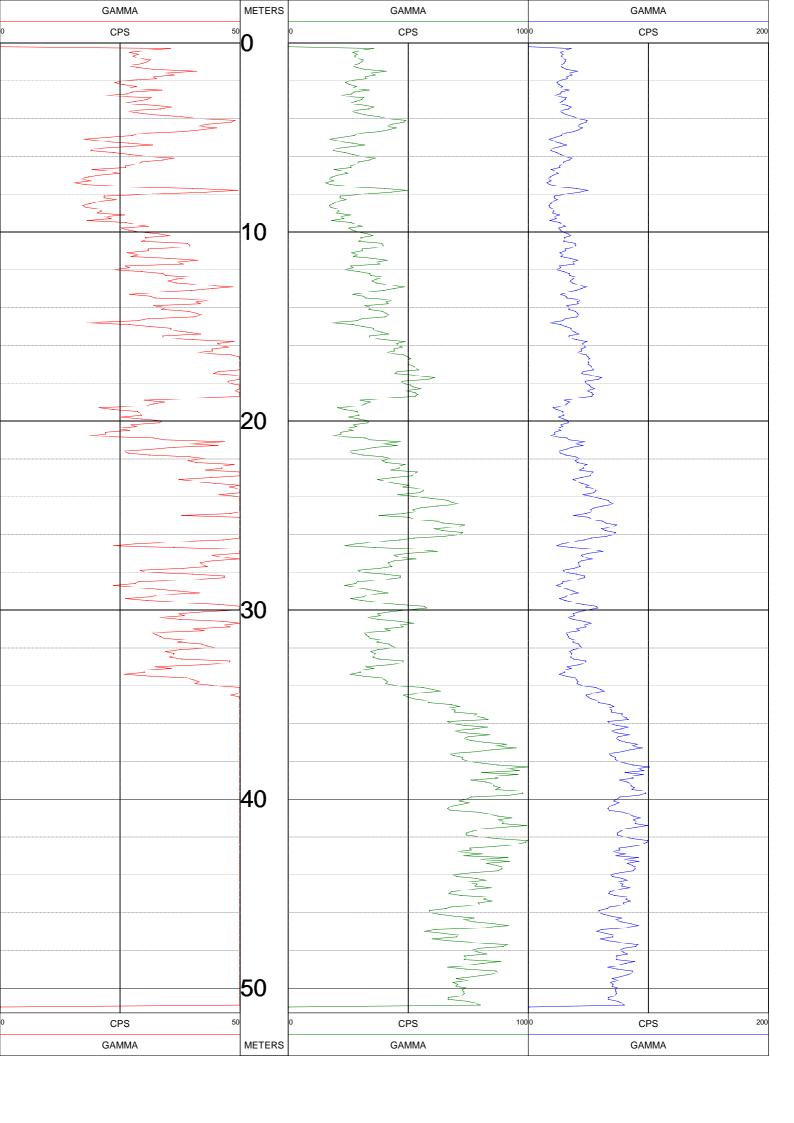
GL

FILE : ORIGINAL

TYPE : 9012C

LGDATE: 03/03/16

THRESH: 90000





## MB16MEH0009

OTHER SERVICES:

16MEH

\_M09

COMPANY : RTIO

WELL: MB16MEH000

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION: MEH TOWNSHIP: RANGE:

DATE : 02/17/16 PERMANENT DATUM : GL

DEPTH DRILLER : 52

LOG BOTTOM

: 52 KB : 51.20 LOG MEASURED FROM: GL DF

LOG TOP : 0.00 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT: SV25
CASING TYPE: RODS: FIELD OFFICE: SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID : FILE : ORIGINAL

