REPORT TO

**NSW HEALTH INFRASTRUCTURE**

ON

# MINE SUBSIDENCE ASSESSMENT

FOR

**MUSWELLBROOK HOSPITAL REDEVELOPMENT STAGE 3**

AT

**BRENTWOOD STREET, MUSWELLBROOK, NSW**

Date: 13 October 2022
Ref: 34804LFrpt3

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## DOCUMENT REVISION RECORD

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**ATTACHMENTS**

# 1 INTRODUCTION

This report presents the results of a geotechnical mine subsidence assessment for the proposed Muswellbrook Hospital Redevelopment – Stage 3 at Brentwood Street, Muswellbrook, NSW. The location of the site is shown in Figure 1. JK Geotechnics previously prepared a desktop assessment report, Ref: 34804LFrpt, dated 2 May 2022 and a detailed geotechnical investigation report, Ref: 34804LFrpt2 dated 25 August 2022.

We understand from the supplied preliminary architectural drawings prepared by DWP (Project No. 21-0338, Dwg. AR_MW_A1040, Issue A dated 15 July 2022) that it is proposed to demolish the existing Weidman Building and construct a new two storey in-patient unit (IPU). The existing lower ground floor of the Surgery building immediately south of the proposed IPU will undergo alterations and additions, including construction of a slab-on-ground over the existing, currently vacant, lower ground floor. It is understood the new inpatient unit will be constructed at existing grade and therefore minimal excavation or filling is expected to be required. We expect structural loads typical for a structure of this type.

We have been provided a report prepared by Coffey Geotechnics Pty Ltd (Coffey) for the Stage 2 works (Ref: GEOTWARA22658AA-AC dated 17 December 2015) which presents results of cored boreholes. A supplementary mine subsidence investigation report prepared by Coffey was also provided (Ref: GEOTWARA22658AA-AG dated 3 August 2016).

The purpose of the assessment was to review the available geotechnical information on the subsurface conditions, and to use this as a basis for providing comments and recommendations on mine subsidence, including the type of possible mine subsidence and the likelihood and impact of subsidence occurring.

# 2 GEOLOGICAL MODEL

The Geological Map of Singleton indicates the site is located within the Branxton Formation comprising of mudstone, sandstone and conglomerate. The geological maps do not take into consideration past earthworks at the site.

Based on our available information, including relevant boreholes contained in the Coffey report, the subsurface conditions generally comprise of fill overlying residual clay and then sandstone bedrock. No groundwater was encountered during drilling; however it was measured at relatively shallow depths a short time after completion of the investigation. The following provides a summary of the subsurface conditions encountered. Reference should be made to the attached boreholes logs, including the relevant boreholes logs by Coffey in Appendix A.

Pavement and fill were encountered extending to depths ranging from 0.6m to 9.5m below existing surface levels. The level of the surface of the rock ranged from RL174.2m to RL181.1m indicating that whilst bedrock is generally grading down from the south-east there seems to be a gentle ridge line, albeit highly weathered, in proximity to BH3 and BH15-3.

Generally, the upper bedrock comprised extremely weathered siltstone and sandstone, that graded into very low to low strength sandstone. Siltstone of very low to low strength was then encountered at depths between 8.0m and 11.2m within BH1, BH2, BH3, BH5 and BH6. The sandstone and siltstone bedrock also contained occasional bands of very high strength bedrock typically less than 300mm thick. Based on the deep boreholes previously drilled by Coffey, the following table provides a summary of the geological units encountered.

| Geological Unit | Depth to base of unit at BH16-01 (m) | Depth to base of unit at BH16-03 (m) | Distance of nearest mining (m) | Drawing of coal seam workings | Other remarks |
|---|---|---|---|---|---|
| Interbedded and interlaminated claystones, siltstones, sandstone and minor coal | 90.5 | 90.7 | N/A | N/A | N/A |
| Greta Seam | 95.4 | 94 | Greater than 160m to north east | Drawing 2 | Room and pillar mining |
| Siltstone | 99.7 | 97.8 | N/A | N/A | N/A |
| Top Seam | 102.4 | 101.6 | 150m to north | Drawing 3 | Room and pillar mining |
| Interlaminated siltstone and sandstone with minor coal | 107.9 | 106.8 | N/A | N/A | N/A |
| No. 2 Seam referred to as Fleming Seam on RT and St Heliers Seam on MSB records | ~115.55 | 113.8 | Mined seam under the site BH16-01 from 112.0m to 115.3 and BH16-03 from 110.8m to 113.1m. | Drawing 4 and Drawing 6 | Room and pillar mining |
| Interlaminated siltstone and sandstone | Limit of investigation | 116.5 | N/A | N/A | N/A |
| No. 3 Seam | - | 120.0 | Greater than 210m east north east | Drawing 7 | Room and pillar mining |
| Interlaminated siltstone and sandstone | - | >124.8 | N/A | N/A | N/A |

Groundwater seepage was encountered during auger drilling in BH2 and BH4 at 5.5m and 4.8m depth, respectively. No groundwater seepage was encountered in the remaining boreholes during auger drilling. The following groundwater measurements were taken by JK Environments on 1 July 2022 within the standpipes installed in the boreholes:

| Borehole | Standing Water Level Depth (m) | Standing Water Level (mAHD) |
|---|---|---|
| 1 | 2.84 | 176.3 |
| 5 | 1.80 | 182.9 |
| 6 | 2.07 | 177.4 |

The groundwater monitoring indicates a groundwater gradient towards the west. The groundwater surface was within the weathered bedrock in BH1 and within the soils in BH5 and BH6. The presence of groundwater was further confirmed by the deep boreholes drilled by Coffey with groundwater level measured at 16.0m and 15.1m depth in BH16-01 and BH16-03, respectively.

# 3 SUBSIDENCE RISK ASSESSMENT

## 3.1 Introduction

The site has been identified to be within the Muswellbrook mine subsidence district as a result of historical underground mining operations. The NSW Government Subsidence Advisory (SA NSW) (formerly Mine Subsidence Board) provide general advice on designing for different subsidence parameters, such as vertical settlements, horizontal strain, tilt, etc. In this instance, Guideline 2 applies to the local area for potential subsidence risk of non-active mine workings, where the risk of damage due to trough subsidence applies. We note however that given the Guideline does not address a development of this type, the development will need to be assessed by SA NSW risk engineers on merit. To assist with such assessment we have carried out a risk assessment and calculations of parameters for structural design. We have made reference to the document provided by Subsidence Advisory NSW "*Development Application – Merit Assessment Policy",* Version 1 dated 25 May 2018.

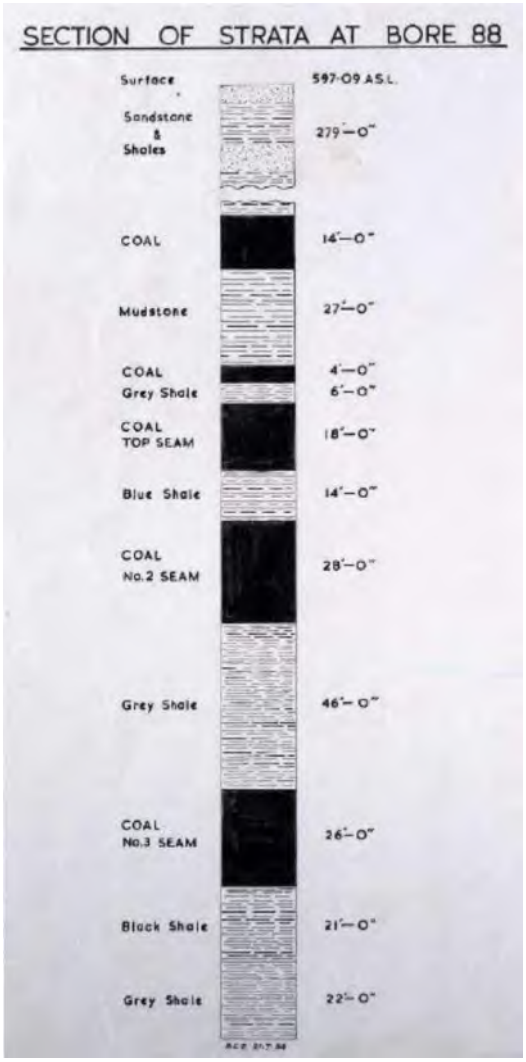
## 3.2 Factual Information on Workings

The site is underlain by abandoned coal mine workings in the No. 2 (St Heliers) Seam of the Muswellbrook Colliery at a depth of about 112m. Mining was performed in the late 1950's and early 1960's using room and pillar methods. In 2016, at the request of SA NSW, Coffey Geotechnics undertook further investigations as part of the Stage 2 development of the Hospital comprising two deep boreholes drilled by non-core methods into the mine workings with one coring the immediate 12m of roof rock. The borehole locations were strategically chosen at the intersection of two headings. After drilling the boreholes, an acoustic televiewer (ATV) was used to confirm conditions encountered during drilling, where notes on the open hole drilling logs are based on ATV footage. Given the close proximity of these deep boreholes to the current development and that they have been drilled within the same mine working present below the current Stage 3 development, we consider these boreholes to be representative of the mine workings relevant to Stage 3. Reference should be made to Appendix A which contains the Coffey borehole logs and ATV results.

As discussed in Section 2, the geological map indicates the geology below the site belongs to the Branxton Formation comprising mudstone, sandstone and conglomerate. The Branxton Formation overlies the Greta Coal Seam, which we understand outcrops under the eastern portion of the Muswellbrook Hospital complex. Based on a historical borehole, Bore 88 as shown below, a number of coal seams have been identified comprising:

- Greta Coal Seam

- Top Seam (Muswellbrook) Rowan Formation
- No. 2 Seam (Fleming and St Heliers) Rowan Formation
- No. 3 Seam (Lewis) Skeletar Formation




Based on historical records and confirmed by the deep boreholes/ATV by Coffey, only No.2 Seam has been mined below the site, with the other seams being mined beyond the site and therefore not relevant to consideration of subsidence issues, i.e. only a single seam was worked. The extent of mine workings of this seam are shown on the attached Figure 5 based on historical plans.

The deep boreholes by Coffey encountered void heights, i.e. pillar height, of 3.3m and 2.3m in BH16-01 and BH16-03, respectively. The coal cored above the void in BH-16-01 was determined to be relatively dull and free from face cleats indicating a high silt percentage and therefore unlikely to have been mined elsewhere in the area indicating the void heights are representative of the heights in the general area. Furthermore, since completion of mining, the workings have been allowed to fill with water with the stationary water height in the boreholes determined to be at depths of 16.0m and 15.1m for BH16-01 and BH16-03, respectively.

Based on the Coffey report, we understand that the immediate roof of the workings comprises approximately 4m of coal in both boreholes. The core sample of this coal in BH16-01 was relatively dull with a Point Load Strength Index, $I_{S50}$, between 0.3MPa and 1.6MPa equating to an Unconfined Compressive Strength (UCS) between 6MPa and 30MPa. Unfortunately the Coffey boreholes were unsuccessful in coring the floor of the workings however based on the downhole investigation, the density of the floor appears to increase, at least in BH16-03. The bedding planes indicate a dip typically between 2° and 7°.

Lastly, as part of the investigations by JK Geotechnics, a walkover of the site was undertaken. No ground surface observations indicated the presence of mine subsidence within the site and adjoining areas.

## 3.3 Likelihood of Mine Subsidence

### 3.3.1 Pillar Factor of Safety

The stability of selected pillars was assessed using rectangular pillar theories incorporated in the modified UNSW Power Law as presented in Galvin et al (1998) to estimate the Factor of Safety (FOS) of pillars and estimate the likelihood of subsidence occurring, at the locations shown on the attached Figure 5. A credible subsidence profile was then determined based on the collapse of a panel of workings developed from the theory of long wall mining for larger panel crushes and adapted to room and pillar methods.

To assess the current stability of the pillars and determine the likelihood of a pillar failure occurring, an assessment of the pillar Factor of Safety has been carried out. The FOS of an individual pillar is the ratio of pillar strength to pillar load. In Australia, the most common method to assess coal pillars in the UNSW Pillar Design method (Galvin et al 1998). It must be noted that the method requires simplifications and therefore has limitations, particularly as the approach is based on semi-empirical relationships derived from a database of failed and un-failed pillars. The method is only valid where roof and floor conditions are stable and where full pillar yield does not exist which appears to be the case of the No. 2 Seam present below the site. Furthermore, we consider these conditions are unlikely to change, such as the pillar geometry, given the age of the workings and that the bedrock forming the overburden predominantly comprises medium to high strength bedrock.

The strength of the pillars can be estimated by the following:

$$S_p = 8.6\ x\ \frac{w^{0.51}}{h^{0.84}}\ (in\ MPa)$$

Where: w is the pillar width (m) and h is the pillar height (m)

The load applied to the coal pillars is obtained by the weight of the overburden layers within the tributary area expressed as a vertical pressure applied to the top of the pillar. The tributary area is taken as the area extending midway along the bords and cuts through surrounding pillars. It must be acknowledged that only so much information can be obtained on the mine workings and therefore it is critical for a number of

sensitivity cases to be analyses to encompass the risk assessment of the workings. Consequently, on the basis of the information obtained from the deep boreholes, the following has been assessed:

- Three pillar heights have been considered; the lower and upper bound actual heights of 2.3m and 3.3 based on BH16-03 and BH16-01, respectively, and a third upper bound theoretical height of 3.8m which comprises an increased height of 0.5m on the upper bound actual height.
- For the pillar plan dimensions we have adopted the actual dimensions as shown, as well as a dimension 0.5m less to assess potential robbing of the pillars.
- We have considered a total of nine pillars as shown on the attached Figure 5 which are considered to be the pillars most critical to the Stage 3 development.
- For the overburden pressure, we have adopted two states consisting of a 'dry' state which would be equivalent to the state during mining and a second 'flooded' state representing current conditions.

The above cases are considered to encompass the likely conditions of the mine workings. The results of the assessment are presented in the attached Table 1 '*Summary of Pillar Stability Calculations and Factor of Safety'*.

The following summarises the results of the FOS assessment:

- The condition most appropriate for current conditions is the case where the pillar height is 3.3m and 'flooded', although for the longer term consideration could also be given to where the pillars have been robbed by 0.5m. As such, the FOS varied between 2.3 and 4.7, however an average FOS of 3.5 was achieved for all the pillars, even when including a 0.5m reduction in the pillar dimensions.
- Where the pillar height is theoretically increased to 3.8m (an additional 0.5m height), the average FOS is 3.1.

### 3.3.2 Likelihood of Pillar Failure

The pillars present below the Stage 3 development are relatively orthogonal, however the tributary loading should still be considered an estimate only. Given the assumptions and estimations, an assessment on the likelihood of failure is difficult. However, Galvin (1998) provides guidance whereby an average FOS of 3.6 for the likely pillar case results in an estimated likelihood of failure is less than 1:1,000,000 which would be considered to be 'Barely Credible' and therefore 'Acceptable' in accordance with the Australian Geomechanics Society (AGS 2007c) '*Practice Note Guidelines for Landslide Risk Management'* which provides guidelines for risk assessment, that we consider applicable to also assessing the risk of failure of the mine workings. Whilst the likelihood is barely credible, it is still prudent to design the proposed structure to withstand potential mine subsidence if a pillar or panel failure were to occur forming a subsidence trough. Furthermore, based on the pillar tributary areas and the UCS of the bedrock, we do not consider pillar foundation failure will occur.

Given the above and the available information, including the two nearby deep boreholes, we do not consider further geotechnical investigations are warranted.

## 3.4 Consequence of Subsidence

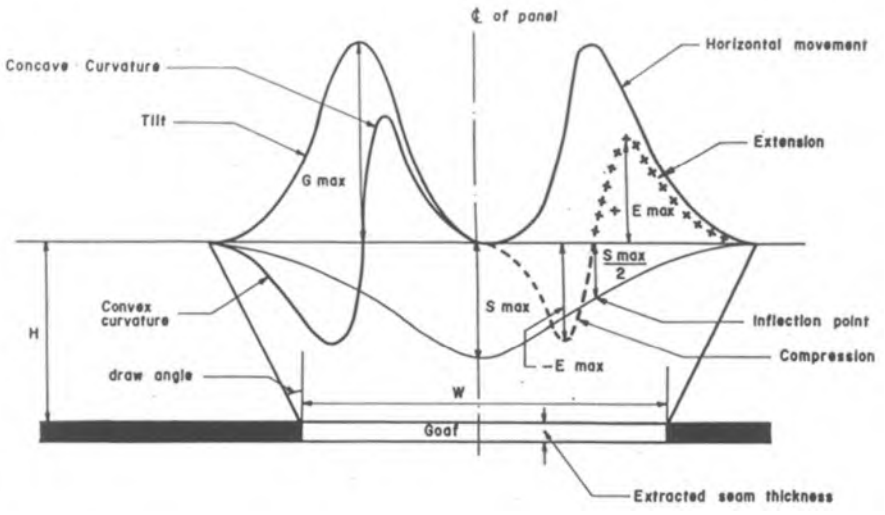
### 3.4.1 Estimated Trough Subsidence

The potential subsidence trough has been estimated based upon empirical charts developed by L. Holla (1987) presented in '*Surface Subsidence Prediction in the Newcastle Coalfield'* for estimating subsidence over longwall panels. It must be noted that the mine workings below our site comprise pillar and panel methods and therefore in the subsidence estimation the ratio of pillars to mine area has been considered.

Whilst the FOS assessment essentially determined that a failure is considered to be a rare event, in order to assess the subsidence parameters for the site, an assumed failed panel of workings and trough subsidence profile has been adopted. The failed panel of works was on the assumption that pillars with width to height ratios of less than 8 would fail. We considered two potential failed panel workings of approximately 74m and 85m in width, which results in width to depth ratios of 0.66 and 0.76, respectively. Strains and tilt are directly proportional to the maximum subsidence and inversely proportional to the cover depth, where the appropriate constants of proportionality are obtained from Figures 10, 11 and 13 in Holla (1987). Based on the assessment, we estimate the following parameters:

- Maximum subsidence of 150mm.
- Maximum tensile strain of 1.2mm/m.
- Maximum compressive strain of 3.1mm/m.
- Maximum tilt of 2.9mm/m.
- Minimum radius of curvature of 4km.

The following image of the trough subsidence characteristics is taken from Figure 6 of Holla (1987), where the left half of the profile are the vertical components and the right half of the profile the horizontal components:




From the above image, the following can be understood:

- The maximum tilt will occur at the boundary between the tensile and compressive strains.

- At the inflection point between the maximum tensile and compressive strains, the subsidence will be approximately half the maximum subsidence. The position of the inflection point is determined from Figure 12 of Holla (1987) and is estimated at about 17m from centre of panel.
- The subsidence will be reduced at the point at which the maximum tensile and compressive strains occur however is difficult to quantify with any confidence.
- The above is an idealisation only and in reality subsidence profiles will form different shapes depending on the failure mechanism, the type of mine workings, the presence of faults, dykes, etc.

Based on our discussions with TTW, we understand the anticipated nature and extent of damage to the proposed development comprises of extensive cracking, however the structure would remain operational.

### 3.4.2 Uncertainty Assessment

The uncertainty factor is used by SA NSW to determine the levels of conservatism and the allowed assumptions required when assessing the likelihood of a trough subsidence event. The Uncertainty Factor (UF) is calculated using the following equation:

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

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 main plans and records (R3)
- Method used to assess stability and impact (R4).

The uncertainty value (U) applied to each of the above are 1, 2 and 3 for low, moderate and high uncertainty respectively, with reference to table C2 of the SA NSW document. The following summarises the determination of the Uncertainty Factor

| Category | Weighting | Uncertainty Value (U) | Result (R) |
|---|---|---|---|
| Geological environment (R1) | 2 | 1 | 2 |
| Level of geotechnical investigation (R2) | 2 | 1 | 2 |
| Type of coal main plans and records (R3) | 3 | 2 | 6 |
| Method used to assess stability and impact (R4) | 3 | 2 | 6 |
| | | **Uncertainty Factor (UF)** | **6** |

The justification for the adopted uncertainty values are as follows:

- Geological environment (R1) – Uncertainty Value 1 (Low Uncertainty): A review of available mine plans and records indicated adverse geological structures are likely not present which upon review of the deep cored boreholes also indicates that this is the case given only sub-horizontal bedding planes and inclined jointing was encountered. Furthermore, the cored boreholes indicate that the seam dip is less than 10°.
- Level of geotechnical investigation (R2) – Uncertainty Value 1 (Low Uncertainty): Two cored boreholes have been drilled that adequately assess the mine workings, such as depth of workings, void heights, material properties, etc.
- Type of coal main plans and records (R3) – Uncertainty Value 2 (Medium Uncertainty): There are minimal post-mining geotechnical boreholes in the area however the mining is in a regular layout and the cored boreholes provide sufficient information to confirm the accuracy.
- Method used to assess stability and impact (R4) – Uncertainty Value 2 (Moderate Uncertainty): A single method has been used to assess stability of pillars, however credible worst-case assumptions have also been made incorporating different scenarios such as robbing of the pillars by 0.5m and increased pillar height of 0.5m. All variables and assumptions have been stated allowing for the pillar stability and subsidence impact assessment to be replicated.

Based on the above table and equation, the Uncertainty Factor (UF) is determined to equal 6.

### 3.5 Estimated Conditions of Approval for Trough Subsidence Risk

Based on the above, the mine subsidence assessment results in the following:

- A Moderate Uncertainty given the Uncertainty Factor greater than 5 but less than 10.
- A Factor of Safety greater than 2.1 given the minimum and average FOS achieved was 2.3 and 3.5, respectively, for the likely pillar case in current and future conditions.
- A width to height ratio greater than 4 for the pillars given the pillar heights between 2.3m and 3.3m and pillar widths between 13.1m and 22.1m resulting in a width to height ratio between approximately 4.0 and 9.6. We note for the assessed pillars, the average width to height ratio achieved is 4.8 and 6.9 for pillar heights of 2.3m and 3.3m, respectively (including robbing of pillars by 0.5m).

We note that in our assessment we:

- Assessed the potential for roof failure and determined that it is unlikely given the rock strength present in the roof.
- In our assessment of the pillar dimensions and factor of safety calculations considered a reduction of 0.5m of the pillar dimensions.
- Assessed the potential for pillar foundation failure and considered it unlikely given the rock strength.

- Considered absolute worst case subsidence impact parameters given that we considered a pillar run failure resulting in a failed panel workings of approximately 74m and 85m in width.

As such, in accordance with Table C3 of the SA NSW document, we consider the following are the likely general approval conditions for the site:

1. Provide a peer review of the initial geotechnical report by a consultant acceptable to SA NSW with confirmation and sign-off 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 scenario subsidence impact (i.e. 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 SA NSW.
4. Following construction, signoff from qualified engineer that improvements have been constructed in accordance with plans and in accordance with all relevant building codes and standards.

To reduce the uncertainty for R4 used in the Uncertainty Factor calculation, consideration could be given to undertaking a peer review of the mine subsidence assessment which would allow for Low Uncertainty to be adopted

### 3.6 Design Comments

In mine subsidence areas it is important for structures to be designed as “flexible” to accommodate the potential differential settlements that may occur as a result of trough subsidence. Typically the most effective design will minimise the magnitude of the horizontal forces and the eccentricity of those forces on the building. This could be achieved by:

- Reducing the magnitude of the passive earth pressures acting on the building by allowing elements in the ground to move with the ground or by allowing the ground to move relative to elements in the ground without developing significant passive forces. For suspended slabs on piles, this could be achieved by sliding joints at the top of piles. For slab-on-ground, this could be achieved by the presence of a sliding layer below the slab and a stepped control joint.
- Minimising the frictional forces between the ground (or elements in the ground) and the structure by either a provision of a sliding layer between the building and the ground/elements in the ground or dividing the building into sections and thereby reducing the overall weight of each section and hence the frictional forces.
- Allowance could be made to relevel floors by slab jacking or relevelling pours.

Notwithstanding all of the above, we recommend the above assessment is reviewed and the subsidence parameters confirmed to be appropriate by SA NSW.

## 4 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the design and construction phases of the project. In the event that any of the recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

**Table 1: Summary of Pillar Stability Calculations and Factor of Safety**

| Pillar | Width (m) | Length (m) | Scaled Tributary Width (m) | Tributary Length (m) | Factor of Safety | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Height** | | | | | 2.3 | | 3.3 | | 3.8 | |
| **State** | | | | | Dry | Flooded | Dry | Flooded | Dry | Flooded |
| **Pillar 1** | 13.5 | 45.7 | 19.1 | 51.5 | 3.7 | 4.5 | 2.7 | **3.3** | 2.4 | 2.9 |
| | 13.0 | | | | 3.5 | 4.3 | 2.6 | 3.1 | 2.3 | 2.8 |
| **Pillar 2** | 16.0 | 41.4 | 21.7 | 48.2 | 4.1 | 5.0 | 3.0 | **3.7** | 2.7 | 3.2 |
| | 15.5 | | | | 3.9 | 4.7 | 2.9 | 3.5 | 2.5 | 3.1 |
| **Pillar 3** | 13.1 | 36.9 | 19.1 | 42.4 | 3.5 | 4.2 | 2.6 | **3.1** | 2.3 | 2.8 |
| | 12.6 | | | | 3.3 | 4.0 | 2.4 | 2.9 | 2.1 | 2.6 |
| **Pillar 4** | 13.8 | 27.7 | 19.6 | 33.5 | 3.5 | 4.2 | 2.6 | **3.1** | 2.3 | 2.8 |
| | 13.3 | | | | 3.3 | 4.0 | 2.4 | 2.9 | 2.1 | 2.6 |
| **Pillar 5** | 13.6 | 25.5 | 19.3 | 31.0 | 3.4 | 4.2 | 2.5 | **3.1** | 2.2 | 2.7 |
| | 13.1 | | | | 3.2 | 3.9 | 2.4 | 2.9 | 2.1 | 2.6 |
| **Pillar 6** | 13.9 | 20.2 | 19.7 | 26.1 | 3.3 | 4.0 | 2.4 | **2.9** | 2.1 | 2.6 |
| | 13.4 | | | | 3.1 | 3.8 | 2.3 | 2.8 | 2.0 | 2.4 |
| **Pillar 7** | 18.8 | 24.3 | 25.1 | 29.8 | 4.3 | 5.2 | 3.2 | **3.8** | 2.8 | 3.4 |
| | 18.3 | | | | 4.1 | 5.0 | 3.0 | 3.7 | 2.7 | 3.3 |
| **Pillar 8** | 22.1 | 33.6 | 27.4 | 39.4 | 5.3 | 6.4 | 3.9 | **4.7** | 3.4 | 4.2 |
| | 21.6 | | | | 5.1 | 6.2 | 3.7 | 4.5 | 3.3 | 4.0 |
| **Pillar 9** | 19.6 | 37.9 | 25.1 | 43.8 | 4.8 | 5.9 | 3.6 | **4.3** | 3.2 | 3.8 |
| | 19.1 | | | | 4.7 | 5.7 | 3.4 | 4.2 | 3.0 | 3.7 |

JKGeotechnics

# BOREHOLE LOG

**Borehole No.** 1



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 179.11 m

**Date:** 28/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | | 179 | | | | FILL: Silty sandy clay, low plasticity, dark grey, fine to medium grained sand, trace of root fibres and fine to medium grained, angular ironstone gravel. | w~PL | | | GRASS COVER<br>APPEARS MODERATELY COMPACTED |
| | | | | | N = 9<br>4,5,4 | | | | | FILL: Silty clay, high plasticity, dark brown, trace of fine to medium grained, sub-angular ironstone gravel. | w>PL | | | |
| | | | | | | 178 | 1 | | CH | Silty CLAY: high plasticity, brown, trace of fine to medium grained, sub-angular ironstone gravel. | w>PL | VSt - Hd | 290<br>300<br>290<br>>600<br>>600 | RESIDUAL |
| | | | | | N > 7<br>9,7/ 50mm<br>REFUSAL | 177 | 2 | | - | Extremely Weathered sandstone: silty SAND, fine to medium grained, brown and orange brown, trace of fine to medium grained ironstone gravel and clay. | XW | (D) | >600 | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | | | | | Extremely Weathered sandstone: silty sandy CLAY, low plasticity, light grey and grey, fine to medium grained sand. | | Hd | | |
| | | | | | N=SPT<br>4/ 50mm<br>REFUSAL | 176 | 3 | | | SANDSTONE: fine to coarse grained, brown. | DW | VL - L | | BRANXTON FORMATION<br>LOW TO MODERATE RESISTANCE |
| | | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | GROUNDWATER MONITORING WELL INSTALLED TO 8.0m. CLASS 18 MACHINE SLOTTED / HAND SLOTTED 50mm DIA. PVC STANDPIPE 8.0m TO 2.0m. CASING 2.0m TO 0m. 2mm SAND FILTER PACK 14.47m TO 0.4m. BENTONITE SEAL 0.4m TO 0m. BACKFILLED WITH SAND (AND/OR CUTTINGS) TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER. |
| | | | | | | 175 | 4 | | | | | | | |
| | | | | | | 174 | 5 | | | | | | | |
| | | | | | | 173 | 6 | | | | | | | |

JKGeotechnics

# CORED BOREHOLE LOG

**Borehole No.** 1 **2 / 3**

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Core Size:** NMLC **R.L. Surface:** 179.11 m

**Date:** 28/6/22 **Inclination:** VERTICAL **Datum:** AHD

**Plant Type:** JK400 **Bearing:** N/A **Logged/Checked By:** J.F./B.Z.

| Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ | DEFECT DETAILS: SPACING (mm) | DEFECT DETAILS: DESCRIPTION (Specific / General) | Formation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 177 | 3 | | START CORING AT 3.10m | | | | | | |
| | | 176 | | | NO CORE 0.29m | | | | | | |
| | | | 4 | | SANDSTONE: fine to coarse grained, orange brown and grey, with fine to medium grained, sub-angular and sub-rounded igneous and ironstone gravel, occasional fine grained, grey brown, high strength sandstone and light grey quartz bands, sub-horizontally bedded. | MW | VL - L | 0.090<br>0.60 | | (3.39m) CS, 0°, 40 mm.t<br>(3.54m) Cr, 0°, 80 mm.t<br>(3.82m) Be, 0°, P, R, Clay Ct<br>(3.86m) Be, 5°, P, R, Clay Vn | Branxton Formation |
| | | 175 | | | | | | | | (4.22m) Jh, 30° | |
| | | | | | | | | 8.4 | | (4.61m) Be, 15°, P, R, Fe Vn | |
| | | 174 | 5 | | | | | | | (5.13m) Be, 15°, C, R, Fe Vn<br>(5.24m) Be, 5°, P, R, Clay Vn<br>(5.35m) Be, 5°, P, R, Clay Vn | |
| | | | | | | | VH | 11 | 60 20 | (5.44m) Jh, 60° | |
| 95% RETURN | | | | | NO CORE 0.06m | | | | | | |
| | | | 6 | | SANDSTONE: fine to coarse grained, orange brown and light grey, with fine grained igneous clasts and high strength sandstone bands, sub-horizontally bedded. | DW | VL - L | 0.20 | | (6.33m) Be, 5°, P, R, Clay Vn<br>(6.44m) Be, 5°, P, R, Clay Vn<br>(6.49m) XWS, 0°, 110 mm.t | Branxton Formation |
| | | 173 | | | | | | 0.10 | | (6.68m) XWS, 0°, 170 mm.t | |
| | | 172 | 7 | | | | | 5.8 | | (7.20m) J, 35°, P, R, Clay Vn | |
| | | | | | | | | | | (7.75m) DRILLING INDUCED | |
| | | | | | NO CORE 0.08m | | | | | | |
| | | | 8 | | SANDSTONE: fine to coarse grained, orange brown and light greym with fine grained igneous clasts and high strength sandstone bands, sub-horizontally bedded. | HW | VL | 0.080<br>1.2 | | (8.13m) Be, 5°, Ir, R, Clay Ct<br>(8.29m) Cr, 0°, 40 mm.t | Branxton Formation |
| | | 171 | | | | | | 0.070 | 60 20 | (8.62m) Cr, 0°, 40 mm.t<br>(8.69m) Jh, 90°<br>(8.71m) Jh, 90°<br>(8.82m) Cr, 30°, 20 mm.t<br>(8.89m) J, 75°, P, R, Clay Vn | |





FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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# CORED BOREHOLE LOG

**Borehole No.** 1



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Core Size:** NMLC **R.L. Surface:** 179.11 m

**Date:** 28/6/22 **Inclination:** VERTICAL **Datum:** AHD

**Plant Type:** JK400 **Bearing:** N/A **Logged/Checked By:** J.F./B.Z.

| Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ | DEFECT DETAILS: SPACING (mm) | DEFECT DETAILS: DESCRIPTION (Specific / General) | Formation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% RETURN | | 170 | | | | | | | | (8.92m) J, 65°, Ir, R, Clay Vn<br>(9.08m) Cr, 0°, 50 mm.t<br>(9.18m) DRILLING INDUCED | |
| | | | | | NO CORE 0.08m | HW | VL | | | | |
| | | | | | SANDSTONE: fine to coarse grained, orange brown and light greym with fine grained igneous clasts and high strength sandstone bands, sub-horizontally bedded. | DW | VL - L | 0.20 | | (9.37m) Be, 5°, P, R, Cn<br>(9.42m) Be, 0°, P, R, Clay Vn | |
| | | | | | | | | 2.1 | | (9.65m) Be, 15°, P, R, Clay Vn<br>(9.67m) Be, 10°, Ir, R, Cn | |
| | | | | | | | | | | (9.85m) Be, 5°, P, R, Clay Vn | |
| | | 169 | 10 | | SILTSTONE: dark grey, with sub-horizontal grey laminar, trace of sub-angular and sub-rounded igneous gravel, occasional fine grained, grey, high strength bands, sub-horizontally bedded. | | | 0.10 | | | Branxton Formation |
| | | | | | | | | 0.10 | | | |
| | | 168 | 11 | | | | | 0.20 | | | |
| | | | | | | | | | | (11.55m) XWS, 0°, 10 mm.t | |
| | | | | | | | | 0.10 | | | |
| | | 167 | 12 | | | | | | | (11.92m) Be, 5°, P, R, Clay Vn<br>(12.11m) Be, 5°, P, R, Clay Vn<br>(12.22m) Be, 5°, P, R, Clay Vn<br>(12.30m) Be, 5°, P, R, Clay Vn | |
| | | | | | | | | 0.20 | | | |
| | | | | | | | | 0.10 | | | |
| | | | | | NO CORE 0.06m | DW | VL - L | | | | |
| | | 166 | 13 | | SILTSTONE: dark grey, with sub-horizontal grey laminar, trace of fine to coarse grained, sub-angular igneous gravel, sub-horiztonally bedded. | | | 0.20 | | (13.07m) Be, 5°, P, R, Clay Vn<br>(13.18m) Cr, 0°, 50 mm.t | Branxton Formation |
| | | | | | END OF BOREHOLE AT 13.41 m | | | | | | |
| | | 165 | 14 | | | | | | | | |
| | | 164 | 15 | | | | | | | | |





FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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Job No: 34804LF
Borehole No: 1
Depth: 3.10 - 13.47m


34804LF BH1 START CORING AT 3.10m

3 → NO CORE : 0.29m

4

5 NO CORE 0.06m

6

7 NO CORE: 0.08m

8

9 NO CORE: 0.08m

10

11

12 NO CORE 0.06m

13 EOH AT 13.47m

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# BOREHOLE LOG

**Borehole No.** 2

1 / 2

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 181.02 m

**Date:** 30/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | FILL: Silty sandy clay, low plasticity, dark brown, trace of root fibres. | w<PL | | | GRASS COVER |
| | | | | | | | | | CH | Silty CLAY: high plasticity, brown, trace of fine grained ironstone gravel, and fine to coarse grained sand. | w>PL | VSt | 300<br>310<br>320 | RESIDUAL |
| | | | | | | 180 | 1 | | | as above,<br>but with fine grained, sub-angular ironstone gravel and fine to medium grained sand. | | | 290<br>270<br>300 | |
| | | | | | N = 15<br>3,6,9 | | | | | | | Hd | 570<br>560<br>550 | |
| | | | | | | 179 | 2 | | | | | | | |
| | | | | | | | | | SC | Silty Clayey SAND: fine to medium grained, light grey and brown, low plasticity clay and occasional ironstone bands. | M | D | | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | N=SPT<br>12/ 150mm<br>REFUSAL | 178 | 3 | | | as above,<br>but brown. | | | | |
| | | | | | | 177 | 4 | | | | | | | |
| | | | | | | 176 | 5 | | CI | Silty CLAY: medium plasticity, brown, trace of fine to medium grained sand. | w<PL | (Hd) | | |
| | | | | | | 175 | 6 | | | | | | | |
| ▽ | | | | | | | | | - | Extremely Weathered sandstone: silty CLAY, medium plasticity, light brown, with low strength bands. | XW | (Hd) | | VERY LOW 'TC' BIT RESISTANCE |

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# BOREHOLE LOG

**Borehole No.** 2



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 181.02 m

**Date:** 30/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 173 | 8 | | - | Extremely Weathered sandstone: silty CLAY, medium plasticity, light brown, with low strength bands. *(continued)* | XW | (Hd) | | BRANXTON FORMATION |
| | | | | | | 172 | 9 | | | | | | | |
| | | | | | | 171 | 10 | | | as above, but with distinctly weathered bands. | DW - XW | (L - Hd) | | LOW TO MODERATE RESISTANCE |
| | | | | | | 170 | 11 | | - | SILTSTONE: dark grey, trace of fine to medium grained, sub-angular igneous clasts. | DW | (VL - L) | | LOW RESISTANCE WITH MODERATE BANDS |
| | | | | | | 169 | 12 | | | | | | | |
| | | | | | | 168 | 13 | | | END OF BOREHOLE AT 13.00 m | | | | |

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# BOREHOLE LOG

**Borehole No.** 3



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 181.69 m

**Date:** 29/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | FILL: Silty sandy clay, low plasticity, dark grey brown, trace of root fibres. | w>PL | | | GRASS COVER |
| | | | | | | | | | CH | Silty CLAY: high plasticity, brown, with fine to medium grained sand, trace of fine to medium grained, sub-angular ironstone gravel and weakly cemented sand nodules. | w>PL | (VSt) | | RESIDUAL |
| | | | | | N = 20 3,8,12 | 181 | 1 | | - | Extremely Weathered sandstone: silty sandy CLAY, medium plasticity, light brown, fine to medium grained sand, with high strength igneous and ironstone bands and weakly cemented sand nodules. | XW | Hd | 560 570 550 | BRANXTON FORMATION |
| | | | | | | | | | | Extremely Weathered sandstone: silty clayey SAND, fine to medium grained, brown, low plasticity, clay and silt, with fine to medium grained, sub-angular ironstone gravel. | | D | | LOW 'TC' BIT RESISTANCE |
| | | | | | N=SPT 11/ 150mm REFUSAL | 180 | 2 | | | | | | | |
| | | | | | | 179 | 3 | | | | | | | |
| | | | | | | 178 | 4 | | | as above, but occasional ironstone bands. | | | | LOW TO MODERATE RESISTANCE<br>3.7m DRILLER ADDED WATER<br>LOW RESISTANCE |
| | | | | | | 177 | 5 | | | SANDSTONE: fine to coarse grained, brown, trace of high strength igneous and ironstone bands. | | (Hd) | | |
| | | | | | | 176 | 6 | | | | HW | VL | | LOW RESISTANCE WITH MODERATE RESISTANCE BANDS |
| | | | | | | 175 | | | | | | | | |

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# BOREHOLE LOG

**Borehole No.** 3 **2 / 2**

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 181.69 m

**Date:** 29/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ■ | | 174 | 8 | | - | SANDSTONE: fine to coarse grained, brown, trace of high strength igneous and ironstone bands. *(continued)* | HW | VL | | MODERATE RESISTANCE |
| | | | | ■ | | 173 | 9 | | - | SILTSTONE: dark grey, trace of medium to high strength igneous and ironstone bands. | HW | VL | | |
| | | | | ■ | | 172 | 10 | | | | | | | |
| | | | | | | 171 | 11 | | | END OF BOREHOLE AT 11.00 m | | | | |
| | | | | | | 170 | 12 | | | | | | | |
| | | | | | | 169 | 13 | | | | | | | |
| | | | | | | 168 | | | | | | | | |

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# BOREHOLE LOG

**Borehole No.** 4 1 / 2

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 183.93 m

**Date:** 29/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | CONCRETE: 80mm.t | | | | NO REINFORCEMENT OBSERVED |
| | | | | | | | | | - | FILL: Silty clay, high plasticity, dark grey brown, trace of fine grained sandstone gravel and root fibres. | w>PL | | | APPEARS POORLY COMPACTED |
| | | | | | N = 4 2,2,2 | | | | | as above, but brown, trace of ash. | | | | |
| | | | | | | 183 | 1 | | | | | | | |
| | | | | | | | | | CH | Silty CLAY: high plasticity, light brown. | w>PL | VSt | | RESIDUAL |
| | | | | | | | | | CI-CH | Silty Sandy CLAY: medium to high plasticity, light grey and orange brown, fine to medium grained sand, with fine to medium grained ironstone gravel. | | | 430 420 450 | |
| | | | | | N = 17 6,8,9 | 182 | 2 | | | | | | 350 340 320 | |
| ON COMPLETION OF AUGERING | | | | | | | | | | as above, but trace of ironstone gravel. | | | | |
| | | | | | | 181 | 3 | | | | | Hd | 450 500 470 | |
| | | | | | N = 14 3,7,7 | | | | | | | | | |
| | | | | | | 180 | 4 | | | | | | | |
| | | | | | | | | | | | | | 400 450 430 | |
| | | | | | N = 16 5,6,10 | 179 | 5 | | | | | | | |
| | | | | | | 178 | 6 | | | | | | | MODERATE 'TC' BIT RESISTANCE |
| | | | | | | | | | | | | | | HIGH RESISTANCE |
| | | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 177 | | | | | | | | |

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# CORED BOREHOLE LOG

**Borehole No.** 4 **2 / 2**

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Core Size:** NMLC **R.L. Surface:** 183.93 m

**Date:** 29/6/22 **Inclination:** VERTICAL **Datum:** AHD

**Plant Type:** JK400 **Bearing:** N/A **Logged/Checked By:** J.F./B.Z.

| Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$<br>VL 0.1 L 0.3 M 1 H 3 VH 10 EH | DEFECT DETAILS<br>SPACING (mm)<br>600 200 60 20 | DEFECT DETAILS<br>DESCRIPTION<br>Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness<br>Specific / General | Formation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 178 | 6 | | START CORING AT 6.20m | | | | | | |
| 90% RETURN | | 177 | 7 | | Extremely Weathered sandstone: silty sandy CLAY, medium plasticity, light brown, with high strength bands. | XW | Hd | | | | Branxton Formation |
| | | 176 | 8 | | NO CORE 1.76m | | | | | CLAY WASHING AWAY | |
| | | 175 | 9 | | Extremely Weathered sandstone: silty sandy CLAY, medium plasticity, light brown, with high strength bands. | XW | Hd | | | STOPPED CORING. WASHBORNING ATTEMPTED DOWN TO 10.5m DEPTH. SAME EXTREMELY WEATHERED SANDSTONE AS ABOVE FROM THE RETURNING WATER. | Branxton Formation |
| | | 174 | 10 | | | | | | | | |
| | | 173 | 11 | | END OF BOREHOLE AT 10.50 m | | | | | | |
| | | 172 | | | | | | | | | |





FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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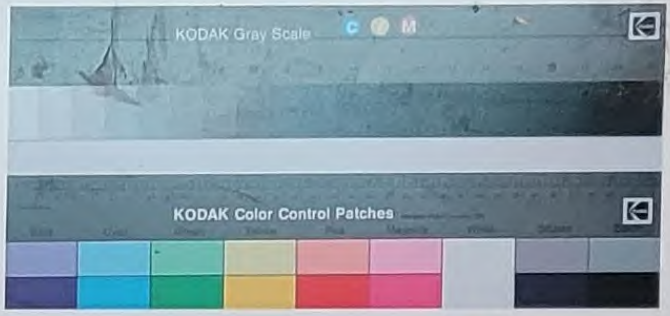
Job No: 34804LF
Borehole No: 4
Depth: 6.20 - 8.28m




34804LF BH4 START CORING AT 6.20 m

6

7 NO CORE : 1.76m

8 STOP CORING AT 8.28m

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# BOREHOLE LOG

**Borehole No.** 5



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 184.72 m

**Date:** 28/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | | | | | | FILL: Silty sandy clay, low plasticity, dark grey, fine to medium grained sand, trace of fine to medium grained igneous. | M | | | GRASS COVER |
| | | | | | | | | | | FILL: Silty clay, high plasticity, dark brown and dark grey, trace of fine to medium grained igneous and ironstone gravel and root fibres. | w>PL | | | APPEARS MODERATELY COMPACTED |
| | | | | | N = 7<br>3,4,3 | 184 | 1 | | | | | | | |
| | | | | | | | | | | | | | | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | | | | CH | Silty CLAY: high plasticity, brown and grey, with fine to medium grained ironstone gravel. | w>PL | VSt | | RESIDUAL |
| | | | | | | 183 | 2 | | | as above,<br>but light grey mottled light brown. | | | 240<br>250<br>260 | |
| | | | | | N = 12<br>3,6,6 | 182 | | | CI | Gravelly CLAY: medium plasticity, brown and red brown, fine to coarse grained, sub-angular and angular ironstone gravel. | | | | |
| | | | | | N = 22<br>6,10,12 | | 3 | | CI | Silty Sandy CLAY: medium plasticity, light grey, fine to medium grained sand, trace of fine to medium grained, sub-angular and rounded ironstone gravel. | | | | BANDS OF LOW TO MODERATE RESISTANCE |
| | | | | | | 181 | 4 | | | | | | | |
| | | | | | N = 13<br>5,6,7 | 180 | 5 | | | | | | 300<br>290<br>340 | |
| | | | | | | 179 | 6 | | | | | | | |
| | | | | | | 178 | | | CI | Silty CLAY: medium plasticity, light brown, trace of fine to medium grained sand. | | | 230<br>260<br>250 | HP TESTING ON REMOULDED SAMPLES |

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# BOREHOLE LOG

**Borehole No.** 5 **2 / 2**

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 184.72 m

**Date:** 28/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 177 | 8 | | CI | Silty CLAY: medium plasticity, light brown, trace of fine to medium grained sand. *(continued)* | w>PL | VSt | | |
| | | | | | | 176 | 9 | | | | | | | |
| | | | | | | 175 | 10 | | - | SILTSTONE: dark grey, with fine to coarse grained, sub-angular igneous clasts inclusion. | DW | L | | BRANXTON FORMATION<br>MODERATE RESISTANCE<br>MODERATE TO HIGH RESISTANCE |
| | | | | | | 174 | 11 | | | | | | | |
| | | | | | | 173 | 12 | | | END OF BOREHOLE AT 11.00 m | | | | GROUNDWATER MONITORING WELL INSTALLED TO 11.0m. CLASS 18 MACHINE SLOTTED / HAND SLOTTED 50mm DIA. PVC STANDPIPE 11.0m TO 2.0m. CASING 2.0m TO 0m. 2mm SAND FILTER PACK 11.0m TO 1.0m. BENTONITE SEAL 1.0m TO 0m. BACKFILLED WITH SAND (AND/OR CUTTINGS) TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER. |
| | | | | | | 172 | 13 | | | | | | | |
| | | | | | | 171 | | | | | | | | |

JKGeotechnics

# BOREHOLE LOG

**Borehole No.** 6



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Method:** SPIRAL AUGER **R.L. Surface:** 179.44 m

