Mulka Bore decommissioning and replacement – Lake Eyre South Region

DEWNR Technical note 2016/27

Government of South Australia
Department of Environment, Water and Natural Resources

Mulka Bore decommissioning and replacement – Lake Eyre South Region

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October, 2016

DEWNR Technical note 2016/27

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- Mulka Station
- Silver City Drilling
- Owen Oil Tools

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1. Introduction

This report discusses the decommissioning of the damaged and leaking artesian Mulka Bore, and the drilling and construction of its replacement on the Mulka pastoral lease. Both wells produce water from the Algebuckina Sandstone and Cadna-owie Formation aquifers of the Great Artesian Basin (Smerdon et al., 2012; Keppel et al., 2013).

The original Mulka Bore was drilled in 1907 and has been rehabilitated several times. Recently the 80 mm diameter fibreglass casing which had been used to reline the well disintegrated at the surface resulting in the headworks breaking off. The well flowed uncontrolled for some time before being temporarily repaired.

The replacement well (Mulka Bore No. 2) was successfully drilled adjacent to the original well in April 2016, targeting the Algebuckina Sandstone aquifer. The original well was perforated adjacent the confining beds and was successfully decommissioned by cementing the well and annulus in several stages.

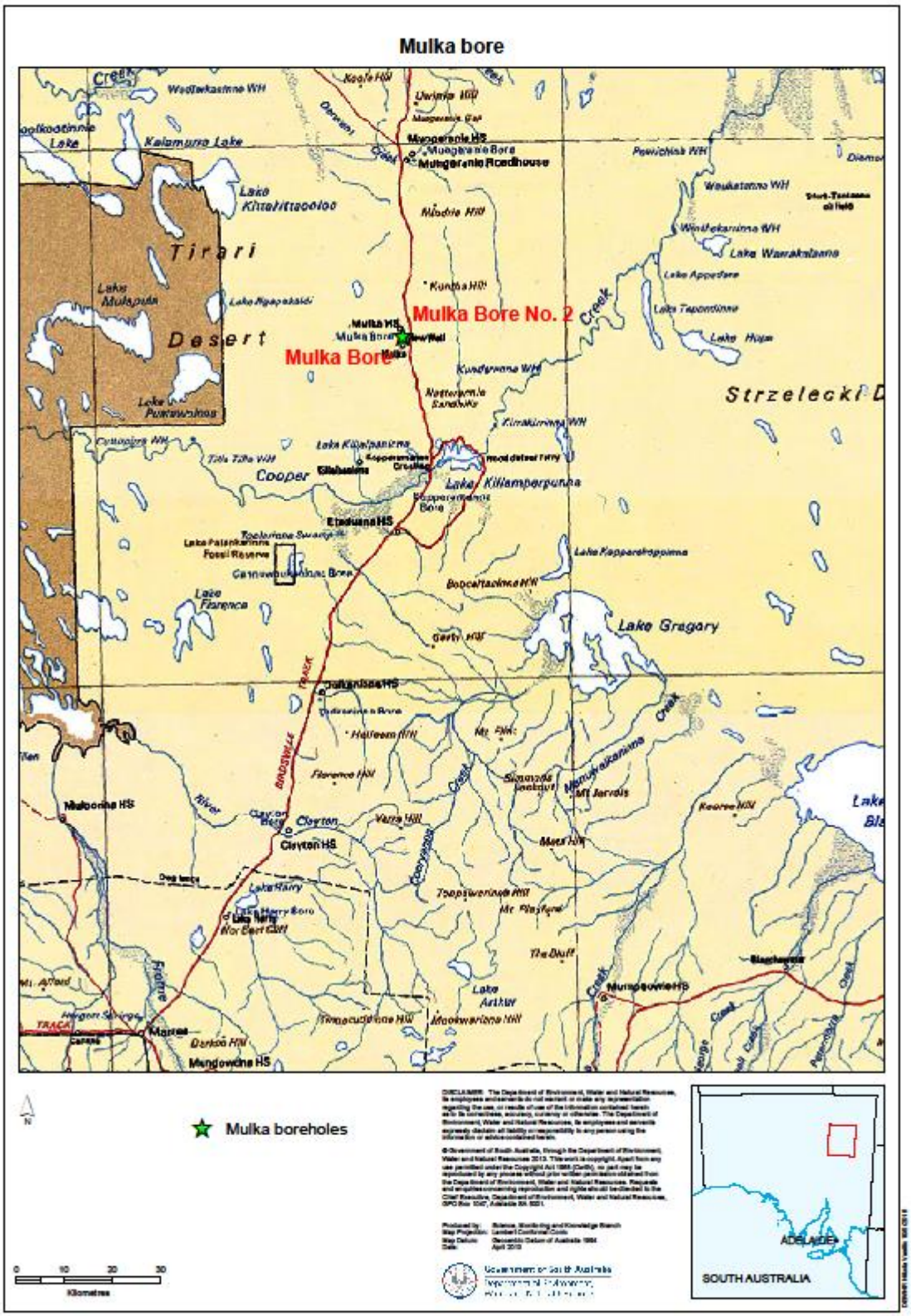

Figure 1. Location of Mulka Bore and Mulka Bore No. 2

2. Construction of Mulka Bore No. 2

2.1. Background

Mulka Bore No. 2 (Unit number 6641-15) was drilled to replace the original Mulka Bore (Unit number 6641-6).

Mulka Bore No. 2 was designed in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2012). It contains three strings of casing to ensure proper control of the water being produced from the artesian aquifer.

All three strings of casing were to be cemented from the shoe to ground level. The well was completed with an 143 mm open hole production zone in the Algebuckina Sandstone.

The well construction diagram is given in Figure 2.

2.2. Well drilling and construction

The drilling contractor, Silver City Drilling (Alice Springs, Northern Territory), used a Schramm T130XD Rotadrill carrier-mounted drill rig (54 tonne GVM) (Figure 3) with a semi-automated rod handling system (Figure 4).

The hole was drilled using the rotary mud method, with several settling pits excavated on site for the mud circulation system. Tulsa TT-560 mud pumps were used. The mud consisted of the viscosifiers LIQUI-POL and XAN-BORE, potassium chloride for clay inhibition and weighting, and barites for weighting.

Casing was manufactured by Yantai Baosteel Pipe Co., Ltd to the American Petroleum Institute (API) 5CT specification's K-55 grade, which is a standard carbon steel grade used in the petroleum industry (Figure 5).

Three strings of steel casing were used (Table 1):

- Conductor casing – buttress threaded steel casing, 326.9 mm ID, wall thickness 10.95 mm.
- Artesian control casing – buttress threaded steel casing, 225.1 mm ID, wall thickness 9.65 mm.
- Production casing – buttress threaded steel casing, 161.7 mm ID, wall thickness 8.05 mm. Casing lengths were joined with an externally fitting threaded coupling with an outside diameter of 194.46 mm.

Table 1. Casing design of Mulka Bore No. 2

Drillhole size (mm)	Casing string	Casing I.D. (mm)	Casing thick-ness (mm)	Casing O.D. (mm)	Joints	O.D. at joint (mm)	Clearance from drillhole to casing (mm)	Clearance between casing strings (mm)	
444.50	Conductor	326.90	10.95	348.80	Welded	348.80	47.85	Conductor to artesian control	41.25
312.13	Artesian control	225.10	9.65	244.40	Welded	244.40	33.87	Artesian control to production	15.32
222.95	Production	161.70	8.05	177.80	Threaded external coupling	194.46	14.25		

The well was drilled and constructed according to the following steps:

- A 444.5 mm polycrystalline diamond cutter (PDC) bit was used to drill to 12 m.
- The conductor casing string was set at 12 m and cemented by tremie line (see details below).
- A 312.13 mm PDC bit was used to drill to 106.07 m.
- The artesian control casing string was set at 104.07 m:
    - Steel 6-wing bowspring centralizers were installed every 12 m (Figure 6).
    - A drillable casing shoe with non-return valve was used.
    - The artesian control casing was pressure cemented by displacement through the shoe (see details below).
- A 222.95 mm PDC bit was used to drill to 1083 m.
- The production casing string was set at 1081.83 m:
    - Steel 4-wing bowspring centralizers were installed every 12 m (Figure 6).
    - A drillable casing shoe with non-return valve was used.
    - The production casing was pressure cemented by displacement through the shoe. Returns were not achieved and a top-up was attempted with a tremie line (see details below).
- The hole was mudded again and a 143.325 mm PDC bit was used to drill to 1112 m.
- After geophysical logging, drill rods were run to 630 m and then 850 m to displace drilling mud with water and artesian flow developed over 24 hours.
- The headworks were completed and the landowner's reticulation system from the original well was connected to the new well.

Appendix A contains further details of:

- The Drillers Well Construction Schedule 8 report.
- Details of the mud program and ingredients.
- Details of the drill bits used.

2.3. Cementing

The conductor casing was cemented using a tremie line, 46 x 20 kg bags of cement and 633 L of water. It was then topped up with 20 L of cement slurry.

On 11 April 2016 the artesian control casing was pressure cemented by displacement through the casing shoe by Silver City Drilling.

- 4387 L of 1.66 S.G. grout mix was pumped comprising:
    - 225 x 20 kg bags of cement.
    - 2955 L cool water from Mulka Bore.
- The mix was displaced through the shoe.
- Returns were observed.

- The well was left undisturbed for 24 hours to allow the grout to set.
- The Silver City Drilling report is attached in Appendix B.

On 17 April 2016 the production casing was pressure cemented by displacement with water through the casing shoe, by the contractor Wellpro (Roma, Queensland):

- 1590 L of water was pumped as a preflush spacer.
- 26,235 L (calculated to exceed the nominal annular volume by 60%) of 1.69 S.G. grout mix was pumped over 1 hour comprising:
    - 26866 kg Class A cement.
    - 17731 L water (from Pandi Pandi Bore).
    - 4% Bentonite.
    - 0.82% Retarder FR-3.
    - 0.275% Dispersant NC-S-1.
    - 0.2% Defoamer 7011D.
- 23,373 L of water was pumped to displace the grout through the casing shoe.
- Returns were not observed.
- The well was left undisturbed to allow the grout to set.
- The Wellpro report is attached in Appendix B.

Interpretation of cement bond logs run at setting times of 16 and 33 hours indicated the top of cement was at 188 m.

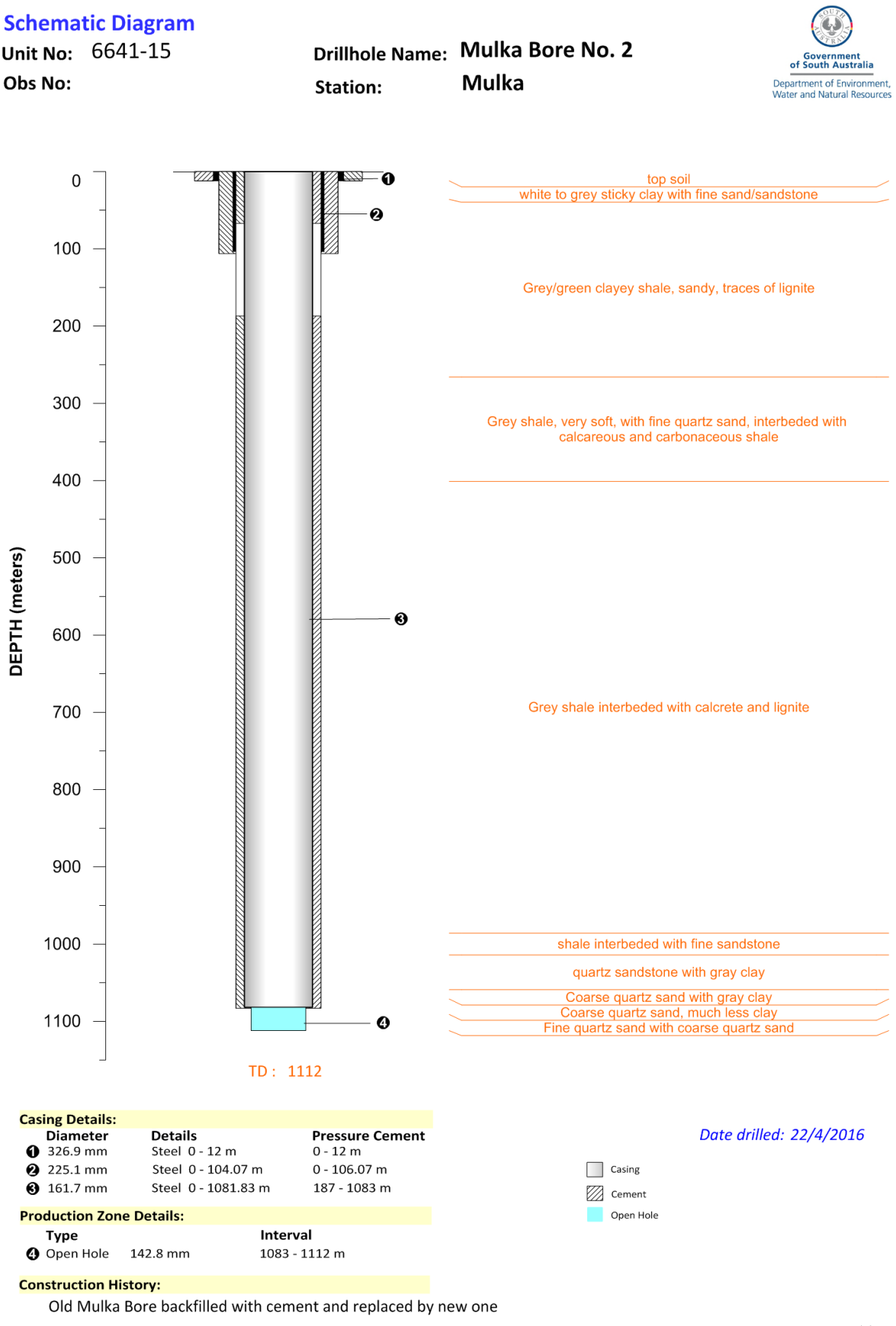

Figure 2. Construction of Mulka Bore No. 2

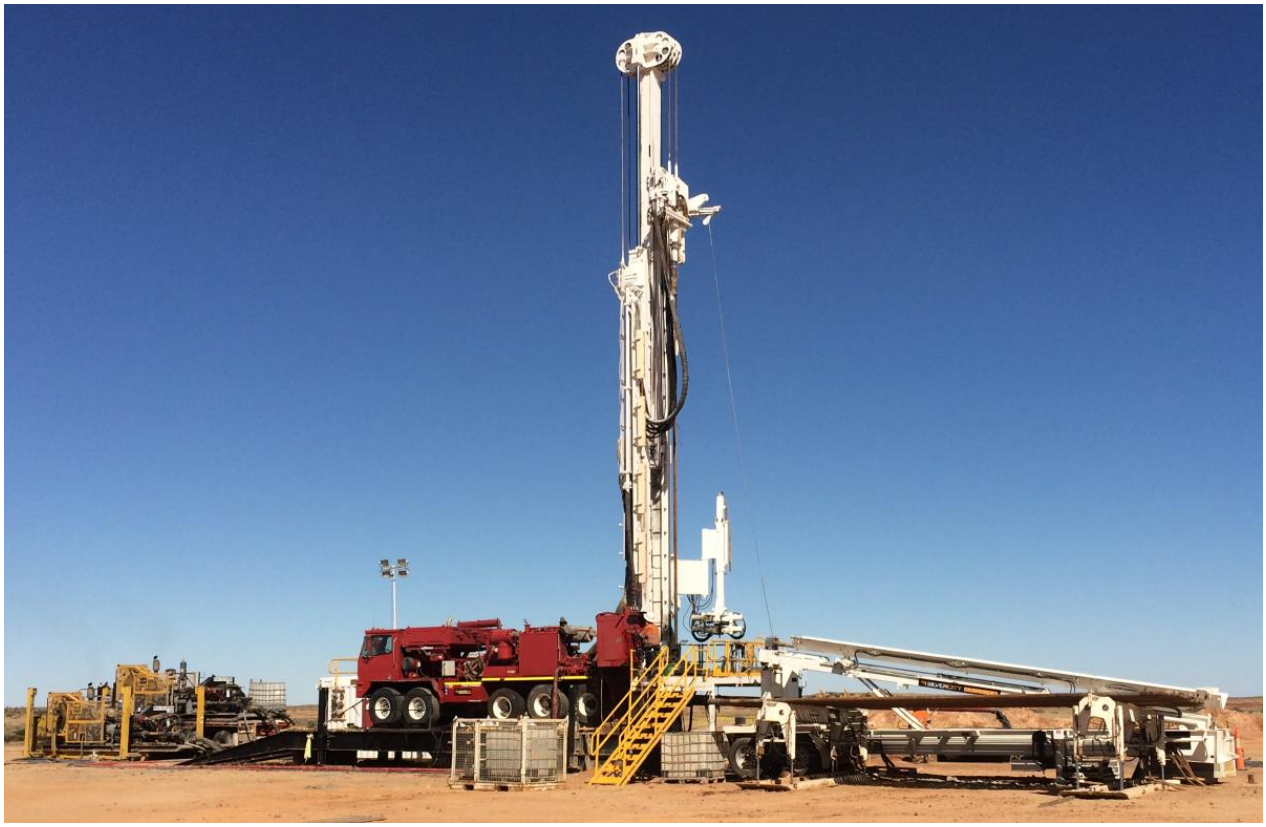

Figure 3. Drilling rig used at Mulka Bore No. 2

Figure 4. Rod loading, blooey line and mud system used for Mulka Bore No. 2

Figure 5. Tags from artesian control and production casing

Figure 6. Centralizers used for artesian control casing (left) and production casing (right)

2.4. Geophysical logging

Downhole geophysical logs were run on four occasions:

1. On 16 April 2016 the open hole was logged with a caliper and temperature probe. The logging equipment then failed due to an electrical fault. After repeated attempts at running further surveys to determine exact lithological boundaries, logging was abandoned after continued electrical problems.
2. On 18 April 2016 the production casing was logged with a cement bond probe 16 hours after the cementing operation. The grout mix samples were not set at this stage, but the log was run to determine the extent to which sample setting affected the log interpretation.
3. On 19 April 2016 the production casing was logged again with a cement bond probe, 33 hours after cementing and after the grout mix samples had set, which indicated the top of cement was at 188 m (Figure 7).
4. On 21 April 2016, after drilling the production zone and 21 hours after the tremie top-up cement job on the production casing, two more runs were undertaken:
    - The production zone was logged with a caliper and temperature probe (1000-1112 m).
    - The top section of the production casing that was cemented by tremie line was logged with a cement bond probe (0-300 m).

All geophysical logs are shown in full in Appendix C.

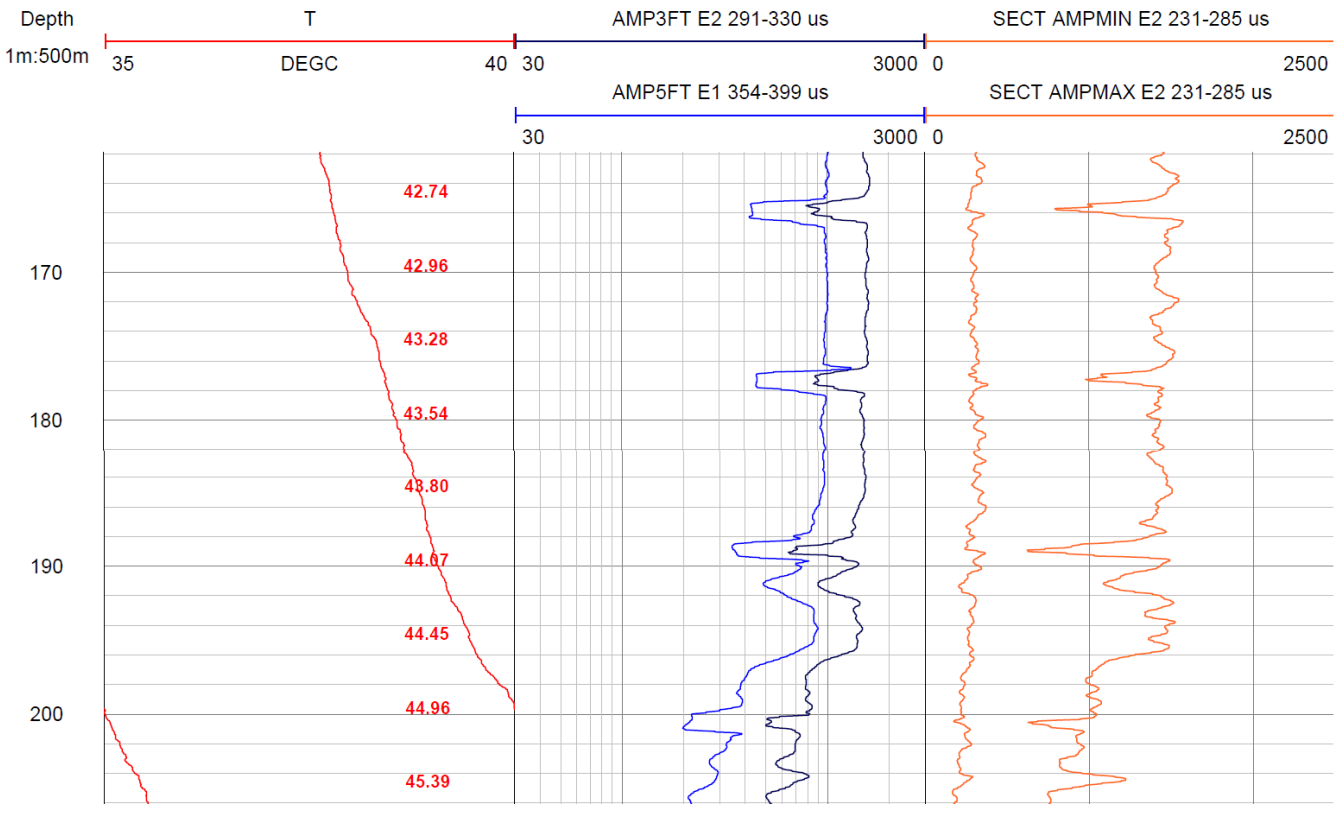

Figure 7. Initial cement bond log results from 19 April 2016, which was 33 hrs Waiting On Cement (WOC). The top of cement was picked at 188 m based on coincident drops in AMP3FT, AMP5FT, and radial SECT receiver amplitudes. The regular drops in amplitude at 168, 178.5, 189.5, and 200 m are casing joints.

A tremie top-up cement job was then conducted by Silver City Drilling:

- A tremie line was run into the annulus to the maximum possible depth between the artesian control and production casing strings to 67 m.
- 2745 L of 1.65 S.G. grout was pumped through the tremie line.
- On 21 April a cement bond log was run from 0–300 m which confirmed the bottom of the tremie cement was at 67 m (Figure 8), and again confirmed the top of the displacement cement job was at 187 m.
- The Silver City Drilling report is attached in Appendix B.

Results:

- Calculations indicate that the freshwater pre-flush fluid should be in the annulus from 67–187 m.
- The interval from 67–187 m is not likely to be cemented:
    - This presents a risk to the long-term integrity of the production casing.
    - The risk is likely to be higher from 104 to 187 m, as this is below the artesian control casing shoe and formation water in this interval is in contact with the production casing.
    - In the short term the risk is minor due to the presence of pre-flush fluid (fresh water) in this annular space.

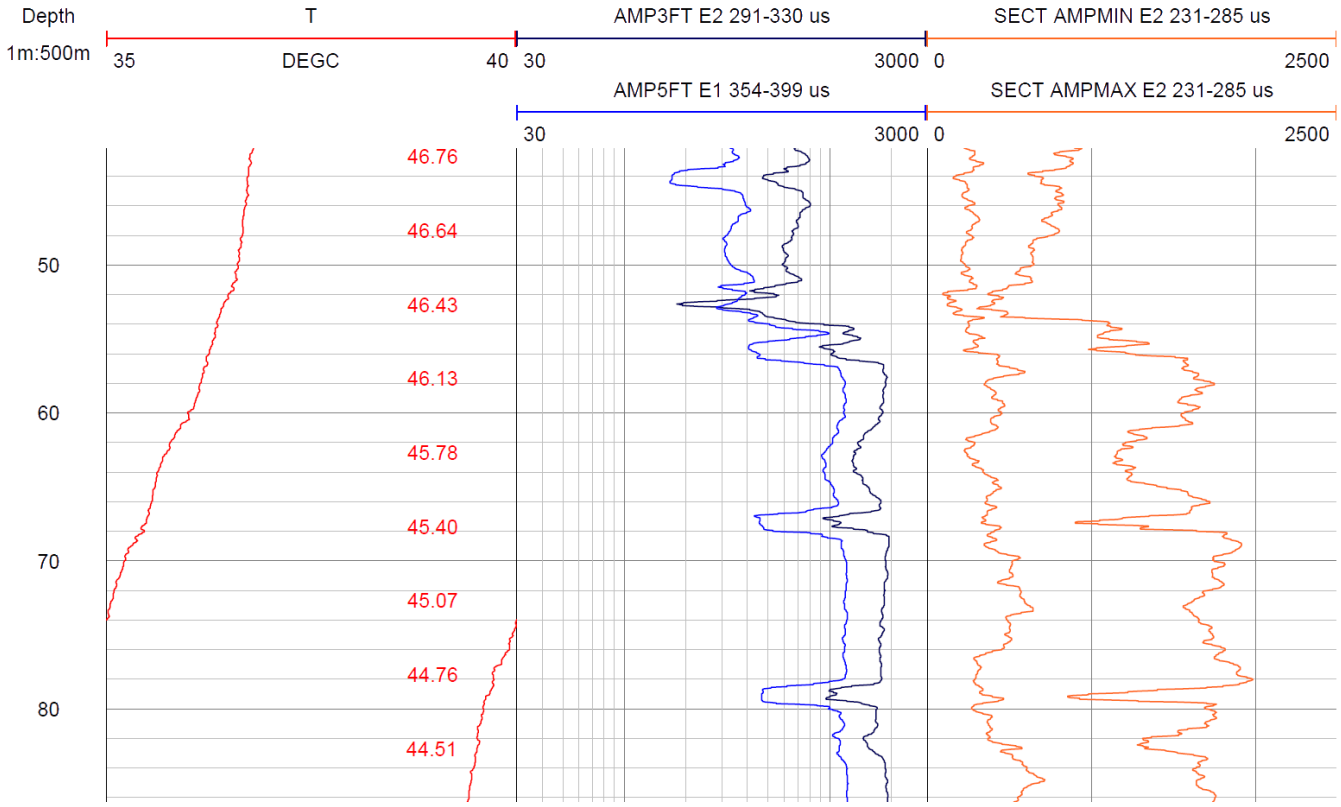

Figure 8. Initial tremie cement bond log results from 21 April 2016. The bottom of the tremie line cement job was picked at 67 m based on coincident rises in the AMP3FT, AMP5FT, and maximum radial (SECT) receiver amplitudes. The regular drops in amplitude at 168, 178.5, 189.5, and 200 m are casing joints.

2.5. Lithological logging

Cuttings were collected for lithological examination across the entire drilled depth. A sieve was used to catch cuttings and the samples described on site by a DEWNR hydrogeologist. A summary log is shown in Table 2, with more detailed descriptions given in Appendix D.

A tentative interpretation of the stratigraphy is shown in Table 2. The interface between Bulldog Shale and Cadna-owie Formation is unclear due to the absence of a natural gamma log. The interface between the Cadna-owie Formation and Algebuckina Sandstone was picked at 1059 m based on the increase in angular quartz sand in cuttings and a change in penetration rate at that depth. The bottom of the Algebuckina Sandstone was not reached before drilling ceased at 1112 m.

Table 2. Summary lithological log for Mulka Bore No. 2

Sample depth (m)		Description	Tentative stratigraphic interpretation
0	12	Top soil	
12	36	White to grey sticky clay with fine sand/sandstone	
36	266	Grey/green clayey shale, sandy, traces of lignite	
266	401	Grey shale, very soft, with fine quartz sand, interbedded with calcareous and carbonaceous shale	
401	986	Grey shale interbedded with calcrete and lignite	Bulldog Shale
986	1014	Shale interbedded with fine sandstone	
1014	1059	Quartz sandstone with gray clay	Cadna-owie Formation
1059	1071	Coarse quartz sand with gray clay	Algebuckina Sandstone
1071	1091	Coarse quartz sand, much less clay	
1091	1112	Fine quartz sand with coarse quartz sand	

2.6. Headworks

The well was completed with two steel 6 inch gate valves (Figure 9) and connected to the landholder's reticulation pipework which was previously attached to the old well.

2.7. Flow testing

After development the well was left to flow under artesian conditions for 24 hours. The flow rate was estimated at 33 L/s using the time taken to fill a 1 m^3 container.

On 4 August 2016 further testing was conducted by DEWNR. A 40 minute flow test resulted in a stable flow rate of 36 L/s and a stable (maximum) temperature of 85.6 °C which was reached after approximately 20 minutes (Figure 10). The electrical conductivity of the water was measured at 1496 µS/cm.

The valve was then shut over 5 minutes and a pressure shut-in test conducted for 35 minutes. The maximum pressure after shut-in was 515 kPa and no leakage was observed.

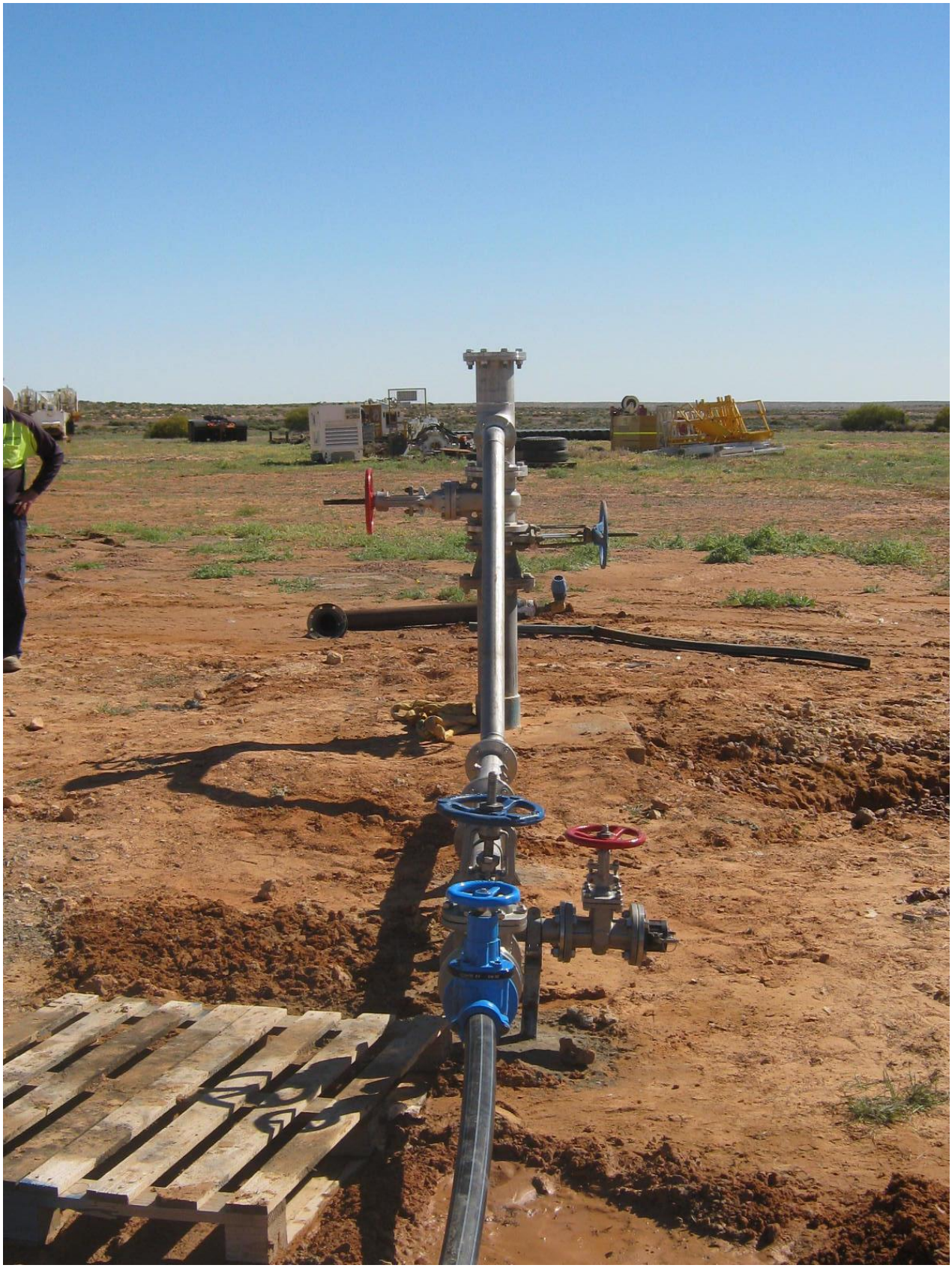

Figure 9. Headworks of Mulka Bore No. 2

Figure 10. Artesian flow of 36 L/s from Mulka Bore No. 2 during flow test on 4 August 2016

3. Decommissioning of Mulka Bore

3.1. Introduction

Mulka Bore (Unit number 6641-6) was originally drilled in 1907 by the cable tool method, and rehabilitation works were undertaken in at least 1957, 1959, and 1984:

- 1907: Bore drilled to 1050 m and completed with 8″ steel casing to 593 m and 6″ steel casing to 1046 m. The annulus was not cemented as the casing was driven into the ground by the cable tool drilling method.
- 1957: Unknown.
- 1959: Unknown.
- 1984: 80 mm FRP casing set at 283 m and 80 mm steel casing set from 283 m to 307 m.
- 1998: Unknown.

The plan to decommission the well was based on perforating the original 6″ casing in two points to ensure cement could be squeezed into the annulus over a confining layer. It was considered likely that the original casing strings had corroded significantly at multiple depths.

The well was then to be cemented in several stages.

3.2. Decommissioning activities

The well was decommissioned between 22–25 April 2016. Site supervision was provided by the DEWNR Drilling Inspector. The Drillers Well Construction Schedule 8 report is given in Appendix E. The well construction diagram is given in Figure 11.

- Flow from the well was controlled by pumping 9295 L of mud slowly through temporary wellhead works which would extend to a depth of at least 810 m.
- The well was geophysically logged to total depth at 1050 m with a 3-arm caliper, and a combination gamma, neutron and casing collar locator (CCL) probe (Appendix F).
- A cement bond log was run to 307 m, the depth to which the well had been relined (Appendix F).
- The well was explosively perforated in two successive runs over two depth intervals, 1015.5 m to 1018.5 m and 440.5 m to 443.5 m.
- Drill rods were run to 600 m (maximum available on site) and 3430 L of grout was pumped through the rods.
- After allowing for setting time when running the rods back to surface an obstruction was encountered at 273 m. A piece of FRP casing was subsequently found inside the drill rods. This indicates the FRP casing had probably degraded in parts down the hole.
- The top of grout was tagged at 489 m, indicating the cement plug spans the interval from 489 m to approximately 683 m. This means the lower perforated interval was not cemented due to the lack of rods on site.

- The next stage of grout was done in two stages:
    - 1980 L of 1.67 S.G. grout was placed from 364 m to approximately 476 m.
    - 1980 L of 1.67 S.G. grout was placed from 364 m.
- After allowing for setting time grout was tagged at 78 m. A tremie pipe was then used to cement the well to surface.

Perforation and cementing reports are included in Appendix G.

4. Conclusions and Recommendations

4.1. Conclusions

Mulka Bore No. 2 was successfully drilled and constructed and is producing at 33 L/s. The old Mulka Bore was decommissioned successfully.

A cement bond log was successfully used to determine a missing section of grout from 67 to 187 m. This presents a risk to the long-term integrity of the production casing.

4.2. Recommendations

Cement bond log surveys that have been undertaken by DEWNR on a number of wells drilled in the Great Artesian Basin over the past two years have indicated that casing is not always being correctly grouted, with grout rarely returning to surface as required. This results in missing sections of grout in the annulus, which can result in casing being exposed to shallow formation fluids and being subject to a higher risk of corrosion than if the annulus were grouted.

In order to improve the outcome of cementing jobs, we recommend that:

- Two or more tremie lines be pre-installed on the production casing to depths of 100 m and 200 m (for example) to enable deeper placement of cement during top-up jobs, if required.
- The drilling or cementing contractor be aware of the fracture pressure of formations that have been drilled through and take steps to ensure mud and cement grout weights are suitable for these conditions.
- Depending on formation types and drilling conditions, consideration should also be given to increasing the volume of grout pumped as a percentage of calculated annular volume, for example up to 100% additional volume of grout. Materials should be on site to allow for this possibility.

