

Figure 2 Mesa H Hydrogeological drilling locations north

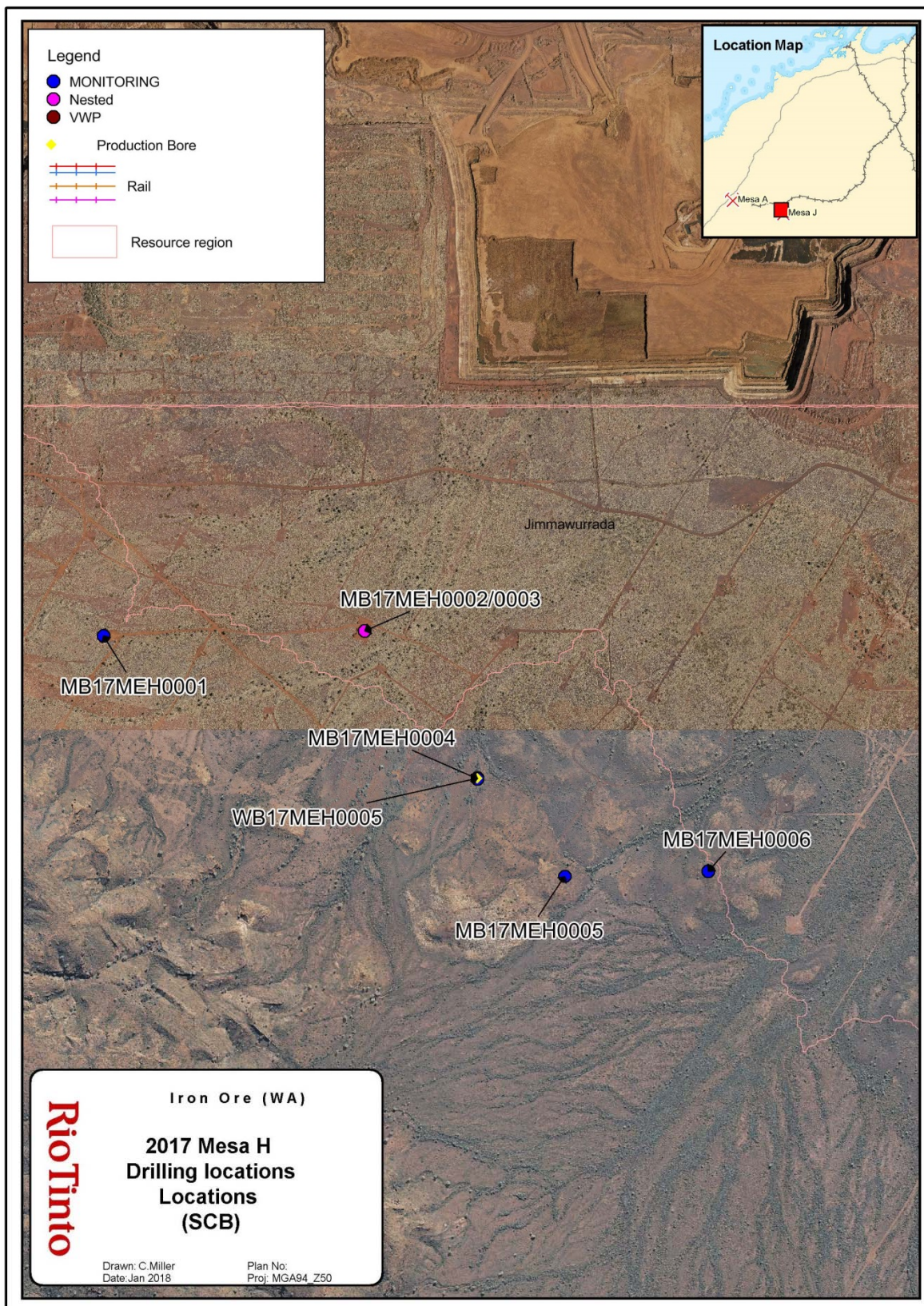


Figure 3 Mesa H Hydrogeological drilling locations Southern Cutback (SCB)

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).

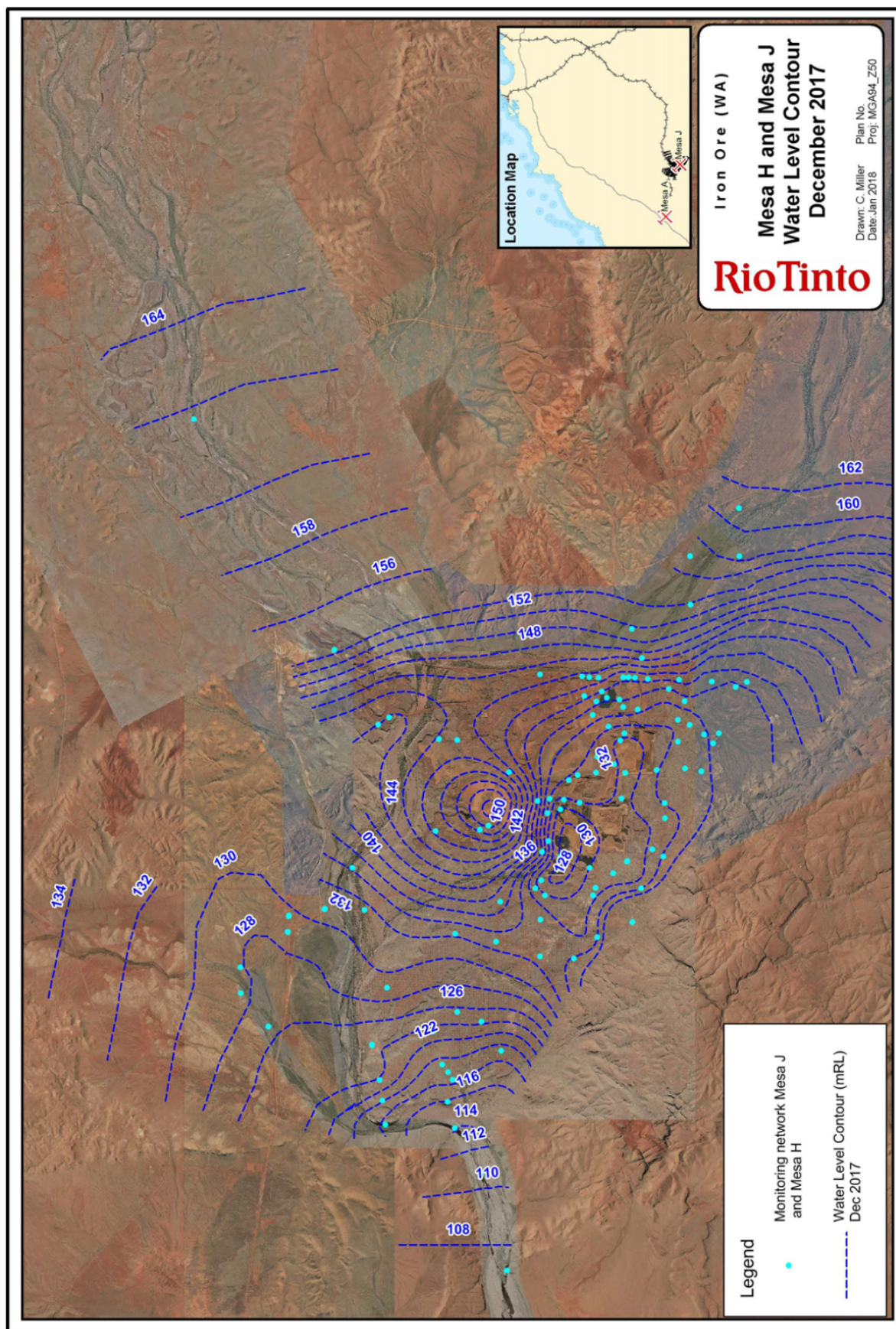


Figure 4 Groundwater level RL post drilling at Mesa C

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 VWP's 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 Field 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 150mm above the top of the plinth;
- Lockable steel lid with handle;
- Concrete plinth measuring 1 m² by 300 mm high (100 mm set below natural ground level).

Monitoring bores (includes dual nested monitoring bores)

- 50mm PVC Class 18 casing, fitted with a PVC cap
- Steel casing stick-up 500 mm above the top of the plinth;
- Lockable steel lid with handle;
- Concrete plinth measuring 1 m² 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 3mm aperture 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. Samples 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 coarse 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 to 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 12m 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 Warramboe 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 trialled 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.

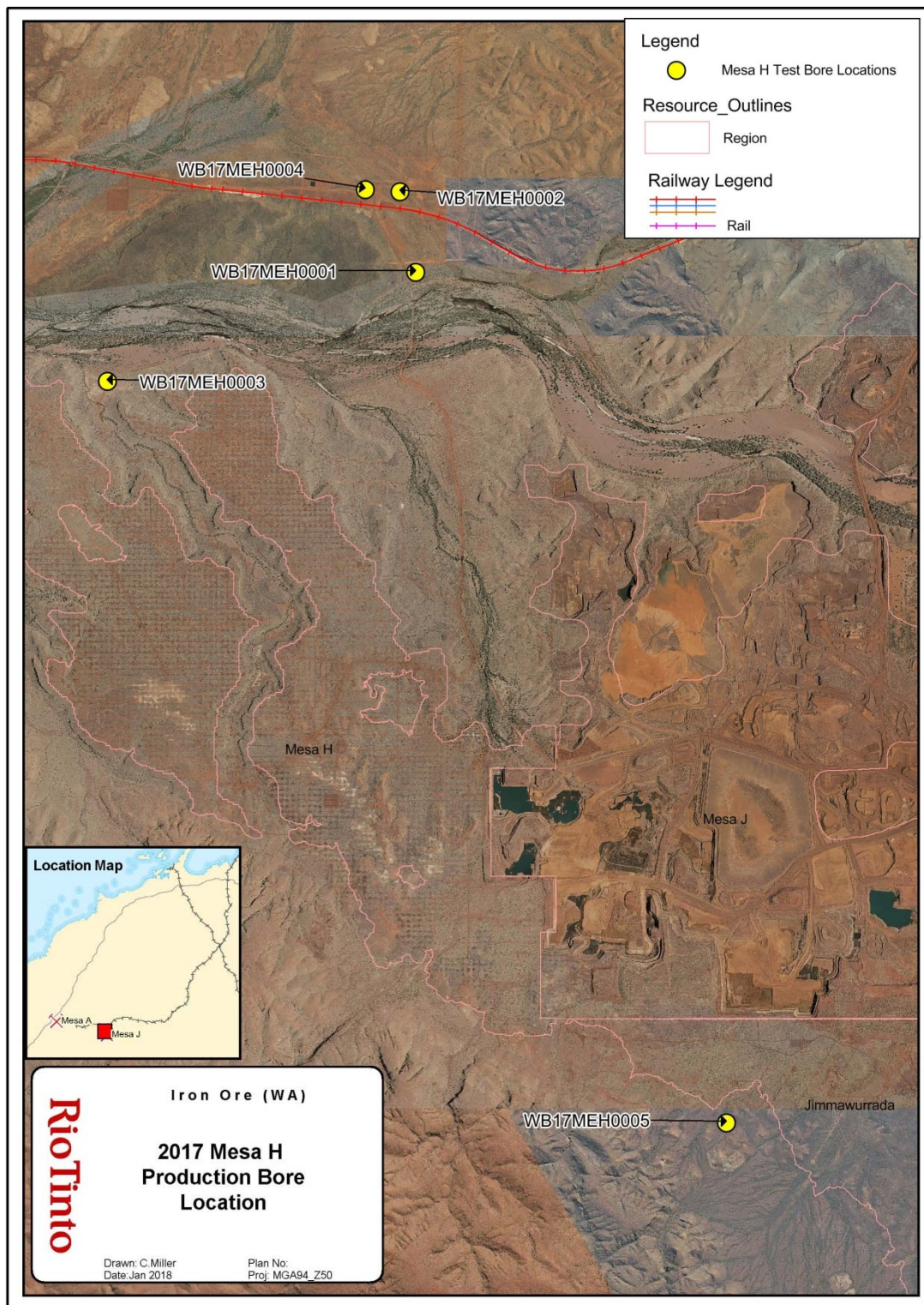


Figure 5: Mesa H production test bore locations

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 parameters 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 1×10^{-4} and 2×10^{-7} .
- 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 6.39×10^{-5} .
- Hydraulic conductivity and storage coefficient of fractured BIF was 568 m/day 6.203×10^{-5} .
- 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 a sharp drop in the water level as can be observed in Figure 6.

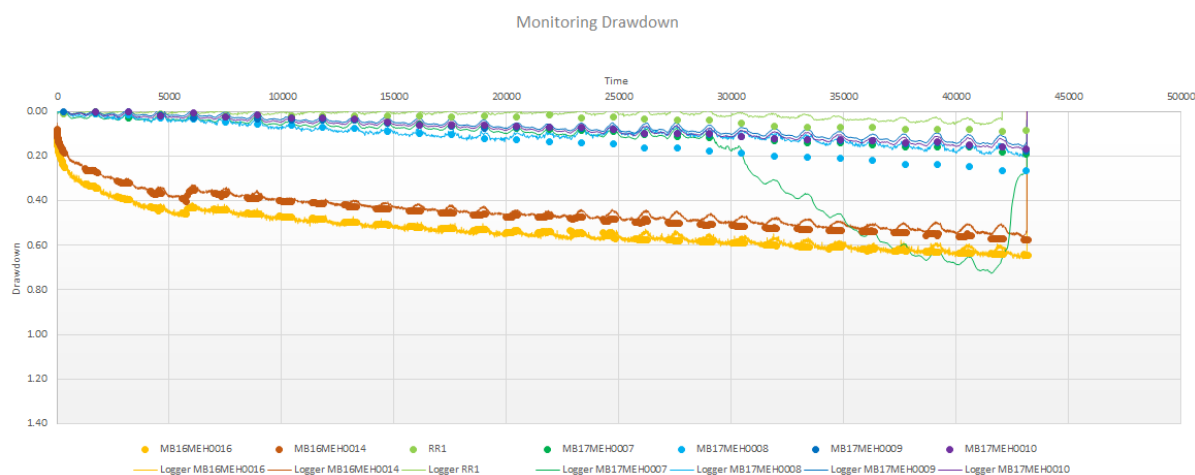


Figure 6: WB17MEH0001 CRT drawdown curves

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 (VWP)					
HM17MEH0001	17MEH_VW02	416034.012	7597714.217	TBC	132.378
HM17MEH0003	17MEH_VW01	414982.062	7596143.524	TBC	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 Piezometre. S: Shallow Piezometre. NA: Not Applicable					

Table 2 Mesa H Water levels and Yields

Bore ID	Peg ID	Initial SWL (mBTC)	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 Piezometre. S: Shallow Piezometre. NA: Not Applicable				

Table 3 Construction Details Mesa H

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 (m bgl)
20/08/2017	22/08/2017	104.000	95.000	PVC 50mm	MB: Single	MR	254.000	12.000	215.900	29-95
23/08/2017	26/08/2017	90.000	87.500	PVC 50mm	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
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		48	PVC 50mm	MB: Nested					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	CH	203.2	5	190.5	14-104
23/08/2017	26/08/2017	46.00	40.000	Threaded Steel 304.80mm	PB	CH	xx	xx	444.5	10-28.0
31/10/2017	3/11/2017	50.00	40.000	Threaded Steel 304.80mm	PB	MR	473.075	16	444.5	16-34
4/11/2017	11/11/2017	36.00	36.000	Threaded Steel 304.80mm	PB	MR	558.8	2	444.5	18-30
7/11/2017	10/11/2017	50.00	46.000	Threaded Steel 304.80mm	PB	MR	508	7	444.5	10-40.0
14/11/2017	19/11/2017	106.00	104.000	Threaded Steel 304.80mm	PB	MR	558.8	2	444.5	74-98
Bore, VWP - Vibrating Wire Piezometer, MR - Mud Rotary, CH - Conventional Hammer Air										

Table 4 Summary step rate testing at Mesa H

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 (m ² /day)	Hydraulic Conductivity (m/day)	Storage Coefficient/ Specific Yield
WB17MEH0001	12"	WB17MEH0001	-			Alluvium		4.1m @ 18L/s, 2.7m @ 16L/s	1013.2	52.77	3.843E-8
	50mm	MB16MEH0016	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 5760 mins, changed to 16L/s until 43200 mins	43200	CID & Dolomite		0.4m @ 18L/s, 0.6m @ 16L/s	2027.6	36.79	3.011E-3
	50mm	MB17MEH0007	2105m			Dolomite	Unconfined	0.7m @ 18L/s by 1440mins	NA	NA	NA
	50mm	MB17MEH0008	2457m			Dolomite		0.2m @ 18L/s by 1440mins	NA	NA	NA
	50mm	MB17MEH0009	2682m			Dolomite		0.2m @ 18L/s by 1440mins	NA	NA	NA
	50mm	MB17MEH0010	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		0	-	-	-
	12"	WB17MEH0003	-	10	1440	Alluvium	Unconfined	8.9	227.1	10.54	1.294E-6
WB17MEH0003	50mm	MB17MEH0015	15m			Alluvium		0.8	1513.4	71.49	1.012E-5
	12"	WB17MEH0004	-	15	1440	Dolomite	Unconfined	10.8	44.9	1.35	6.39E-5
WB17MEH0004											
WB17MEH0005	12"	WB17MEH0005	-	45	1440	BIF	Unconfined	4.2	568	17.14	6.203E-5

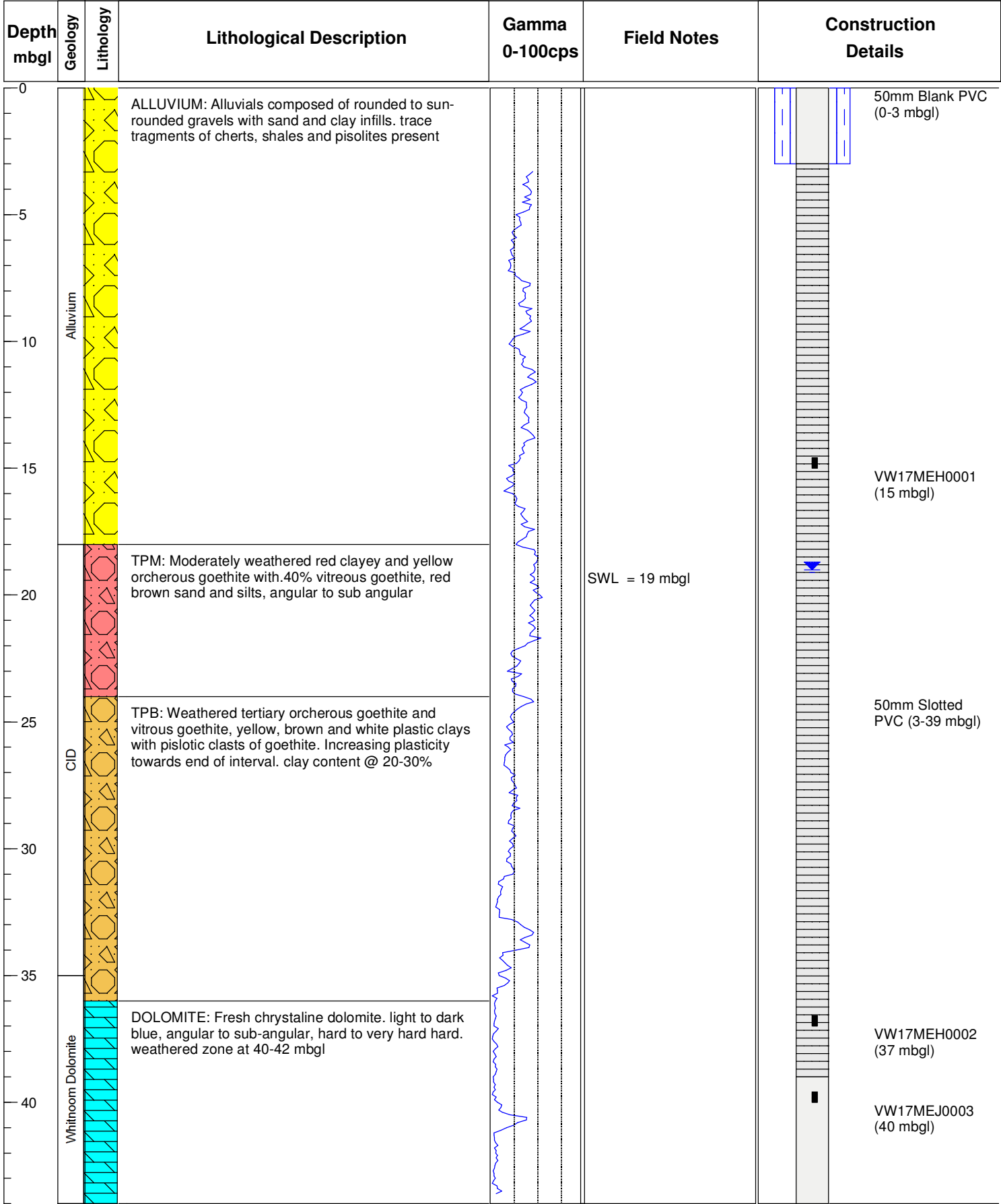
Appendix A - Borehole Logs

Bore Completion Details

HM17MEH0001

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Luke Wallace	EASTING: 416034.012
DATE COMMENCED: 18/08/2017	DRILLING METHOD: Mud Drilling	NORTHING: 7597714.217
DATE COMPLETED: 19/08/2017	HYDROGEOLOGIST: Y. Alaak	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.

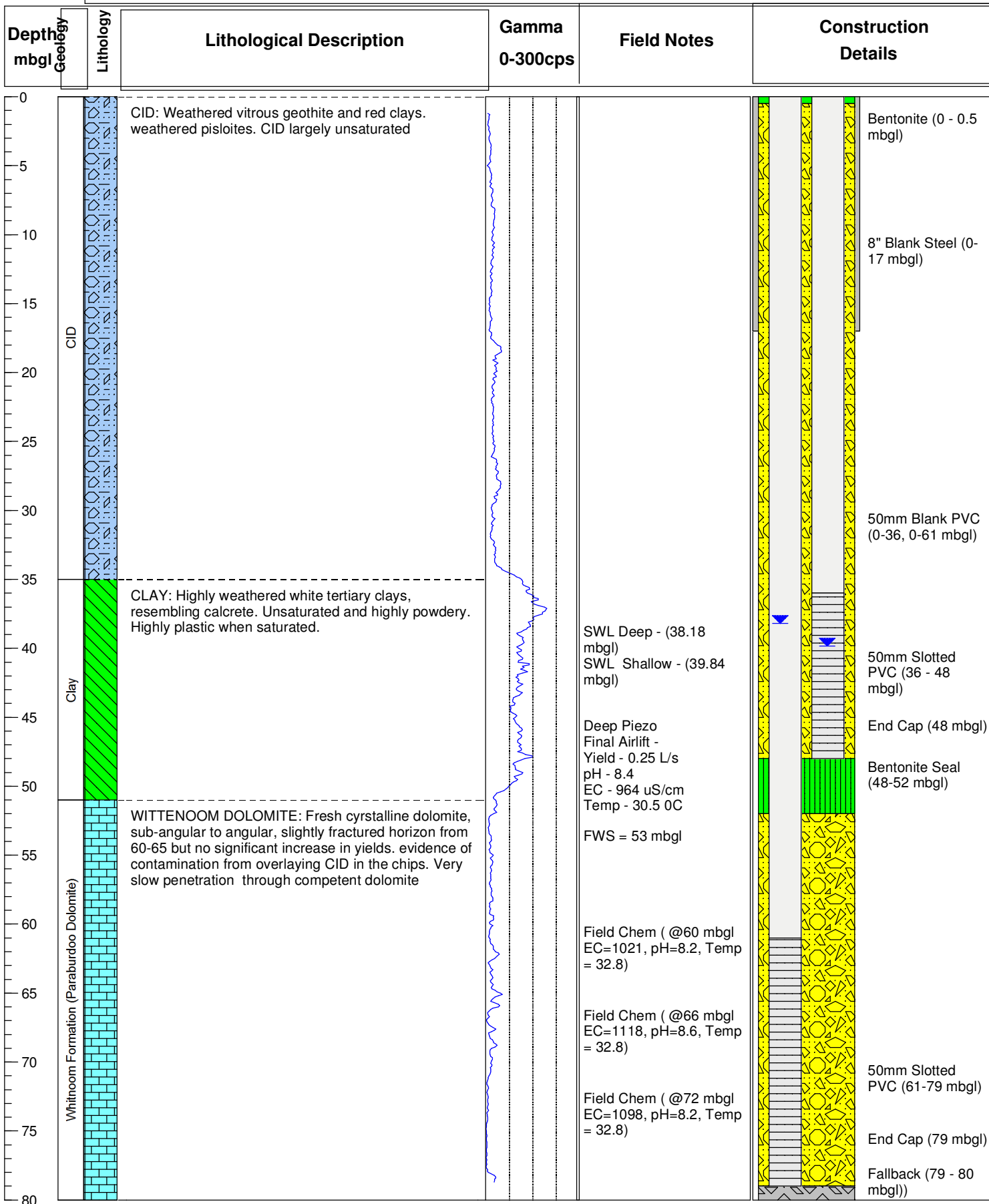


Bore Completion Details

HM17MEH0002

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Joe Mason	EASTING: 421409.959
DATE COMMENCED: 20/08/2017	DRILLING METHOD: ROTARY HAMMER - AIR	NORTHING: 7591295.997
DATE COMPLETED: 22/08/2017	HYDROGEOLOGIST: YUOT ALAAK	ELEVATION: 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

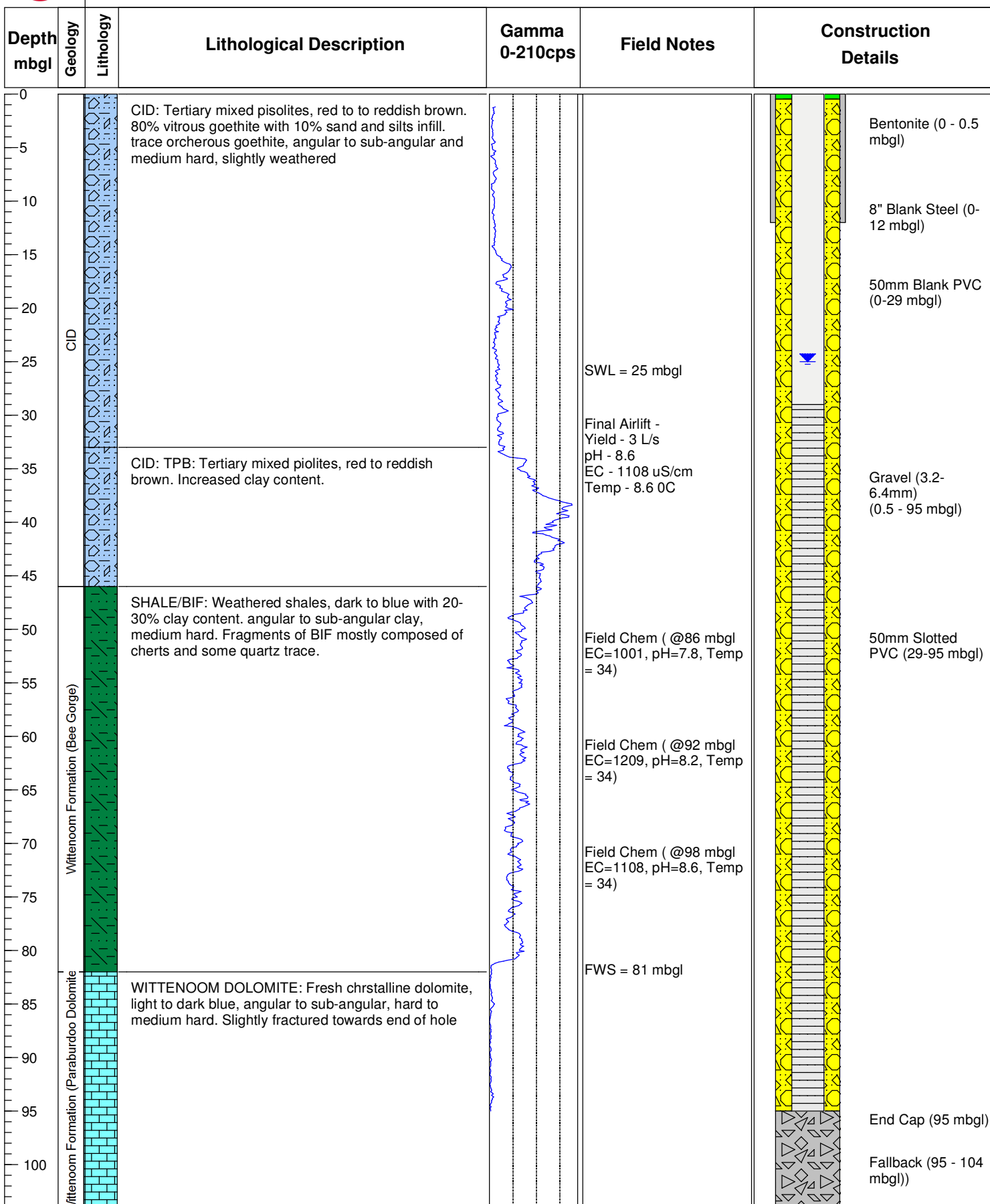


Bore Completion Details

MB17MEH0001

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Manu Rekena	EASTING: 420764.006
DATE COMMENCED: 20/08/2017	DRILLING METHOD: ROTARY HAMMER - AIR	NORTHING: 7591282.880
DATE COMPLETED: 22/08/2017	HYDROGEOLOGIST: Y. Alaak	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



Bore Completion Details

MB17MEH0004

PROJECT: MESA H

DRILLING COMPANY: BDC

GRID NAME: MGA94_50

LOCATION: Mesa H

DRILLER: Luke Wallace

EASTING: 421705.351

DATE COMMENCED: 23/08/2017

DRILLING METHOD: ROTARY HAMMER - AIR

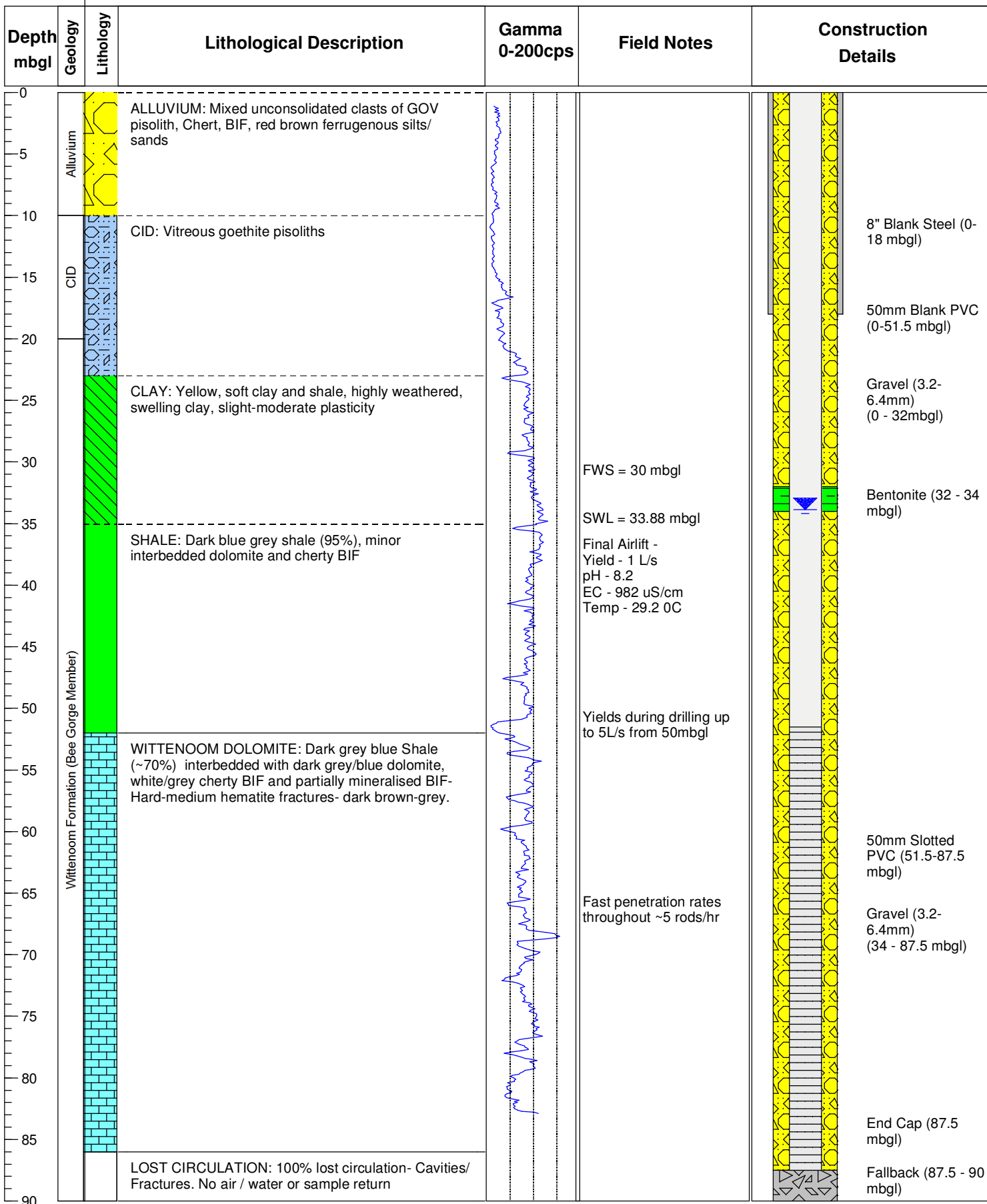
NORTHING: 7590918.035

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)

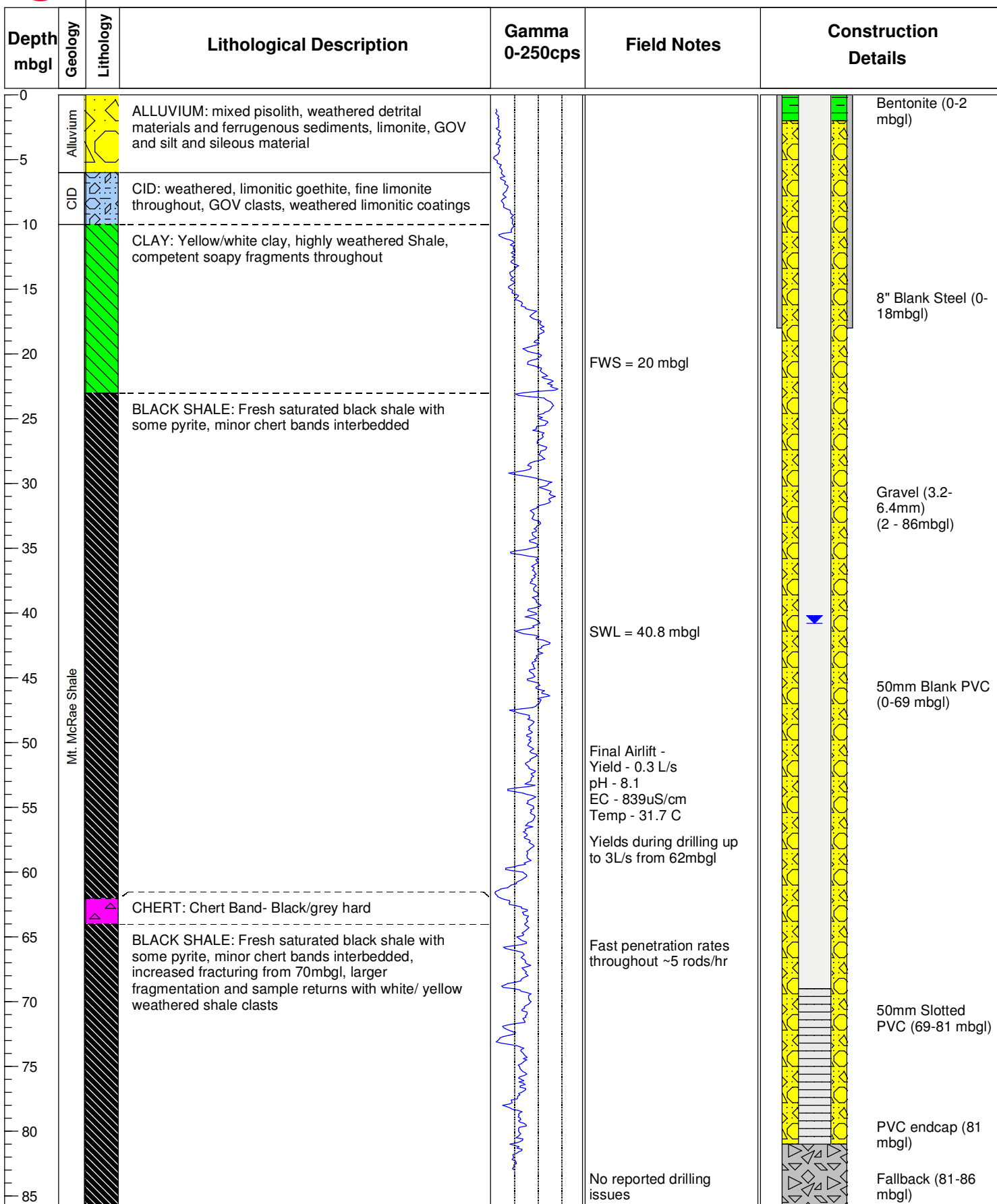


Bore Completion Details

MB17MEH0005

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Luke Wallace	EASTING: 421909.743
DATE COMMENCED: 26/08/2017	DRILLING METHOD: ROTARY HAMMER - AIR	NORTHING: 7590687.074
DATE COMPLETED: 27/08/2017	HYDROGEOLOGIST: C. Miller	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)

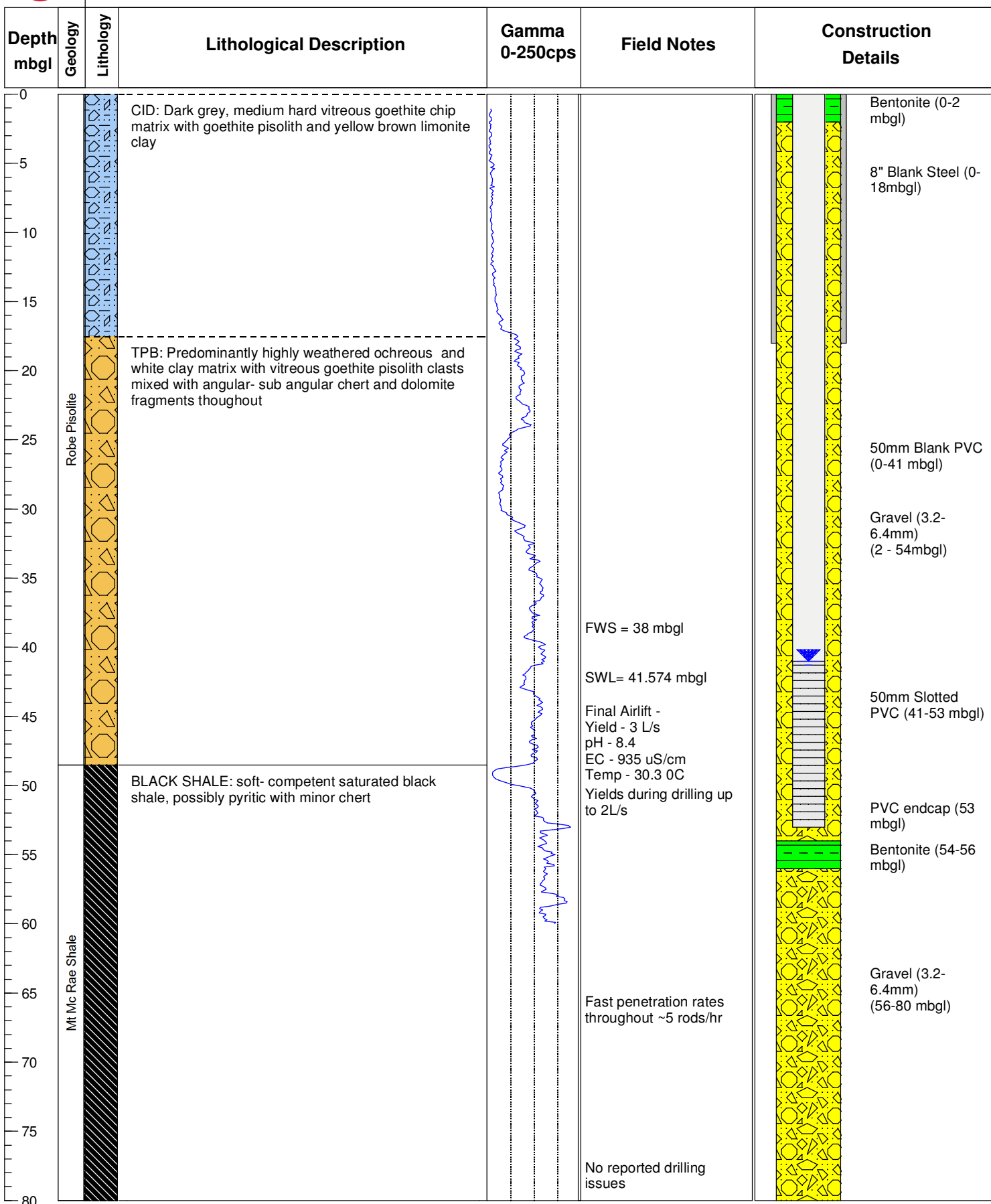


Bore Completion Details

MB17MEH0006

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_Z50
LOCATION: Mesa H	DRILLER: Luke Wallace	EASTING: 422272.376
DATE COMMENCED: 26/08/2017	DRILLING 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



Bore Completion Details

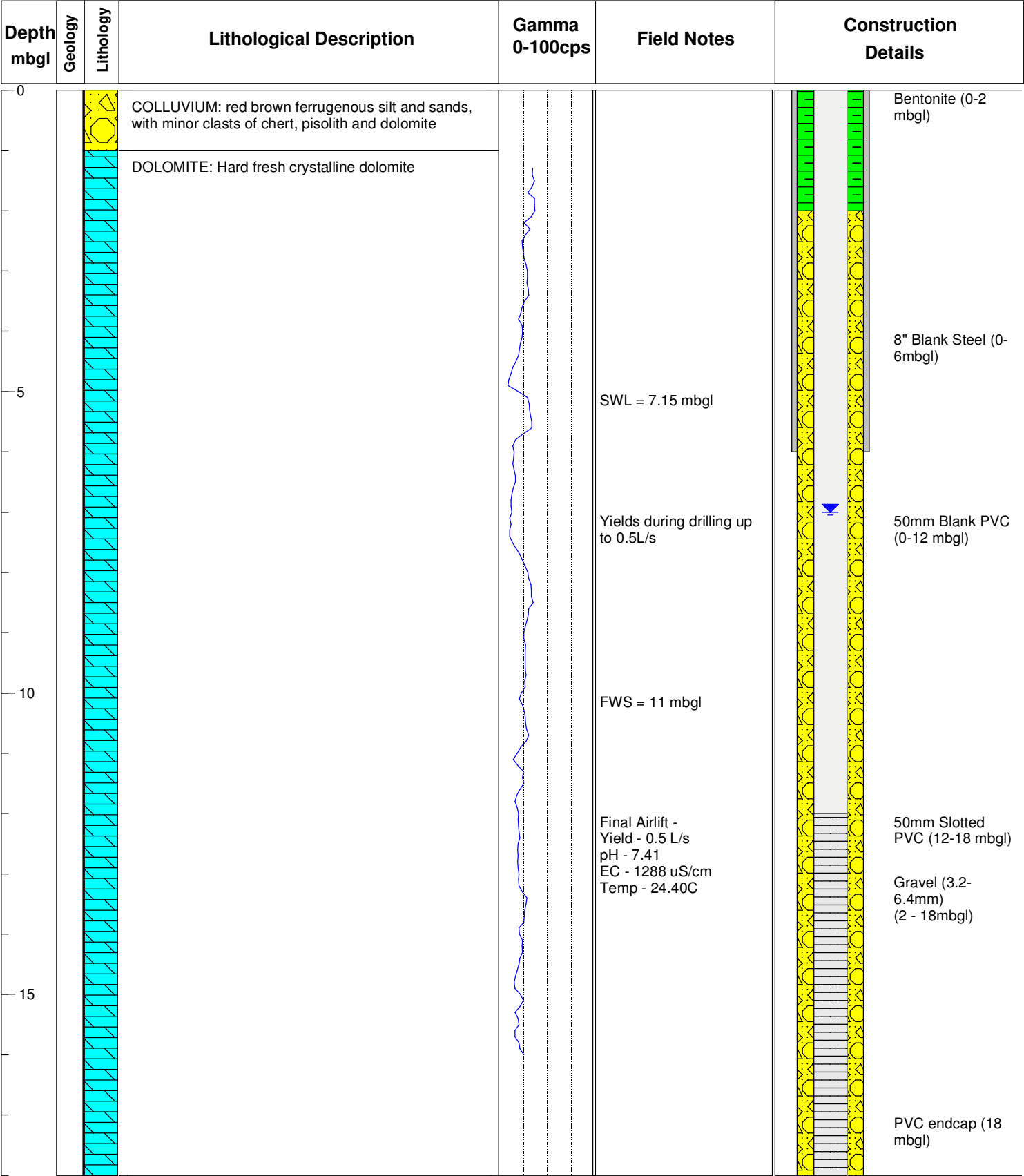
MB17MEH0007

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_Z50
LOCATION: Mesa H	DRILLER: Luke Wallace	EASTING: 417658.827
DATE COMMENCED: 28/08/2017	DRILLING METHOD: Air Hammer	NORTHING: 7600422.641
DATE COMPLETED: 29/08/2017	HYDROGEOLOGIST: C. Miller	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.