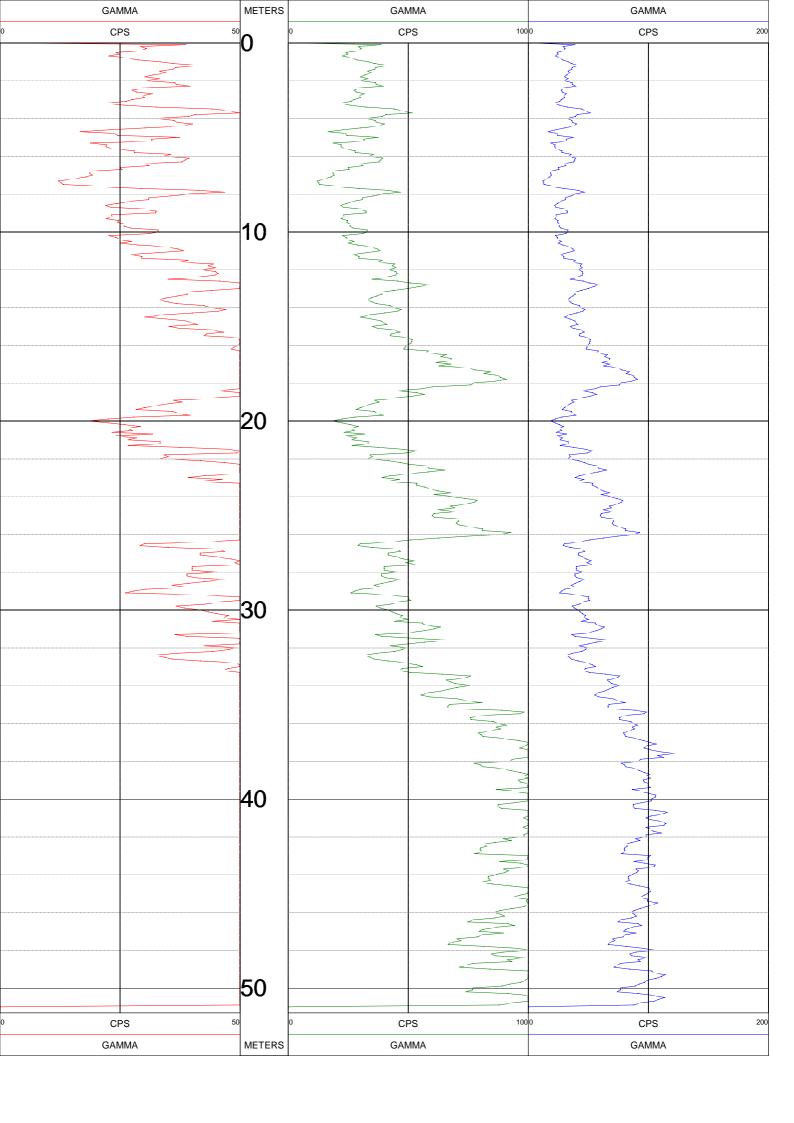
MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/17/16

NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL





# MB16MEH0012

OTHER SERVICES:

16MEH

\_M01

: RTIO COMPANY

WELL : MB16MEH001

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH **TOWNSHIP** RANGE:

DATE : 02/22/16 PERMANENT DATUM : GL

DEPTH DRILLER : 49

KΒ LOG BOTTOM : 46.70 LOG MEASURED FROM: GL DF

LOG TOP : 0.40 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT : SV25

CASING TYPE : PVC FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID FILE : ORIGINAL

