REPORT TO

HEALTH INFRASTRUCTURE

ON

GEOTECHNICAL INVESTIGATION

FOR

MUSWELLBROOK HOSPITAL REDEVELOPMENT STAGE 3

AT

BRENTWOOD STREET, MUSWELLBROOK, NSW

Date: 25 August 2022
Ref: 34804LFrpt2

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DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
34804LFrpt2 Draft	Draft Report for Comment	2 August 2022
34804LFrpt	Final Report	25 August 2022

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1 INTRODUCTION

This report presents the results of a geotechnical investigation 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.

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) comprising 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 investigation was to obtain geotechnical information on the subsurface conditions, and to use this as a basis for providing comments and recommendations on site preparation, retention systems, footings, mine subsidence, pavement design parameters, subgrade preparation and engineered fill.

This geotechnical investigation was carried out in conjunction with a detailed (Stage 2) site investigation by our environmental division, JK Environments (JKE). Reference should be made to the separate report by JKE, Ref: E34804PTrpt2, for the results of the detailed environmental investigation.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out on 27 June 2022 to 30 June 2022 and comprised six boreholes drilled with our truck mounted JK400 drilling rig. The boreholes were drilled to depths between 3.10m and 13.0m below existing surface levels using spiral auger techniques and a Tungsten Carbide ('TC') bit. Three of the boreholes (BH1, BH4 and BH6) were then extended to depths ranging from 10.50m to 13.41m using an NMLC triple tube barrel fitted with a diamond coring bit and water flush. The original scope of work required the drilling of cored boreholes to a maximum 10m depth. However, the scope was adjusted whilst on-site resulting in fewer cored boreholes due to deeper drilling being required as a result of the presence of poor quality bedrock. Attempts to reach better quality bedrock that was consistently of at least low strength were unsuccessful within the borehole termination depths.

The strength of the subsurface soils was assessed from Standard Penetration Test (SPT) 'N' values augmented by hand penetrometer tests on the SPT split tube samples. The strength of the bedrock was assessed by

observation of the auger penetration resistance using a tungsten carbide 'TC' drill bit, together with examination of the recovered rock cuttings and from correlations with subsequent moisture content test results on recovered rock chips. It should be noted that strengths assessed in this way are approximate and variances of one strength order should not be unexpected.

Dynamic Cone Penetration (DCP) tests were carried out within the existing lower ground floor of the surgery building extending to refusal or termination depths of 0.05m to 1.6m below existing surface levels. The refusal depth of the DCP tests may provide an indicative depth to rock, though we note that premature refusal can also occur on obstructions in the fill, 'floaters' and other hard layers, such as the existing gravel layer present across the area.

Selected samples were tested by Soil Test Services (STS), a NATA accredited laboratory, to determine California Bearing Ratio (CBR) values, shrink-swell index, moisture contents, Atterberg limits, and linear shrinkage. The results are summarised in the attached Tables A to C. Selected samples were also sent to Envirolab Services Pty Ltd to determine pH, sulphate, chloride and resistivity values. The results are summarised in the attached Envirolab Services Certificate of Analysis No. 300005.

Where bedrock was diamond cored, the recovered core was returned to our laboratory for photographing and Point Load Strength Index (Is_{50}) testing. The results are plotted on the borehole logs and presented on the attached Table D. Using established correlations the Unconfined Compressive Strength (UCS) of the bedrock was then calculated from the Is_{50} results. Copies of the colour photographs are provided with the borehole logs.

Groundwater observations were made in the boreholes during and on completion of drilling and at the end of the field work. We note that water is introduced into the borehole during coring and therefore the water levels measured at completion of coring may be artificially high as the water levels have not had time to stabilise. In BH1, BH5 and BH6, Class 18 machine slotted PVC standpipes were installed and finished with a cast iron gatic cover to allow longer term groundwater monitoring to be completed. Our environmental division., JK Environments, measured the groundwater levels within the wells on 1 July 2022. No further groundwater monitoring was carried out as was outside the scope of works.

The fieldwork was completed in the full-time presence of our geotechnical engineer who set out the borehole locations, nominated the testing and sampling, and prepared the attached borehole logs and DCP sheets. The borehole locations are shown on the attached Figure 2, and these were set out by a differential GPS unit, which also provided the relative levels shown on the attached logs. The height datum used is the Australian Height Datum (AHD). For more details of the investigation procedures and their limitations and a glossary of terms and symbols used, reference should be made to the attached Report Explanation Notes.

We also reviewed previous geotechnical reports by Coffey, as detailed in Section 1 and have incorporated the relevant information into this report. The relevant borehole logs have been included as Appendix A to this report.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located in the western half of the wider hospital property, which itself is located in a mixed use (medical and residential) area of Muswellbrook. Possum Gully (a creek) is located approximately 20m to the north of the site within the wider hospital property.

The regional topography is characterised by undulating topography generally sloping down to the east towards the Hunter River. The site is located mid-slope on a western facing slope with a gentle slope towards the west at approximately 1° to 3°. Parts of the site appear to have been levelled to account for the slope and accommodate the existing development.

At the time of the inspection, the subject area comprised a road/driveway in the eastern portion and a carpark in the western portion. There were no buildings or structures over the subject area.

During the site inspection, we observed the following land uses in the immediate surrounds:

- North – wider hospital property including Possum Gully (detention basin) with residential properties and a cemetery beyond Bowman and Doyle Streets;
- South – wider hospital property and a childcare centre with residential properties beyond Brentwood Street;
- East – wider hospital property including the main hospital buildings and residential properties beyond; and
- West – wider hospital property including the helipad, with residential properties beyond Doyle Street.

The DBYD plans indicated that a sewer main extends through the central section of the site in an east-west direction. The sewer is likely to be at a depth of approximately 2.5m to 3m below ground and is also noted to extend through the majority of the main hospital site.

3.2 Subsurface Conditions

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 following 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

In BH4, concrete pavement of 80mm thickness was encountered at surface level.

Fill was encountered in all boreholes from the either the surface, or from below the pavement (in BH4) and extended to depths ranging from 0.3m to 1.5m. The fill was predominantly clayey fill, with the exception of BH6, and contained varying amounts of sands, gravels and other potentially deleterious materials, such as root fibres and slag. The fill in BH6 comprised of silty sand and contained slag inclusions. Based on the limited SPT 'N' values, the fill was of variable compaction, but predominantly appeared to be poorly to moderately compacted.

The Coffey boreholes were drilled in 2015 since when the site conditions have changed and therefore the topsoil and limited fill depth encountered in the boreholes would no longer be relevant.

Residual Clay

Residual silty clay was encountered in all boreholes, including the Coffey boreholes, below the fill and was assessed to be of medium to high plasticity and generally of very stiff to hard strength. The moisture content of the clays were typically greater than the plastic limit, although occasionally was equal to or less than the plastic limit.

Weathered Bedrock

Weathered bedrock was encountered below the residual clay in all boreholes at 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.

We have classified the rock in general accordance with Pells et al "Classification of Sandstones and Shales in the Sydney Region: A Forty Year Review", Australian Geomechanics, June 2019. Table 1 provides the depths and levels where each class of rock was encountered in each borehole.

Table 1: Showing Assessed Rock Classification

BH	Depth and Level To the Start of Each Rock Class			
	Class V Rock		Class IV Rock	
	Depth (m)	RL (mAHD)	Depth (m)	RL (mAHD)
1	1.8	177.3	3.4	175.7
2*	6.6	174.4	10.0	171.0

BH	Depth and Level To the Start of Each Rock Class			
	Class V Rock		Class IV Rock	
	Depth (m)	RL (mAHD)	Depth (m)	RL (mAHD)
3*	0.6	181.1	5.5	176.2
4*	6.2	177.7	8.3	175.6
5*	-	-	9.5	175.2
6	4.2	175.2	6.4	173.0
15-1	1.3	177.3	4.0	174.6
15-2	1.8	177.9	3.0	176.7
15-3	1.5	179.7	4.2	177.0

Note: * Assessment based upon auger drilling only. No core samples obtained and therefore considered an estimate only.

Groundwater

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 into 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.

3.3 Laboratory Test Results

Based on the shrink-swell, Atterberg limits and linear shrinkage test results, the clayey fill and residual silty clay are of medium to high plasticity. The moisture content test results on samples of the weathered rock recovered from the augered portions of the boreholes showed reasonably good correlation with our field assessment of rock strengths. Reference should be made to the attached STS Tables A and C for further details.

The four day soaked CBR tests on a samples of the clayey fill and residual clay from compacted to 98% of their Standard Maximum Dry Density (SMDD) returned CBR values of 5% and 6% for the clayey fill and 3.5% and 4.0% for the residual clay. Reference should be made to the attached STS Table B for further details.

The results of the point load strength index tests on the recovered rock core correlated well with our field assessments of rock strength. The results indicate a typical Unconfined Compressive Strength (UCS) between 2MPa and 6MPa, although high UCS values up to 216MPa were also achieved in the bands of very high strength bedrock present within the cores. Reference should be made to the attached Table D for further details.

The following table summarises the soil chemistry test results from Envirolab Services. Reference should be made to the attached Certificate of Analysis No. 300005 for further details.

Sample	Soil Type	pH	Chloride mg/kg	Sulphate mg/kg	Resistivity ohm.cm
BH1 1.2-1.4m	Silty Clay	6.3	260	250	2,600
BH2 1.5-1.95m	Silty Clay	8.9	880	370	1,000
BH2 5.6-5.9m	Silty Clay	9.4	640	150	1,500
BH3 3.2-3.5m	Sandstone	9.7	100	46	3,800
BH3 7.2-7.5m	Sandstone	9.2	510	220	1,600
BH4 3.0-3.45m	Sandy Clay	9.4	180	100	2,400
BH5 0.5-0.95m	Fill: Silty Clay	8.3	<10	26	6,300
BH5 4.5-4.95	Sandy Clay	9.1	37	20	9,600
BH6 1.5-1.95	Silty Clay	8.8	20	34	9,000

4 COMMENTS AND RECOMMENDATIONS

4.1 Site Preparation

Prior to any excavation commencing we recommend that reference be made to the NSW Government "Code of Practice Excavation Work" dated January 2020 or the most recent version at the time of works commencing.

Site preparation is expected to comprise demolition of the existing building, removal of trees and stripping of topsoil and/or root affected soils. We also assume that partial demolition of the existing access road will also be required.

Following the above site preparation, in areas where no excavation is required, any obvious deleterious or contaminated existing fill should be removed. These stripped materials should be taken offsite as they are not suitable for re-use as engineered fill. However, from a geotechnical perspective (i.e. assuming these materials are not contaminated), existing gravelly materials present below existing pavements may be re-used as select fill provided it is separately stockpiled and inspected and approved by the geotechnical

engineers. The topsoil and/or root affected soils may also be separately stockpiled and used for subsequent landscaping purposes, or appropriately disposed off site. If the depth of topsoil is critical, then we recommend test pits are excavated to confirm the topsoil thickness. We recommend test pits in lieu of boreholes, as test pits allow a more detailed visual inspection of the soil, compared to boreholes where the soil is assessed from the drill spoil and SPT samples.

Trees dry out the surrounding clayey soils in and around their root systems. Removal of trees usually results in an increase in the soil moisture content over time, leading to swelling of the soils, which may have a detrimental impact on the performance of proposed buildings and paved surfaces founded/supported in the clayey soil profile within the site. Therefore, trees should only be removed where absolutely necessary and as soon as practicable, in order for the moisture content of the clayey subsoils to recover; ideally this would be years in advance of construction though we understand this is usually not practical.

We expect any cut and fill earthworks to be relatively minor and therefore expect to encounter fill, residual soils and extremely weathered bedrock. The soil materials and upper weathered bedrock should be readily excavated using the buckets of conventional earthmoving equipment, such as hydraulic excavators. We note the bedrock contains occasional bands of higher strength that may require the use of hydraulic impact hammers to penetrate through the band until the weaker bedrock is again encountered. Where percussive excavation equipment is used, care should be taken to prevent vibration induced damage to any nearby structures. In this regard, reference should be made to the attached Vibration Emission Design Goals for suitable vibration threshold criteria.

We recommend temporary batter slopes no steeper than 1 Vertical (V) in 1 Horizontal (H) through the clay soils and weathered bedrock.

The subgrade will comprise clay soils. The clays may be found to be unstable if proper site drainage is not implemented during construction. It is therefore important to provide good drainage in order to promote run-off and reduce ponding. Earthworks platforms should be graded to maintain cross-falls during construction. If the clays are exposed to periods of rainfall, softening may result and site trafficability will be poor. Furthermore, the soils may no longer be suitable for re-use as engineered fill or as a suitable subgrade. If softening occurs, the subgrade should be over-excavated to below the depth of moisture softening. The material removed should be replaced with engineered fill. Such work would likely cause delays to the earthworks program. Trafficability may be improved by the use of a sacrificial surface layer of crushed demolition rubble.

4.2 Footings

Due to the possibility of abnormal moisture conditions due to existing pavements and trees, we consider that the site classifies as Class 'P' in accordance with AS2870-2011 ‘Residential Slabs and Footings’. We note however that given the site is within a mine subsidence district footings will need to be designed in accordance with the requirements for mine subsidence. The impact of mine subsidence is discussed further in Section 4.3 below.

We expect relatively low to moderate structural loads will apply to this development, and therefore we do not expect the soils to be a suitable founding stratum. As such, we recommend the development is uniformly founded on the underlying sandstone/siltstone bedrock. Given the depth of bedrock, high level footings are unlikely to be feasible and therefore bored piles will need to be adopted. Notwithstanding, smaller ancillary structures separate from the main development may be supported by high level footings founded on the natural residual clay.

If the footings are designed to be founded below the fill on the inferred natural residual soils or weathered bedrock, consideration must still be given to the potential for the natural silty clays to shrink and swell with changes in moisture content. In our opinion, any new footings may be designed on the shrink-swell movements of the residual silty clays similar to Class 'H1' type movements will occur. We note that in the strictest sense AS2870 does not apply to development such as this, however it provides a useful guide for footing design on reactive clay sites. Reference may also be made to AS2870 for design, construction, performance criteria and maintenance precautions on reactive clay sites. We note that this classification does not take into account the placement of any new fill or the removal of the surface cracked zone of clay soils and therefore we recommend the above site classification is reviewed once details of the earthworks are known, primarily the type and depth of any new fill placement. If slabs are suspended between footings founded in bedrock then void formers of at least 60mm would need to be provided to separate the slab from the reactive subgrade.

The design of footings founded within the rock may be based on the following parameters. We note that the serviceability parameters given are based on settlement of less than 1% of the pile diameter or footing width. The ultimate parameters may be used with limit state design methodology on the understanding that detailed settlement analysis of footings must also be carried out to assess likely settlements under these higher pressures. We note that the use of ultimate pressures can produce settlements up to 5% of the pile diameter or footing width. Differential settlements of about half the total settlements would be expected. The designer may use the modulus values given below to estimate the settlements of particular footings.

Rock Class	Allowable End Bearing Pressure	Allowable Shaft Adhesion in Compression	Ultimate End Bearing Pressure	Ultimate Shaft Adhesion in Compression	Elastic Modulus
Class V	700kPa	70kPa	1,200kPa	100kPa	100MPa
Class IV	1,000kPa	100kPa	2,500kPa	150kPa	200MPa

Higher allowable end bearing pressures may be feasible, however suitable bedrock was not encountered in the boreholes. If required, we recommend additional deeper boreholes be drilled, potentially in the order of at least 20m depth, to confirm whether higher bearing pressures are possible. This scope may need to be amended depending on advice obtained from Subsidence Advisory NSW and the known mine workings present below the site, as discussed further below in Section 4.3.

Consideration could also be given to design of footings based on limit state design analysis procedures and the above ultimate values can be adopted. Ultimate values must be used in conjunction with an appropriate geotechnical strength reduction factor (ϕ_g) which must be calculated in accordance with the methodology

outlined in AS2159-2009 '*Piling Design and Installation*'. It is not possible at this stage to accurately determine the geotechnical strength factor as we have no knowledge of the design and installation factors. However, as a guide we have estimated the Average Risk Rating (ARR) and geotechnical strength reduction factor based on the following assumptions:

- The designer has extensive experience with similar foundations in similar geological conditions.
- The design method adopted is well established and soundly based.
- The method for utilising results of in-situ test data and installation data is based on indirect measurements used during installation and not calibrated to static load tests.
- There is a detailed level of construction control with professional geotechnical supervision and construction processes that are well established and relatively straightforward are adopted.
- No monitoring of the structure after construction will be undertaken.

Based on the above assumptions and our geotechnical knowledge, we estimate an ARR of 2.93 in accordance with Equation 4.3.2 and Table 4.3.2(A) of AS2159-2009. Accordingly, the overall risk category is Low to Moderate, resulting in a geotechnical strength reduction factor of 0.52 for low redundancy systems and 0.60 for high redundancy systems, in accordance with Table 4.3.2(C) of AS2159-2009. The use of ultimate values will result in higher settlements. Therefore, specific analysis of the footing settlements must be carried out to confirm that the structure will still perform satisfactorily.

Where footings are founded within Class V or Class IV Rock, we consider that at least the initial stages of footing excavation should be inspected by a geotechnical engineer to confirm that a suitable founding stratum has been achieved. The requirements for further inspections can be decided at that time, and the frequency will depend on the level of 'sign-off' required.

Based on the soil aggressivity testing, the soils and weathered rock would be classified as having a 'Non-aggressive' exposure classification for concrete piles in accordance with Table 6.4.2(c) of AS2159-2009 'Piling – Design and Installation'. For steel piles, the soils would be classified as 'Mild' in accordance with Table 6.5.2(c) of AS2159-2009.

For lighter loaded footings, high level footings, such as stiffened raft slabs, strip or pad footings founded on natural residual clay of at least very stiff strength may be designed based on a preliminary ABP of 150kPa. If shallow weathered bedrock is encountered, then a higher ABP of 600kPa may be adopted, however if encountered then all footings must be similarly founded on the weathered bedrock to avoid potential damage as a result of differential settlements.

Subgrade preparation recommendations below stiffened raft slabs are provided in Section 4.6. The designer should also note that there are some trees and pavements at the site and that these will affect the performance of footings on clay soils. A potential 'abnormal moisture condition' may exist where the trees and pavements are to be removed or increase substantially and consideration must be given to this in the design.

For the proposed lower ground slab-on-ground within the existing undercroft of the Surgery building, the existing subgrade comprises a gravelly fill, that appears to be DGB20 (or similar). Unfortunately the DCP testing was limited due to premature refusal within the gravelly fill, although the DCP tests that were able to penetrate the gravel indicate reasonably 'stiff' soils. Based on the limited testing, we consider the existing gravelly subgrade will likely be suitable for re-use, however we recommend the subgrade is proof rolled under a heavy smooth drum roller of at least 10 tonnes in non-vibratory mode to assess the presence of any loose or heaving subgrade. If any areas are detected, the material should be excavated down to a sound base and replaced with engineered fill. If there are concerns regarding damage to existing ground beams by the roller then lightweight compaction equipment can be adopted to prevent damage, however we recommend limiting to no less than 3 tonnes if possible.

4.3 Mine Subsidence

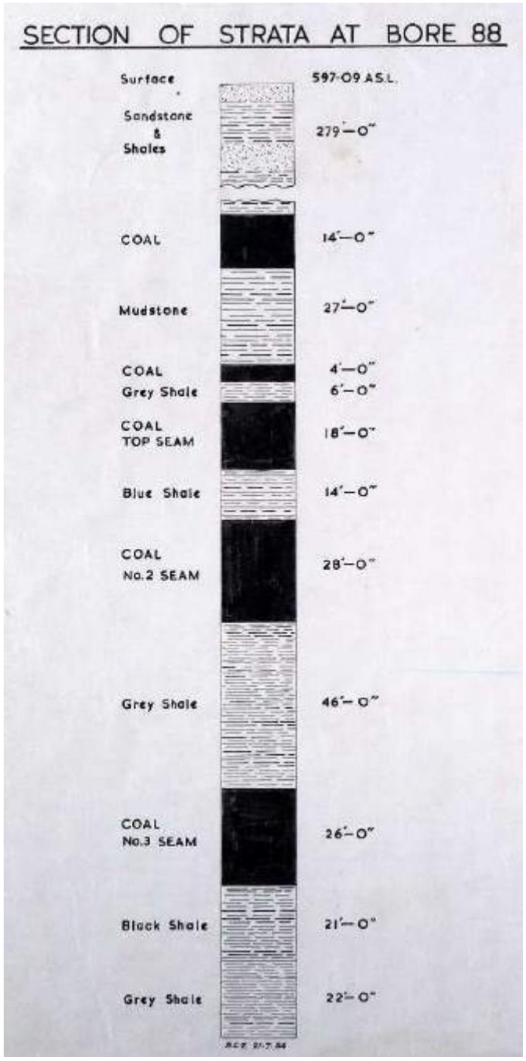
The comments and recommendations above for footings are made on the basis of typical geotechnical parameters. However, the site has been identified to be within the Muswellbrook mine subsidence district as a result of underground mining operations which may govern the footing systems. The NSW Government 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.

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 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 within the open hole drilling 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.

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. 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.

As discussed in Section 3.2, 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 Measure, 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 do not apply.

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 at 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.

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 have 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.

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 limited information is available 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 4.5m which comprises an increased height of 1.2m on the upper bound actual height.
- For the pillar plan dimensions we have adopted the actual dimensions as shown, as well as a dimension 1m 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 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 1m. As such, the FOS varied between 2.2 and 4.7.

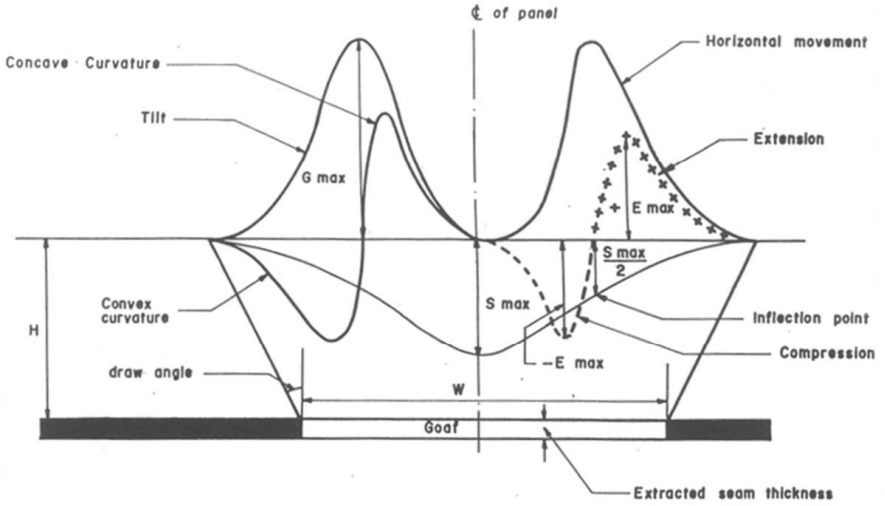
The pillars present below the Stage 3 development are relatively orthogonal however the tributary loading should still be considered an estimate only. Given the assumptions and estimations, an assessment on the likelihood of failure is difficult. However, Galvin (1998) provides guidance whereby a minimum FOS of 2.2 for the likely pillar case results in an estimated likelihood of failure is less than 1:100,000 which would be considered to be 'Rare' 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 rare, 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.

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. We considered two potential failed panel workings of approximately 74m and 85m in width, which results in a width to depth ratio 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.

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.

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 by SA NSW.

4.4 Earthquake Design Classification

Based upon AS1170.4-2007 "Structural Design Actions, Part 4: Earthquake Actions in Australia", the following design parameters may be adopted:

- Hazard Factor (Z) = 0.09;
- Class C_e – Shallow soil site

4.5 Retaining Walls

If space allows, permanent batters may be formed at no steeper than 1 Vertical to 3 Horizontal. The batters should also be vegetated to prevent erosion.

If space does not allow for permanent batters, then for the limited retention heights expected, cantilevered gravity type retaining walls may be adopted. For any cantilevered gravity type retaining walls supporting soil materials (if required and assuming they are set-back sufficient distance from the site boundaries or adjoining structures and services), we recommend that walls be designed on the basis of an 'active' earth pressure coefficient (K_a) of 0.35 where some wall movements are tolerable and assuming a horizontal backfill surface. If retaining walls are temporarily propped, backfilled and permanently supported by the structure, or if wall movements need to be reduced, then an 'at rest' earth pressure co-efficient (K_o) of 0.55 should be adopted. A bulk unit weight of 20kN/m^3 should be adopted for the soil profile. Surcharge loads (e.g. nearby footings, compaction stresses, sloping retained surfaces, construction loads etc) should be allowed for in the design using the appropriate above earth pressure coefficient. The retaining walls should be designed as drained, otherwise hydrostatic pressures would be in addition to the above earth pressures.

Any backfill behind retaining walls should comprise engineered fill in order to reduce post construction settlements. We note that compaction of engineered fill behind retaining walls is very difficult and time consuming to carry out effectively, and it is inevitable that even with good quality control and compaction that some post construction settlements will occur. Post construction settlements can cause adverse impacts on paving, landscaped retaining walls or other structures and services founded on or within the backfill. If potential post construction settlements are deemed problematic by the designers, then we recommend that further geotechnical advice be obtained. However, due to the limited space that may be available behind the walls, our preference for backfill behind retaining walls is to backfill using a single sized durable gravel, such as 'blue metal' or crushed concrete gravel (free of fines). These granular materials do not require significant compactive effort and provide better long term performance in regard to settlement than soil materials. A non-woven geotextile filter fabric should be placed over the cut faces prior to backfilling and then over the top surface of the gravel in order to reduce subsoil erosion. A clay capping layer should be provided above the free draining backfill material to reduce the likelihood of surface water entering the backfill and surcharging the retaining walls.

4.6 Subgrade Preparation

Earthworks recommendations provided in this report should be complemented by reference to AS3798.

4.6.1 Subgrade Preparation

If the floor slabs are proposed to be fully suspended on the piled footings, then no particular subgrade preparation would be necessary other than stripping all root-affected or deleterious topsoil/fill. However, based on the reactivity of the clay soils, as discussed above, we recommend the use of void formers at least 60mm thick under the building floor slabs to separate the slab from the subgrade. Further advice in this regard can be provided once details of the footing system and site earthworks (cut and fill) are known.

Recommendations for subgrade preparation below stiffened raft slabs and slabs on ground are outlined below. Slab-on-ground (other than stiffened raft slabs) should also be constructed separate from the footings of the building (i.e. designed as 'floating').

1. All root affected or deleterious fill or topsoil must be removed; there may be an extensive zone of root affected soil where trees have been removed. These stripped materials should be taken off site as they are not suitable for reuse as engineered fill. Where depressions result from stripping, they may be infilled with inert well-graded granular fill such as crushed sandstone, placed and compacted in layers as engineered fill.
2. Where existing uncontrolled fill is present and the proposed building will be formed over areas of existing fill, then the existing fill must be excavated to the natural subgrade. We recommend excavation of the fill extend at least 1m beyond the building footprint.
3. Following the above, the entire subgrade should be proof rolled with at least 6 passes of an at least 8 tonne smooth drum roller used in static or non-vibratory mode of operation. The purpose of the proof rolling is to detect any soft or heaving areas.
4. The final pass of proof rolling should be undertaken in the presence of an experienced geotechnician or geotechnical engineer, to detect any unstable or soft subgrade areas, and to allow for some further improvement in strength/compaction. Care should be taken not to over-compact clayey subgrade areas.
5. If dry conditions prevail at the time of construction, the clay subgrade may become desiccated or have shrinkage cracks prior to pouring any concrete slabs. If this occurs then the subgrade must be watered and rolled until the cracks disappear. This should be completed immediately prior to pouring concrete.
6. Unstable subgrade detected during proof rolling should be locally excavated down to a stiff or sound base and replaced with engineered fill or further advice from the geotechnical engineers should be sought. Any fill placed to raise site levels should also be engineered fill. From the borehole results we expect few, if any, unstable subgrade areas to occur provided good site drainage is maintained and the earthworks are carried out during good weather.

4.6.2 Engineered Fill

Any fill used to backfill unstable subgrade areas, raise surface levels or backfill service trenches should be engineered fill. Materials preferred for use as engineered fill are well-graded granular materials, such as crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. Such fill should be compacted in horizontal layers not greater than 200mm loose thickness, to a minimum density of 98% of Standard Maximum Dry Density (SMDD). For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness and with a reduced maximum particle size of 40mm for the engineered fill.

From a geotechnical perspective, the existing fill and residual clays at the site may be acceptable for re-use as engineered fill on condition that the soils used are clean (i.e. free of organics and inclusions greater than 75mm size (or 40mm size, as necessary), and free of contaminants. These clayey soils should be compacted in maximum 200mm loose layers to a density strictly between 98% and 102% of SMDD and at moisture content within 2% of their Standard Optimum Moisture Content (SOMC). All clay fill should preferably be used in the lower fill layers. Thus, the use of clay materials for engineered fill will entail more rigorous earthwork supervision and compaction control, time for possible moisture conditioning and hence, possibly a greater eventual cost for earthworks. Consideration must also be made by the building designer of the greater reactive potential of new fills comprising reactive clays as opposed to existing clayey soils, as discussed in Section 4.2 above.

Density tests should be regularly carried out on engineered fill to confirm the above specifications are achieved. Density tests should be carried out at the frequencies outlined in AS3798 (Table 8.1) for the volume of fill involved. Within the proposed building footprint and particularly if the engineered fill will be supporting structural loads, then the fill must be placed under Level 1 supervision, as defined in AS3798-2007. Areas where engineered fill will not be supporting structural loads, then a reduced Level 2 control of fill compaction may be adopted. Any areas of insufficient compaction will require reworking and retesting to confirm the required specification has been achieved. Preferably, the geotechnical testing authority (GTA) should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.7 Pavement Design

The design of new pavements will depend on subgrade preparation, subgrade drainage, the nature and composition of fill excavated or imported to the site, as well as vehicle loadings and use. Various alternative types of construction could be used for the pavements. Concrete construction would undoubtedly be the best in areas where heavy vehicles manoeuvre. Flexible pavements may have a lower initial cost but maintenance will be higher. These factors should be considered when making the final choice. We recommend that reference also be made to AS2870 for drainage and vegetation precautions on reactive clay sites.