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

Bore Completion Details		MB17MEH0008	
PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_Z50	
LOCATION: Mesa H	DRILLER: Luke Wallace	EASTING: 417119.022	
DATE COMMENCED:28/08/2017	DRILLING METHOD: Air Hammer	NORTHING: 7600417.544	
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			

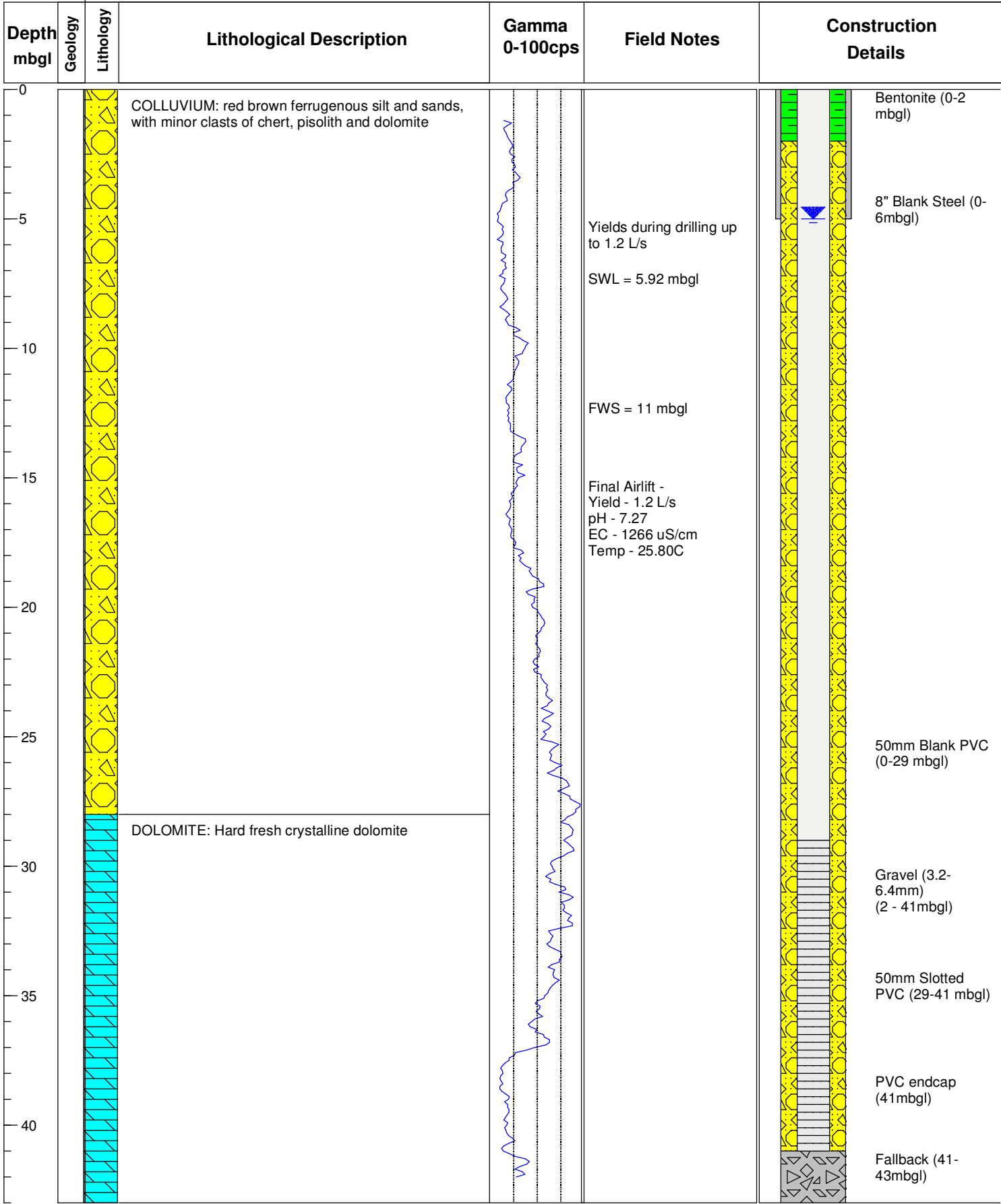


Bore Completion Details

MB17MEH0009

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_Z50
LOCATION: Mesa H	DRILLER: Hayden Kent	EASTING: 416434.642
DATE COMMENCED: 29/08/2017	DRILLING METHOD: Air Hammer	NORTHING: 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

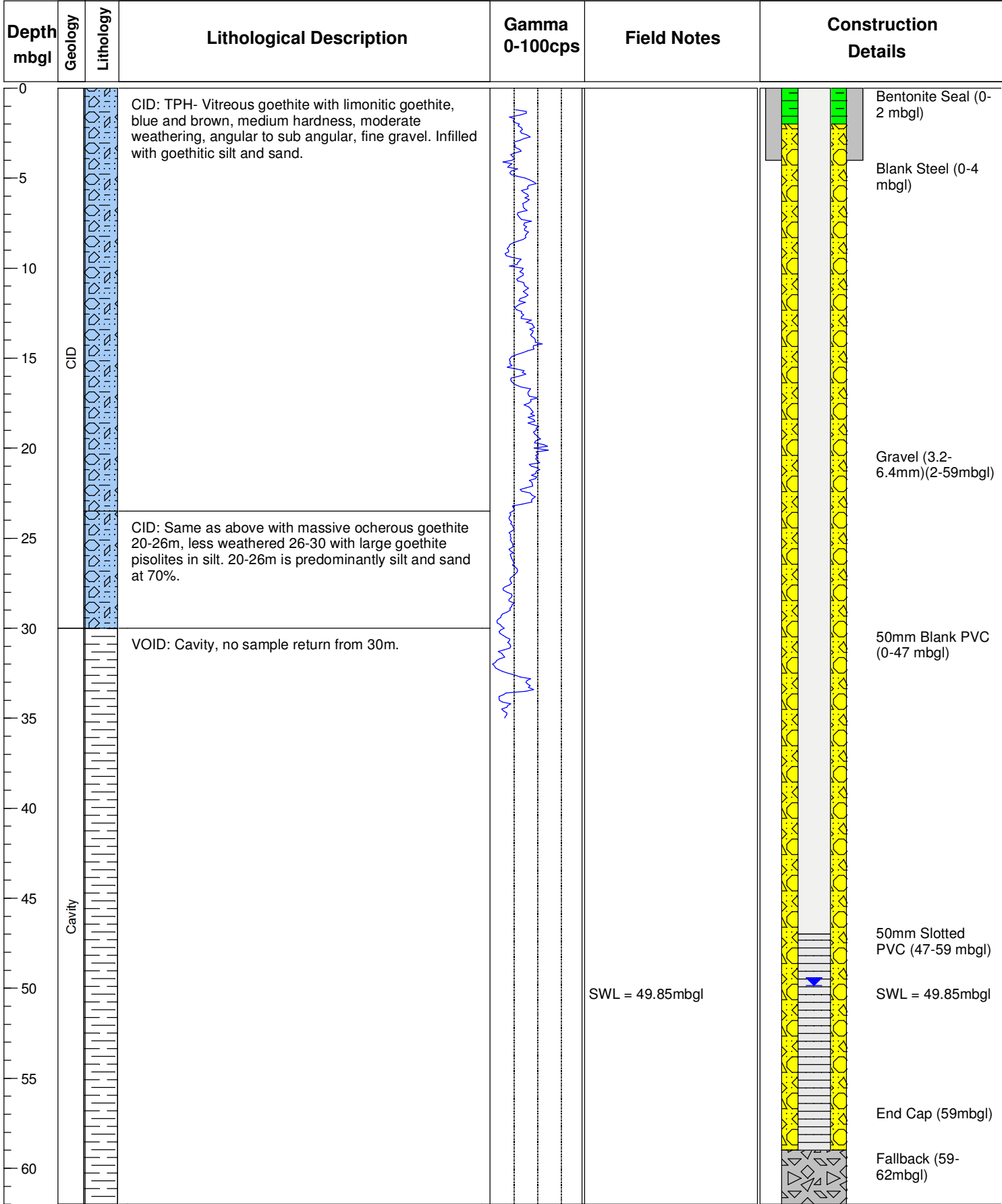


Bore Completion Details

MB17MEH0011

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Hayden Kent	EASTING: 414868.454
DATE COMMENCED: 24/10/2017	DRILLING METHOD: Air Hammer	NORTHING: 7596153.963
DATE COMPLETED: 29/10/2017	HYDROGEOLOGIST: Yuot Alaak	ELEVATION: 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.



Bore Completion Details

MB17MEH0012

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Hayden Kent	EASTING: 414881.979
DATE COMMENCED: 25/10/2017	DRILLING METHOD: Rotary Hammer - Air	NORTHING: 7596152.854
DATE COMPLETED: 28/10/2017	HYDROGEOLOGIST: Yuot Alaak	ELEVATION: 166.430 mRL TOC

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.

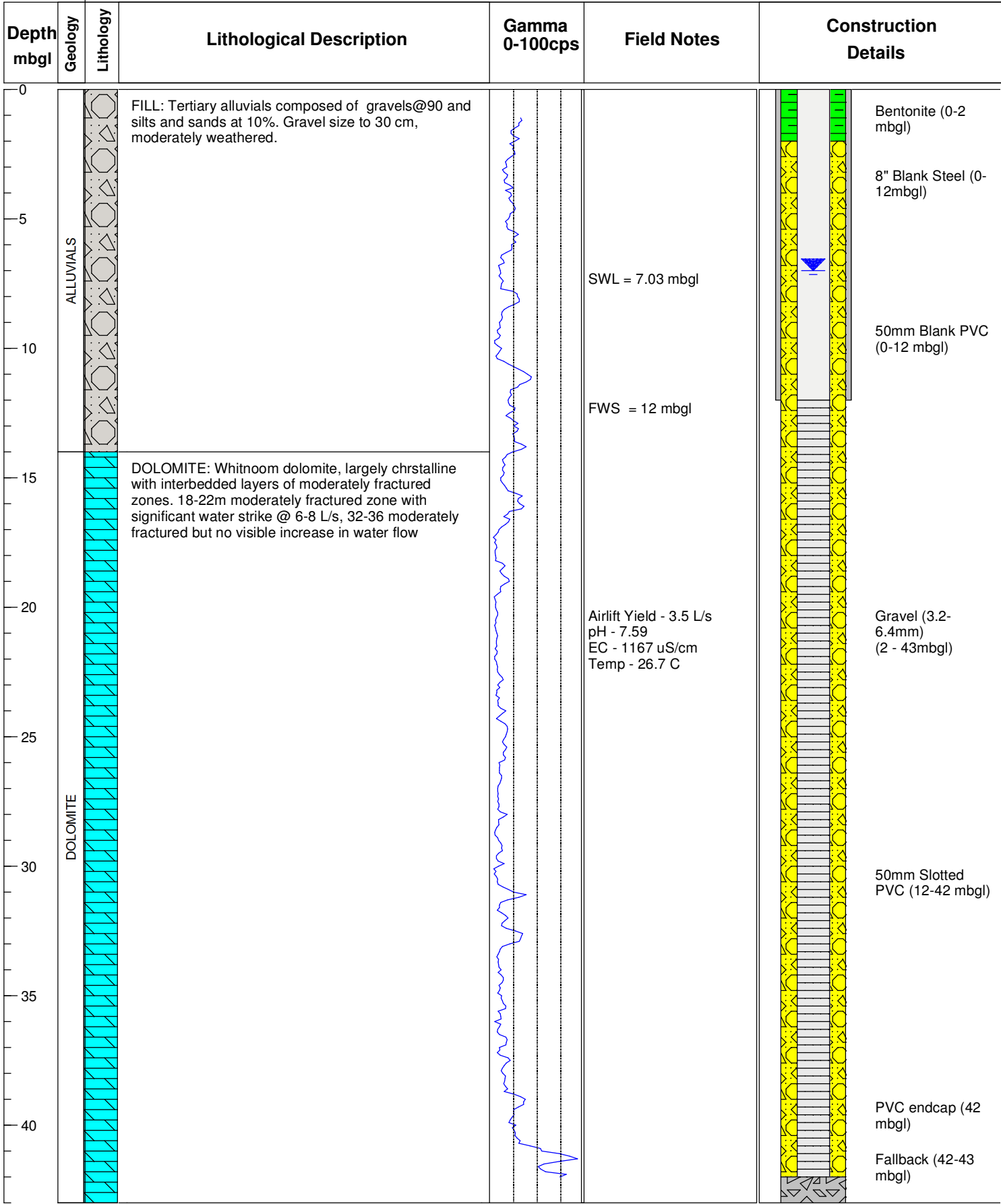
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-50cps	Field Notes	Construction Details	
0	CID		TPH: Bright to darkish yellow predominantly orcherous goethite, medium weathered and medium hardness, angular to sub-angular, 10-20% sand infills			Headworks	
5			CID			TPM: Moderately weathered yellow orcheous goethite at 70%, with trace limnonite towards end of interval, slightly less weathered than interval above. 5 %vitreous goethite fine gravel and silt towards end of hole	10" Blank Steel (0-40mbgl)
10							50mm Blank PVC (0-56 mbgl)
15	BIF	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		Bentonite Seal (40-44mbgl)			
20			BIF	MARRA MAMBA: Shalley marra mamba bifs with chert bands and trace goethite with sand and silts infills	Gravel (3.2-6.4mm) (0 - 40, 44 - 116 mbgl)		
25					50mm Slotted PVC (56-80 mbgl)		
30	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			PVC endcap (80 mbgl)		
35			BIF				
40						BIF	
45	BIF						
50			BIF				
55						BIF	
60	BIF						
65			BIF				
70						BIF	
75	BIF						
80			BIF				
85						BIF	
90	BIF						
95			BIF				
100						BIF	
105	BIF						
110			BIF				
115						BIF	

Bore Completion Details

MB17MEH0013

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Hayden Kent	EASTING: 418380.559
DATE COMMENCED: 30/10/2017	DRILLING METHOD: Rotary Hammer - Air	NORTHING: 7599440.612
DATE COMPLETED: 1/11/2017	HYDROGEOLOGIST: Yuot Alaak	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.

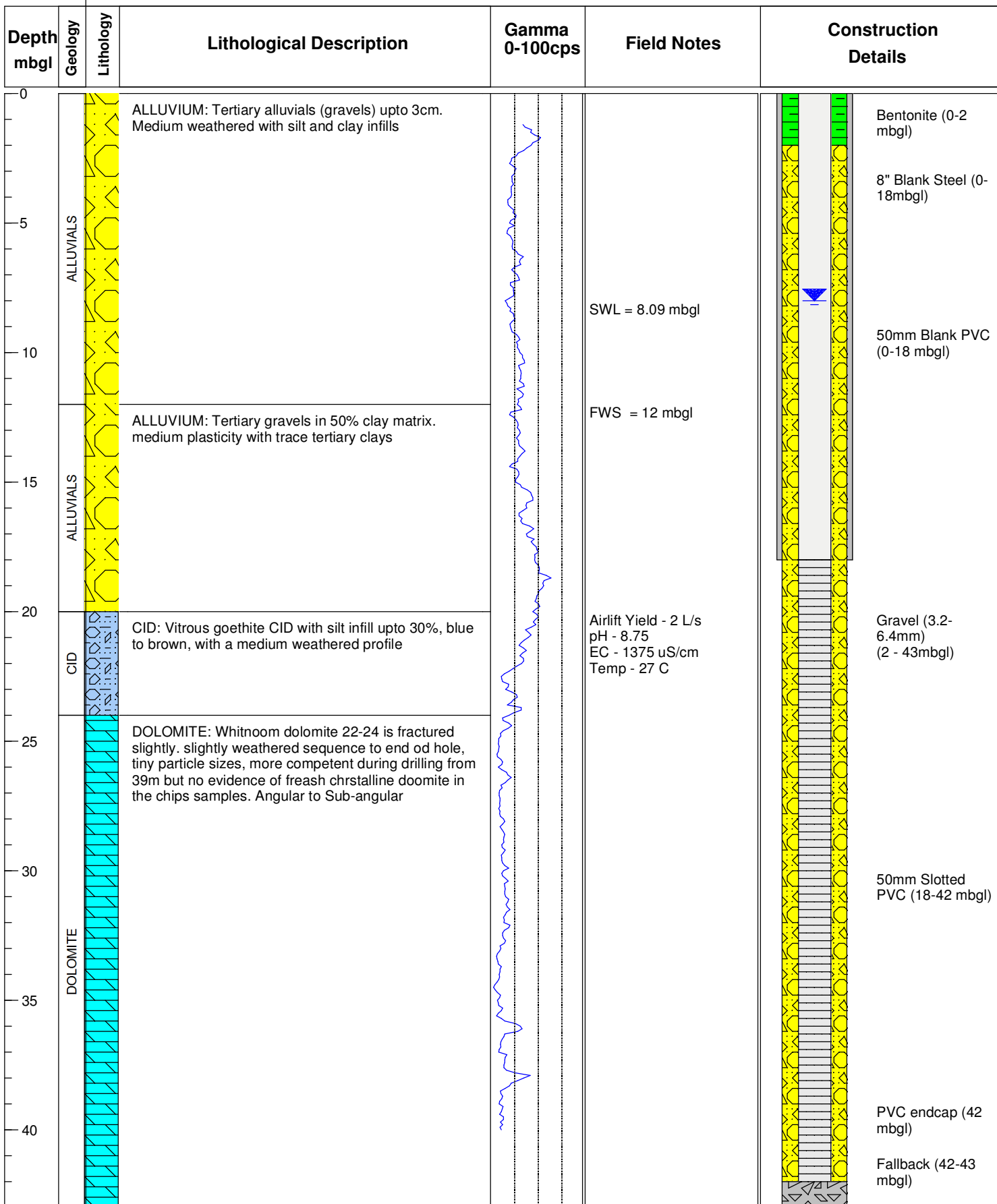


Bore Completion Details

MB17MEH0014

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Luke Wallace	EASTING: 418723.950
DATE COMMENCED: 27/10/2017	DRILLING METHOD: Rotary Hammer - Air	NORTHING: 7599428.420
DATE COMPLETED: 29/10/2017	HYDROGEOLOGIST: Yuot Alaak	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.

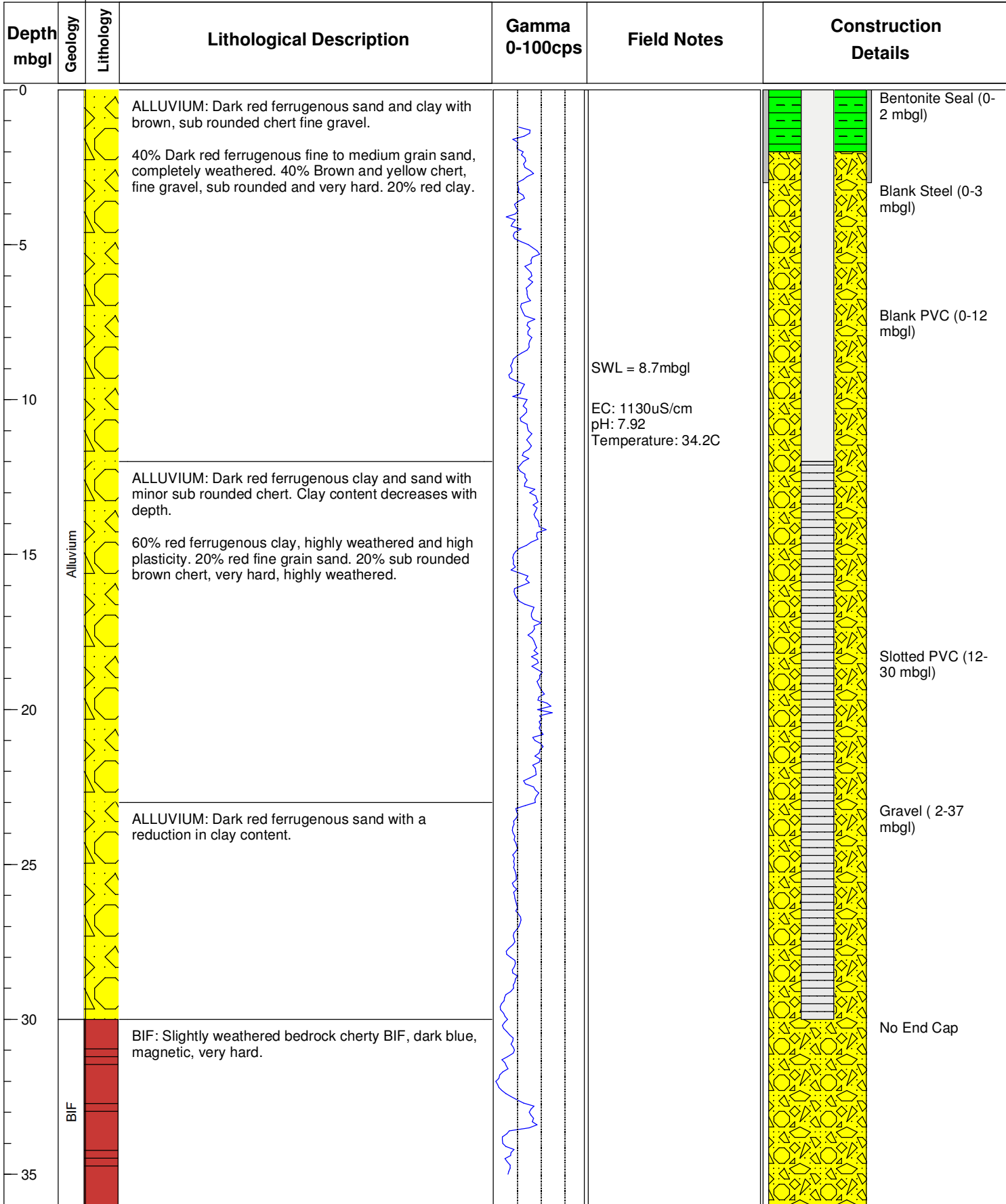


Bore Completion Details

MB17MEH0015

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Manu Rekena	EASTING: 416044.945
DATE COMMENCED: 2/11/2017	DRILLING METHOD: Mud	NORTHING: 7597712.125
DATE COMPLETED: 3/11/2017	HYDROGEOLOGIST: Nik Adam	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.



Bore Completion Details

WB17MEH0001

PROJECT: MESA H

DRILLING COMPANY: BDC

GRID NAME: MGA94_50

LOCATION: Mesa H

DRILLER: Hayden Kent

EASTING: 418857.053

DATE COMMENCED: 23/08/2017

DRILLING METHOD: Mud Rotary

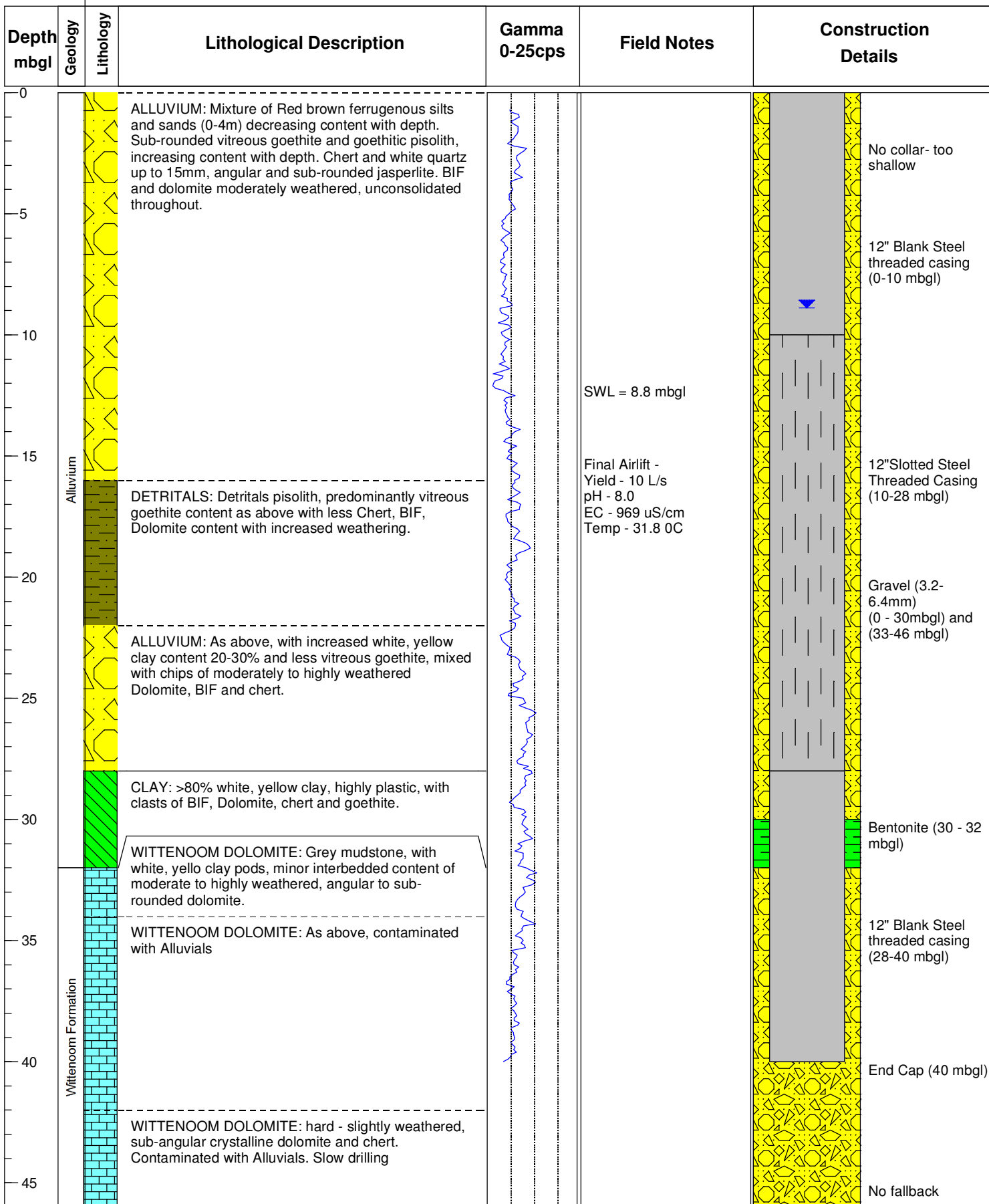
NORTHING: 7598693.336

DATE COMPLETED: 25/08/2017

HYDROGEOLOGIST: C. Miller

ELEVATION: 139.413

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

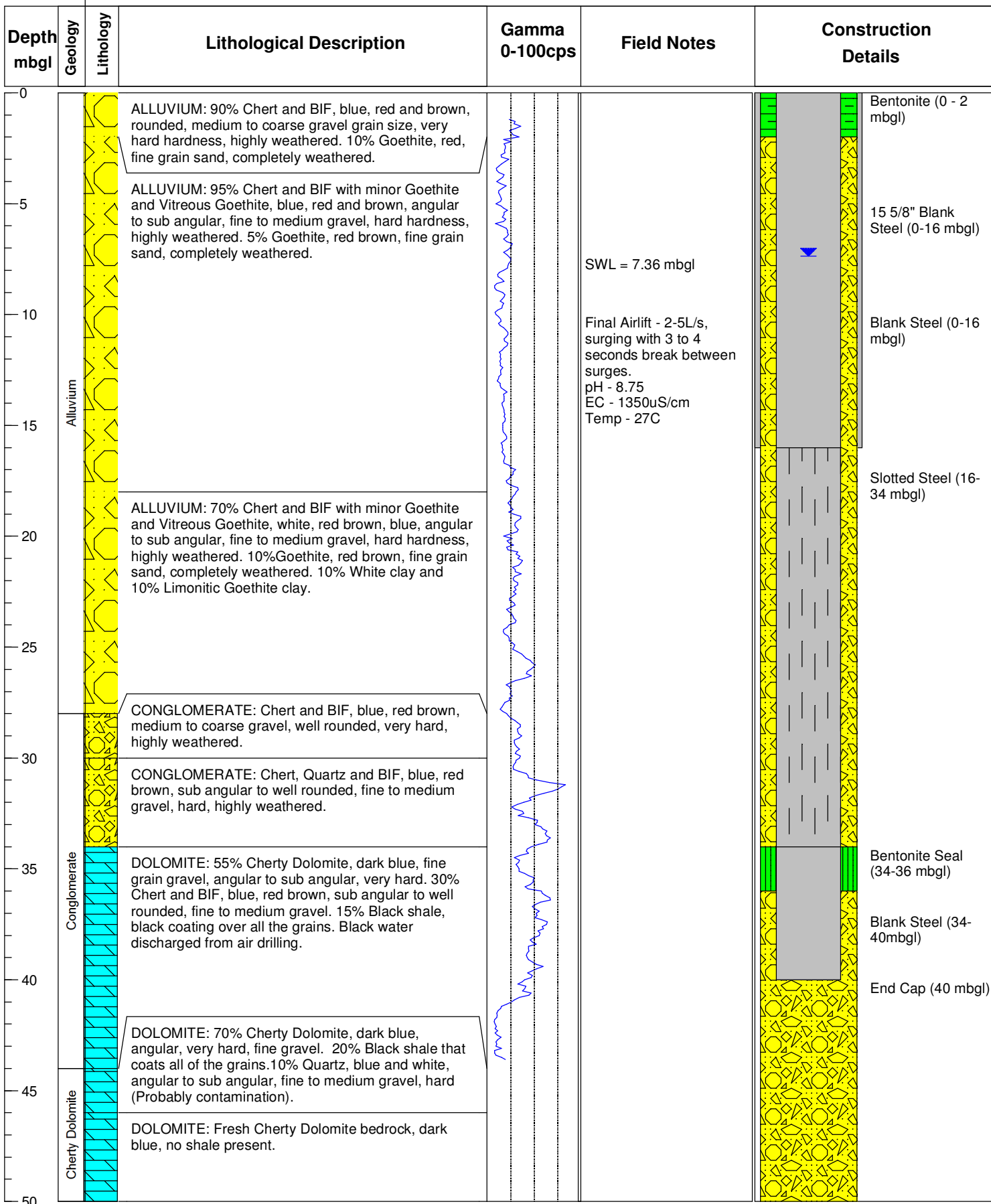


Bore Completion Details

WB17MEH0002

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	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	ELEVATION: 139.413 mRL TOC

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



Bore Completion Details

WB17MEH0003

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Manu Rekena	EASTING: 416059.508
DATE COMMENCED: 04/11/2017	DRILLING METHOD: Mud Rotary 0-36m	NORTHING: 7597705.964
DATE COMPLETED: 11/11/2017	HYDROGEOLOGIST: Nik Adam	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.

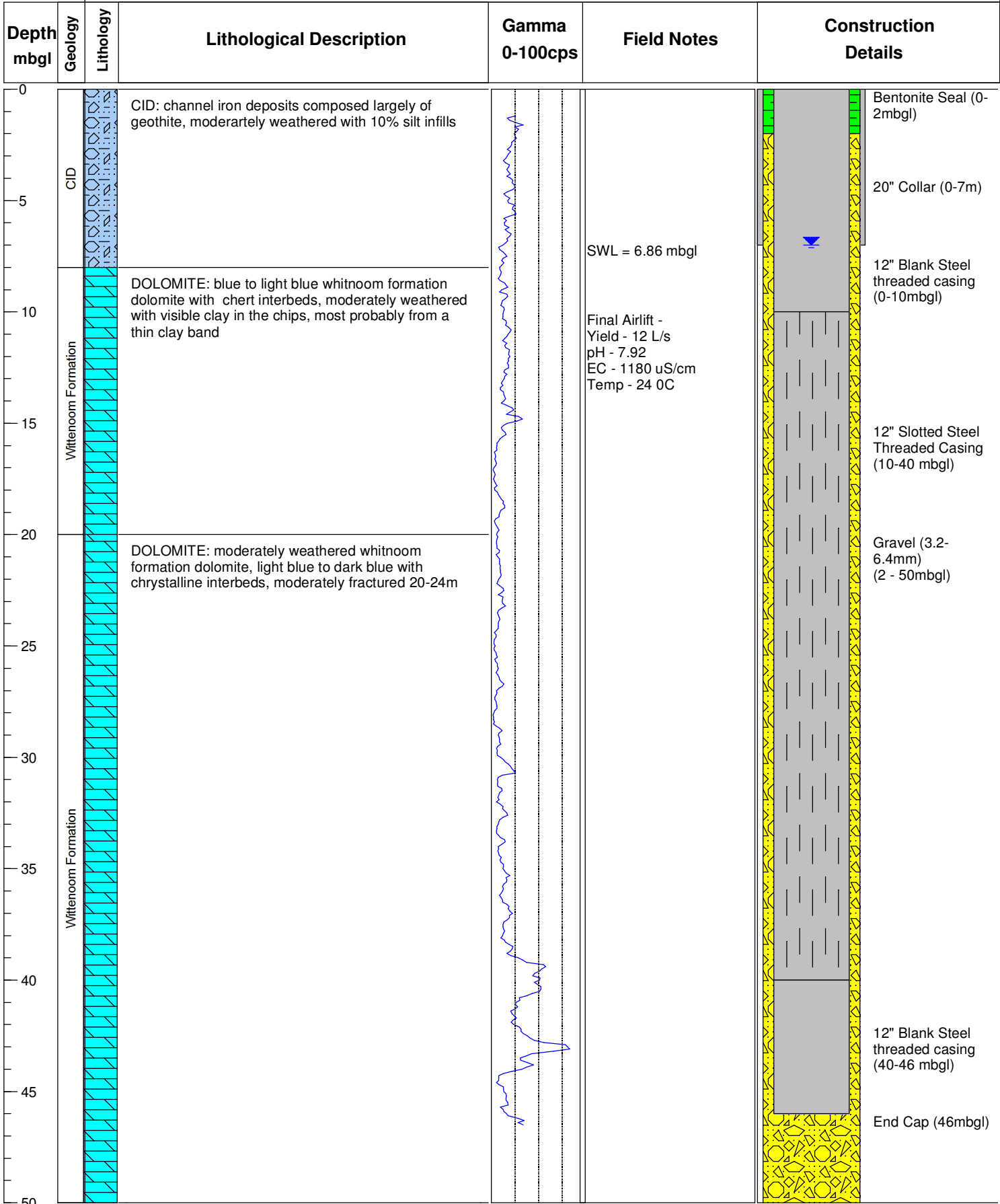
Depth mbgl	Geology	Lithology	Lithological Description	Gamma 0-100cps	Field Notes	Construction Details
0			<p>ALLUVIUM: Predominantly highly weathered red brown chert with minor quartz and goethite.</p> <p>75% chert, red brown, angular to sub rounded, fine to medium gravel, hard, highly weathered. 15% Goethite, yellow, angular to sub angular, fine to medium gravel, hard. 10% quartz, white, angular to sub angular, fine to medium gravel, hard.</p>			Blank Steel (0-2 mbgl)
5						Bentonite (0 - 2 mbgl)
10			<p>ALLUVIUM: Highly weathered, dark red brown clay and sand with minor chert and goethite clasts.</p> <p>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.</p>		SWL = 8.46 mbgl	Blank PVC (0-18 mbgl)
15					Final Airlift - 6L/s pH - 7.82 EC - 1108 mS/cm Temperature - 30.2C	
20			<p>ALLUVIUM: Highly weathered red brown clay with a high proportion of chert, goethite and quartz clasts.</p> <p>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.</p>			Slotted PVC (18-30 mbgl)
25			<p>ALLUVIUM: Moderately weathered chert, goethite and quartz, dark blue and white, angular to sub angular, fine to medium gravel, hard.</p>			
30						Blank PVC (30-36 mbgl)
35			<p>BIF: Slightly weathered cherty BIF, magnetic, fractured, dark blue, platy, very hard. Problems drilling past 32m with the drill stopping on numerous occasions.</p>			End Cap (36 mbgl)

Bore Completion Details

WB17MEH0004

PROJECT: MESA H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Joe Mason	EASTING: 418388.056
DATE COMMENCED: 7/11/2017	DRILLING METHOD: Mud Rotary	NORTHING: 7599451.981
DATE COMPLETED: 10/11/2017	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.

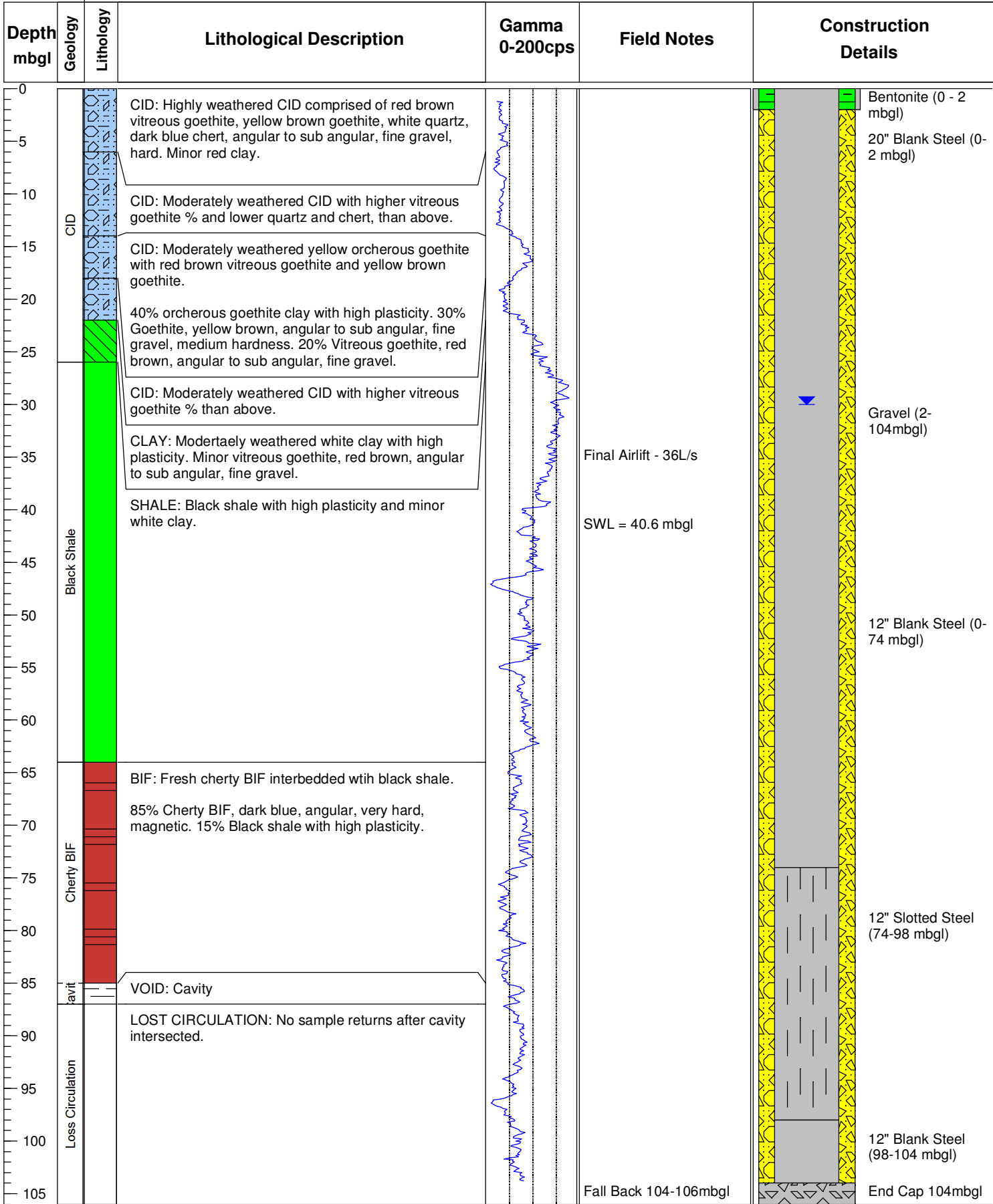


Bore Completion Details

WB17MEH0005

PROJECT: Mesa H	DRILLING COMPANY: BDC	GRID NAME: MGA94_50
LOCATION: Mesa H	DRILLER: Hayden Kent	EASTING: 421699.218
DATE COMMENCED: 14/11/2017	DRILLING METHOD: Mud Rotary 0-106m	NORTHING: 7590927.611
DATE COMPLETED: 19/11/2017	HYDROGEOLOGIST: Nik Adam	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.

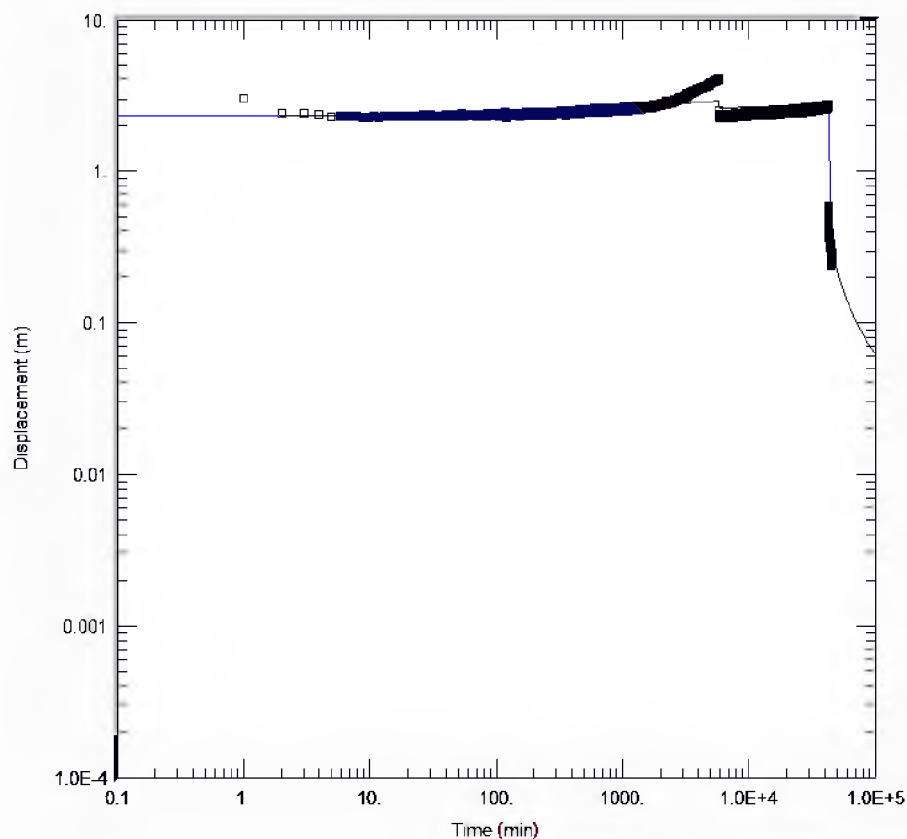


Fall Back 104-106mbgl

End Cap 104mbgl

Appendix B - Constant Rate Test Analysis

DRAFT



Obs. Wells

□ WB17MEH0001

Aquifer Model

Unconfined

Solution

Moench

Parameters

$T = 1013.2 \text{ m}^2/\text{day}$

$S = 3.843\text{E-}8$

$S_y = 0.3338$

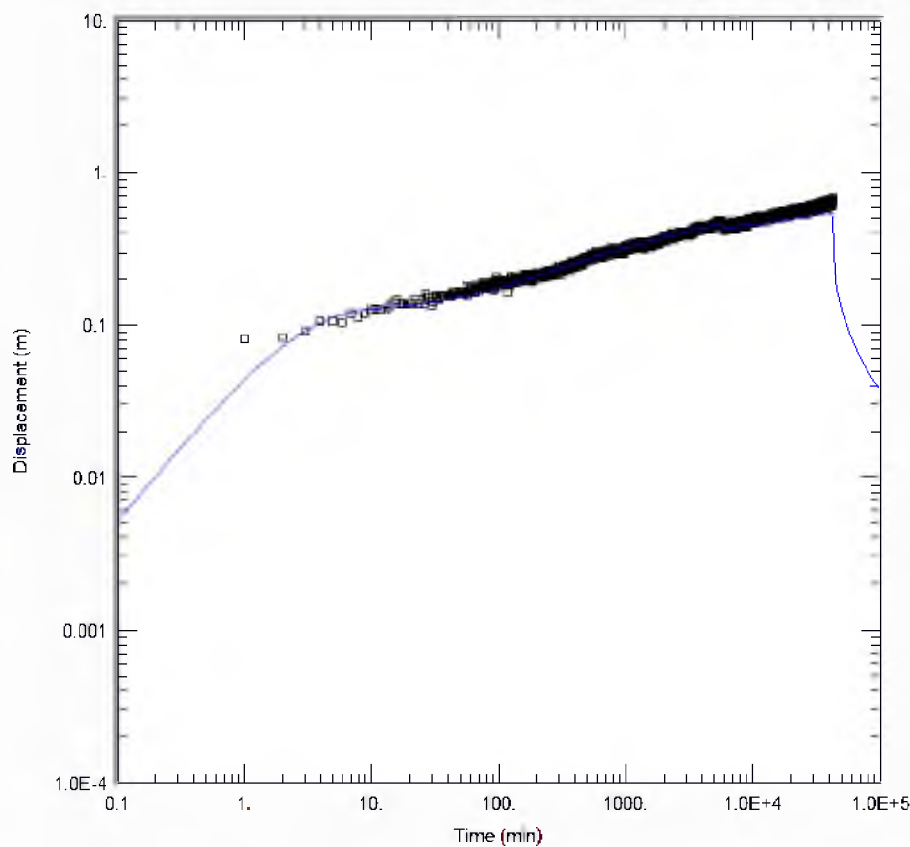
$Kz/Kr = 5348.3$

$Sw = 2.55$

$r(w) = 0.01413 \text{ m}$

$r(c) = 0.01941 \text{ m}$

$\alpha = 0.01 \text{ min}^{-1}$



Obs. Wells

□ MB16MEH0016

Aquifer Model

Unconfined

Solution

Moench

Parameters

$T = 1649.7 \text{ m}^2/\text{day}$

$S = 1.938\text{E-}5$

$S_y = 0.3338$

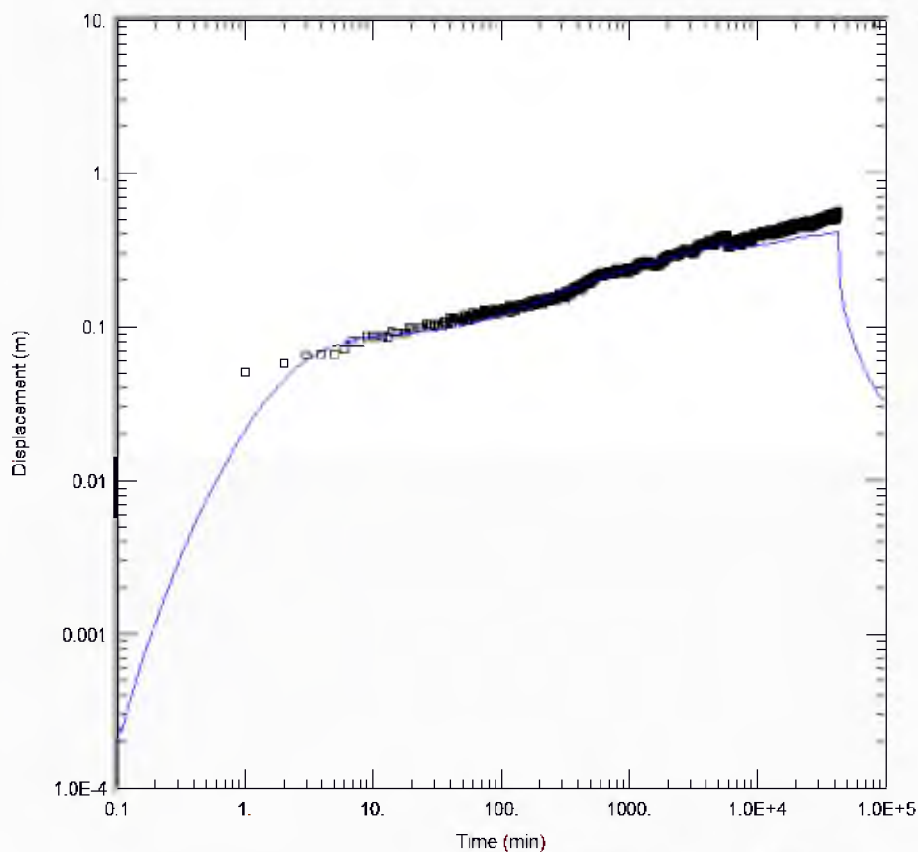
$Kz/Kr = 1542.5$

$Sw = 2.55$

$r(w) = 0.01413 \text{ m}$

$r(c) = 0.004246 \text{ m}$

$\alpha = 0.01 \text{ min}^{-1}$



Obs. Wells

□ MB16MEH0014

Aquifer Model

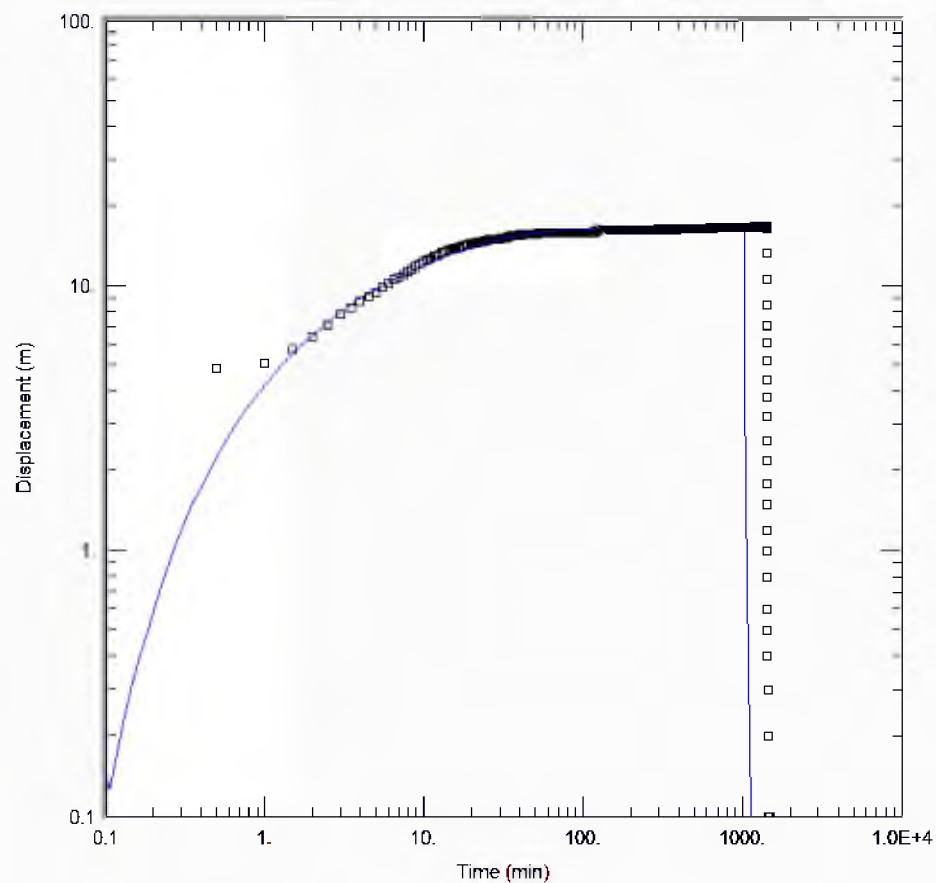
Unconfined

Solution

Moench

Parameters

$T = 2027.6 \text{ m}^2/\text{day}$
 $S = 0.003011$
 $S_y = 0.3338$
 $Kz/Kr = 5348.3$
 $Sw = 2.55$
 $r(w) = 0.01413 \text{ m}$
 $r(c) = 0.01941 \text{ m}$
 $\alpha = 0.01 \text{ min}^{-1}$



