



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation

Proposed Medical Facility
31-33 Smith Street, Charlestown

Prepared for
Archadia Projects Pty Ltd

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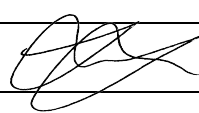
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Geotechnical Investigation

Proposed Medical Facility

31-33 Smith Street, Charlestown

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed medical facility at 31-33 Smith Street, Charlestown. The investigation was commissioned in an email dated 4 April 2022 by Ian Gill of Archadia Projects Pty Ltd and was undertaken in accordance with Douglas Partners' proposal 210780.01.P.001.Rev1 dated 1 April 2022.

It is understood that the proposed development of the site will include the construction of a new four-storey health care facility with rooftop plant fronting the Pacific Highway and a multi-deck car park structure facing Smith Street.

DP has previously undertaken a mine subsidence desktop assessment (DP, 2021) for the proposed development. The site is undermined within the Victoria Tunnel Seam (VT Seam), which was anticipated to be at a depth of between 150 m and 160 m depth. No signs of pillar extraction (secondary workings) or abnormally shaped pillars are shown beneath the site of the relevant RT. Based on the available information and investigation methodologies undertaken in DP (2021), a moderate uncertainty factor had been determined for the workings. The aim of the present investigation was to provide details of the workings beneath the site in order to reduce the uncertainty factor to low with reference to the Subsidence Advisory NSW (SA NSW) Merit Assessment Policy and re-assess the stability of the workings.

The investigation included the drilling of one borehole, downhole CCTV and geophysical logging. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Field Work

2.1 Field Work Methods

The investigation included drilling of one bore designated Bore 1001 to 158.0 m depth between 9 to 17 May 2022.

The bore location was selected by georeferencing the RT supplied by the Department of Lands to the digital cadastre and surface features with an aim at targeting voids (bords) in the VT seam mine workings of the Waratah Colliery.

The bore was drilled using solid flight auger and wash boring techniques to the final depth. An attempt to core from 140 m depth was made, however unfavourable drilling conditions resulted in coring to be abandoned and the hole was finished using wash boring methods.

Bore 1001 encountered the void and subsequent CCTV camera inspection and sonar imaging of the void was undertaken.

After the completion of drilling geophysical logging of the bores was undertaken by Ground Search Australia. The logging suite included the following:

- Density;
- Natural Gamma;
- Sonic – Below the standing water level;
- Neutron; and
- Deviation.

At the completion of drilling, CCTV, sonar and geophysical logging the bore were cased with PVC and capped.

The bore was set-out and picked up using a differential GPS unit relative to MGA 1994 coordinates and AHD, which is typically accurate to ± 0.1 m by the geotechnical engineer from DP. The bore coordinates and RL is shown on the log in Appendix B. It should be noted that DP are not registered surveyors and if more accurate survey is required registered surveyors should be engaged.

The bore location is shown on Drawing 1, in Appendix C.

2.2 Field Work Results

The subsurface profile encountered in the bore is presented in the borehole log attached in Appendix B. The logs should be read in conjunction with the notes preceding them in Appendix A that define the classification methods and descriptive terms.

The subsurface conditions encountered in the in the bore is presented in Table 1 below

Table 1: Summary of Subsurface Conditions

Depth (m)		Thickness (m)	Formation	Description
From	To			
0.0	4.5	4.5	Soil	
4.5	54.6	50.1	Tickhole Formation	Siltstone, sandstone conglomerate with minor tuff and coal
54.6	57.5	2.9	Montrose Seam	Coal with tuffaceous and carbonaceous bands
57.5	69.8	12.3	Kahibah Formation	Sandstone, conglomerate minor siltstone with basal Wave Hill Tuff Member
69.8	72.7	2.9	Wave Hill Seam	Coal with tuffaceous clay seams
72.7	119.4	46.7	Highfields / Glebe Formation	Sandstone, conglomerate, and laminate
119.4	121.5	2.1	Fern Valley Upper Seam	Stoney coal with carbonaceous tuffaceous bands
121.5	125.1	3.6	Fern Valley Split	Tuffaceous sandstone and siltstone, with basal siltstone unit
125.1	130.2	5.1	Fern Valley Lower Seam	Stoney coal with carbonaceous and tuffaceous bands
130.2	153.9	23.7	Kotara Formation	Siltstone, sandstone and tuffaceous siltstone
153.9	154.4	0.5	Victoria Tunnel Seam	Coal with tuffaceous bands
154.4	155.6	1.2	Void (Based on CCTV inspection and drilling resistance)	
155.6	156.88	1.28	Rubble (Based on CCTV inspection and drilling resistance)	Large 'blocky' (based on CCTV inspection)
156.88	>158.0	>1.12	Shepherds Hill Formation	No sample returned to surface

Standing water level was observed at 97.4 m with seepage observed from 11 m depth during CCTV inspection. It should be noted that groundwater levels are affected by factors such as climatic conditions, soil permeability and tidal fluctuations and will therefore vary with time.

During drilling water return was maintained to about 0.5 m of the VT Seam workings.

2.3 CCTV Downhole Camera Inspection

The pertinent results of the CCTV camera inspections were as follows:

- Standing water level observed at 97.4 m (seepage observed at 11.0 m depth, and 54.3 m).



Figure 1: CCTV Screenshot - Seepage

- 0.9 m void observed above the top of rubble. The rubble was observed to comprise large blocks indicative of prior roof collapse.



Figure 2: CCTV Screenshot - Blocky rubble

The downhole camera inspection is summarised on the CCTV Camera Record Sheet in Appendix B.

2.4 Sonar Imaging

Downhole sonar images were taken within the void space in Bore 1001. The sonar images were georeferenced considering borehole deviation and overlaid against the geo-referenced RT 293 as shown on Drawing 1, in Appendix C.

The sonar images indicate that the bore corresponds to a cut-through in the workings.

The sonar image captured in Bore 1001 indicates that the cut-through width correlate well within the dimensions of the bords shown on RT 293. The sonar image suggests that the NW to SE cut-through is approximately 3.1 m wide and is likely to have been sealed (possibly for ventilation purposes). The sonar image is consistent with the results of the CCTV inspection which suggests the presence of a coal pillar wall immediately adjacent to the north-west of Bore 1001.

2.5 Geophysical Logging

The results of the geophysical logging are presented in Appendix B. The inferred depths and thicknesses of the coal seams encountered in the bore appear to be consistent with the logged depths and thicknesses presented on the borehole log.

3. Comments

3.1 Appreciation of Subsurface Conditions

The pertinent subsurface conditions with respect to the VT Seam workings beneath the site are summaries as follows:

- The depth of cover to the VT Seam / workings was recorded to be 153.9 m depth with the void encountered at 154.4 m depth;
- The VT Seam was inferred to be approximately 2.98 m thick based on drilling observations and geophysical logging;
- An alternative method of estimating the height of the working section would be to assume a bulking factor for the rubble to back calculate an estimated working section using the following formula:

$$\text{Working Section} = \text{Height of Void} + \text{Rubble} - \left(\frac{\text{Height of Rubble}}{\text{Bulking factor } \{ \text{Assume} \approx 1.6 \} } \right)$$

Based on the above the working section was inferred to be approximately 1.68 m;

- A section provided within RT293 indicates that the VT Seam is approximately 2.54 m thick. The shaft to which this data relates is not specified on the RT. The seam section from RT293 is reproduced in Figure 3 below.

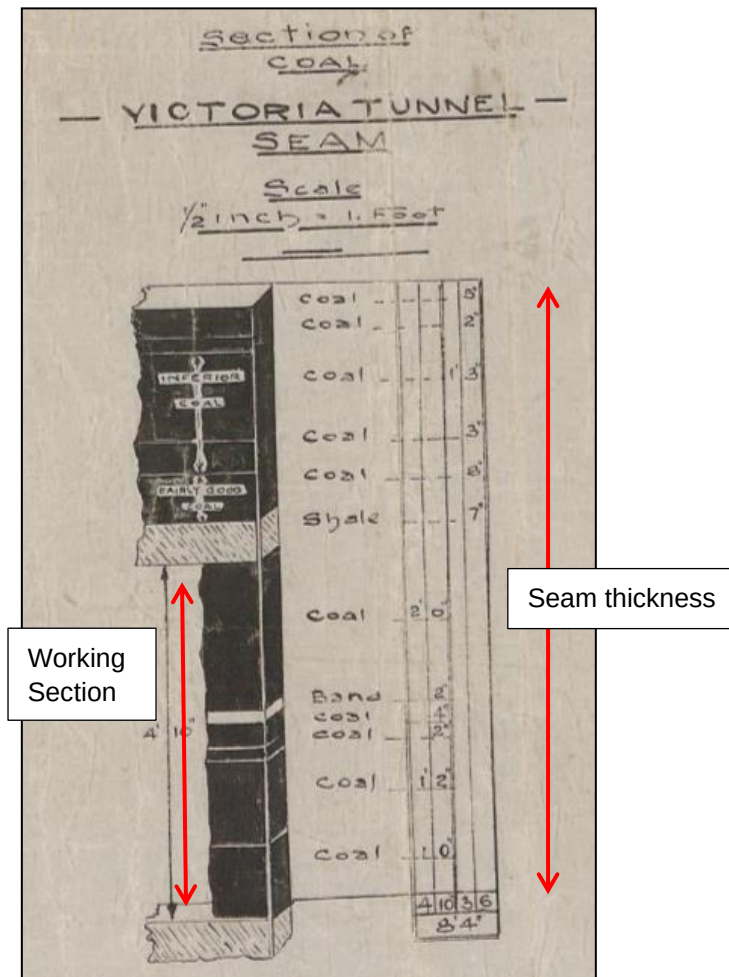


Figure 3: Seam section of VT seam from RT293

- Figure 3 shows the complete section of the VT seam (8'4"; 2.54 m) and the working section (4'10"; 1.47 m), indicating that coal was mined from the lower part of the seam and the coal tops of "inferior coal" were left in place;
- Therefore, for our analysis, we have adopted the more conservative working seam thickness of 1.68 m;
- The combined total void and rubble height encountered in the void was 2.43 m with the open void height observed during the CCTV inspection recorded to be 0.9 m;
- The results of the sonar imaging suggest that the mapped bord and pillar working dimensions correlate to those encountered during the investigation and also matches DPs in house data of workings of the VT Seam at nearby sites;
- Water return was maintained during drilling in the bore to within 0.5 m of the VT Seam / open void (workings). This suggests that there is limited mine subsidence induced fracturing in the overburden;
- The Kotara Formation that forms the roof above the VT Seam was approximately 23.7 m thick comprising laminite, tuff, siltstone and sandstone;

- The workings are flooded.

The results of this investigation and in-house data sourced from nearby sites suggest that there is a reasonable level of confidence in the position and layout of the workings in the Victoria Tunnel Seam as shown on RT 293 exists in the areas investigated.

3.2 SA NSW Merit Assessment Criteria

In order to provide an understanding on the risk of subsidence to proposed developments, a framework for assessing proposed developments was developed by SA NSW (2018), within SA NSW Development Application – Merit Assessment Policy. The framework assesses developments on the basis of building category, level of geotechnical uncertainty (uncertainty factor) and assessed stability of the remnant coal pillars based on pillar factors of safety and pillar slenderness. A copy of framework, outlined in Attachment C of the policy, is reproduced in Appendix D of this report.

With reference to SA NSW (2018), Appendix C, Table C2, the proposed development is likely classified as a building type category 'B3' due to the cost of development and the proposed use being a health facility with hospital wards.

For the purposes of this assessment, the uncertainty factor was calculated using the criteria as outlined in SA NSW's Merit Assessment Policy and is shown in Table 2 below, for the VT Seam workings.

Table 2: Uncertainty Factor – Victoria Tunnel Seam Workings

Model Scenario	Weighting Value (Ri)	Uncertainty Value (Ui)	Uncertainty Factor	
			Weight x Value (RiUi)	UF ($\sum RiUi - 10$)
R1 – Geological Environment	2	Low (1)	2	= 5 Low (UF ≤ 5)
R2 – Level of Geotechnical Investigation	2	Medium (2)	4	
R3 – Type of Coal Mine Plans and Records	3	Low (1)	3	
R4 – Method Used to Assess Stability and Impact	3	Medium (2)	6	

Notes to Table 2:

UF is equal to the sum of Weight x Value - 10.

Reference to Table C3 of Attachment C in SA NSW (2018) indicates that for low uncertainty, the pillar FoS are to be greater than 2.1 and the pillar width to height ratios (W/H) are to be greater than 2 for B3 type structures, to allow development with the following likely SA NSW conditions being applied:

(1) Provide a peer review of the initial geotechnical report by a consultant acceptable to SA NSW with confirmation and signoff that the pillars are long-term stable.

(2) Provide signoff by a Structural Engineer experienced in mine subsidence design that the proposed improvement will remain structurally sound and safe in the event that it is subject to absolute worst case subsidence impact (ie that all pillars with W/H ratios of less than 8 fail).

(3) A number of permanent survey marks to AHD will be required so that building movement can be monitored should mine subsidence occur. Survey marks need to be initially surveyed and all details are to be forwarded to Subsidence Advisory NSW.

(4) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans and in accordance with all relevant building codes and standards.

In addition, if the pillars beneath the site have a FoS of less than 2.1 and / or the pillar width to height ratios (W/H) are less than 2 the following SA NSW conditions apply:

Structure must be designed to be "safe, serviceable and readily repairable" under the predicted subsidence impact parameters.

If estimated subsidence impact greater than specified, subsidence impact must be either eliminated or mitigated by a suitable means such as the emplacement of grout into the mine workings, or another suitable engineered mitigation measure put forward for SA NSW acceptance.

3.3 Pillar Stability Analysis

Pillar stability analysis was undertaken using the UNSW Power Formula, Galvin, et al (1998), for 79 pillars within the angle of draw of the workings in the VT Seam.

Drawing 2 shows the approximate angle of draw based on the site boundary and extent of the workings (blue line), which is typically taken as an angle of 1H:2V within the Newcastle Coal Measures. For the purposes of this report the depth to the workings was assumed to be 154 m (i.e. the angle of draw is equal to approximately 84 m).

The results of the bore drilled at the site were used as a basis for the assumptions used in the analysis. The assumptions are summarised below:

- Depth to workings calculated from site survey and workings as measured in the borehole i.e 153.9 m depth (about RL -46.2 AHD) to top of VT Seam;
- Seam thickness of 2.98 m (measured in Bore 1001);
- Working section height of 1.68 m based on Bore 1001. As discussed in Section 3.1, RT293 indicates a working section of 1.46 m however, DP have adopted the more conservative thickness encountered in Bore 1001;
- Pillar height of seam 2.43 m (1.2 m thickness of void and 1.23 m thickness of rubble);
- Sonar image of Bore 1001 indicates the width of bords are commensurate to those traced on RT 293;

- Average bulk density of overburden is 25 kN/m³;
- Large geological structures (faults) were not mapped within the angle of draw of the site or encountered in the boreholes and therefore not considered in analysis.

Analysis comprised the following cases:

1. 'Typical Conditions': Pillar height of 1.68 m as per the calculated working seam thickness of 1.68 m and pillar dimensions as traced from the RT 293;
2. 'Worst-Case Collapsed Roof': Pillar height of 2.43 m (to account for roof collapse and pillar dimensions as per RT 293).

The results of these analyses are given in Appendix E and Tables E1 and E2. A summary is given below.

Summary of Pillar Stability Analysis – All Pillars within Angle of Draw

Refer to Appendix E	Table E1	Table E2
Model Case	Typical Conditions	Worst Case Collapsed Roof

Assumptions

Loading Conditions	Full tributary area	
Depth of Cover (m)	154.4	
Model Pillar Height (m) for Stability	1.68	2.48
Seam Thickness (m)	2.98	2.98
Pillar Dimensions	RT293	RT293

Results of Analysis

Min. W:H Ratio	4.3	3.1
Max W:H Ratio	13.5	9.0
Average W:H Ratio	6.3	4.2
No. of Pillars with W:H Ratio <2	0	0
No. of Pillars with W:H Ratio <4	0	50
No. of Pillars with W:H Ratio <8	70	76
Overall Extraction Ratio	0.44	0.44
Max FoS	11.9	5.9
Min FoS	2.0 ^(a)	1.3
Mean FoS	3.6	2.18
No. of Pillars with FOS < 2.1	3 ^(a)	58
% of Pillars with FOS < 2.1	4	73
Panel Factor of Safety	4.3	2.5

Notes to Table:

- Panel Factor of Safety (FoS) is total strength of pillars (kN) / total load on pillars (kN)
 - Total stress analysis (ie dry workings with no buoyancy affect), which is considered conservative but in-line with SA NSW requirements.
- a See comments below in relation to these pillars

The analysis indicated the following:

- For the “typical conditions” case, based on a pillar height equal to the working section:
 - all pillars assessed satisfy the SA NSW criteria for width to height ratio (W:H>2);
 - Three (3) of the 79 pillars assessed do not have a factor of safety greater than 2.1 for Typical Conditions. It is noted that these two pillars are located to the north-west of the site (Pillars 159 and 161 on Drawing 1) and there are very large pillars with factors of safety in excess of 10 (Pillars 148 to 150) that separate the site from these weaker pillars.

- For the “worst case” analysis, based on the pillar height being equivalent to the working section plus accounting for roof fall (ie pillar height of 2.48 m):
 - o all pillars assessed satisfy the SA NSW criteria for width to height ratio ($W:H > 2$); and
 - o 58 of the 79 pillars assessed do not have a factor of safety greater than 2.1.

It is noted that a number of panels of similar dimensioned pillars were noted within the workings under the site and within the area of draw. These panels are shown on Drawing 3 and are summarised as follows:

- Panel 1 Located within north-western part of site which includes pillars which have a width to height ratio in excess of 8;
- Panel 2 Located to the south-east of Panel 1;
- Panel 3 Located to the north-west of Panel 1; and
- Panel 4 Located to the south-west of Panel 1 and only includes eight pillars.

Panels 2 and 3 appear to be part of a larger panel of workings of similar dimensions which extend beyond the area of investigation. The panel widths have been estimated to be in the order of 365 m and 320 m respectively.

3.4 Summary and Recommendations

The results of the subsurface investigation (including sonar survey) indicate:

- Bord and cut-through dimensions are similar to those traced from RT 293;
- The borehole data and data review indicates that a working section of approximately 1.68 m is a reasonable estimate for the workings beneath the site;
- The void plus rubble thickness measured in the bore was 2.43 m.

SA NSW (2018) indicates that likely approval for a B3 category structure with a low uncertainty factor such as the proposed development would require pillar width to height (W/H) ratios greater than 2 and pillar FoS greater than 2.1 considering the potential for roof failure.

Where the pillar factor of safety is less than the nominated values than according to (SA NSW, 2018), *The structure should be designed to be “safe, serviceable and readily repairable” under the predicted subsidence impact parameters;*

If estimated subsidence impact greater than specified, subsidence impact must be either eliminated or mitigated by suitable means such as the emplacement of grout into the mine workings, or another suitable engineered mitigation measure put forward for SA NSW acceptance.

3.5 Revised Subsidence Parameters

SA NSW (2018) describes an ‘absolute worst case’ subsidence event where all pillars with a width to height ratio of less than eight are assumed to fail. The pillar stability analysis indicates that the majority of pillars within Panel 2, Panel 3 and Panel 4 have a width to height ratio of less than eight and therefore ‘absolute worst case’ subsidence parameters were estimated.

The method adopted to estimate the credible worst case subsidence associated with crush of the pillars was to assign an elastic modulus to these pillars which represents the behaviour of a crushed pillar and then apply tributary loading on each of these “softened” pillars to determine the total elastic movement. This would allow an estimate of the convergence of each pillar under tributary loading which would relate to surface subsidence. In this case, the average convergence of the pillars within each identified panel was estimated and the highest value from the panels was adopted to be the maximum credible subsidence in the area.

In order to assess the modulus of a crushed pillar, back-analysis was undertaken on the pillars that failed in the Borehole Seam during the creep events which commenced on 15 May 1906 at The Hill (Newcastle). Data presented in E. M. To (1988) indicated that the maximum subsidence of the First Creep event in the Borehole Seam was 1’ 4” to 2’ 9” (i.e. about 405 mm to 840 mm) and the second creep 9” to 2ft 7” (i.e. about 230 mm to about 790 mm). For the maximum subsidence observed and an overburden depth of about 110 m, the average crushed modulus of the failed pillars was estimated to be about 36 MPa, which is similar to that observed for medium dense sands.

Based on the above data, the maximum subsidence for this site was estimated based on the following:

- Average crushed pillar modulus of 36 MPa;
- Working section of 1.68 m;
- Cover depth of 154.4 m;
- Total stress conditions; and
- Pillar dimensions as presented on the RT.

Based on the above, the estimated maximum subsidence due to crush of the pillars was estimated to be about 300 mm (Panel 3).

Once the maximum subsidence was estimated, the tilt, strain and curvatures were estimated using the Newcastle Coalfields Longwall Guidelines (Holla , 1987) and ACARP (2003).

The resulting values of surface subsidence, strains, tilt and curvature are considered to be limiting values for the available mine data as described in this report. For this reason, the values are denoted ‘worst credible’ subsidence parameters.

Estimates of maximum subsidence parameters in the event of a yield of pillars are presented in Table 3.

Table 3: Worst Credible Subsidence Parameters

Working Section (m)	1.68
Maximum Surface Subsidence (m)	0.30
Maximum Tensile Strain (mm/m)	0.8
Maximum Compressive Strain (mm/m)	1.2
Maximum Tilt (mm/m)	3.5
Radius of Curvature (km)	8.5

In accordance with SA NSW (2018), the structure must be designed to be “safe, serviceable and any damage from mine subsidence shall be limited to ‘slight’ in accordance with AS2870 (Damage Classification), and readily repairable” under the predicted subsidence impact parameters.

It should be noted that the parameters provided above may be able to be reduced as a result of numerical modelling.

4. References

- DP. (2021). *Report on Mine Subsidence Desktop Assessment, Proposed Multi-Storey Development, 31-33 Smith Street, Charlestown*. Doc Ref: 210780.00.R.001.Rev0: Douglas Partners Pty Ltd.
- Galvin, J. M. (1998). *Establishing the Strength of Rectangular and Irregular Pillars Final Report for ACARP Project*. ACARP 1998.
- Holla . (1987). *Holla L, Mining Subsidence in NSW - Surface Subsidence Prediction in the Newcastle Coalfield*. Department of Mineral Resources.
- SA NSW. (2018). *Development Applicatin - Merit Assessment Policy*. Subsidence Advisory NSW.

5. Limitations

Douglas Partners (DP) has prepared this report for this project at 31-33 Smith Street, Charlestown in accordance with DP’s proposal 210780.01.P.001.Re1 dated 1 April 2022 and acceptance received from Ian Gill of Archadia Projects Pty Ltd dated 4 April 2022. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Archadia Projects Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the

work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report
Terminology, Symbols and Abbreviations
Soil Descriptions
Rock Descriptions
Sampling, Testing and Excavation Methodology

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;

- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

continued next page

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style **XW**. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example **PL** is used for plastic limit in the context of soil moisture condition, as well as in **PL(A)** for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

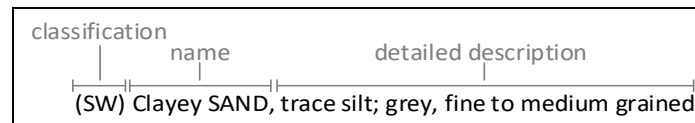
Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Introduction

All materials which are not considered to be “in-situ rock” are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:



The “classification” comprises a two character “group symbol” providing a general summary of dominant soil characteristics. The “name” summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about the soil’s composition, condition, structure, and origin.

Classification, naming and description of soils requires the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either “fine grained” (also known as “cohesive” behaviour) or “coarse grained” (“non cohesive” behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Fraction	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as “oversize”	
Cobble	63 - 200		
Gravel ¹	2.36 - 63	Coarse	>65%
Sand ¹	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

¹ – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer “component proportions” below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a “Sandy CLAY”, this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a “primary”, “secondary”, or “minor” component of the soil mixture, depending on its influence over the soils behaviour.

Component Proportion Designation	Definition ¹	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor ²	Present in the soil, but not significant to its engineering properties	All other components	All other components

¹ – As defined in AS1726-2017 6.1.4.4

² – in the detailed material description, minor components are split into two further sub categories. Refer “identification of minor components” below

Composite Materials

In certain situations a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example “INTERBEDDED Silty CLAY AND SAND”.

Classification

The soil classification comprises a two character group symbol. The first symbol identifies the primary component. The second symbol identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component ¹	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

¹ – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	clay/silt: 0-5% sand/gravel: 0-15%

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

	Type	Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 - 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular particle size with the range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

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Soil Condition**Moisture**

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	<PL
	Near plastic limit	Can be moulded	≈PL
	Wet of plastic limit	Water residue remains on hands when handling	>PL
	Near liquid limit	"oozes" when agitated	≈LL
	Wet of liquid limit	"oozes"	>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code **NDF**, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Rock

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered rock origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description

Quantitative engineering performance of these materials may be determined by laboratory testing, or estimated by correlated field tests (for example penetration or shear vane testing), or by tactile methods, as appropriate.

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	ST
Very stiff	Indented by thumbnail	>100 - ≤200	VST
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	FR

Relative Density (coarse grained soils)

Tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15-≤35	L
Medium dense	>35-≤65	MD
Dense	>65-≤85	D
Very dense	>85	VD

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MCE
Weakly cemented	WKCE
Cemented	CE
Strongly bound	SB
Weakly bound	WB
Unbound	UB

Extremely Weathered Rock

AS1726-2017 considers weathered rock material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. very low strength rock). These materials may be identified as “extremely weathered rock” in reports and by the abbreviation code **XWR** on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RES
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than ‘very low’ as per AS1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LCS
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or sea shore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be “oversize” may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with “MIXTURE OF”.

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Rock Strength

Rock strength is defined by the unconfined compressive strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $I_{s(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Unconfined Compressive Strength (MPa)	Point Load Index ¹ $I_{s(50)}$ MPa	Abbreviation Code
Very low	0.6 - 2	0.03 - 0.1	VL
Low	2 - 6	0.1 - 0.3	L
Medium	6 - 20	0.3 - 1.0	M
High	20 - 60	1 - 3	H
Very high	60 - 200	3 - 10	VH
Extremely high	>200	>10	EH

¹ Assumes a ratio of 20:1 for UCS to $I_{s(50)}$. It should be noted that the UCS to $I_{s(50)}$ ratio varies significantly for different rock types and specific ratios may be required for each site.

On investigation logs only, the following data contiguity codes may be in rock strength tables for layers or seams of material "within rock", but for which the equivalent UCS strength is less than 0.6 MPa.

Scenario	Abbreviation Code
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The properties of the material encountered over this interval are described in the "Description of Strata" and soil properties columns.	SOIL
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The prominence of the material is such that it can be considered to be a seam (as defined in Table 22 of AS1726-2017) and the properties of the material are described in the defect column.	SEAM

Degree of Weathering

The degree of weathering of rock is classified as follows:

Weathering Term	Description	Abbreviation Code
Residual Soil ^{1,2}	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.	RS
Extremely weathered ^{1,2}	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible	XW
Highly weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.	HW
Moderately weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.	MW
Slightly weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.	SW
Fresh	No signs of decomposition or staining.	FR
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.	DW

¹ – AS1726-2017 6.1.9 provides similar definitions for "residual soil" and "extremely weathered material" as soil origins. Generally, the soil origin terms would be used above the depth at which very low strength or stronger rock material is first encountered, while both soil origin and weathering should may be stated for soil encountered below the first contact with rock material, where appropriate.

² –The parent rock type, of which the residual/extremely weathered material is a derivative, will be stated in the description (where discernible).

Degree of Alteration

The degree of alteration of the rock material (physical or chemical changes caused by hot gasses or liquids at depth) is classified as follows:

Term	Description	Abbreviation Code
Extremely altered	Material is altered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.	XA
Highly altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be increased by leaching, or may be decreased due to precipitation of secondary materials in pores.	HA
Moderately altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable but shows little or no change of strength from fresh rock.	MA
Slightly altered	Rock is slightly discoloured but shows little or no change of strength from fresh rock	SA
Note: If HA and MA cannot be differentiated use DA (see below)		
Distinctly altered	Rock strength usually changed by alteration. The rock may be highly discoloured, usually by staining or bleaching. Porosity may be increased by leaching, or may be decreased due to precipitation of secondary minerals in pores.	DA

Degree of Fracturing

The following descriptive classification apply to the spacing of natural occurring fractures in the rock mass. It includes bedding plane partings, joints and other defects, but excludes drilling breaks. These terms are generally not required on investigation logs where fracture spacing is presented as a histogram, and where used are presented in an unabbreviated format.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$RQD \% = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

These terms may be used to describe the spacing of bedding partings in sedimentary rocks. Where used, these terms are generally presented in an unabbreviated format

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Defect Descriptions

Defect Type

Term	Abbreviation Code
Bedding plane	B
Clay seam	CS
Cleavage	CV
Crushed zone	CZ
Decomposed seam	DS
Fault	F
Joint	J
Lamination	LAM
Parting	PT
Sheared zone	SZ
Vein	VN
Drilling/handling break	DB , HB
Fracture	FCT

Rock Defect Orientation

Term	Abbreviation Code
Horizontal	H
Vertical	V
Sub-horizontal	SH
Sub-vertical	SV

Rock Defect Coating

Term	Abbreviation Code
Clean	CLN
Coating	CO
Healed	HE
Infilled	INF
Stained	STN
Tight	TI
Veneer	VEN

Rock Defect Infill

Term	Abbreviation Code
Calcite	CA
Carbonaceous	CBS
Clay	CLY
Iron oxide	FE
Manganese	MN
Silty	SLT

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Rock Defect Shape/Planarity

Term	Abbreviation Code
Curved	CU
Irregular	IR
Planar	PL
Stepped	ST
Undulating	UN

Rock Defect Roughness

Term	Abbreviation Code
Polished	PO
Rough	RO
Slickensided	SL
Smooth	SM
Very rough	VR

Other Rock Defect Attributes

Term	Abbreviation Code
Fragmented	FG
Band	BND
Quartz	QTZ

Defect Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

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Sampling and Testing

A record of samples retained and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:

SAMPLE			DEPTH (m)	TESTING	
SAMPLE REMARKS	TYPE	INTERVAL		TEST TYPE	RESULTS AND REMARKS
	SPT		1.0 1.45	SPT	4,9,11 N=20

Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Sample from SPT test	SPT
Environmental sample	E
Gas sample	G
Jar sample	J
Undisturbed tube sample	U ¹
Water sample	W
Piston sample	P
Core sample for unconfined compressive strength testing	UCS

¹ – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kpa)	PP
Photo ionisation detector	PID
Standard Penetration Test	SPT
Shear vane (kpa)	V
Unconfined compressive strength, (MPa)	UCS
Point load test, axial (A), diametric (D), irregular (I)	PLT()

Field and laboratory testing (continued)

Test Type	Code
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	Observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Excavator/backhoe bucket	B ¹
Toothed bucket	TB ¹
Mud/blade bucket	MB ¹
Ripping tyne/ripper	RT
Rock breaker/hydraulic hammer	RB
Hand auger	HA ¹
NMLC series coring	NMLC
HMLC series coring	HMLC
NQ coring	NQ
HQ coring	HQ
PQ coring	PQ
Push tube	PT ¹
Rock roller	RR ¹
Solid flight auger. Suffixes (TC) and (V) indicate tungsten carbide or v-shaped tip respectively	SFA ¹
Sonic drilling	SON ¹
Vibrocore	VC ¹
Wash bore (unspecified bit type)	WB ¹
Existing exposure	X
Hand tools (unspecified)	HT
Predrilled	PD
Specialised bit (refer report)	SPEC ¹
Diatube	DT ¹
Hollow flight auger	HFA ¹
Vacuum excavation	VE

¹ – numeric suffixes indicate tool diameter/width in mm

Appendix B

Borehole Log (Bore 1001)
Geophysical Logging Results (Bore 1001)
CCTV Camera Record Sheet

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 1 of 16

CONDITIONS ENCOUNTERED														SAMPLE			TESTING			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ⁽¹⁾ DENSITY ⁽¹⁾	MOISTURE	WEATH.	DEPTH (m)	VL L	SL CH	SH VH	STRENGTH	RECOVERY (%)						
	107	0.0	FILL/ (CH) CLAY, with gravel; yellow brown; clay fraction high plasticity; gravel fraction fine to medium, sub-angular to sub-rounded		FILL	NA	>PL													
	106	1.0	(CH) CLAY, with sand; yellow brown mottled grey; clay fraction high plasticity; sand fraction fine to medium		RES	(ST)	>PL											1		
	106	1.4	(CL) Sandy CLAY; orange brown mottled grey; clay fraction low plasticity; sand fraction fine to medium			(VST)	<PL											2		
	105	2.0			RES	(VST)	<PL											3		
	104	3.4	(CH) CLAY, with gravel; red brown mottled grey; clay fraction high plasticity; gravel fraction fine to medium, sub-angular to sub-rounded		RES	(ST)	>PL											4		
	103	4.5	CONGLOMERATE; grey brown; fine to coarse						4.5									5		
	102	6.0						MW										6		
	101	6.5																7		
	100	7.0																8		
	99	8.0						SW-FR										9		
	98	9.0																		

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

OPERATOR:
CASING: HWT to 5.5m

LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 2 of 16

CONDITIONS ENCOUNTERED													SAMPLE			TESTING				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ⁽¹⁾ DENSITY ⁽¹⁾	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS						
			CONGLOMERATE; grey brown; fine to coarse <i>(continued)</i>																	
		97															11			
		96															12			
		95															13			
		94						SW-FR		UK							14			
		93															15			
		92															16			
		91															17			
		17.5	SANDSTONE; grey; fine to medium																	
		90															18			
		89						SW-FR		UK							19			
		88																		

NOTES: ^(#) Soil origin is "probable" unless otherwise stated. ⁽¹⁾ Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth **OPERATOR:** **LOGGED:** RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m **CASING:** HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 3 of 16

CONDITIONS ENCOUNTERED													SAMPLE			TESTING				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS						
	87		SANDSTONE; grey; fine to medium (continued)																	
	21		21.0-22.0m: Conglomerate band														21			
	86																22			
	22																			
	85																23			
	23							SW-FR		UK										
	84																24			
	24																			
	83																25			
	25																			
	82																26			
	26.0		CONGLOMERATE; grey; fine and coarse						26.0											
	81																27			
	27																			
	80																28			
	28							SW-FR		UK										
	79																29			
	29																			
	78																			

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NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth **OPERATOR:** **LOGGED:** RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m **CASING:** HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---
LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 4 of 16

CONDITIONS ENCOUNTERED											SAMPLE			TESTING						
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN ^(#)	SOIL		WEATH.	ROCK					SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	
						CONSIS. ⁽¹⁾ DENSITY ⁽¹⁾	MOISTURE		DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)							DEFECTS & REMARKS
	77	31	CONGLOMERATE; grey; fine and coarse (continued)													31				
	76	32															32			
	75	33															33			
	74	34															34			
	73	35							SW-FR		UK						35			
	72	36															36			
	71	37															37			
	70	38															38			
	69	39															39			
	68																			

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NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

OPERATOR:
CASING: HWT to 5.5m

LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 5 of 16

CONDITIONS ENCOUNTERED											SAMPLE			TESTING					
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK						SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)						
			CONGLOMERATE; grey; fine and coarse <i>(continued)</i>																
	67																		
		41															41		
	66																		
		42															42		
	65																		
		43															43		
	64																		
		44															44		
	63																		
		45						SW-FR		UK							45		
	62																		
		46															46		
	61																		
		47															47		
	60		47.0-48.0m: Sandstone band																
		48															48		
	59																		
		49															49		
	58																		

NOTES: ^(#) Soil origin is "probable" unless otherwise stated. ^(*) Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

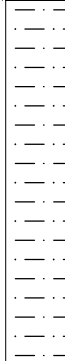
PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth **OPERATOR:** **LOGGED:** RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m **CASING:** HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 6 of 16

CONDITIONS ENCOUNTERED												SAMPLE			TESTING				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK						SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ⁽¹⁾ DENSITY: ⁽¹⁾	MOISTURE	WEATH.	DEPTH (m)	VL L LL MH VH	STRENGTH	RECOVERY (%)	RQD						
	57		CONGLOMERATE; grey; fine and coarse <i>(continued)</i>																
		51															51		
		56																	
		52															52		
		55							SW-FR										
		53															53		
		54																	
		54															54		
		54.5	54.5m: Drilling slowed						54.5										
		53	COAL; black																
		55															55		
		52																	
		56							MW								56		
		51																	
		57															57		
		57.5	CARBONACEOUS SILTSTONE; dark grey						57.5										
		50																	
		58															58		
		49																	
		59							SW								59		
		48																	

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NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ⁽¹⁾Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth **OPERATOR:** **LOGGED:** RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m **CASING:** HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 7 of 16

CONDITIONS ENCOUNTERED														SAMPLE			TESTING			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ⁽¹⁾ DENSITY ⁽¹⁾	MOISTURE	WEATH.	DEPTH (m)	VL UH VH TEH	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)						
	47		CARBONACEOUS SILTSTONE; dark grey (continued)																	
	61							SW			UK							61		
	46																			
	62.0		LAMINITE; grey and dark grey						62.0									62		
	45																			
	63																	63		
	44																			
	64																	64		
	43																			
	65							SW			UK							65		
	42																			
	66																	66		
	41																			
	67																	67		
	40																			
	68.0		TUFFACEOUS SILTSTONE; pale grey						68.0									68		
	39																			
	69							SW			UK							69		
	38																			

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PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth **OPERATOR:** **LOGGED:** RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m **CASING:** HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---
LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 8 of 16

CONDITIONS ENCOUNTERED														SAMPLE			TESTING																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
					ORIGIN ^(#)	CONSIS. ^(*)	DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	VL	LV	LM	LVH							TEH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	37		TUFFACEOUS SILTSTONE; pale grey (continued)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

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PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

OPERATOR:
CASING: HWT to 5.5m

LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---
LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 9 of 16

CONDITIONS ENCOUNTERED										SAMPLE			TESTING					
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL		ROCK						SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	VL L M H VH	STRENGTH	RECOVERY (%)						
	27		CONGLOMERATE; grey (continued)															
	81																	
	26																	
	82																	
	25																	
	83																	
	24																	
	84																	
	23							SW		UK								
	85																	
	22																	
	86																	
	21																	
	87																	
	20																	
	88																	
	19																	
	89																	
	18																	

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PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

OPERATOR:
CASING: HWT to 5.5m

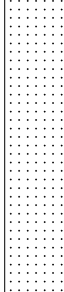
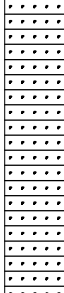
LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 10 of 16

CONDITIONS ENCOUNTERED											SAMPLE			TESTING							
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS	
					ORIGIN ^(#)	CONSIS. ⁽¹⁾ 	DENSITY ⁽¹⁾ 	MOISTURE	WEATH.	DEPTH (m)	VL L M VH EH	STRENGTH	RECOVERY (%)	RQD							FRACTURE SPACING (m) 0.01 0.05 0.10 0.50
Approximate from camera only following drilling 																					
	17		CONGLOMERATE; grey (continued)																		
	91							SW			UK							91			
	16																				
	92.0		SANDSTONE; grey; fine to medium							92.0								92			
	15																				
	93							SW			UK							93			
	14																				
	94.0		TUFFACEOUS LAMINITE; pale grey							94.0								94			
	13																				
	95																	95			
	12																				
	96																	96			
	11																				
	97							SW			UK							97			
	10																				
	98																	98			
	9																				
	99		99.0m: Possible siderite banding															99			
	8																				

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PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

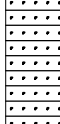
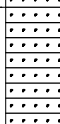
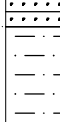
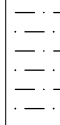
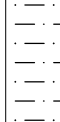
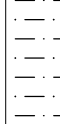
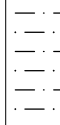
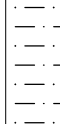
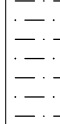
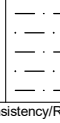
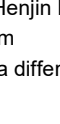
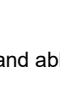
OPERATOR:
CASING: HWT to 5.5m

LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---
LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 11 of 16

CONDITIONS ENCOUNTERED														SAMPLE			TESTING			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	VL LH CH VH EH	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)						
	7		TUFFACEOUS LAMINITE; pale grey <i>(continued)</i>																	
	101		101.0m: High percentage of cutting passing through sieve					SW		UK								101		
	6																	102		
	102																			
	5																			
	103.0		CARBONACEOUS SILTSTONE; grey; with interbedded tuffaceous siltstone						103.0									103		
	4																	104		
	104																			
	3																	105		
	105																			
	2																	106		
	106																			
	1							SW		UK								107		
	107																			
	0																	108		
	108																			
	-1																	109		
	109																			
	-2																			

NOTES: ^(#) Soil origin is "probable" unless otherwise stated. ^(*) Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth OPERATOR: LOGGED: RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m CASING: HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---
LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 12 of 16

CONDITIONS ENCOUNTERED											SAMPLE			TESTING					
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK						SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)						
			CARBONACEOUS SILTSTONE; grey; with interbedded tuffaceous siltstone <i>(continued)</i>																
	-3	111														111			
	-4	112														112			
	-5	113														113			
	-6	114														114			
	-7	115						SW		UK						115			
	-8	116														116			
	-9	117														117			
	-10	118														118			
	-11	119														119			
	-12																		

NOTES: ^(#) Soil origin is "probable" unless otherwise stated. ^(*) Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

OPERATOR:
CASING: HWT to 5.5m

LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 13 of 16

CONDITIONS ENCOUNTERED													SAMPLE			TESTING				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS						
	120.0		COAL; black																	
	-13																			
	121																			
	-14																			
	122																			
	-15																			
	123.0		TUFFACEOUS SILTSTONE; pale grey																	
	-16																			
	124																			
	-17																			
	125																			
	125.5		COAL; black																	
	-18																			
	126																			
	-19																			
	127																			
	-20																			
	128																			
	-21																			
	129																			
	-22																			

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth **OPERATOR:** **LOGGED:** RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m **CASING:** HWT to 5.5m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 **N:** 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 14 of 16

[illegible]

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth	OPERATOR:	LOGGED: RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m	CASING: HWT to 5.5m	
REMARKS: Coordinates obtained using a differential GPS typically accurate to ± 0.1 m.		