**Date:** 27/6/22 **Datum:** AHD

**Plant Type:** JK400 **Logged/Checked By:** J.F./B.Z.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | RL (m AHD) | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel Density | Hand Penetrometer Readings (kPa) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | | 179 | | | | FILL: Silty sand, fine to medium grained, dark grey, with slag. | w~PL | | | GRASS COVER |
| | | | | | N = 4 1,2,2 | | 1 | | CH | Silty CLAY: high plasticity, brown and dark brown, trace of fine to medium grained ironstone gravel and root fibres. | w>PL | VSt | | RESIDUAL |
| | | | | | | | | | | as above, but with fine to medium grained sand. | | Hd | | |
| | | | | | N = 8 2,4,4 | 178 | | | | | | St | | |
| | | | | | | | 2 | | | | | | | |
| | | | | | | 177 | | | CI | Silty Sandy CLAY: medium plasticity, light grey and grey, fine to medium grained sand, trace of fine to medium grained quartz and ironstone gravel. | | | | LOW 'TC' BIT RESISTANCE |
| | | | | | N = 21 6,9,12 | | 3 | | | | | | | |
| | | | | | | 176 | | | | | | | | |
| | | | | | | | 4 | | - | Extremely Weathered sandstone: silty sandy CLAY, medium plasticity, light brown and brown, fine to medium grained sand, trace of fine to medium grained, angular gravel. | XW | Hd | | BRANXTON FORMATION |
| | | | | | N=SPT 3/ 100mm REFUSAL | 175 | | | | | | | | GROUNDWATER MONITORING WELL INSTALLED TO 8.0m. CLASS 18 MACHINE SLOTTED / HAND SLOTTED 50mm DIA. PVC STANDPIPE 8.0m TO 2.0m. CASING 1.5m TO 0m. 2mm SAND FILTER PACK 14.14m TO 1.5m. BENTONITE SEAL 2.0m TO 0m. BACKFILLED WITH SAND (AND/OR CUTTINGS) TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER. |
| | | | | | | | 5 | | | | | | | |
| | | | | | | 174 | | | | | | | | |
| | | | | | | | 6 | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 173 | | | | | | | | |

# JKGeotechnics

# CORED BOREHOLE LOG

**Borehole No.** 6



**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Core Size:** NMLC **R.L. Surface:** 179.44 m

**Date:** 27/6/22 **Inclination:** VERTICAL **Datum:** AHD

**Plant Type:** JK400 **Bearing:** N/A **Logged/Checked By:** J.F./B.Z.

| Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ | DEFECT DETAILS: SPACING (mm) | DEFECT DETAILS: DESCRIPTION (Specific / General) | Formation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 174 | | | START CORING AT 5.93m | | | | | | |
| | | | 6 | | NO CORE 0.48m | | | | | | |
| 95% RETURN | | 173 | | | SANDSTONE: fine to medium grained, brown, with fine to medium grained sub-angular and sub-rounded igneous gravel, sub-horizontally bedded, occasional fine grained, grey brown, high strength sandstone and ironstone bands. | HW | VL - L | 0.20 | | (6.49m) Be, 5°, Ir, R, Clay Vn<br>(6.53m) Be, 5°, Ir, R, Clay Ct<br>(6.57m) Cr, 0°, 20 mm.t<br>(6.60m) XWS, 0°, 20 mm.t<br>(6.65m) Be, 15°, P, R, Fe Cn | |
| | | | | | | | | 0.090 | | | |
| | | | 7 | | | MW | L | | | (6.96m) XWS, 0°, 70 mm.t | |
| | | 172 | | | | | | 1.7 | | (7.38m) Be, 10°, P, R, Fe Ct<br>(7.52m) Be, 15°, P, R, Fe Vn | |
| | | | | | | | | 0.30 | | | |
| | | | | | | HW | VL | | | (7.86m) XWS, 0°, 120 mm.t | |
| | | | 8 | | | MW | VL - L | | | (8.12m) Jh, 20°<br>(8.14m) Jh, 14°<br>(8.20m) J, 35°, Ir, R, Fe Sn | |
| | | | | | | | | 0.080 | | | |
| | | 171 | | | | | | | | (8.38m) XWS, 0°, 100 mm.t | |
| | | | | | SILTSTONE: dark grey, sub-horizontally laminated, trace of fine to coarse grained, sub-angular igneous gravel, occasional medium to high strength bands, sub-horizontally bedded. | | L - M | 0.50 | | | |
| | | | 9 | | | | | | | (9.16m) Be, 0°, P, R, Clay Vn<br>(9.31m) J, 30°, P, R, Clay Vn | |
| | | 170 | | | | | | 0.40 | | | |
| | | | | | | | VL - L | 0.10 | | | |
| | | | 10 | | | | | | | (9.97m) J, 10°, P, R, Clay Vn | |
| | | | | | | | | 0.10 | | | |
| | | 169 | | | | | | | | (10.44m) Be, 5°, P, R, Clay Vn<br>(10.56m) Be, 5°, P, R, Clay Vn | |
| | | | | | | | | 0.30 | | | |
| | | | 11 | | | | | | | | |
| | | | | | | | | 0.20 | | (11.33m) XWS, 0°, 70 mm.t | |
| | | 168 | | | | | | | | | |





FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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# CORED BOREHOLE LOG

**Borehole No.** 6

3 / 3

**Client:** NSW HEALTH INFRASTRUCTURE

**Project:** PROPOSED STAGE 3 DEVELOPMENT

**Location:** MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

**Job No.:** 34804LF **Core Size:** NMLC **R.L. Surface:** 179.44 m

**Date:** 27/6/22 **Inclination:** VERTICAL **Datum:** AHD

**Plant Type:** JK400 **Bearing:** N/A **Logged/Checked By:** J.F./B.Z.

| Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ | DEFECT DETAILS: SPACING (mm) | DEFECT DETAILS: DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) | Formation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% RETURN | | 167 | 13 | | SILTSTONE: dark grey, sub-horizontally laminated, trace of fine to coarse grained, sub-angular igneous gravel, occasional medium to high strength bands, sub-horizontally bedded. *(continued)* | MW | VL - L | 0.10 | | (12.35m) Be, 0°, Ir, R, Clay Vn | |
| | | | | | | | | | | (12.63m) Be, 10°, P, R, Clay Vn | |
| | | | | | | | | 0.20 | | (12.95m) Jh, 30°<br>(12.96m) Jh, 85° | |
| | | 166 | | | | | | | | (13.19m) J, 35°, Ir, R, Cn | |
| | | | | | | | | | | (13.34m) Jh, 30° | |
| | | | | | | | | 0.20 | | | |
| | | | | | | | | | | (13.67m) J, 40°, P, R, Cn<br>(13.71m) J, 75°, P, R, Cn | |
| | | | 14 | | | | | 0.10 | | | |
| | | | | | | | | 0.30 | | (14.11m) J, 90°, P, R, Cn | |
| | | 165 | | | END OF BOREHOLE AT 14.14 m | | | | | | |
| | | | 15 | | | | | | | | |
| | | 164 | | | | | | | | | |
| | | | 16 | | | | | | | | |
| | | 163 | | | | | | | | | |
| | | | 17 | | | | | | | | |
| | | 162 | | | | | | | | | |
| | | | 18 | | | | | | | | |
| | | 161 | | | | | | | | | |





FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

Job No: 34804LF
Borehole No: 6
Depth: 5.93 - 14.14m


34804LF BH6 START CORING AT 5.93m →

6 NO CORE: 0.48m

7

8

9

10

11

12

13

14 EOH @ 14.14m

JKGeotechnics

# DYNAMIC CONE PENETRATION TEST RESULTS

| | |
|---|---|
| Client: | NSW HEALTH INFRASTRUCTURE |
| Project: | PROPOSED STAGE 3 DEVELOPMENT |
| Location: | MUSWELLBROOK DISTRICT HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW |

| | | | |
|---|---|---|---|
| Job No. | 34804LF | Hammer Weight & Drop: | 9kg/510mm |
| Date: | 28-6-22 | Rod Diameter: | 16mm |
| Tested By: | J.F. | Point Diameter: | 20mm |

| Test Location | 1 | 2 | 3* | 4* | 5* | 6* | 11 |
|---|---|---|---|---|---|---|---|
| Surface RL | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Depth (mm) | Number of Blows per 100mm Penetration | | | | | | |
| 0 - 100 | 3 | 7 | 11/80mm | 10/50mm | 8/50mm | 10/50mm | 7 |
| 100 - 200 | 7 | 18 | REFUSAL | REFUSAL | REFUSAL | REFUSAL | 15 |
| 200 - 300 | 6 | 16 | | | | | 7 |
| 300 - 400 | 3 | 15 | | | | | 7 |
| 400 - 500 | 5 | 12/50mm | | | | | 6 |
| 500 - 600 | 7 | REFUSAL | | | | | 3 |
| 600 - 700 | 8 | | | | | | 4 |
| 700 - 800 | 4 | | | | | | 4 |
| 800 - 900 | 3 | | | | | | 3 |
| 900 - 1000 | 1 | | | | | | 3 |
| 1000 - 1100 | 1 | | | | | | 2 |
| 1100 - 1200 | ↓ | | | | | | 2 |
| 1200 - 1300 | ↓ | | | | | | 2 |
| 1300 - 1400 | 6 | | | | | | 2 |
| 1400 - 1500 | 7 | | | | | | 3 |
| 1500 - 1600 | REFUSAL | | | | | | 9 |
| 1600 - 1700 | | | | | | | REFUSAL |
| 1700 - 1800 | | | | | | | |
| 1800 - 1900 | | | | | | | |
| 1900 - 2000 | | | | | | | |
| 2000 - 2100 | | | | | | | |
| 2100 - 2200 | | | | | | | |
| 2200 - 2300 | | | | | | | |
| 2300 - 2400 | | | | | | | |
| 2400 - 2500 | | | | | | | |
| 2500 - 2600 | | | | | | | |
| 2600 - 2700 | | | | | | | |
| 2700 - 2800 | | | | | | | |
| 2800 - 2900 | | | | | | | |
| 2900 - 3000 | | | | | | | |

Remarks:
1. The procedure used for this test is described in AS1289.6.3.2-1997 (R2013)
2. Usually 8 blows per 20mm is taken as refusal
3. Datum of levels is AHD
*At least 2 times attempted nearby


AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

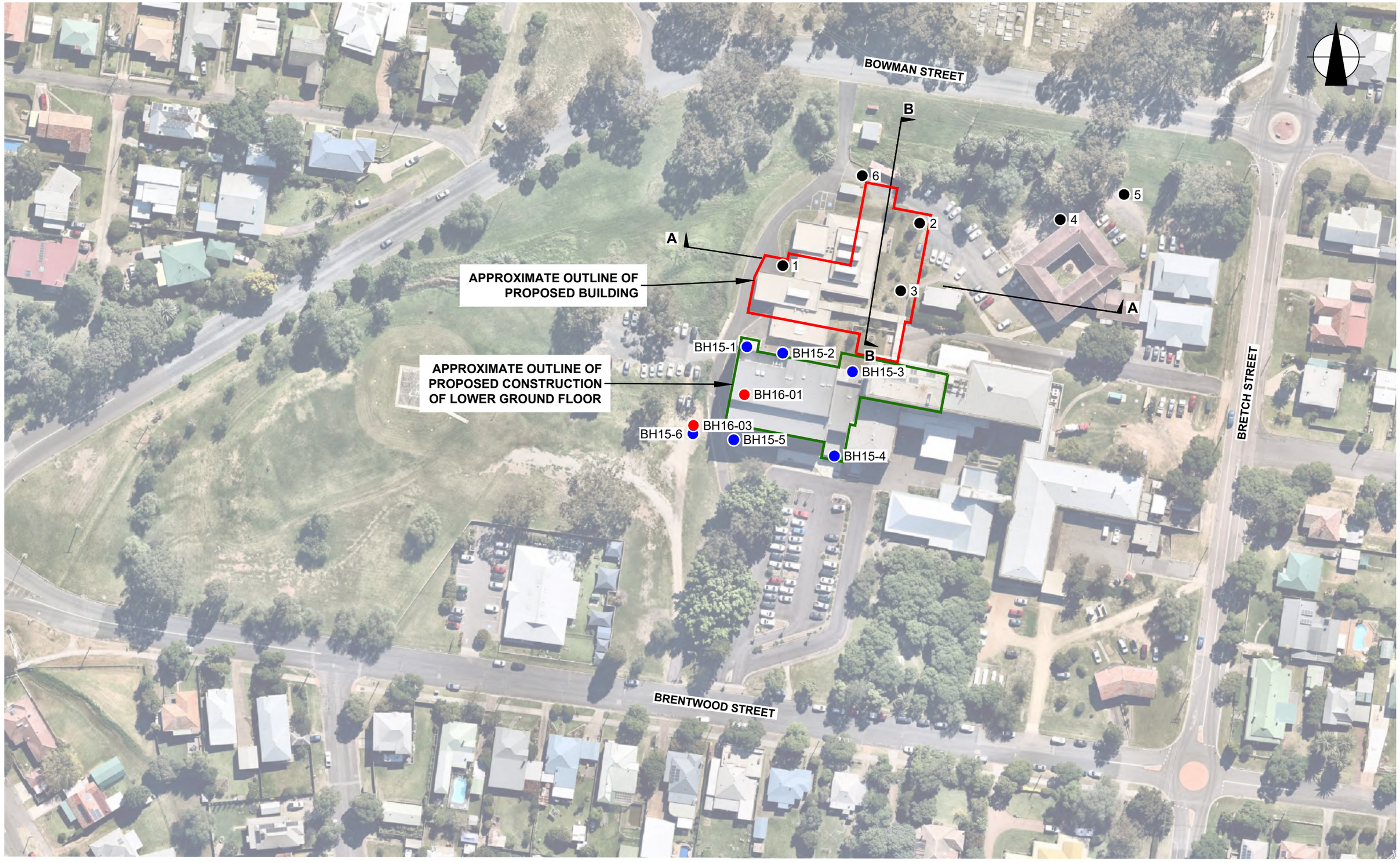
Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

Report No: 34804LF

Figure No: 1

JKGeotechnics

PLOT DATE: 11/07/2022 1:31:38 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\34000'S\34804LF MUSWELLBROOK\CAD\34804LF.DWG




## LEGEND

- BOREHOLE DRILLED DURING CURRENT JK GEOTECHNICS INVESTIGATION
- BOREHOLE DRILLED DURING PREVIOUS 2016 COFFEY INVESTIGATION
- BOREHOLE DRILLED DURING PREVIOUS 2015 COFFEY INVESTIGATION

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

0 12 24 36 48 60

SCALE 1:1200 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **BOREHOLE LOCATION PLAN**

Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

Report No: 34804LF

Figure No: 2

JKGeotechnics

PLOT DATE: 2/08/2022 4:15:36 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\34000'S\34804LF MUSWELLBROOK\CAD\34804LF.DWG

DISTANCE (m)

0 20 40 60 80 100 120

ELEVATION (m AHD)

182 180 178 176 174 172 170 168 166 164

1 (-1 m) N=9 N=R N=R

3 (-3 m) N=20 N=R

4 (30 m) N=17 N=14 N=16

5 (42 m) N=22 N=13

FILL AND RESIDUAL CLAY

CLASS V

CLASS IV

11.00

10.50

13.41

MATERIAL GRAPHIC

- GRAVELLY CLAY (CL, CI, CH)
- SILTY SANDY CLAY (CL, CI, CH)
- SILTSTONE
- NO CORE
- FILL
- SILTY CLAY (CL, CI, CH)
- SANDSTONE

H: SCALE 1:400 @A3 METRES

0 4 8 12 16 20

V: SCALE 1:100 @A3 METRES

0 1 2 3 4 5

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SECTION A-A**
**GRAPHICAL BOREHOLE SUMMARY**

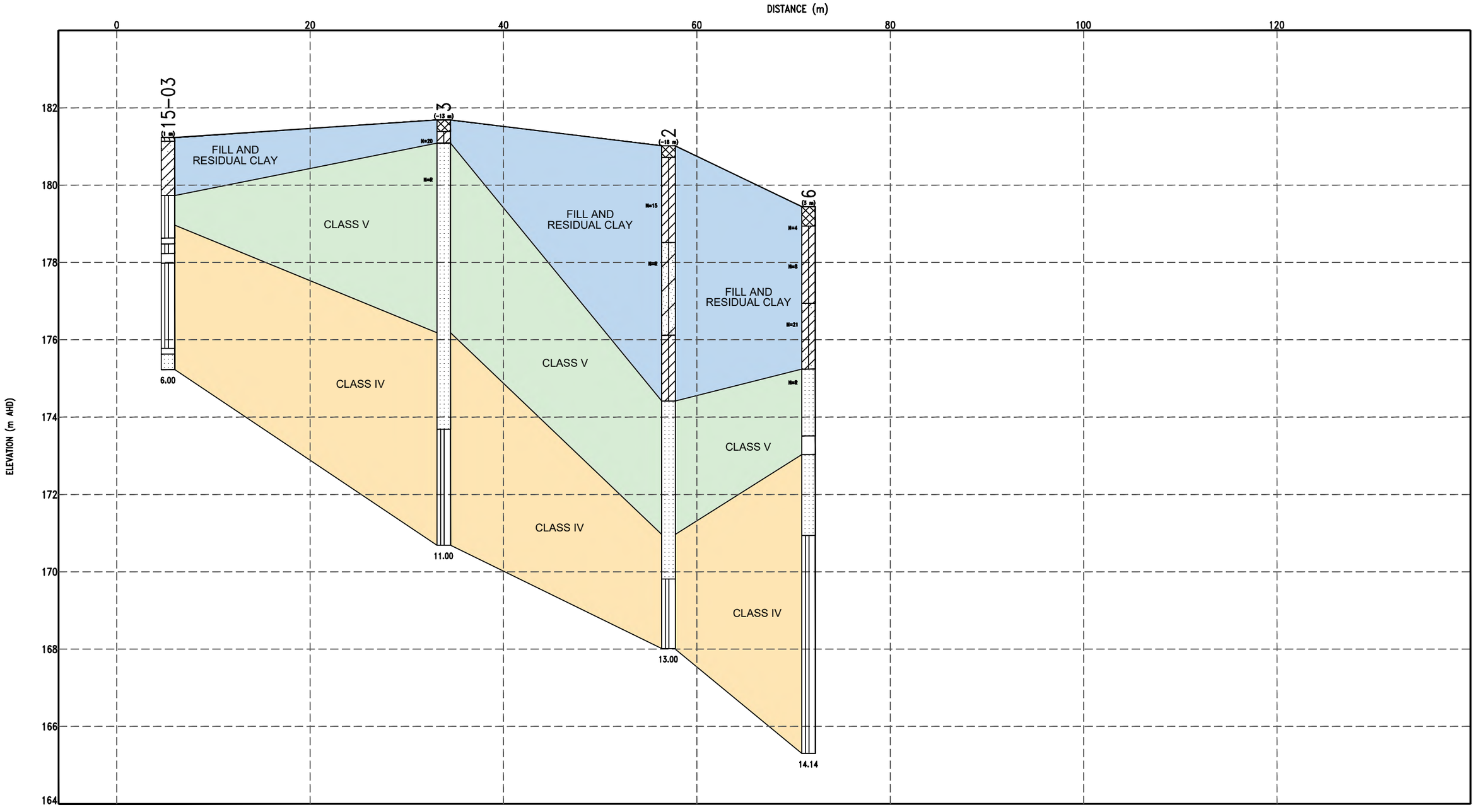
Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

Report No: 34804LF

Figure No: 3

JKGeotechnics

PLOT DATE: 3/08/2022 9:48:31 AM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\34000'S\34804LF MUSWELLBROOK\CAD\34804LF.DWG




MATERIAL GRAPHIC

- CLAYEY SILTY SAND (SM, SC)
- NO CORE
- SANDY CLAY (CL, CI, CH)
- SILTY CLAY (CL, CI, CH)
- SILTY SANDY CLAY (CL, CI, CH)
- FILL
- SANDSTONE
- SILTSTONE
- TOPSOIL

H: SCALE 1:400 @A3 METRES (0 4 8 12 16 20)

V: SCALE 1:100 @A3 METRES (0 1 2 3 4 5)

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SECTION B-B**
**GRAPHICAL BOREHOLE SUMMARY**

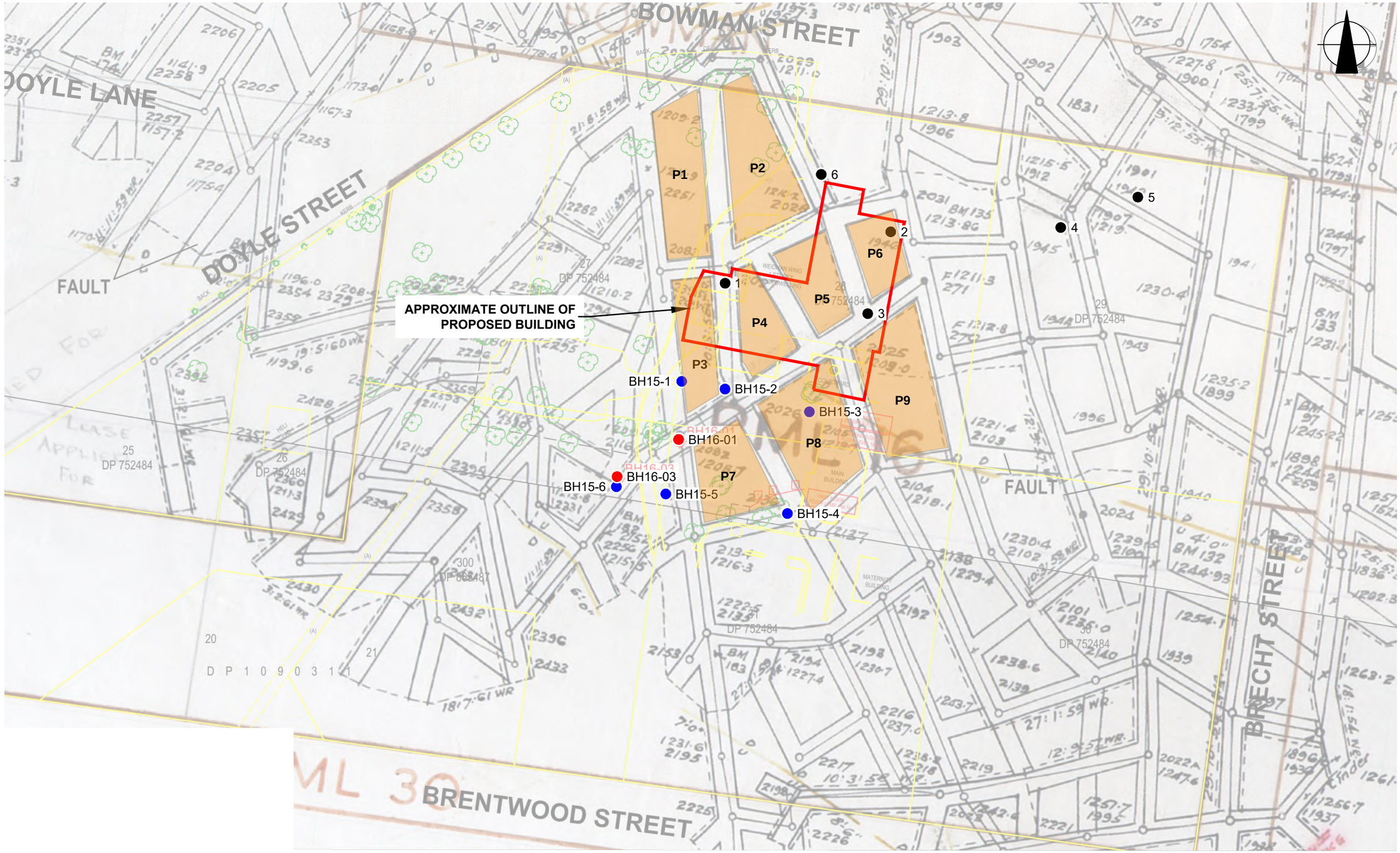
Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

Report No: 34804LF

Figure No: 4

JKGeotechnics

PLOT DATE: 3/08/2022 9:48:48 AM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\34000\S\34804LF MUSWELLBROOK\CAD\34804LF.DWG




**LEGEND**

- BOREHOLE DRILLED DURING CURRENT JK GEOTECHNICS INVESTIGATION
- BOREHOLE DRILLED DURING PREVIOUS 2016 COFFEY INVESTIGATION
- BOREHOLE DRILLED DURING PREVIOUS 2015 COFFEY INVESTIGATION

0 10 20 30 40 50
SCALE 1:1000 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **MINE SUBSIDENCE ASSESSMENT**

Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

Report No: 34804LF

Figure No: 5

**JKGeotechnics**

PLOT DATE: 2/08/2022 4:16:29 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\34000'S\34804LF MUSWELLBROOK\CAD\34804LF.DWG

# VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 1 below.

It should be noted that peak vibration velocities higher than the minimum figures in Table 1 for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual condition of the structure.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

**Table 1: DIN 4150 – Structural Damage – Safe Limits for Building Vibration**

| Group | Type of Structure | Peak Vibration Velocity in mm/s | | | |
|---|---|---|---|---|---|
| | | At Foundation Level at a Frequency of: | | | Plane of Floor of Uppermost Storey |
| | | Less than 10Hz | 10Hz to 50Hz | 50Hz to 100Hz | All Frequencies |
| 1 | Buildings used for commercial purposes, industrial buildings and buildings of similar design. | 20 | 20 to 40 | 40 to 50 | 40 |
| 2 | Dwellings and buildings of similar design and/or use. | 5 | 5 to 15 | 15 to 20 | 15 |
| 3 | Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (eg. buildings that are under a preservation order). | 3 | 3 to 8 | 8 to 10 | 8 |

**Note:** For frequencies above 100Hz, the higher values in the 50Hz to 100Hz column should be used.

# REPORT EXPLANATION NOTES

**INTRODUCTION**

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

**DESCRIPTION AND CLASSIFICATION METHODS**

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

| Soil Classification | Particle Size |
|---|---|
| Clay | < 0.002mm |
| Silt | 0.002 to 0.075mm |
| Sand | 0.075 to 2.36mm |
| Gravel | 2.36 to 63mm |
| Cobbles | 63 to 200mm |
| Boulders | > 200mm |

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

| Relative Density | SPT 'N' Value (blows/300mm) |
|---|---|
| Very loose (VL) | < 4 |
| Loose (L) | 4 to 10 |
| Medium dense (MD) | 10 to 30 |
| Dense (D) | 30 to 50 |
| Very Dense (VD) | > 50 |

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

| Classification | Unconfined Compressive Strength (kPa) | Indicative Undrained Shear Strength (kPa) |
|---|---|---|
| Very Soft (VS) | ≤ 25 | ≤ 12 |
| Soft (S) | > 25 and ≤ 50 | > 12 and ≤ 25 |
| Firm (F) | > 50 and ≤ 100 | > 25 and ≤ 50 |
| Stiff (St) | > 100 and ≤ 200 | > 50 and ≤ 100 |
| Very Stiff (VSt) | > 200 and ≤ 400 | > 100 and ≤ 200 |
| Hard (Hd) | > 400 | > 200 |
| Friable (Fr) | Strength not attainable – soil crumbles | |

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

**SAMPLING**

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

**INVESTIGATION METHODS**

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

**Test Pits:** These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

**Hand Auger Drilling:** A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

**Continuous Spiral Flight Augers:** The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

**Rock Augering:** Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

**Wash Boring:** The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

**Mud Stabilised Drilling:** Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

**Continuous Core Drilling:** A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

**Standard Penetration Tests:** Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as '$N_c$' on the borehole logs, together with the number of blows per 150mm penetration.

**Cone Penetrometer Testing (CPT) and Interpretation:** The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

As penetration occurs (at a rate of approximately 20mm per second), the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

**Flat Dilatometer Test:** The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index ($I_D$), horizontal stress index ($K_D$), and dilatometer modulus ($E_D$). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient ($K_o$), over-consolidation ratio (OCR), undrained shear strength ($C_u$), friction angle ($\phi$), coefficient of consolidation ($C_h$), coefficient of permeability ($K_h$), unit weight ($\gamma$), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity ($V_s$). Using established correlations, the SDMT results can also be used to assess the small strain modulus ($G_o$).

**Portable Dynamic Cone Penetrometers:** Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

**Vane Shear Test:** The vane shear test is used to measure the undrained shear strength ($C_u$) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

**LOGS**

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

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

**GROUNDWATER**

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to 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 perched water tables or surface water.

**FILL**

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

**LABORATORY TESTING**

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

**ENGINEERING REPORTS**

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

If these occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

**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, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

**REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES**

Where information obtained from this investigation 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. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.



**REVIEW OF DESIGN**

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves an experienced geotechnical engineer/engineering geologist.

**SITE INSPECTION**

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

## SYMBOL LEGENDS

### SOIL


FILL


TOPSOIL


CLAY (CL, CI, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CI, CH)


SILTY CLAY (CL, CI, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CI, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML, MH)


PEAT AND HIGHLY ORGANIC SOILS (Pt)

### ROCK


CONGLOMERATE


SANDSTONE


SHALE/MUDSTONE


SILTSTONE


CLAYSTONE


COAL


LAMINITE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

### OTHER MATERIALS


BRICKS OR PAVERS


CONCRETE


ASPHALTIC CONCRETE

# CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

| Major Divisions | | Group Symbol | Typical Names | Field Classification of Sand and Gravel | Laboratory Classification | |
|---|---|---|---|---|---|---|
| Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm) | GRAVEL (more than half of coarse fraction is larger than 2.36mm) | GW | Gravel and gravel-sand mixtures, little or no fines | Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength | ≤ 5% fines | $C_u > 4$ $1 < C_c < 3$ |
| | | GP | Gravel and gravel-sand mixtures, little or no fines, uniform gravels | Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength | ≤ 5% fines | Fails to comply with above |
| | | GM | Gravel-silt mixtures and gravel-sand-silt mixtures | 'Dirty' materials with excess of non-plastic fines, zero to medium dry strength | ≥ 12% fines, fines are silty | Fines behave as silt |
| | | GC | Gravel-clay mixtures and gravel-sand-clay mixtures | 'Dirty' materials with excess of plastic fines, medium to high dry strength | ≥ 12% fines, fines are clayey | Fines behave as clay |
| | SAND (more than half of coarse fraction is smaller than 2.36mm) | SW | Sand and gravel-sand mixtures, little or no fines | Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength | ≤ 5% fines | $C_u > 6$ $1 < C_c < 3$ |
| | | SP | Sand and gravel-sand mixtures, little or no fines | Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength | ≤ 5% fines | Fails to comply with above |
| | | SM | Sand-silt mixtures | 'Dirty' materials with excess of non-plastic fines, zero to medium dry strength | ≥ 12% fines, fines are silty | N/A |
| | | SC | Sand-clay mixtures | 'Dirty' materials with excess of plastic fines, medium to high dry strength | ≥ 12% fines, fines are clayey | |

| Major Divisions | | Group Symbol | Typical Names | Field Classification of Silt and Clay | | | Laboratory Classification |
|---|---|---|---|---|---|---|---|
| | | | | Dry Strength | Dilatancy | Toughness | % < 0.075mm |
| ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm) | SILT and CLAY (low to medium plasticity) | ML | Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity | None to low | Slow to rapid | Low | Below A line |
| | | CL, CI | Inorganic clay of low to medium plasticity, gravelly clay, sandy clay | Medium to high | None to slow | Medium | Above A line |
| | | OL | Organic silt | Low to medium | Slow | Low | Below A line |
| | SILT and CLAY (high plasticity) | MH | Inorganic silt | Low to medium | None to slow | Low to medium | Below A line |
| | | CH | Inorganic clay of high plasticity | High to very high | None | High | Above A line |
| | | OH | Organic clay of medium to high plasticity, organic silt | Medium to high | None to very slow | Low to medium | Below A line |
| | Highly organic soil | Pt | Peat, highly organic soil | – | – | – | – |

### Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

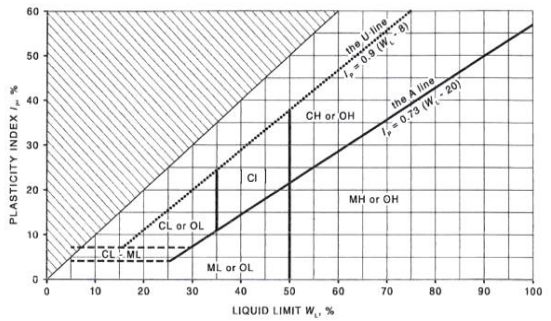
$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

Where $D_{10}$, $D_{30}$ and $D_{60}$ are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

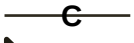
NOTES:

1. For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.
2. Where the grading is determined from laboratory tests, it is defined by coefficients of curvature ($C_c$) and uniformity ($C_u$) derived from the particle size distribution curve.
3. Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.
4. The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

**Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour**



# LOG SYMBOLS

| Log Column | Symbol | Definition |
|---|---|---|
| Groundwater Record |  | Standing water level. Time delay following completion of drilling/excavation may be shown. |
| |  | Extent of borehole/test pit collapse shortly after drilling/excavation. |
| |  | Groundwater seepage into borehole or test pit noted during drilling or excavation. |
| Samples | ES | Sample taken over depth indicated, for environmental analysis. |
| | U50 | Undisturbed 50mm diameter tube sample taken over depth indicated. |
| | DB | Bulk disturbed sample taken over depth indicated. |
| | DS | Small disturbed bag sample taken over depth indicated. |
| | ASB | Soil sample taken over depth indicated, for asbestos analysis. |
| | ASS | Soil sample taken over depth indicated, for acid sulfate soil analysis. |
| | SAL | Soil sample taken over depth indicated, for salinity analysis. |
| Field Tests | N = 17<br>4, 7, 10 | Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment. |
| | $N_c$ = 5<br>7<br>3R | Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment. |
| | VNS = 25<br>PID = 100 | Vane shear reading in kPa of undrained shear strength.<br>Photoionisation detector reading in ppm (soil sample headspace test). |
| Moisture Condition (Fine Grained Soils) | *w* > PL<br>*w* ≈ PL<br>*w* < PL<br>*w* ≈ LL<br>*w* > LL | Moisture content estimated to be greater than plastic limit.<br>Moisture content estimated to be approximately equal to plastic limit.<br>Moisture content estimated to be less than plastic limit.<br>Moisture content estimated to be near liquid limit.<br>Moisture content estimated to be wet of liquid limit. |
| (Coarse Grained Soils) | D<br>M<br>W | DRY – runs freely through fingers.<br>MOIST – does not run freely but no free water visible on soil surface.<br>WET – free water visible on soil surface. |
| Strength (Consistency) Cohesive Soils | VS<br>S<br>F<br>St<br>VSt<br>Hd<br>Fr<br>( ) | VERY SOFT – unconfined compressive strength ≤ 25kPa.<br>SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.<br>FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.<br>STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.<br>VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.<br>HARD – unconfined compressive strength > 400kPa.<br>FRIABLE – strength not attainable, soil crumbles.<br>Bracketed symbol indicates estimated consistency based on tactile examination or other assessment. |
| Density Index/ Relative Density (Cohesionless Soils) | VL<br>L<br>MD<br>D<br>VD<br>( ) | **Density Index ($I_D$) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**<br>VERY LOOSE ≤ 15 / 0 – 4<br>LOOSE > 15 and ≤ 35 / 4 – 10<br>MEDIUM DENSE > 35 and ≤ 65 / 10 – 30<br>DENSE > 65 and ≤ 85 / 30 – 50<br>VERY DENSE > 85 / > 50<br>Bracketed symbol indicates estimated density based on ease of drilling or other assessment. |
| Hand Penetrometer Readings | 300<br>250 | Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise. |

| Log Column | Symbol | Definition |
|---|---|---|
| Remarks | 'V' bit | Hardened steel 'V' shaped bit. |
| | 'TC' bit | Twin pronged tungsten carbide bit. |
| | $T_{60}$ | Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers. |
| | Soil Origin | The geological origin of the soil can generally be described as:<br>RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock.<br>EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock.<br>ALLUVIAL – soil deposited by creeks and rivers.<br>ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents.<br>MARINE – soil deposited in a marine environment.<br>AEOLIAN – soil carried and deposited by wind.<br>COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits.<br>LITTORAL – beach deposited soil. |

## Classification of Material Weathering

| Term | | Abbreviation | | Definition |
|---|---|---|---|---|
| Residual Soil | | RS | | 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. |
| Extremely Weathered | | XW | | 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. |
| Highly Weathered | Distinctly Weathered (Note 1) | HW | DW | 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. |
| Moderately Weathered | | MW | | 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. |
| Slightly Weathered | | SW | | Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock. |
| Fresh | | FR | | Rock shows no sign of decomposition of individual minerals or colour changes. |

**NOTE 1:** The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'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 weathering products in pores'*. There is some change in rock strength.

## Rock Material Strength Classification

| Term | Abbreviation | Uniaxial Compressive Strength (MPa) | Guide to Strength | |
|---|---|---|---|---|
| | | | Point Load Strength Index $Is_{(50)}$ (MPa) | Field Assessment |
| Very Low Strength | VL | 0.6 to 2 | 0.03 to 0.1 | Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure. |
| Low Strength | L | 2 to 6 | 0.1 to 0.3 | Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling. |
| Medium Strength | M | 6 to 20 | 0.3 to 1 | Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty. |
| High Strength | H | 20 to 60 | 1 to 3 | A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer. |
| Very High Strength | VH | 60 to 200 | 3 to 10 | Hand specimen breaks with pick after more than one blow; rock rings under hammer. |
| Extremely High Strength | EH | > 200 | > 10 | Specimen requires many blows with geological pick to break through intact material; rock rings under hammer. |

## Abbreviations Used in Defect Description

| Cored Borehole Log Column | | Symbol Abbreviation | Description |
|---|---|---|---|
| Point Load Strength Index | | • 0.6 | Axial point load strength index test result (MPa) |
| | | x 0.6 | Diametral point load strength index test result (MPa) |
| Defect Details | – Type | Be | Parting – bedding or cleavage |
| | | CS | Clay seam |
| | | Cr | Crushed/sheared seam or zone |
| | | J | Joint |
| | | Jh | Healed joint |
| | | Ji | Incipient joint |
| | | XWS | Extremely weathered seam |
| | – Orientation | Degrees | Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole) |
| | – Shape | P | Planar |
| | | C | Curved |
| | | Un | Undulating |
| | | St | Stepped |
| | | Ir | Irregular |
| | – Roughness | Vr | Very rough |
| | | R | Rough |
| | | S | Smooth |
| | | Po | Polished |
| | | Sl | Slickensided |
| | – Infill Material | Ca | Calcite |
| | | Cb | Carbonaceous |
| | | Clay | Clay |
| | | Fe | Iron |
| | | Qz | Quartz |
| | | Py | Pyrite |
| | – Coatings | Cn | Clean |
| | | Sn | Stained – no visible coating, surface is discoloured |
| | | Vn | Veneer – visible, too thin to measure, may be patchy |
| | | Ct | Coating ≤ 1mm thick |
| | | Filled | Coating > 1mm thick |
| | – Thickness | mm.t | Defect thickness measured in millimetres |

# APPENDIX A

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# **Soil Description** Explanation Sheet (1 of 2)

### DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

### CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

### PARTICLE SIZE DESCRIPTIVE TERMS

| NAME | SUBDIVISION | SIZE |
|---|---|---|
| Boulders | | >200 mm |
| Cobbles | | 63 mm to 200 mm |
| Gravel | coarse | 20 mm to 63 mm |
| | medium | 6 mm to 20 mm |
| | fine | 2.36 mm to 6 mm |
| Sand | coarse | 600 μm to 2.36 mm |
| | medium | 200 μm to 600 μm |
| | fine | 75 μm to 200 μm |

### MOISTURE CONDITION

**Dry** Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

**Moist** Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

**Wet** As for moist but with free water forming on hands when handled.

### CONSISTENCY OF COHESIVE SOILS

| TERM | UNDRAINED STRENGTH $s_u$ (kPa) | FIELD GUIDE |
|---|---|---|
| Very Soft | <12 | A finger can be pushed well into the soil with little effort. |
| Soft | 12 - 25 | A finger can be pushed into the soil to about 25mm depth. |
| Firm | 25 - 50 | The soil can be indented about 5mm with the thumb, but not penetrated. |
| Stiff | 50 - 100 | The surface of the soil can be indented with the thumb, but not penetrated. |
| Very Stiff | 100 - 200 | The surface of the soil can be marked, but not indented with thumb pressure. |
| Hard | >200 | The surface of the soil can be marked only with the thumbnail. |
| Friable | – | Crumbles or powders when scraped by thumbnail. |

### DENSITY OF GRANULAR SOILS

| TERM | DENSITY INDEX (%) |
|---|---|
| Very loose | Less than 15 |
| Loose | 15 - 35 |
| Medium Dense | 35 - 65 |
| Dense | 65 - 85 |
| Very Dense | Greater than 85 |

### MINOR COMPONENTS

| TERM | ASSESSMENT GUIDE | PROPORTION OF MINOR COMPONENT IN: |
|---|---|---|
| Trace of | Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component. | Coarse grained soils: <5%<br>Fine grained soils: <15% |
| With some | Presence easily detected by feel or eye, soil properties little different to general properties of primary component. | Coarse grained soils: 5 - 12%<br>Fine grained soils: 15 - 30% |

### SOIL STRUCTURE

| ZONING | | CEMENTING | |
|---|---|---|---|
| Layers | Continuous across exposure or sample. | Weakly cemented | Easily broken up by hand in air or water. |
| Lenses | Discontinuous layers of lenticular shape. | Moderately cemented | Effort is required to break up the soil by hand in air or water. |
| Pockets | Irregular inclusions of different material. | | |

### GEOLOGICAL ORIGIN

#### WEATHERED IN PLACE SOILS

Extremely weathered material — Structure and fabric of parent rock visible.

Residual soil — Structure and fabric of parent rock not visible.

#### TRANSPORTED SOILS

Aeolian soil — Deposited by wind.

Alluvial soil — Deposited by streams and rivers.

Colluvial soil — Deposited on slopes (transported downslope by gravity).

Fill — Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.

Lacustrine soil — Deposited by lakes.

Marine soil — Deposited in ocean basins, bays, beaches and estuaries.

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# **Soil Description** Explanation Sheet (2 of 2)

## SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass) | | | | | | | USC | PRIMARY NAME |
|---|---|---|---|---|---|---|---|---|
| COARSE GRAIINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm | (A 0.075 mm particle is about the smallest particle visible to the naked eye) | GRAVELS More than half of coarse fraction is larger than 2.0 mm | CLEAN GRAVELS (Little or no fines) | Wide range in grain size and substantial amounts of all intermediate particle sizes. | | | GW | GRAVEL |
| | | | | Predominantly one size or a range of sizes with more intermediate sizes missing. | | | GP | GRAVEL |
| | | | GRAVELS WITH FINES (Appreciable amount of fines) | Non-plastic fines (for identification procedures see ML below) | | | GM | SILTY GRAVEL |
| | | | | Plastic fines (for identification procedures see CL below) | | | GC | CLAYEY GRAVEL |
| | | SANDS More than half of coarse fraction is smaller than 2.0 mm | CLEAN SANDS (Little or no fines) | Wide range in grain sizes and substantial amounts of all intermediate sizes | | | SW | SAND |
| | | | | Predominantly one size or a range of sizes with some intermediate sizes missing. | | | SP | SAND |
| | | | SANDS WITH FINES (Appreciable amount of fines) | Non-plastic fines (for identification procedures see ML below). | | | SM | SILTY SAND |
| | | | | Plastic fines (for identification procedures see CL below). | | | SC | CLAYEY SAND |
| FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm | | | IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm. | | | | | |
| | | SILTS & CLAYS Liquid limit less than 50 | **DRY STRENGTH** | **DILATANCY** | **TOUGHNESS** | | | |
| | | | None to Low | Quick to slow | None | | ML | SILT |
| | | | Medium to High | None | Medium | | CL | CLAY |
| | | | Low to medium | Slow to very slow | Low | | OL | ORGANIC SILT |
| | | SILTS & CLAYS Liquid limit greater than 50 | Low to medium | Slow to very slow | Low to medium | | MH | SILT |
| | | | High | None | High | | CH | CLAY |
| | | | Medium to High | None | Low to medium | | OH | ORGANIC CLAY |
| HIGHLY ORGANIC SOILS | | | Readily identified by colour, odour, spongy feel and frequently by fibrous texture. | | | | Pt | PEAT |

• Low plasticity – Liquid Limit $W_L$ less than 35%. • Medium plasticity – $W_L$ between 35% and 50%.