Obs. Wells

□ WB17MEH0002

Aquifer Model

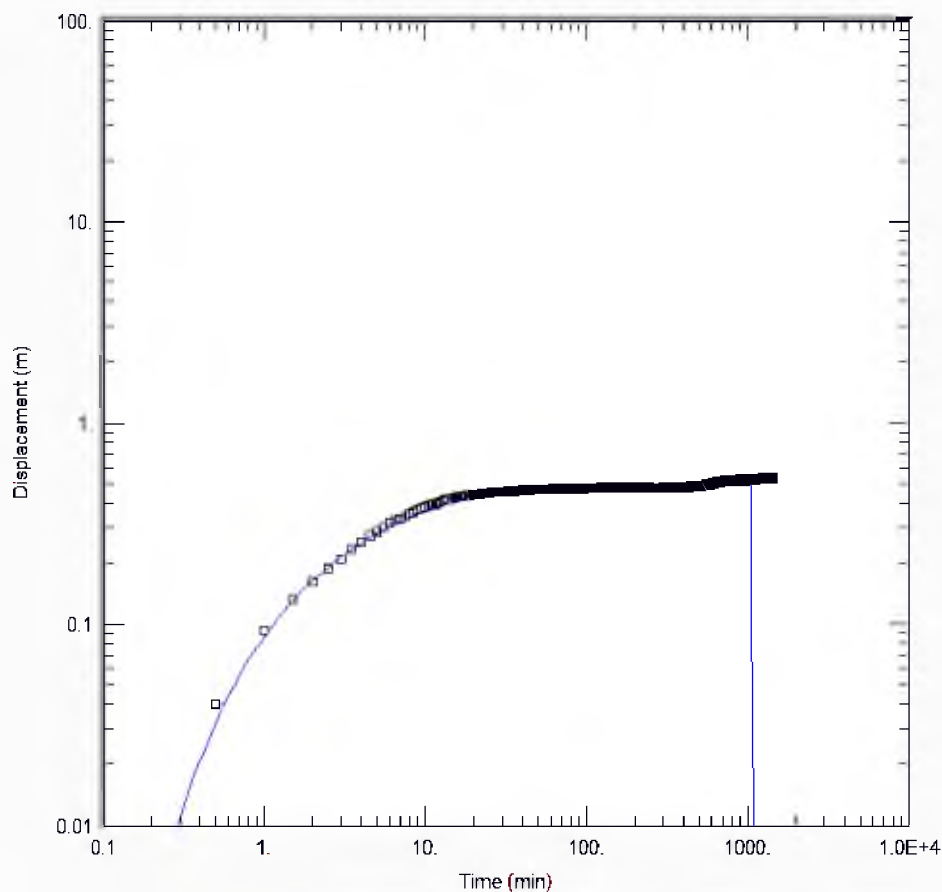
Leaky

Solution

Hantush-Jacob

Parameters

$T = 9.418 \text{ m}^2/\text{day}$
 $S = 0.006448$
 $1/B = 0.1479 \text{ m}^{-1}$
 $Kz/Kr = 1$
 $b = 17.54 \text{ m}$



Obs. Wells

□ MB17MEH0014

Aquifer Model

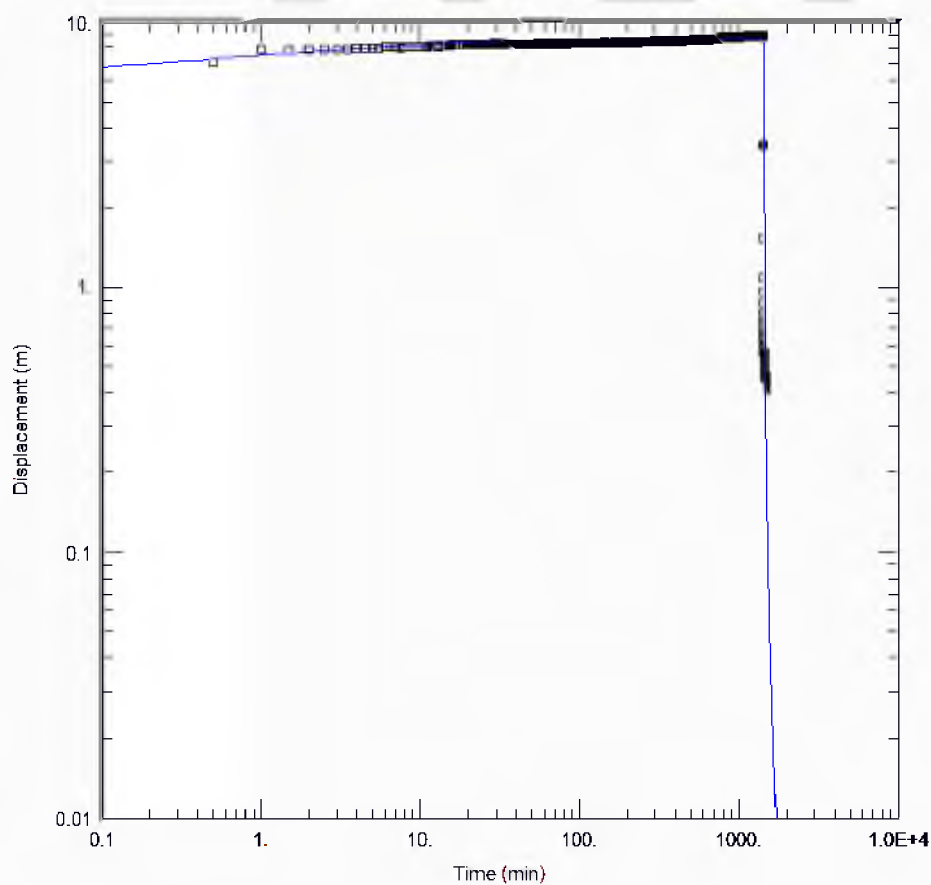
Leaky

Solution

Hantush-Jacob

Parameters

T = 220.7 m²/day
 S = 0.001931
 1/B = 0.02138 m⁻¹
 Kz/Kr = 1.
 b = 17.54 m



Obs. Wells

□ WB17MEH0003

Aquifer Model

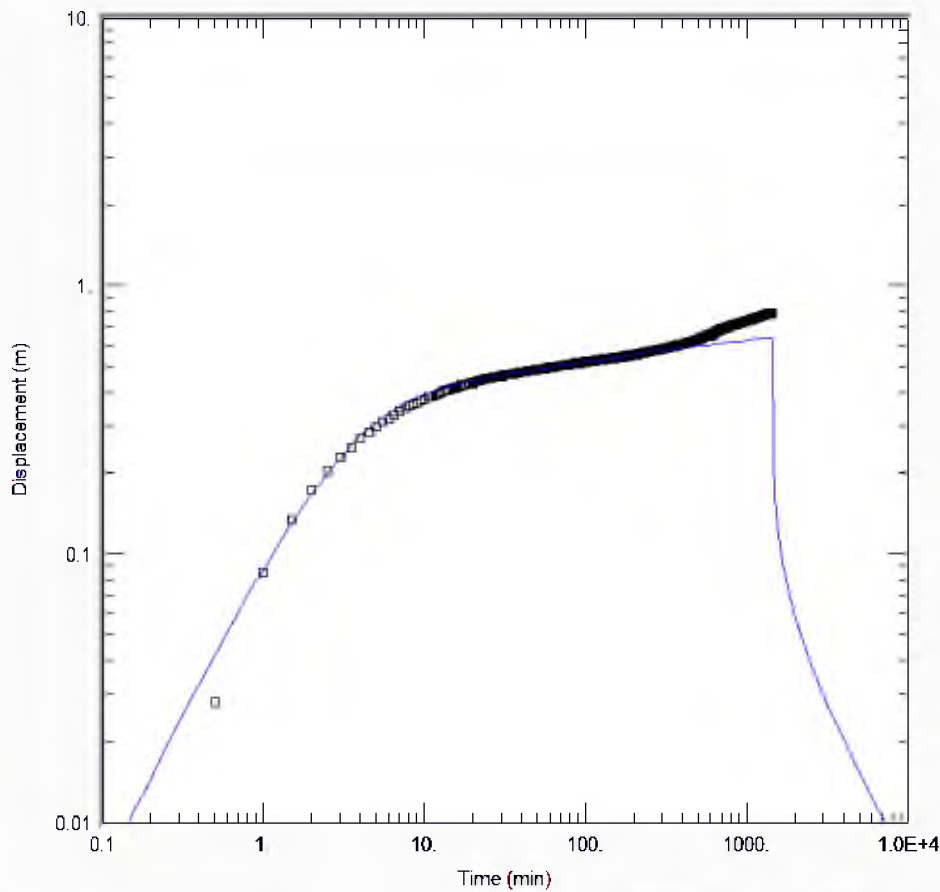
Unconfined

Solution

Moench

Parameters

T = 227.1 m²/day
 S = 1.294E-6
 Sy = 0.001
 Kz/Kr = 7576.4
 Sw = -4.8
 r(w) = 0.0007586 m
 r(c) = 0.0007586 m
 alpha = 1.585E-5 min⁻¹



Obs. Wells

□ MB17MEH0015

Aquifer Model

Unconfined

Solution

Moench

Parameters

$T = 1513.4 \text{ m}^2/\text{day}$

$S = 1.012\text{E-}5$

$S_y = 0.001$

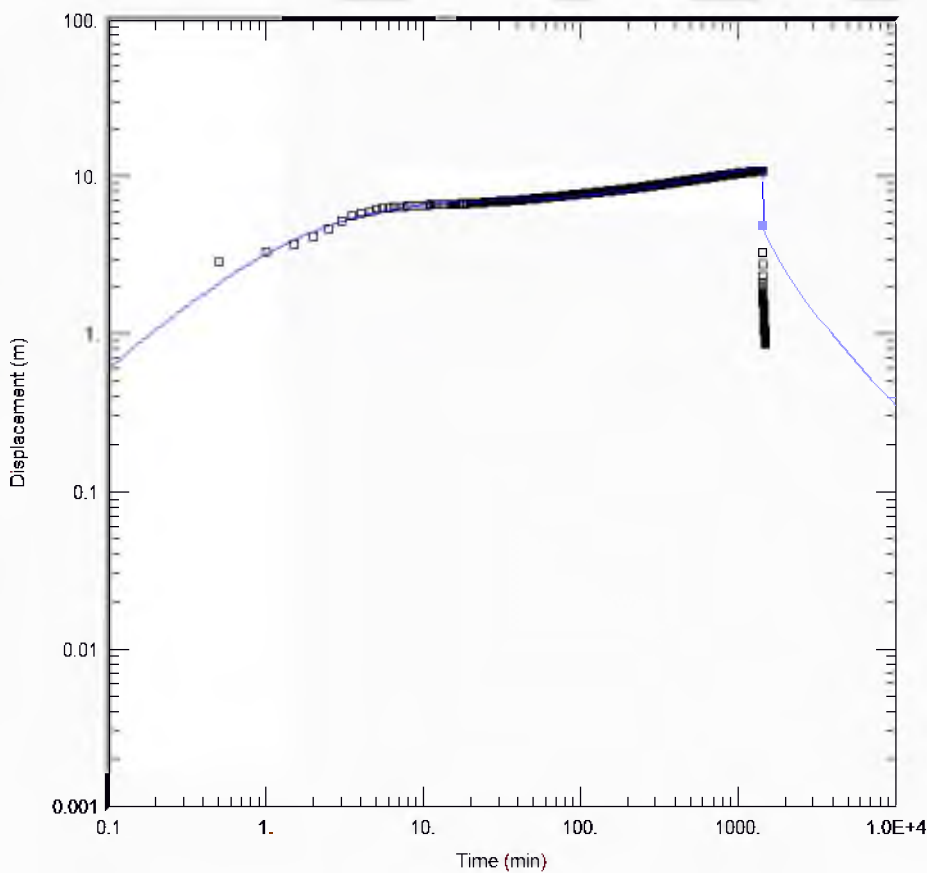
$Kz/Kr = 0.001$

$Sw = -4.8$

$r(w) = 0.0007586 \text{ m}$

$r(c) = 0.0007586 \text{ m}$

$\alpha = 1.0\text{E-}10 \text{ min}^{-1}$



Obs. Wells

□ WB17MEH0004

Aquifer Model

Unconfined

Solution

Moench

Parameters

$T = 44.9 \text{ m}^2/\text{day}$

$S = 6.39\text{E-}5$

$S_y = 0.004048$

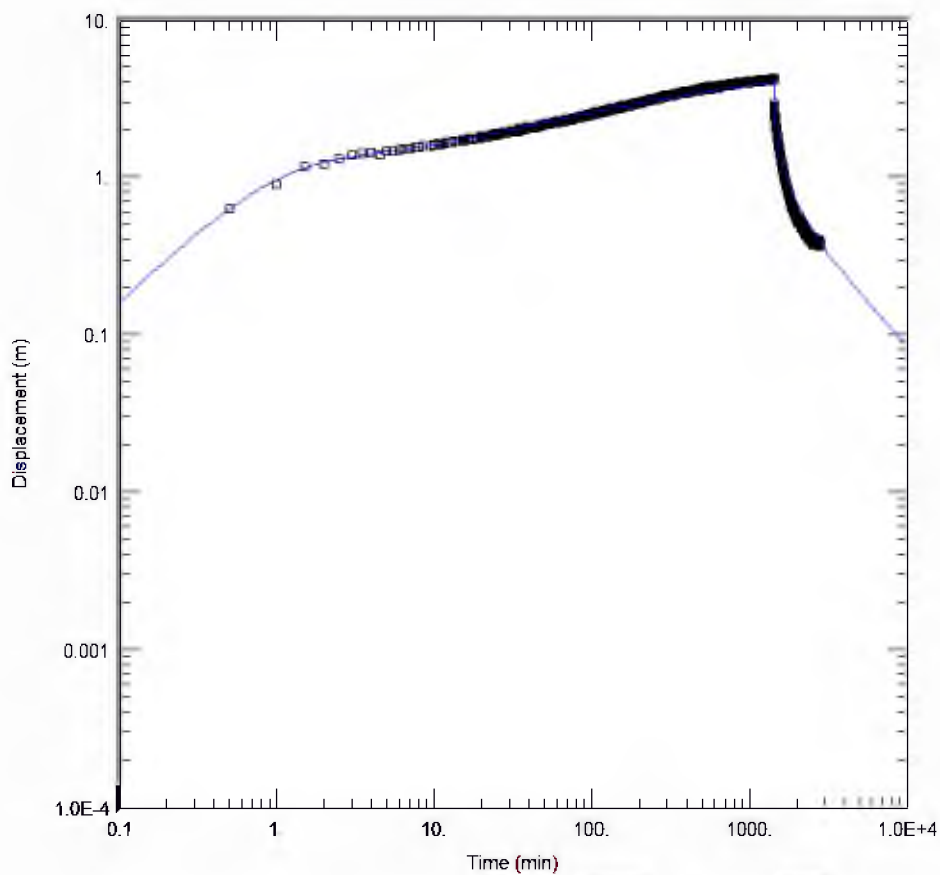
$Kz/Kr = 0.235$

$Sw = -1.325$

$r(w) = 3.548 \text{ m}$

$r(c) = 0.1905 \text{ m}$

$\alpha = 6.31\text{E+}19 \text{ min}^{-1}$



Obs. Wells

□ WB17MEH0005

Aquifer Model

Unconfined

Solution

Moench

Parameters

T = 568. m²/day

S = 6.203E-5

Sy = 0.3558

Kz/Kr = 68.18

Sw = 8.327E-17

r(w) = 1.514 m

r(c) = 0.7079 m

alpha = 1.0E+30 min⁻¹

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 8th of February and the 25th 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

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Project Sponsor:	Darren Sharp
Project Manager:	Alexandre Russo

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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:
 - 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 m² 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;
 - PVC stick-up 350 mm above the top of the plinth and fitted with a PVC cap;
 - Lockable steel lid with handle;
 - Concrete plinth measuring 1 m² 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.

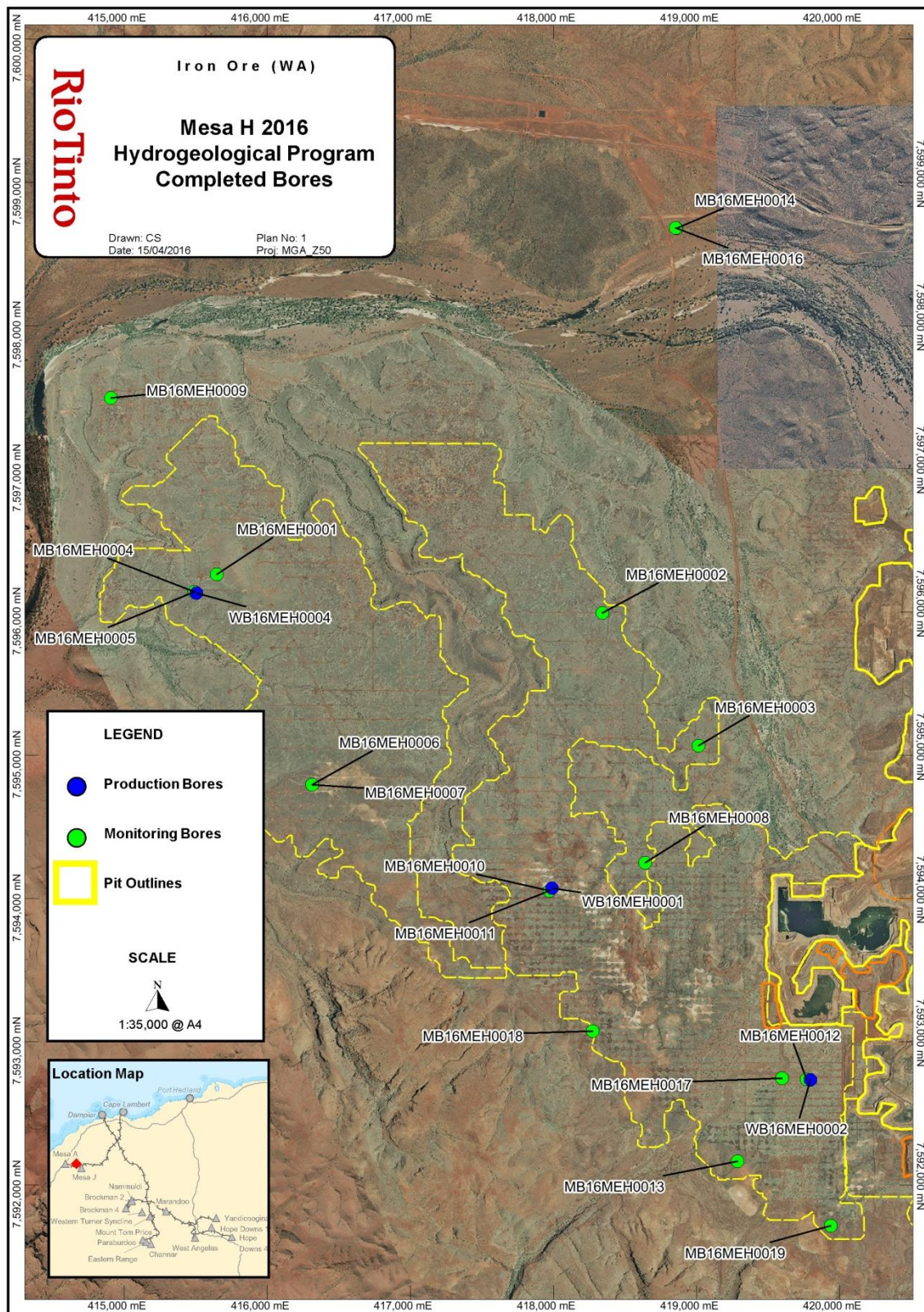


Figure 1 Completed Bore Locations (OoM pit design)

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 abandoned and not constructed due to surface casing blowout and hole 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
Nested 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)
Monitoring Bores												
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 abandoned and not constructed due to surface casing blowout and hole collapse							
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
Nested Monitoring Bores												
S: MB16MEH0004 D: MB16MEH0005	16MEH_M15	15/02/2016	16/02/2016	76	S: 60 D: 78	50mm PVC	MB: Nested	CH	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	CH	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	CH	250	6	216	S: 46 – 58 D: 65 - 77
Production Bores												

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	PB	MR	473	2	432	45 - 81
WB16MEH0002	16MEH_P01	24/02/2016	02/03/2016	57	56	Steel 305mm	PB	MR	473	6	432	38 - 50
WB16MEH0003	16MEH_P03	01/03/2016	08/03/2016	70	70	Steel 305mm	PB	MR	473	2	432	46 - 70
WB16MEH0004	16MEH_P04	04/03/2016	13/03/2016	79	76	Steel 305mm	PB	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 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

* 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	$4.2E^{-06}$	$Sw = 0.0056Q + 4e-6Q^2$
WB16MEH0002	4	60	1.5, 2, 2.5, 3	$1.66E^{-04}$	$Sw = 0.0082Q + 1e-4Q^2$
WB16MEH0003	Bore could not be tested due to yield lower than 1.5 L/s				
WB16MEH0004	3	60	1.5, 2.5, 3.5	$3.4E^{-05}$	$Sw = 0.015Q + 8e-5Q^2$

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.

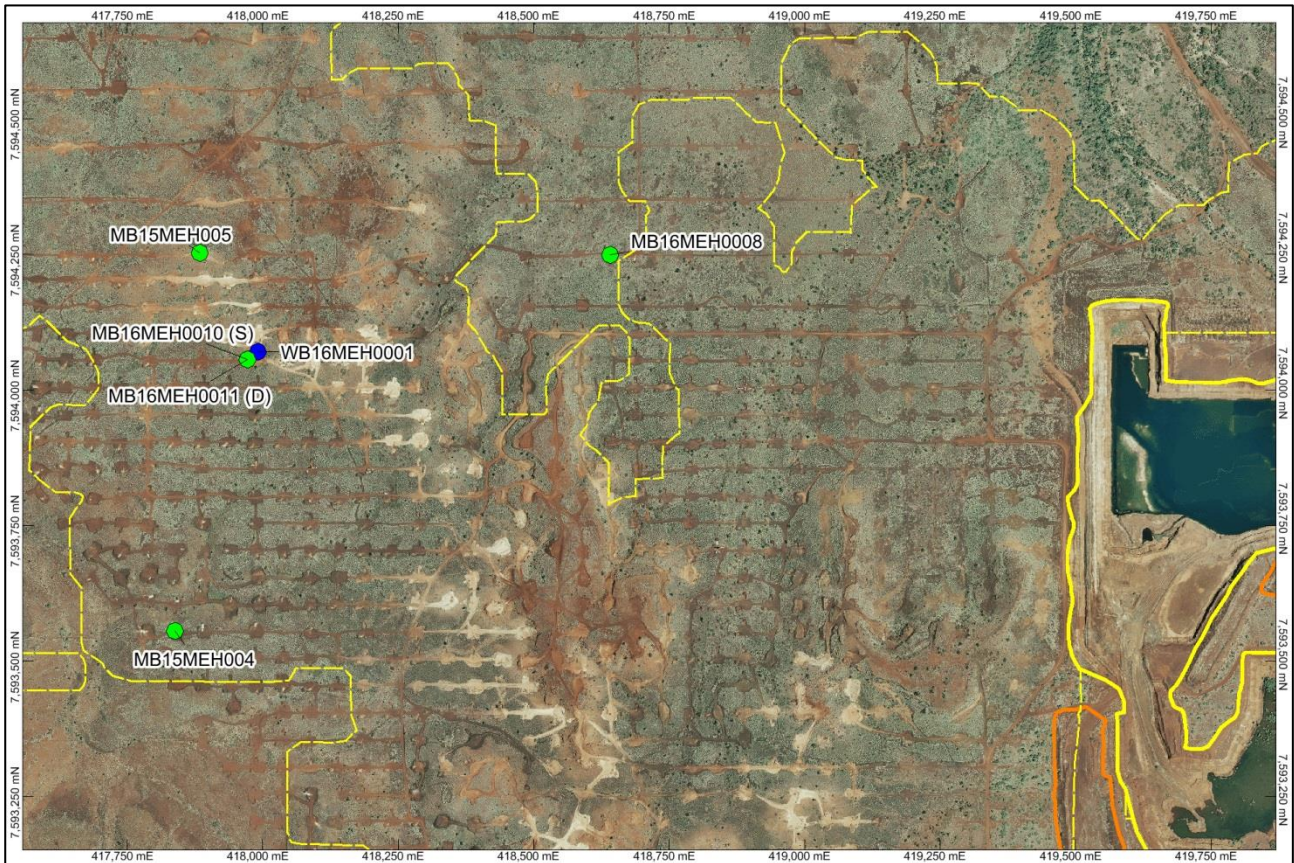


Figure 2: WB16MEH0001 CRT observation bores

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 $61.8 \text{ m}^2/\text{day}$, a hydraulic conductivity (K) of 1.6 m/day and storage coefficient (S) of 8E^{-3} (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 $323.30 \text{ m}^2/\text{day}$,

corresponding K of 20.21 m/day and S of $7.3E^{-4}$. 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 $63.16 \text{ m}^2/\text{day}$, and corresponding K of 5.26 m/day and S of $3.3E^{-4}$ (Figure 5).

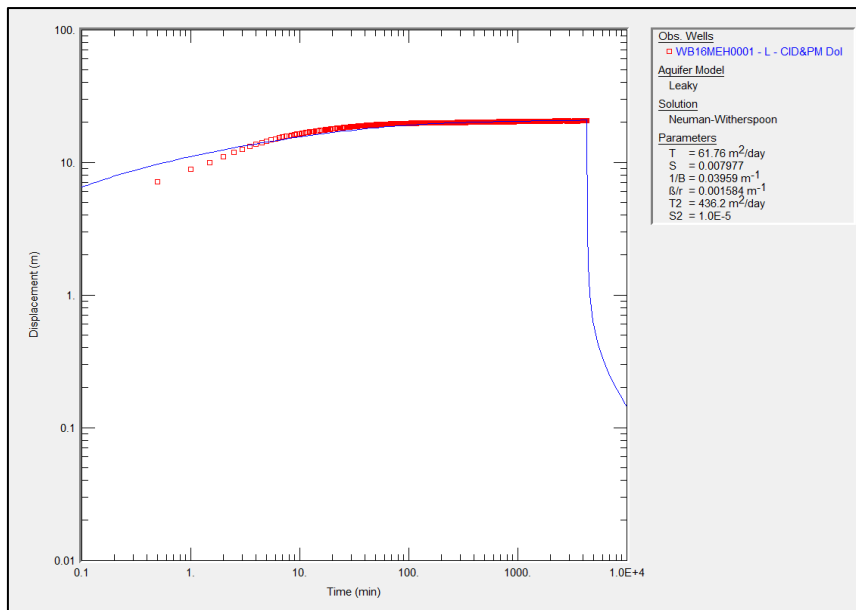


Figure 3: WB16MEH0001 CRT drawdown data with Neuman-Witherspoon solution

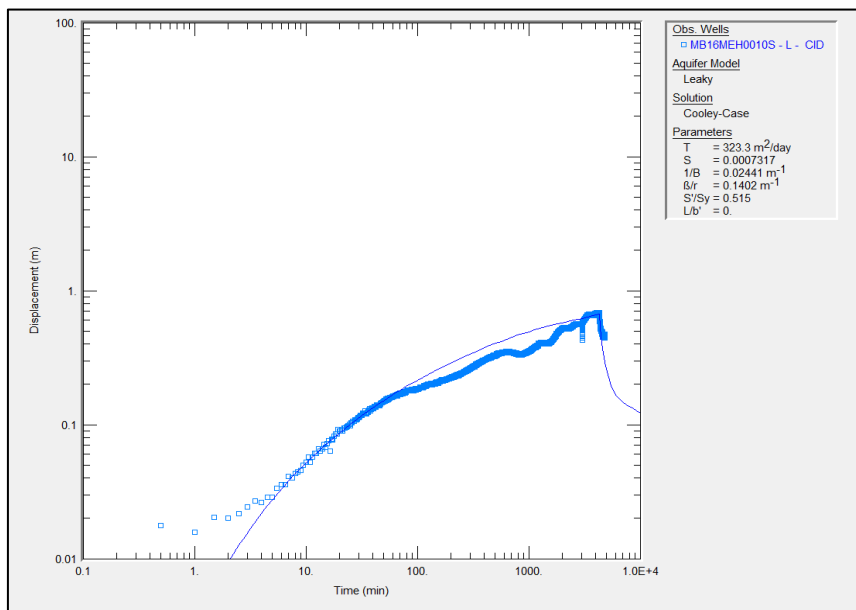


Figure 4: MB16MEH0010 CRT drawdown data with Cooley-Case solution

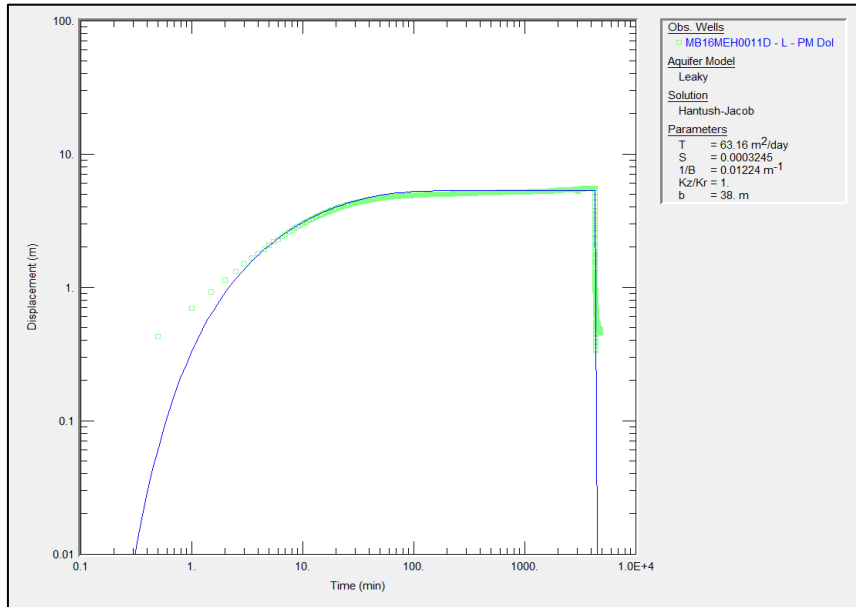


Figure 5: MB16MEH0011 CRT drawdown data with Hantush-Jacob solution

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 1.4×10^{-4} (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 μ S/cm to 860 μ S/cm during the CRT, then declining to 780 μ 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.

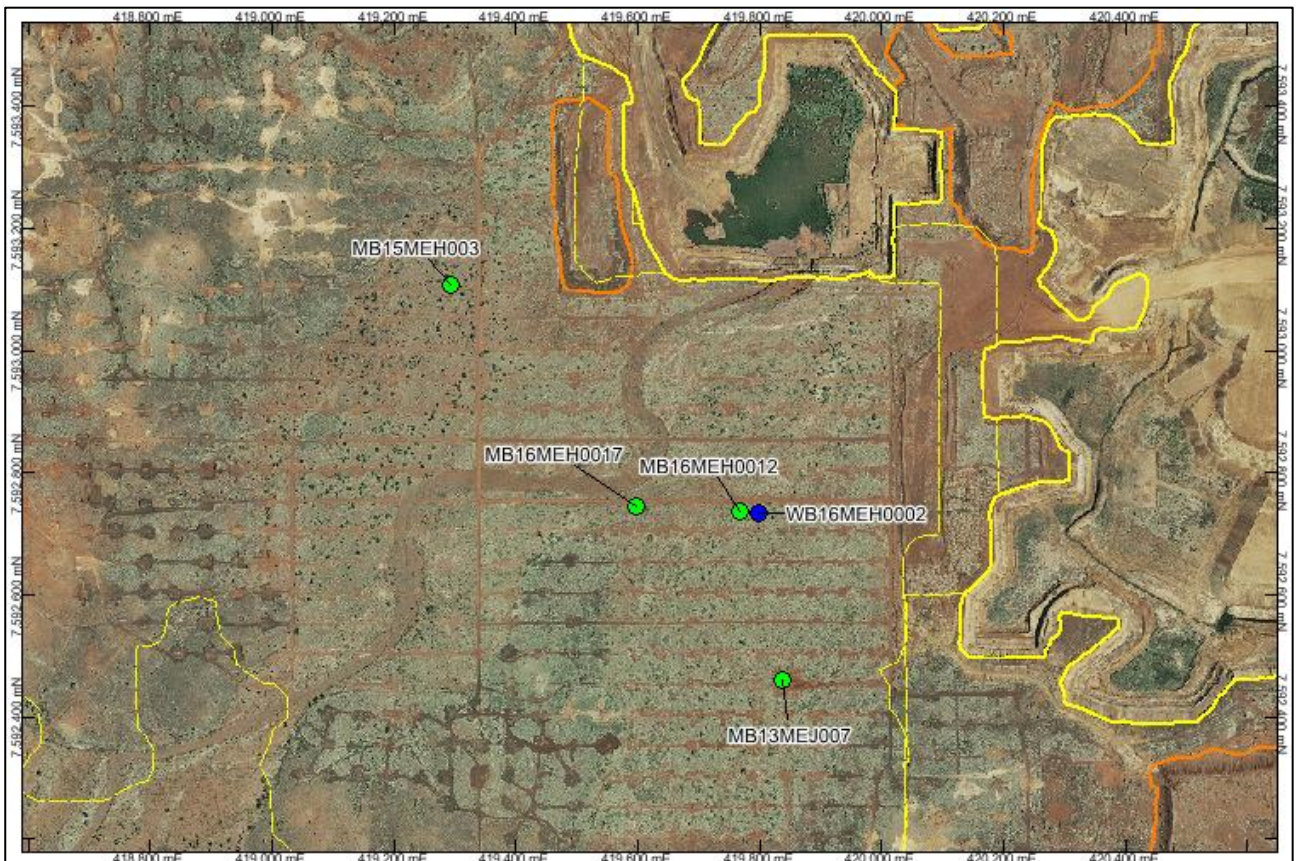


Figure 6: WB16MEH0002 CRT observation bores

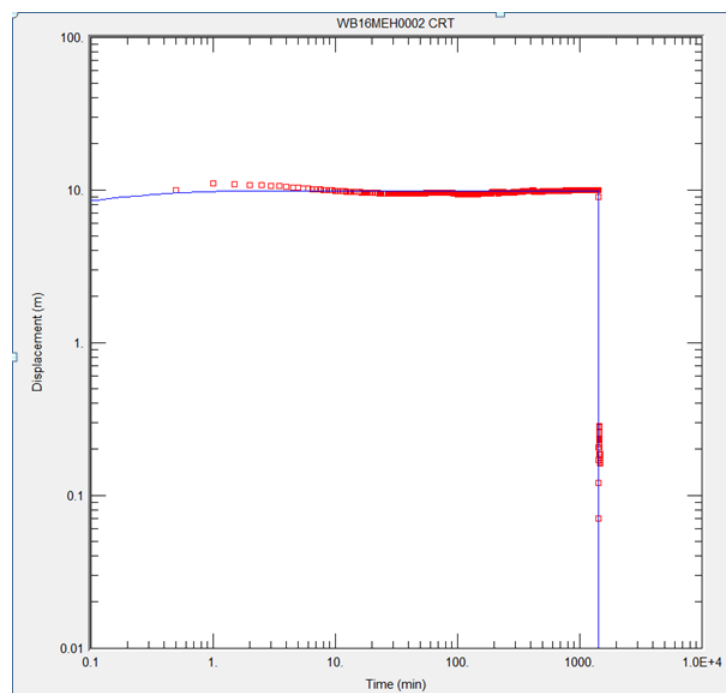


Figure 7: WB16MEH0002 CRT drawdown

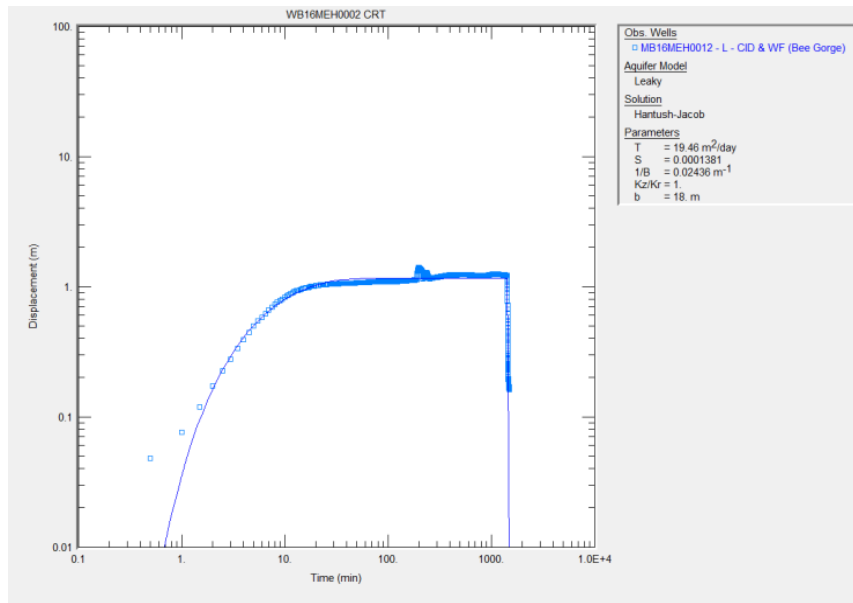


Figure 8: MB16MEH0012 CRT drawdown data with Hantush-Jacob solution

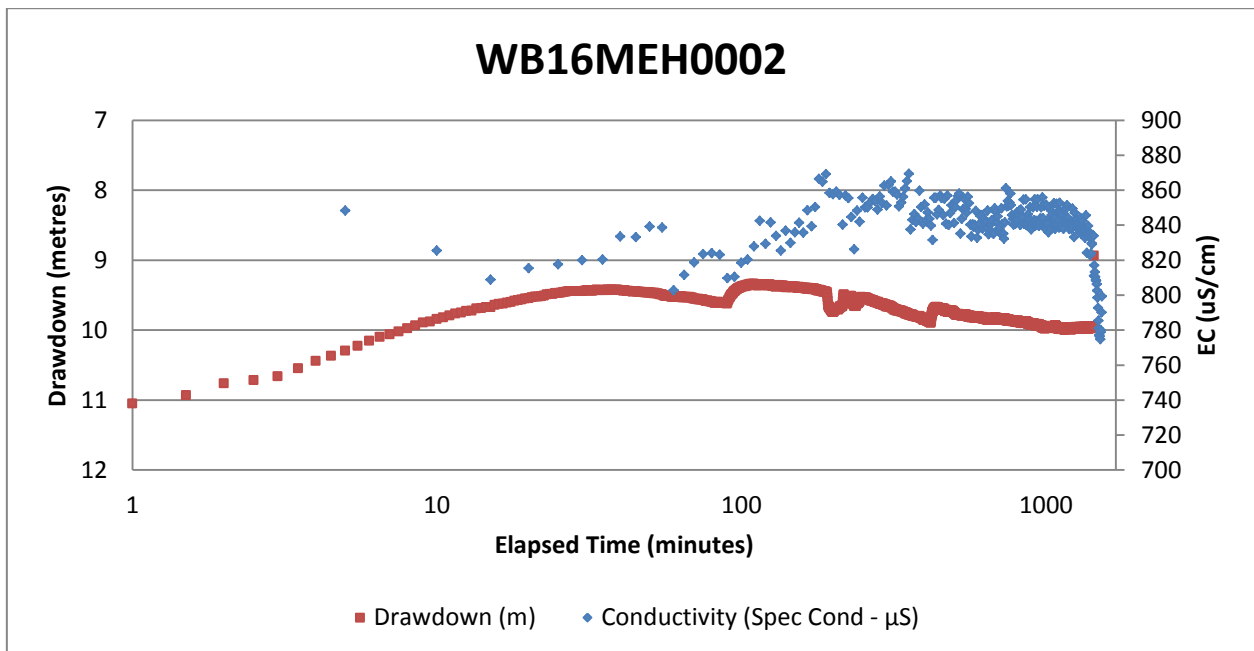


Figure 9: WB16MEH0002 drawdown and EC response during pumping test

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 MB16MEH0004, producing a low T value of $10.23 \text{ m}^2/\text{day}$, a corresponding K of 0.43 m/day and S of 8.6E^{-6} (

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 $51.07 \text{ m}^2/\text{day}$, a corresponding K of 3.65 m/day and S of 2.7E^{-3} (Figure 12). The Neuman-Witherspoon (1969) solution was used to fit a curve to the drawdown data for MB16MEH0005, producing a T of $23.34 \text{ m}^2/\text{day}$, a corresponding K of 0.73 m/day and S of 1.8E^{-4} (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 $\mu\text{S}/\text{cm}$ to 800 $\mu\text{S}/\text{cm}$ at 720 minutes where it stabilised until the rate was changed, then rose to 860 $\mu\text{S}/\text{cm}$ with the drawdown recovery of 7 metres in the bore until 4,000 minutes, where it started decreasing again to 800 $\mu\text{S}/\text{cm}$, and stabilising at this reading until 7,000 minutes, where the EC began to slowly increase to 850 $\mu\text{S}/\text{cm}$ 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.

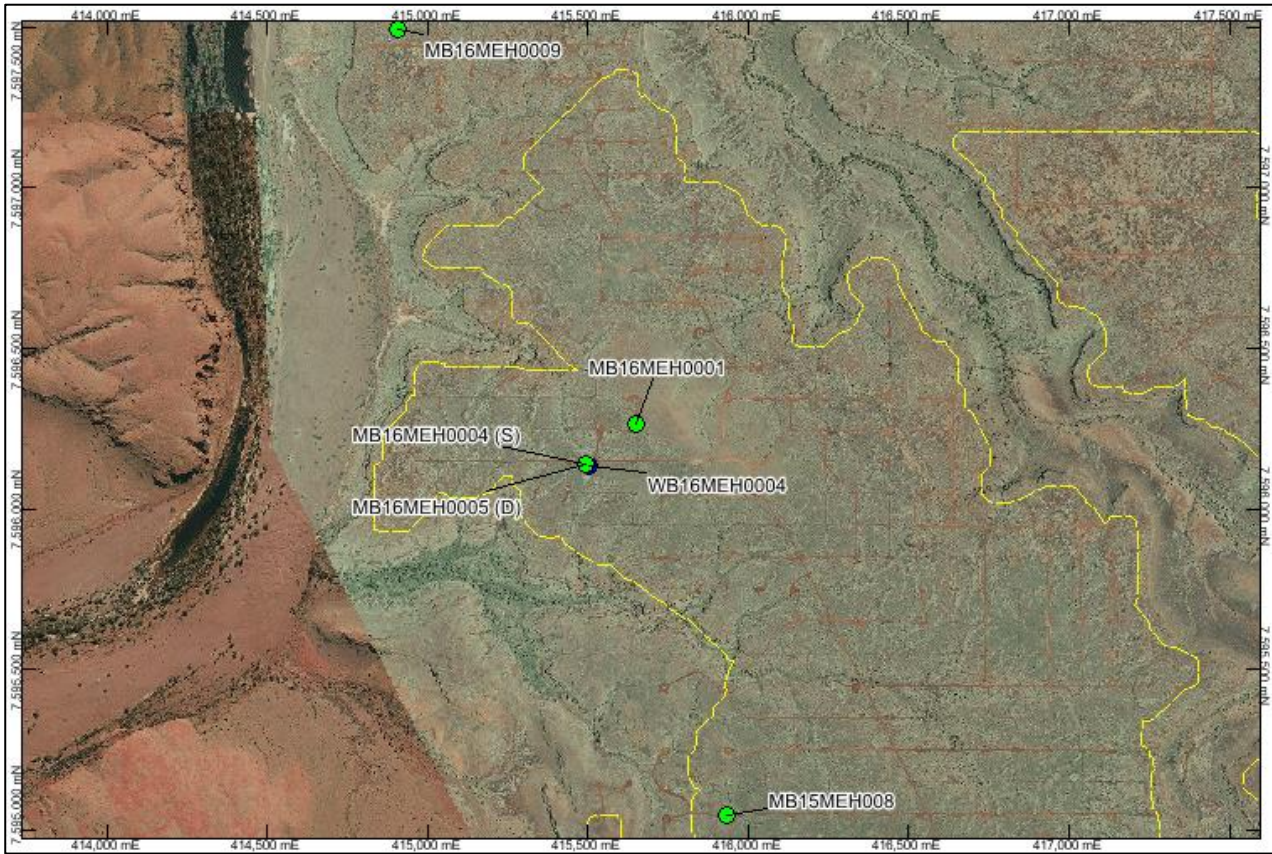


Figure 10: WB16MEH0004 CRT observation bores (Scale 1:15,000)

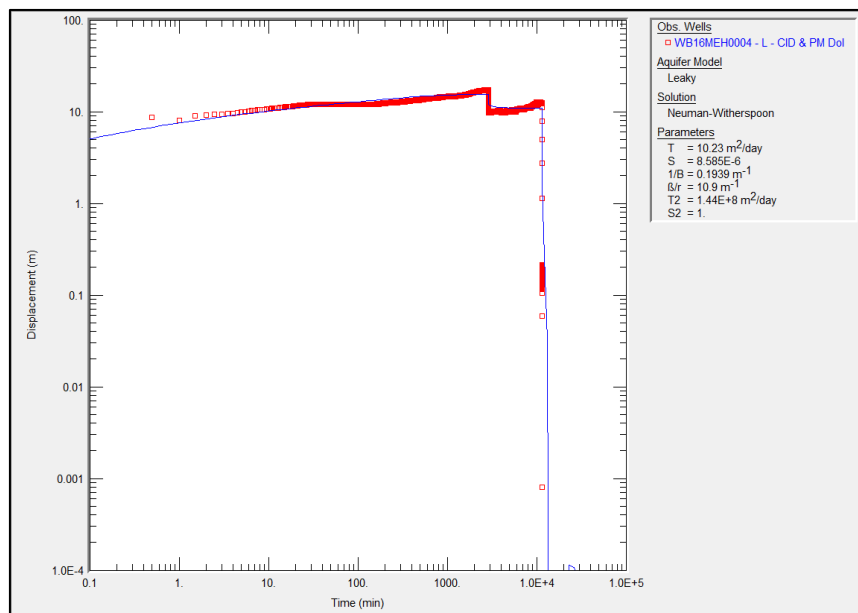


Figure 11: WB16MEH0004 CRT drawdown data with Neuman-Witherspoon solution

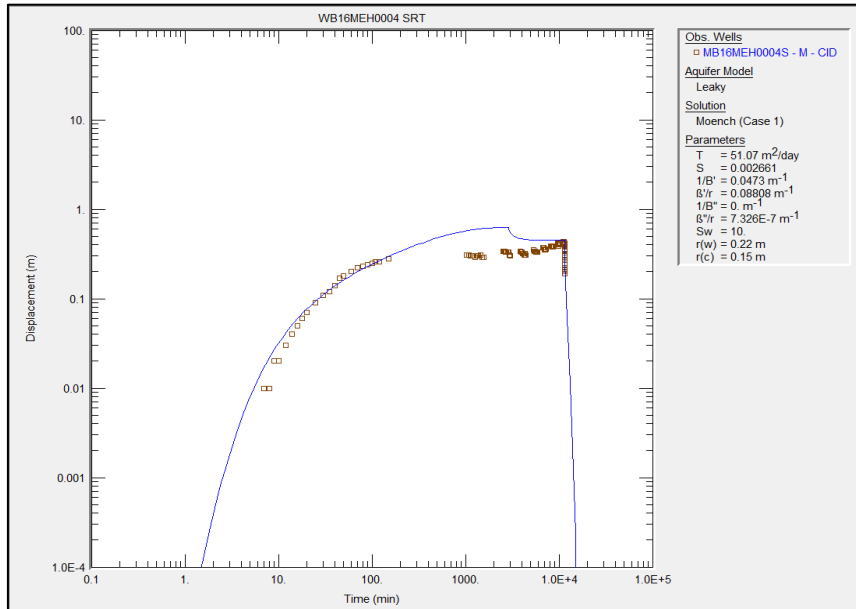


Figure 12: MB16MEH0004 CRT drawdown data with Moench solution

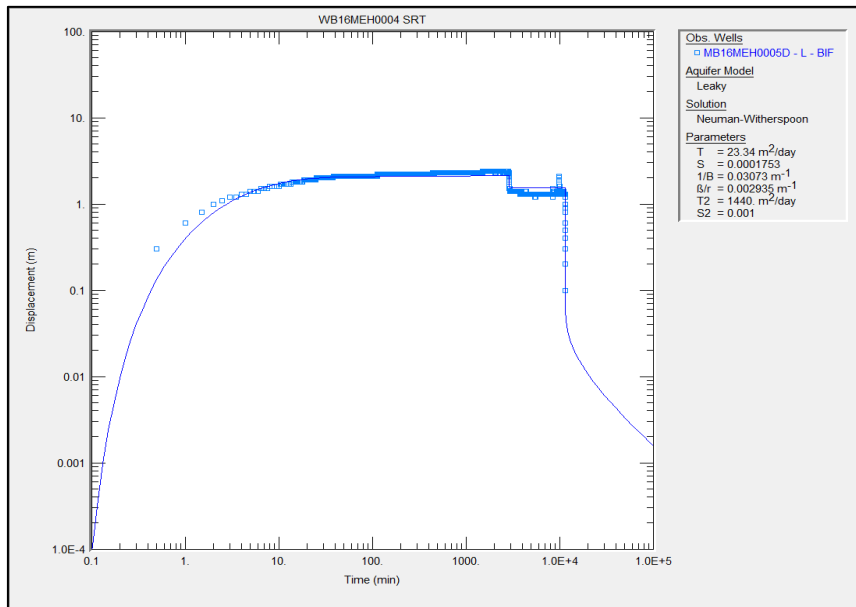


Figure 13: MB16MEH0005 CRT drawdown data with Neuman-Witherspoon solution

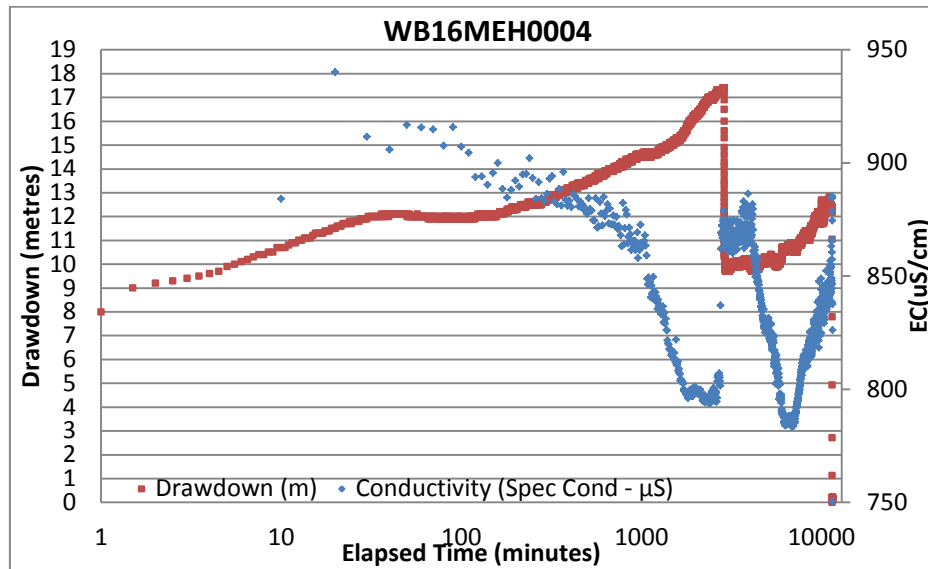


Figure 14: WB16MEH0004 CRT drawdown and EC response during pumping test

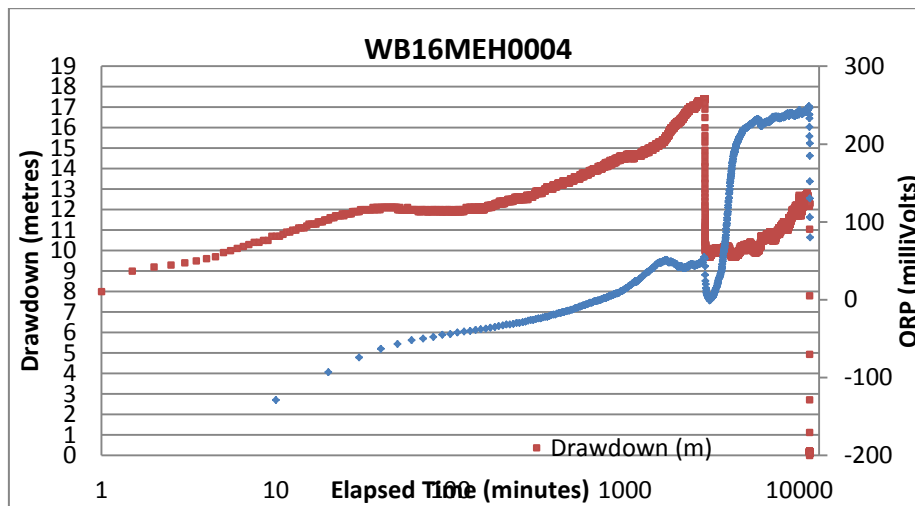


Figure 15: WB16MEH0004 CRT drawdown and ORP response during pumping test

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 (m ² /day)	Hydraulic Conductivity (m/day)	Storage Coefficient / Specific Yield
WB16MEH0001	WB16MEH0001 RECOVERY	0	18	4,320	CID & Paraburdoo Member	Leaky	20.7	61.8	1.6	7.98 x 10 ⁻³
	MB16MEH0010	23			CID		0.7	323.3	20.2	7.32 x 10 ⁻⁴
	MB16MEH0011	23			Paraburdoo Member		5.5	63.2	5.3	3.25 x 10 ⁻⁴
	MB15MEH005	202			CID & 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			
WB16MEH0002	WB16MEH0001 RECOVERY	0	2.5	1,440	CID	Leaky	11.1	19.2	1.2	4.21 x 10 ⁻⁶
	MB16MEH0012	36			Paraburdoo Member		1.4	19.5	1.5	1.38 x 10 ⁻⁴
	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	WB16MEH0004 RECOVERY	0	3.5, 2.5	11,460	CID & Paraburdoo Member	Leaky	17.4	10.2	0.4	8.59 x 10 ⁻⁶
	MB16MEH0004	17			CID		1.2	51.1	3.7	2.66 x 10 ⁻³
	MB16MEH0005	17			Paraburdoo Member		2.4	23.3	0.7	1.75 x 10 ⁻⁴
	MB16MEH0001	190			Marra Mamba Iron Formation		Could not be analysed due to negligible drawdown			
	MB15MEH008	1,170			CID & Paraburdoo Member		Could not be analysed due to negligible drawdown			
	MB16MEH0009	1,490			Wittenoom Formation		Could not be analysed due to negligible 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^{-3} and 4.2E^{-6} respectively.
- Hydraulic conductivity of the Paraburdoo Member dolomite ranges between 0.7 and 5.3 m/day with a storage coefficient of approximately 2E^{-4} .
- The bulk average hydraulic conductivity of the CID and Wittenoom aquifer has been calculated as 2.5 m/day with a storage coefficient of 5.5E^{-3} .
- 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