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 N: 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 15 of 16

CONDITIONS ENCOUNTERED													SAMPLE			TESTING				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL			ROCK							SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(*) DENSITY ^(*)	MOISTURE	WEATH.	DEPTH (m)	VL L U CH VH EH	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)						
			LAMINITE; grey (continued)																	
	-33																	141		
	-34																	142		
	-35																	143		
	-36																	144		
	-37							SW-FS			UK							145		
	-38																	146		
	-39																	147		
	-40																	148.0		
	-41		TUFF; pale brown	✓				SW			UK							149.0		
	-42		LAMINITE; grey	✓				SW-FS			UK									

NOTES: ^(#) Soil origin is "probable" unless otherwise stated. ^(*) Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth
METHOD: AT to 5.5m, then WB to 157.3m
REMARKS: Coordinates obtained using a differential GPS typically accurate to ±0.1 m.

OPERATOR:
CASING: HWT to 5.5m

LOGGED: RLP/CTB

BOREHOLE LOG

CLIENT: Archadia Projects Pty Ltd
PROJECT: Proposed Medical Facility
LOCATION: 31-33 Smith Street, Charlestown

SURFACE LEVEL: 107.7 AHD
COORDINATE E:378148.5 **N:** 6351797.7
DATUM/GRID: MGA94 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 1001
PROJECT No: 210780.01
DATE: 09/05/22 - 17/05/22
SHEET: 16 of 16

CONDITIONS ENCOUNTERED													SAMPLE			TESTING				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL		ROCK								SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
					ORIGIN ^(#)	CONSIS. ^(%) DENSITY ^(%)	MOISTURE	WEATH.	DEPTH (m)	VL M H VH EH	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)						
Total water loss ▼	-43	151	LAMINITE; grey (continued)														151			
	-44	152															152			
	-45	153															153			
	-46	153.9															154			
	-46	154	COAL; black														154			
	-47	154.4	VOID; (Drill string drop, rods lowered without rotation to 155.65 m depth with no resistance encountered. Sudden total water loss)														155			
	-49	155.65	RUBBLE; (Rods lowered with minimal rotation and water pressure)														156			
	-49	156															156			
	-50	156.88	FLOOR; (Consistent increased drill resistance)														157			
	-50	157															157			
	-51	158.0	Borehole discontinued at 158.00m depth Limit of investigation														158			
	-52	159															159			

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(%)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hydrapower Scout Switched to Henjin DB8 from 140 m depth	OPERATOR:	LOGGED: RLP/CTB
METHOD: AT to 5.5m, then WB to 157.3m	CASING: HWT to 5.5m	
REMARKS: Coordinates obtained using a differential GPS typically accurate to ± 0.1 m.		

GROUNDSEARCH

AUSTRALIA



1001 DENSITY 1 20

COMPANY : DOUGLAS PARTNERS
WELL : 1001 DENSITY 1 20
LOCATION/FIELD : 30 SMITH ST
COUNTY :
LOCATION : CHARLESTOWN
SECTION : N/A

OTHER SERVICES:
DEN DEV
SON NEU

TOWNSHIP : N/A RANGE : N/A

DATE : 05/18/22
DEPTH DRILLER : 155.65
LOG BOTTOM : 155.31
LOG TOP : 0.00

PERMANENT DATUM : -0.6
LOG MEASURED FROM: N/A
DRL MEASURED FROM: N/A

KB : N/A
DF : N/A
GL : 0

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS: .5

LOGGING UNIT : T104
FIELD OFFICE : RUTHERFORD
RECORDED BY : M CRANE

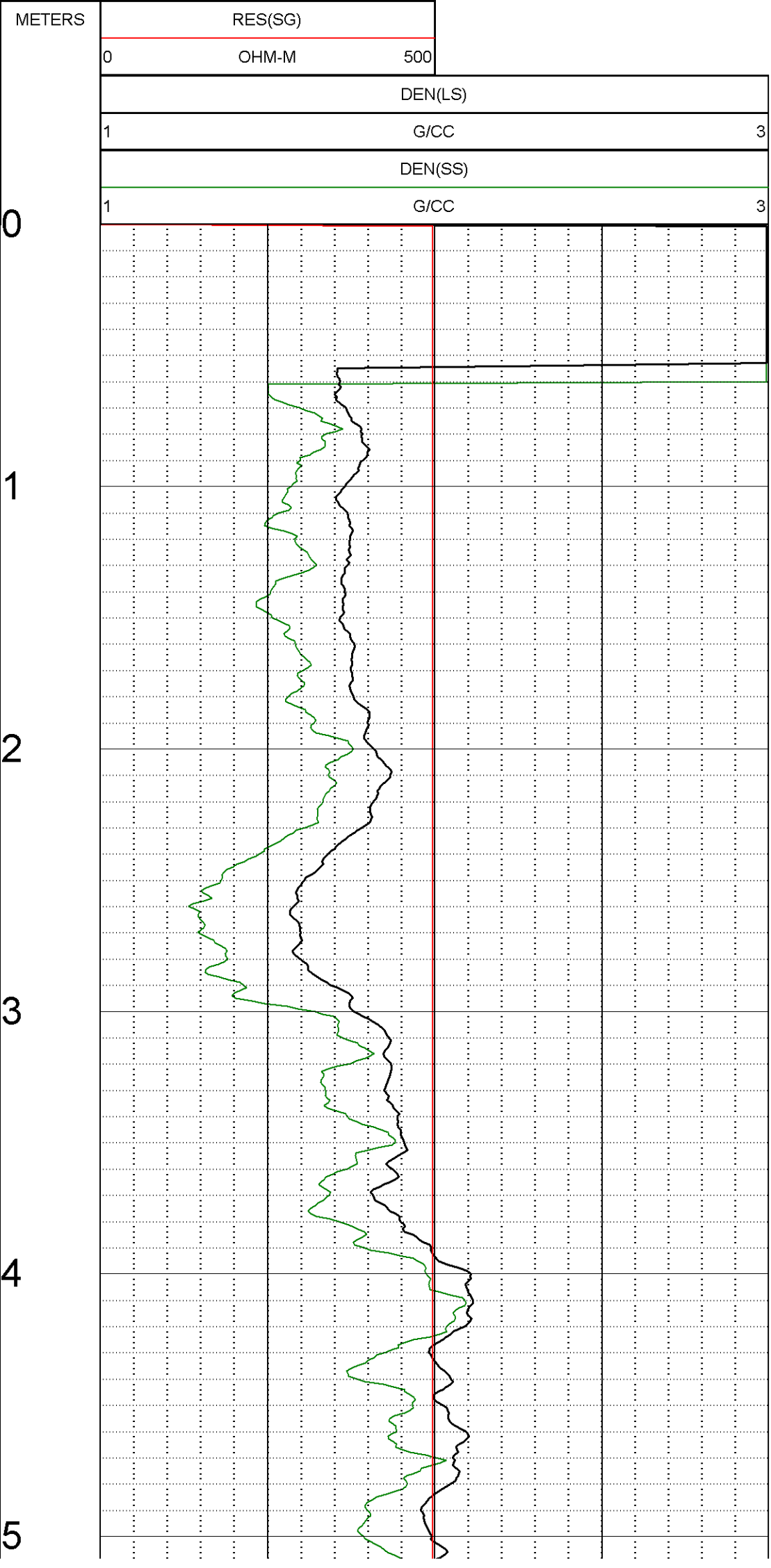
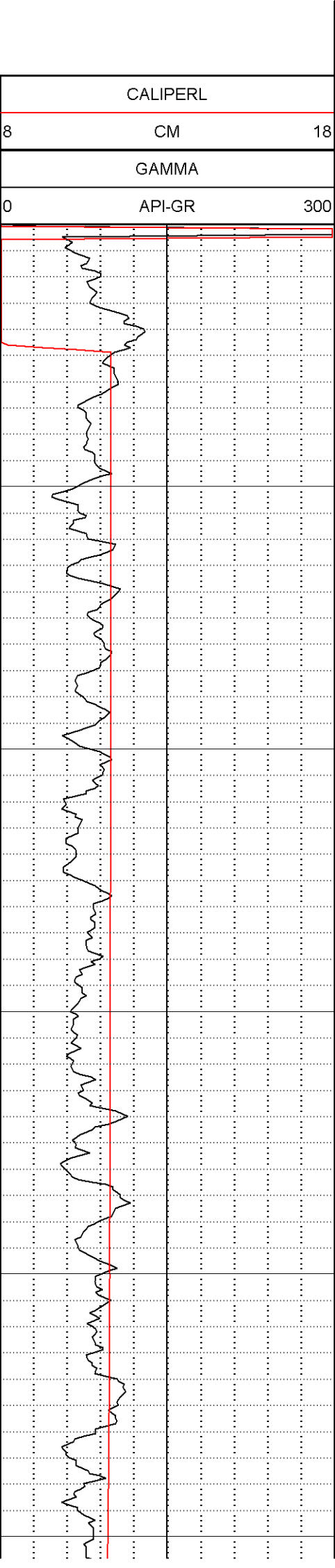
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MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

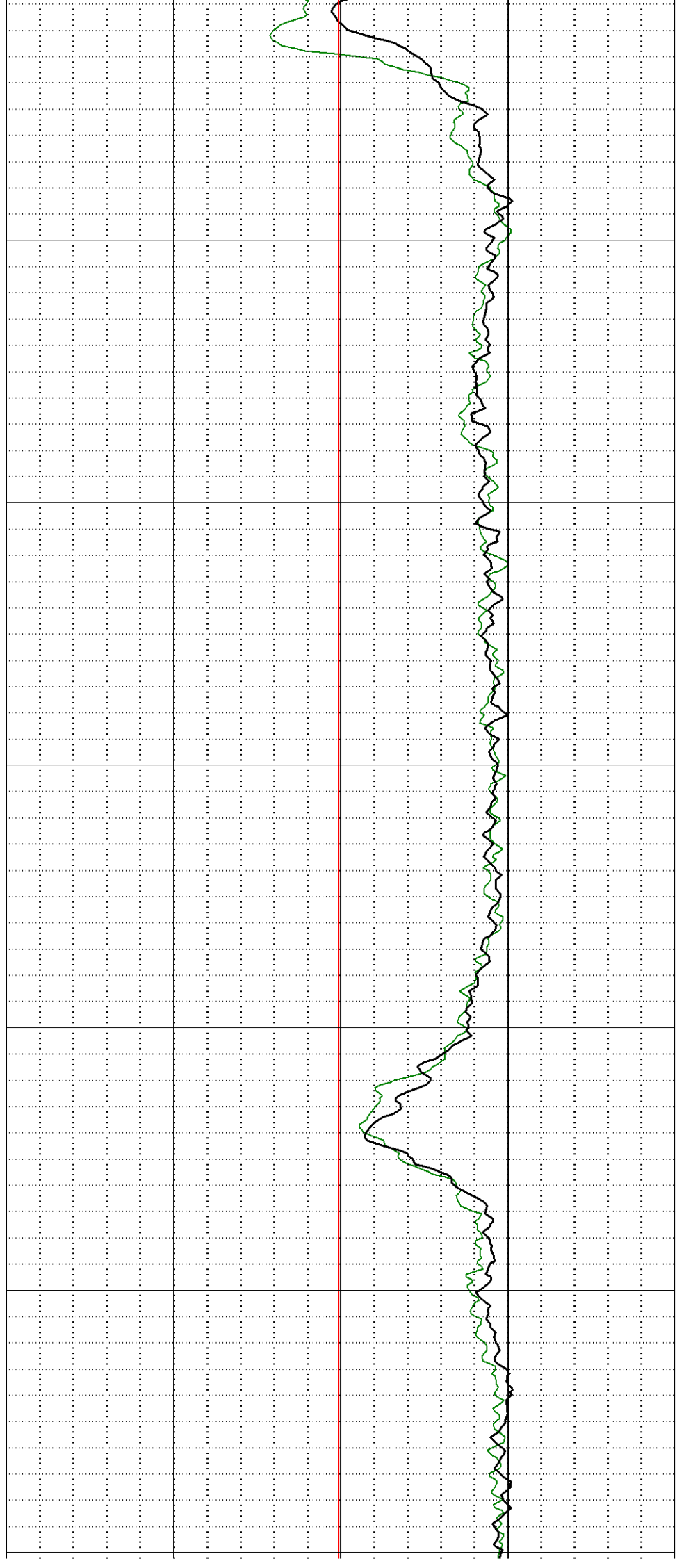
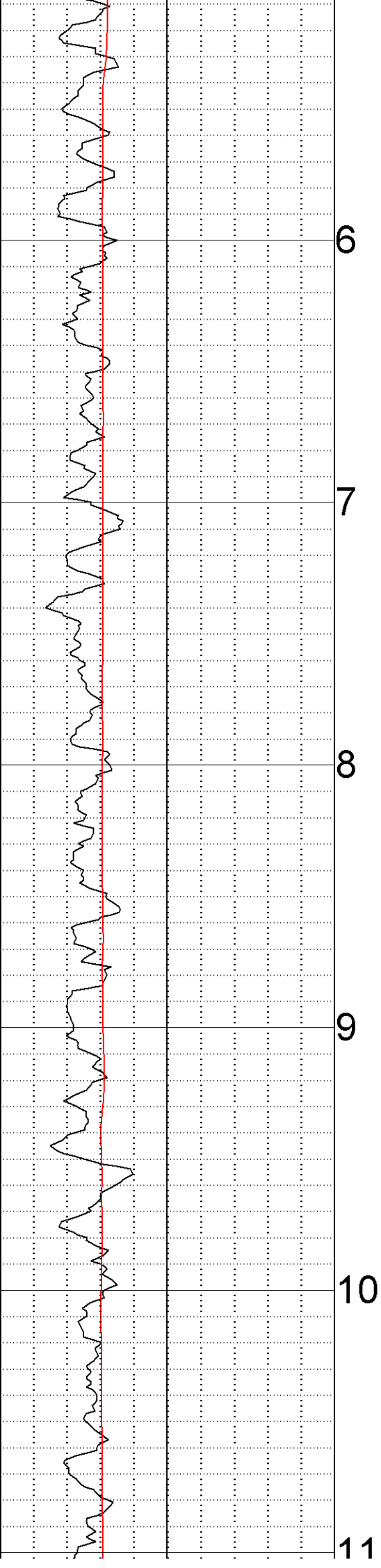
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RM : N/A
RM TEMPERATURE : N/A
MATRIX DELTA T : 177

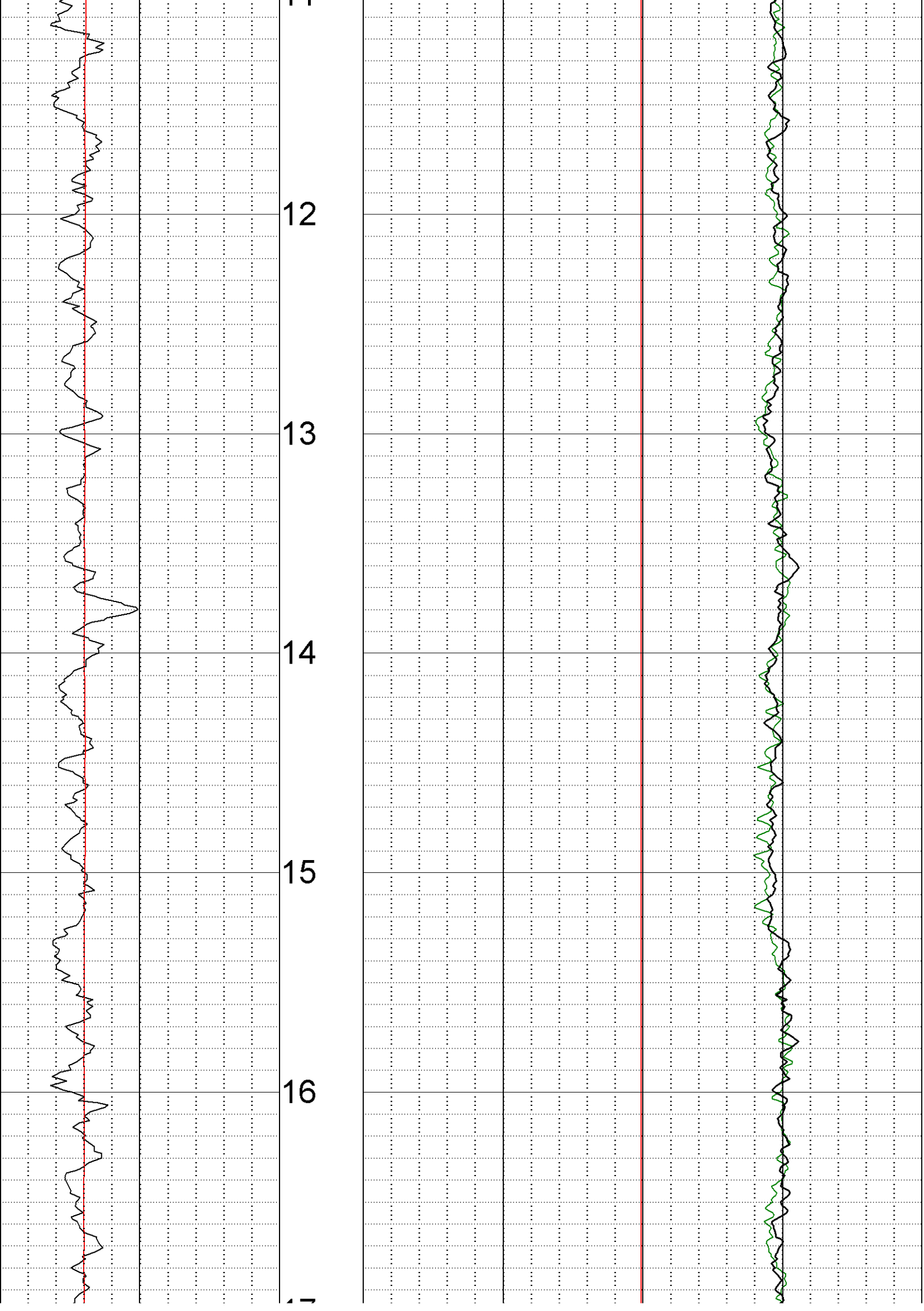
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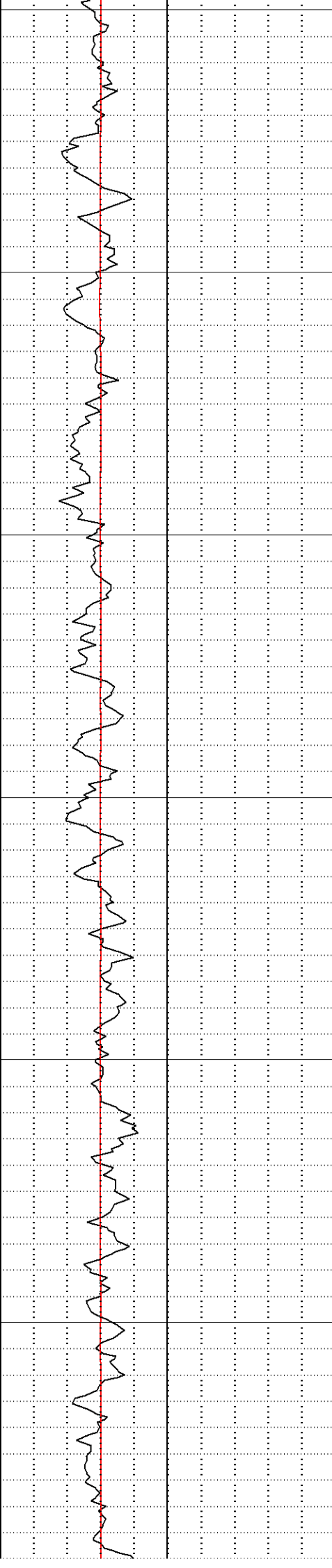
TOP OF VOID 154.4M

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS









17

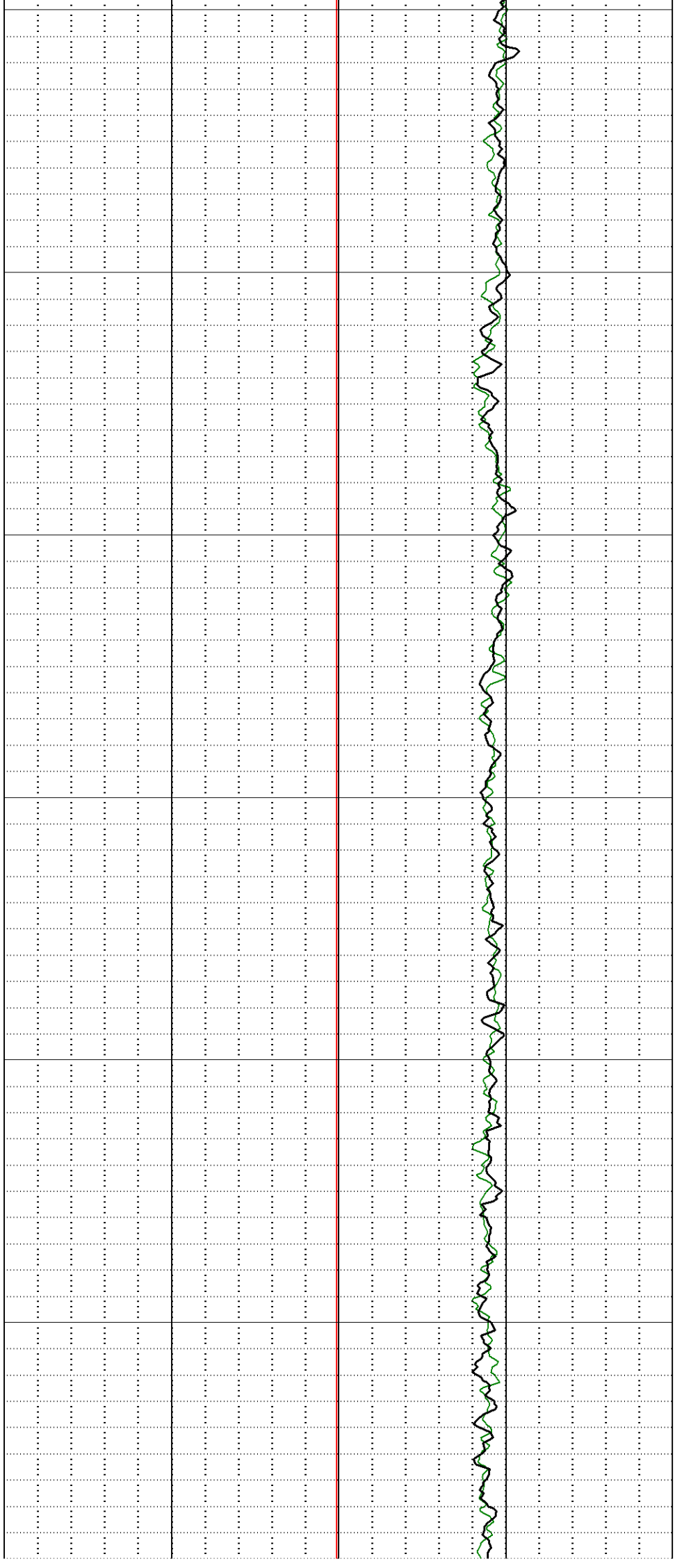
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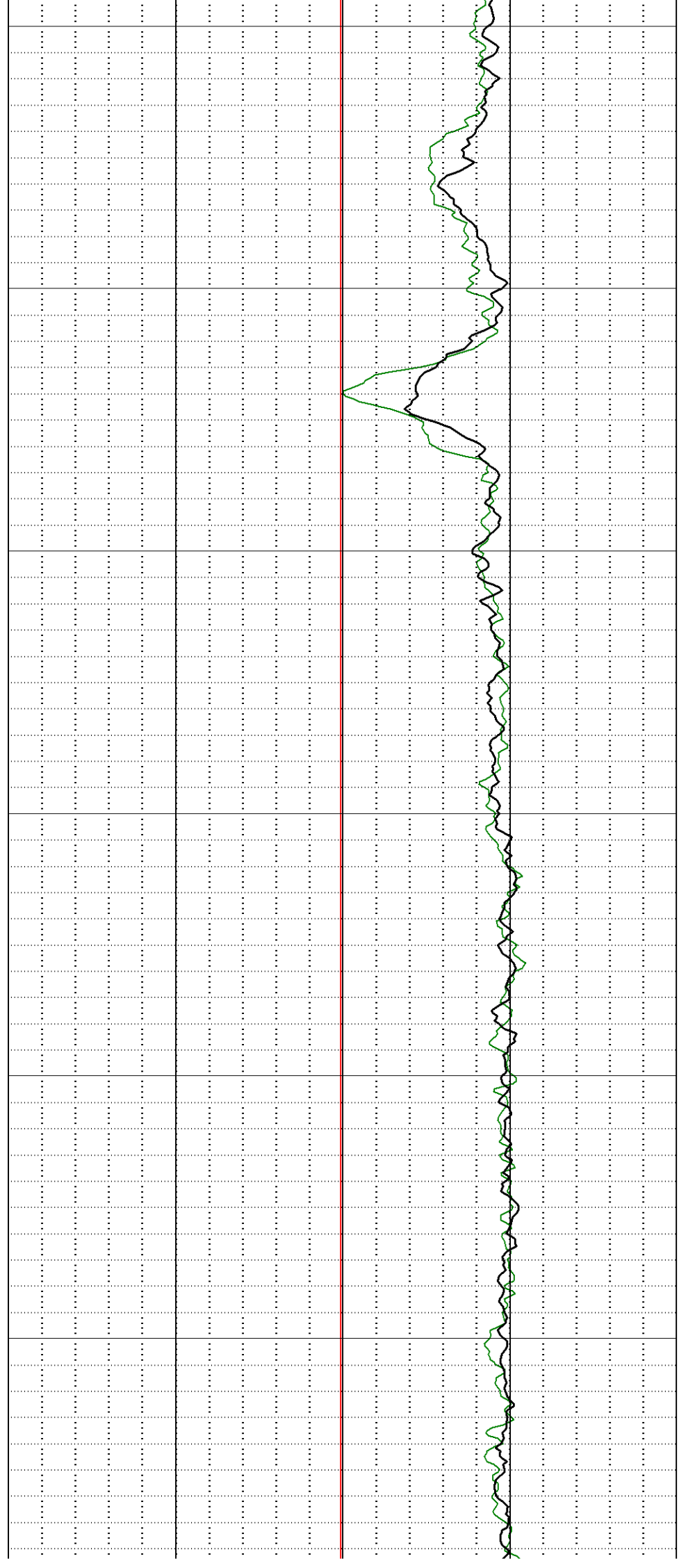
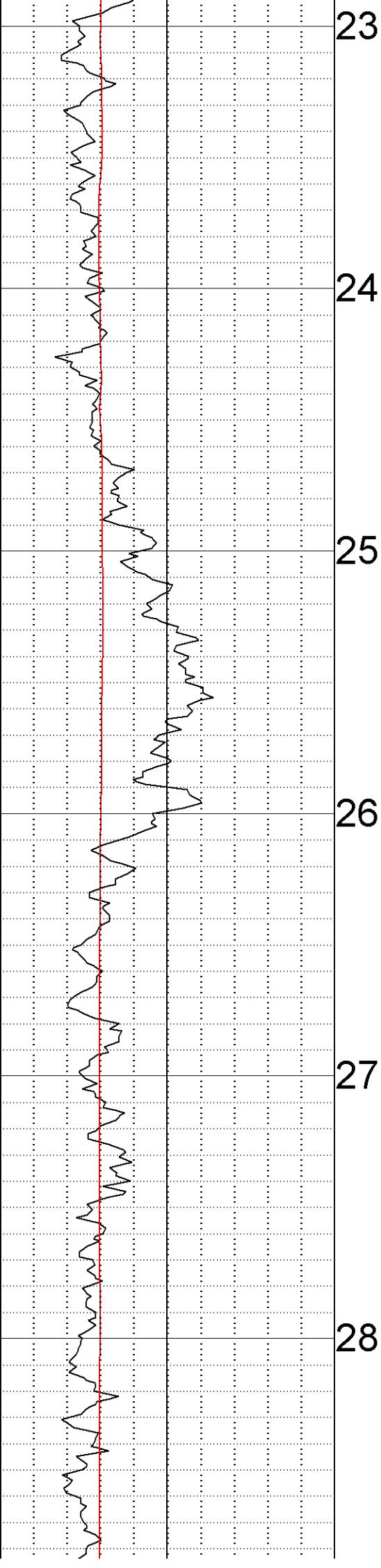
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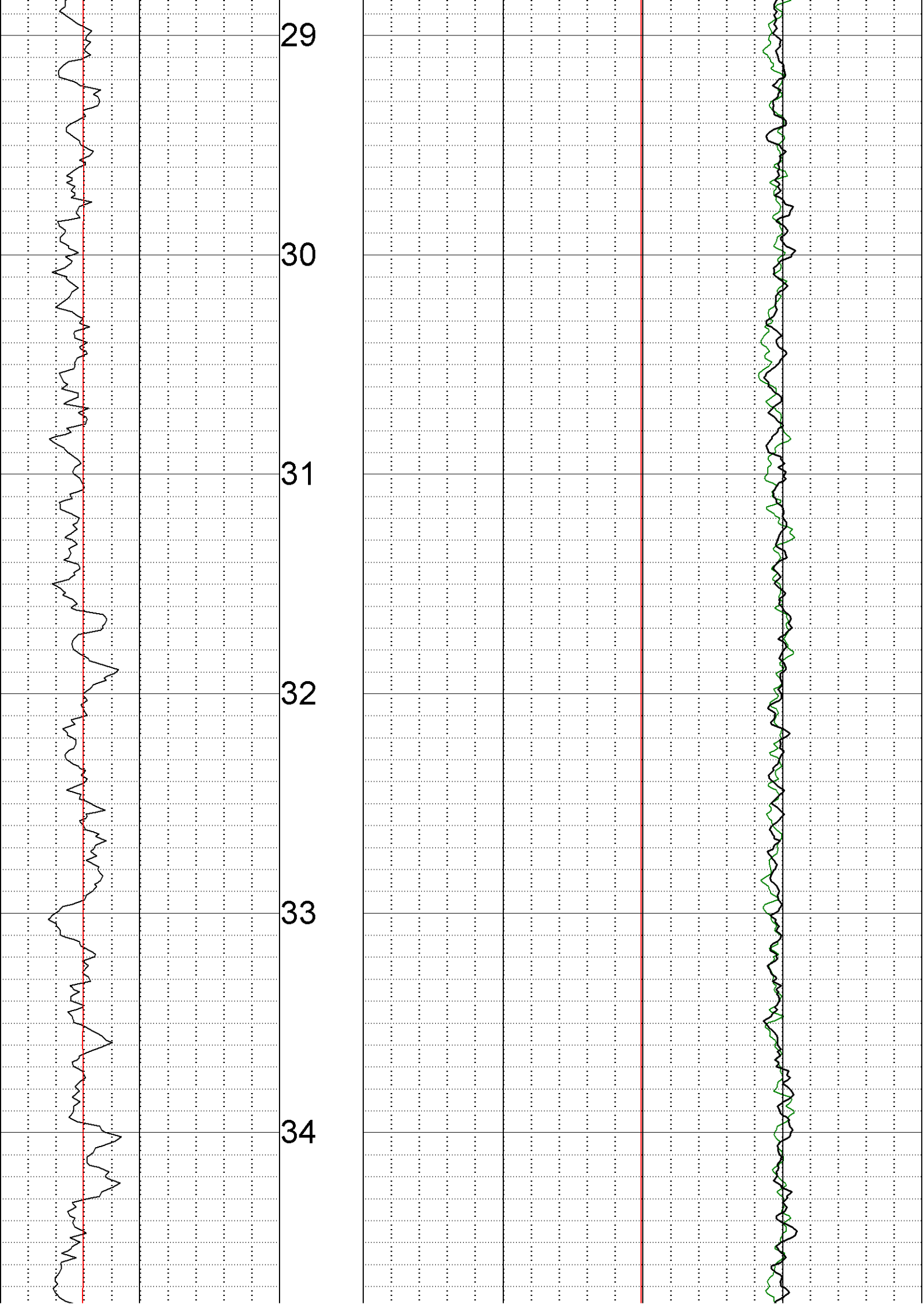
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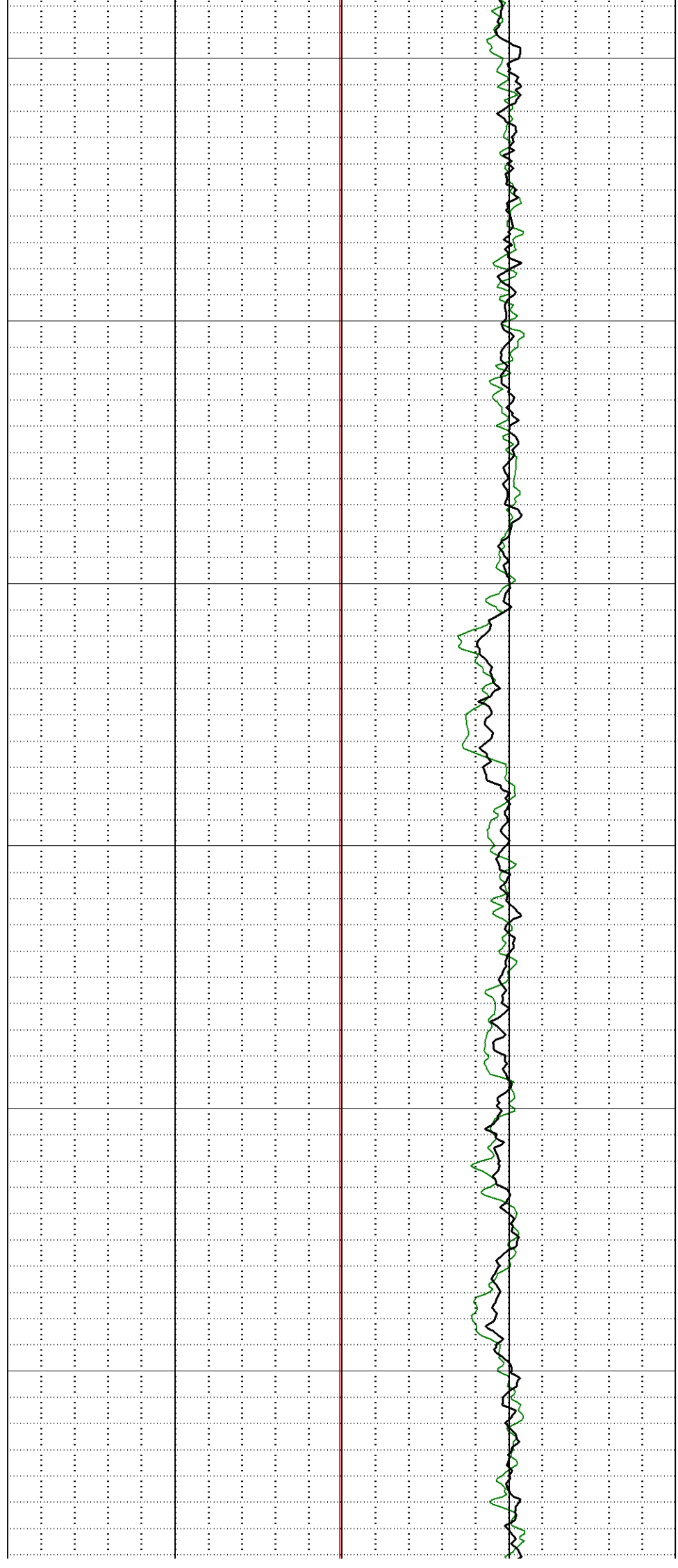
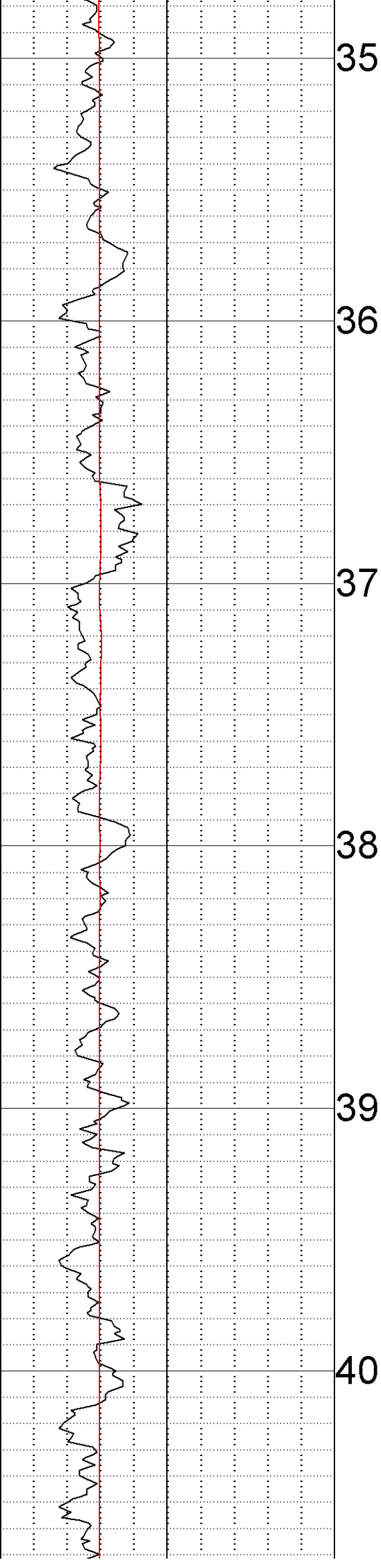
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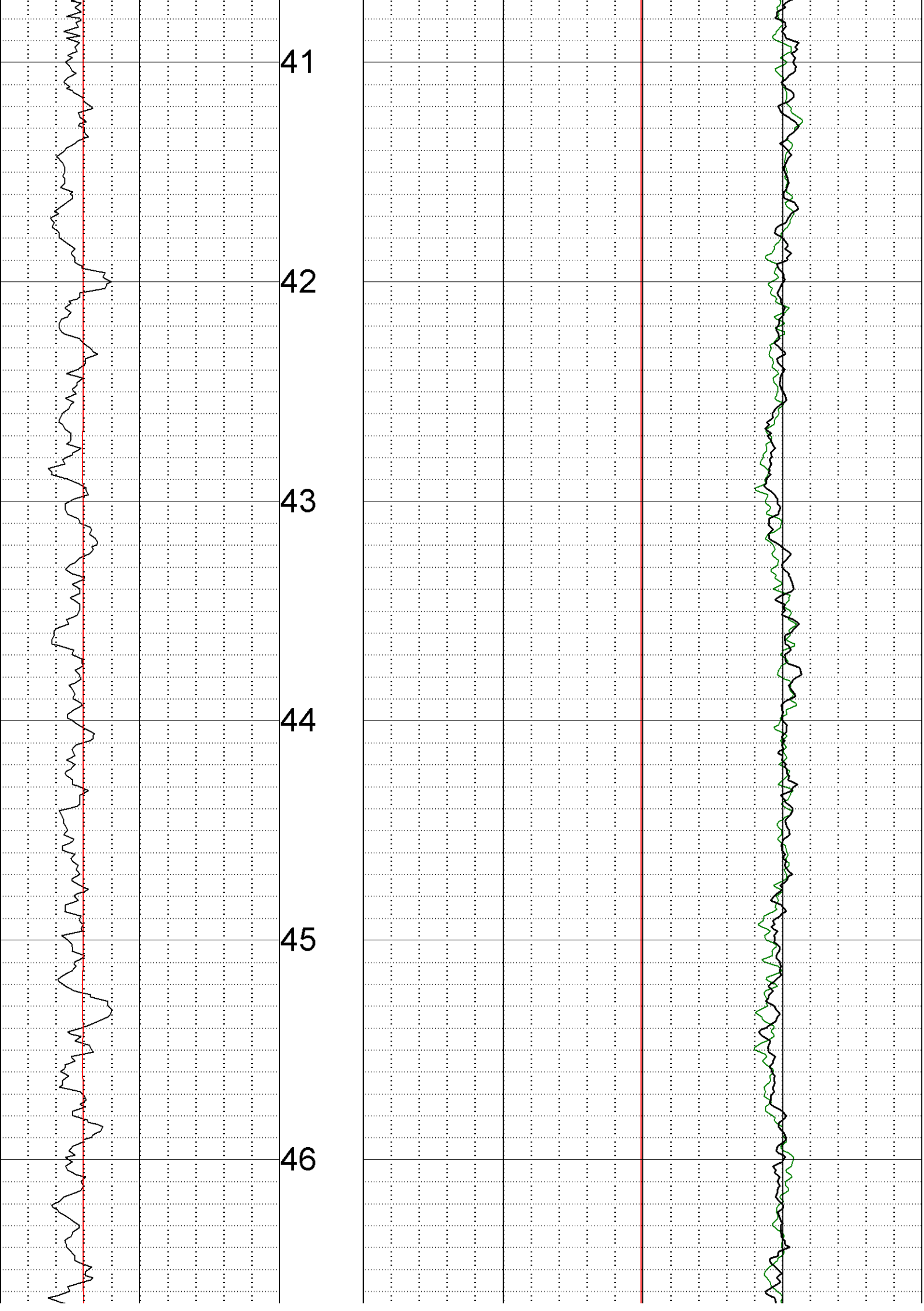
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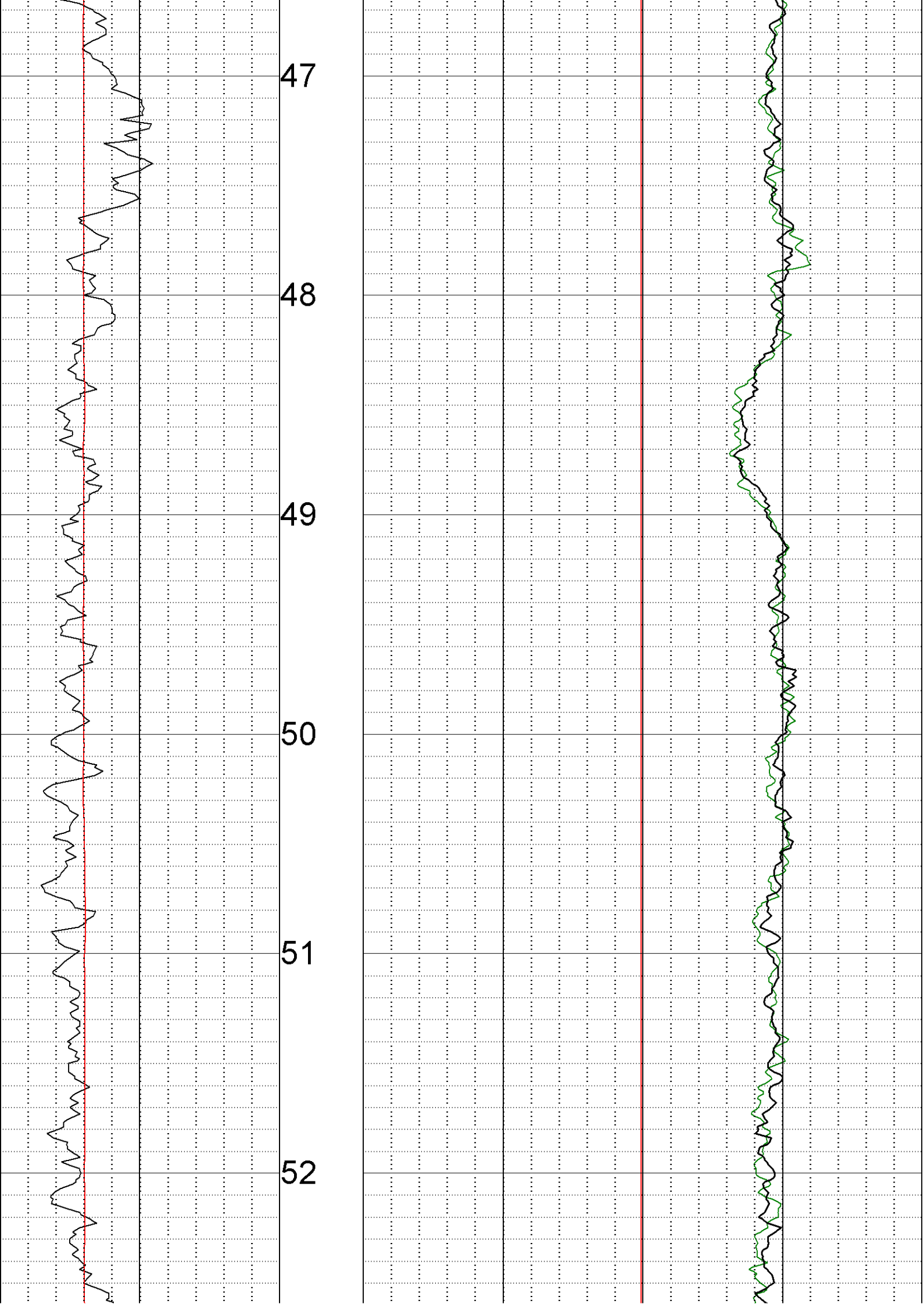