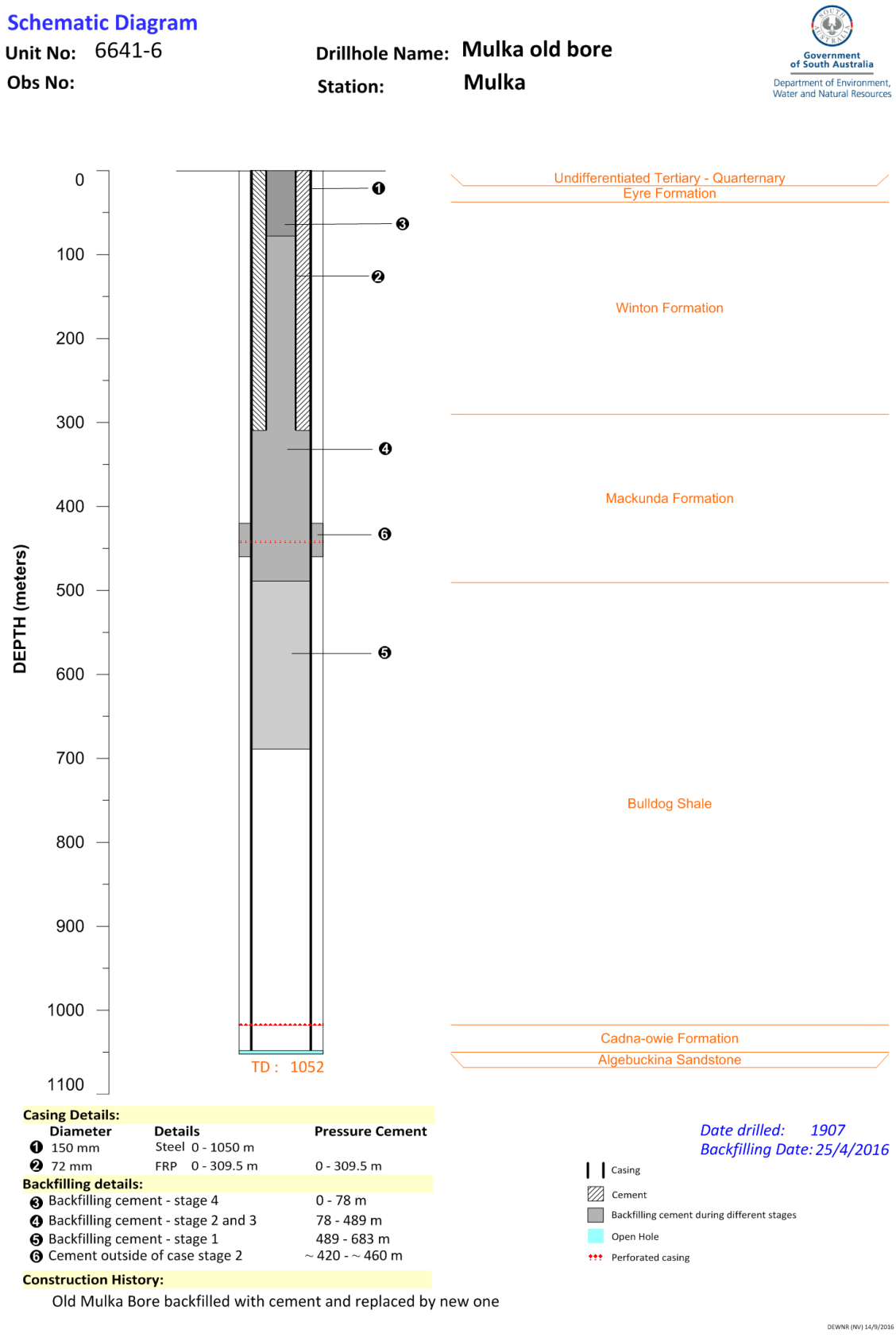

Figure 11. Decommissioning of Mulka Bore

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National Uniform Drillers Licensing Committee (NUDLC) 2011. Minimum construction requirements for water bores in Australia, 3rd edition. National Water Commission, Canberra.

Smerdon BD, Welsh WD and Ransley TR (Eds) 2012. Water resource assessment for the Western Eromanga region. A report to the Australian Government from the CSIRO Great Artesian Basin Water Resource Assessment. CSIRO Water for a Healthy Country Flagship, Canberra.

Appendices

A. Mulka Bore No. 2 Construction

This appendix contains:

- Drillers Well Construction Schedule 8 Report (1 page)
- Mulka Bore basic mud program (drilling fluids) (5 pages)
- Manufacturer data sheets for drill bits used (2 pages)

GOVERNMENT OF SOUTH AUSTRALIA

DRILLERS WELL CONSTRUCTION REPORT

Natural Resource Management Act 2004

1. PERMIT NO: 258255 Site

NAME OF DRILLER JOHN L DIXON Licence No 218562

Contact Phone (Mobile No.) 0407 195 080

Name of plant operator if under supervision T.M^c ISAAC J. WHADDLE H.BEACH

PERMIT HOLDER or land occupier SHILLIGAN P/L

Postal Address C/- NGJ LEGAL, UNIT 4 25 BELLAH ROAD, NORWOOD S.A. Post Code 5067

2. LOCATION OF WELL J. STRATFORD. S. BROWNBILL. L. ELDER

Date of Survey 11-04-16 Surveyed by HB Method GPS

GPS COORDINATES AND DATUM USED

☒ GDA 94/WGS84 ☐ AGD 66/84

54J 0270159 6861014

☐ ZONE 52 ☐ ZONE 53 ☒ ZONE 54

3. WELL NAME MULKA BORE REDRILL

4. LAND IDENTIFICATION

Hundred or Pastoral Lease: Kopperamanna

Parcel ID or CT number CL 1323/20 Sec 103

Name of Property Mulka

5. SUMMARY *(Please tick appropriate boxes and complete all relevant details)*

Date work Commenced 09/04/2016 Date work Completed 22/04/2016

Work carried out: New Well ☒ Deepen ☐ Enlarge ☐ Rehabilitate ☐ Backfill ☐

Is this a Replacement well? YES/NO if yes please quote replaced well number 6641-6

Is this an Existing well? YES/NO **if yes please quote well number or GPS coordinates**

Was well Abandoned? YES/NO if so please state reason and method of backfill

Maximum Depth Drilled 1112 (m) Final Depth 1112 (m) Final Standing Water Level FLOW (m) Final Yield 33 (L/sec)

6. DRILLING DETAILS If not a drilled well, please complete Sections: 6.2, 9, 10, 11, 12 and 13 as necessary

6.1 Construction Details

From (m)	To (m)	Diam (mm)	Drilling Method Cable Tool, Rotary Auger, Down Hole Hammer, etc.	Fluid Used (Air, Water, Mud Type)
0	12	488.15	Rotary	mud
12	106.07	311.15	Rotary	mud
106.07	1083	222.25	Rotary	mud
1083	1112	142.8	Rotary	mud

6.2 Water Cut Details (measurements from natural surface to nearest 0.1 m)

Date	Water Cut From (m)	Water Cut To (m)	Standing Water Level (m)	Estimated Yield (L/sec)	Hole Depth at Test (m)	Casing at Test (m)	Test Method	Salinity (mg/L) or Taste
							Free flow into $1m^3$	
20/04/16	1081	1112	FLOW	33	1112	1081		

7. CASING LEFT IN WELL

7.1 Dimensions / 7.2 Type / 7.3 Casing Cemented

From (m)	To (m)	Internal Diam. (mm)	Swell Joint, Welded Collar, Steel, FRP, PVC, etc.	Yes	No	From (m)	To (m)	Cement (bags)	Water (litres)	Other Additives	Cementing Method Used	Comments
0	12	326.9	Steel BTC	☑	☐	0	12	46	633	NIL	Trammie	20L Top up
0	104.07	225.1	Steel BTC	☑	☐	0	104.07	225	2955	NIL	Displaced	20L Top up
0	1081.83	163	Steel BTC	☑	☐	~180	1083	1252	14490	See Well Pro	Displaced	No Returns
				☐	☐							

8. CONSTRUCTION AT PRODUCTION LEVEL

8.1 Method

☒ Open Hole

☐ Slotted Casing

☐ Screen(s)

☐ Other, give details

8.2 Screen or Casing (*If variable aperture screen used give limits)

Type	From (m)	To (m)	Aperture* (mm)	Inner Diam (mm)	Outer Diam (mm)	Material	Trade Name	Completion of Base

8.3 Liner Seal (Packer)

Material	Depth (m)	Internal Diam (mm)

8.4 Gravel Packing

Method of Placement	Gravel Passing Mesh Size	From (m)	To (m)

9. IF NOT A DRILLED WELL

Method	Depth (m)	Length (m)	Width (m)	Diam (m)	Lining Material	From (m)	To (m)

10. DEVELOPMENT (State methods and time taken)

Method	Hours	Minutes
Free Flow	24	

11. PUMPING TEST (measurements from natural surface to nearest 0.1m)

Interval Tested From (m)	Interval Tested To (m)	Water Level (m)	Test Method	Pump Depth (m)	Discharge Rate (L/sec)	Method of Measuring Discharge	Hours Pumped	Draw Down (m)
1081	1112		MM3 F/F		33	$1m^3$ Pail	24	

12. SAMPLES

The provision of the Natural Resource Management Act 2004 and Regulations require that strata and water samples must be obtained. If any samples have not been obtained state reasons:

W Handed to DEWNR

As the person responsible I advise that the work has been completed as described above.

Signature of Licensed Driller John L Dixon Date 23/4/16

Driller to deliver this copy together with water samples collected and well location map within 14 days of completion to any of the below locations:
Department of Water Land and Biodiversity Conservation
Water Laboratory and Geophysical Services, 23 Conyngham Street GLENSIDE SA 5065 or
Mount Gambier Regional Office, 11 Helen Street MOUNT GAMBIER SA 5290 or
Naracoorte Regional Office, 101 Cedar Avenue, NARACOORTE SA 5271

13. FORMATION LOG

From (m)	To (m)	Description of Material
		- See also well pro Report attached
		- Production to Control casing annular Top up 1.65 sg 289OL Trammie
		- Strata Summery attached
		- Temp 91°c
		- CEMENTING REPORTS ATTACHED.

UNIT NUMBER

MULKA BORE BASIC MUD PROGRAM (DRILLING FLUIDS)

- Top Section (Conductor Casing to 12mtrs)

Spud Mud Liquipol @ 2 - 2.5kgs /1000

Using one (25,000 ltr) sump plus hole volume (1,200 ltrs) – rounded up Circulating Volume 26,000 ltrs

Liquipol required @ 2.5kgs/1000 65kgs (3 x 25kg Cubes)

- 12¼" Section to 600mtrs

Introduction of KCL @ 5% (50kgs/1000) to inhibit Bulldog Shale and Xanbore @ 1 -1.5kgs/1000 for hole cleaning purposes.

To be introduced across both 25,000 ltr sumps plus hole volume.

Sumps 50,000 ltrs plus hole volume 46,000 ltrs plus 20% dilution factor

Total volume to be conditioned 115,000 ltrs

KCL required @ 5% (50kgs/1000) 5,750kgs

Xanbore required @ 1.5kgs/1000 172kgs

At the end of this section the hole should be flushed as much as possible to evacuate as many cuttings as possible as the fluid in the hole will be utilised for the 8¾" section.

Once this section is completed the intial two sumps should be abandoned and two new sumps utilised.

- 8¾" Section to 900mtrs

Given that we will be utilising the fluid occupying the 12¼" hole for this section the amount of fluid to be conditioned will be 2 x 25,000 ltr sumps plus the extended hole volume (8¾" from 600 to 900mtrs).

Volume to be conditioned 50,000 ltrs (sumps) plus 12,000 ltrs hole volume plus 20% dilution rate = total volume of 75,500 ltrs.

KCL required @ 5% (50kgs/1000)	3,775kgs
Xanbore required @ 1.5kgs/1000	114kgs

Please note that additional Xanbore may be required to gain your desired viscosity.

- 6" Section to TD (1000mtrs)

Fluid from the second bank of sumps can remain in use as the Bulldog shale is still evident through this section.

An extra 2,000 ltrs of fluid plus a dilution factor of 20% will need to be conditioned to allow for the extended hole volume.

Extra fluid to be conditioned – 2,500 ltrs (Rounded up)

KCL required @ 5% (50kgs/1000)	125kgs
Xanbore required @ 1.5kgs/1000	3kgs

It is within this section that we encounter the pressurised Artesian Aquifer. The aquifer is pressurised at 150 PSI with the top of Aquifer being at 940mtrs.

Taking this into consideration our fluid needs to be weighted up to subdue the pressure. The fluid needs to be weighted approximately 20mtrs prior to intersection, and given the depth to top of aquifer and the PSI reading the fluid (which will be currently weighted at 1.065SG due to solids and KCL addition) will need to be weighted up to 1.132SG.

To enable this weight to be achieved Baryte was added at 99kgs/1000 ltrs. Extra addition of Xanbore will be required to enable the Baryte to stay in suspension.

The circulating volume to be weighted is as follows

Sump Volume	50,000 ltrs
Hole volume (6" to 1000mtrs)	18,750 ltrs
Total circulating volume	69,000 ltrs (rounded up)
Baryte required @ 99kgs/1000	6,831kgs

an imdex limited company

LIQUI-POL

VISCOSIFIER

Description

LIQUI-POL is a liquid anionic polymer viscosifier with high molecular weight providing rapid viscosity without the problems associated with mixing, as is the case with most powdered polymers. It provides a complete drilling fluid system and mixes very rapidly in fresh or brackish water.

Application

LIQUI-POL can be used in diamond drilling or water well drilling:

- Produces rapid viscosity.
- Very cost effective - low concentration required.
- Reduces rod chatter and torque - increases core recovery.
- Inhibits water sensitive formations - improves borehole stability.

Diamond Drilling Recommended Treatment

Add 0.75 - 1.25 litres / 1,000 litres water for complete drilling fluid. Add 0.5 - 0.75 litres / 1,000 litres to stop rod vibration and reduce torque.

Water Well Drilling Advantages

- The polymer can be easily and economically broken down for the development of water wells after setting screens.
- Controls sticky clays and inhibits water sensitive, swelling formations.
- Promotes effective settling of drilling solids in surface pits.
- Cost effective and economical to transport.

Water Well Drilling Recommended Treatment

Add 1.0 - 1.5 litres / 1,000 litres for complete water well drilling fluid.

Packaging

25 kg plastic pail.

20 kg box.

Several factors will dictate the most appropriate concentration rate. Please contact your nearest AMC representative for the best results.

Certified System
Quality
ISO 9001
SAI GLOBAL

With more than 20 years experience, AMC has enjoyed a successful history of supplying specialist drilling products to the mineral, oil & gas, water well, horizontal directional drilling, civil and tunnelling industries world wide. The success of AMC is due to its quality products, and the dedication of its skilled team who offer on site support where and when customers need it.

amc@imdexlimited.com **www.amcmud.com**

AMC Africa	AMC Asia Pacific	AMC Europe	AMC North America	AMC South America
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an imdex limited company

XAN-BORE

BIODEGRADABLE VISCOSIFIER FOR FRESH WATER, SEAWATER OR HIGHLY SALINE SYSTEMS

Description

XAN-BORE is a premium quality biopolymer powder designed to provide maximum solids suspension and hole cleaning in vertical and highly deviated wells as well as horizontal directional drilling applications. XAN-BORE is a distinctive product, able to produce a thixotropic shear thinning fluid. XAN-BORE also acts as a very effective mud filtrate viscosifier.

Application

XAN-BORE can be added to a pre-hydrated bentonite based fluid or can be used as a single viscosifying additive in fresh, brackish or saturated salt water.

XAN-BORE fluids are highly shear thinning which improves bit cleaning and ROP significantly. The fluid will revert to higher viscosities at low shear rates. This unique property provides many benefits in highly deviated wells and in HDD bores by providing excellent carrying capacity of coarse cuttings, sand and gravel.

In HDD drilling improved hole cleaning and cuttings transport allows for quicker and easier back reams and pull backs on longer bores.

In CBM drilling XAN-BORE's highly thixotropic mud filtrate limits damage to coal seams and cleats.

Advantages

- Highly effective in low concentrations
- Mixes easily in all water types
- Maximises hole cleaning and suspension properties
- Improves lifting capacity with the only a small effect on ECD
- Improved hydraulics
- Stabilizes unconsolidated formations
- Prevents surging and swabbing
- Provides excellent lubricity
- Biodegradable and non toxic.

Typical Properties

Appearance:	Cream coloured powder
pH (1% solution):	6.0 – 8.0
Specific gravity:	0.65

Recommended Treatment

Add 1 – 3 kg per 1000 litres of water through a mud hopper or a high shear mixer.

Packaging

5 kg plastic pail.

25 kg paper sack.

Certified System
Quality
ISO 9001
SAI GLOBAL

Several factors will dictate the most appropriate concentration rate. Please contact your nearest AMC representative for the best results.

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Rev. 17-3-2011

an imdex limited company

POTASSIUM CHLORIDE (KCl)

CLAY AND SHALE STABILISER / WEIGHTING AGENT

Description

POTASSIUM CHLORIDE (KCl) is a soluble salt that is an extremely efficient shale stabilizer when drilling hydro sensitive clays and shales. Inhibition is produced through exchange; the potassium ion enters between the individual clay platelets in the shale so that they are held together, thus eliminating entry of water from the drilling fluid.

Application

POTASSIUM CHLORIDE (KCl) can be added directly to a drilling fluid system to enhance its inhibitive quality, and can be used as a weighting agent ranging in densities from 1.005 S.G. (8.4 ppg) to 1.162 S.G. (9.7 ppg). POTASSIUM CHLORIDE (KCl) solution becomes saturated near 1.162 S.G. (9.7 ppg); the closer to saturation the less soluble the salt becomes.

Advantages

- Inexpensive and easily obtainable
- Benefits achieved at low concentrations
- Compatible with most drilling fluid additives
- Stabilizes water sensitive clays and shales
- Prevents issues resulting for shale instability
- Fast dissolving

Typical Properties

Physical appearance:	White crystals or powder
pH Saturated aq. sl. @ 15°C:	7.0
Solubility:	28.1g/100g of water @ 0°C
	34.2g/100g of water @ 20°C
	37.2g/100g of water @ 40°C
Purity:	95% min

Recommended Treatment

Normal use: 3.0 % (30 kg) – 8.0 % (80 kg) by volume (per 1000 litres).

Polymers such as EZEE-TROL, AUS-TROL, EZEE-PAC R & L, PACs, CR-650 and LIQUI-POL can all be used in conjunction with POTASSIUM CHLORIDE (KCl). It is recommended the water be pre-treated and polymers mixed before adding POTASSIUM CHLORIDE (KCl).

NOTE: Environmental Sensitivities may exclude the use of POTASSIUM CHLORIDE (KCl) in certain areas, please contact your local AMC Representative to discuss alternatives.

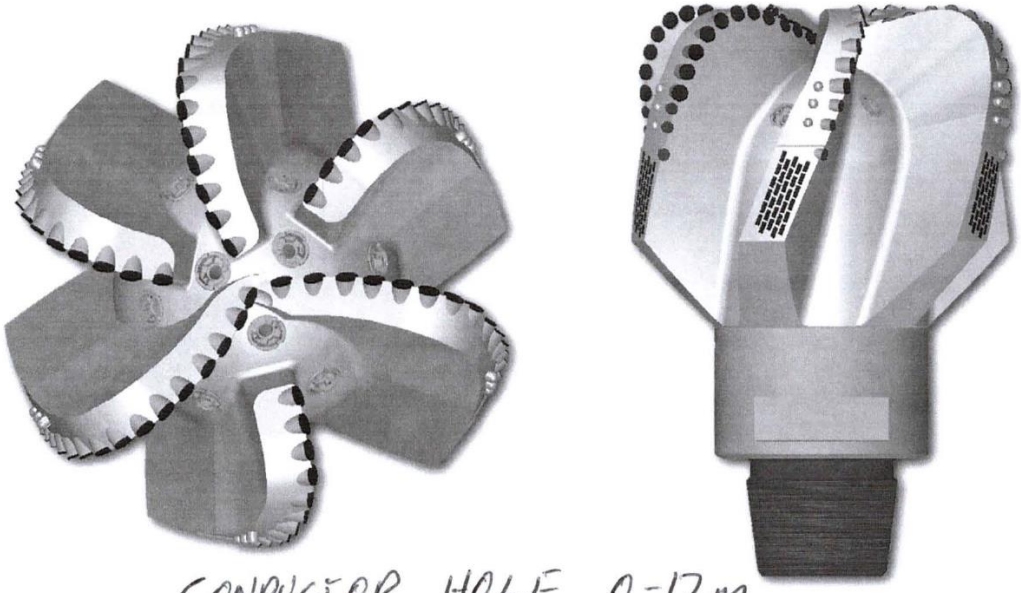
Packaging

25 kg polypropylene sack.

Certified System
Quality
ISO 9001
SAI GLOBAL

Several factors will dictate the most appropriate concentration rate. Please contact your nearest AMC representative for the best results.

17 ½" (444.5 mm) IADC: S223 MD619HDXS



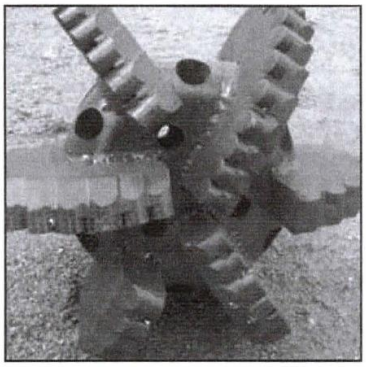
CONDUCTOR HOLE 0-12m

Product Specifications	
Body Type	Steel
Profile	Medium Parabolic
Cutter Size	19 mm / 13 mm
Total Cutter Count	78
Cutter Backup	Shock Studs
Blade Count	6
Number of Ports	-
Number of Nozzles	9
API Pin Connection	7 5/8" Reg
Gage Length	4" (101.6 mm)
Gage Protection	T2A / PDC
Blade Profile	Spiral
Order-No.	31-00005601
Operating Parameters	
Rotary Speed	Suitable for Rotary and PDM
Max Weight on Bit	62 klbs (28 t)
Flow Rate, Min - Max	600 - 1,300 gpm (2,270 - 4,920 l/min)
Max TFA	3.341
Make-Up Torque	64,800 - 66,200 ft·lb

Technical data and pictures for information only
Please contact us for recommendations for your individual well

Ground Combat

Performance PDC bits.



Sniper

These economical steel bodied bits are designed for sandstone and shale. These bits are specifically constructed to withstand higher impact force and are loaded with higher abrasion resistant cutters than competitors. Sniper bits can be designed with flushing holes or open center and include various blade and cutter size configuration options.

SNIPER SERIES BITS

BIT SIZE	BLADE COUNT	CUTTER SIZE	PIN SIZE	BODY	HYDRAULICS	
3 3/4" - 3 7/8"	3	1304	2 3/8" REG	Steel	Flushing Holes/Open Center	
4" - 4 1/2"	4	1304/1308	2 7/8" REG	Steel	Flushing Holes/Open Center	
4 5/8" - 4 3/4"	4-5	1308	2 7/8" REG	Steel	Flushing Holes/Open Center	
4 7/8" - 5"	4-5	1308/1613	2 7/8" REG	Steel	Flushing Holes/Open Center	
5 1/8" - 5 1/4"	4-5	1308/1613	2 7/8" REG	Steel	Flushing Holes/Open Center	
5 1/2"	4-5	1308/1613	2 7/8" REG	Steel	Flushing Holes/Open Center	
✱ 5 5/8"	4-5	1308/1613	2 7/8" REG	Steel	Flushing Holes/Open Center ✱	Bottom Hole to T.D
5 7/8"	4-5	1308/1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
6"	4-5	1308/1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
6 1/2"	4-5	1308/1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
6 3/4"	5	1308/1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
6 3/4"	6	1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
7"	5	1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
7"	6	1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
7 1/2"	5	1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
7 1/2"	6	1613	3 1/2" REG	Steel	Flushing Holes/Open Center	
7 7/8"	5	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
7 7/8"	6	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
8 1/2"	5	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
8 1/2"	6	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
✱ 8 3/4"	5	1613	4 1/2" REG	Steel	Flushing Holes/Open Center ✱	Production
8 3/4"	6	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
9 7/8"	5	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
9 7/8"	6	1613	4 1/2" REG	Steel	Flushing Holes/Open Center	
11"	5	1613	6 5/8" REG	Steel	Flushing Holes/Open Center	
✱ 12 1/4"	5	1613	6 5/8" REG	Steel	Flushing Holes/Open Center ✱	Control
12 1/2" - 17 1/2" +	Call for Details					

B. Mulka Bore No. 2 Cementing reports

This appendix contains contractor reports with details of the different stages of cementing conducted at Mulka Bore No. 2:

- Artesian Control Casing Cementing Report (1 page, 11 April 2016, SCD)
- Production Casing Cementing Report (1 page, 17 April 2016, SCD)
- Annulus Grout Top Up Confirmation (1 page, SCD)
- Wellpro Cement Job Report (3 pages, 17 April 2016, Wellpro)

Control Casing Cementing Report

Mulka Bore Redrill - Mulka Station S.A.

Permit No. 258255

Date:	11-04-2016
Diameter of hole:	311.15 mm
Depth of hole:	106 m
Casing dimensions:	244.4 mm O.D. x 9.65 mm Wall , API 5L x42.
Casing shoe:	Seated 2m above bottom at 104.07m
Centralised:	Yes. Steel bow spring centralisers.
Type of grouting:	Displacement cementing
Method of grouting:	Displaced down the centre by a drillable plug by drilling mud through drillable casing shoe.
Grout makeup:	4387 L of 1.66 S.G. Grout comprising, 225 Sacks of cement (20kg). 2955 L cooled water from existing bore.
Distance grouted:	Shoe to surface.
Return Observed:	Yes.
Mixing time;	2hours 40 mins
Pumping time:	15 mins. (00:45hrs)
Displacement Time:	15mins. (01:00hrs)
Top Up:	Yes.11-04-2016, 20L.

Licensed Driller:	John Laurence Dixon	Lic.No.	218562
2nd Lic. Driller	Hamish Beach	Lic. No.	T.B.A.
Signed:	John L Dixon.	Date:	12-04-2016
		Date	12-04-2016

Production Casing Cementing Report

Mulka Bore Redrill - Mulka Station S.A.

Permit No. 258255

Date:	17/04/2016
Depth of hole:	1086 m x(222.25 mm hole below control casing)
Casing dimensions:	177.8 mm O.D.x 163mm I.D. to 226.6 mm I.D. x 104.07 m control casing.,
Casing shoe:	Seated above the bottom at 1081.83 m B.G.L. Cement Head to shoe 1084.63m.
Centralised:	Yes. Steel bowspring centralisers.
Type of grouting:	Inter-casing.
Method of grouting:	Displacement through a drillable float shoe.
Contractor.	Wellpro - Roma Qld.
Grout makeup:	26235 L of 1.69 S.G. Grout. (See also Wellpro report)
	26866 Kg of cement,(Calculated)
	17731 L water, from existing Pandi Pandi bore.
	0.82% BWOC FR-3 Retarder. 4% Bentonite etc..(See Wellpro cement job report.)
Distance to grout:	Shoe to surface.
Displacement:	22578 L pumped.
Return Observed:	No. Returns ceased during final displacement pumping.
Pre-flush Pumped:	1590 L of water. 16 mins.
Mixing time and Pumping Time;	56 mins.
Displacement time:	54 mins. (22578 L)
Cement Bond Log:	Indicates grout top at 180 m BGL 33 hours after lock in. Confirmed 19-04-2016.
Top Up:	2745 L of 1.65 S.G. trammied to annulus. 19-04-2016.
Final Top Up:	—

Licensed Driller:	John Laurence Dixon	Lic.No.	218562
2nd Lic. Driller	Hamish Beach	Lic. No.	T.B.A.
Signed:	John R Dixon	Date:	21.4.16
		Date	21.4.16

Mulka Bore Redrill

Annulus Grout Top-Up Confirmation

Production to Control Casings Annulus

Data:

Control Casing I.D.	226.6 mm.
Depth of Control Casing.	104.07 m
Production Casing O.D.	177.8 mm
Depth of Calculation.	104.07 m to 180 m B.G.L.
Volume of Water Spacer.	10 bbl. or 1590 L.

Calculation:

@SUM((226.6-177.8)*(226.6+177.8)*0.0007854)*(180-104.07))

= 15.5 L/m * 75.93m = 1177 L

Length of Fresh water Spacer within the annulus = 1590 L / 15.5 L/m = 102.58 m.

Determination:

The fresh water spacer location, at final cement set following placement by Wellpro, is calculated as being from the top of the cement grout, which was located by the cement bond log at 180 m, to (180 - 102.58m) 77.42 m B.G.L.

Observations:

At commencement of the placement of the top-up grout, via trammie to the annulus, the first return to surface was observed to be clean water, and this continued as the only discharged fluid prior to the return to surface of the excess grout.

Signed: John R Devoir

Lic. Class 3 Driller # 218562

WELLPRO SERVICES

CEMENT JOB REPORT

Customer:	Date:	PO#	Service Supplied:
Silver city Drilling	17-4-2016		P&A

Lease & Well No.	Location:	Field Ticket No.
Mulka Bore	Mulka Station (South Australia)	

Materials Furnished by WellPro	Slurry WGT PPG	Slurry YLD L/SK	Water L/SK	Pump Time HR:MIN	BBL Slurry	BBL Water Mix
100% Class A Cement 0.2% Defoamer 7011D, 4% Bentonite, 0.275% Dispersant NC-S-1, 0.82% Retarder FR-3	14.1ppg	43.88	29.5		165	92.5

Available mix water (bbl):	Available Displ. Fluid (bbl):	Total:
140bbl	140bbl	280bl

Hole

Stage 1			Stage 2			Stage 3		
Size	% Excess	Depth	Size	% Excess	Depth	Size	% Excess	Depth
7	60	1084m						

Mix Water			Displacement Fluid		Well Fluid			
PH	EC	Temp	Type	WGT	Type	WGT		
			water	8.4				

Pre cement jobs

PSV set and tested	Yes	PSI	3000psi
Lines and equipment Pressure tested	Yes	PSI and duration	2500psi 5mins
Previous Cement plug pressure tested	N/A	PSI and duration	N/A

Tools run, eg stingers, mule shoe, bit ect:

Cement head, 7 inch casing

Explanation, Trouble setting Tool, pipe stuck ect

Total barrels pumped:

Pre flush	Cement Slurry	Displacement	Wash up
10bbl	165bbl	142bbl	21bbl

Post cement jobs:

Cement to surface	No	Cement weight at surface	N/A
Cement squeeze conducted	N/A	PSI and duration	N/A

Wellpro Rep:

Name	Signature	Date
Jason Burns		17-4-16

Operating Company Rep:

Name	Signature	Date
JEREMY WARDLE		17-4-2016.

WELLPRO SERVICES

CEMENT JOB REPORT

Pressure / Rate Detail						
Time HR:MIN	Pressure – PSI Pipe	Annulus	Rate BPM	Fluid Pumped Bbl	Fluid Type	Explanation
19:00						
19:15			2.5	10bbl	water	TBM with all crew
19:30			4	165bbl	slurry	Pump water spacer.
20:30	600psi		3	142bbl	water	Start mixing and pumping 14.1ppg cement slurry
21:30						Displace with water. No cement seen at surface water flow out blooie line slowed down at 120bbl displacement.
			3	21bbl	water	Shut down pump shut in cement head and hold pressure on casing.
21:45						Wash up unit.
						R/D equipment.
						End of job.

Wellpro Rep:

Name	Signature	Date
Jason Burns		17-4-16

Operating Company Rep:

Name	Signature	Date
JEREMY WARDLE		

WELLPRO

Wellpro Job Pump Sheet

Date:	17/06/2016			
Client:	Silver City Drilling			
Well:	Mulka			
Job Description:	7" Production casing cement job			
Open hole excess:	60%			
Slurry:	14.1ppg, class a cement, 4% bentonite, 0.2% defoamer, 0.275% dispersant, 0.82% retarder			
Mix water:		gal/sk	29.5	l/sk
Yield:		cuft/sk	43.88	l/sk

Surface - 9-5/8" section		162.00	bbl
	Sacks	Kilograms	Ton
Cement Required:	587.0100273	25,029	25.029
bentonite		1,001.2	
Defoamer		50.1	
Dispersant		68.8	
Retarder		205.2	
	Barrels	Litres	Cubic Metres
Mix Water Required:	90.82	14440.45	14.44
Displacement water required:*	147.00	23373.00	23.37

ISO 17402S

	Volume			Rate		
	Barrels	Litres	Cubic Metres	Barrels/min	Litres/min	Cubic Meters /min
Stage 1: Pump	10.00	1590.00	1.59	2.5	397.5	0.3975
Stage 2: Mix and pump cement.	162.00	25758.00	25.76	3	477	0.477
Stage 4: Displacement water	147.00	23373.00	23.37	2.5	397.5	0.3975
Stage 4: Dispalcement	0	0	0.000	3	477	0.477
Name and signature (Wellpro):	JASON BURNS					
Name and signature (OCR):	JEREMY WARDLE					

Plug	From	To	V
	m	m	M^3
Cased Section	80	0	1.24
8.75" Open Hole	1200	80	15.63
8.75" Open Hole - excess 60%			
Shoe track	12	0	0.25
			Total

C. Mulka Bore No. 2 Geophysical logs

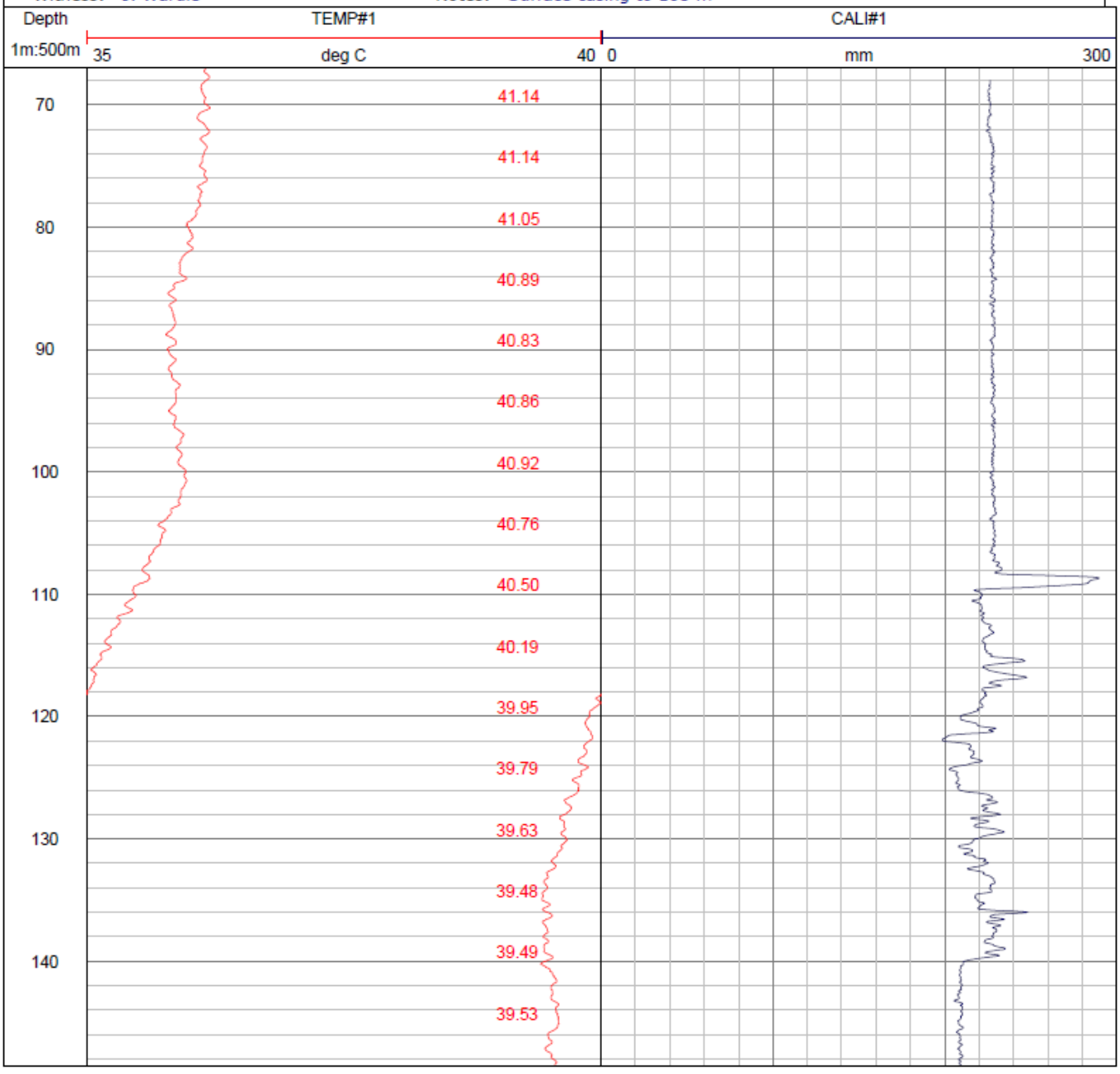
This appendix contains copies of the geophysical logs run on Mulka Bore No. 2:

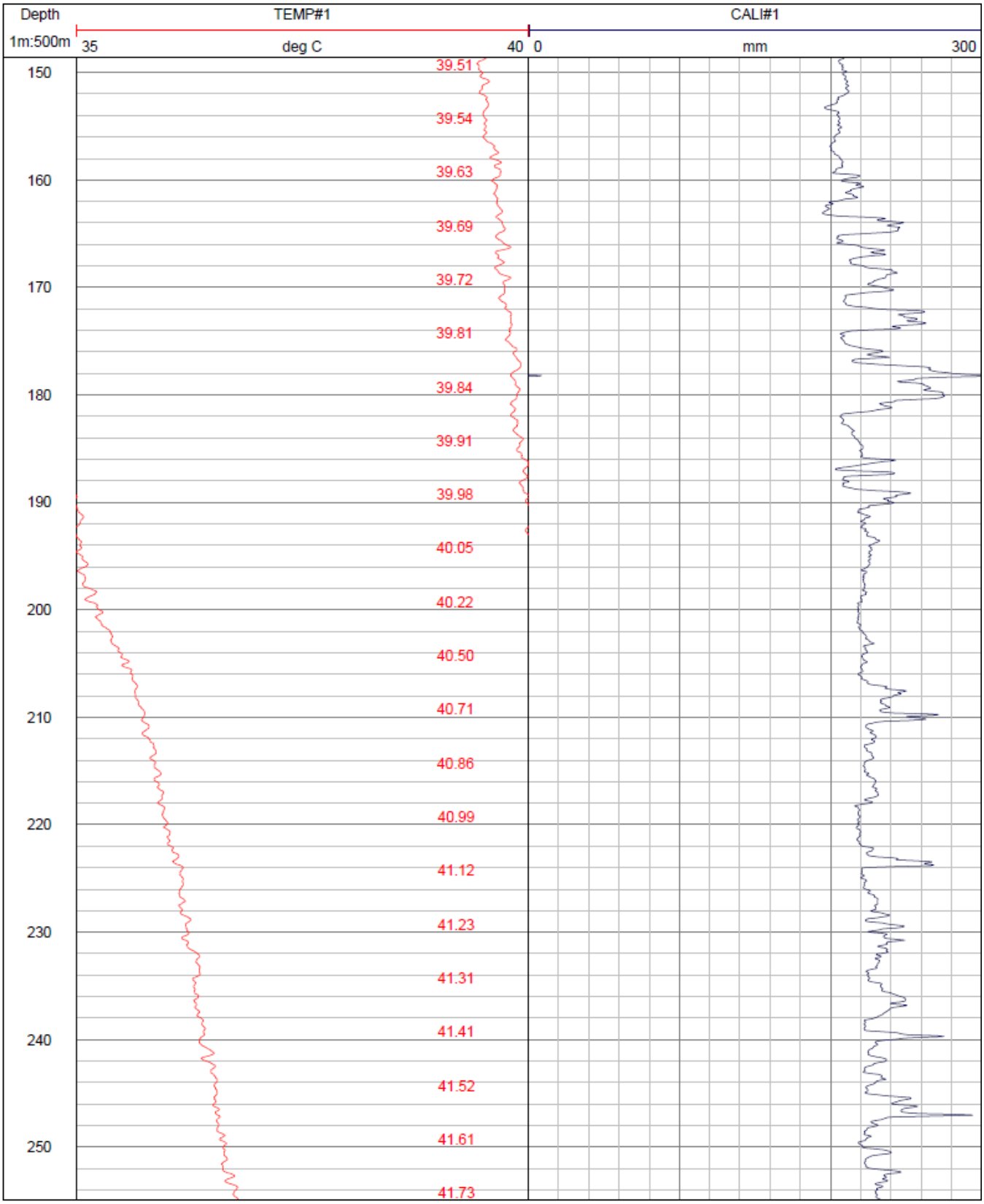
- Caliper and temperature probe, run on 18 April 2016 from 69 m to 1082 m
- Cement bond probe, run on 19 April 2016 from 7 m to 1074 m.
- Caliper and temperature probe, run on 21 April 2016 from 1052 m to 1109 m.
- Cement bond probe, run on 21 April 2016 from 18 m to 313 m.