Surface Water Quality				
Bore ID	Peg ID	pH	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	583	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	16MEH_M03	No yield achieved		
Nested Monitoring Bores				
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 than 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 SO₄ 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.
- 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 m²/day, with an associated K of 2.5 m/day and storage coefficient of 5.5E⁻³;
- 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 LOGS

WB16MEH0001

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 20/02/2016
DATE COMPLETED: 27/02/2016

DRILLING DETAILS

DRILLING COMPANY: Bunbury Drilling Company
DRILLER: John Nesbitt
DRILLING METHOD: Mud Rotary
HYDROGEOLOGIST: Marisa Mochizuki

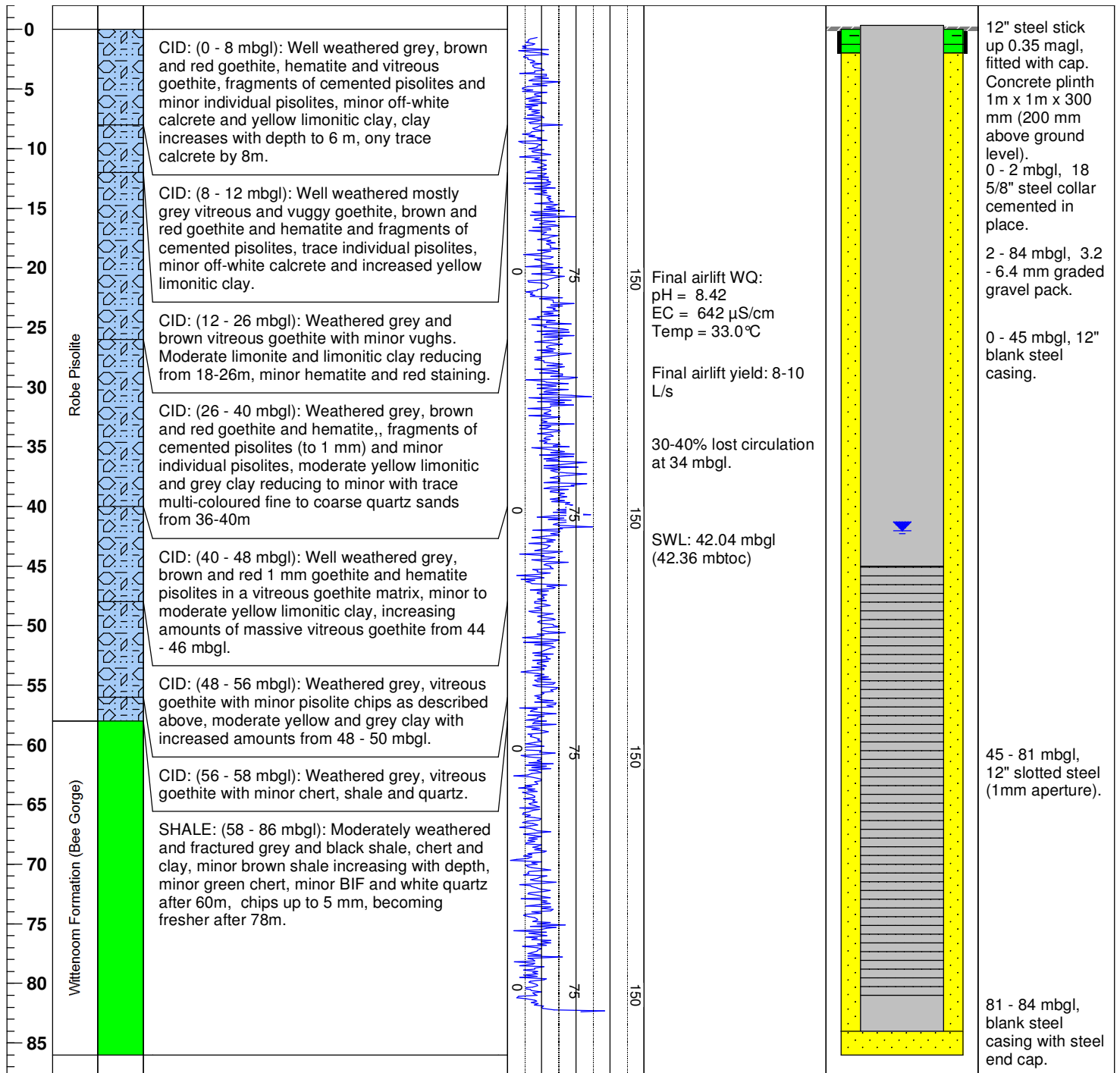
LOCATION

GRID NAME: MGA94 Zone 50
EASTING: 417990.96
NORTHING: 7594070.94
ELEVATION: 175.24 mRL (TOC)

Peg ID: 16MEH_P02

Mud Rotary Tricone Bit: 17½" diameter 0 - 86 mbgl. 0 - 2 mbgl reamed to 22" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-150cps)	Field Notes	Well Design	Well Construction
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WB16MEH0002

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 24/02/2016
DATE COMPLETED: 02/03/2016

DRILLING DETAILS

DRILLING COMPANY: Bunbury Drilling Company
DRILLER: Dave Usher
DRILLING METHOD: Mud Rotary
HYDROGEOLOGIST: A. Price/ M. Mochizuki

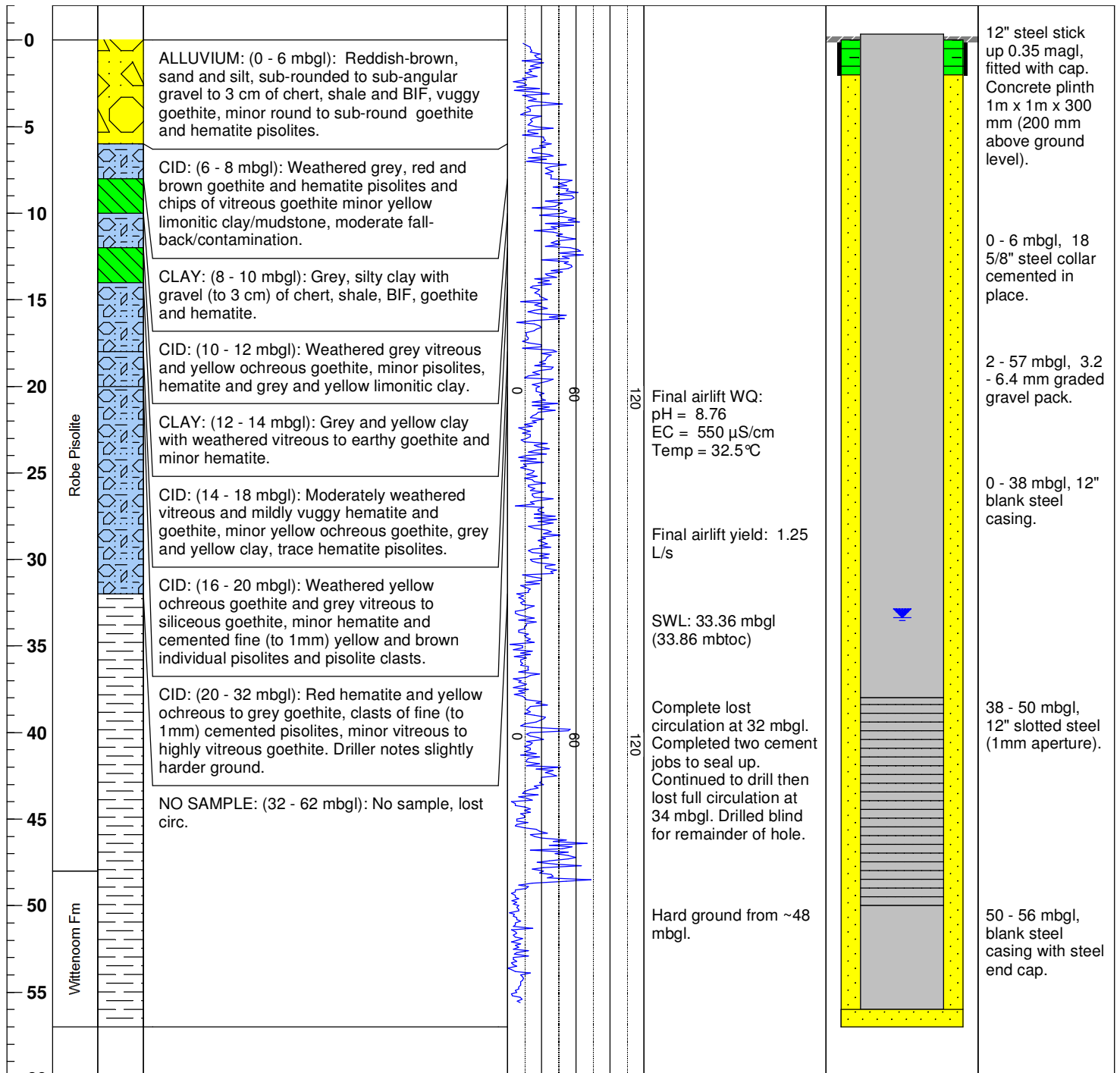
LOCATION

GRID NAME: MGA94 Zone 50
EASTING: 419797.07
NORTHING: 7592735.16
ELEVATION: 165.03 mRL (TOC)

Peg ID: 16MEH_P01

Mud Rotary Tricone Bit: 17½" diameter 0 - 57 mbgl. 0 - 6 mbgl reamed to 22" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-120cps)	Field Notes	Well Design	Well Construction
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WB16MEH0003

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 01/03/2016
DATE COMPLETED: 08/03/2016

DRILLING DETAILS

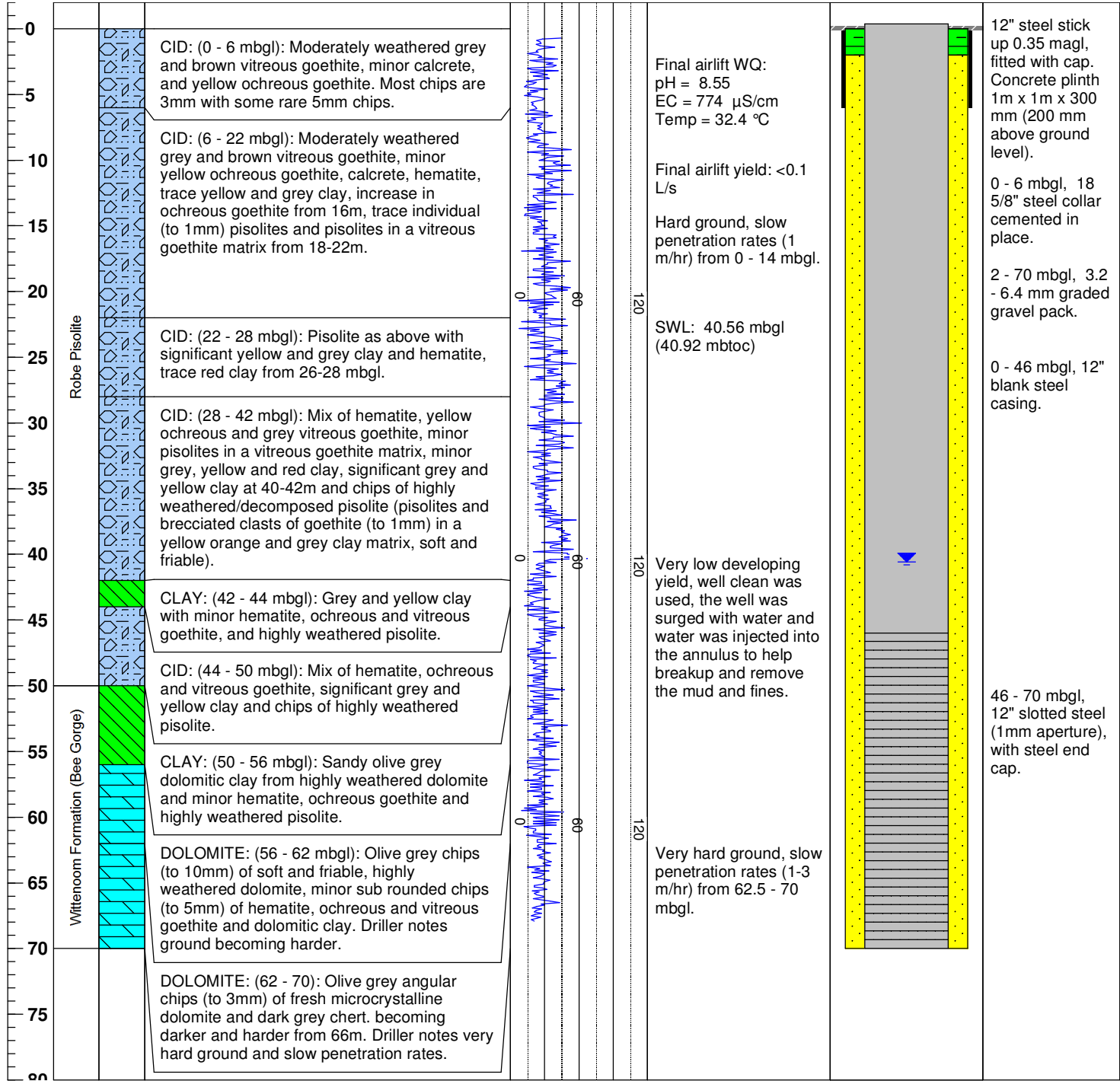
DRILLING COMPANY: Bunbury Drilling Company
DRILLER: John Nesbitt
DRILLING METHOD: Mud Rotary
HYDROGEOLOGIST: Marisa Mochizuki

LOCATION

GRID NAME: MGA94 Zone 50
EASTING: 416321.85
NORTHING: 7594781.07
ELEVATION: 170.06 mRL (TOC)

Peg ID: 16MEH_P03
Mud Rotary Tricone Bit: 17½" diameter 0 - 70 mbgl. 0 - 2 mbgl reamed to 22" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-120cps)	Field Notes	Well Design	Well Construction
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WB16MEH0004

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 04/03/2016
DATE COMPLETED: 13/03/2016

DRILLING DETAILS

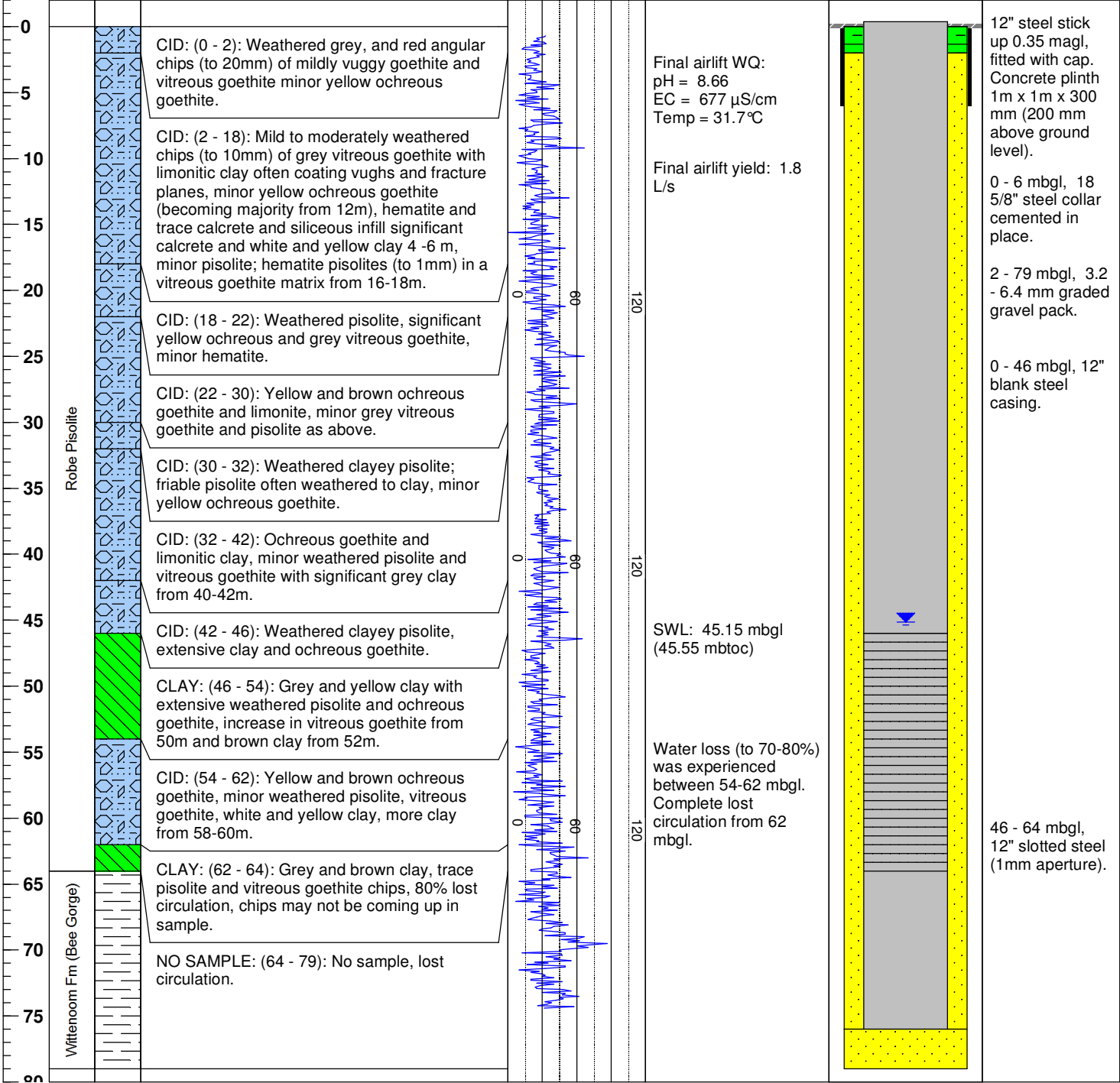
DRILLING COMPANY: Bunbury Drilling Company
DRILLER: Tom Massey
DRILLING METHOD: Mud Rotary
HYDROGEOLOGIST: Marisa Mochizuki

LOCATION

GRID NAME: MGA94 Zone 50
EASTING: 415504.09
NORTHING: 7596133.77
ELEVATION: 164.90 mRL (TOC)

Peg ID: 16MEH_P04
Mud Rotary Tricone Bit: 17½" diameter 0 - 79 mbgl. 0 - 6 mbgl reamed to 22" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-120cps)	Field Notes	Well Design	Well Construction
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MB16MEH0001

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

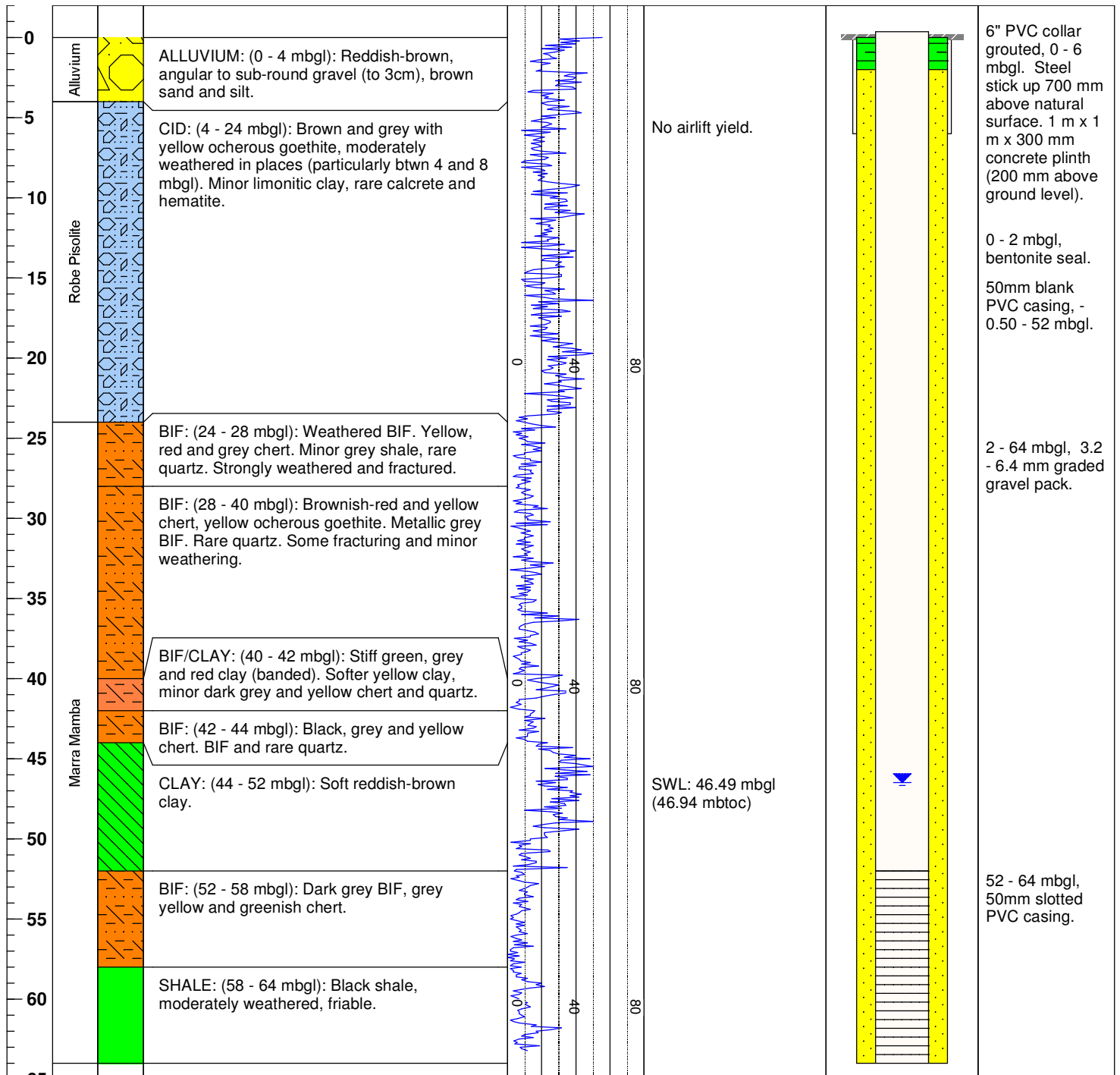
LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 415648.30
NORTHING: 7596263.24
ELEVATION: 166.52 mRL (TOC)

Peg ID: 16MEH_M16

RC: 7½" diameter 0 - 5 mbgl. 5 - 76 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-80cps)	Field Notes	Well Design	Well Construction
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MB16MEH0002

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 10/2/2015
DATE COMPLETED: 11/2/2015

DRILLING DETAILS

DRILLING COMPANY: Ranger Drilling
DRILLER: Adam Mennell
DRILLING METHOD: RC
HYDROGEOLOGIST: A.Price

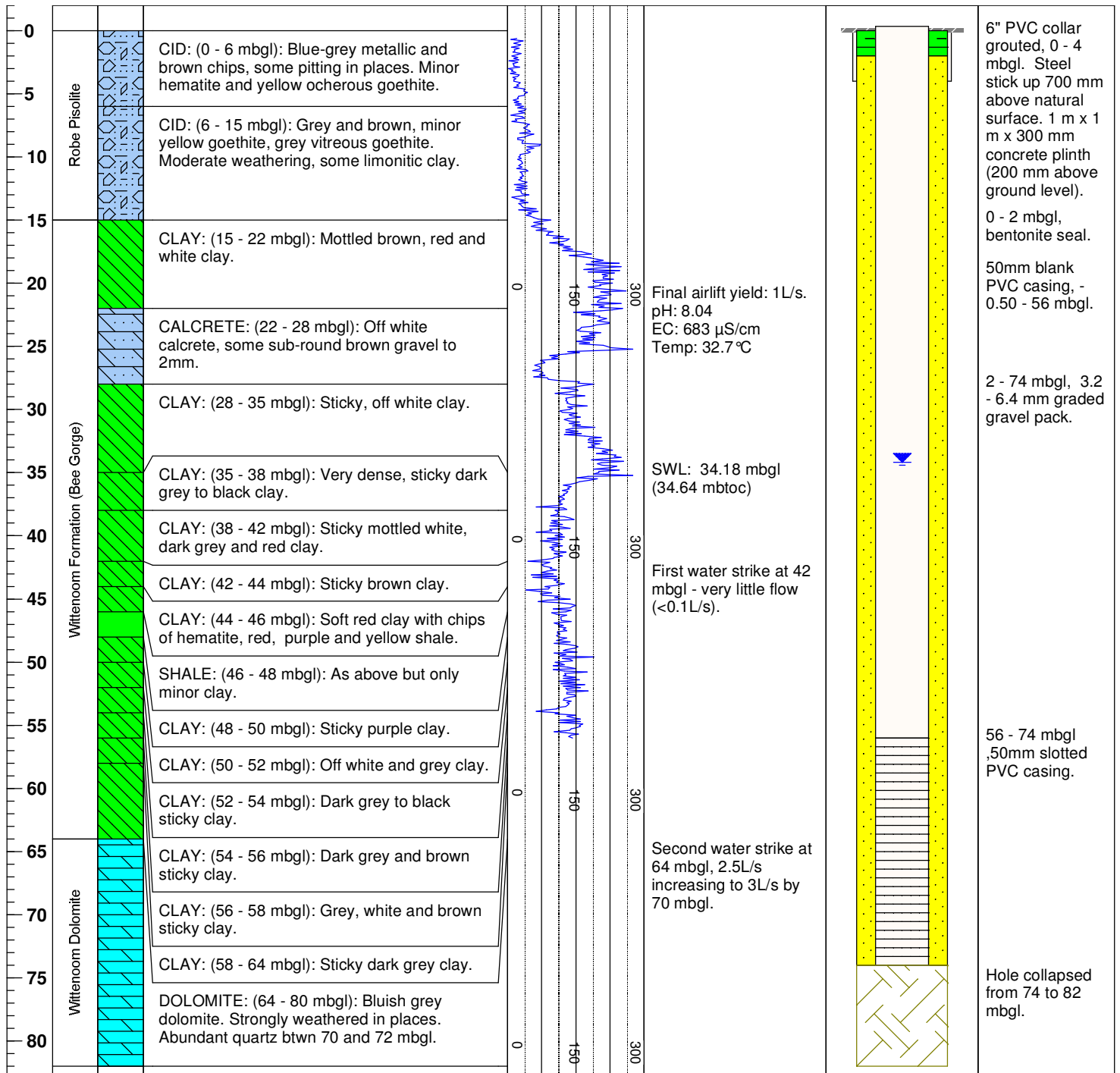
LOCATION

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 (0-300cps)	Field Notes	Well Design	Well Construction
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MB16MEH0003

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 12/2/2015
DATE COMPLETED: 14/2/2015

DRILLING DETAILS

DRILLING COMPANY: Ranger Drilling
DRILLER: Ben Smith
DRILLING METHOD: RC
HYDROGEOLOGIST: A.Price

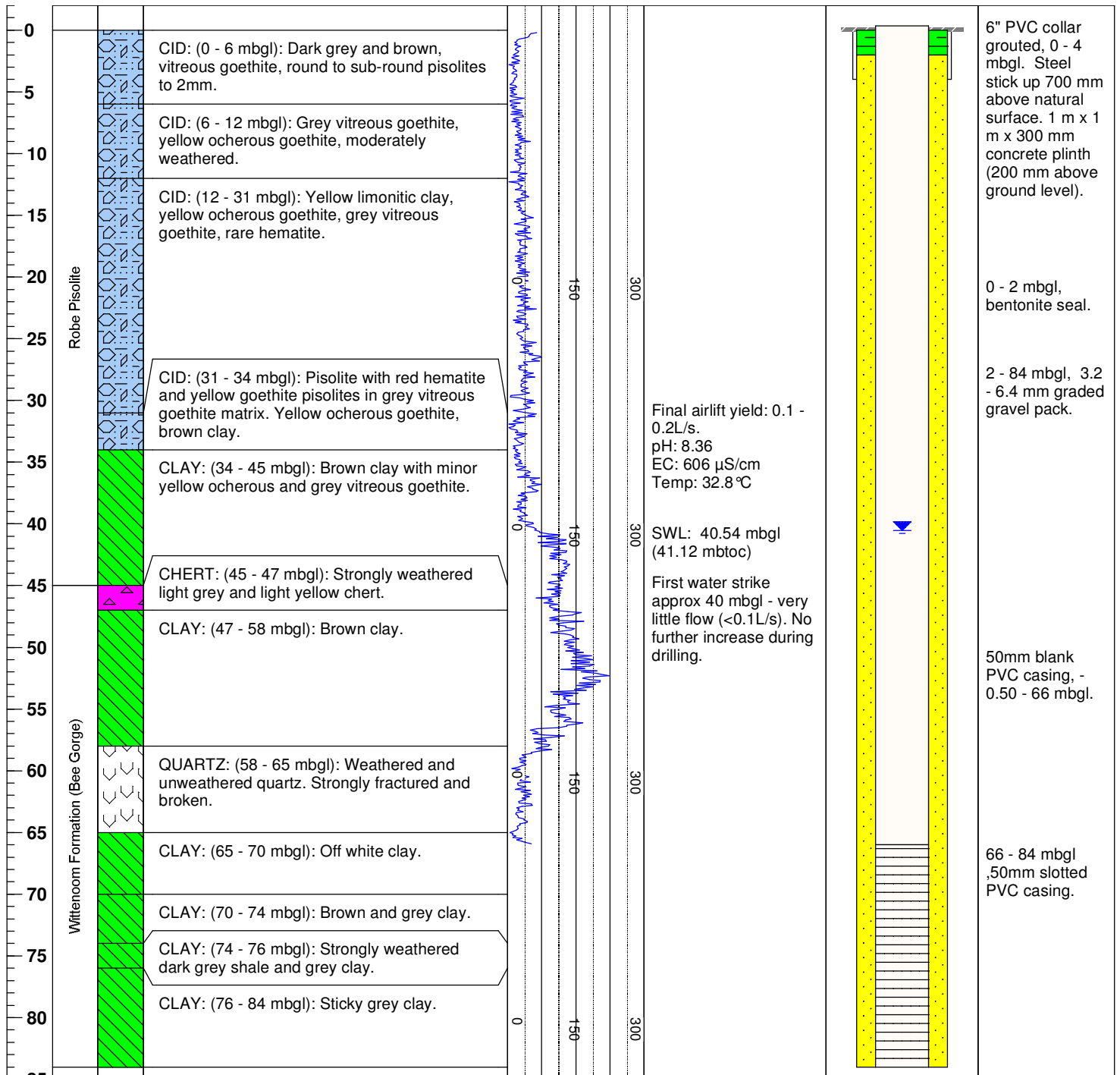
LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 419013.90
NORTHING: 7595067.08
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
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MB16MEH0004/ MB16MEH0005

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 15/2/2016
DATE COMPLETED: 16/2/2016

DRILLING DETAILS

DRILLING COMPANY: Bunbury Drilling
DRILLER: Luke Wallace
DRILLING METHOD: Air Hammer
HYDROGEOLOGIST: Ashley Price

LOCATION

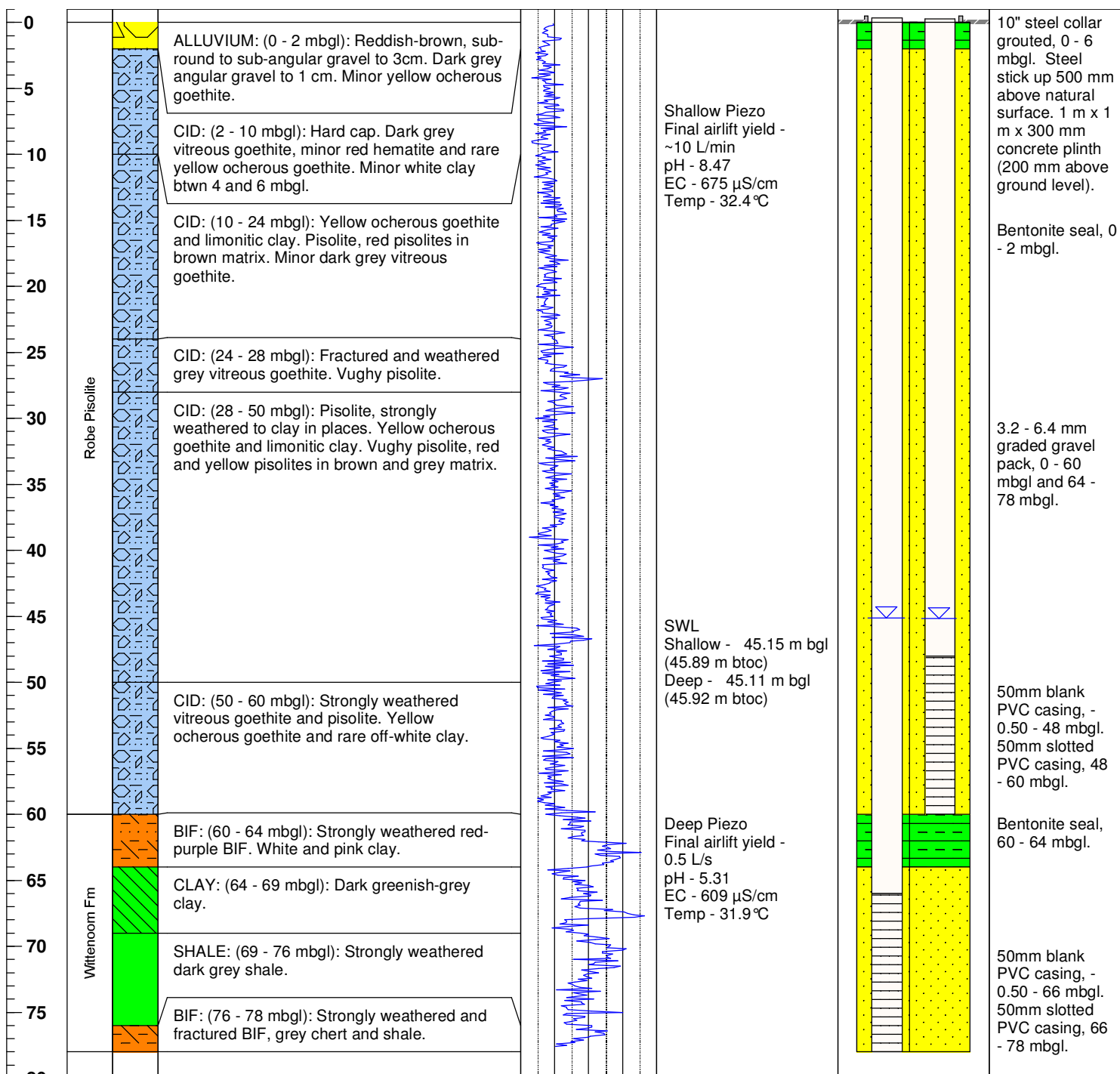
GRID NAME: MGA 94, Zone 50
EASTING: 415490.51
NORTHING: 7596140.85
ELEVATION S: 165.24 mRL TOC
ELEVATION D: 165.31 mRL TOC

Peg ID: 16MEH_M15

Hammer Bit: 14¾" diameter 0 - 6 mbgl . 8½" diameter 0 - 78 mbgl.

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

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-200 cps)	Field Notes	Well Design	Well Construction
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MB16MEH0006 / MB16MEH0007

HOLE DETAILS

PROJECT: Mesa H PFS 2016

LOCATION: Mesa H

DATE COMMENCED: 14/02/2016

DATE COMPLETED: 29/02/2016

DRILLING DETAILS

DRILLING COMPANY: Bunbury Drilling

DRILLER: Dan Morris

DRILLING METHOD: Air Hammer

HYDROGEOLOGIST: Ashley Price

LOCATION

GRID NAME: MGA 94, Zone 50

EASTING: 416312.82

NORTHING: 7594795.87

ELEVATION S: 170.5 mRL TOC

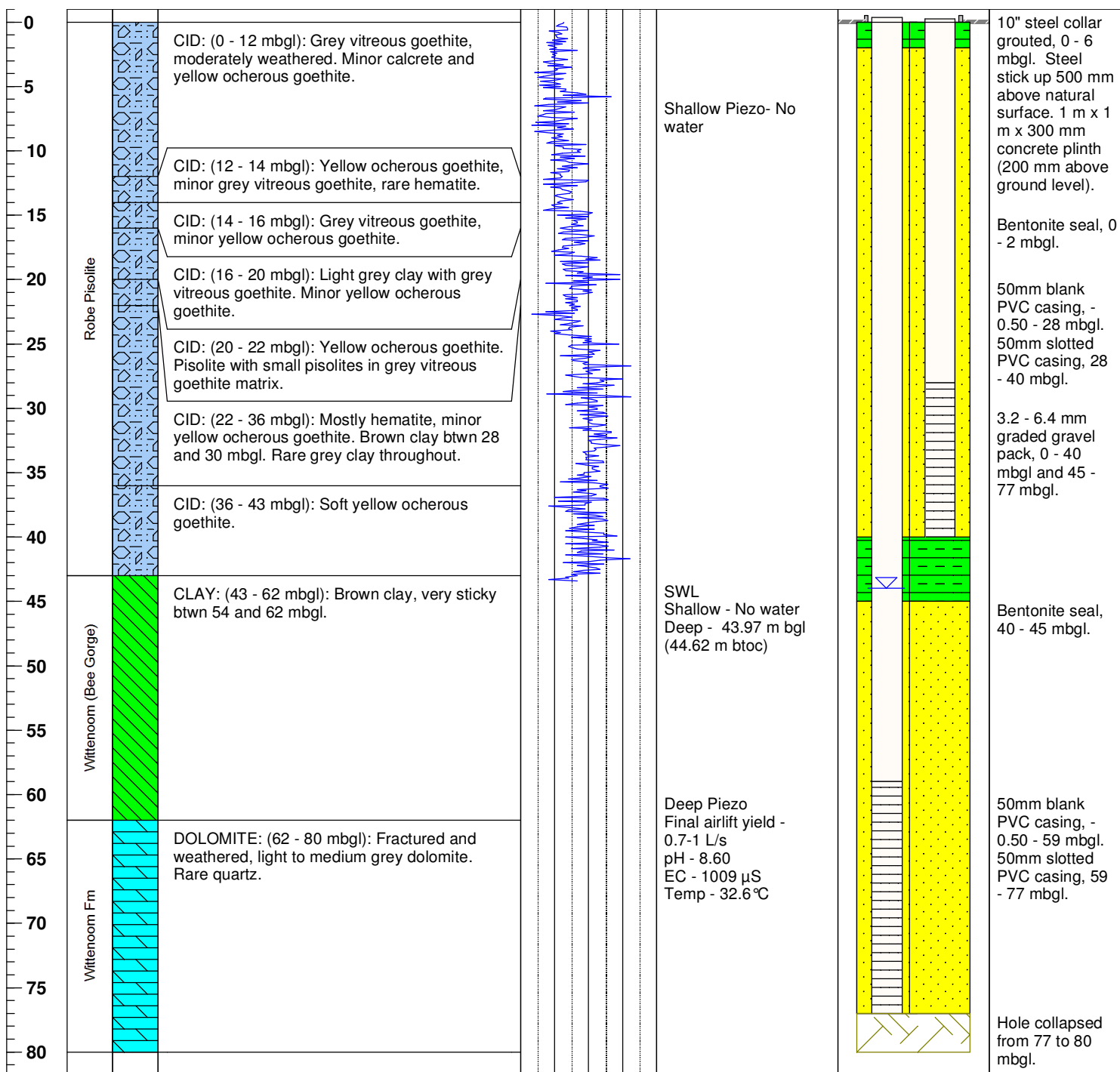
ELEVATION D: 170.11 mRL TOC

Peg ID: 16MEH_M02

Hammer Bit: 14¾" diameter 0 - 6 mbgl . 8½" diameter 0 - 80 mbgl.