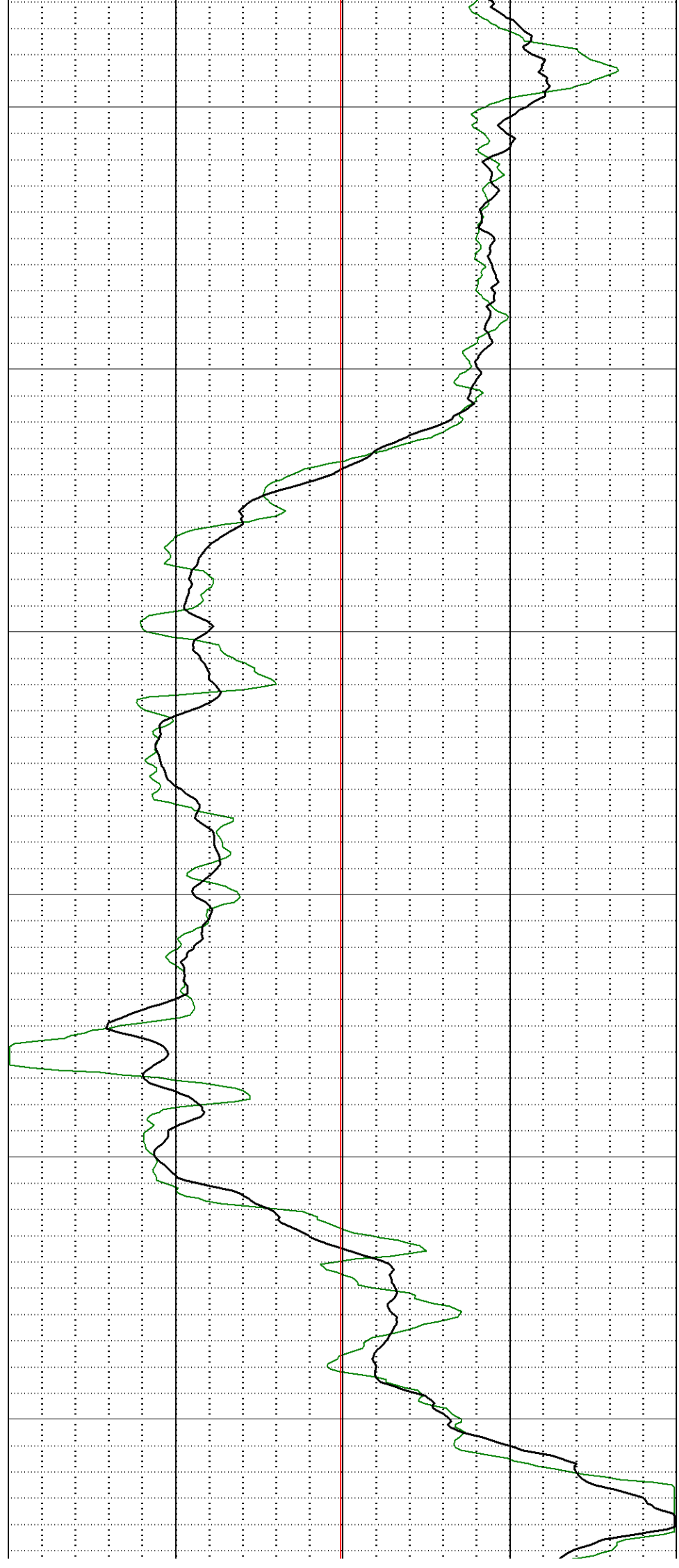
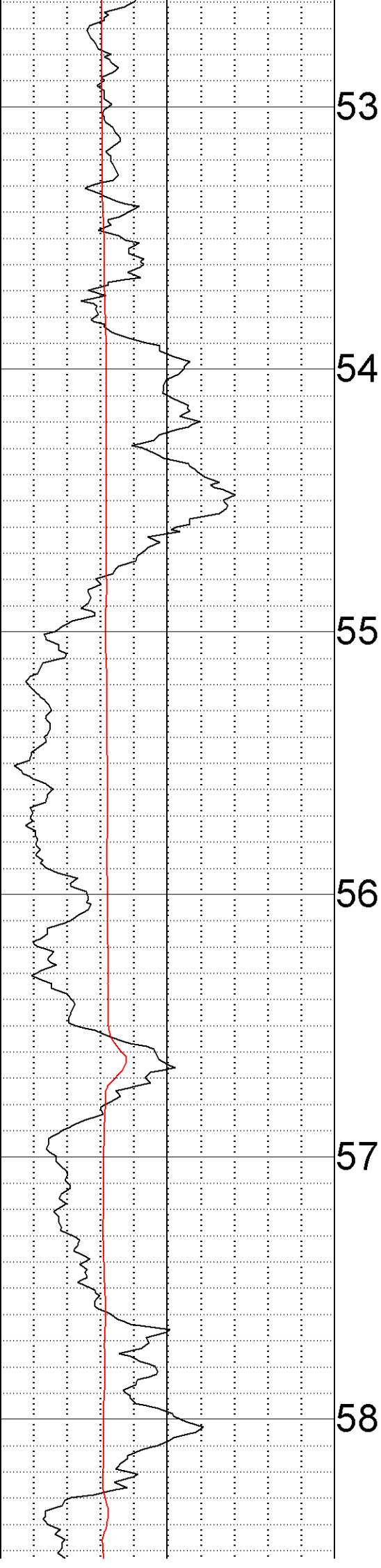


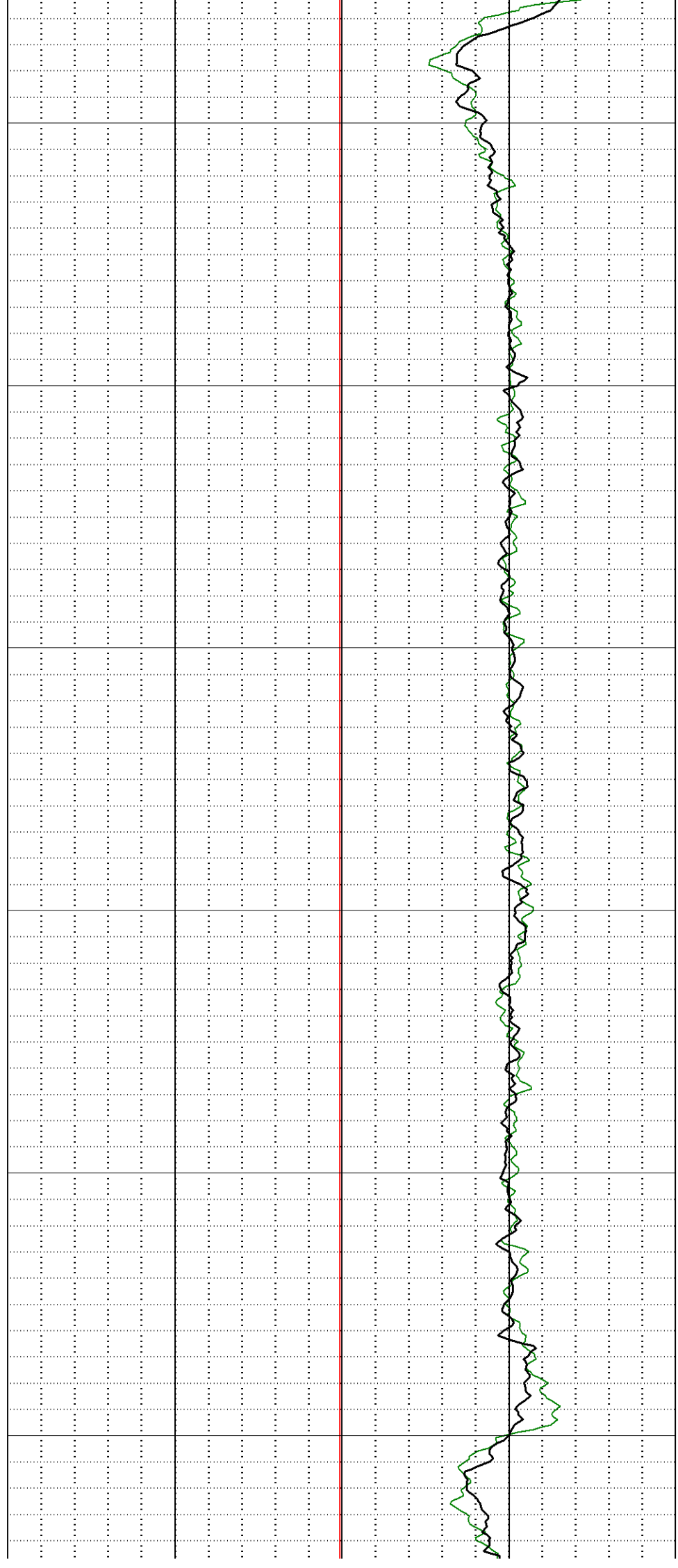
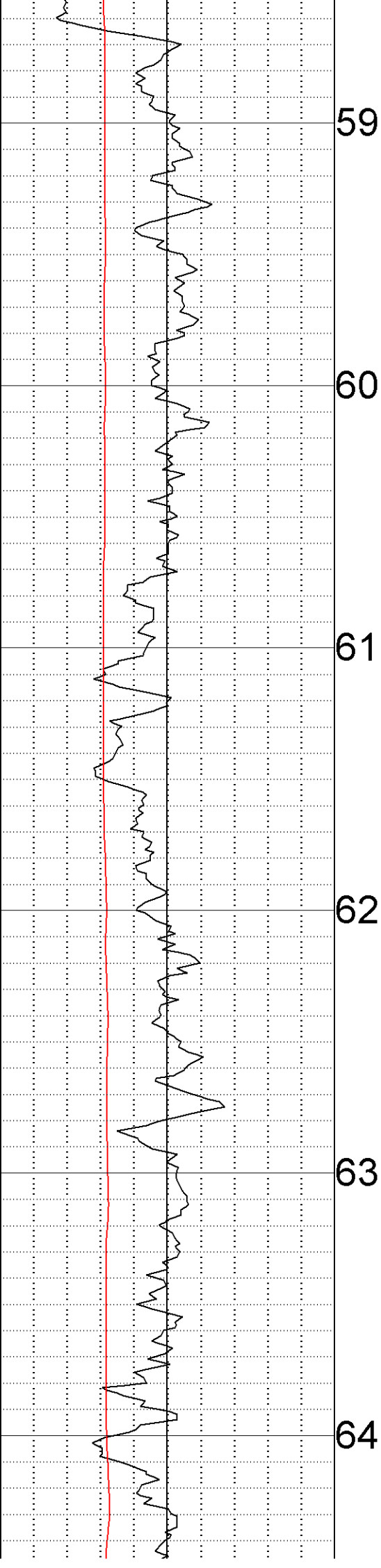


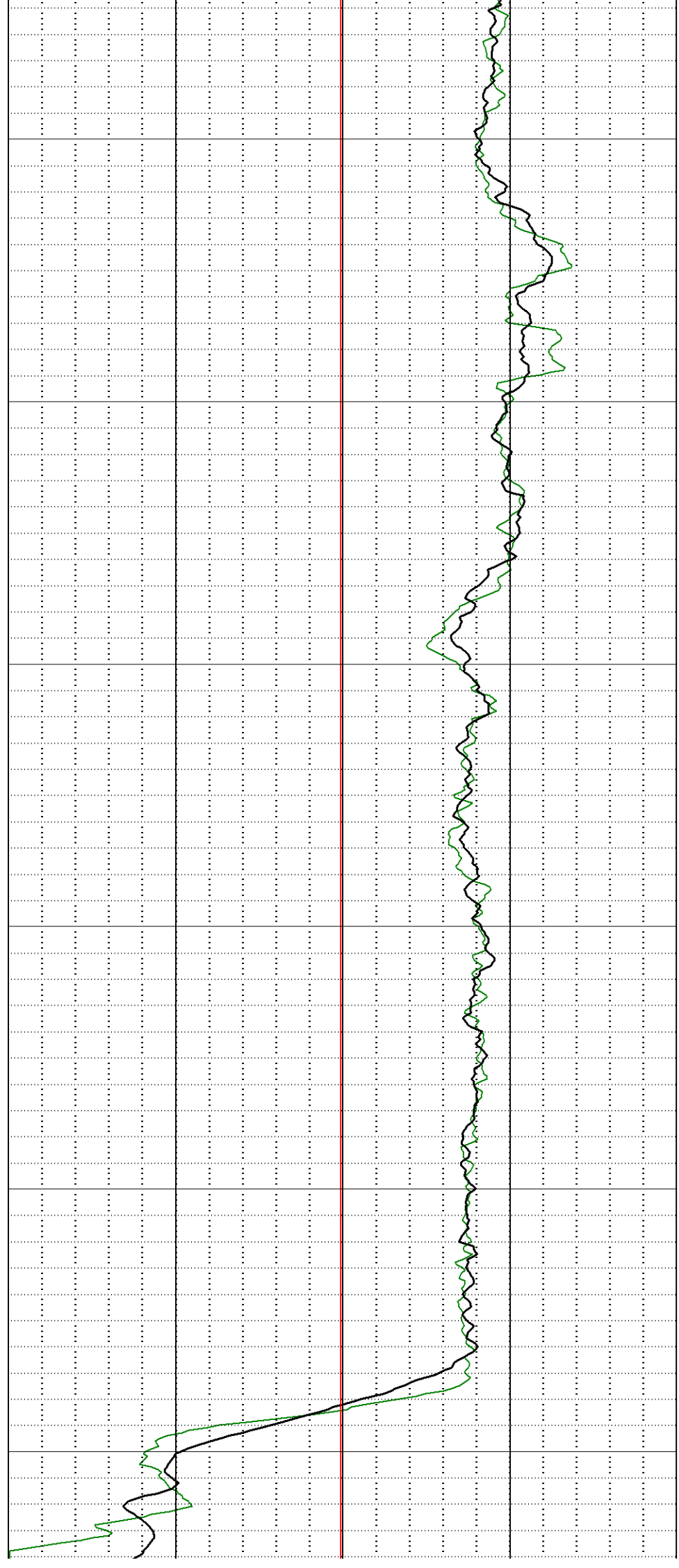
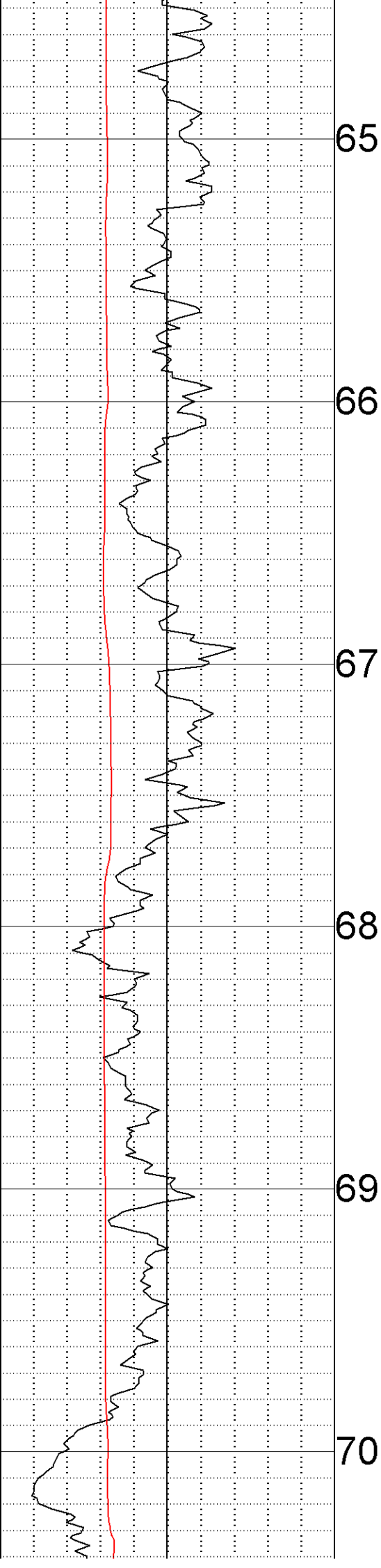


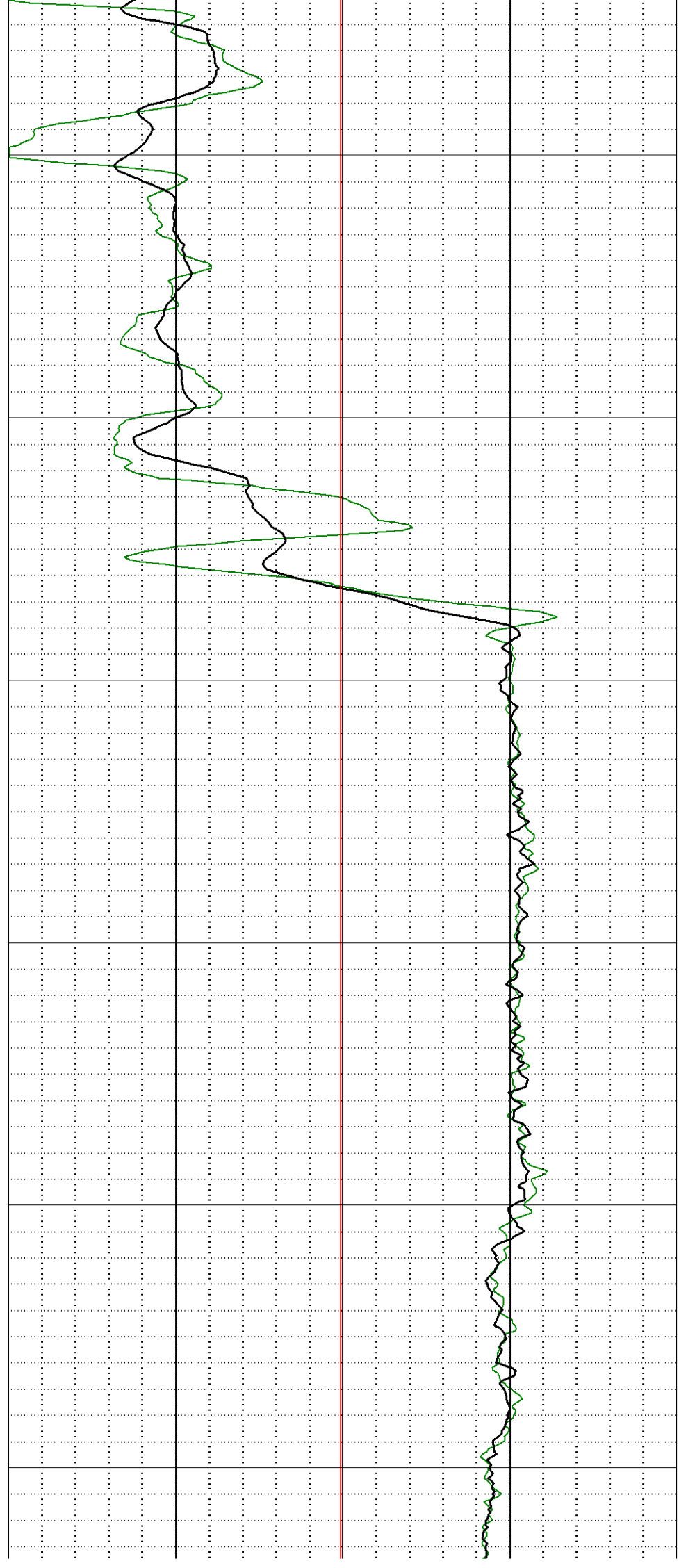
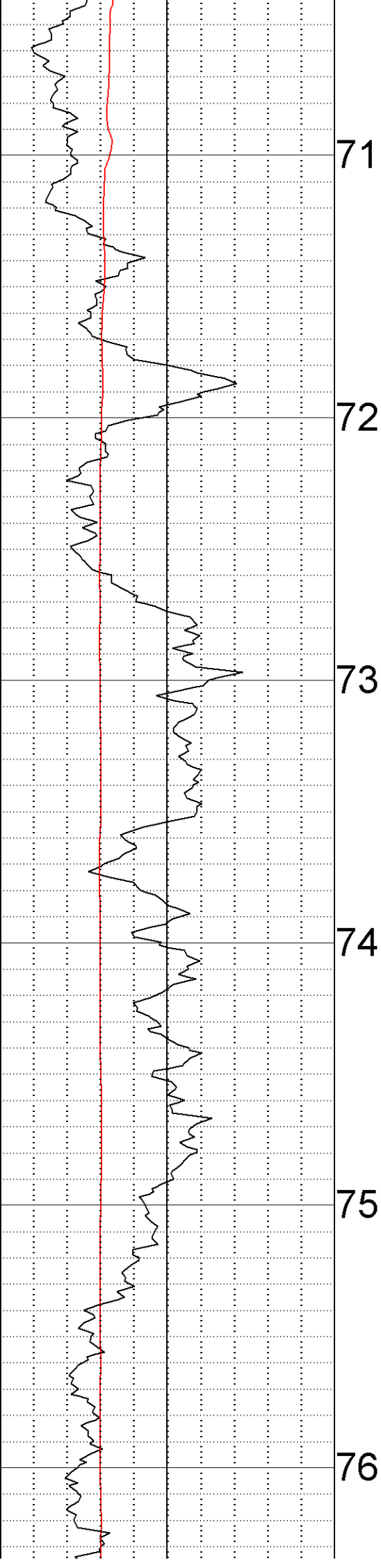