## COMMON DEFECTS IN SOIL

| TERM | DEFINITION | DIAGRAM |
|---|---|---|
| PARTING | A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed. |  |
| JOINT | A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length. |  |
| SHEARED ZONE | Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks. |  |
| SHEARED SURFACE | A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect. |  |

| TERM | DEFINITION | DIAGRAM |
|---|---|---|
| SOFTENED ZONE | A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere. |  |
| TUBE | Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter |  |
| TUBE CAST | Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented. |  |
| INFILLED SEAM | Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints. |  |

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# **Rock Description** Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

**DEFINITIONS:** Rock substance, defect and mass are defined as follows:

| | |
|---|---|
| **Rock Substance** | In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic. |
| **Defect** | Discontinuity or break in the continuity of a substance or substances. |
| **Mass** | Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects. |

## SUBSTANCE DESCRIPTIVE TERMS:

| | |
|---|---|
| **ROCK NAME** | Simple rock names are used rather than precise geological classification. |
| **PARTICLE SIZE** | Grain size terms for sandstone are: |
| Coarse grained | Mainly 0.6mm to 2mm |
| Medium grained | Mainly 0.2mm to 0.6mm |
| Fine grained | Mainly 0.06mm (just visible) to 0.2mm |
| **FABRIC** | Terms for layering of penetrative fabric (eg. bedding, cleavage etc. ) are: |
| Massive | No layering or penetrative fabric. |
| Indistinct | Layering or fabric just visible. Little effect on properties. |
| Distinct | Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric. |

## CLASSIFICATION OF WEATHERING PRODUCTS

| Term | Abbreviation | Definition |
|---|---|---|
| **Residual Soil** | **RS** | Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported. |
| **Extremely Weathered Material** | **XW** | Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible. |
| **Highly Weathered Rock** | **HW** | Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores. |
| **Moderately Weathered Rock** | **MW** | The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable. |
| **Slightly Weathered Rock** | **SW** | Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance. |
| **Fresh Rock** | **FR** | Rock substance unaffected by weathering. |

**Notes on Weathering:**

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

## ROCK SUBSTANCE STRENGTH TERMS

| Term | Abbrev-iation | Point Load Index, $I_{s(50)}$ (MPa) | Field Guide |
|---|---|---|---|
| **Very Low** | **VL** | Less than 0.1 | Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure. |
| **Low** | **L** | 0.1 to 0.3 | Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling. |
| **Medium** | **M** | 0.3 to 1.0 | Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty. |
| **High** | **H** | 1 to 3 | A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer. |
| **Very High** | **VH** | 3 to 10 | Hand specimen breaks after more than one blow of a pick; rock rings under hammer. |
| **Extremely High** | **EH** | More than 10 | Specimen requires many blows with geological pick to break; rock rings under hammer. |

**Notes on Rock Substance Strength:**

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index $I_{s(50)}$. The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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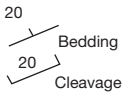
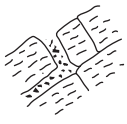
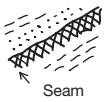
# **Rock Description** Explanation Sheet (2 of 2)

| COMMON DEFECTS IN ROCK MASSES<br>Term | Definition | Diagram | Map Symbol | Graphic Log (Note 1) |
|---|---|---|---|---|
| **Parting** | A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed. |  |  |  <br>(Note 2) |
| **Joint** | A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed. |  |  |  <br>(Note 2) |
| **Sheared Zone** (Note 3) | Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks. |  |  |  |
| **Sheared Surface** (Note 3) | A near planar, curved or undulating surface which is usually smooth, polished or slickensided. |  |  |  |
| **Crushed Seam** (Note 3) | Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties. |  |  |  |
| **Infilled Seam** | Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface. |  |  |  |
| **Extremely Weathered Seam** | Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place. |  |  |  |

**Notes on Defects:**

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

| DEFECT SHAPE TERMS | |
|---|---|
| **Planar** | The defect does not vary in orientation |
| **Curved** | The defect has a gradual change in orientation |
| **Undulating** | The defect has a wavy surface |
| **Stepped** | The defect has one or more well defined steps |
| **Irregular** | The defect has many sharp changes of orientation |

**Note:** The assessment of defect shape is partly influenced by the scale of the observation.

| ROUGHNESS TERMS | |
|---|---|
| **Slickensided** | Grooved or striated surface, usually polished |
| **Polished** | Shiny smooth surface |
| **Smooth** | Smooth to touch. Few or no surface irregularities |
| **Rough** | Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper. |
| **Very Rough** | Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper. |

| COATING TERMS | |
|---|---|
| **Clean** | No visible coating |
| **Stained** | No visible coating but surfaces are discoloured |
| **Veneer** | A visible coating of soil or mineral, too thin to measure; may be patchy |
| **Coating** | A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein. |

| BLOCK SHAPE TERMS | |
|---|---|
| **Blocky** | Approximately equidimensional |
| **Tabular** | Thickness much less than length or width |
| **Columnar** | Height much greate than cross section |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH15-01*** |
| sheet: | 1 of 2 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***TSA MANAGEMENT*** | date started: ***17 Nov 2015*** |
| principal: | date completed: ***17 Nov 2015*** |
| project: ***PROPOSED BUILDING*** | logged by: ***AWJ*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***DLK*** |

position: E: 302157; N: 6428356 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | hole diameter : 100 mm

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T CASING | | Not Observed | SPT 6, 7, 7 N*=14 | 178 | 1.0 | | CH | **TOPSOIL: SILT**: black, some roots. | D | VSt | | **TOPSOIL** |
| | | | | | | | | **Sandy CLAY**: high plasticity, grey and orange, coarse grained sand, trace of fine grained, sub-rounded gravel. | <Wp | | | **RESIDUAL SOIL** |
| | | | SPT 21, 33, 27 N*=60 | 177 | 2.0 | | | **SANDSTONE**: fine to coarse grained, pale grey and orange brown, extremely weathered, estimated very low strength, remoulds to Sand. | | H | | **WEATHERED ROCK** |
| | | | | | | | | Borehole BH15-01 continued as cored hole | | | | ADT refusal |
| | | | | 176 | 3.0 | | | | | | | |
| | | | | 175 | 4.0 | | | | | | | |
| | | | | 174 | 5.0 | | | | | | | |
| | | | | 173 | 6.0 | | | | | | | |
| | | | | 172 | 7.0 | | | | | | | |
| | | | | 171 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH15-01** |
| sheet: | 2 of 2 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **17 Nov 2015** |
| principal: | |
| date completed: | **17 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302157; N: 6428356 (MGA94 ) surface elevation: 178.63 m (AHD) angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted drilling fluid: hole diameter : 100 mm vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 178 | 1.0 | | | | | | | | |
| | | 177 | 2.0 | | start coring at 2.60m | | | | | | |
| NMLC | Not Observed | 176 | 3.0 | | **NO CORE:** 0.90 m | | | | 0% | | |
| | | 175 | | | **PEBBLY SANDSTONE**: coarse grained, brown, fine grained, sub-angular to sub-rounded gravel sized rock fragments of ironstone, siltstone and basalt. | XW - HW | | | 0% | | Fractured rock |
| | | | 4.0 | | **NO CORE:** 0.30 m | XW - HW | | | 0% | | Fractured rock |
| | | 174 | | | **PEBBLY SANDSTONE**: coarse grained, brown, fine grained, sub-angular to sub-rounded gravel sized rock fragments of ironstone, siltstone and basalt.<br>4.73 to 4.83 m: Pale grey, bleached zone. | HW<br>XW - HW<br>HW | X O | a=0.10<br>d=0.40 | 70% | | JT, 15°, PL, VR, Fe SN<br>Weathered rock<br>JT, 40°, PL, RO, Fe SN |
| | | 173 | 5.0 | | **SIDERITE**: brown and dark grey, coarse grained. | MW<br>SW<br>MW | O X | a=9.30<br>d=1.20 | | | PT, 5°, PL, RO, Clay CO |
| | | 172 | 6.0 | | **PEBBLY SANDSTONE**: coarse grained, brown, fine grained, sub-angular to sub-rounded gravel sized rock fragments of ironstone, siltstone and basalt, extremely weathered material remoulded to Sandy Clay. | XW - HW | | a=0.10<br>d=0.10 | 96% | | PT, 10°, PL, RO, Fe SN<br>JT, 45°, PL, RO, Fe SN |
| | | | 7.0 | | Borehole BH15-01 terminated at 6.50 m<br>Target depth | | | | | | |
| | | 171 | | | | | | | | | |

Defects are: PT, 0 - 10°, PL, RO, CN - Fe SN, unless otherwise described

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**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

Start depth 2.60m | BH15-01 BOX 1 | End depth 6.50m


| | | | | |
|---|---|---|---|---|
| drawn | ELC | coffey | client: | TSA MANAGEMENT |
| approved | DLK | | project: | PROPOSED BUILDING<br>MUSWELLBROOK HOSPITAL NSW |
| date | 23/11/2015 | | title: | CORE PHOTOGRAPH |
| scale | N/A | | project no: GEOTWARA22658AA | borehole no: BH15-01 |
| original size | A4 | | | |

coffey

# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH15-02*** |
| sheet: | 1 of 2 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***TSA MANAGEMENT*** | date started: ***17 Nov 2015*** |
| principal: | date completed: ***17 Nov 2015*** |
| project: ***PROPOSED BUILDING*** | logged by: ***AWJ*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***DLK*** |

position: E: 302170; N: 6428354 (MGA94 ) | surface elevation: 179.71 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | hole diameter :

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T | | NO GROUNDWATER ENCOUNTERED | E | | | | | **TOPSOIL: Silty SAND**: fine to medium grained, brown, some roots. | D | | | **TOPSOIL / FILL** |
| | | | E | | | | | **FILL: Sandy GRAVEL**: fine grained, sub-angular, gravel of coal. | | | | **FILL** |
| | | | SPT 4, 3, 10 N*=13 | 179 | | | CH | **FILL: SILT**: brown, trace of fine grained sand. | <Wp | VSt - H | | **RESIDUAL SOIL** |
| | | | E | | 1.0 | | | **Sandy CLAY**: high plasticity, orange brown, fine to coarse grained sand. | | | | |
| | | | SPT 4, 8, 28 HB N*=36 | 178 | | | | | | | | |
| | | | E | | 2.0 | | | **SANDSTONE**: fine to medium grained, pale grey and orange brown, extremely weathered, very low strength, easily remoulds to Sand. | | | | **WEATHERED ROCK** |
| | | | | 177 | | | | | | | | |
| | | | | | 3.0 | | | Borehole BH15-02 continued as cored hole | | | | |
| | | | | 176 | 4.0 | | | | | | | |
| | | | | 175 | 5.0 | | | | | | | |
| | | | | 174 | 6.0 | | | | | | | |
| | | | | 173 | 7.0 | | | | | | | |
| | | | | 172 | | | | | | | | |

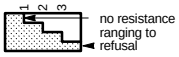
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:31

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

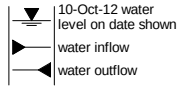
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**




**water**




**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

coffey

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | ***BH15-02*** |
| sheet: | 2 of 2 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***TSA MANAGEMENT*** | date started: ***17 Nov 2015*** |
| principal: | date completed: ***17 Nov 2015*** |
| project: ***PROPOSED BUILDING*** | logged by: ***AWJ*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***DLK*** |

position: E: 302170; N: 6428354 (MGA94 ) | surface elevation: 179.71 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | drilling fluid: | hole diameter : | vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 179 | 1.0 | | start coring at 2.80m | | | | | | |
| | | 178 | 2.0 | | | | | | | | |
| | | 177 | | | **NO CORE:** 0.20 m | | | | 0% | | |
| NMLC | Not Observed | | 3.0 | | **PEBBLY SANDSTONE**: fine to coarse grained, brown, some fine to medium grained, sub-rounded gravel sized rock fragmnets of coal and siltstone. | HW - MW | | | 40% | | Fractured rock<br>Weathered rock |
| | | 176 | | | **NO CORE:** 0.10 m | | | | | | |
| | | | 4.0 | | **PEBBLY SANDSTONE**: fine to coarse grained, brown, some fine to medium grained, sub-rounded gravel sized rock fragmnets of coal and siltstone. | HW - MW | | a=0.20<br>d=0.20 | 0% | | Fractured rock |
| | | | | | **NO CORE:** 0.20 m | HW - MW<br>MW | | a=0.40<br>d=0.10 | 27% | | Fractured rock |
| | | 175 | 5.0 | | **PEBBLY SANDSTONE**: fine to coarse grained, brown, some fine to medium grained, sub-rounded gravel sized rock fragmnets of coal and siltstone. | XW - HW | | | | | |
| | | | | | **NO CORE:** 0.10 m | HW | | | | | |
| | | 174 | | | **PEBBLY SANDSTONE**: fine grained, brown, some fine to medium grained, sub-rounded gravel sized rock fragmnets of coal and siltstone, extremely weathered, remoulds to Sandy Clay. 5.59 m: Cobble sized inclusion of siderite (30mm) | | | a=0.20<br>d=0.30 | 94% | | |
| | | | 6.0 | | **SILTSTONE**: pale grey - orange brown. | | | | | | |
| | | | | | Borehole BH15-02 terminated at 6.00 m<br>Target depth | | | | | | |
| | | 173 | 7.0 | | | | | | | | |
| | | 172 | | | | | | | | | |

Defects are: PT, 0 - 10° PL, RO, Fe SN, unless otherwise described

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**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

Start depth 2.80m | BH15-02 BOX 1 | End depth 6.00m


| | | | | |
|---|---|---|---|---|
| drawn | ELC | coffey | client: | TSA MANAGEMENT |
| approved | DLK | | project: | PROPOSED BUILDING<br>MUSWELLBROOK HOSPITAL NSW |
| date | 23/11/2015 | | | |
| scale | N/A | | title: | CORE PHOTOGRAPH |
| original size | A4 | | project no: GEOTWARA22658AA | borehole no: BH15-02 |

coffey

# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH15-03*** |
| sheet: | 1 of 2 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***TSA MANAGEMENT*** | date started: ***17 Nov 2015*** |
| principal: | date completed: ***17 Nov 2015*** |
| project: ***PROPOSED BUILDING*** | logged by: ***AWJ*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***DLK*** |

position: E: 302193; N: 6428347 (MGA94 ) | surface elevation: 181.23 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | hole diameter :

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T | | Not Observed | SPT 7, 8, 8 N*=16 | 181 | | | | **TOPSOIL: SILT**: brown, some sand, trace roots. | D | | | **TOPSOIL** |
| | | | | | | | CH | **Sandy CLAY**: high plasticity, pale brown, coarse grained sand, trace fine grained gravel. | <Wp | VSt | | **RESIDUAL SOIL** |
| | | | | 180 | 1.0 | | | | | | | |
| | | | SPT 25/80mm HB N=R | | | | | **SILTSTONE**: pale brown, extremely weathered, remoulds to Clay. | | H | | **WEATHERED ROCK** No SPT recovery |
| | | | | 179 | 2.0 | | | | | | | |
| | | | | | | | | Borehole BH15-03 continued as cored hole | | | | |
| | | | | 178 | 3.0 | | | | | | | |
| | | | | | 4.0 | | | | | | | |
| | | | | 177 | | | | | | | | |
| | | | | | 5.0 | | | | | | | |
| | | | | 176 | | | | | | | | |
| | | | | | 6.0 | | | | | | | |
| | | | | 175 | | | | | | | | |
| | | | | | 7.0 | | | | | | | |
| | | | | 174 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

coffey

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH15-03** |
| sheet: | 2 of 2 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **17 Nov 2015** |
| principal: | |
| date completed: | **17 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302193; N: 6428347 (MGA94 ) surface elevation: 181.23 m (AHD) angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted drilling fluid: hole diameter : vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 181 | | | | | | | | | |
| | | | 1.0 | | | | | | | | |
| | | 180 | | | | | | | | | |
| | | | 2.0 | | | | | | | | |
| | | 179 | | | start coring at 2.60m | | | | | | |
| NMLC | Not Observed | | | | **NO CORE:** 0.15 m | | | | 0% | | Weathered rock PP = 180Kpa<br>300Kpa |
| | | | 3.0 | | **PEBBLY SILTSTONE**: pale grey and orange brown, fine to coarse grained, sub-rounded gravel sized rock fragments, extremely weathered material remoulds to Clay. | XW | | | | | |
| | | 178 | | | **NO CORE:** 0.25 m | XW | | | 0% | | Weathered Rock |
| | | | 4.0 | | **PEBBLY SILTSTONE**: pale grey and orange brown, fine to coarse grained, sub-rounded gravel sized rock fragments, extremely weathered material remoulds to Clay.<br>3.88 to 3.95 m: Cobble sized rock fragments of dolerite - (70m thick) brown, fine to medium grained crystaline. | HW<br>XW<br>HW<br>XW - HW | | a=0.10<br>d=0.10<br>a=0.10<br>d=0.10 | 40% | | JT, 90°, PL, RO, Fe SN, 60 mm, VN<br>Calcite<br>Weathered Rock |
| | | 177 | | | | | | | | | |
| | | | 5.0 | | | | | | 59% | | PT, 0°, PL, RO, Fe SN<br>JT, 50°, PL, RO, Clay VN<br>PT, 0°, PL, RO, Fe SN<br>JT, 40°, PL, RO, Clay CO<br>Weathered zone |
| | | 176 | | | **NO CORE:** 0.15 m | | | | | | |
| | | | 6.0 | | **PEBBLY SANDSTONE**: fine to coarse grained, pale grey and orange brown, fine to coarse grained, sub-rounded gravel sized rock fragments, extremely weathered material remoulds to Sandy Clay. | XW - HW | | a=0.10<br>d=0.10 | | | |
| | | 175 | | | Borehole BH15-03 terminated at 6.00 m<br>Target depth | | | | | | |
| | | | 7.0 | | | | | | | | |
| | | 174 | | | | | | | | | |

CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:30

**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

Start depth 2.60m | BH15-03 BOX 1 | End depth 6.00m


| | | | | |
|---|---|---|---|---|
| drawn | ELC | coffey | client: | TSA MANAGEMENT |
| approved | DLK | | project: | PROPOSED BUILDING<br>MUSWELLBROOK HOSPITAL NSW |
| date | 23/11/2015 | | | |
| scale | N/A | | title: | CORE PHOTOGRAPH |
| original size | A4 | | project no: GEOTWARA22658AA | borehole no: BH15-03 |

coffey

# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH15-04** |
| sheet: | 1 of 2 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **18 Nov 2015** |
| principal: | |
| date completed: | **18 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302187; N: 6428319 (MGA94 ) surface elevation: 184.10 m (AHD) angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted hole diameter :

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CASING | | | E | 184 | | | | **FILL: Sandy SILT**: brown, fine grained sand, fome fine to medium grained gravel of asphalt. Trace roots. | D | | | **TOPSOIL / FILL** |
| | | | SPT 9, 16, 10 N*=26 | 183 | 1.0 | | | **FILL: Sandy CLAY**: medium to high plasticity, pale brown, some fine to coarse grained sub-angular gravel and concreate, coal. Trace roots, trace fragments. | <Wp | | | **FILL** |
| AD/T | | Not Observed | SPT 3, 4, 3 N*=7 | 182 | 2.0 | | | **FILL: Silty SAND**: fine to coarse grained, brown - dark brown, some fine to medium grained, angular gravel of rock, coal and brick. | D | | | |
| | | | SPT 19, 32, 32 N*=64 | 181 | 3.0 | | CH | **Sandy CLAY**: high plasticity, orange brown, coarse grained sand. | ~Wp | VSt | | **RESIDUAL SOIL** |
| | | | | 180 | 4.0 | | | **SANDSTONE**: medium to coarse grained, orange - brown and pale grey, trace fine grained gravel, extremely weathered, very low strength , recovered as Clayey Sand. | | | | **WEATHERED ROCK** |
| | | | SPT 18, 38 HB N*=R | 179 | 5.0 | | | | | | | AD/T refusal |
| | | | | | | | | Borehole BH15-04 continued as cored hole | | | | |
| | | | | 178 | 6.0 | | | | | | | |
| | | | | 177 | 7.0 | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

coffey

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH15-04** |
| sheet: | 2 of 2 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **18 Nov 2015** |
| principal: | |
| date completed: | **18 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302187; N: 6428319 (MGA94 ) surface elevation: 184.10 m (AHD) angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted drilling fluid: hole diameter : vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 184 | | | | | | | | | |
| | | 183 | 1.0 | | | | | | | | |
| | | 182 | 2.0 | | | | | | | | |
| | | 181 | 3.0 | | | | | | | | |
| | | 180 | 4.0 | | | | | | | | |
| | | 179 | 5.0 | | start coring at 5.10m | | | | | | |
| NMLC | Not Observed | | | | **NO CORE:** 0.20 m | | | | | | |
| | | | | | **PEBBLY SANDSTONE**: coarse grained, orange brown and pale grey, some fine to medium grained sub-rounded gravel sized rock fragmnets. Trace roots to 6.1m. | XW | | | 0% | | Weathered rock |
| | | | | | | XW - HW | | | | | |
| | | | 6.0 | | **NO CORE:** 0.30 m | HW | | | 13% | | Fractured Rock |
| | | 178 | | | **PEBBLY SANDSTONE**: coarse grained, orange brown and pale grey, some fine to medium grained, sub-rounded gravel sized rock fragmnets of siltstone and ironstone and quartz. Extremely weathered material remoulds to Sandy Clay and Sand. | MW | | | | | Weathered Rock<br>JT, 60°, PL, RO, Fe SN<br>JT, 40°, PL, VR, Fe SN |
| | | | | | | XW | | | | | Fractured Rock |
| | | | | | | MW | | | | | |
| | | | | | | MW - SW | | a=0.20 d=0.30 | 80% | | |
| | | 177 | 7.0 | | 6.15 m: Cobble sized rock fragments of dolerite. | | | a=0.60 d=0.30 | | | |
| | | | | | Borehole BH15-04 terminated at 7.30 m Target depth | | | | | | |

Defects are: PT, 0 - 10°, PL, RO, Fe SN unless otherwise described

CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:30

**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

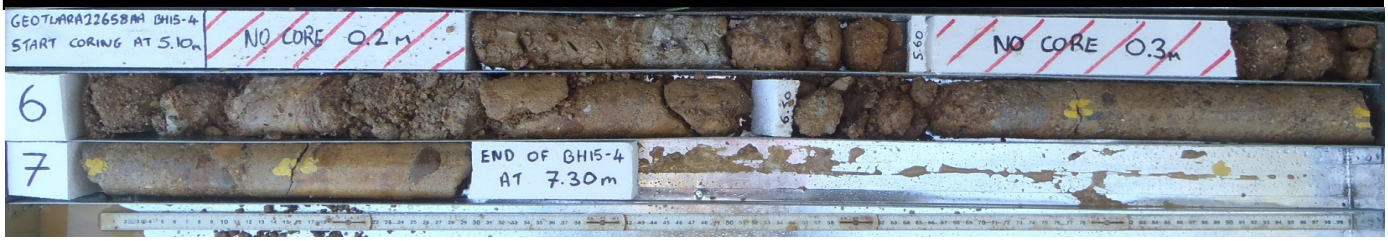
**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

Start depth 5.10m | BH15-04 BOX 1 | End depth 7.30m




| | | | | |
|---|---|---|---|---|
| drawn | ELC | coffey | client: | TSA MANAGEMENT |
| approved | DLK | | project: | PROPOSED BUILDING<br>MUSWELLBROOK HOSPITAL NSW |
| date | 23/11/2015 | | title: | CORE PHOTOGRAPH |
| scale | N/A | | project no: GEOTWARA22658AA | borehole no: BH15-04 |
| original size | A4 | | | |

coffey

# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH15-05*** |
| sheet: | 1 of 2 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***TSA MANAGEMENT*** | date started: ***18 Nov 2015*** |
| principal: | date completed: ***18 Nov 2015*** |
| project: ***PROPOSED BUILDING*** | logged by: ***AWJ*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***DLK*** |

position: E: 302153; N: 6428324 (MGA94 ) | surface elevation: 180.31 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | hole diameter :

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T CASING | | Not Observed | E | 180 | | | | **TOPSOIL: Sandy SILT**: brown, fine grained sand. | D | | | **TOPSOIL** |
| | | | U50<br>E | | | | | **FILL: Sandy CLAY**: medium to high plasticity, grey, fine to coarse grained sand, some fine grained gravel of coal and brick. | <Wp | | | **FILL**<br>U50 -300mm sample |
| | | | SPT<br>6, 10, 7<br>N*=17 | 179 | 1.0 | | | **FILL: Silty SAND**: fine to coarse grained, dark brown, some fine to medium grained gravel of coal and concrete. | D | | | |
| | | | E<br>SPT<br>10, 16, 28<br>N*=44 | 178 | 2.0 | | CH | **Sandy CLAY**: high plasticity, orange brown, coarse grained sand. | >Wp | VSt | | **RESIDUAL SOIL** |
| | | | | | 3.0 | | | **SANDSTONE**: coarse grained, orange brown and pale grey, extremely to highly weathered, very low strength. | | | | **WEATHERED ROCK** |
| | | | | 177 | | | | Borehole BH15-05 continued as cored hole | | | | AD/T refusal |
| | | | | 176 | 4.0 | | | | | | | |
| | | | | 175 | 5.0 | | | | | | | |
| | | | | 174 | 6.0 | | | | | | | |
| | | | | 173 | 7.0 | | | | | | | |

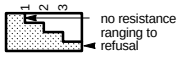
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:32

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

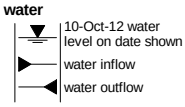
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**




**water**




**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH15-05** |
| sheet: | 2 of 2 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **18 Nov 2015** |
| principal: | |
| date completed: | **18 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302153; N: 6428324 (MGA94 ) | surface elevation: 180.31 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | drilling fluid: | hole diameter : | vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular | general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 180 | 1.0 | | | | | | | | | |
| | | 179 | 2.0 | | | | | | | | | |
| | | 178 | 3.0 | | start coring at 3.10m | | | | | | | |
| NMLC | Not Observed | 177 | 4.0 | | **NO CORE:** 0.50 m | | | | 0% | | Weathered rock | |
| | | | | | **PEBBLY SANDSTONE**: coarse grained, brown, fine to coarse grained gravel sized rock fragments, recovered as fine to coarse grained gravel and sand. | XW<br>MW | | | | | | |
| | | 176 | 5.0 | | **NO CORE:** 0.15 m<br>**PEBBLY SANDSTONE**: coarse grained, brown, fine to medium grained gravel sized rock fragments. trace cobble sized rock fragments of igneous (dolerite?) rock. | MW | | a=0.30<br>d=0.50<br>a=0.00<br>d=0.40 | 45% | | JT, 20°, PL, RO, Fe SN<br>JT, 25°, PL, RO, Fe SN<br>JT, 20°, PL, RO, Fe SN<br>Fractured rock<br>JT, 90°, PL, RO, Fe SN, 70 mm | Defects are: PT, 0 - 10°, PL, RO, Fe SN, unless otherwise described |
| | | 175 | 6.0 | | Borehole BH15-05 terminated at 5.00 m<br>Target depth | | | | | | | |
| | | 174 | 7.0 | | | | | | | | | |
| | | 173 | | | | | | | | | | |

CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:30

**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

Start depth 3.10m | BH15-05 BOX 1 | End depth 5.00m


| | | | | |
|---|---|---|---|---|
| drawn | ELC | coffey | client: | TSA MANAGEMENT |
| approved | DLK | | project: | PROPOSED BUILDING<br>MUSWELLBROOK HOSPITAL NSW |
| date | 23/11/2015 | | title: | CORE PHOTOGRAPH |
| scale | N/A | | project no: GEOTWARA22658AA | borehole no: BH15-05 |
| original size | A4 | | | |

coffey

# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH15-06*** |
| sheet: | 1 of 2 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***TSA MANAGEMENT*** | date started: ***18 Nov 2015*** |
| principal: | date completed: ***18 Nov 2015*** |
| project: ***PROPOSED BUILDING*** | logged by: ***AWJ*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***DLK*** |

position: E: 302139; N: 6428326 (MGA94 ) | surface elevation: 178.53 m (AHD) | angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted | hole diameter : 100 mm

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T CASING | | 18/11/15 17:30 | U50 | 178 | | | | **FILL: Silty SAND**: fine to medium grained, dark brown, grey, trace fine grained gravel of coal and pottery fragments. Trace of rootlets. | D | | | **FILL** |
| | | | | | | | CH | **Sandy CLAY**: high plasticity, orange brown, fine to coarse grained sand. | ~Wp | VSt | | **RESIDUAL SOIL** |
| | | | | | 1.0 | | | **SANDSTONE**: coarse grained, pale brown and orange, some fine to medium grained, sub-rounded gravel rized rock fragments, extremely weathered, very low strength, remoulds to Clayey Sand. | | | | **WEATHERED ROCK** U50 refusal |
| | | | SPT 10, 11, 27 N*=38 | 177 | | | | | | | | |
| | | | | | 2.0 | | | | | | | |
| | | | | 176 | | | | | | | | |
| | | | | | | | | Borehole BH15-06 continued as cored hole | | | | |
| | | | | 175 | 3.0 | | | | | | | |
| | | | | | 4.0 | | | | | | | |
| | | | | 174 | | | | | | | | |
| | | | | | 5.0 | | | | | | | |
| | | | | 173 | | | | | | | | |
| | | | | | 6.0 | | | | | | | |
| | | | | 172 | | | | | | | | |
| | | | | | 7.0 | | | | | | | |
| | | | | 171 | | | | | | | | |

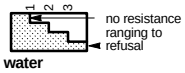
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:32

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

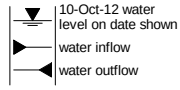
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**




**water**




**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

coffey

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH15-06** |
| sheet: | 2 of 2 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **18 Nov 2015** |
| principal: | |
| date completed: | **18 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302139; N: 6428326 (MGA94 ) surface elevation: 178.53 m (AHD) angle from horizontal: 90°

drill model: Enviro TD104, Truck mounted drilling fluid: hole diameter : 100 mm vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 178 | 1.0 | | start coring at 2.80m | | | | | | |
| | | 177 | 2.0 | | | | | | | | |
| | | 176 | | | | | | | | | |
| NMLC | 19/11/15 06:30 12:00 | | 3.0 | | **NO CORE:** 0.35 m | | | | | | |
| | | 175 | | | **PEBBLY SANDSTONE**: coarse grained, brown and pale brown, some fine to medium grained, sub-angular gravel sized rock fragments. | XW - HW<br>MW | | a=0.20<br>d=0.20 | 0% | | Fractured rock<br>JT, 20°, PL, RO, infill roots<br>Fractured rock |
| | | | 4.0 | | | | | | 88% | | PT, 10°, PL, RO, Fe SN |
| | | 174 | | | 4.10 m: Cobble sized rock fragment if dolerite, green (110mm thick)<br>**PEBBLY SANDSTONE**: coarse grained, brown, some fine to coarse grained gravel sized rock frangments of siltstone and quartz. Trace cobbles. | | | | | | Fractured rock |
| | | | 5.0 | | | | | a=0.60<br>d=0.50 | 59% | | SM Clay, 0°, PL, 4 mm<br>JT, 70°, PL, RO, Fe SN - Clay CO |
| | | 173 | | | | | | d=0.40<br>a=0.40<br>d=0.40 | | | SM Clay, 0°, PL, 10 mm |
| | | | 6.0 | | Borehole BH15-06 terminated at 5.90 m<br>Target depth | | | | | | |
| | | 172 | | | | | | | | | |
| | | | 7.0 | | | | | | | | |
| | | 171 | | | | | | | | | |

Defects are: PT, 0 - 10°, PL, RO, Fe SN, unless otherwise described

CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:30

**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

# Engineering Log - Borehole

| | |
|---|---|
| Hole ID. | **BH15-06** |
| sheet: | 1 of 1 |
| project no. | **GEOTWARA22658AA** |
| client: | **TSA MANAGEMENT** |
| date started: | **18 Nov 2015** |
| principal: | |
| date completed: | **18 Nov 2015** |
| project: | **PROPOSED BUILDING** |
| logged by: | **AWJ** |
| location: | **MUSWELLBROOK HOSPITAL** |
| checked by: | **DLK** |

position: E: 302139; N: 6428326 (MGA94 ) surface elevation: 178.53 m (AHD) angle from horizontal: 90°

equipment type: Enviro TD104, Truck mounted hole diameter : 100 mm

| drilling information | | | | well details | material substance | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| method & support | penetration 1 2 3 | water | samples & field tests | BH15-06 | RL (m) | depth (m) | graphic log | classification symbol | material description<br>**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components | moisture condition | consistency / relative density | structure and additional observations |
| AD/T CASING | | 18/11/15 17:30 | U50 | | 178 | | | | **FILL: Silty SAND**: fine to medium grained, dark brown, grey, trace fine grained gravel of coal and pottery fragments. Trace of rootlets. | D | | **FILL** |
| | | | | | | | | CH | **Sandy CLAY**: high plasticity, orange brown, fine to coarse grained sand. | ~Wp | VSt | **RESIDUAL SOIL** |
| | | | SPT 10, 11, 27 N*=38 | | 177 | 1.0 | | | **SANDSTONE**: coarse grained, pale brown and orange, some fine to medium grained, sub-rounded gravel rized rock fragments, extremely weathered, very low strength, remoulds to Clayey Sand. | | | **WEATHERED ROCK**<br>U50 refusal |
| | | | | | 176 | 2.0 | | | Borehole BH15-06 continued as cored hole | | | |
| NMLC | | 19/11/15 12:00 | d=0.2 a=0.2 | | | 3.0 | | | **NO CORE:** 0.35m (2.80-3.15 m) | | | |
| | | | | | 175 | | | | **PEBBLY SANDSTONE**: coarse grained, brown and pale brown, some fine to medium grained, sub-angular gravel sized rock fragments, moderately weathered, very low - very high strength. | | | |
| | | | | | | 4.0 | | | 4.1 m: Cobble sized rock fragment if dolerite, green (110mm thick) | | | |
| | | | d=0.5 a=0.6 | | 174 | | | | **PEBBLY SANDSTONE**: coarse grained, brown, some fine to coarse grained gravel sized rock frangments of siltstone and quartz. Trace cobbles, moderately weathered, very low to medium strength. | | | |
| | | | d=0.4 d=0.4 a=0.4 | | 173 | 5.0 | | | | | | |
| | | | | | | 6.0 | | | Borehole BH15-06 terminated at 5.90 m Target depth | | | **standpipe BH15-06 details:** stickup: 0.11m 2.9-m: screen |
| | | | | | 172 | | | | | | | |
| | | | | | | 7.0 | | | | | | |
| | | | | | 171 | | | | | | | |

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**method**

| | |
|---|---|
| AD | auger drilling* |
| AS | auger screwing* |
| HA | hand auger |
| W | washbore |
| * | bit shown by suffix |
| e.g. | AD/T |
| B | blank bit |
| T | TC bit |
| V | V bit |

**support**

| | |
|---|---|
| M | mud |
| C | casing |
| N | nil |

**penetration**

1 2 3 — no resistance ranging to refusal

**water**

10-Oct-12 water level on date shown; water inflow; water outflow

**samples & field tests**

| | |
|---|---|
| B | bulk disturbed sample |
| D | disturbed sample |
| E | environmental sample |
| SS | split spoon sample |
| U## | undisturbed sample ##mm diameter |
| HP | hand penetrometer (kPa) |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| VS | vane shear; peak/remouded (kPa) |
| R | refusal |
| HB | hammer bouncing |

**classification symbol & soil description** based on Unified Classification System

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| Wl | liquid limit |

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

Start depth 2.80m | BH15-06 BOX 1 | End depth 5.90m


| | | | | |
|---|---|---|---|---|
| drawn | ELC | coffey | client: | TSA MANAGEMENT |
| approved | DLK | | project: | PROPOSED BUILDING<br>MUSWELLBROOK HOSPITAL NSW |
| date | 23/11/2015 | | | |
| scale | N/A | | title: | CORE PHOTOGRAPH |
| original size | A4 | | project no: GEOTWARA22658AA | borehole no: BH15-06 |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 1 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T, PW casing | | | | 179 | | | | **FILL: Gravelly CLAY**: low plasticity, brown, fine to medium subangular gravel. | >Wp | | | **FILL** |
| | | | | 178 | | | | **Sandy CLAY**: medium to high plasticity, pale grey, some fine to medium subangular gravel. | <Wp | St to VSt | | **RESIDUAL SOIL** |
| | | | | 177 | 2.0 | | | | | | | **EXTREMELY WEATHERED TO HIGHLY WEATHERED ROCK** |
| | | | | 176 | | | | Becoming orange brown. | | | | |
| | | | | 175 | 4.0 | | | **Gravelly SAND**: fine to medium grained, brown to pale grey, fine to medium subangular gravel, some clay. | | | | |
| | | | | 174 | | | | **PEBBLY SANDSTONE**: fine to medium grained, grey and brown, fine to medium sized subangular clasts. | | | | **MODERATELY WEATHERED TO SLIGHTLY WEATHERED** |
| | | | | 173 | 6.0 | | | | | | | |
| | | | | 172 | | | | | | | | |
| | | | | 171 | 8.0 | | | | | | | JT |
| CB | | | | 170 | | | | Becoming grey. | | | | **SLIGHTLY WEATHERED ROCK** Several small washouts |
| | | | | 169 | 10.0 | | | | | | | |
| | | | | 168 | | | | | | | | JT |

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**method**
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

**support**
M mud
C casing
N nil

**penetration**
1 2 3 no resistance ranging to refusal

**water**
10-Oct-12 water level on date shown
water inflow
water outflow

**samples & field tests**
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

**consistency / relative density**
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 2 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | 16 mbgl , 13/07/16 , cased to 5.5 m | | 167 | | | | **PEBBLY SANDSTONE**: fine to medium grained, grey and brown, fine to medium sized subangular clasts. *(continued)* | | | | some shale oil? **SLIGHTLY WEATHERED ROCK** JT |
| | | | | 166 | | | | Gravel component proportion decreases. | | | | JT |
| | | | | | 14.0 | | | | | | | JT |
| | | | | 165 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some fine to medium sized clasts. | | | | **FRESH ROCK** |
| | | | | 164 | | | | | | | | |
| | | | | | | | | | | | | JT |
| | | | | 163 | 16.0 | | | | | | | |
| | | | | 162 | | | | | | | | |
| | | | | 161 | 18.0 | | | | | | | |
| | | | | | | | | | | | | PT |
| | | | | 160 | | | | | | | | |
| | | | | 159 | 20.0 | | | | | | | |
| | | | | 158 | | | | | | | | PT |
| | | | | 157 | 22.0 | | | | | | | |
| | | | | 156 | | | | | | | | Breakout |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-01** |
| sheet: | 3 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **14 Jun 2016** |
| principal: | date completed: **17 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 155 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some fine to medium sized clasts. *(continued)* | | | | **FRESH ROCK** |
| | | | | 154 | | | | | | | | |
| | | | | 153 | 26.0 | | | | | | | |
| | | | | 152 | | | | 27.4 to 27.5 m: 100mm white siltstone bed, brittle? | | | | JT on rock bed |
| | | | | 151 | 28.0 | | | | | | | |
| | | | | 150 | | | | | | | | Small breakout and JT |
| | | | | 149 | 30.0 | | | 30.0 to 30.2 m: 200mm conglomerate bed. | | | | |
| | | | | 148 | | | | | | | | |
| | | | | 147 | 32.0 | | | | | | | |
| | | | | 146 | | | | 32.8 to 32.9 m: 100mm white bed. | | | | |
| | | | | 145 | 34.0 | | | | | | | JT<br>JT, loose rocks in sidewall |
| | | | | 144 | | | | | | | | JT |

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**method**
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

**support**
M mud
C casing
N nil

**penetration**
1 2 3 no resistance ranging to refusal

**water**
10-Oct-12 water level on date shown
water inflow
water outflow

**samples & field tests**
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-01** |
| sheet: | 4 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **14 Jun 2016** |
| principal: | date completed: **17 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 143 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some fine to medium sized clasts. *(continued)* | | | | **FRESH ROCK** Breakout |
| | | | | 142 | | | | | | | | |
| | | | | 141 | 38.0 | | | | | | | Breakout |
| | | | | 140 | | | | 38.9 to 39.0 m: 100mm white bed. | | | | Small breakout |
| | | | | 139 | 40.0 | | | | | | | Breakout |
| | | | | 138 | | | | | | | | Triangular breakout on JTs |
| | | | | | | | | **COAL**: black, dull. | | | | |
| | | | | 137 | 42.0 | | | **INTERBEDDED SILTSTONE AND SANDSTONE** fine to medium grained, grey, some large sized white clasts. | | | | |
| | | | | 136 | | | | | | | | |
| | | | | 135 | 44.0 | | | | | | | Bridged rock was able to remove |
| | | | | 134 | | | | | | | | |
| | | | | 133 | 46.0 | | | | | | | JT JT |
| | | | | 132 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 5 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 131 | | | | **INTERBEDDED SILTSTONE AND SANDSTONE**: fine to medium grained, grey, some large sized white clasts. *(continued)* | | | | **FRESH ROCK** |
| | | | | 130 | | | | | | | | |
| | | | | 129 | 50.0 | | | | | | | |
| | | | | 128 | | | | | | | | |
| | | | | 127 | 52.0 | | | | | | | |
| | | | | 126 | | | | | | | | JT/PT<br>JT |
| | | | | 125 | 54.0 | | | | | | | |
| | | | | 124 | | | | | | | | |
| | | | | 123 | 56.0 | | | 55.8 to 56.1 m: 300mm brown bed. | | | | |
| | | | | 122 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: some fine to medium sized clasts. | | | | JT |
| | | | | 121 | 58.0 | | | | | | | |
| | | | | 120 | | | | 59.7 m: 100mm brown bed. | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**: no resistance ranging to refusal

**water**: 10-Oct-12 water level on date shown; water inflow; water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-01** |
| sheet: | 6 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **14 Jun 2016** |
| principal: | date completed: **17 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 119 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**; some fine to medium sized clasts. *(continued)* | | | | **FRESH ROCK** |
| | | | | 118 | | | | | | | | |
| | | | | 117 | 62.0 | | | | | | | |
| | | | | 116 | | | | | | | | |
| | | | | | | | | Grey and brown bedding. | | | | Borehole side walls starts to smooth out |
| | | | | 115 | 64.0 | | | | | | | |
| | | | | | | | | **COAL**: black, dull. | | | | PT |
| | | | | 114 | | | | | | | | |
| | | | | | | | | **INTERBEDDED SILTSTONE AND SANDSTONE** fine to medium grained, yellow and grey. | | | | JT |
| | | | | 113 | 66.0 | | | | | | | JT |
| | | | | 112 | | | | | | | | Near vertical JT |
| | | | | 111 | 68.0 | | | | | | | |
| | | | | 110 | | | | | | | | |
| | | | | 109 | 70.0 | | | | | | | |
| | | | | 108 | | | | Some carbonaceous laminations. | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
- 1 2 3 no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 7 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 107 | | | | **INTERBEDDED SILTSTONE AND SANDSTONE**: fine to medium grained, yellow and grey. *(continued)* | | | | JT |
| | | | | | | | | | | | | **FRESH ROCK** |
| | | | | 106 | | | | | | | | JT |
| | | | | | | | | | | | | JT |
| | | | | 105 | 74.0 | | | | | | | |
| | | | | 104 | | | | **INTERBEDDED COAL AND RHYOLITE**: black and pale grey, dull coal beds. | | | | |
| | | | | | 76.0 | | | **RHYOLITE**: grey. | | | | |
| | | | | 103 | | | | | | | | JT |
| | | | | 102 | | | | | | | | White (fieldspar?) vein |
| | | | | | 78.0 | | | **SILTSTONE**: grey. | | | | |
| | | | | 101 | | | | | | | | |
| | | | | 100 | | | | **INTERBEDDED CLAYSTONE AND SILTSTONE**: grey, some carbonaceous laminations. | | | | |
| | | | | | 80.0 | | | | | | | |
| | | | | 99 | | | | | | | | |
| | | | | 98 | | | | | | | | JT |
| | | | | | 82.0 | | | | | | | |
| | | | | 97 | | | | | | | | |
| | | | | 96 | | | | 400mm weathered zone. | | | | JT<br>Breakout<br>Large JT<br>PT |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
- 1 2 3 no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-01** |
| sheet: | 8 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **14 Jun 2016** |
| principal: | date completed: **17 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 95 | | | | **INTERBEDDED CLAYSTONE AND SILTSTONE**: grey, some carbonaceous laminations. *(continued)* | | | | **FRESH ROCK** |
| | | | | 94 | | | | | | | | |
| | | | | 93 | 86.0 | | | 86.1 m: 400mm rhyolite bed. | | | | PT<br>JT |
| | | | | 92 | | | | | | | | JT |
| | | | | 91 | 88.0 | | | | | | | |
| | | | | 90 | | | | Some 50mm carbonaceous beds. | | | | JT |
| | | | | 89 | 90.0 | | | **COAL**: black, dull to shiny.<br>Becoming clean and shiny coal. | | | | |
| | | | | 88 | | | | **SILTSTONE**: brown, some carbonaceous laminations. | | | | |
| | | | | 87 | 92.0 | | | **COAL**: black. | | | | |
| | | | | 86 | | | | | | | | |
| | | | | 85 | 94.0 | | | **SILTSTONE**: grey to brown, some carbonaceous laminations. | | | | |
| | | | | 84 | | | | **COAL**: black. | | | | |
| | | | | | | | | **SILTSTONE**: grey to brown, some carbonaceous laminations. | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
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| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 9 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 83 | | | | **SILTSTONE**: grey to brown, some carbonaceous laminations. *(continued)* | | | | **FRESH ROCK** |
| | | | | 82 | | | | | | | | |
| | | | | 81 | 98.0 | | | | | | | |
| | | | | 80 | | | | | | | | |
| | | | | | 100.0 | | | **COAL:** black, dull with bright bands | | | | |
| | | | | 79 | | | | Borehole BH16-01 continued as cored borehole | | | | |
| | | | | 78 | | | | | | | | |
| | | | | 77 | 102.0 | | | | | | | |
| | | | | 76 | | | | | | | | |
| | | | | 75 | 104.0 | | | | | | | |
| | | | | 74 | | | | | | | | |
| | | | | 73 | 106.0 | | | | | | | |
| | | | | 72 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 no resistance ranging to refusal

**water**
10-Oct-12 water level on date shown
water inflow
water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 10 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW | vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular | general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HQ | | 79 | | | start coring at 100.00m | | | | | | | |
| | | 78 | | | **COAL**: black, dull with bright bands. | FR | | a=1.43<br>d=0.25 | 20% | | CS, IR, SO, CN<br>CS, IR, SO, CN<br>JT, 45°, PL, SL, CN<br>JT, 45°, PL, SL, CN<br>JT, 45°, PL, SL, CN<br>JT, 45°, PL, SL, CN | |
| | | 77 | 102.0 | | | | | a=0.97<br>d=0.10<br>a=0.52<br>d=0.94 | | | CS, IR, SO, CN | |
| | | 76 | | | **INTERLAMINATED SILTSTONE & SANDSTONE**: fine grained, dark grey, some coal beds. | | | | 64% | | SM, 5°, PL, SO, CN, 0.01 mm | |
| | | 75 | 104.0 | | | | | a=2.36<br>d=0.89 | | | | |
| | | 74 | | | | | | | | | JT, 20°, PL, SO, CN<br>PT, 20°, UN, SO, CN | |
| | | 73 | 106.0 | | | | | a=0.65<br>d=0.18 | 59% | | PT, UN, SO, CN<br>PT, 5°, IR, SL, CN<br>CS, IR, SL, CN<br>CS, IR, SL, CN, CORE LOSS<br>CS, IR, SL, CN<br>CS, IR, SL, CN<br>CS, IR, SO, CN | |
| | | 72 | | | | | | a=1.44<br>d=0.20<br>a=0.70<br>d=0.08 | | | PT, 5°, CU, SO, CN<br>PT, 5°, CU, SO, CN<br>PT, 5°, CU, SO, CN<br>PT, 5°, CU, SO, CN<br>CS, 5°, IR, SL, CN | |
| | | 71 | 108.0 | | **COAL**: black, dull with bright bands. | | | a=1.58<br>d=0.57 | | | CS, IR, RO, CN<br>CS, IR, RO, CN<br>CS, IR, RO, CN<br>CS, IR, RO, CN<br>PT, 5°, PL, SL, CN | |
| | | 70 | | | | | | | 63% | | CS, IR, SO, CN<br>CS, IR, SO, CN<br>CS, IR, SO, CN<br>CS, IR, SO, CN<br>CS, IR, SO, CN<br>CS, IR, SO, CN | |
| | | 69 | 110.0 | | | | | | | | CS, IR, SO, CN<br>CS, IR, SO, CN<br>JT, PL, SL, CN | |
| | | 68 | | | | | | a=1.22<br>d=0.29<br>a=0.79<br>d=0.32<br>a=0.53<br>d=0.13 | 66% | | CS, IR, SO, CN | |
| | | | | | **NO CORE:** 0.31 m **NO CORE**: COAL visible | | | | | | CS, IR, SO, CN | |

Defects are: PT, 5°, PL, SO, CN, unless otherwise described

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**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

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# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-01*** |
| sheet: | 11 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***14 Jun 2016*** |
| principal: | date completed: ***17 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302157; N: 6428339 (MGA94 ) | surface elevation: 179.15 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW | vane id.:

**drilling information** | **material substance** | **rock mass defects**

| method & support | water | RL (m) | depth (m) | graphic log | material description<br>**ROCK TYPE**: grain characterisics, colour, structure, minor components | weathering & alteration | estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH | samples, field tests & Is(50) (MPa) a = axial; d = diametral | core run & RQD | defect spacing (mm) 30 100 300 1000 3000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HQ | | 67<br>66<br>65<br>64 | 114.0 | | on CCTV.<br>**NO CORE:** 3.30 m **VOID**: base of void not confirmed on CCTV. | | | | | | |
| | | | | | **NO CORE:** 0.25 m **NO CORE**: not confirmed. | | | | | | |
| | | 63<br>62<br>61<br>60<br>59<br>58<br>57<br>56 | 116.0<br>118.0<br>120.0<br>122.0 | | Borehole BH16-01 terminated at 115.55 m | | | | | | |

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**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**water**
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

**graphic log / core recovery**
- core recovered (graphic symbols indicate material)
- no core recovered

**core run & RQD**
- barrel withdrawn

RQD = Rock Quality Designation (%)

**weathering & alteration***
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

**strength**
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

**defect type**
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 1 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD/T | | | | 178 | | | | **FILL: Gravelly SAND**: fine to medium grained, dark brown, fine to coarse gravel. | M | | | **FILL** |
| | | | | | | | | **Sandy CLAY**: medium to high plasticity, orange brown, fine to coarse grained sand. | >Wp | St to VSt | | **RESIDUAL SOIL** |
| | | | | 177 | 2.0 | | | **SAND**: fine to medium grained. | M | | | **EXTREMELY WEATHERED TO HIGHLY WEATHERED ROCK** |
| | | | | 176 | | | | | | | | |
| | | | | 175 | 4.0 | | | | | | | |
| | | | | 174 | | | | | | | | |
| | | | | 173 | 6.0 | | | **PEBBLY SANDSTONE**: medium - coarse grained, yellow brown, some subangular gravel,. | | | | **MODERATELY WEATHERED TO SLIGHTLY WEATHERED** |
| | | | | 172 | | | | | | | | |
| | | | | 171 | 8.0 | | | Becoming grey. | | | | **SLIGHTLY WEATHERED ROCK** |
| CB | | | | 170 | | | | | | | | |
| | | | | 169 | | | | | | | | Washout |
| | | | | 168 | 10.0 | | | Becoming dark grey. | | | | PT |
| | | | | 167 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
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- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
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- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-03** |
| sheet: | 2 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **20 Jun 2016** |
| principal: | date completed: **23 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | 13/07/16 ▽ | | 166 | | | | **PEBBLY SANDSTONE**: medium - coarse grained, yellow brown, some subangular gravel,. *(continued)* | | | | **SLIGHTLY WEATHERED ROCK** |
| | | | | 165 | 14.0 | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some large sized white clasts. | | | | **FRESH ROCK** |
| | | | | 164 | | | | | | | | Washout |
| | | | | 163 | 16.0 | | | | | | | Slight washout |
| | | | | 162 | | | | | | | | JT |
| | | | | 161 | 18.0 | | | Becoming pale grey. | | | | JT |
| | | | | 160 | | | | | | | | JT |
| | | | | 159 | 20.0 | | | | | | | |
| | | | | 158 | | | | | | | | |
| | | | | 157 | 22.0 | | | 22.1 m: 100mm white bed. | | | | |
| | | | | 156 | | | | | | | | |
| | | | | 155 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 no resistance ranging to refusal