Based on the subsurface conditions and laboratory test results, we recommend the pavements are designed based on a CBR value of 3.5% or an estimated subgrade reaction modulus (for concrete slabs or pavements)

of 25kPa/mm (750mm diameter plate). The pavement sections where imported fill is used to raise site levels, by at least 0.5m may be designed on the basis of a four-day soaked CBR value of the imported fill material.

Concrete pavements should have a sub-base layer of at least 100mm thickness of crushed rock to latest revision of Transport for NSW QA specification 3051 (2010) unbound base material (or equivalent good quality and durable fine crushed rock) which is compacted using a heavy roller to at least 100% of Standard Maximum Dry Density (SMDD). Adequate moisture conditioning to within 2% of Standard Optimum Moisture Content (MOMC) should be provided during placement so as to reduce the potential for material breakdown during compaction. Concrete pavements should be designed with an effective shear transmission of all joints by way of either doweled or keyed joints.

Careful attention to subsurface and surface drainage is required in view of the effect of moisture on the clay subgrade. The surface of the pavement and the subgrade should be sloped to shed water, and adequate subsurface drainage should be installed around the pavement to intercept and dispose of water flows. The drainage trenches should be excavated with a longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The subsoil drainage should extend at least 0.3m below the subgrade levels.

4.8 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Additional geotechnical investigation, if deemed required.
- Review of civil and structural drawings.
- Inspection of footing excavations.
- Inspection of proof rolling soil subgrade.
- Testing of engineered fill

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase 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.

The long term successful performance of floor slabs and pavements may be dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer.

Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

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.

A waste classification is required for any soil and/or bedrock excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM), General Solid, Restricted Solid or Hazardous Waste. Analysis can take up to seven to ten working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) could be expected. We strongly recommend that this requirement is addressed prior to the commencement of excavation on site.

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.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
MOISTURE CONTENT, ATTERBERG LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client:	JK Geotechnics	**Report No.:**	34804LF - A
Project:	Proposed Inpatient Unit	**Report Date:**	28/07/2022
Location:	Muswellbrook District Hospital, Brentwood Street, Muswellbrook, NSW	**Page 1 of 1**	

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
1	0.50 - 0.95	15.0	76	25	51	14.0
1	3.00 - 3.10	10.7	-	-	-	-
2	1.20 - 1.40	39.9	56	17	39	12.5
2	7.40 - 7.80	28.6	-	-	-	-
2	11.30 - 11.60	21.7	-	-	-	-
3	2.60 - 3.00	8.8	-	-	-	-
4	0.50 - 0.95	27.9	53	17	36	13.0
4	4.50 - 4.95	20.0	-	-	-	-
5	2.00 - 2.45	23.9	61	17	44	17.0*
5	9.80 - 10.00	8.8	-	-	-	-
6	0.50 - 0.95	19.0	47	17	30	14.0*
6	5.20 - 5.50	4.4	-	-	-	-

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions
- Date of receipt of sample: 08/07/2022.
- Sampled and supplied by client. Samples tested as received.
- * Denotes Linear Shrinkage curled.

NATA

NATA Accredited Laboratory Number:1327

28/07/2022

Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: JK Geotechnics
Project: Proposed Inpatient Unit
Location: Muswellbrook District Hospital, Brentwood Street, Muswellbrook, NSW

Report No.: 34804LF - B
Report Date: 20/07/2022
Page 1 of 1

BOREHOLE NUMBER		BH 1	BH 2	BH 5	BH 6
DEPTH (m)		0.40 - 1.20	0.50 - 1.40	0.60 - 1.50	0.60 - 1.40
Surcharge (kg)		9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)		1.84 STD	1.81 STD	1.65 STD	1.84 STD
Optimum Moisture Content (%)		13.8	16.0	20.5	14.3
Moulded Dry Density (t/m^3)		1.81	1.77	1.61	1.80
Sample Density Ratio (%)		98	98	98	98
Sample Moisture Ratio (%)		98	100	100	99
Moisture Contents					
Insitu (%)		16.7	16.6	26.0	18.0
Moulded (%)		13.5	16.0	20.4	14.2
After soaking and					
After Test, Top 30mm(%)		17.4	22.2	24.5	18.9
Remaining Depth (%)		16.5	17.7	21.6	14.8
Material Retained on 19mm Sieve (%)		0	0	0	0
Swell (%)		0.0	1.0	0.5	0.5
C.B.R. value:	@2.5mm penetration	5		6	3.5
	@5.0mm penetration		4.0		

NOTES: Sampled and supplied by client. Samples tested as received.

- Refer to appropriate notes for soil descriptions
- BH's 1, 5 & 6 dried back prior to testing as too saturated.
- BH 1 & 6 had insufficient material supplied to complete a 4-point compaction curve.
- BH 5 had to use recycled material from the compaction curve for the CBR sample as insufficient material was supplied.
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 08/07/2022.

NATA Accredited Laboratory Number:1327

20/07/2022
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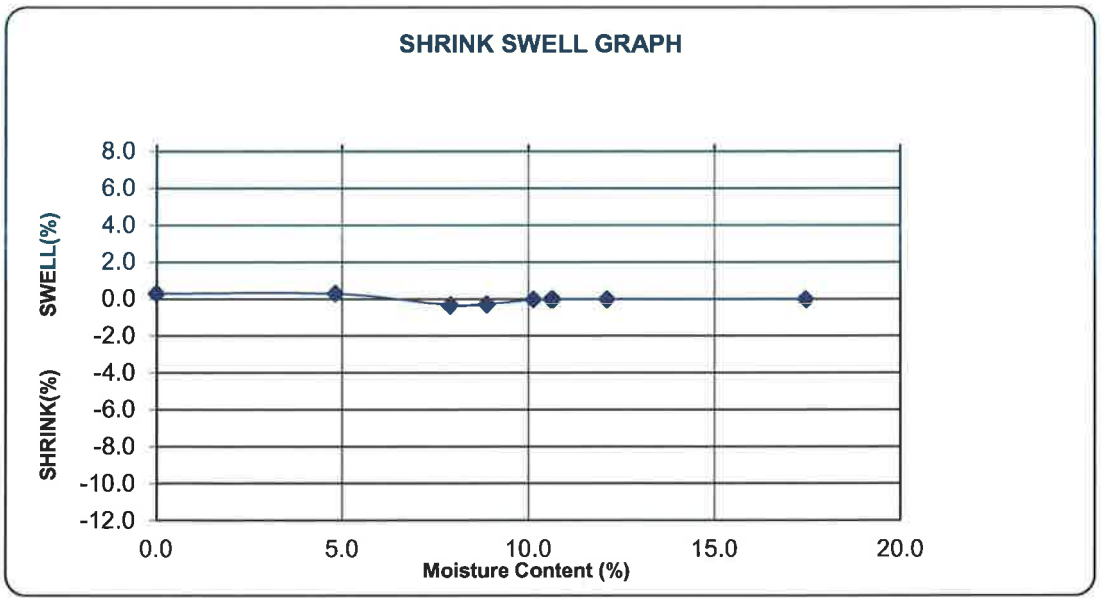
SOIL TEST SERVICES
ABN 43 002 145 173

TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Inpatient Unit
Location: Muswellbrook District Hospital, Brentwood Street, Muswellbrook, NSW

Report No.: 34804LF - C
Report Date: 19/07/2022
Page 1 of 4

Borehole No.: 1		Depth: 1.50 - 2.00m			
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH			
BEFORE TEST	AFTER TEST	BEFORE TEST		AFTER TEST	
12.1%	17.4%	>550	kPa	130,300,280	kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION			SWELL ON SATURATION	SHRINKAGE
25	-0.7%			0.0%	0.3%



SHRINK SWELL INDEX
0.18 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 08/07/2022.

NATA Accredited Laboratory Number:1327

Authorised Signature / Date (D. Treweek) 19/7/22

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SOIL TEST SERVICES
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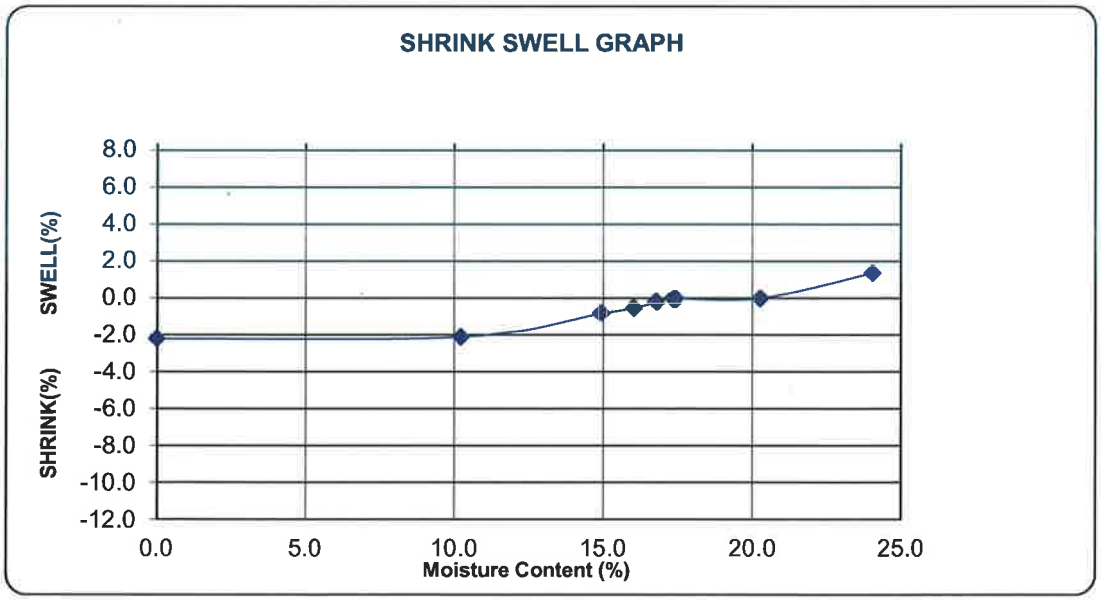
TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Inpatient Unit
Location: Muswellbrook District Hospital, Brentwood Street, Muswellbrook, NSW

Report No.: 34804LF - C
Report Date: 19/07/2022
Page 2 of 4

Borehole No.: 2		Depth: 0.50 - 0.95			
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH			
BEFORE TEST	AFTER TEST	BEFORE TEST		AFTER TEST	
20.3%	24.0%	290,490	kPa	220,290	kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION			SWELL ON SATURATION	SHRINKAGE
25	-1.9%			1.4%	2.1%



SHRINK SWELL INDEX
1.57 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 08/07/2022.

NATA Accredited Laboratory Number:1327

Authorised Signature / Date (D. Treweek) 19/7/22

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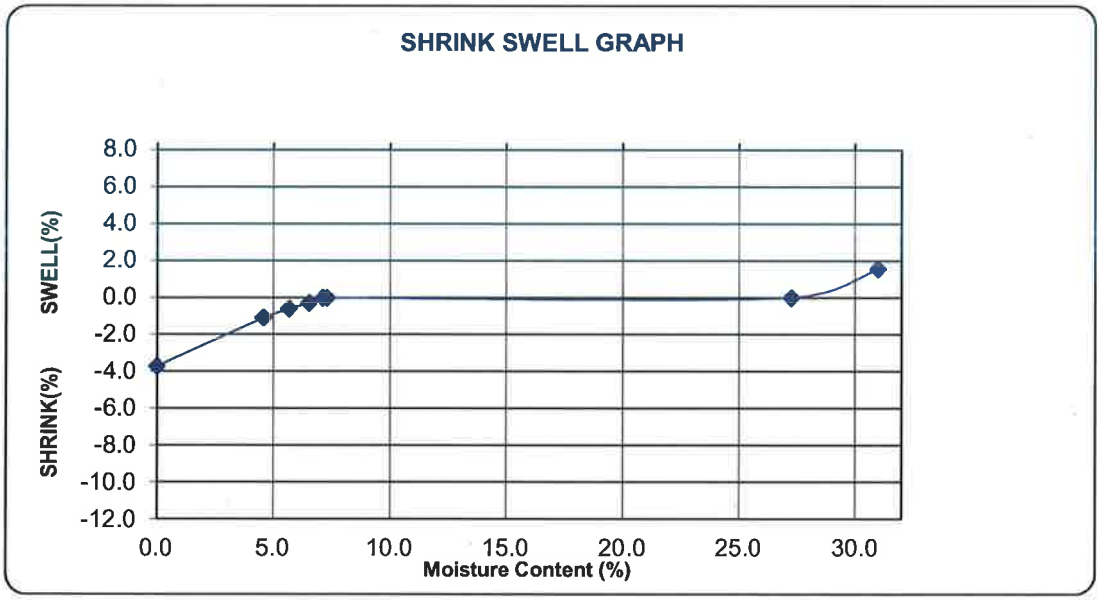
SOIL TEST SERVICES
ABN 43 002 145 173

TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Inpatient Unit
Location: Muswellbrook District Hospital, Brentwood Street, Muswellbrook, NSW

Report No.: 34804LF - C
Report Date: 19/07/2022

Borehole No.: 4		Depth: 1.00 - 1.45m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
27.3%	31.0%	250 kPa	100 kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-1.0%	1.6%	3.6%



SHRINK SWELL INDEX
2.46 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 08/07/2022.

NATA Accredited Laboratory Number:1327

Authorised Signature / Date (D. Treweek) 19/7/22

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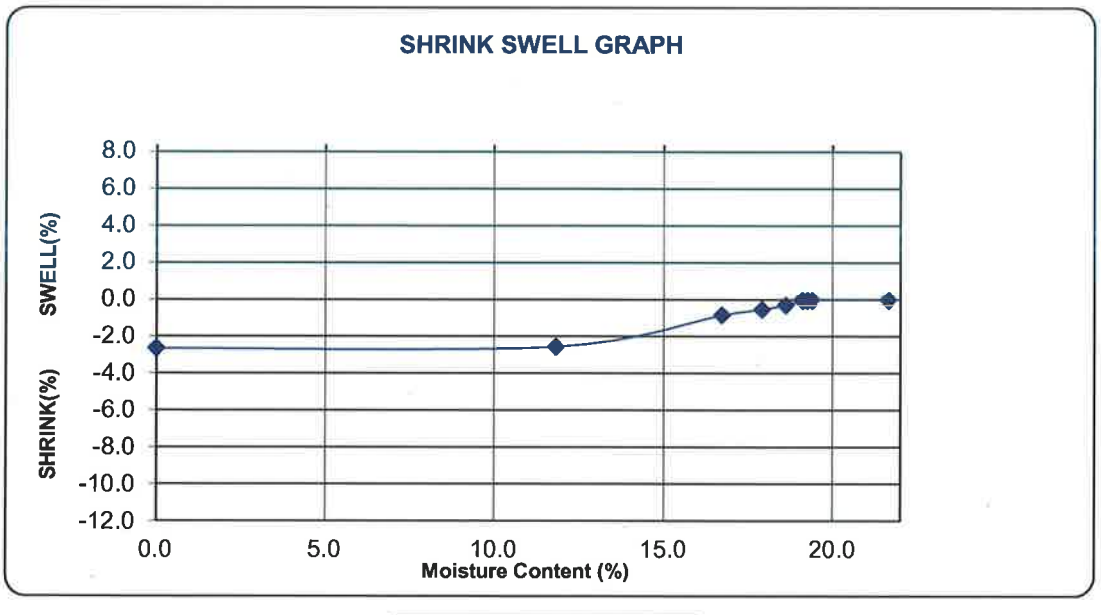
SOIL TEST SERVICES
ABN 43 002 145 173

TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Inpatient Unit
Location: Muswellbrook District Hospital, Brentwood Street, Muswellbrook, NSW

Report No.: 34804LF - C
Report Date: 19/07/2022
Page 4 of 4

Borehole No.: 6		Depth: 1.00 - 1.45			
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH			
BEFORE TEST	AFTER TEST	BEFORE TEST		AFTER TEST	
19.1%	21.6%	>520	kPa	200,220	kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION			SWELL ON SATURATION	SHRINKAGE
25	-0.8%			0.0%	2.6%



SHRINK SWELL INDEX
1.44 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 08/07/2022.

NATA Accredited Laboratory Number:1327

Authorised Signature / Date (D. Treweek) 19/7/22

TABLE D
POINT LOAD STRENGTH INDEX TEST REPORT

Client: NSW Health Infrastructure **Ref No:** 34804LF

Project: Proposed Inpatient Unit **Report:** A

Location: Muswellbrook District Hospital, Brentwood Street, MUSWELLBROOK, NSW **Report Date:** 5/07/22

BOREHOLE NUMBER	DEPTH (m)	$I_{S(50)}$ (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
1	3.88 - 3.92	0.09	2	A
	4.14 - 4.18	0.6	12	A
	4.65 - 4.69	8.4	168	A
	5.47 - 5.51	10.8	216	A
	6.08 - 6.11	0.2	4	A
	6.76 - 6.79	0.1	2	A
	7.56 - 7.59	5.8	116	A
	7.92 - 7.94	0.08	2	A
	8.09 - 8.13	1.2	24	A
	8.59 - 8.61	0.07	1	A
	9.43 - 9.45	0.2	4	A
	9.70 - 9.72	2.1	42	A
	10.16 - 10.19	0.1	2	A
	10.60 - 10.62	0.1	2	A
	11.21 - 11.25	0.2	4	A
	11.78 - 11.81	0.1	2	A
	12.40 - 12.44	0.2	4	A
	12.72 - 12.75	0.1	2	A
	13.11 - 13.14	0.2	4	A
4	6.30 - 6.33	10.1	202	A
6	6.48 - 6.51	0.2	4	A
	6.78 - 6.82	0.09	2	A
	7.27 - 7.30	1.7	34	A
	7.60 - 7.64	0.3	6	A
	8.24 - 8.28	0.08	2	A
	8.79 - 8.82	0.5	10	A
	9.42 - 9.44	0.4	8	A
	9.85 - 9.88	0.1	2	A
	10.13 - 10.17	0.1	2	A
	10.65 - 10.68	0.3	6	A
	11.15 - 11.18	0.2	4	A

TABLE D
POINT LOAD STRENGTH INDEX TEST REPORT

Client: NSW Health Infrastructure **Ref No:** 34804LF

Project: Proposed Inpatient Unit **Report:** A

Location: Muswellbrook District Hospital, Brentwood Street, MUSWELLBROOK, NSW **Report Date:** 5/07/22

BOREHOLE NUMBER	DEPTH (m)	$I_{S(50)}$ (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
6	12.25 - 12.28	0.1	2	A
	12.88 - 12.92	0.2	4	A
	13.43 - 13.46	0.2	4	A
	13.92 - 13.95	0.1	2	A
	14.03 - 14.07	0.3	6	A

NOTES

1. In the above table, testing was completed in test direction A for the axial direction, D for the diametral direction, B for the block test and L for the lump test.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the $I_{S(50)}$ has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa.
5. The estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' and rounded off to the nearest whole number: U.C.S. = 20 $I_{S(50)}$.

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CERTIFICATE OF ANALYSIS 300005

Client Details

Client	JK Geotechnics
Attention	Jacob Feng
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**34804LF, Muswellbrook, NSW**
Number of Samples	9 Soil
Date samples received	08/07/2022
Date completed instructions received	08/07/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/07/2022
Date of Issue	15/07/2022

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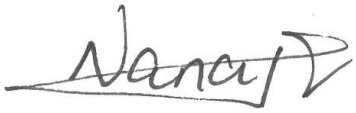
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Diego Bigolin, Inorganics Supervisor

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		300005-1	300005-2	300005-3	300005-4	300005-5
Your Reference	UNITS	BH1	BH2	BH2	BH3	BH3
Depth		1.2-1.4	1.5-1.95	5.6-5.9	3.2-3.5	7.2-7.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	13/07/2022	13/07/2022	13/07/2022	13/07/2022	13/07/2022
Date analysed	-	13/07/2022	13/07/2022	13/07/2022	13/07/2022	13/07/2022
pH 1:5 soil:water	pH Units	6.3	8.9	9.4	9.7	9.2
Chloride, Cl 1:5 soil:water	mg/kg	260	880	640	100	510
Sulphate, SO4 1:5 soil:water	mg/kg	250	370	150	46	220
Resistivity in soil*	ohm m	26	10	15	38	16

Misc Inorg - Soil					
Our Reference		300005-6	300005-7	300005-8	300005-9
Your Reference	UNITS	BH4	BH5	BH5	BH6
Depth		3.0-3.45	0.5-0.95	4.5-4.95	1.5-1.95
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	13/07/2022	13/07/2022	13/07/2022	13/07/2022
Date analysed	-	13/07/2022	13/07/2022	13/07/2022	13/07/2022
pH 1:5 soil:water	pH Units	9.4	8.3	9.1	8.8
Chloride, Cl 1:5 soil:water	mg/kg	180	<10	37	20
Sulphate, SO4 1:5 soil:water	mg/kg	100	26	20	34
Resistivity in soil*	ohm m	24	63	96	90

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	300005-6
Date prepared	-			13/07/2022	4	13/07/2022	13/07/2022		13/07/2022	13/07/2022
Date analysed	-			13/07/2022	4	13/07/2022	13/07/2022		13/07/2022	13/07/2022
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	4	9.7	9.7	0	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	100	100	0	96	#
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	46	46	0	92	#
Resistivity in soil*	ohm m	1	Inorg-002	<1	4	38	39	3	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

MISC_INORG_DRY:# Percent recovery is not applicable due to the high concentration of the analyte/s in the sample/s. However an acceptable recovery was obtained for the LCS.

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		4.5	
State					Dry	Flooded	Dry	Flooded	Dry	Flooded
Pillar 1	12.9	45.7	18.5	51.5	3.6	4.3	2.6	**3.2**	2.0	2.4
	11.9				3.2	3.8	2.3	2.8	1.8	2.2
Pillar 2	16.0	41.4	21.7	48.2	4.1	5.0	3.0	**3.7**	2.3	2.8
	15.0				3.7	4.5	2.7	3.3	2.1	2.5
Pillar 3	10.8	36.9	16.8	42.4	2.9	3.6	2.2	**2.6**	1.7	2.0
	9.8				2.5	3.1	1.9	2.3	1.4	1.7
Pillar 4	10.9	27.7	16.7	33.5	2.9	3.5	2.1	**2.5**	1.6	2.0
	9.9				2.5	3.0	1.8	2.2	1.4	1.7
Pillar 5	13.6	25.5	19.3	31.0	3.4	4.2	2.5	**3.1**	1.9	2.4
	12.6				3.1	3.7	2.2	2.7	1.7	2.1
Pillar 6	13.5	20.2	19.3	26.1	3.2	3.9	2.3	**2.9**	1.8	2.2
	12.5				2.8	3.5	2.1	2.5	1.6	1.9
Pillar 7	18.8	24.3	25.1	29.8	4.3	5.2	3.2	**3.8**	2.4	2.9
	17.8				3.9	4.8	2.9	3.5	2.2	2.7
Pillar 8	22.1	33.6	27.4	39.4	5.3	6.4	3.9	**4.7**	3.0	3.6
	21.1				4.9	5.9	3.6	4.4	2.8	3.4
Pillar 9	19.6	37.9	25.1	43.8	4.8	5.9	3.6	**4.3**	2.7	3.3
	18.6				4.5	5.4	3.3	4.0	2.5	3.1

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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 APPEARS MODERATELY COMPACTED
					N = 9 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	290 300 290 >600 >600	RESIDUAL
					N > 7 9,7/ 50mm 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 4/ 50mm REFUSAL	176	3			SANDSTONE: fine to coarse grained, brown.	DW	VL - L		BRANXTON FORMATION 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							

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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						
		175	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; 0.60; 8.4		(3.39m) CS, 0°, 40 mm.t; (3.54m) Cr, 0°, 80 mm.t; (3.82m) Be, 0°, P, R, Clay Ct; (3.86m) Be, 5°, P, R, Clay Vn; (4.22m) Jh, 30°; (4.61m) Be, 15°, P, R, Fe Vn	Branxton Formation
		174	5				VH	11	60 20	(5.13m) Be, 15°, C, R, Fe Vn; (5.24m) Be, 5°, P, R, Clay Vn; (5.35m) Be, 5°, P, R, Clay Vn; (5.44m) Jh, 60°	
95% RETURN		173	6		NO CORE 0.06m 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; 0.10; 5.8		(6.33m) Be, 5°, P, R, Clay Vn; (6.44m) Be, 5°, P, R, Clay Vn; (6.49m) XWS, 0°, 110 mm.t; (6.68m) XWS, 0°, 170 mm.t; (7.20m) J, 35°, P, R, Clay Vn	Branxton Formation
		172	7							(7.75m) DRILLING INDUCED	
		171	8		NO CORE 0.08m 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; 1.2; 0.070		(8.13m) Be, 5°, Ir, R, Clay Ct; (8.29m) Cr, 0°, 40 mm.t; (8.62m) Cr, 0°, 40 mm.t; (8.69m) Jh, 90°; (8.71m) Jh, 90°; (8.82m) Cr, 30°, 20 mm.t; (8.89m) J, 75°, P, R, Clay Vn	Branxton Formation

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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CORED BOREHOLE LOG

Borehole No. 1 **3 / 3**

Client: NSW HEALTH INFRASTRUCTURE

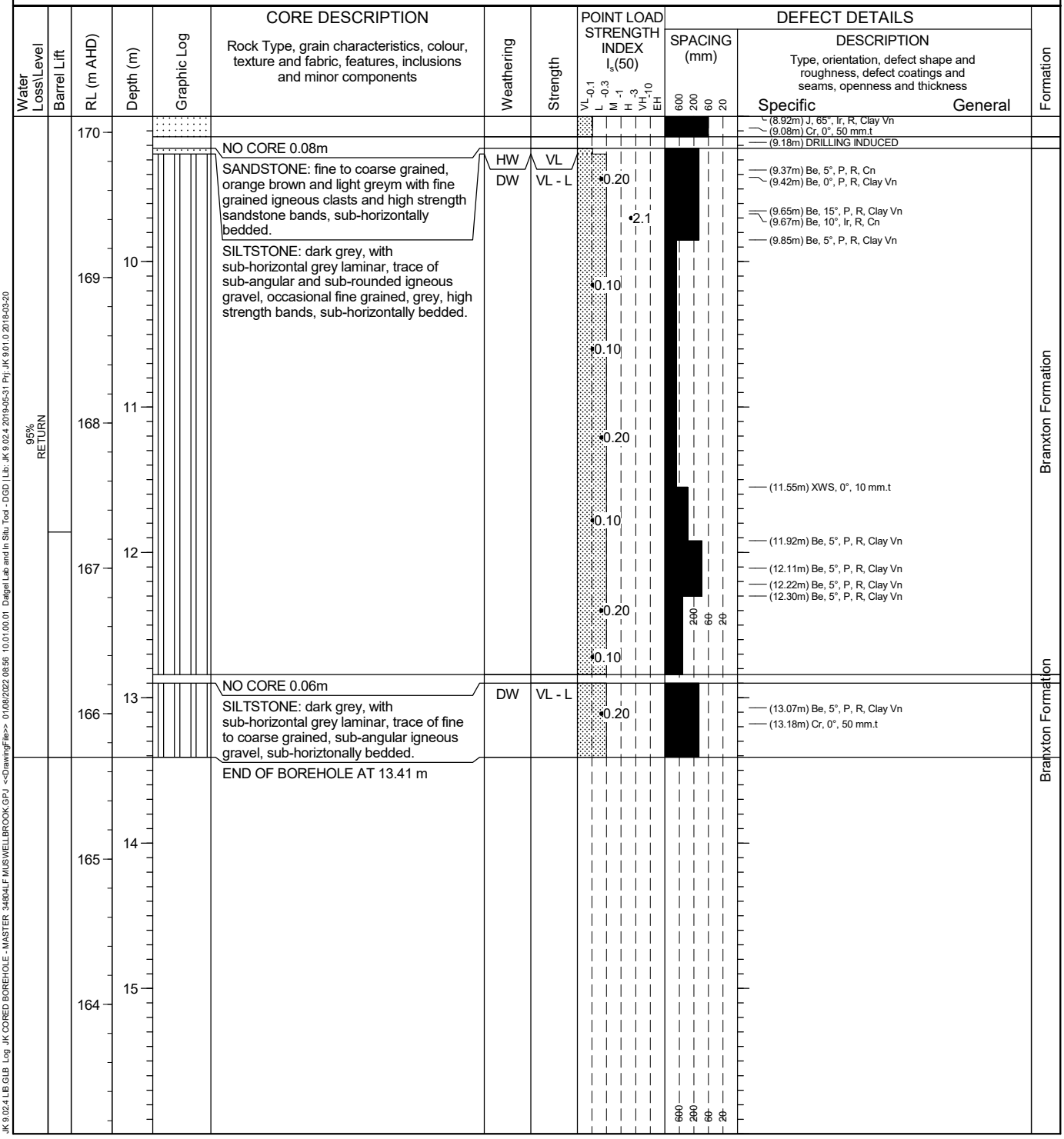
Project: PROPOSED STAGE 3 DEVELOPMENT

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

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

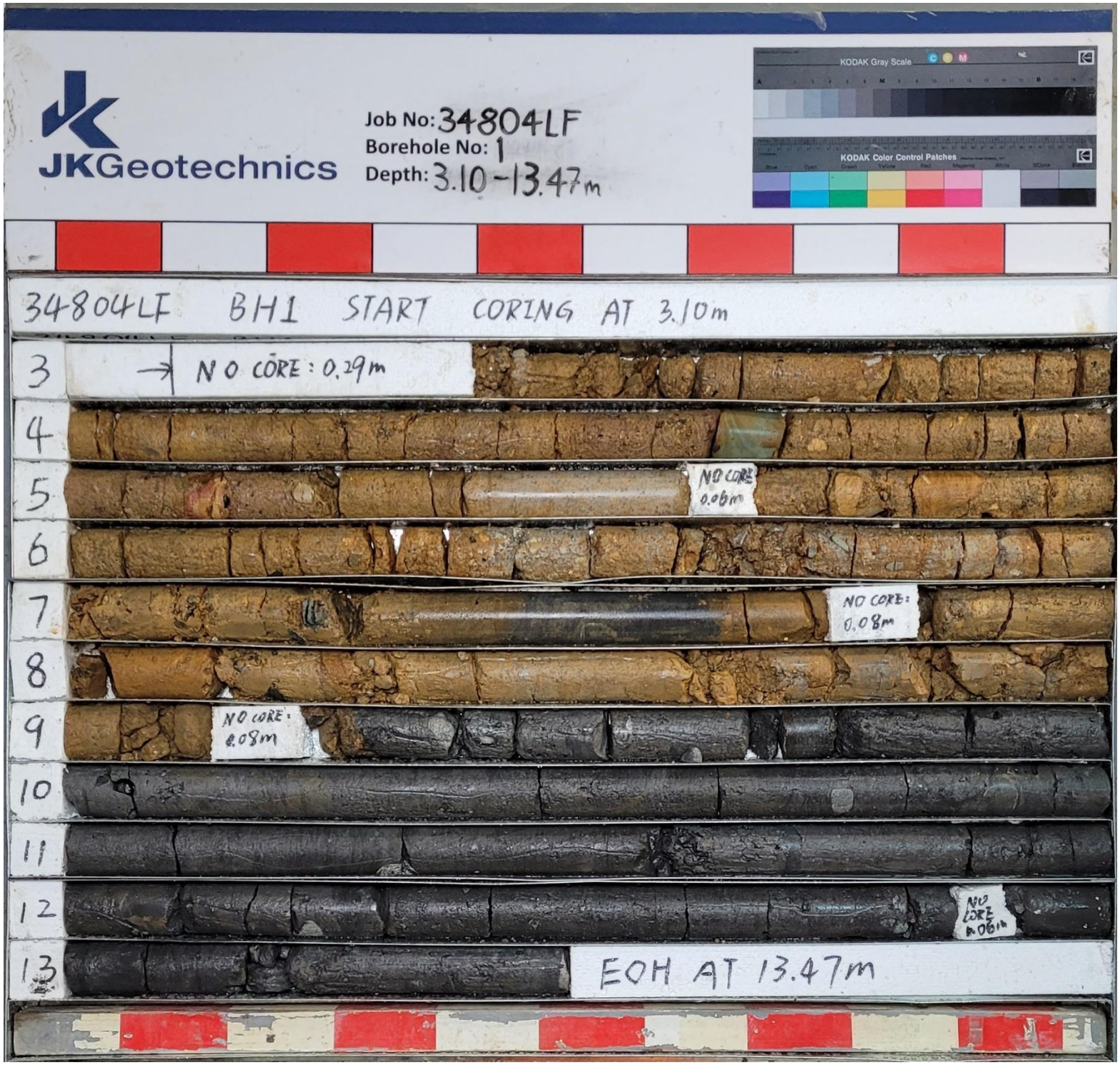
Date: 28/6/22 **Inclination:** VERTICAL **Datum:** AHD