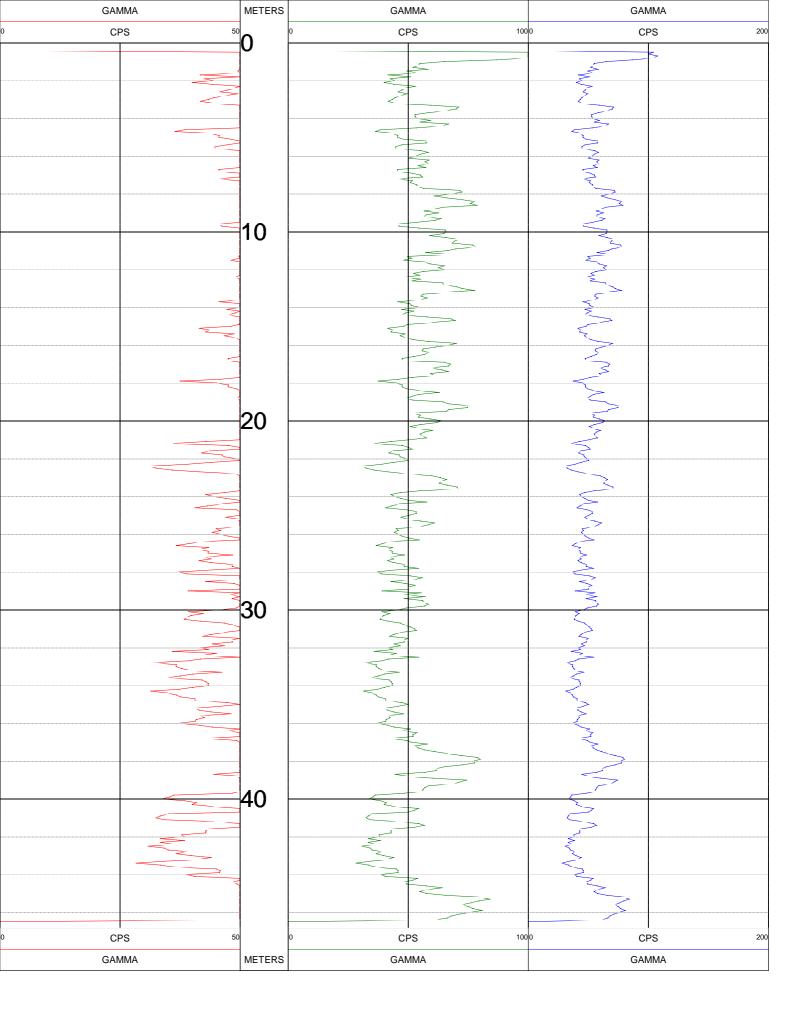
MAGNETIC DECL. : 1.438 TYPE : 9012C RM

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/22/16

**NEUTRON MATRIX**: SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL





# MB16MEH0013

COMPANY : RTIO

WELL : MB16MEH001

LOCATION/FIELD : MEH

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : TOWNSHIP : RANGE :

DATE : 03/03/16 PERMANENT DATUM : GL

DEPTH DRILLER : 76

: 76 KB

LOG BOTTOM : 74.90 LOG MEASURED FROM: GL
LOG TOP : 0.20 DRL MEASURED FROM: GL

RL MEASURED FROM: GL GL

OTHER SERVICES:

PEG#

16MEH

M04

CASING DIAMETER: 10. LOGGING UNIT: SV10
CASING TYPE: PVC: FIELD OFFICE: SURTRON

CASING THICKNESS: RECORDED BY : CJ

CASING ITHORNESS. RECORDED BY . C.

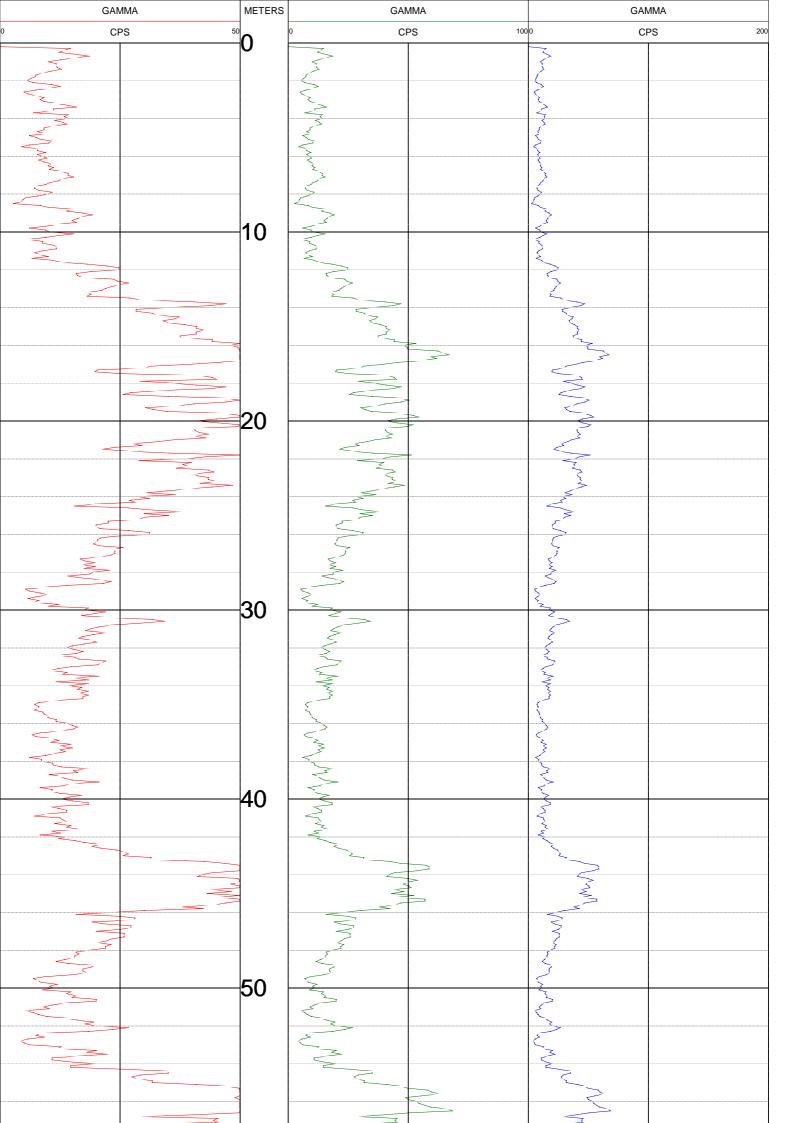
BIT SIZE : 31 BOREHOLE FLUID : FILE : ORIGINAL MAGNETIC DECL. : 1.438 RM : TYPE : 9012C