**water**
10-Oct-12 water level on date shown
water inflow
water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
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- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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| St | stiff |
| VSt | very stiff |
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| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 3 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 154 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some large sized white clasts. *(continued)* | | | | **FRESH ROCK** JT |
| | | | | 153 | | | | | | | | Washout |
| | | | | 152 | 26.0 | | | | | | | |
| | | | | 151 | | | | | | | | |
| | | | | 150 | 28.0 | | | | | | | |
| | | | | 149 | | | | | | | | JT |
| | | | | 148 | 30.0 | | | | | | | |
| | | | | 147 | | | | | | | | |
| | | | | 146 | 32.0 | | | With some gravel clasts. | | | | |
| | | | | 145 | | | | | | | | |
| | | | | 144 | 34.0 | | | | | | | |
| | | | | 143 | | | | Becoming grey. | | | | JT |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 4 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 142 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some large sized white clasts. *(continued)* | | | | **FRESH ROCK** |
| | | | | 141 | 38.0 | | | | | | | Breakout |
| | | | | 140 | | | | | | | | |
| | | | | 139 | 40.0 | | | | | | | |
| | | | | 138 | | | | | | | | |
| | | | | | | | | **COAL**: black, dull. | | | | Breakout |
| | | | | 137 | | | | **INTERBEDDED SILTSTONE AND SANDSTONE** fine medium grained, grey, some large sized white clasts. | | | | |
| | | | | 136 | 42.0 | | | | | | | |
| | | | | 135 | | | | | | | | |
| | | | | 134 | 44.0 | | | | | | | Breakout |
| | | | | 133 | | | | | | | | |
| | | | | 132 | 46.0 | | | | | | | |
| | | | | 131 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-03** |
| sheet: | 5 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **20 Jun 2016** |
| principal: | date completed: **23 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 130 | | | | **INTERBEDDED SILTSTONE AND SANDSTONE**: fine medium grained, grey, some large sized white clasts. *(continued)* | | | | **FRESH ROCK** |
| | | | | 129 | 50.0 | | | | | | | |
| | | | | 128 | | | | | | | | JT |
| | | | | 127 | 52.0 | | | | | | | |
| | | | | 126 | | | | | | | | |
| | | | | 125 | | | | | | | | |
| | | | | 124 | 54.0 | | | | | | | Small breakout |
| | | | | 123 | | | | | | | | Breakout JT |
| | | | | 122 | 56.0 | | | | | | | |
| | | | | 121 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey brown, some fine to medium sized clasts. | | | | JT |
| | | | | 120 | 58.0 | | | | | | | |
| | | | | 119 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 6 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 118 | | | | **INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey brown, some fine to medium sized clasts. *(continued)*<br>Some fine to medium sized subangular gravel clasts. | | | | **FRESH ROCK** |
| | | | | 117 | 62.0 | | | | | | | |
| | | | | 116 | | | | | | | | |
| | | | | 115 | 64.0 | | | | | | | |
| | | | | 114 | | | | **COAL**: black, dull.<br>Becoming shiny. | | | | |
| | | | | 113 | 66.0 | | | **INTERBEDDED SILTSTONE AND SANDSTONE**<br>fine medium grained, yellow grey. | | | | |
| | | | | 112 | | | | | | | | |
| | | | | 111 | 68.0 | | | Becoming grey. | | | | |
| | | | | 110 | | | | | | | | |
| | | | | 109 | 70.0 | | | | | | | |
| | | | | 108 | | | | | | | | |
| | | | | 107 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 7 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 106 | | | | **INTERBEDDED SILTSTONE AND SANDSTONE**: fine medium grained, yellow grey. *(continued)* | | | | **FRESH ROCK** |
| | | | | 105 | | | | | | | | |
| | | | | | 74.0 | | | | | | | |
| | | | | 104 | | | | | | | | |
| | | | | 103 | | | | **INTERBEDDED COAL AND RHYOLITE**: black and pale grey, dull coal beds. | | | | |
| | | | | | 76.0 | | | **RHYOLITE**: pale grey. | | | | |
| | | | | 102 | | | | | | | | JT |
| | | | | 101 | | | | | | | | |
| | | | | | 78.0 | | | **SILTSTONE**: grey. | | | | |
| | | | | 100 | | | | | | | | |
| | | | | 99 | | | | **INTERBEDDED CLAYSTONE AND SILTSTONE**: grey, some carbonaceous laminations. | | | | |
| | | | | | 80.0 | | | | | | | |
| | | | | 98 | | | | | | | | JT |
| | | | | 97 | | | | | | | | |
| | | | | | 82.0 | | | | | | | |
| | | | | 96 | | | | | | | | |
| | | | | 95 | | | | | | | | Large 200mm breakout |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
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| Fb | friable |
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| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-03** |
| sheet: | 8 of 11 |
| project no. | **GEOTWARA22658AA** |
| client: **HEALTH INFRASTRUCTURE** | date started: **20 Jun 2016** |
| principal: | date completed: **23 Jun 2016** |
| project: **PROPOSED BUILDING** | logged by: **TT** |
| location: **MUSWELLBROOK HOSPITAL** | checked by: **SJB** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 94 | | | | **INTERBEDDED CLAYSTONE AND SILTSTONE** grey, some carbonaceous laminations. *(continued)* | | | | **FRESH ROCK** |
| | | | | 93 | 86.0 | | | | | | | |
| | | | | 92 | | | | | | | | |
| | | | | 91 | 88.0 | | | | | | | |
| | | | | 90 | | | | | | | | |
| | | | | 89 | 90.0 | | | | | | | |
| | | | | 88 | | | | **COAL**: black, dull to bright. | | | | |
| | | | | 87 | | | | | | | | |
| | | | | 86 | 92.0 | | | **SILTSTONE**: brown, some carbonaceous laminations. | | | | |
| | | | | 85 | | | | **COAL**: black. | | | | |
| | | | | 84 | 94.0 | | | **SILTSTONE**: brown. | | | | |
| | | | | 83 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 9 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 82 | | | | **SILTSTONE**: brown. *(continued)* | | | | **FRESH ROCK** |
| | | | | 81 | | | | | | | | |
| | | | | | 98.0 | | | **COAL**: black, dull, with bright bands. | | | | |
| | | | | 80 | | | | | | | | |
| | | | | 79 | | | | | | | | |
| | | | | | 100.0 | | | | | | | |
| | | | | 78 | | | | | | | | |
| | | | | 77 | | | | **INTERLAMINATED SILTSTONE AND SANDSTONE**: brown. | | | | |
| | | | | | 102.0 | | | | | | | |
| | | | | 76 | | | | | | | | |
| | | | | 75 | | | | | | | | |
| | | | | | 104.0 | | | | | | | |
| | | | | 74 | | | | | | | | |
| | | | | 73 | | | | | | | | |
| | | | | | 106.0 | | | | | | | |
| | | | | 72 | | | | **COAL**: black, dull, with bright bands. | | | | |
| | | | | 71 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
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- N* SPT - sample recovered
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- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
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| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | ***BH16-03*** |
| sheet: | 10 of 11 |
| project no. | ***GEOTWARA22658AA*** |
| client: ***HEALTH INFRASTRUCTURE*** | date started: ***20 Jun 2016*** |
| principal: | date completed: ***23 Jun 2016*** |
| project: ***PROPOSED BUILDING*** | logged by: ***TT*** |
| location: ***MUSWELLBROOK HOSPITAL*** | checked by: ***SJB*** |

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 70 | | | | **COAL**: black, dull, with bright bands. *(continued)* | | | | |
| | | | | 69 | | | | | | | | |
| | | | | | 110.0 | | | | | | | |
| | | | | 68 | | | | | | | | |
| | | | | | | | | **NO CORE:** 2.30m (110.80-113.10 m) **VOID**. | | | | |
| | | | | 67 | | | | | | | | |
| | | | | | 112.0 | | | | | | | |
| | | | | 66 | | | | | | | | |
| | | | | | | | | **COAL**: black, dull. | | | | |
| | | | | 65 | | | | | | | | |
| | | | | | 114.0 | | | **SILTSTONE**: grey. | | | | |
| | | | | 64 | | | | | | | | |
| | | | | 63 | | | | | | | | |
| | | | | | 116.0 | | | | | | | |
| | | | | 62 | | | | **COAL**: black. | | | | |
| | | | | 61 | | | | | | | | |
| | | | | | 118.0 | | | | | | | |
| | | | | 60 | | | | | | | | |
| | | | | 59 | | | | | | | | |

CDF_0_9_06_LIBRARY.GLB rev:AM Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 02/08/2016 13:10

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

coffey
A TETRA TECH COMPANY

# Engineering Log - Borehole

| | |
|---|---|
| Borehole ID. | **BH16-03** |
| sheet: | 11 of 11 |
| project no. | **GEOTWARA22658AA** |
| date started: | **20 Jun 2016** |
| date completed: | **23 Jun 2016** |
| logged by: | **TT** |
| checked by: | **SJB** |

client: ***HEALTH INFRASTRUCTURE***

principal:

project: ***PROPOSED BUILDING***

location: ***MUSWELLBROOK HOSPITAL***

position: E: 302139; N: 6428329 (MGA94 ) | surface elevation: 178.63 m (AHD) | angle from horizontal: 90°

drill model: , Truck mounted | drilling fluid: | casing diameter : PW

**drilling information** | **material substance**

| method & support | penetration | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | hand penetrometer (kPa) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CB | | | | 58 | | | | **INTERBEDDED SILTSTONE AND SANDSTONE** brown grey. | | | | |
| | | | | 57 | | | | | | | | |
| | | | | | 122.0 | | | | | | | |
| | | | | 56 | | | | | | | | |
| | | | | 55 | | | | | | | | |
| | | | | | 124.0 | | | | | | | |
| | | | | 54 | | | | | | | | |
| | | | | 53 | | | | Borehole BH16-03 terminated at 124.80 m | | | | |
| | | | | | 126.0 | | | | | | | |
| | | | | 52 | | | | | | | | |
| | | | | 51 | | | | | | | | |
| | | | | | 128.0 | | | | | | | |
| | | | | 50 | | | | | | | | |
| | | | | 49 | | | | | | | | |
| | | | | | 130.0 | | | | | | | |
| | | | | 48 | | | | | | | | |
| | | | | 47 | | | | | | | | |

CDF_0_9_06_LIBRARY.GLB rev:AM Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 02/08/2016 13:10

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
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1 2 3 — no resistance ranging to refusal

**water**
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

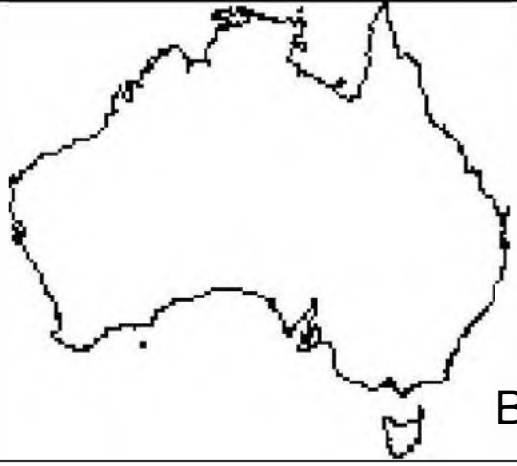
**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |



# GROUNDSEARCH AUSTRALIA

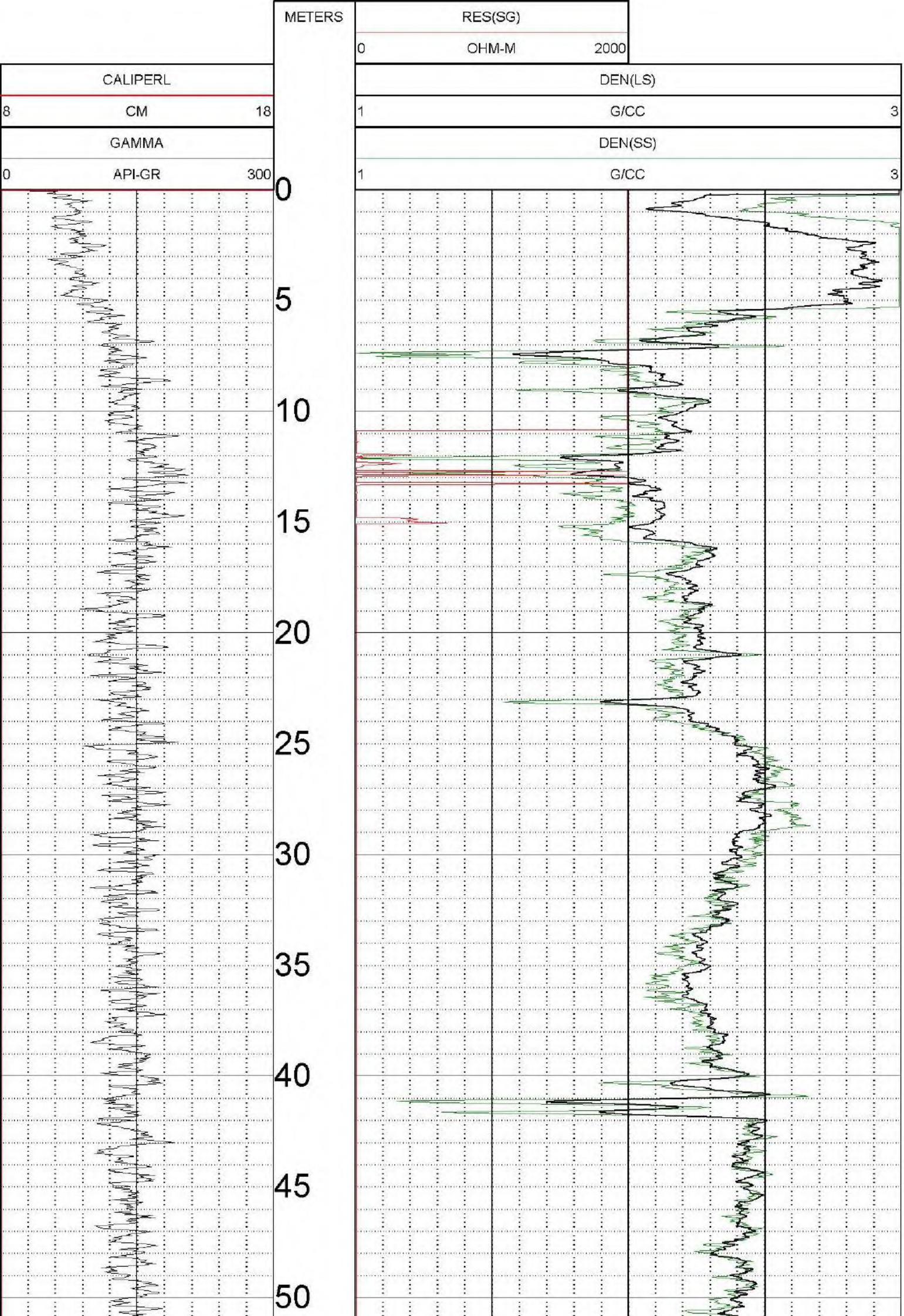
(ABN 11 057 389 152)

## BH16-01 DENSITYC 1:200

| | | | | | |
|---|---|---|---|---|---|
| COMPANY | : COFFEY GEOTECH | | | OTHER SERVICES: | |
| WELL | : BH16-01 DENSITYC | | | DEN | |
| LOCATION/FIELD | : 1 :200 HOSPITAL | | | | |
| COUNTY | : AUST MUSWELLBROOK | | | | |
| LOCATION | : NA | | | | |
| SECTION | : | TOWNSHIP | : NA | RANGE | : NA |
| | 06/17/16 | | | | |
| DATE | : 115.75 | PERMANENT DATUM | : 2.4 | | |
| DEPTH DRILLER | : | | | KB | : NA |
| LOG BOTTOM | : 115.27 | LOG MEASURED FROM: | GL | DF | : NA |
| LOG TOP | : -2.19 | DRL MEASURED FROM: | GL | GL | : 0 |
| CASING DIAMETER | : 10. | LOGGING UNIT | : 120 | | |
| CASING TYPE | : HQ | FIELD OFFICE | : RUTHERFORD | | |
| CASING THICKNESS: | .5 | RECORDED BY | : M CRANE | | |
| BIT SIZE | : 9.60 | BOREHOLE FLUID | : 0 | FILE | : PROCESSED |
| MAGNETIC DECL. | : 0 | RM | : 0 | TYPE | : 9239C1 |
| MATRIX DENSITY | : 2.65 | RM TEMPERATURE | : 0 | LGDATE | : 06/17/16 |
| NEUTRON MATRIX | : SANDSTONE | MATRIX DELTA T | : 177 | LGTIME | : 11:07: |
| | | | | THRESH: | 99999 |

IN RODS

TOP OF BARREL 111.5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RES(SG)
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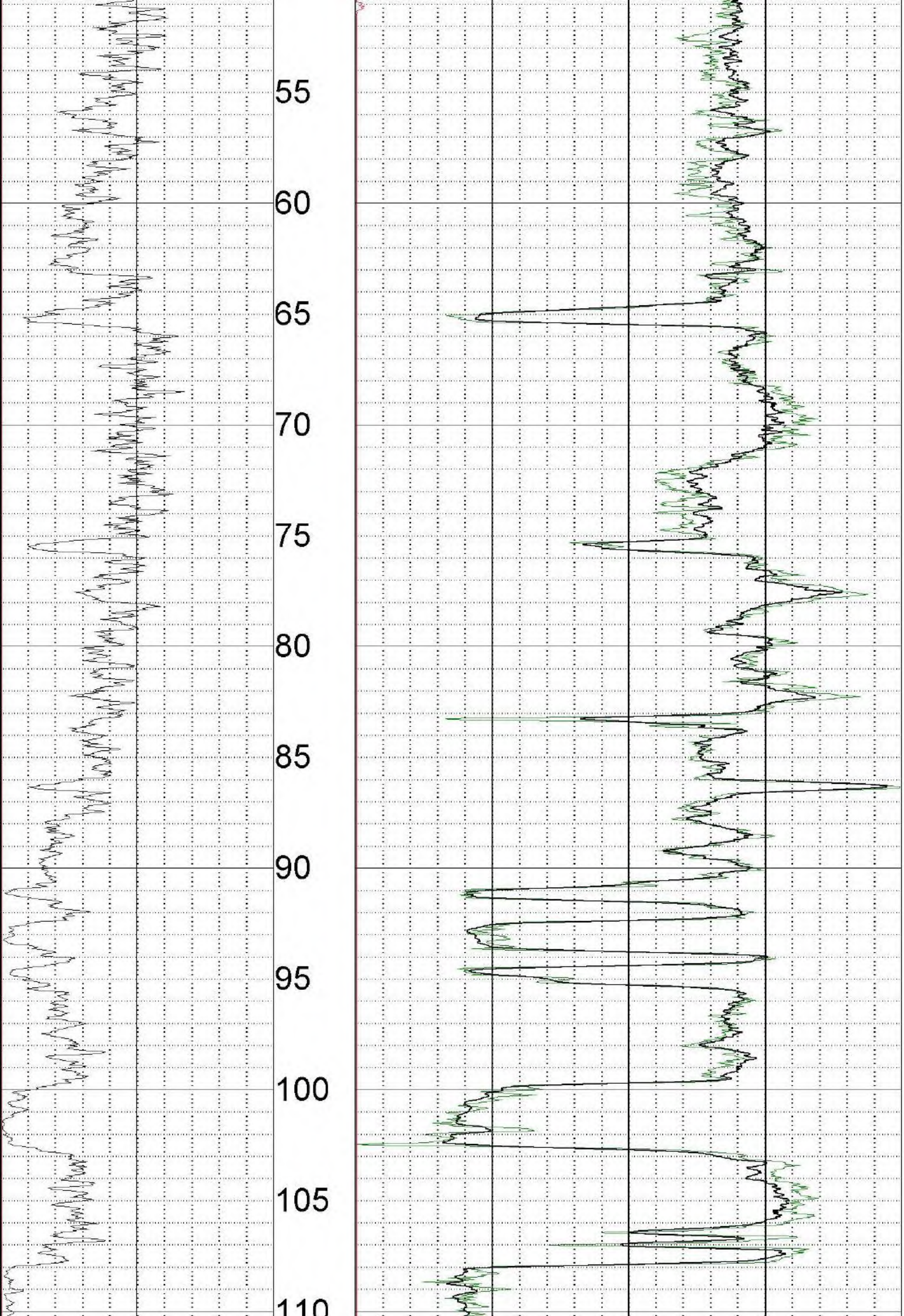
OHM-M
2000
CALIPERL
8
CM
18
DEN(LS)
1
G/CC
3
GAMMA
0
API-GR
300
DEN(SS)
1
G/CC
3
0
5
10
15
20
25
30
35
40
45
50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60
65
70
75
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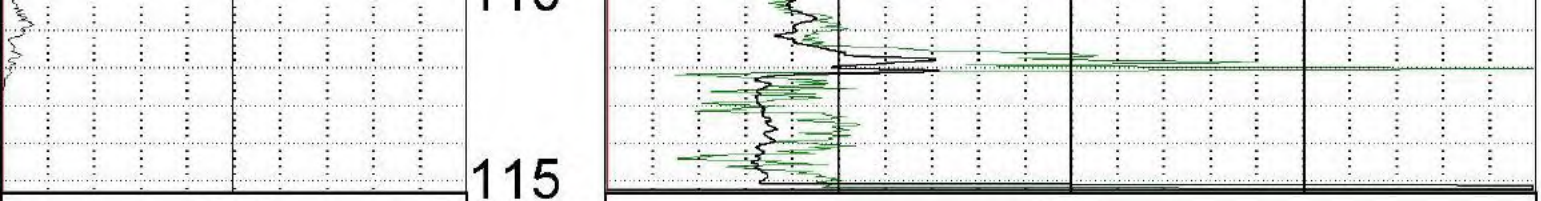
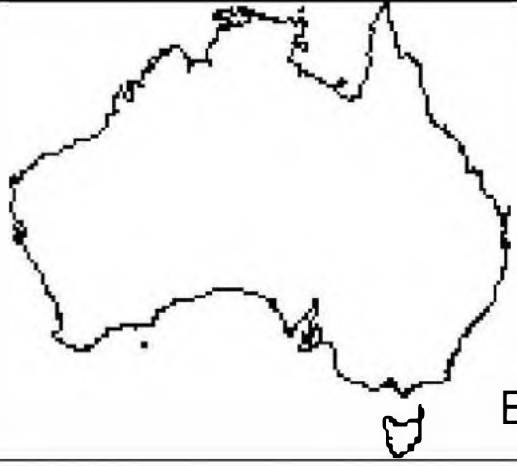
85
90
95
100
105
110



| | | |
|---|---|---|
| 0 | API-GR | 300 |
| | GAMMA | |
| 8 | CM | 18 |
| | CALIPERL | |

115

| | | |
|---|---|---|
| 1 | G/CC | 3 |
| | DEN(SS) | |
| 1 | G/CC | 3 |
| | DEN(LS) | |
| 0 | OHM-M | 2000 |
| METERS | RES(SG) | |



# GROUNDSEARCH AUSTRALIA

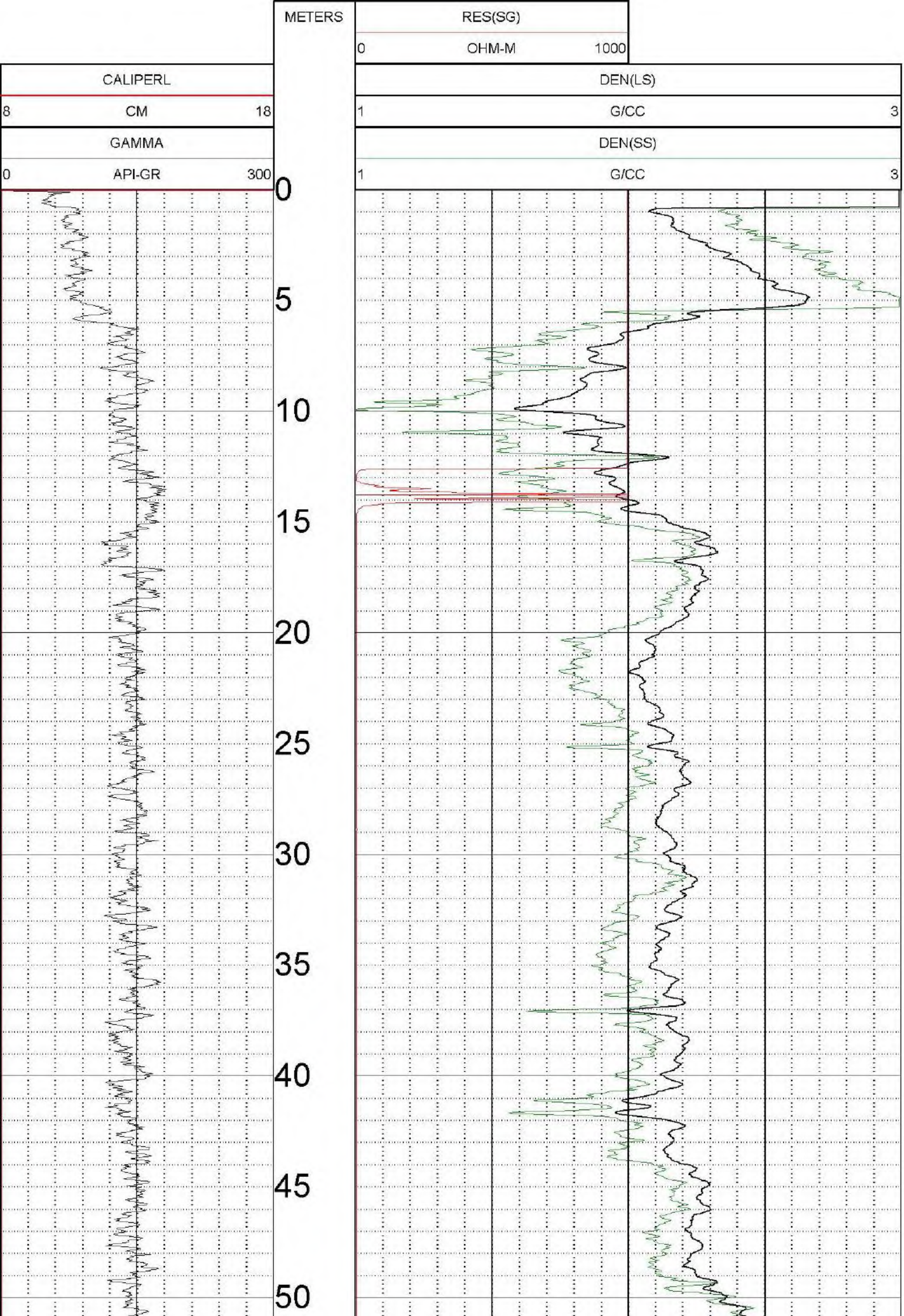
(ABN 11 057 389 152)

## BH16-03 DENSITYc 1:200

| | | | | | |
|---|---|---|---|---|---|
| COMPANY | : COFFEY GEOTECH | | | OTHER SERVICES: | |
| WELL | : BH16-03 DENSITYc 1:200 | | | DEN | |
| LOCATION/FIELD | : | | | | |
| COUNTY | : AUST | | | | |
| LOCATION | : JESMOND | | | | |
| SECTION | : NA | TOWNSHIP | : NA | RANGE | : NA |
| DATE | : 06/23/16 | PERMANENT DATUM | : -1.15 | | |
| DEPTH DRILLER | : 125 | | | KB | : NA |
| LOG BOTTOM | : 124.55 | LOG MEASURED FROM: | GL | DF | : NA |
| LOG TOP | : -1.61 | DRL MEASURED FROM: | GL | GL | : 0 |
| CASING DIAMETER | : 10. | LOGGING UNIT | : 120 | | |
| CASING TYPE | : HQ STEE | FIELD OFFICE | : RUTHERFORD | | |
| CASING THICKNESS: | .5 | RECORDED BY | : M CRANE | | |
| BIT SIZE | : 9.60 | BOREHOLE FLUID | : 0 | FILE | : PROCESSED |
| MAGNETIC DECL. | : 0 | RM | : 0 | TYPE | : 9239C1 |
| MATRIX DENSITY | : 2.65 | RM TEMPERATURE | : 0 | LGDATE: | 06/23/16 |
| NEUTRON MATRIX | : SANDSTONE | MATRIX DELTA T | : 177 | LGTIME : | 09:44: |
| | | | | THRESH: | 99999 |

LOFFED THROUGH THE RODS

CORRECTED FOR STEEL


METERS
RES(SG)
0
OHM-M
1000
CALIPERL
8
CM
18
DEN(LS)
1
G/CC
3
GAMMA
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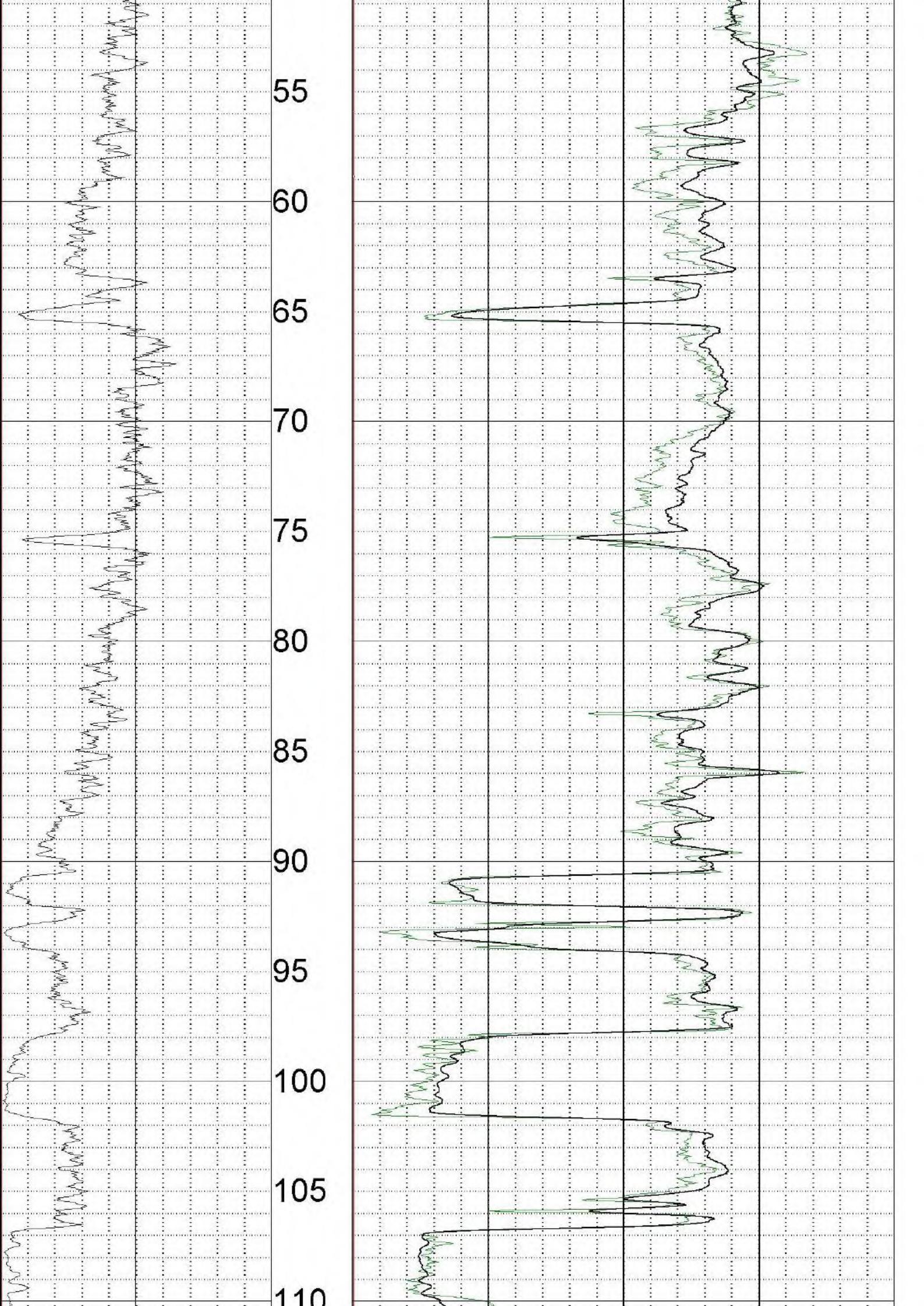
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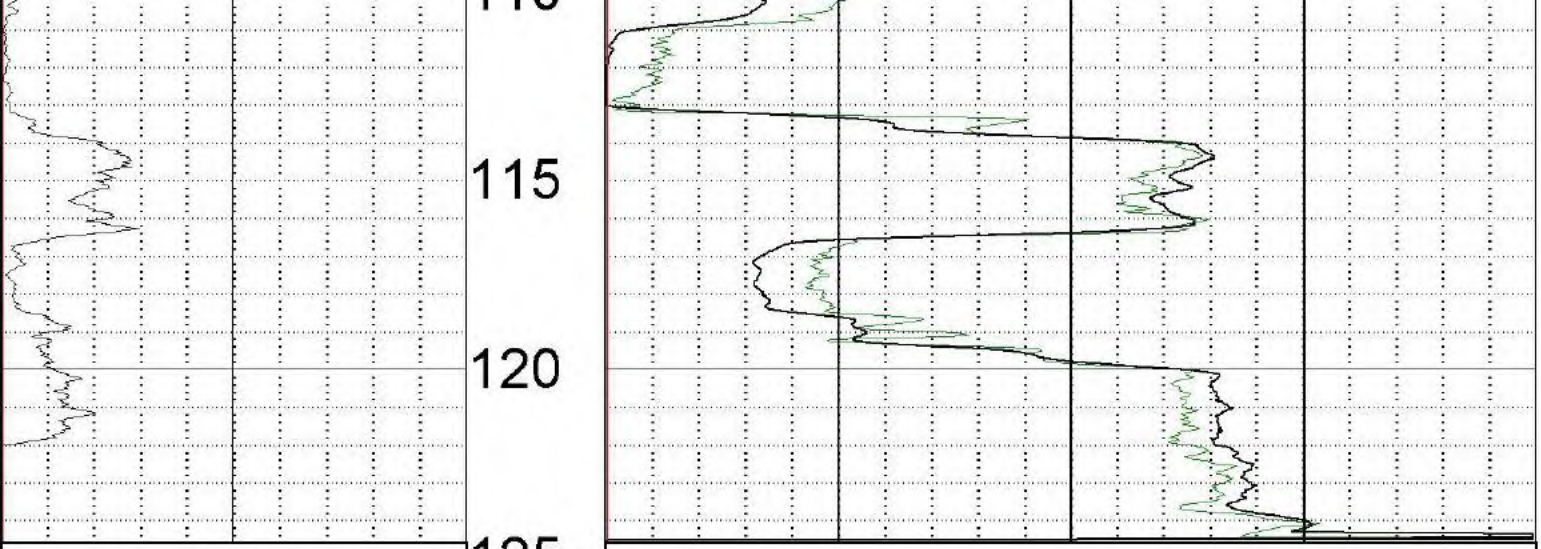
105
110



| 0 | API-GR | 300 |
|---|---|---|
| GAMMA | | |
| 8 | CM | 18 |
| CALIPERL | | |

| 115 |
|---|
| 120 |
| 125 |
| METERS |

| 1 | G/CC | 3 |
|---|---|---|
| DEN(SS) | | |
| 1 | G/CC | 3 |
| DEN(LS) | | |
| 0 | OHM-M | 1000 |
| RES(SG) | | |

# Coffey Geotechnics

## Borehole BH16-01

### ACOUSTIC TELEVIEWER PETROPHYSICAL REPORT

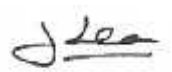
**Groundsearch Australia Pty. Limited**

**15 July 2016**

# DISCLAIMER

The data used in this report were obtained using equipment manufactured by the Century Geophysical Corporation. The interpretations given in this report are based on judgement and experience of Groundsearch Australia's personnel. They are provided for Coffey Geotechnics sole use in accordance with a specified brief. As such, the interpretation outcomes do not necessarily address all aspects of ground conditions and behaviour on the subject site. The responsibility of Groundsearch Australia is solely to Coffey Geotechnics and it is not intended that any third party rely upon this report. This report shall not be reproduced either wholly or in part without the written permission of Groundsearch Australia Pty. Limited.

For and on behalf of Groundsearch Australia Pty. Limited



John Lea BSc (Hons)
FAusIMM MMICA MAIMVA (CPA)
Principal Geologist
Managing Director

## *Executive summary*

The data contained in this report were obtained from one 9.6cm diameter, vertical, non-cored borehole that was drilled as a component of the 2016 geotechnical exploration programme for Coffey Geotechnics Muswellbrook Hospital Project.

Century Geophysical Corporation downhole 9804 acoustic televiewer and 9329 density tools were run to collect data in the field on 13 July 2016 and 17 June 2016 respectively. The density run was through drill rods and the data corrected to reflect open hole conditions. This report is for data from 15.50 to 113.11 mbgl.

The borehole wall sonic data appear to be affected by rugosity caused by the drilling method used.

The 284 identified features are interpreted as bedding (75%), fractures, washouts, the SWL and top of the abandoned coal workings. The bedding to fractures ratio is 4:1. The coal contains some high angle features that are probably cleats.

The Century Display program has automatically recalculated the dip angle data to represent the borehole in the vertical position and the dip direction data is referenced to magnetic north.

## *1.0 Background technical information*

The data contained in this report were obtained from one 9.6cm diameter, vertical, non-cored borehole that was drilled as a component of the 2016 geotechnical exploration programme for Coffey Geotechnics Muswellbrook Hospital Project.

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The Century Display program has automatically recalculated the dip angle data to represent the borehole in the vertical position and the dip direction data is referenced to magnetic north.

Subsequent processing and interpretation of data were carried out by Groundsearch.

The ATV takes an oriented image of the borehole using high-resolution sound waves. This acoustic image is displays amplitude variations. This information is used to detect bedding planes, fractures, and other borehole anomalies without the need to have clear fluid filling the boreholes. The tool works only in fluid-filled boreholes.

The televiewer digitises 256 measurements around the borehole at each high-resolution sample interval. These data can be oriented to North and displayed real-time while logging using the Visual Compu-Log System.

Analysis software includes colour adjustment, fracture dip and strike determination, and classification of features. It allows information to be displayed on the graphical screen, plot, and in report format.

## *2.0 Interpretation methodology*

It should be noted that the ATV is a bowspring-type, centralised tool and is affected by poor wallrock conditions known as rugosity.

The ATV data interpretation procedure is based on the superposition of curves on feature logs directly onto the computer screen by using a subjective, manual; two-point definition of a feature's top and base to produce a sine curve. The sides of the time and

amplitude plots represent magnetic north and magnetic south is in the centre of each plot. The low side, or trough, of the sine curve defines the dip direction of the feature.

The logging program automatically records the televiewer tool slant angle and bearing and corrects for any borehole deviations. The curves are automatically given an identification number for subsequent referencing in a report file.

There are possibly more bedding planes and structural fractures appearing in the televiewer logs that have not been included in this report due to their poor graphic definition or the inability to resolve their geometry by superposing a sine curve using the program's two point method.

This report contains a;

- Text summary of the interpreted features
- Circular representation of interpreted features
- Logs that show geological features with their subjective, numbered interpretation curves shown at 1:20 scale. The logs are in standard format whereby the optical image of the borehole wall is "flattened" onto the plot. The logs have the following additional features to enhance geological interpretations of the strata;
    - Amplitude image differentials
    - Tadpoles that represent feature dip and dip direction
    - Open fracture planes in **RED**
    - Partially open fractures in **MAGENTA**
    - Discontinuous fractures in **DARK BLUE**
    - Natural gamma
    - Slant (dip angle)
    - Slant angle bearing
    - Long and short space density
- Table containing feature curve ID, top, base, dip angle, dip azimuth, feature description and the generalised rock type that hosts the feature
- Graphical representations of the interpreted features

### *3.0 Borehole BH16-01interpretation*

The borehole wall sonic data appear to be affected by rugosity caused by the drilling method used.

The 284 identified features are interpreted as bedding (75%), fractures, washouts, the SWL and top of the abandoned coal workings. The bedding to fractures ratio is 4:1. The coal contains some high angle features that are probably cleats.

A description of each interpreted feature is presented in Table 1 and the log is presented in Appendix 1.

***Table 1 Interpreted features report for BH16-01***

| FEATURE ID | DIP ( DEG ) | AZIMUTH ( DEG ) | MIDPOINT (MBGL) | TOP ( M) | BASE ( M ) | TYPE OF FEATURE | GENERALISED ROCK TYPE |
|---|---|---|---|---|---|---|---|
| 1 | | | 15.85 | 15.85 | 15.85 | SWL | Overburden |
| 2 | 5 | 258 | 17.99 | 17.98 | 17.99 | Bedding plane | Overburden |
| 3 | 6 | 279 | 18.05 | 18.04 | 18.05 | Bedding plane | Overburden |
| 4 | 42 | 113 | 18.42 | 18.38 | 18.46 | Fracture plane - open | Overburden |
| 5 | 52 | 282 | 18.42 | 18.36 | 18.49 | Fracture plane - open | Overburden |
| 6 | 45 | 142 | 20.05 | 20.00 | 20.10 | Fracture plane - open | Overburden |
| 7 | 36 | 73 | 20.85 | 20.82 | 20.89 | Bedding plane | Overburden |
| 8 | 35 | 84 | 20.88 | 20.85 | 20.92 | Bedding plane | Overburden |
| 9 | 54 | 108 | 20.94 | 20.87 | 21.00 | Fracture plane - open | Overburden |
| 10 | 17 | 285 | 21.07 | 21.06 | 21.09 | Bedding plane | Overburden |
| 11 | 3 | 240 | 21.22 | 21.22 | 21.23 | Bedding plane | Overburden |
| 12 | 5 | 248 | 21.28 | 21.27 | 21.28 | Bedding plane | Overburden |
| 13 | 28 | 205 | 23.01 | 22.99 | 23.04 | Top of washout | Overburden |
| 14 | 5 | 88 | 23.22 | 23.21 | 23.22 | Base of washout | Overburden |
| 15 | 53 | 232 | 23.23 | 23.17 | 23.29 | Fracture plane - open | Overburden |
| 16 | 5 | 232 | 25.13 | 25.12 | 25.13 | Bedding plane | Overburden |
| 17 | 12 | 241 | 26.03 | 26.02 | 26.04 | Bedding plane | Overburden |
| 18 | 5 | 249 | 27.01 | 27.00 | 27.01 | Bedding plane | Overburden |
| 19 | 5 | 243 | 27.05 | 27.04 | 27.05 | Bedding plane | Overburden |
| 20 | 3 | 240 | 27.30 | 27.30 | 27.31 | Bedding plane | Overburden |
| 21 | 10 | 233 | 27.33 | 27.32 | 27.34 | Bedding plane | Overburden |
| 22 | 5 | 238 | 28.94 | 28.94 | 28.95 | Bedding plane | Overburden |
| 23 | 2 | 270 | 32.15 | 32.15 | 32.15 | Bedding plane | Overburden |
| 24 | 2 | 276 | 32.62 | 32.62 | 32.63 | Bedding plane | Overburden |
| 25 | 24 | 210 | 32.89 | 32.87 | 32.92 | Bedding plane | Overburden |
| 26 | 7 | 59 | 33.09 | 33.09 | 33.10 | Bedding plane | Overburden |
| 27 | 15 | 307 | 33.32 | 33.30 | 33.33 | Bedding plane | Overburden |
| 28 | 2 | 270 | 33.86 | 33.85 | 33.86 | Bedding plane | Overburden |
| 29 | 5 | 250 | 35.76 | 35.76 | 35.77 | Bedding plane | Overburden |
| 30 | 2 | 271 | 35.79 | 35.79 | 35.79 | Bedding plane | Overburden |
| 31 | 7 | 246 | 36.03 | 36.03 | 36.04 | Bedding plane | Overburden |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32 | 7 | 254 | 36.15 | 36.14 | 36.15 | Bedding plane | Overburden |
| 33 | 5 | 95 | 36.42 | 36.41 | 36.42 | Bedding plane | Overburden |
| 34 | 20 | 173 | 37.92 | 37.90 | 37.94 | Fracture plane - open | Overburden |
| 35 | 7 | 268 | 38.09 | 38.09 | 38.10 | Bedding plane | Overburden |
| 36 | 33 | 294 | 38.72 | 38.69 | 38.76 | Fracture plane - open | Overburden |
| 37 | 56 | 222 | 39.18 | 39.11 | 39.25 | Fracture plane - partially open | Overburden |
| 38 | 35 | 269 | 39.21 | 39.18 | 39.24 | Fracture plane - partially open | Overburden |
| 39 | 5 | 68 | 39.71 | 39.71 | 39.72 | Bedding plane | Overburden |
| 40 | 14 | 58 | 40.12 | 40.11 | 40.13 | Bedding plane | Overburden |
| 41 | 58 | 282 | 40.22 | 40.15 | 40.30 | Fracture plane - open | Overburden |
| 42 | 48 | 3 | 40.33 | 40.28 | 40.39 | Fracture plane - open | Overburden |
| 43 | 7 | 194 | 40.45 | 40.45 | 40.46 | Bedding plane | Overburden |
| 44 | 21 | 286 | 40.98 | 40.96 | 40.99 | Top of washout | Overburden |
| 45 | 20 | 301 | 41.34 | 41.32 | 41.35 | Base of washout | Overburden |
| 46 | 26 | 33 | 41.52 | 41.50 | 41.55 | Top of washout | Overburden |
| 47 | 32 | 333 | 41.87 | 41.84 | 41.90 | Base of washout | Overburden |
| 48 | 2 | 65 | 42.18 | 42.18 | 42.18 | Bedding plane | Overburden |
| 49 | 6 | 250 | 44.66 | 44.66 | 44.67 | Bedding plane | Overburden |
| 50 | 9 | 290 | 44.77 | 44.76 | 44.78 | Bedding plane | Overburden |
| 51 | 11 | 254 | 46.42 | 46.41 | 46.43 | Bedding plane | Overburden |
| 52 | 4 | 255 | 47.63 | 47.62 | 47.63 | Bedding plane | Overburden |
| 53 | 10 | 130 | 49.17 | 49.16 | 49.18 | Bedding plane | Overburden |
| 54 | 27 | 193 | 49.65 | 49.63 | 49.68 | Bedding plane | Overburden |
| 55 | 20 | 207 | 49.71 | 49.69 | 49.73 | Bedding plane | Overburden |
| 56 | 5 | 323 | 49.97 | 49.97 | 49.97 | Bedding plane | Overburden |
| 57 | 12 | 317 | 50.02 | 50.01 | 50.03 | Bedding plane | Overburden |
| 58 | 20 | 29 | 50.67 | 50.65 | 50.69 | Fracture plane - partially open | Overburden |
| 59 | 2 | 271 | 53.27 | 53.27 | 53.28 | Bedding plane | Overburden |
| 60 | 16 | 74 | 54.57 | 54.55 | 54.58 | Bedding plane | Overburden |
| 61 | 16 | 44 | 54.69 | 54.68 | 54.71 | Bedding plane | Overburden |
| 62 | 9 | 35 | 54.83 | 54.82 | 54.84 | Bedding plane | Overburden |
| 63 | 7 | 340 | 55.16 | 55.16 | 55.17 | Bedding plane | Overburden |
| 64 | 12 | 344 | 55.29 | 55.28 | 55.30 | Bedding plane | Overburden |
| 65 | 34 | 343 | 55.81 | 55.78 | 55.85 | Fracture plane - open | Overburden |
| 66 | 9 | 117 | 56.19 | 56.18 | 56.20 | Bedding plane | Overburden |
| 67 | 5 | 220 | 56.25 | 56.25 | 56.25 | Bedding plane | Overburden |
| 68 | 5 | 199 | 56.30 | 56.30 | 56.31 | Bedding plane | Overburden |
| 69 | 2 | 299 | 56.44 | 56.44 | 56.45 | Bedding plane | Overburden |
| 70 | 18 | 305 | 56.63 | 56.61 | 56.64 | Bedding plane | Overburden |
| 71 | 18 | 321 | 56.80 | 56.78 | 56.82 | Bedding plane | Overburden |
| 72 | 16 | 333 | 56.84 | 56.83 | 56.85 | Bedding plane | Overburden |
| 73 | 13 | 272 | 56.89 | 56.88 | 56.91 | Bedding plane | Overburden |
| 74 | 10 | 232 | 56.95 | 56.95 | 56.96 | Bedding plane | Overburden |
| 75 | 5 | 223 | 57.01 | 57.01 | 57.02 | Bedding plane | Overburden |
| 76 | 2 | 223 | 57.07 | 57.07 | 57.08 | Bedding plane | Overburden |
| 77 | 15 | 302 | 57.65 | 57.64 | 57.66 | Bedding plane | Overburden |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 78 | 15 | 316 | 57.69 | 57.68 | 57.70 | Bedding plane | Overburden |
| 79 | 7 | 23 | 57.87 | 57.87 | 57.88 | Bedding plane | Overburden |
| 80 | 3 | 320 | 57.94 | 57.94 | 57.94 | Bedding plane | Overburden |
| 81 | 5 | 229 | 57.98 | 57.98 | 57.99 | Bedding plane | Overburden |
| 82 | 14 | 333 | 58.05 | 58.04 | 58.07 | Bedding plane | Overburden |
| 83 | 5 | 68 | 58.18 | 58.17 | 58.18 | Bedding plane | Overburden |
| 84 | 12 | 313 | 58.22 | 58.21 | 58.23 | Bedding plane | Overburden |
| 85 | 14 | 316 | 58.32 | 58.31 | 58.34 | Bedding plane | Overburden |
| 86 | 5 | 342 | 58.44 | 58.43 | 58.44 | Bedding plane | Overburden |
| 87 | 14 | 94 | 59.04 | 59.02 | 59.05 | Bedding plane | Overburden |
| 88 | 7 | 264 | 59.07 | 59.07 | 59.08 | Bedding plane | Overburden |
| 89 | 11 | 105 | 59.25 | 59.24 | 59.26 | Bedding plane | Overburden |
| 90 | 0 | 90 | 59.33 | 59.33 | 59.33 | Bedding plane | Overburden |
| 91 | 7 | 246 | 59.68 | 59.68 | 59.69 | Bedding plane | Overburden |
| 92 | 10 | 207 | 59.76 | 59.75 | 59.77 | Bedding plane | Overburden |
| 93 | 9 | 157 | 60.08 | 60.07 | 60.09 | Bedding plane | Overburden |
| 94 | 12 | 155 | 60.13 | 60.12 | 60.14 | Bedding plane | Overburden |
| 95 | 14 | 233 | 62.58 | 62.56 | 62.59 | Bedding plane | Overburden |
| 96 | 2 | 245 | 63.12 | 63.11 | 63.12 | Bedding plane | Overburden |
| 97 | 5 | 265 | 63.14 | 63.14 | 63.15 | Bedding plane | Overburden |
| 98 | 9 | 321 | 63.28 | 63.27 | 63.28 | Bedding plane | Overburden |
| 99 | 3 | 188 | 64.50 | 64.50 | 64.50 | Bedding plane | Overburden |
| 100 | 2 | 264 | 64.58 | 64.57 | 64.58 | Bedding plane | Overburden |
| 101 | 5 | 270 | 64.82 | 64.81 | 64.82 | Top of coal unit | COAL SEAM |
| 102 | 4 | 269 | 64.88 | 64.88 | 64.88 | Bedding plane | COAL SEAM |
| 103 | 72 | 289 | 64.92 | 64.77 | 65.08 | Fracture plane - partially open | COAL SEAM |
| 104 | 2 | 284 | 64.95 | 64.94 | 64.95 | Bedding plane | COAL SEAM |
| 105 | 3 | 281 | 65.05 | 65.05 | 65.05 | Bedding plane | COAL SEAM |
| 106 | 5 | 292 | 65.13 | 65.13 | 65.14 | Bedding plane | COAL SEAM |
| 107 | 8 | 277 | 65.21 | 65.20 | 65.22 | Bedding plane | COAL SEAM |
| 108 | 74 | 286 | 65.25 | 65.09 | 65.42 | Fracture plane - partially open | COAL SEAM |
| 109 | 5 | 290 | 65.44 | 65.44 | 65.45 | Bedding plane | COAL SEAM |
| 110 | 0 | 210 | 65.51 | 65.51 | 65.51 | Base of coal unit | COAL SEAM |
| 111 | 10 | 179 | 66.07 | 66.06 | 66.08 | Bedding plane | Interburden |
| 112 | 77 | 308 | 66.25 | 66.03 | 66.46 | Fracture plane - partially open | Interburden |
| 113 | 76 | 296 | 67.04 | 66.84 | 67.24 | Fracture plane - partially open | Interburden |
| 114 | 2 | 320 | 67.41 | 67.41 | 67.41 | Bedding plane | Interburden |
| 115 | 9 | 243 | 67.60 | 67.59 | 67.61 | Bedding plane | Interburden |
| 116 | 7 | 64 | 68.02 | 68.01 | 68.02 | Bedding plane | Interburden |
| 117 | 8 | 89 | 68.11 | 68.10 | 68.12 | Bedding plane | Interburden |
| 118 | 7 | 261 | 68.56 | 68.56 | 68.57 | Bedding plane | Interburden |
| 119 | 0 | 90 | 68.79 | 68.79 | 68.79 | Bedding plane | Interburden |
| 120 | 15 | 327 | 69.04 | 69.03 | 69.06 | Bedding plane | Interburden |
| 121 | 7 | 300 | 69.10 | 69.09 | 69.10 | Bedding plane | Interburden |
| 122 | 5 | 270 | 69.67 | 69.67 | 69.68 | Bedding plane | Interburden |
| 123 | 0 | 333 | 71.14 | 71.14 | 71.14 | Bedding plane | Interburden |