Client:	DEWNR / Silver City Drilling	Location:	Mulka
Purpose:	Aquifer definition	State:	SA
Project:	Mulka replacement	Longitude/Easting:	0270154
Date:	18/04/2016	Latitude/Northing:	6861008
Bore name:	New Mulka Bore	UTM zone:	54J 5 m
Unit no.:		Depth reference:	Ground level
Permit no.:		Depth ref. elev.:	
Fluid level:		Depth ref. above G.L.:	
Fluid type:		Casing depth range:	
Operator:	GPK	Casing type:	Steel
Witness:	J. Wardle	Notes:	Surface casing to 105 m

Government of South Australia
Department of Environment, Water and Natural Resources

Job number:	
Sample interval:	5 cm
Vehicle:	XQB449
Driller depth:	
Logged depth:	1081.5 m
Bit size:	
Casing I.D.:	

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1m:500m
TEMP#1
35
deg C
40
CALI#1
0
mm
300
150
160
170
180
190
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210
220
230
240
250
39.51
39.54
39.63
39.69
39.72
39.81
39.84
39.91
39.98
40.05
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41.23
41.31
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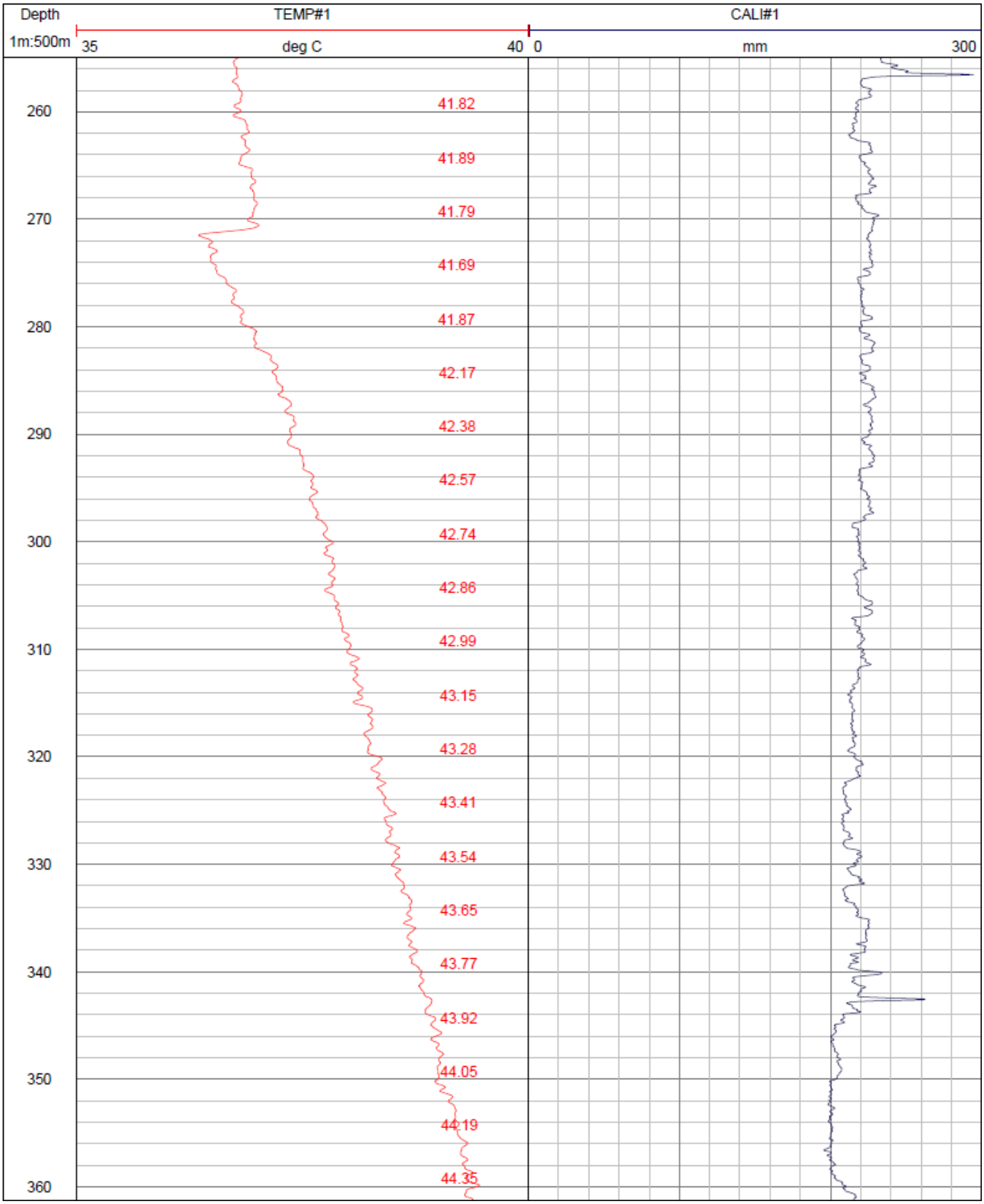
41.52
41.61
41.73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35
deg C
40
CALI#1
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mm
300
260
270
280
290
300
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340
350
360
41.82
41.89
41.79
41.69
41.87
42.17
42.38
42.57
42.74
42.86
42.99
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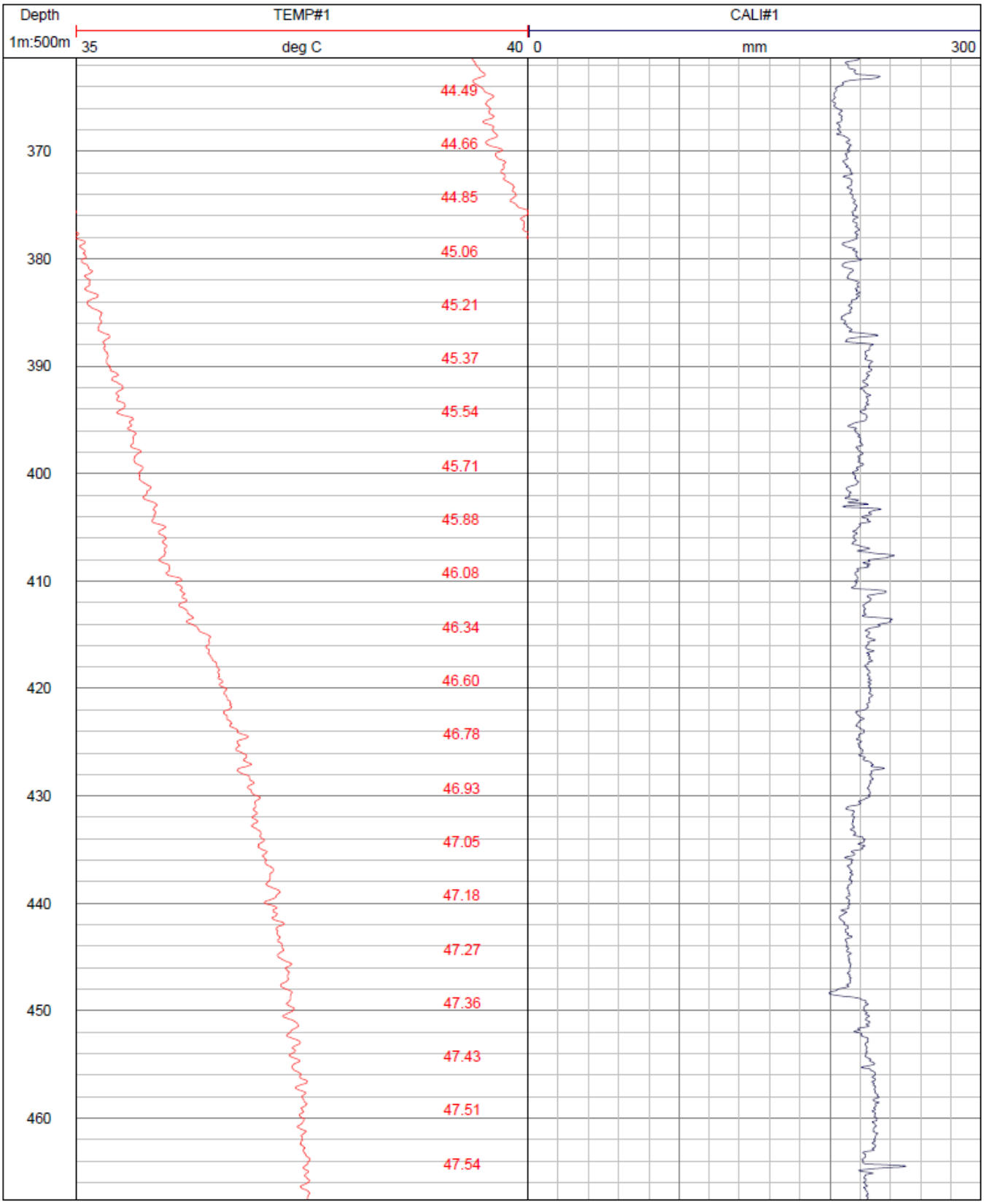
43.28
43.41
43.54
43.65
43.77
43.92
44.05
44.19
44.35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35
deg C
40
CALI#1
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mm
300
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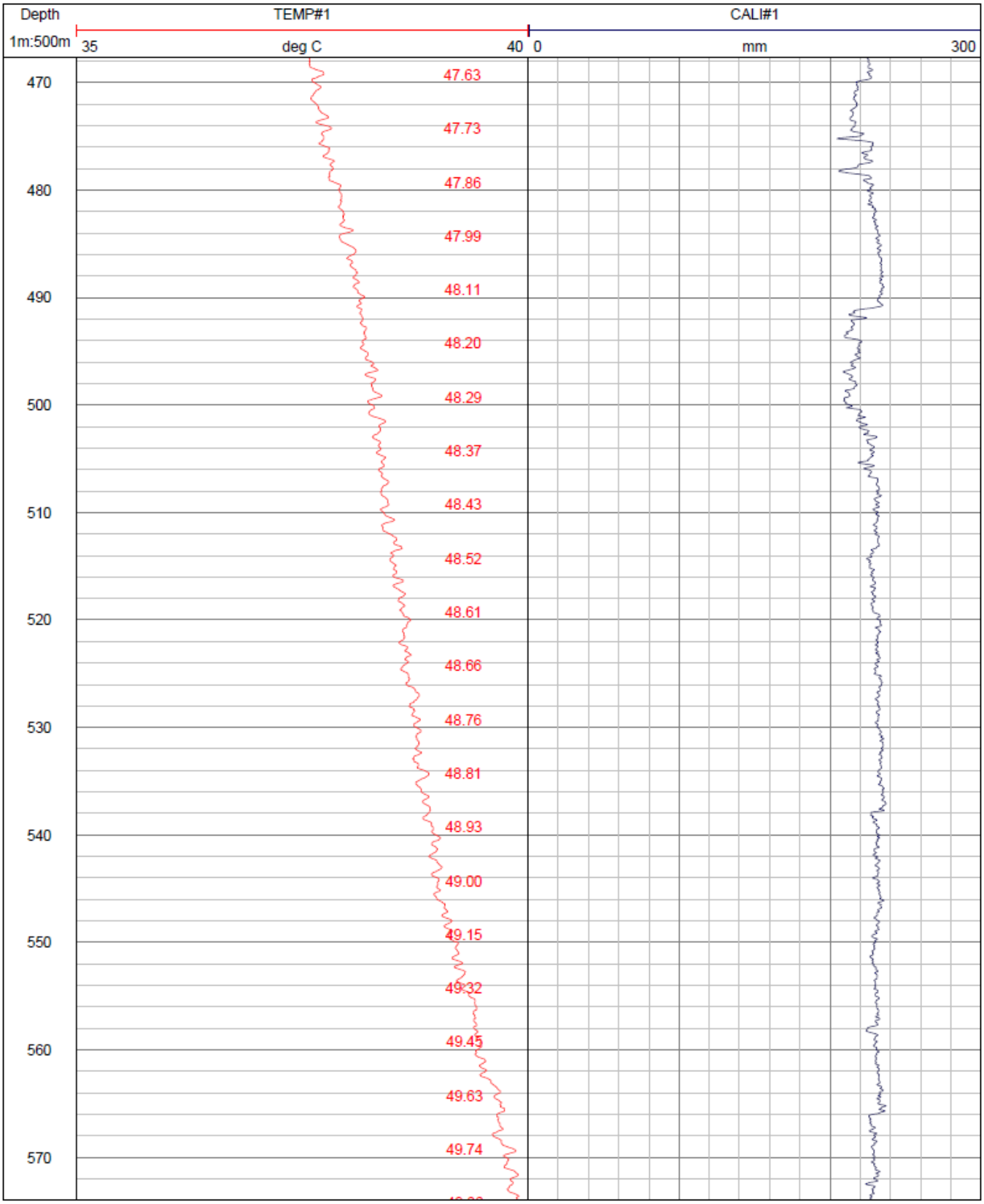
380
390
400
410
420
430
440
450
460
44.49
44.66
44.85
45.06
45.21
45.37
45.54
45.71
45.88
46.08
46.34
46.60
46.78
46.93
47.05
47.18
47.27
47.36
47.43
47.51
47.54


Depth
1m:500m
TEMP#1
35
deg C
40
CALI#1
0
mm
300
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480
490
500
510
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540
550
560
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48.29
48.37
48.43
48.52
48.61
48.66
48.76
48.81
48.93
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49.15
49.32
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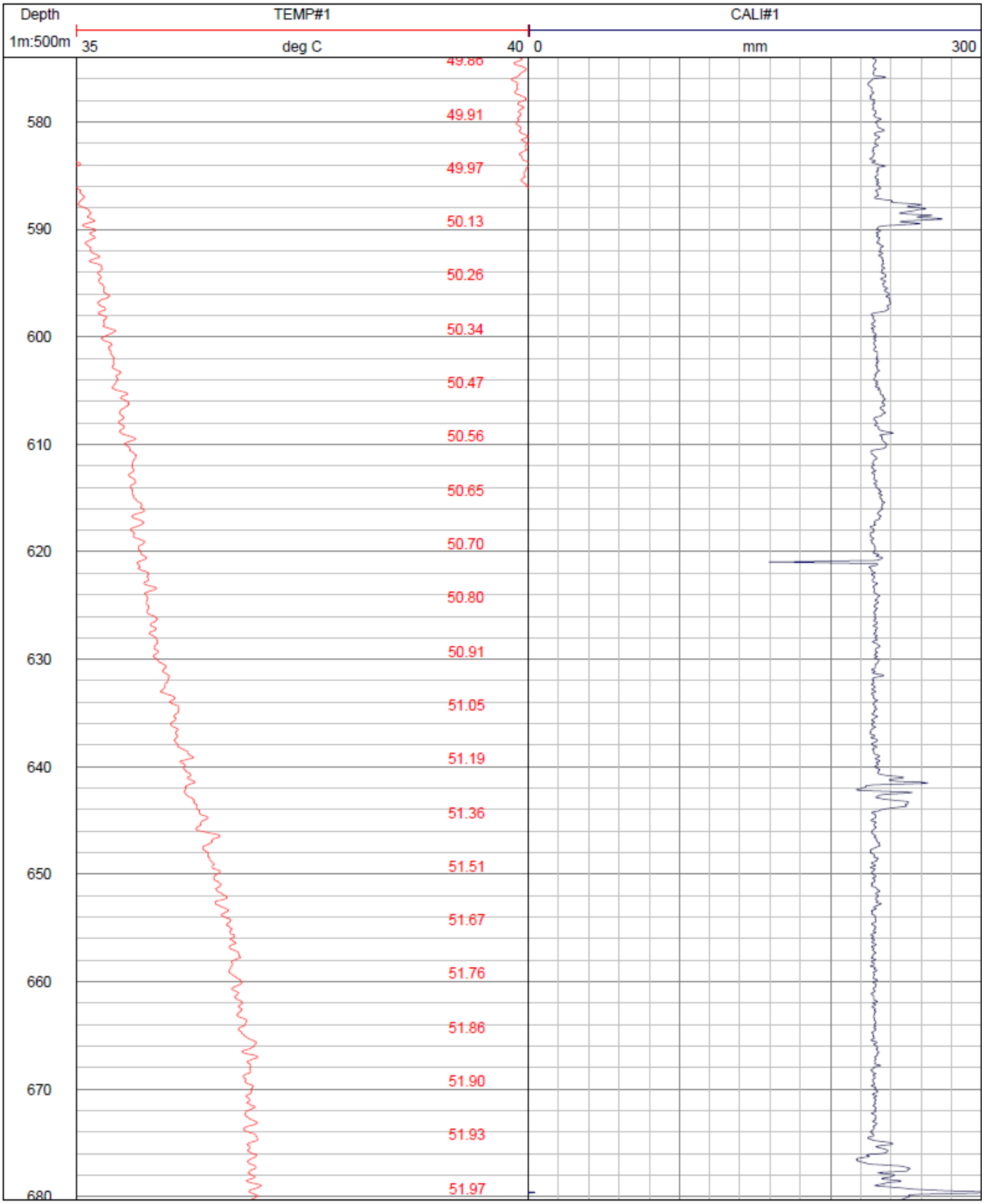
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deg C
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CALI#1
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mm
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600
610
620
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640
650
660
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49.91
49.97
50.13
50.26
50.34
50.47
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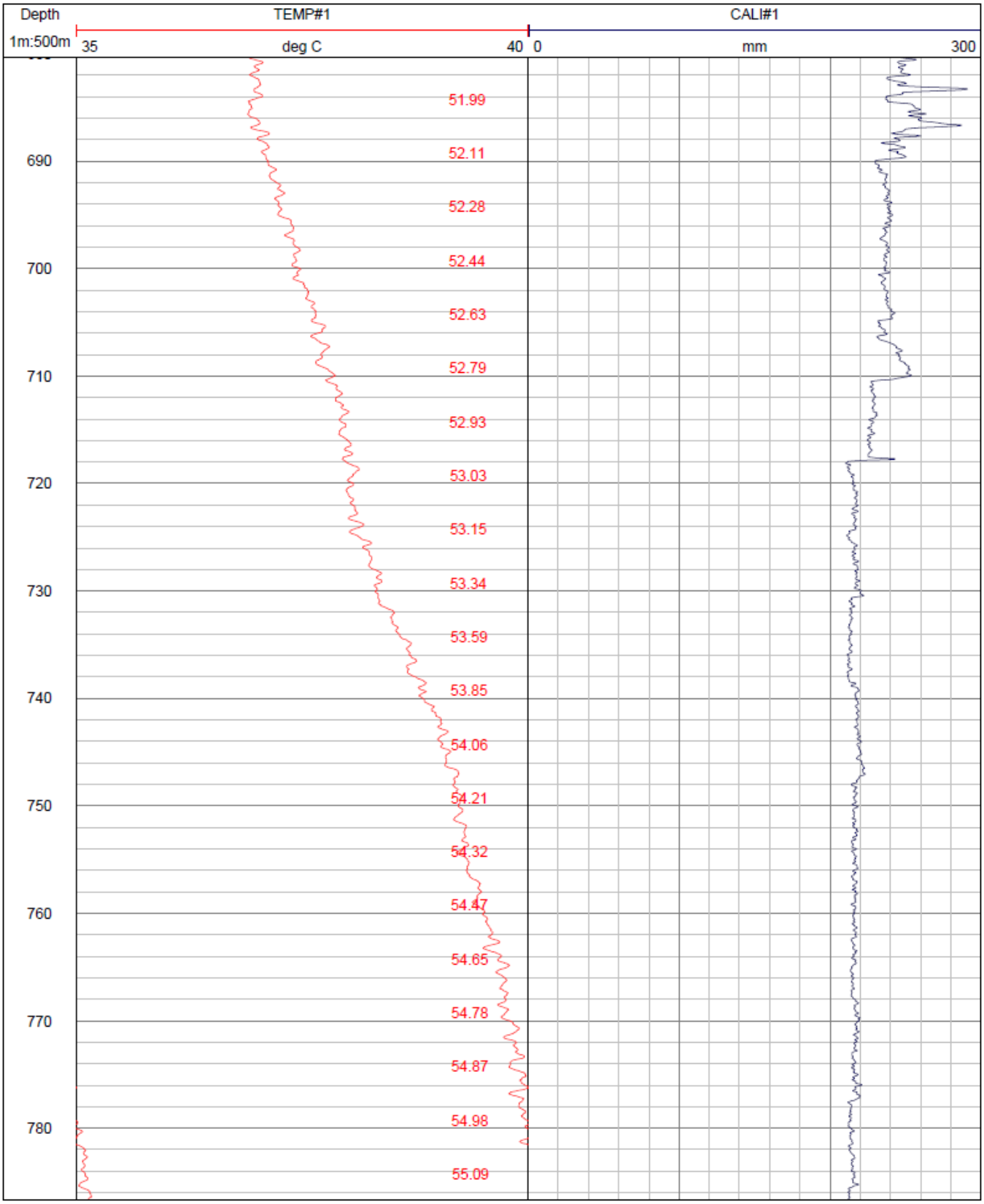
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mm
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710
720
730
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750
760
770
780
51.99
52.11
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52.63
52.79
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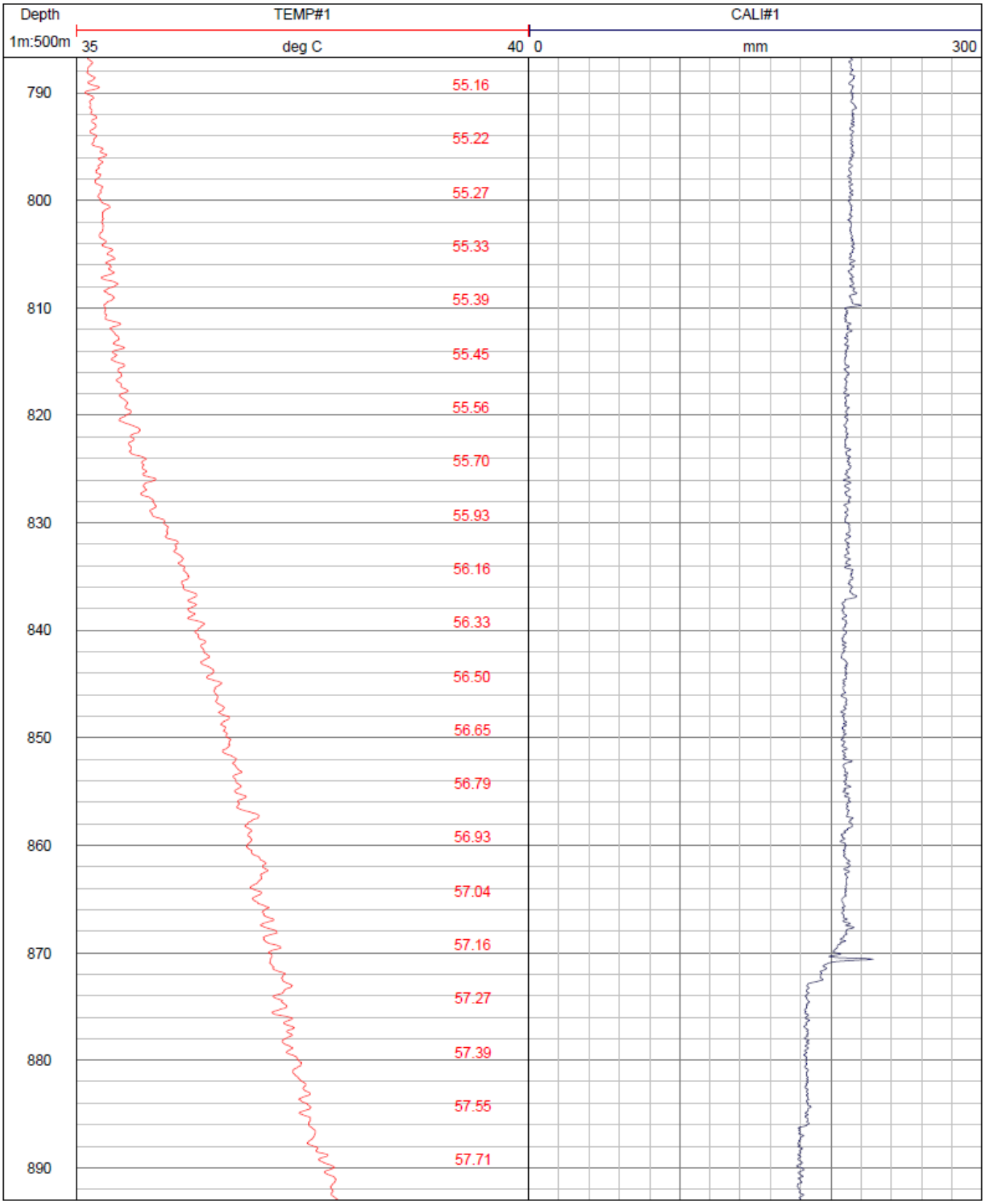
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mm
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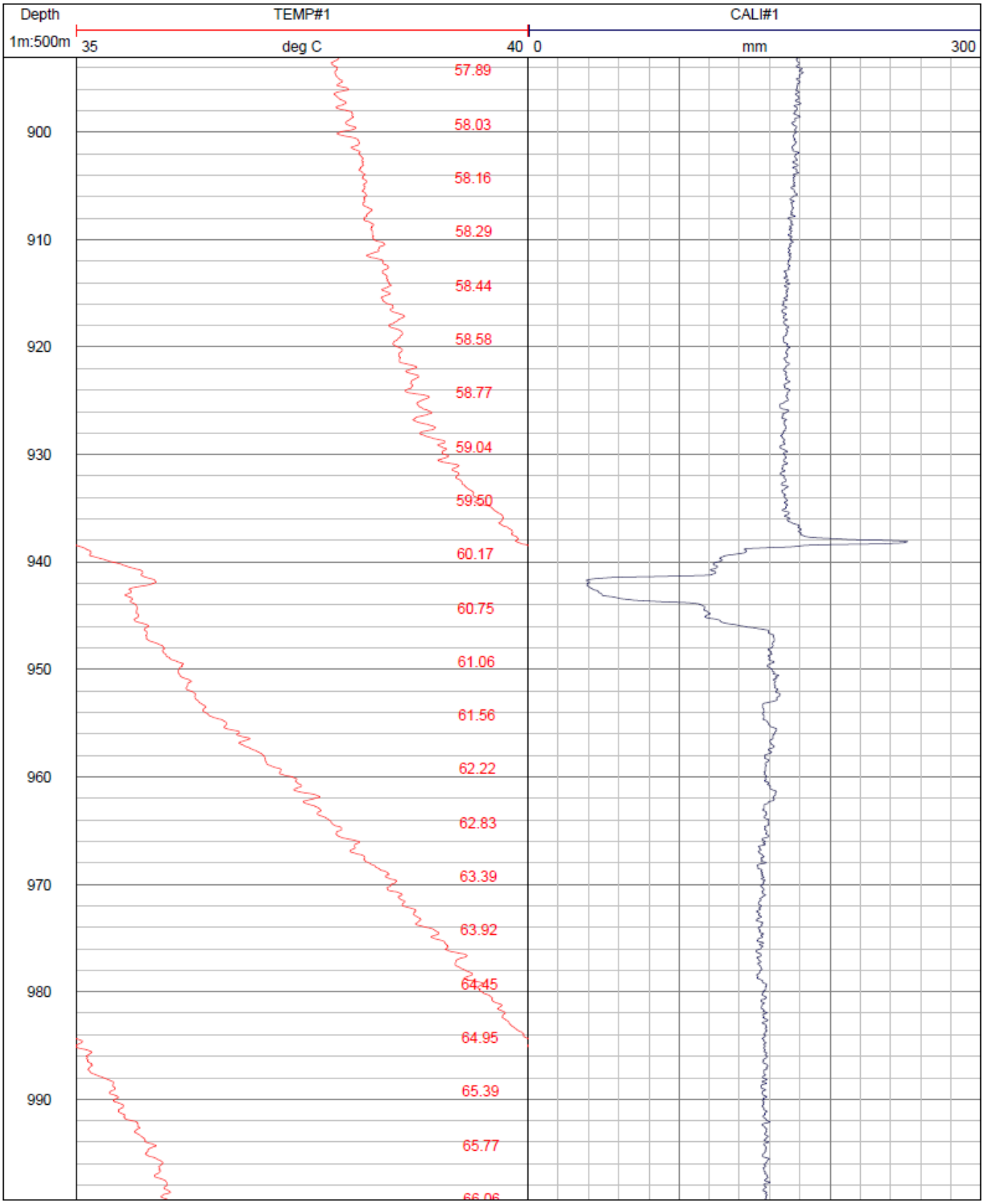
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930
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950
960
970
980
990
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58.03
58.16
58.29
58.44
58.58
58.77
59.04
59.50
60.17
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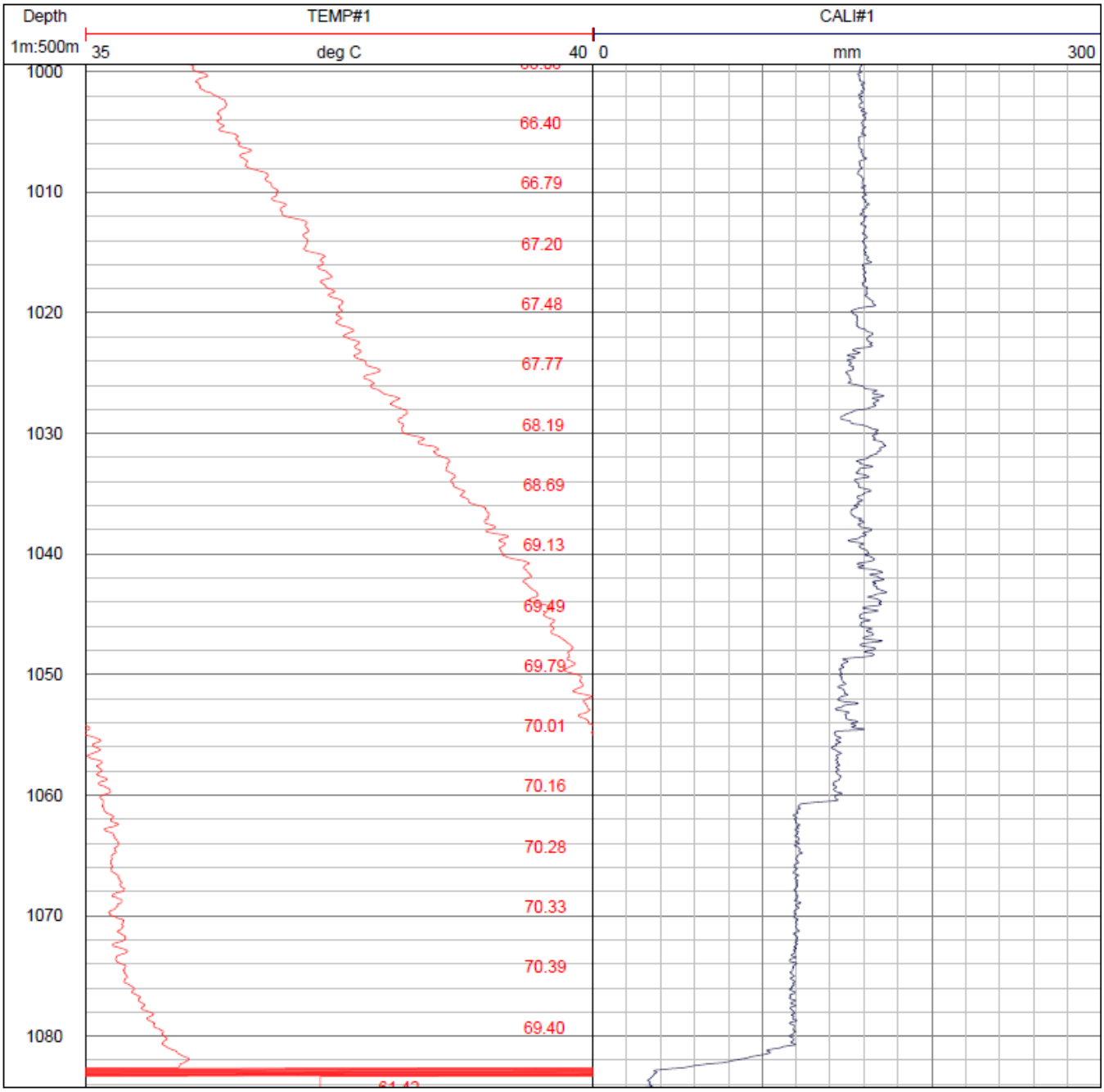
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69.13
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69.79
70.01
70.16
70.28
70.33
70.39
69.40

Client:	DEWNR/Silver City Drilling	Location:	Mulka		
Purpose:	Cement evaluation	State:	SA		
Project:	Mulka replacement	Longitude/Easting:	0270154		
Date:	18/04/2016	Latitude/Northing:	6861008	Job number:	
Bore name:	New Mulka Bore	UTM zone:	54H	Sample interval:	5 cm
Unit no.:		Depth reference:	Top of casing	Vehicle:	XQB449
Permit no.:		Depth ref. elev.:		Driller depth:	1084 m
Fluid level:	0 m	Depth ref. above G.L.:	3.8 m (1 m above rig floor)	Logged depth:	1081 m
Fluid type:	Follow on water	Casing depth range:	0 m - 1084 m	Bit size:	
Operator:	KI & GK	Casing type:	Steel	Casing I.D.:	
Witness:	J. Wardle	Notes:	Cement curing time = 16 hrs		