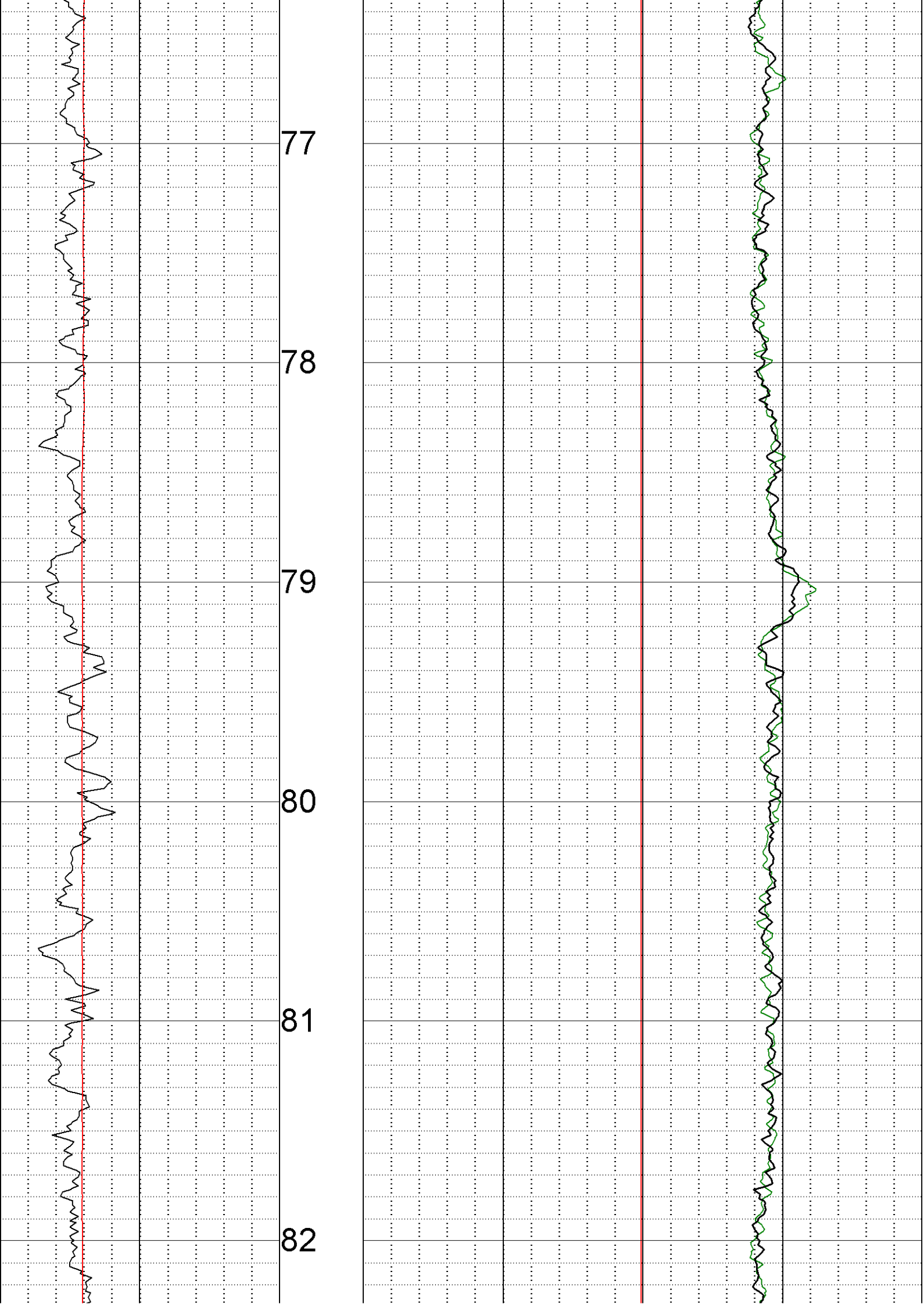


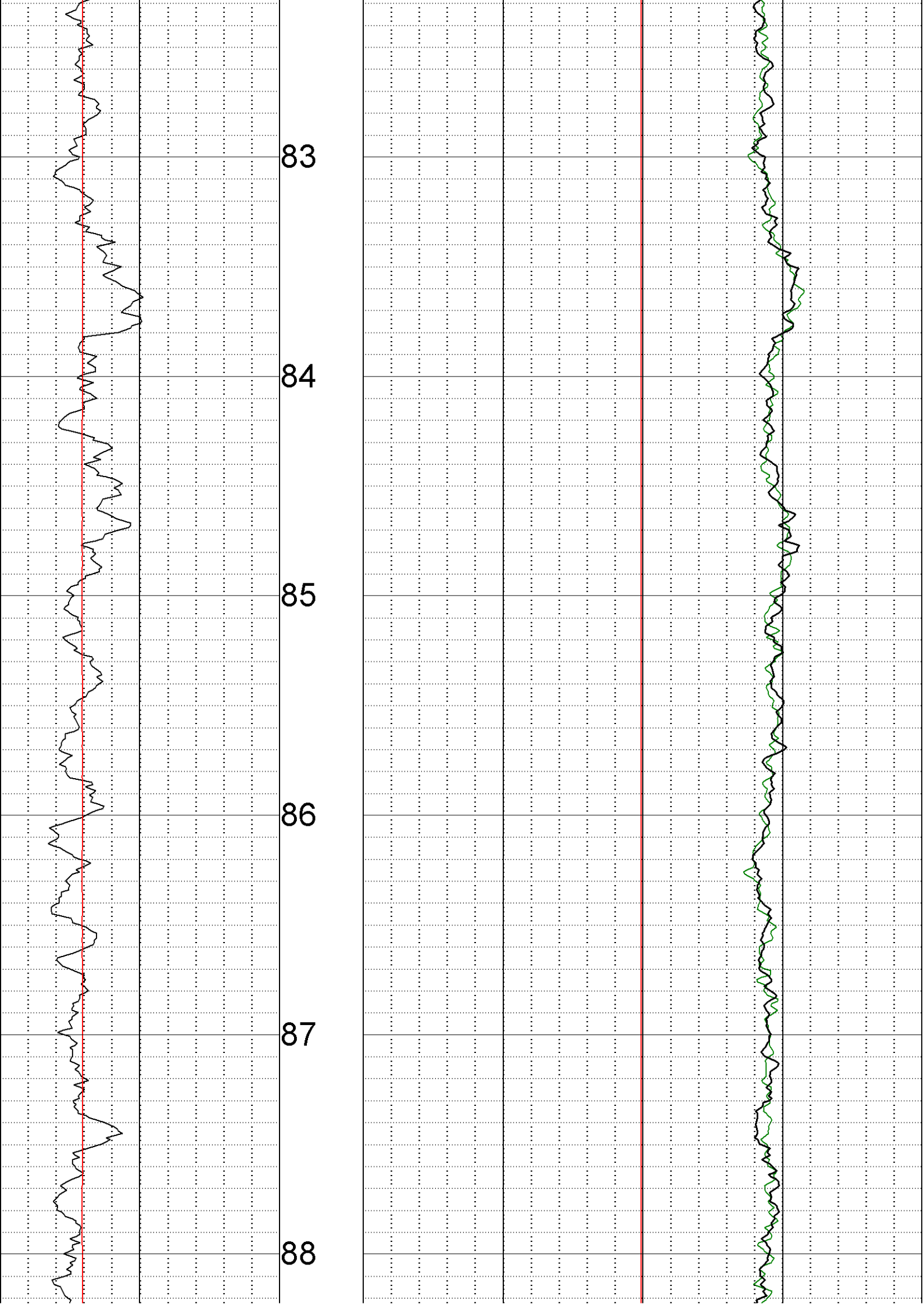


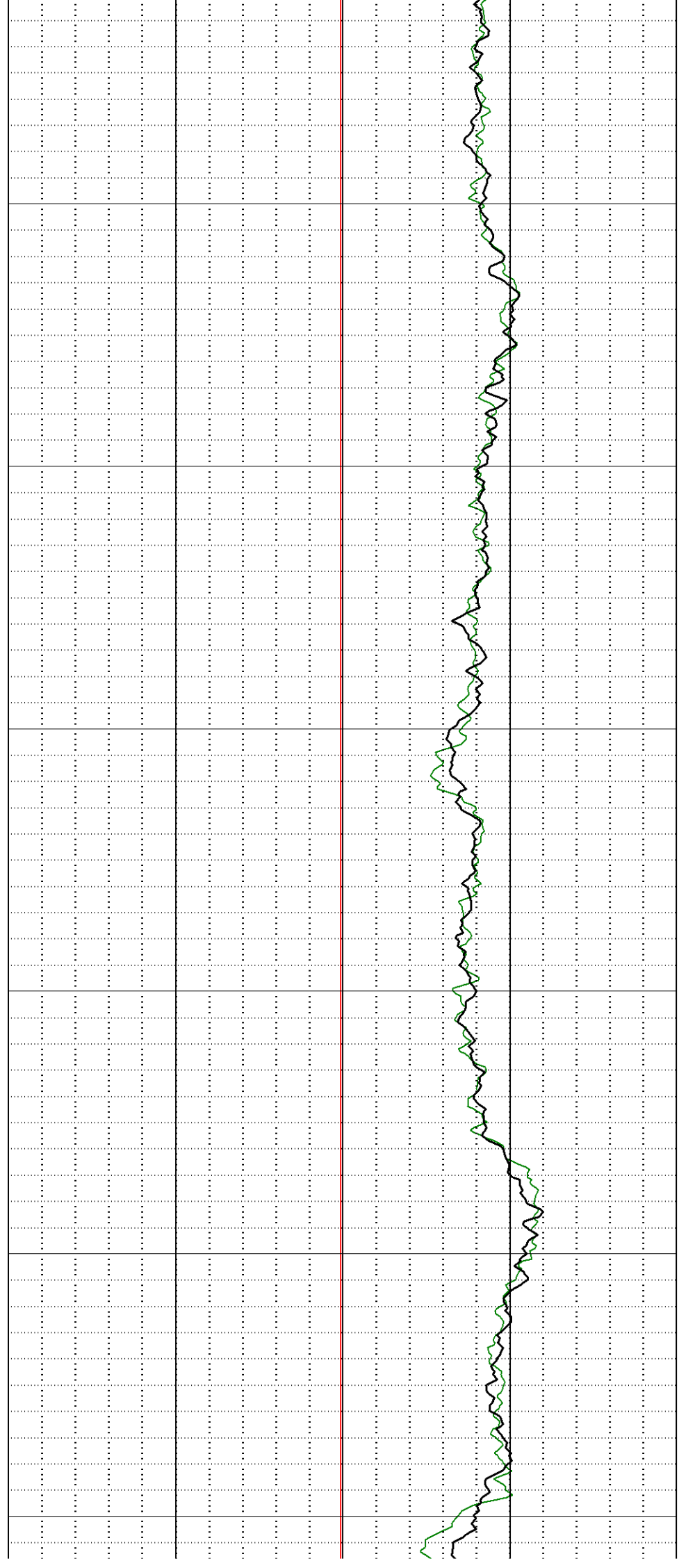
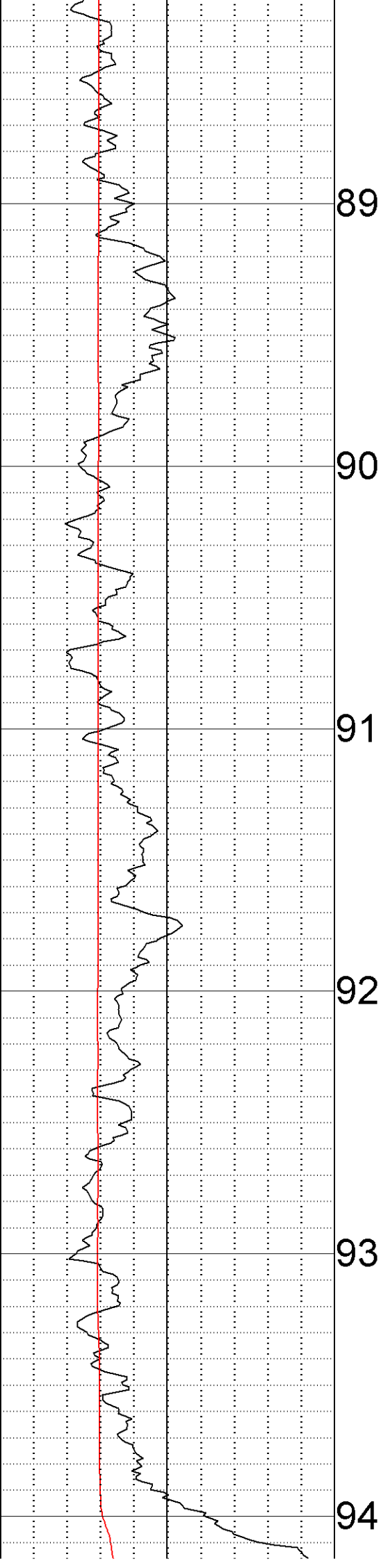


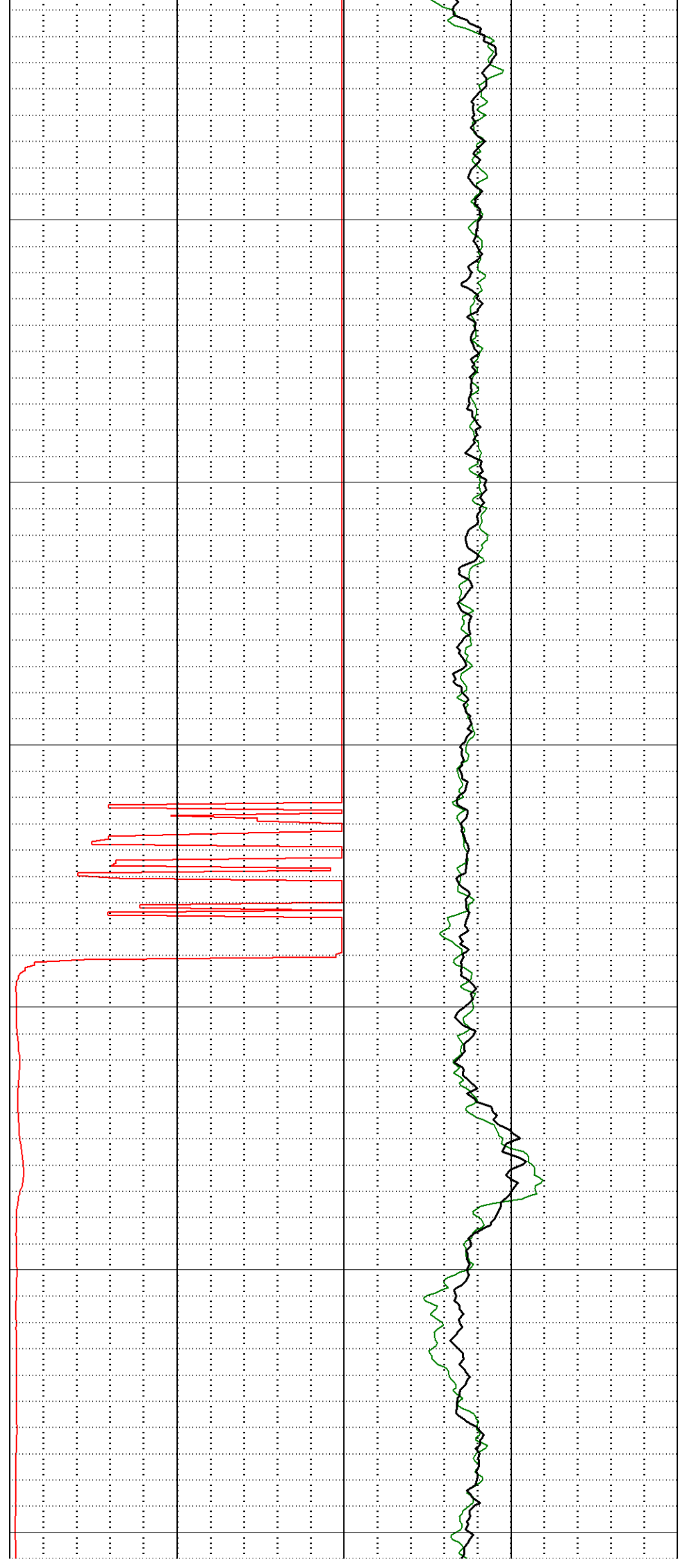
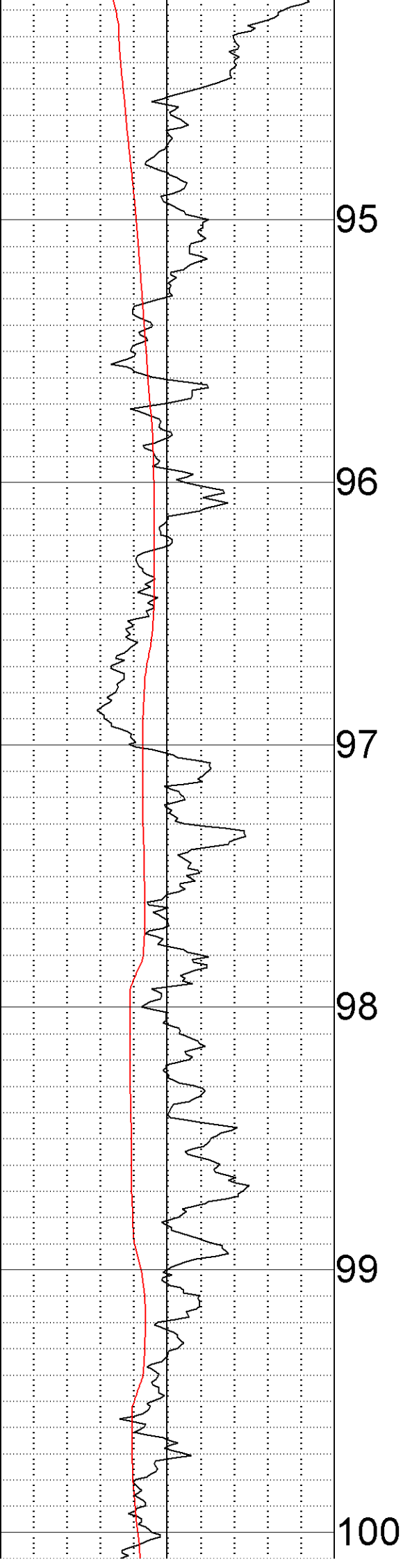


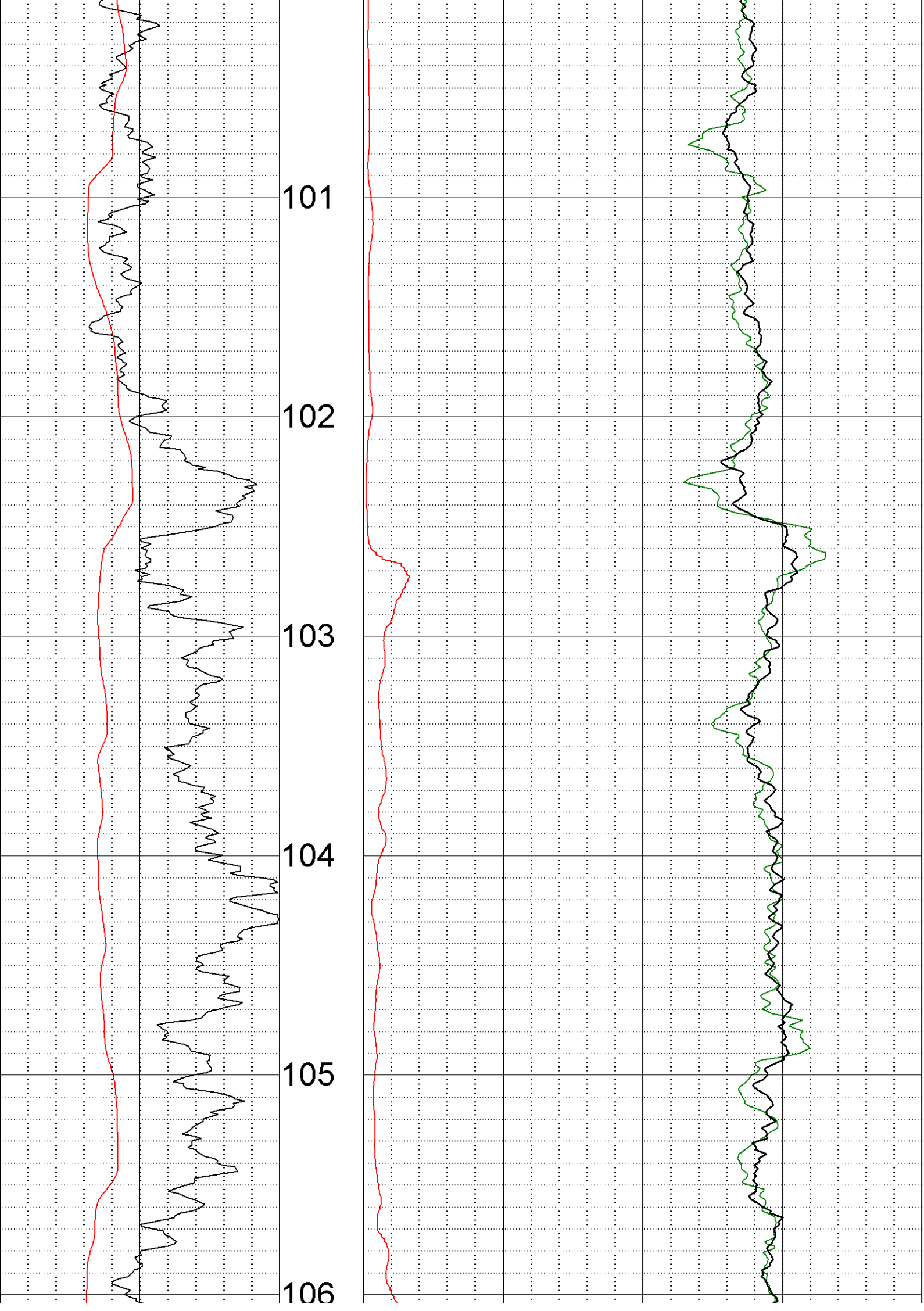


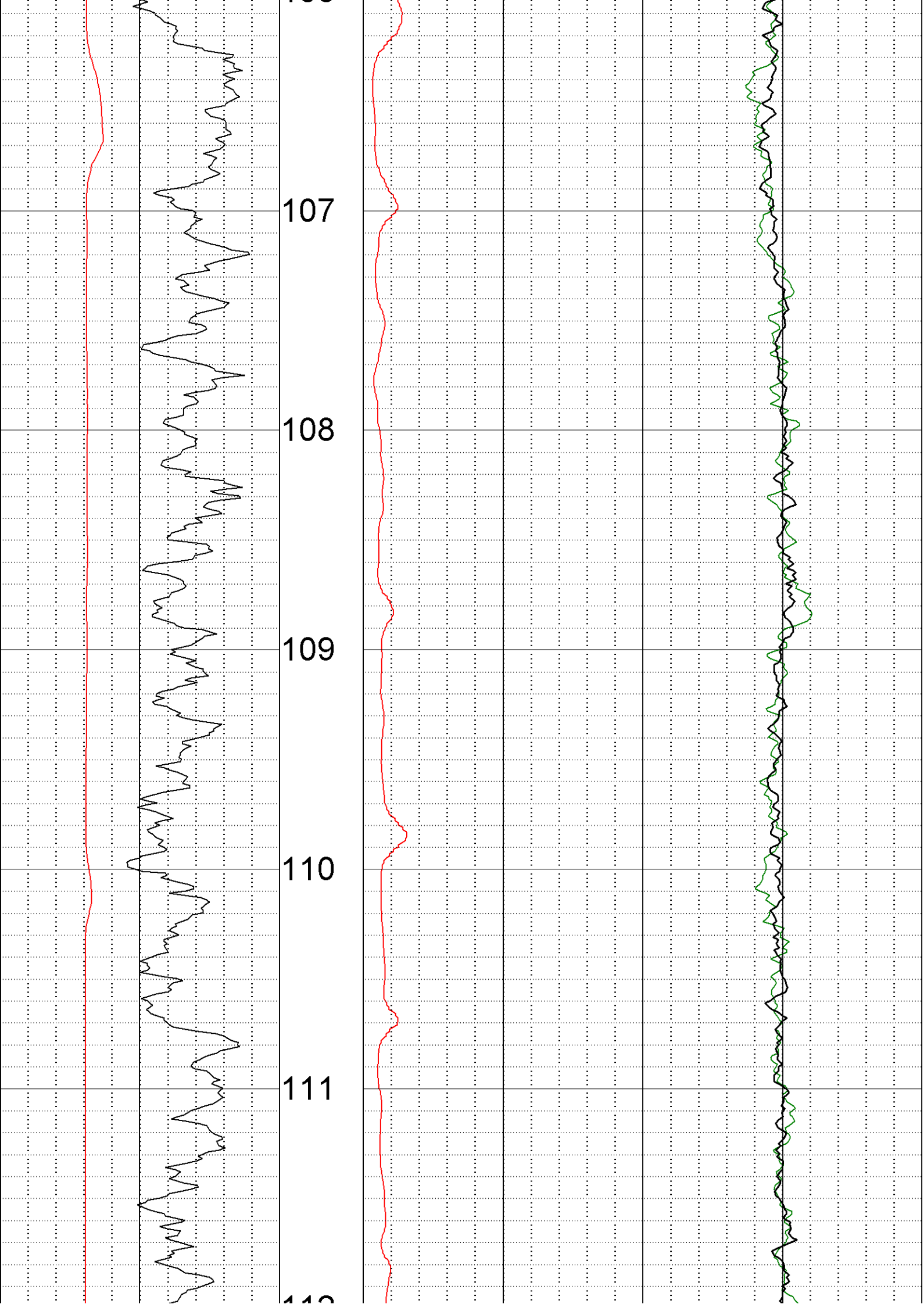


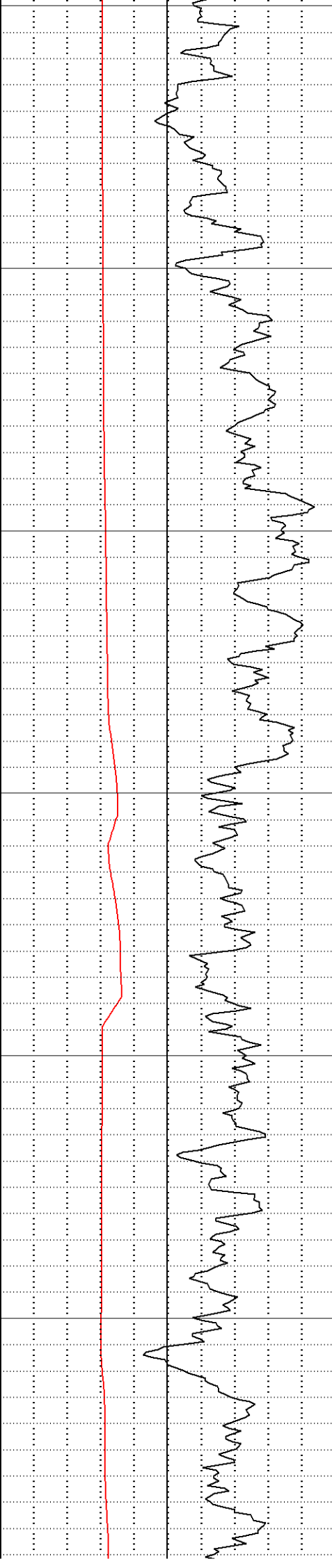




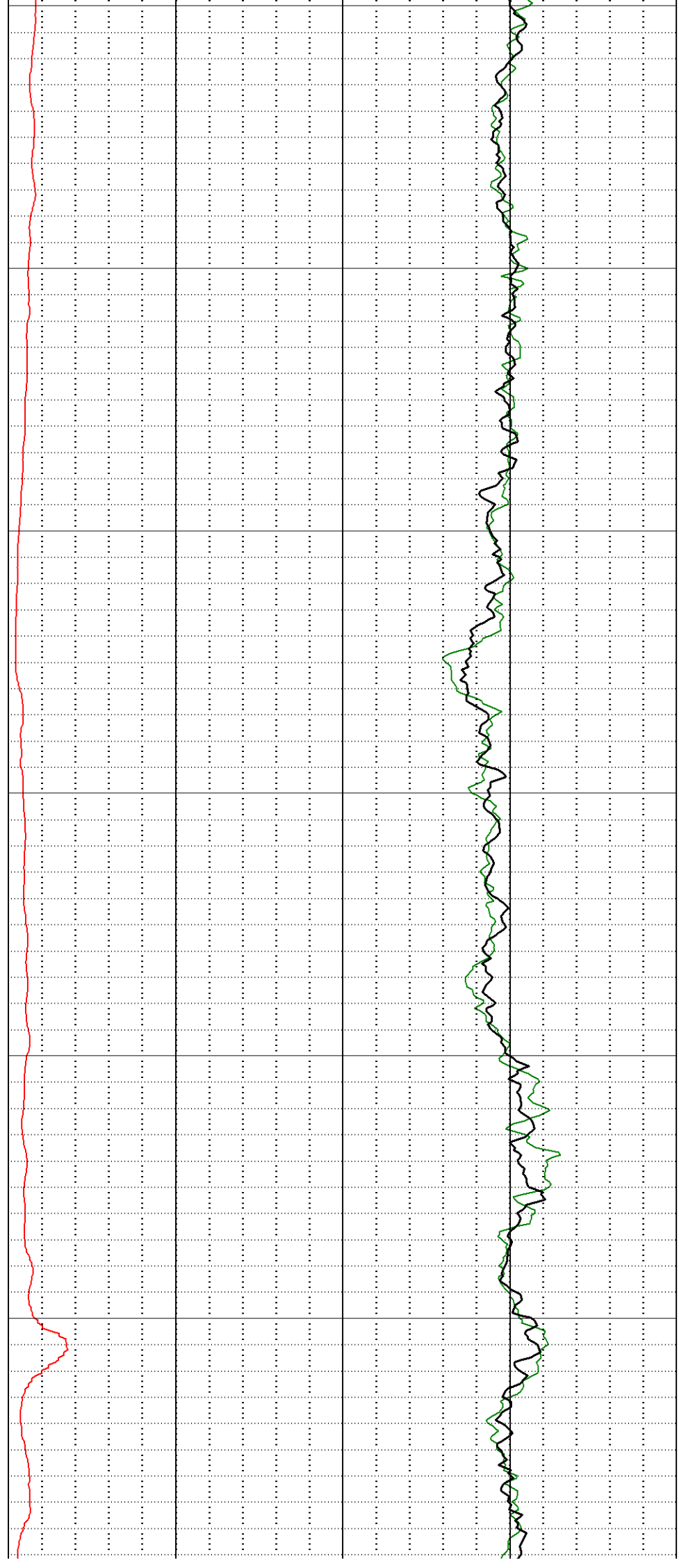


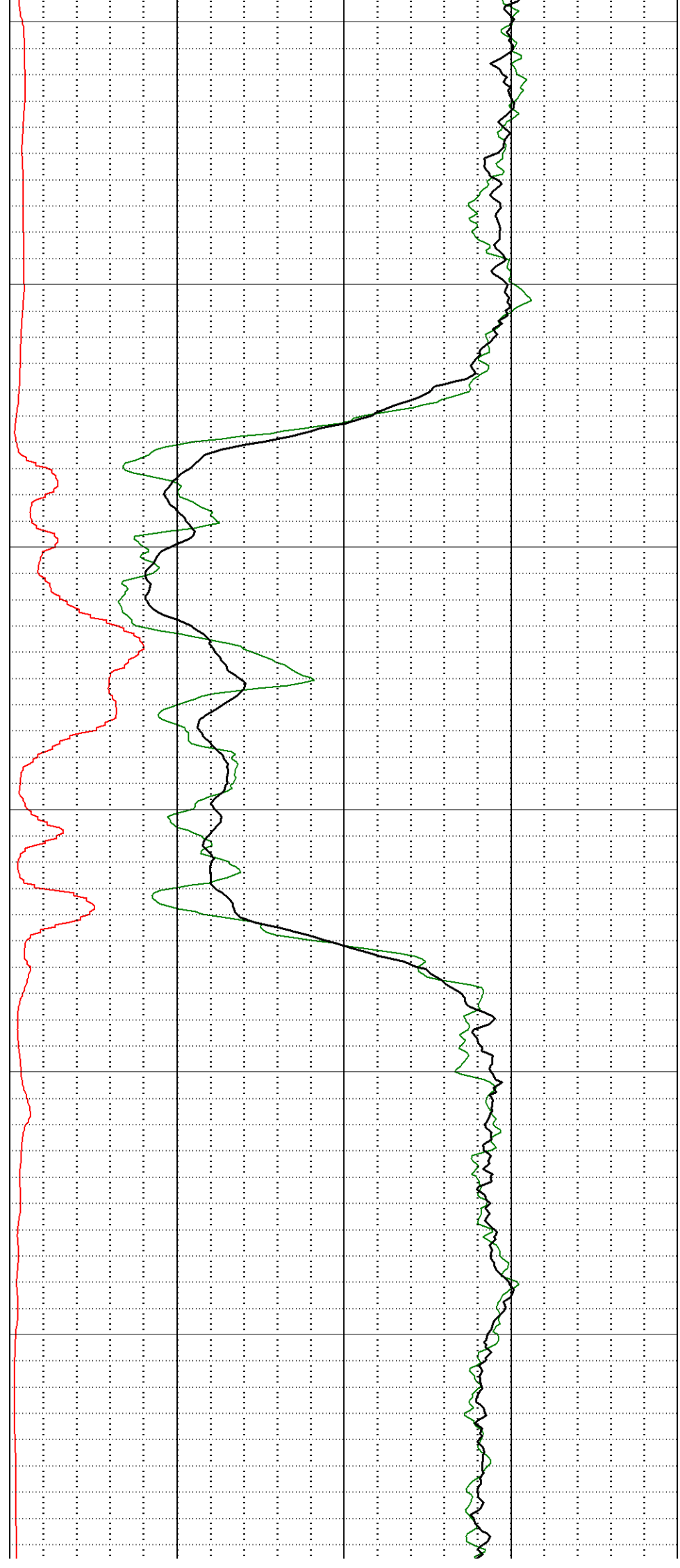
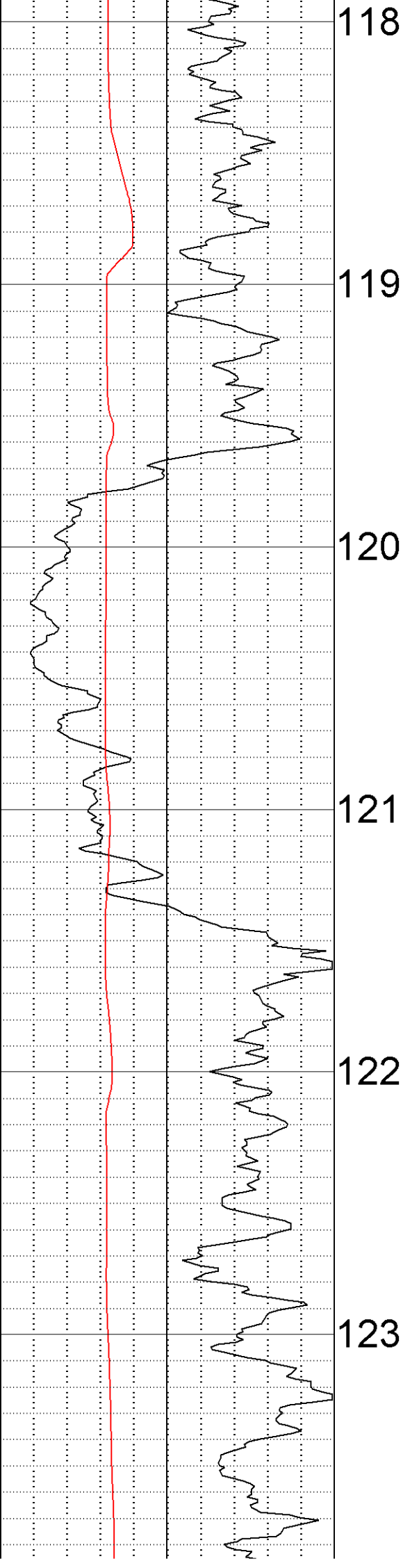


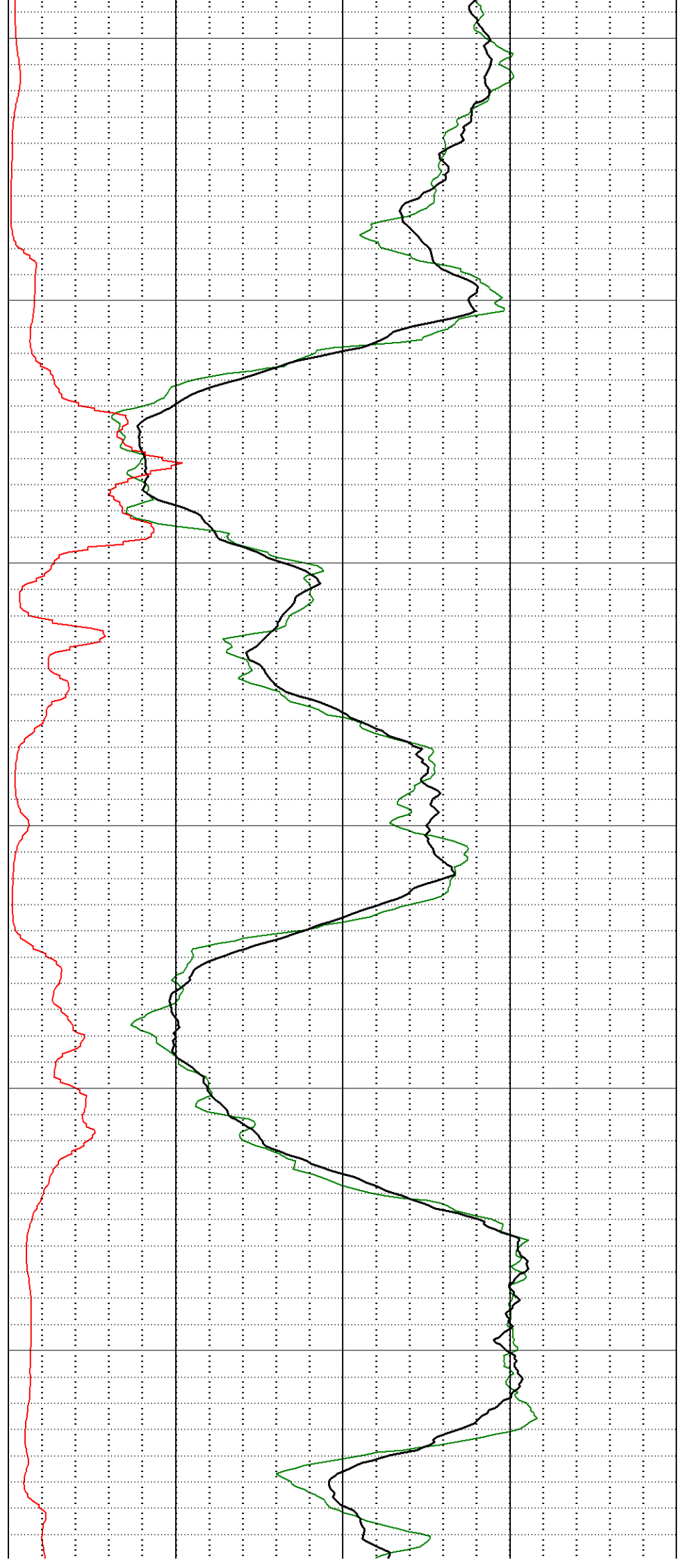
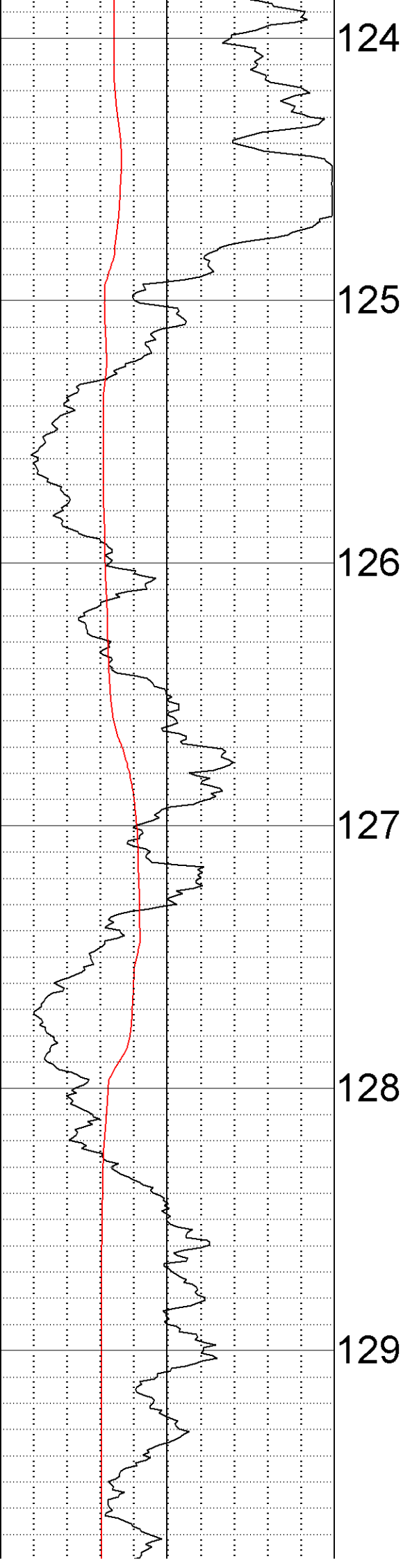