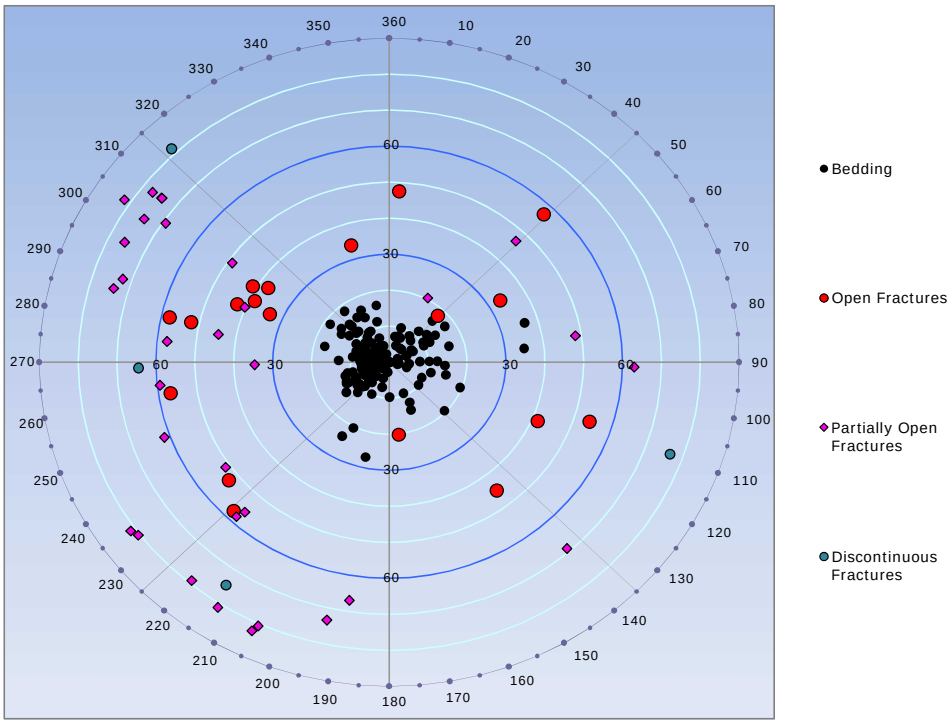
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 124 | 2 | 106 | 71.47 | 71.46 | 71.47 | Bedding plane | Interburden |
| 125 | 2 | 306 | 73.11 | 73.11 | 73.11 | Bedding plane | Interburden |
| 126 | 5 | 260 | 73.23 | 73.23 | 73.24 | Bedding plane | Interburden |
| 127 | 7 | 218 | 73.82 | 73.81 | 73.83 | Bedding plane | Interburden |
| 128 | 17 | 55 | 73.92 | 73.90 | 73.93 | Bedding plane | Interburden |
| 129 | 2 | 75 | 74.04 | 74.04 | 74.04 | Bedding plane | Interburden |
| 130 | 2 | 261 | 74.13 | 74.13 | 74.13 | Bedding plane | Interburden |
| 131 | 69 | 304 | 74.19 | 74.07 | 74.32 | Fracture plane - partially open | Interburden |
| 132 | 74 | 308 | 74.32 | 74.14 | 74.49 | Fracture plane - partially open | Interburden |
| 133 | 74 | 308 | 74.50 | 74.33 | 74.67 | Fracture plane - partially open | Interburden |
| 134 | 0 | 90 | 75.06 | 75.06 | 75.06 | Bedding plane | Interburden |
| 135 | 7 | 239 | 75.29 | 75.28 | 75.29 | Bedding plane | Interburden |
| 136 | 12 | 244 | 75.30 | 75.29 | 75.31 | Bedding plane | Interburden |
| 137 | 5 | 225 | 75.38 | 75.37 | 75.38 | Bedding plane | Interburden |
| 138 | 7 | 225 | 75.41 | 75.41 | 75.42 | Bedding plane | Interburden |
| 139 | 7 | 248 | 75.48 | 75.47 | 75.49 | Bedding plane | Interburden |
| 140 | 5 | 236 | 75.51 | 75.51 | 75.52 | Bedding plane | Interburden |
| 141 | 5 | 248 | 75.54 | 75.54 | 75.55 | Bedding plane | Interburden |
| 142 | 7 | 254 | 75.72 | 75.72 | 75.73 | Bedding plane | Interburden |
| 143 | 10 | 254 | 75.87 | 75.86 | 75.88 | Bedding plane | Interburden |
| 144 | 12 | 301 | 76.93 | 76.92 | 76.94 | Top of washout | Interburden |
| 145 | 5 | 271 | 76.98 | 76.97 | 76.98 | Base of washout | Interburden |
| 146 | 0 | 277 | 77.77 | 77.77 | 77.77 | Bedding plane | Interburden |
| 147 | 2 | 276 | 79.28 | 79.28 | 79.28 | Bedding plane | Interburden |
| 148 | 5 | 300 | 79.40 | 79.40 | 79.40 | Bedding plane | Interburden |
| 149 | 7 | 271 | 79.57 | 79.56 | 79.58 | Bedding plane | Interburden |
| 150 | 39 | 296 | 81.08 | 81.05 | 81.12 | Fracture plane - open | Interburden |
| 151 | 7 | 266 | 81.17 | 81.16 | 81.17 | Bedding plane | Interburden |
| 152 | 2 | 274 | 82.20 | 82.20 | 82.21 | Bedding plane | Interburden |
| 153 | 2 | 246 | 82.55 | 82.55 | 82.55 | Bedding plane | Interburden |
| 154 | 77 | 109 | 82.66 | 82.46 | 82.86 | Fracture plane - discontinuous | Interburden |
| 155 | 5 | 254 | 82.77 | 82.77 | 82.78 | Bedding plane | Interburden |
| 156 | 7 | 253 | 82.87 | 82.87 | 82.88 | Bedding plane | Interburden |
| 157 | 5 | 310 | 83.12 | 83.12 | 83.13 | Bedding plane | Interburden |
| 158 | 9 | 337 | 83.21 | 83.21 | 83.22 | Top of washout | Interburden |
| 159 | 8 | 300 | 83.69 | 83.68 | 83.70 | Base of washout | Interburden |
| 160 | 2 | 292 | 83.76 | 83.75 | 83.76 | Top of washout | Interburden |
| 161 | 10 | 295 | 83.98 | 83.97 | 83.99 | Base of washout | Interburden |
| 162 | 5 | 317 | 85.23 | 85.22 | 85.23 | Bedding plane | Interburden |
| 163 | 5 | 233 | 86.15 | 86.14 | 86.15 | Bedding plane | Interburden |
| 164 | 10 | 89 | 86.51 | 86.50 | 86.52 | Bedding plane | Interburden |
| 165 | 2 | 314 | 86.59 | 86.58 | 86.59 | Bedding plane | Interburden |
| 166 | 63 | 91 | 86.86 | 86.76 | 86.95 | Fracture plane - partially open | Interburden |
| 167 | 2 | 268 | 87.34 | 87.34 | 87.34 | Bedding plane | Interburden |
| 168 | 81 | 205 | 87.35 | 87.05 | 87.65 | Fracture plane - partially open | Interburden |
| 169 | 2 | 343 | 87.68 | 87.68 | 87.68 | Bedding plane | Interburden |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 170 | 57 | 261 | 88.65 | 88.58 | 88.73 | Fracture plane - open | Interburden |
| 171 | 0 | 249 | 88.88 | 88.88 | 88.88 | Bedding plane | Interburden |
| 172 | 48 | 81 | 89.05 | 88.99 | 89.10 | Fracture plane - partially open | Interburden |
| 173 | 5 | 34 | 89.17 | 89.17 | 89.17 | Bedding plane | Interburden |
| 174 | 7 | 12 | 89.24 | 89.23 | 89.24 | Bedding plane | Interburden |
| 175 | 7 | 18 | 89.26 | 89.26 | 89.27 | Bedding plane | Interburden |
| 176 | 11 | 42 | 89.36 | 89.35 | 89.37 | Bedding plane | Interburden |
| 177 | 2 | 289 | 89.39 | 89.39 | 89.39 | Bedding plane | Interburden |
| 178 | 5 | 268 | 90.09 | 90.09 | 90.10 | Bedding plane | Interburden |
| 179 | 5 | 107 | 90.46 | 90.46 | 90.46 | Bedding plane | Interburden |
| 180 | 7 | 320 | 90.90 | 90.89 | 90.90 | Top of coal unit | COAL SEAM |
| 181 | 7 | 18 | 91.55 | 91.55 | 91.56 | Base of coal unit | COAL SEAM |
| 182 | 20 | 133 | 91.95 | 91.93 | 91.96 | Bedding plane | Interburden |
| 183 | 14 | 157 | 92.08 | 92.07 | 92.09 | Bedding plane | Interburden |
| 184 | 5 | 258 | 92.41 | 92.40 | 92.41 | Top of coal unit | COAL SEAM |
| 185 | 2 | 255 | 92.53 | 92.53 | 92.53 | Bedding plane | COAL SEAM |
| 186 | 0 | 258 | 93.47 | 93.47 | 93.47 | Bedding plane | COAL SEAM |
| 187 | 7 | 264 | 93.51 | 93.50 | 93.51 | Bedding plane | COAL SEAM |
| 188 | 12 | 224 | 93.64 | 93.63 | 93.65 | Bedding plane | COAL SEAM |
| 189 | 7 | 261 | 93.65 | 93.64 | 93.66 | Bedding plane | COAL SEAM |
| 190 | 2 | 99 | 93.71 | 93.71 | 93.72 | Bedding plane | COAL SEAM |
| 191 | 7 | 230 | 93.82 | 93.81 | 93.83 | Base of coal unit | COAL SEAM |
| 192 | 5 | 249 | 93.89 | 93.88 | 93.89 | Bedding plane | Interburden |
| 193 | 2 | 302 | 94.01 | 94.01 | 94.01 | Bedding plane | Interburden |
| 194 | 2 | 251 | 94.19 | 94.18 | 94.19 | Bedding plane | Interburden |
| 195 | 10 | 225 | 94.44 | 94.44 | 94.45 | Top of coal unit | COAL SEAM |
| 196 | 12 | 251 | 94.73 | 94.72 | 94.74 | Bedding plane | COAL SEAM |
| 197 | 5 | 287 | 95.16 | 95.15 | 95.16 | Bedding plane | COAL SEAM |
| 198 | 0 | 90 | 95.29 | 95.29 | 95.29 | Base of coal unit | COAL SEAM |
| 199 | 0 | 90 | 95.35 | 95.35 | 95.35 | Bedding plane | Interburden |
| 200 | 0 | 90 | 99.39 | 99.39 | 99.39 | Bedding plane | Interburden |
| 201 | 33 | 59 | 99.42 | 99.39 | 99.45 | Fracture plane - open | Interburden |
| 202 | 10 | 63 | 99.49 | 99.48 | 99.50 | Bedding plane | Interburden |
| 203 | 5 | 68 | 99.60 | 99.60 | 99.61 | Bedding plane | Interburden |
| 204 | 12 | 62 | 99.78 | 99.77 | 99.79 | Top of coal unit | COAL SEAM |
| 205 | 12 | 60 | 99.78 | 99.77 | 99.79 | Top of washout | COAL SEAM |
| 206 | 5 | 39 | 99.95 | 99.95 | 99.95 | Base of washout | COAL SEAM |
| 207 | 67 | 189 | 99.98 | 99.87 | 100.09 | Fracture plane - partially open | COAL SEAM |
| 208 | 57 | 224 | 100.19 | 100.12 | 100.27 | Fracture plane - open | COAL SEAM |
| 209 | 75 | 214 | 100.38 | 100.20 | 100.55 | Fracture plane - discontinuous | COAL SEAM |
| 210 | 41 | 301 | 100.41 | 100.37 | 100.45 | Fracture plane - open | COAL SEAM |
| 211 | 69 | 139 | 100.43 | 100.30 | 100.55 | Fracture plane - partially open | COAL SEAM |
| 212 | 37 | 304 | 100.43 | 100.40 | 100.47 | Fracture plane - open | COAL SEAM |
| 213 | 49 | 304 | 100.49 | 100.44 | 100.55 | Fracture plane - partially open | COAL SEAM |
| 214 | 51 | 235 | 100.59 | 100.53 | 100.65 | Fracture plane - partially open | COAL SEAM |
| 215 | 61 | 250 | 100.73 | 100.64 | 100.82 | Fracture plane - partially open | COAL SEAM |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 216 | 58 | 222 | 100.83 | 100.75 | 100.90 | Fracture plane - partially open | COAL SEAM |
| 217 | 42 | 292 | 100.98 | 100.94 | 101.03 | Fracture plane - open | COAL SEAM |
| 218 | 7 | 258 | 101.26 | 101.25 | 101.27 | Bedding plane | COAL SEAM |
| 219 | 40 | 292 | 101.34 | 101.30 | 101.38 | Fracture plane - partially open | COAL SEAM |
| 220 | 45 | 280 | 101.55 | 101.50 | 101.60 | Fracture plane - partially open | COAL SEAM |
| 221 | 5 | 266 | 101.65 | 101.65 | 101.66 | Bedding plane | COAL SEAM |
| 222 | 10 | 279 | 101.72 | 101.71 | 101.72 | Bedding plane | COAL SEAM |
| 223 | 75 | 302 | 101.83 | 101.66 | 102.00 | Fracture plane - partially open | COAL SEAM |
| 224 | 57 | 276 | 101.84 | 101.77 | 101.92 | Fracture plane - partially open | COAL SEAM |
| 225 | 3 | 263 | 101.95 | 101.95 | 101.96 | Bedding plane | COAL SEAM |
| 226 | 47 | 44 | 102.15 | 102.10 | 102.20 | Fracture plane - partially open | COAL SEAM |
| 227 | 57 | 44 | 102.27 | 102.20 | 102.34 | Fracture plane - open | COAL SEAM |
| 228 | 59 | 264 | 102.41 | 102.33 | 102.49 | Fracture plane - partially open | COAL SEAM |
| 229 | 12 | 241 | 102.49 | 102.48 | 102.50 | Bedding plane | COAL SEAM |
| 230 | 2 | 266 | 102.68 | 102.68 | 102.68 | Bedding plane | COAL SEAM |
| 231 | 2 | 253 | 102.72 | 102.71 | 102.72 | Bedding plane | COAL SEAM |
| 232 | 7 | 272 | 102.73 | 102.72 | 102.74 | Base of coal unit | COAL SEAM |
| 233 | 8 | 275 | 102.87 | 102.86 | 102.87 | Bedding plane | Interburden |
| 234 | 0 | 90 | 102.90 | 102.90 | 102.90 | Bedding plane | Interburden |
| 235 | 12 | 52 | 103.89 | 103.88 | 103.90 | Bedding plane | Interburden |
| 236 | 20 | 111 | 106.10 | 106.09 | 106.12 | Bedding plane | Interburden |
| 237 | 15 | 104 | 106.13 | 106.11 | 106.14 | Bedding plane | Interburden |
| 238 | 5 | 332 | 106.28 | 106.27 | 106.28 | Bedding plane | Interburden |
| 239 | 8 | 301 | 106.34 | 106.33 | 106.34 | Bedding plane | Interburden |
| 240 | 10 | 58 | 106.41 | 106.40 | 106.42 | Bedding plane | Interburden |
| 241 | 8 | 43 | 106.44 | 106.43 | 106.45 | Bedding plane | Interburden |
| 242 | 10 | 18 | 106.47 | 106.46 | 106.47 | Bedding plane | Interburden |
| 243 | 8 | 311 | 106.59 | 106.59 | 106.60 | Bedding plane | Interburden |
| 244 | 10 | 301 | 106.61 | 106.60 | 106.62 | Bedding plane | Interburden |
| 245 | 12 | 89 | 106.66 | 106.65 | 106.67 | Bedding plane | Interburden |
| 246 | 8 | 18 | 106.88 | 106.88 | 106.89 | Bedding plane | Interburden |
| 247 | 13 | 306 | 106.93 | 106.92 | 106.94 | Bedding plane | Interburden |
| 248 | 10 | 327 | 106.98 | 106.97 | 106.99 | Bedding plane | Interburden |
| 249 | 10 | 331 | 107.00 | 106.99 | 107.01 | Bedding plane | Interburden |
| 250 | 5 | 20 | 107.16 | 107.16 | 107.17 | Bedding plane | Interburden |
| 251 | 2 | 310 | 107.96 | 107.95 | 107.96 | Top of coal unit | COAL SEAM |
| 252 | 3 | 291 | 108.01 | 108.01 | 108.01 | Bedding plane | COAL SEAM |
| 253 | 5 | 306 | 108.09 | 108.09 | 108.09 | Bedding plane | COAL SEAM |
| 254 | 16 | 348 | 108.18 | 108.16 | 108.19 | Bedding plane | COAL SEAM |
| 255 | 5 | 251 | 108.34 | 108.34 | 108.34 | Bedding plane | COAL SEAM |
| 256 | 10 | 243 | 108.40 | 108.39 | 108.41 | Bedding plane | COAL SEAM |
| 257 | 81 | 213 | 108.53 | 108.23 | 108.84 | Fracture plane - partially open | COAL SEAM |
| 258 | 83 | 205 | 108.57 | 108.20 | 108.93 | Fracture plane - partially open | COAL SEAM |
| 259 | 2 | 246 | 108.70 | 108.70 | 108.70 | Bedding plane | COAL SEAM |
| 260 | 79 | 220 | 108.78 | 108.53 | 109.03 | Fracture plane - partially open | COAL SEAM |
| 261 | 73 | 193 | 109.06 | 108.90 | 109.22 | Fracture plane - partially open | COAL SEAM |

| FEATURE ID | DIP ( DEG ) | AZIMUTH ( DEG ) | MIDPOINT (MBGL) | TOP ( M) | BASE ( M ) | TYPE OF FEATURE | GENERALISED ROCK TYPE |
|---|---|---|---|---|---|---|---|
| 262 | 2 | 308 | 109.06 | 109.06 | 109.06 | Bedding plane | COAL SEAM |
| 263 | 3 | 296 | 109.12 | 109.12 | 109.12 | Bedding plane | COAL SEAM |
| 264 | 64 | 269 | 109.16 | 109.06 | 109.25 | Fracture plane - discontinuous | COAL SEAM |
| 265 | 3 | 270 | 109.29 | 109.29 | 109.29 | Bedding plane | COAL SEAM |
| 266 | 82 | 304 | 109.42 | 109.10 | 109.73 | Fracture plane - partially open | COAL SEAM |
| 267 | 5 | 222 | 109.56 | 109.56 | 109.57 | Bedding plane | COAL SEAM |
| 268 | 3 | 239 | 109.68 | 109.68 | 109.68 | Bedding plane | COAL SEAM |
| 269 | 0 | 90 | 109.80 | 109.80 | 109.80 | Bedding plane | COAL SEAM |
| 270 | 5 | 265 | 110.11 | 110.11 | 110.12 | Bedding plane | COAL SEAM |
| 271 | 5 | 264 | 110.15 | 110.14 | 110.15 | Bedding plane | COAL SEAM |
| 272 | 82 | 317 | 110.15 | 109.85 | 110.46 | Fracture plane - discontinuous | COAL SEAM |
| 273 | 7 | 291 | 110.27 | 110.26 | 110.27 | Bedding plane | COAL SEAM |
| 274 | 7 | 250 | 110.75 | 110.75 | 110.76 | Bedding plane | COAL SEAM |
| 275 | 5 | 280 | 110.83 | 110.83 | 110.83 | Bedding plane | COAL SEAM |
| 276 | 9 | 223 | 110.88 | 110.87 | 110.89 | Bedding plane | COAL SEAM |
| 277 | 3 | 238 | 111.07 | 111.07 | 111.07 | Bedding plane | COAL SEAM |
| 278 | 5 | 243 | 111.08 | 111.08 | 111.09 | Bedding plane | COAL SEAM |
| 279 | 80 | 233 | 111.19 | 110.92 | 111.46 | Fracture plane - partially open | COAL SEAM |
| 280 | 5 | 42 | 111.30 | 111.30 | 111.31 | Bedding plane | COAL SEAM |
| 281 | 81 | 235 | 111.41 | 111.09 | 111.72 | Fracture plane - partially open | COAL SEAM |
| 282 | 18 | 44 | 111.41 | 111.39 | 111.43 | Fracture plane - open | COAL SEAM |
| 283 | 0 | 249 | 111.86 | 111.86 | 111.86 | Bedding plane | COAL SEAM |
| 284 | 5 | 258 | 112.11 | 112.10 | 112.11 | Top of coal void | COAL SEAM |

***Figure 1 BH16-01 circular plan representation of interpreted features***




The 213 identified sedimentary features are predominantly bedding planes that appear to range in dip from flat-lying to $36^0$. Figures 2 and 3 show the distribution of the planes' dip angles and dip direction with depth.

Table 2 details the variation in the dip angle and dip direction data. Figure 4 shows the dip direction data in a rose diagram with the bedding planes' dip angle and dip direction data shown as histograms in Figures 5 and 6.

The 55 fractures are identified has as open (35%), partially open (58%) and discontinuous (7%).

Table 3 details the variation in the fractures' dip angle and dip direction data. Figure 7 shows the dip direction data in a rose diagram with the fractures' plane dip angle and dip direction data as histograms in Figures 8 and 9.

***Figure 2 BH16-01feature dip angle data distribution***

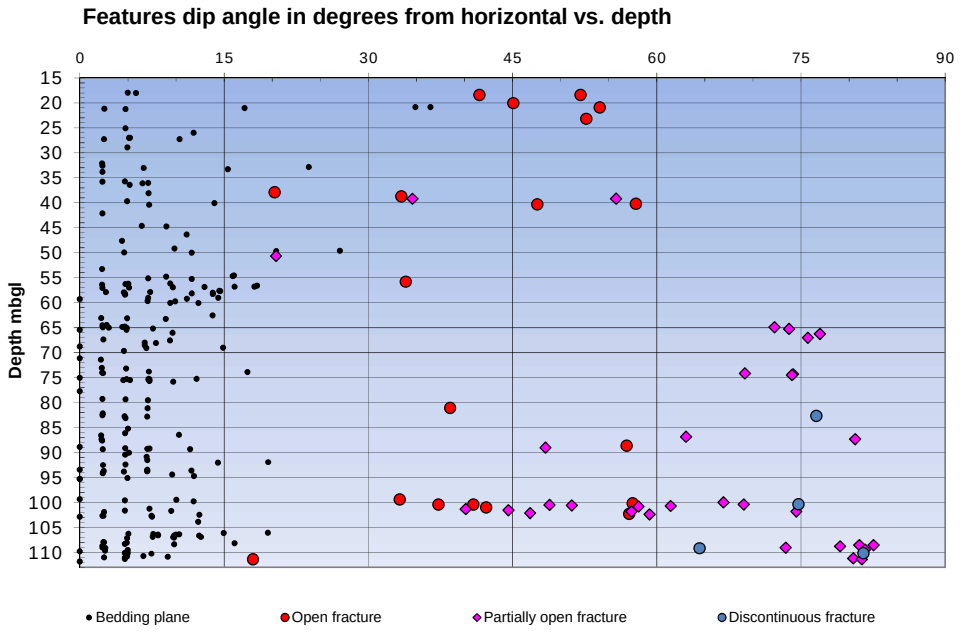
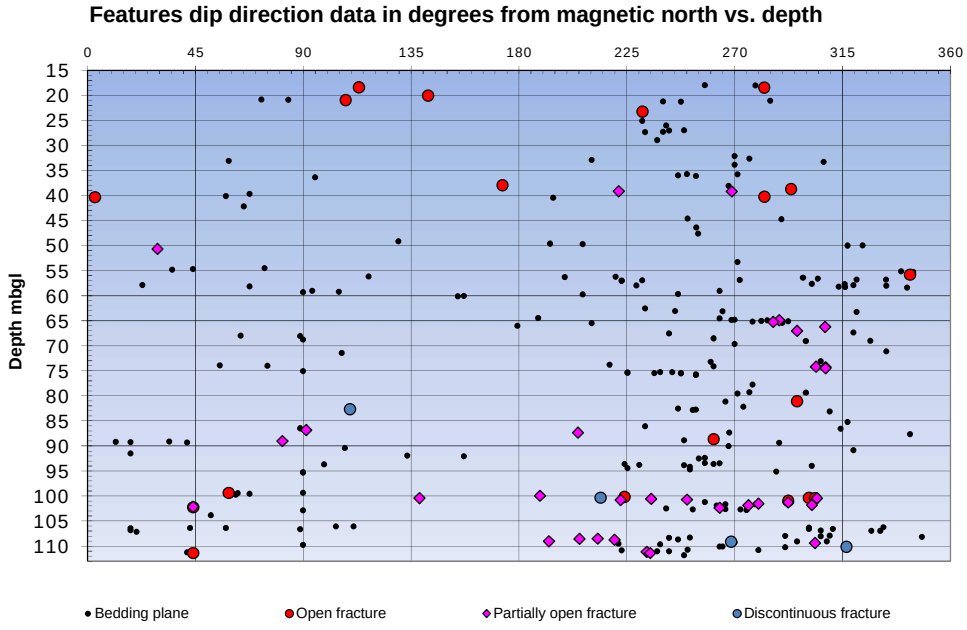


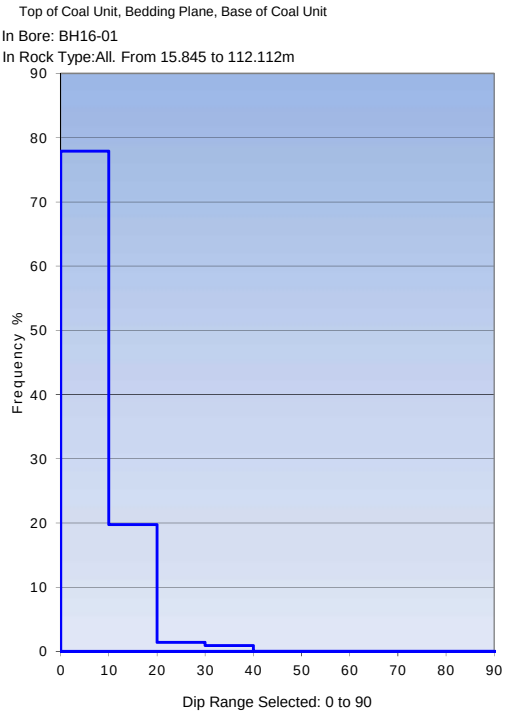

***Figure 3 BH16-01feature dip direction data distribution***



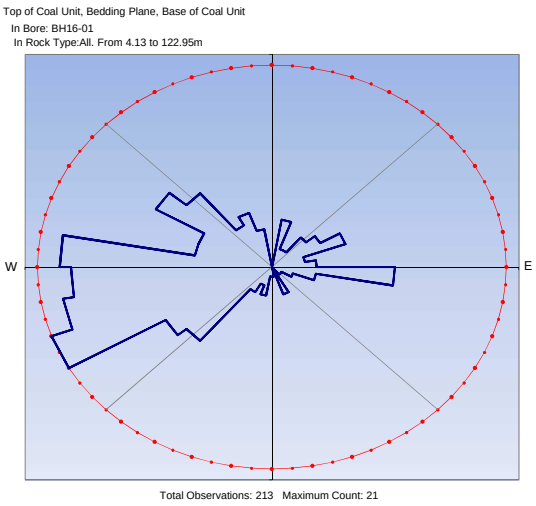
## *Table 2 BH16-01bedding histogram data*

| Dip Distribution Total: 213 | | | Orientation Distribution Total: 213 | | |
|---|---|---|---|---|---|
| Dip Range | Count | % | Bearing Range | Count | % |
| 0 to 10 | 166 | 77.9 | 0 to 10 | 0 | 0.0 |
| 10 to 20 | 42 | 19.7 | 10 to 20 | 5 | 2.3 |
| 20 to 30 | 3 | 1.4 | 20 to 30 | 2 | 0.9 |
| 30 to 40 | 2 | 0.9 | 30 to 40 | 2 | 0.9 |
| 40 to 50 | 0 | 0.0 | 40 to 50 | 4 | 1.9 |
| 50 to 60 | 0 | 0.0 | 50 to 60 | 5 | 2.3 |
| 60 to 70 | 0 | 0.0 | 60 to 70 | 7 | 3.3 |
| 70 to 80 | 0 | 0.0 | 70 to 80 | 3 | 1.4 |
| 80 to 90 | 0 | 0.0 | 80 to 90 | 4 | 1.9 |
| | | | 90 to 100 | 11 | 5.2 |
| | | | 100 to 110 | 4 | 1.9 |
| | | | 110 to 120 | 2 | 0.9 |
| | | | 120 to 130 | 1 | 0.5 |
| | | | 130 to 140 | 1 | 0.5 |
| | | | 140 to 150 | 0 | 0.0 |
| | | | 150 to 160 | 3 | 1.4 |
| | | | 160 to 170 | 0 | 0.0 |
| | | | 170 to 180 | 1 | 0.5 |
| | | | 180 to 190 | 1 | 0.5 |
| | | | 190 to 200 | 3 | 1.4 |
| | | | 200 to 210 | 2 | 0.9 |
| | | | 210 to 220 | 3 | 1.4 |
| | | | 220 to 230 | 10 | 4.7 |
| | | | 230 to 240 | 11 | 5.2 |
| | | | 240 to 250 | 21 | 9.9 |
| | | | 250 to 260 | 19 | 8.9 |
| | | | 260 to 270 | 18 | 8.5 |
| | | | 270 to 280 | 19 | 8.9 |
| | | | 280 to 290 | 7 | 3.3 |
| | | | 290 to 300 | 7 | 3.3 |
| | | | 300 to 310 | 12 | 5.6 |
| | | | 310 to 320 | 10 | 4.7 |
| | | | 320 to 330 | 5 | 2.3 |
| | | | 330 to 340 | 6 | 2.8 |
| | | | 340 to 350 | 4 | 1.9 |
| | | | 350 to 360 | 0 | 0.0 |

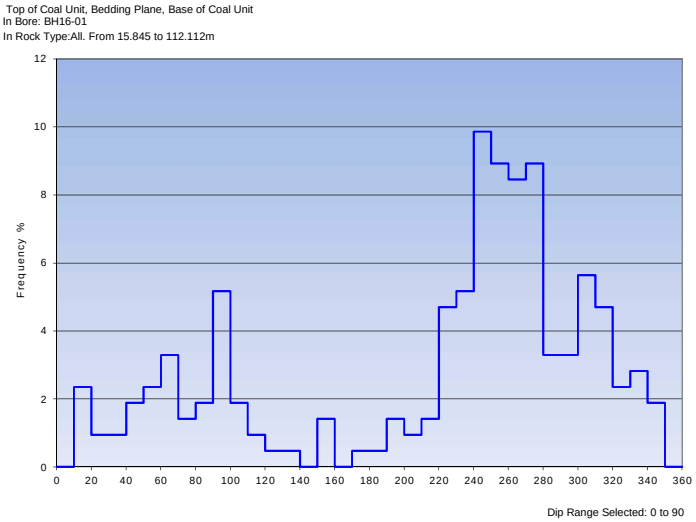
## *Figure 5 BH16-01bedding dip angles histogram*




## *Figure 4 BH16-01bedding dip direction data rose diagram*



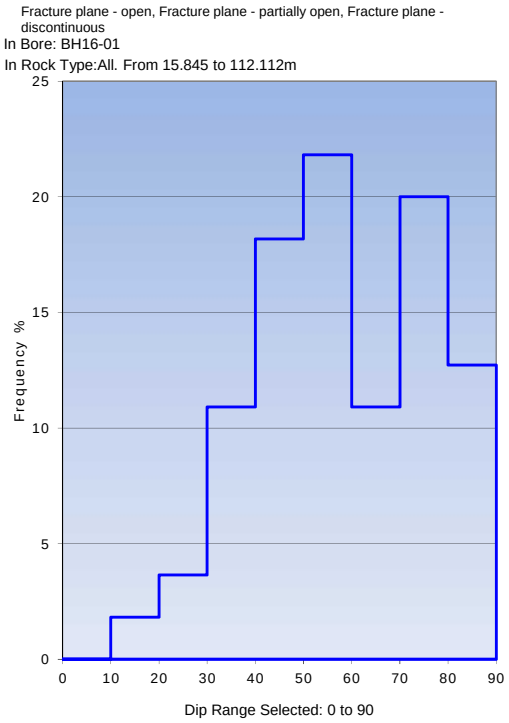

## *Figure 6 BH16-01bedding dip directions histogram*



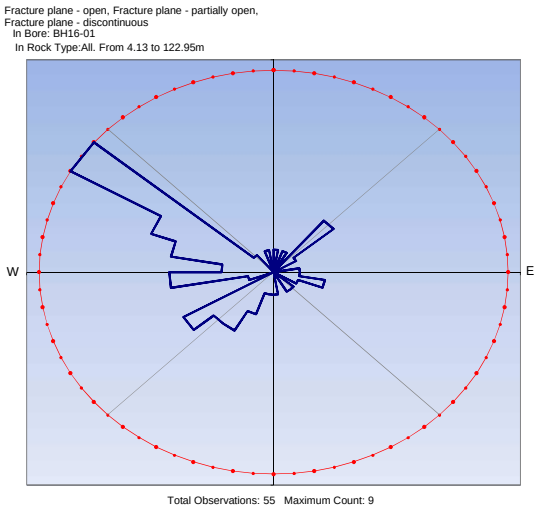
## Table 3 BH16-01 fractures histogram data

| Dip Distribution Total: 55 | | | Orientation Distribution Total: 55 | | |
|---|---|---|---|---|---|
| Dip Range | Count | % | Bearing Range | Count | % |
| 0 to 10 | 0 | 0.0 | 0 to 10 | 1 | 1.8 |
| 10 to 20 | 1 | 1.8 | 10 to 20 | 0 | 0.0 |
| 20 to 30 | 2 | 3.6 | 20 to 30 | 1 | 1.8 |
| 30 to 40 | 6 | 10.9 | 30 to 40 | 0 | 0.0 |
| 40 to 50 | 10 | 18.2 | 40 to 50 | 3 | 5.5 |
| 50 to 60 | 12 | 21.8 | 50 to 60 | 1 | 1.8 |
| 60 to 70 | 6 | 10.9 | 60 to 70 | 0 | 0.0 |
| 70 to 80 | 11 | 20.0 | 70 to 80 | 0 | 0.0 |
| 80 to 90 | 7 | 12.7 | 80 to 90 | 1 | 1.8 |
| | | | 90 to 100 | 1 | 1.8 |
| | | | 100 to 110 | 2 | 3.6 |
| | | | 110 to 120 | 1 | 1.8 |
| | | | 120 to 130 | 0 | 0.0 |
| | | | 130 to 140 | 1 | 1.8 |
| | | | 140 to 150 | 1 | 1.8 |
| | | | 150 to 160 | 0 | 0.0 |
| | | | 160 to 170 | 0 | 0.0 |
| | | | 170 to 180 | 1 | 1.8 |
| | | | 180 to 190 | 1 | 1.8 |
| | | | 190 to 200 | 1 | 1.8 |
| | | | 200 to 210 | 2 | 3.6 |
| | | | 210 to 220 | 3 | 5.5 |
| | | | 220 to 230 | 3 | 5.5 |
| | | | 230 to 240 | 4 | 7.3 |
| | | | 240 to 250 | 0 | 0.0 |
| | | | 250 to 260 | 1 | 1.8 |
| | | | 260 to 270 | 4 | 7.3 |
| | | | 270 to 280 | 2 | 3.6 |
| | | | 280 to 290 | 4 | 7.3 |
| | | | 290 to 300 | 5 | 9.1 |
| | | | 300 to 310 | 9 | 16.4 |
| | | | 310 to 320 | 1 | 1.8 |
| | | | 320 to 330 | 0 | 0.0 |
| | | | 330 to 340 | 0 | 0.0 |
| | | | 340 to 350 | 1 | 1.8 |
| | | | 350 to 360 | 0 | 0.0 |

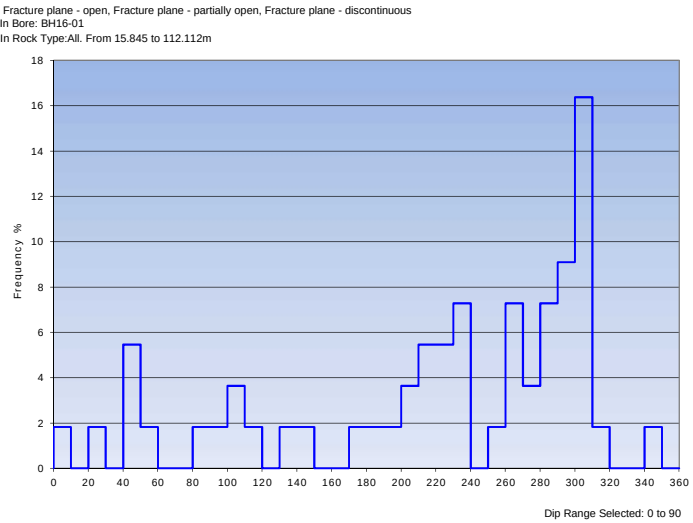
## Figure 8 BH16-01fractures dip angles histogram




## Figure 7 BH16-01fractures dip direction data rose diagram




## Figure 9 BH16-01fractures dip directions histogram



## *Appendix 1*

**Appendix 1** 1:20 Interpretation logs – 15.50 to 113.11 mbgl

# GROUNDSEARCH AUSTRALIA

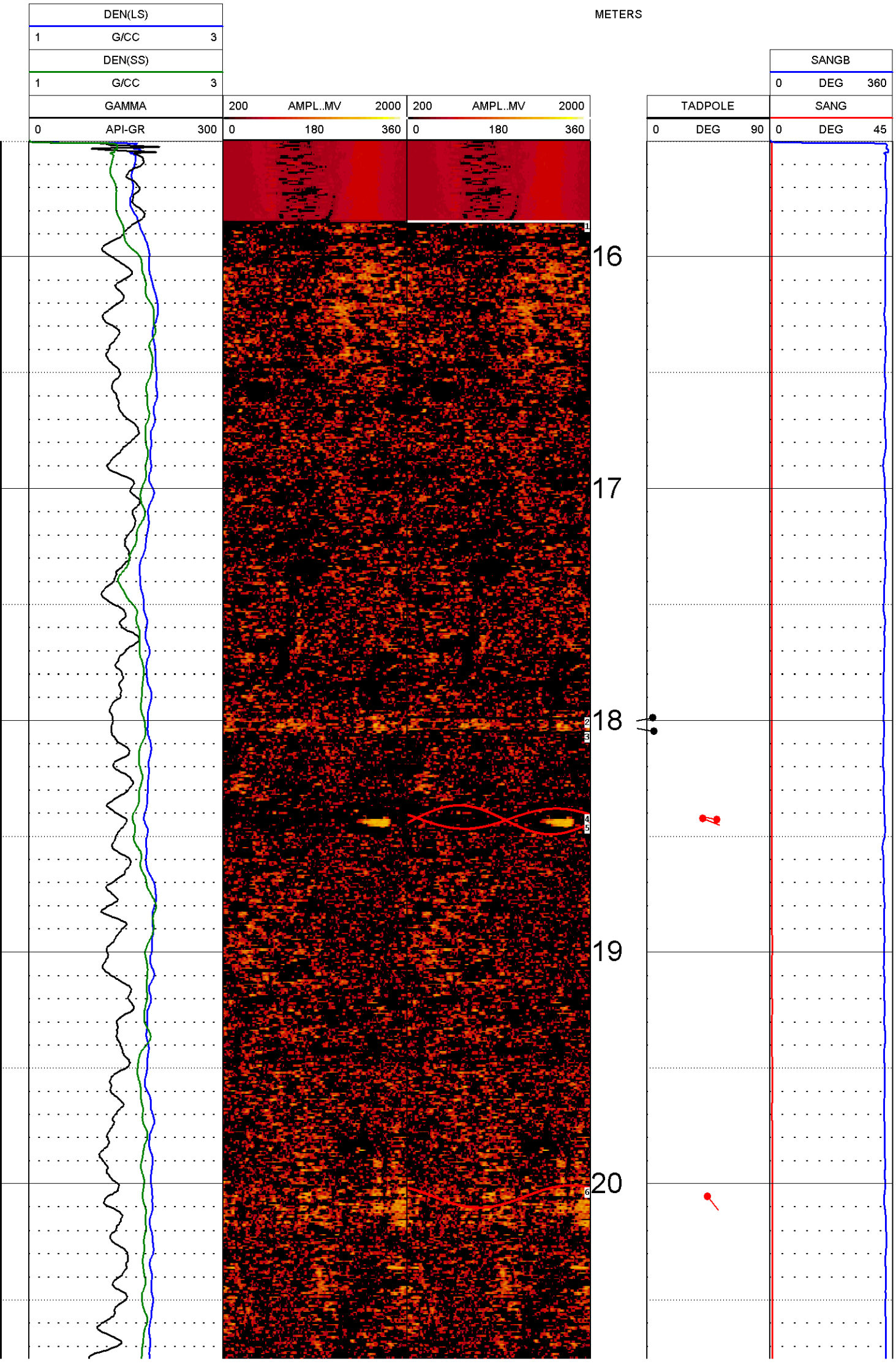
(ABN 11 057 389 152)

## BH16-01 ATV 1:20

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| COMPANY | : | COFFEY GEOTECHNICS | | | OTHER SERVICES: | UTM-E | : N/A |
| WELL | : | BH16-01 ATV 1:20 | | | CAMERA | UTM-N | : N/A |
| LOCATION/FIELD | : | COFFEY MBROOK HOSPITAL | | | TV | | |
| COUNTY | : | AUST | | | | | |
| LOCATION | : | N/A/V | | | | | |
| SECTION | : | N/A | TOWNSHIP | : N/A | | RANGE | : N/A |
| DATE | : | 07/13/16 | PERMANENT DATUM | : GL | | | |
| DEPTH DRILLER | : | 110 | | | | KB | : N/A |
| LOG BOTTOM | : | 113.110 | LOG MEASURED FROM: | N/A | | DF | : N/A |
| LOG TOP | : | 15.500 | DRL MEASURED FROM: | N/A | | GL | : N/A |
| CASING DIAMETER | : | 10. | LOGGING UNIT | : 102 | | | |
| CASING TYPE | : | | FIELD OFFICE | : RUTHERFORD | | | |
| CASING THICKNESS: | | .5 | RECORDED BY | : A DAVIS | | | |
| BIT SIZE | : | 9.6 | BOREHOLE FLUID | : 0 | | FILE | : PROCESSED |
| MAGNETIC DECL. | : | 0 | RM | : 0 | | TYPE | : 9804A |
| MATRIX DENSITY | : | 2.65 | RM TEMPERATURE | : 0 | | LGDATE | : 07/13/16 |
| NEUTRON MATRIX | : | SANDSTONE | MATRIX DELTA T | : 177 | | LGTIME | : 15:26 |
| | | | | | | THRESH: | 99999 |