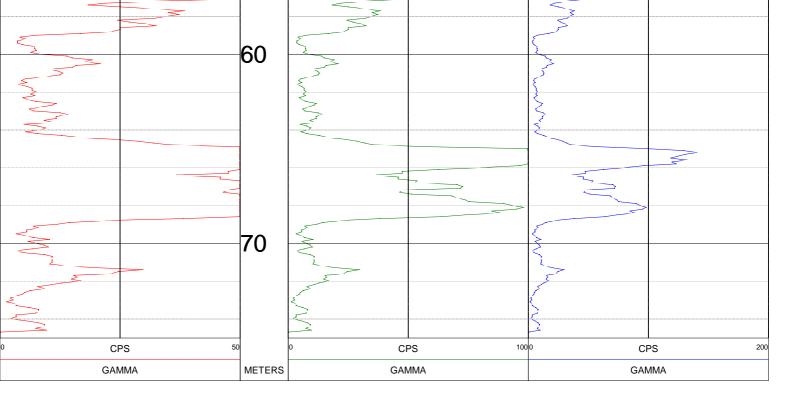
MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 03/03/16

MATRIX DENSITY : 2.65 RM TEMPERATURE : LC
NEUTRON MATRIX : SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

DF







## MB16MEH0013

OTHER SERVICES:

16MEH

\_M04

: RTIO COMPANY

WELL : MB16MEH001

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH **TOWNSHIP** RANGE:

DATE : 02/22/16 PERMANENT DATUM : GL

DEPTH DRILLER : 76

LOG BOTTOM : 74.00 LOG MEASURED FROM: GL DF GL

LOG TOP : 0.70 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT : SV25 CASING TYPE : RODS FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : CJ