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



JK 9.02.4 LIB GLB Log JK CORED BOREHOLE - MASTER 34804LF MUSWELLBROOK.GPJ <<DrawingFile>> 01/08/2022 08:56 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 34804LF
Borehole No: 1
Depth: 3.10-13.47m
KODAK Gray Scale
KODAK Color Control Patches
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

JKGeotechnics

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
										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	300 310 320	RESIDUAL
						180	1			as above, but with fine grained, sub-angular ironstone gravel and fine to medium grained sand.			290 270 300	
					N = 15 3,6,9							Hd	570 560 550	
						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 12/ 150mm REFUSAL	178	3			as above, 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

JKGeotechnics

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				

JKGeotechnics

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 3.7m DRILLER ADDED WATER 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

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 Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL 0.1 L 0.3 M 1 H 3 VH 10 EH	SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness 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. NO CORE 1.76m	XW	Hd			CLAY WASHING AWAY	Branxton Formation
		176	8								
		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									

JK 9.02.4 LIB GLB Log JK CORED BOREHOLE - MASTER 34804LF MUSWELLBROOK.GPJ <<DrawingFile>> 01/08/2022 08:57 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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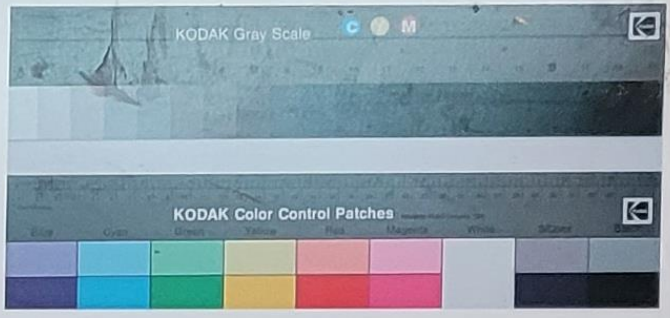
Job No: 34804LF
Borehole No: 4
Depth: 6.20 - 8.28m



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 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, but light grey mottled light brown.			240 250 260	
					N = 12 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 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 5,6,7	180	5						300 290 340	
						179	6							
						178			CI	Silty CLAY: medium plasticity, light brown, trace of fine to medium grained sand.			230 260 250	HP TESTING ON REMOULDED SAMPLES

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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
						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 MODERATE RESISTANCE
						174	11							MODERATE TO HIGH RESISTANCE
						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								

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 34804LF MUSWELLBROOK.GPJ <<DrawingFile>> 01/08/2022 08:58 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

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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								

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CORED BOREHOLE LOG

Borehole No. 6 **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:** 179.44 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 $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
		174			START CORING AT 5.93m						
			6		NO CORE 0.48m						
		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 (6.53m) Be, 5°, Ir, R, Clay Ct (6.57m) Cr, 0°, 20 mm.t (6.60m) XWS, 0°, 20 mm.t (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 (7.52m) Be, 15°, P, R, Fe Vn	
								0.30			
			8			HW	VL			(7.86m) XWS, 0°, 120 mm.t	
						MW	VL - L			(8.12m) Jh, 20° (8.14m) Jh, 14° (8.20m) J, 35°, Ir, R, Fe Sn	
								0.080			
		171								(8.38m) XWS, 0°, 100 mm.t	
95% RETURN					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 (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 (10.56m) Be, 5°, P, R, Clay Vn	
								0.30			
			11								
								0.20			
		168								(11.33m) XWS, 0°, 70 mm.t	

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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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 $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS: DESCRIPTION (Specific / General)	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	
		166						0.20		(12.95m) Jh, 30° (12.96m) Jh, 85°	
										(13.19m) J, 35°, Ir, R, Cn	
										(13.34m) Jh, 30°	
								0.20			
										(13.67m) J, 40°, P, R, Cn (13.71m) J, 75°, P, R, Cn	
			14					0.10 0.30			
										(14.11m) J, 90°, P, R, Cn	
					END OF BOREHOLE AT 14.14 m						
		165	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
KODAK Gray Scale
KODAK Color Control Patches
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**

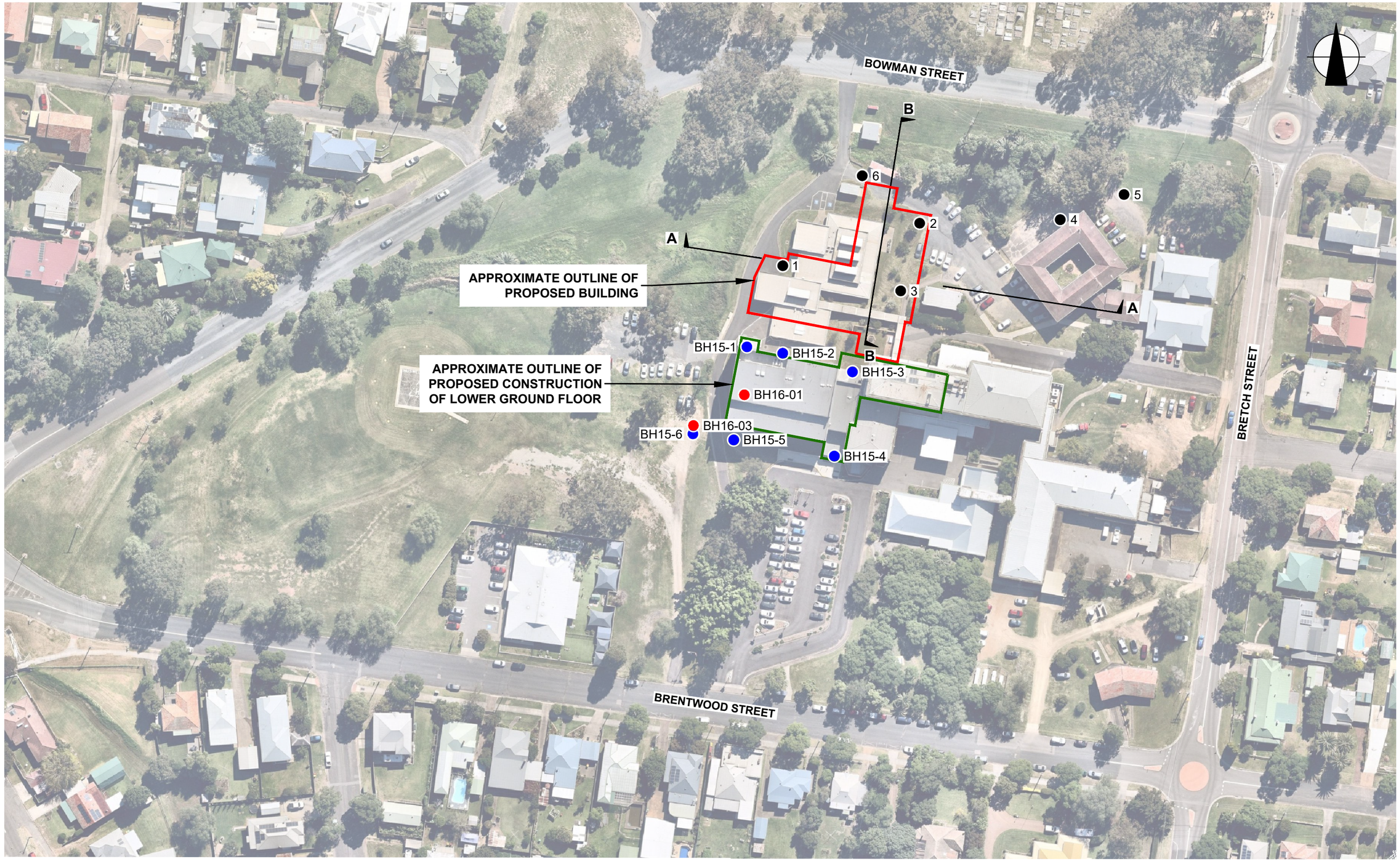
Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

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**

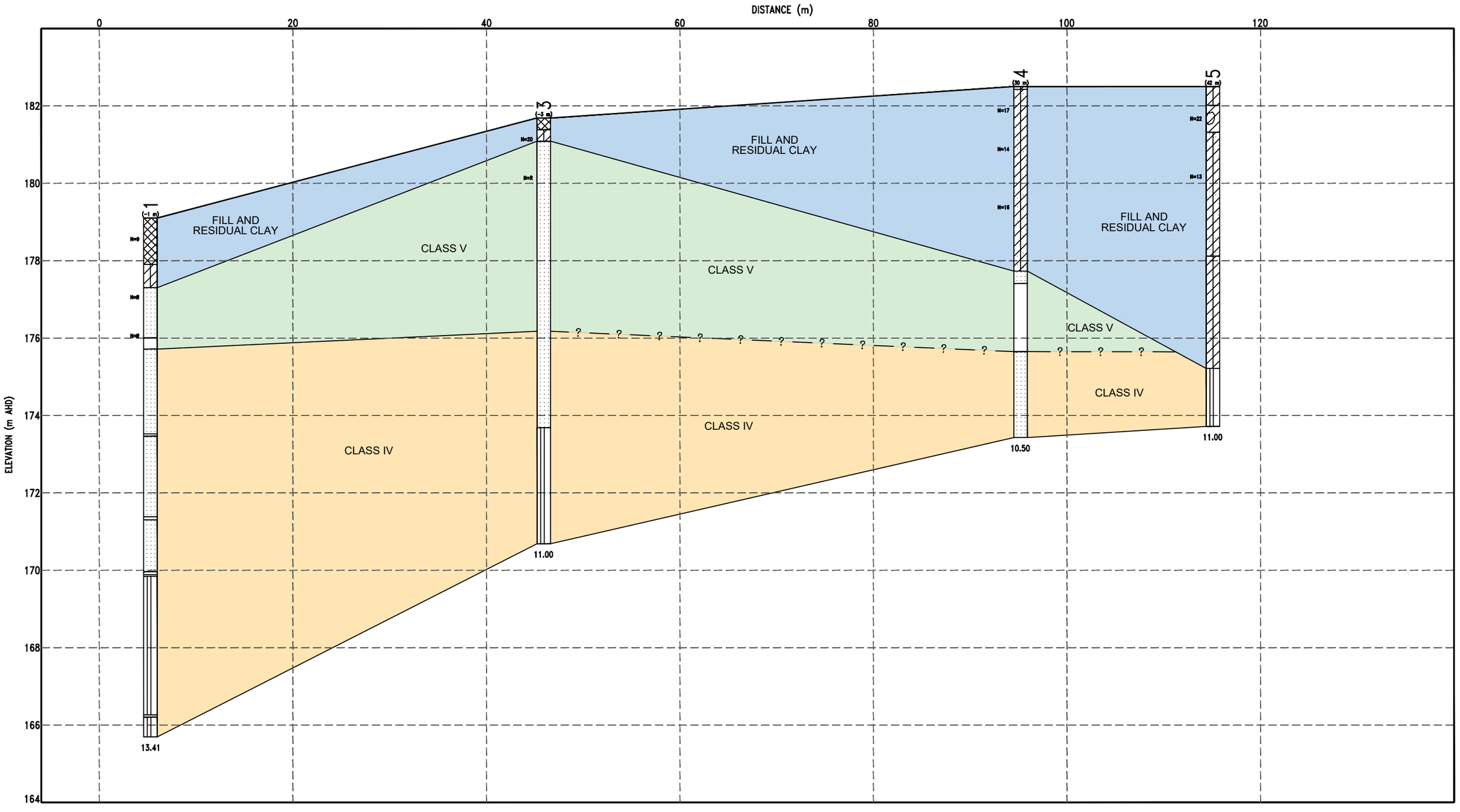
Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

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



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

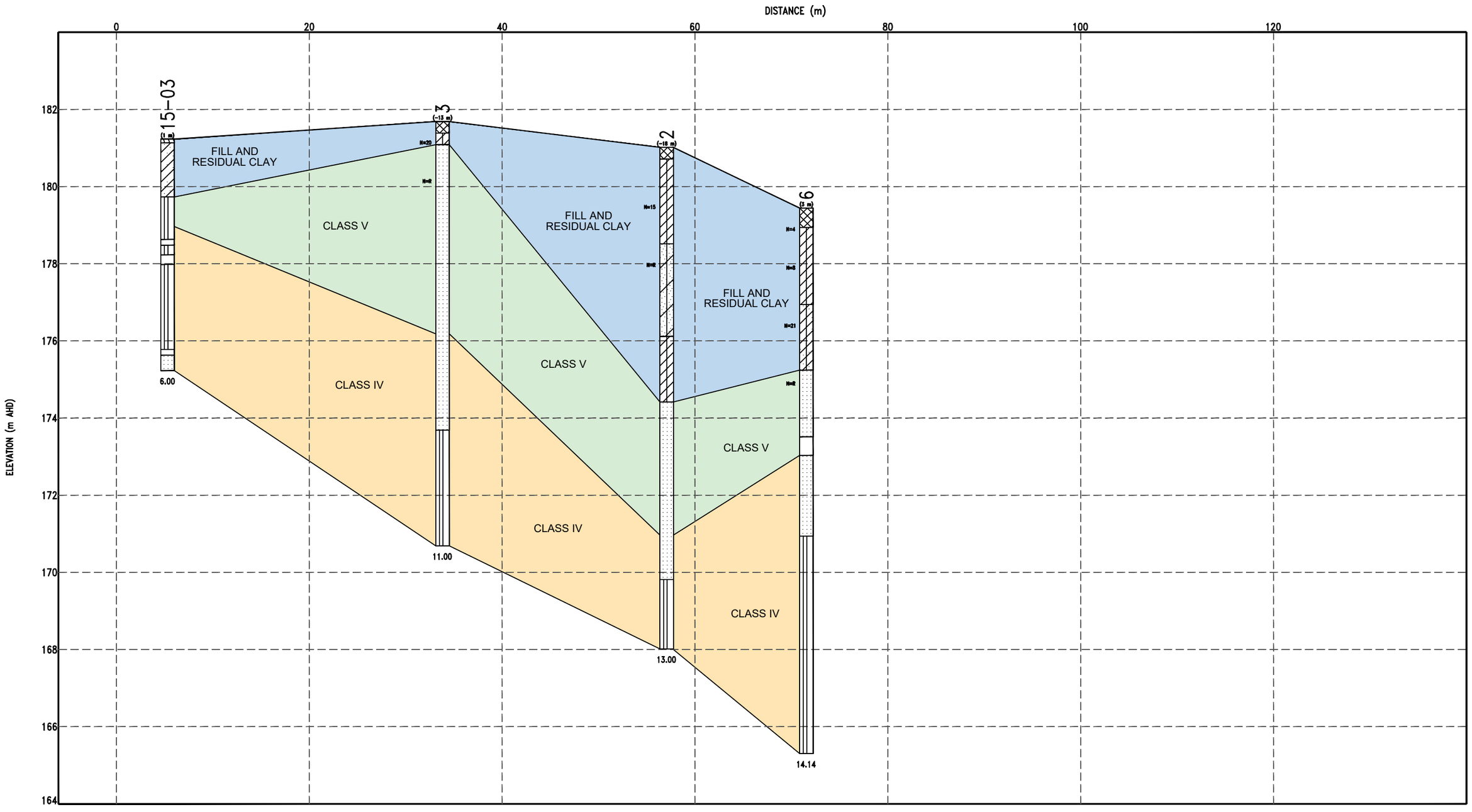
Location: MUSWELLBROOK HOSPITAL, BRENTWOOD STREET, MUSWELLBROOK, NSW

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



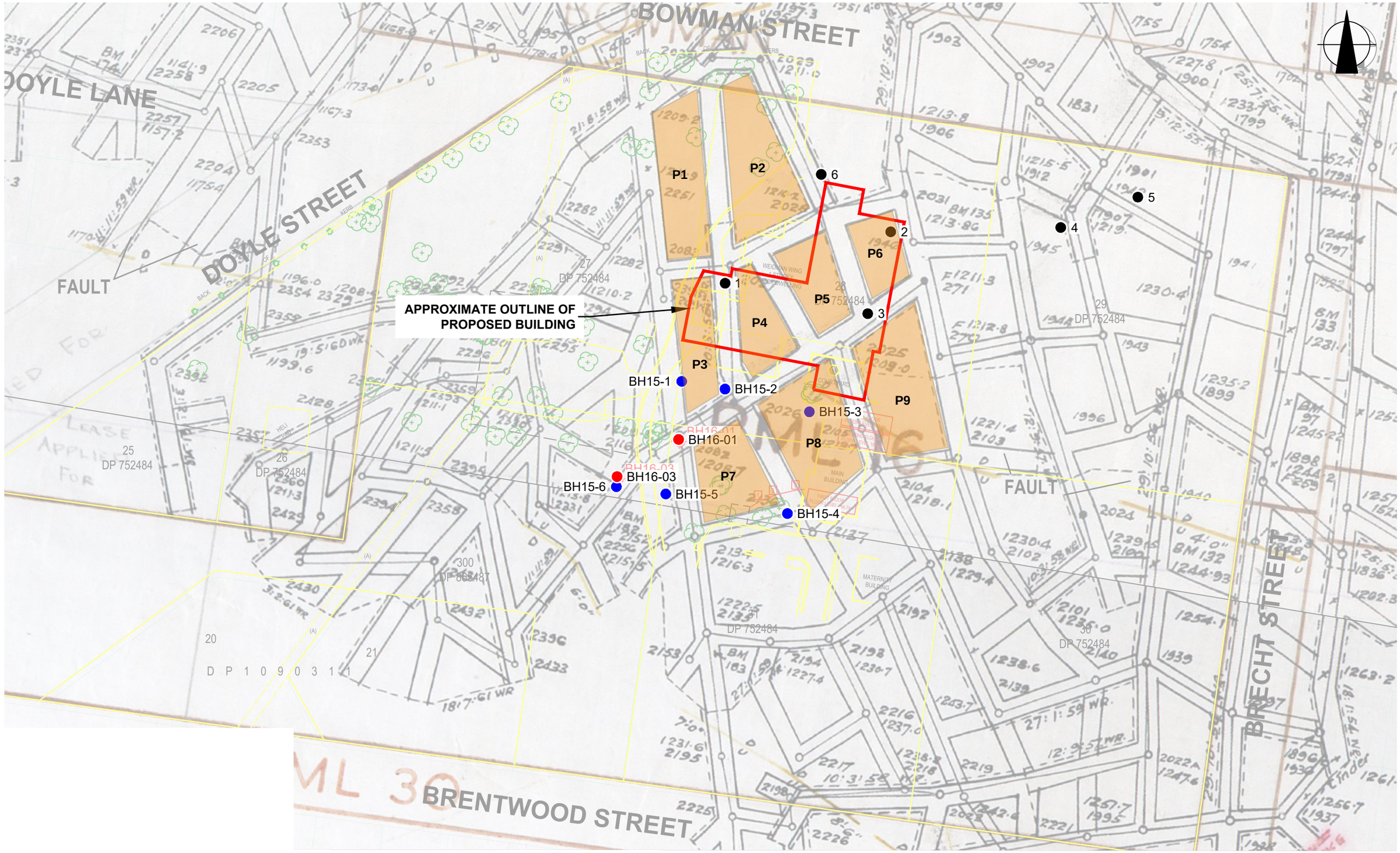
MATERIAL GRAPHIC

- 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

0 4 8 12 16 20
H: SCALE 1:400 @A3 METRES
0 1 2 3 4 5
V: SCALE 1:100 @A3 METRES
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 (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), 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:

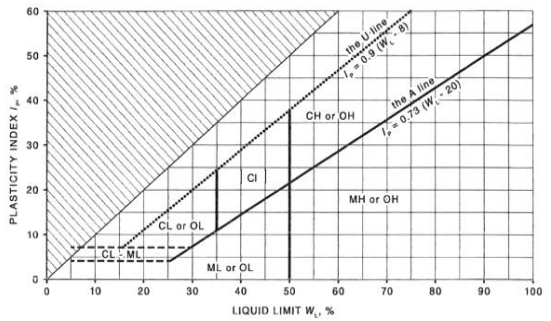
$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

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.

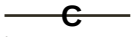
NOTES:

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 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 7 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 PID = 100	Vane shear reading in kPa of undrained shear strength. Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	*w* > PL *w* ≈ PL *w* < PL *w* ≈ LL *w* > LL	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. Moisture content estimated to be near liquid limit. Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D M W	DRY – runs freely through fingers. MOIST – does not run freely but no free water visible on soil surface. WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt Hd Fr ( )	VERY SOFT – unconfined compressive strength ≤ 25kPa. SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa. FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa. STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa. VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa. HARD – unconfined compressive strength > 400kPa. FRIABLE – strength not attainable, soil crumbles. Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)	VL L MD D VD ( )	**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)** VERY LOOSE ≤ 15 / 0 – 4 LOOSE > 15 and ≤ 35 / 4 – 10 MEDIUM DENSE > 35 and ≤ 65 / 10 – 30 DENSE > 65 and ≤ 85 / 30 – 50 VERY DENSE > 85 / > 50 Bracketed symbol indicates estimated density based on ease of drilling or other assessment.
Hand Penetrometer Readings	300 250	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: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. 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. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. 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. 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% 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% 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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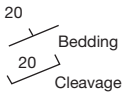
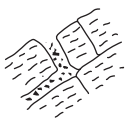
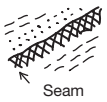
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES 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.			 (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.			 (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.			

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

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.

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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								

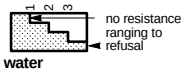
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:31

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

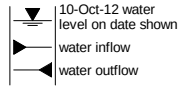
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

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

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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 **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 2.60m						
		177	2.0								
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. 4.73 to 4.83 m: Pale grey, bleached zone.	HW XW - HW HW	X O	a=0.10 d=0.40	70%		JT, 15°, PL, VR, Fe SN Weathered rock JT, 40°, PL, RO, Fe SN
		173	5.0		**SIDERITE**: brown and dark grey, coarse grained.	MW SW MW	O X	a=9.30 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 d=0.10	96%		PT, 10°, PL, RO, Fe SN JT, 45°, PL, RO, Fe SN
					Borehole BH15-01 terminated at 6.50 m Target depth						
		171	7.0								

Defects are: PT, 0 - 10°, PL, RO, CN - 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 2.60m | BH15-01 BOX 1 | End depth 6.50m

drawn	ELC	coffey	client:	TSA MANAGEMENT
approved	DLK		project:	PROPOSED BUILDING 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								

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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/remoulded (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 **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 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 d=0.20	0%		Fractured rock
					NO CORE: 0.20 m	HW - MW MW		a=0.40 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 d=0.30	94%		
			6.0		**SILTSTONE**: pale grey - orange brown.						
					Borehole BH15-02 terminated at 6.00 m Target depth						
		173	7.0								
		172									

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

drawn	ELC	coffey	client:	TSA MANAGEMENT
approved	DLK		project:	PROPOSED BUILDING 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			CH	**TOPSOIL: SILT**: brown, some sand, trace roots.	D			**TOPSOIL**
					1.0			**Sandy CLAY**: high plasticity, pale brown, coarse grained sand, trace fine grained gravel.	<Wp	VSt		**RESIDUAL SOIL**
				180								
			SPT 25/80mm HB N=R		2.0			**SILTSTONE**: pale brown, extremely weathered, remoulds to Clay.		H		**WEATHERED ROCK** No SPT recovery
				179								
								Borehole BH15-03 continued as cored hole				
				178	3.0							
					4.0							
				177								
					5.0							
				176								
					6.0							
				175								
					7.0							
				174								

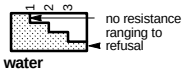
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:32

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

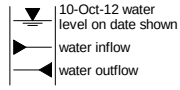
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

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.	**BH15-03**
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 **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 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. 3.88 to 3.95 m: Cobble sized rock fragments of dolerite - (70m thick) brown, fine to medium grained crystaline.	HW XW HW			40%		JT, 90°, PL, RO, Fe SN, 60 mm, VN Calcite Weathered Rock
		177				XW - HW		a=0.10 d=0.10			
			5.0					a=0.10 d=0.10			
		176							59%		PT, 0°, PL, RO, Fe SN JT, 50°, PL, RO, Clay VN PT, 0°, PL, RO, Fe SN JT, 40°, PL, RO, Clay CO Weathered zone
			6.0		**NO CORE:** 0.15 m						
					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 d=0.10			
		175			Borehole BH15-03 terminated at 6.00 m Target depth						
			7.0								
		174									

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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 | BH15-03 BOX 1 | End depth 6.00m

drawn	ELC	coffey	client:	TSA MANAGEMENT
approved	DLK		project:	PROPOSED BUILDING 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**
			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			
AD/T		Not Observed	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

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 **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					
					NO CORE: 0.30 m	HW					
		178	6.0		**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			13%		Fractured Rock
						XW					Weathered Rock JT, 60°, PL, RO, Fe SN JT, 40°, PL, VR, Fe SN
						MW					Fractured Rock
					6.15 m: Cobble sized rock fragments of dolerite.	MW - SW		a=0.20 d=0.30	80%		
		177	7.0					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

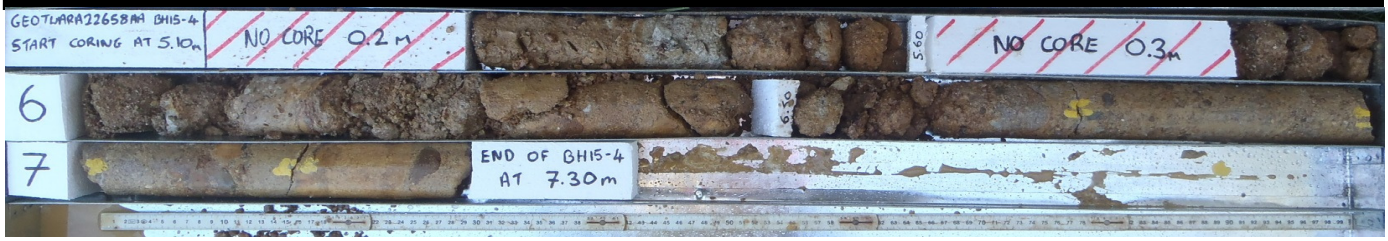
defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

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 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	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
AD/T, CASING		Not Observed	E	180	0.0			**TOPSOIL: Sandy SILT**: brown, fine grained sand.	D			**TOPSOIL**
			U50 E					**FILL: Sandy CLAY**: medium to high plasticity, grey, fine to coarse grained sand, some fine grained gravel of coal and brick.	<Wp			**FILL** U50 -300mm sample
			SPT 6, 10, 7 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 SPT 10, 16, 28 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	4.0			Borehole BH15-05 continued as cored hole				AD/T refusal
				176								
				175	5.0							
				174	6.0							
				173	7.0							

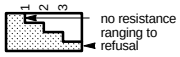
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:32

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

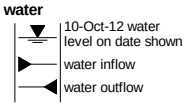
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

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

coffey

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 **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			**NO CORE:** 0.50 m				0%		Weathered rock	
			4.0		**PEBBLY SANDSTONE**: coarse grained, brown, fine to coarse grained gravel sized rock fragments, recovered as fine to coarse grained gravel and sand.	XW						
						MW						
		176			**NO CORE:** 0.15 m	MW		a=0.30 d=0.50	45%		JT, 20°, PL, RO, Fe SN JT, 25°, PL, RO, Fe SN	
					PEBBLY SANDSTONE: coarse grained, brown, fine to medium grained gravel sized rock fragments. trace cobble sized rock fragments of igneous (dolerite?) rock.						JT, 20°, PL, RO, Fe SN Fractured rock JT, 90°, PL, RO, Fe SN, 70 mm	
			5.0		Borehole BH15-05 terminated at 5.00 m Target depth			a=0.00 d=0.40				Defects are: PT, 0 - 10°, PL, RO, Fe SN, unless otherwise described
		175	6.0									
		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 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			CH	**FILL: Silty SAND**: fine to medium grained, dark brown, grey, trace fine grained gravel of coal and pottery fragments. Trace of rootlets.	D			**FILL**
								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								

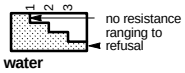
CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF BOREHOLE: NON CORED GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:32

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

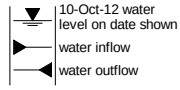
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