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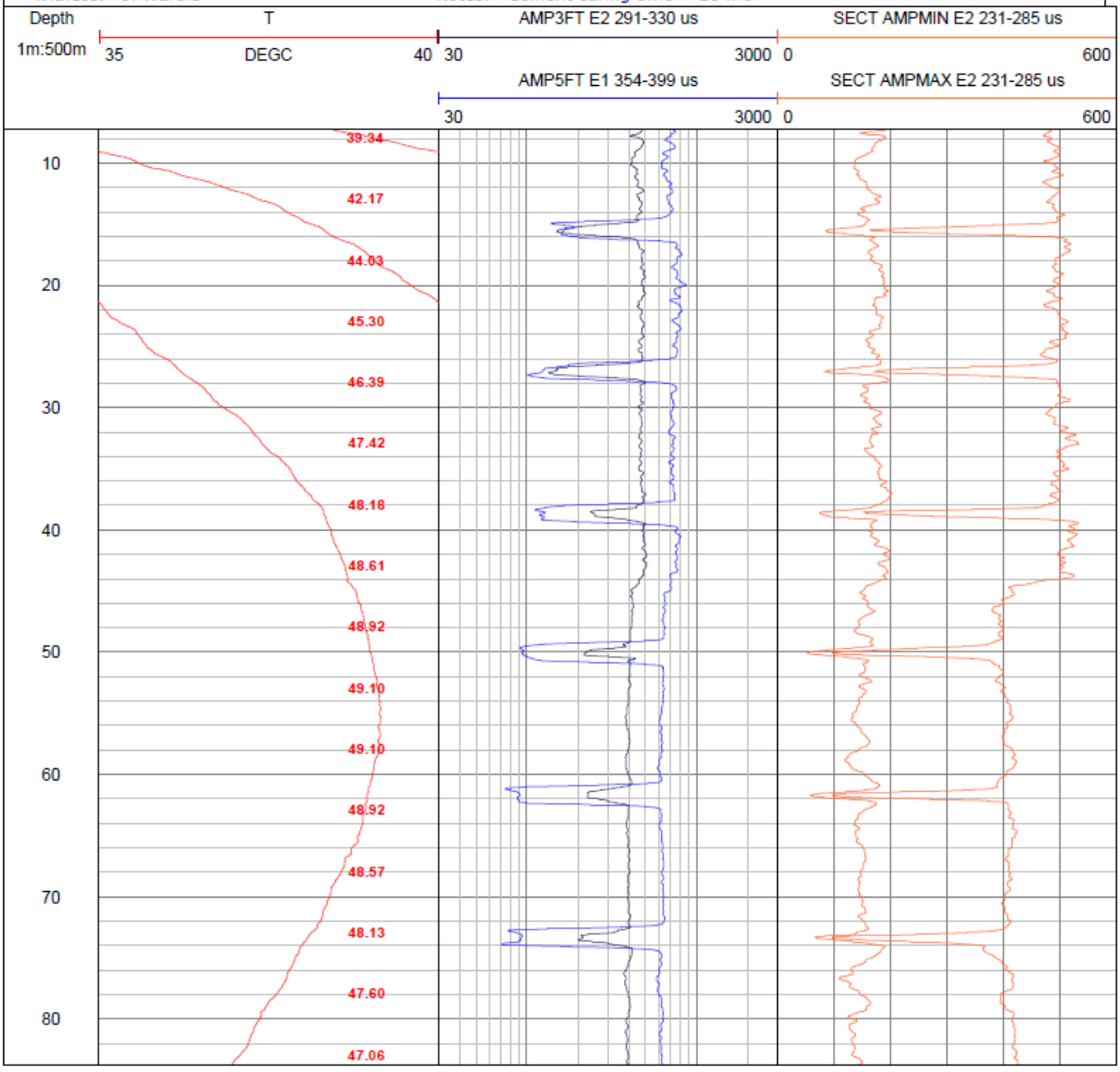

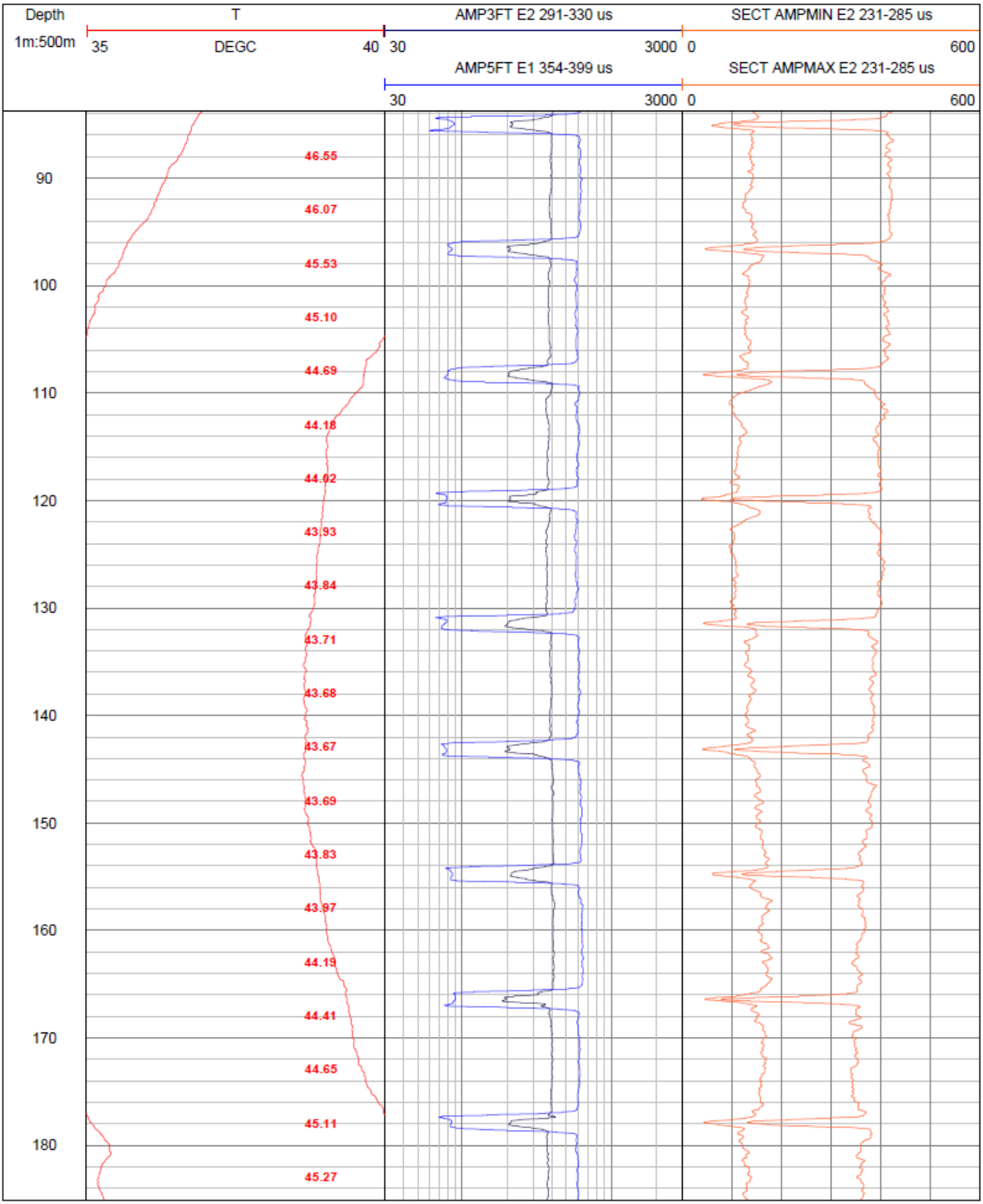
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AMP5FT E1 354-399 us
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3000
SECT AMPMIN E2 231-285 us
0
600
SECT AMPMAX E2 231-285 us
0
600
90
100
110
120
130
140
150
160
170
180
46.55
46.07
45.53
45.10
44.69
44.18
44.02
43.93
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43.97
44.19
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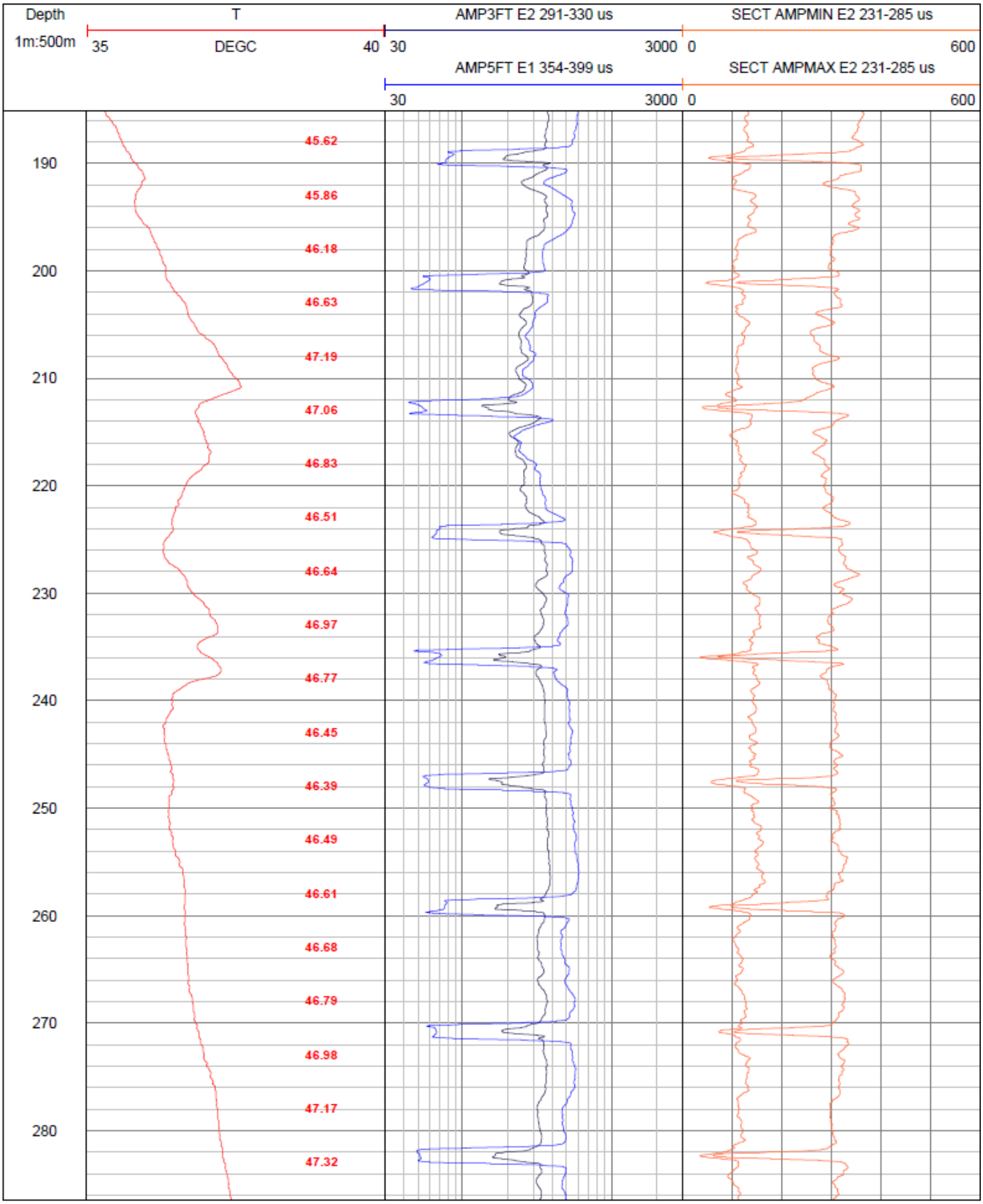
44.65
45.11
45.27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AMP5FT E1 354-399 us
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600
SECT AMPMAX E2 231-285 us
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600
190
200
210
220
230
240
250
260
270
280
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45.86
46.18
46.63
47.19
47.06
46.83
46.51
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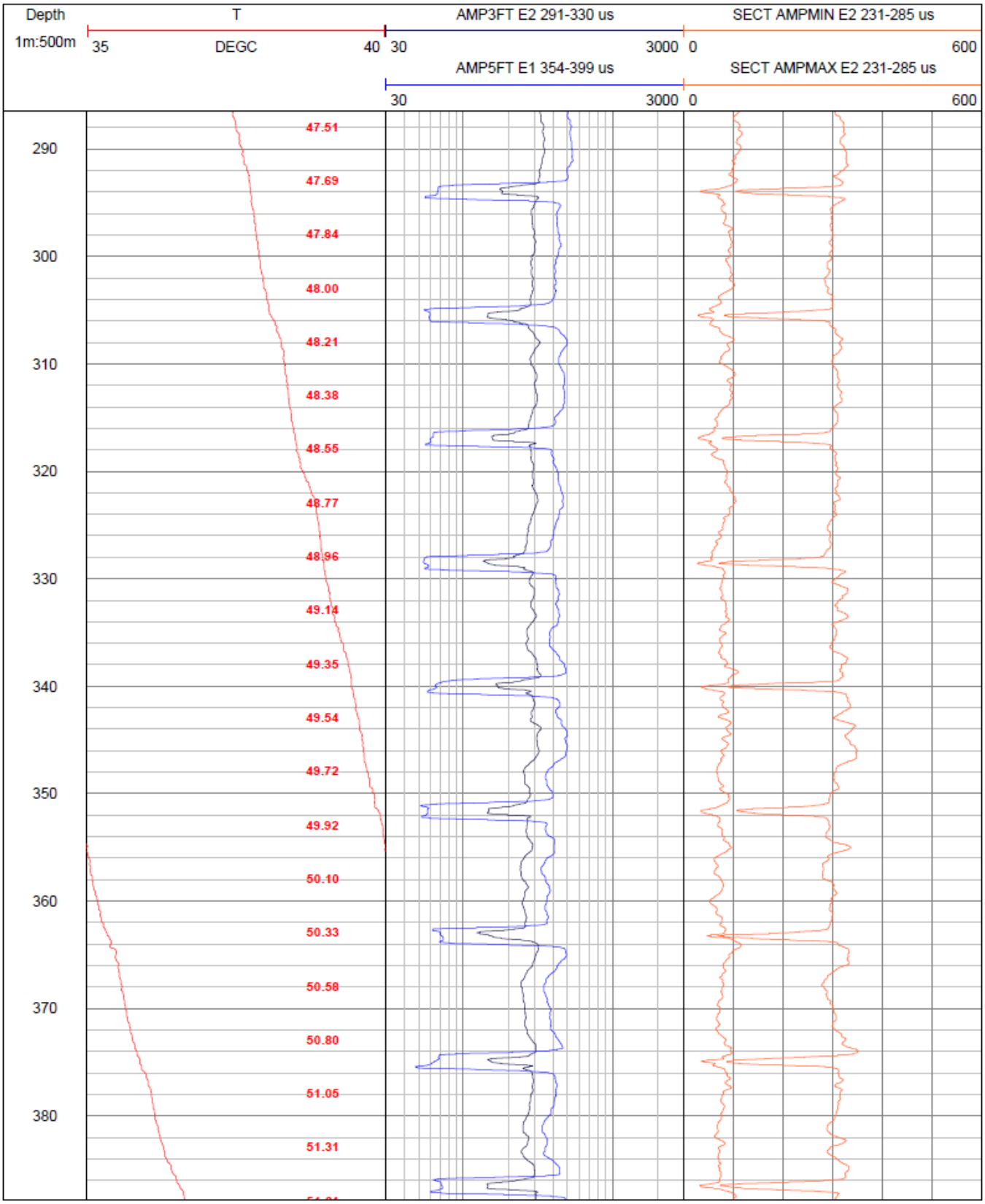
46.79
46.98
47.17
47.32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AMP5FT E1 354-399 us
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600
SECT AMPMAX E2 231-285 us
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290
300
310
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330
340
350
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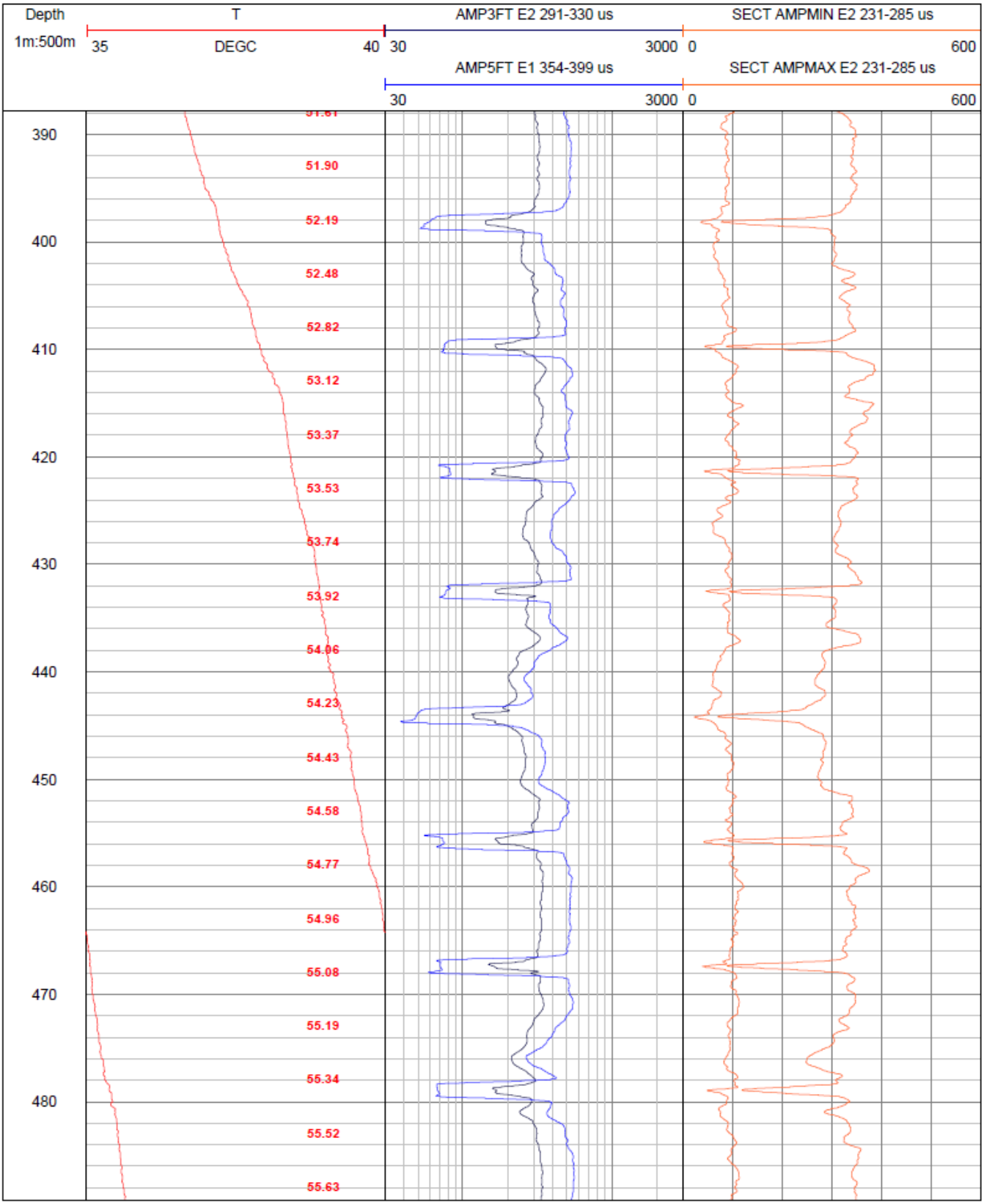
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1m:500m
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DEGC
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AMP5FT E1 354-399 us
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3000
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600
SECT AMPMAX E2 231-285 us
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600
390
400
410
420
430
440
450
460
470
480
51.90
52.19
52.48
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53.53
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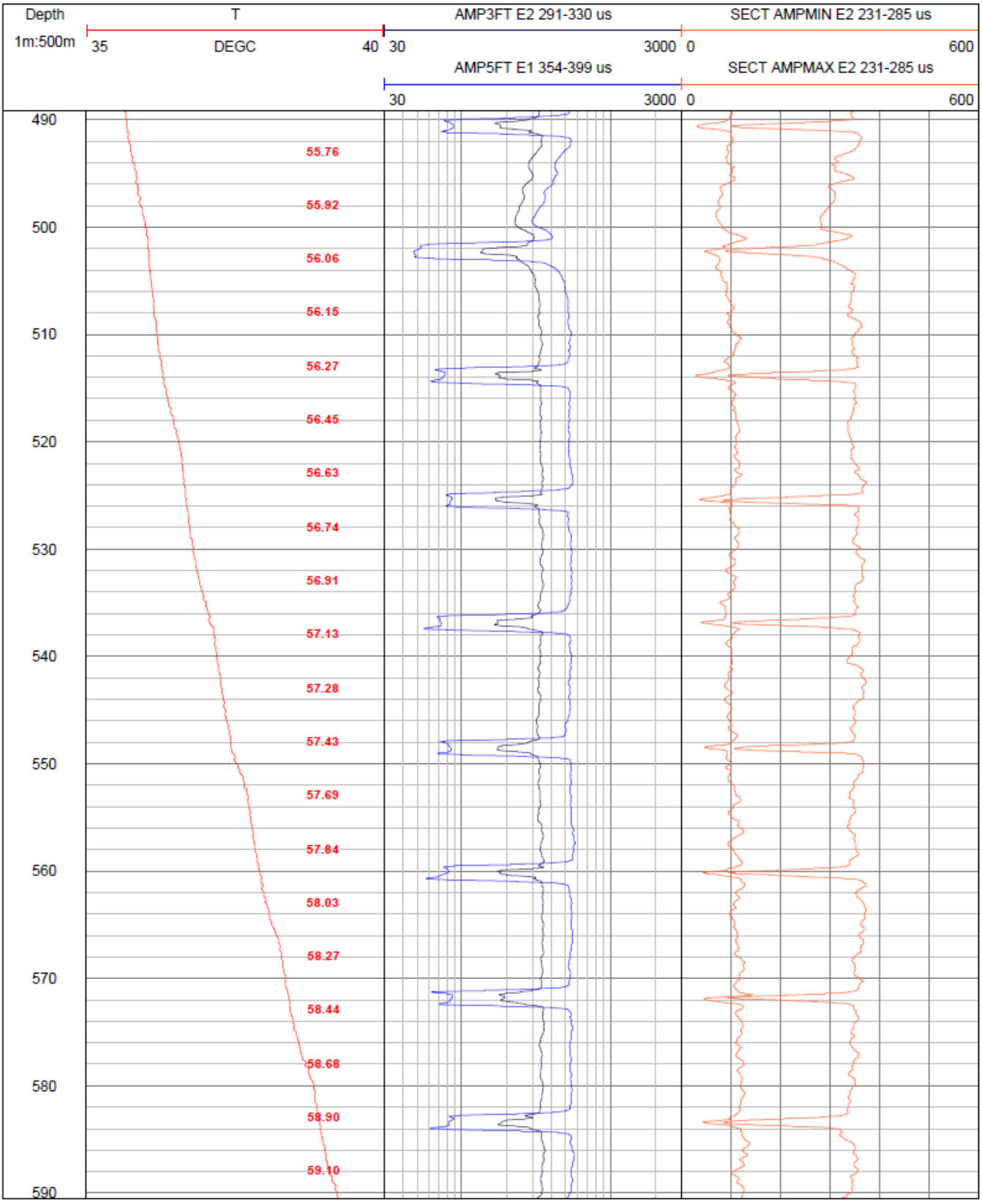
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1m:500m
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AMP5FT E1 354-399 us
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600
SECT AMPMAX E2 231-285 us
0
600
490
500
510
520
530
540
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560
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580
590
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56.06
56.15
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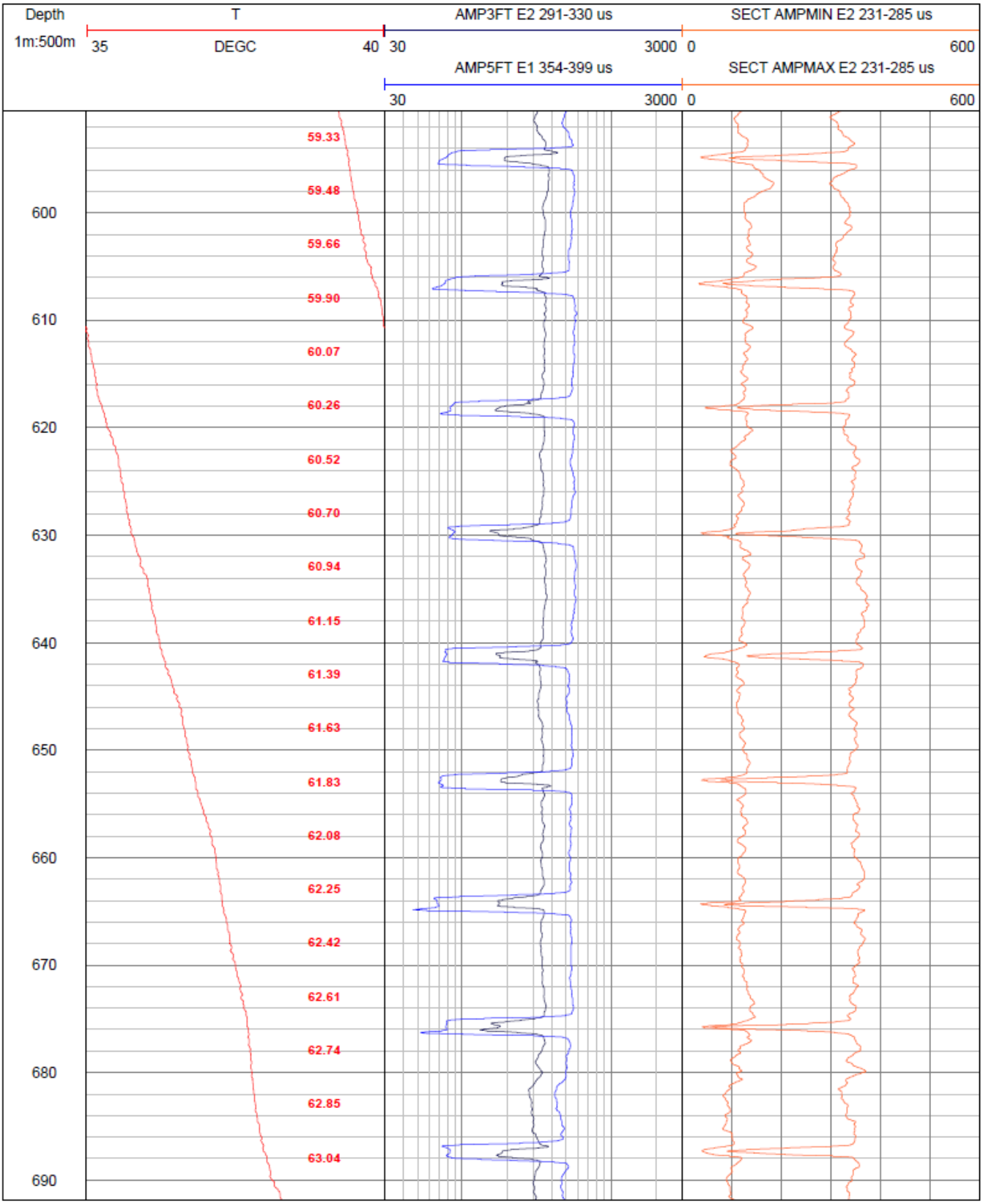
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DEGC
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AMP3FT E2 291-330 us
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AMP5FT E1 354-399 us
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3000
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SECT AMPMAX E2 231-285 us
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600
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61.63
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62.08
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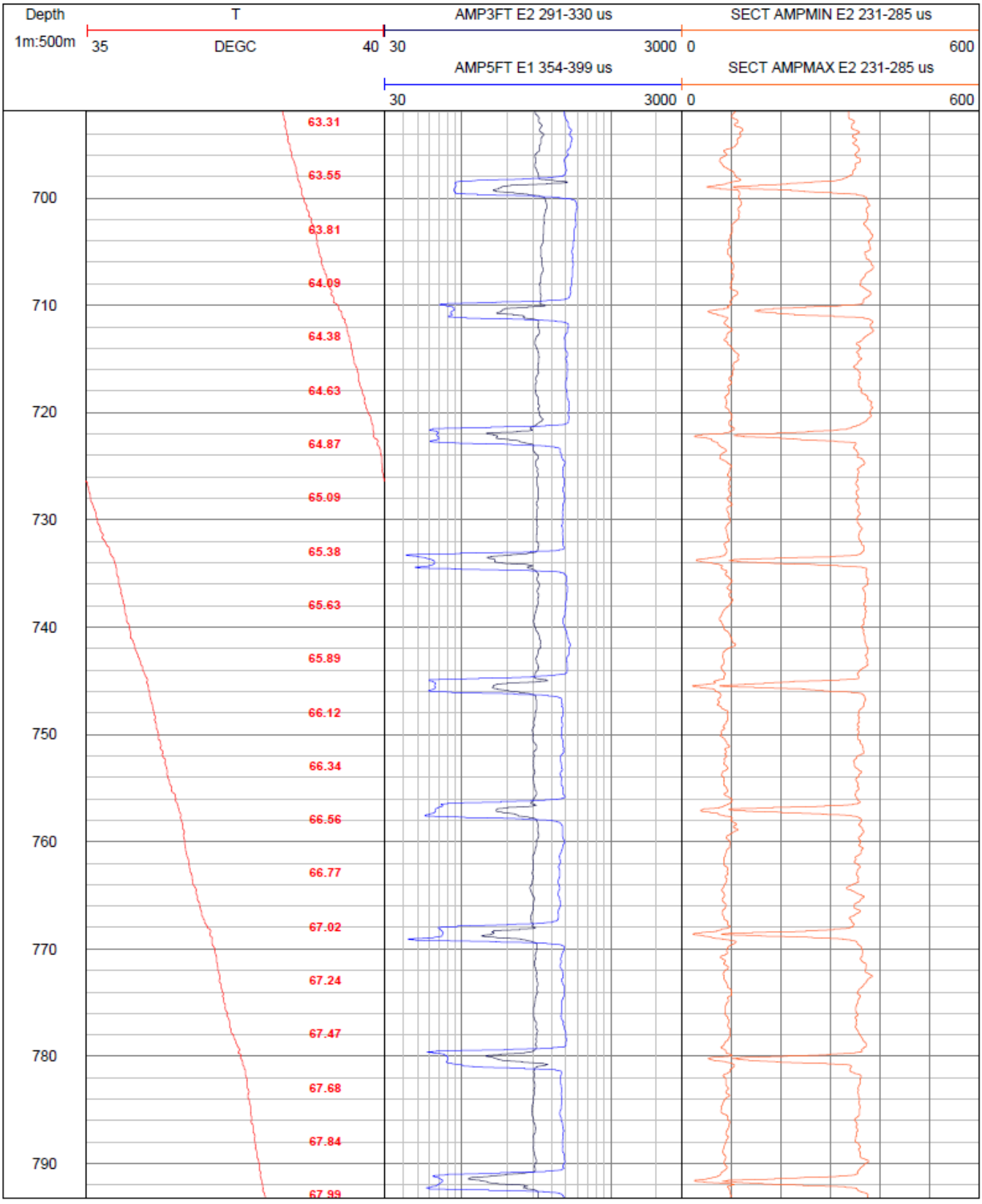
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AMP5FT E1 354-399 us
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3000
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SECT AMPMAX E2 231-285 us
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600
700
710
720
730
740
750
760
770
780
790
63.31
63.55
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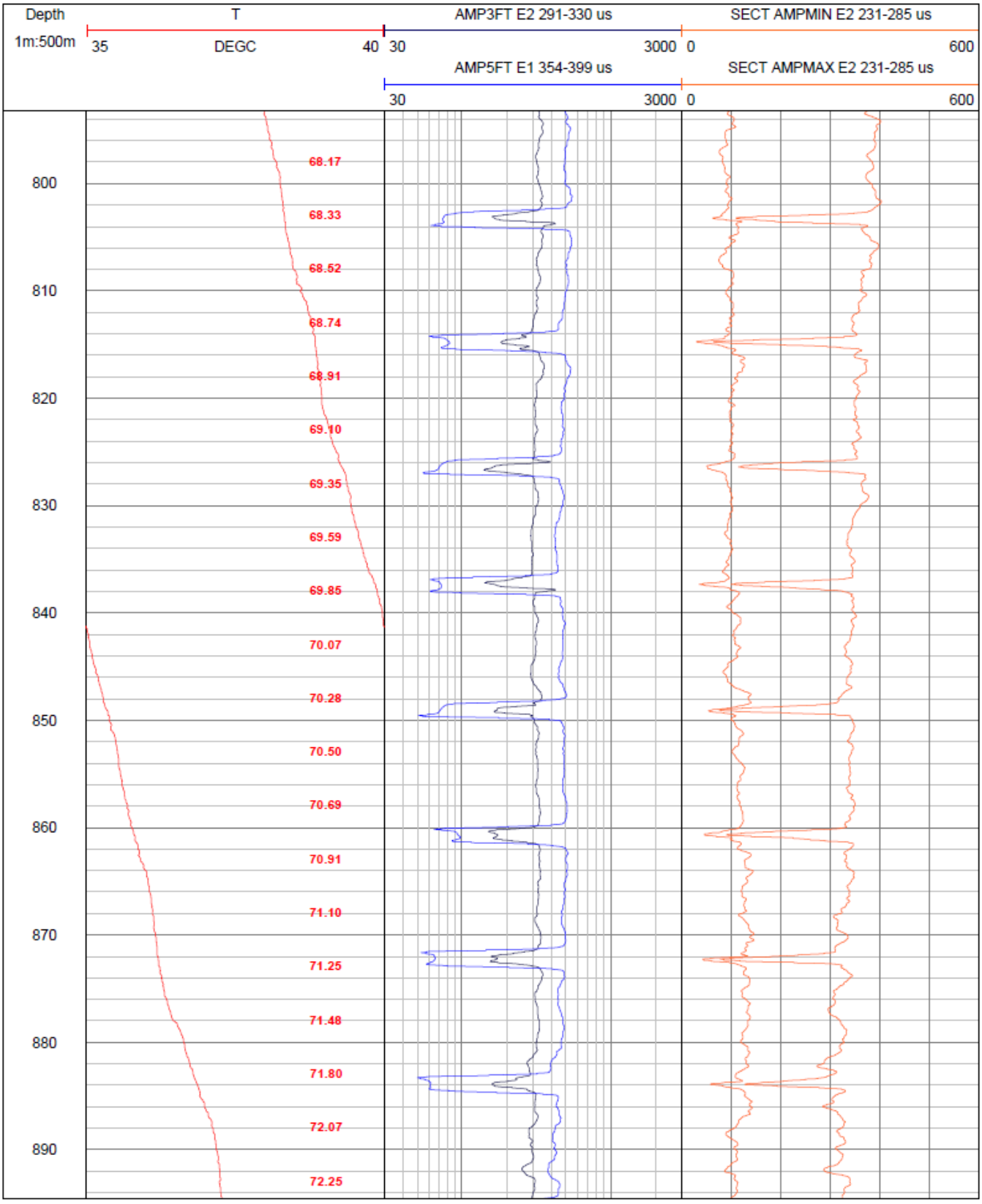
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AMP5FT E1 354-399 us
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SECT AMPMAX E2 231-285 us
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600
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810
820
830
840
850
860
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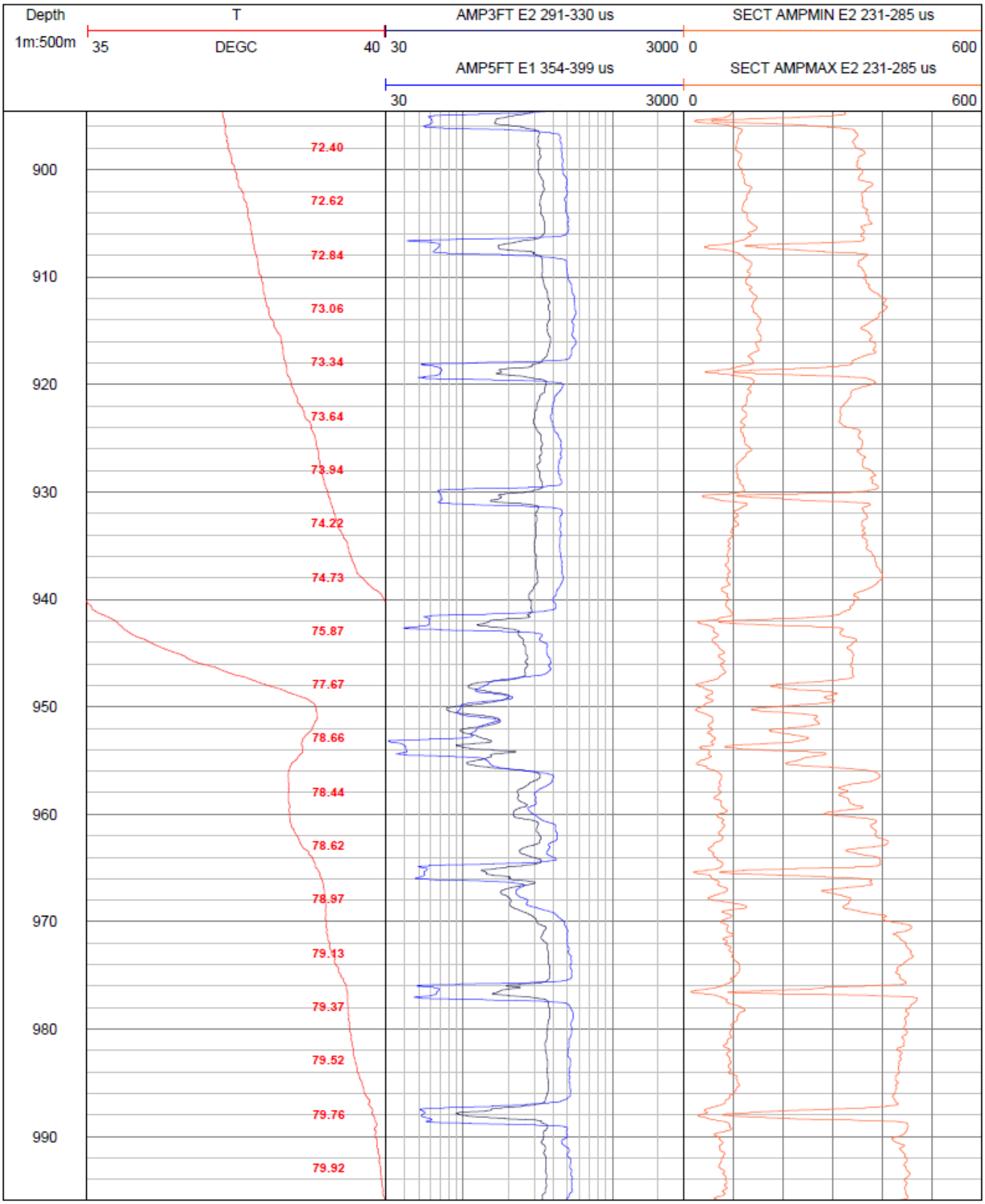
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AMP5FT E1 354-399 us
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SECT AMPMAX E2 231-285 us
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920
930
940
950
960
970
980
990
72.40
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73.34
73.64
73.94
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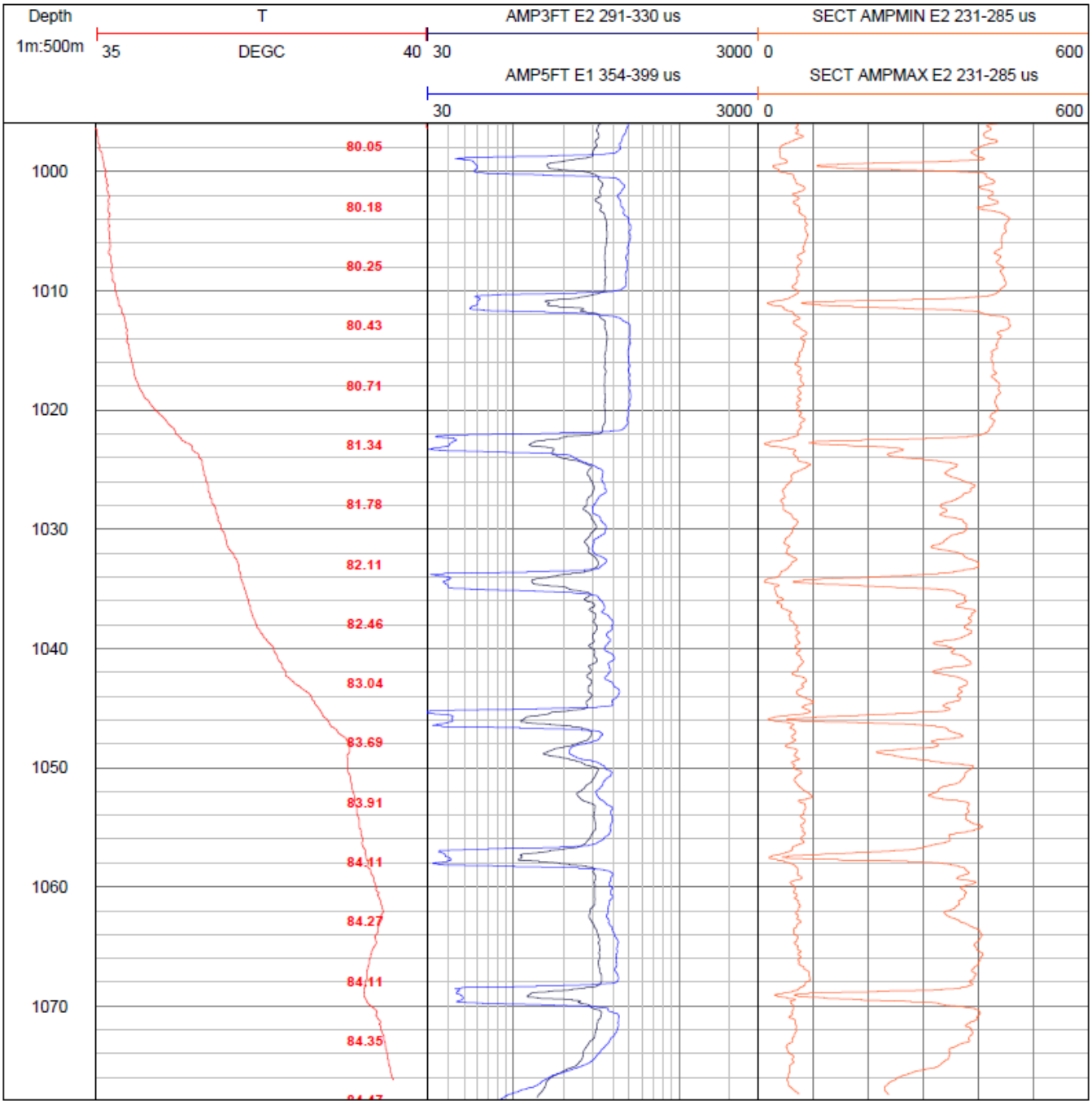
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AMP5FT E1 354-399 us
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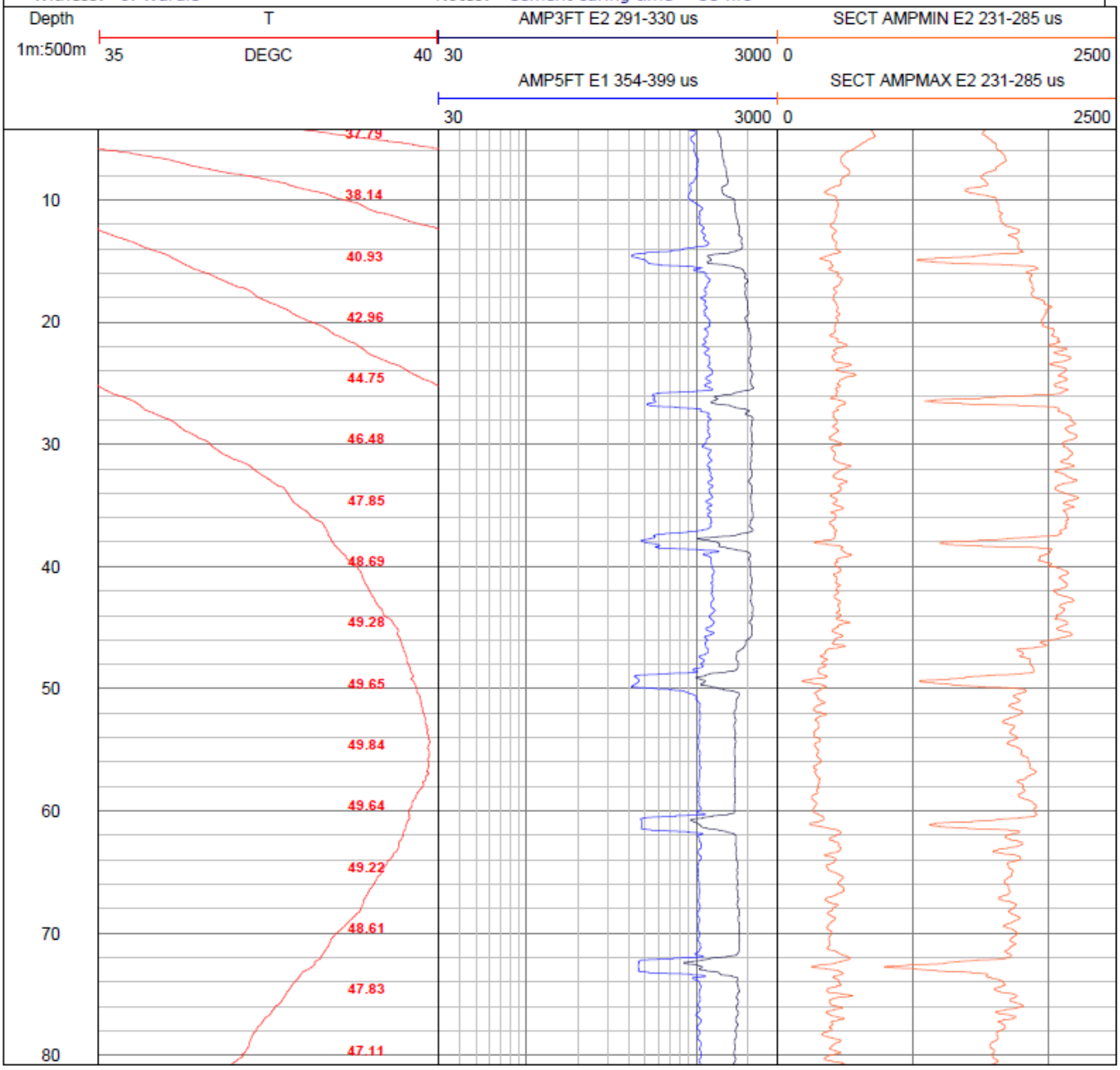
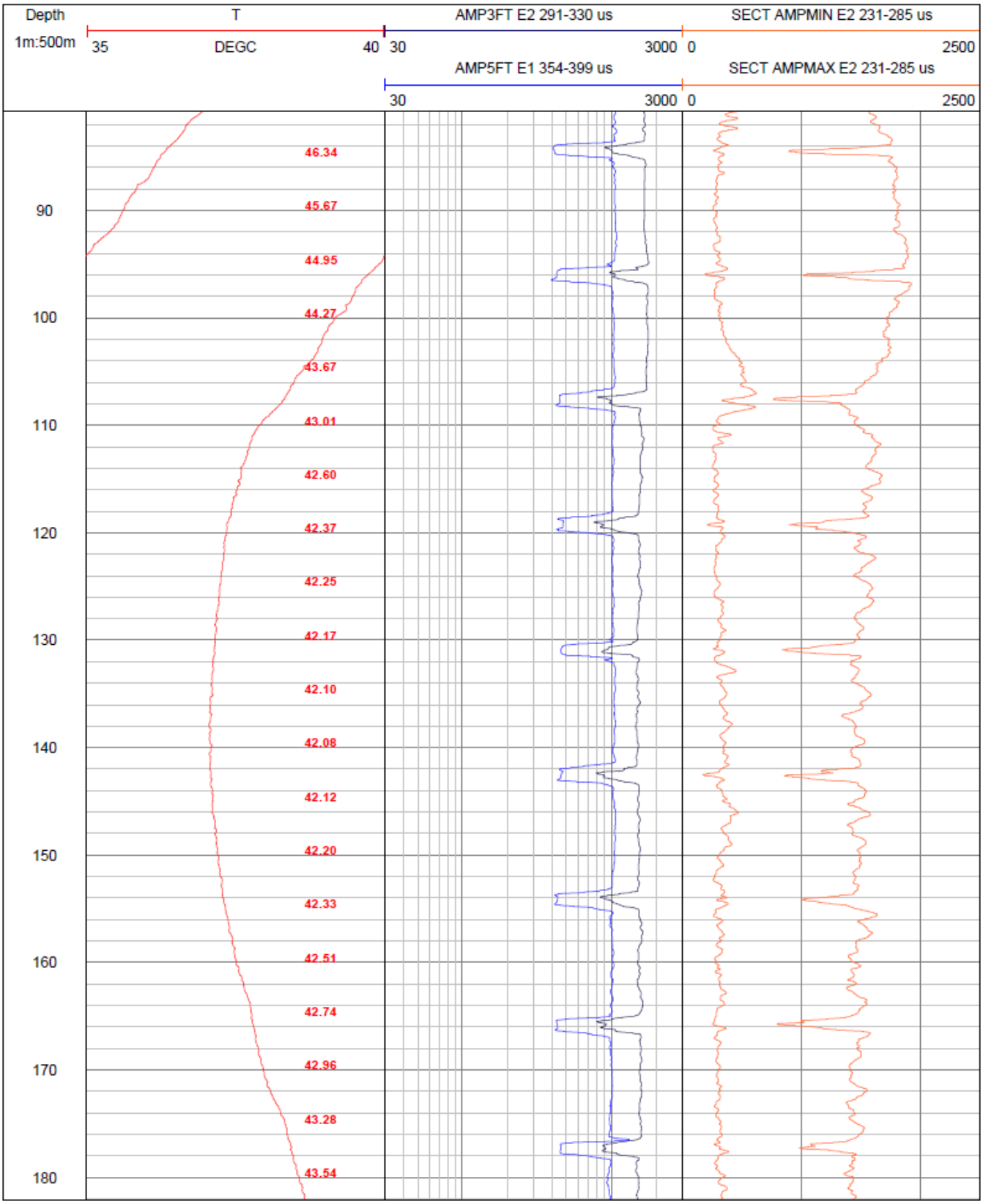
81.78
82.11
82.46
83.04
83.69
83.91
84.11
84.27
84.11
84.35