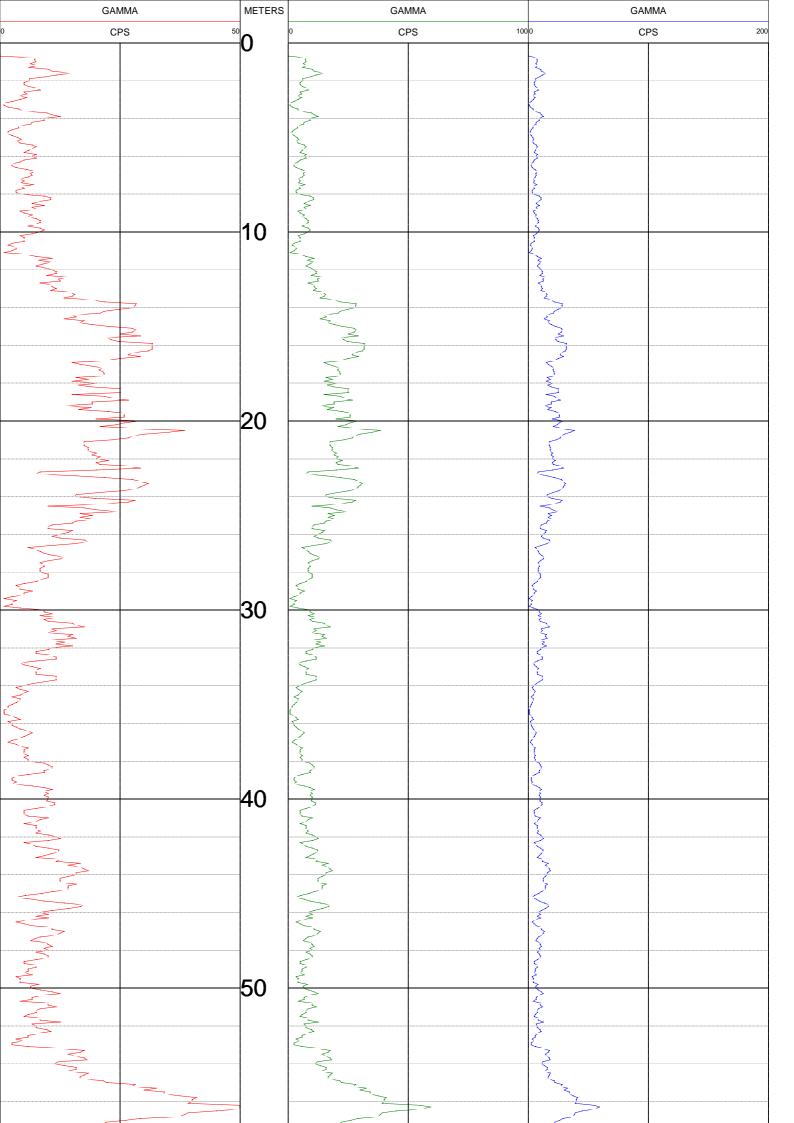
BIT SIZE : 12.5 BOREHOLE FLUID FILE : ORIGINAL MAGNETIC DECL. : 1.438 TYPE : 9012C RM

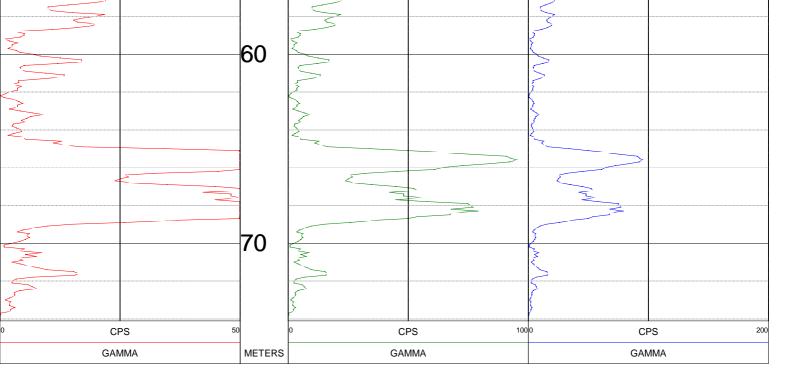
RM TEMPERATURE : MATRIX DENSITY : 2.65 LGDATE: 02/22/16

**NEUTRON MATRIX**: SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

KΒ







# MB16MEH0014

: RTIO COMPANY

WELL : MB16MEH001

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH **TOWNSHIP** RANGE:

DATE : 02/20/16 PERMANENT DATUM : GL

DEPTH DRILLER : 60

LOG BOTTOM : 58.90

LOG TOP : 0.30

CASING DIAMETER: 10. CASING TYPE : PVC

CASING THICKNESS:

BIT SIZE

MAGNETIC DECL. : 1.438 MATRIX DENSITY : 2.65

**NEUTRON MATRIX**: SANDSTONE

: 12.5

OTHER SERVICES:

16MEH

\_M11

KΒ

DF

GL

: SV25

: SURTRON

: CJ

BOREHOLE FLUID

RMRM TEMPERATURE :