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 **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								
		176			start coring at 2.80m						
NMLC	19/11/15 06:30 12:00	175	3.0		**NO CORE:** 0.35 m				0%		Fractured rock JT, 20°, PL, RO, infill roots Fractured rock
					PEBBLY SANDSTONE: coarse grained, brown and pale brown, some fine to medium grained, sub-angular gravel sized rock fragments.	XW - HW MW		a=0.20 d=0.20	88%		PT, 10°, PL, RO, Fe SN
		174	4.0		4.10 m: Cobble sized rock fragment if dolerite, green (110mm thick) **PEBBLY SANDSTONE**: coarse grained, brown, some fine to coarse grained gravel sized rock frangments of siltstone and quartz. Trace cobbles.			a=0.60 d=0.50			Fractured rock
		173	5.0					d=0.40 a=0.40 d=0.40	59%		SM Clay, 0°, PL, 4 mm JT, 70°, PL, RO, Fe SN - Clay CO SM Clay, 0°, PL, 10 mm
		172	6.0		Borehole BH15-06 terminated at 5.90 m Target depth						
		171	7.0								

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

coffey

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 **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 2.0			**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
					176				Borehole BH15-06 continued as cored hole			
NMLC		19/11/15 12:00	d=0.2 a=0.2		175	3.0 4.0			**NO CORE:** 0.35m (2.80-3.15 m) **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.			
			d=0.5 a=0.6		174				4.1 m: Cobble sized rock fragment if dolerite, green (110mm thick) **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						
					172	6.0			Borehole BH15-06 terminated at 5.90 m Target depth			**standpipe BH15-06 details:** stickup: 0.11m 2.9-m: screen
					171	7.0						

CDF_0_9_06AK PHOTO 4PP.GLB rev:AK Log COF PIEZOMETER GEOTWARA22658AA.GPJ <<DrawingFile>> 26/11/2015 16:34

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 MUSWELLBROOK HOSPITAL NSW
date	23/11/2015			
scale	N/A		title:	CORE PHOTOGRAPH
original size	A4		project no: GEOTWARA22658AA	borehole no: BH15-06

coffey
A TETRA TECH COMPANY

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

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
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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	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								
					16.0							JT
				163								
				162								
					18.0							
				161								PT
				160								
					20.0							
				159								
				158								PT
					22.0							
				157								
				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

coffey
A TETRA TECH COMPANY

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 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

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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 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.				
				121	58.0							
				120				59.7 m: 100mm brown bed.				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:	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							
				114				**COAL**: black, dull.				PT
				113	66.0			**INTERBEDDED SILTSTONE AND SANDSTONE** fine to medium grained, yellow and grey.				JT 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) 100 200 300 400	structure and additional observations
CB				107				**INTERBEDDED SILTSTONE AND SANDSTONE**: fine to medium grained, yellow and grey. *(continued)*				JT
				106								**FRESH ROCK**
												JT
				105	74.0							JT
				104				**INTERBEDDED COAL AND RHYOLITE**: black and pale grey, dull coal beds.				
				103	76.0			**RHYOLITE**: grey.				JT
				102								White (fieldspar?) vein
				101	78.0			**SILTSTONE**: grey.				
				100				**INTERBEDDED CLAYSTONE AND SILTSTONE**: grey, some carbonaceous laminations.				
				99	80.0							
				98								JT
				97	82.0							
				96				400mm weathered zone.				JT Breakout Large JT 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
- 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.	**BH16-01**
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 JT
				92								JT
				91	88.0							
				90				Some 50mm carbonaceous beds.				JT
				89	90.0			**COAL**: black, dull to shiny. Becoming clean and shiny coal.				
				88								
				87	92.0			**SILTSTONE**: brown, some carbonaceous laminations. **COAL**: black.				
				86								
				85	94.0			**SILTSTONE**: grey to brown, some carbonaceous laminations. **COAL**: black.				
				84				**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
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- N standard penetration test (SPT)
- N* SPT - sample recovered
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- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
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consistency / relative density

VS	very soft
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VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
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D	dense
VD	very dense

coffey
A TETRA TECH COMPANY

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								

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
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- Wp plastic limit
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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: 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							
					COAL: black, dull with bright bands.	FR		a=1.43 d=0.25	20%		CS, IR, SO, CN	
		78									CS, IR, SO, CN	
											JT, 45°, PL, SL, CN	
								a=0.97 d=0.10			JT, 45°, PL, SL, CN	
											JT, 45°, PL, SL, CN	
		77	102.0					a=0.52 d=0.94			JT, 45°, PL, SL, CN	
											CS, IR, SO, CN	
					INTERLAMINATED SILTSTONE & SANDSTONE: fine grained, dark grey, some coal beds.						SM, 5°, PL, SO, CN, 0.01 mm	
		76							64%			
			104.0					a=2.36 d=0.89				
		75										
		74									JT, 20°, PL, SO, CN	
											PT, 20°, UN, SO, CN	
			106.0								PT, UN, SO, CN	
		73							59%		PT, 5°, IR, SL, CN	
								a=0.65 d=0.18			CS, IR, SL, CN	
											CS, IR, SL, CN, CORE LOSS	
											CS, IR, SL, CN	
											CS, IR, SL, CN	
											CS, IR, SO, CN	
								a=1.44 d=0.20			PT, 5°, CU, SO, CN	
		72						a=0.70 d=0.08			PT, 5°, CU, SO, CN	
											PT, 5°, CU, SO, CN	
											PT, 5°, CU, SO, CN	
											CS, 5°, IR, SL, CN	
			108.0								CS, IR, RO, CN	
		71			**COAL**: black, dull with bright bands.			a=1.58 d=0.57			CS, IR, RO, CN	
											CS, IR, RO, CN	
											CS, IR, RO, CN	
											PT, 5°, PL, SL, CN	
									63%		CS, IR, SO, CN	
											CS, IR, SO, CN	
		70									CS, IR, SO, CN	
											CS, IR, SO, CN	
											CS, IR, SO, CN	
			110.0								CS, IR, SO, CN	
		69									CS, IR, SO, CN	
								a=1.22 d=0.29			JT, PL, SL, CN	
									66%			
		68						a=0.79 d=0.32			CS, IR, SO, CN	
								a=0.53 d=0.13				
					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

coffey
A TETRA TECH COMPANY

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 **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			on CCTV.						
		66			**NO CORE:** 3.30 m **VOID**: base of void not confirmed on CCTV.						
		65	114.0								
		64			**NO CORE:** 0.25 m **NO CORE**: not confirmed.						
					Borehole BH16-01 terminated at 115.55 m						
		63	116.0								
		62									
		61	118.0								
		60									
		59	120.0								
		58									
		57	122.0								
		56									

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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

coffey
A TETRA TECH COMPANY

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
- 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:	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)	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
- 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:	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)	structure and additional observations
CB				154				**INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey, some large sized white clasts. *(continued)*				**FRESH ROCK** JT
				153								Washout
					26.0							
				152								
				151								
					28.0							
				150								
				149								JT
					30.0							
				148								
				147								
					32.0			With some gravel clasts.				
				146								
				145								
					34.0							
				144								
				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							JT
				128								
				127	52.0							
				126								
				125	54.0							Small breakout
				124								Breakout JT
				123	56.0							
				122				**INTERLAMINATED CLAYSTONE AND SILTSTONE**: grey brown, some fine to medium sized clasts.				
				121	58.0							JT
				120								
				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

coffey
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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)* Some fine to medium sized subangular gravel clasts.				**FRESH ROCK**
				117	62.0							
				116								
				115	64.0							
				114				**COAL**: black, dull. Becoming shiny.				
				113	66.0			**INTERBEDDED SILTSTONE AND SANDSTONE** 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

coffey
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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

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
- 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:	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								

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
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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**

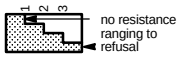
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	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								

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

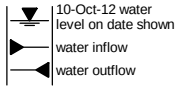
support
- M mud
- C casing
- N nil

penetration



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
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coffey
A TETRA TECH COMPANY

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***
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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								
				64	114.0			**SILTSTONE**: grey.				
				63								
				62	116.0			**COAL**: black.				
				61								
				60	118.0							
				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
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- 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***
client: ***HEALTH INFRASTRUCTURE***	date started: ***20 Jun 2016***
principal:	date completed: ***23 Jun 2016***
project: ***PROPOSED BUILDING***	logged by: ***TT***
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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

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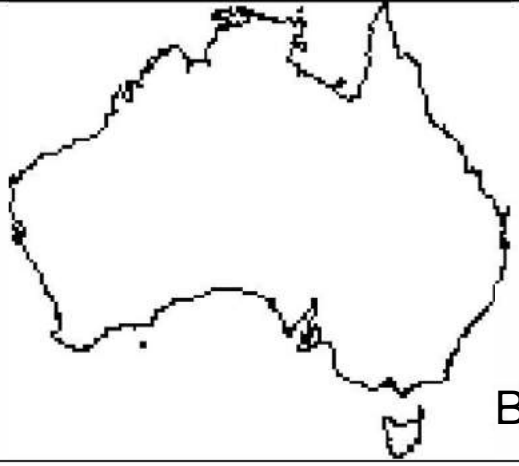


GROUNDSEARCH AUSTRALIA

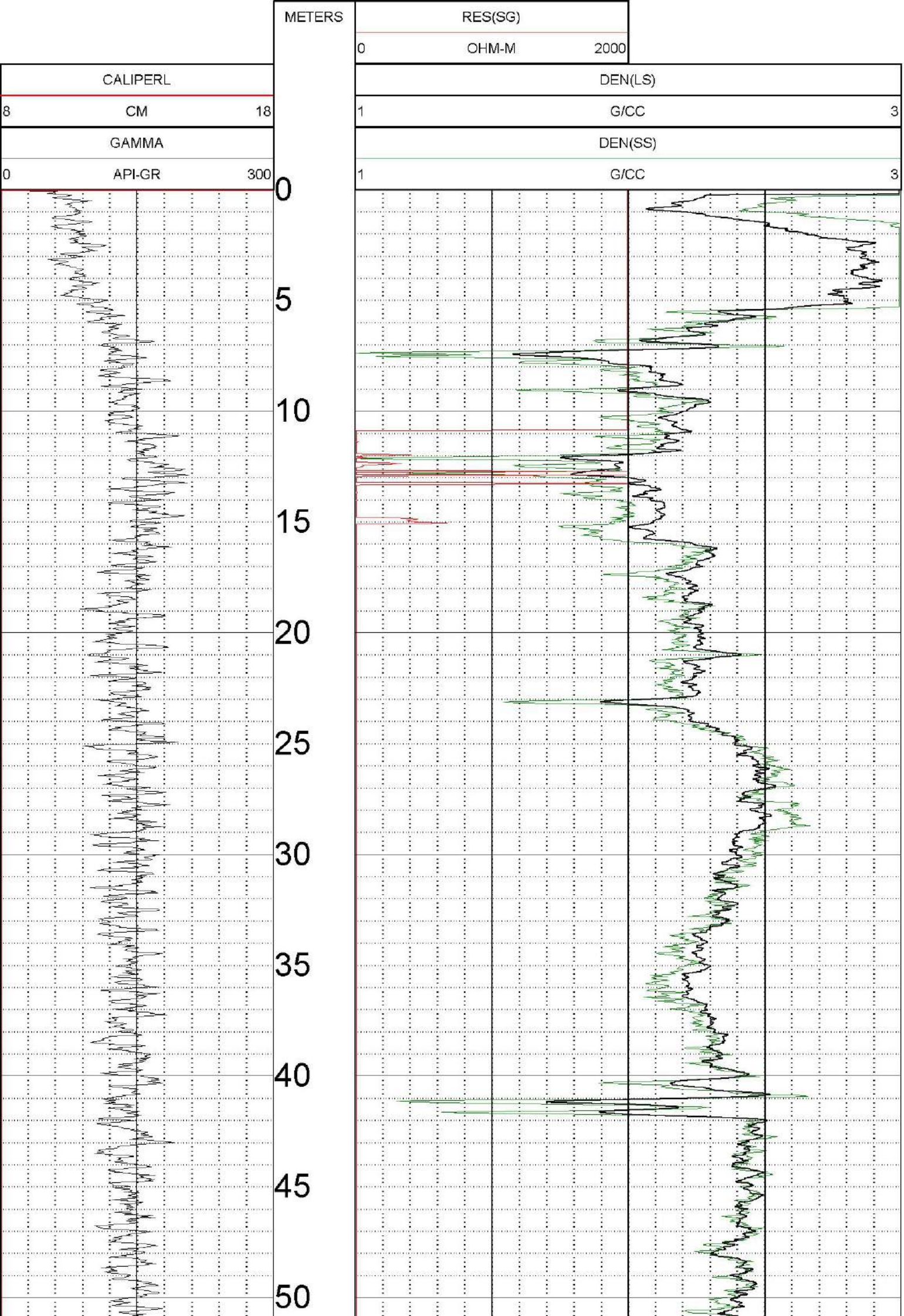
(ABN 11 057 389 152)

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
DATE	: 06/17/16	PERMANENT DATUM	: 115.75		
DEPTH DRILLER	:			KB	: 2.4
LOG BOTTOM	: 115.27	LOG MEASURED FROM:	GL	DF	: NA
LOG TOP	: -2.19	DRL MEASURED FROM:	GL	GL	: NA
CASING DIAMETER	: 10.	LOGGING UNIT	: 120		: 0
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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OHM-M
2000
CALIPERL
8
CM
18
DEN(LS)
1
G/CC
3
GAMMA
0
API-GR
300
DEN(SS)
1
G/CC
3
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5
10
15
20
25
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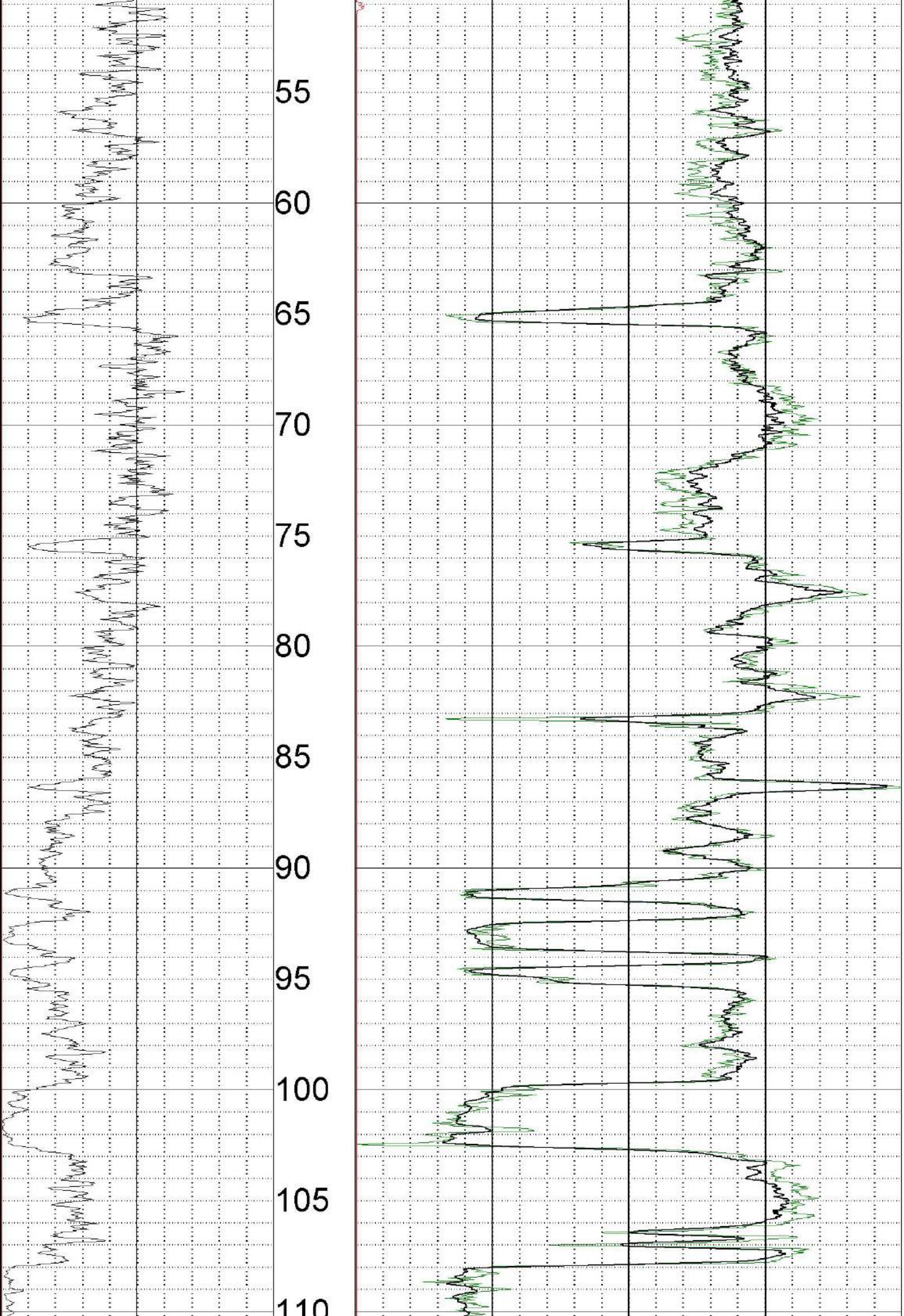
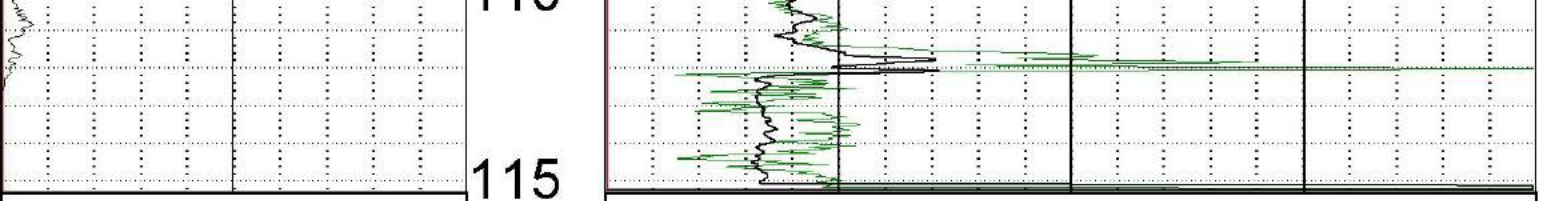
35
40
45
50


55
60
65
70
75
80
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
	RES(SG)	

METERS

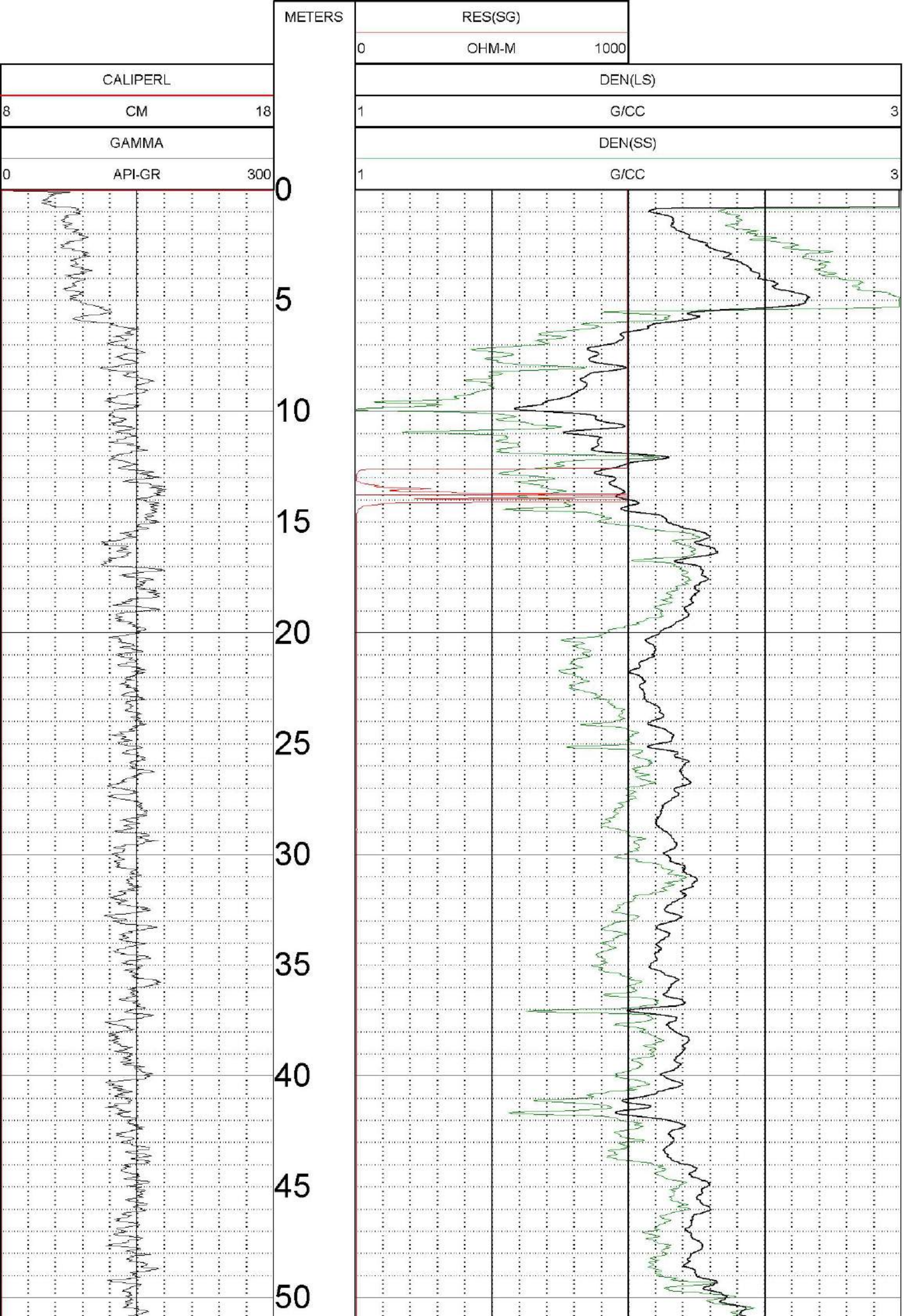
GROUNDSEARCH AUSTRALIA

(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)
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OHM-M
1000
CALIPERL
8
CM
18
DEN(LS)
1
G/CC
3
GAMMA
0
API-GR
300
DEN(SS)
1
G/CC
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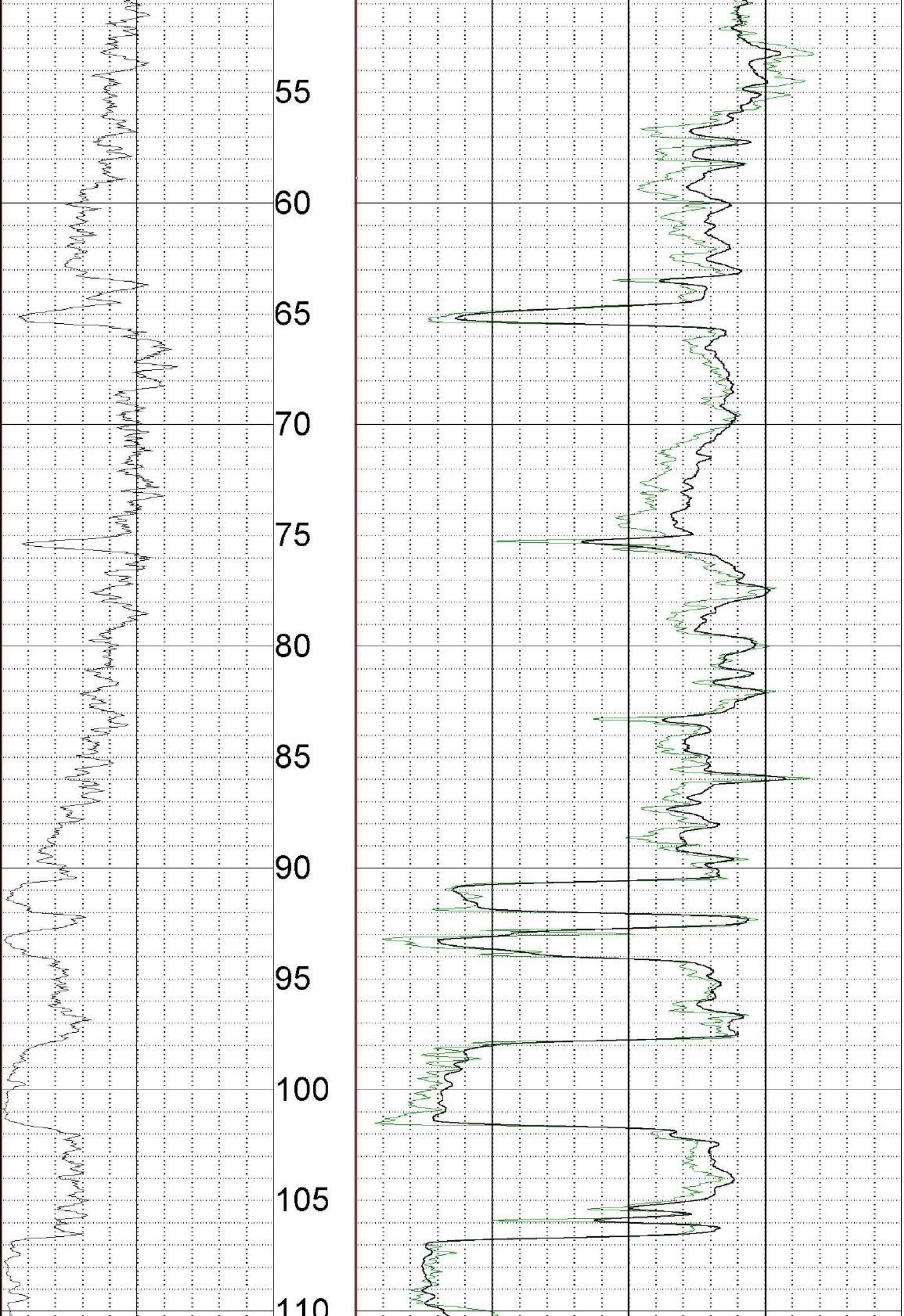
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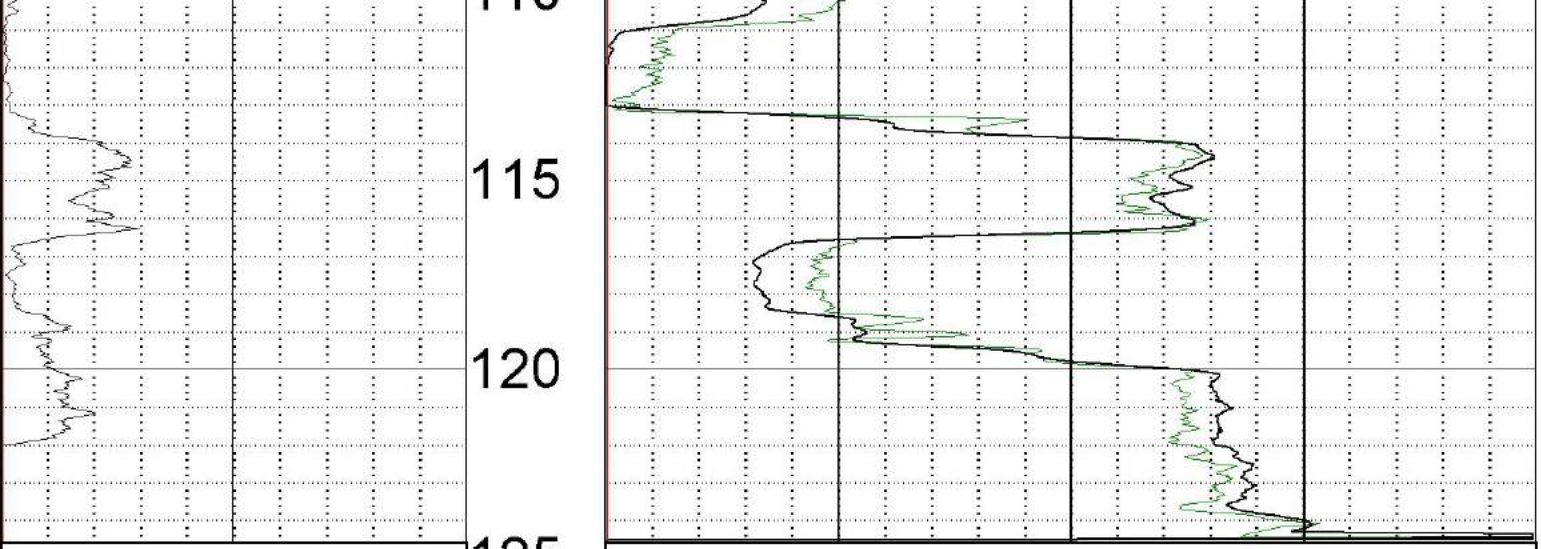
95
100
105
110



0	API-GR	300	1	G/CC	3
GAMMA			DEN(SS)		
8	CM	18	1	G/CC	3
CALIPERL			DEN(LS)		
			0	OHM-M	1000
METERS			RES(SG)		

Coffey Geotechnics

Borehole BH16-01

ACOUSTIC TELEVIEWER PETROPHYSICAL REPORT

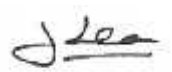
Groundsearch Australia Pty. Limited

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.