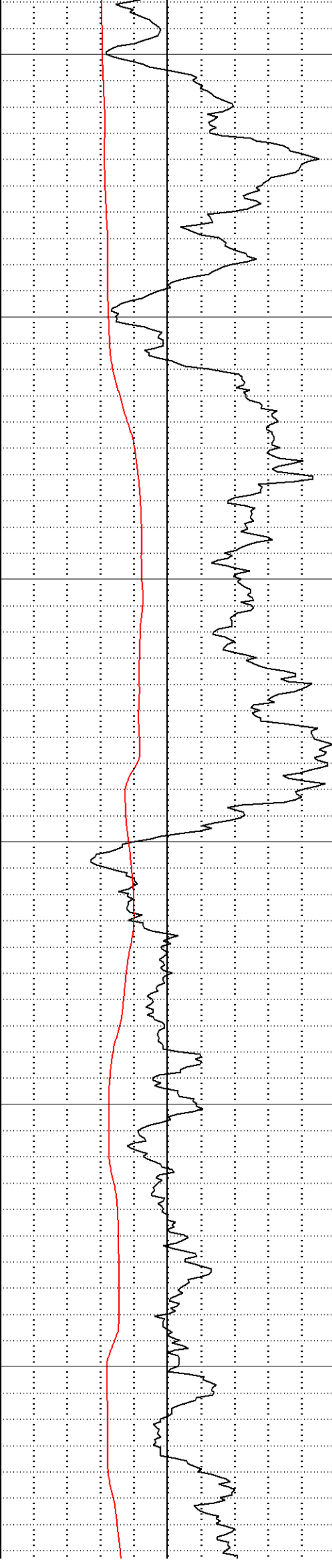


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115
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117









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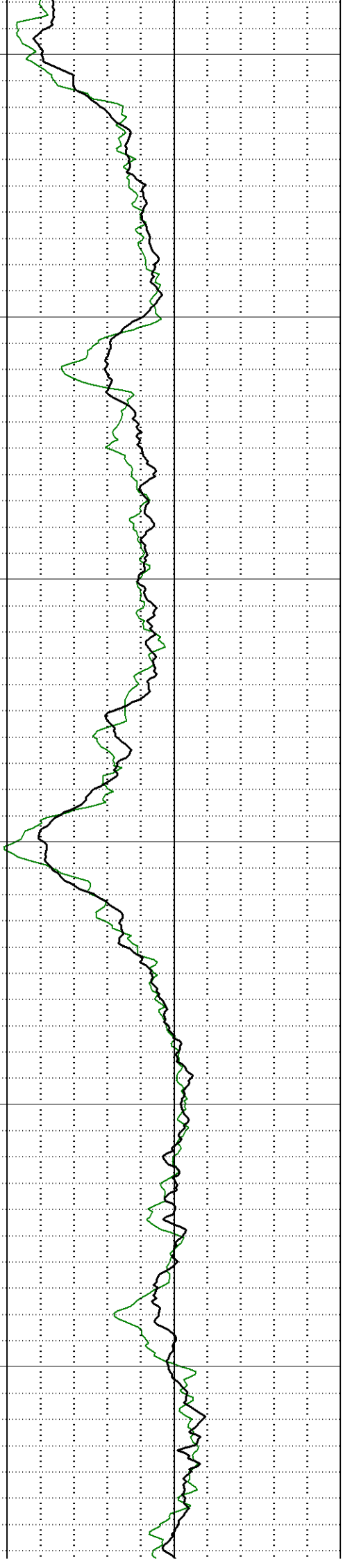
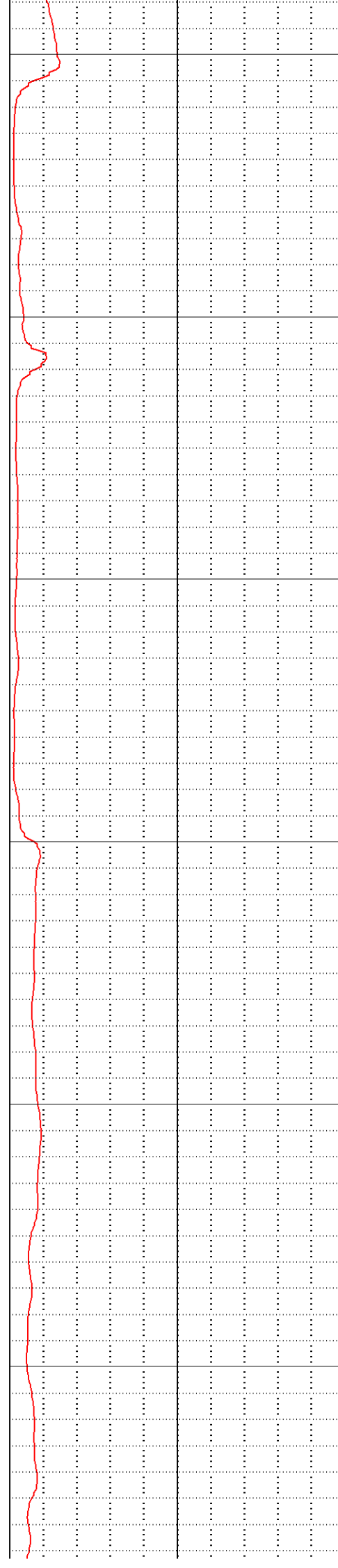
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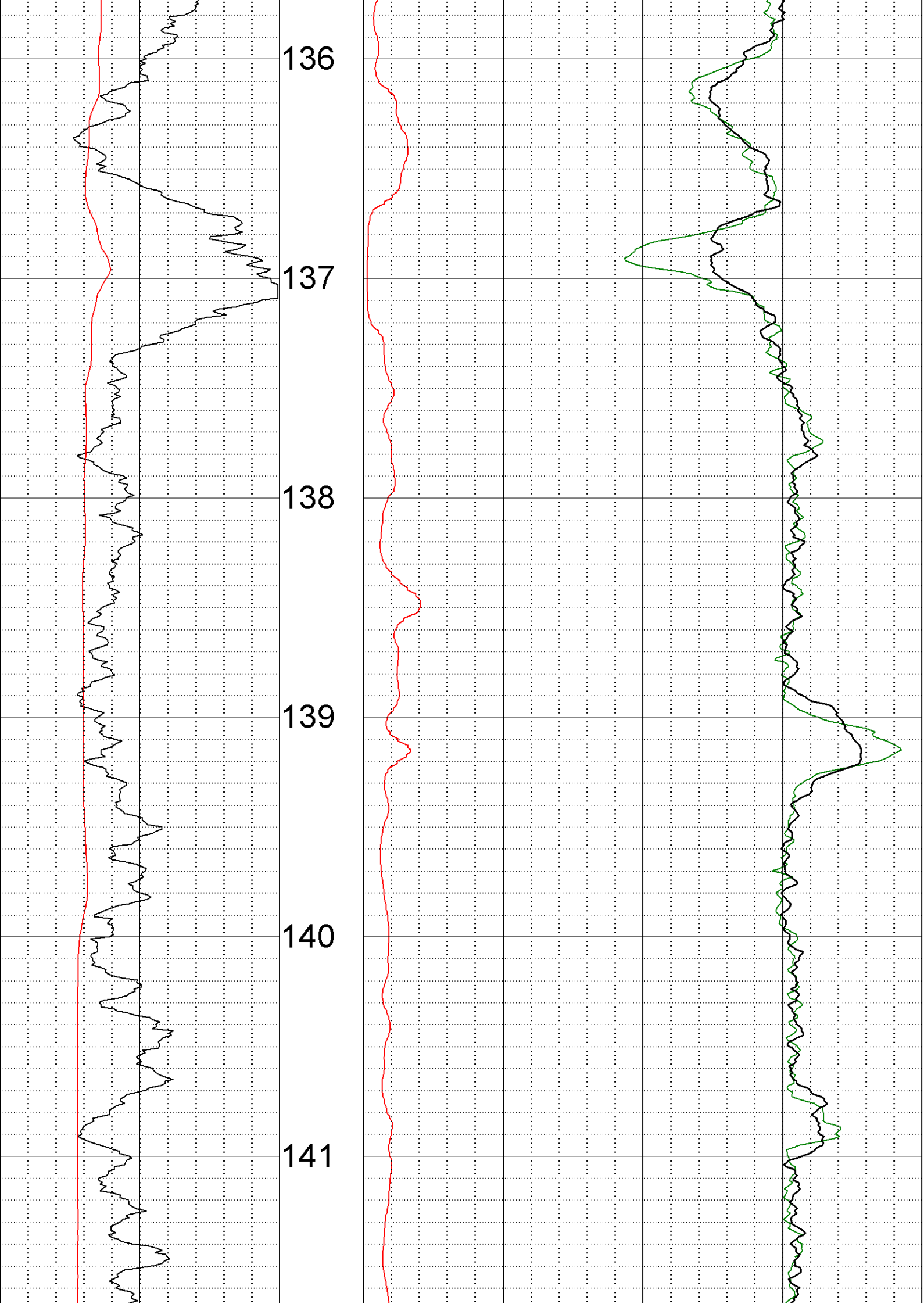
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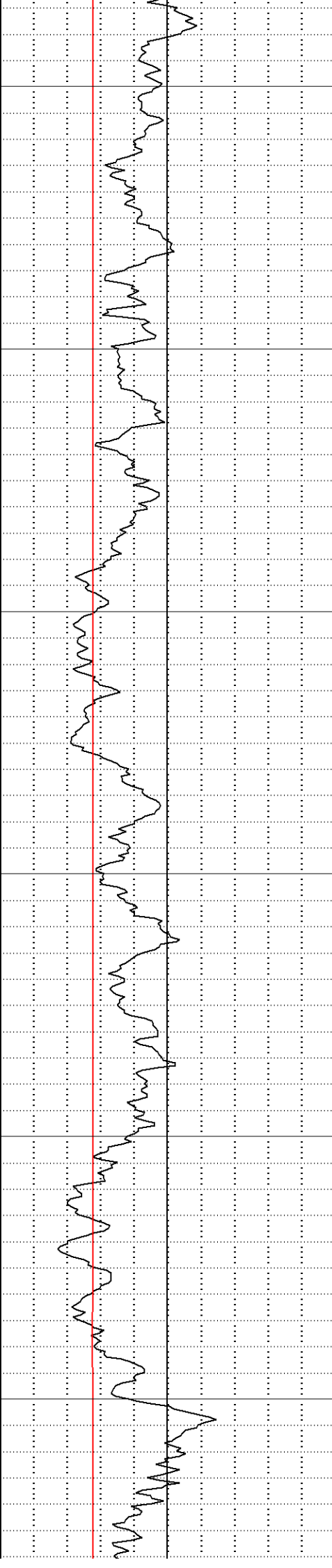
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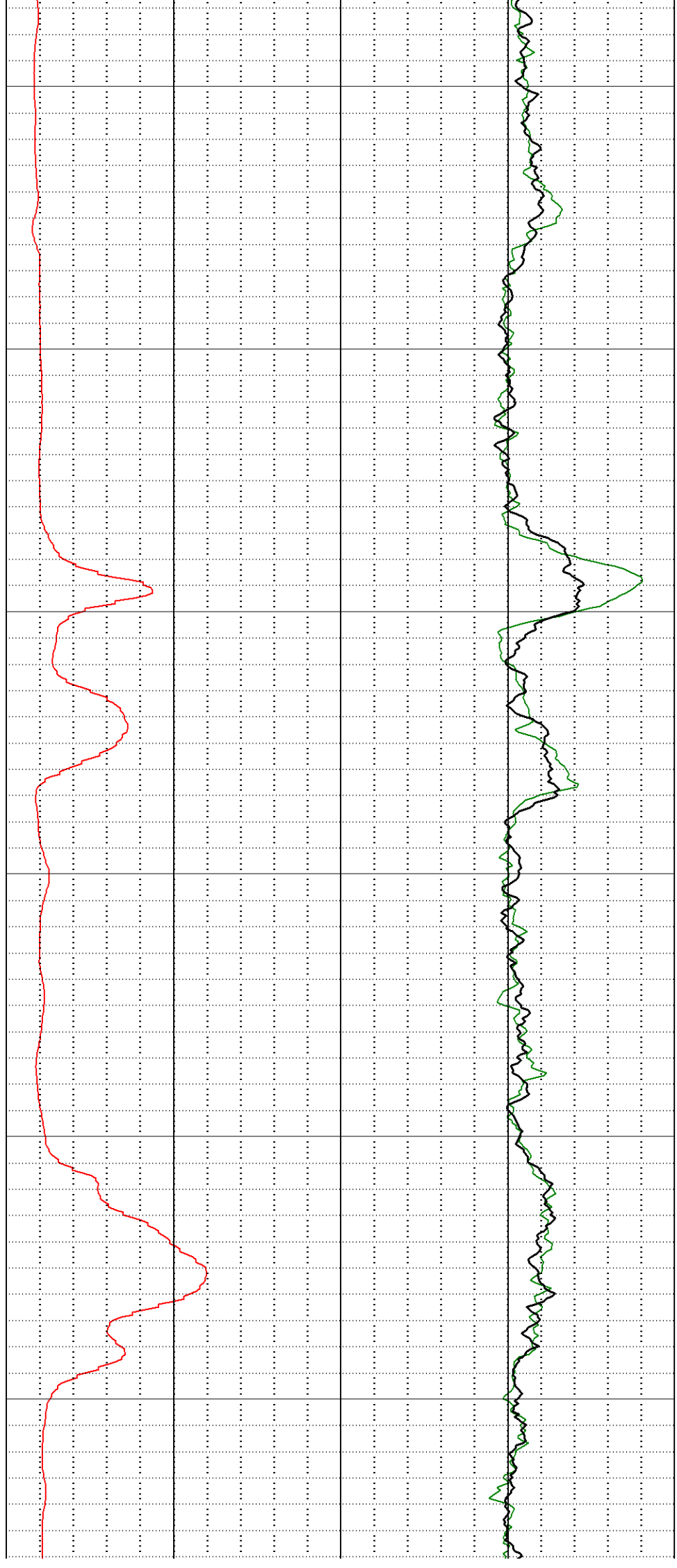
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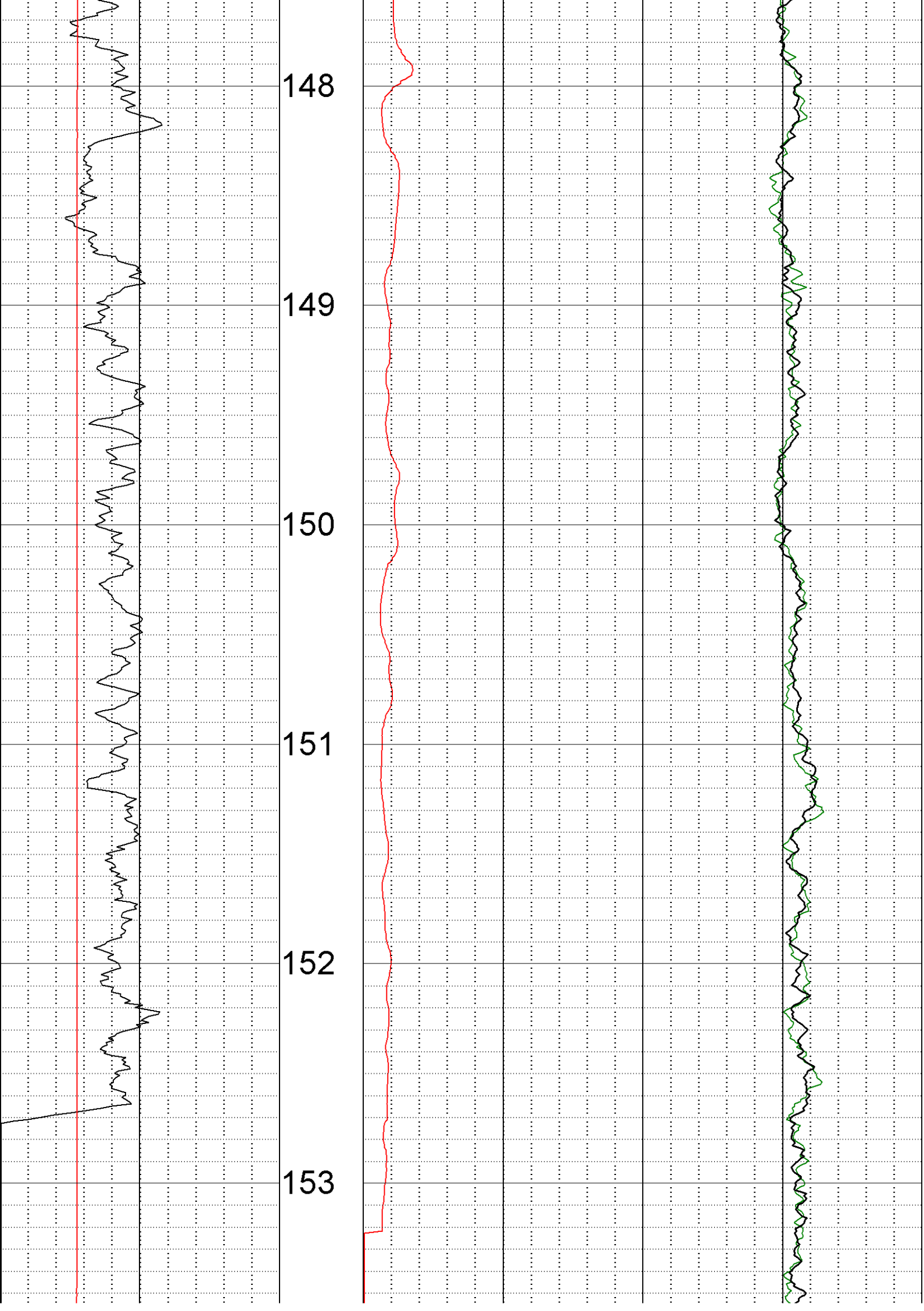
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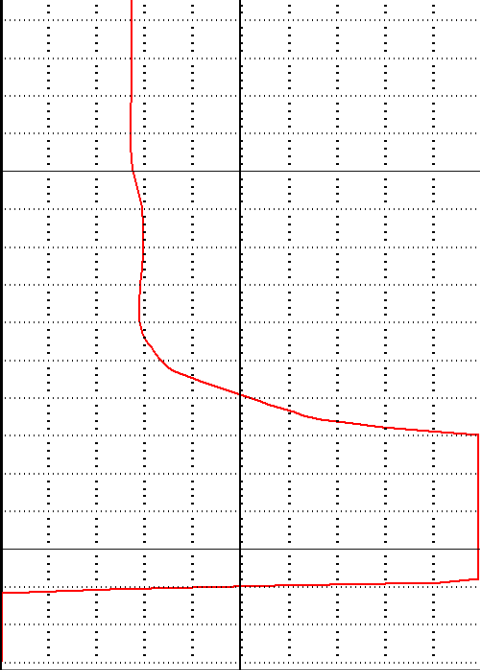
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146

147





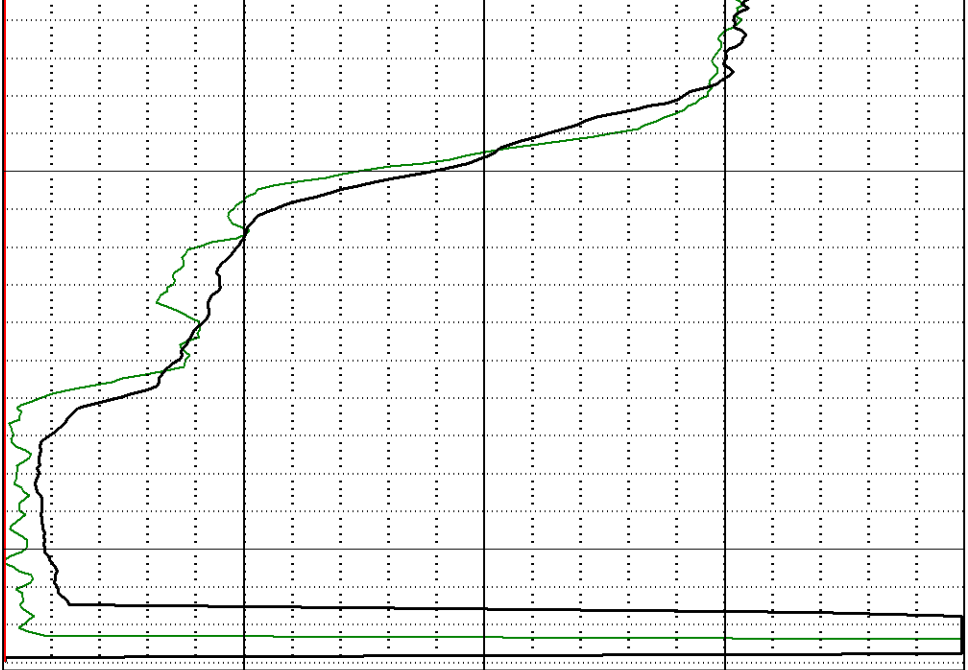


0	API-GR	300
GAMMA		
8	CM	18
CALIPERL		

154

155

METERS



1	G/CC	3
DEN(SS)		
1	G/CC	3
DEN(LS)		

0	OHM-M	500
RES(SG)		

GROUNDSEARCH

AUSTRALIA



1001 DENSITY 1 200

COMPANY : DOUGLAS PARTNERS
WELL : 1001 DENSITY 1 200
LOCATION/FIELD : 30 SMITH ST
COUNTY :
LOCATION : CHARLESTOWN
SECTION : N/A

OTHER SERVICES:
DEN DEV
SON NEU

TOWNSHIP : N/A RANGE : N/A

DATE : 05/18/22
DEPTH DRILLER : 155.65
LOG BOTTOM : 155.31
LOG TOP : 0.00

PERMANENT DATUM : -0.6
LOG MEASURED FROM: N/A
DRL MEASURED FROM: N/A

KB : N/A
DF : N/A
GL : 0

CASING DIAMETER : 10.
CASING TYPE : PVC
CASING THICKNESS: .5

LOGGING UNIT : T104
FIELD OFFICE : RUTHERFORD
RECORDED BY : M CRANE

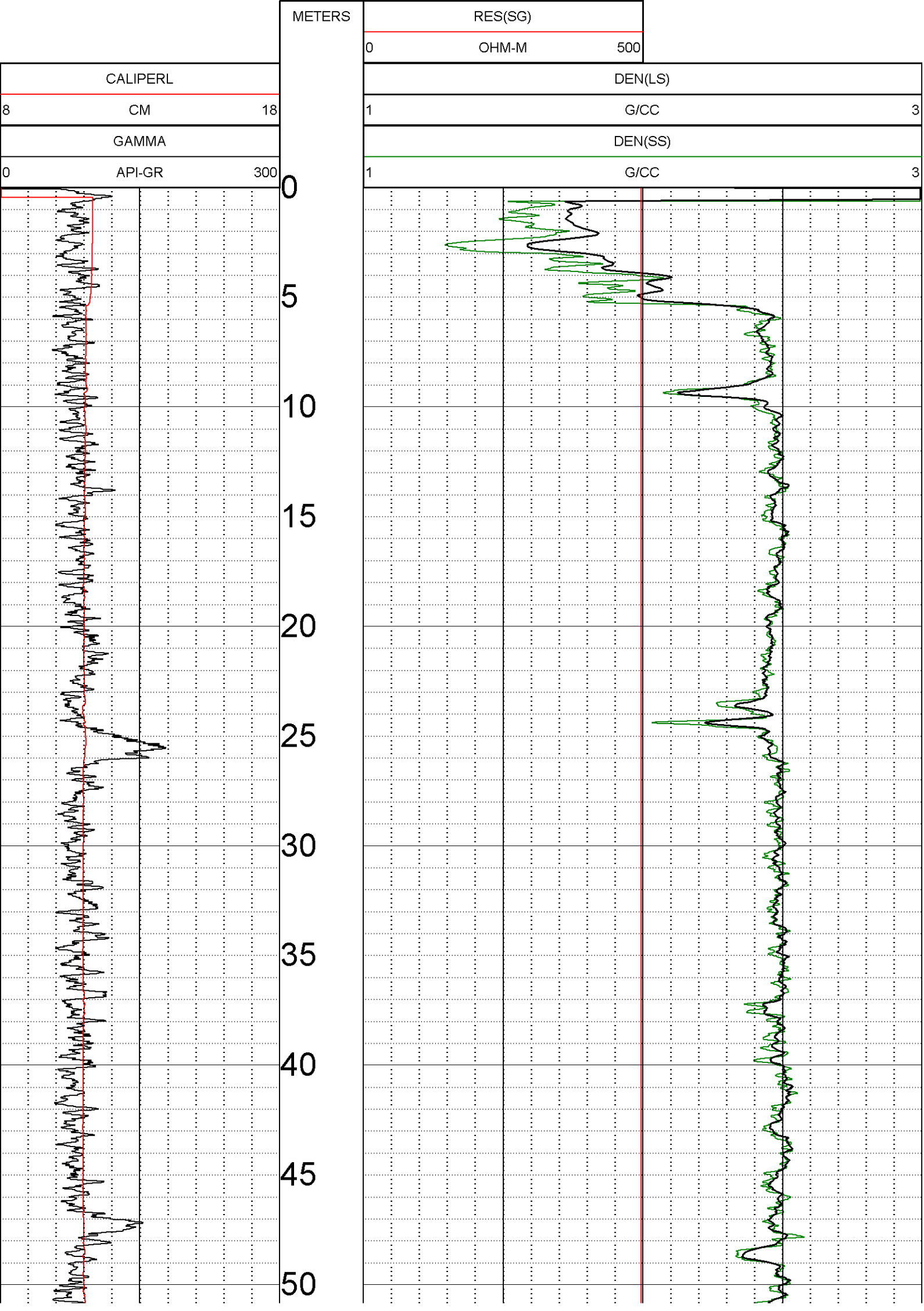
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MATRIX DENSITY : 2.65
NEUTRON MATRIX : SANDSTONE

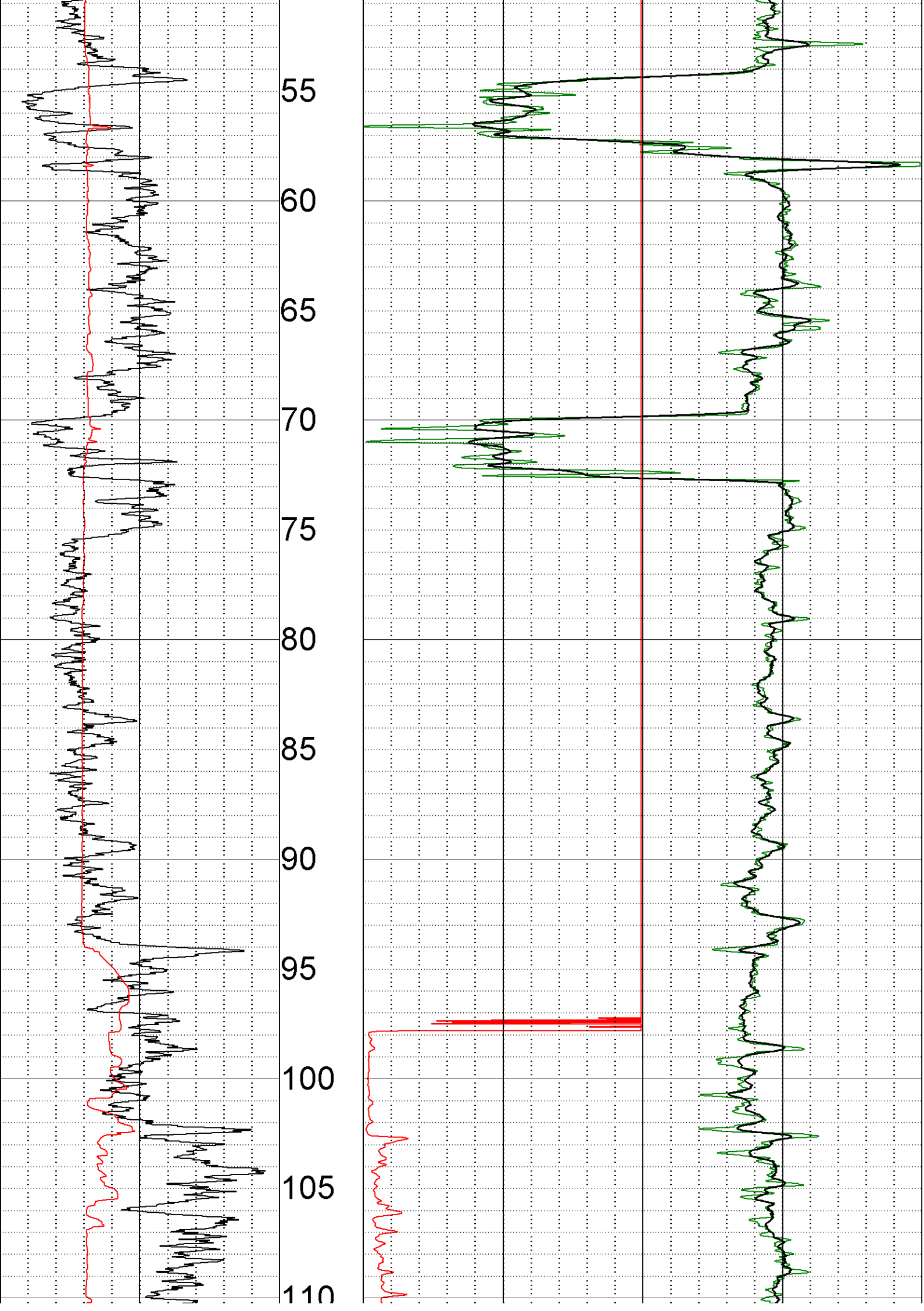
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RM : N/A
RM TEMPERATURE : N/A
MATRIX DELTA T : 177

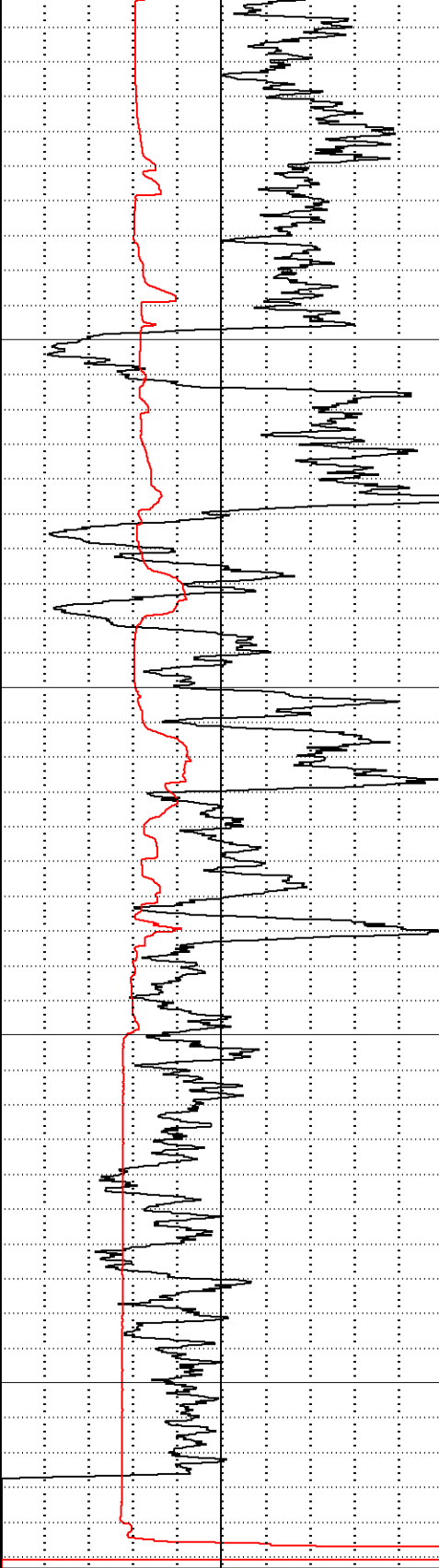
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LGTIME : 08:54:
THRESH: 99999

TOP OF VOID 154.4M

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



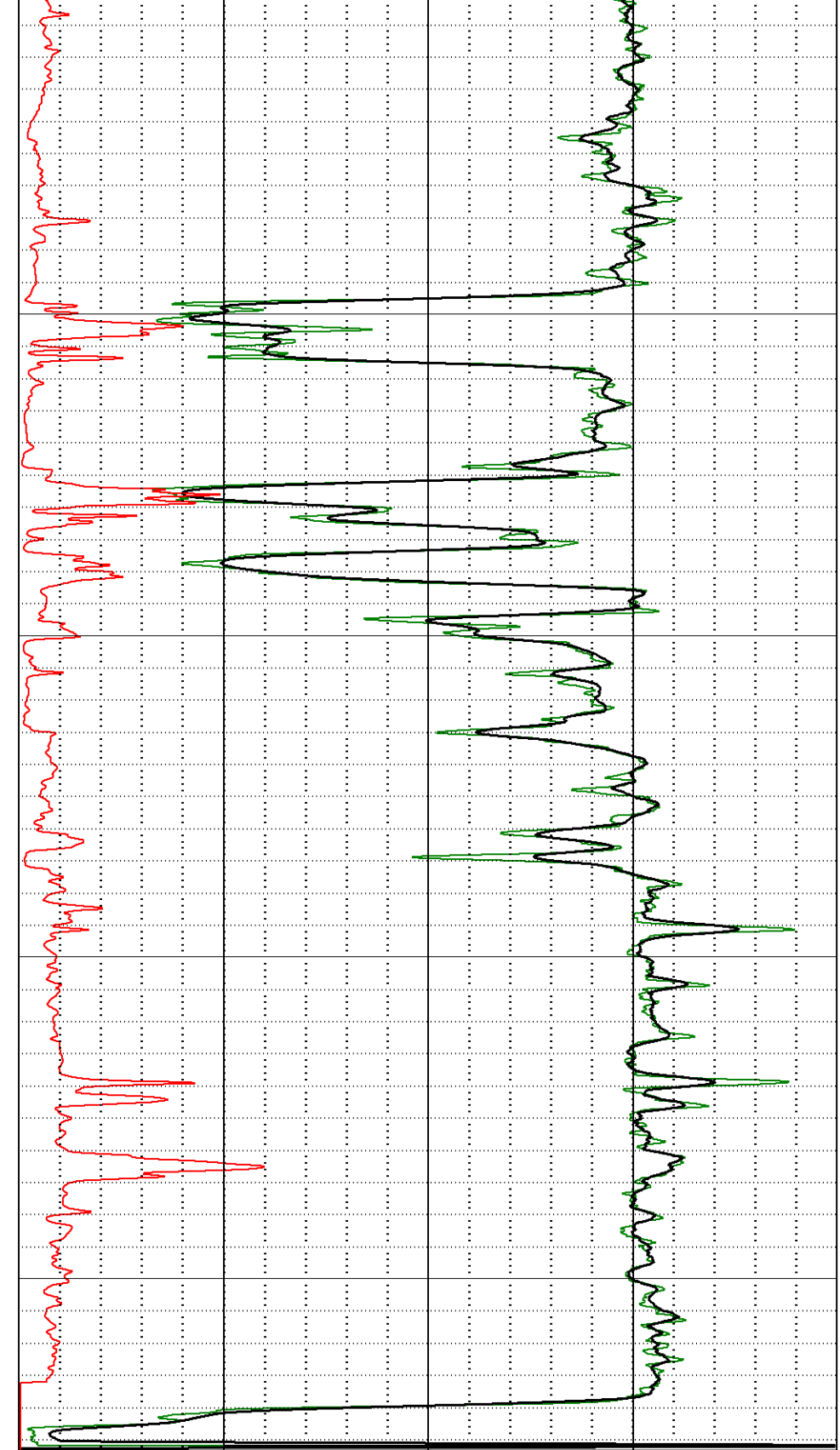




0	API-GR	300
	GAMMA	
8	CM	18
	CALIPERL	

110
115
120
125
130
135
140
145
150
155

METERS

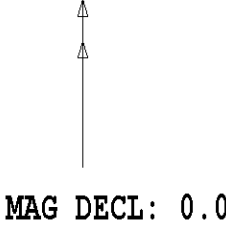


1	G/CC	3
	DEN(SS)	
1	G/CC	3
	DEN(LS)	
0	OHM-M	500
	RES(SG)	

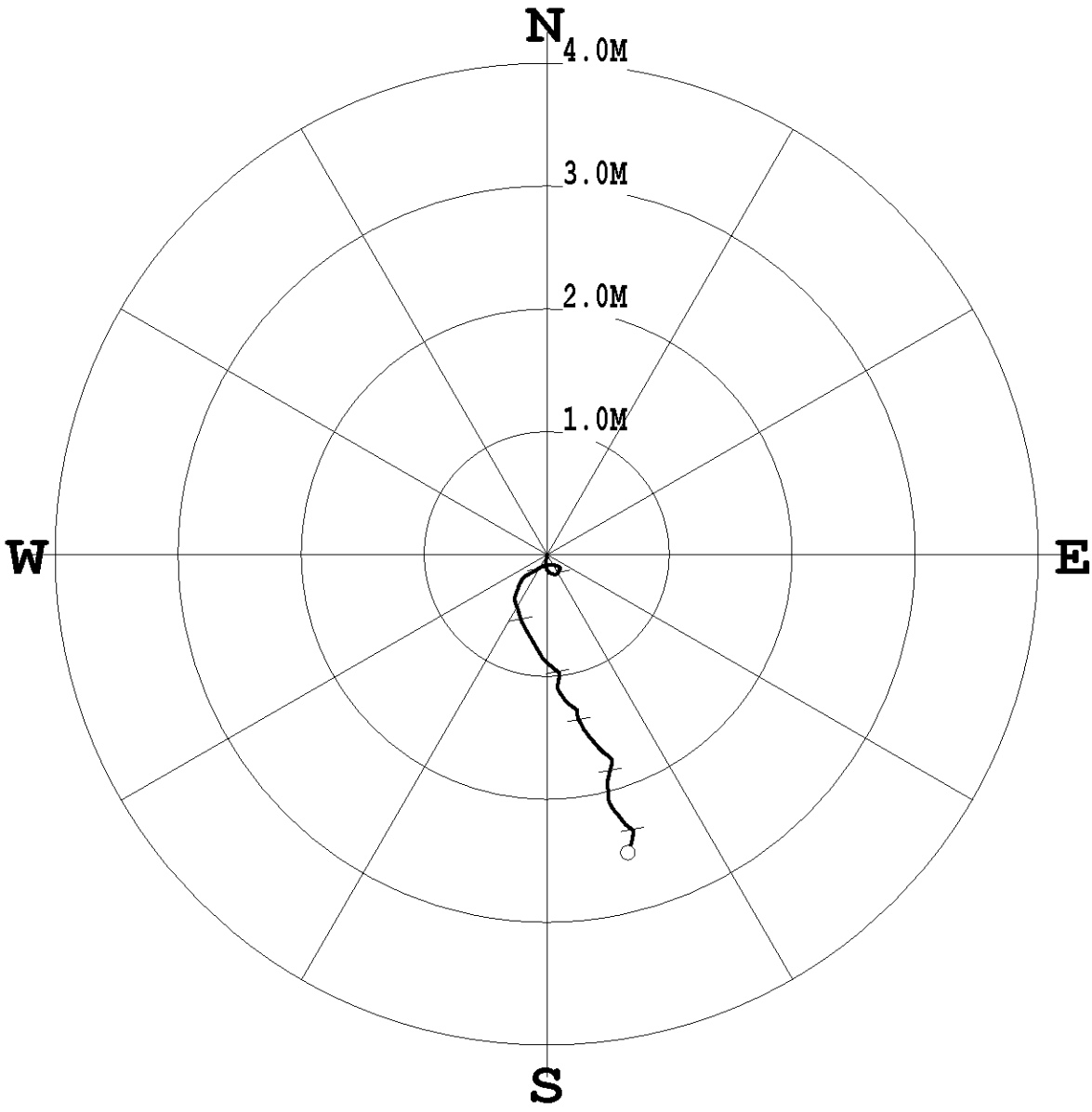
PLAN VIEW

COMPU-LOG DEVIATION

CLIENT: DOUGLAS PARTNERS
LOCATION: 30 SMITH ST
HOLE ID: 1001 DEVIATION
DATE OF LOG: 05/18/22
PROBE: 9057A 4603



SCALE: 1 M/CM
TRUE DEPTH: 155.01 M
AZIMUTH: 164.9
DISTANCE: 2.5 M
+ = 20 M INCR
○ = BOTTOM OF HOLE



CLIENT : DOUGLAS PARTNERS HOLE ID. : 1001 DEVIATIO
 FIELD OFFICE : RUTHERFORD DATE OF LOG : 05/18/22
 DATA FROM : N/A PROBE : 9057A , 4603
 MAG. DECL. : 0.000 DEPTH UNITS : METERS
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GROUNDSEARCH