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

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-120 cps)	Field Notes	Well Design	Well Construction
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MB16MEH0008

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 15/2/2015
DATE COMPLETED: 16/2/2015

DRILLING DETAILS

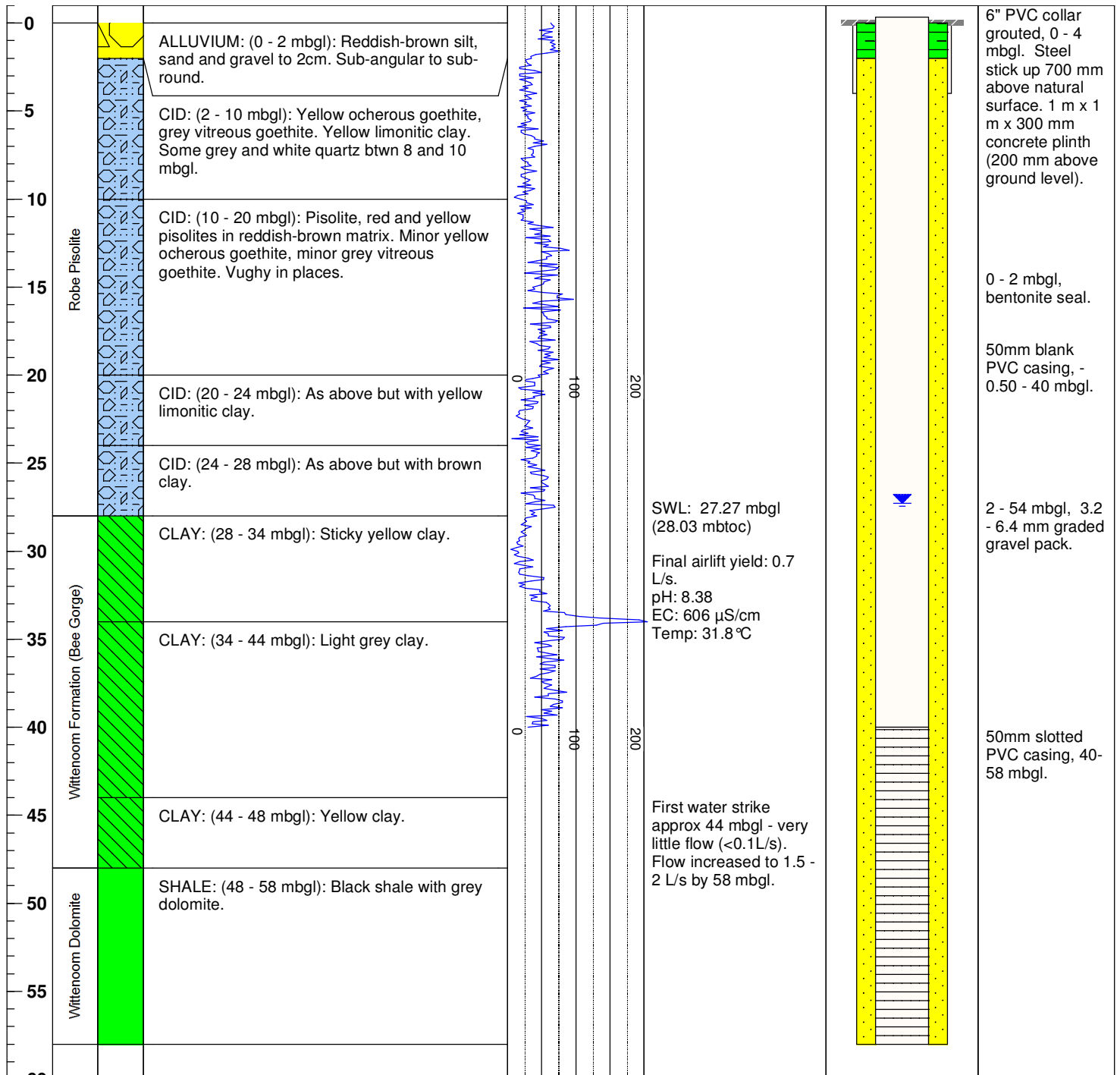
DRILLING COMPANY: Ranger Drilling
DRILLER: Ben Smith
DRILLING METHOD: RC
HYDROGEOLOGIST: A.Price

LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 418640.88
NORTHING: 7594248.67
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 (0-200cps)	Field Notes	Well Design	Well Construction
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MB16MEH0009

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 15/2/2015
DATE COMPLETED: 16/2/2015

DRILLING DETAILS

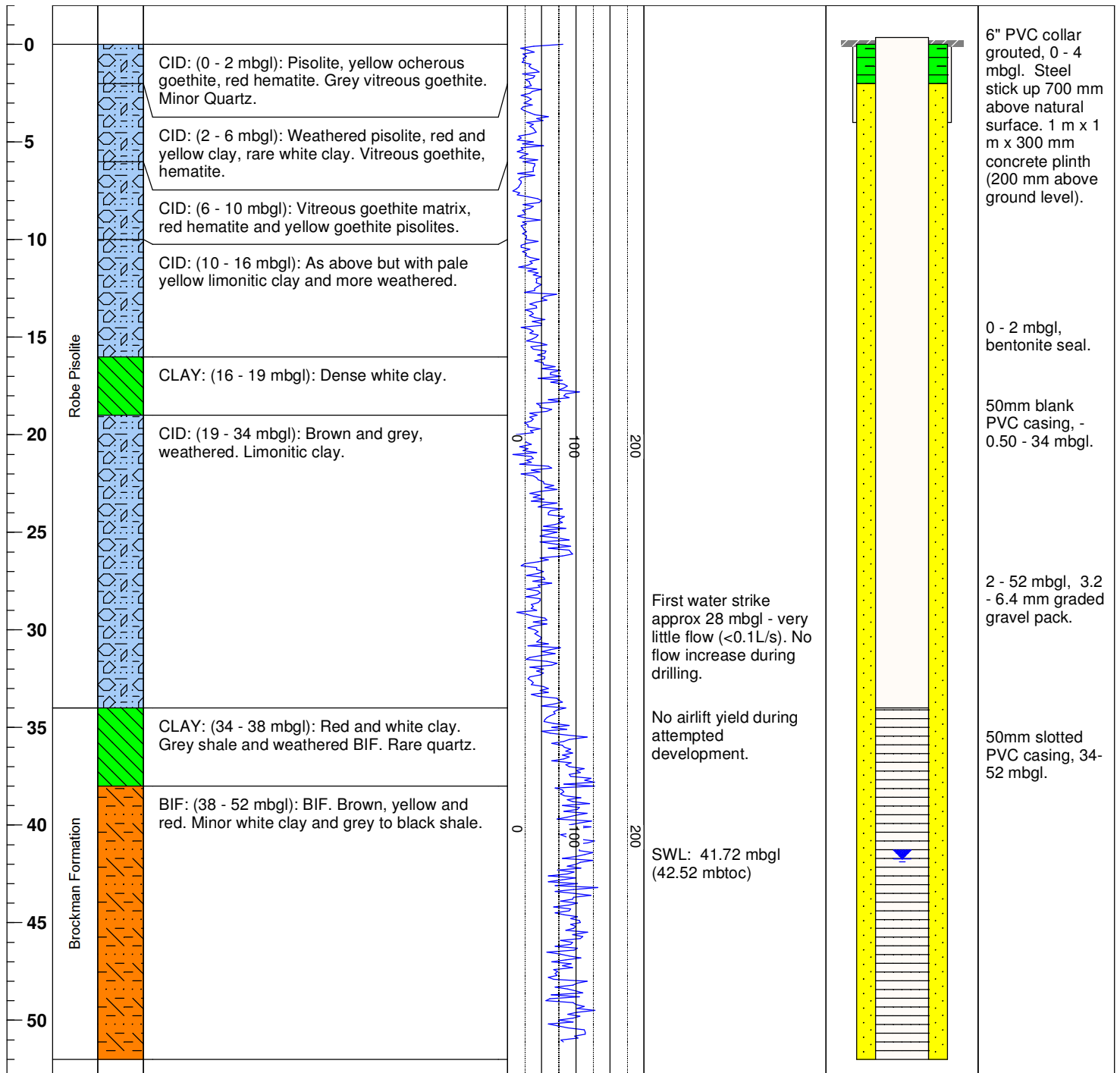
DRILLING COMPANY: Ranger Drilling
DRILLER: Ben Smith
DRILLING METHOD: RC
HYDROGEOLOGIST: A.Price

LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 414906.39
NORTHING: 7597496.70
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 (0-200cps)	Field Notes	Well Design	Well Construction
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MB16MEH0010 / MB16MEH0011

HOLE DETAILS

PROJECT: Mesa H PFS 2016

LOCATION: Mesa H

DATE COMMENCED: 17/2/2016

DATE COMPLETED: 18/02/2016

DRILLING DETAILS

DRILLING COMPANY: Bunbury Drilling

DRILLER: John Nesbitt

DRILLING METHOD: Air Hammer

HYDROGEOLOGIST: Marisa Mochizuki

LOCATION

GRID NAME: MGA 94, Zone 50

EASTING: 417971.10

NORTHING: 7594055.67

ELEVATION S: 175.08 mRL (TOC)

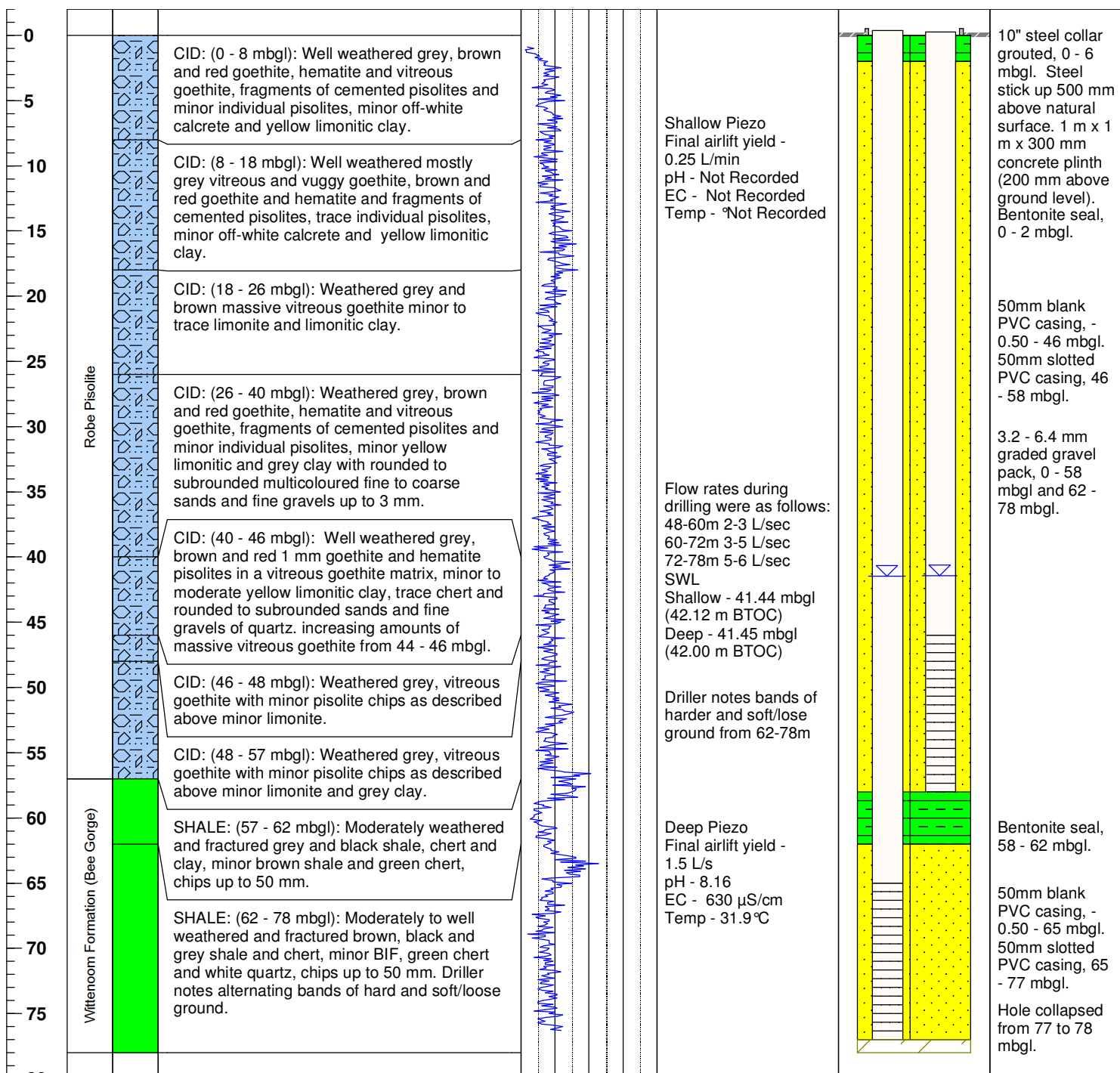
ELEVATION D: 174.96 mRL (TOC)

Peg ID: 16MEH_M14

Hammer Bit: 14 3/4" diameter 0 - 6 mbgl . 8 1/2" diameter 0 - 78 mbgl.

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

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-80 cps)	Field Notes	Well Design	Well Construction
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MB16MEH0012

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 19/2/2016
DATE COMPLETED: 22/02/2016

DRILLING DETAILS

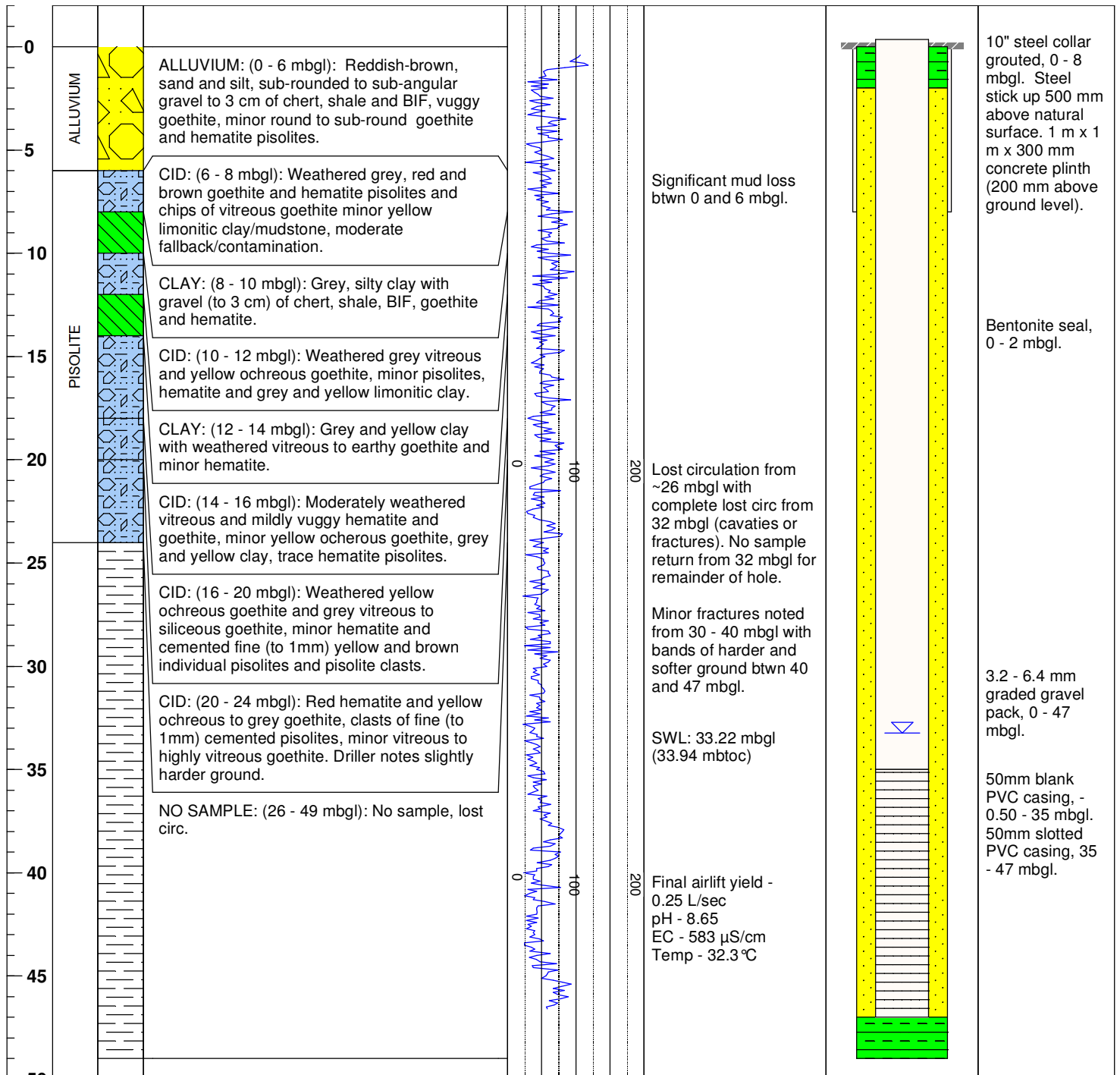
DRILLING COMPANY: Bunbury Drilling
DRILLER: Dave Usher
DRILLING METHOD: Air Hammer
HYDROGEOLOGIST: Marisa Mochizuki

LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 419768.32
NORTHING: 7592737.21
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
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MB16MEH0013

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

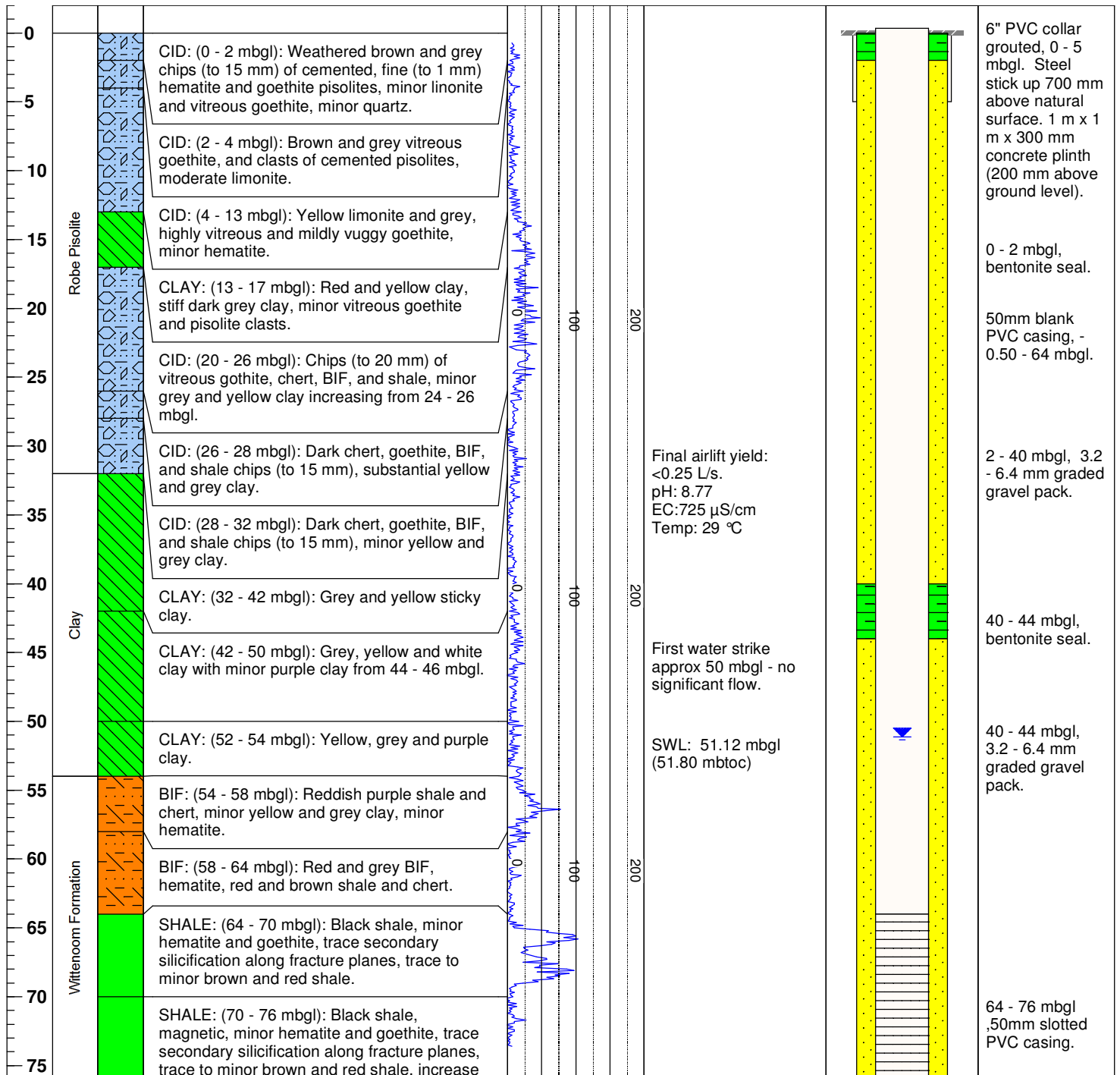
LOCATION

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 (0-200cps)	Field Notes	Well Design	Well Construction
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MB16MEH0014

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 18/02/2016
DATE COMPLETED: 18/02/2016

DRILLING DETAILS

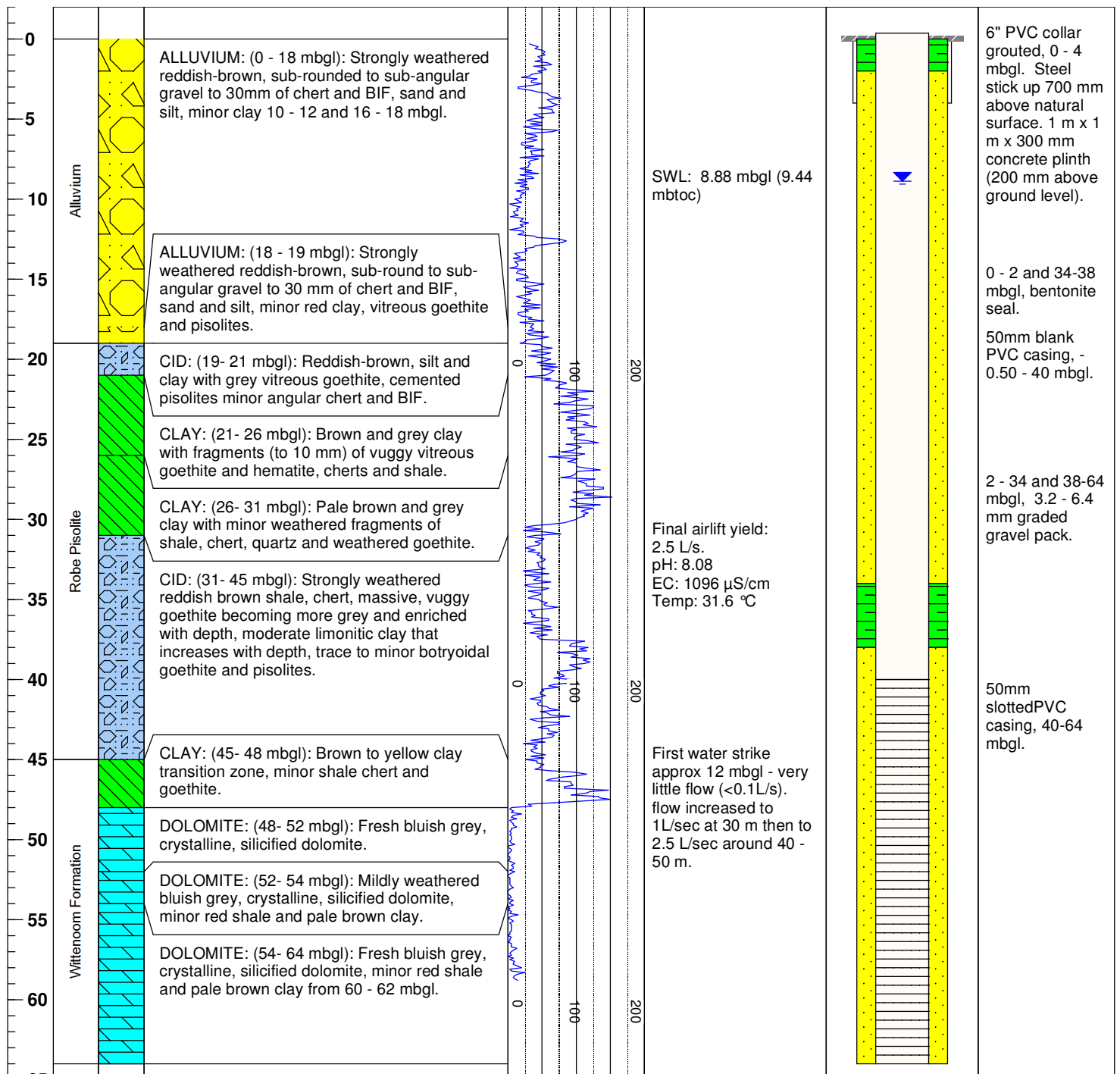
DRILLING COMPANY: Ranger Drilling
DRILLER: Andrew McPherson
DRILLING METHOD: RC
HYDROGEOLOGIST: Marisa Mochizuki

LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 418861.54
NORTHING: 7598680.02
ELEVATION: 139.33 mRL (TOC)

Peg ID: 16MEH_M11
 RC: 7½" diameter 0 - 5 mbgl. 5 - 64 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-200cps)	Field Notes	Well Design	Well Construction
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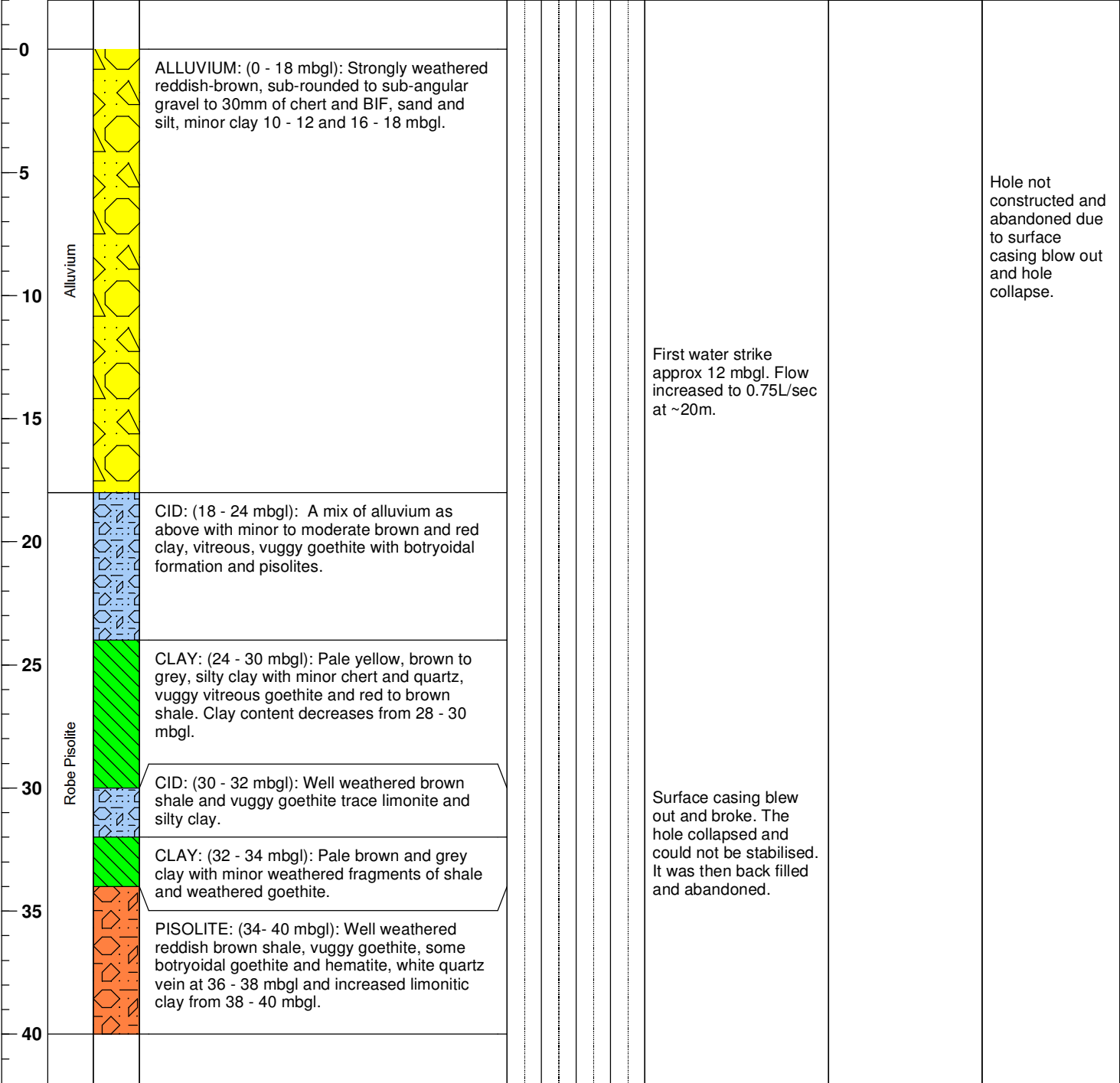


MB16MEH0015

HOLE DETAILS	DRILLING DETAILS	LOCATION
PROJECT: Mesa H PFS 2016	DRILLING COMPANY: Ranger Drilling	GRID NAME: MGA 94, Zone 50
LOCATION: Mesa H	DRILLER: Andrew McPherson	EASTING: Not Surveyed
DATE COMMENCED: 19/02/2016	DRILLING METHOD: RC	NORTHING: Not Surveyed
DATE COMPLETED: 19/02/2016	HYDROGEOLOGIST: Marisa Mochizuki	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 (0-200cps)	Field Notes	Well Design	Well Construction
-----------------	---------	-----------	--------------------------	--------------------------	-------------	-------------	-------------------

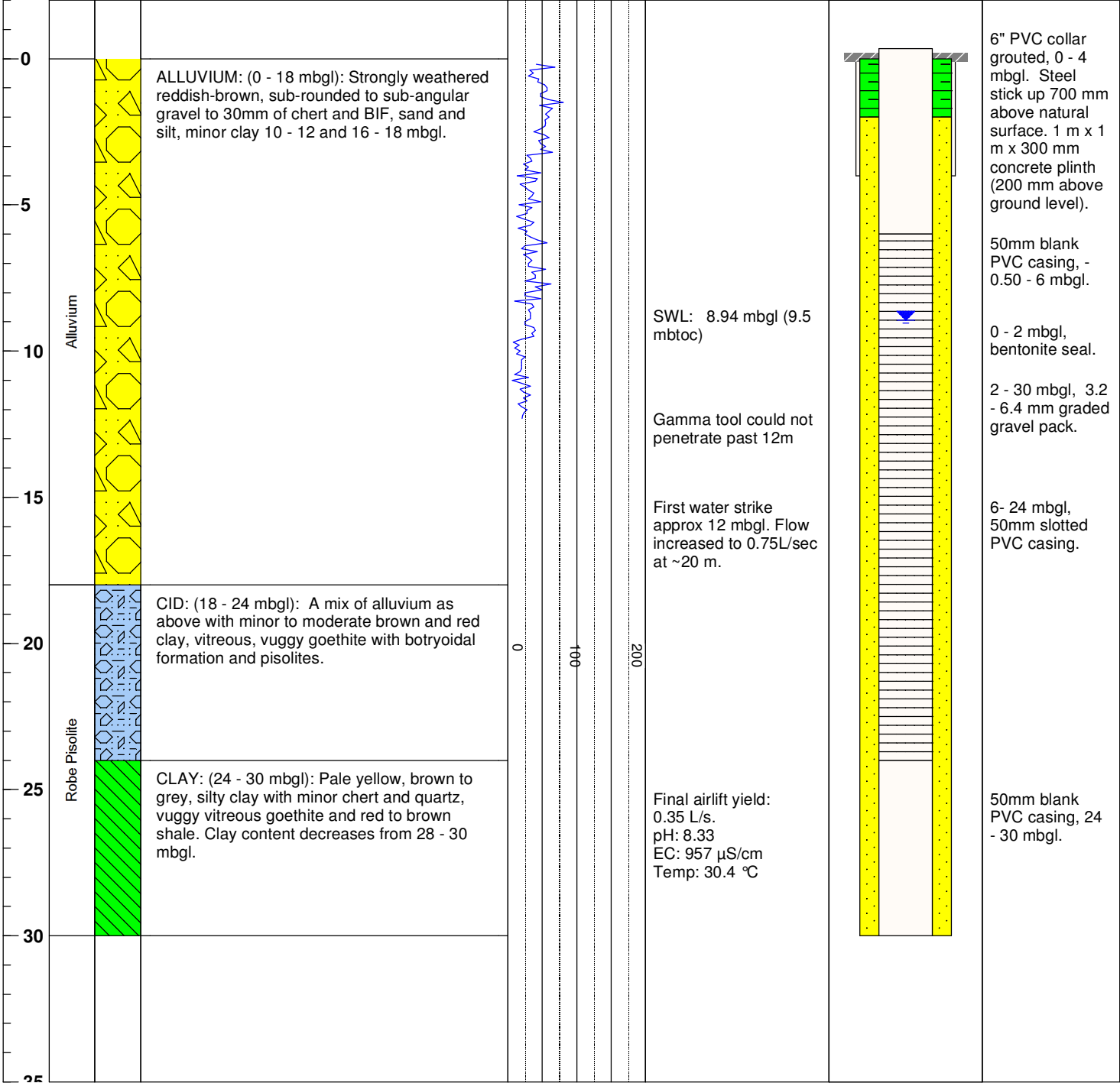


MB16MEH0016

HOLE DETAILS	DRILLING DETAILS	LOCATION
PROJECT: Mesa H PFS 2016	DRILLING COMPANY: Ranger Drilling	GRID NAME: MGA 94, Zone 50
LOCATION: Mesa H	DRILLER: Andrew McPherson	EASTING: 418854.63
DATE COMMENCED: 19/02/2016	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)	Field Notes	Well Design	Well Construction
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MB16MEH0017

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 19/02/2016
DATE COMPLETED: 21/02/2016

DRILLING DETAILS

DRILLING COMPANY: Ranger Drilling
DRILLER: Andrew McPherson
DRILLING METHOD: RC
HYDROGEOLOGIST: Marisa Mochizuki

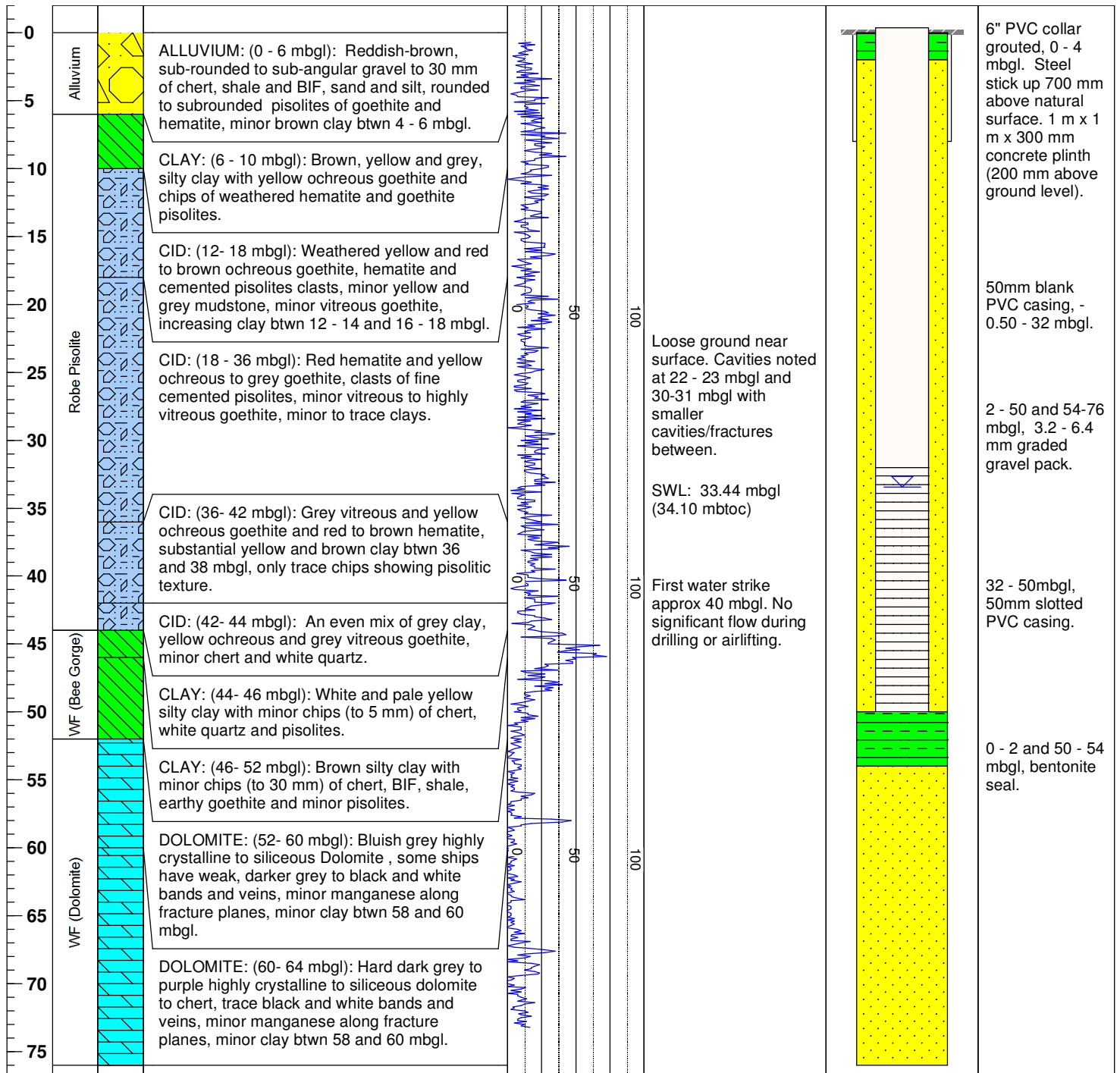
LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 419597.88
NORTHING: 7592744.90
ELEVATION: 165.68 mRL (TOC)

Peg ID: 16MEH_M13

RC: 7½" diameter 0 - 8 mbgl. 8 - 76 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-100cps)	Field Notes	Well Design	Well Construction
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MB16MEH0018

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 23/02/2016
DATE COMPLETED: 23/02/2016

DRILLING DETAILS

DRILLING COMPANY: Ranger Drilling
DRILLER: Andrew McPherson
DRILLING METHOD: RC
HYDROGEOLOGIST: Marisa Mochizuki

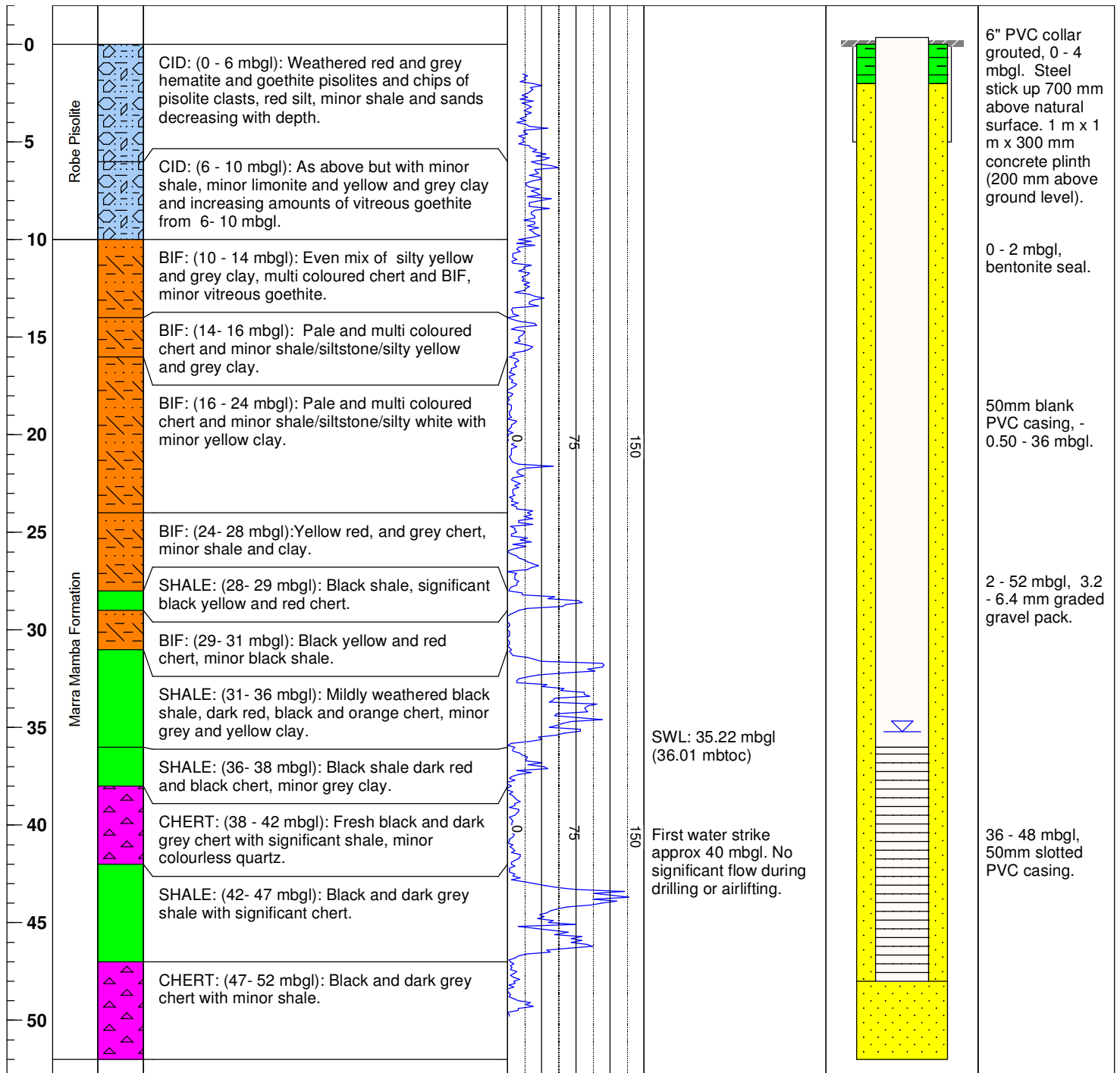
LOCATION

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 (0-150cps)	Field Notes	Well Design	Well Construction
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MB16MEH0019

HOLE DETAILS

PROJECT: Mesa H PFS 2016
LOCATION: Mesa H
DATE COMMENCED: 23/02/2016
DATE COMPLETED: 24/02/2016

DRILLING DETAILS

DRILLING COMPANY: Ranger Drilling
DRILLER: Andrew McPherson
DRILLING METHOD: RC
HYDROGEOLOGIST: Marisa Mochizuki

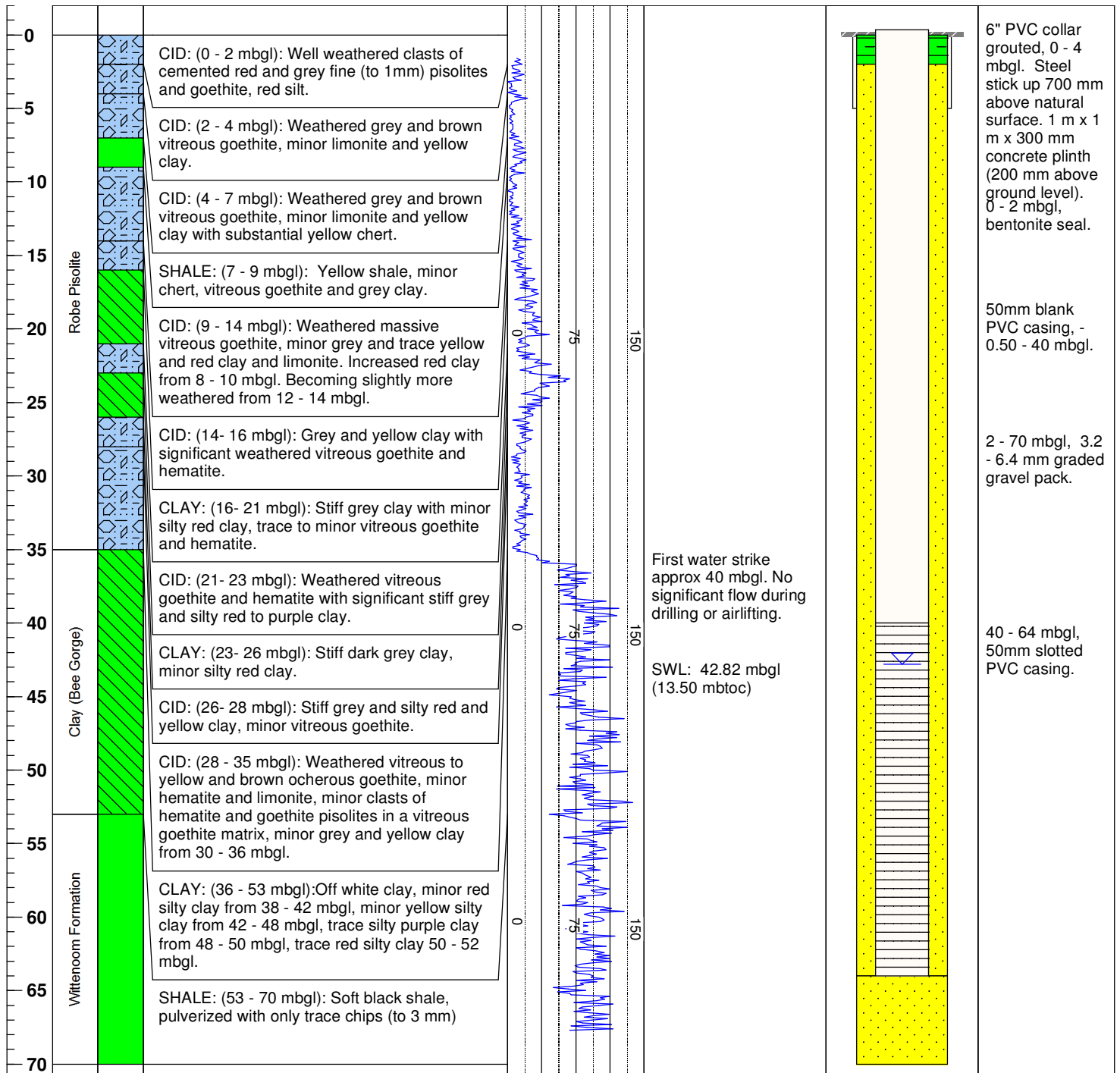
LOCATION

GRID NAME: MGA 94, Zone 50
EASTING: 419938.38
NORTHING: 7591715.26
ELEVATION: 178.53 mRL (TOC)

Peg ID: 16MEH_M03

RC: 7½" diameter 0 - 5 mbgl. 5 - 70 mbgl 5½" diameter.

Depth (mbgl)	Geology	Lithology	Lithological Description	Gamma (0-150cps)	Field Notes	Well Design	Well Construction
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WIRELINE SERVICES

WB16MEH0001

COMPANY : RTIO
WELL : WB16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:

PEG#
16MEH
_P02

TOWNSHIP : RANGE :

DATE : 03/13/16
DEPTH DRILLER : 84
LOG BOTTOM : 83.50
LOG TOP : -0.80

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : STEEL
CASING THICKNESS:

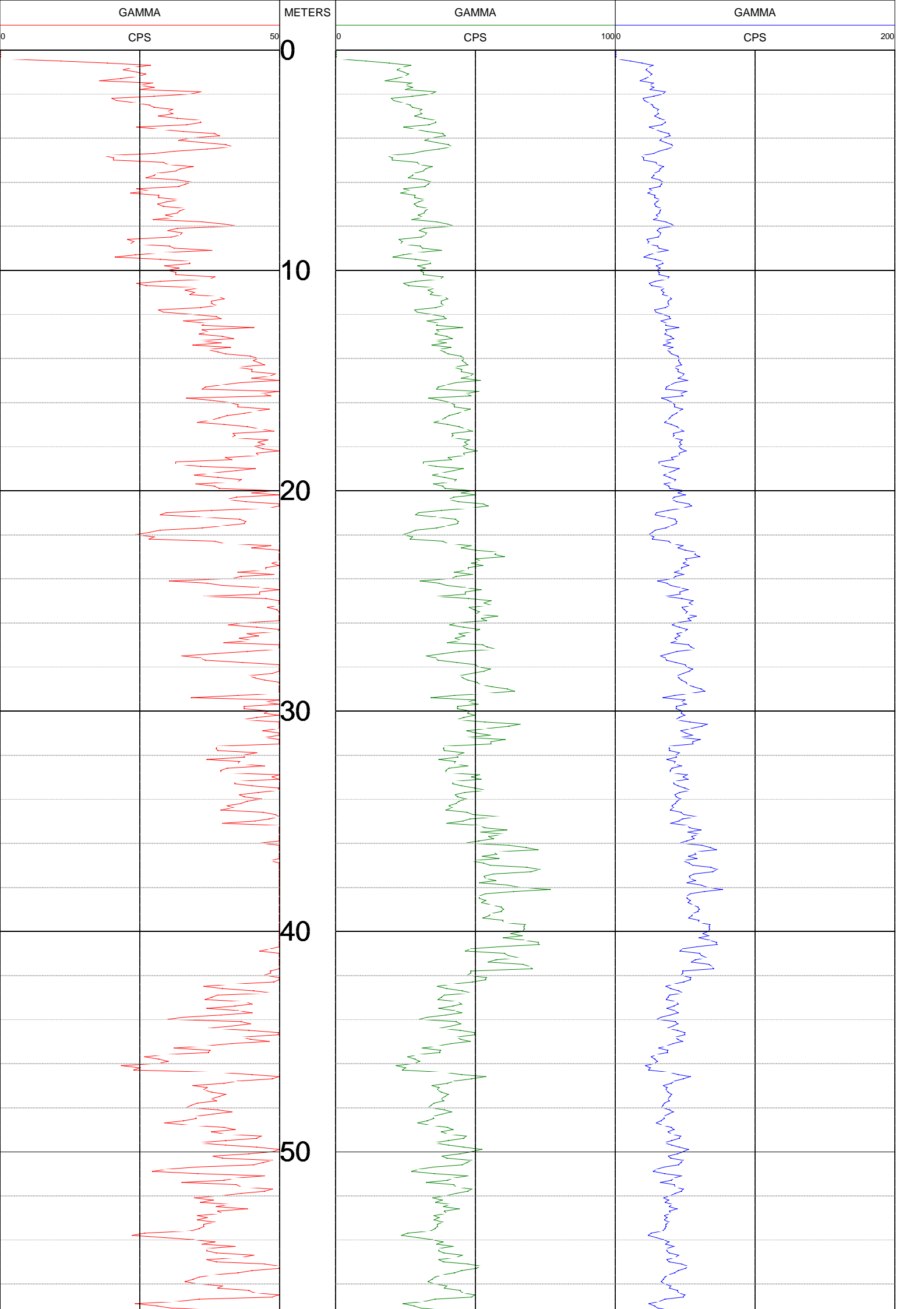
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

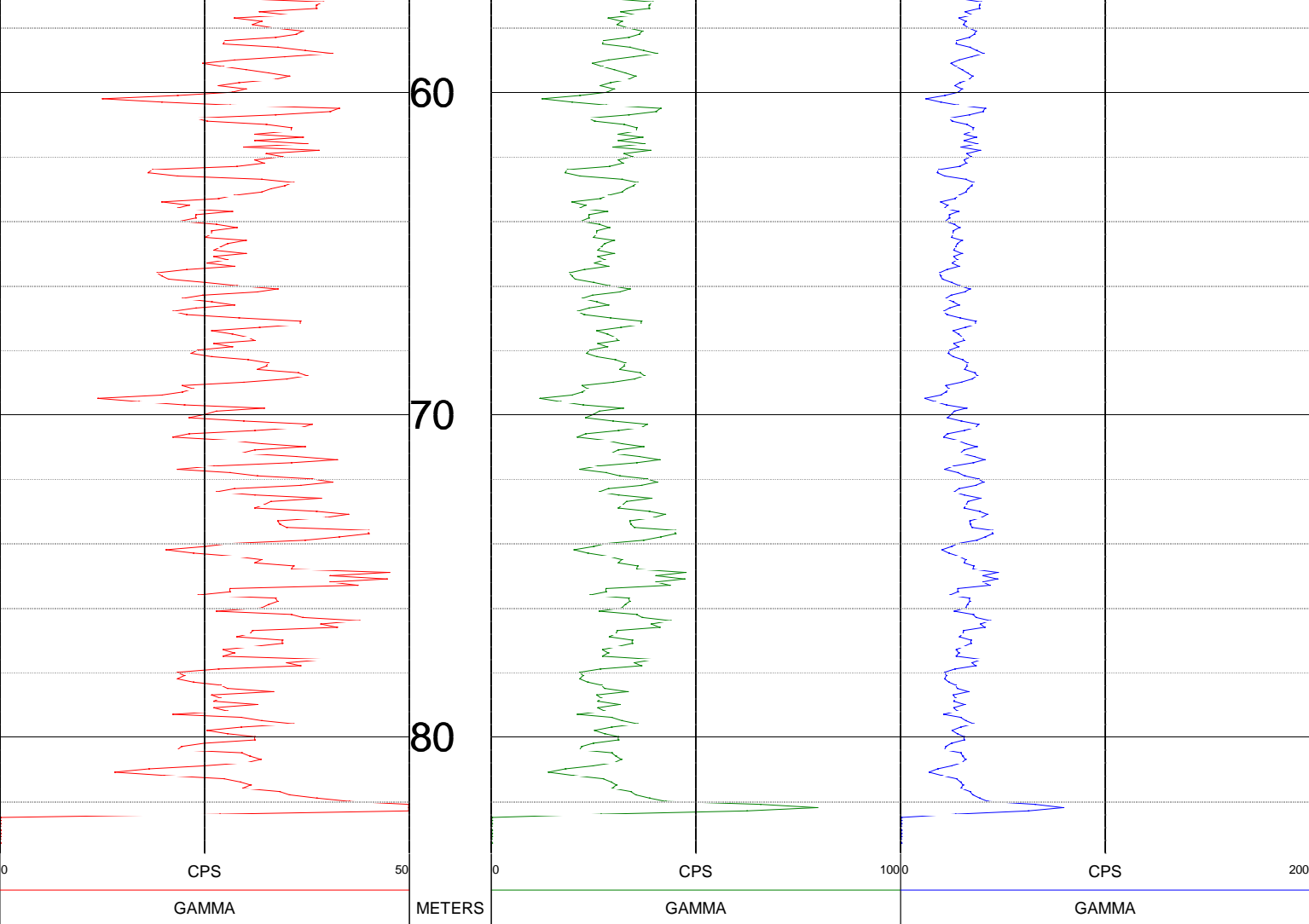
BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