Page #

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Executive Summary 3

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2.0 Interpretation Methodology 5
3.0 Borehole BH16-01Interpretation 7

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Figure 8 BH16-01fracture dip angle data distribution 17
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Appendix 1 1:20 Interpretation logs – 15.50 to 113.11 mbgl

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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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

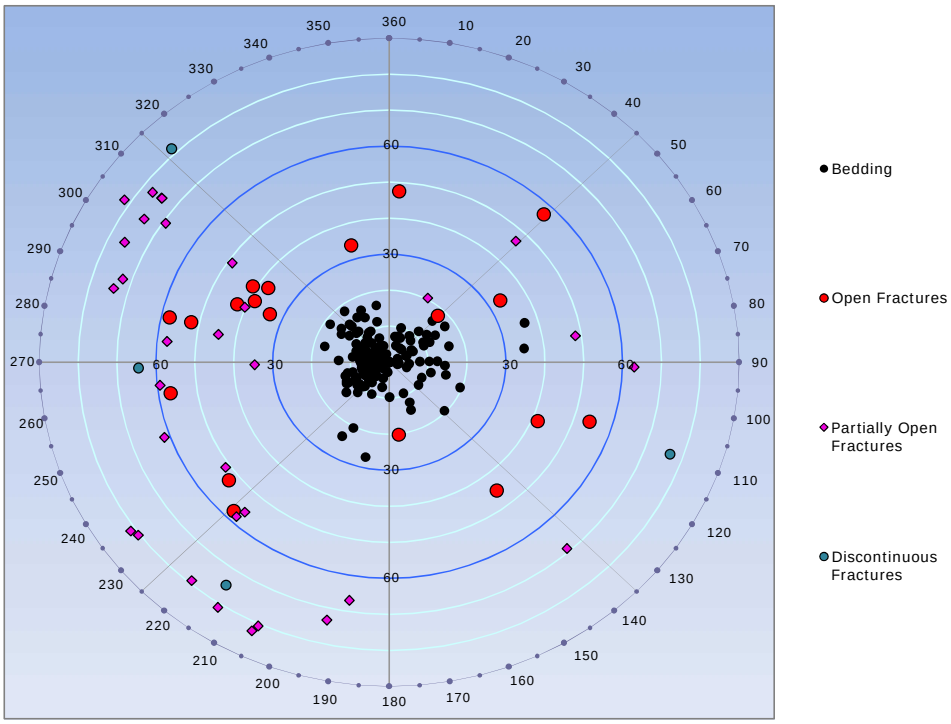
124	2	106	71.47	71.46	71.47	Bedding plane	Interburden
125	2	306	73.11	73.11	73.11	Bedding plane	Interburden
126	5	260	73.23	73.23	73.24	Bedding plane	Interburden
127	7	218	73.82	73.81	73.83	Bedding plane	Interburden
128	17	55	73.92	73.90	73.93	Bedding plane	Interburden
129	2	75	74.04	74.04	74.04	Bedding 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

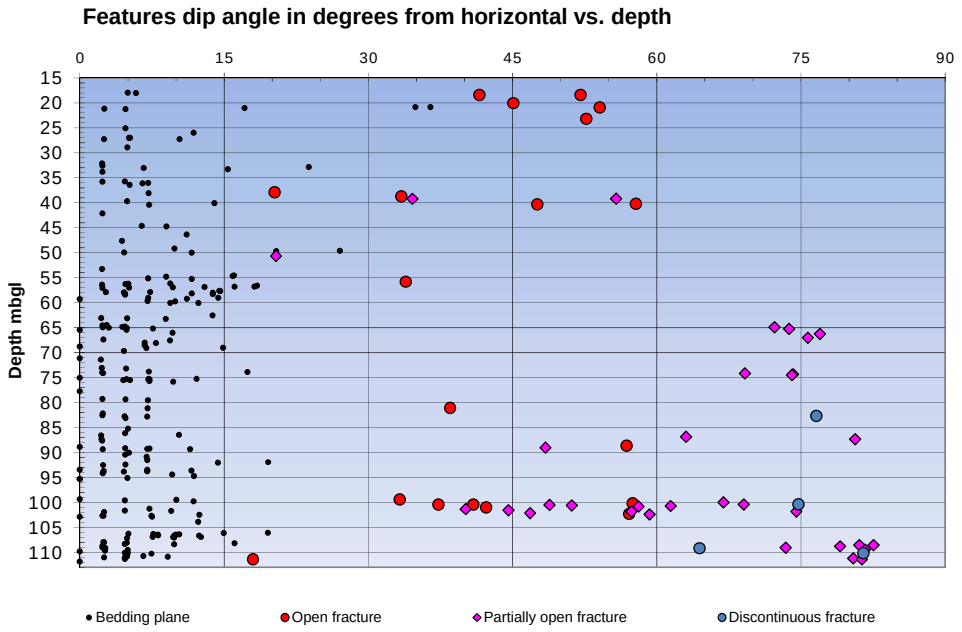


Figure 3 BH16-01feature dip direction data distribution

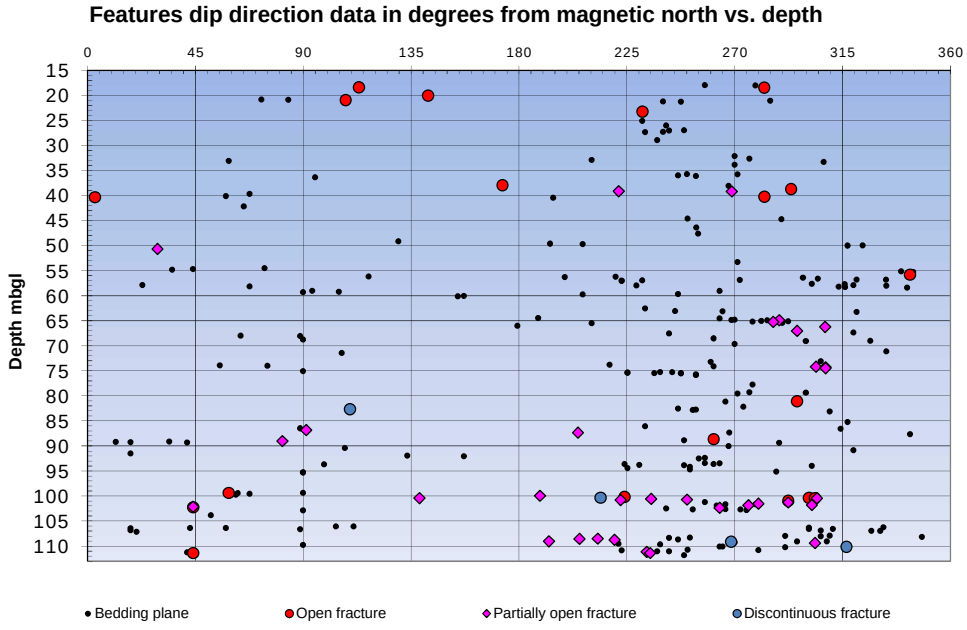


Table 2 BH16-01bedding histogram data

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

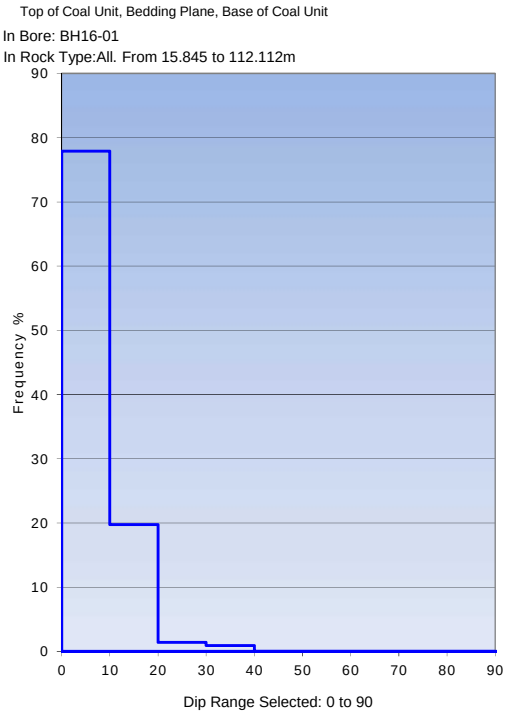


Figure 4 BH16-01bedding dip direction data rose diagram

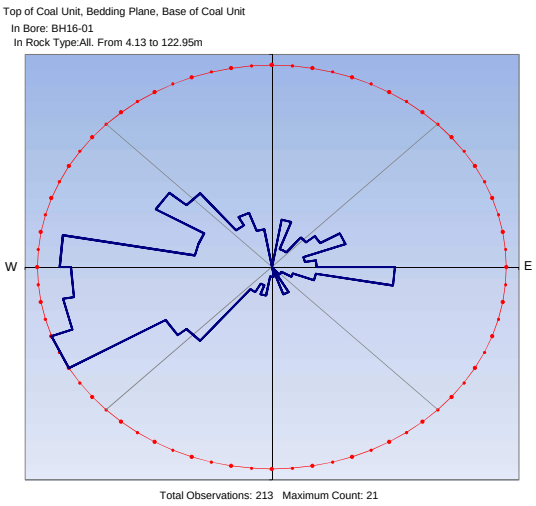


Figure 6 BH16-01bedding dip directions histogram

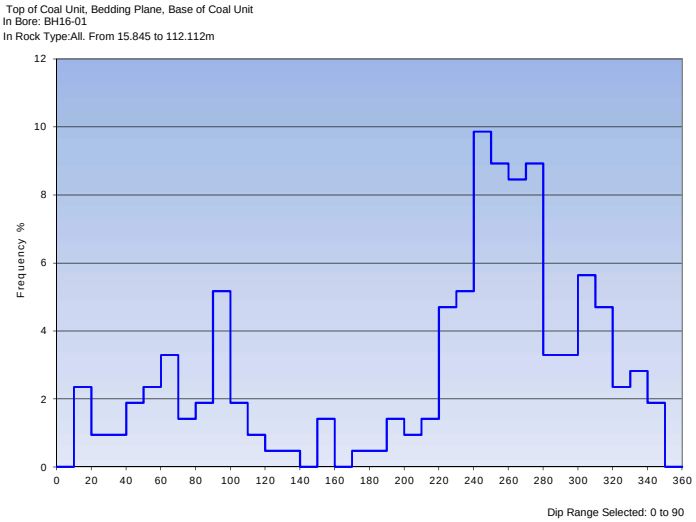


Table 3 BH16-01 fractures histogram data

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

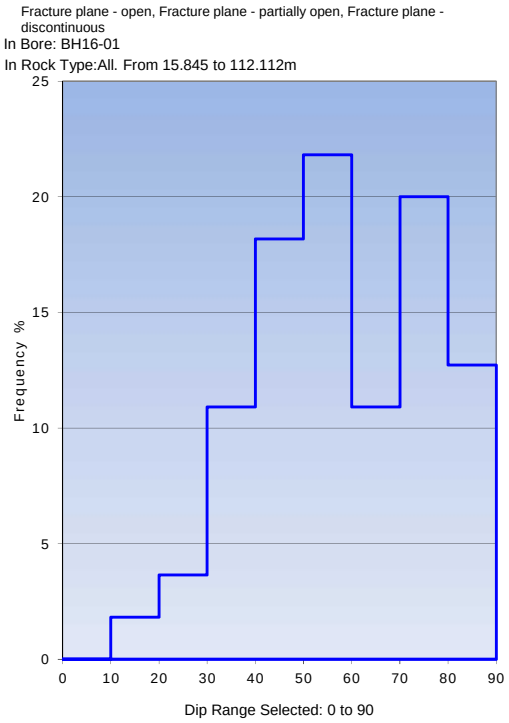


Figure 7 BH16-01fractures dip direction data rose diagram

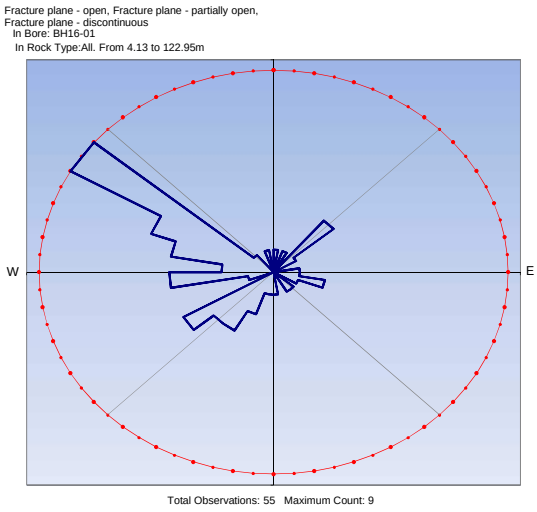
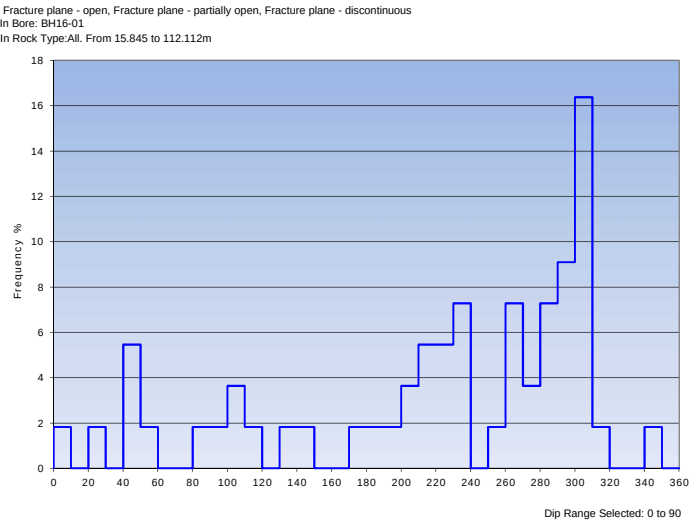


Figure 9 BH16-01fractures dip directions histogram



Appendix 1

Appendix 1 1:20 Interpretation logs – 15.50 to 113.11 mbgl

GROUNDSEARCH AUSTRALIA

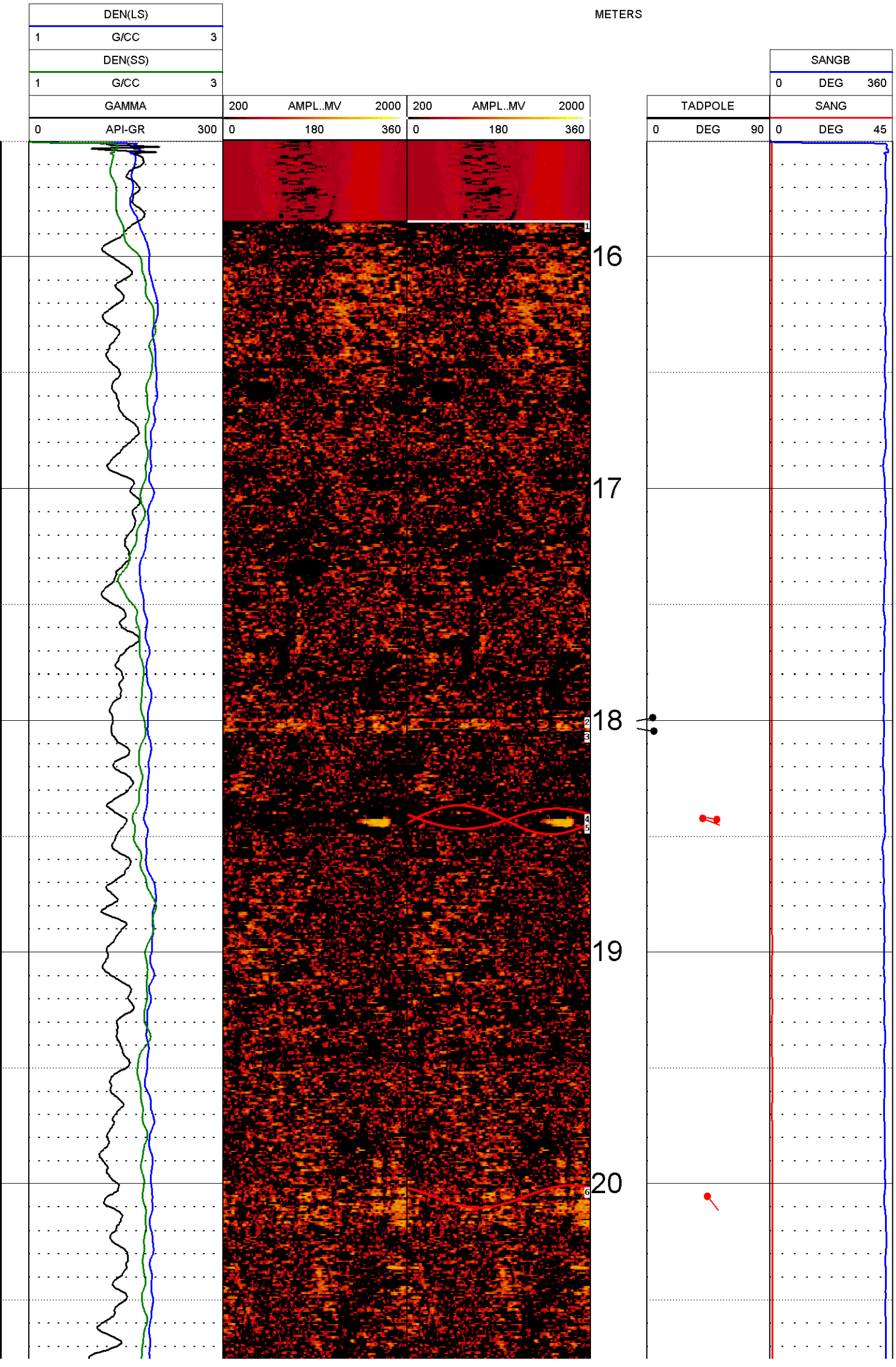
(ABN 11 057 389 152)