AUSTRALIA



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WELL : 1001 NEUTRON 1 200
LOCATION/FIELD : 30 SMITH ST
COUNTY :
LOCATION : CHARLESTOWN
SECTION : N/A

OTHER SERVICES:
DEN DEV
SON NEU

TOWNSHIP : N/A RANGE : N/A

DATE : 05/18/22
DEPTH DRILLER : 155.65
LOG BOTTOM : 155.24
LOG TOP : 0.00

PERMANENT DATUM : -0.6

KB : N/A
DF : N/A
GL : 0

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CASING TYPE : PVC
CASING THICKNESS: .5

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RECORDED BY : M CRANE

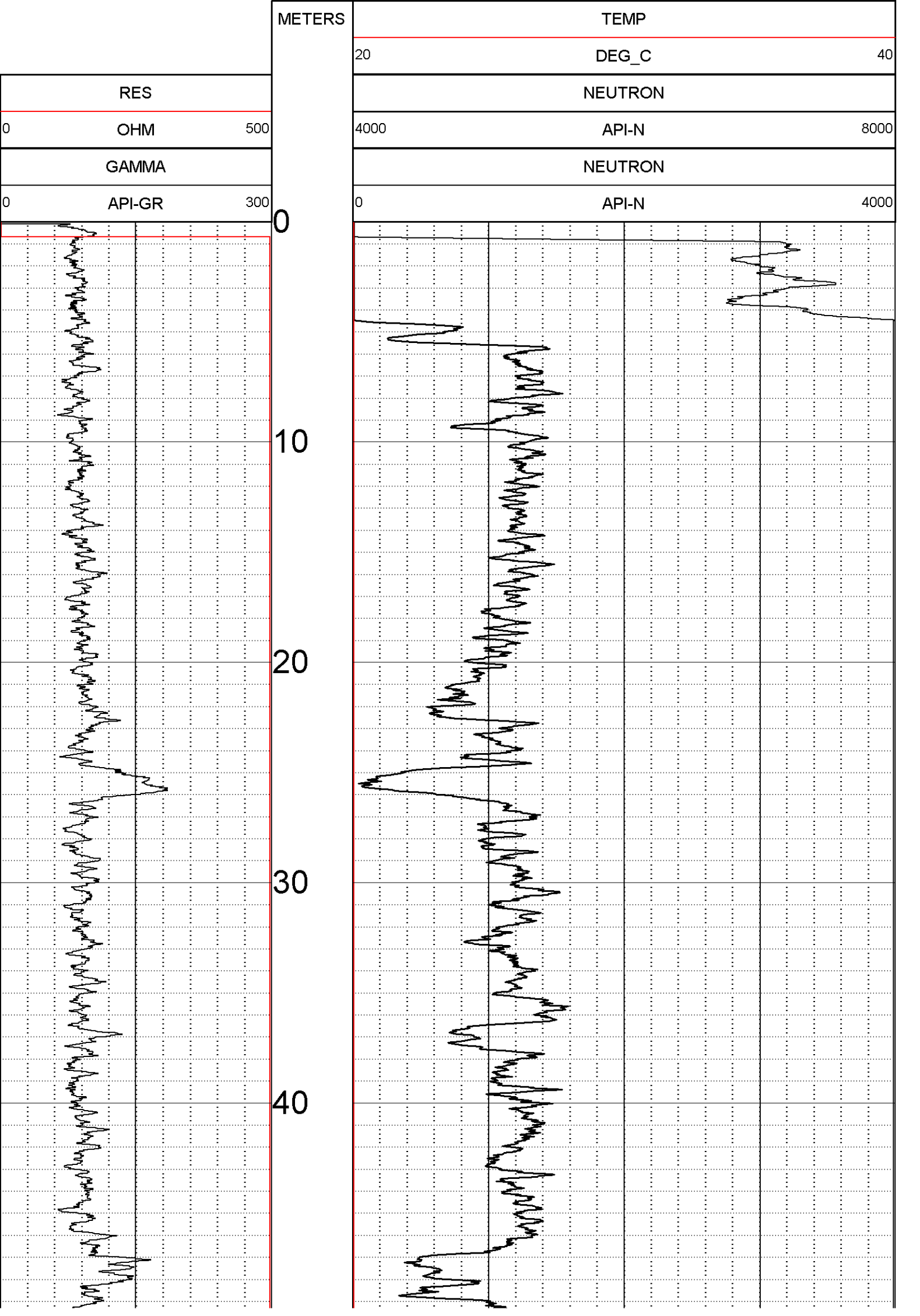
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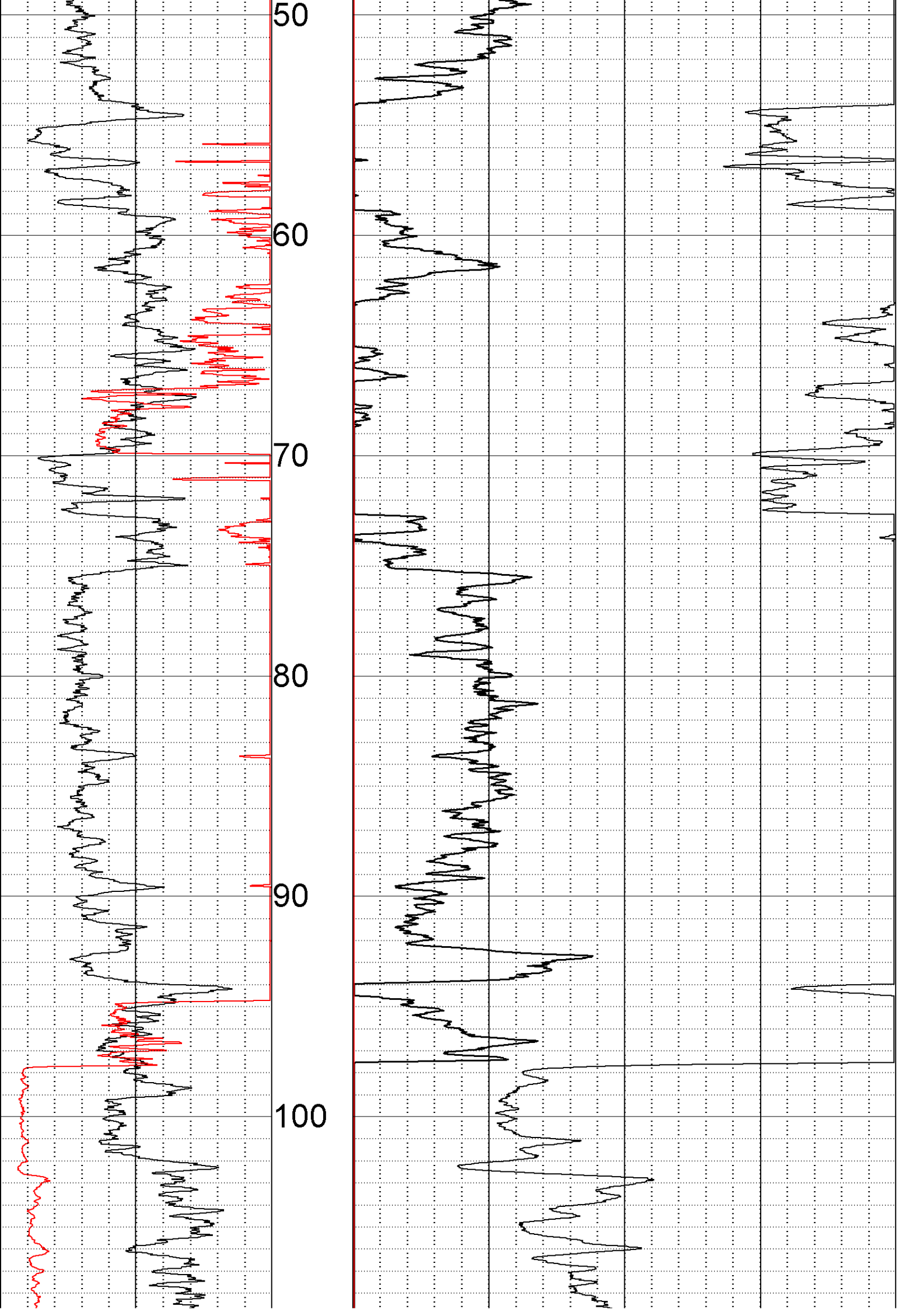
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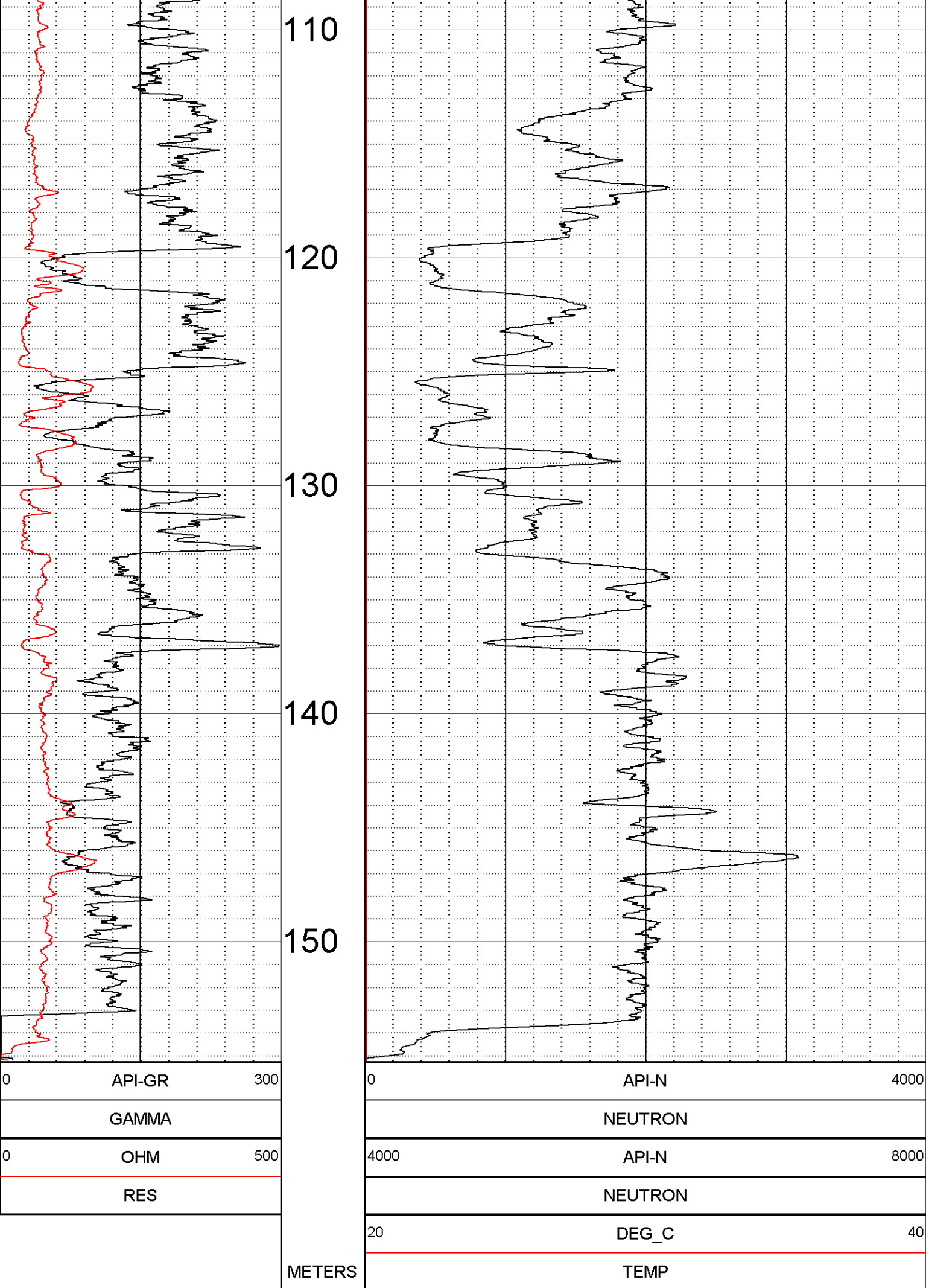
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THRESH: 99999

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W/L 97.8

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS







GROUNDSEARCH

AUSTRALIA

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WELL : 1001 VELOCITY 1:200
LOCATION/FIELD : 30 SMITH ST
COUNTRY :
LOCATION : CHARLESTOWN
SECTION : N/A

OTHER SERVICES:
DEN DEV
SON NEU

TOWNSHIP : N/A RANGE : N/A

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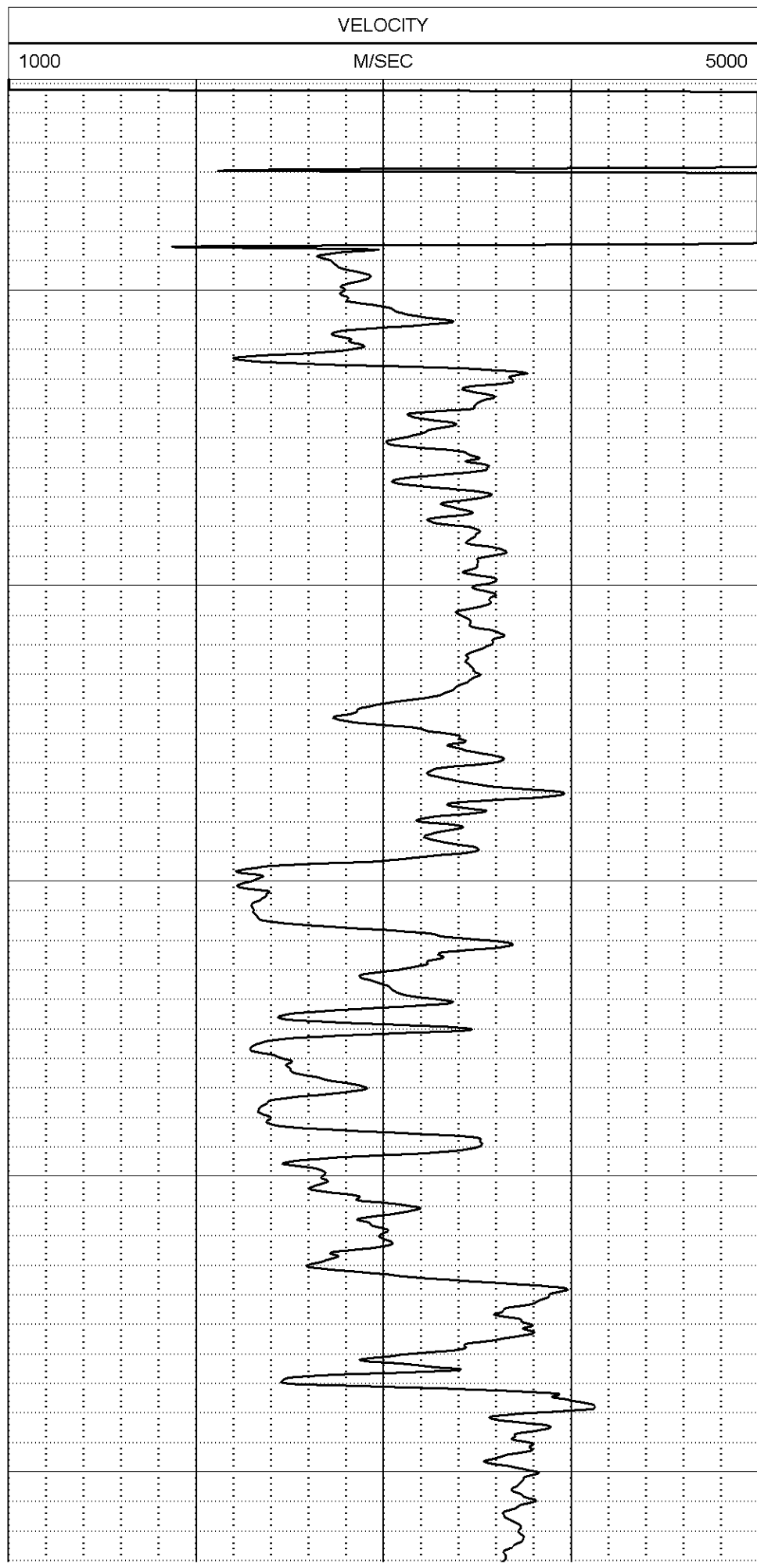
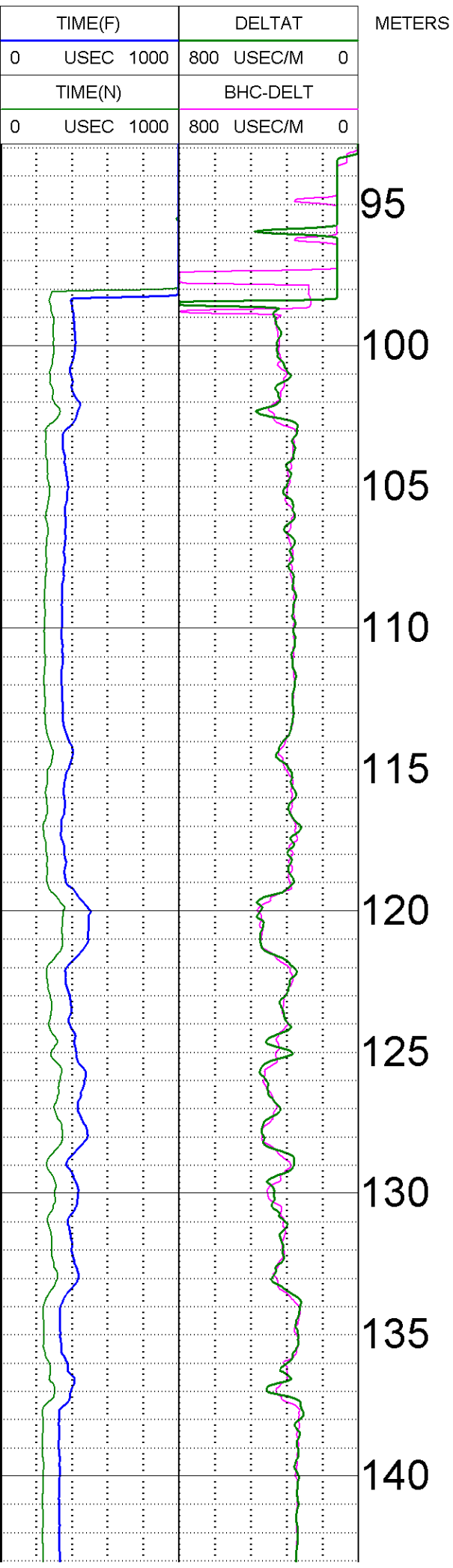
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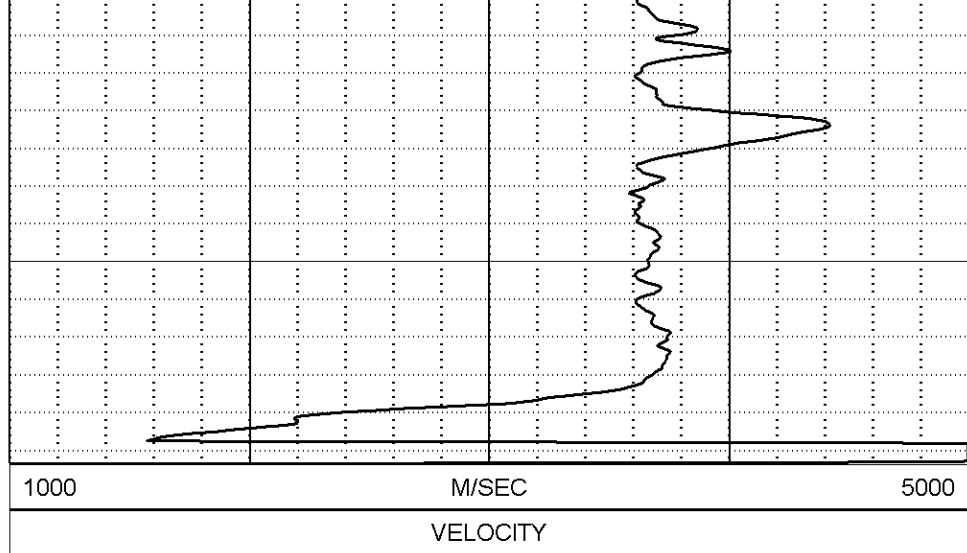
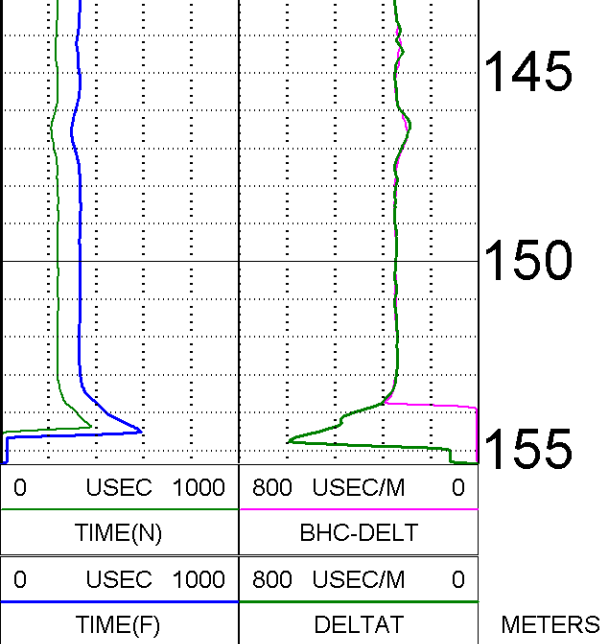
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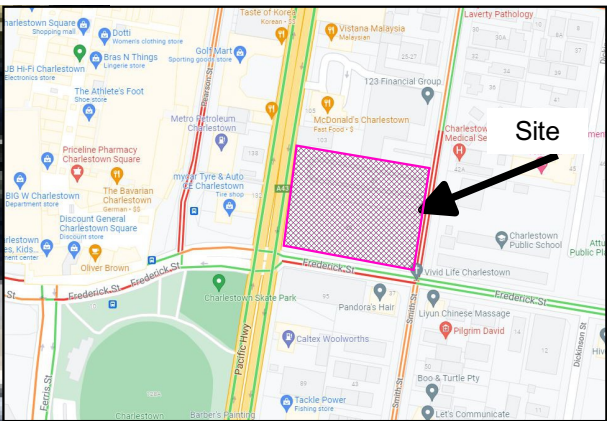
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Appendix C

Drawing 1 – Test Location Plan and Sonar Image Overlay
Drawing 2 – Inferred Layout of Mine Workings in Victoria Tunnel Seam
Drawing 3 – Inferred Panels of Workings of VT Seam



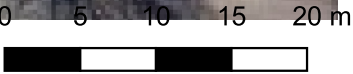
Site Location

Legend

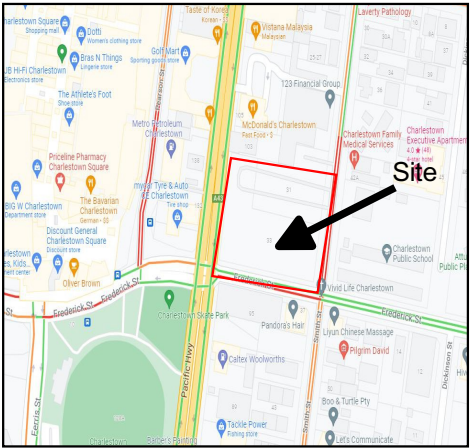
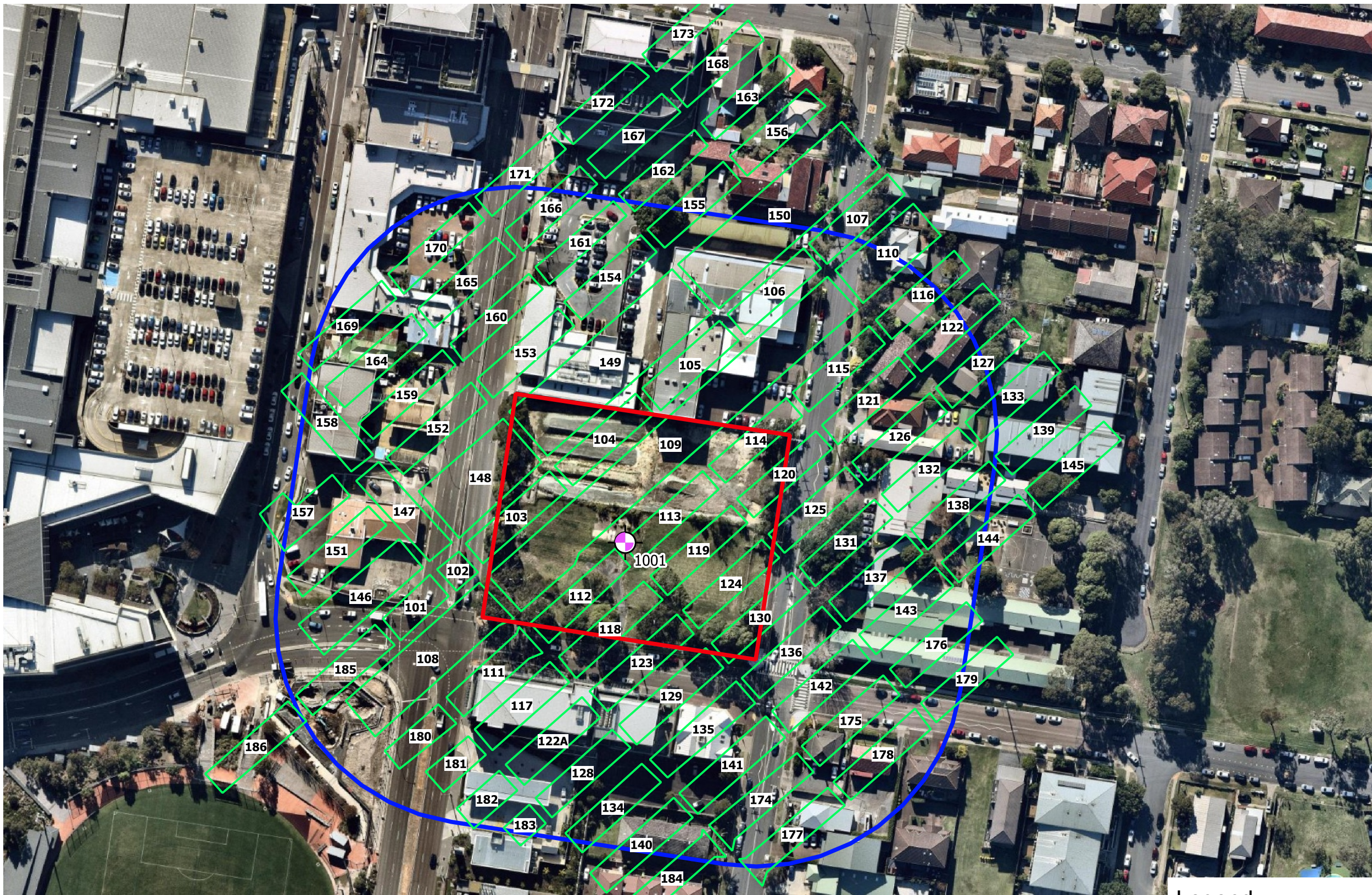
-  Approximate Bore Location
-  Approximate Site boundary

Drawing adapted from aerial imagery from metromap.com

Test locations are approximate only and were located using Differential GPS typically Accurate to ± 0.1 m.



 Douglas Partners Geotechnics Environment Groundwater	CLIENT: Archadia Projects Pty Ltd		TITLE: Test Location Plan with Sonar Overlay Geotechnical Investigation 31 - 33 Smith Street, Charlestown, NSW		Project: 210780.01
	OFFICE: Newcastle	DRAWN BY: CTB			DRAWING No: 1
	SCALE: 1:500 @A3	DATE: 14.June.2022			REVISION: 0



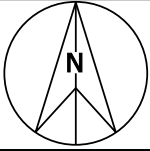
Site Location

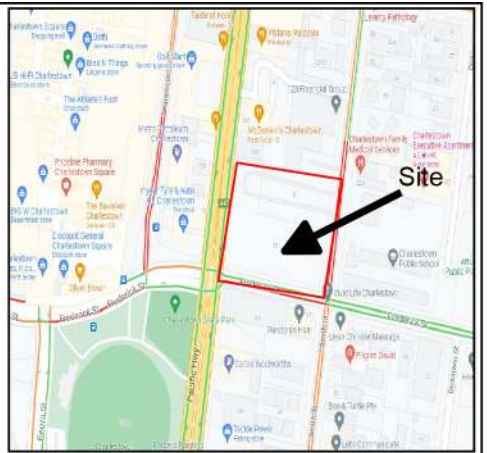
Disclaimer: any excerpts of original mine survey plans or record tracings and any data provided from such original mine survey plans or record tracings must not be relied upon in any way by any person, including (without limitation) for the accuracy or completeness of mine workings, and are intended for indicative purposes only. The Department of Planning is not responsible or liable to any person for any loss or liability arising out of or in connection with the use of any such excerpts or derived data.

Legend

- Approximate Site boundary
- Approximate Inferred Location of Coal Pillars (RT 293)
- Angle of Draw (154m Depth)
- Proposed Mine Bore Location

Drawing adapted from aerial imagery from MetroMap dated 09.03.2020, and RT 293. 0 50 100 150 200 m

	CLIENT: Archadia Projects Pty Limited		TITLE: Inferred Layout of VT Seam (RT 293) Workings and Bore Location Proposed Multi-Storey Development 31-33 Smith Street, Charlestown, NSW		Project: 210780.01
	OFFICE: Newcastle	DRAWN BY: CTB			DRAWING No: 2
		DATE: 14.June.2022			REVISION: 0



Site Location

Disclaimer: any excerpts of original mine survey plans or record tracings and any data provided from such original mine survey plans or record tracings must not be relied upon in any way by any person, including (without limitation) for the accuracy or completeness of mine workings, and are intended for indicative purposes only. The Department of Planning is not responsible or liable to any person for any loss or liability arising out of or in connection with the use of any such excerpts or derived data.

Legend

- Approximate Site boundary
- pillars VT
- Buffer
- ⊗ Mine Bore
- Identified Panels of Workings

Drawing adapted from aerial imagery from MetroMap dated 09.03.2020, and RT 293.

0 50 100 150 200 m



Appendix D

Appendix C of Development Application Merit Assessment Policy



Development Application – Merit Assessment Policy

Document number:	Version number: 1
Date: Friday, May 25, 2018	

Contact details

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1. Introduction

1.1 Subsidence Advisory NSW

Subsidence Advisory NSW (SA NSW) is a NSW Government agency responsible for administering the *Coal Mine Subsidence Compensation Act 2017* (the Act). SA NSW has three primary functions:

1. To manage claims for compensation where surface developments are damaged by mine subsidence following extraction of coal or shale in NSW.
2. To regulate surface development within mine subsidence districts (districts) to minimise liabilities arising from mine subsidence.
3. To manage risk associated with mine subsidence including public awareness of mine subsidence.

1.2 Regulation of surface development

Districts are proclaimed in areas where there is potential for mine subsidence to impact surface development. This may be a result of potential ground instability in previously mined areas or ground movement due to planned future mining activity.

SA NSW has set surface development guidelines (guidelines) which specify the type of construction permitted on each property in districts. SA NSW has assigned one of eight guidelines to each property located in a district. The type of guideline that is applied depends on subsidence hazards at the property. Each guideline includes restrictions on building footprints, height, foundation type, superstructure material and occupation density.

Applications that comply with certain guidelines can be assessed by an Accredited Certifier, including councils, and do not require SA NSW approval. Table 1 summarises each development guideline and the relevant certifying authority for compliant applications. All applications for proposed development on a property that does not comply with the property's guideline must be considered by SA NSW on merit.

Applicants can find out the guideline assigned to a property through the NSW Planning Portal at www.planningportal.nsw.gov.au/find-a-property.

Table 1 - Summary of SA NSW's development guidelines

SA NSW surface development guideline	Brief description*	Assessment authority
Guideline 1. Non-active mine workings at risk of pothole subsidence	Single storey brick veneer or two storey clad frame on engineer designed footings to span a 5m pothole	SA NSW
Guideline 2. Non-active mine workings possible subsidence risk	Single or two storey brick veneer on AS 2870 footings/slabs. Maximum length of 24m and maximum footprint of 400m ² .	Councils and certifying authorities*
Guideline 3. Non-active mine workings remote subsidence risk	Up to four storey residential structures in accordance with all standards and codes.	Councils and certifying authorities*
Guideline 4. Active mining areas - high predicted subsidence impact	Single storey clad frame on strip footings or waffle slab to minimum H2 AS2870 site classification. Maximum length 18m and maximum footprint of 250m ² .	SA NSW
Guideline 5. Active mining areas – moderate predicted subsidence impact	Single or two-storey clad frame or brick veneer on footings/slabs to minimum H2 AS 2870 site classification. Maximum length of 24m and maximum footprint of 400m ² .	Councils and certifying authorities*
Guideline 6. Active mining areas – minimal predicted subsidence impact	Single or two-storey clad frame or brick veneer on AS 2870 slabs/footings Maximum length of 30m and maximum footprint of 500m ² .	Councils and certifying authorities*
Guideline 7. On Application	The complexity of the geotechnical environment or lack of information regarding subsidence risk requires that all surface development be assessed by SA NSW	SA NSW
Guideline 8. No Restrictions	SA NSW has assessed, based on available records the subsidence hazard to be negligible	Councils and certifying authorities*

*A full copy of each SA NSW surface development guideline is available at www.subsidenceadvisory.nsw.gov.au/development-guidelines.

** Councils and Certifying Authorities, can approve compliant applications on properties assigned these guidelines. All applications that do not comply with the guideline assigned to the property must be assessed by SA NSW on merit.