NO SURFACE CASING

BLOCKAGE AT 83M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DEN(SS)
1 G/CC 3
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0 API-GR 300
200 AMPL..MV 2000
0 180 360
200 AMPL..MV 2000
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METERS
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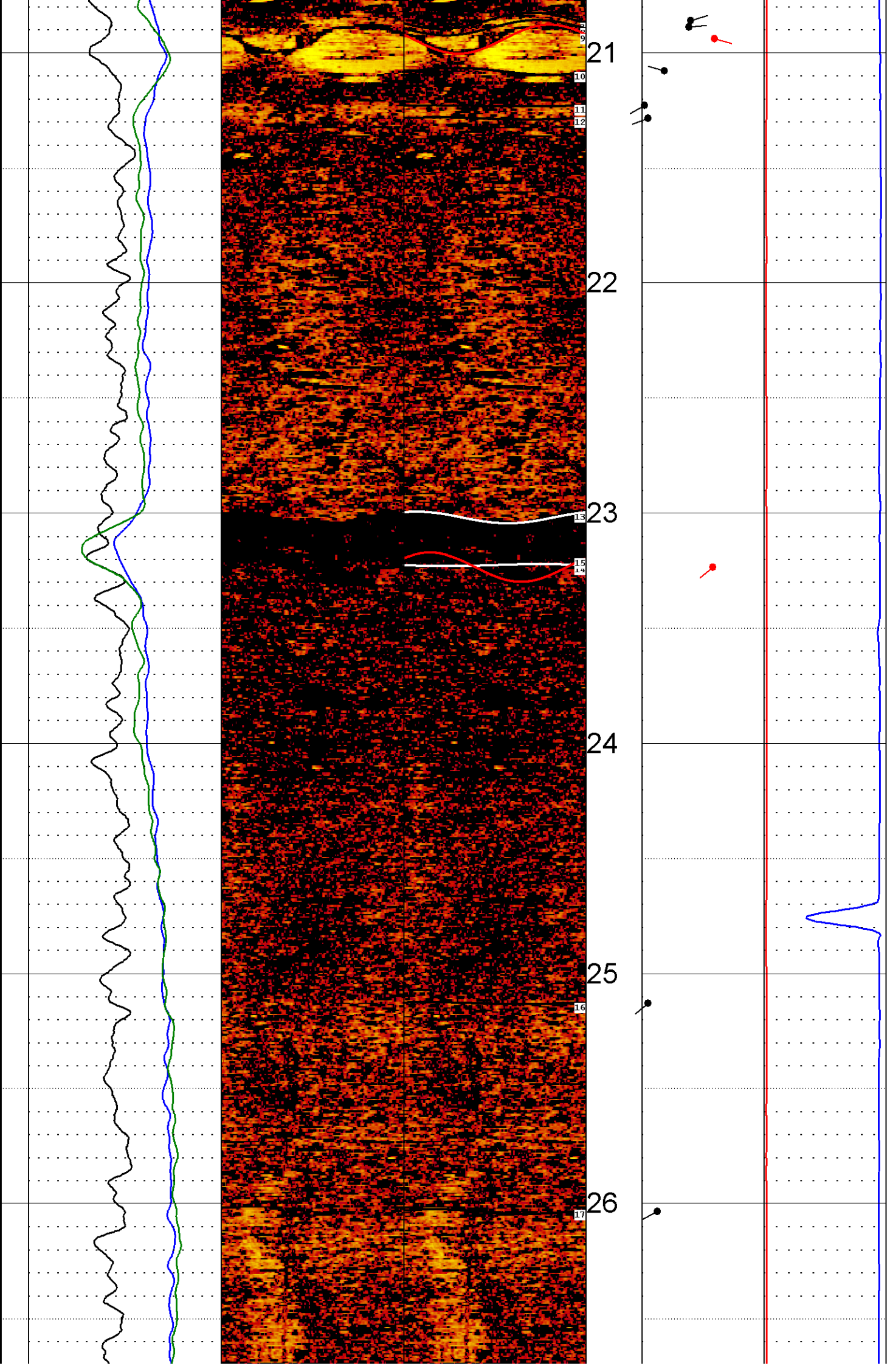
TADPOLE
0 DEG 90
SANGB
0 DEG 360
SANG
0 DEG 45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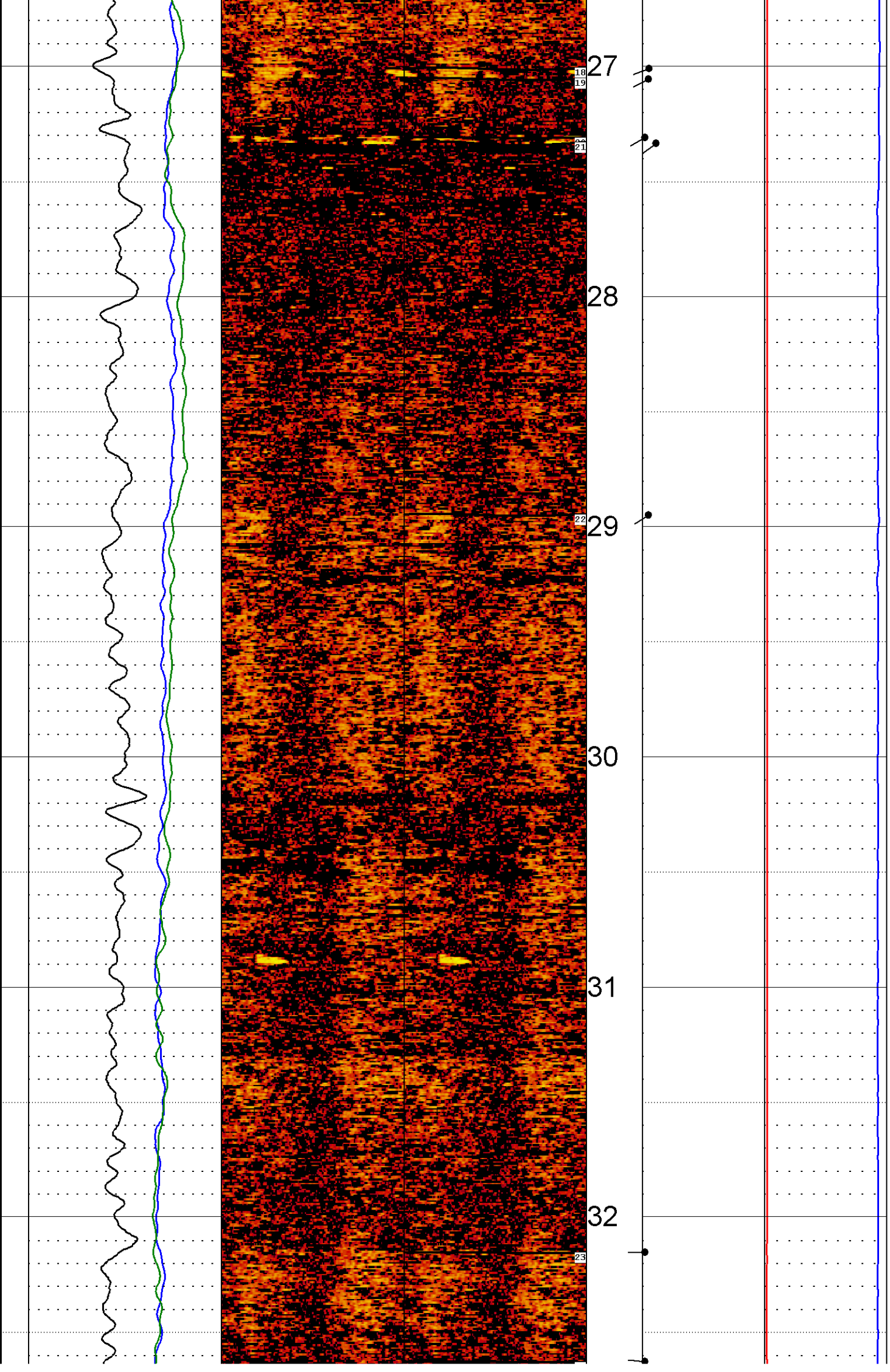
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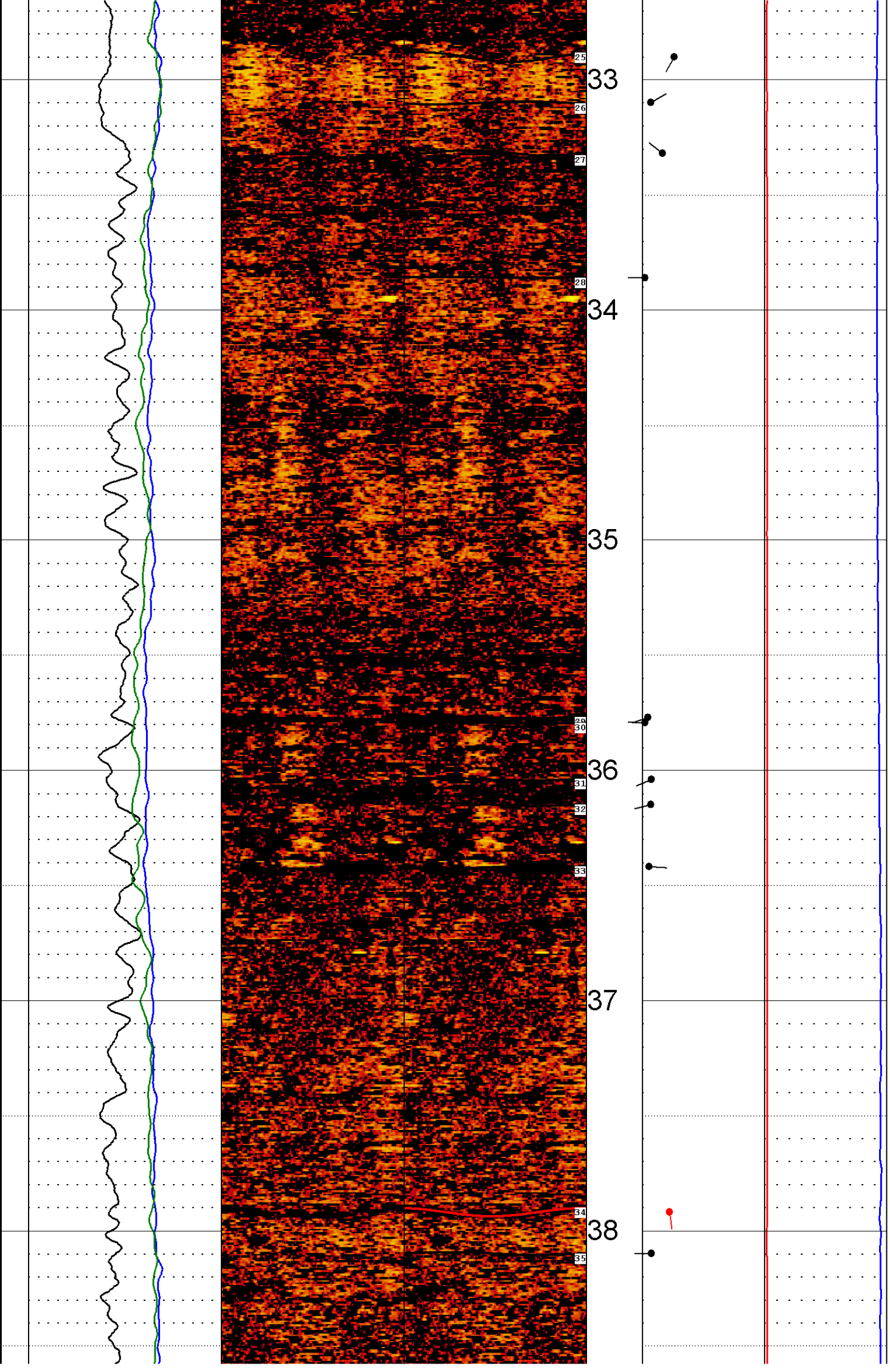
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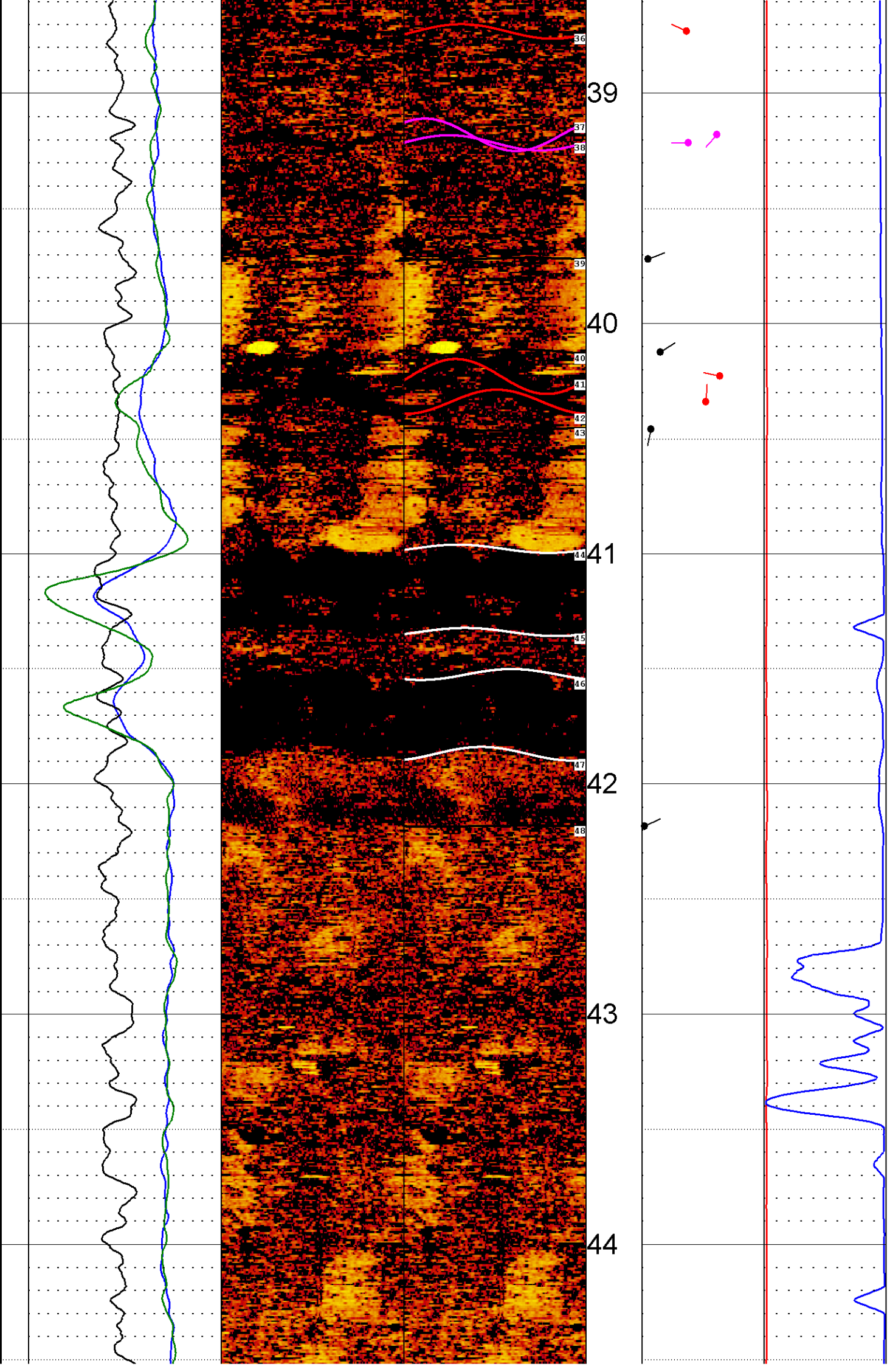
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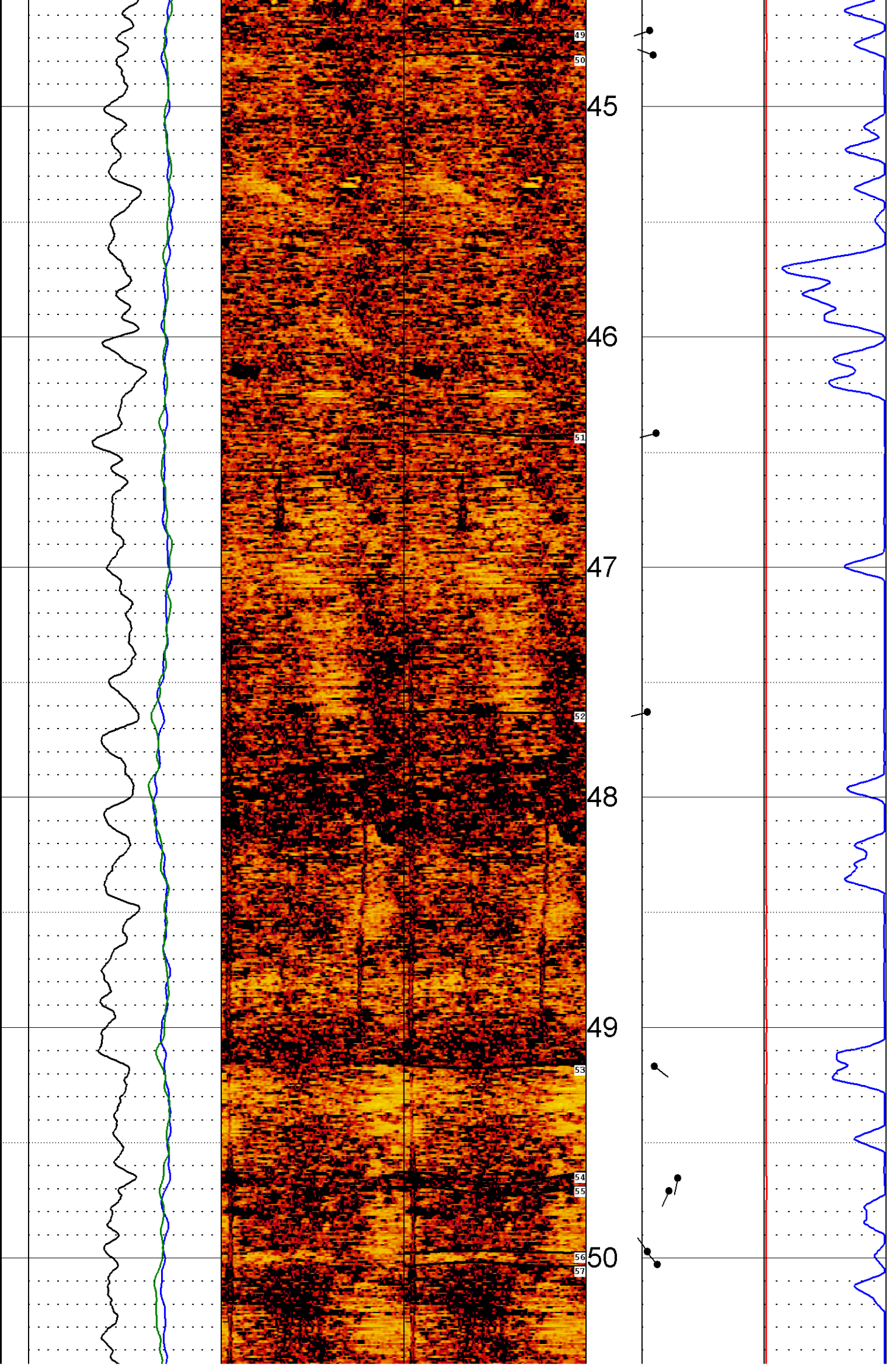
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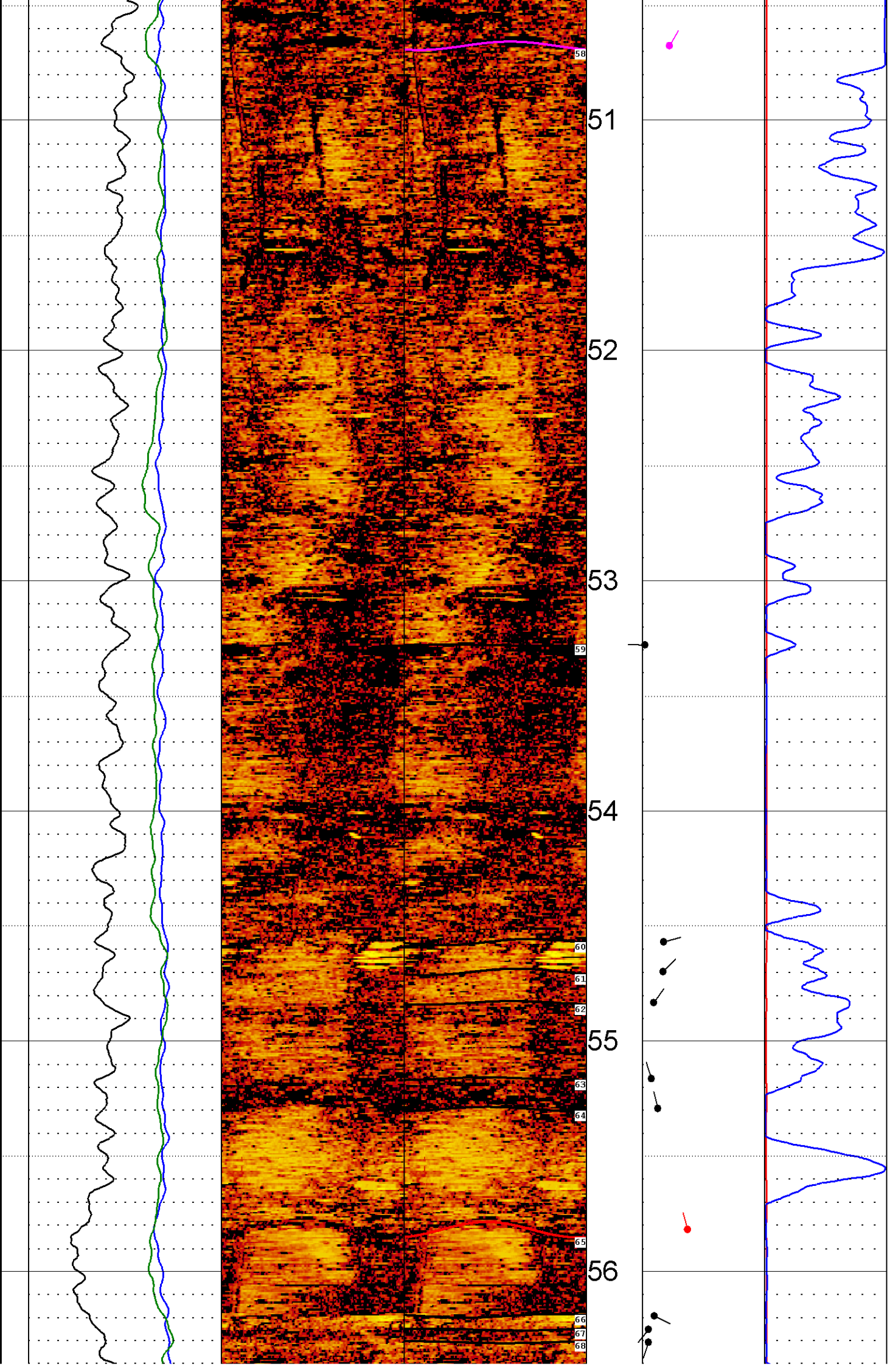
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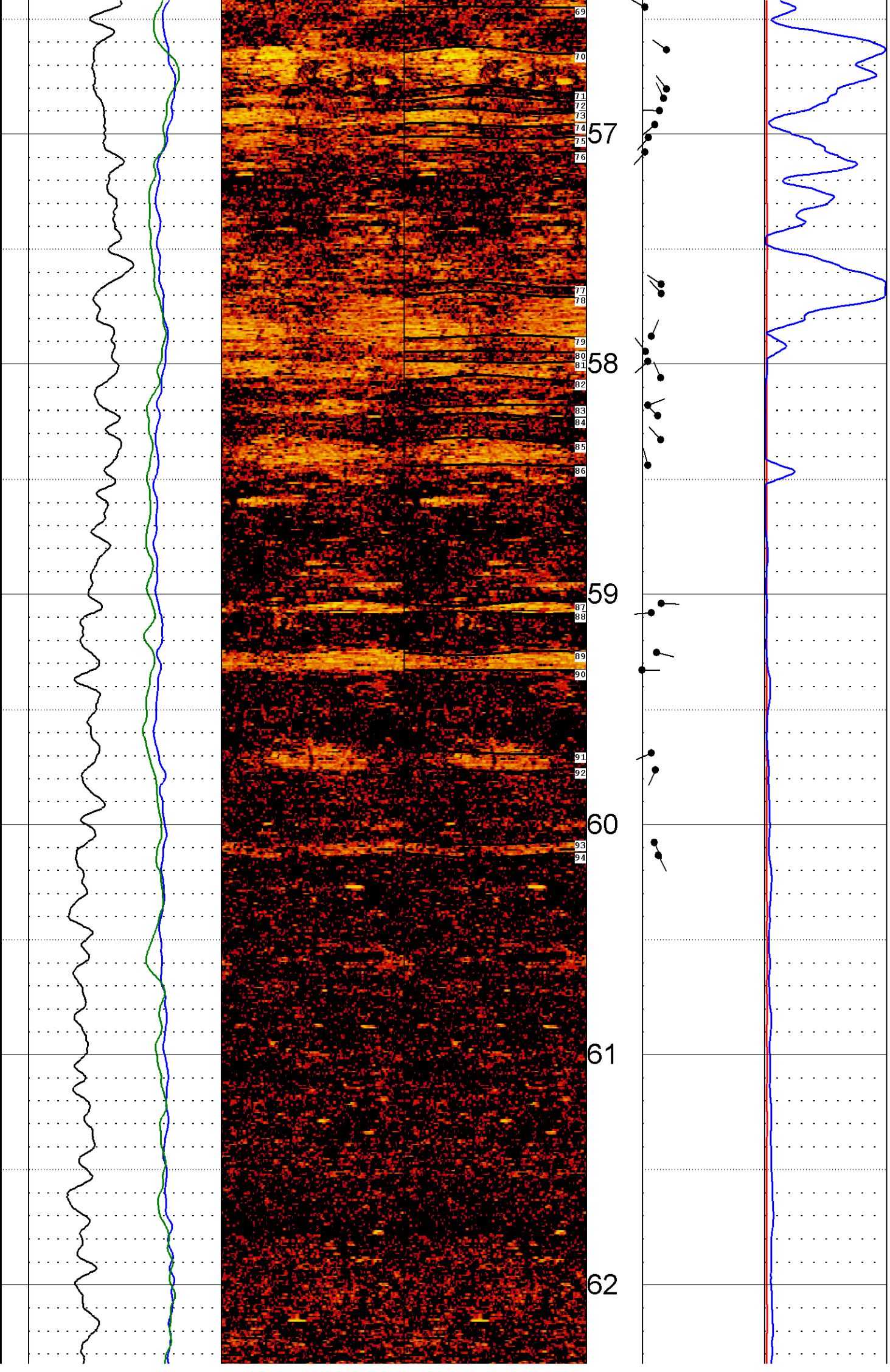
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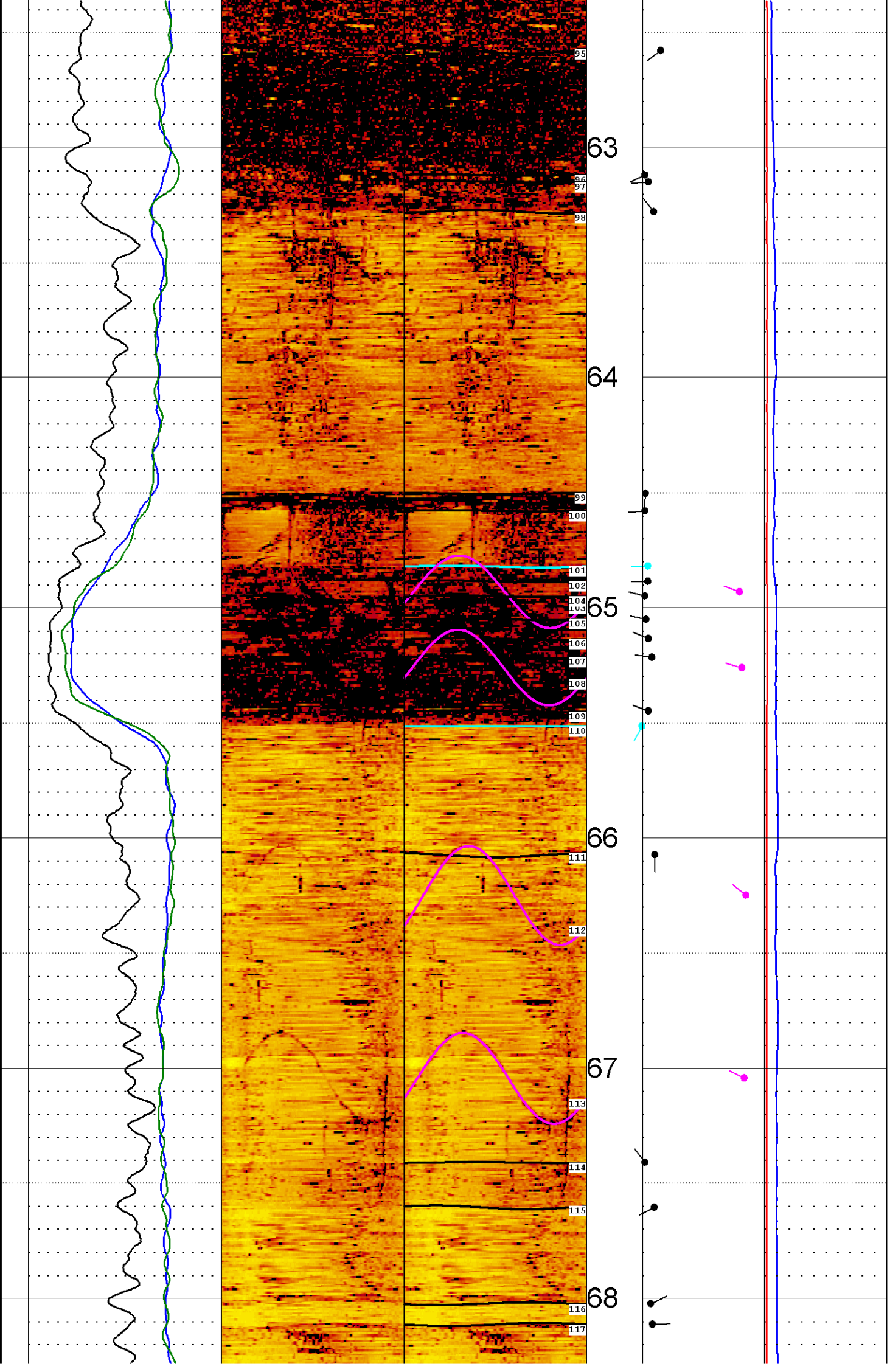
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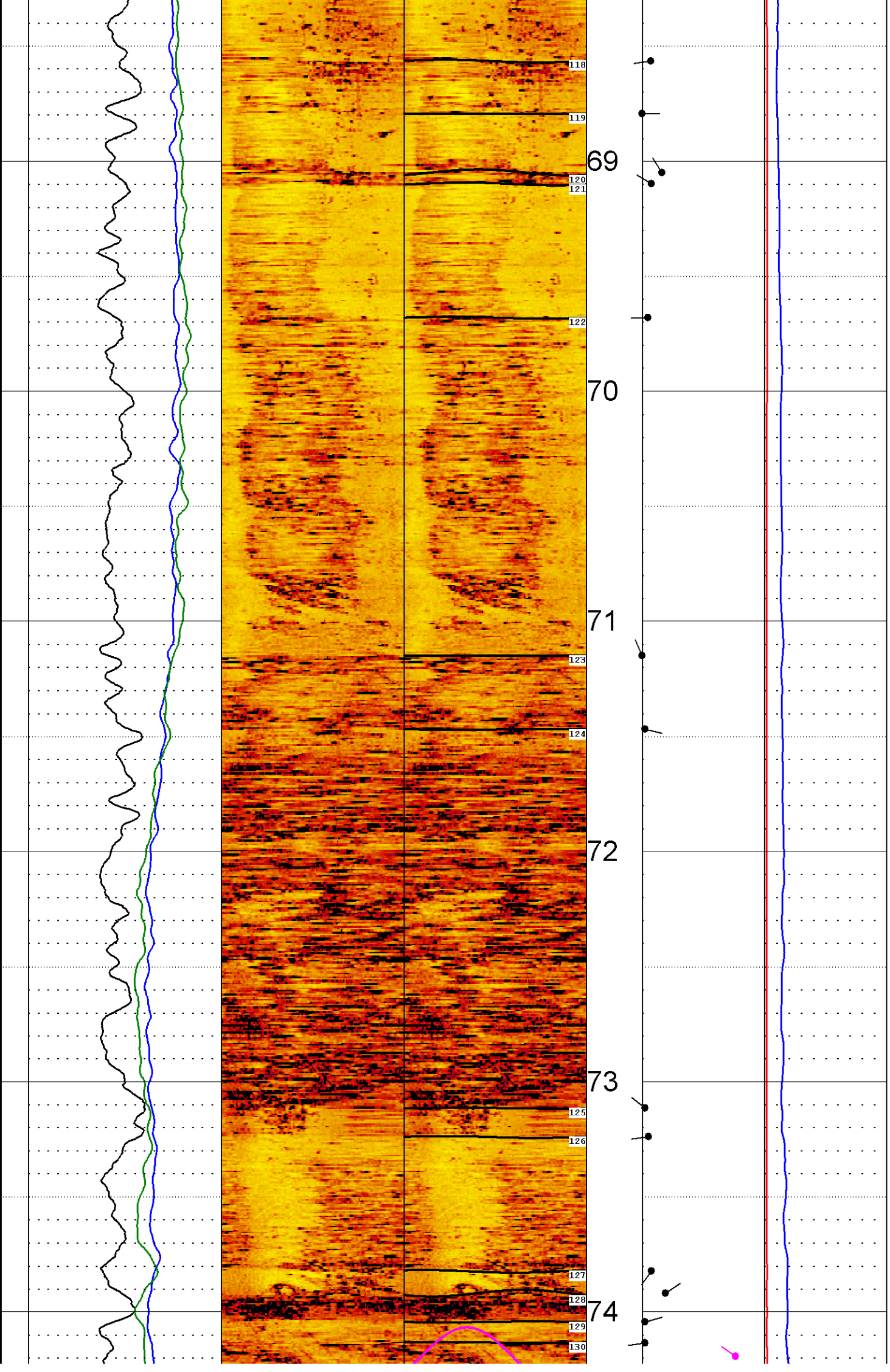
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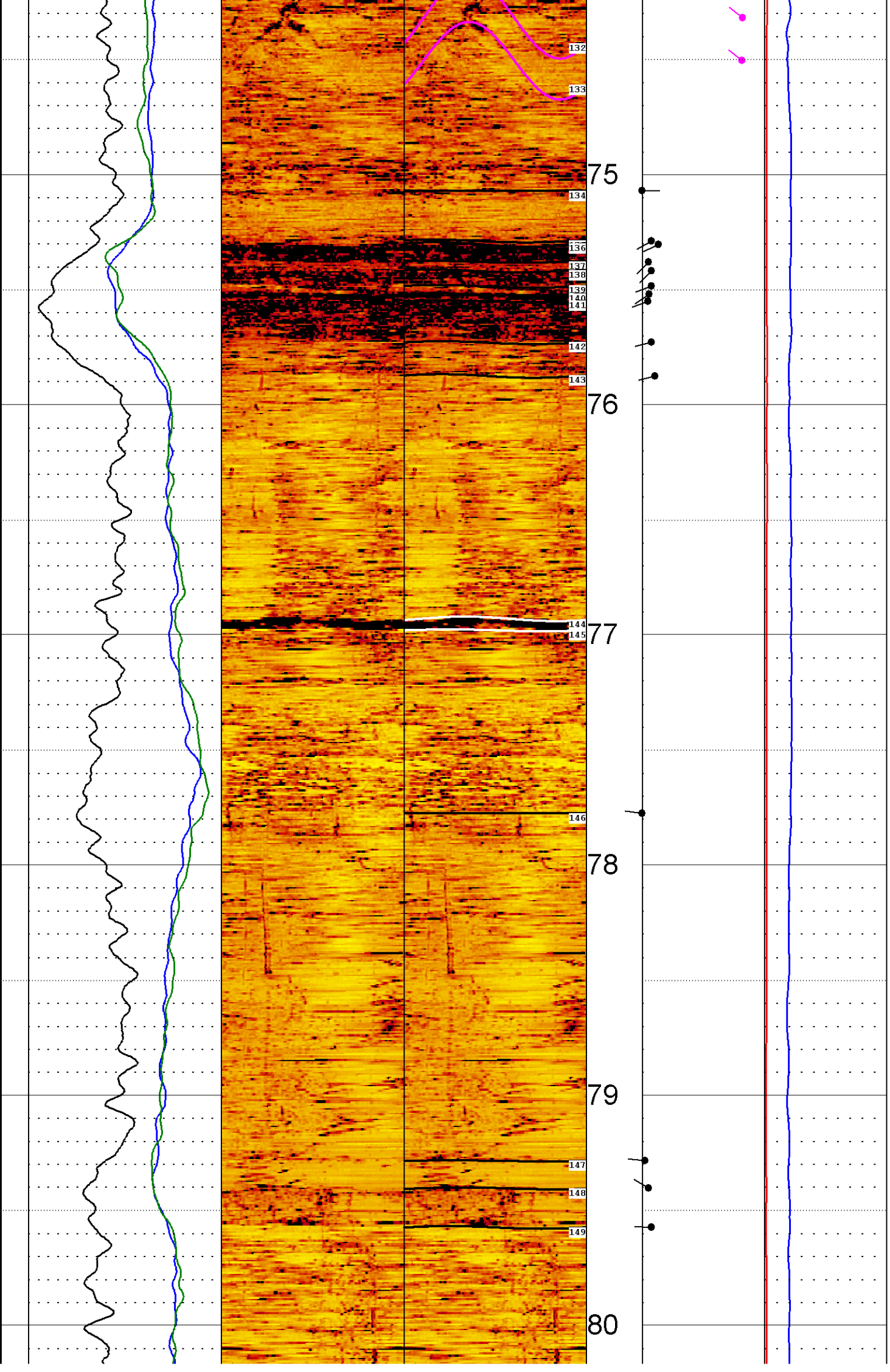
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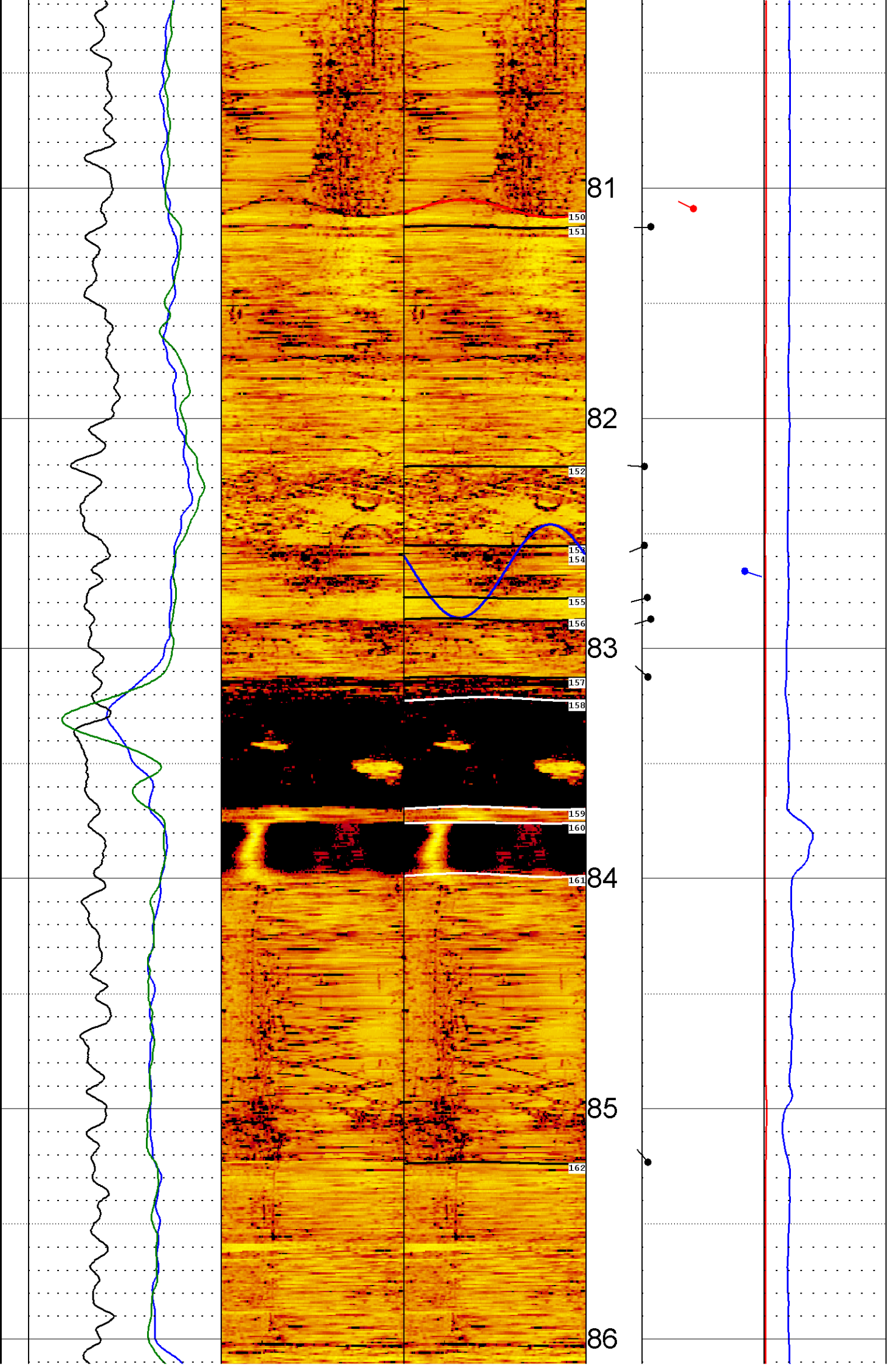
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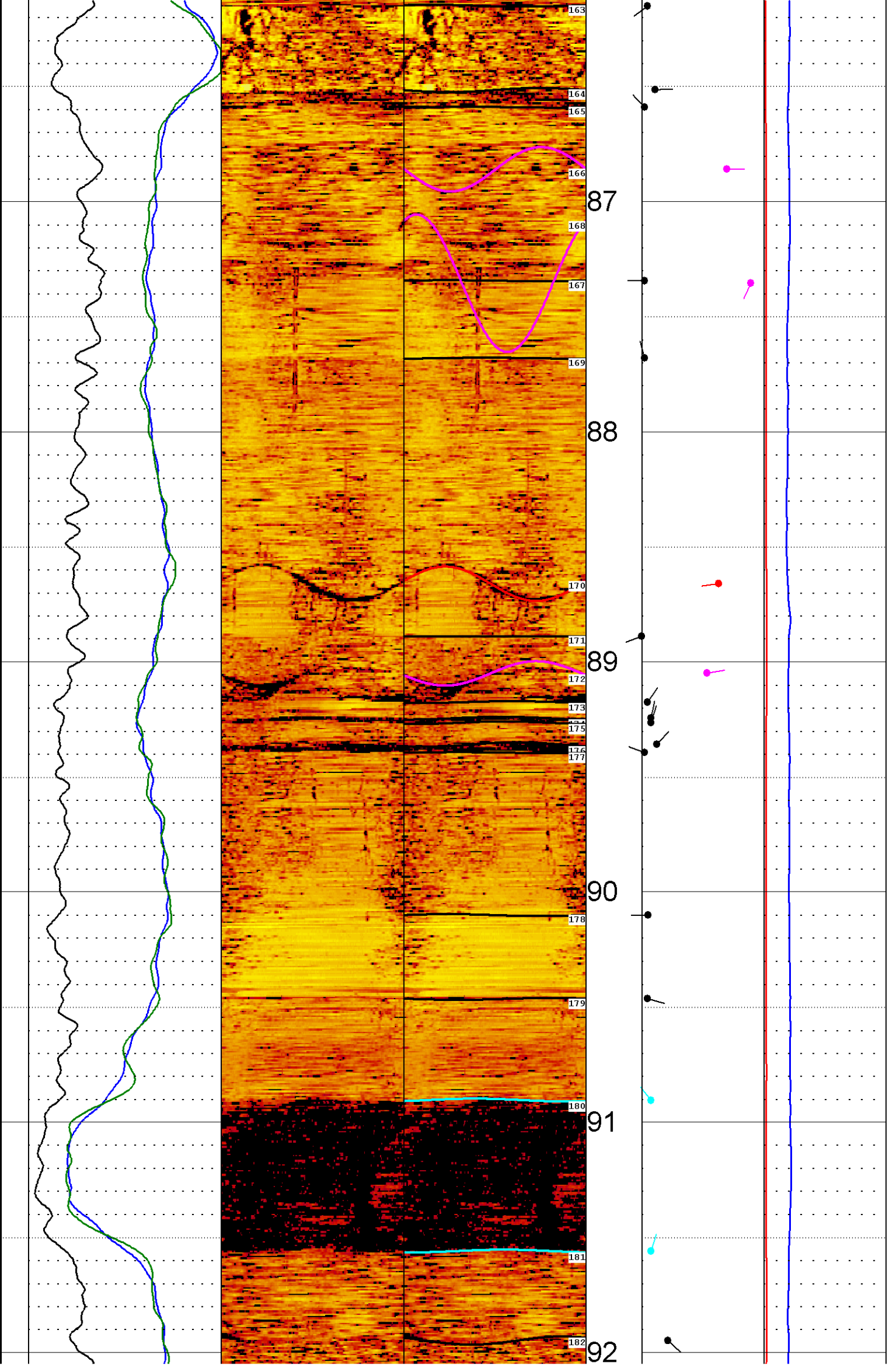
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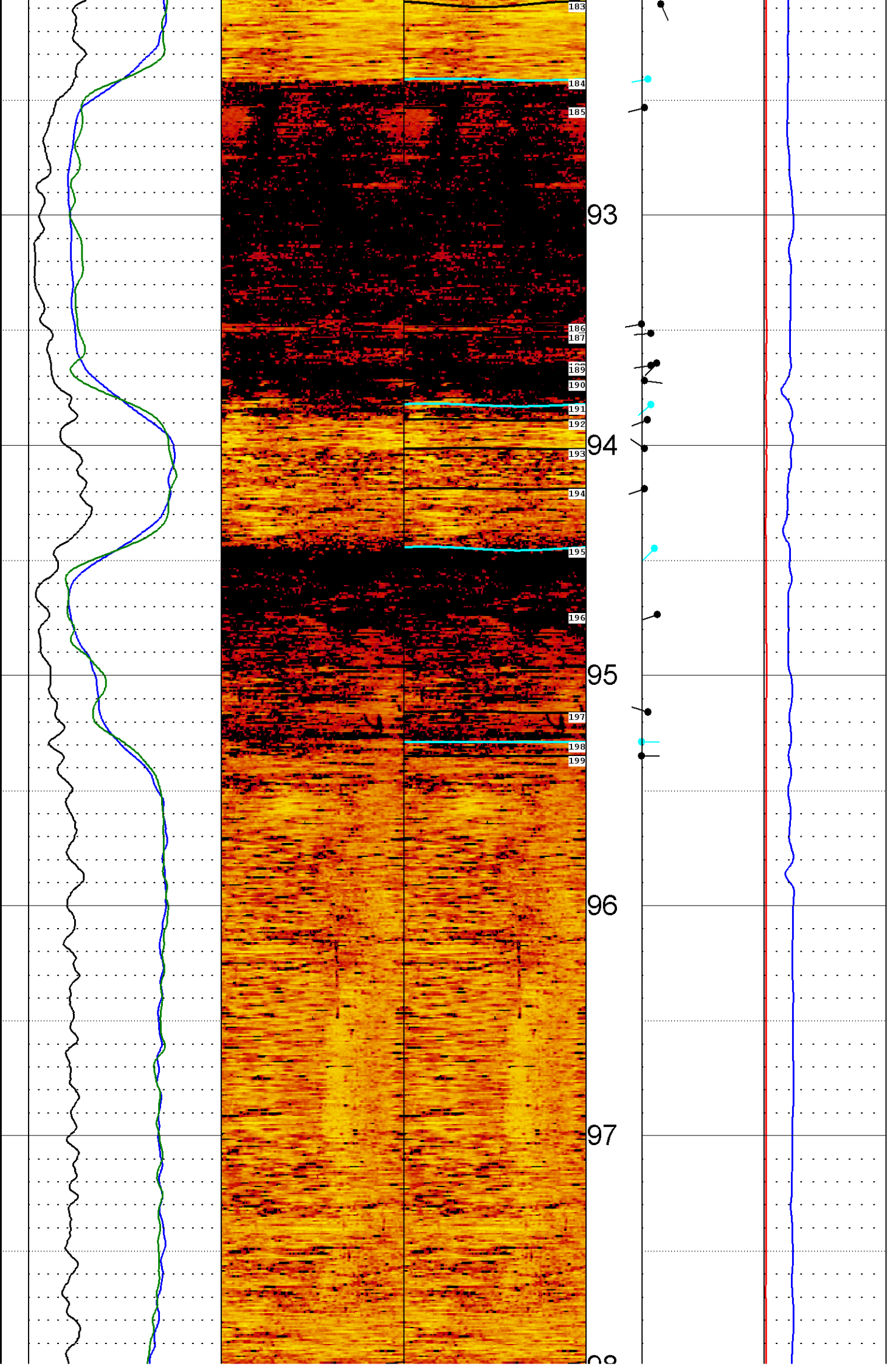
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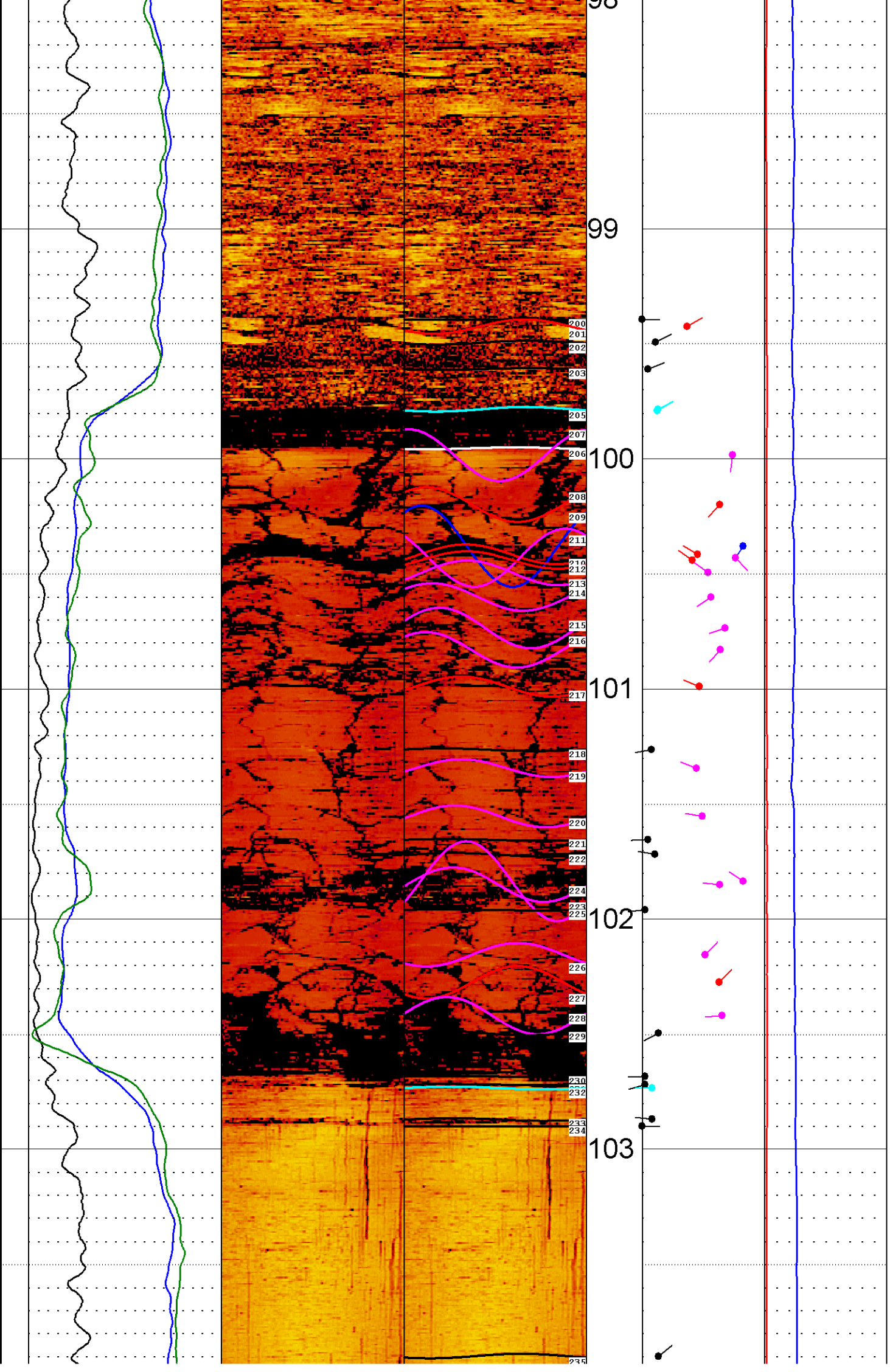
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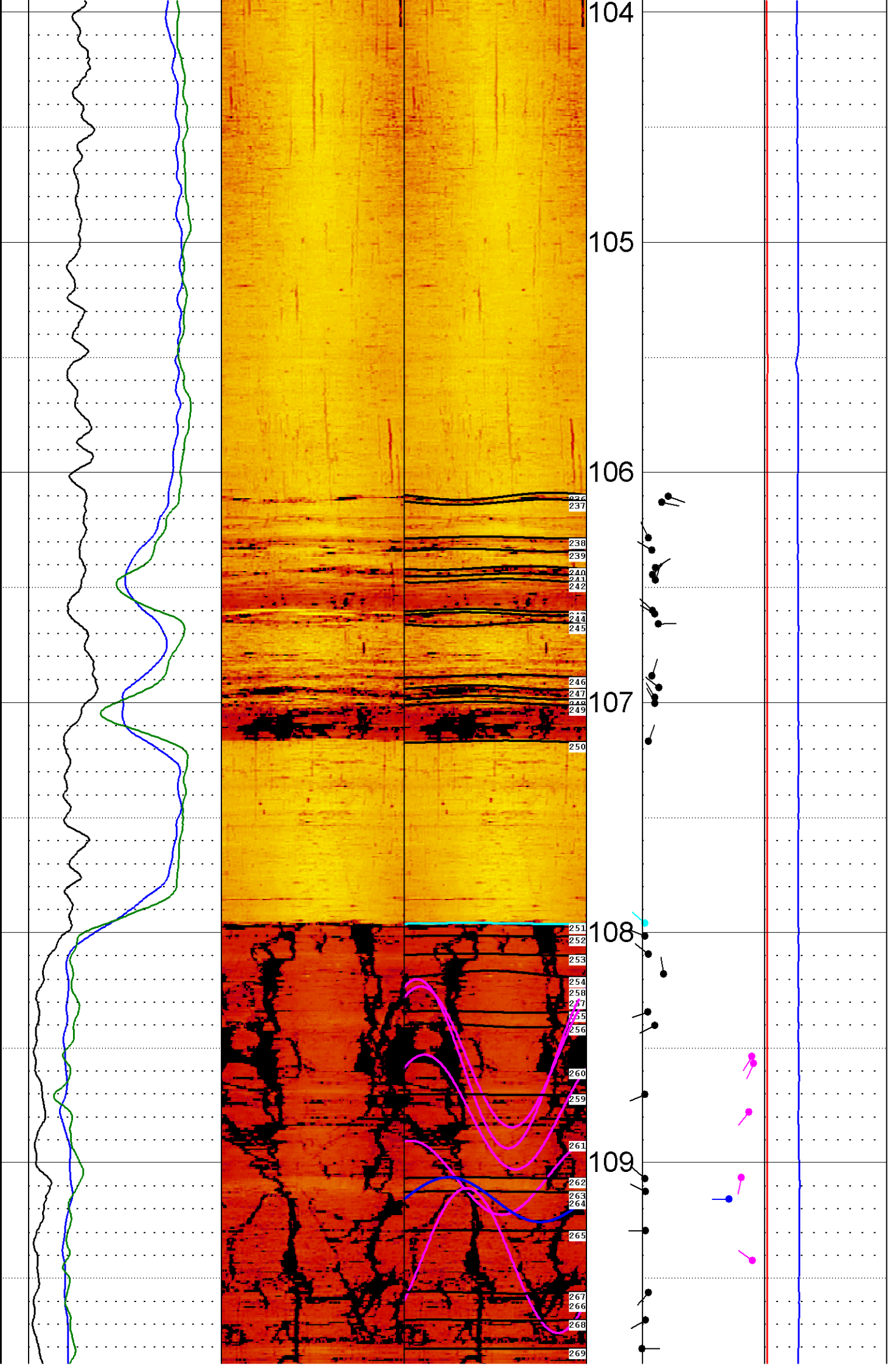
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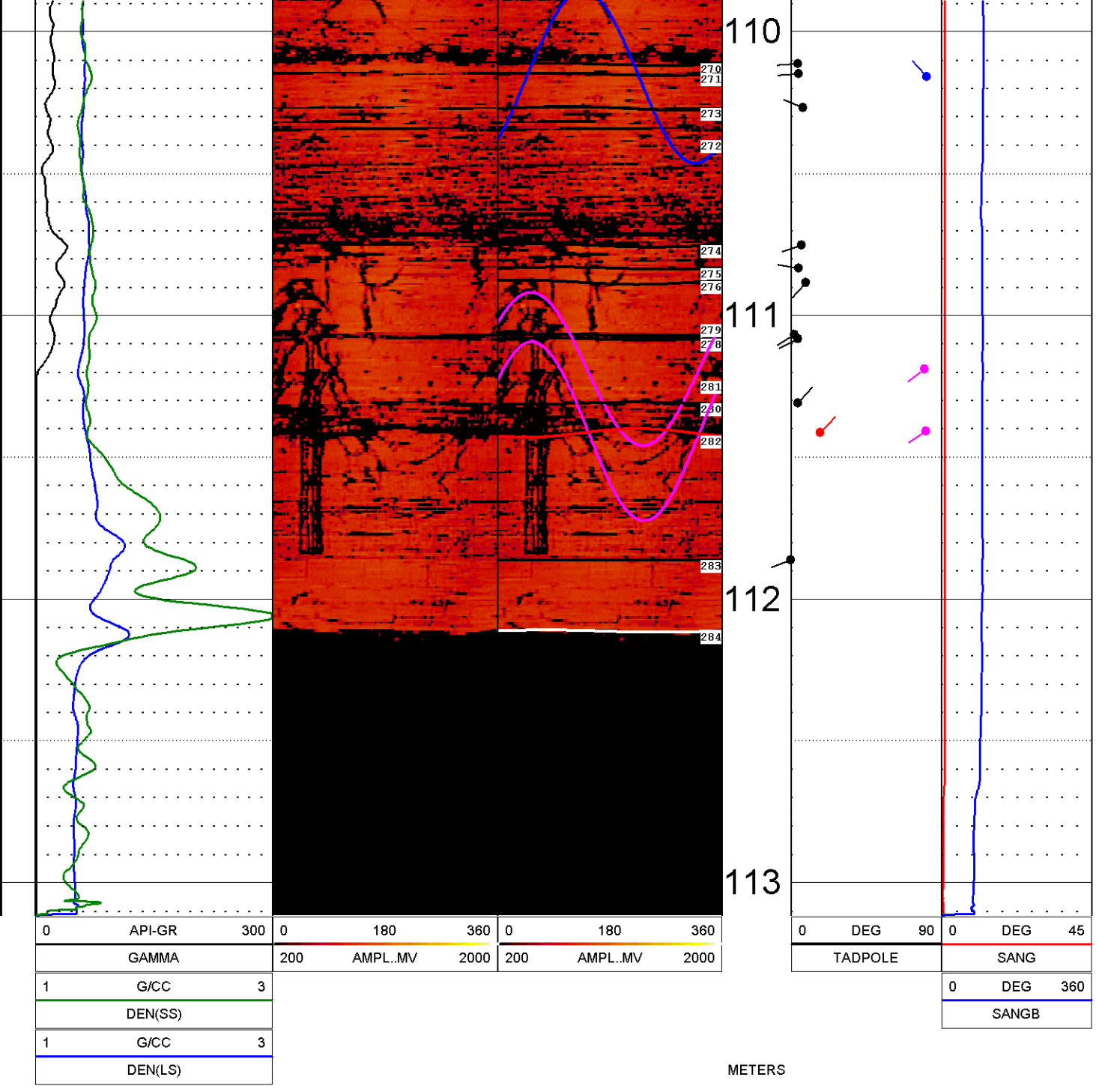
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DEN(SS)
1 G/CC 3
DEN(LS)
0 180 360
200 AMPL..MV 2000
0 180 360
200 AMPL..MV 2000
0 DEG 90
TADPOLE
0 DEG 45
SANG
0 DEG 360
SANGB
METERS