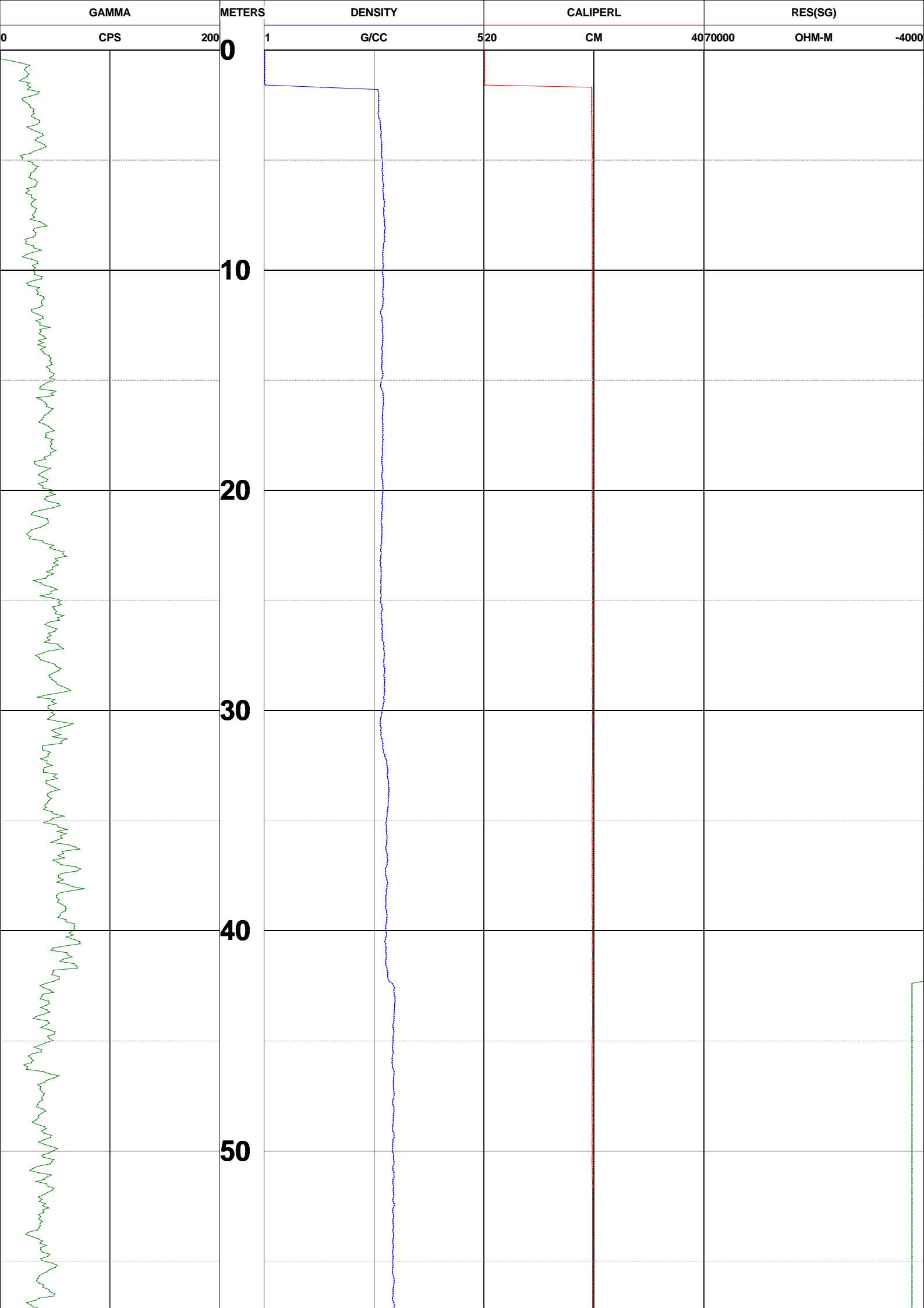
BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

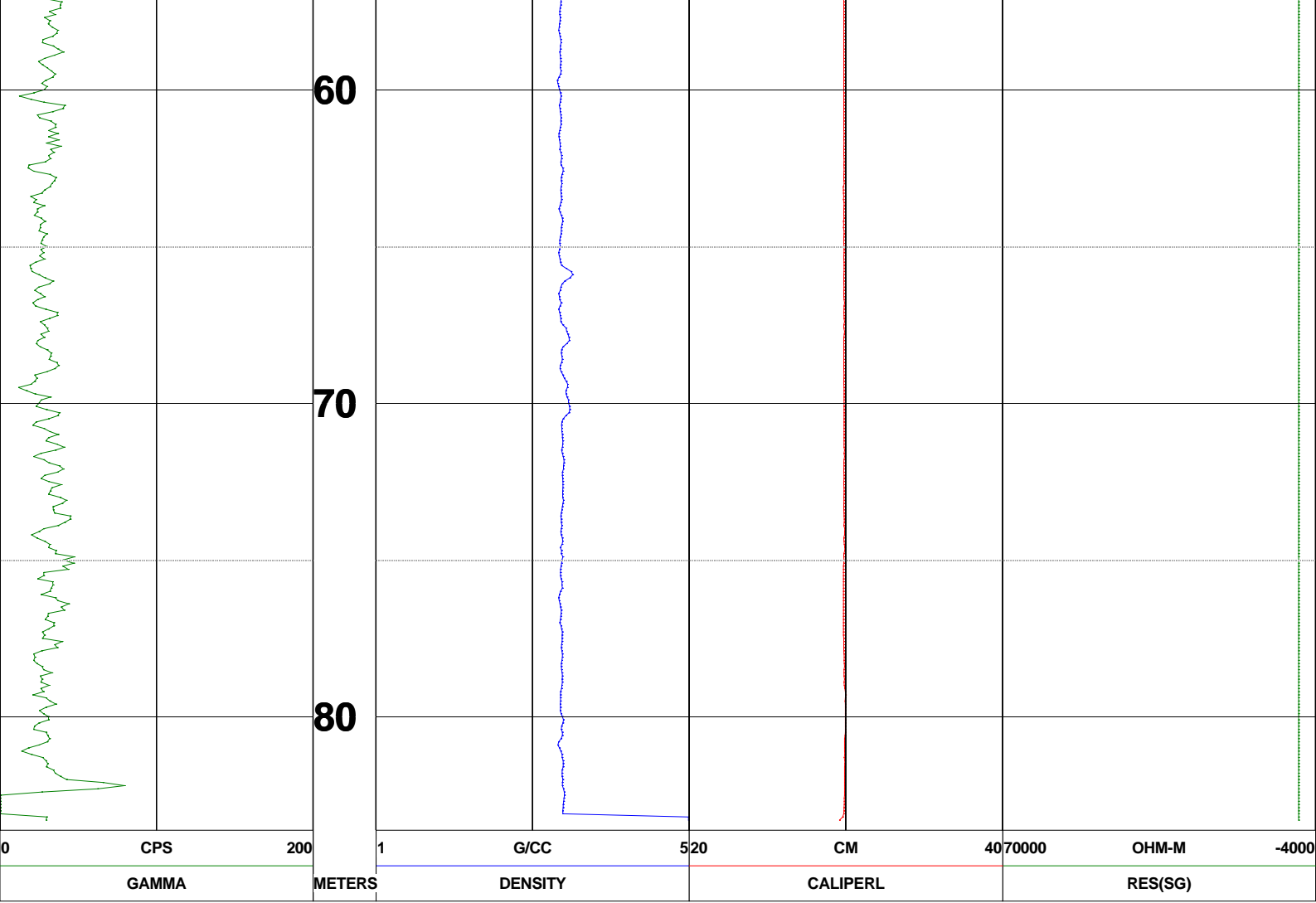
FILE : PROCESSED
TYPE : 9238AA
LGDATE: 03/13/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS











WIRELINE SERVICES

WB16MEH0002

COMPANY : RTIO
WELL : WB16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:
PEG#
16-MEH
P01

TOWNSHIP : RANGE :

DATE : 02/29/16
DEPTH DRILLER : 57
LOG BOTTOM : 55.60
LOG TOP : 0.10

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : OPEN
CASING THICKNESS:

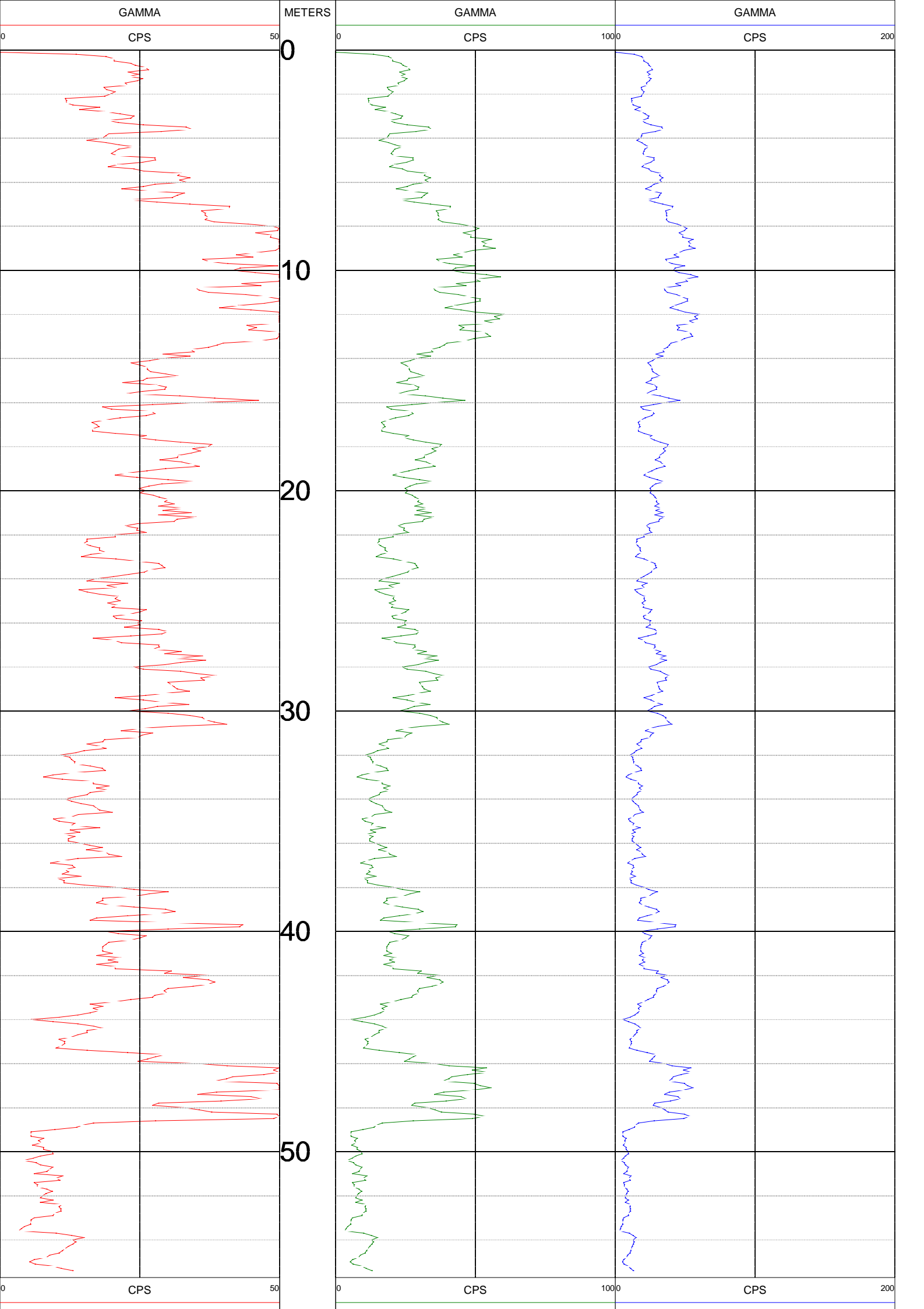
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : RP

BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : PROCESSED
TYPE : 9012C
LGDATE: 02/29/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



GAMMA

METERS

GAMMA

GAMMA



WIRELINE SERVICES

WB16MEH0002

COMPANY : RTIO
WELL : WB16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:
PEG#
16MEH
_P01

TOWNSHIP : RANGE :

DATE : 03/04/16
DEPTH DRILLER : 57
LOG BOTTOM : 54.30
LOG TOP : -0.80

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : STEEL
CASING THICKNESS:

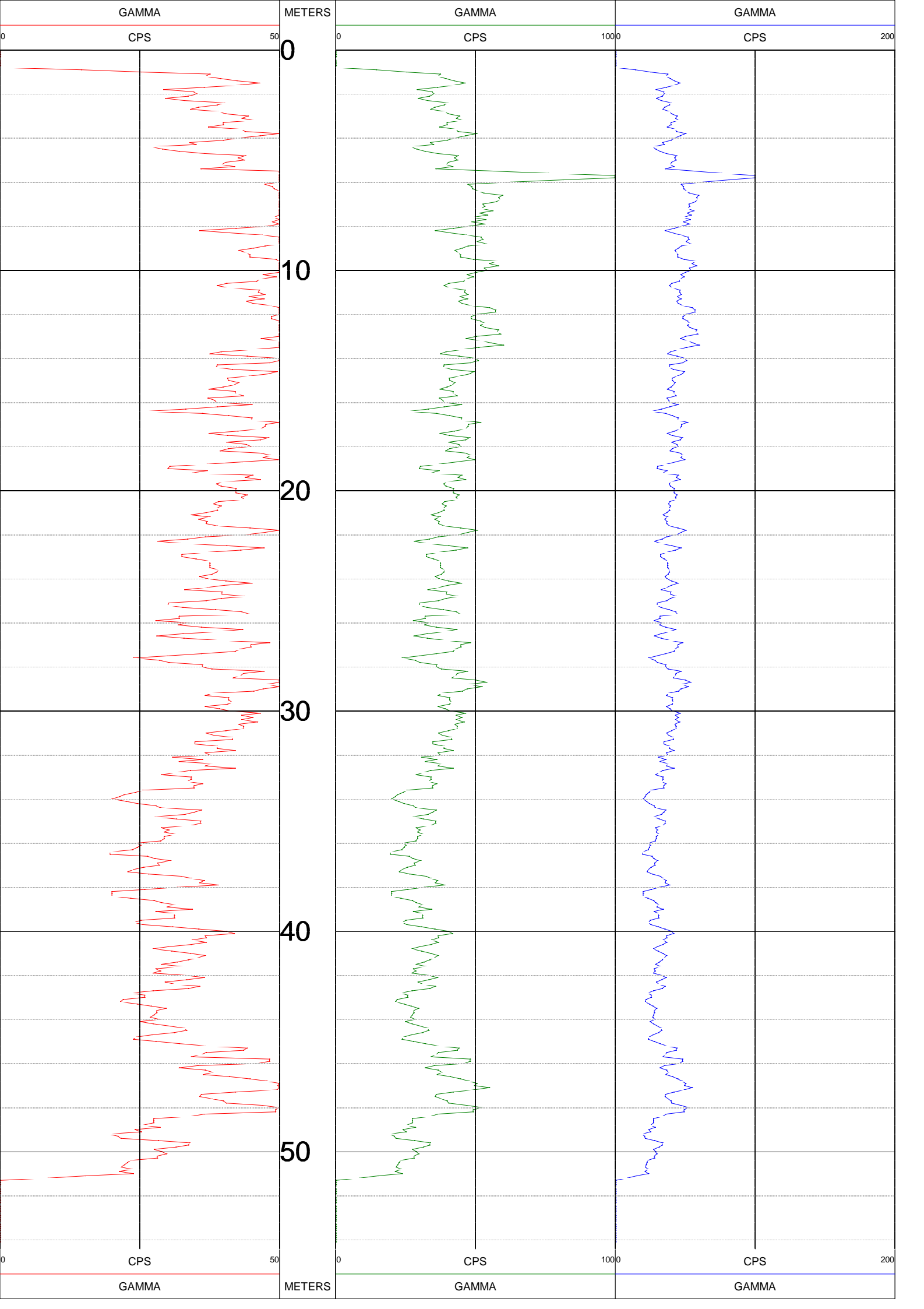
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

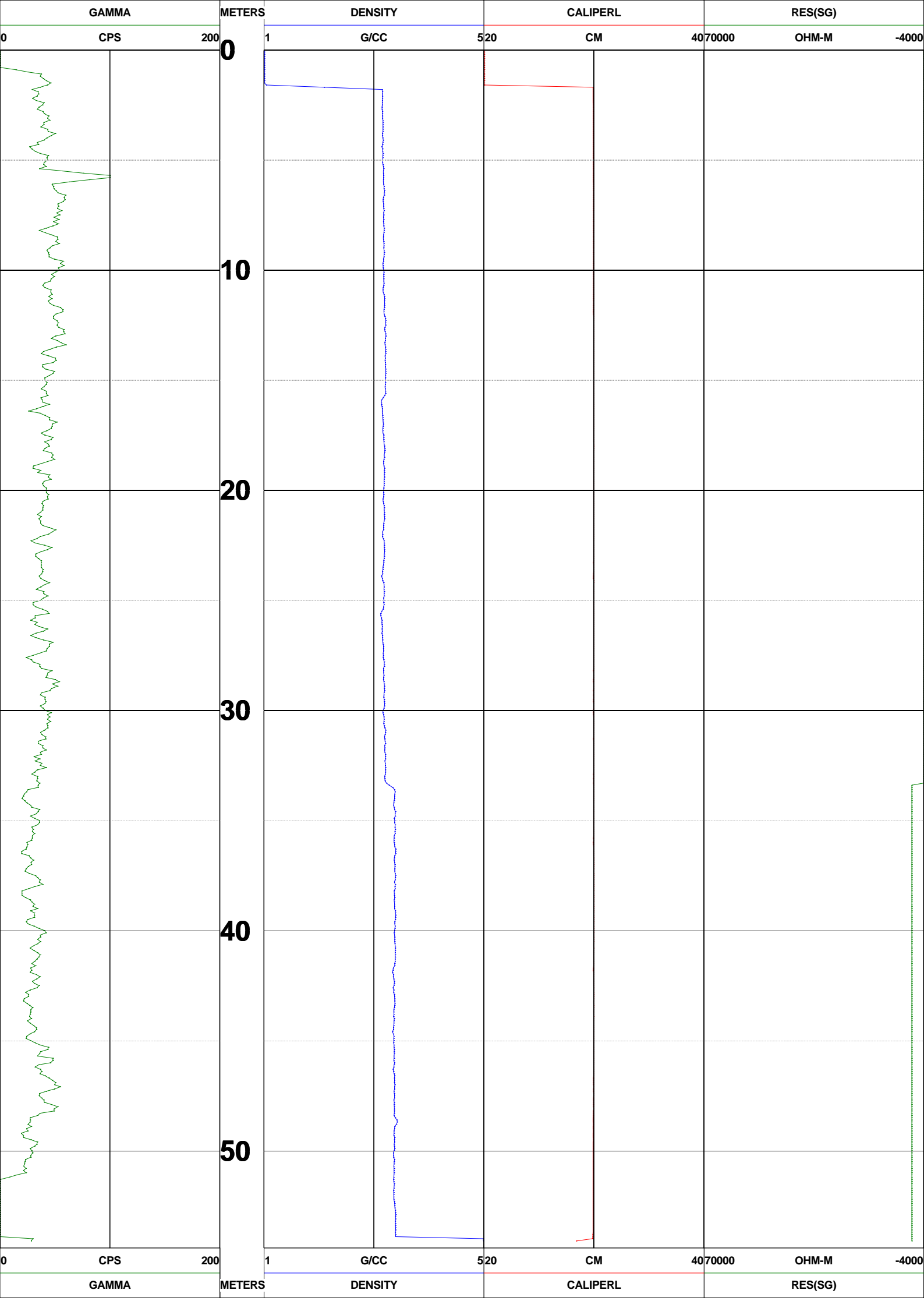
BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : PROCESSED
TYPE : 9238AA
LGDATE: 03/04/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





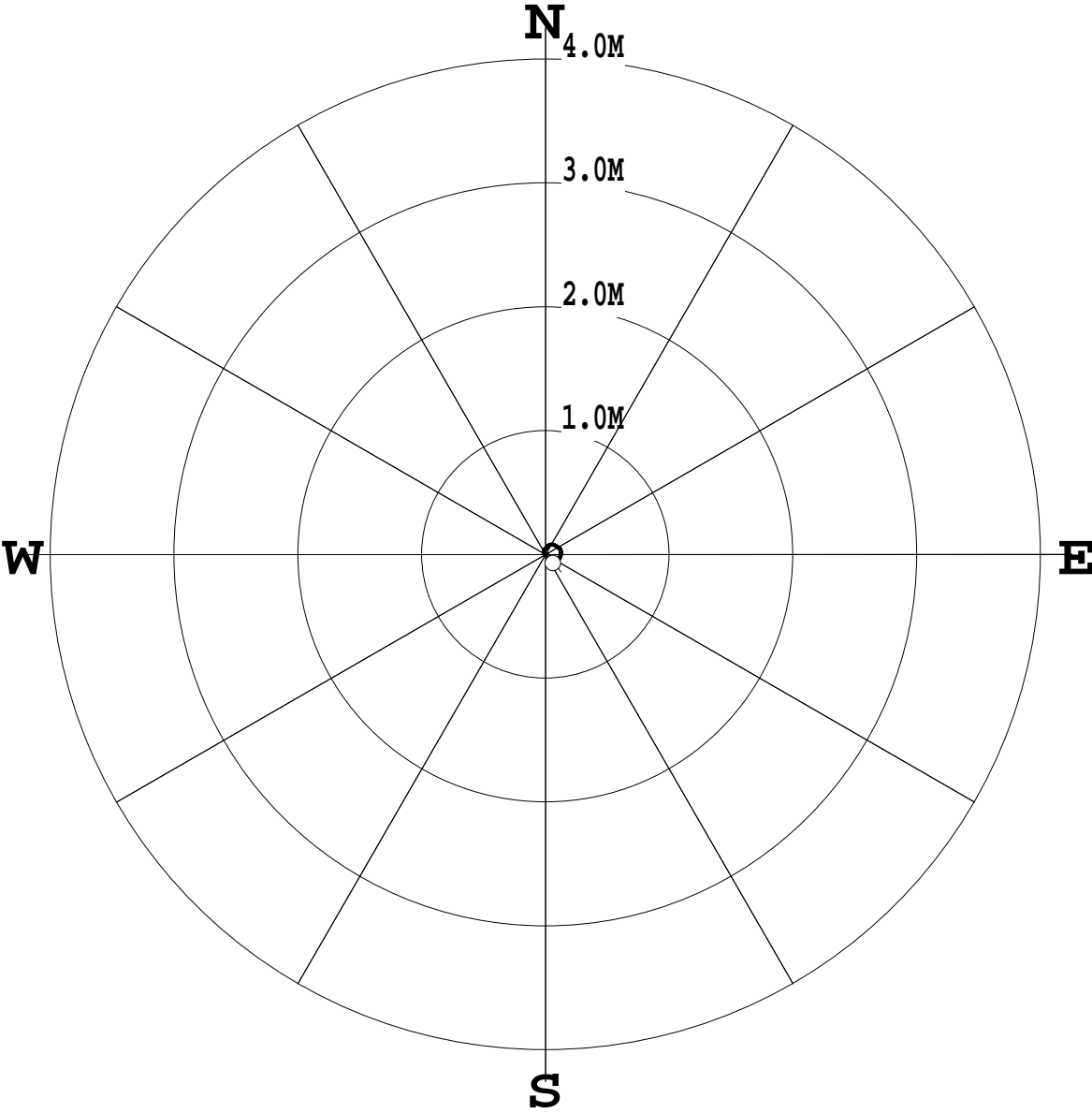
PLAN VIEW

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 * * * * *

CLIENT : RTIO HOLE ID. : WB16MEH0002
FIELD OFFICE : SURTRON DATE OF LOG : 03/04/16
DATA FROM : PROBE : 9098C , 1217
MAG. DECL. : 1.438 DEPTH UNITS : METERS
LOG: WB16MEH0002_GYRO.log

CABLE 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



WIRELINE SERVICES

WB16MEH0003

COMPANY : RTIO
WELL : WB16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:
PEG#
16MEH
_P03

TOWNSHIP : RANGE :

DATE : 03/11/16
DEPTH DRILLER : 70
LOG BOTTOM : 69.50
LOG TOP : -0.80

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : STEEL
CASING THICKNESS:

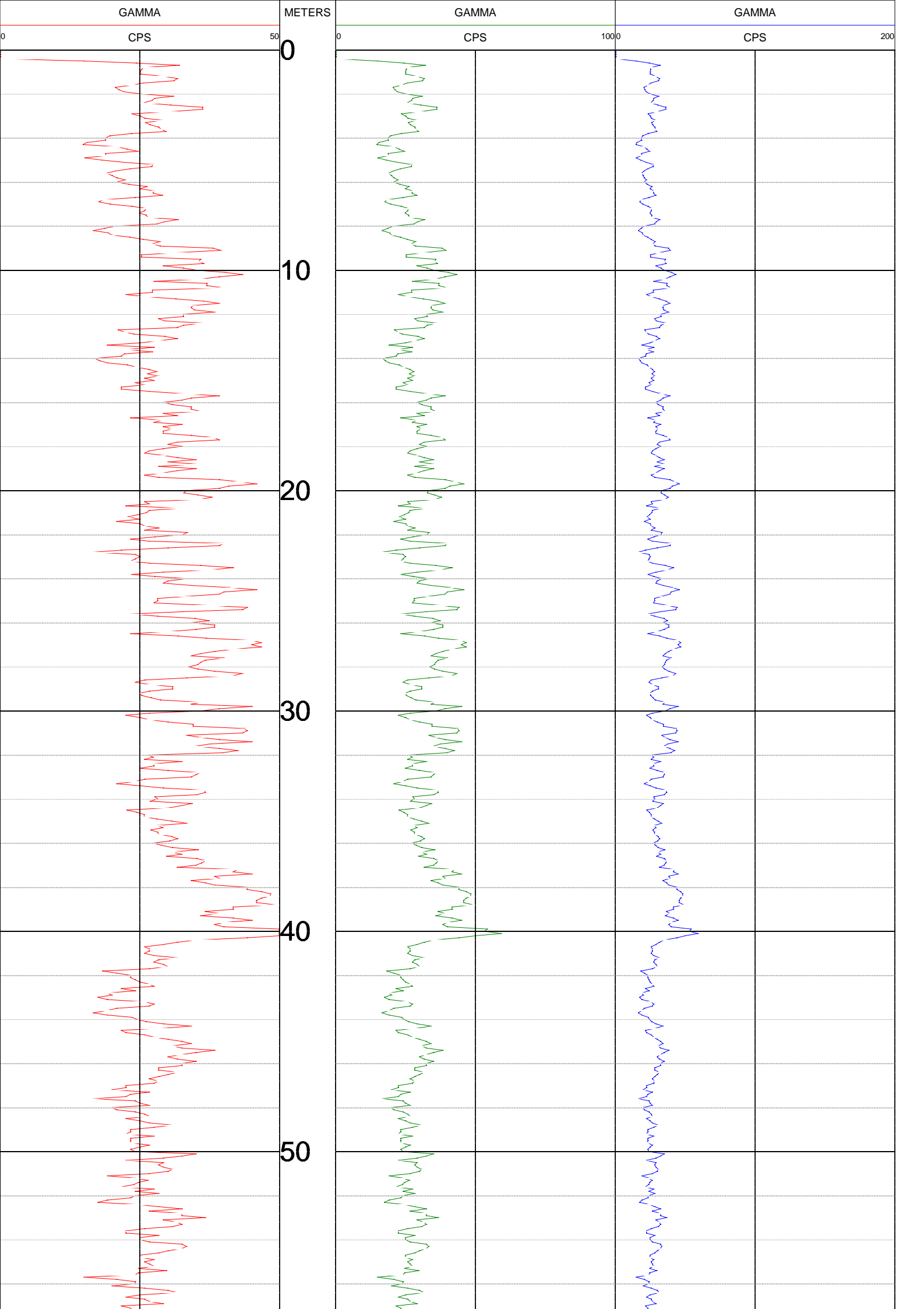
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

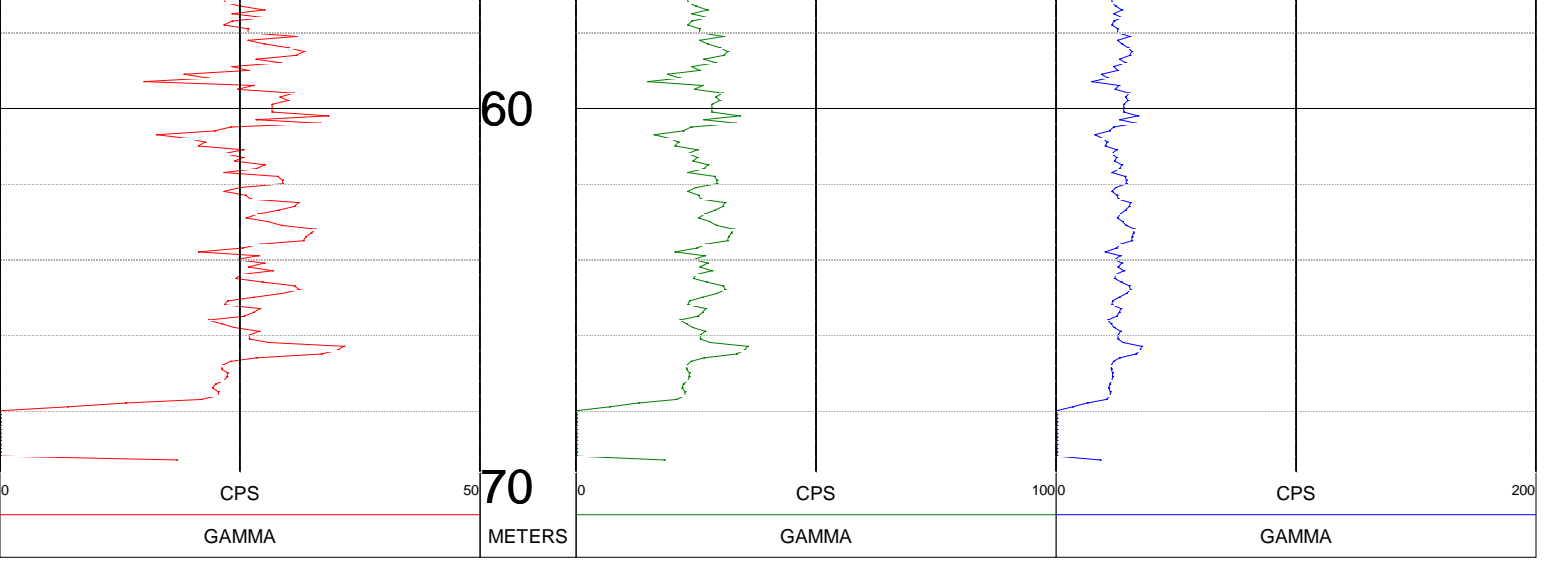
BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

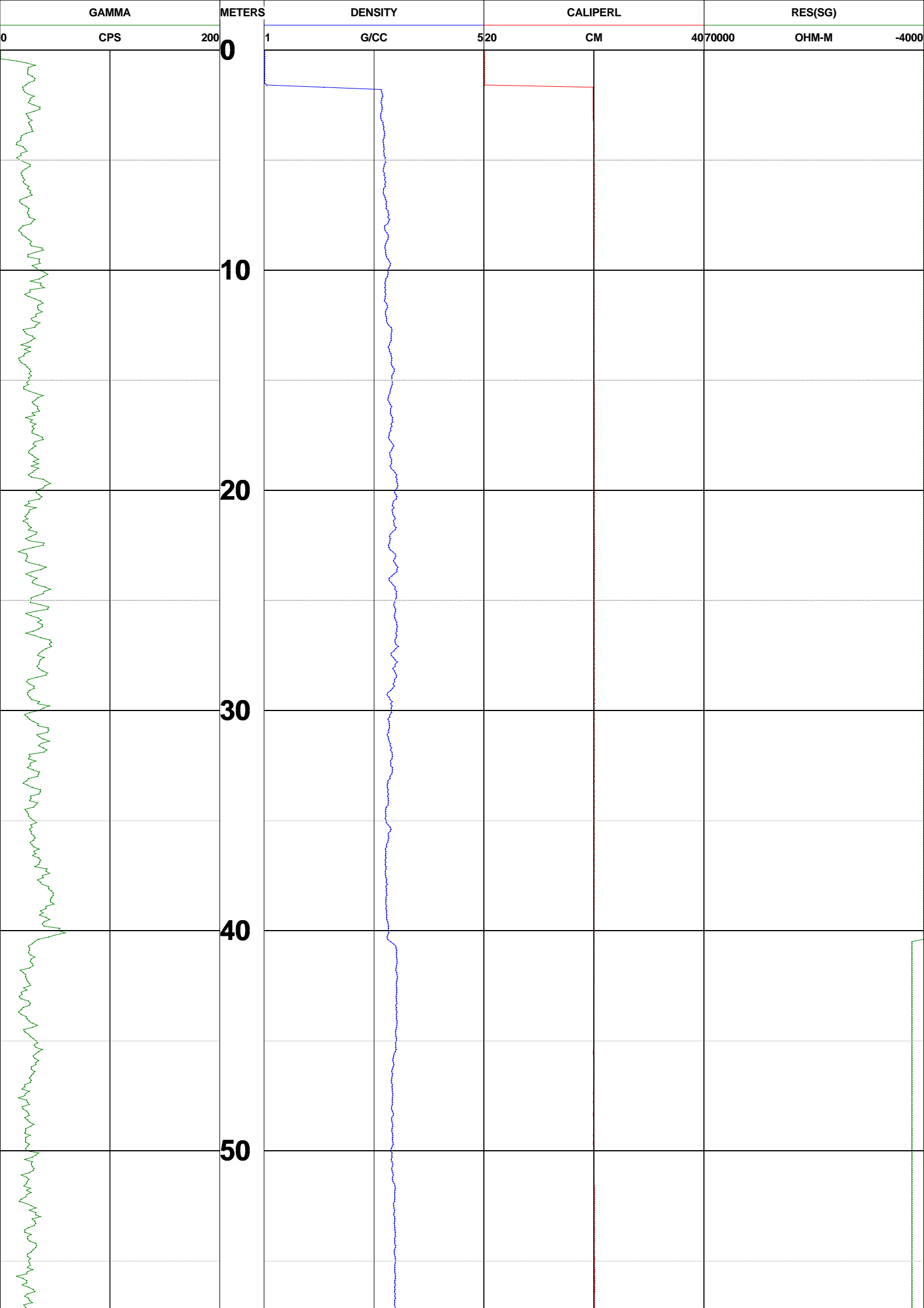
BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

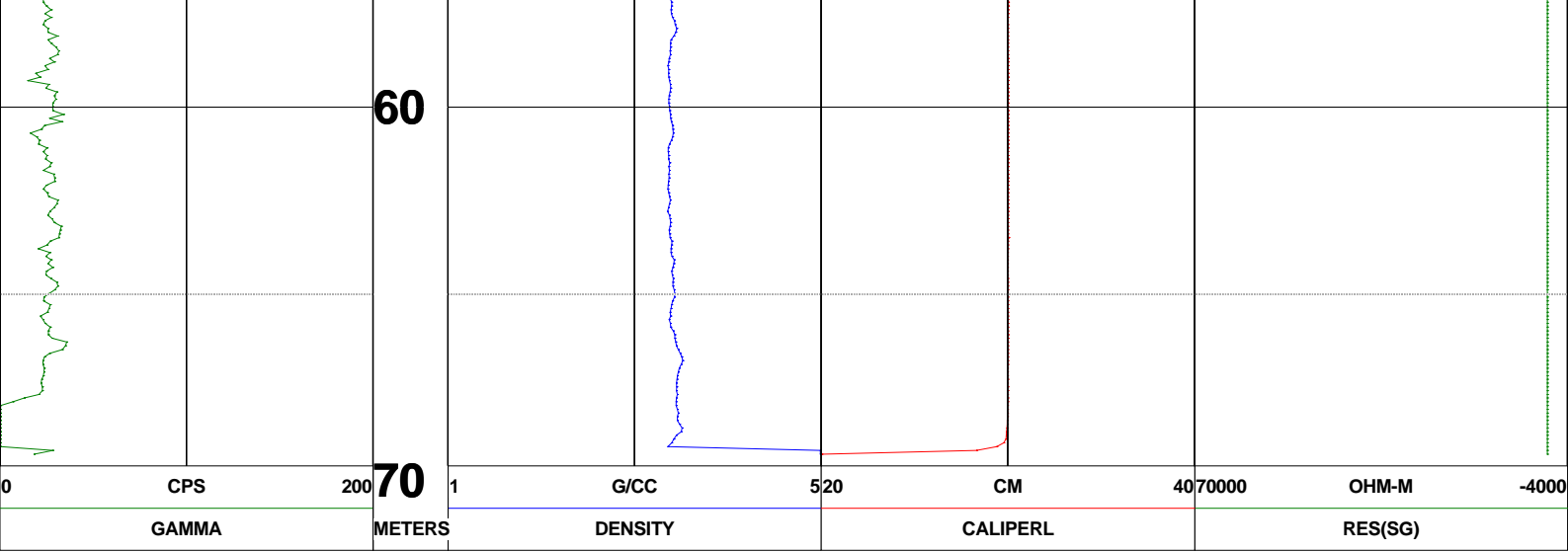
FILE : PROCESSED
TYPE : 9238AA
LGDATE: 03/11/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS











WIRELINE SERVICES

WB16MEH0004

COMPANY : RTIO
WELL : WB16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:
PEG#
16MEH
_P04

TOWNSHIP : RANGE :

DATE : 03/14/16
DEPTH DRILLER : 76
LOG BOTTOM : 75.00
LOG TOP : -0.80

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : STEEL
CASING THICKNESS:

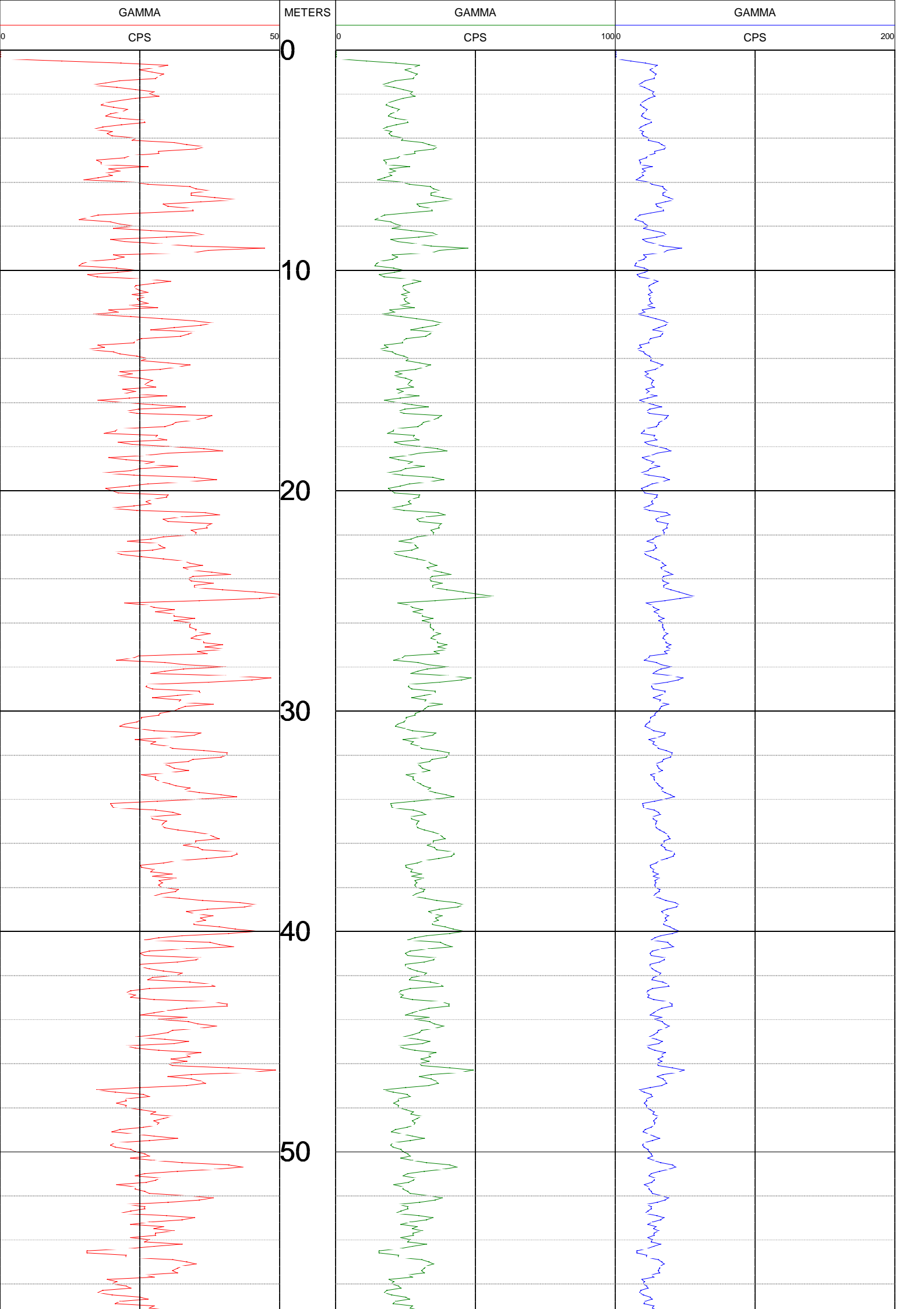
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

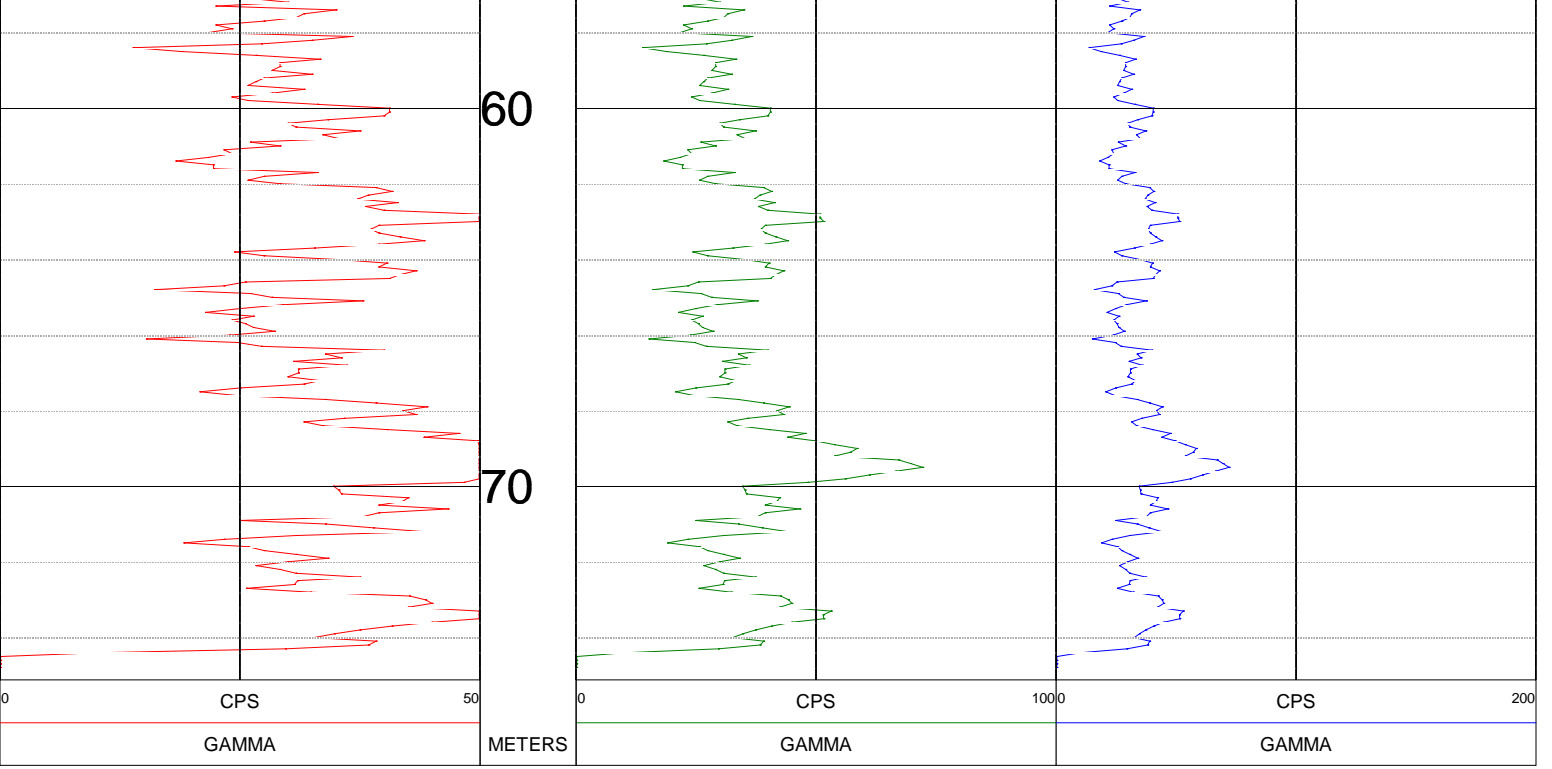
BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

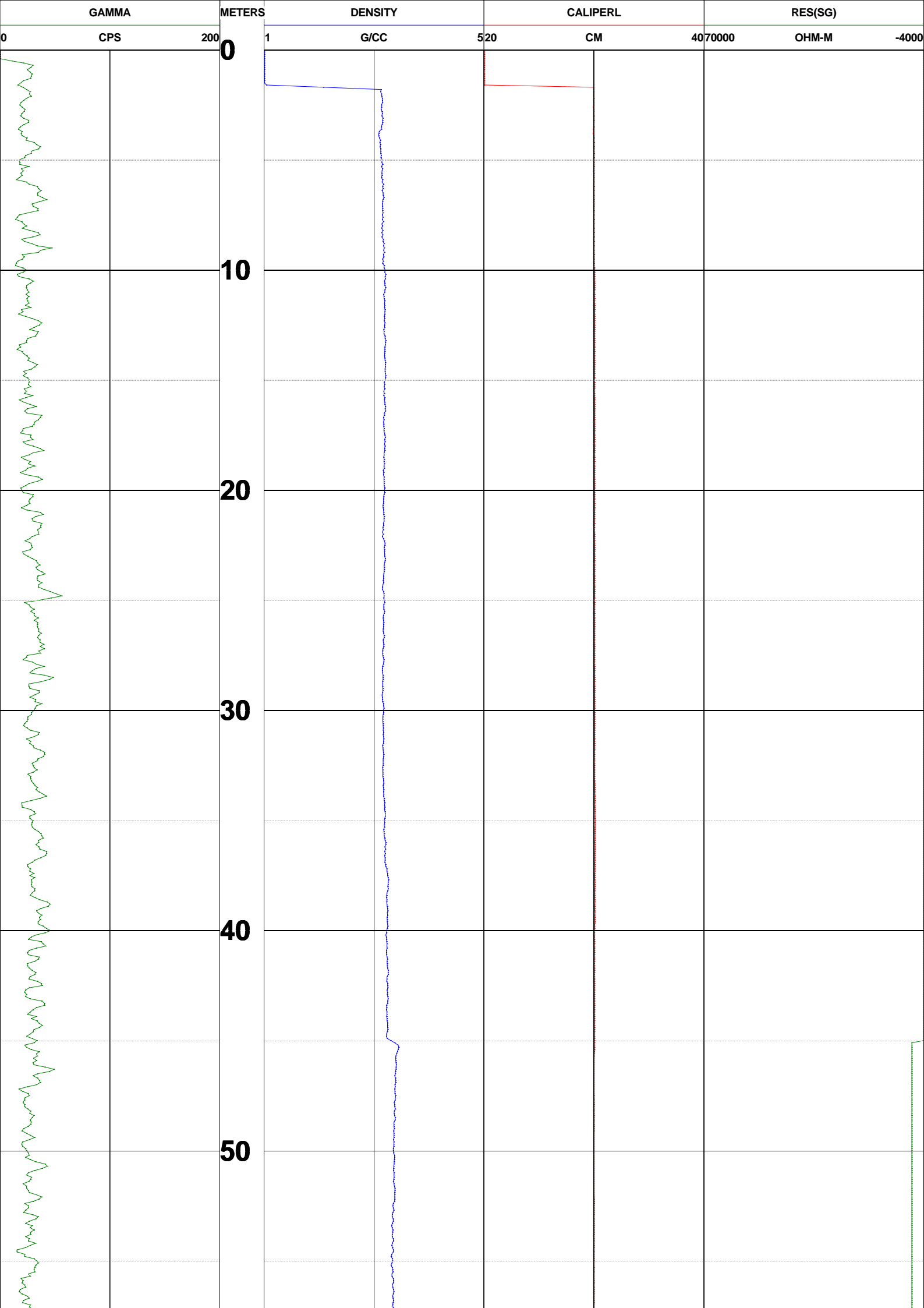
BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