2. Policy Statement

This policy provides a framework for the assessment and determination of development applications within districts that do not comply with the SA NSW development guideline assigned to the property.

2.1 Objectives

The key objectives of the policy are to:

- ensure compliance with all relevant statutory requirements
- ensure public safety
- establish a comprehensive, transparent and consistent process for assessing development applications that do not comply with SA NSW's development guidelines
- clearly define roles and responsibilities
- provide guidance on the type of conditions that SA NSW may impose as part of a conditional approval of a development application prior to construction in order to gain final approval following construction
- establish a consultation process
- establish a dispute resolution process
- prevent unnecessary delays in SA NSW's assessment of development applications.

2.2 Scope

This policy applies to all officers, consultants, contractors and outsourced service providers performing work for SA NSW. It also applies to all SA NSW activities that involve assessment of applications for proposed surface development that do not comply with SA NSW's guidelines and the preparation of associated guidelines and procedures.

2.3 Ethical Conduct

All activities must be conducted in an ethical and transparent manner and comply with the values, principles and articles in the Code of Conduct.

Staff will ensure they are not, or are not perceived to be, in a conflict of interest with any stakeholders. Those staff who have, or may be perceived to have, a perceived conflict of interest in the outcome of a development application or related decision should disclose

any perceived conflict to their manager and discuss whether they should exclude themselves from any role in the consideration of the application.

2.4 Roles and Responsibilities

Each of the following has specific assigned responsibilities under this policy:

- Chief Executive Officer (CEO)
- Technical Manager
- Senior Risk Engineer & Senior Advisor Residential Subsidence Regulation
- SA NSW officers

2.4.1 Chief Executive Officer

The CEO is responsible for:

- establishing a policy for the assessment of development proposals within a district
- ensuring the delegations set out in the Instrument of Delegation are appropriate to the development assessment process
- reviewing any determination of an application that is subject to an appeal by a stakeholder.

2.4.2 Technical Manager

The Technical Manager is responsible for:

- ensuring that their staff, including consultants, contractors and outsourced service providers, comply with this policy and associated procedures
- reviewing and updating this policy and the associated procedures and guidelines
- approving or refusing applications for proposed development of land in line with SA NSW's Instrument of Delegations.

2.4.3 Senior Risk Engineer & Senior Advisor, Residential Subsidence Regulation

The Senior Risk Engineer and Senior Advisor, Residential Subsidence Regulation are responsible for:

- complying with this policy, the associated procedure and Instrument of Delegations.

2.4.4 SA NSW officers

SA NSW officers undertaking the assessment of Integrated Development referrals and applications are responsible for:

- complying with this policy, the associated procedure and Instrument of Delegations.
- referring any suggestions for improvement or queries to their respective Manager.

3. Development applications

This policy applies to the assessment and determination of development applications:

- made under section 22 of the Act
- referred to SA NSW as integrated development under section 91A of the *Environmental Planning and Assessment Act 1979*.

3.1 Application lodgement

Applications for development within a district may be submitted directly through SA NSW's online portal at www.subsidenceadvisory.nsw.gov.au or as an Integrated Development application through the relevant local council.

Applications should include detailed plans of the proposed structure, including the location and details of articulation / control joints in brickwork to confirm compliance with the requirements of the Building Code of Australia.

3.1.1 Referral of Integrated Development

Integrated Development is development that requires consent under the *Environmental Planning and Assessment Act 1979* and one or more approvals under other Acts.

Integrated Development is referred to SA NSW by a local council. Referrals may occur through SA NSW's portal.

Integrated Development is referred when an applicant has indicated on a development application (DA) form submitted to council that the DA is to be assessed as Integrated Development.

3.2 Application process

After receiving a development application, SA NSW will:

- register the application and determine whether it requires assessment on merit.

Note applicants may refer to the NSW Planning Portal to find out the surface development guideline applied to a property in order to determine whether the proposed application complies with the guideline or will require a merit assessment.

- undertake a preliminary review and if necessary either (1) request more information from the applicant or (2) consult the relevant coal mine operator or the Division of Resources and Geoscience (DRG).

- Refer to Attachment A for an overview of the merit assessment process based on building type, and whether the application is inside a current mining title. If additional information is required, SA NSW will notify the applicant within **14 calendar days** of receipt of the application.
- make a determination based on its records and any other available information.
- issue written notification advising the applicant of the outcome of the application.

SA NSW is to provide the applicant with a determination within **40 calendar days** of receipt of the application, excluding any time lost due to requests for additional information or consultation with external parties.

3.3 Advisory services

SA NSW offers expert advice on matters relating to mine subsidence or proposed development of land that may be subject to mine subsidence, whether or not the land is within a district.

Any interested party, including councils, can approach SA NSW for advice on mine subsidence matters, including requests for comment on development proposals that are not Integrated Development.

4. Assessment process

4.1 Assessment overview

SA NSW's assessment process aims to generate appropriate controls to eliminate or reduce risks associated with mine subsidence in districts.

As part of the assessment process for development applications that do not comply with SA NSW's guidelines, SA NSW will consider the:

- likelihood that mine subsidence events will occur
- consequence of mine subsidence events on surface infrastructure and public safety
- reliability of information used to determine the above, including mine plans, assumed pillar and extraction dimensions, and assumptions regarding geotechnical modelling
- risks arising from the proposed engineering controls.

The assessment process will vary depending on the type, size, potential repair cost of the proposed development, and whether it is in an area affected by operational, historical or future mining (refer to **Attachment A**).

The guideline assigned to a property includes information about whether the property is located in an operational (active) or non-active mining area. Applicants can find out the SA NSW guideline assigned to a property through the NSW Planning Portal. A full copy of all SA NSW development guidelines is available at www.subsidenceadvisory.nsw.gov.au/development-guidelines.

4.2 Applications within a current mining title

4.2.1 Assessing mine subsidence risks within current mining titles

In assessing risks associated with mine subsidence for development applications within a current mining title, SA NSW will consider the available information at the time including:

- the current development approval or mining lease to extract coal under the site
- any plans to extract coal under the site, including the likely timeframe and predicted ground surface subsidence impact
- the potential consequences of predicted subsidence on proposed development and the appropriate engineering controls required to mitigate against subsidence damage.

SA NSW will request information from the relevant mine operator or the Division of Resources & Geoscience within **5 calendar days** of receipt of the application. If no response is received from the mine operator within **14 calendar days**, SA NSW may make its own reasonable determination on the development application based on available information.

SA NSW does not require geotechnical desktop assessments to support development applications in operational or future mining areas. However, SA NSW may require a geotechnical investigation or desktop study to support large infrastructure projects or developments in active mining areas as part of its conditions of approval.

4.2.2 Consultation with the title holder

SA NSW is to consult the relevant title holder during the assessment of development applications within a current mining title.

SA NSW is to consider the title holders advice when making a determination. The title holder will be notified of any determination of a development application in a current mining title that varies from the relevant advice. On request, SA NSW shall provide the title holder with an explanation for the decision.

There may be situations where a mine operator objects to a proposed development in a current mining title. In these situations, SA NSW may request the mine operator and applicant to reach a co-existence agreement before making a determination.

4.2.3 Co-existence agreements

Co-existence agreements between the mine operator and applicant may include a subsidence liability and cost prediction assessment based on the likely mining plans and development of land.

There may be some instances, such as in areas where there is a high degree of certainty for coal extraction within a well constrained timeframe, where it is more appropriate for co-existence agreements to require mining to precede development.

4.2.4 Request for further information to facilitate assessment

SA NSW is able to encourage discussions on co-existence agreements between applicants, mine operators and the Department of Planning including the Division of Resources and Geoscience as necessary.

4.2.5 Previous mine workings within a current mining title

In areas where there are previous mine workings in a current mining title, SA NSW will also assess the mine subsidence risk in accordance with section 4.3 of this policy in addition to section 4.2 of this policy.

4.2.6 Areas of potential future mining

SA NSW may consult the Division of Resources and Energy (DRG) on applications for B3 category structures as identified in **Table 2**.

SA NSW is to provide DRG with at least **14 calendar days** to provide advice on the application. SA NSW will consider DRG's advice when making a determination on such applications. If DRG does not provide a response within the specified timeframe, SA NSW may make its own assessment and determination.

4.3 Mine workings outside a current mining title

Some districts cover mine workings outside a current mining title, these include known or suspected historical underground mine workings, shafts and tunnel entries.

4.3.1 Assessing mine subsidence outside a current mining title

In assessing the risk associated with mine subsidence for development applications near mine workings outside a current mining title, SA NSW will consider the:

- nature of the proposed surface development
- type and condition of the mine workings beneath the site
- depth of the mine workings beneath the site
- history of subsidence at the site
- estimated likelihood of subsidence occurring in the future
- geotechnical characteristics of the site
- potential consequences of subsidence
- reliability of the information available to assess the above.

4.3.2 Requests for further information to facilitate assessment

SA NSW may require additional information to facilitate assessment of an application, including geotechnical studies or investigations into potential subsidence risk. SA NSW's standards for geotechnical analysis and reporting for mine subsidence are outlined at **Attachment B**.

Applicants planning to build in areas where there are mine workings outside a current mining title are encouraged to contact SA NSW in the preliminary stages to ascertain

whether geotechnical studies will be required. SA NSW's building type classifications and requirements for geotechnical desktop studies are outlined at **Table 2**.

SA NSW is to notify applicants when further information is required to progress the assessment of a development application within **14 calendar days** of receipt. In instances where geotechnical investigations are deemed necessary, SA NSW is to outline the necessary scope and objectives of the investigations.

In instances where SA NSW has requested further information from the applicant, the development application will be placed on hold until the information has been received. If SA NSW has not received a response from the applicant within **two months** of the request, SA NSW is to issue a reminder email to the applicant. If no response is received within **one month** of the reminder, SA NSW may close the application and notify the applicant by email. The applicant can re-submit the application at any time.

Refer to **Attachment C** for guidance on how SA NSW assesses subsidence risk and the type of engineering controls that may be applied based on geotechnical uncertainty, the estimated level of subsidence risk and the type of proposed surface development.

4.3.3 Geotechnical investigations

The types of geotechnical investigations SA NSW may require to facilitate assessment of a development application include, but are not limited to:

- desktop studies of mining history, geological/geotechnical conditions, subsidence history
- ground surface observation and geotechnical mapping
- subsurface investigation
- stability and subsidence analysis
- risk assessment and development of risk mitigation measures.

The extent of investigations required will depend on anticipated subsidence hazards as well as the nature of the proposed development. In areas with minimal well-defined subsidence hazards, SA NSW may deem a simple desktop study to be sufficient. Development applications in areas with a history of subsidence and complex ground conditions are more likely to require extensive desktop studies followed by further mapping, subsurface investigation, analysis, assessment and reporting.

The selection of investigation techniques and the evaluation of pillar stability and subsidence impact should be made by competent professionals. SA NSW's minimum requirements for geotechnical reports accompanying development applications are outlined at **Attachment B**.

All geotechnical studies and investigations must be undertaken by suitably qualified and experienced geotechnical, mining or engineering geology professionals. SA NSW can provide details of suitably qualified professionals upon request.

A list of key technical papers that SA NSW recognises as providing acceptable methodologies for estimating subsidence risk are set out at **Attachment D**. SA NSW may also accept other technical papers on request.

Table 2 – SA NSW classification of building type used to indicate requirement for desktop geotechnical study

Building Structure Description		
SA NSW category	General Classification of Building type	SA NSW requirement for Geotechnical Assessment
B1	- up to and including 3 storeys (including rooftop access) < 50m maximum plan footprint dimension - no basement - no load bearing masonry construction - up to and equal to \$3 M construction cost	Desktop assessment not required with submission. <i>SA NSW may request further geotechnical work following submission if site undermined by historical workings.</i>
B2	- up to and including 4 Storeys (including basements and rooftop access); or - Between \$3 M to \$5 M construction cost; or > 50m in maximum plan footprint dimension	Desktop assessment not required with submission. <i>SA NSW may request further geotechnical work following submission if site undermined by historical workings.</i>
B3	- greater than 4 storeys (including basements and rooftop access) or > 100m maximum plan footprint dimension - Greater than \$5 M construction cost; or - Use - Hospital Wards, Operating theaters, critical public infrastructure Public Buildings with high trafficability (i.e. school halls etc.)	Desktop assessment required with submission if site undermined by historical workings. <i>SA NSW may request further geotechnical work following submission if site undermined by historical workings.</i>

5. Determinations and Approvals

Certifying Authorities, including local councils, can approve some applications that comply with development guidelines that SA NSW has assigned to a property. Details of surface development guidelines that do not require SA NSW approval is available at **Table 1**. All applications that do not comply with a property's development guideline are to be considered by SA NSW on merit.

5.1 Section 22 Approval

For all applications lodged directly to SA NSW by the applicant, approval is granted by SA NSW under Section 22 (3) of the Act. Copies of this approval can be used to accompany a Development Application with the relevant local council.

5.2 General Terms of Approval

For development applications lodged through council as an 'integrated development', council is to lodge the application with SA NSW on behalf of the applicant under Section 91 of the *Environmental Planning and Assessment Act 1979* in order to obtain General Terms of Approval (GTAs).

SA NSW is to issue GTAs within **21 calendar days** of receiving the development application from council. If an integrated referral cannot be returned within **21 calendar days**, SA NSW is to notify council of the delay within the **21 calendar day** timeframe.

In instances where SA NSW requires further information to assess a development application referred through council, SA NSW is to request the additional information from council within **21 calendar days** of receiving the application.

SA NSW is to specify whether approval or conditional approval has been granted under section 22 of the Act when issuing GTAs. In instances where SA NSW grants conditional approval, the applicant is required to meet any applicable conditions before building works can be carried out.

In the event that SA NSW does not grant approval, council is required to refuse the application.

5.3 Refusals

SA NSW may refuse a development application where mine subsidence risks are considered too high. Examples of development applications that SA NSW may refuse include:

- Development applications that SA NSW has determined present an unacceptable financial or safety risk and the potential subsidence impact cannot be effectively mitigated through engineering design.
- Areas where the subsidence hazard has been assessed by SA NSW to present a credible and unacceptable public safety risk and an effective mitigation strategy is not feasible.

In such cases, SA NSW officers are available to meet with the applicant to attempt to find a mutually agreeable solution. If the applicant is not satisfied with the proposed pathway forward, they may request a meeting with the CEO or dispute the determination in accordance with Section 6 of this policy.

6. Reviews and Dispute resolution

SA NSW offers applicants the option to formally request a review if they are not satisfied with the determination of a development application. The CEO is to be notified of all requests for review and make the final determination on the outcome of reviews.

Prior to initiating the formal review process, SA NSW may suggest meeting with the applicant to attempt to reach a mutually agreeable solution.

6.1 Review process

To initiate a review, applicants are to submit a written request to SA NSW for a review of a determination on a development application. The submission needs to outline the reasons for the request including justifying why there should be a review and what the applicant considers would be a reasonable determination. If applicable, details of the applicant's preferred review type should be included.

SA NSW is to acknowledge requests for reviews within **7 calendar days** and advise the applicant of timing and next steps, depending on the review type, within **14 calendar days**.

The findings and recommendations from external reviews are to be provided to the CEO for consideration. The CEO is to make the final determination on the outcome of the review. Once finalised, SA NSW is to advise the applicant of the outcome of the review with an explanation for the determination. SA NSW is to finalise reviews within **40 calendar days** of the request.

6.1.1 Reviews of applications with mine workings outside a current mining title

Applicants disputing SA NSW's determination of applications within historical (non-active) mine areas have the option for an internal review by a different SA NSW officer or a review by an external consultant. The CEO may use these subsequent reports to inform the final decision.

6.1.2 Reviews of applications within a current mining title

Applicants disputing SA NSW's determination of an application within a current mining title have the option for an internal review by an SA NSW Risk Engineer who was not involved in the original determination.

Note: There is no option for external reviews of applications within a current mining title as subsidence impacts in these locations have generally been previously agreed upon by coal mine operators and the Division of Resources & Geoscience.

6.2 Review of determination

6.2.1 Internal reviews

SA NSW offers applicants the option of an internal review of a determination on a development application at no cost. Internal reviews are carried out by a SA NSW Risk Engineer with no involvement in the original determination.

6.2.2 External reviews

External reviews of development applications in areas with existing mine workings outside a current mining title are to be carried out by an independent consultant with extensive experience in mine subsidence studies and acceptable to SA NSW. SA NSW will use the report to reconsider the determination.

If the review results in SA NSW's original determination on the application being overturned, SA NSW may re-imbursement the applicant for the cost of the review.

7. Key Performance Indicators

Key Performance Indicators are an important part of the strategic planning process and play a role in the measurement of SA NSW's progress towards achieving its planned goals. The following table lists the key performance indicators.

- If the application is made under section 22 of the Act, SA NSW will advise the applicant if additional information is required to progress their application within **14 calendar days** of receipt.
- If the application is made as an integrated development under section 91 of the *Environmental Planning and Assessment Act 1979*, SA NSW will advise council if it requires additional information to progress the application within **21 calendar days** of receipt unless additional information is requested by SA NSW in order to progress the application.
- All merit based approvals under section 22 of the Act will be determined within **40 calendar days** of receipt unless additional information is requested by SA NSW to progress the application.
- 90% of integrated development applications made under section 91 of the *Environmental Planning and Assessment Act 1979* will be determined within **21 calendar days** of receipt unless additional information is requested by SA NSW in order to progress the application.
- 10% of integrated development applications made under section 91 of the *Environmental Planning and Assessment Act 1979* will be determined within **40 calendar days**. SA NSW will notify council that additional time is required within **21 calendar days**.

***Note:** assessment durations exclude “stop the clock” periods where SA NSW is waiting for additional information from the applicant or a third party to enable an assessment.

8. Related Policies and Documents

Issuer	Reference	Document Name
NSW Government	No 23	<i>Coal Mine Subsidence Compensation Act 2017</i>
NSW Government		<i>Coal Mine Subsidence Compensation Regulation 2017</i>
NSW Government	No 203	<i>Environmental Planning and Assessment Act 1979</i>
NSW Government		<i>Environmental Planning and Assessment Regulation 2000</i>
NSW Government		<i>State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007</i>
NSW Government	No 17	<i>State Records Act 1998</i> (regarding the creation, management and protection of records and public access to those records)
NSW Government	No 52	<i>Government Information (Public Access) Act 2009</i> (regarding public access arrangements to agency information)
NSW Government	No 133	<i>Privacy and Personal Information Protection Act 1998</i> (regarding the collection and protection of personal information)
NSW Government	No 35	<i>Independent Commission Against Corruption Act 1988</i> (regarding reporting of any matter suspected on reasonable grounds to involve corrupt conduct)
NSW Government	October 2015	NSW Integrated Mining Policy - <i>Indicative Secretary's Environmental Assessment Requirements for State Significant Development - Mining</i> (Hotlink)
NSW Public Service Commission	Direction No 1 of 2015	The Code of Ethics and Conduct for NSW government sector employees
Department of Finance, Services and Innovation	Hotlink	Code of Ethics and Conduct

9. Document Control

9.1 Document Approval

Name & Position	Signature	Date
Kieran Black Technical Manager		25 May 2018
Brendan Killen A/Chief Executive Officer		25 May 2018

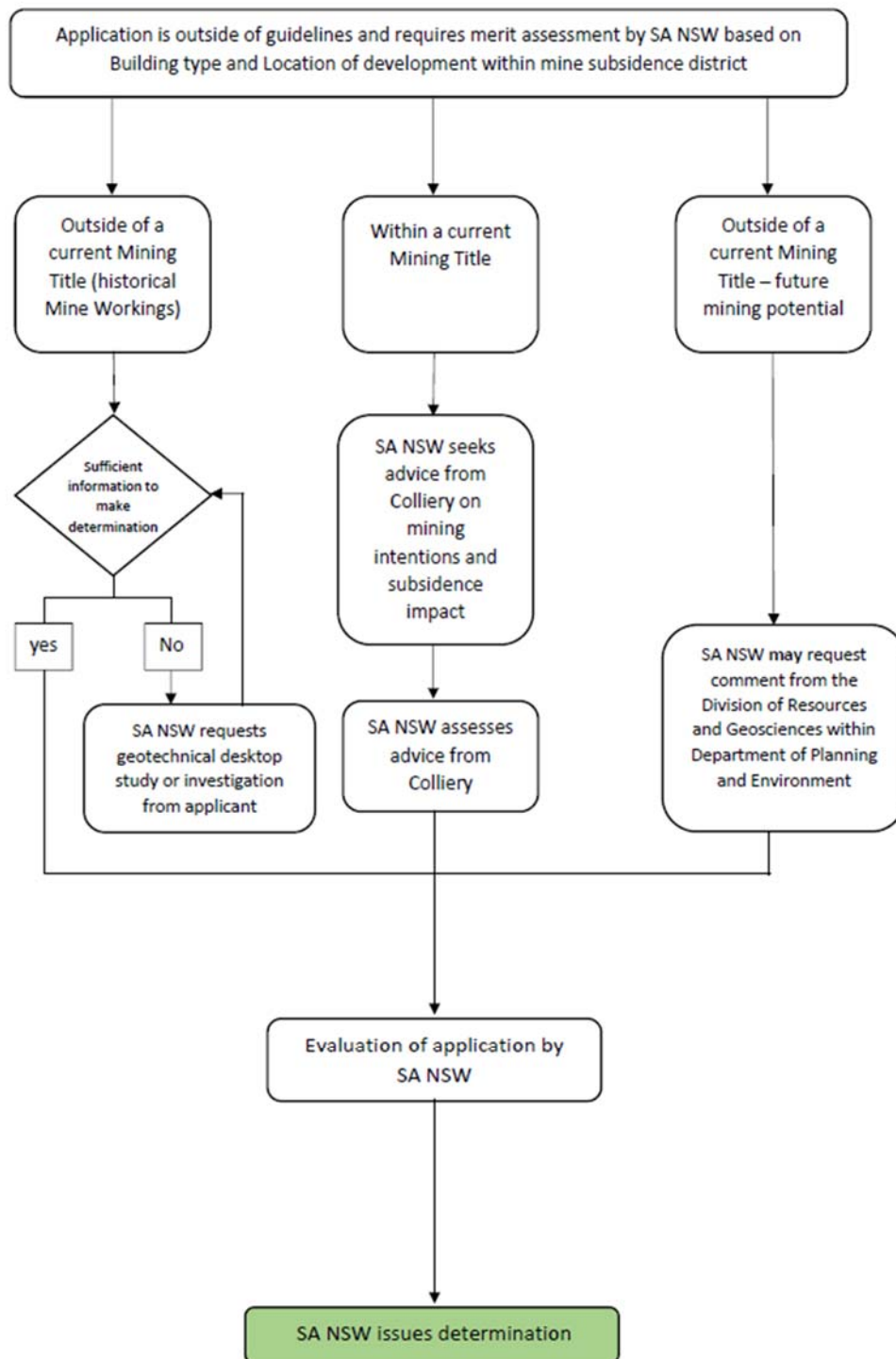
9.2 Document Version Control

Version	Status	Date	Prepared By	Comments
1.0	Draft	23 March 2018	Kieran Black	

9.3 Review Date

The attachments to this policy will be reviewed and updated as required. A formal review will be undertaken every two years. Feedback from applicants and other stakeholders will be considered during the review process.

Attachment A: Merit based development application assessment flowchart



Attachment B: SA NSW's minimum requirements for geotechnical reports

Geotechnical desktop study or geotechnical investigation reports provided to SA NSW as part of a development application should clearly address the following.

The likelihood of mine subsidence affecting the site. An assessment of this should be clearly stated in the report. Include if applicable an assessment of:

- Pillar failure – (The UNSW pillar strength formula should not be used without providing a thorough assessment of the inputs used and the level of confidence in them. The formulae should not be used on selected isolated pillars, but rather averaged over an entire panel. An assessment should then be made if the panel is susceptible to a pillar run. Clear recommendations should be made on what further work the applicant could undertake to reduce the uncertainty.)
- Surface pothole formation.
- Migration of overlying soil into subsidence cracks or mine voids.
- Poorly or un-remediated mine openings such as drifts and shafts.
- Residual subsidence due to ongoing goaf consolidation and settlement of the overburden (superincumbent strata).
- The potential for variability in any assumptions used in the assessment (as described above) including:
 - o Parametric Analysis: Identify the primary variables and provide their adopted values and expected variability.
 - o Sensitivity Analysis: Assessment of how outcomes or risks are affected by variations in input values for a parameter.
 - o Sources of information and their reliability, including discussion of perceived gaps in information with specific reference to a geotechnical model as defined in Australian Standard AS 1726-2017 Geotechnical site investigations.
- Recommendation on whether further geotechnical studies or investigations should occur in order to make a more accurate assessment.

The consequence of subsidence. Including, if applicable, predictions of:

- o Surface deformations including;

- Vertical subsidence (mm)
 - Horizontal displacement both tensile and compressive (mm/m)
 - Tilt (mm/m)
 - Radius of curvature (km)
- o Anticipated nature and extent of damage to the proposed development

Additionally, SA NSW may request that the applicant provide;

- o An estimate of repair costs (including cost of re-housing of inhabitants during repair) of proposed development should a subsidence event occur
- o An assessment of whether a credible safety risk exists should a subsidence event occur. This should include both structural failure and formation of subsidence features.

Recommendation on appropriate engineering controls (if applicable). All engineering controls should be accompanied by clear justification as to how and why the adopted methods are appropriate. The likelihood and consequence of a subsidence event with the controls in place should be assessed.

- Each report should, if applicable, include the following in assessing subsidence risk:
 - o Seams worked (single or multi-seam, seam thickness and structure)
 - o The class of mine workings (i.e. Historical, Operational or Future)
 - o The characteristics of mine workings (e.g. depth, extraction height, percentage of extraction, geotechnical conditions).
 - o Mine workings type, age and level of confidence in accuracy (bord and pillar, pillar extraction, longwall/miniwall, mining height, 1st workings, 2nd workings)
 - o Regional geology (Stratigraphy/dip/faults/dykes)
 - o Overburden properties (soil cover, rock strength, discontinuities, moisture sensitivity, water table, potential for time dependent strength and stiffness changes (i.e. creep)
 - o Mine workings roof, seam and floor properties (as per overburden properties plus peak and residual strength and stiffness of coal pillars, strain hardening goaf)
 - o Propensity for pillar geometry change (rib spall, roof collapse)
 - o Standing pillars factor of safety (FoS), goaf, bearing capacity of roof and floor, pothole development potential

- o Justification for adopted parameters
- o Mine subsidence parameters for systematic behavior (vertical subsidence, horizontal strain, tilt, curvature).
- o Likelihood and allowance for non-systematic mine subsidence behavior (e.g. dependent on geological structure: faults, dykes, slip planes and / or topography, cuttings).
- **Clear recommendations** – The geotechnical consultant should clearly put forward their conclusions and recommendations and avoid the use of ambiguous language.

Attachment C: Procedure used by SA NSW Risk Engineers to assess surface development on merit

The purpose of this procedure is to:

1. provide a consistent approach when assessing development applications
2. provide guidance on the type of engineering mitigation measures and geotechnical reporting that may be required to facilitate assessment of a development application.

SA NSW will apply different conditions of approval based on building category. SA NSW classification of building category is described in Table C1.

Table C1 – Classification of Building type

SA NSW category	General Classification of Building type
B1	• up to and including 3 storeys (including rooftop access) • < 50m maximum plan footprint dimension • no basement • no load bearing masonry construction • up to and equal to \$3 M construction cost
B2	• up to and including 4 storeys (including basements and rooftop access); or • Between \$3 M to \$5 M construction cost; or • > 50m in maximum plan footprint dimension
B3	• greater than 4 storeys (including basements and rooftop access) or • > 100m maximum plan footprint dimension • Greater than \$5 M construction cost; or • Use - Hospital Wards, Operating theaters, critical public infrastructure Public Buildings with high trafficability (ie school halls)

Trough Subsidence Risk

SA NSW will apply our conditions of approval based on;

- the assessed level of geotechnical uncertainty (uncertainty factor),
- the assessed stability of remnant coal pillars based on estimated factors of safety and slenderness of remnant coal pillars, and
- the type of structure (building category).

It should be noted that this is intended as a guide, and the conditions of approval may vary in areas that have a high level of geotechnical complexity. SA NSW will provide justification on request should the applicant dispute the outcome.

The uncertainty factor is used by SA NSW to determine the levels of conservatism and allowed assumptions required when assessing the likelihood of a trough subsidence event.

The level of geotechnical uncertainty is categorised as low, medium or high based on the level of confidence and understanding of the;

- Geological environment (R1)
- Level of geotechnical investigation (R2)
- Type of coal mine plans and records (R3)
- Method used to assess stability and impact (R4).

The weighting applied to each factor is outlined below;

- R1 = 2
- R2 = 2
- R3 = 3
- R4 = 3

Refer to **Table C2** to determine the uncertainty value (U) that should be applied for each of the above. The uncertainty value (U) that can be applied to each of the above are as follows;

- Low uncertainty = 1
- Moderate uncertainty = 2
- High uncertainty = 3

Once these have been determined, the Uncertainty Factor can be determined by applying the following formulae;

$$\text{Uncertainty Factor (UF)} = (R1 \times U) + (R2 \times U) + (R3 \times U) + (R4 \times U) - 10$$

Table C2 – Factors used to determine the Uncertainty factor

	(Low Uncertainty)	Medium Uncertainty	High Uncertainty (U)
	U value = 1	U value = 2	U value = 3
Geological Environment (R1) value = 2	- A review of available mine plans and records indicate that faults, dykes or other adverse geological structures are likely not present. (i.e. should be regular layout - no evidence of limiting intersection spans, no significant patterns of truncated or miss-aligned roadways) - If borehole information is available, a review of geotechnical and geophysical logs indicate no anomalous geological structures or stratigraphy being present. - Records indicate seam dip is less than 10 degrees	- A review of available mine plans and records, indicate that Faults dykes or other geological structures may be present. (i.e. evidence of limiting intersection spans, no significant patterns of truncated or miss-aligned roadways) - If borehole information is available, a review of geotechnical and geophysical logs indicate an anomalous high density of joints and/or small faults (i.e. less than 200mm throw) - Records indicate seam is dipping at between 10 and 20 degrees	- An analysis of record tracings, indicates faults / dykes are present. Structures are either clearly marked on plan or immediately obvious from analysis of mine plan layout. - If borehole information is available, an analysis of core samples and geophysical logs indicates an anomalous high density and orientation of faults / dykes or other rock types that may contribute to magnitude of subsidence impact. - Borehole information indicates potential for soft floor or roof conditions resulting in foundation or roof punching failure. - Records indicate seam is dipping at greater than 20 degrees
Level of geotechnical Investigation (R2) Value = 2	- Geotechnical investigation sufficient to adequately assess; - depth of workings, - geo reference mine plans - void heights and widths - pillar plan dimension under site - material properties and slaking potential of overburden and roof and floor - state of workings (failed or standing) Note: this will likely require a minimum of two fully cored and geotechnically logged boreholes	- Geotechnical investigation sufficient to confirm; - mine void dimensions - depth to seam - state of workings (failed or standing) roof and floor properties. Note: this will require a minimum of one borehole	No site specific borehole data, or inferences made from boreholes located more than 50m from site

	(Low Uncertainty)	Medium Uncertainty	High Uncertainty (U)
	U value = 1	U value = 2	U value = 3
Coal Mine Plans and Records (R3) Value = 3	- Mechanised mining showing 1st workings only - Mine workings record tracing based on post mining survey results with regular layout - Sufficient post mining geotechnical boreholes in area to confirm record tracings accuracy - Mine workings show previously extracted longwall panels - Multi-seam mining is a minimum of 100m between seams	- Hand worked mines (welsh bords) with regular layout and sufficient borehole data to confirm dimensional accuracy. - Mechanised workings showing partial or full pillar extraction Mechanised workings showing single gate road mini-wall panels.	Irregular mechanised or hand worked mining
Method used to assess stability and impact (R4) Value = 3	- Method used to assess stability of pillars and subsidence impact has been validated by use of another method – i.e. numerical modelling validated by empirical method OR peer review by relevant professional accepted by SA NSW - Pillar stability calculations are based on the average pillar FoS for panel. - Other potential pillar loading scenarios considered if applicable. - All variables and assumptions used in estimating both pillar stability and subsidence impact clearly outlined - in the absence of borehole data, credible worst-case assumptions have been made (ie assume 0.5m off plan dimensions, full seam extraction + 0.5m to allow for roof fall). - Pillar stability and subsidence impact assessment capable of being replicated from data published in report	- single method used to assess stability of pillars and subsidence impact (note that in assessing pillar stability the average panel FoS should be used rather than assessment on isolated pillars) - Other potential pillar loading scenarios considered if applicable. - All variables and assumptions used in estimating both pillar stability and subsidence impact clearly outlined	- No geotechnical report or analysis - Geotechnical analysis does not meet specified criteria - Internal estimation of subsidence risk based on available records carried out by SA NSW Risk Engineers.

The application of these can be divided up into low, medium and high uncertainty based on the following values;

- Low uncertainty - ≤ 5
- Moderate uncertainty > 5 and ≤ 10

- High uncertainty >10

Refer to **Table C1** in order to determine the building type.

Apply the Building Type classification (B1, B2 or B3) in conjunction with the uncertainty **C3** for a guide as to the conditions of approval and design requirements based on building category, the uncertainty factor and calculated FoS and slenderness ratio (W/h) of the remnant coal pillars.

Sinkhole (pothole) Risk

The attached table (**Table C2**) provides a broad outline on the conditions that SA NSW may apply for areas that have been identified as having a sinkhole (or pothole) risk.

This is based on (1) cover depth, (2) borehole information, (3) the nature of the workings and (4) seam dip and (5) previous history of pothole formation.

The assessment of pothole risk outlined below is intended as a guide. The proponent may engage a geotechnical consultant to provide a more detailed analysis of the risk of sinkhole (pothole) formation for a particular site. However, it should be noted that if a credible pothole risk is identified, SA NSW will generally require that the risk of sinkhole formation be effectively eliminated as far as is practicable.

Refer to **Table C4** for a guide as to the type of conditions that SA NSW may apply based SA NSW classification of building category and sinkhole risk.

Internal refit

If a proposal is for an internal re-fit of an existing building, and the existing building will remain structurally unaltered, SA NSW will not require any design mitigation measures unless (1) site is subject to medium or high sinkhole risk and (2) existing structure is inadequate to cater for the assessed maximum pothole diameter and (3) cost of refit is greater than \$3 M (\$3,000,000.00).