# Coffey Geotechnics

## Borehole BH16-03

### ACOUSTIC TELEVIEWER PETROPHYSICAL REPORT

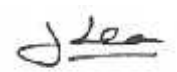
**Groundsearch Australia Pty. Limited**

**15 July 2016**

# DISCLAIMER

The data used in this report were obtained using equipment manufactured by the Century Geophysical Corporation. The interpretations given in this report are based on judgement and experience of Groundsearch Australia's personnel. They are provided for Coffey Geotechnics sole use in accordance with a specified brief. As such, the interpretation outcomes do not necessarily address all aspects of ground conditions and behaviour on the subject site. The responsibility of Groundsearch Australia is solely to Coffey Geotechnics and it is not intended that any third party rely upon this report. This report shall not be reproduced either wholly or in part without the written permission of Groundsearch Australia Pty. Limited.

For and on behalf of Groundsearch Australia Pty. Limited



John Lea BSc (Hons)
FAusIMM MMICA MAIMVA (CPA)
Principal Geologist
Managing Director

## *Executive summary*

The data contained in this report were obtained from one 9.6cm diameter, vertical, non-cored borehole that was drilled as a component of the 2016 geotechnical exploration programme for Coffey Geotechnics Muswellbrook Hospital Project.

Century Geophysical Corporation downhole 9804 acoustic televiewer and 9329 density tools were run to collect data in the field on 13 July 2016 and 23 June 2016 respectively. The density run was through drill rods and the data corrected to reflect openhole conditions. This report is for data from 14.50 to 82.12 mbgl.

The borehole wall sonic data appear to be affected by rugosity caused by the drilling method used.

The 92 identified features are interpreted as bedding (83%), fractures, washouts, the SWL and top of the abandoned coal workings. The bedding to fractures ratio is 15:1. The coal contains some high angle features that are probably cleats.

The Century Display program has automatically recalculated the dip angle data to represent the borehole in the vertical position and the dip direction data is referenced to magnetic north.

## *1.0 Background technical information*

The data contained in this report were obtained from one 9.6cm diameter, vertical, non-cored borehole that was drilled as a component of the 2016 geotechnical exploration programme for Coffey Geotechnics Muswellbrook Hospital Project.

Century Geophysical Corporation downhole 9804 acoustic televiewer and 9329 density tools were run to collect data in the field on 13 July 2016 and 23 June 2016 respectively. The density run was through drill rods and the data corrected to reflect openhole conditions. This report is for data from 14.50 to 82.12 mbgl.

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The Century Display program has automatically recalculated the dip angle data to represent the borehole in the vertical position and the dip direction data is referenced to magnetic north.

Subsequent processing and interpretation of data were carried out by Groundsearch.

The ATV takes an oriented image of the borehole using high-resolution sound waves. This acoustic image is displays amplitude variations. This information is used to detect bedding planes, fractures, and other borehole anomalies without the need to have clear fluid filling the boreholes. The tool works only in fluid-filled boreholes.

The televiewer digitises 256 measurements around the borehole at each high-resolution sample interval. These data can be oriented to North and displayed real-time while logging using the Visual Compu-Log System.

Analysis software includes colour adjustment, fracture dip and strike determination, and classification of features. It allows information to be displayed on the graphical screen, plot, and in report format.

## *2.0 Interpretation methodology*

It should be noted that the ATV is a bowspring-type, centralised tool and is affected by poor wallrock conditions known as rugosity.

The ATV data interpretation procedure is based on the superposition of curves on feature logs directly onto the computer screen by using a subjective, manual; two-point definition of a feature's top and base to produce a sine curve. The sides of the time and

amplitude plots represent magnetic north and magnetic south is in the centre of each plot. The low side, or trough, of the sine curve defines the dip direction of the feature.

The logging program automatically records the televiewer tool slant angle and bearing and corrects for any borehole deviations. The curves are automatically given an identification number for subsequent referencing in a report file.

There are possibly more bedding planes and structural fractures appearing in the televiewer logs that have not been included in this report due to their poor graphic definition or the inability to resolve their geometry by superposing a sine curve using the program's two point method.

This report contains a;

- Text summary of the interpreted features
- Circular representation of interpreted features
- Logs that show geological features with their subjective, numbered interpretation curves shown at 1:20 scale. The logs are in standard format whereby the optical image of the borehole wall is "flattened" onto the plot. The logs have the following additional features to enhance geological interpretations of the strata;
    - Amplitude image differentials
    - Tadpoles that represent feature dip and dip direction
    - Open fracture planes in **RED**
    - Partially open fractures in **MAGENTA**
    - Natural gamma
    - Slant (dip angle)
    - Slant angle bearing
    - Long and short space density
- Table containing feature curve ID, top, base, dip angle, dip azimuth, feature description and the generalised rock type that hosts the feature
- Graphical representations of the interpreted features

### *3.0 Borehole BH16-03interpretation*

The borehole wall sonic data appear to be affected by rugosity caused by the drilling method used.

The 92 identified features are interpreted as bedding (83%), fractures, washouts, the SWL and top of the abandoned coal workings. The bedding to fractures ratio is 15:1. The coal contains some high angle features that are probably cleats.

A description of each interpreted feature is presented in Table 1 and the log is presented in Appendix 1.

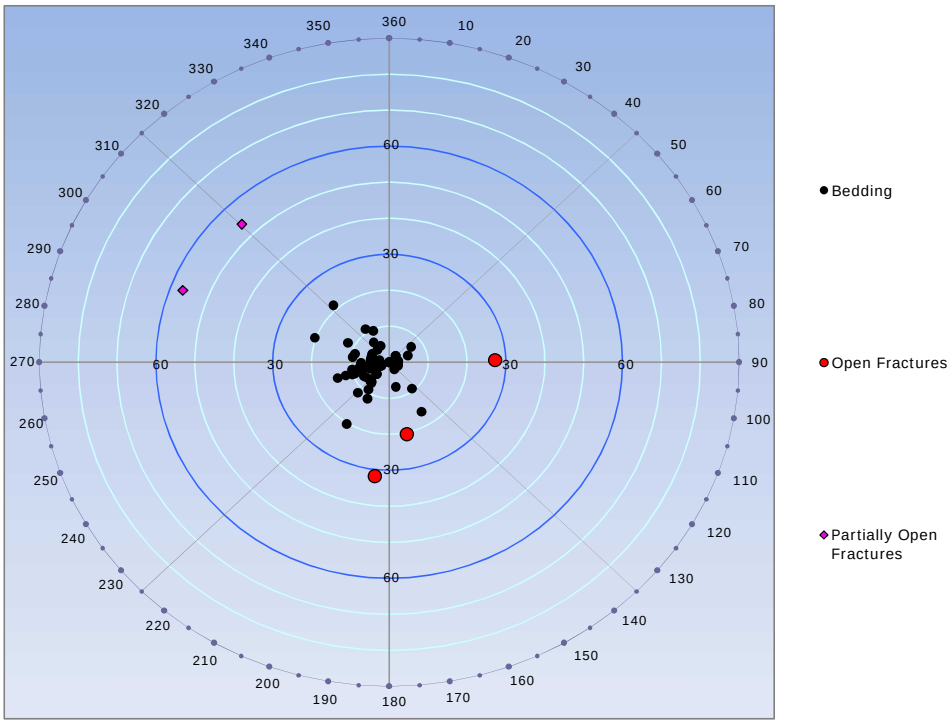
***Table 1 Interpreted features report for BH16-03***

| FEATURE ID | DIP ( DEG ) | AZIMUTH ( DEG ) | MIDPOINT (MBGL) | TOP ( M) | BASE ( M ) | TYPE OF FEATURE | GENERALISED ROCK TYPE |
|---|---|---|---|---|---|---|---|
| 1 | 3 | 248 | 15.03 | 15.03 | 15.03 | SWL | Overburden |
| 2 | 5 | 266 | 16.07 | 16.07 | 16.07 | Bedding plane | Overburden |
| 3 | 32 | 187 | 16.66 | 16.63 | 16.69 | Fracture plane - open | Overburden |
| 4 | 14 | 252 | 17.01 | 17.00 | 17.02 | Bedding plane | Overburden |
| 5 | 21 | 318 | 20.40 | 20.38 | 20.42 | Bedding plane | Overburden |
| 6 | 20 | 212 | 19.95 | 19.93 | 19.97 | Bedding plane | Overburden |
| 7 | 20 | 290 | 20.32 | 20.30 | 20.33 | Bedding plane | Overburden |
| 8 | 20 | 167 | 23.73 | 23.72 | 23.75 | Fracture plane - open | Overburden |
| 9 | 16 | 137 | 25.14 | 25.13 | 25.16 | Top of washout | Overburden |
| 10 | 0 | 90 | 25.22 | 25.22 | 25.22 | Base of washout | Overburden |
| 11 | 12 | 209 | 26.72 | 26.71 | 26.73 | Bedding plane | Overburden |
| 12 | 27 | 89 | 36.39 | 36.36 | 36.41 | Fracture plane - open | Overburden |
| 13 | 21 | 162 | 37.05 | 37.03 | 37.07 | Top of washout | Overburden |
| 14 | 22 | 139 | 37.18 | 37.16 | 37.20 | Base of washout | Overburden |
| 15 | 5 | 287 | 38.80 | 38.79 | 38.80 | Bedding plane | Overburden |
| 16 | 28 | 243 | 41.08 | 41.06 | 41.11 | Top of washout | Overburden |
| 17 | 37 | 301 | 41.27 | 41.23 | 41.31 | Base of washout | Overburden |
| 18 | 7 | 283 | 41.69 | 41.68 | 41.70 | Top of washout | Overburden |
| 19 | 22 | 151 | 41.76 | 41.74 | 41.78 | Base of washout | Overburden |
| 20 | 5 | 298 | 42.47 | 42.47 | 42.48 | Bedding plane | Overburden |
| 21 | 10 | 258 | 43.42 | 43.41 | 43.42 | Bedding plane | Overburden |
| 22 | 2 | 107 | 43.84 | 43.84 | 43.84 | Bedding plane | Overburden |
| 23 | 5 | 287 | 44.42 | 44.41 | 44.42 | Bedding plane | Overburden |
| 24 | 9 | 250 | 50.17 | 50.16 | 50.18 | Bedding plane | Overburden |
| 25 | 8 | 260 | 54.91 | 54.90 | 54.92 | Bedding plane | Overburden |
| 26 | 7 | 236 | 56.78 | 56.77 | 56.78 | Bedding plane | Overburden |
| 27 | 9 | 285 | 56.91 | 56.90 | 56.92 | Bedding plane | Overburden |
| 28 | 2 | 114 | 57.30 | 57.30 | 57.30 | Bedding plane | Overburden |
| 29 | 9 | 215 | 57.37 | 57.36 | 57.38 | Bedding plane | Overburden |
| 30 | 5 | 264 | 57.91 | 57.91 | 57.91 | Bedding plane | Overburden |
| 31 | 2 | 249 | 58.21 | 58.21 | 58.22 | Bedding plane | Overburden |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32 | 3 | 282 | 58.33 | 58.33 | 58.33 | Bedding plane | Overburden |
| 33 | 7 | 258 | 58.47 | 58.46 | 58.47 | Bedding plane | Overburden |
| 34 | 12 | 297 | 58.57 | 58.56 | 58.58 | Bedding plane | Overburden |
| 35 | 7 | 269 | 58.85 | 58.85 | 58.86 | Bedding plane | Overburden |
| 36 | 7 | 257 | 59.75 | 59.74 | 59.75 | Bedding plane | Overburden |
| 37 | 7 | 255 | 59.82 | 59.81 | 59.83 | Bedding plane | Overburden |
| 38 | 5 | 250 | 61.67 | 61.67 | 61.68 | Bedding plane | Overburden |
| 39 | 7 | 258 | 62.65 | 62.65 | 62.66 | Bedding plane | Overburden |
| 40 | 7 | 219 | 62.84 | 62.84 | 62.85 | Bedding plane | Overburden |
| 41 | 5 | 226 | 63.39 | 63.39 | 63.40 | Bedding plane | Overburden |
| 42 | 7 | 166 | 63.47 | 63.46 | 63.47 | Bedding plane | Overburden |
| 43 | 16 | 149 | 63.57 | 63.56 | 63.58 | Bedding plane | Overburden |
| 44 | 9 | 141 | 63.59 | 63.58 | 63.60 | Bedding plane | Overburden |
| 45 | 2 | 264 | 63.89 | 63.89 | 63.89 | Bedding plane | Overburden |
| 46 | 7 | 53 | 64.50 | 64.49 | 64.50 | Bedding plane | Overburden |
| 47 | 2 | 43 | 64.57 | 64.56 | 64.57 | Bedding plane | Overburden |
| 48 | 5 | 69 | 64.59 | 64.58 | 64.59 | Bedding plane | Overburden |
| 49 | 2 | 81 | 64.61 | 64.61 | 64.62 | Bedding plane | Overburden |
| 50 | 5 | 266 | 64.82 | 64.81 | 64.82 | Top of coal unit | COAL SEAM |
| 51 | 10 | 335 | 64.97 | 64.96 | 64.98 | Bedding plane | COAL SEAM |
| 52 | 12 | 252 | 65.09 | 65.08 | 65.10 | Bedding plane | COAL SEAM |
| 53 | 7 | 223 | 65.51 | 65.50 | 65.52 | Base of coal unit | COAL SEAM |
| 54 | 5 | 225 | 66.18 | 66.18 | 66.18 | Bedding plane | Interburden |
| 55 | 7 | 227 | 66.23 | 66.23 | 66.24 | Bedding plane | Interburden |
| 56 | 0 | 90 | 66.26 | 66.26 | 66.26 | Bedding plane | Interburden |
| 57 | 2 | 43 | 68.47 | 68.47 | 68.47 | Bedding plane | Interburden |
| 58 | 5 | 270 | 68.60 | 68.60 | 68.61 | Bedding plane | Interburden |
| 59 | 5 | 225 | 68.81 | 68.81 | 68.81 | Bedding plane | Interburden |
| 60 | 5 | 223 | 68.89 | 68.89 | 68.90 | Bedding plane | Interburden |
| 61 | 0 | 90 | 69.33 | 69.33 | 69.33 | Bedding plane | Interburden |
| 62 | 0 | 90 | 69.93 | 69.93 | 69.93 | Bedding plane | Interburden |
| 63 | 3 | 265 | 70.29 | 70.29 | 70.29 | Bedding plane | Interburden |
| 64 | 2 | 243 | 70.51 | 70.51 | 70.52 | Bedding plane | Interburden |
| 65 | 2 | 84 | 70.70 | 70.70 | 70.70 | Bedding plane | Interburden |
| 66 | 7 | 258 | 70.89 | 70.89 | 70.90 | Bedding plane | Interburden |
| 67 | 11 | 326 | 71.00 | 70.99 | 71.01 | Bedding plane | Interburden |
| 68 | 5 | 277 | 71.73 | 71.73 | 71.73 | Bedding plane | Interburden |
| 69 | 7 | 324 | 71.88 | 71.88 | 71.89 | Bedding plane | Interburden |
| 70 | 5 | 249 | 72.61 | 72.61 | 72.62 | Bedding plane | Interburden |
| 71 | 5 | 319 | 72.85 | 72.85 | 72.86 | Bedding plane | Interburden |
| 72 | 7 | 257 | 73.08 | 73.08 | 73.09 | Bedding plane | Interburden |
| 73 | 7 | 220 | 73.19 | 73.19 | 73.20 | Bedding plane | Interburden |
| 74 | 5 | 334 | 73.71 | 73.71 | 73.72 | Bedding plane | Interburden |
| 75 | 8 | 170 | 75.21 | 75.21 | 75.22 | Top of washout | Interburden |
| 76 | 5 | 275 | 75.41 | 75.40 | 75.41 | Base of washout | Interburden |
| 77 | 5 | 274 | 75.67 | 75.67 | 75.68 | Bedding plane | Interburden |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 78 | 0 | 304 | 75.73 | 75.73 | 75.73 | Bedding plane | Interburden |
| 79 | 2 | 146 | 77.05 | 77.05 | 77.06 | Bedding plane | Interburden |
| 80 | 4 | 263 | 77.28 | 77.27 | 77.28 | Bedding plane | Interburden |
| 81 | 8 | 239 | 78.04 | 78.03 | 78.04 | Bedding plane | Interburden |
| 82 | 2 | 100 | 79.24 | 79.23 | 79.24 | Bedding plane | Interburden |
| 83 | 10 | 279 | 79.43 | 79.43 | 79.44 | Bedding plane | Interburden |
| 84 | 10 | 250 | 80.16 | 80.15 | 80.16 | Bedding plane | Interburden |
| 85 | 2 | 263 | 80.94 | 80.94 | 80.94 | Bedding plane | Interburden |
| 86 | 57 | 291 | 81.02 | 80.95 | 81.09 | Fracture plane - partially open | Interburden |
| 87 | 54 | 315 | 81.06 | 81.00 | 81.13 | Fracture plane - partially open | Interburden |
| 88 | 5 | 249 | 81.08 | 81.08 | 81.09 | Bedding plane | Interburden |
| 89 | 3 | 280 | 81.32 | 81.32 | 81.32 | Bedding plane | Interburden |
| 90 | 5 | 296 | 81.41 | 81.40 | 81.41 | Bedding plane | Interburden |
| 91 | 2 | 243 | 81.74 | 81.74 | 81.75 | Bedding plane | Interburden |
| 92 | 12 | 223 | 81.84 | 81.83 | 81.85 | Bedding plane | Interburden |
| **FEATURE ID** | **DIP ( DEG )** | **AZIMUTH ( DEG )** | **MIDPOINT (MBGL)** | **TOP ( M)** | **BASE ( M )** | **TYPE OF FEATURE** | **GENERALISED ROCK TYPE** |

***Figure 1 BH16-03 circular plan representation of interpreted features***




The 76 identified sedimentary features are predominantly bedding planes that appear to range in dip from flat-lying to $21^0$. Figures 2 and 3 show the distribution of the planes' dip angles and dip direction with depth.

Table 2 details the variation in the dip angle and dip direction data. Figure 4 shows the dip direction data in a rose diagram with the bedding planes' dip angle and dip direction data shown as histograms in Figures 5 and 6.

The five fractures are identified has as three open and two partially open.

Table 3 details the variation in the fractures' dip angle and dip direction data. Figure 7 shows the dip direction data in a rose diagram with the fractures' plane dip angle and dip direction data as histograms in Figures 8 and 9.

***Figure 2 BH16-03feature dip angle data distribution***

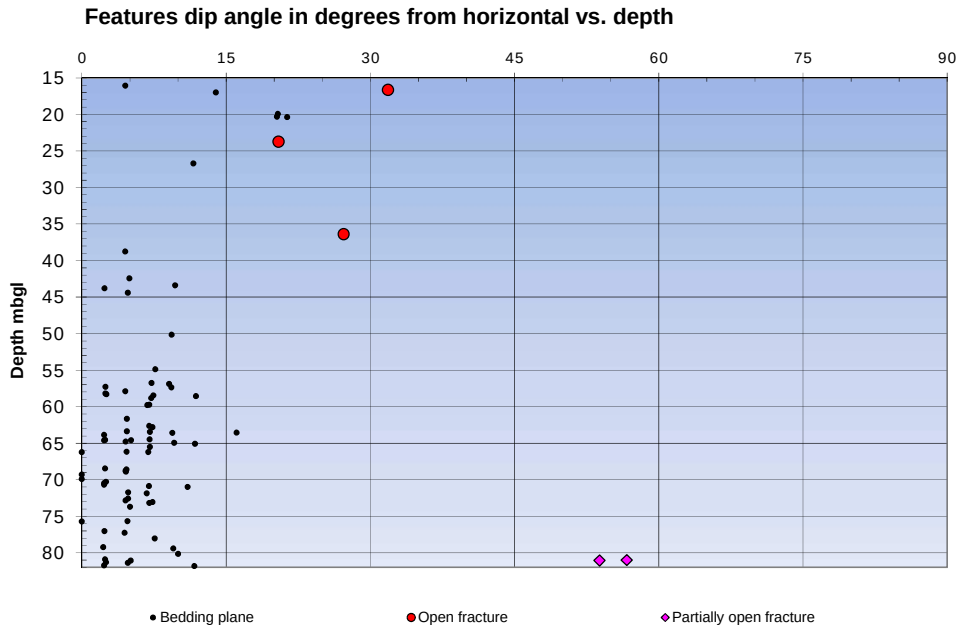
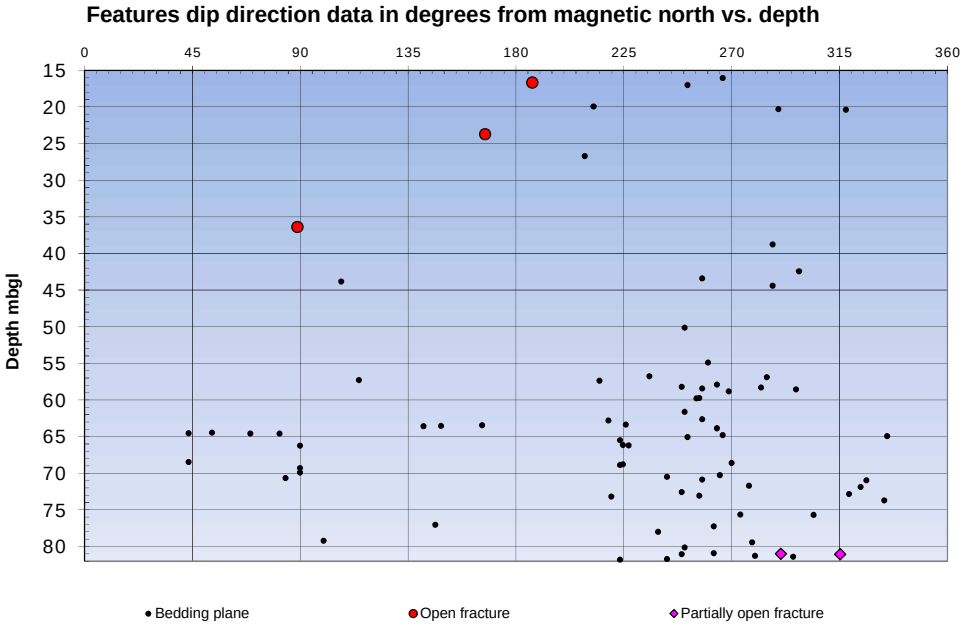


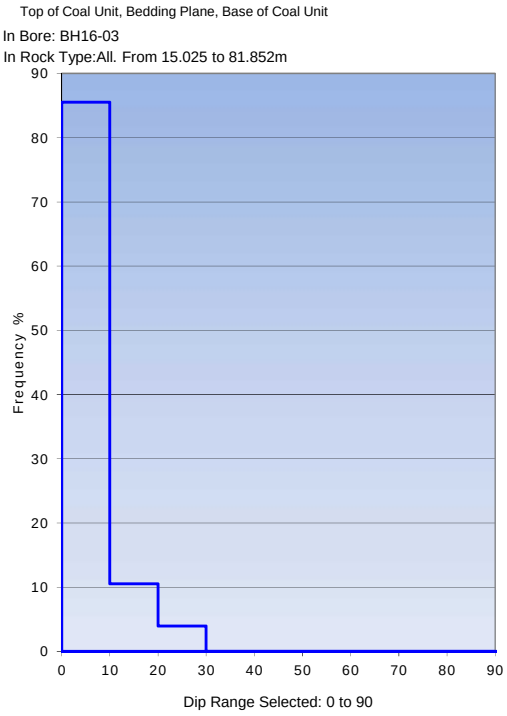

***Figure 3 BH16-03feature dip direction data distribution***



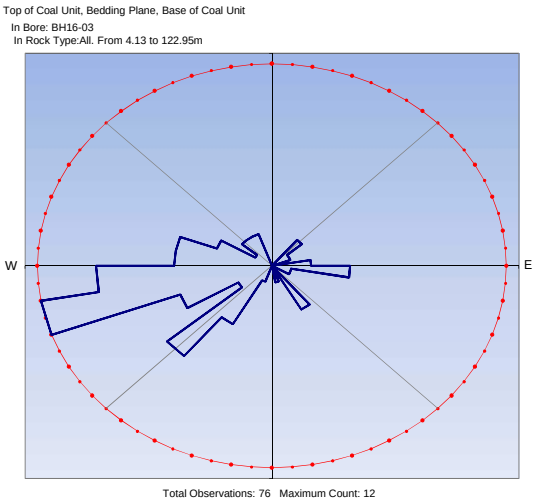
## *Table 2 BH16-03bedding histogram data*

| Dip Distribution Total: 76 | | | Orientation Distribution Total: 76 | | |
|---|---|---|---|---|---|
| Dip Range | Count | % | Bearing Range | Count | % |
| 0 to 10 | 65 | 85.5 | 0 to 10 | 0 | 0.0 |
| 10 to 20 | 8 | 10.5 | 10 to 20 | 0 | 0.0 |
| 20 to 30 | 3 | 3.9 | 20 to 30 | 0 | 0.0 |
| 30 to 40 | 0 | 0.0 | 30 to 40 | 0 | 0.0 |
| 40 to 50 | 0 | 0.0 | 40 to 50 | 2 | 2.6 |
| 50 to 60 | 0 | 0.0 | 50 to 60 | 1 | 1.3 |
| 60 to 70 | 0 | 0.0 | 60 to 70 | 1 | 1.3 |
| 70 to 80 | 0 | 0.0 | 70 to 80 | 0 | 0.0 |
| 80 to 90 | 0 | 0.0 | 80 to 90 | 2 | 2.6 |
| | | | 90 to 100 | 4 | 5.3 |
| | | | 100 to 110 | 1 | 1.3 |
| | | | 110 to 120 | 1 | 1.3 |
| | | | 120 to 130 | 0 | 0.0 |
| | | | 130 to 140 | 0 | 0.0 |
| | | | 140 to 150 | 3 | 3.9 |
| | | | 150 to 160 | 0 | 0.0 |
| | | | 160 to 170 | 1 | 1.3 |
| | | | 170 to 180 | 0 | 0.0 |
| | | | 180 to 190 | 0 | 0.0 |
| | | | 190 to 200 | 0 | 0.0 |
| | | | 200 to 210 | 1 | 1.3 |
| | | | 210 to 220 | 4 | 5.3 |
| | | | 220 to 230 | 7 | 9.2 |
| | | | 230 to 240 | 2 | 2.6 |
| | | | 240 to 250 | 5 | 6.6 |
| | | | 250 to 260 | 12 | 15.8 |
| | | | 260 to 270 | 9 | 11.8 |
| | | | 270 to 280 | 5 | 6.6 |
| | | | 280 to 290 | 5 | 6.6 |
| | | | 290 to 300 | 3 | 3.9 |
| | | | 300 to 310 | 1 | 1.3 |
| | | | 310 to 320 | 2 | 2.6 |
| | | | 320 to 330 | 2 | 2.6 |
| | | | 330 to 340 | 2 | 2.6 |
| | | | 340 to 350 | 0 | 0.0 |
| | | | 350 to 360 | 0 | 0.0 |

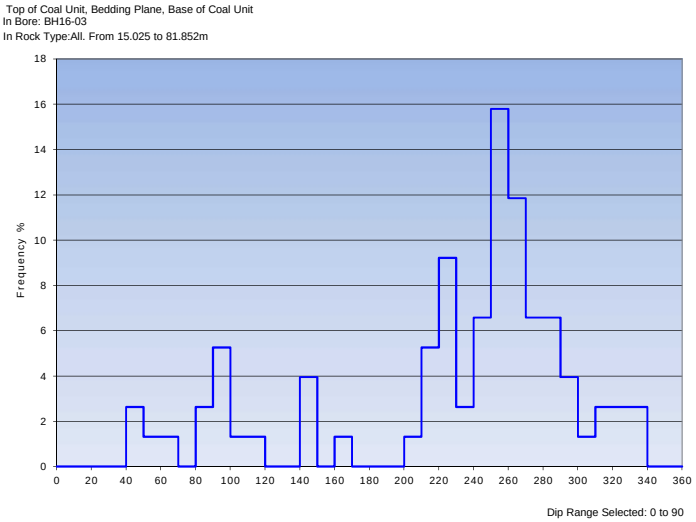
## *Figure 5 BH16-03bedding dip angles histogram*




## *Figure 4 BH16-03bedding dip direction data rose diagram*



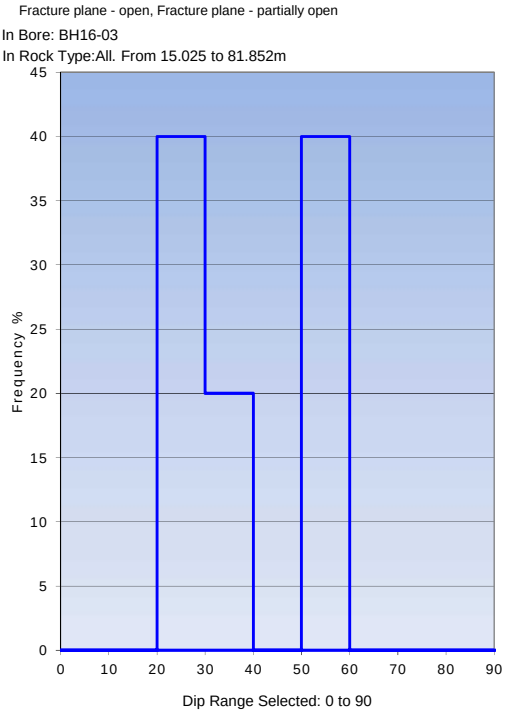

## *Figure 6 BH16-03bedding dip directions histogram*



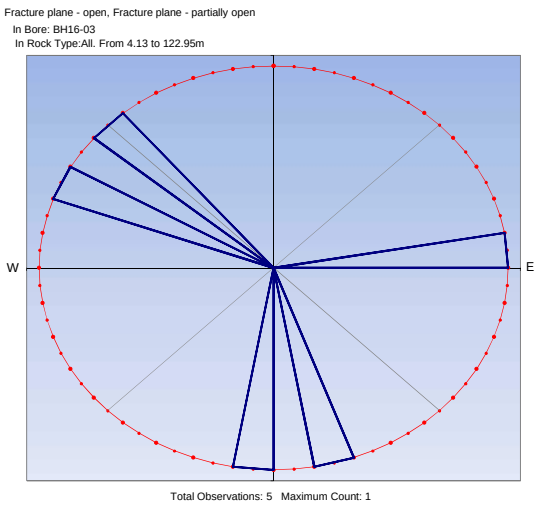
## Table 3 BH16-03 fractures histogram data

| Dip Distribution Total: 5 | | | Orientation Distribution Total: 5 | | |
|---|---|---|---|---|---|
| Dip Range | Count | % | Bearing Range | Count | % |
| 0 to 10 | 0 | 0.0 | 0 to 10 | 0 | 0.0 |
| 10 to 20 | 0 | 0.0 | 10 to 20 | 0 | 0.0 |
| 20 to 30 | 2 | 40.0 | 20 to 30 | 0 | 0.0 |
| 30 to 40 | 1 | 20.0 | 30 to 40 | 0 | 0.0 |
| 40 to 50 | 0 | 0.0 | 40 to 50 | 0 | 0.0 |
| 50 to 60 | 2 | 40.0 | 50 to 60 | 0 | 0.0 |
| 60 to 70 | 0 | 0.0 | 60 to 70 | 0 | 0.0 |
| 70 to 80 | 0 | 0.0 | 70 to 80 | 0 | 0.0 |
| 80 to 90 | 0 | 0.0 | 80 to 90 | 1 | 20.0 |
| | | | 90 to 100 | 0 | 0.0 |
| | | | 100 to 110 | 0 | 0.0 |
| | | | 110 to 120 | 0 | 0.0 |
| | | | 120 to 130 | 0 | 0.0 |
| | | | 130 to 140 | 0 | 0.0 |
| | | | 140 to 150 | 0 | 0.0 |
| | | | 150 to 160 | 0 | 0.0 |
| | | | 160 to 170 | 1 | 20.0 |
| | | | 170 to 180 | 0 | 0.0 |
| | | | 180 to 190 | 1 | 20.0 |
| | | | 190 to 200 | 0 | 0.0 |
| | | | 200 to 210 | 0 | 0.0 |
| | | | 210 to 220 | 0 | 0.0 |
| | | | 220 to 230 | 0 | 0.0 |
| | | | 230 to 240 | 0 | 0.0 |
| | | | 240 to 250 | 0 | 0.0 |
| | | | 250 to 260 | 0 | 0.0 |
| | | | 260 to 270 | 0 | 0.0 |
| | | | 270 to 280 | 0 | 0.0 |
| | | | 280 to 290 | 0 | 0.0 |
| | | | 290 to 300 | 1 | 20.0 |
| | | | 300 to 310 | 0 | 0.0 |
| | | | 310 to 320 | 1 | 20.0 |
| | | | 320 to 330 | 0 | 0.0 |
| | | | 330 to 340 | 0 | 0.0 |
| | | | 340 to 350 | 0 | 0.0 |
| | | | 350 to 360 | 0 | 0.0 |

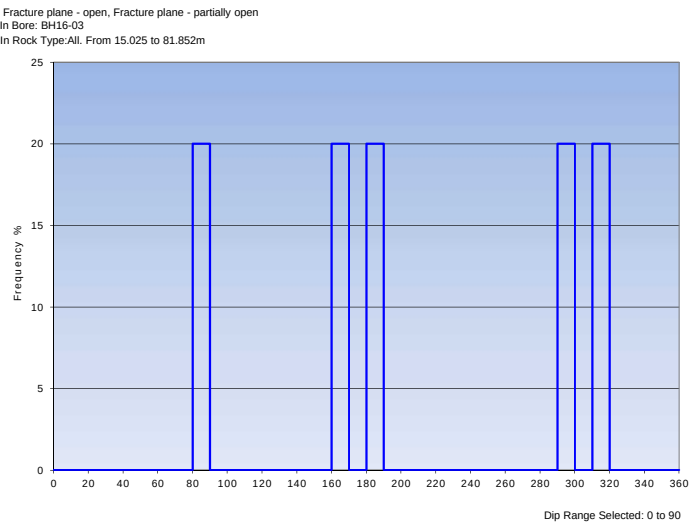
## Figure 8 BH16-03fractures dip angles histogram