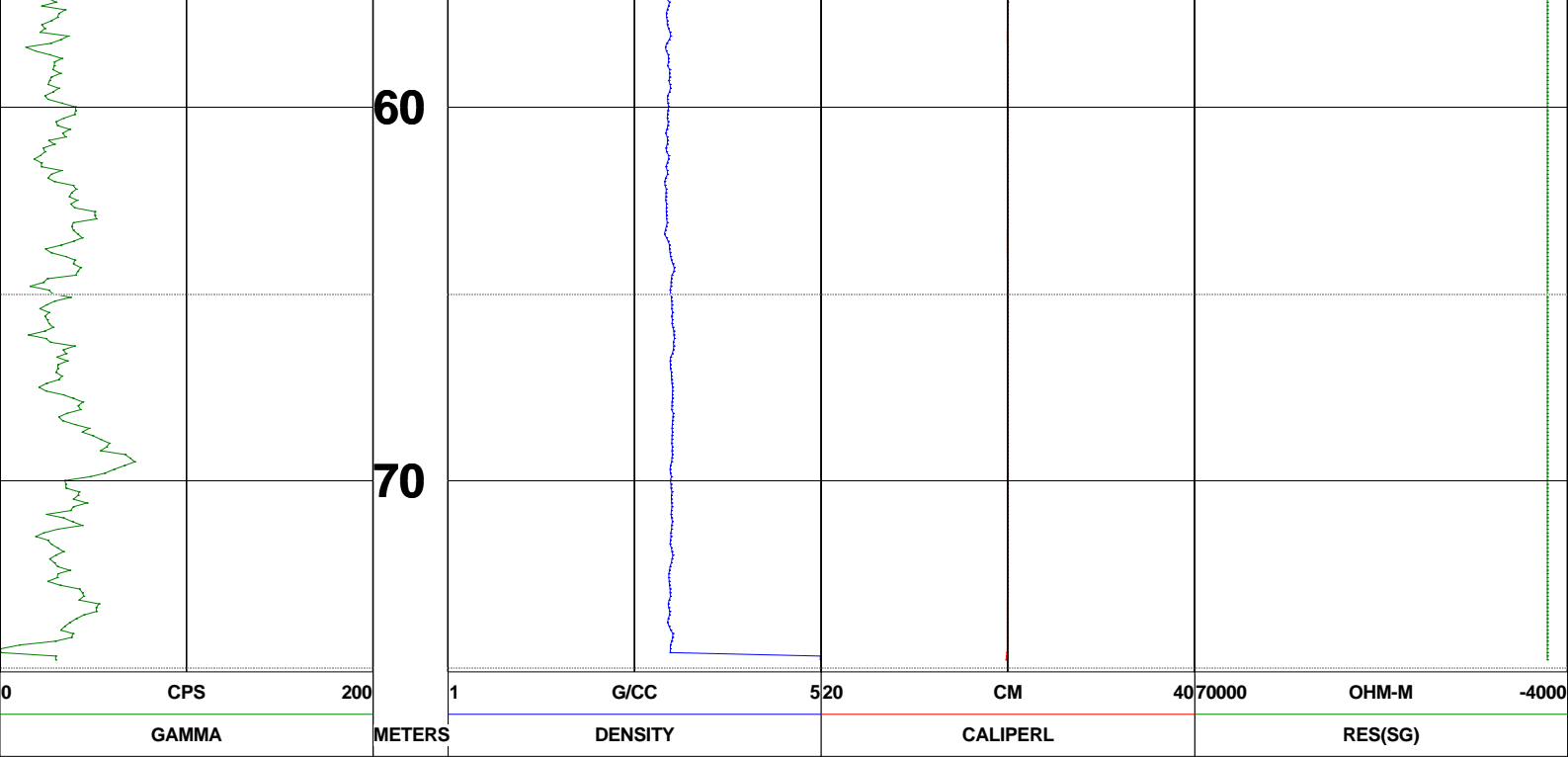
FILE : PROCESSED
TYPE : 9238AA
LGDATE: 03/14/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS











WIRELINE SERVICES

HM16MEH0001

COMPANY : RTIO
WELL : HM16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:
PEG#
16MEH
_M15

TOWNSHIP : RANGE :

DATE : 03/04/16
DEPTH DRILLER : 78
LOG BOTTOM : 77.70
LOG TOP : 0.10

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

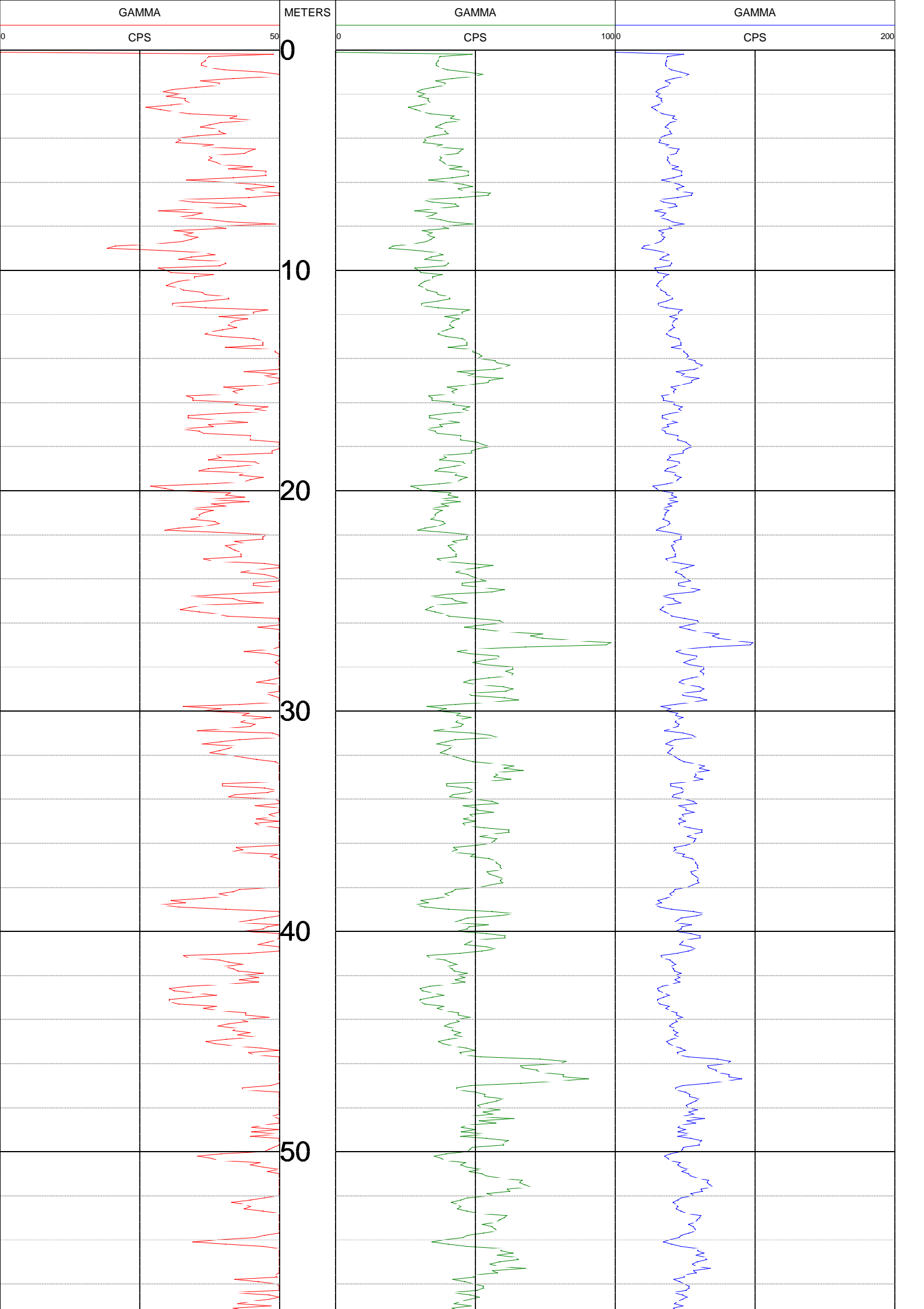
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

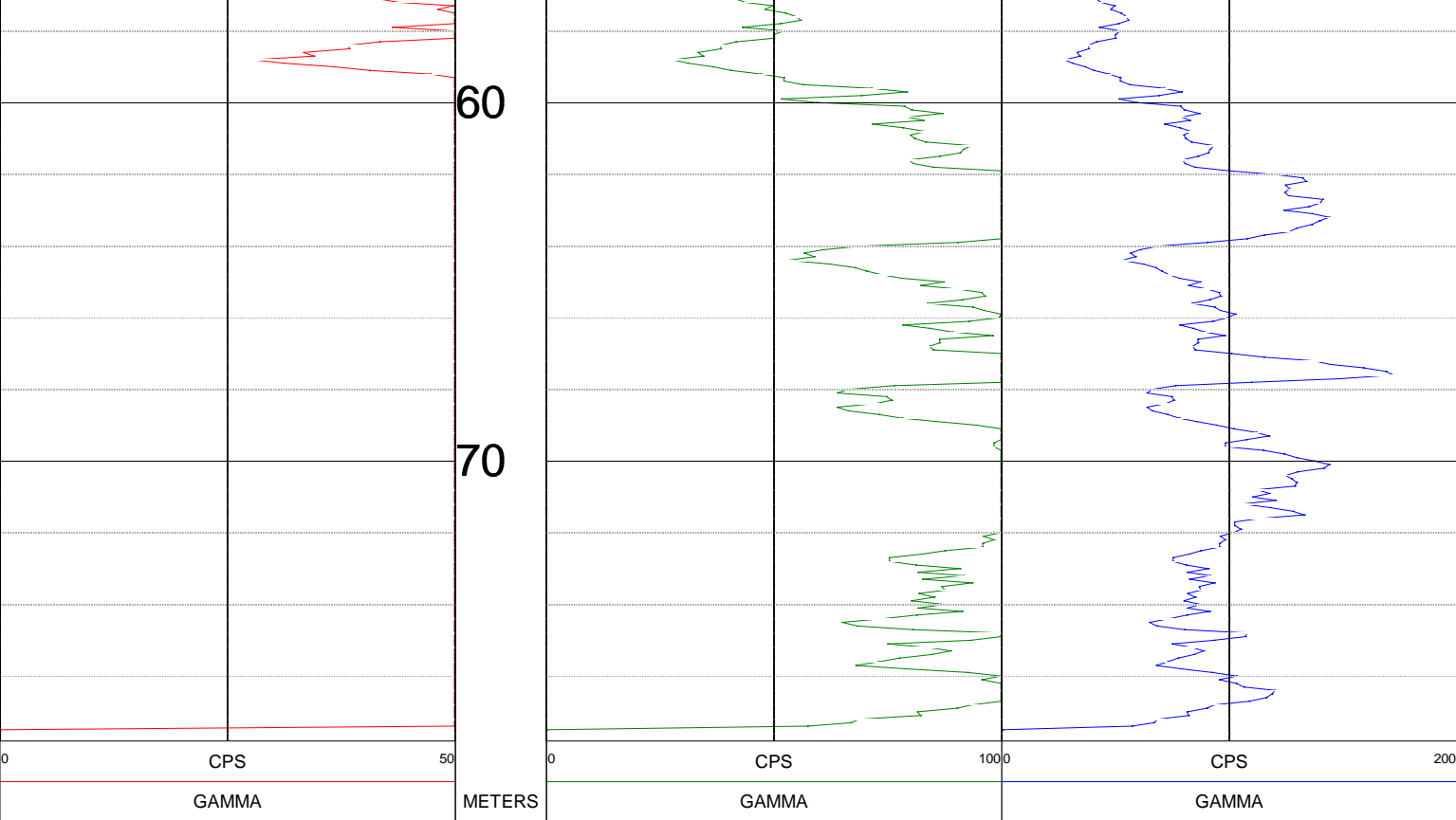
BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 03/04/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

HM16MEH0001

COMPANY : RTIO
WELL : HM16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:
16MEH
_M15

TOWNSHIP : RANGE :

DATE : 02/17/16
DEPTH DRILLER : 78
LOG BOTTOM : 59.50
LOG TOP : 0.00

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

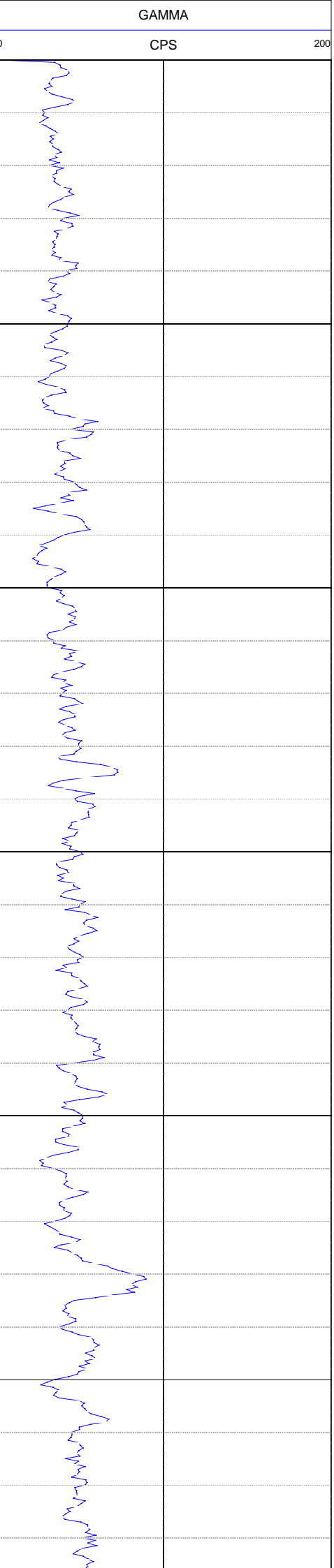
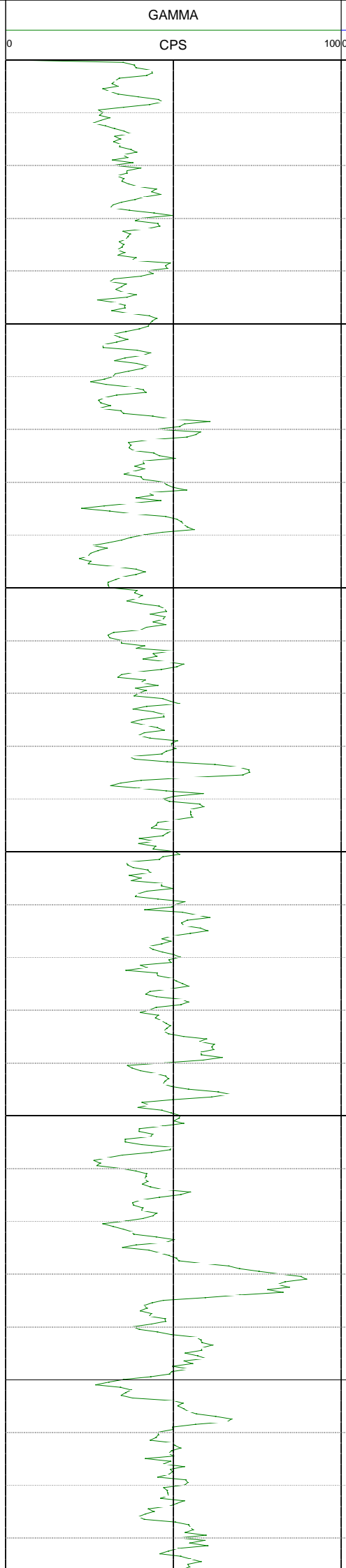
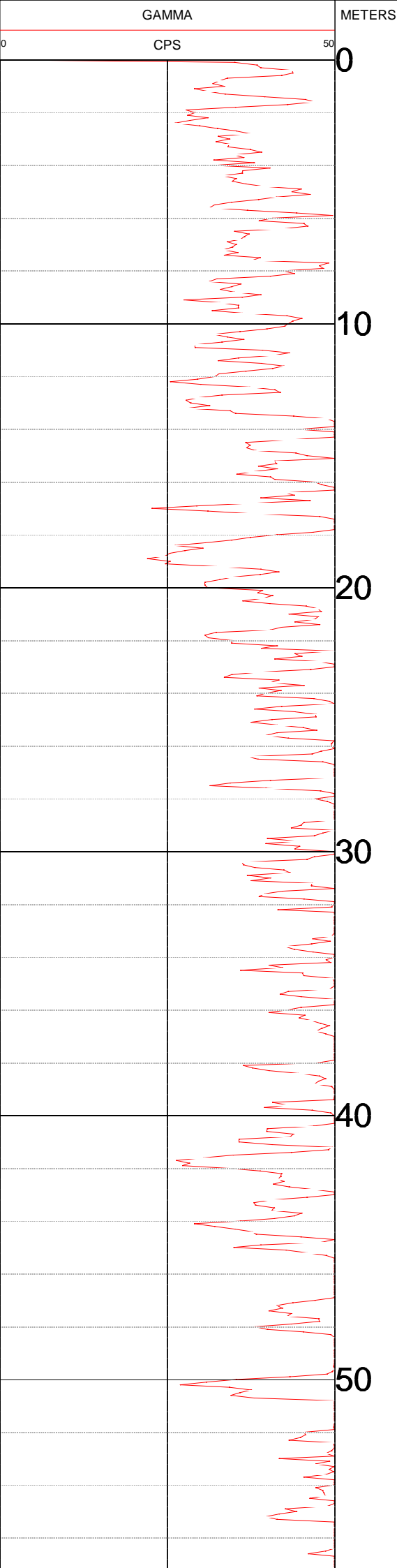
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

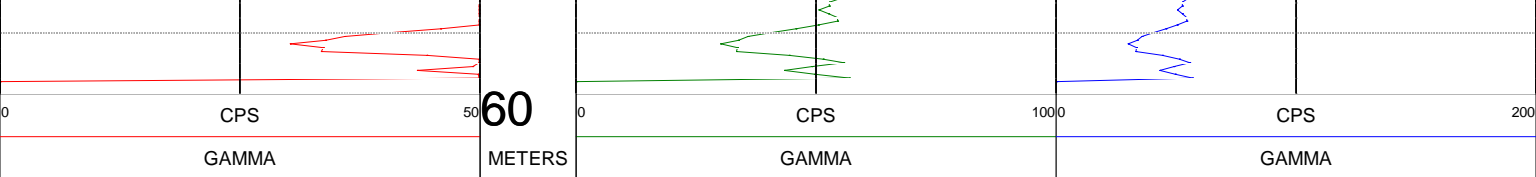
BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/17/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

HM16MEH0002

COMPANY : RTIO
WELL : HM16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:

PEG#
16MEH
_M02

TOWNSHIP : RANGE :

DATE : 03/04/16
DEPTH DRILLER : 77
LOG BOTTOM : 43.40
LOG TOP : -0.10

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

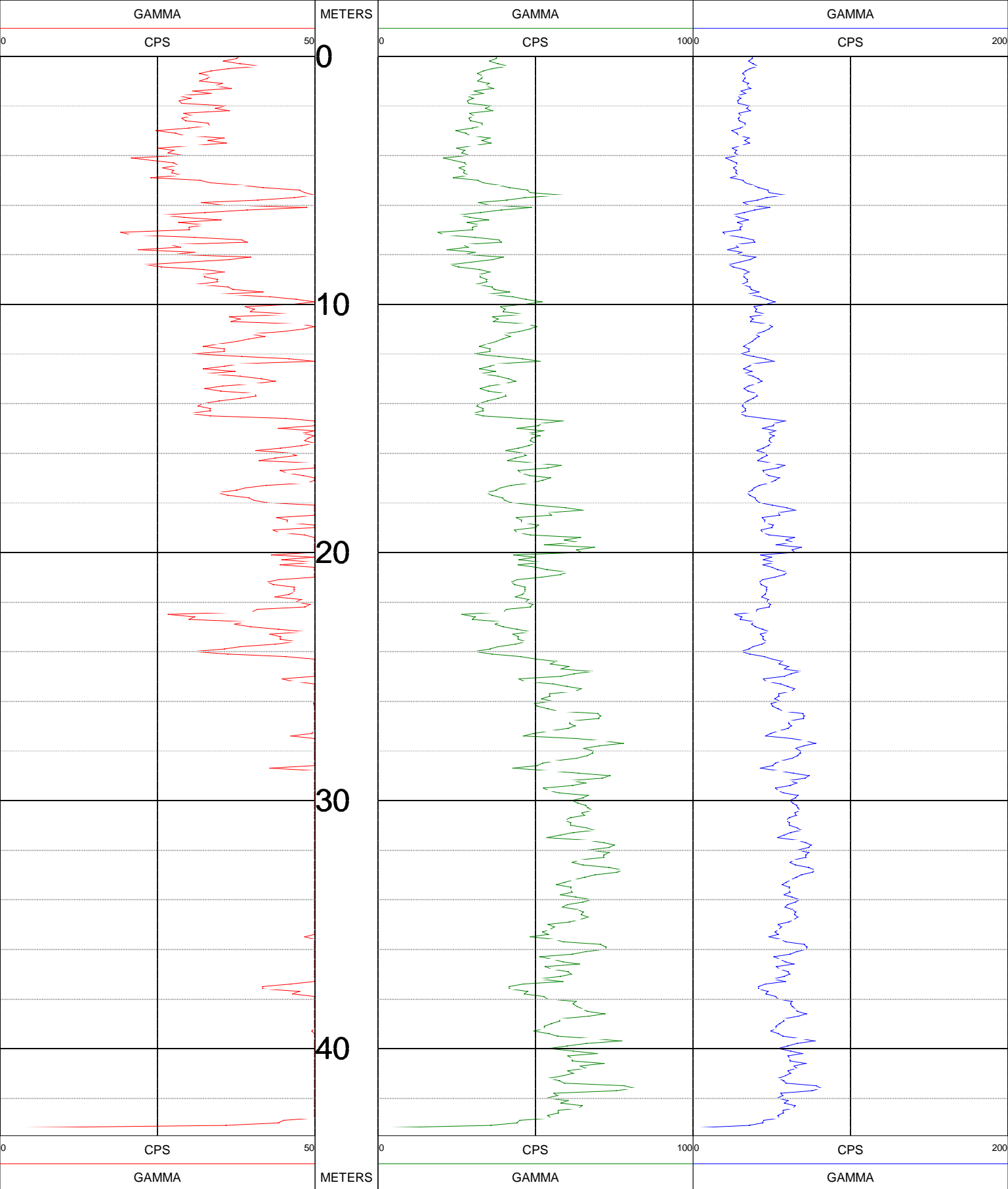
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 03/04/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





WIRELINE SERVICES

HM16MEH0003

COMPANY : RTIO
WELL : HM16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:
16MEH
_M14

TOWNSHIP : RANGE :

DATE : 02/18/16
DEPTH DRILLER : 77
LOG BOTTOM : 76.60
LOG TOP : 0.80

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

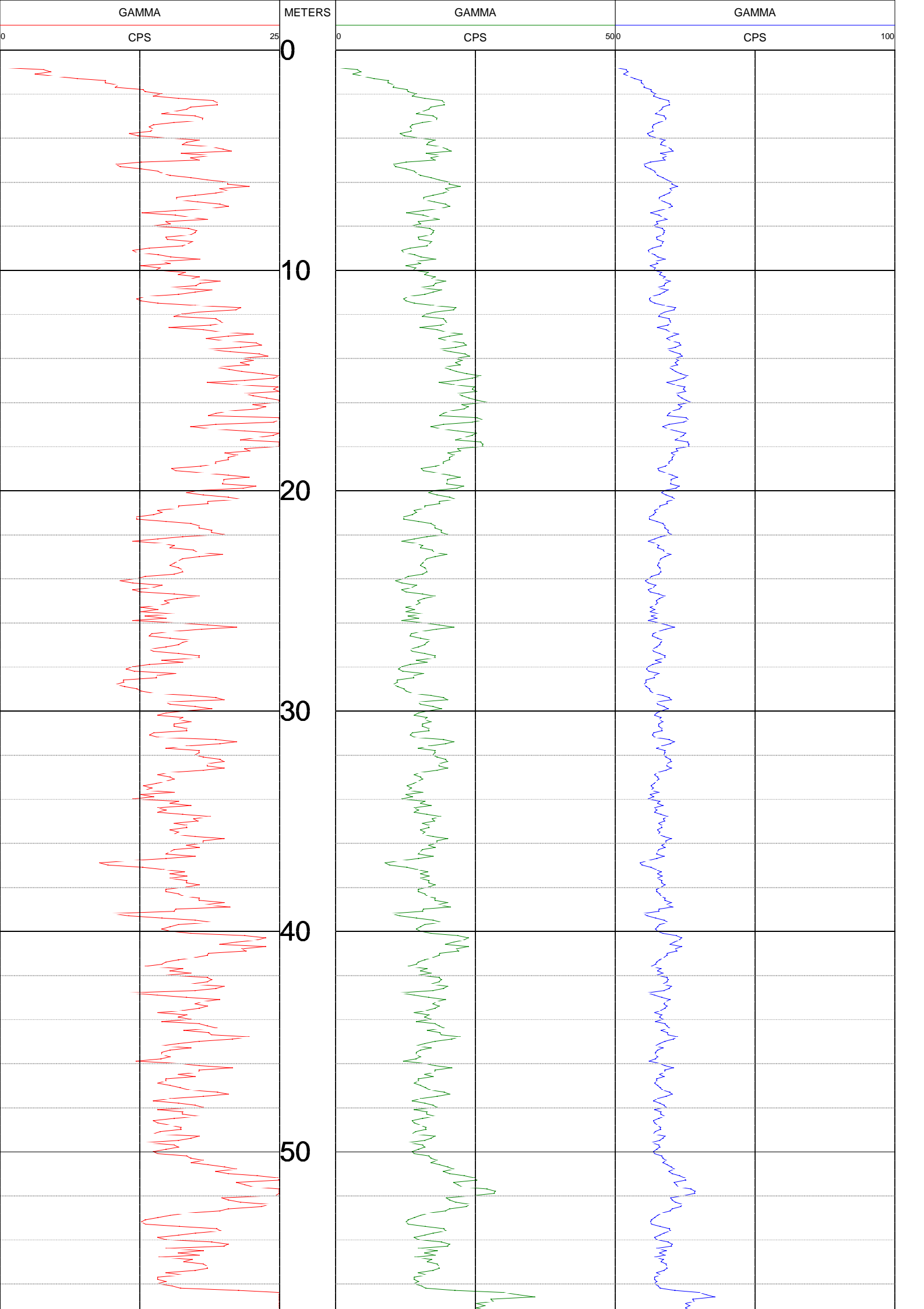
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

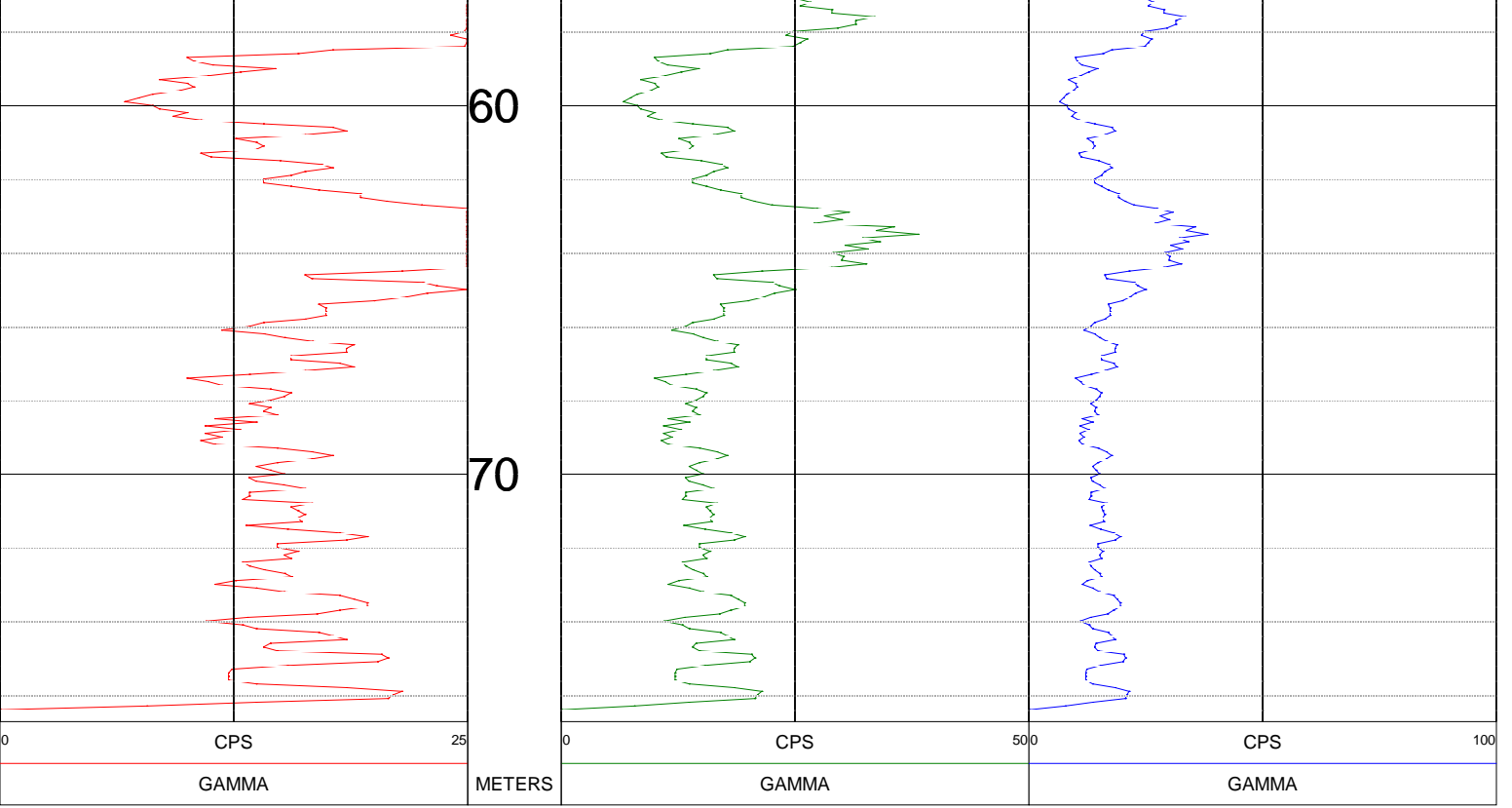
BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9060C
LGDATE: 02/18/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

MB16MEH0001

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:
PEG#
16MEH_
M16

TOWNSHIP : RANGE :

DATE : 02/10/16
DEPTH DRILLER : 64
LOG BOTTOM : 63.20
LOG TOP : -0.30

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

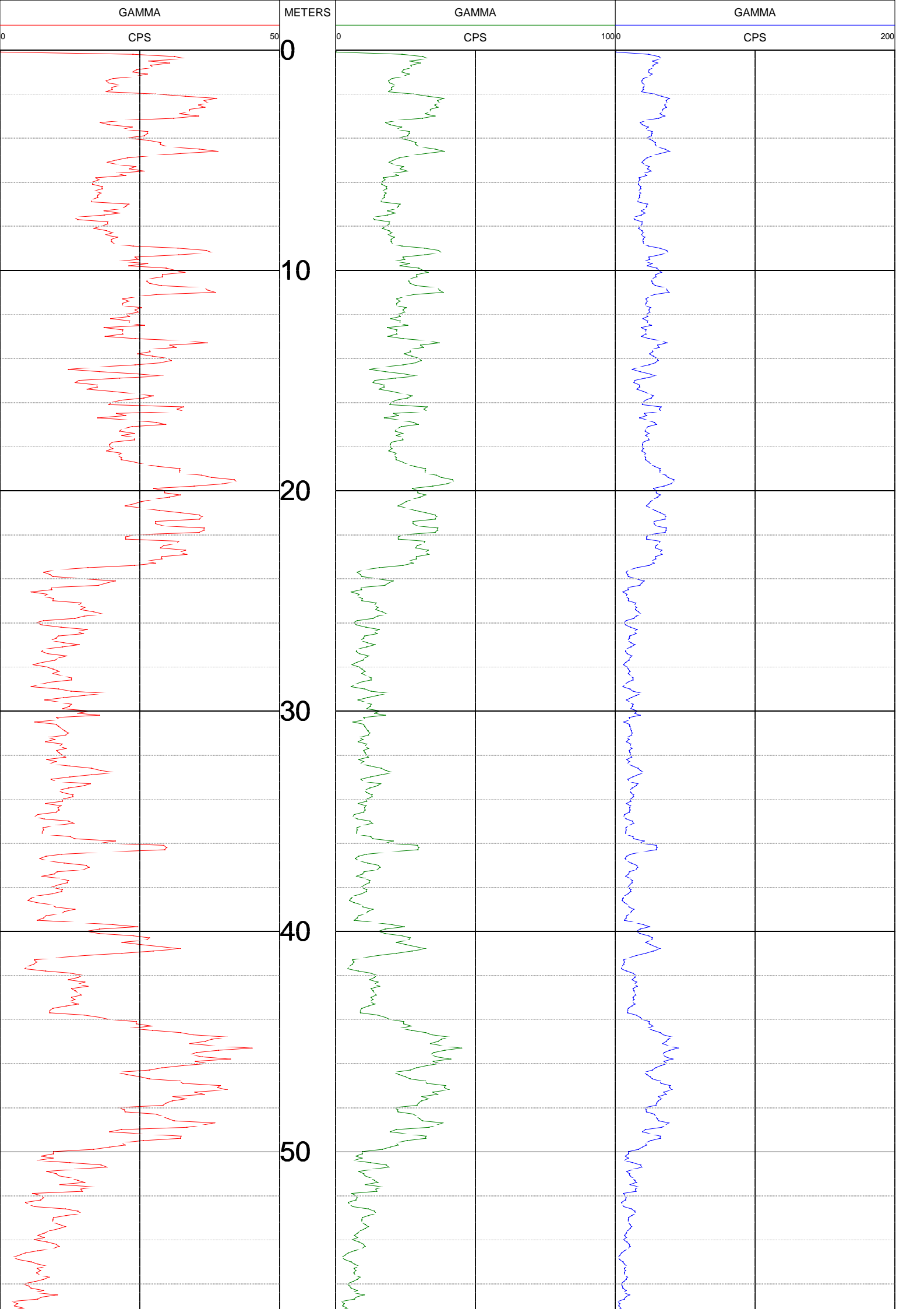
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : DP

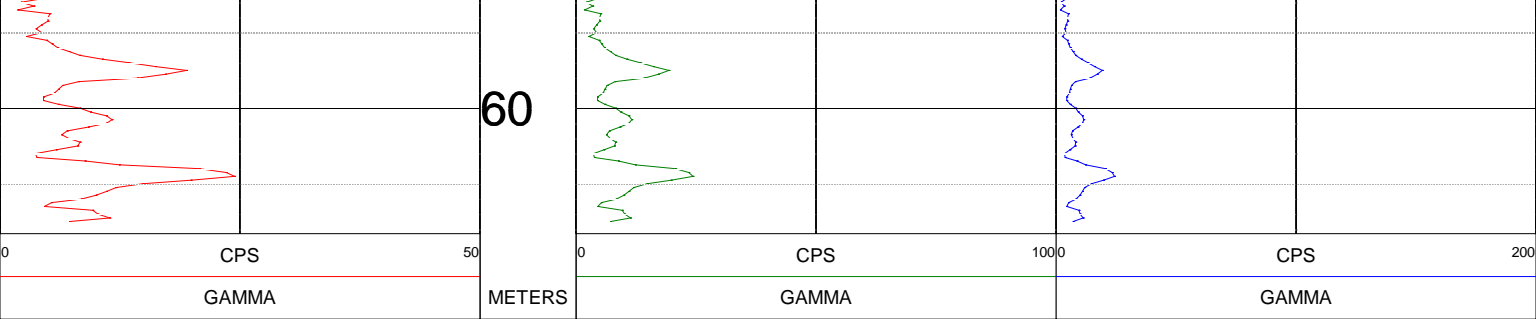
BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : PROCESSED
TYPE : 9012C
LGDATE: 02/10/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

MB16MEH0002

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:
16MEH_
M08

TOWNSHIP : RANGE :

DATE : 02/12/16
DEPTH DRILLER : 80
LOG BOTTOM : 56.00
LOG TOP : 0.50

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

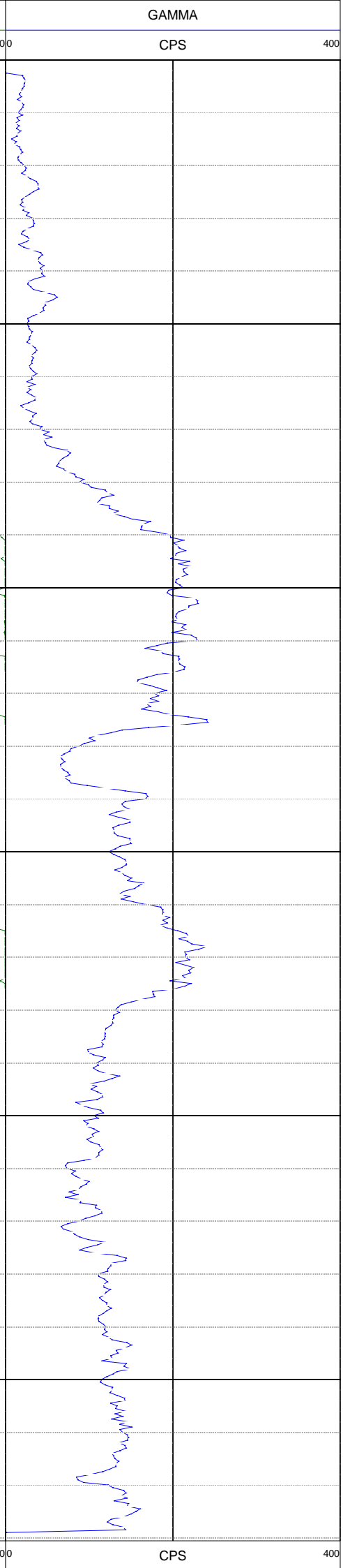
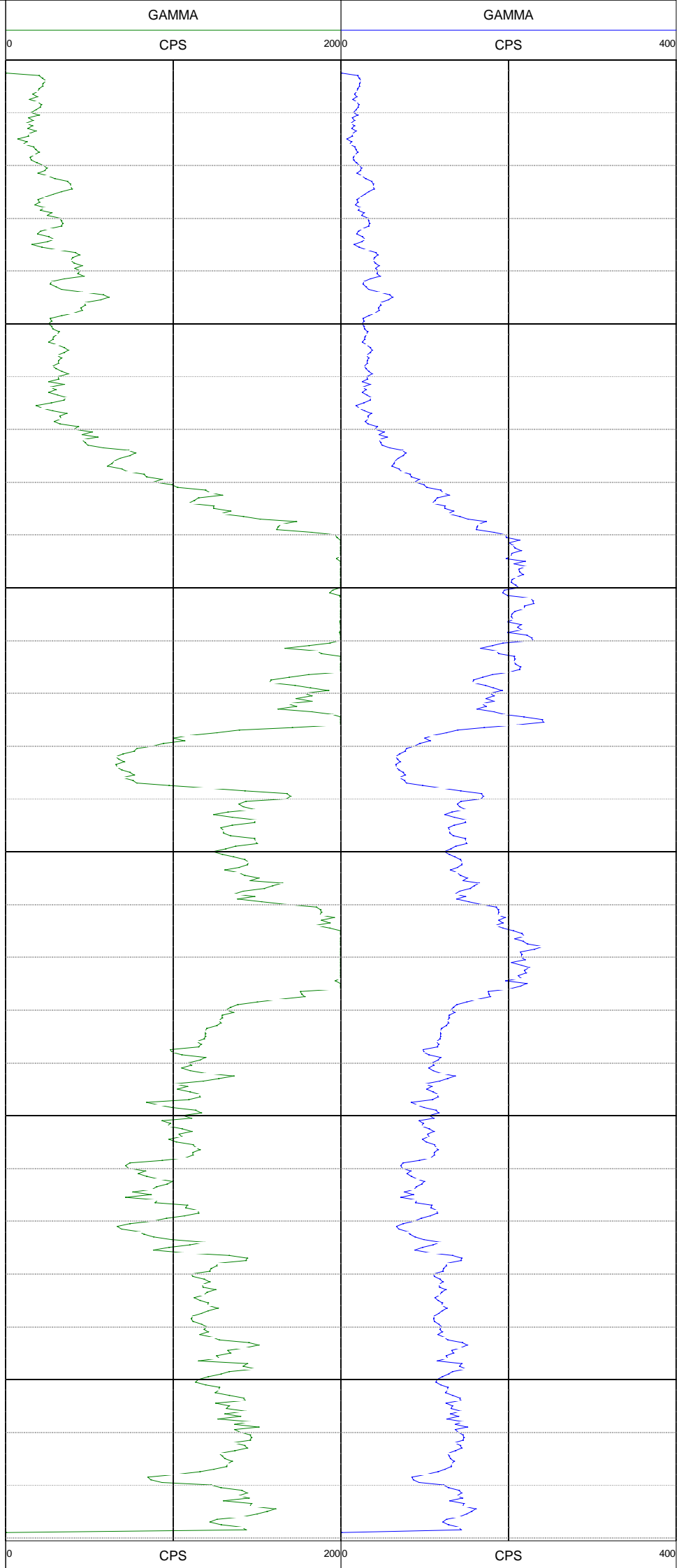
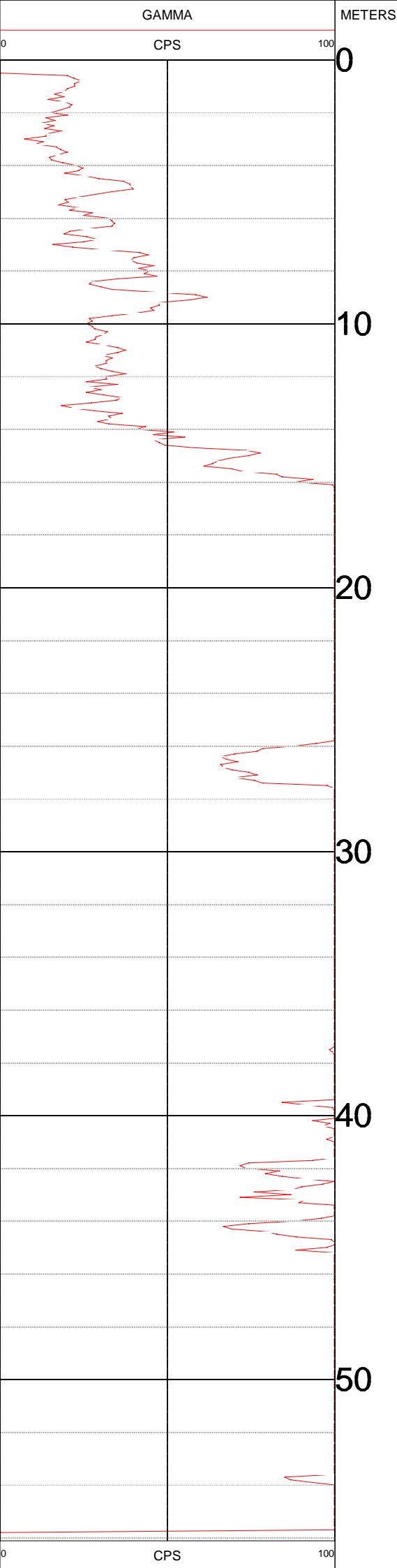
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/12/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



GAMMA	METERS	GAMMA	GAMMA
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WIRELINE SERVICES

MB16MEH0003

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M07

TOWNSHIP : RANGE :

DATE : 02/15/16
DEPTH DRILLER : 84
LOG BOTTOM : 66.00
LOG TOP : 0.20

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

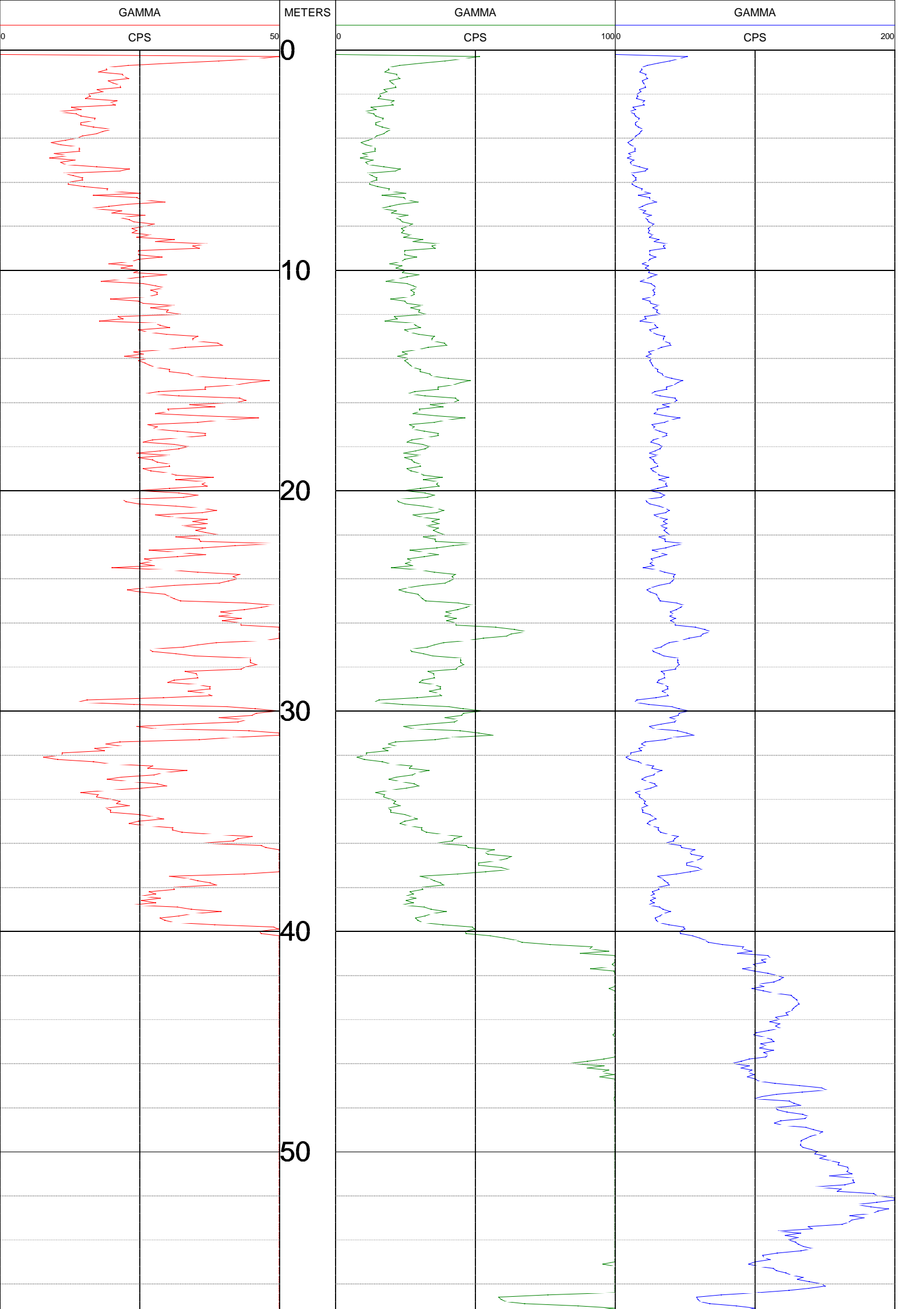
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

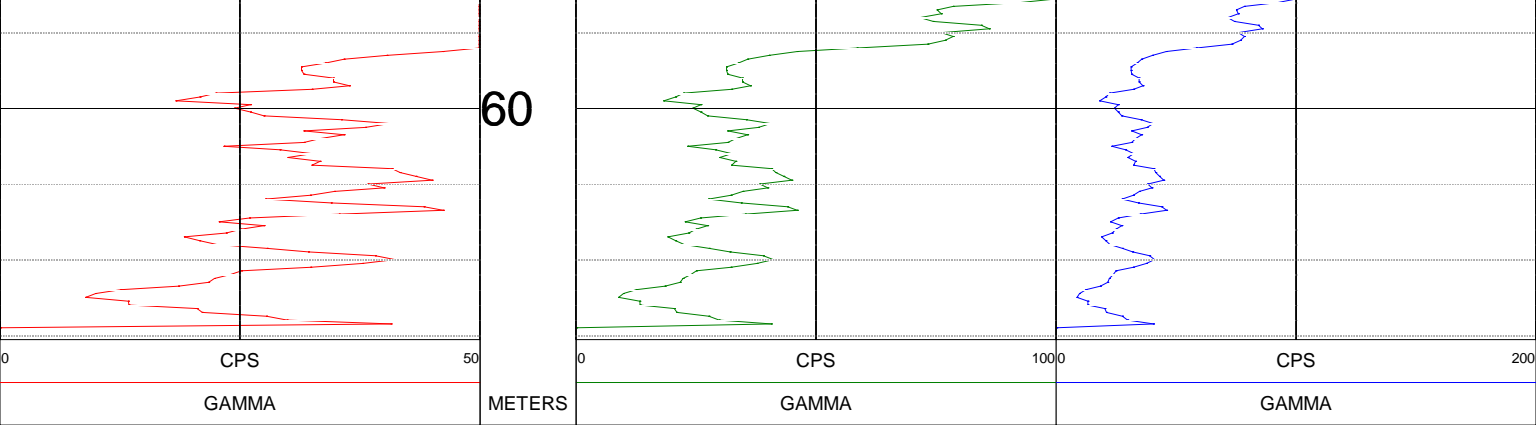
BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/15/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