Client:	DEWNR/Silver City Drilling	Location:	Mulka
Purpose:	Cement evaluation	State:	SA
Project:	Mulka replacement	Longitude/Easting:	0270154
Date:	19/04/2016	Latitude/Northing:	6861008
Bore name:	New Mulka Bore	UTM zone:	54H
Unit no.:		Depth reference:	Top of casing
Permit no.:		Depth ref. elev.:	
Fluid level:	0 m	Depth ref. above G.L.:	3.8 m (1 m above rig floor)
Fluid type:	Follow on water	Casing depth range:	0 m to 1084 m
Operator:	KI & GK	Casing type:	Steel
Witness:	J. Wardle	Notes:	Cement curing time = 33 hrs

Government of South Australia
Department of Environment, Water and Natural Resources

Job number:	
Sample interval:	5 cm
Vehicle:	XQB449
Driller depth:	1084 m
Logged depth:	1081 m
Bit size:	
Casing I.D.:	

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1m:500m
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DEGC
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30
3000
AMP5FT E1 354-399 us
30
3000
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0
2500
SECT AMPMAX E2 231-285 us
0
2500
90
100
110
120
130
140
150
160
170
180
46.34
45.67
44.95
44.27
43.67
43.01
42.60
42.37
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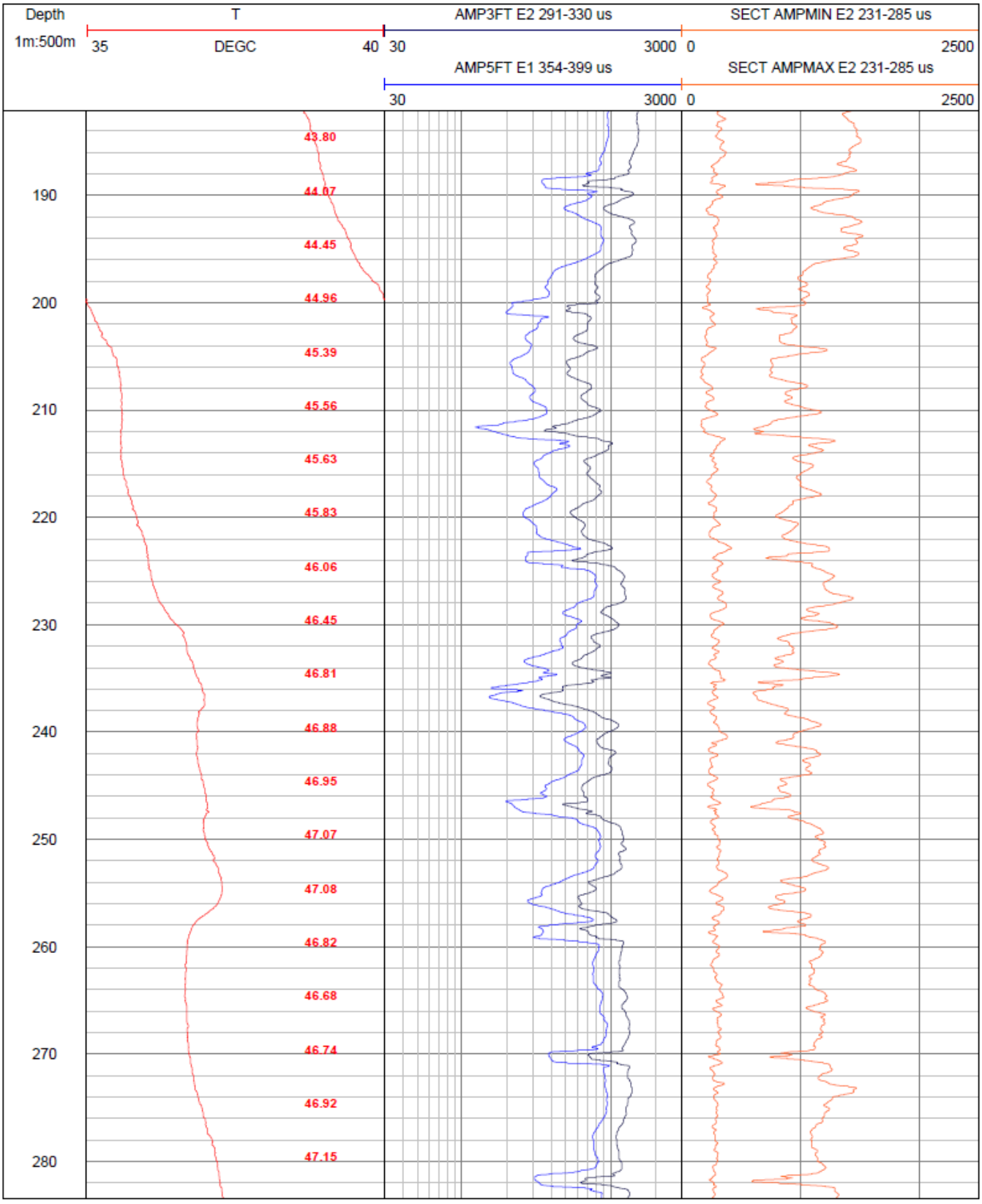
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DEGC
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3000
AMP5FT E1 354-399 us
30
3000
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0
2500
SECT AMPMAX E2 231-285 us
0
2500
190
200
210
220
230
240
250
260
270
280
43.80
44.07
44.45
44.96
45.39
45.56
45.63
45.83
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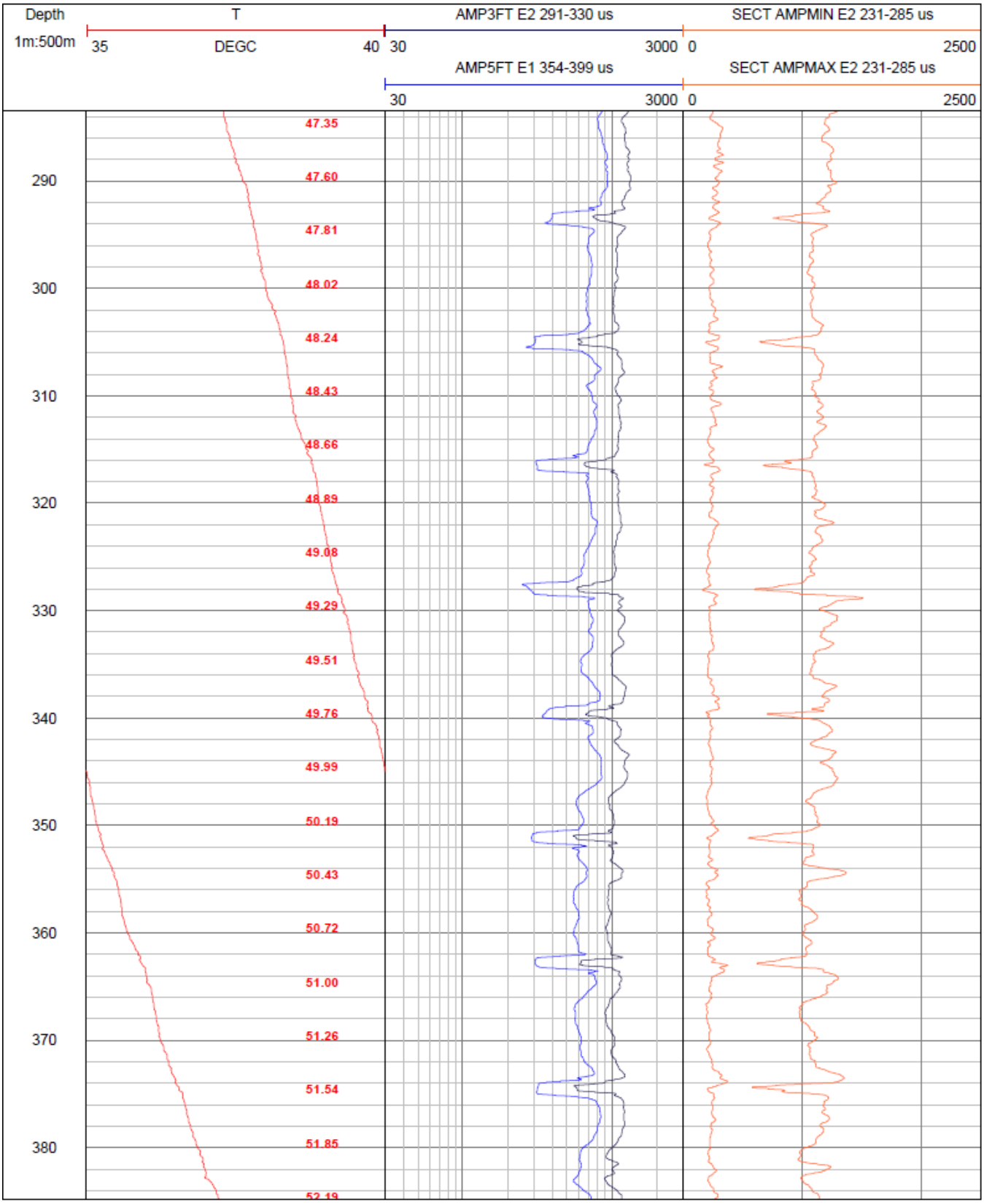
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AMP5FT E1 354-399 us
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2500
SECT AMPMAX E2 231-285 us
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2500
290
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310
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340
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360
370
380
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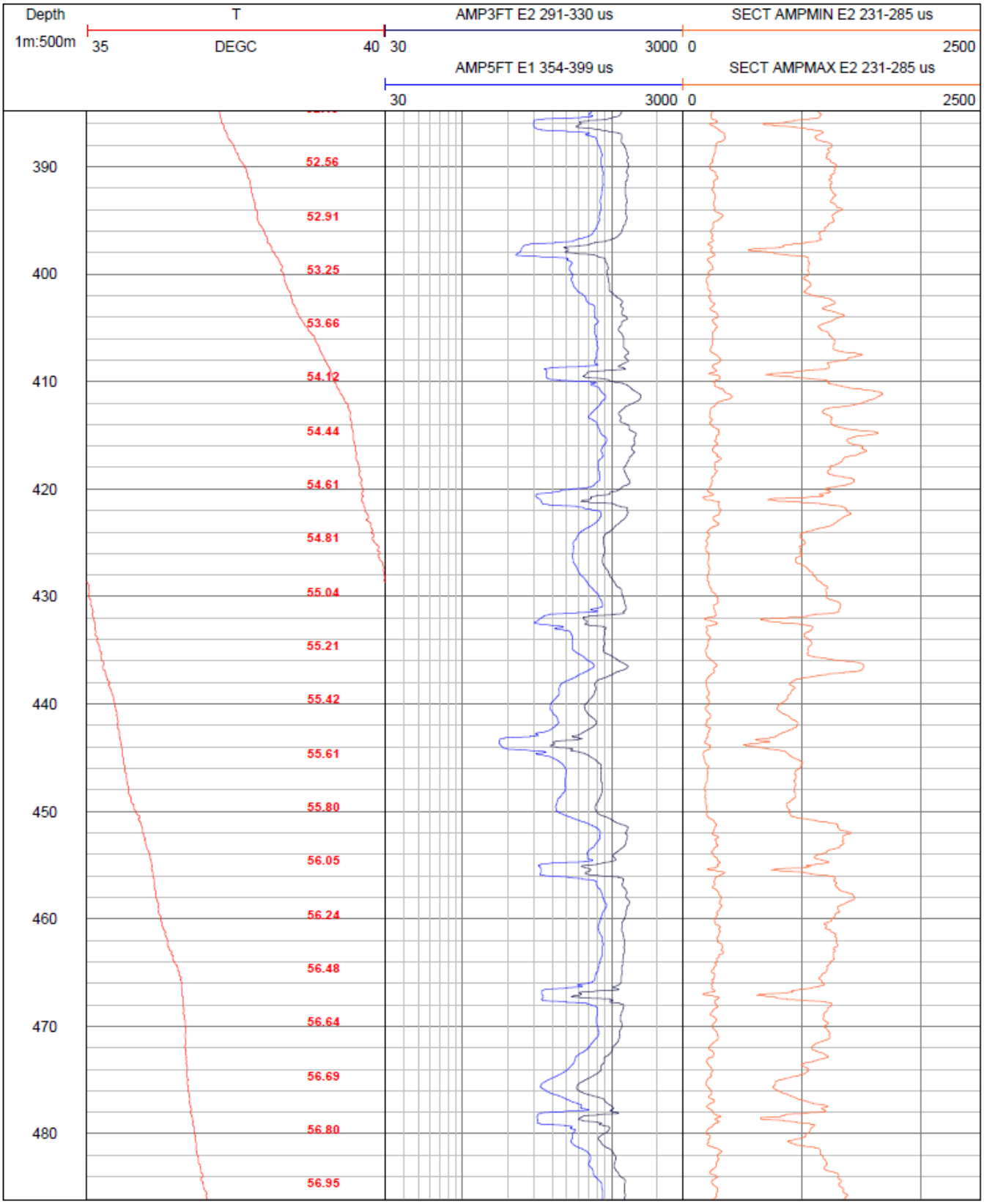
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AMP5FT E1 354-399 us
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SECT AMPMAX E2 231-285 us
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2500
390
400
410
420
430
440
450
460
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52.56
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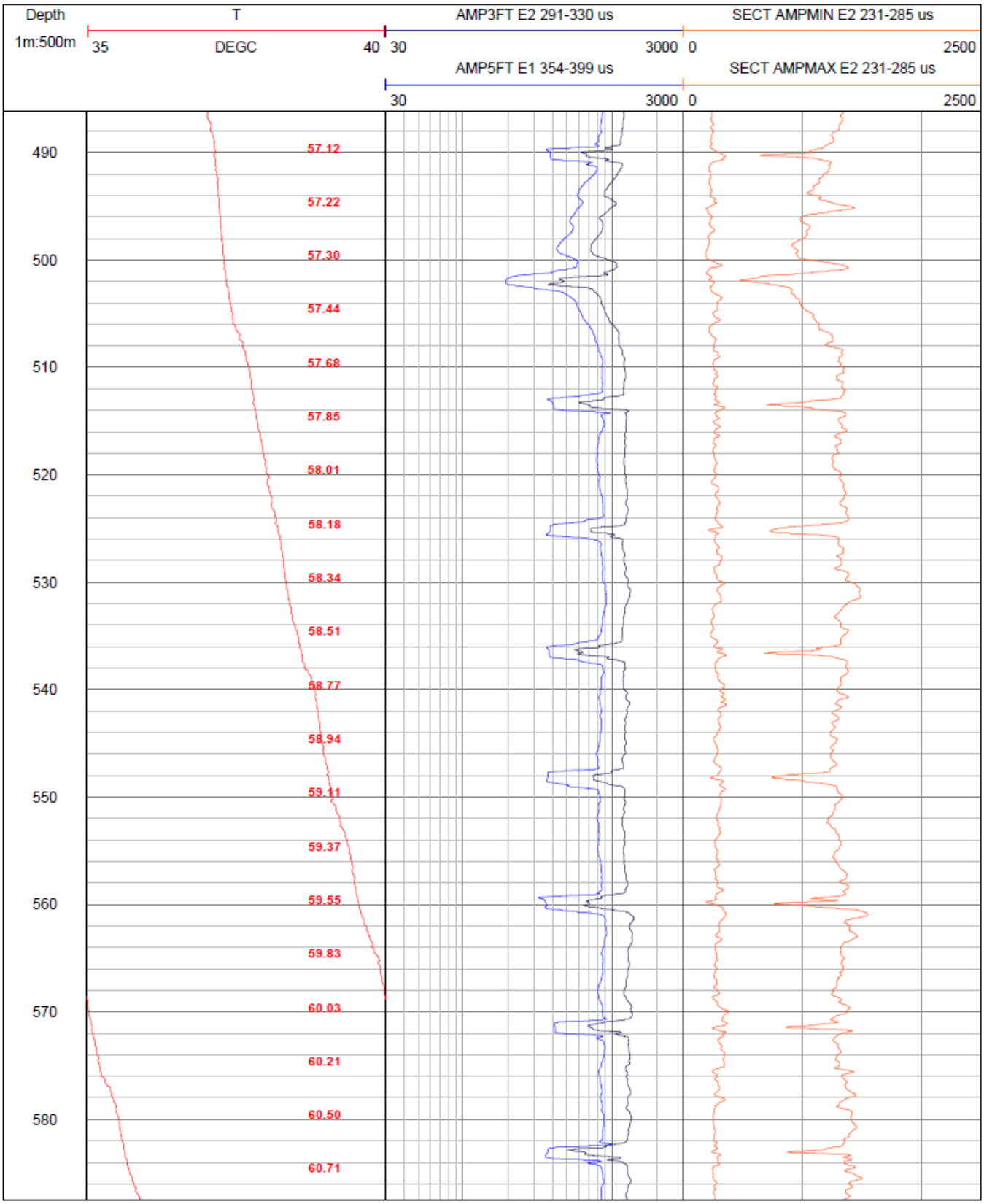
Depth
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DEGC
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AMP5FT E1 354-399 us
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2500
SECT AMPMAX E2 231-285 us
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2500
490
500
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520
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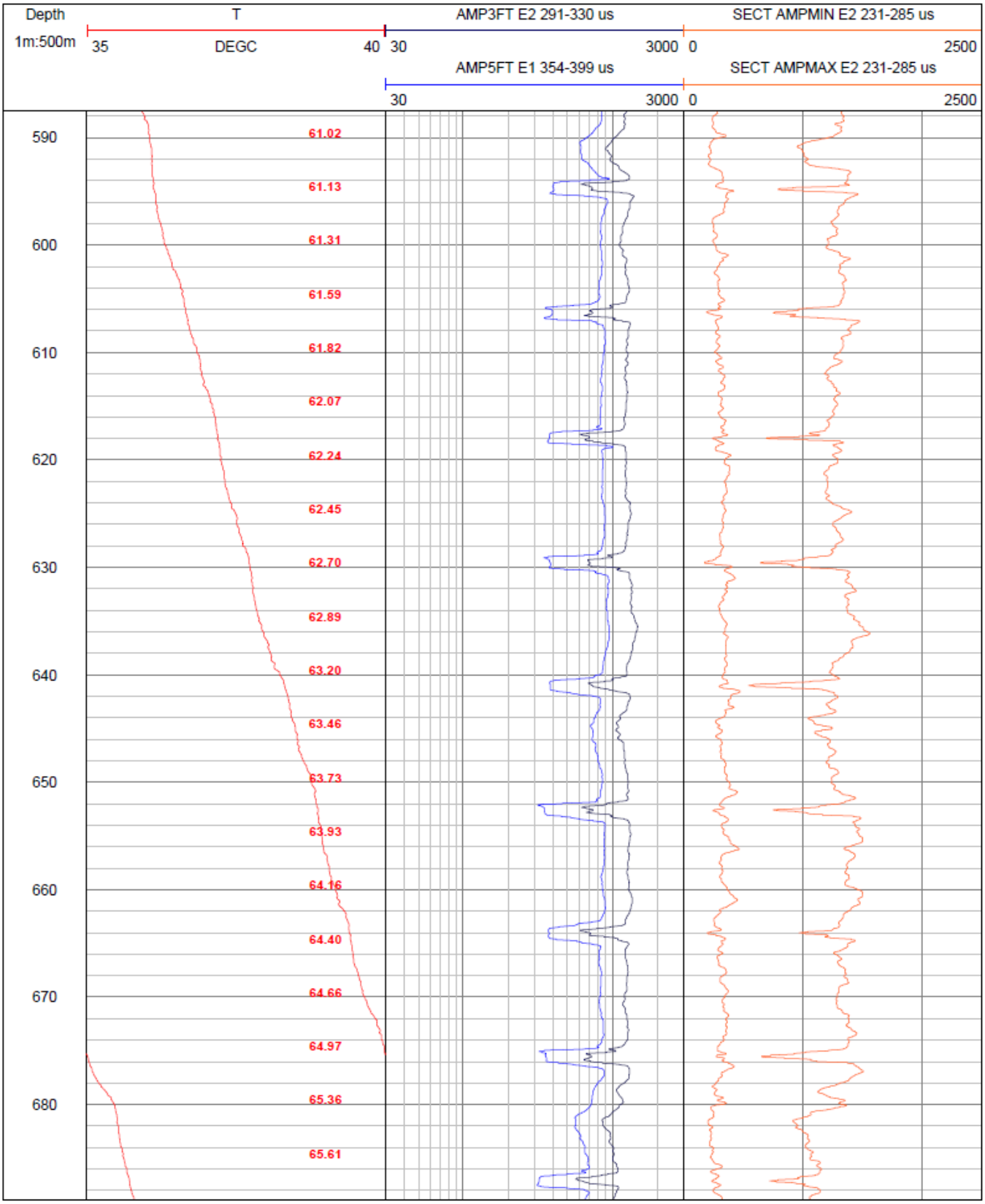
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DEGC
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3000
AMP5FT E1 354-399 us
30
3000
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0
2500
SECT AMPMAX E2 231-285 us
0
2500
590
600
610
620
630
640
650
660
670
680
61.02
61.13
61.31
61.59
61.82
62.07
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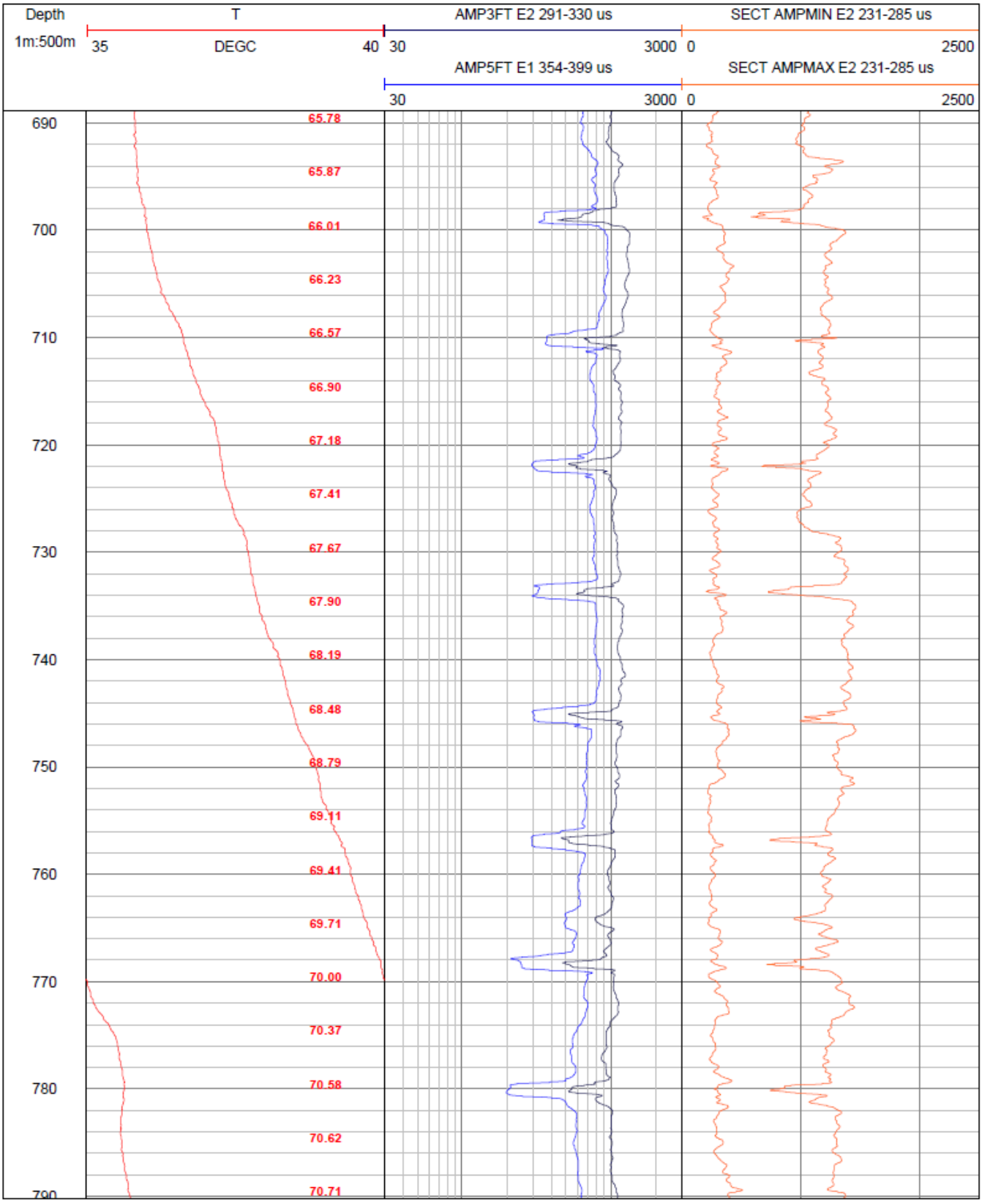
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1m:500m
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DEGC
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AMP3FT E2 291-330 us
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AMP5FT E1 354-399 us
30
3000
SECT AMPMIN E2 231-285 us
0
2500
SECT AMPMAX E2 231-285 us
0
2500
690
700
710
720
730
740
750
760
770
780
790
65.78
65.87
66.01
66.23
66.57
66.90
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67.41
67.67
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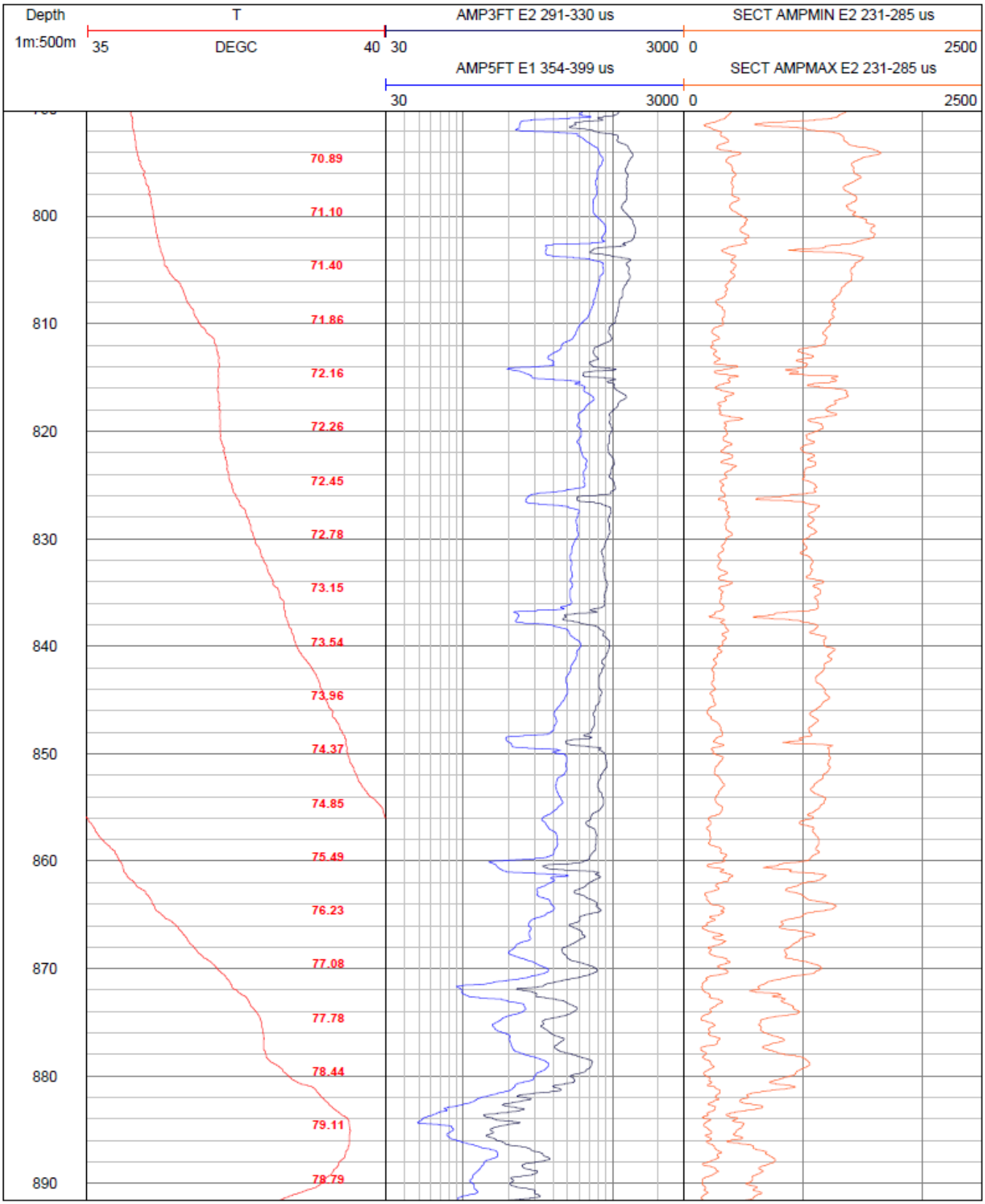
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2500
SECT AMPMAX E2 231-285 us
0
2500
800
810
820
830
840
850
860
870
880
890
70.89
71.10
71.40
71.86
72.16
72.26
72.45
72.78
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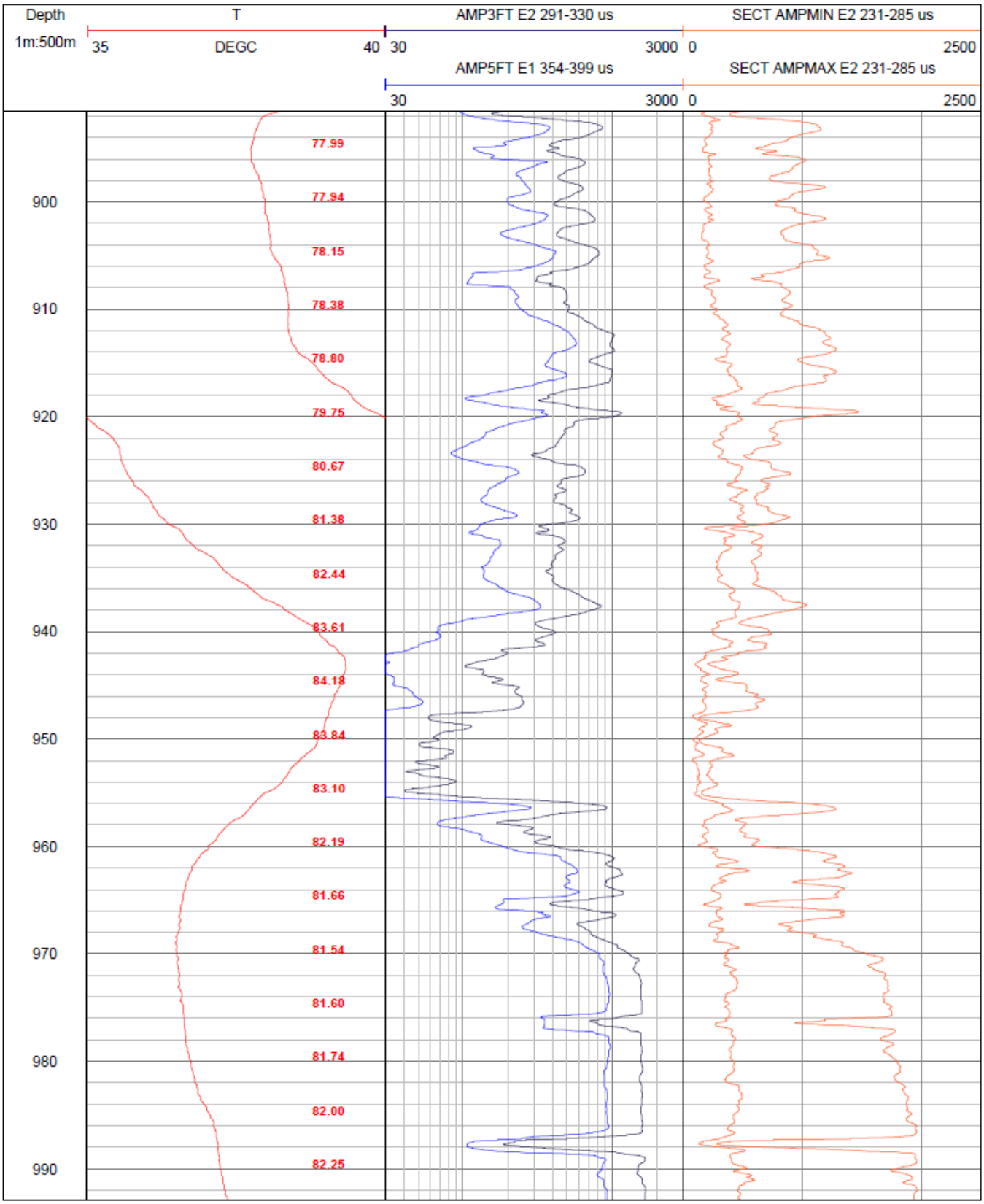
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2500
SECT AMPMAX E2 231-285 us
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2500
900
910
920
930
940
950
960
970
980
990
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77.94
78.15
78.38
78.80
79.75
80.67
81.38
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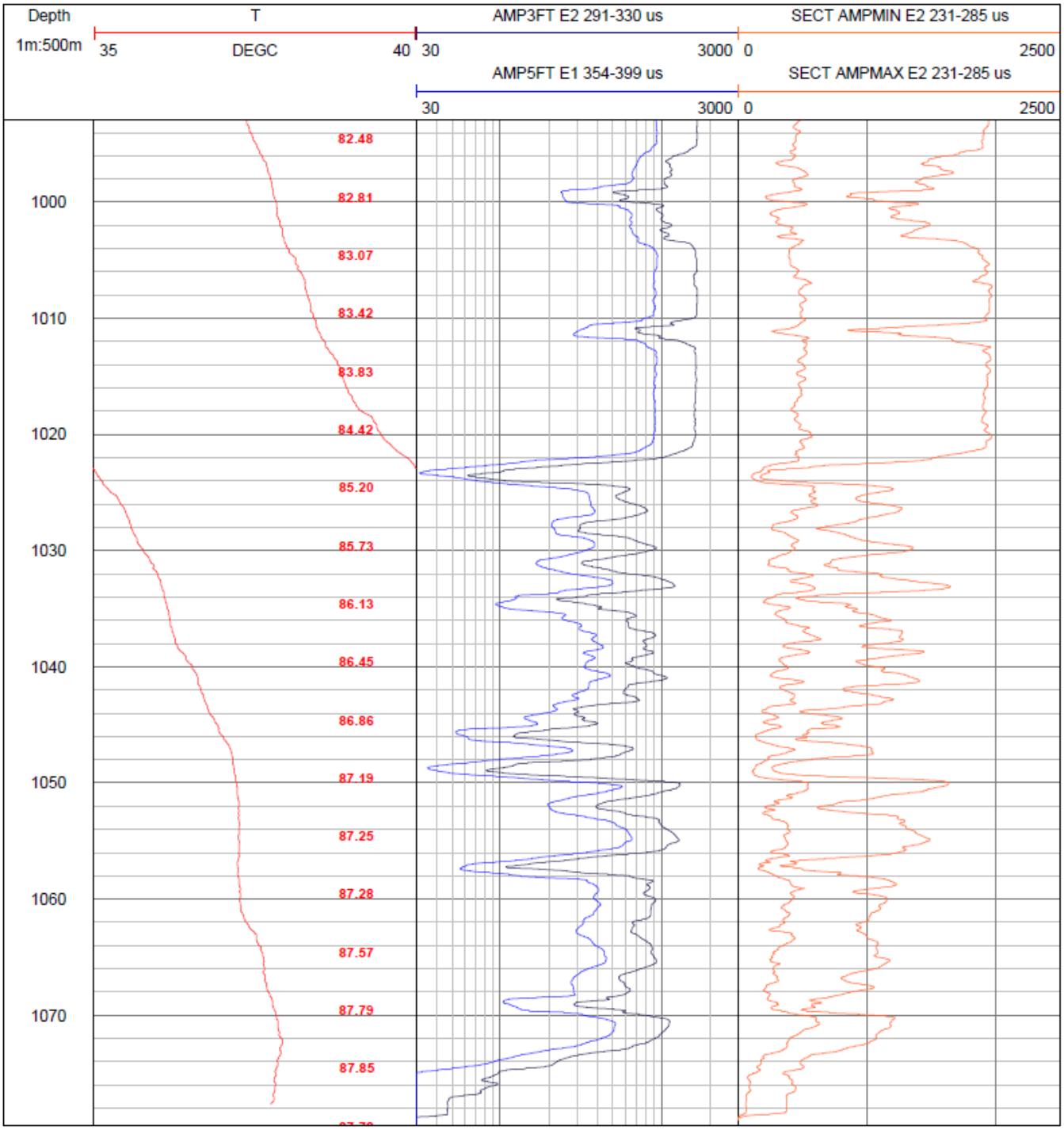
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DEGC
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3000
AMP5FT E1 354-399 us
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SECT AMPMIN E2 231-285 us
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2500
SECT AMPMAX E2 231-285 us
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2500
1000
1010
1020
1030
1040
1050
1060
1070
82.48
82.81
83.07
83.42
83.83
84.42
85.20
85.73
86.13
86.45
86.86
87.19
87.25
87.28
87.57
87.79
87.85