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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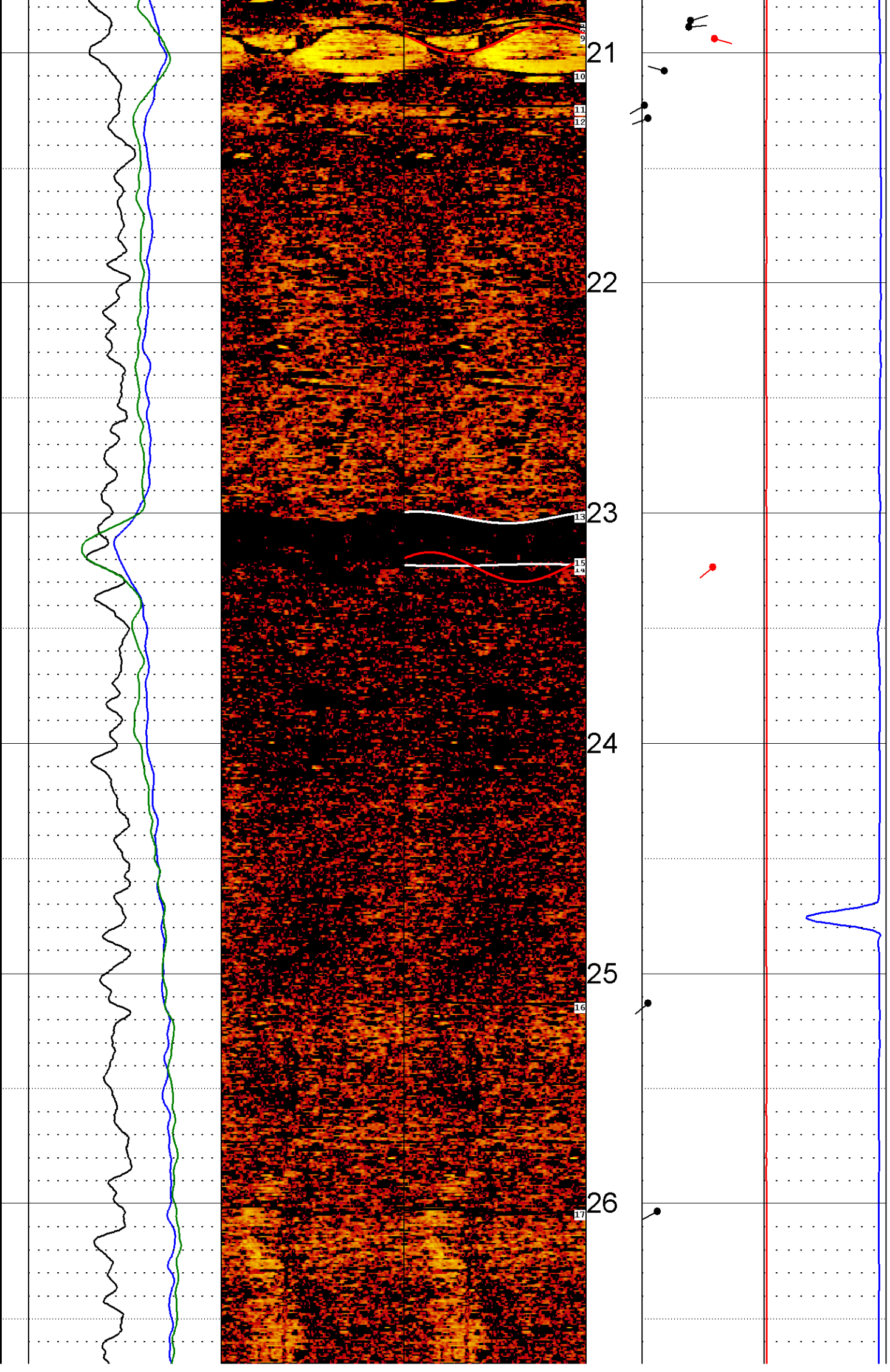
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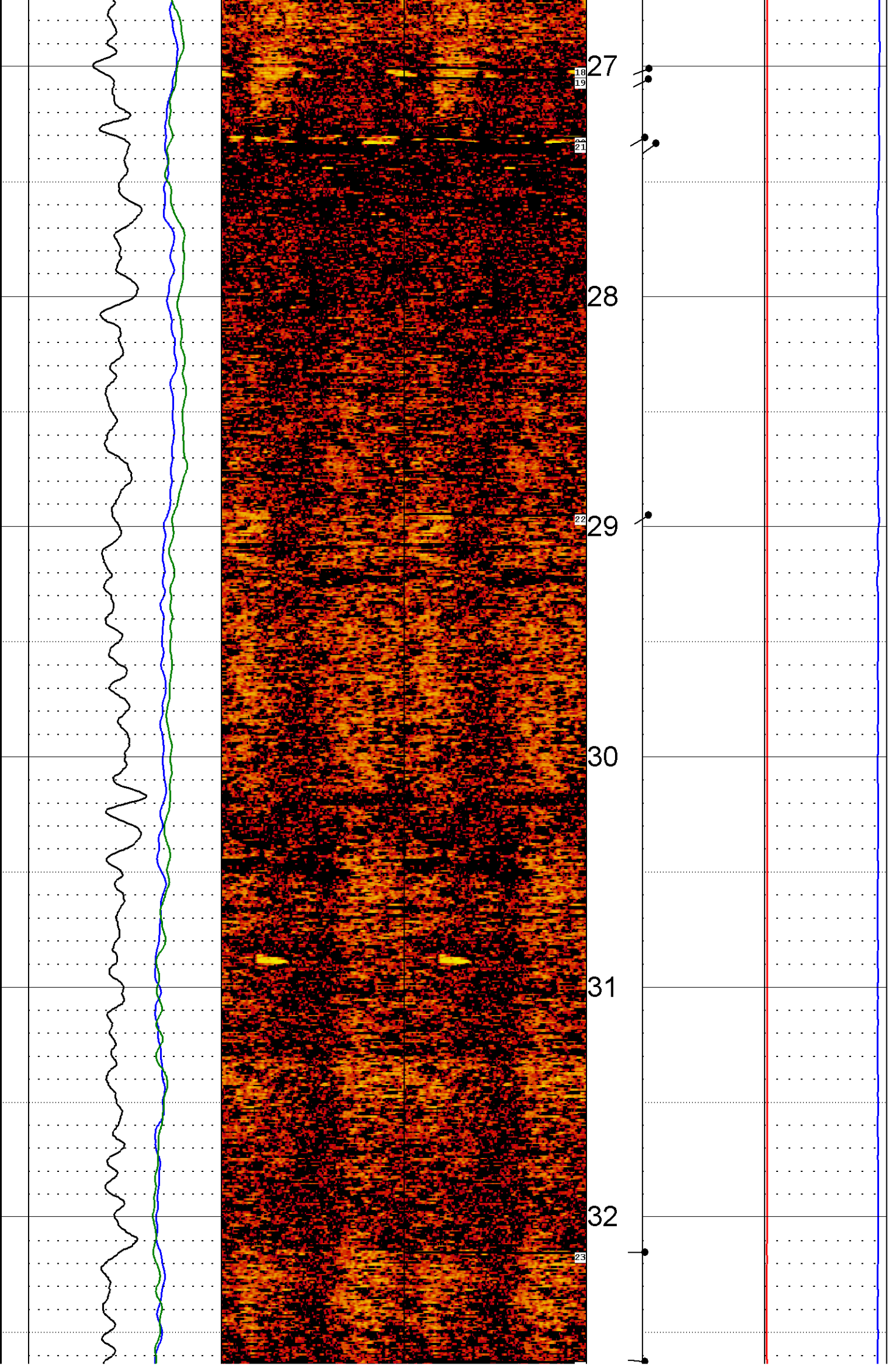
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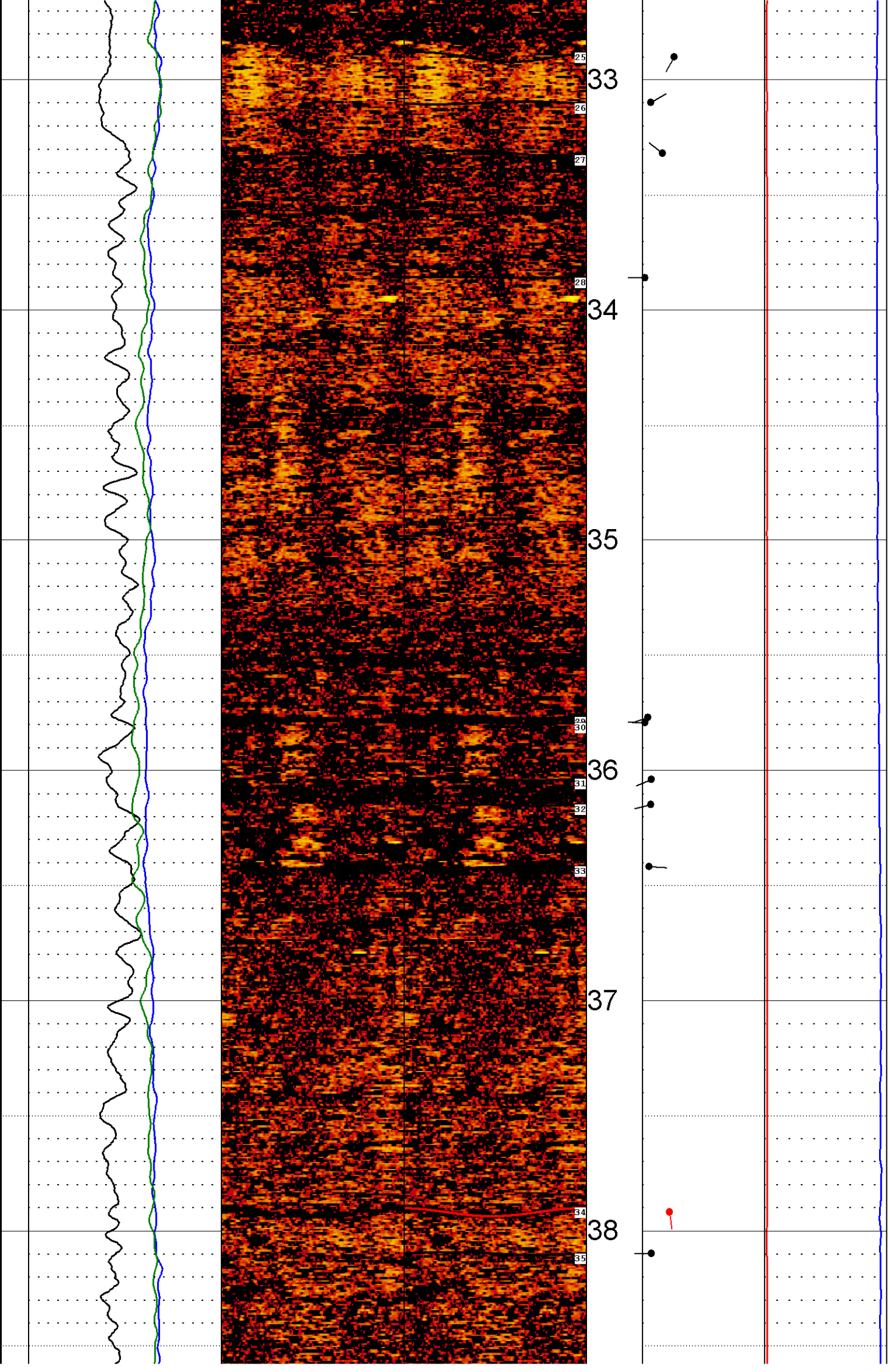
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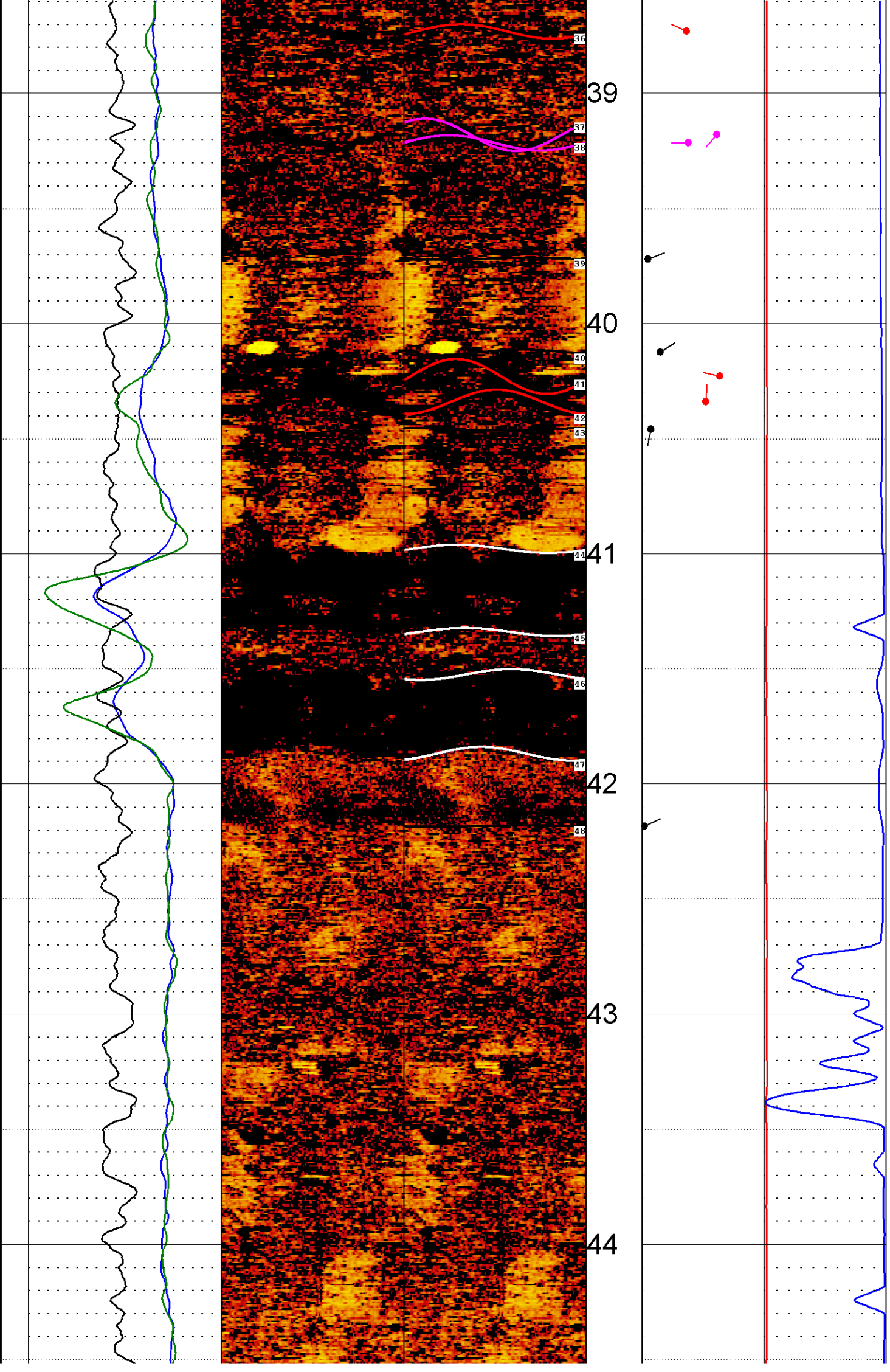
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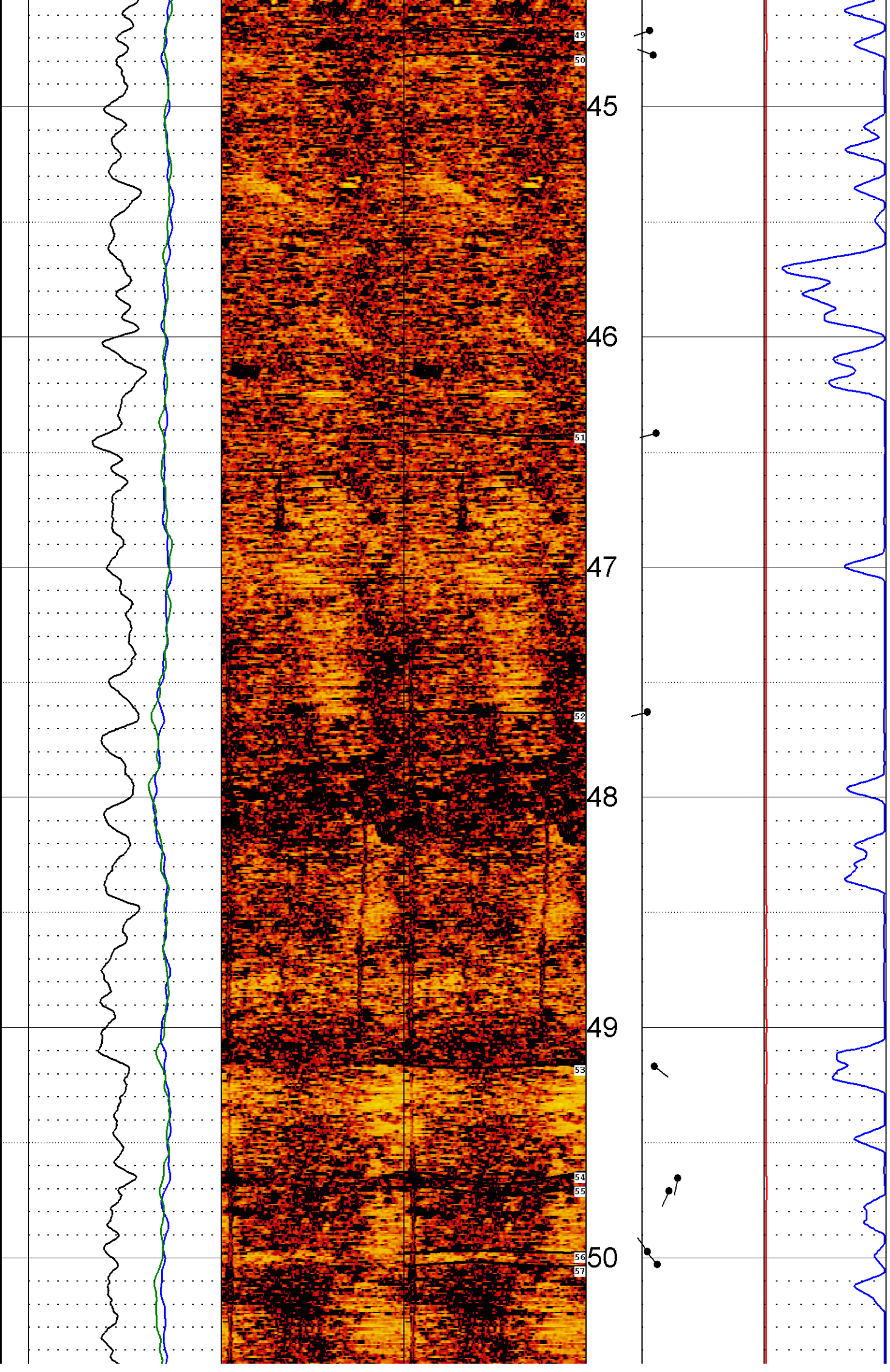
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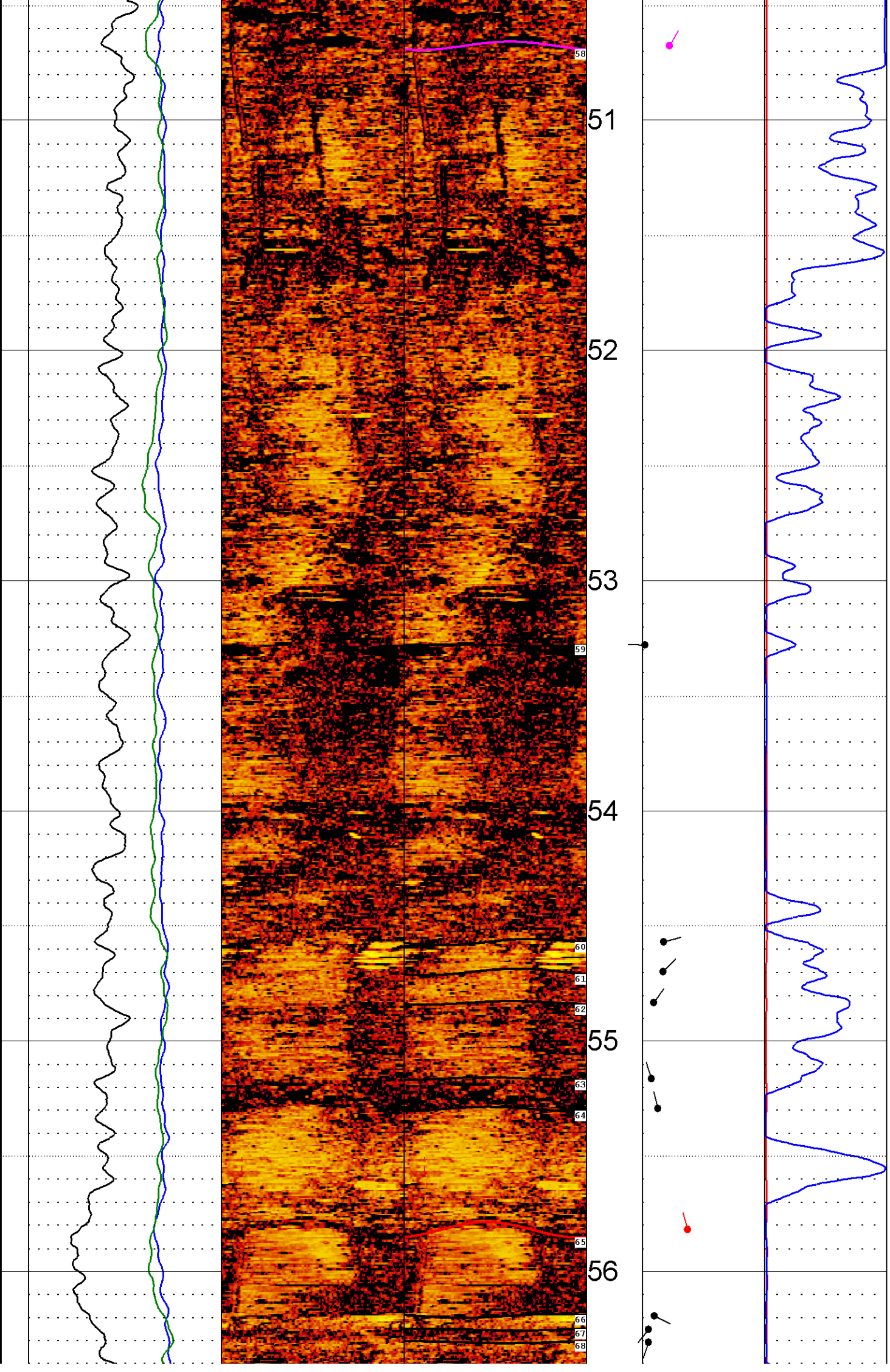
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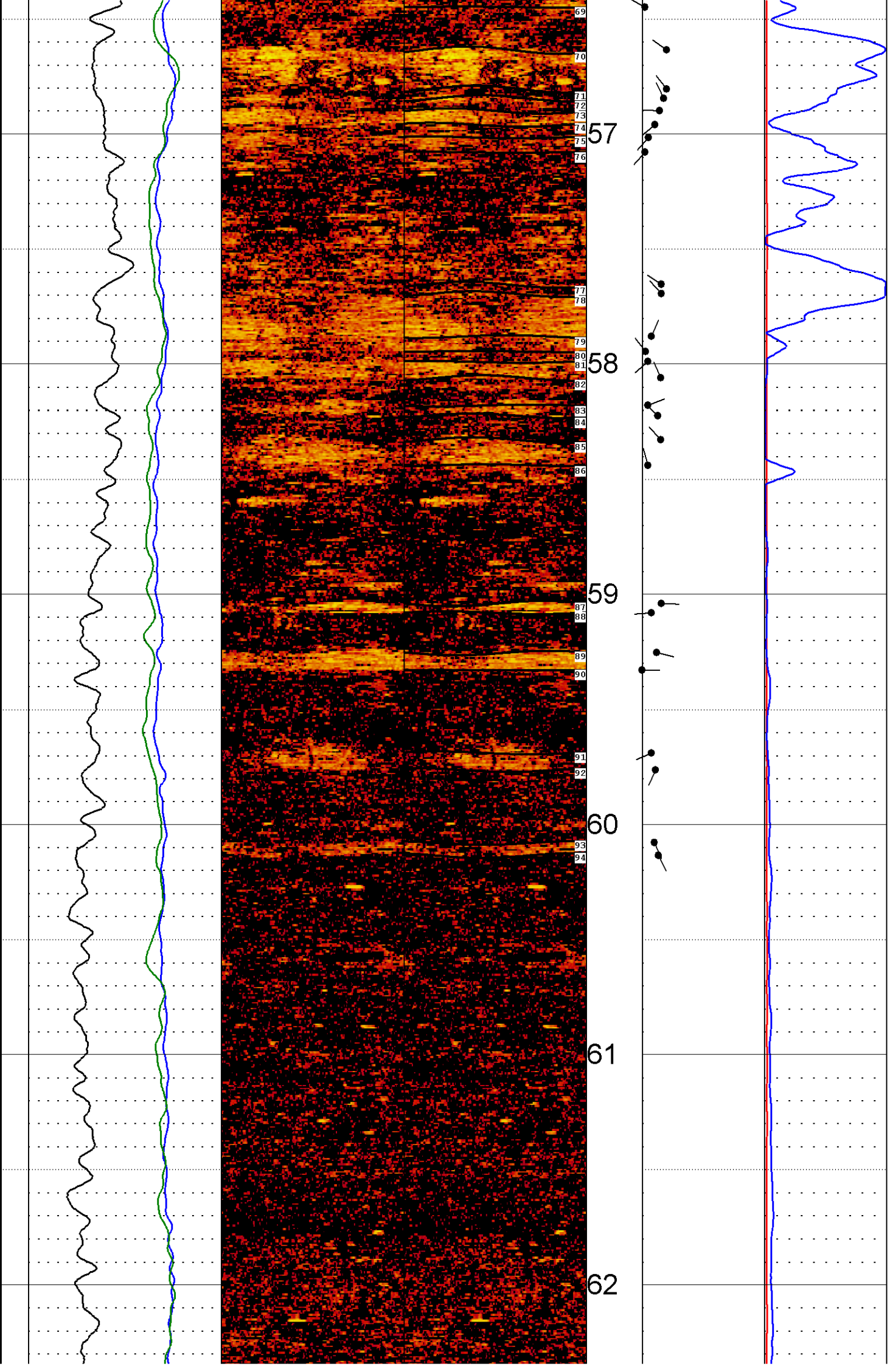
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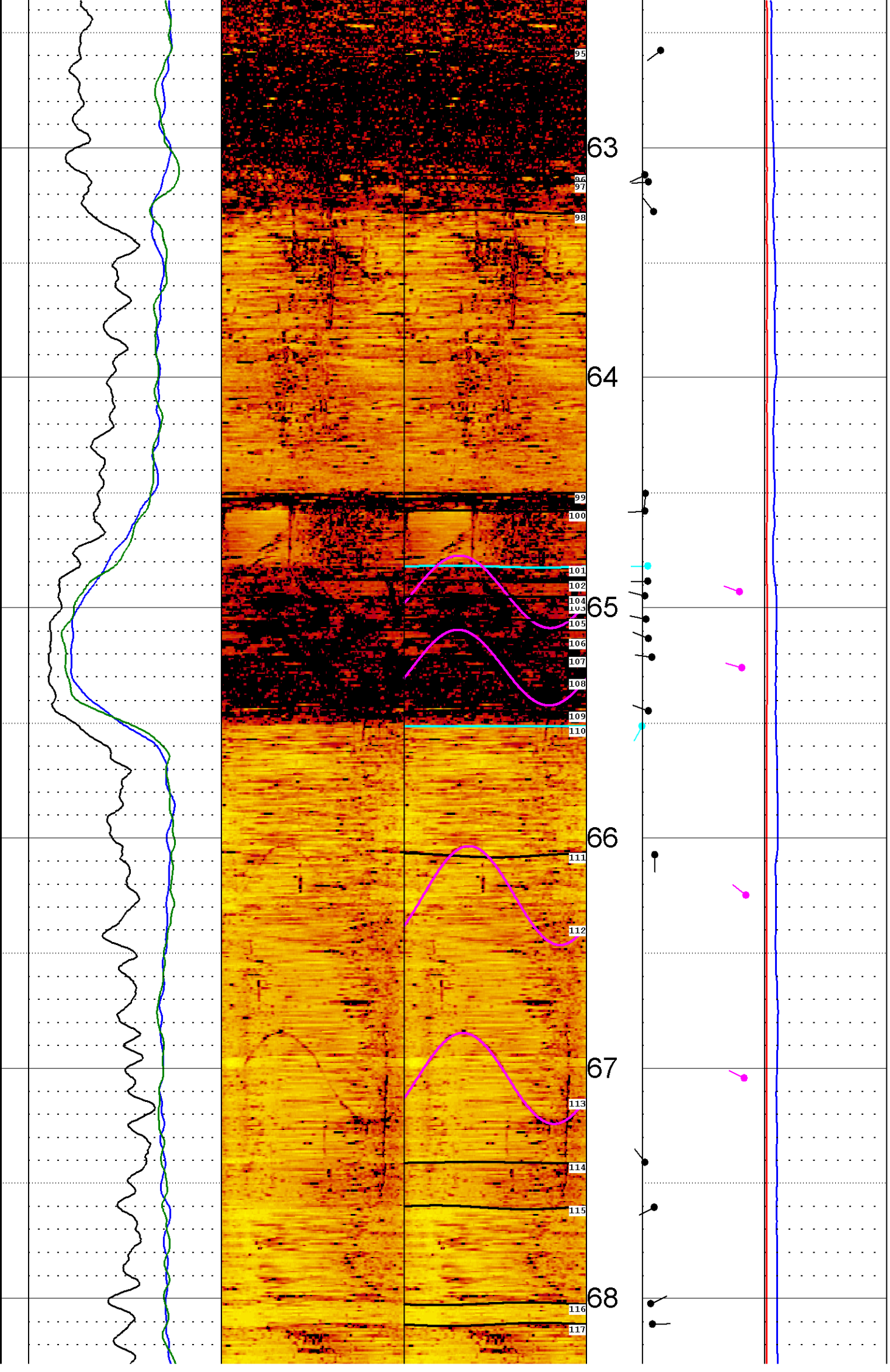
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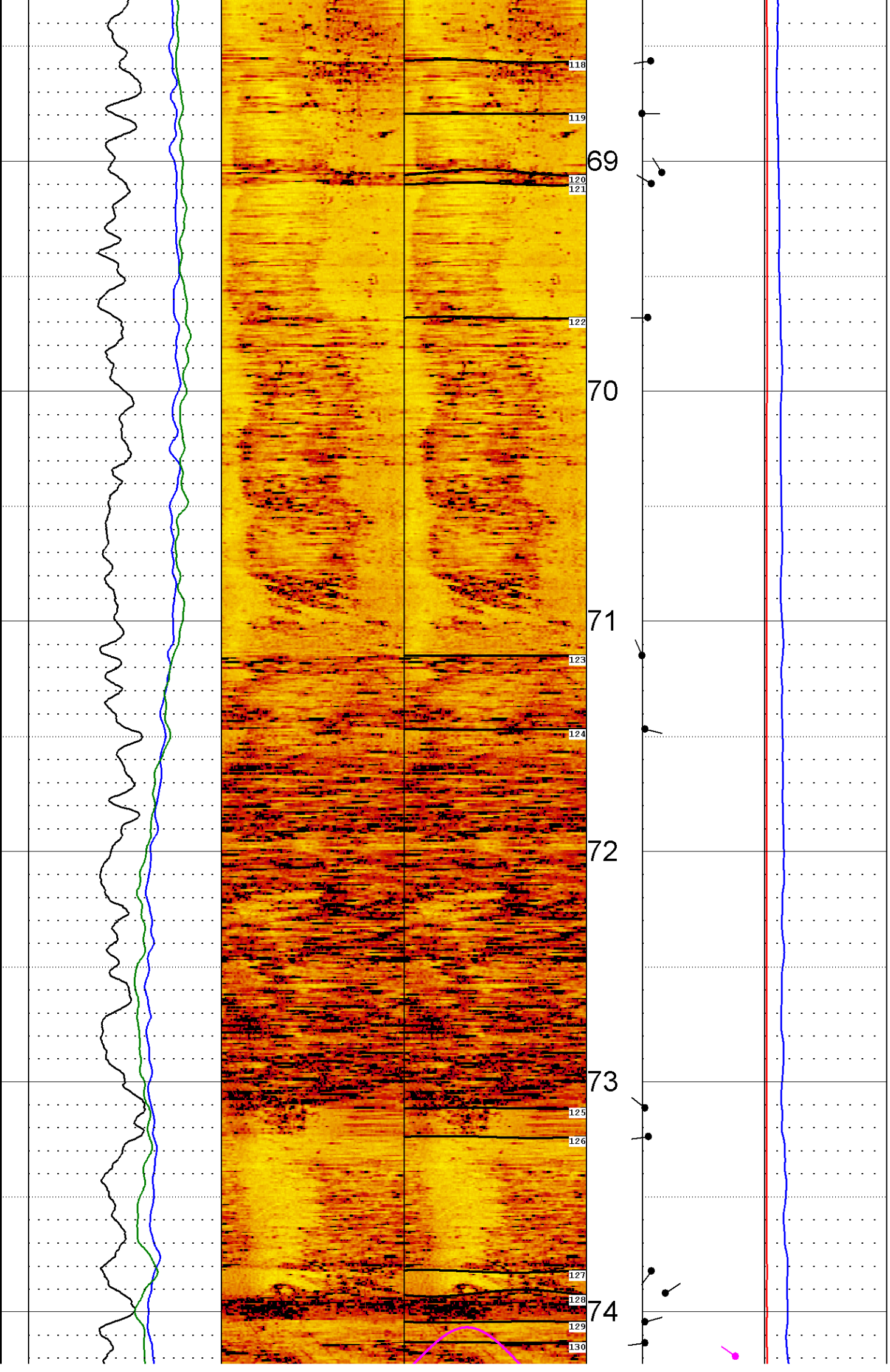
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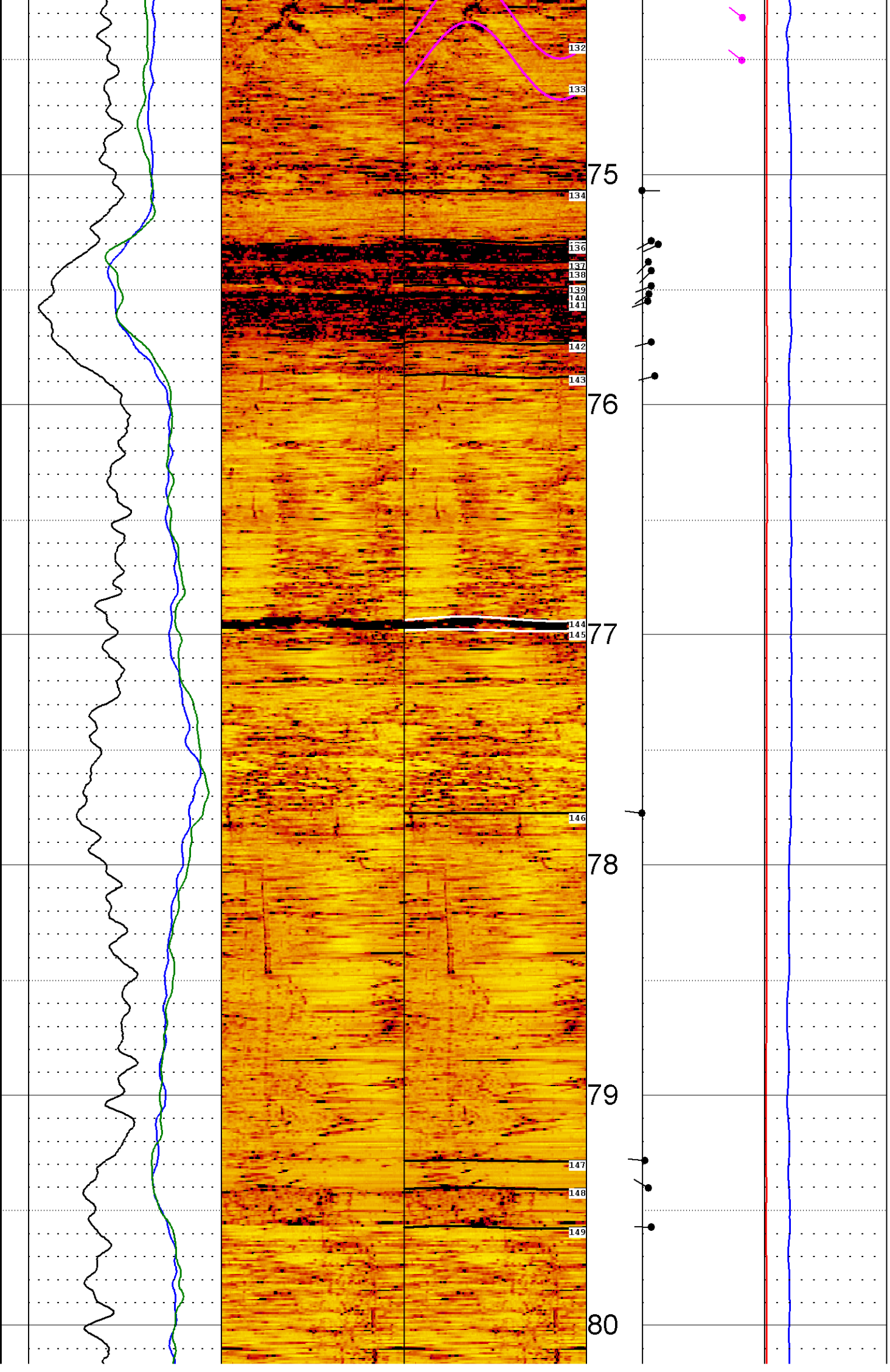
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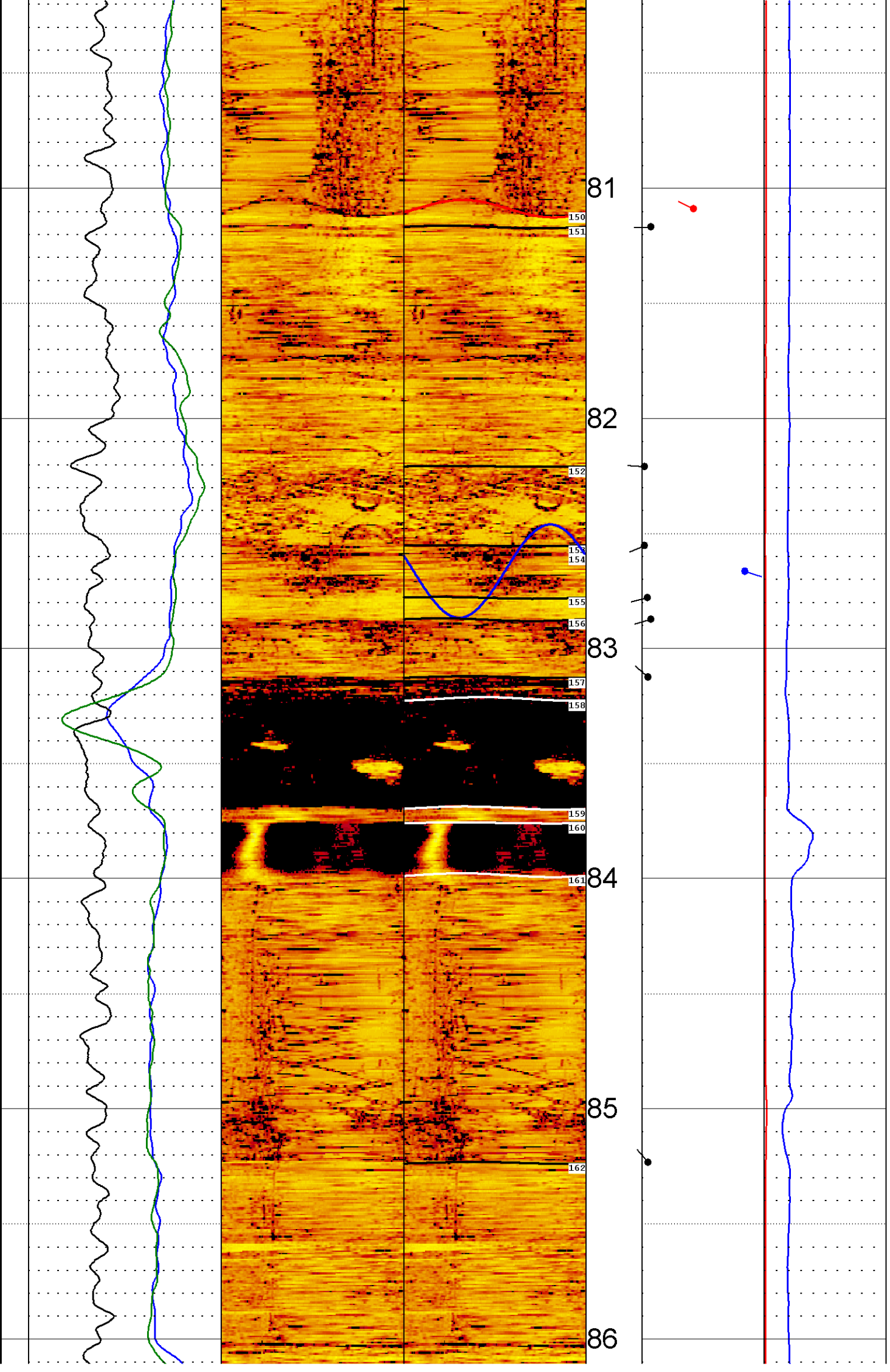
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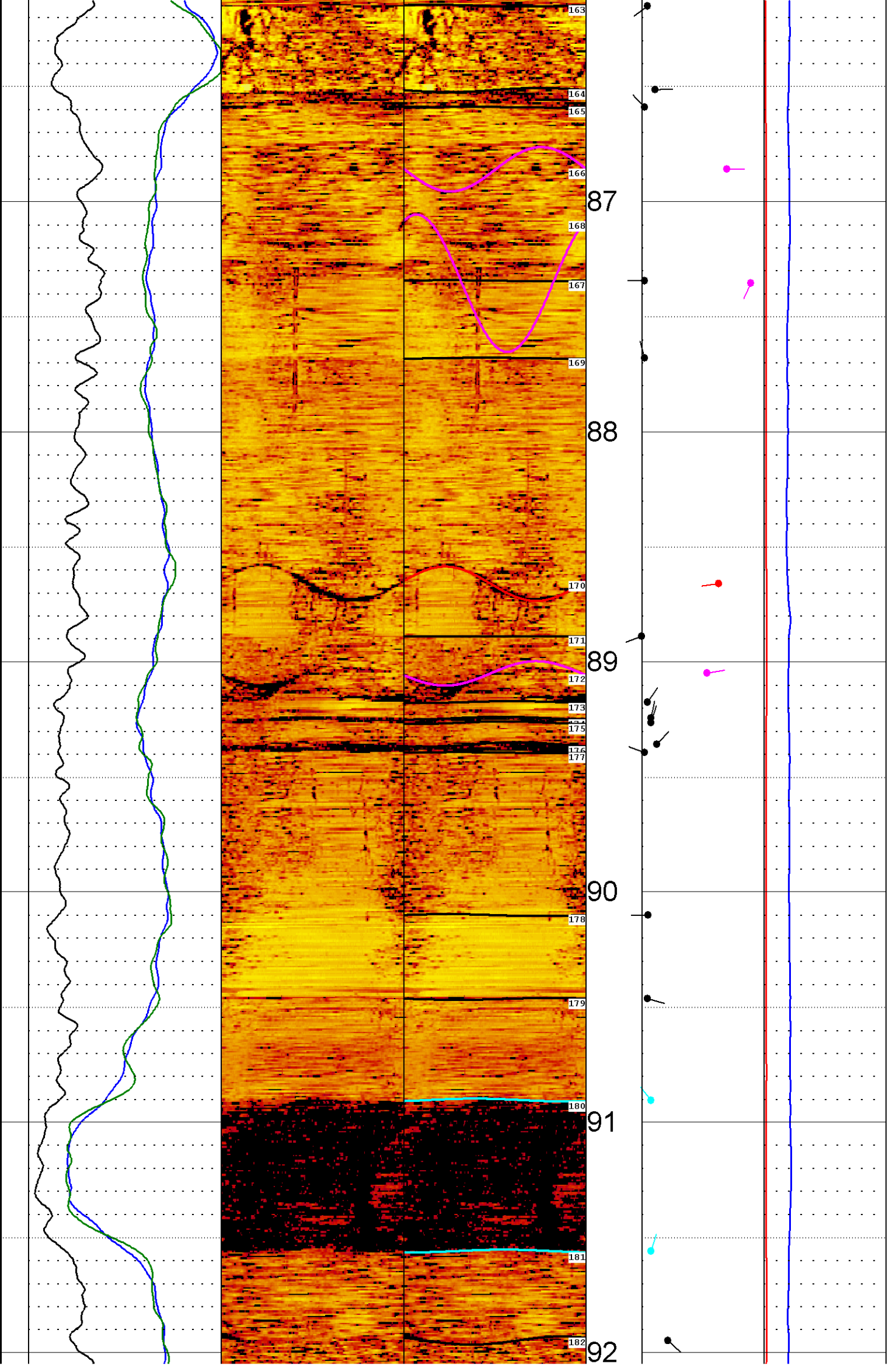
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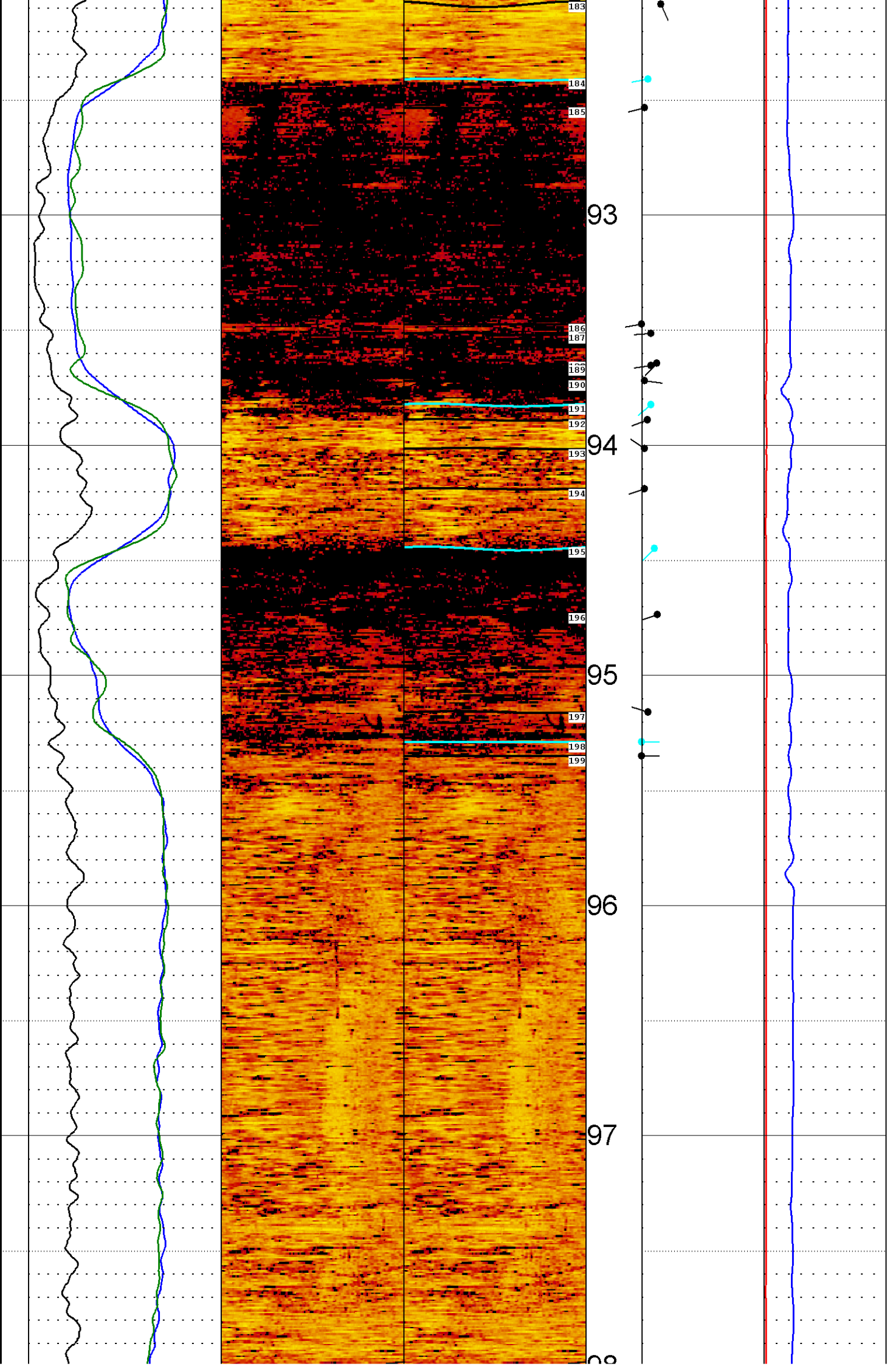
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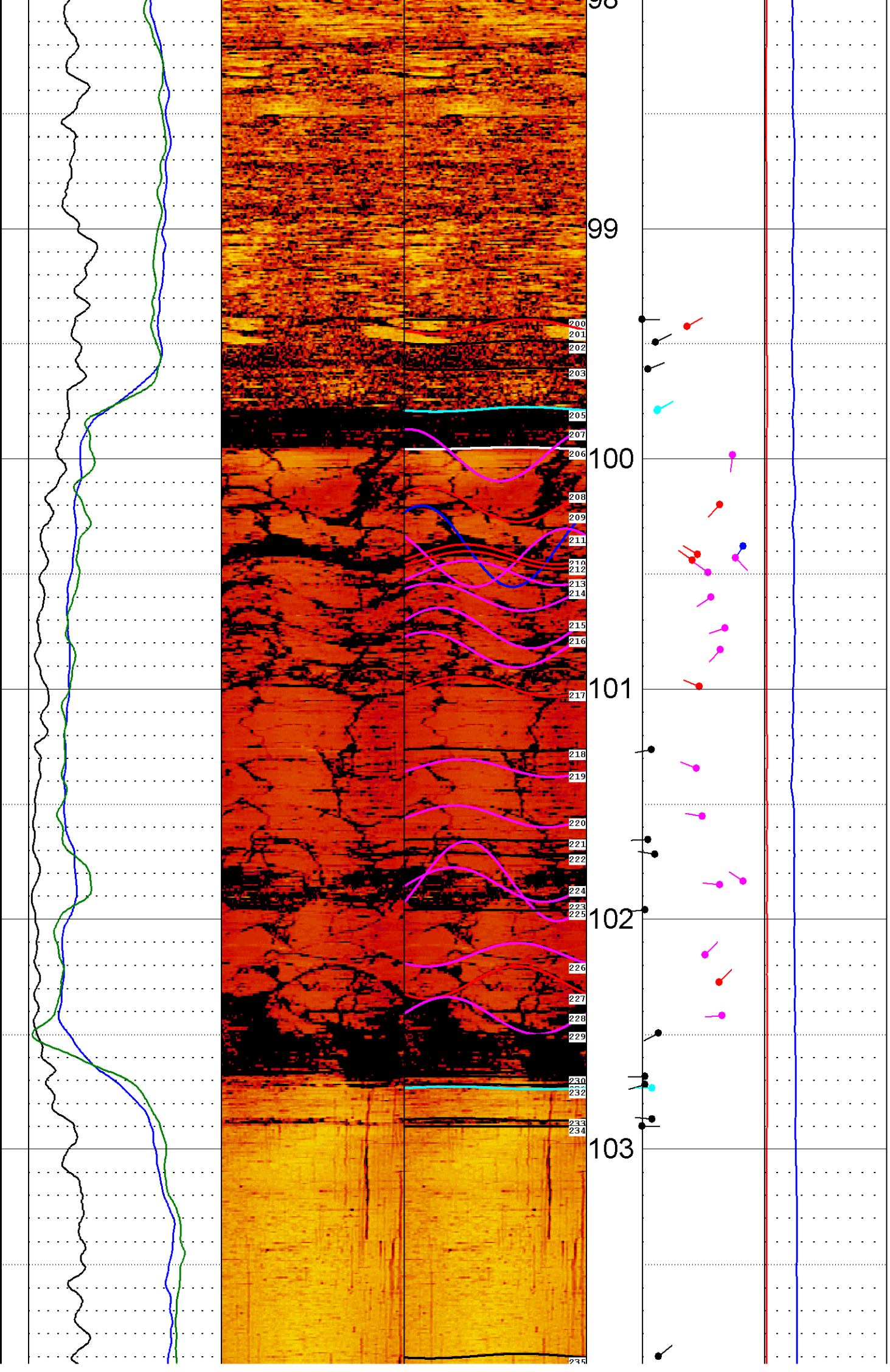
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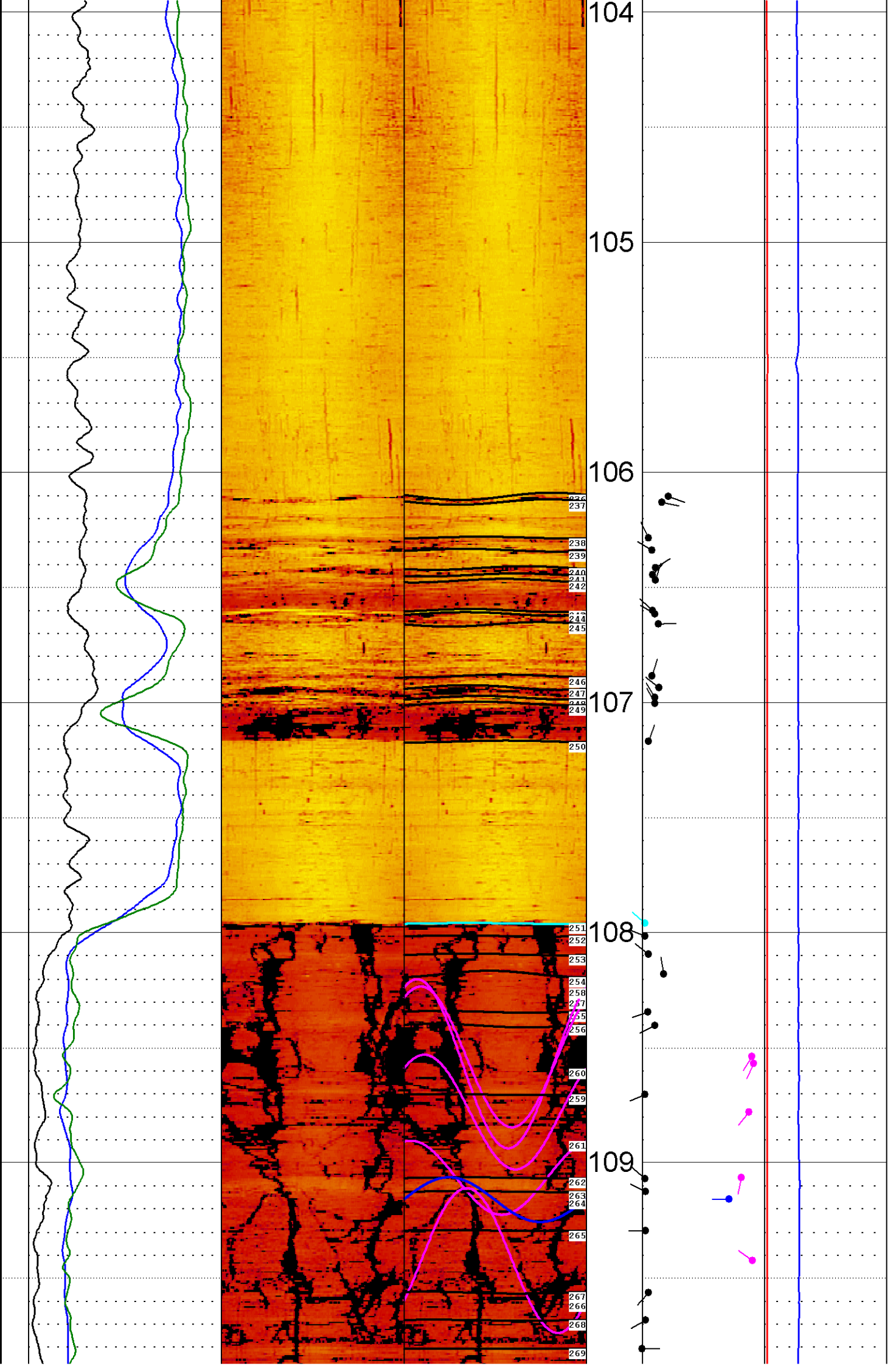
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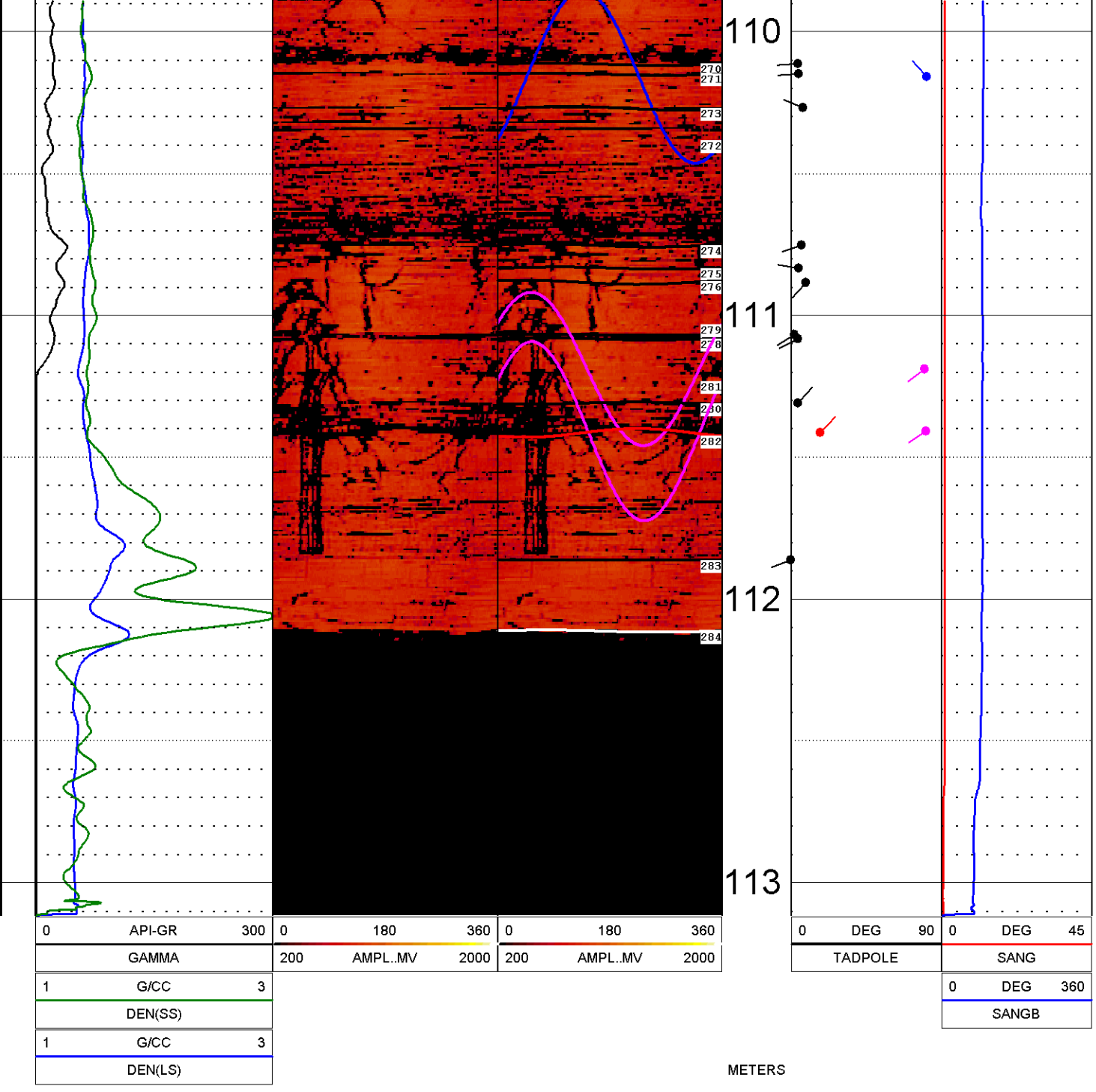
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TADPOLE
0 DEG 45
SANG
0 DEG 360
SANGB
METERS