MB16MEH0003

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:
16MEH
_M07

TOWNSHIP : RANGE :

DATE : 02/13/16
DEPTH DRILLER : 84
LOG BOTTOM : 65.40
LOG TOP : 0.20

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : IROD
CASING THICKNESS:

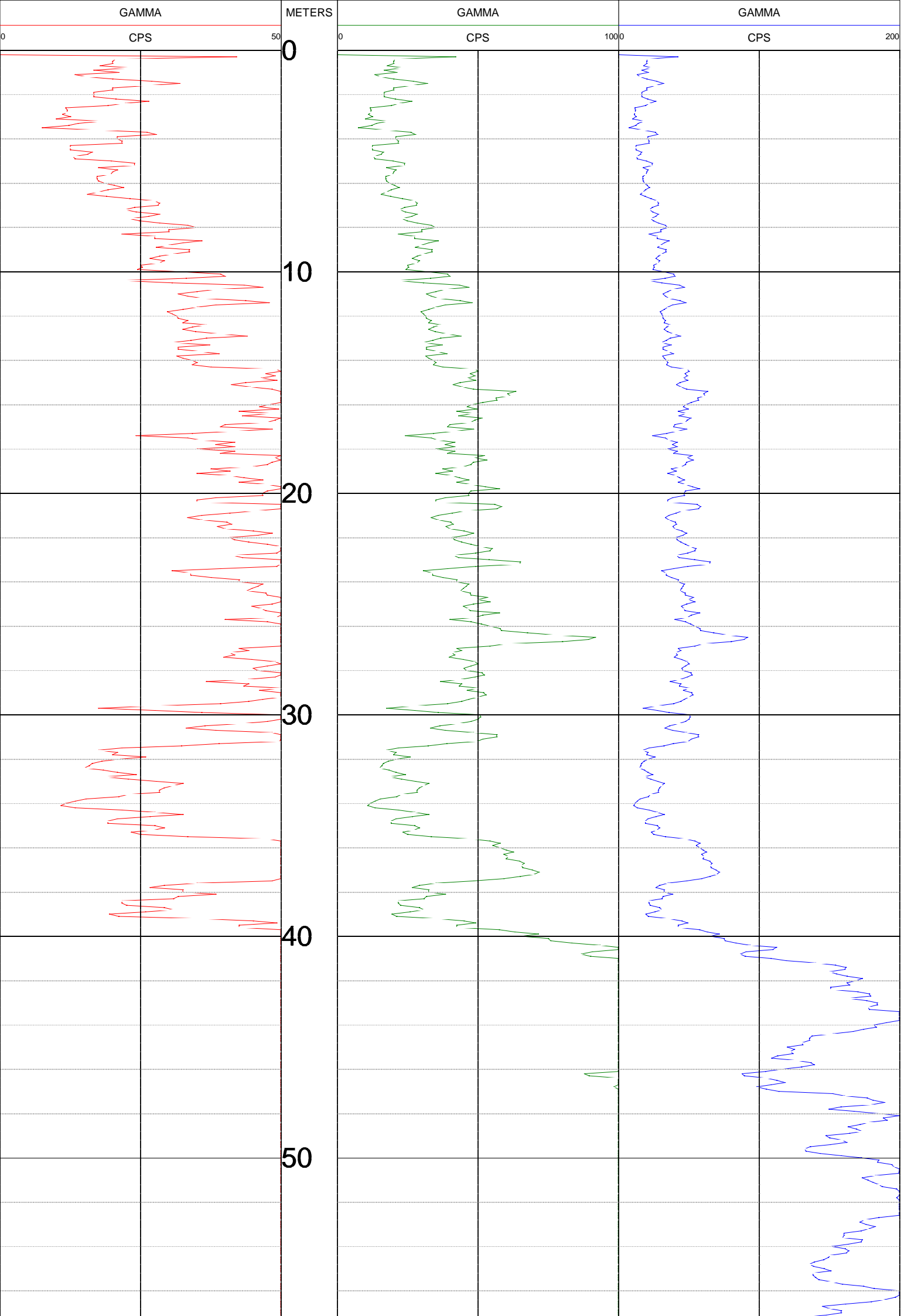
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

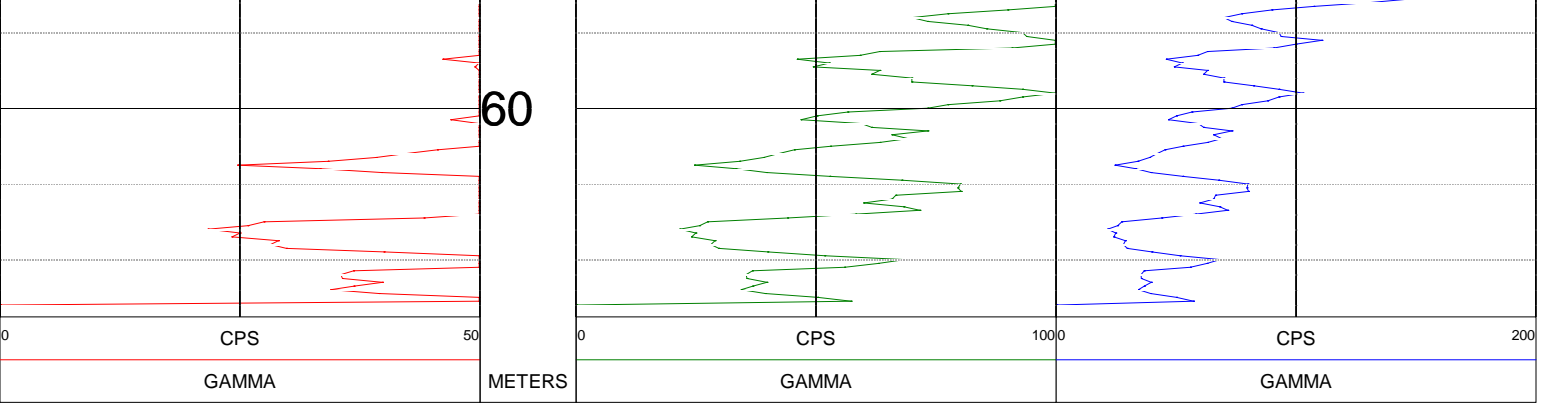
BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/13/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

MB16MEH0008

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M06

TOWNSHIP : RANGE :

DATE : 02/17/16
DEPTH DRILLER : 58
LOG BOTTOM : 40.00
LOG TOP : 0.00

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

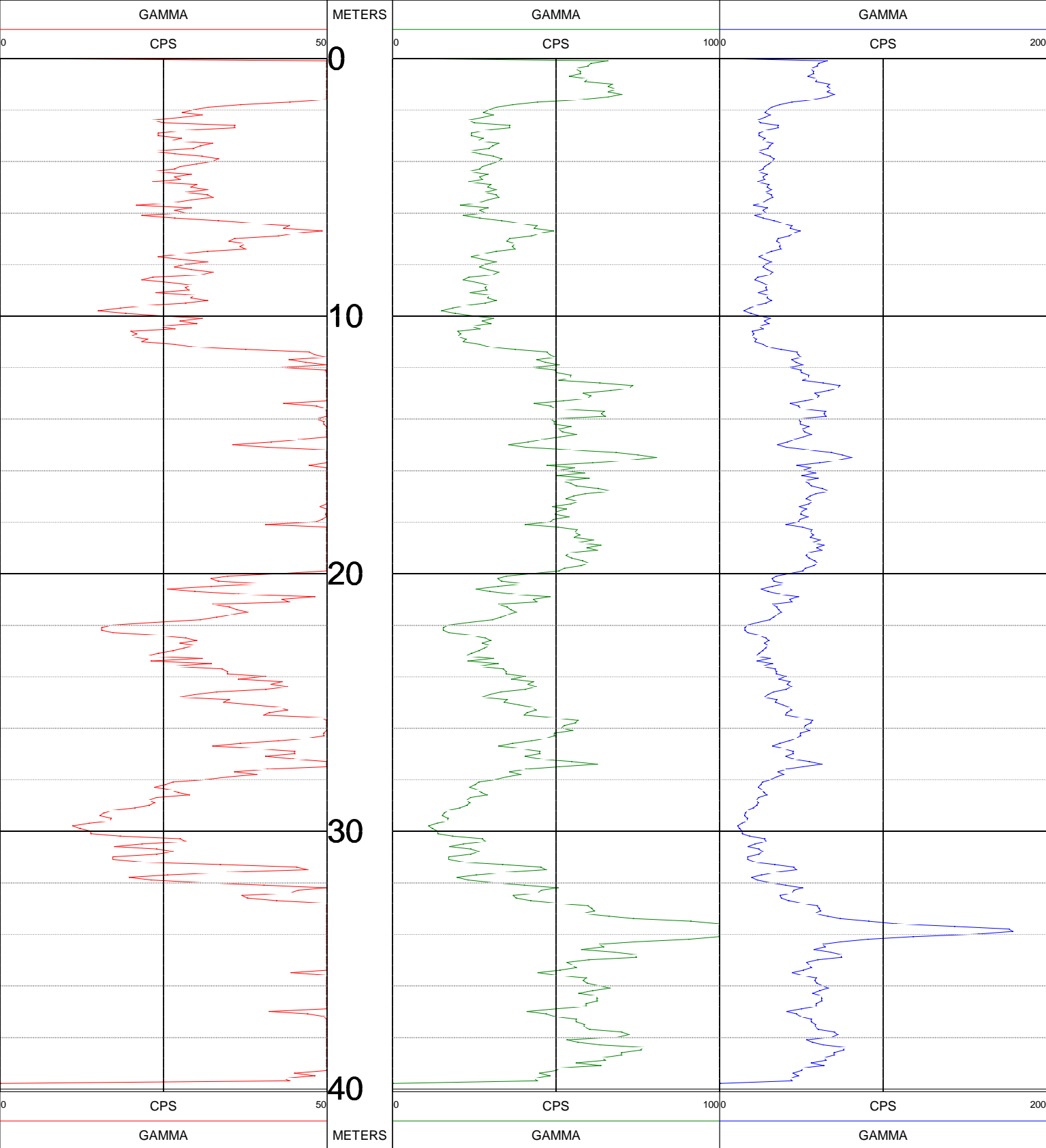
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/17/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





WIRELINE SERVICES

MB16MEH0008

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M06

TOWNSHIP : RANGE :

DATE : 02/15/16
DEPTH DRILLER : 58
LOG BOTTOM : 55.80
LOG TOP : 0.00

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : RODS
CASING THICKNESS:

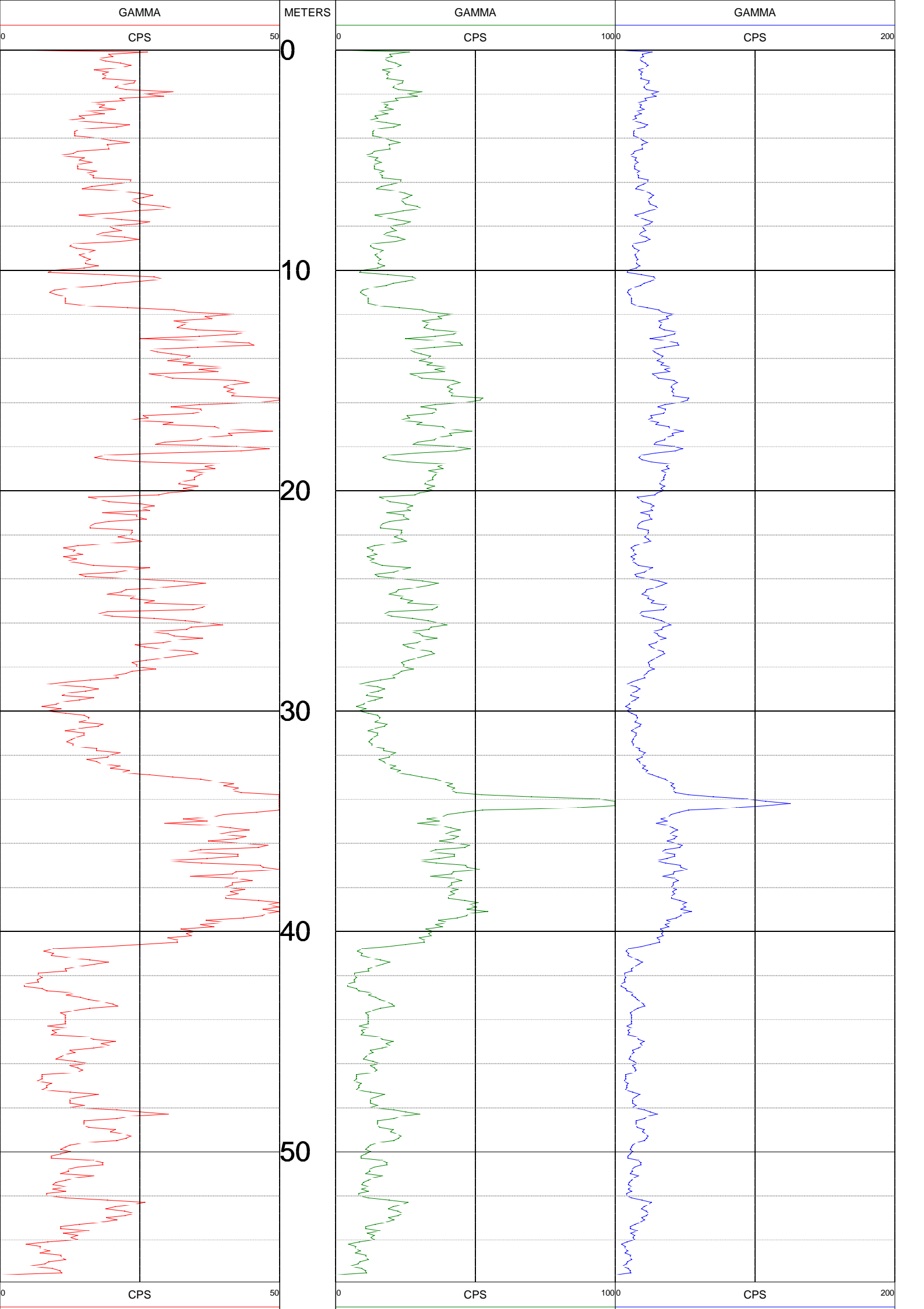
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/15/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



GAMMA	METERS	GAMMA	GAMMA
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WIRELINE SERVICES

MB16MEH0009

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:
PEG#
16MEH
_M09

TOWNSHIP : RANGE :

DATE : 03/03/16
DEPTH DRILLER : 52
LOG BOTTOM : 51.20
LOG TOP : 0.20

PERMANENT DATUM : GL
LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

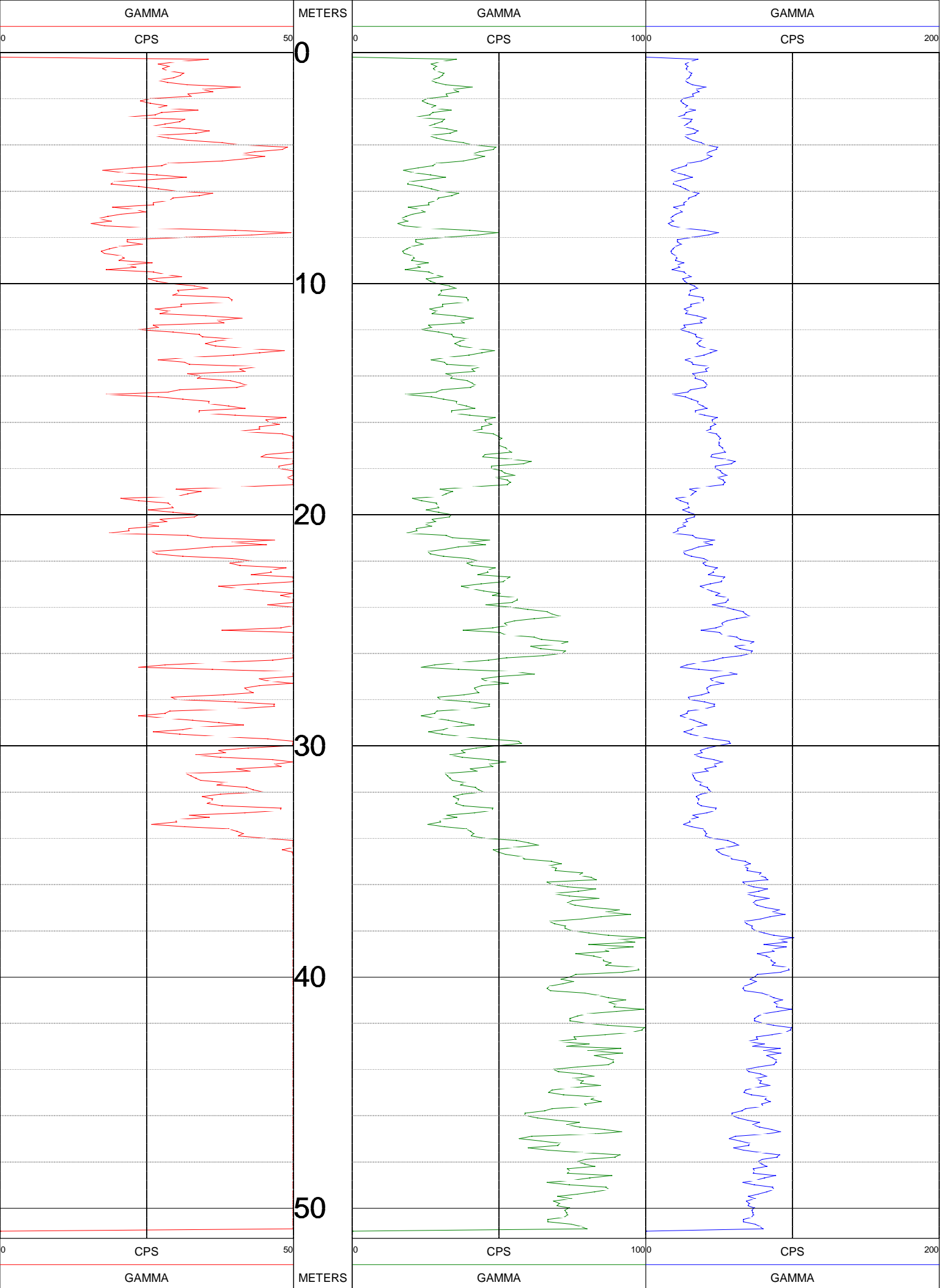
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 03/03/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





WIRELINE SERVICES

MB16MEH0009

COMPANY : RTIO
WELL : MB16MEH000
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M09

TOWNSHIP : RANGE :

DATE : 02/17/16
DEPTH DRILLER : 52
LOG BOTTOM : 51.20
LOG TOP : 0.00

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : RODS
CASING THICKNESS:

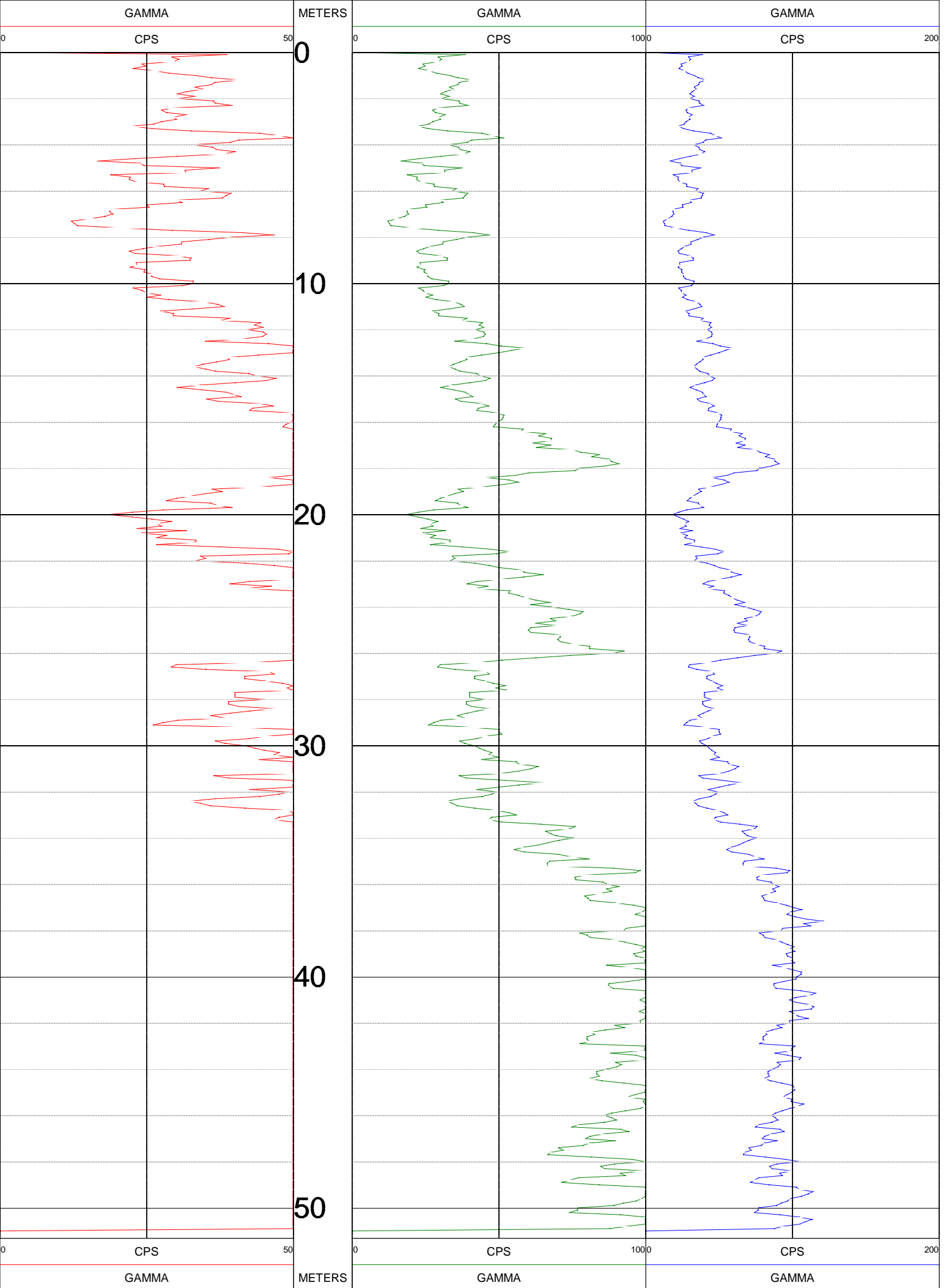
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/17/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





WIRELINE SERVICES

MB16MEH0012

COMPANY : RTIO
WELL : MB16MEH001
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M01

TOWNSHIP : RANGE :

DATE : 02/22/16
DEPTH DRILLER : 49
LOG BOTTOM : 46.70
LOG TOP : 0.40

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

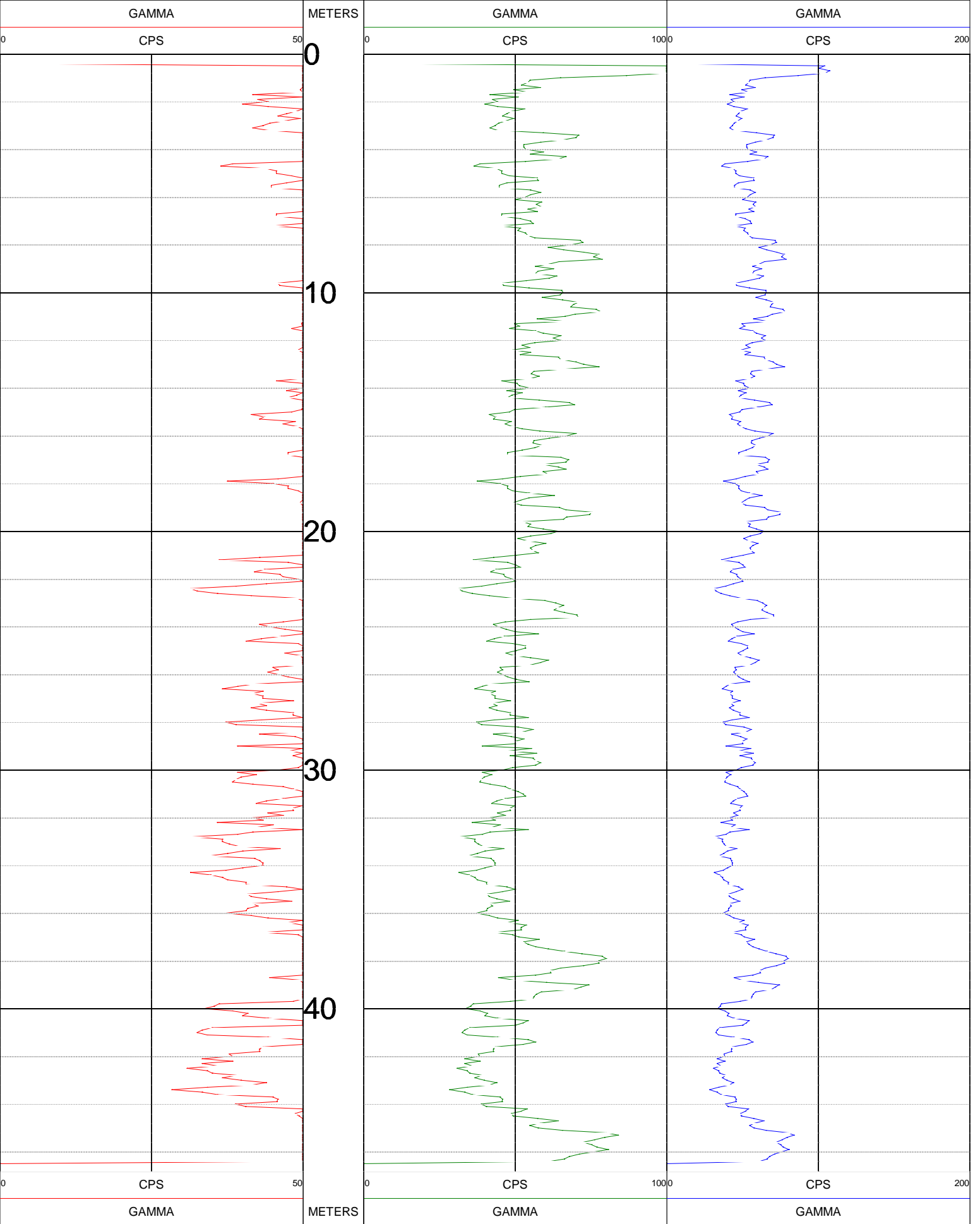
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/22/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS





WIRELINE SERVICES

MB16MEH0013

COMPANY : RTIO
WELL : MB16MEH001
LOCATION/FIELD : MEH
COUNTY : MEGDC0202
LOCATION : MEH
SECTION :

OTHER SERVICES:

PEG#
16MEH
_M04

TOWNSHIP : RANGE :

DATE : 03/03/16
DEPTH DRILLER : 76
LOG BOTTOM : 74.90
LOG TOP : 0.20

PERMANENT DATUM : GL

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

KB :
DF :
GL :

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

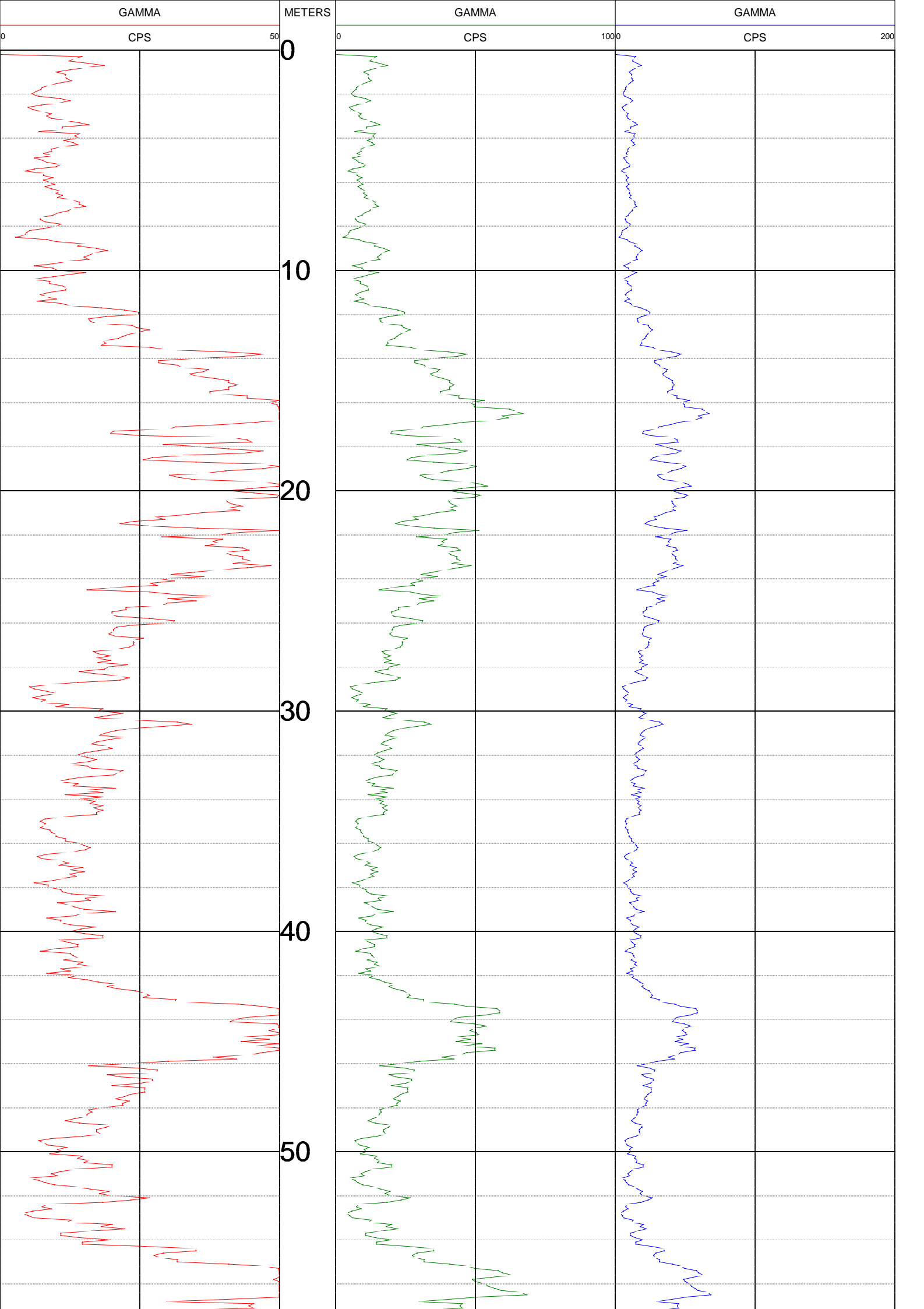
LOGGING UNIT : SV10
FIELD OFFICE : SURTRON
RECORDED BY : CJ

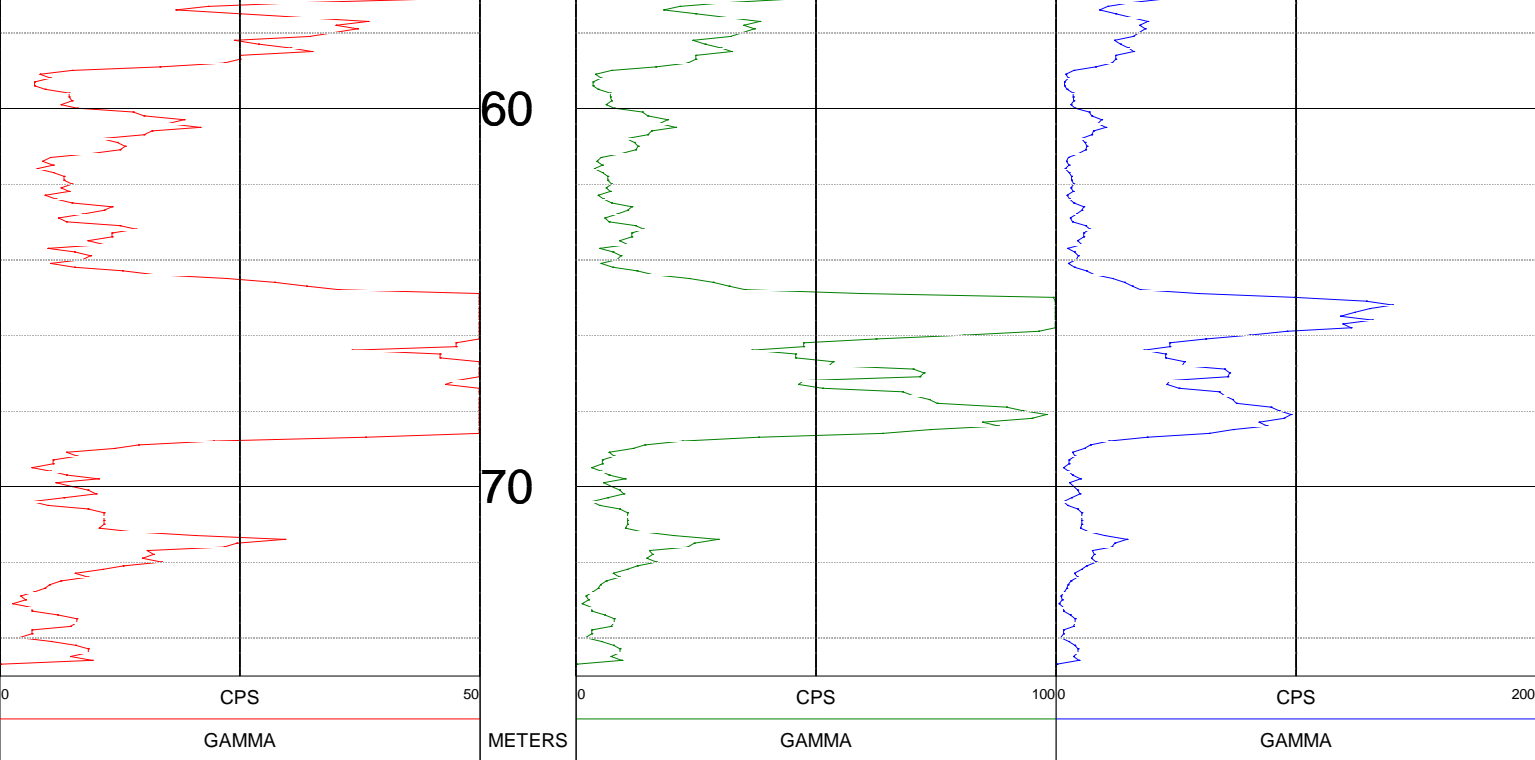
BIT SIZE : 31
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 03/03/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

MB16MEH0013

COMPANY : RTIO
WELL : MB16MEH001
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M04

TOWNSHIP : RANGE :

DATE : 02/22/16
DEPTH DRILLER : 76
LOG BOTTOM : 74.00
LOG TOP : 0.70

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : RODS
CASING THICKNESS:

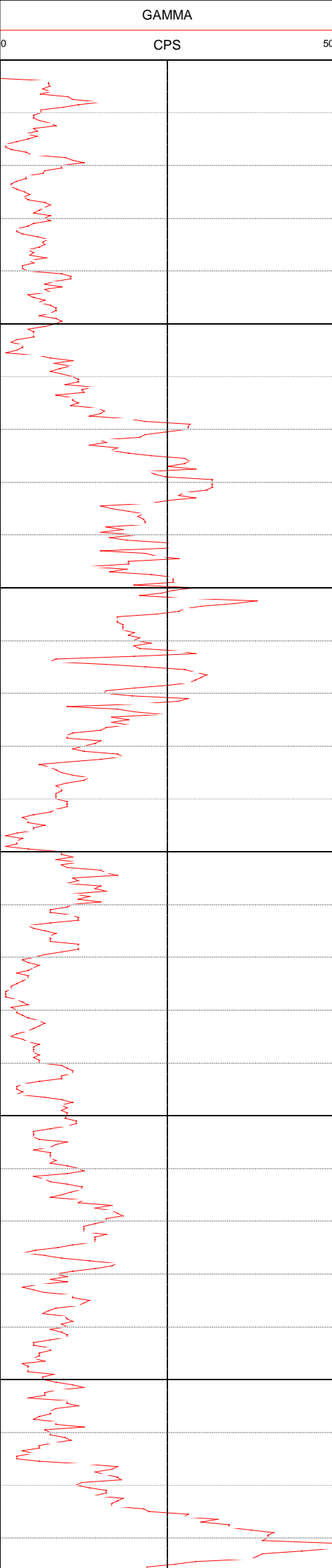
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/22/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



METERS

0

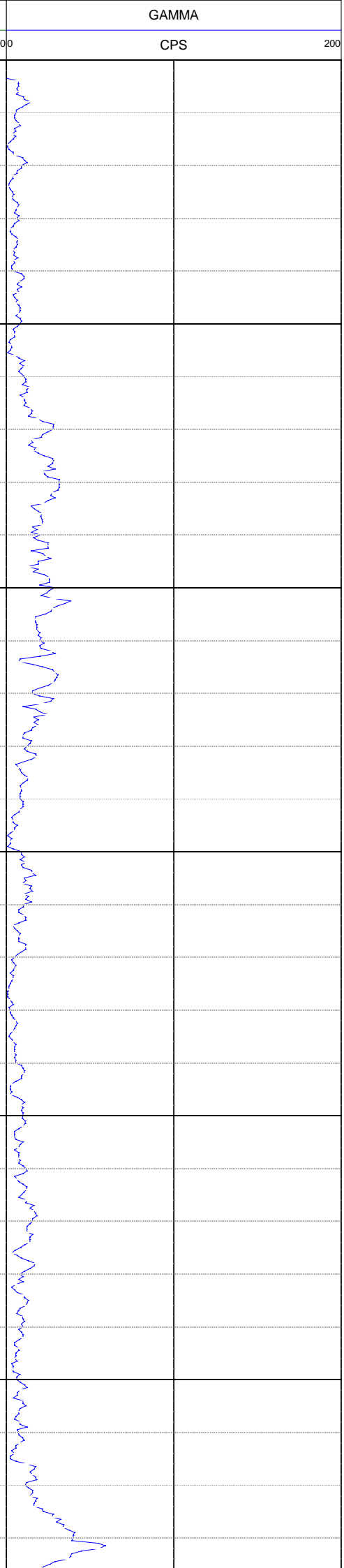
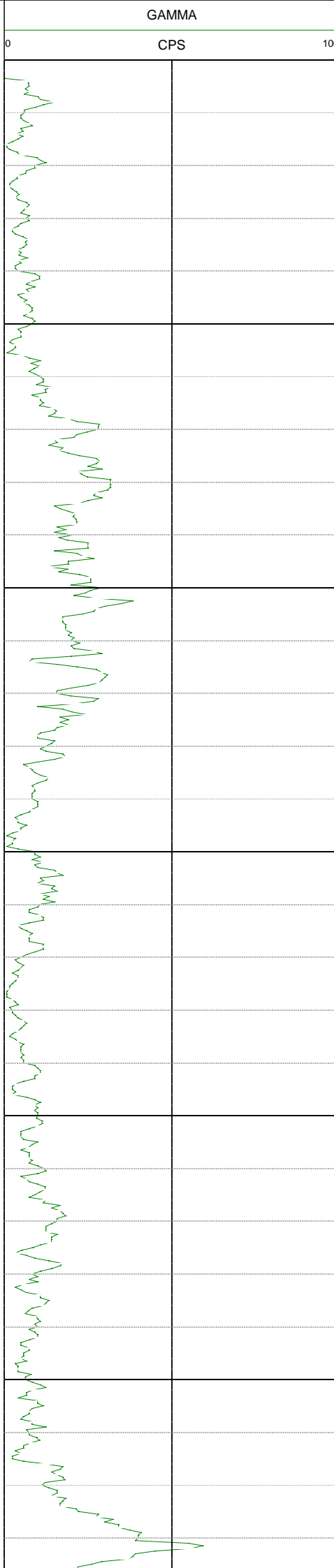
10

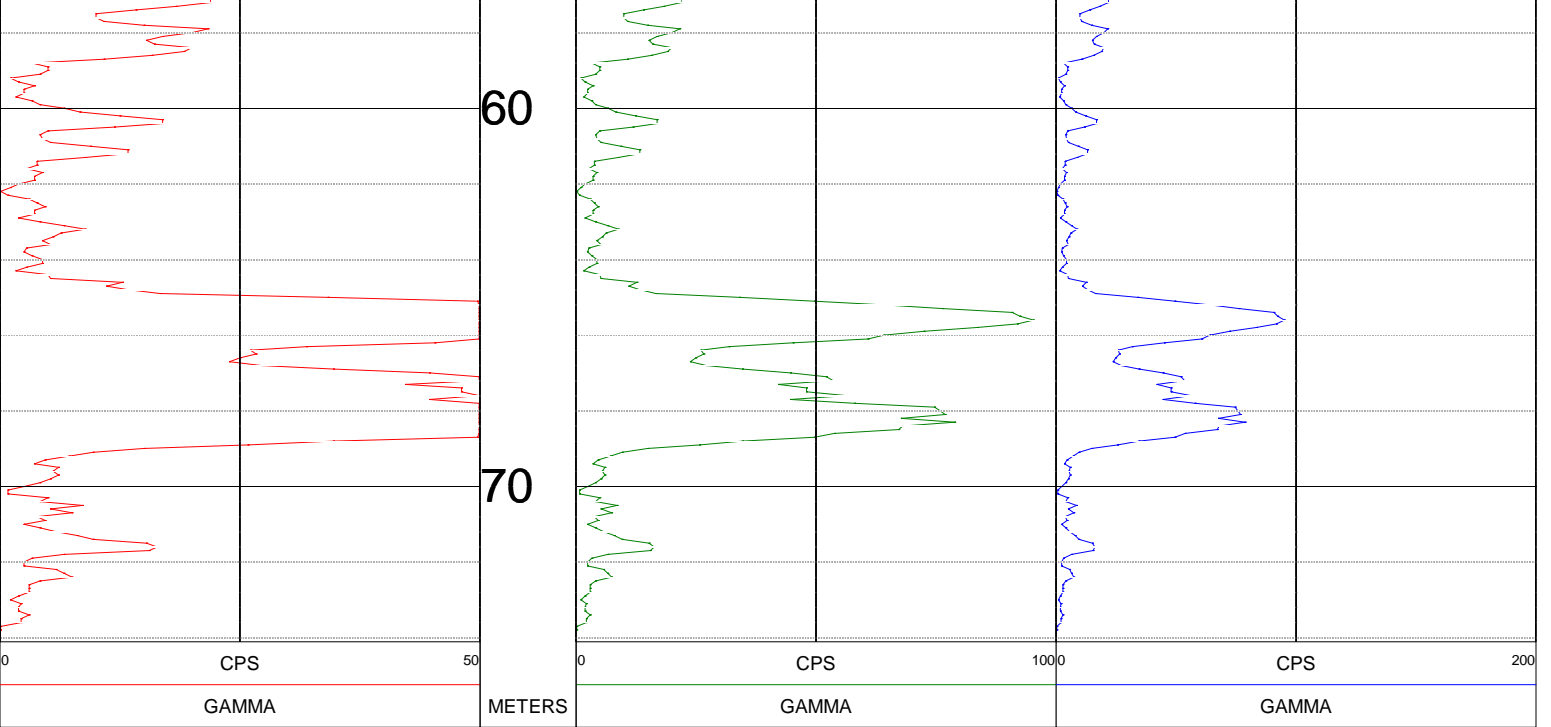
20

30

40

50







WIRELINE SERVICES

MB16MEH0014

COMPANY : RTIO
WELL : MB16MEH001
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M11

TOWNSHIP : RANGE :

DATE : 02/20/16
DEPTH DRILLER : 60
LOG BOTTOM : 58.90
LOG TOP : 0.30

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS:

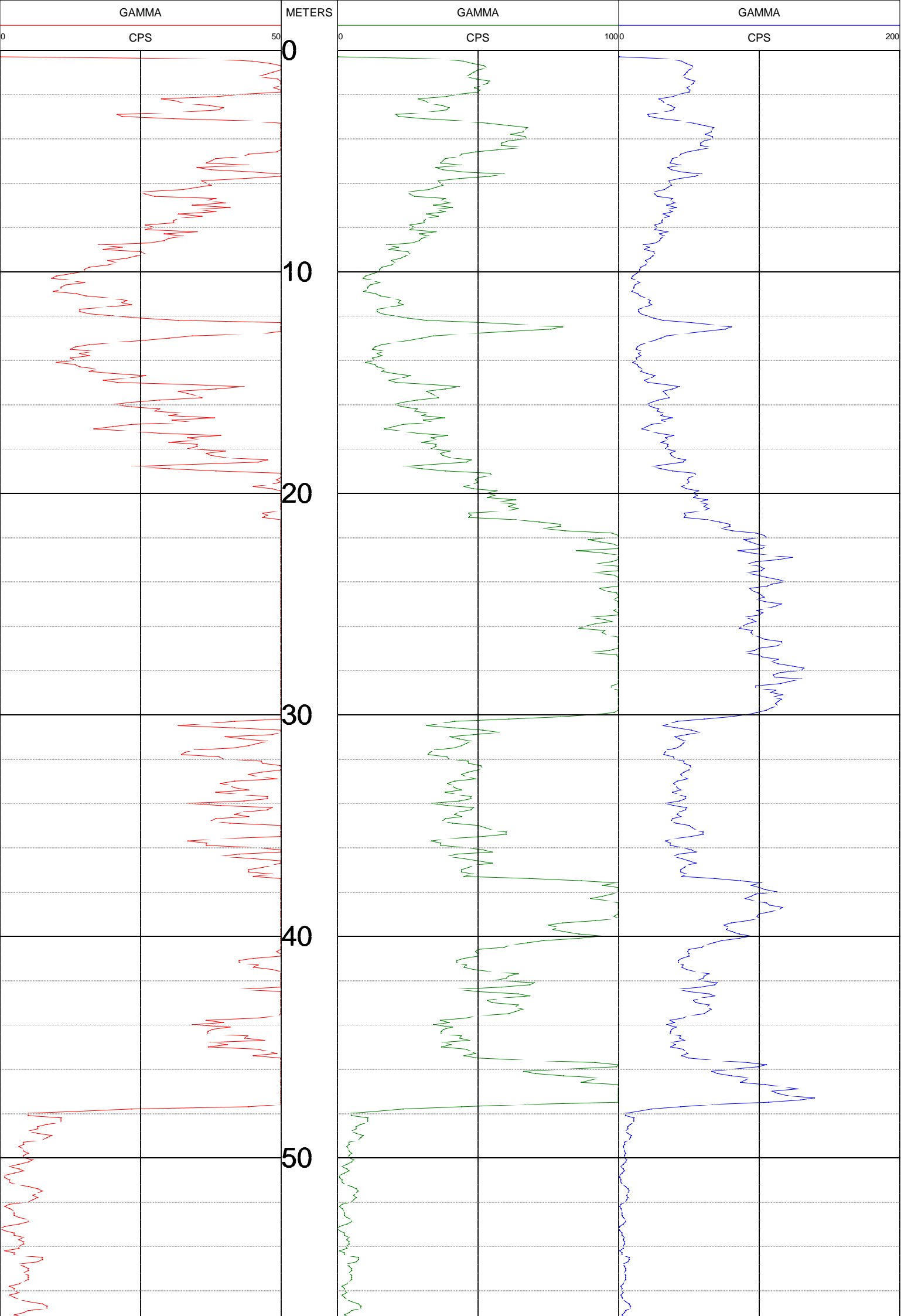
LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

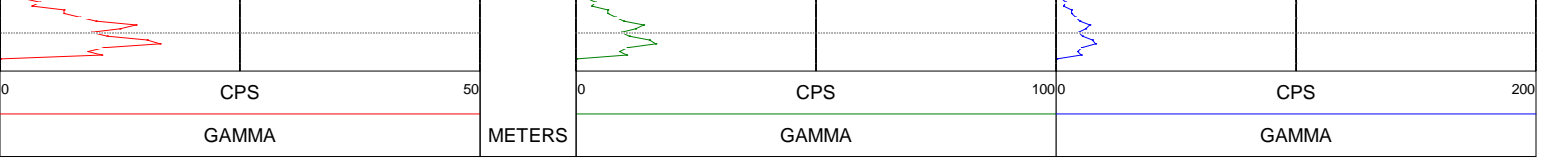
BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : ORIGINAL
TYPE : 9012C
LGDATE: 02/20/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







WIRELINE SERVICES

MB16MEH0014

COMPANY : RTIO
WELL : MB16MEH001
LOCATION/FIELD :
COUNTY : MEGDC0202
LOCATION : MEH
SECTION : MEH

OTHER SERVICES:

16MEH
_M11

TOWNSHIP : RANGE :

DATE : 02/18/16
DEPTH DRILLER : 52
LOG BOTTOM : 49.80
LOG TOP : 0.70

PERMANENT DATUM : GL

KB :
DF :
GL :

LOG MEASURED FROM: GL
DRL MEASURED FROM: GL

CASING DIAMETER : 10.
CASING TYPE : RODS
CASING THICKNESS:

LOGGING UNIT : SV25
FIELD OFFICE : SURTRON
RECORDED BY : CJ

BIT SIZE : 12.5
MAGNETIC DECL. : 1.438
MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

BOREHOLE FLUID :
RM :
RM TEMPERATURE :
MATRIX DELTA T : 177

FILE : PROCESSED
TYPE : 9012C
LGDATE: 02/18/16
THRESH: 90000

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