Attachment C - Table C3. SA NSW Estimated Conditions of Approval for Trough Subsidence Risk

SA NSW category (refer to table C1)	Uncertainty Factor	General Summary of likely approval conditions for sites where the pillar FoS (and W/h ratio's) greater than nominated values				General Summary of likely approval conditions for sites where the pillar FoS less than nominated values	
		FoS	W/h Ratio	Allowed assumptions for assessment of pillar stability	General Summary of approval conditions	Summary of design requirements	General summary of likely approval conditions (these may vary in accordance with the geotechnical environment and subsidence risk)
B1	Low uncertainty (≤ 5)	>1.6	>2	Unless informed by borehole data; 1) Pillars are full seam height 2) Plan pillar dimensions are as shown on record tracings.	(1) Submit Site Classification report (to AS2870 standard) to SA NSW for our records (2) Following construction, provide sign-off from qualified engineer that improvements have been constructed in accordance with plans and foundations have been constructed accordance with AS2870. Note: Nominal subsidence parameters up to 2mm/m +/- horizontal strain, 2mm/m tilt and 7km radius of curvature may be applied by Risk Engineer dependant upon type of structure	If the estimated subsidence impact is less than or equal to; (1) 3mm/m horizontal strain (+/-), (2) 4mm/m Tilt and (3) 5km radius of curvature. Structure must be designed to be "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable". If estimated subsidence impact is greater than above, then structure must both satisfy the above and in addition remain structurally safe to occupants taking into account additional estimated subsidence impact.	(1) Submit plans prior to construction with a letter from a qualified structural engineer that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable". The subsidence impact parameters should be clearly stated. (2) If the parameters exceed (+/-) 3mm/m horizontal strain, 4mm/m Tilt and 5km radius of curvature, then signoff from a structural engineer that the point (1) above is met and (2) that structure will remain structurally safe given the estimated additional subsidence impact. (3) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant codes and standards.
	Moderate uncertainty (> 5 to ≤ 10)	>1.8	>2				
	High uncertainty (> 10)	>2.1	>4				
B2	Low uncertainty (≤ 5)	>1.8	>2	Unless informed by an adequate level of borehole data; 1) Pillars are full seam height 2) take 0.5m off pillar dimensions as shown on available mine plan records to allow for error 3) Absolute worst-case subsidence impact parameters should be determined regardless of apparent pillar stability (this assumes that all pillars with W/H ratios of less than 8 fail) 4) Following construction, provide sign-off from a suitably qualified engineer that improvements have been constructed in accordance with plans and foundations have been constructed in accordance with AS2870. Note: Nominal subsidence parameters up to 2mm/m +/- horizontal strain, 2mm/m tilt and 7km radius of curvature may be applied by Risk Engineer dependant upon type of structure	(1) Submit Site Classification report (to AS2870 standard) to SA NSW for our records (2) If not already submitted, a geotechnical desktop study or investigation for SA NSW acceptance confirming that the pillars under the site meet the nominated pillar Factors of Safety for the appropriate uncertainty factor. (3) Provide signoff by a Structural Engineer experienced in mine subsidence design that the proposed improvement will remain structurally sound and safe in the event that it is subject to absolute worst case subsidence impact. (4) Following construction, provide sign-off from a suitably qualified engineer that improvements have been constructed in accordance with plans and foundations have been constructed in accordance with AS2870. Note: potential exists for refusal or requirement to grout if the risk of pillar failure and subsidence impact has been assessed by Risk Engineers as being unacceptable.	If the estimated subsidence impact is less than or equal to; (1) 5 mm/m horizontal strain (+/-), (2) 7 mm/m Tilt and (3) 2 km radius of curvature. Structure must be designed to be "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable". If estimated subsidence impact is greater than above, structure must remain safe to occupants taking into account additional estimated subsidence impact. Note: potential exists for refusal or requirement to grout if the risk of pillar failure and subsidence impact has been assessed by Risk Engineers as being unacceptable.	(1) Submit plans prior to construction with a letter from a qualified structural engineer that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable". The subsidence impact parameters should be clearly stated. (2) If the parameters are within (+/-) 5mm/m horizontal strain, 7mm/m Tilt and 2km radius of curvature, then signoff from a structural engineer that the structure will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 up to and including the above. In addition, the structure must be designed to remain safe under absolute worst-case subsidence impact. (3) Submit a "Subsidence Impact Statement" prior to commencement of detailed design for acceptance by SANSW, which shall identify the: a. Mine subsidence parameters used for the design. b. Main building elements and materials. c. Risk of damage due to mine subsidence d. Design measures proposed to control the risks. e. Comment on the likely building damage in the event of mine subsidence and sensitivity of the design to greater levels of mine subsidence. (4) Submit detailed design drawings prior to the commencement construction with design measures proposed to control the mine subsidence risk clearly highlighted. (5) Following construction, sign-off from a suitably qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant codes and standards.
	Moderate uncertainty (> 5 to ≤ 10)	>2.1	>3				
	High uncertainty (> 10)	>2.1	>5				
B3	Low uncertainty (≤ 5)	2.1	>2	Unless informed by borehole data; 1) Assumed pillar height should take into account potential for roof failure 2) take 0.5m off pillar dimensions as shown on record tracings to allow for error 3) Potential for pillar foundation failure should be considered 4) Absolute worst case subsidence impact parameters should be determined regardless of apparent pillar stability (this assumes that all pillars with W/H ratios of less than 8 fail)	(1) Provide a peer review of the initial geotechnical report by a consultant acceptable to SA NSW with confirmation and signoff that the pillars are long-term stable. (2) Provide signoff by a Structural Engineer experienced in mine subsidence design that the proposed improvement will remain structurally sound and safe in the event that it is subject to absolute worst case subsidence impact (ie that all pillars with W/H ratios of less than 8 fail). (3) A number of permanent survey marks to AHD will be required so that building movement can be monitored should mine subsidence occur. survey marks need to be initially surveyed and all details are to be forwarded to Subsidence Advisory NSW. (4) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans and in accordance with all relevant building codes and standards.	Structure must be designed to be "safe, serviceable and readily repairable" under the predicted subsidence impact parameters. If estimated subsidence impact greater than specified, subsidence impact must be either eliminated or mitigated by a suitable means such as the emplacement of grout into the mine workings, or another suitable engineered mitigation measure put forward for SA NSW acceptance.	(1) Submit plans prior to construction with a letter from a qualified structural engineer that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'very slight' in accordance with AS2870 (Damage Classification), and readily repairable". The subsidence impact parameters should be clearly stated. (2) Either (a) submit a proposal to remove the risk of mine subsidence by a suitable means, such as grouting or (b) demonstrate that the improvement can be designed to remain "safe, serviceable and any damage from mine subsidence shall be limited to 'very slight' damage in accordance with AS2870 (Damage Classification), and readily repairable". If grouting option chosen, submit for acceptance by Subsidence Advisory NSW prior to commencing work: a. Grout Design, including grout locations (dimensioned in plan and elevation), and design parameters for any residual mine subsidence. b. Grout Implementation Plan; including a site plan (showing property boundaries within 200m of the site), grout locations (dimensioned in plan and elevation), proposed bore locations, and grout designers endorsement. c. Grout Verification Plan; showing the location of verification holes and the grout designer's endorsement. Any assumptions applied to the numerical modelling shall be subject to verification (using empirical or analytical methods) and a sensitivity analysis. Arrange for an independent peer review of the grouting design and implementation plan by a suitably qualified engineer acceptable to the Subsidence Advisory NSW. On completion of grouting submit a Grout Verification Output Report endorsed by the grout designer and site verification engineers for compliance with the accepted Grouting Plan. (3) Submit an "Engineering Impact Statement" prior to commencement of detailed design for acceptance by SANSW, which shall identify the: a. Mine subsidence parameters used for the design. b. Main building elements and materials. c. Risk of damage due to mine subsidence d. Design measures proposed to control the risks. e. Comment on the likely building damage in the event of mine subsidence and sensitivity of the design to greater levels of mine subsidence. (4) Submit detailed design drawings prior to commencement construction with the design measures proposed to control the mine subsidence risk clearly highlighted and the design subsidence parameters clearly marked on the plan. (5) A number of permanent survey marks to AHD will be required so that building movement can be monitored should mine subsidence occur. survey marks need to be initially surveyed and all details are to be forwarded to Subsidence Advisory NSW. (6) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant codes and standards.
	Moderate uncertainty (> 5 to ≤ 10)	2.1	>4				
	High uncertainty (> 10)	High uncertainty not acceptable for B3 type surface developments					

Attachment C - Table C4. Estimated Sinkhole conditions of approval based on Building type and Subsidence Risk

SA NSW category	Pothole Risk	Summary of design requirements*	General summary of likely approval conditions*
B1	Low Risk - Cover depth is less than 10 times the seam thickness, however on-site borehole evidence has been provided that workings have completely failed and risk is limited to piping of soil into pre-existing tension cracks and consolidation of goaf. - SA NSW risk engineers have assessed the risk of pothole formation as being low	Additions (i.e. deck, additional storey, garage with slab): No additional design requirements Granny Flats (<60m2 internal floor area): No additional design requirements if constructed with lightweight materials. No cavity brick, brick veneer or other masonry allowed without being required to be designed for the parameters outlined below. For single residential dwellings in the absence of geotechnical advice accepted by SA NSW risk engineers. Waffle-pod slabs or slab on ground permitted. Structure must be designed to be "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" given following subsidence parameters; (1) 3mm/m horizontal strain (+/-), (2) 7mm/m Tilt and (3) 2km radius of curvature.	(1) Submit plans prior to construction with a letter from a qualified structural engineer that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" given the following subsidence parameters; (+/-) 3mm/m horizontal strain, 7mm/m Tilt and 2km radius of curvature. (2) Submit Site Classification report (to AS2870 standard) to SA NSW for our records (3) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant codes and standards.
	Moderate Risk - Borehole confirmation that cover depth is 5 to 10 times the Seam Thickness - No previous history of pothole formation on current block or neighbouring blocks with similar cover depths. - Records indicate the seam dip is less than 10 deg - SA NSW risk engineers have assessed the risk of pothole formation as being moderate	Additions (i.e. deck, additional storey, uninhabitable garage with slab): No additional design requirements Granny flats (<60m2 internal floor area) and single dwellings: Structure must be designed to be "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" should a pothole with maximum diameter of 5m open up at any point underneath. Dual Occupancy or units: Removal of risk of mine subsidence by a suitable means such as grouting under building footprint commercial premises: Removal of risk of mine subsidence by a suitable means such as grouting under building footprint	(1) Submit plans prior to construction with a letter from a qualified structural engineer that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" given that a 5m pothole could open up at any point underneath the proposed structure. (2) Submit Site Classification report (to AS2870 standard) to SA NSW for our records (3) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant codes and standards.
	High Risk - No borehole confirmation of cover depth and available records indicate cover depth is less than or equal to 10 x the Seam Thickness - Borehole confirmation of cover depth is less than or equal to 5 x the Seam Thickness, or less than 10m - Records indicate the seam dip is greater than 10 deg - Previous history of pothole formation on current block or neighbouring blocks with similar cover depths. - Geotechnical environment allows for accelerated weathering and degradation of both pillars and overburden. - SA NSW risk engineers have assessed the risk of pothole formation as being high	Additions (i.e. deck, garage with slab on ground, retaining walls over 1m etc): Structure must be designed to be "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" should a pothole with maximum diameter of 5m open up at any point underneath. Additional Storeys not allowed without removal of risk by suitable means such as grouting. Single Dwelling: Removal of the risk by a suitable means such as grouting under building footprint Dual Occupancy or units: Removal of risk of mine subsidence by a suitable means such as grouting under entire lot commercial premises: Removal of risk of mine subsidence by a suitable means such as grouting under entire lot	(1) Submit a plan for acceptance by SA NSW prior to construction to remove the risk by the emplacement of grout into any mine voids. (2) Submit a grout verification report following grouting works for SA NSW acceptance that the risk of pothole formation on the site has been effectively eliminated such that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" if constructed in accordance with all relevant building codes and standards. (3) Submit Site Classification report (to AS2870 standard) to SA NSW for our records (4) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant and applicable building codes and standards.
B2	Low Risk - Cover depth is less than 10 times the seam thickness, however on-site borehole evidence has been provided that workings have completely failed and risk is limited to piping of soil into pre-existing tension cracks and consolidation of goaf. - SA NSW risk engineers have assessed the risk of pothole formation as being low	Structure must be designed to be "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" given subsidence parameters provided by Geotechnical Engineer in report accepted by SA NSW.	(1) Submit a geotechnical report prior to construction that provides residual subsidence design parameters for SA SW acceptance. (2) Submit Signoff from a qualified structural engineer that improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" given the subsidence parameters accepted by SA NSW. (3) Submit an "Engineering Impact Statement" prior to commencement of detailed design for acceptance by SANSW, which shall identify the: a. Mine subsidence parameters used for the design. b. Main building elements and materials. c. Risk of damage due to mine subsidence d. Design measures proposed to control the risks. e. Comment on the likely building damage in the event of mine subsidence and sensitivity of the design to greater levels of mine subsidence. (4) Submit detailed design drawings prior to commencement construction with design measures proposed to control the mine subsidence risk clearly highlighted. (5) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant codes and standards.
	Moderate Risk - Borehole confirmation that cover depth is 5 to 10 times the Seam Thickness - No previous history of pothole formation on current block or neighbouring blocks with similar cover depths. - Records indicate the seam dip is less than 10 deg - SA NSW risk engineers have assessed the risk of pothole formation as being moderate	Residential Development (single residence, townhouses, units, duel occupancy): Removal of risk of mine subsidence by a suitable means such as grouting under building footprint. commercial premises: Removal of risk of mine subsidence by a suitable means such as grouting under all trafficable areas of property.	(1) Submit a plan for acceptance by SA NSW prior to construction to remove the risk by the emplacement of grout into any mine voids. (2) Submit a grout verification report following grouting works for SA NSW acceptance that the risk of pothole formation on the site has been effectively eliminated such that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" if constructed in accordance with all relevant building codes and standards. (3) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant and applicable building codes and standards.
	High Risk - No borehole confirmation of cover depth and available records indicate cover depth is less than or equal to 10 x the Seam Thickness - Borehole confirmation of cover depth is less than or equal to 5 x the Seam Thickness, or less than 10m - Records indicate the seam dip is greater than 10 deg - Previous history of pothole formation on current block or neighbouring blocks with similar cover depths. - Geotechnical environment allows for accelerated weathering and degradation of both pillars and overburden. - SA NSW risk engineers have assessed the risk of pothole formation as being high	Residential Development (single residence, townhouses, units, duel occupancy): Removal of risk of mine subsidence by a suitable means such as grouting under entire lot. commercial premises: Removal of risk of mine subsidence by a suitable means such as grouting under all trafficable areas of property	
B3	Low Risk - Cover depth is less than 10 times the seam thickness, however on-site borehole evidence has been provided that workings have completely failed and risk is limited to piping of soil into pre-existing tension cracks and consolidation of goaf. - SA NSW risk engineers have assessed the risk of pothole formation as being low	Residential and commercial development (single residence, townhouses, units, duel occupancy): Removal of risk of mine subsidence by a suitable means such as grouting under building footprint.	(1) Submit a plan for acceptance by SA NSW prior to construction to remove the risk by the emplacement of grout into any mine voids. (2) Submit a grout verification report following grouting works for SA NSW acceptance that the risk of pothole formation on the site has been effectively eliminated such that the improvement will remain "safe, serviceable and any damage from mine subsidence shall be limited to 'slight' in accordance with AS2870 (Damage Classification), and readily repairable" if constructed in accordance with all relevant building codes and standards. (3) Following construction, sign-off from qualified engineer that improvements have been constructed in accordance with plans submitted to SA NSW and in accordance with all relevant and applicable building codes and standards.
	Moderate Risk - Borehole confirmation that cover depth is 5 to 10 times the Seam Thickness - No previous history of pothole formation on current block or neighbouring blocks with similar cover depths. - Records indicate the seam dip is less than 10 deg - SA NSW risk engineers have assessed the risk of pothole formation as being moderate	Residential and commercial development (single residence, townhouses, units, duel occupancy): Removal of risk of mine subsidence by a suitable means such as grouting under all trafficable areas of property.	
	High Risk - No borehole confirmation of cover depth and available records indicate cover depth is less than or equal to 10 x the Seam Thickness - Borehole confirmation of cover depth is less than or equal to 5 x the Seam Thickness, or less than 10m - Records indicate the seam dip is greater than 10 deg - Previous history of pothole formation on current block or neighbouring blocks with similar cover depths. - Geotechnical environment allows for accelerated weathering and degradation of both pillars and overburden. - SA NSW risk engineers have assessed the risk of pothole formation as being high		

Attachment D: List of methods and papers recognised for assessing likelihood and consequence of mine subsidence

Canbulat, I., Life of Coal Pillars and Design Considerations, 2010. Second Australasian Ground Control in Mining Conference / Sydney, NSW, 23 - 24 November 2010.

Galvin, J.M., Hebblewhite, B. K, M. D. G. Salamon and B. B. Lin, Establishing the Strength of Rectangular and Irregular Pillars, ACARP, 1998.

Healy, P.R. Head, J.M. Construction over Abandoned Mine Workings – CIRIA special publication, PSA Civil Engineering Technical guide 34, 1984.

Hill, D. Stone, R. Suchowerska, A and Trueman, R. Pillar Abutment Loading – New Concepts for Coal Mining Industry, 15th Coal Operators' Conference, University of Wollongong, The Australasian Institute of Mining and Metallurgy and Mine Managers Association of Australia, 2015, 204-211.

Holla, L. 1985, Surface subsidence prediction in the Southern Coalfield, New South Wales Department of Mineral Resources.

Holla, L. 1986, Evaluation of the surface subsidence characteristics in the Newcastle Coalfield of New South Wales, The Coal Journal 11, p11-22.

Holla, L. 1987, Surface subsidence prediction in the Newcastle Coalfield, New South Wales Department of Mineral Resources.

Holla, L. 1991, Surface subsidence prediction in the Western Coalfield, New South Wales Department of Mineral Resources.

Holla, L. 1997, Ground movement due to longwall mining in high relief areas in New South Wales, International Journal of Rock Mechanics and Mining Science 34 (5), p775-787.

Holla, L. and Barclay, E. 2000, Mine subsidence on the Southern Coalfield New South Wales, New South Wales Department of Mineral Resources, Sydney, 118p.

Piggott, R.J. Wardell, K and Eynon, P, "Ground movements arising from the presence of shallow abandoned mine workings Proc. Conf. on Large ground movements and structures at University of Wales," Pentech Press, London, Pages 749 to 780, 1977.

Appendix E

Table E1 – Pillar Stability Analysis – Measured Pillar Dimensions, Pillar
Height = 1.68 m

Table E1 – Pillar Stability Analysis – Measured Pillar Dimensions, Pillar
Height = 2.43 m

Table E1: Pillar Stability Analysis (RT293) based on Working Height and RT dimensions

Project: Proposed Medical Centre
Location: 31 - 33 Smith Street Charlestown
Analysis Assumptions: Pillar dimensions from RT, Pillar Height = Working Section
Project Number: 210780.01

Client: Archadia Project Pty Ltd
Date: 15 June 2022
Sheet: 1
Calculations by: MPG

Key to Colour Coding of Width to Height Ratio

9.00	Greater than 8.0
6.00	Between 5.0 and 8.0
4.50	Between 4 and 5
3.00	Between 2 and 4
1.80	Less than 2

Key to Colour Coding of Factors of Safety

1.50	Greater than 3.0
2.40	Between 2.1 and 3.0
2.00	Between 1.8 and 2.1
1.70	Between 1.5 and 1.8
1.20	Less than 1.5



3 332937608
+61 26260889
2 764186777

Indicating Pillar Located within Project Angle of Draw
Indicating Pillar Located beneath development area

Analysis Id:	Comment	Depth D (m)	Panel Width/Span (Longwall only) (m)	Seam Thickness (m)	Working Section H (m)	Pillar Height Section H (m)	Unit Weight γ (kN/m³)	Pillar Details			adway Det		Extract Ratio (%)	Pillar Area m²	Total Area m²	w/H Ratio w1/H	w2/H Ratio w2/H	Width/Height Ratio	Width Modifier			Pillar Stress (Tributary) (MPa)	Pillar Load (Tributary) MN	Proportion Abutment transfer R	ment Abut (A) Yield (Y) (?)	Abutment Loading Type M,T,G	Shed Load MN	Abutment Load Received MN	Pillar Stress (MPa) ("Yield") ϕs = 0.7	Pillar Stress ("Abut") (MPa)	Squat	Power Law				Ecoal GPa	Efloor GPa	Eroof GPa	Poissons Ratio Floor/Roof	Initial Vertical Stress γH MPa	Net Change in Vertical Stress MPa	Settlement Influence Factor	Elastic Compression of Pillar m	Elastic Compression of Roof m	Elastic Compression of Floor m	Total Elastic Compression m
								Width w1 (m)	Length w2 (m)	Internal Angle (°)	b1 (m)	b2 (m)							θ0	θ	w9 Effective Width											Strength (MPa)	Ultimate Load MN	FoS	Probability of Failure											
101	Panel 4	154.4		2.98	1.68	1.68	25	10.3	23.8	90.0	4.0	3.6	37.6	245.7	393.4	6.1	14.2	6.13	1.396	1.396	14.390	6.18	1519	0.53						Yes	22.10	5430	3.58	9.0E-16	1 in 1000000	0.04	10	10	0.25	3.86	2.32	1.60	0.105	0.004	0.004	0.113
102	Panel 4	154.4		2.98	1.68	1.68	25	10.2	10.8	90.0	3.9	3.8	46.6	110.5	207.1	6.1	6.4	6.10	1.026	1.026	10.509	7.23	799	0.53						Yes	18.80	2077	2.60	1.1E-09	1 in 1000000	0.04	10	10	0.25	3.86	3.37	1.09	0.153	0.004	0.004	0.160
103	Panel 1	154.4		2.98	1.68	1.68	25	9.5	40.3	90.0	4.1	3.5	35.9	382.4	596.7	5.6	24.0	5.65	1.619	1.530	14.523	6.02	2303	0.51						Yes	21.81	8340	3.62	4.7E-16	1 in 1000000	0.04	10	10	0.25	3.86	2.16	1.99	0.098	0.004	0.004	0.106
104	Panel 1	154.4		2.98	1.68	1.68	25	9.9	39.3	90.0	4.5	3.1	36.2	388.4	609.0	5.9	23.4	5.89	1.598	1.569	15.518	6.05	2351	0.54						Yes	22.73	8830	3.76	6.7E-17	1 in 1000000	0.04	10	10	0.25	3.86	2.19	1.94	0.100	0.004	0.004	0.107
105	Panel 1	154.4		2.98	1.68	1.68	25	10.4	37.8	90.0	4.1	3.6	34.5	393.1	599.9	6.2	22.5	6.19	1.569	1.569	16.306	5.89	2316	0.54						Yes	23.62	9285	4.01	1.7E-18	1 in 1000000	0.04	10	10	0.25	3.86	2.03	1.89	0.092	0.004	0.004	0.100
106	Panel 1	154.4		2.98	1.68	1.68	25	9.7	36.4	90.0	4.1	3.4	35.7	353.6	550.1	5.8	21.7	5.78	1.579	1.526	14.809	6.01	2123	0.52						Yes	22.11	7817	3.68	2.0E-16	1 in 1000000	0.04	10	10	0.25	3.86	2.15	1.91	0.097	0.004	0.004	0.105
107	Panel 1	154.4		2.98	1.68	1.68	25	9.8	38.0	90.0	4.3	3.8	36.6	372.8	587.9	5.8	22.6	5.84	1.589	1.551	15.219	6.09	2269	0.53						Yes	22.47	8377	3.69	1.7E-16	1 in 1000000	0.04	10	10	0.25	3.86	2.23	1.93	0.101	0.004	0.004	0.109
108	Panel 1	154.4		2.98	1.68	1.68	25	18.0	65.8	90.0	5.5	2.2	26.0	1183.6	1598.9	10.7	39.2	10.71	1.571	1.571	28.251	5.21	6172	0.75						Yes	46.21	54687	8.86	8.4E-49	1 in 1000000	0.04	10	10	0.25	3.86	1.35	1.89	0.062	0.004	0.004	0.070
109	Panel 1	154.4		2.98	1.68	1.68	25	17.7	163.8	90.0	6.2	4.1	27.7	2894.6	4004.7	10.5	97.5	10.52	1.805	1.805	31.904	5.34	15458	0.75						Yes	48.23	139598	9.03	7.2E-50	1 in 1000000	0.04	10	10	0.25	3.86	1.48	2.48	0.067	0.006	0.006	0.079
110	Panel 1	154.4		2.98	1.68	1.68	25	15.6	37.3	90.0	6.2	3.6	34.8	580.1	889.9	9.3	22.2	9.26	1.411	1.411	21.959	5.92	3435	0.71						Yes	35.12	20373	5.93	1.7E-30	1 in 1000000	0.04	10	10	0.25	3.86	2.06	1.62	0.094	0.005	0.005	0.103
111	Panel 2	154.4		2.98	1.68	1.68	25	9.5	36.7	90.0	6.8	4.3	47.9	348.4	668.2	5.7	21.8	5.65	1.588	1.506	14.308	7.40	2579	0.59						Yes	21.64	7540	2.92	1.1E-11	1 in 1000000	0.04	10	10	0.25	3.86	3.54	1.92	0.161	0.006	0.006	0.173
112	Panel 2	154.4		2.98	1.68	1.68	25	9.3	40.6	90.0	6.2	4.0	45.5	377.6	692.2	5.5	24.2	5.54	1.627	1.509	14.035	7.08	2672	0.57						Yes	21.37	8067	3.02	2.7E-12	1 in 1000000	0.04	10	10	0.25	3.86	3.22	2.00	0.146	0.006	0.006	0.157
113	Panel 2	154.4		2.98	1.68	1.68	25	8.9	39.2	90.0	7.6	3.6	50.6	348.7	705.9	5.3	23.3	5.30	1.630	1.454	12.938	7.81	2725	0.59						Yes	20.41	7116	2.61	9.5E-10	1 in 1000000	0.04	10	10	0.25	3.86	3.95	2.01	0.180	0.007	0.007	0.193
114	Panel 2	154.4		2.98	1.68	1.68	25	8.8	37.3	90.0	7.8	3.4	51.4	328.3	675.2	5.2	22.2	5.24	1.619	1.432	12.595	7.94	2606	0.59						Yes	20.11	6603	2.53	2.9E-09	1 in 1000000	0.04	10	10	0.25	3.86	4.08	1.98	0.185	0.007	0.007	0.199
115	Panel 2	154.4		2.98	1.68	1.68	25	9.1	36.9	90.0	7.6	3.4	50.1	336.0	672.8	5.4	22.0	5.41	1.605	1.463	13.302	7.73	2597	0.60						Yes	20.73	6966	2.68	3.4E-10	1 in 1000000	0.04	10	10	0.25	3.86	3.87	1.96	0.176	0.006	0.006	0.189
116	Panel 2	154.4		2.98	1.68	1.68	25	9.1	38.1	90.0	7.6	3.4	50.2	346.1	694.7	5.4	22.7	5.41	1.614	1.470	13.368	7.75	2681	0.60						Yes	20.79	7196	2.68	3.4E-10	1 in 1000000	0.04	10	10	0.25	3.86	3.89	1.98	0.176	0.007	0.007	0.190
117	Panel 2	154.4		2.98	1.68	1.68	25	10.1	37.1	90.0	7.1	3.6	46.4	376.0	701.6	6.0	22.1	6.03	1.571	1.571	15.921	7.20	2708	0.61						Yes	23.17	8712	3.22	1.6E-13	1 in 1000000	0.04	10	10	0.25	3.86	3.34	1.89	0.152	0.006	0.006	0.164
118	Panel 2	154.4		2.98	1.68	1.68	25	9.9	42.3	90.0	7.5	3.4	47.3	419.7	795.8	5.9	25.2	5.91	1.620	1.596	15.850	7.32	3072	0.62						Yes	23.00	9653	3.14	4.6E-13	1 in 1000000	0.04	10	10	0.25	3.86	3.46	1.99	0.157	0.006	0.006	0.170
119	Panel 2	154.4		2.98	1.68	1.68	25	9.3	39.0	90.0	8.0	3.3	50.4	364.2	734.6	5.6	23.2	5.56	1.613	1.504	14.053	7.79	2835	0.61						Yes	21.39	7790	2.75	1.3E-10	1 in 1000000	0.04	10	10	0.25	3.86	3.93	1.97	0.178	0.007	0.007	0.192
120	Panel 2	154.4		2.98	1.68	1.68	25	9.1	37.9	90.0	8.3	3.3	51.9	343.1	713.7	5.4	22.5	5.39	1.614	1.465	13.265	8.03	2755	0.61						Yes	20.70	7101	2.58	1.6E-09	1 in 1000000	0.04	10	10	0.25	3.86	4.17	1.98	0.189	0.007	0.007	0.203
121	Panel 2	154.4		2.98	1.68	1.68	25	9.4	37.1	90.0	8.0	3.2	50.1	349.6	700.5	5.6	22.1	5.61	1.595	1.500	14.126	7.74	2704	0.62						Yes	21.47	7506	2.78	8.9E-11	1 in 1000000	0.04	10	10	0.25	3.86	3.88	1.94	0.176	0.007	0.007	0.189
122	Panel 2	154.4		2.98	1.68	1.68	25	9.3	38.1	90.0	7.0	3.3	47.4	354.7	674.2	5.5	22.7	5.55	1.607	1.495	13.932	7.34	2602																							

Table E2: Pillar Stability Analysis (RT293) based on Working Height plus Roof Collapse and RT dimensions

Key to Colour Coding of Width to Height Ratio

9.00	Greater than 8.0
6.00	Between 5.0 and 8.0
4.50	Between 4 and 5
3.00	Between 2 and 4
1.00	Less than 2

Key to Colour Coding of Factors of Safety

1.50	Greater than 3.0
2.40	Between 2.1 and 3.0
2.00	Between 1.8 and 2.1
1.70	Between 1.5 and 1.8
1.20	Less than 1.5



3.332937608
-4.026260869
2.764186777

Project: Proposed Medical Centre
Location: 31 - 33 Smith Street Charlestown
Analysis Assumptions: Pillar dimensions from RT, Pillar Height = Working Section plus roof cc
Project Number: 210780.01
Client: Archadia Project Pty Ltd
Date: 15 June 2022
Sheet: 1
Calculations by: MPG

Indicating Pillar Located within Project Angle of Draw
Indicating Pillar Located beneath development area

Analysis Id.	Comment	Depth D (m)	Panel Width/Span (Longwall only) (m)	Seam Thickness (m)	Working Section H (m)	Pillar Height Section H (m)	Unit Weight γ (kN/m³)	Pillar Width Details			adway Det		Extract Ratio (%)	Pillar Area m²	Total Area m²	w1/ Height Ratio	w2/H Ratio	Width/ Height Ratio	Width Modifier			Pillar Stress (Tributary) (MPa)	Pillar Load (Tributary) MN	Proportion Abutment transfer R	ment Abut (A) Yield (Y) (%)	Abutment Loading Type M,T,G	Shed Load MN	Abutment Load Received MN	Pillar Stress (MPa) ("Yield") % = 0.7	Pillar Stress ("Abut") (MPa)	Squat	Strength (MPa)	Power Law			Probability of Failure NSW Power Formulae	Ecoal GPa	Efloor GPa	Eroof GPa	Poissons Ratio Floor/Roof	Initial Vertical Stress γH MPa	Net Change in Vertical Stress MPa	Settlement Influence Factor	Elastic Compression of Pillar m	Elastic Compression of Roof m	Elastic Compression of Floor m	Total Elastic Compression m
								Pillar Width w1 (m)	Details Length w2 (m)	Internal Angle (°)	b1 (m)	b2 (m)							θ ₀	θ ₁	w9 Effective Width												FOS	Ultimate Load MN													
101	Panel 4	154.4		2.98	1.68	2.43	25	10.3	23.8	90.0	4.0	3.6	37.6	245.7	393.4	4.2	9.8	4.24	1.396	1.148	11.832	6.18	1519	0.53						No	14.38	3533	2.33	5.8E-08	1 in 1000000	0.04	10	10	0.25	3.86	2.32	1.60	0.153	0.004	0.004	0.160	
102	Panel 4	154.4		2.98	1.68	2.43	25	10.2	10.8	90.0	3.9	3.8	46.6	110.5	207.1	4.2	4.4	4.22	1.026	1.010	10.350	7.23	799	0.53						No	13.43	1485	1.86	4.9E-05	1 in 23418	0.04	10	10	0.25	3.86	3.37	1.09	0.222	0.004	0.004	0.229	
103	Panel 1	154.4		2.98	1.68	2.43	25	9.5	40.3	90.0	4.1	3.5	35.9	382.4	596.7	3.9	16.6	3.91	1.619	1.157	10.977	6.02	2303	0.51						No	13.84	5294	2.30	8.6E-08	1 in 1000000	0.04	10	10	0.25	3.86	2.16	1.99	0.142	0.004	0.004	0.150	
104	Panel 1	154.4		2.98	1.68	2.43	25	9.9	39.3	90.0	4.5	3.1	36.2	388.4	609.0	4.1	16.2	4.07	1.598	1.182	11.684	6.05	2351	0.54						No	14.29	5551	2.36	3.5E-08	1 in 1000000	0.04	10	10	0.25	3.86	2.19	1.94	0.144	0.004	0.004	0.152	
105	Panel 1	154.4		2.98	1.68	2.43	25	10.4	37.8	90.0	4.1	3.6	34.5	393.1	599.9	4.3	15.6	4.28	1.569	1.211	12.589	5.89	2316	0.54						No	14.85	5836	2.52	3.5E-09	1 in 1000000	0.04	10	10	0.25	3.86	2.03	1.89	0.133	0.004	0.004	0.141	
106	Panel 1	154.4		2.98	1.68	2.43	25	9.7	36.4	90.0	4.1	3.4	35.7	353.6	550.1	4.0	15.0	3.99	1.579	1.163	11.287	6.01	2123	0.52						No	14.04	4964	2.34	4.9E-08	1 in 1000000	0.04	10	10	0.25	3.86	2.15	1.91	0.141	0.004	0.004	0.148	
107	Panel 1	154.4		2.98	1.68	2.43	25	9.8	38.0	90.0	4.3	3.8	36.6	372.8	587.9	4.0	15.6	4.04	1.589	1.174	11.520	6.09	2269	0.53						No	14.19	5289	2.33	5.4E-08	1 in 1000000	0.04	10	10	0.25	3.86	2.23	1.93	0.146	0.004	0.004	0.154	
108	Panel 1	154.4		2.98	1.68	2.43	25	18.0	65.8	90.0	5.5	2.2	26.0	1183.6	1598.9	7.4	27.1	7.40	1.571	1.571	28.251	5.21	6172	0.75						Yes	24.78	29328	4.75	4.0E-23	1 in 1000000	0.04	10	10	0.25	3.86	1.35	1.89	0.089	0.004	0.004	0.098	
109	Panel 1	154.4		2.98	1.68	2.43	25	17.7	163.8	90.0	6.2	4.1	27.7	2894.6	4004.7	7.3	67.4	7.27	1.805	1.805	31.904	5.34	15458	0.75						Yes	26.11	75569	4.89	5.6E-24	1 in 1000000	0.04	10	10	0.25	3.86	1.48	2.48	0.097	0.006	0.006	0.109	
110	Panel 1	154.4		2.98	1.68	2.43	25	15.6	37.3	90.0	6.2	3.6	34.8	580.1	889.9	6.4	15.3	6.41	1.411	1.411	21.959	5.92	3435	0.71						Yes	20.39	11827	3.44	6.1E-15	1 in 1000000	0.04	10	10	0.25	3.86	2.06	1.62	0.135	0.005	0.005	0.145	
111	Panel 2	154.4		2.98	1.68	2.43	25	9.5	36.7	90.0	6.8	4.3	47.9	348.4	668.2	3.9	15.1	3.91	1.588	1.151	10.931	7.40	2579	0.59						No	13.81	4812	1.87	4.4E-05	1 in 26535	0.04	10	10	0.25	3.86	3.54	1.92	0.233	0.006	0.006	0.245	
112	Panel 2	154.4		2.98	1.68	2.43	25	9.3	40.6	90.0	6.2	4.0	45.5	377.6	692.2	3.8	16.7	3.83	1.627	1.144	10.636	7.08	2672	0.57						No	13.62	5144	1.92	1.9E-05	1 in 65993	0.04	10	10	0.25	3.86	3.22	2.00	0.211	0.006	0.006	0.222	
113	Panel 2	154.4		2.98	1.68	2.43	25	8.9	39.2	90.0	7.6	3.6	50.6	348.7	705.9	3.7	16.1	3.66	1.630	1.114	9.914	7.81	2725	0.59						No	13.14	4583	1.68	6.1E-04	1 in 1900	0.04	10	10	0.25	3.86	3.95	2.01	0.260	0.007	0.007	0.273	
114	Panel 2	154.4		2.98	1.68	2.43	25	8.8	37.3	90.0	7.8	3.4	51.4	328.3	675.2	3.6	15.4	3.62	1.619	1.105	9.717	7.94	2606	0.59						No	13.01	4271	1.64	1.1E-03	1 in 1066	0.04	10	10	0.25	3.86	4.08	1.98	0.268	0.007	0.007	0.281	
115	Panel 2	154.4		2.98	1.68	2.43	25	9.1	36.9	90.0	7.6	3.4	50.1	336.0	672.8	3.7	15.2	3.74	1.605	1.124	10.221	7.73	2597	0.60						No	13.35	4485	1.73	3.2E-04	1 in 3525	0.04	10	10	0.25	3.86	3.87	1.96	0.254	0.006	0.006	0.267	
116	Panel 2	154.4		2.98	1.68	2.43	25	9.1	38.1	90.0	7.6	3.4	50.2	346.1	694.7	3.7	15.7	3.74	1.614	1.126	10.239	7.75	2681	0.60						No	13.36	4625	1.72	3.3E-04	1 in 3420	0.04	10	10	0.25	3.86	3.89	1.98	0.255	0.007	0.007	0.268	
117	Panel 2	154.4		2.98	1.68	2.43	25	10.1	37.1	90.0	7.1	3.6	46.4	376.0	701.6	4.2	15.3	4.17	1.571	1.193	12.090	7.20	2708	0.61						No	14.54	5468	2.02	4.8E-06	1 in 297313	0.04	10	10	0.25	3.86	3.34	1.89	0.220	0.006	0.006	0.232	
118	Panel 2	154.4		2.98	1.68	2.43	25	9.9	42.3	90.0	7.5	3.4	47.3	419.7	795.8	4.1	17.4	4.09	1.620	1.191	11.823	7.32	3072	0.62						No	14.38	6034	1.96	1.1E-05	1 in 12774	0.04	10	10	0.25	3.86	3.46	1.99	0.227	0.006	0.006	0.240	
119	Panel 2	154.4		2.98	1.68	2.43	25	9.3	39.0	90.0	8.0	3.3	50.4	364.2	734.6	3.8	16.0	3.84	1.613	1.144	10.689	7.79	2835	0.61						No	13.66	4973	1.75	2.2E-04	1 in 5159	0.04	10	10	0.25	3.86	3.93	1.97	0.258	0.007	0.007	0.271	
120	Panel 2	154.4		2.98	1.68	2.43	25	9.1	37.9	90.0	8.3	3.3	51.9	343.1	713.7	3.7	15.6	3.73	1.614	1.123	10.171	8.03	2755	0.61						No	13.32	4568	1.66	8.6E-04	1 in 1381	0.04	10	10	0.25	3.86	4.17	1.98	0.274	0.007	0.007	0.288	
121	Panel 2	154.4		2.98	1.68	2.43	25	9.4	37.1	90.0	8.0	3.2	50.1	349.6	700.5	3.9	15.3	3.88	1.595	1.146	10.791	7.74	2704	0.62						No	13.72	4797	1.77	1.6E-04	1 in 6870	0.04	10	10	0.25	3.86	3.88	1.94	0.255	0.007	0.007	0.268	
122	Panel 2	154.4		2.98	1.68	2.43	25	9.3	38.1	90.0	7.0	3.3	47.4	354.7	674.2	3.8	15.7	3.83	1.607	1.141	10.629																										