Client:	DEWNR / Silver City	Location:	Mulka		
Purpose:	Construction	State:	SA		
Project:		Longitude/Easting:	270151		
Date:	21/04/2016	Latitude/Northing:	6861019	Job number:	
Bore name:	New Mulka Bore	UTM zone:	54J	Sample interval:	5 cm
Unit no.:		Depth reference:	Rig floor	Vehicle:	XQB449
Permit no.:		Depth ref. elev.:		Driller depth:	1114 m
Fluid level:		Depth ref. above G.L.:	Rig floor = 2.8 m AGL	Logged depth:	1109.5 m
Fluid type:		Casing depth range:		Bit size:	
Operator:	KI and GK	Casing type:	Steel	Casing I.D.:	
Witness:		Notes:			

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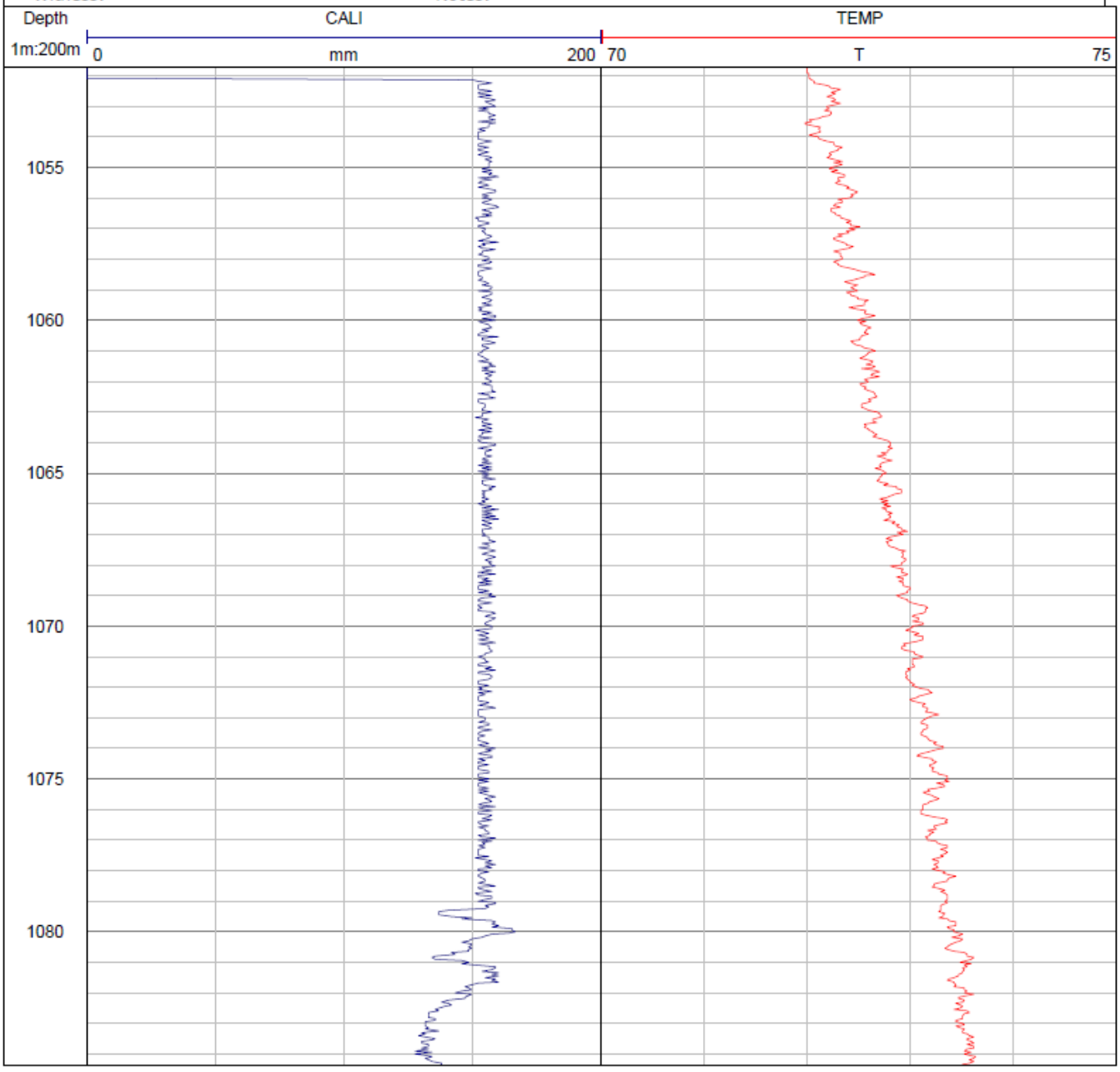
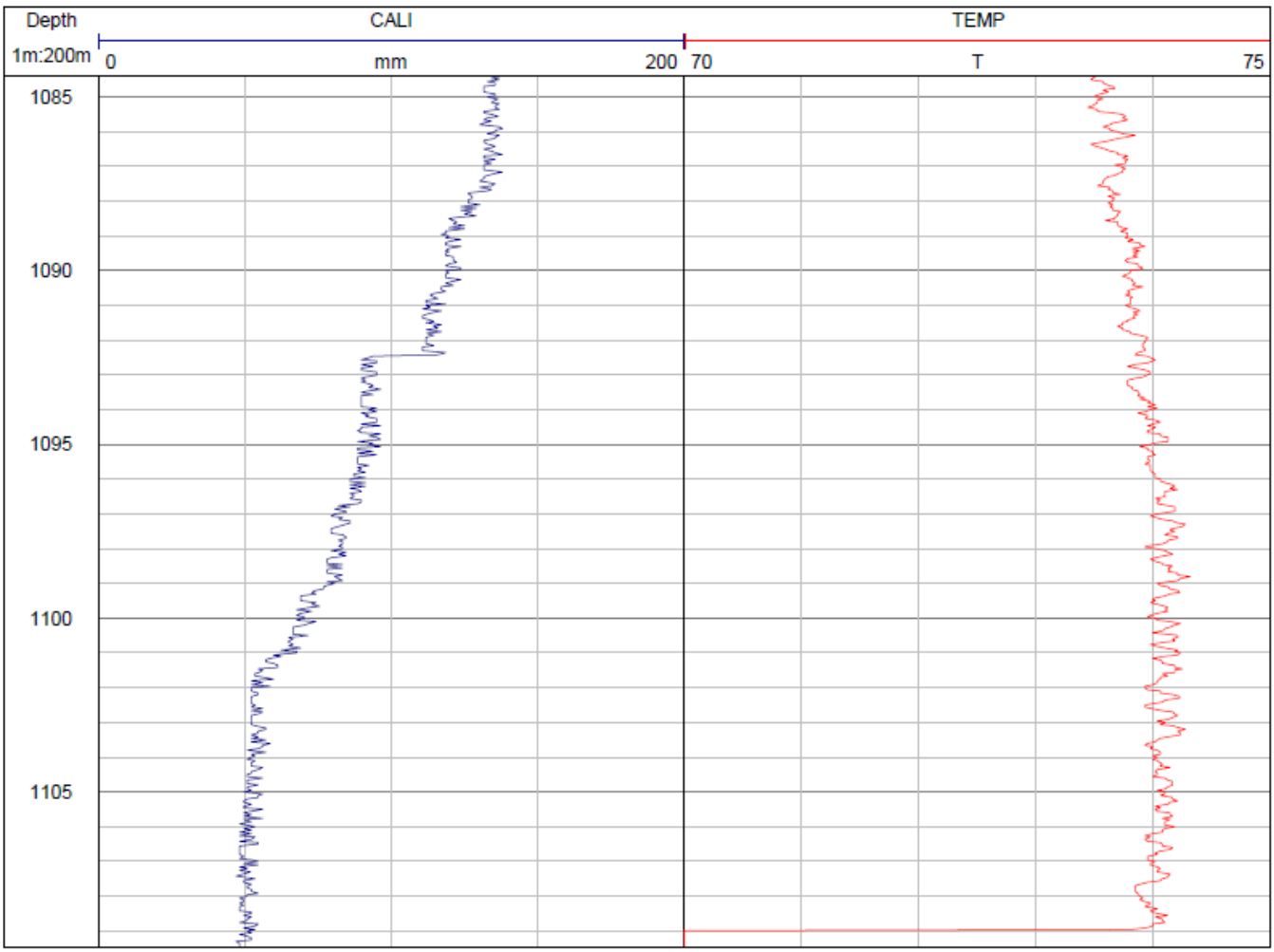
Department of Environment, Water and Natural Resources

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0
mm
200
TEMP
70
T
75
1085
1090
1095
1100
1105

Client:	DEWNR / Silver City Drilling	Location:	Mulka		
Purpose:	Construction	State:	SA		
Project:		Longitude/Easting:	270151		
Date:	21/04/2016	Latitude/Northing:	6861019	Job number:	
Bore name:	New Mulka Bore	UTM zone:	54J	Sample interval:	5 cm
Unit no.:		Depth reference:	Rig floor	Vehicle:	XQB449
Permit no.:		Depth ref. elev.:		Driller depth:	1114 m
Fluid level:	41 m	Depth ref. above G.L.:	Rig floor = 2.8 magl	Logged depth:	316 m
Fluid type:	Mud	Casing depth range:		Bit size:	
Operator:	KI and GK	Casing type:	Steel	Casing I.D.:	
Witness:	J. Wardle	Notes:	Bottom of tremie line at 67 m, bottom of cement job noted here.		

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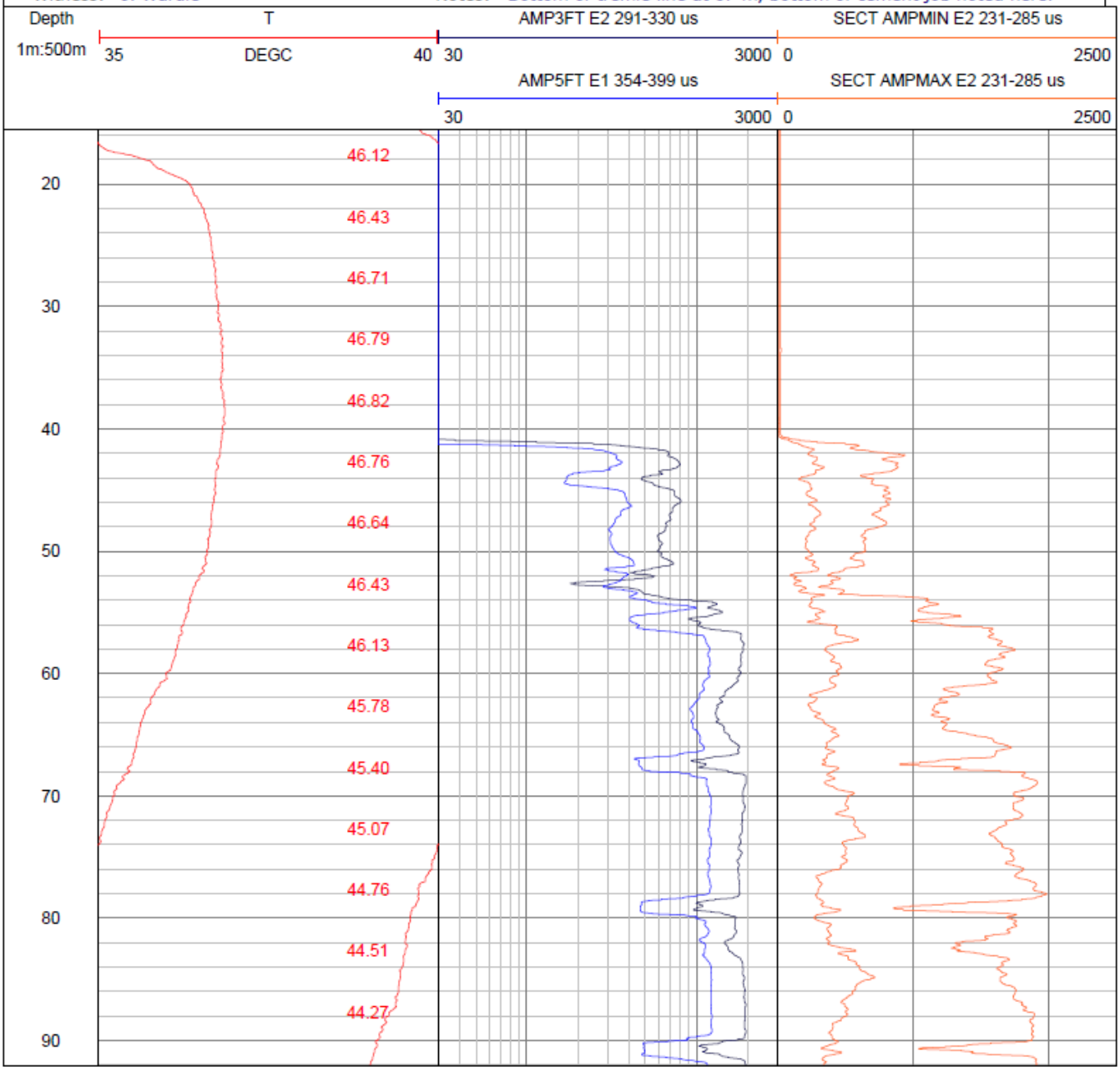
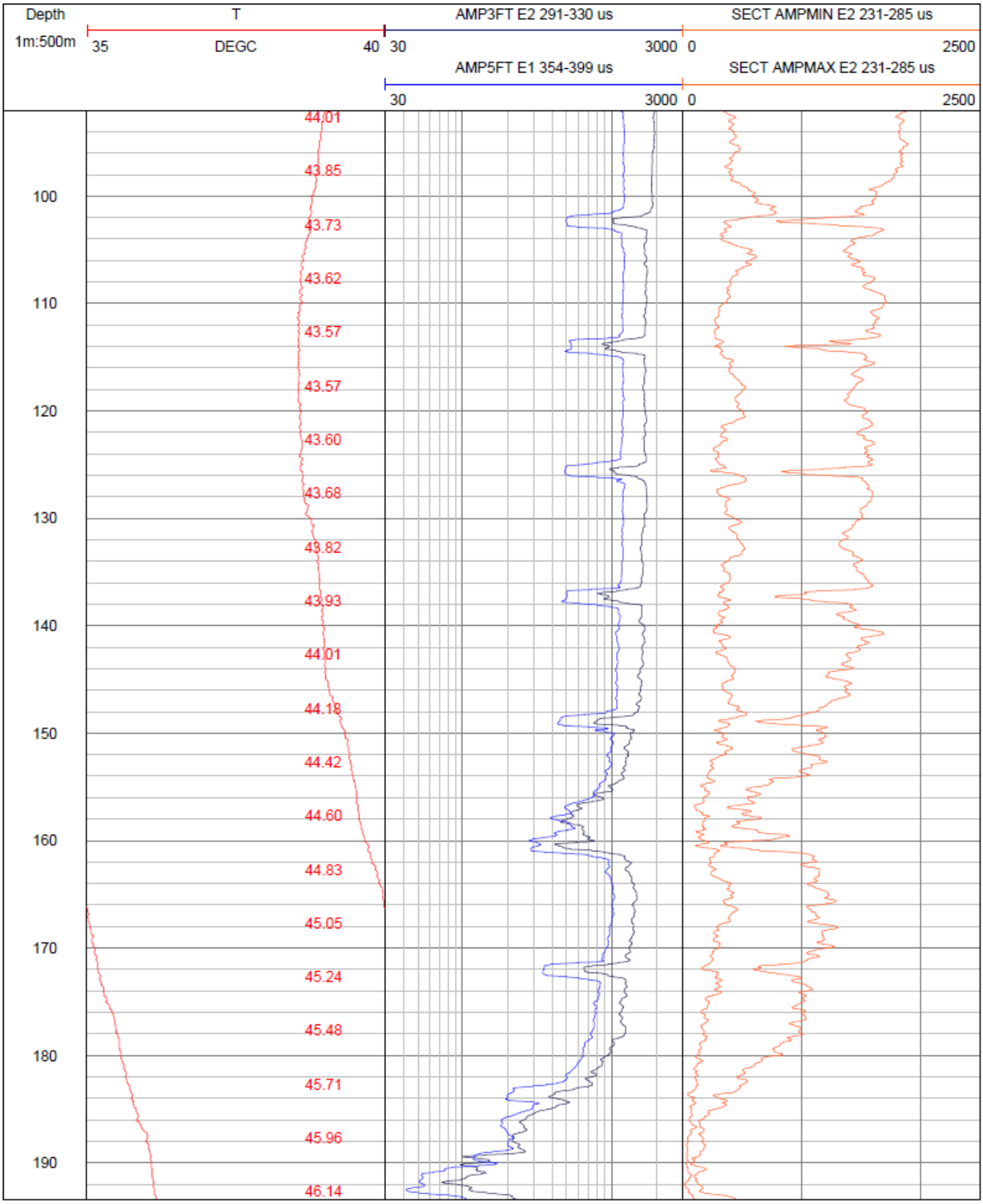
Department of Environment, Water and Natural Resources

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AMP5FT E1 354-399 us
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SECT AMPMIN E2 231-285 us
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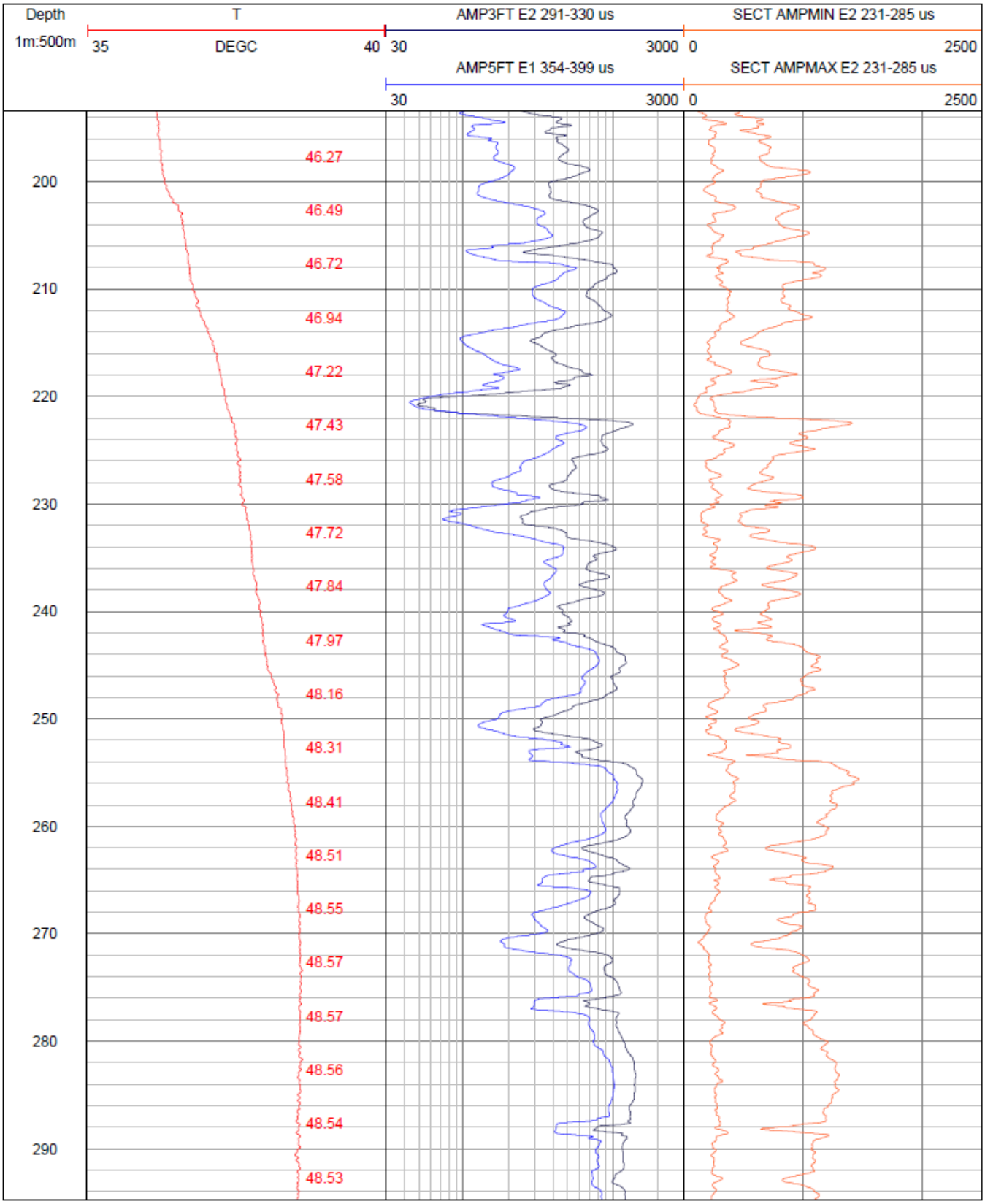
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1m:500m
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AMP5FT E1 354-399 us
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3000
SECT AMPMIN E2 231-285 us
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2500
SECT AMPMAX E2 231-285 us
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2500
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290
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46.49
46.72
46.94
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47.43
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47.72
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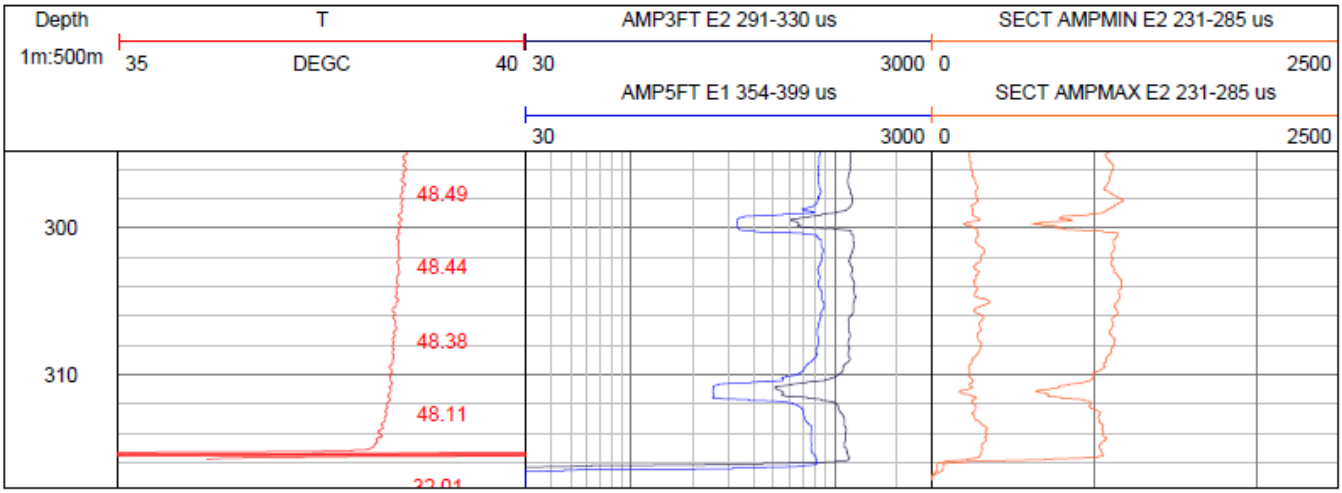
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AMP3FT E2 291-330 us
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AMP5FT E1 354-399 us
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SECT AMPMIN E2 231-285 us
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SECT AMPMAX E2 231-285 us
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48.49
48.44
48.38
48.11

D. Mulka Bore No. 2 Lithology

This appendix contains a detailed lithological log from cuttings taken while drilling Mulka Bore No. 2.