Coffey Geotechnics

Borehole BH16-03

ACOUSTIC TELEVIEWER PETROPHYSICAL REPORT

Groundsearch Australia Pty. Limited

15 July 2016

DISCLAIMER

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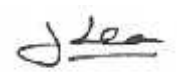
For and on behalf of Groundsearch Australia Pty. Limited



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.

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3.0 Borehole BH16-03Interpretation 7

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Appendix 1 1:20 Interpretation logs – 14.50 to 82.12 mbgl

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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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.

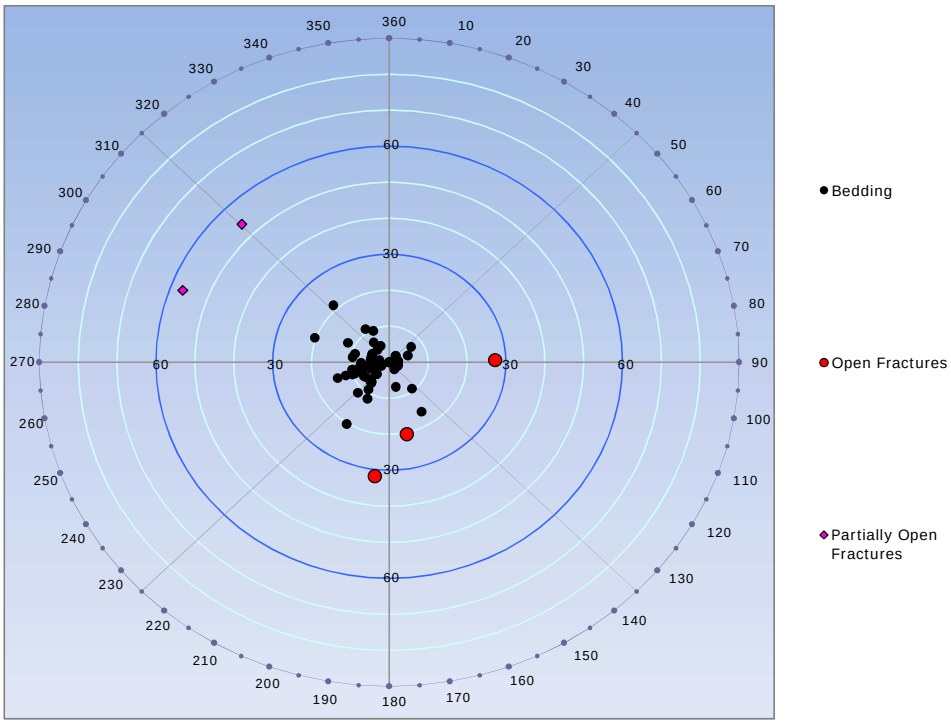
Table 1 Interpreted features report for BH16-03

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

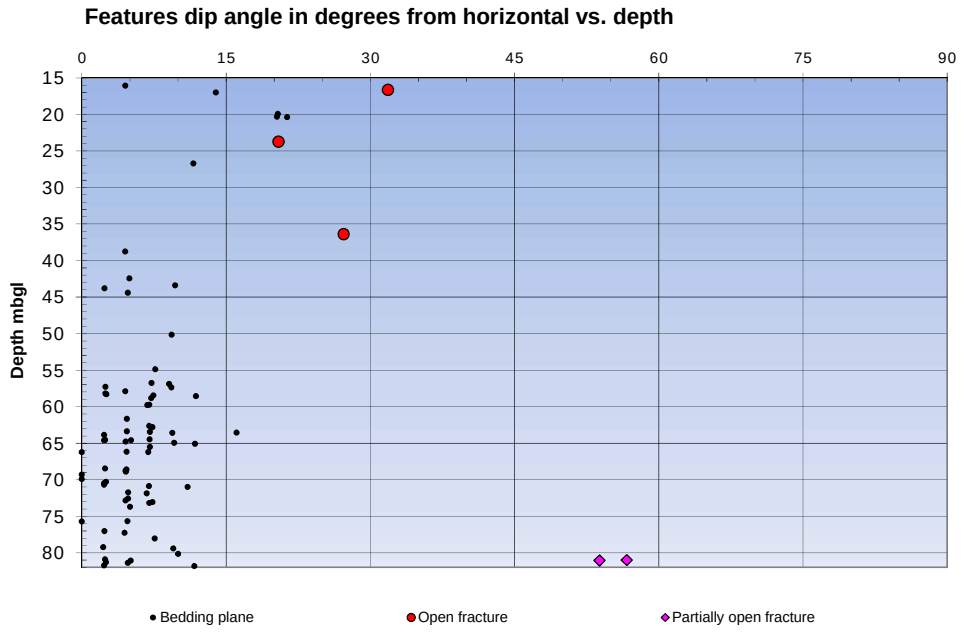


Figure 3 BH16-03feature dip direction data distribution

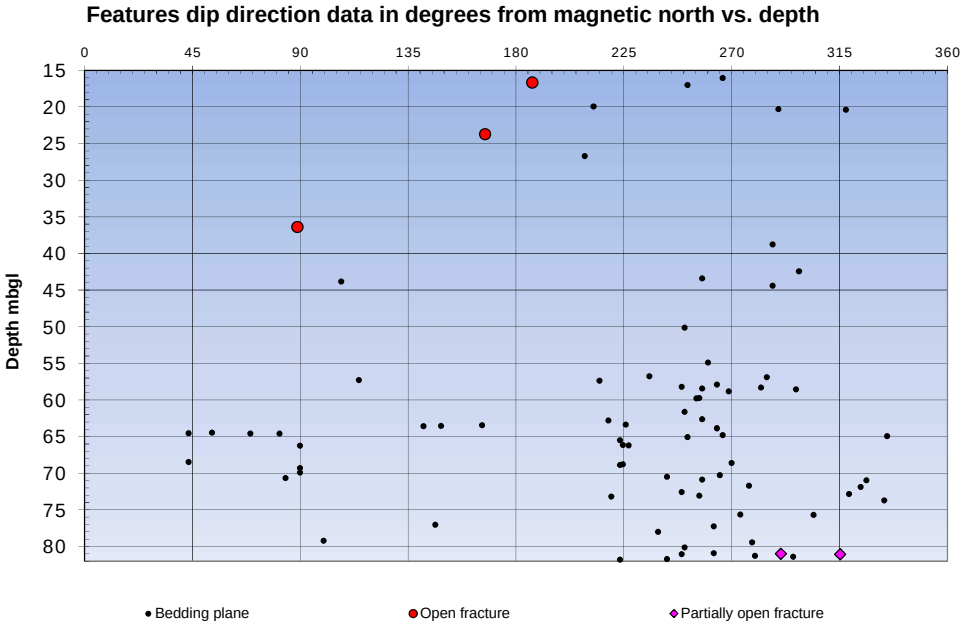


Table 2 BH16-03bedding histogram data

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

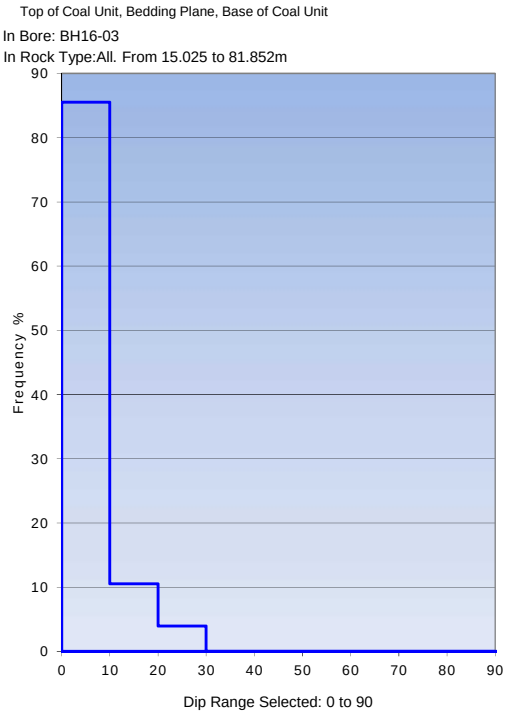


Figure 4 BH16-03bedding dip direction data rose diagram

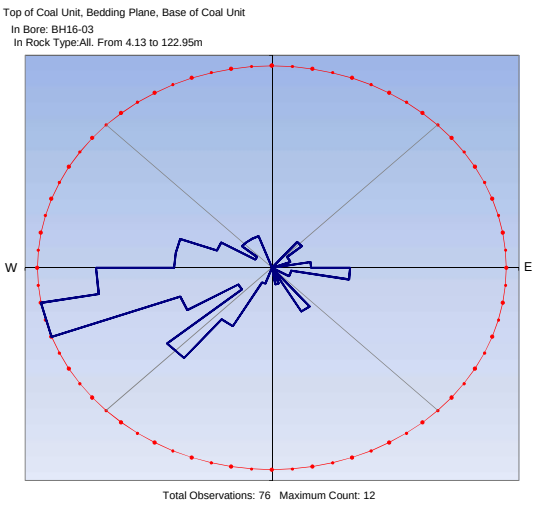


Figure 6 BH16-03bedding dip directions histogram

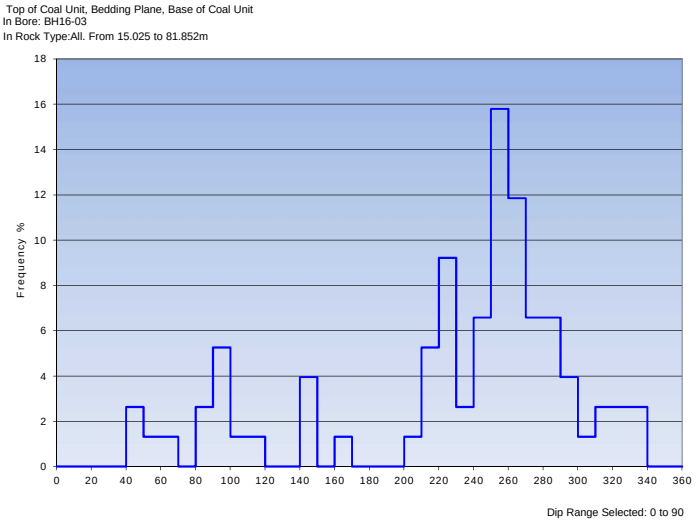


Table 3 BH16-03 fractures histogram data

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

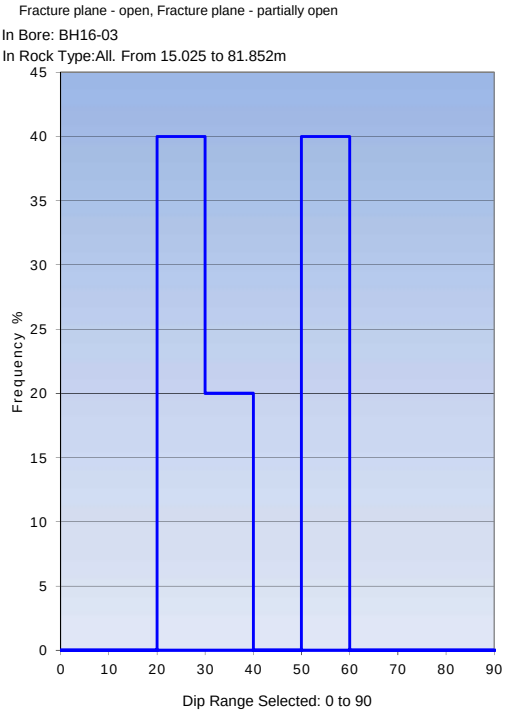


Figure 7 BH16-03fractures dip direction data rose diagram

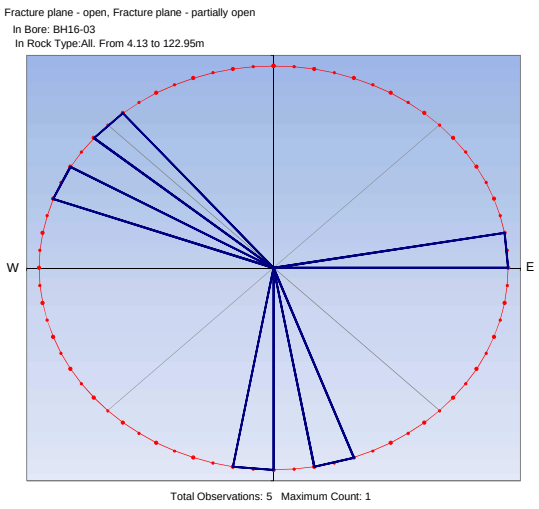
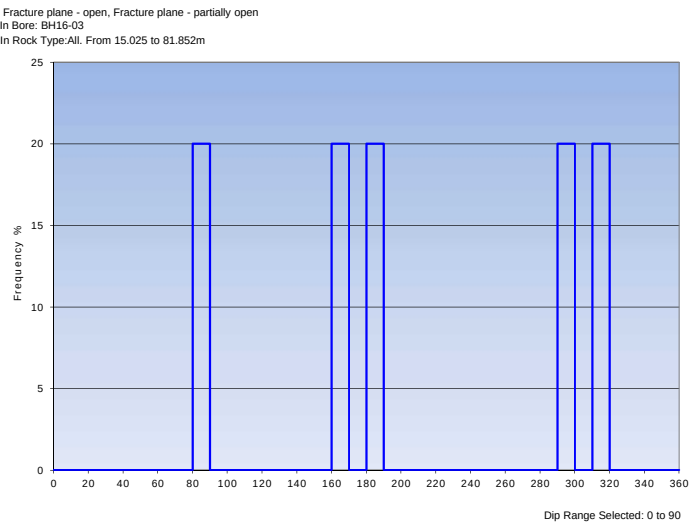