## Figure 7 BH16-03fractures dip direction data rose diagram




## Figure 9 BH16-03fractures dip directions histogram



## *Appendix 1*

**Appendix 1** 1:20 Interpretation logs – 14.50 to 82.12 mbgl

# GROUNDSEARCH AUSTRALIA

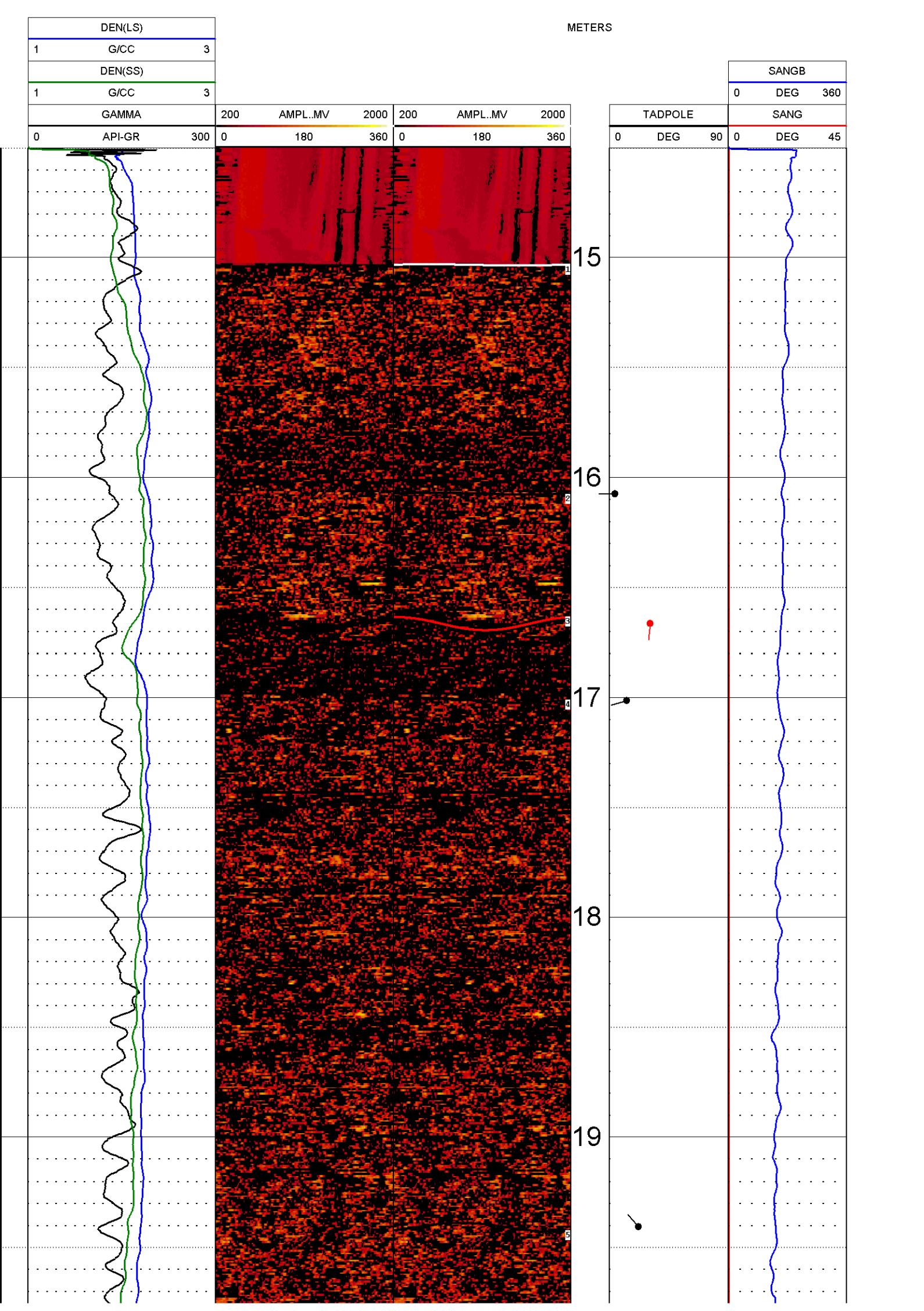
(ABN 11 057 389 152)

## BH16-03 ATV 1:20

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| COMPANY | : | COFFEY GEOTECHNICS | | | OTHER SERVICES: | UTM-E | : N/A |
| WELL | : | BH16-03 ATV 1:20 | | | CAMERA | UTM-N | : N/A |
| LOCATION/FIELD | : | COFFEY MBROOK HOSPITAL | | | TV | | |
| COUNTY | : | AUST | | | | | |
| LOCATION | : | N/A/V | | | | | |
| SECTION | : | N/A | TOWNSHIP | : N/A | | RANGE | : N/A |
| DATE | : | 07/13/16 | PERMANENT DATUM | : GL | | | |
| DEPTH DRILLER | : | 110 | | | | KB | : N/A |
| LOG BOTTOM | : | 82.120 | LOG MEASURED FROM: | N/A | | DF | : N/A |
| LOG TOP | : | 14.500 | DRL MEASURED FROM: | N/A | | GL | : N/A |
| CASING DIAMETER | : | 10. | LOGGING UNIT | : 102 | | | |
| CASING TYPE | : | | FIELD OFFICE | : RUTHERFORD | | | |
| CASING THICKNESS: | | .5 | RECORDED BY | : A DAVIS | | | |
| BIT SIZE | : | 9.6 | BOREHOLE FLUID | : 0 | | FILE | : PROCESSED |
| MAGNETIC DECL. | : | 0 | RM | : 0 | | TYPE | : 9804A |
| MATRIX DENSITY | : | 2.65 | RM TEMPERATURE | : 0 | | LGDATE | : 07/13/16 |
| NEUTRON MATRIX | : | SANDSTONE | MATRIX DELTA T | : 177 | | LGTIME | : 14:14 |
| | | | | | | THRESH: | 99999 |

NO SURFACE CASING

BLOCKAGE AT 83M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1 G/CC 3
DEN(SS)
1 G/CC 3
GAMMA
0 API-GR 300
200 AMPL..MV 2000
0 180 360
200 AMPL..MV 2000
0 180 360
METERS
TADPOLE
0 DEG 90
SANGB
0 DEG 360
SANG
0 DEG 45
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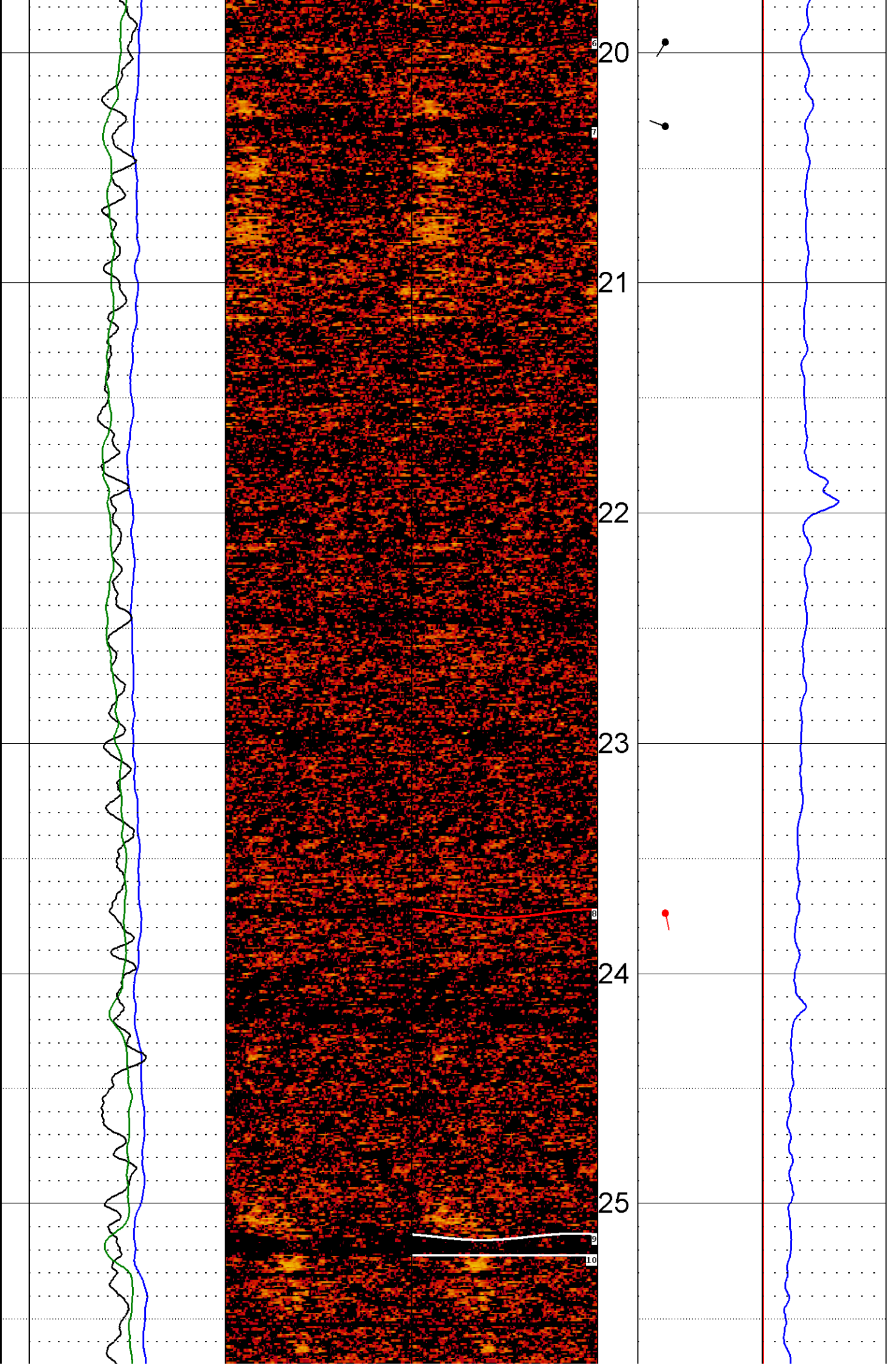
19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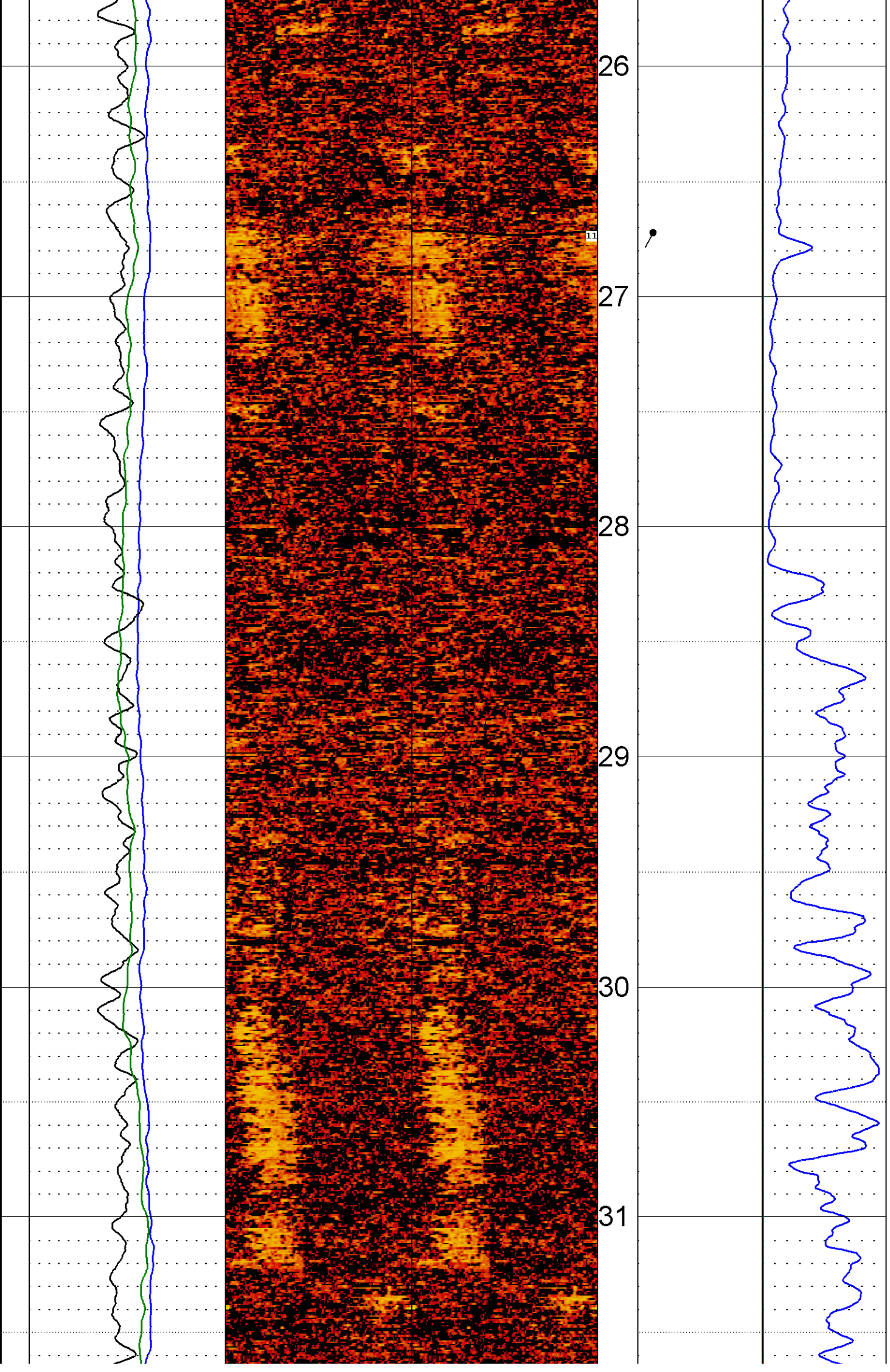
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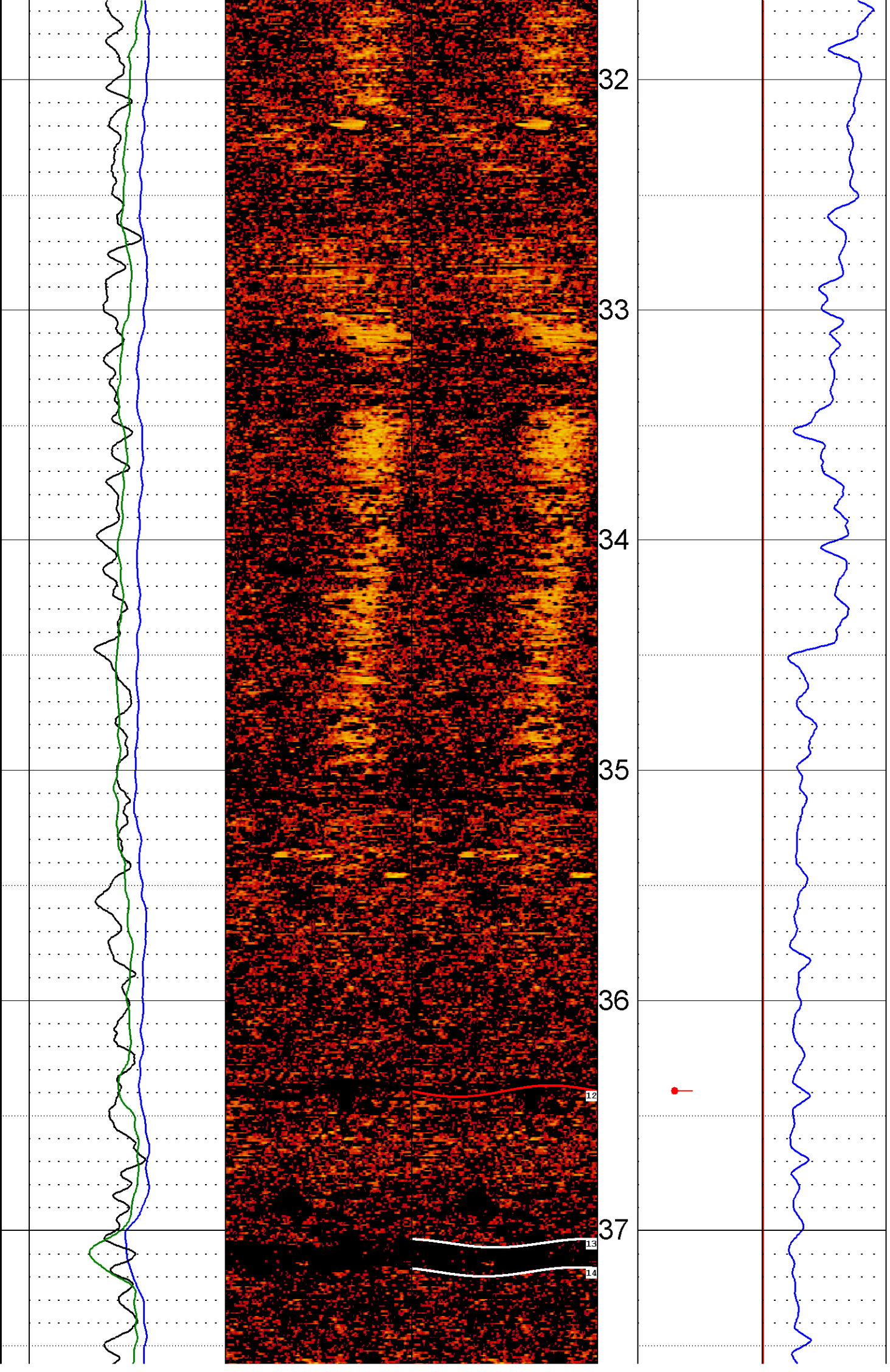
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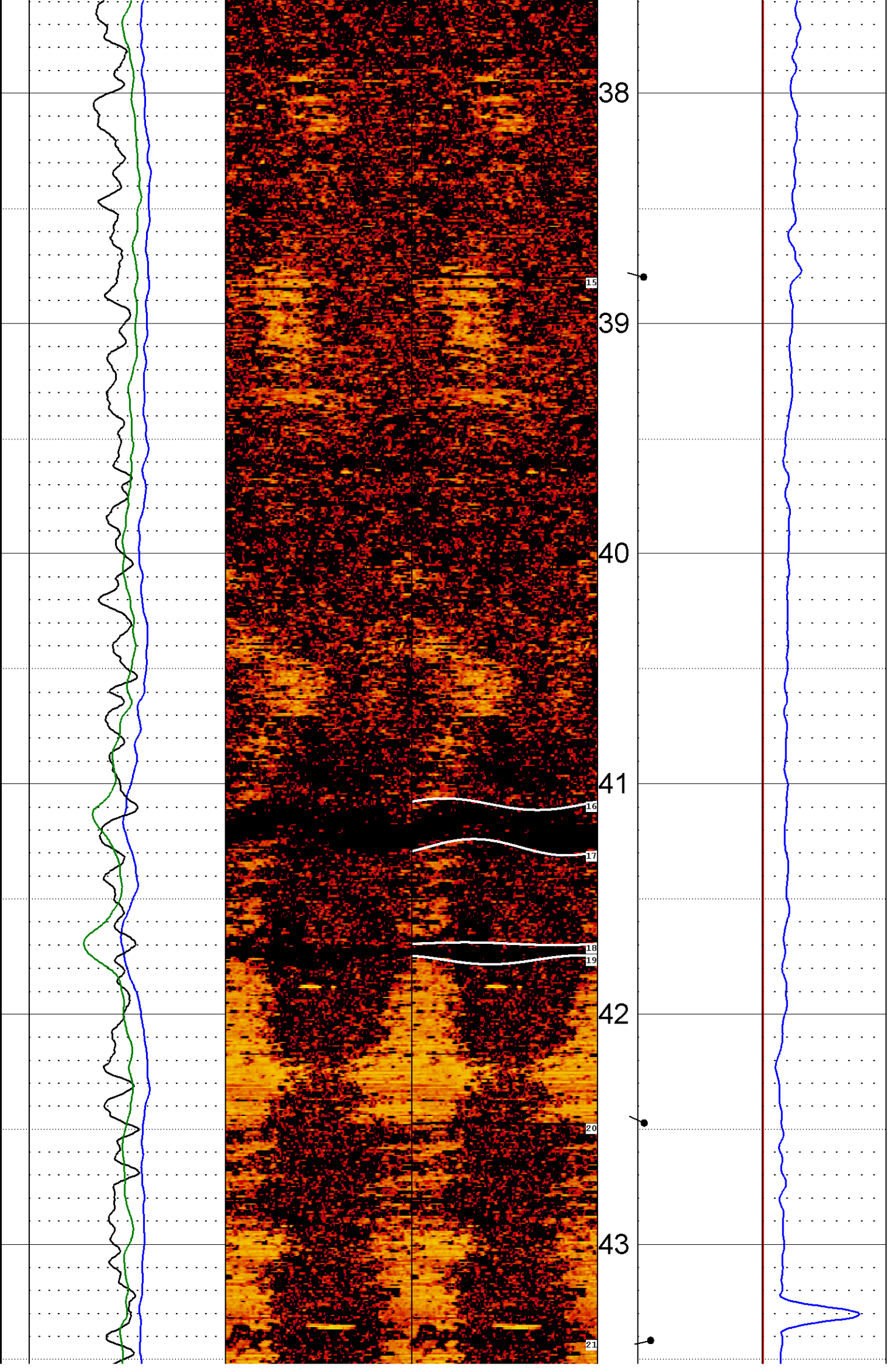
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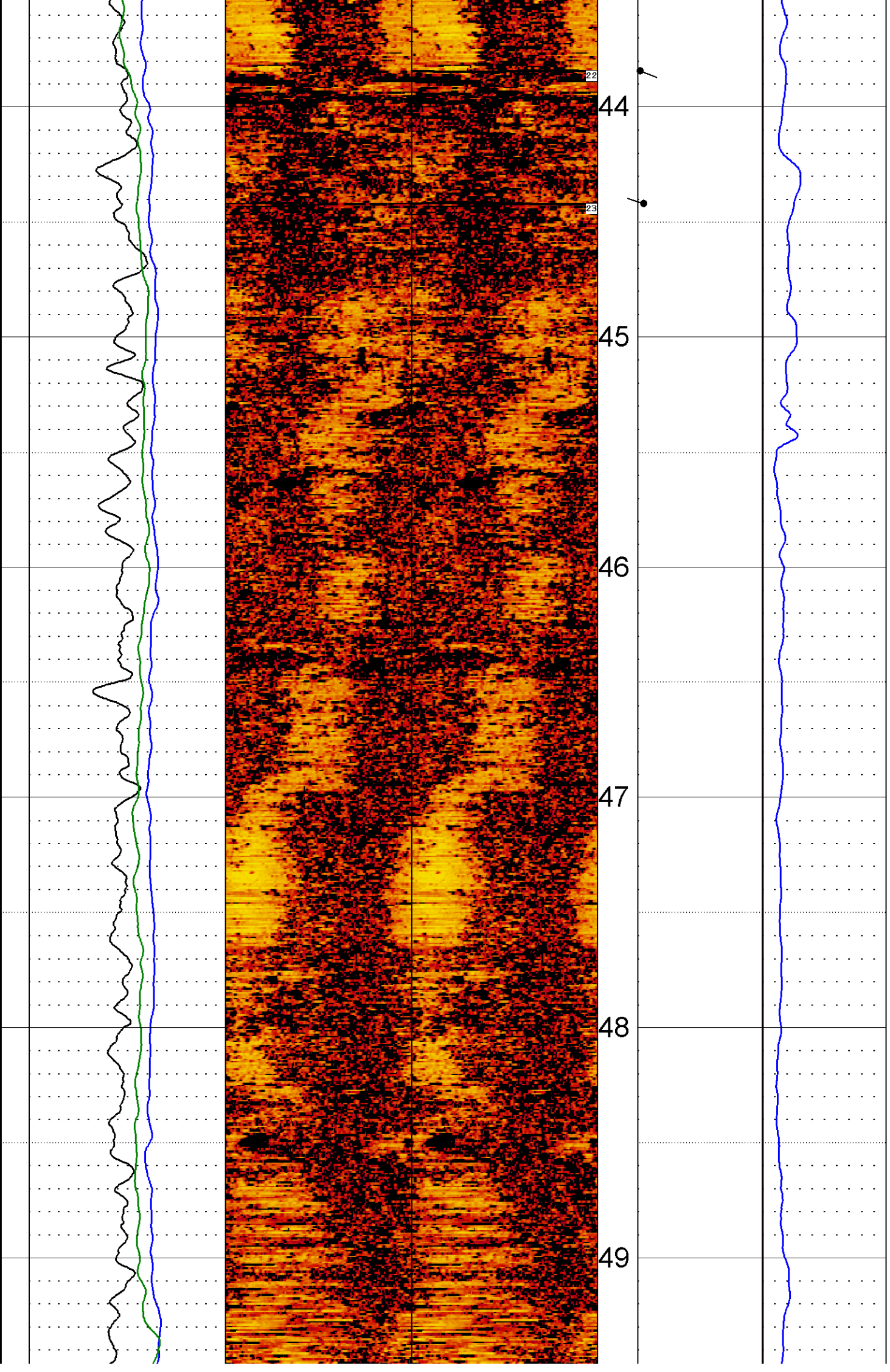
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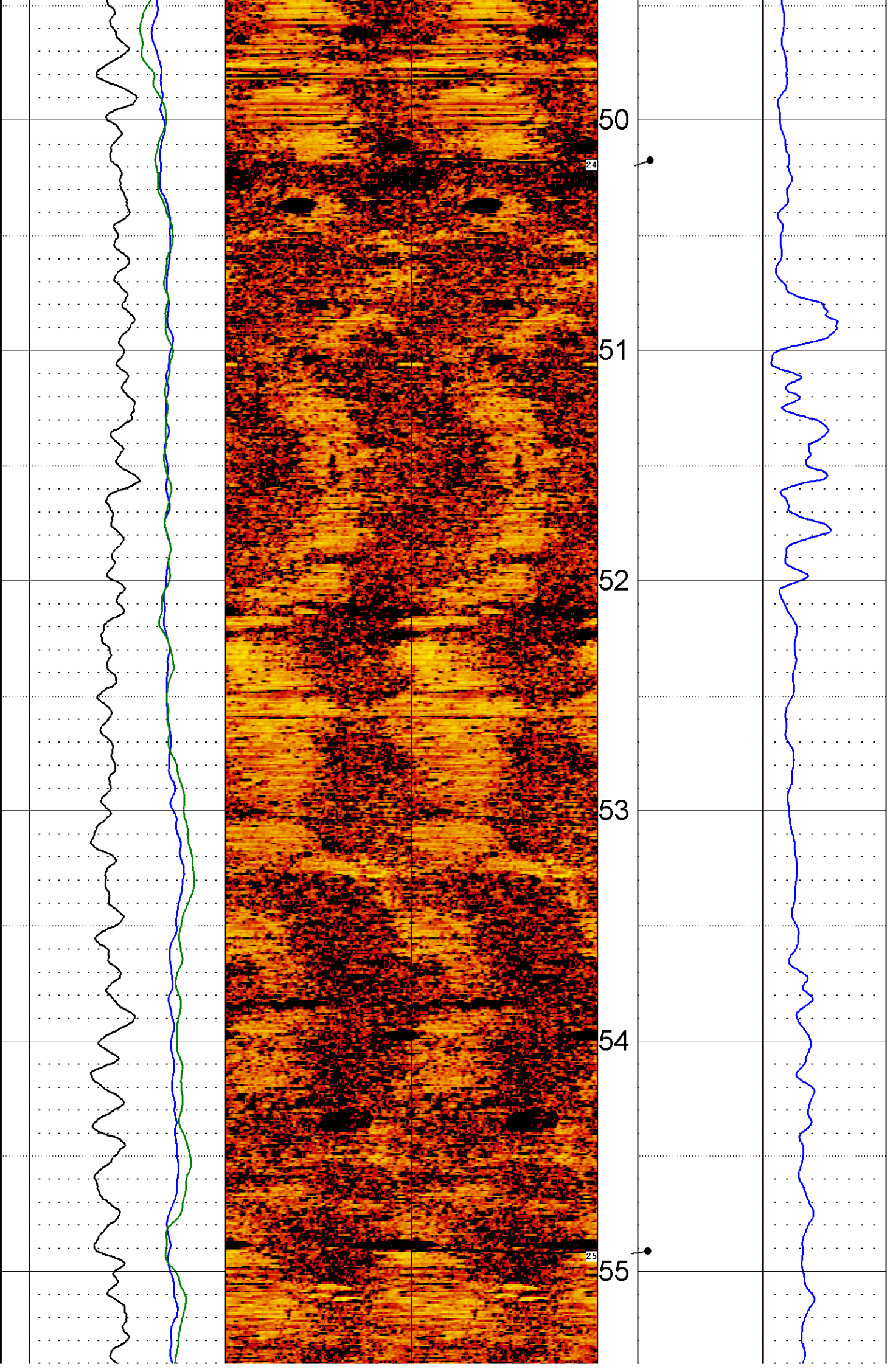
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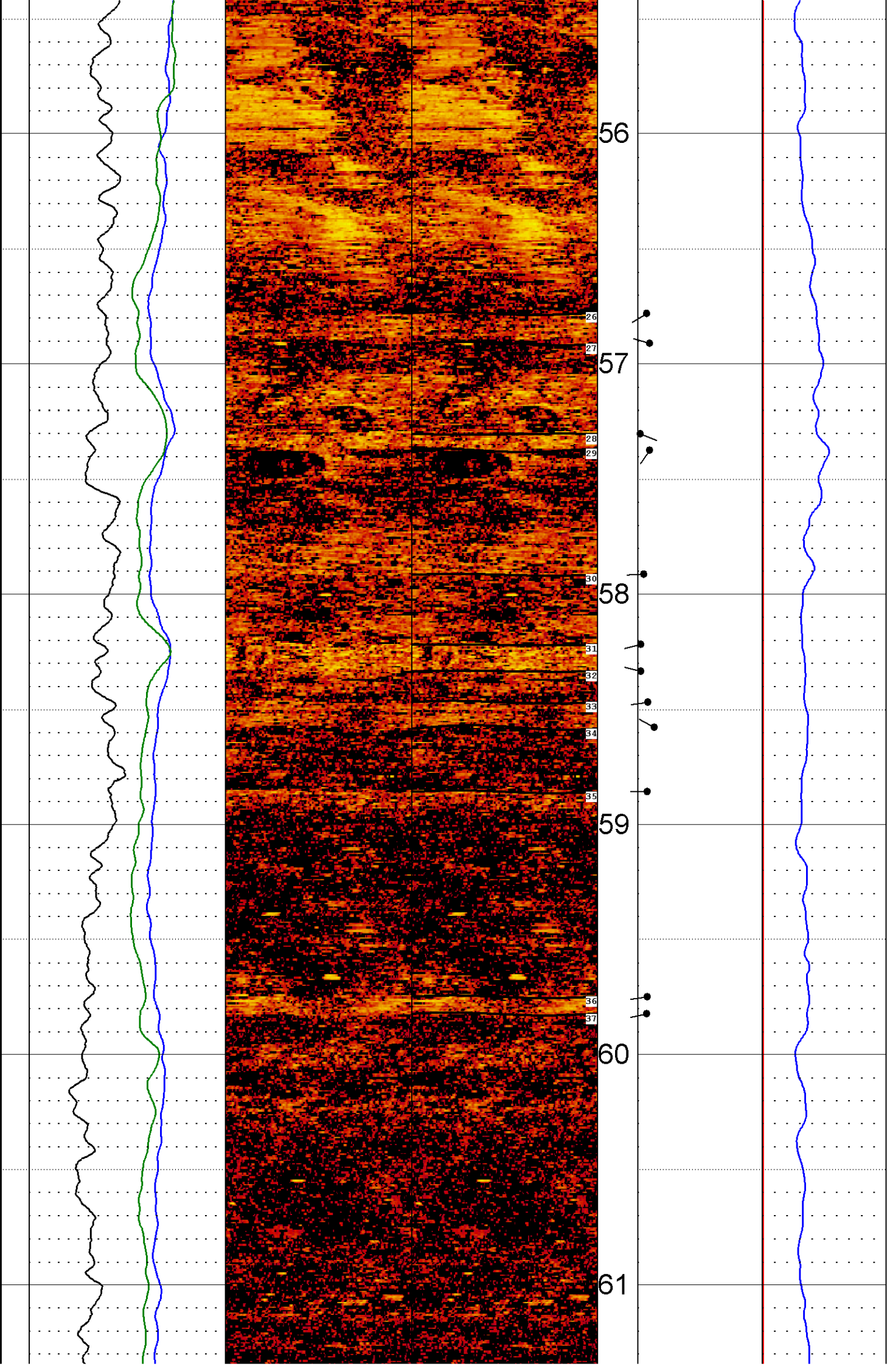
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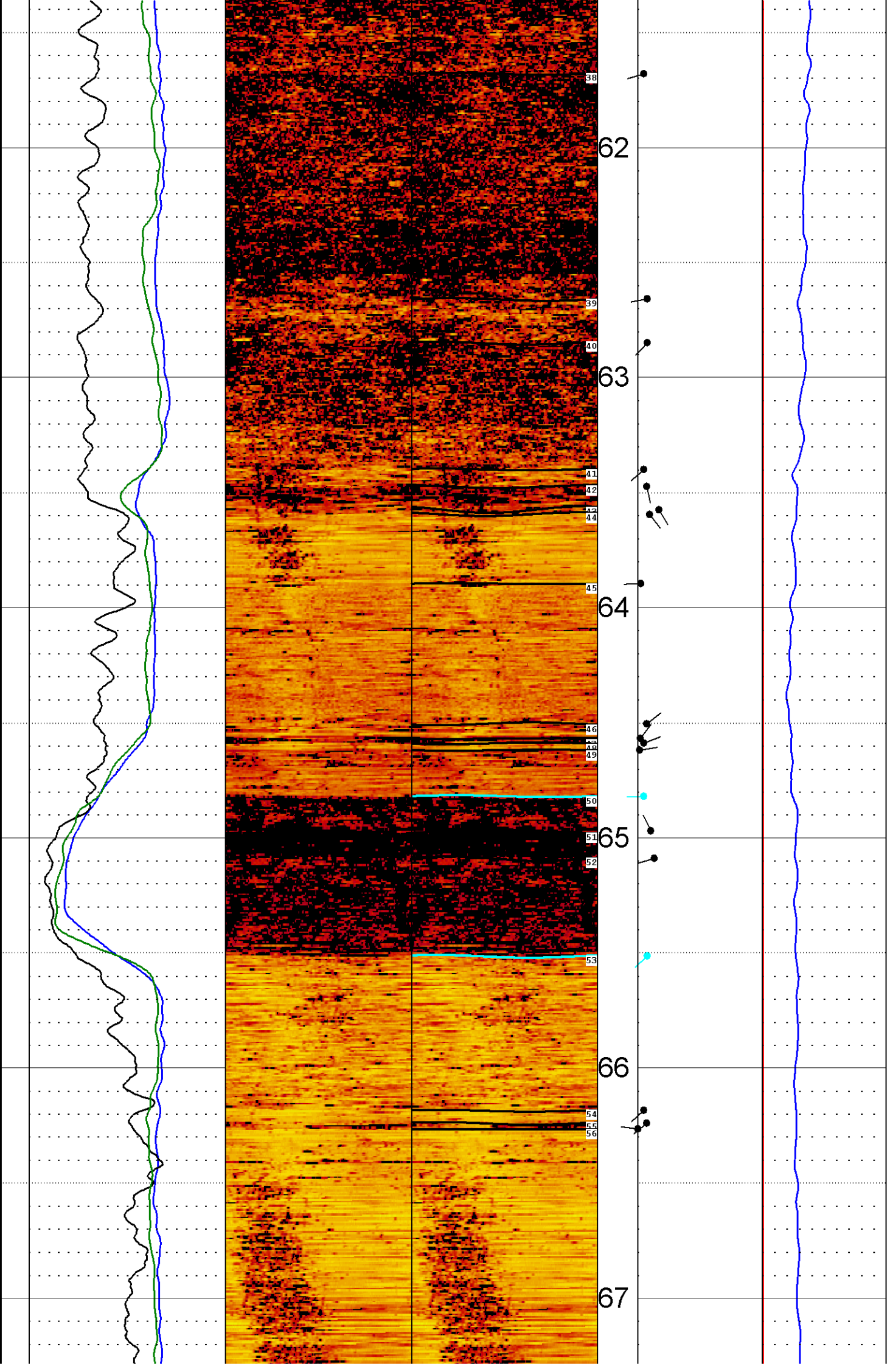
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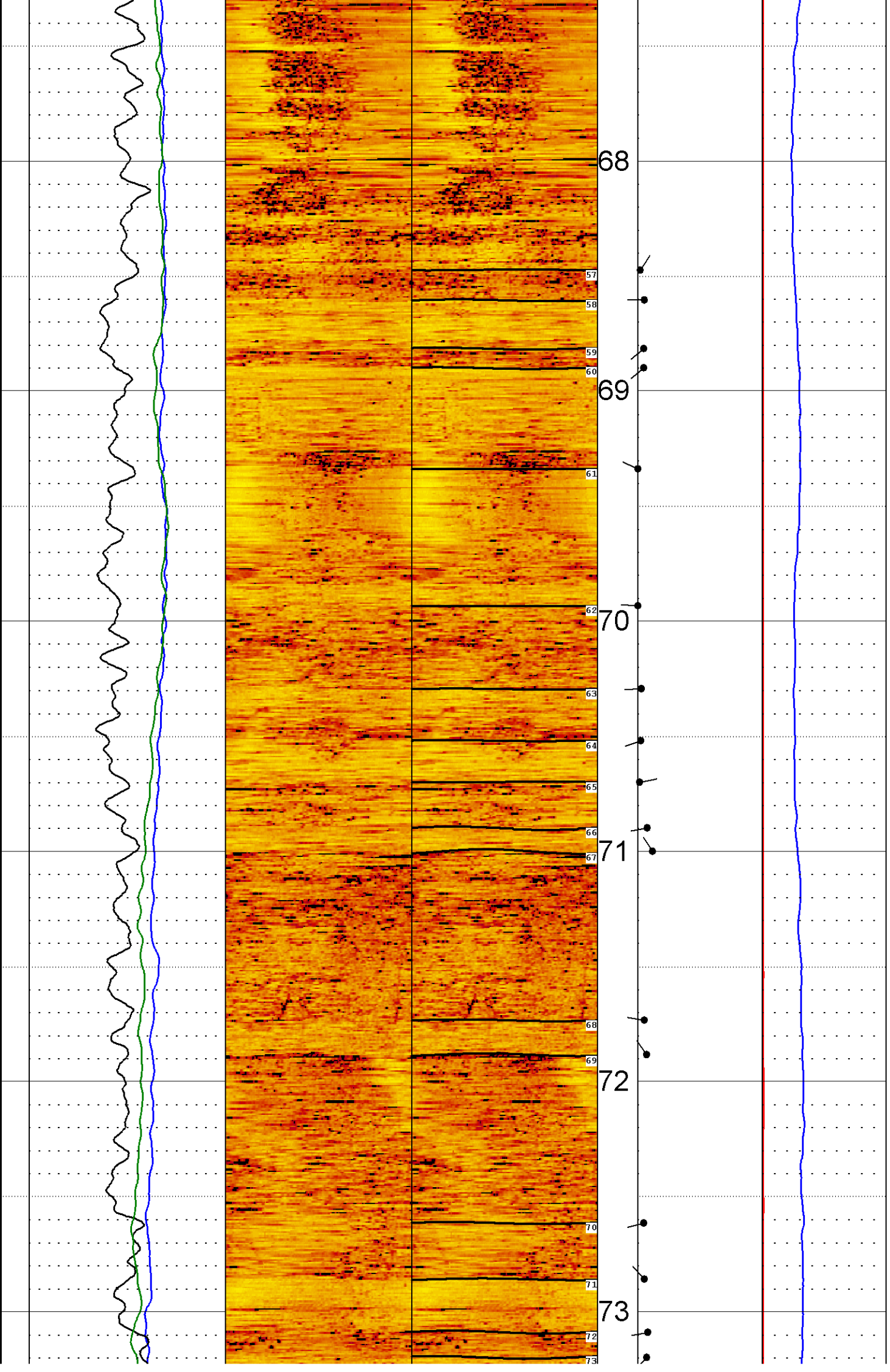
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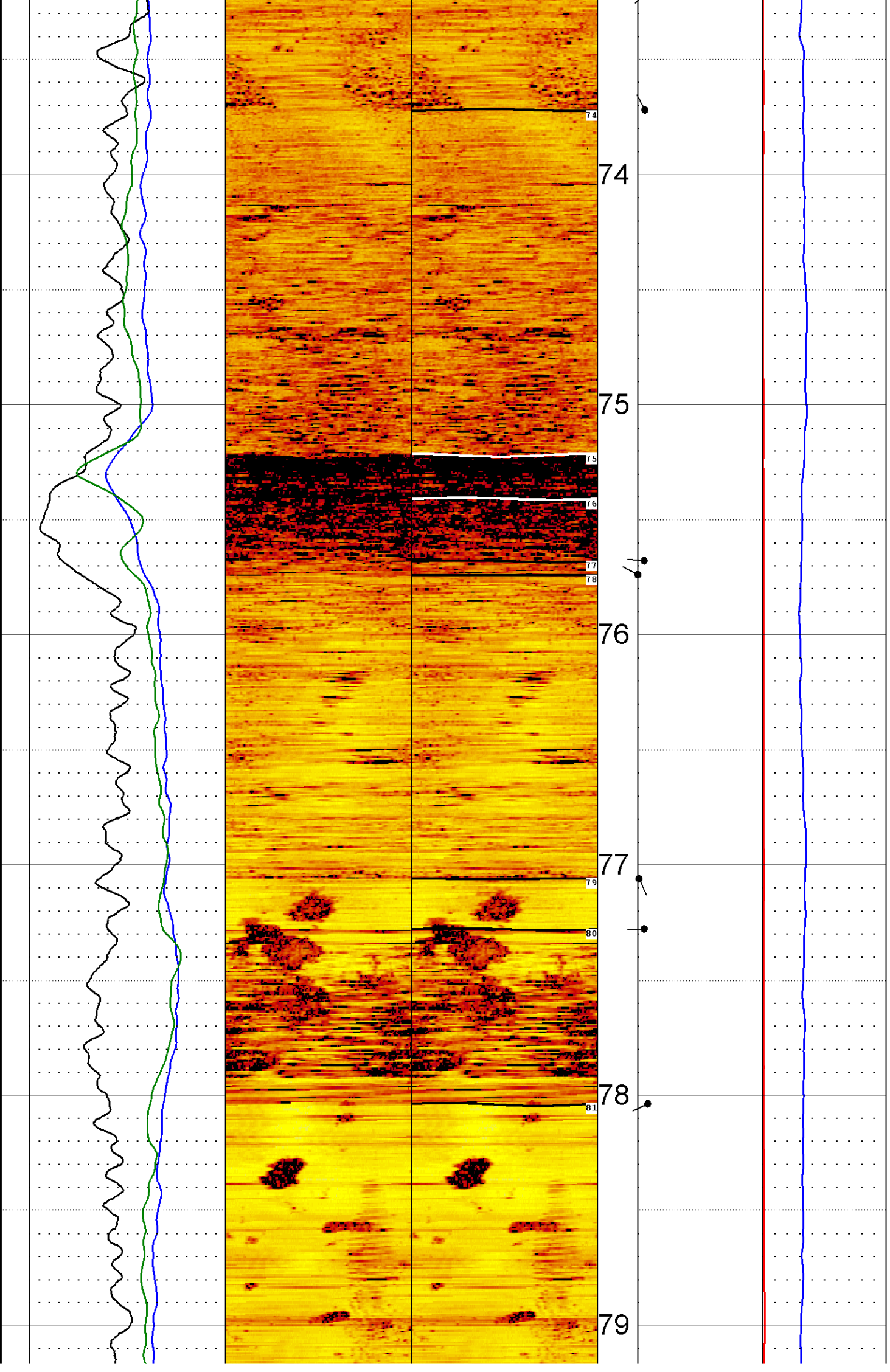
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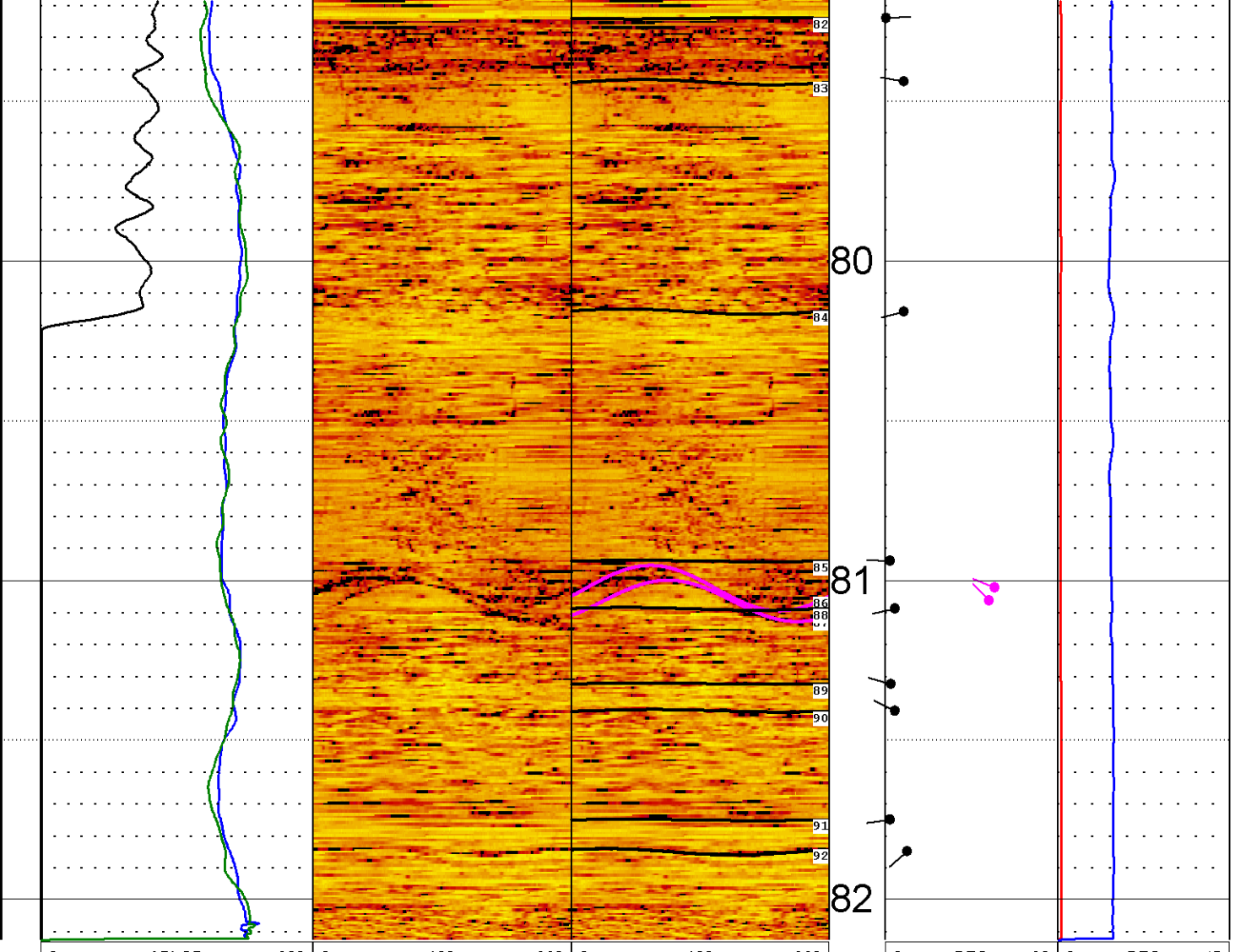


| 0 | API-GR | 300 |
|---|---|---|
| GAMMA | | |
| 1 | G/CC | 3 |
| DEN(SS) | | |
| 1 | G/CC | 3 |
| DEN(LS) | | |

| 0 | 180 | 360 |
|---|---|---|
| 200 | AMPL..MV | 2000 |

| 0 | 180 | 360 |
|---|---|---|
| 200 | AMPL..MV | 2000 |

| 0 | DEG | 90 |
|---|---|---|
| TADPOLE | | |

| 0 | DEG | 45 |
|---|---|---|
| SANG | | |
| 0 | DEG | 360 |
| SANGB | | |

METERS