Detailed lithological log for Mulka Bore No. 2

Sample depth (m)		Description
0	2	Sandy top soil, fine quartz sand, clear to orange, red stained, well sorted, chips of iron stones, sample tending to sandy clay at 2 m
2	12	Sandy clay, fine quartz sand, well rounded, clear to orange red, tending to clay at base
12	15	Clay, white sticky plastic clay, fine grey quartz sand, poorly sorted, sub angular to angular
15	18	AS ABOVE , hard sandstone band 16–17m , sandstone well sorted, fine grey, well sorted grains
18	21	AS ABOVE, intermittent hard sandstone bar
21	24	White grey clay, plastic, sandy, quartz sand as above
24	27	White grey clay, mottled in part, red/yellow fine-medium quartz sand, iron stone stained, interbedded hard bars of sandstone
27	30	AS ABOVE - interbedded hard bars of sandstone
30	33	Grey sticky plastic clay
33	36	Mottled grey yellow weak clay, angular quartz sandstone chips, interbedded hard bars of sandstone
36	39	Grey clayey shale-moderately stiff, yellow mottling present
39	42	AS ABOVE
42	45	AS ABOVE, mottled yellow / grey intrebedded black shale
45	48	Green/grey shale (glauconitic), stiff, some blebs of yellow shake evident
48	69	AS ABOVE
69	72	AS ABOVE, blebs of white clay evident
72	75	Highly glauconitic
75	78	Weak salty shale, gritty sand, fine, well rounded, clear to grey/black, carbonaceous material evident
78	81	AS ABOVE
81	84	Grey/green silty shale
84	87	AS ABOVE, stiff shale-highly glauconitic
87	106	AS ABOVE
106	180	Grey / green shale with poorly cemented fine grained sandstone in bands and traces of lignite
180	210	AS ABOVE - grey /green soft shale with fine sand
210	257	Grey /green soft shale
257	266	Grey shale, very soft
266	269	Calcareous gray shale with fine quartz sand
269	275	Grey shale, some sand
275	281	Brown lignite and grey shale
281	323	Carbonaceous grey shale
323	341	Calcareous grey shale
341	347	Grey shale, some fine sand, traces of lignite
347	353	Calcareous grey shale
353	365	Grey shale with fine quartz sand

Sample depth (m)		Description
365	371	Calcareous grey shale
371	395	Grey shale, carbonaceous in parts, some fine sand
395	401	Grey shale, some fine sand
401	404	Lignitic grey shale
404	413	Grey shale
413	422	Lignitic grey shale
422	493	Grey shale
493	505	Calcareous grey shale
505	641	Grey shale
641	646	Carbonaceous gray shale
646	652	Gray shale
652	661	Calcareous gray shale
661	741	Gray shale
741	747	Calcareous gray shale
747	800	Grey shale
800	860	Grey shale, much harder
860	947	Very hard grey shale
947	959	Calcareous very hard grey shale
959	965	Very hard grey shale
965	977	Grey hard shale with light grey clay
977	986	Hard grey and black shale with grey green clay, pieces of coal present
986	1014	Grey sandy grey shale, soft, sand are very fine
1014	1047	Pale grey very fine grained sandstone / siltstone with gray plastic clay and gray shale
1047	1059	Pale grey very fine grained sandstone / siltstone with coarse angular quartz sand and gray plastic clay
1059	1071	Coarse quartz angular sand with very fine grained sandstone and gray plastic clay (much faster drilling)
1071	1085	Coarse quartz angular sand with gray plastic clay
1085	1091	Coarse quartz angular sand
1091	1112	Unsorted, fine to coarse, angular quartz sand, mainly fine sand

E. Mulka Bore Decommissioning

This appendix contains:

- Drillers Well Construction Schedule 8 Report (1 page)

GOVERNMENT OF SOUTH AUSTRALIA

DRILLERS WELL CONSTRUCTION REPORT

Natural Resource Management Act 2004

1. PERMIT NO: 25825 Site

NAME OF DRILLER JOHN L DIXON Licence No: 218562

Contact Phone/Mobile No.: 0407 175 080

Name of plant operator if under supervision: T. McISAAC, J. WARDLE, H. BEACH

PERMIT HOLDER or land occupier SHILLIGAN P/L

Postal Address C/- NGJ LEGAL, UNIT 4

25 BEULAH ROAD, NORWOOD S.A. Post Code 5067

2. LOCATION OF WELL J. STRATFORD, L. ELBER

Date of Survey 22-04-16 Surveyed by J.L.D Method GPS

GPS COORDINATES AND DATUM USED

☑ GDA 94/WGS84

☐ AGD 66/84

54J 0270196

6861087

☐ ZONE 52 ☐ ZONE 53 ☑ ZONE 54

3. WELL NAME MULKA BORE - KILL

4. LAND IDENTIFICATION

Hundred or Pastoral Lease: KOPPERAMANNA

Parcel ID or CT number CL 1323/20 SEC 103

Name of Property MULKA

5. SUMMARY *(Please tick appropriate boxes and complete all relevant details)*

Date work Commenced 22-04-2016 Date work Completed 25-04-2016

Work carried out: New Well ☐ Deepen ☐ Enlarge ☐ Rehabilitate ☐ Backfill ☒

Is this a Replacement well? YES (NO) if yes please quote replaced well number

Is this an Existing well? (YES) NO **if yes please quote well number or GPS coordinates** 6641-0006

Was well Abandoned? (YES) NO if so please state reason and method of backfill BORE REPLACED - OLD BORE GROUT PLUGGED TO SURFACE

Maximum Depth Drilled (m) Final Depth 0 (m) Final Standing Water Level (m) Final Yield NIL (L/sec)

6. DRILLING DETAILS If not a drilled well, please complete Sections: 6.2, 9, 10, 11, 12 and 13 as necessary

6.1 Construction Details

From (m)	To (m)	Diam (mm)	Drilling Method Cable Tool, Rotary Auger, Down Hole Hammer, etc.	Fluid Used (Air, Water, Mud Type)

6.2 Water Cut Details (measurements from natural surface to nearest 0.1 m)

Date	Water Cut From (m)	Water Cut To (m)	Standing Water Level (m)	Estimated Yield (L/sec)	Hole Depth at Test (m)	Casing at Test (m)	Test Method	Salinity (mg/L) or Taste

7. CASING LEFT IN WELL

7.1 Dimensions / 7.2 Type / 7.3 Casing Cemented

From (m)	To (m)	Internal Diam. (mm)	Swell Joint, Welded Collar, Steel, FRP, PVC, etc.	Yes	No	From (m)	To (m)	Cement (bags)	Water (litres)	Other Additives	Cementing Method Used	Comments
				☐	☐							
				☐	☐							
				☐	☐							
				☐	☐							

8. CONSTRUCTION AT PRODUCTION LEVEL

8.1 Method

☐ Open Hole

☐ Slotted Casing

☐ Screen(s)

☐ Other, give details:

8.2 Screen or Casing (*If variable aperture screen used give limits)

Type	From (m)	To (m)	Aperture* (mm)	Inner Diam (mm)	Outer Diam (mm)	Material	Trade Name	Completion of Base

8.3 Liner Seal (Packer)

Material	Depth (m)	Internal Diam (mm)

8.4 Gravel Packing

Method of Placement	Gravel Passing Mesh Size	From (m)	To (m)

9. IF NOT A DRILLED WELL

Method	Depth (m)	Length (m)	Width (m)	Diam (m)	Lining Material	From (m)	To (m)

10. DEVELOPMENT (State methods and time taken)

Method	Hours	Minutes

11. PUMPING TEST (measurements from natural surface to nearest 0.1m)

Interval Tested From (m)	Interval Tested To (m)	Water Level (m)	Test Method	Pump Depth (m)	Discharge Rate (L/sec)	Method of Measuring Discharge	Hours Pumped	Draw Down (m)

12. SAMPLES

The provision of the Natural Resource Management Act 2004 and Regulations require that strata and water samples must be obtained. If any samples have not been obtained state reasons:

N/A

As the person responsible I advise that the work has been completed as described above.

Signature of Licensed Driller John L Dixon Date 25/4/16

Driller to deliver this copy together with water samples collected and well location map within 14 days of completion to any of the below locations:
Department of Water Land and Biodiversity Conservation
Water Laboratory and Geophysical Services, 23 Conyngham Street GLENSIDE SA 5065 or
Mount Gambier Regional Office, 11 Helen Street MOUNT GAMBIER SA 5290 or
Naracoorte Regional Office, 101 Cedar Avenue, NARACOORTE SA 5271

13. FORMATION LOG

From (m)	To (m)	Description of Material
		Bore Flow killed from Top with 1.152 sg mud
		9295 L Pumped
		SEE ALSO CEMENTING REPORTS ATTACHED.

UNIT NUMBER

F. Mulka Bore Decommissioning Geophysical Logs

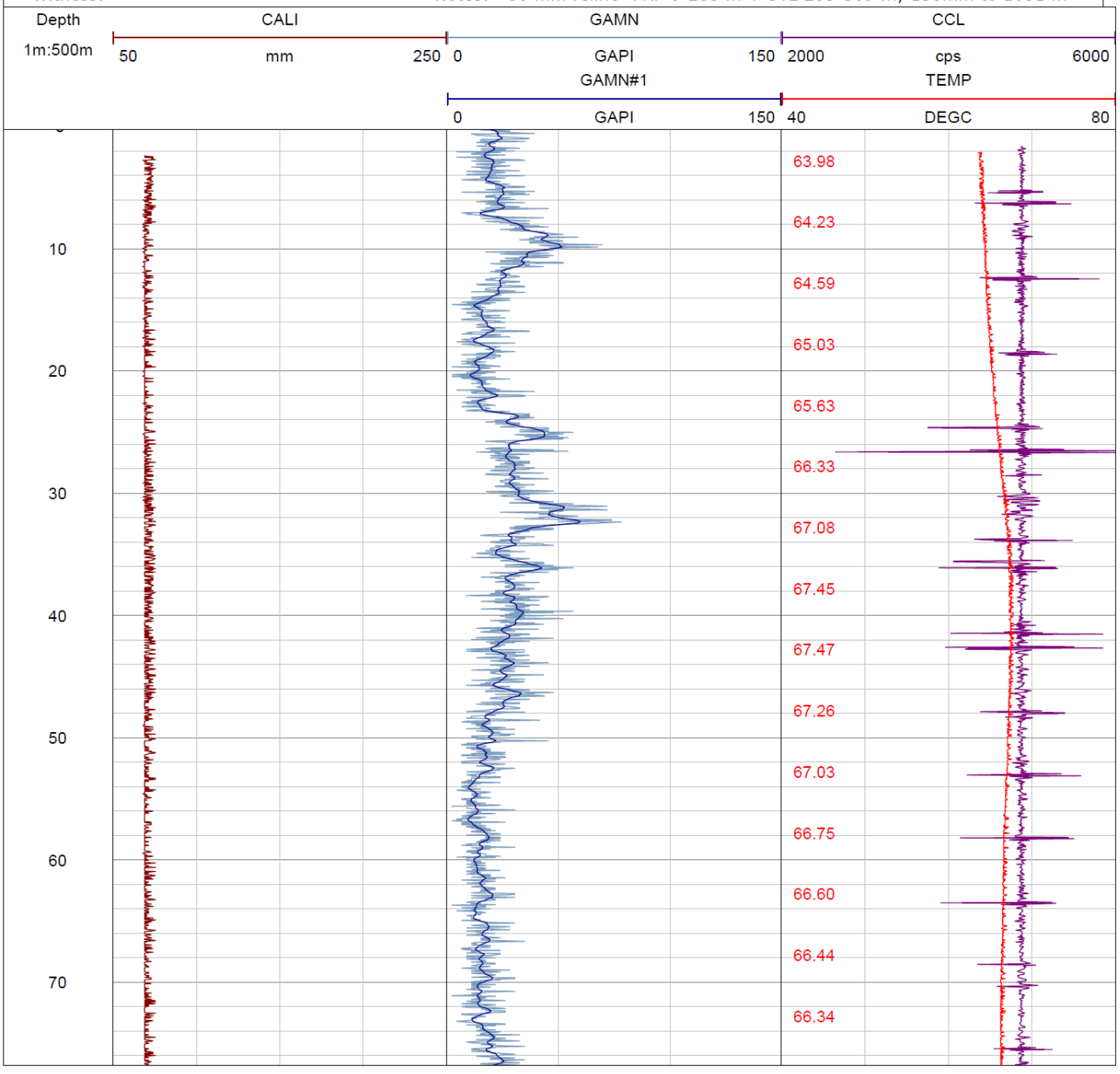
This appendix contains:

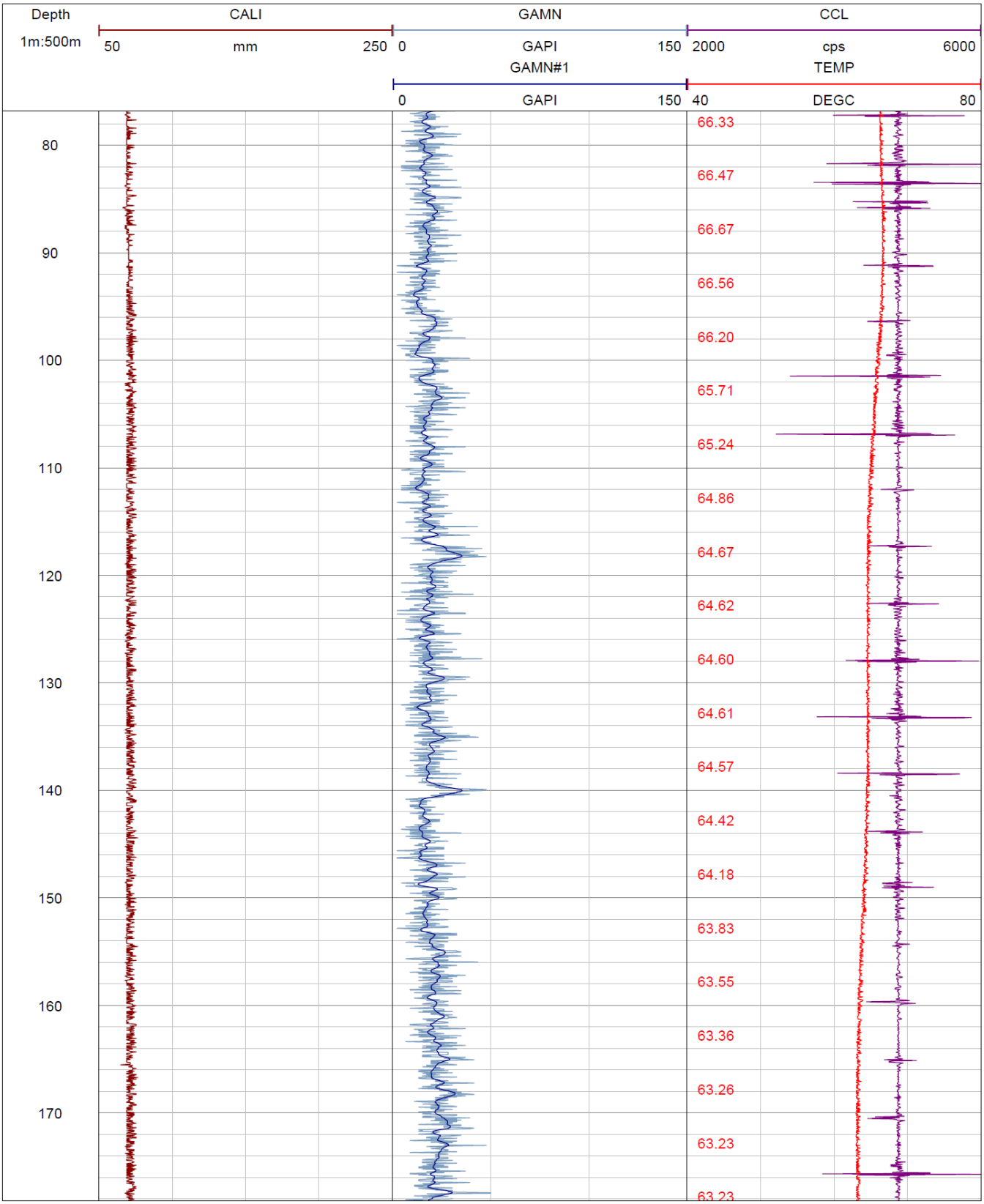
- Geophysical logs run on 22 April 2016 including caliper, gamma, casing collar locator (CCL), and temperature, from 0 m to 1051 m.
- Cement bond survey run on 22 April 2016 in the relined FRP section of the bore, from 6 m to 304 m.

Client:	DEWNR (Silver City Drilling)	Location:	Mulka
Purpose:	Casing condition	State:	SA
Project:		Longitude/Easting:	270193
Date:	22/04/2016	Latitude/Northing:	6861086
Bore name:	Mulka Bore	UTM zone:	54J
Unit no.:	6641-6	Depth reference:	GL
Permit no.:		Depth ref. elev.:	
Fluid level:	60-66 m (varying)	Depth ref. above G.L.:	
Fluid type:	Mud	Casing depth range:	Reline 0-309 m; Prod to 1051 m
Operator:	KI	Casing type:	
Witness:		Notes:	80 mm reline=FRP 0-283 m + STL 283-309 m; 150mm to 1051 m

Government of South Australia
Department of Environment, Water and Natural Resources

Job number:			
Sample interval:	5 cm		
Vehicle:	XQB449		
Driller depth:	1050 m		
Logged depth:	1053 m		
Bit size:			
Casing I.D.:	80 mm / 150 mm		

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mm
250
GAMN
0
GAPI
150
GAMN#1
0
GAPI
150
CCL
2000
cps
6000
TEMP
40
DEGC
80
80
90
100
110
120
130
140
150
160
170
66.33
66.47
66.67
66.56
66.20
65.71
65.24
64.86
64.67
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63.23
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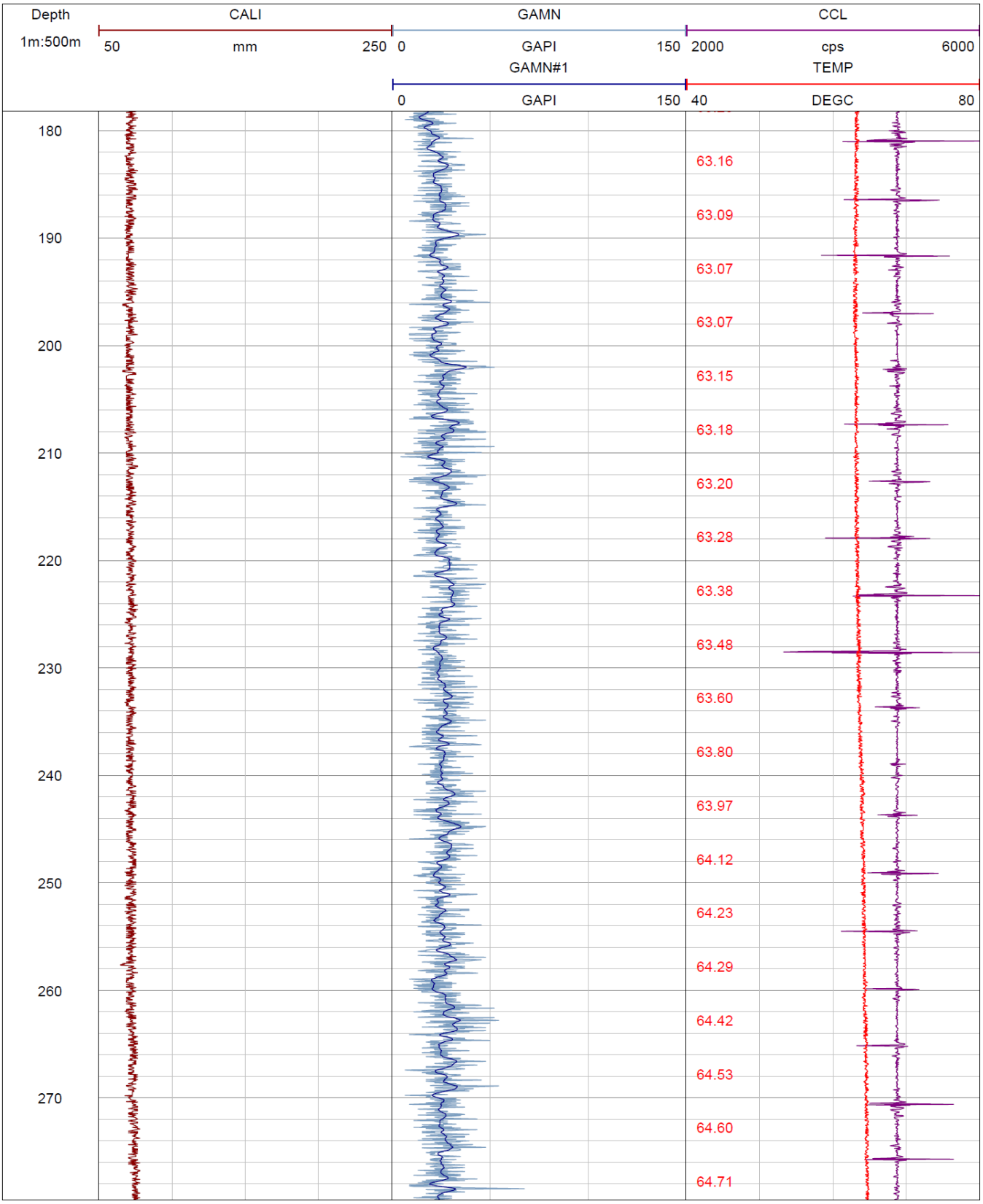
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GAPI
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CCL
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TEMP
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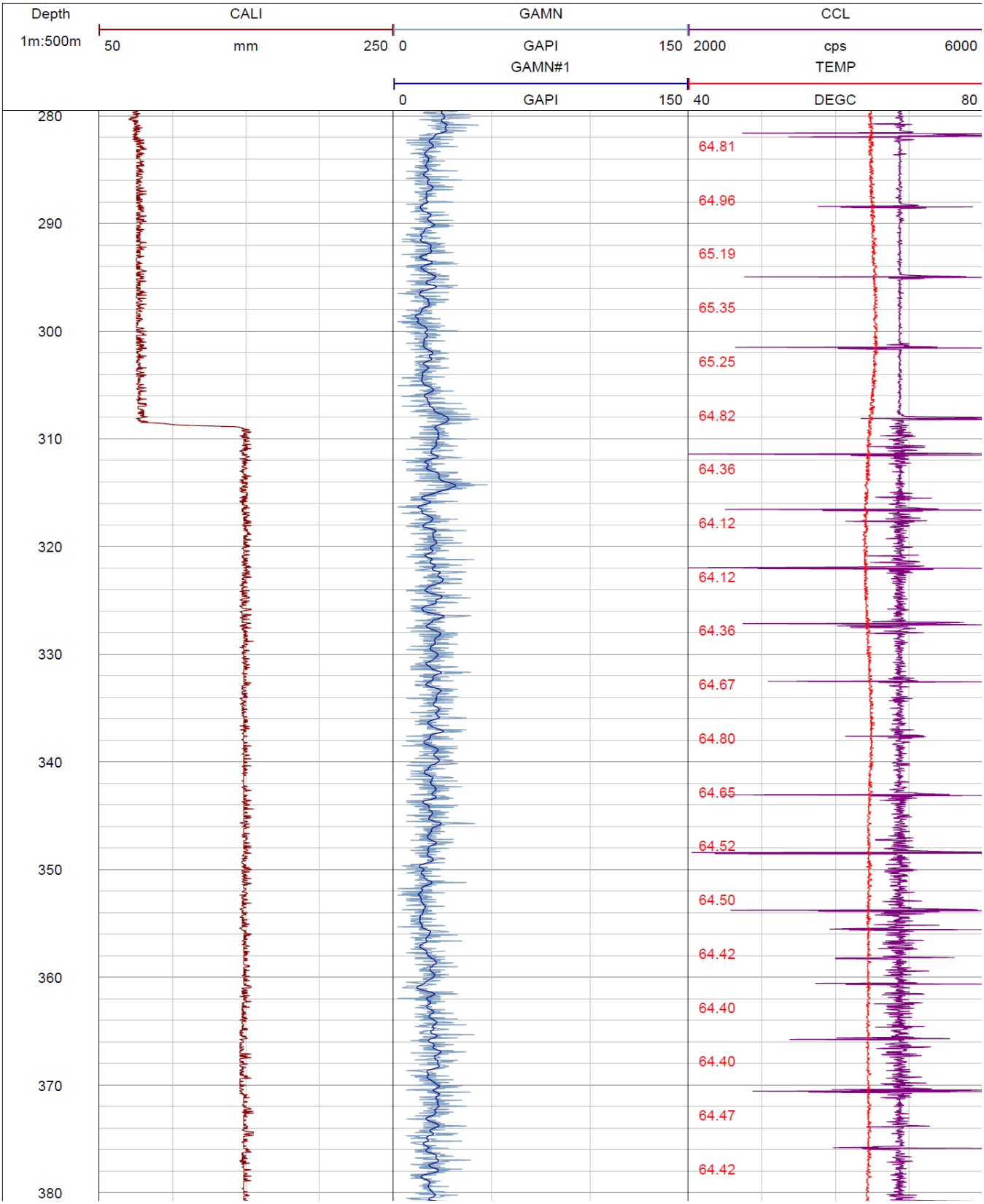
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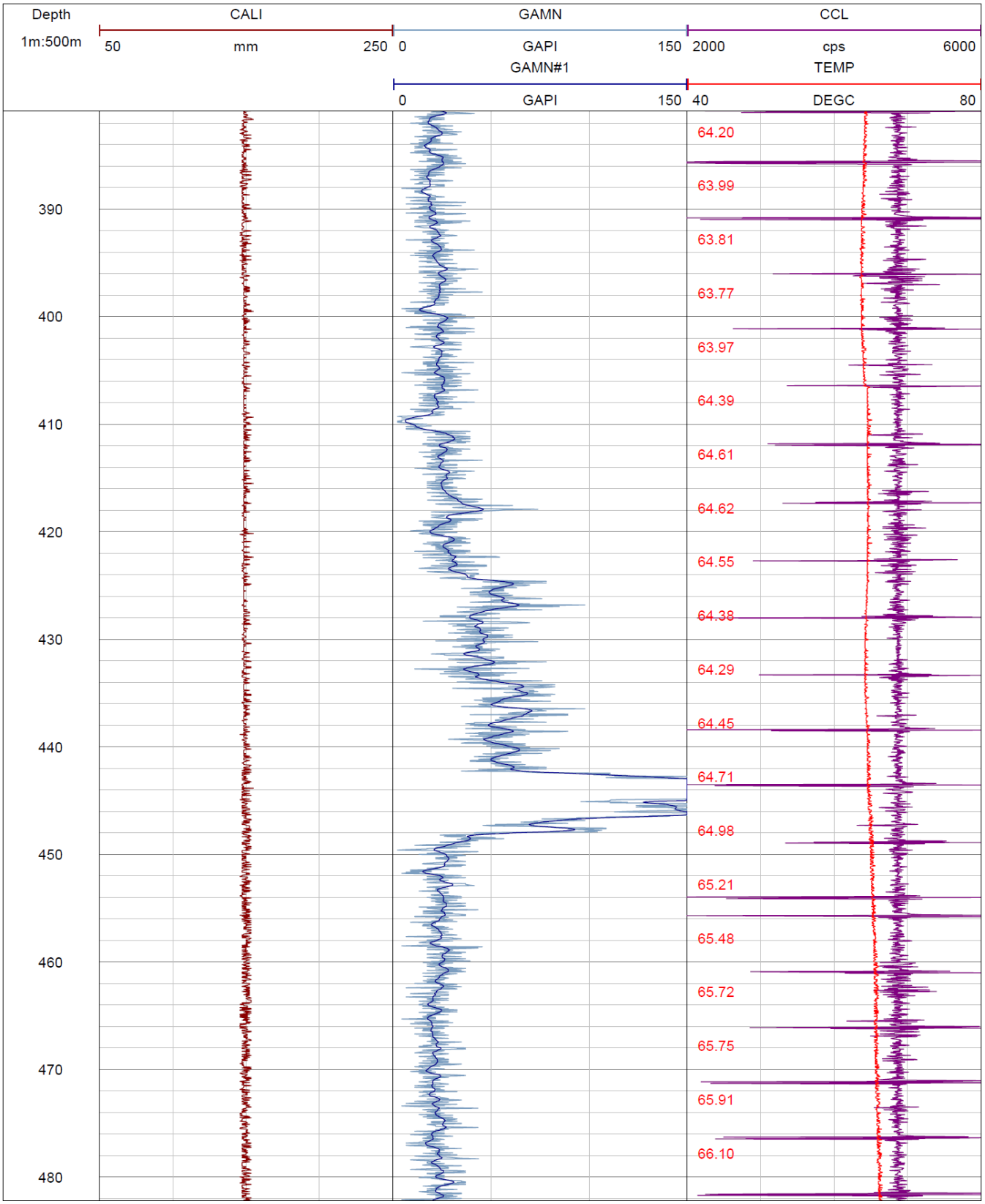
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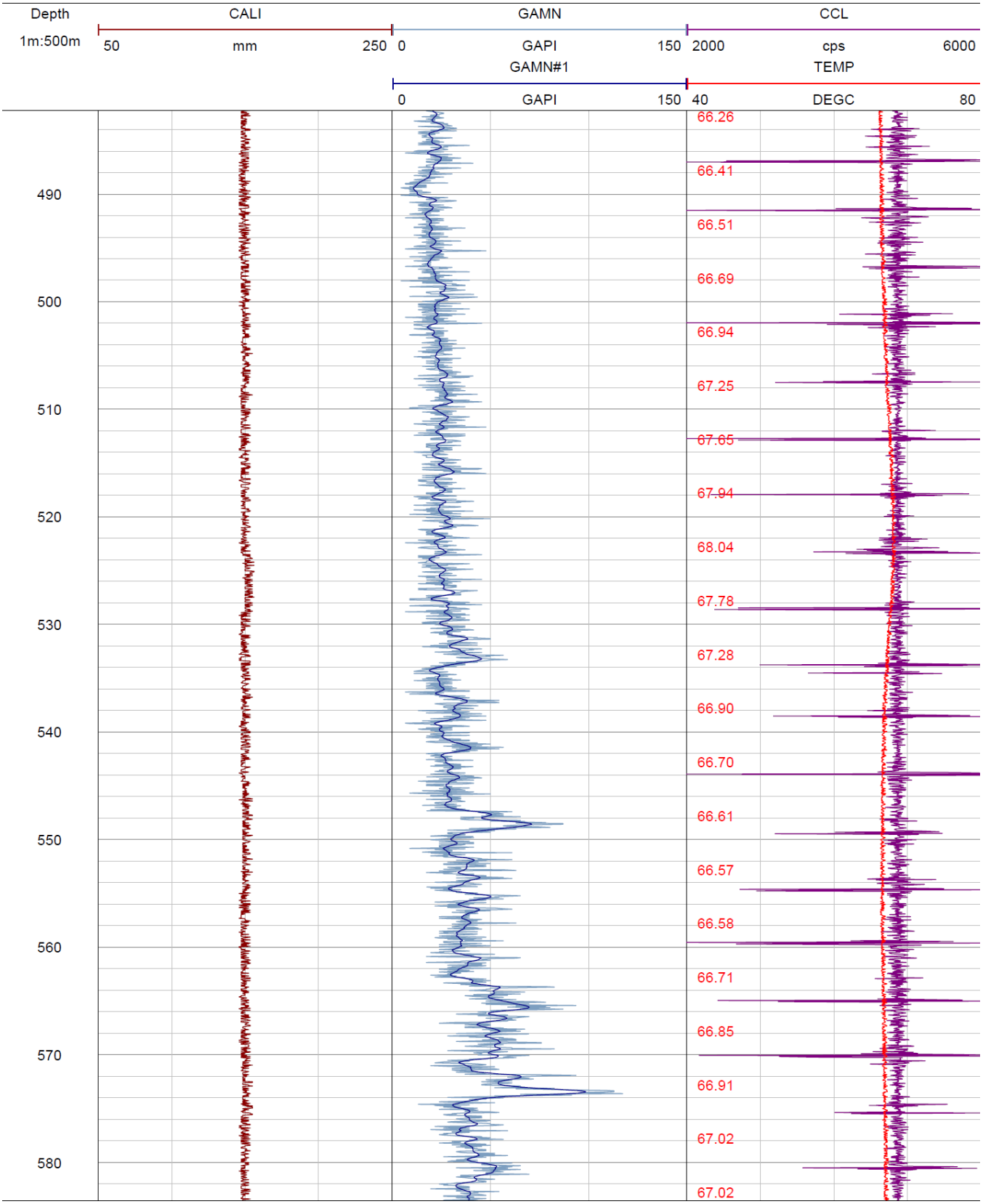
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GAPI
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TEMP
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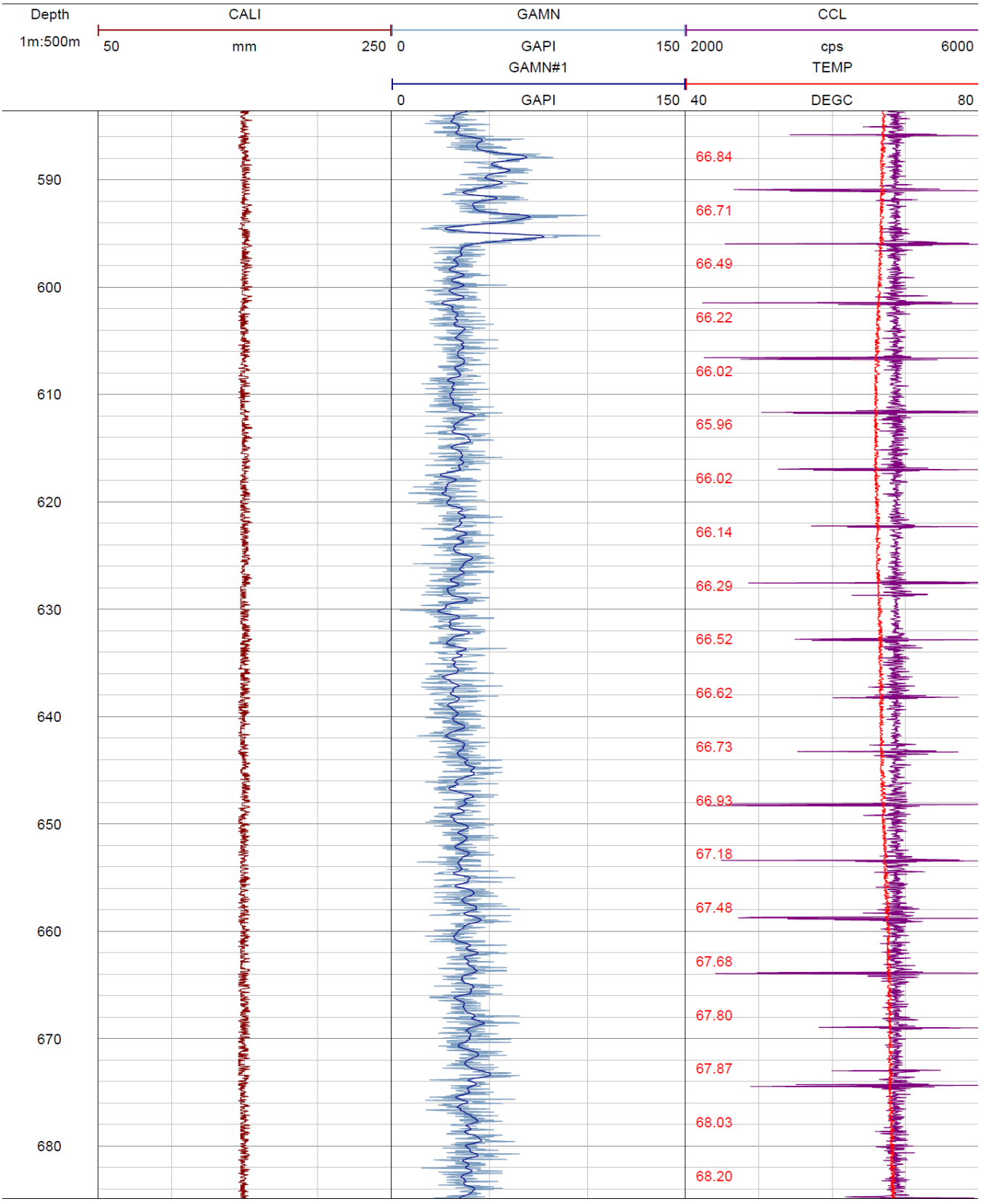
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CCL
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TEMP
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600
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620
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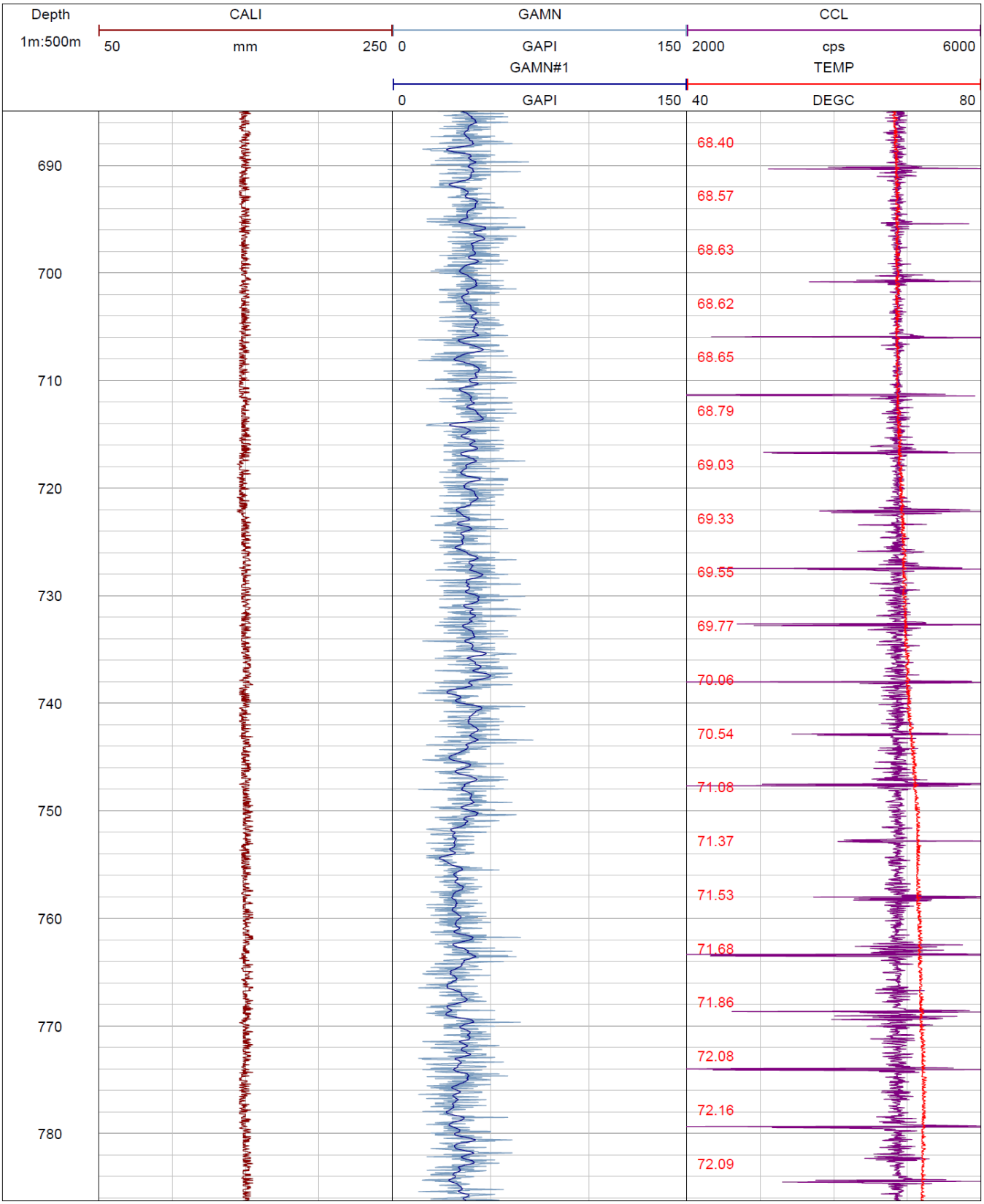
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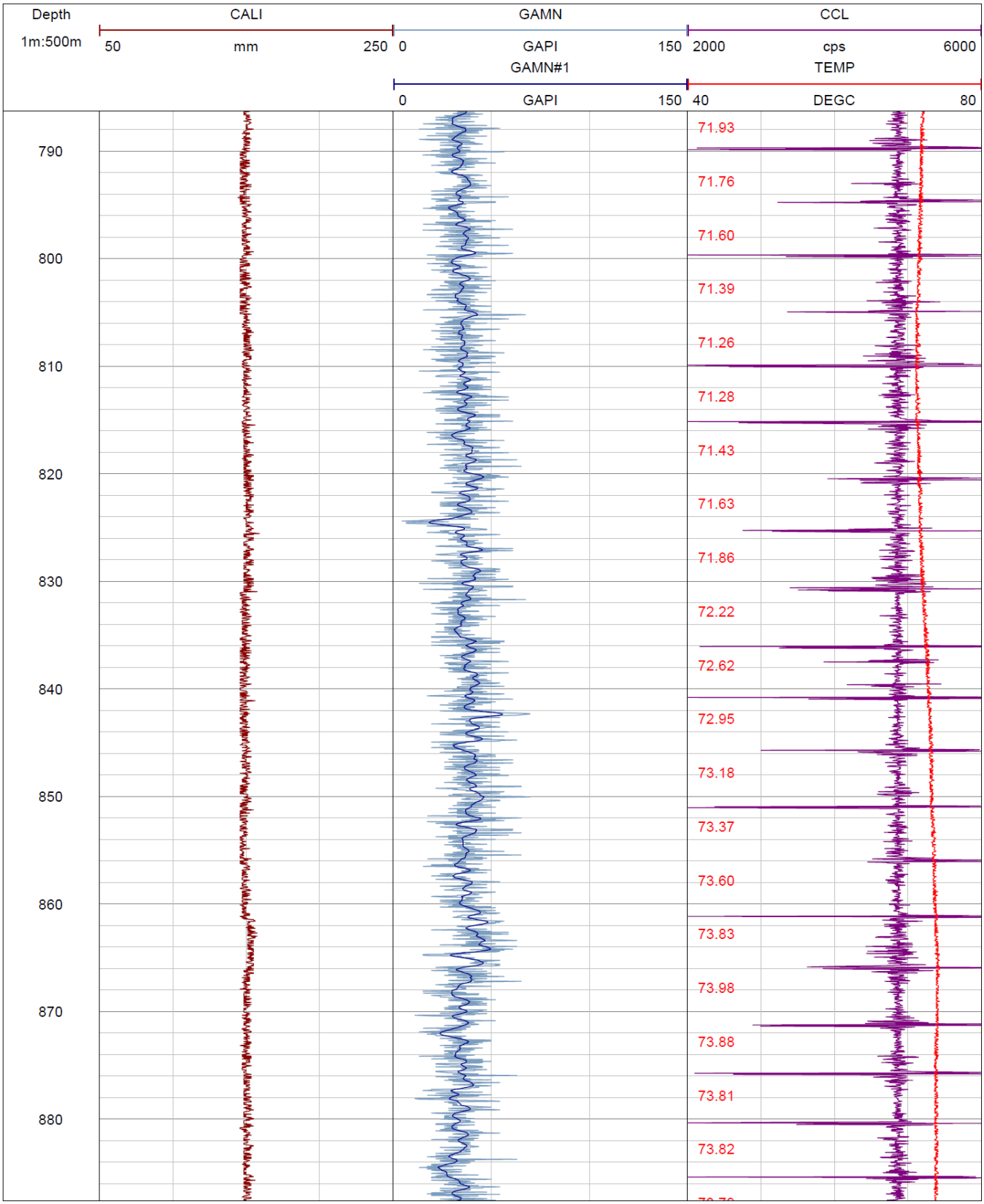
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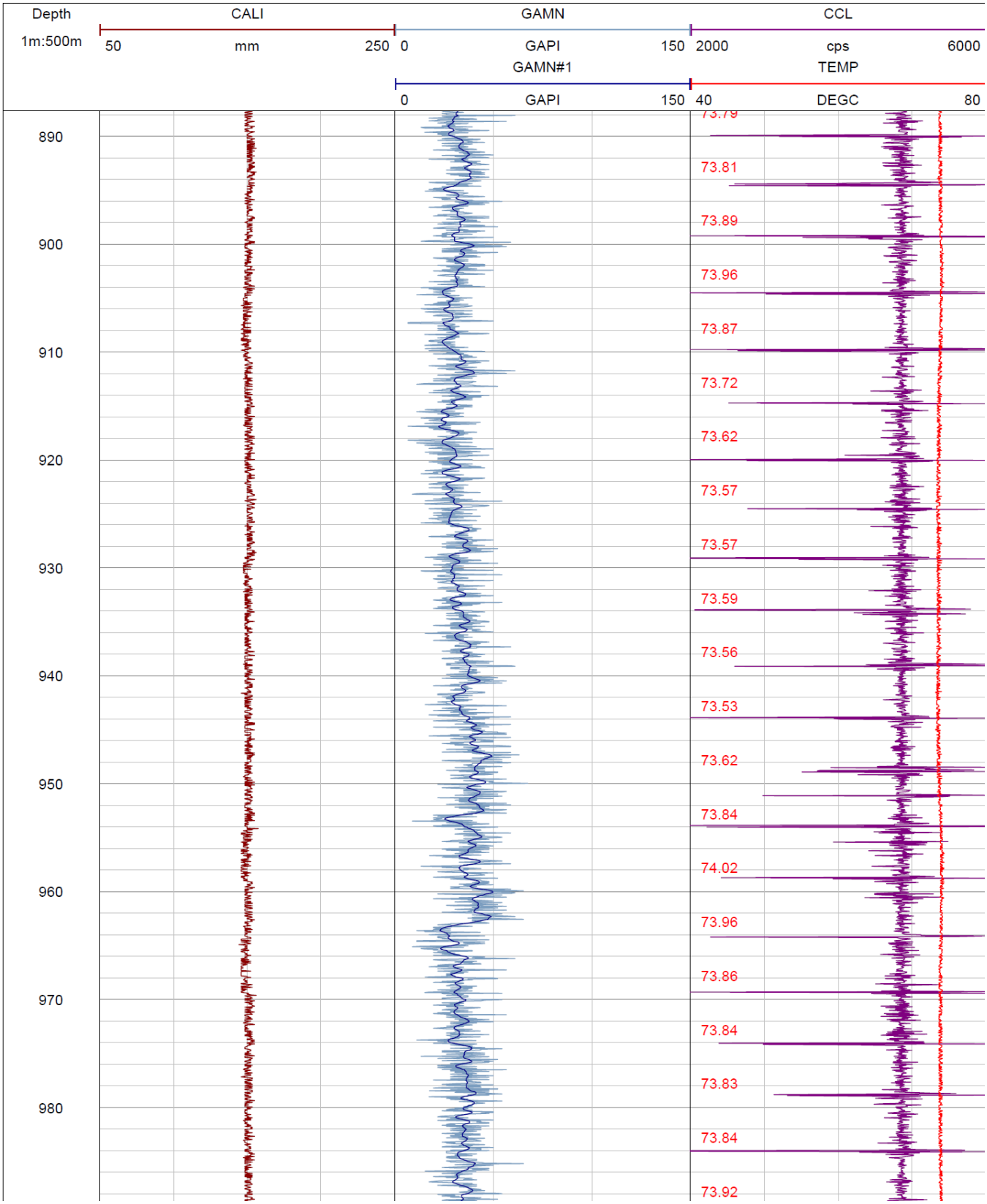
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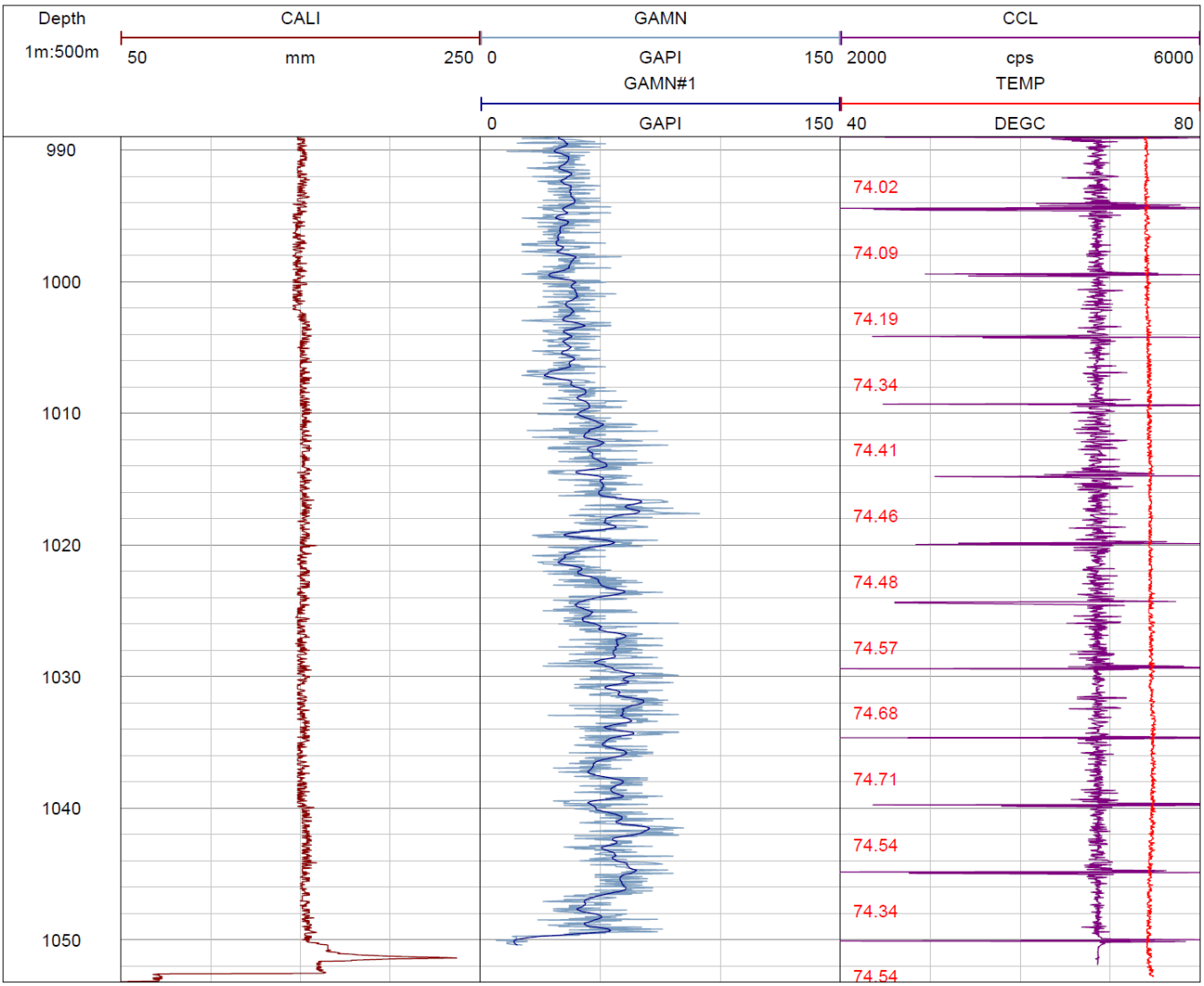
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TEMP
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74.34
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74.46
74.48
74.57
74.68
74.71
74.54
74.34
74.54