LOG MEASURED FROM: GL

DRL MEASURED FROM: GL

LOGGING UNIT

FIELD OFFICE

RECORDED BY

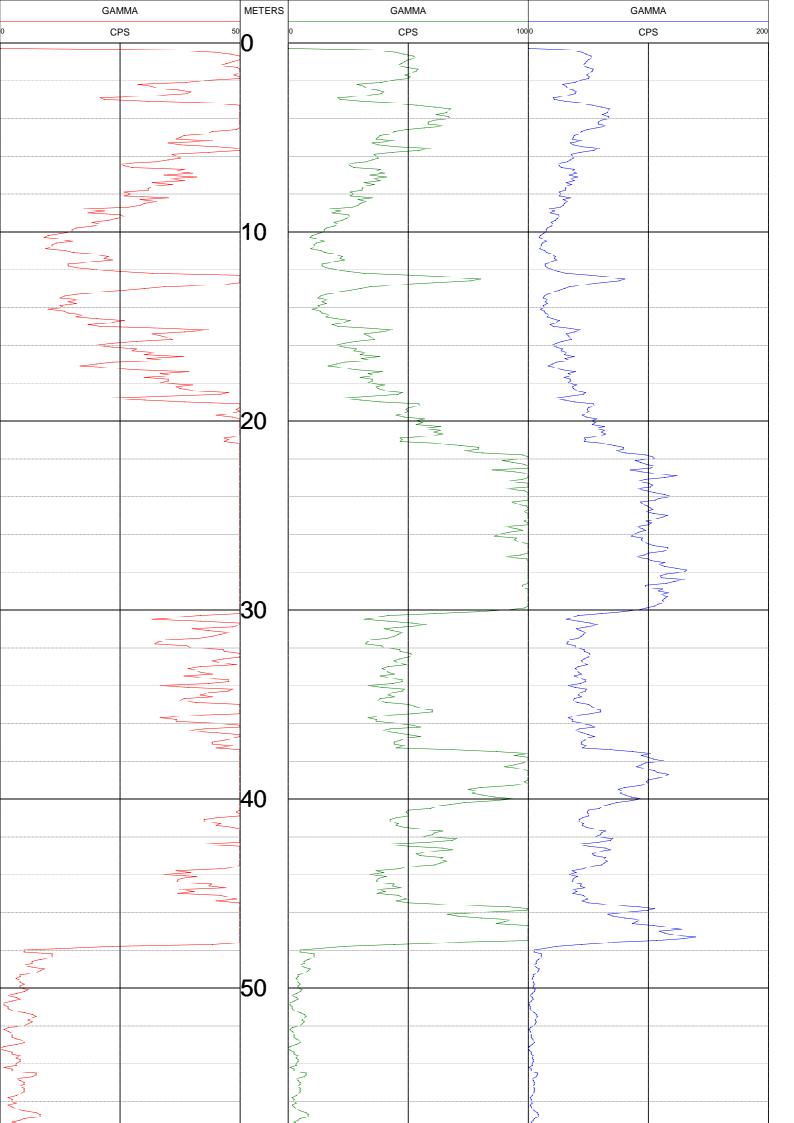
MATRIX DELTA T : 177

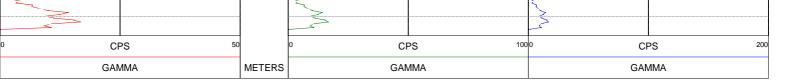
FILE : ORIGINAL

TYPE : 9012C

LGDATE: 02/20/16

THRESH: 90000







## MB16MEH0014

OTHER SERVICES:

16MEH

\_M11

: RTIO COMPANY

WELL : MB16MEH001

LOCATION/FIELD :

COUNTY : MEGDC0202

LOCATION : MEH

SECTION : MEH **TOWNSHIP** RANGE:

DATE : 02/18/16 PERMANENT DATUM : GL

DEPTH DRILLER : 52

KΒ LOG BOTTOM : 49.80 LOG MEASURED FROM: GL DF

LOG TOP : 0.70 DRL MEASURED FROM: GL

CASING DIAMETER: 10. LOGGING UNIT : SV25

CASING TYPE : RODS FIELD OFFICE : SURTRON

CASING THICKNESS: RECORDED BY : CJ

BIT SIZE : 12.5 BOREHOLE FLUID FILE : PROCESSED

MAGNETIC DECL. : 1.438 TYPE : 9012C RM

MATRIX DENSITY : 2.65 RM TEMPERATURE : LGDATE: 02/18/16

**NEUTRON MATRIX**: SANDSTONE MATRIX DELTA T : 177

THRESH: 90000

GL