Client:	DEWNR (Silver City Drilling)	Location:	Mulka		
Purpose:	Casing condition	State:	SA		
Project:		Longitude/Easting:	270193		
Date:	22/04/2016	Latitude/Northing:	6861086	Job number:	
Bore name:	Mulka Bore	UTM zone:	54J	Sample interval:	5 cm
Unit no.:	6641-6	Depth reference:	GL	Vehicle:	XQB449
Permit no.:		Depth ref. elev.:		Driller depth:	1050 m
Fluid level:	76 m	Depth ref. above G.L.:		Logged depth:	1052.7 m
Fluid type:	Mud	Casing depth range:	Reline 0-309 m; Prod -1051 m	Bit size:	
Operator:	KI	Casing type:		Casing I.D.:	80 mm / 150 mm
Witness:		Notes:	80 mm reline = FRP 0-283 m + STL 283-309 m. 150 mm to 1051 m		

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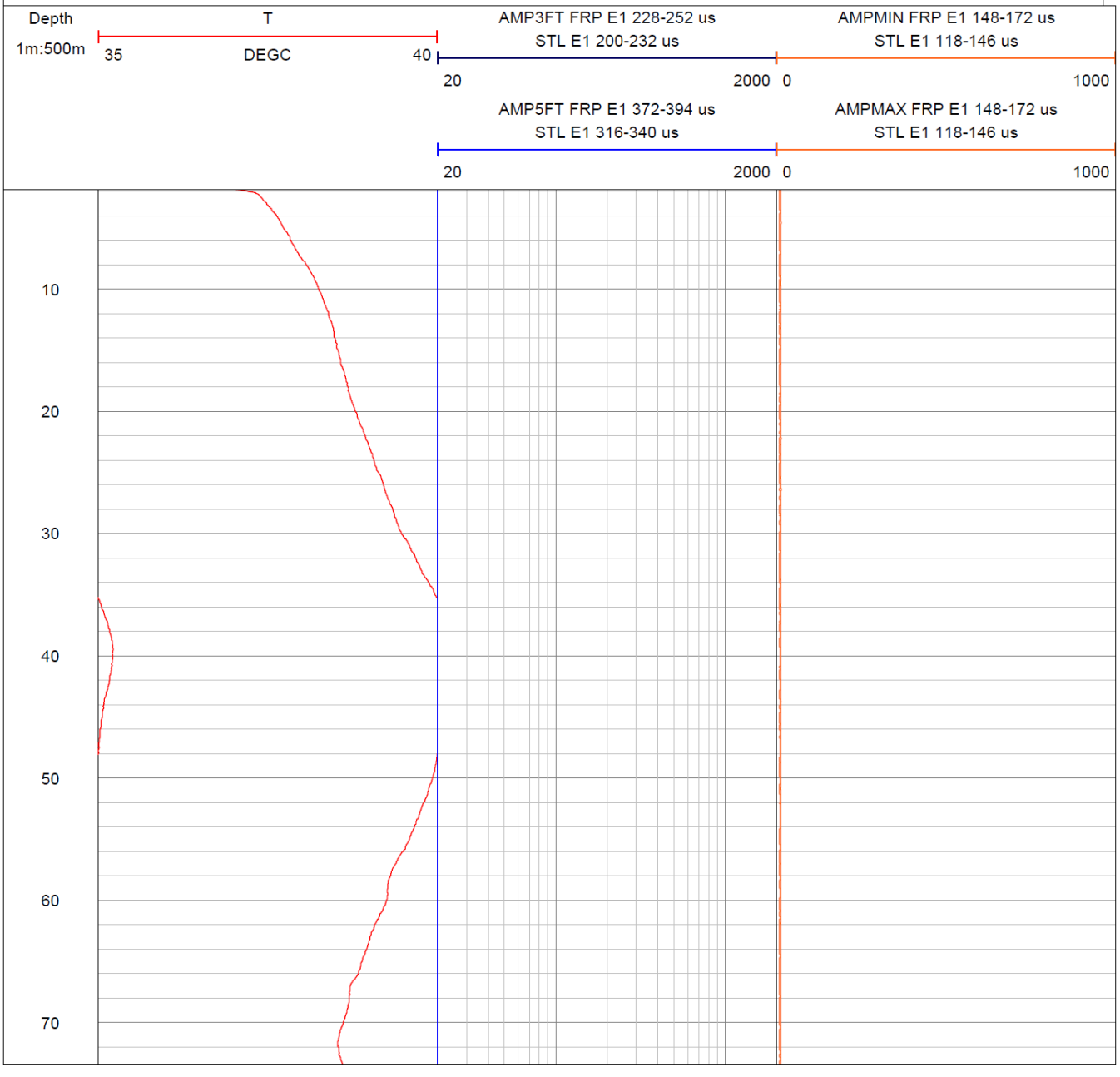

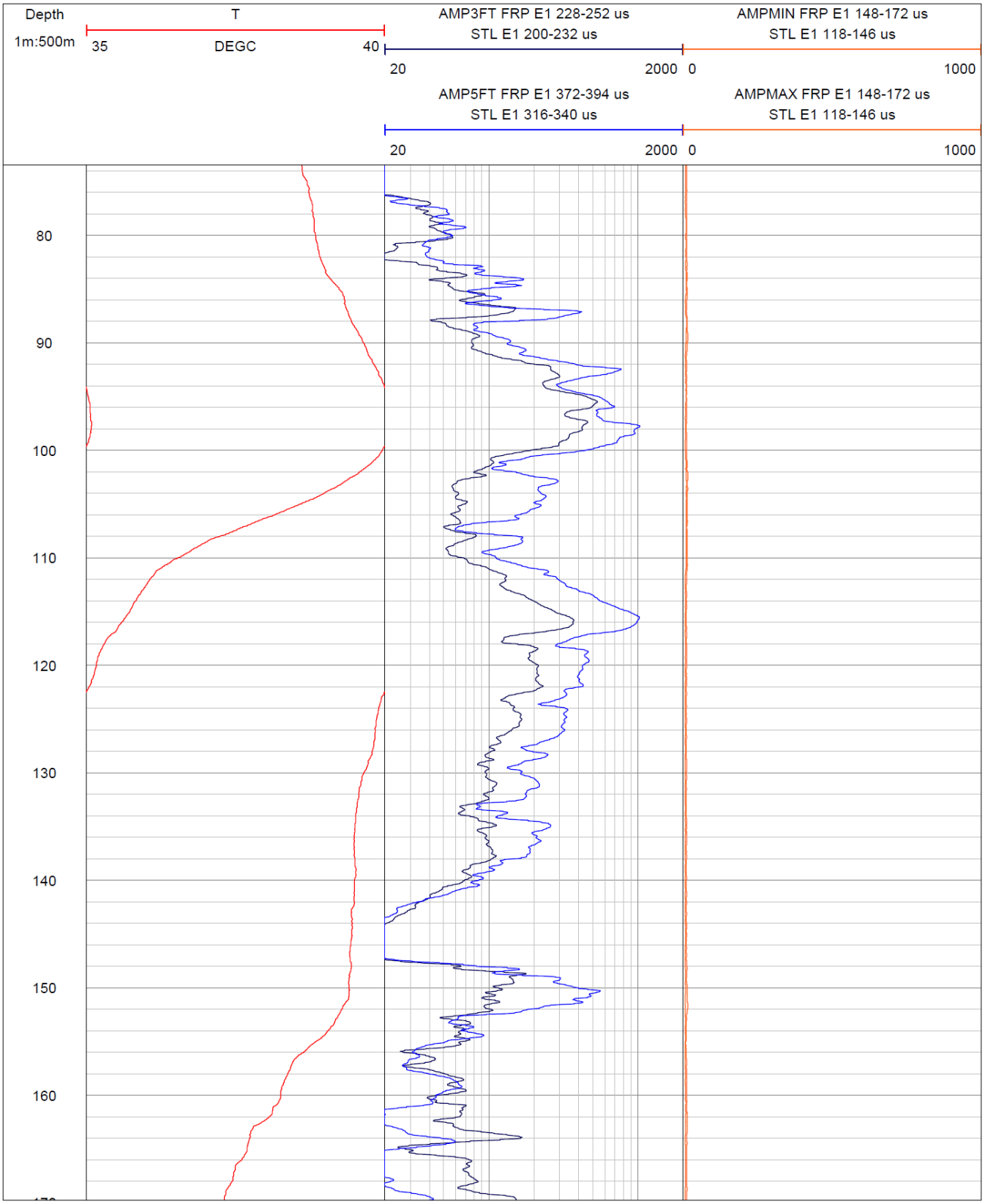
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DEGC
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STL E1 200-232 us
20
2000
AMPMIN FRP E1 148-172 us
STL E1 118-146 us
0
1000
AMP5FT FRP E1 372-394 us
STL E1 316-340 us
20
2000
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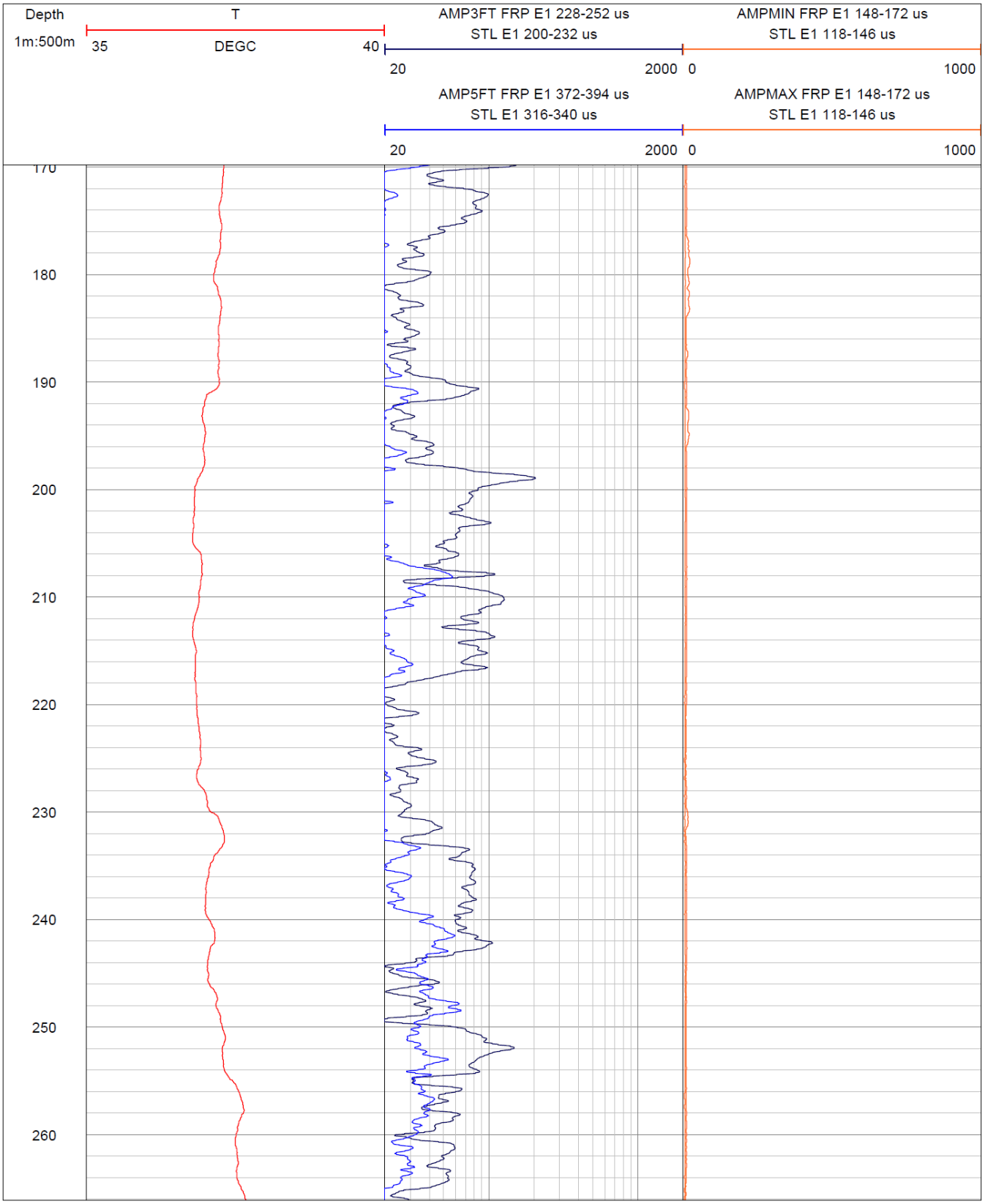
STL E1 118-146 us
0
1000
80
90
100
110
120
130
140
150
160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T
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DEGC
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STL E1 200-232 us
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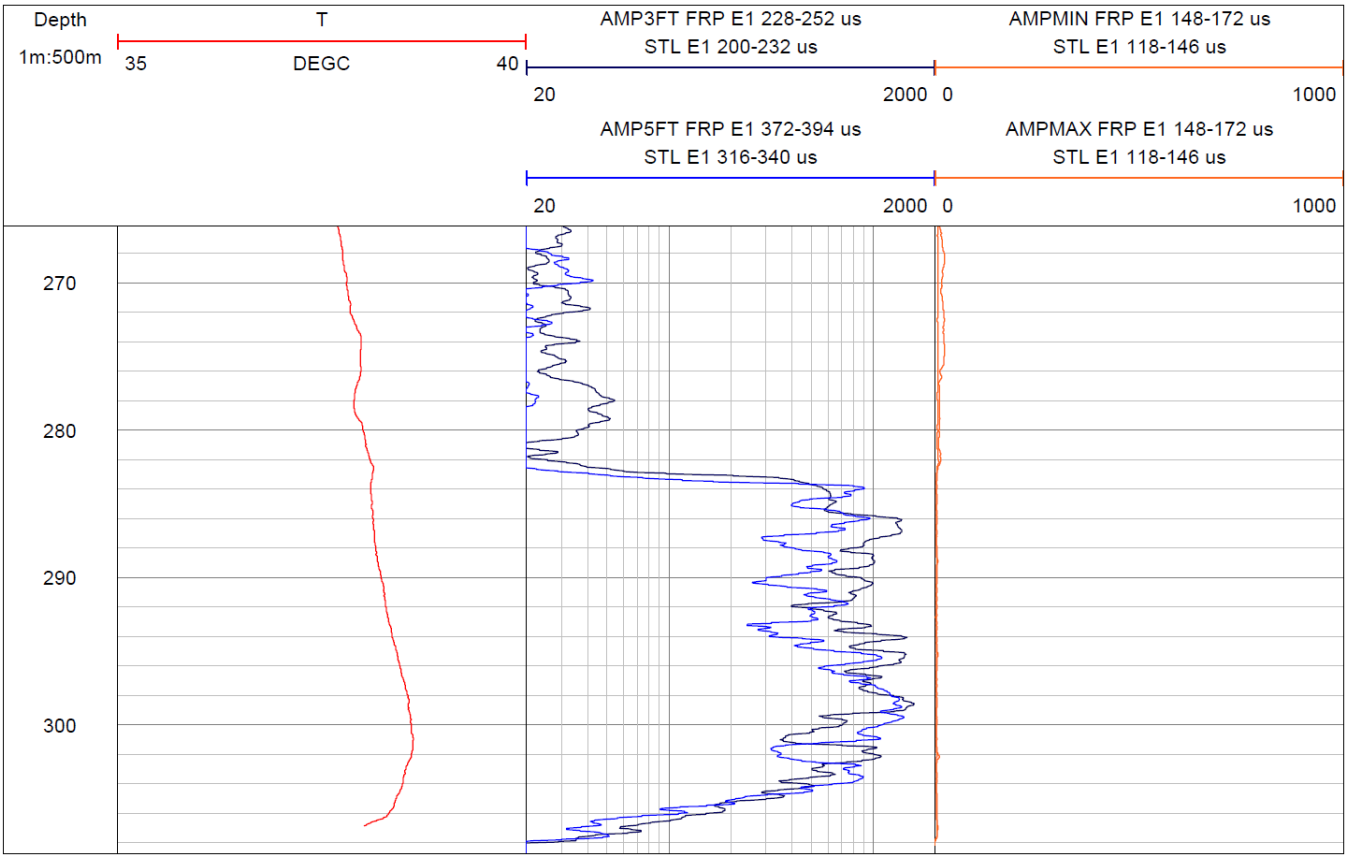
AMPMIN FRP E1 148-172 us
STL E1 118-146 us
0
1000
AMP5FT FRP E1 372-394 us
STL E1 316-340 us
20
2000
AMPMAX FRP E1 148-172 us
STL E1 118-146 us
0
1000
170
180
190
200
210
220
230
240
250
260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STL E1 118-146 us
0
1000
AMP5FT FRP E1 372-394 us
STL E1 316-340 us
20
2000
AMPMAX FRP E1 148-172 us
STL E1 118-146 us
0
1000
270
280
290
300

G. Mulka Bore Decommissioning Perforation and Cementing

This appendix contains:

- Decommissioning cementing report (1 page, SCD)
- Mulka Bore Squeeze Perforations report (2 pages, Owen Oil Tools)

Mulka Bore 6641-6

Decommissioning Cementing

22-04-2016

Drilling mud from the construction of the adjacent replacement bore was pumped slowly to the bore via a temporary borehead to a final volume of 9295 L to a calculated 810 m minimum depth, which killed the bore.

Logging commenced and continued to 21:30.

23-04-2016

The bore casing was perforated with the assistance of the DEWNR logging equipment, from 1015.5m - 1018.5m and from 440.5m - 443.5m,

Drill stem (70mm O.D. x 60mm I.D.) was run into the bore to 600 m.

3500 kg (7 x bulker sacks) of cement was mixed in to 2310 L of water in 5 x 1m3 pod tanks, to make 3430 L of grout, which was pumped down the drill string and partially displaced from the string with 600 L of clean water, the drill string was then withdrawn 100m and flushed, then completely withdrawn from the bore. ROH to surface. W.O.C.

The 3430 L of averaged S.G. 1.66 grout, mixed in 90 minutes, was placed via the bean pump through the rods to the bore at 600m, in 30 minutes, displaced and completed at 18:00 hours.

24-04-2016

Sounding for the grout top found an obstruction at 273 m. - dislodged. Piece of FRP Casing found in rods.

RIH with injection / tagging tool on end of rods. Tagged grout plug at 489 m.

Mixed in 30 minutes and pumped in 15 minutes, 1980 L of averaged S.G. 1.67 grout from 470 to about 364 m . Displaced with clean water.

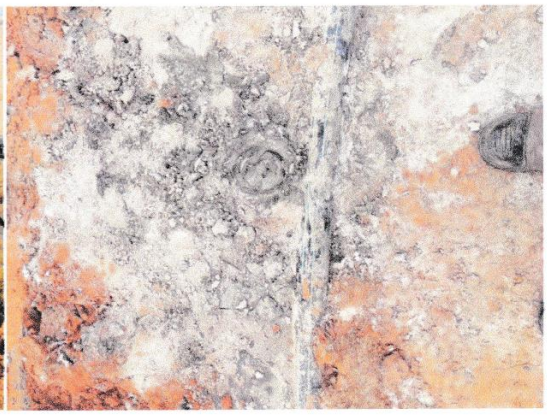
Pulled rods back to 364 m, mix time now 1 hour, and placed time now 30 mins, 1980 L of averaged S.G. 1.67 grout from 364 m to surface.

ROH to surface. W.O.C.

25-04-2016 ANZAC Day.

Tagged grout at 78 m.

Filled bore to surface via a tremmie pipe, with 1.65 S.G. Grout.



John L Dixon, Lic. Class 3 Driller # 218562.

Owen Oil Tools

Mulka Bore Squeeze Perforations
Run #1

Charge Specifications		Company	DEWNR	Ticket Number	SNAWR# 240416_PERF
Charge P/N	SDP-2125-402NT3	Region	South Australia	Date	23-Apr-16
Charge P/N	RTG-2125-302GH	Rig	Silver City SC004	Rig Rep	Jeremey Wardle
Loaded Shots	60 SDP & GH	Area	South Australia	DWNER Rep.	Glen Kleinschmidt
Penetration	19.72" & 6.0"	Well	Mulka Bore	Owen Rep	Matt Truscott
Entry Hole	0.18" & 0.34"	No.	#1	District	Australia

Internal String			External String				
Schematic	Description.	O.D.	Schematic	Description	O.D (in)	Length (m)	Depth (m)
				Cable Head	1.375"	0.380 m	1014.430 m
				Detonator Sub	1.687	0.240 m	1014.810 m
				Top Sub	2.125	0.450 m	1015.050 m
				TOP CHARGE AT			1015.500 m
			3.00	11ft 2.125" Perf Gun 60 Shots	2.125	3.000 m	
				BOTTOM CHARGE AT			1018.500 m
				Bottom of Gun	2.125	0.138 m	1018.638 m
				Bottom Nose	2.125	0.050 m	1018.688 m

Tubing size	Weight	Grade	I.D	Drift	Restriction	Depth	Max. Dev.	Depth
153mm	N/A		153mm		80mm	0 - 280m	N/A	
Casing Size	**Weight**	**Grade**	**I.D**	**Drift**				
203mm	N/A		203					
Well Fluid Type	**Weight**	**B.H.T**	**Firing Head Type**				**Wire**	
Kill Mud	9.6 ppg	N/A	Electric				3/16"	
Tool String Length			**Distance from Top Shot to Bottom Shot**					
4.258 m			3.00M					

COMMENTS: PERFORATIONS SHOT IN BULLDOG SHALE AT 1018.5M - 1018.5M

Owen Oil Tools

Mulka Bore Squeeze Perforations
Run #2

Charge Specifications		Company	DEWNR	Ticket Number	SNAWR# 240416_PERF
Charge P/N	SDP-2125-402NT3	Region	South Australia	Date	23-Apr-16
Charge P/N	RTG-2125-302GH	Rig	Silver City SC004	Rig Rep	Jeremey Wardle
Loaded Shots	60 SDP & GH	Area	South Australia	DWNER Rep.	Glen Kleinschmidt
Penetration	19.72" & 6.0"	Well	Mulka Bore	Owen Rep	Matt Truscott
Entry Hole	0.18" & 0.34"	No.	#1	District	Australia

Internal String			External String				
Schematic	Description.	O.D.	Schematic	Description	O.D (in)	Length (m)	Depth (m)
				Cable Head	1.375"	0.380 m	439.430 m
				Detonator Sub	1.687	0.240 m	439.810 m
				Top Sub	2.125	0.450 m	440.050 m
				TOP CHARGE AT			440.500 m
			3.00	11ft 2.125" Perf Gun 60 Shots	2.125	3.000 m	
				BOTTOM CHARGE AT			443.500 m
				Bottom of Gun	2.125	0.138 m	443.638 m
				Bottom Nose	2.125	0.050 m	443.688 m

Tubing size	Weight	Grade	I.D	Drift	Restriction	Depth	Max. Dev.	Depth
153mm	N/A		153mm		80mm	0 - 280m	N/A	
Casing Size	**Weight**	**Grade**	**I.D**	**Drift**				
203mm	N/A		203					
Well Fluid Type	**Weight**	**B.H.T**	**Firing Head Type**				**Wire**	
Kill Mud	9.6 ppg	N/A	Electric				3/16"	
Tool String Length			**Distance from Top Shot to Bottom Shot**					
4.257 m			3.00M					

COMMENTS: PERFORATIONS SHOT IN MACKUNDA FORMATION AT 440.5M - 443.5M

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