Figure 9 BH16-03fractures dip directions histogram



Appendix 1

Appendix 1 1:20 Interpretation logs – 14.50 to 82.12 mbgl

GROUNDSEARCH AUSTRALIA

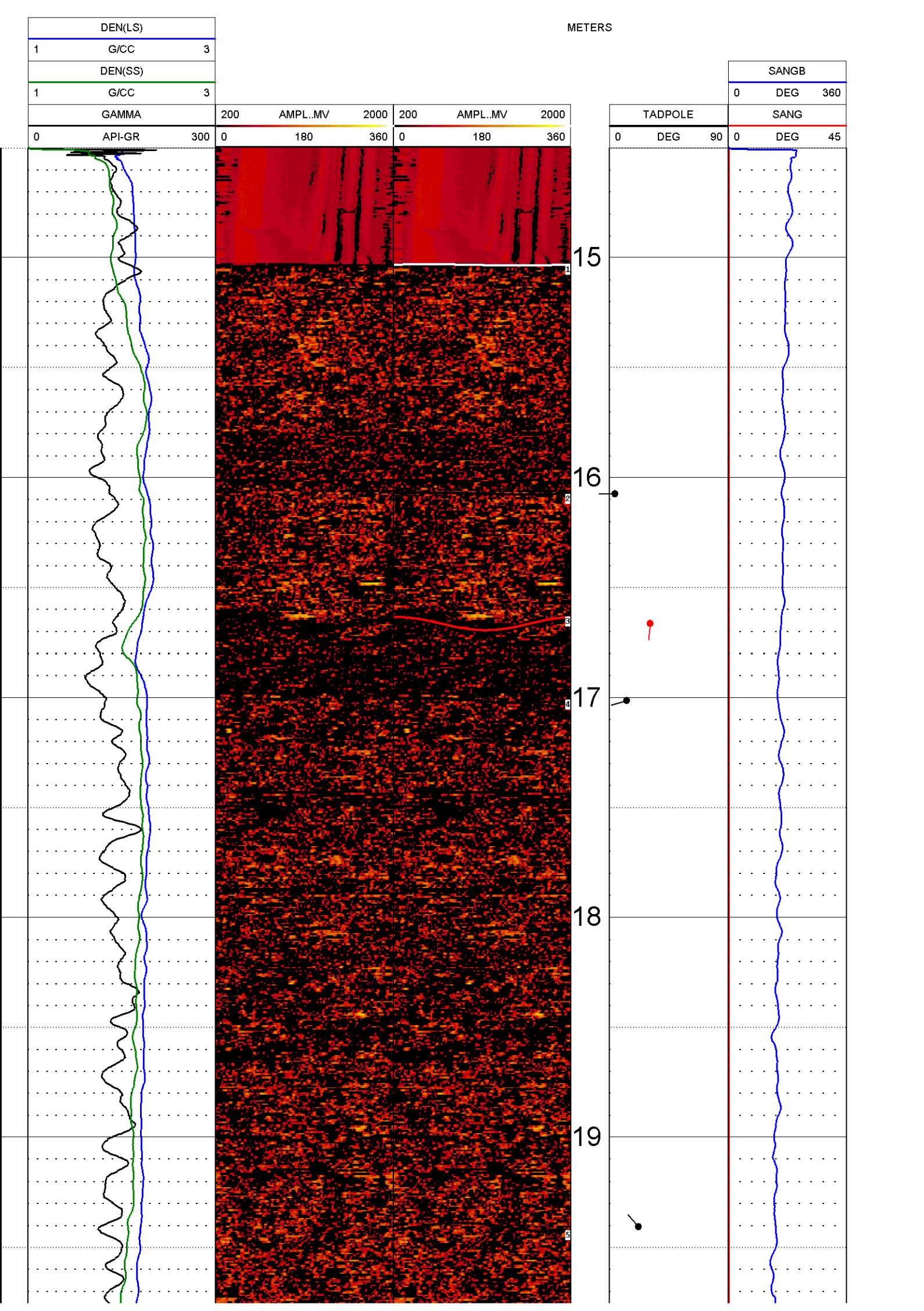
(ABN 11 057 389 152)

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
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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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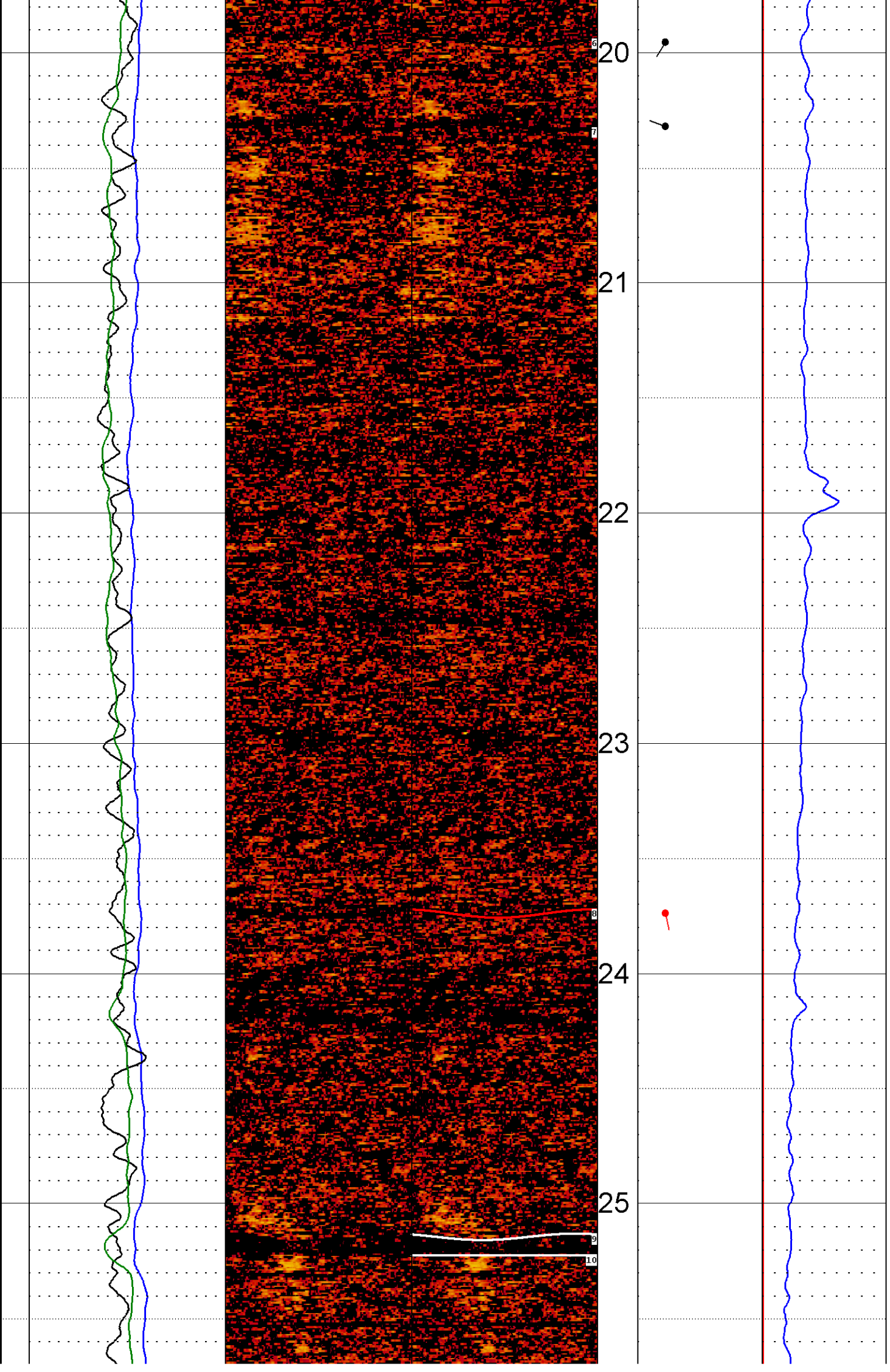
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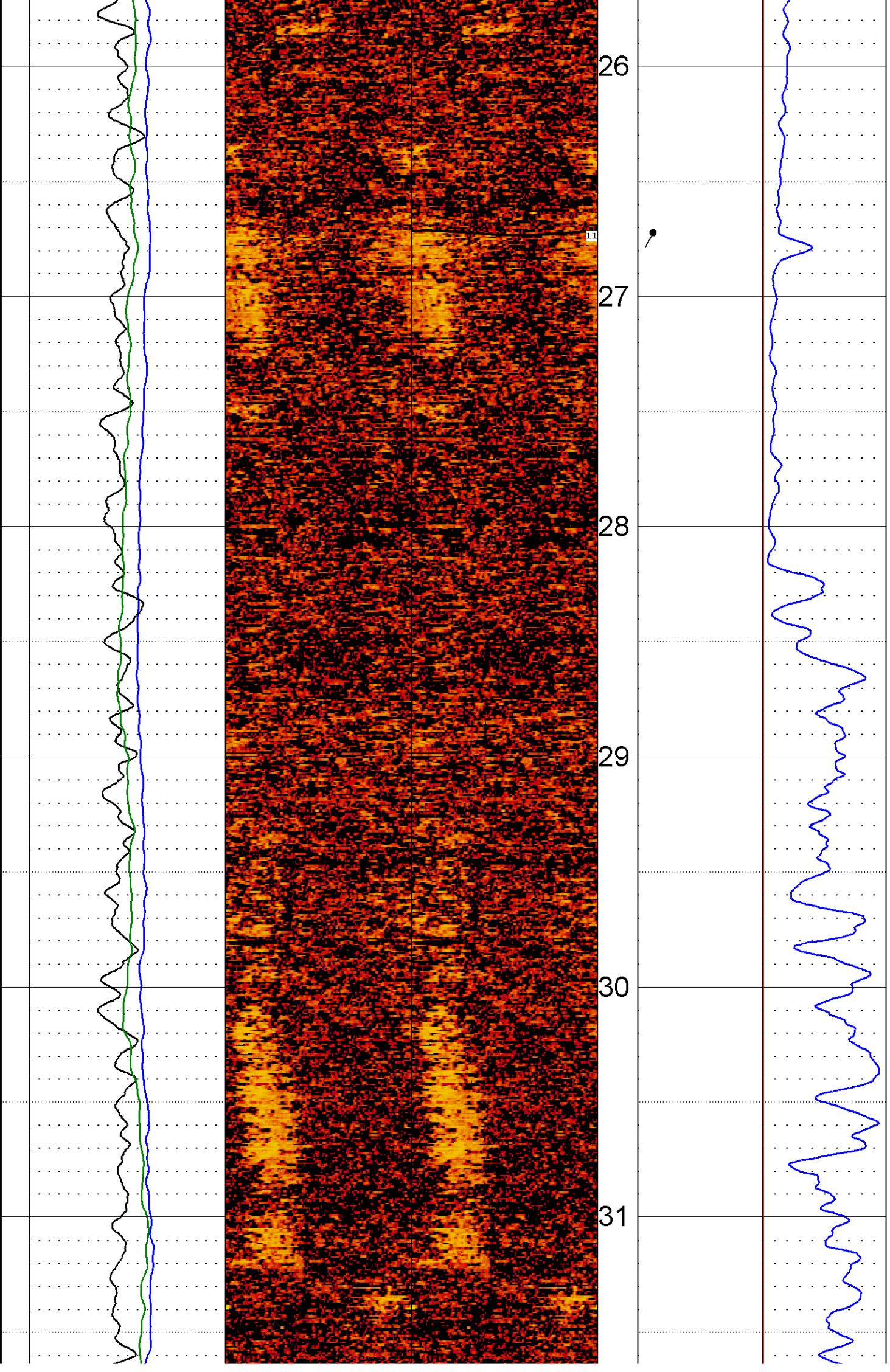
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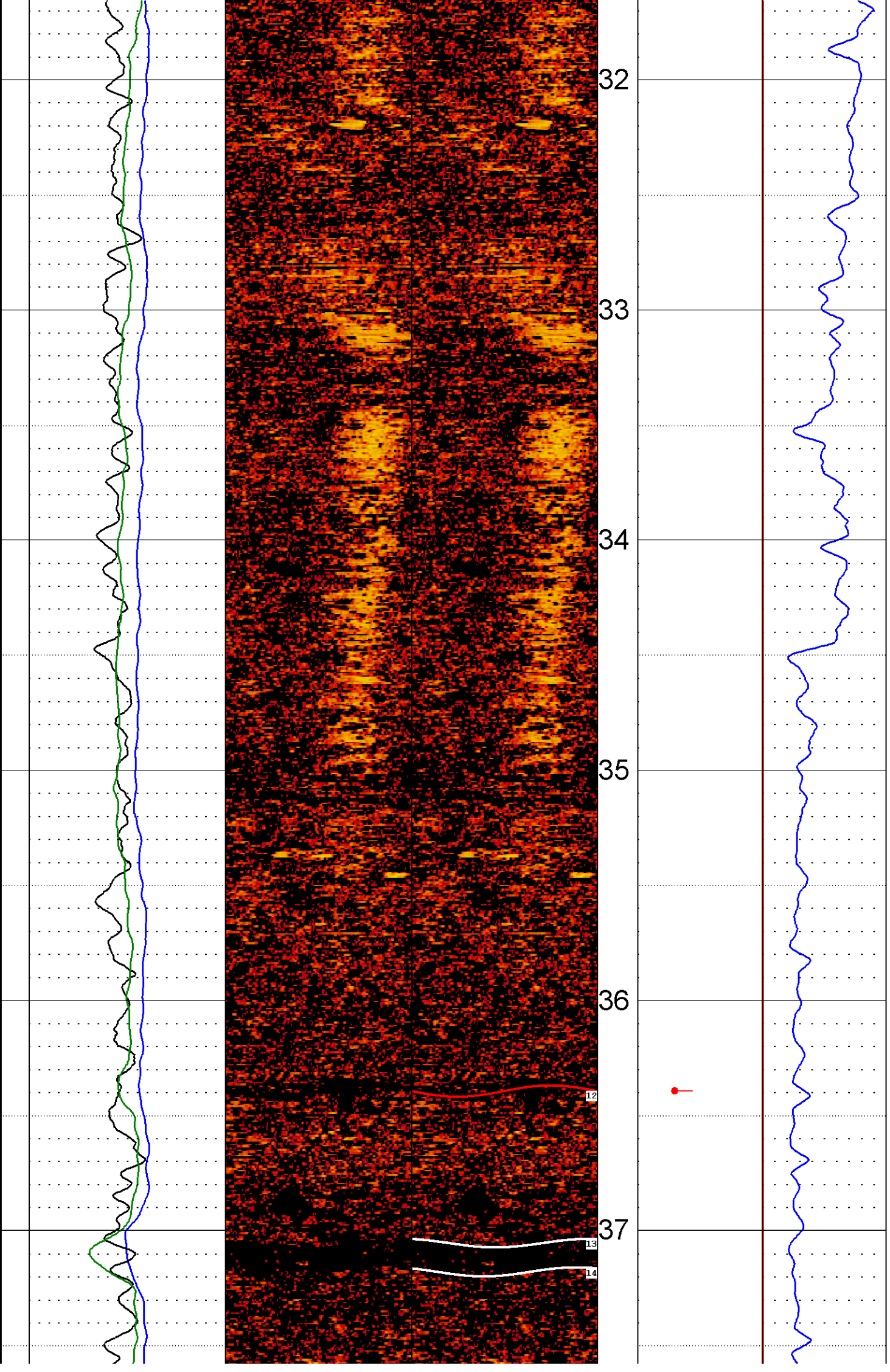
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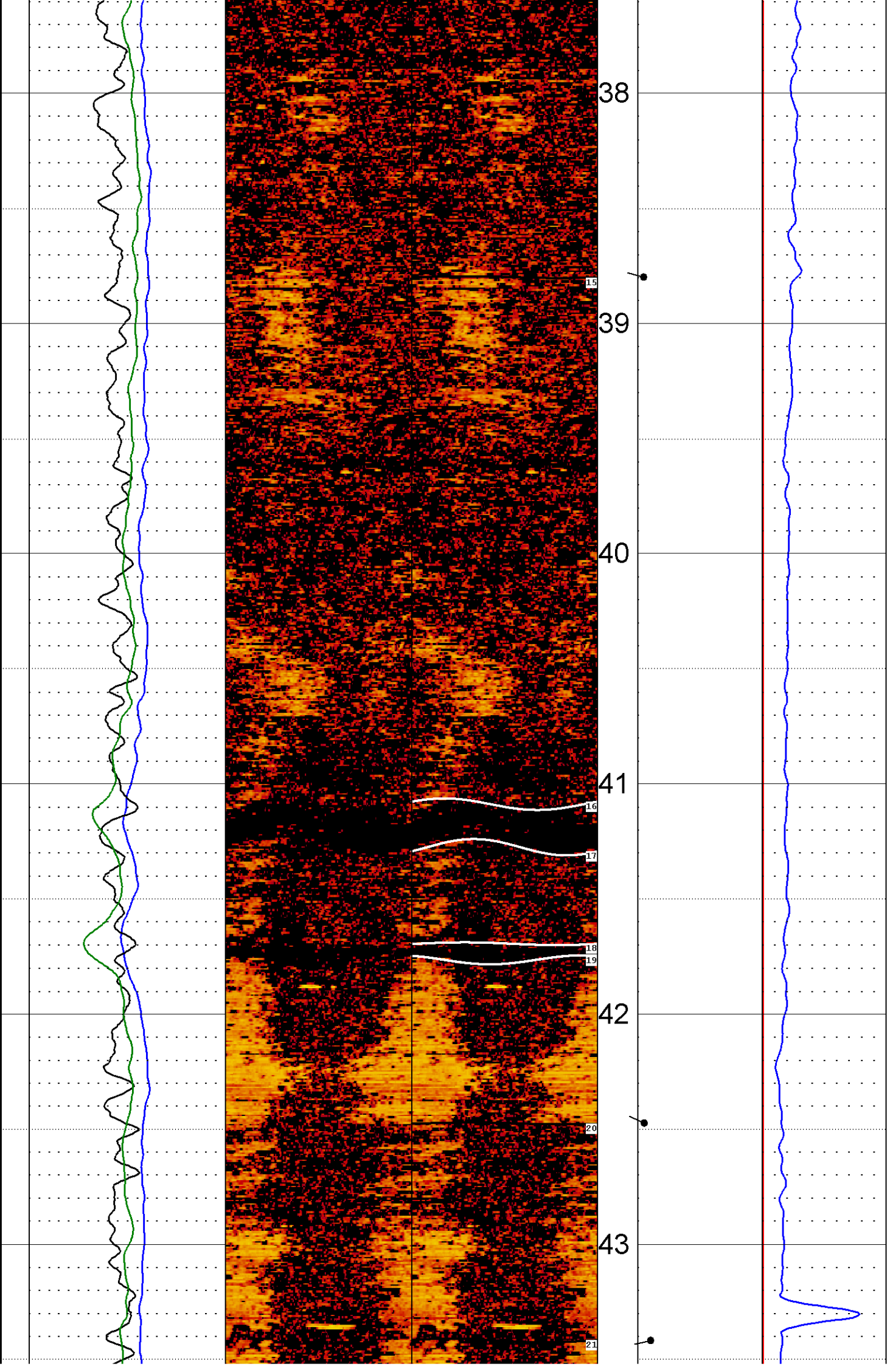
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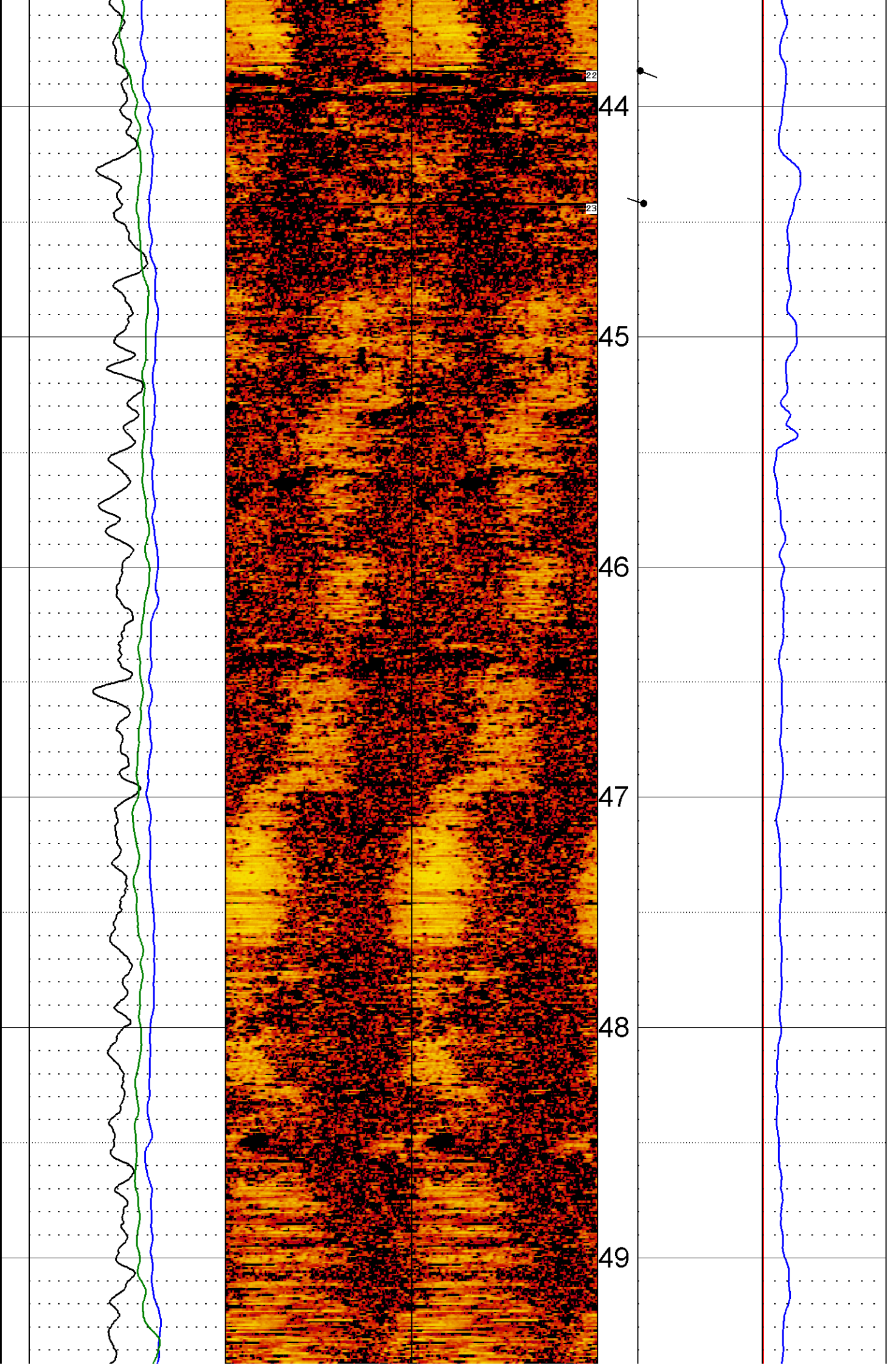
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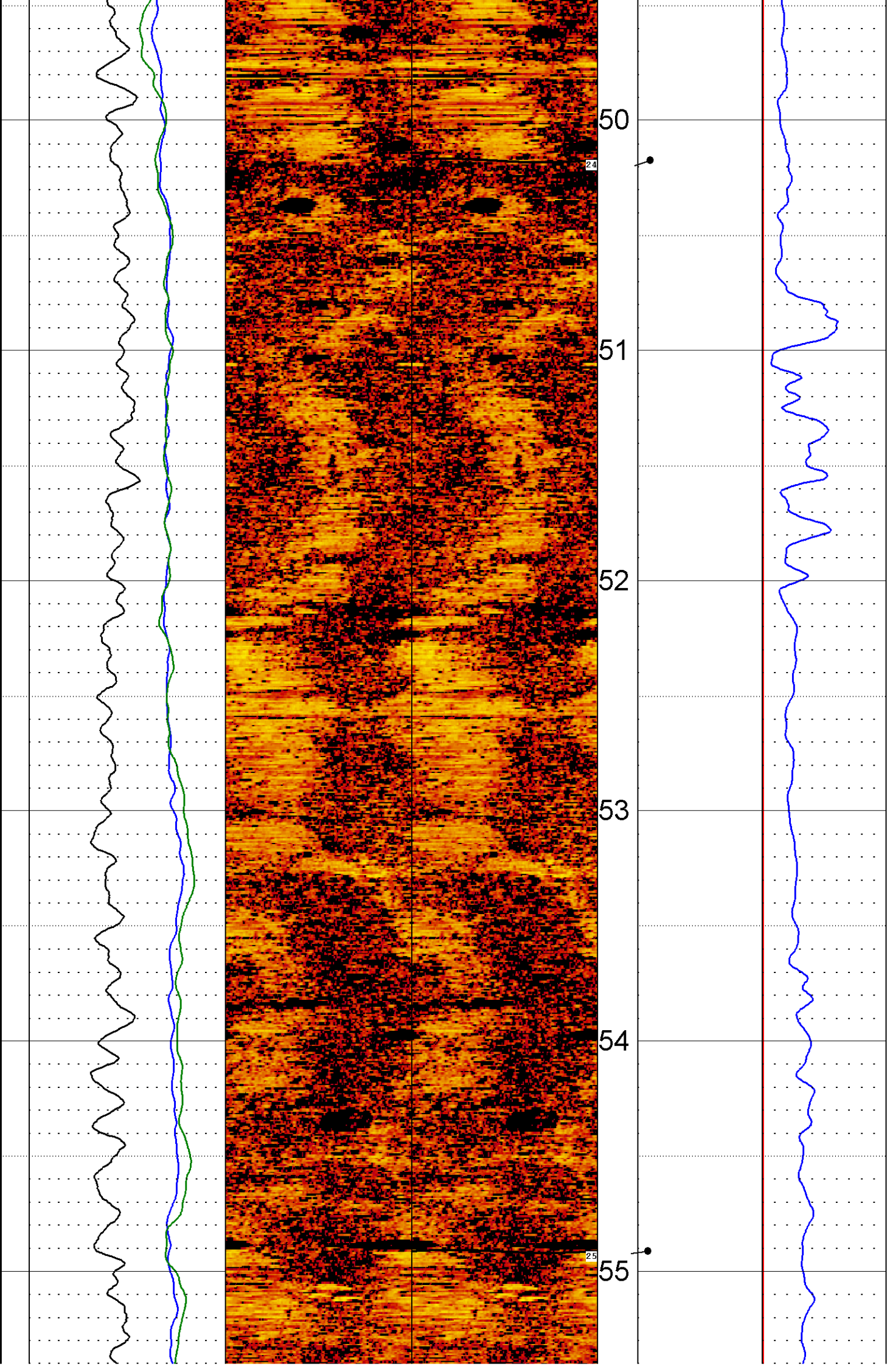
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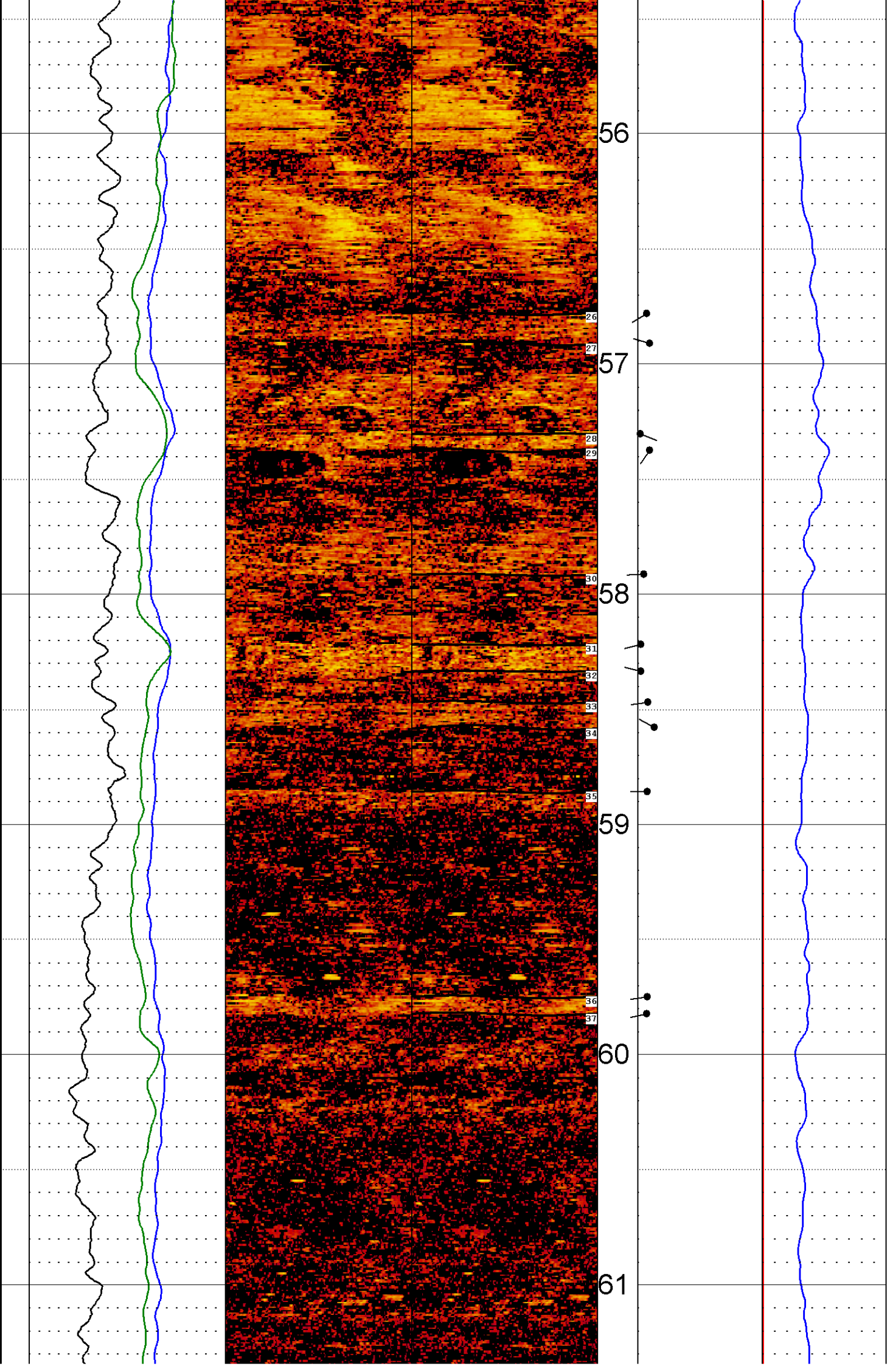
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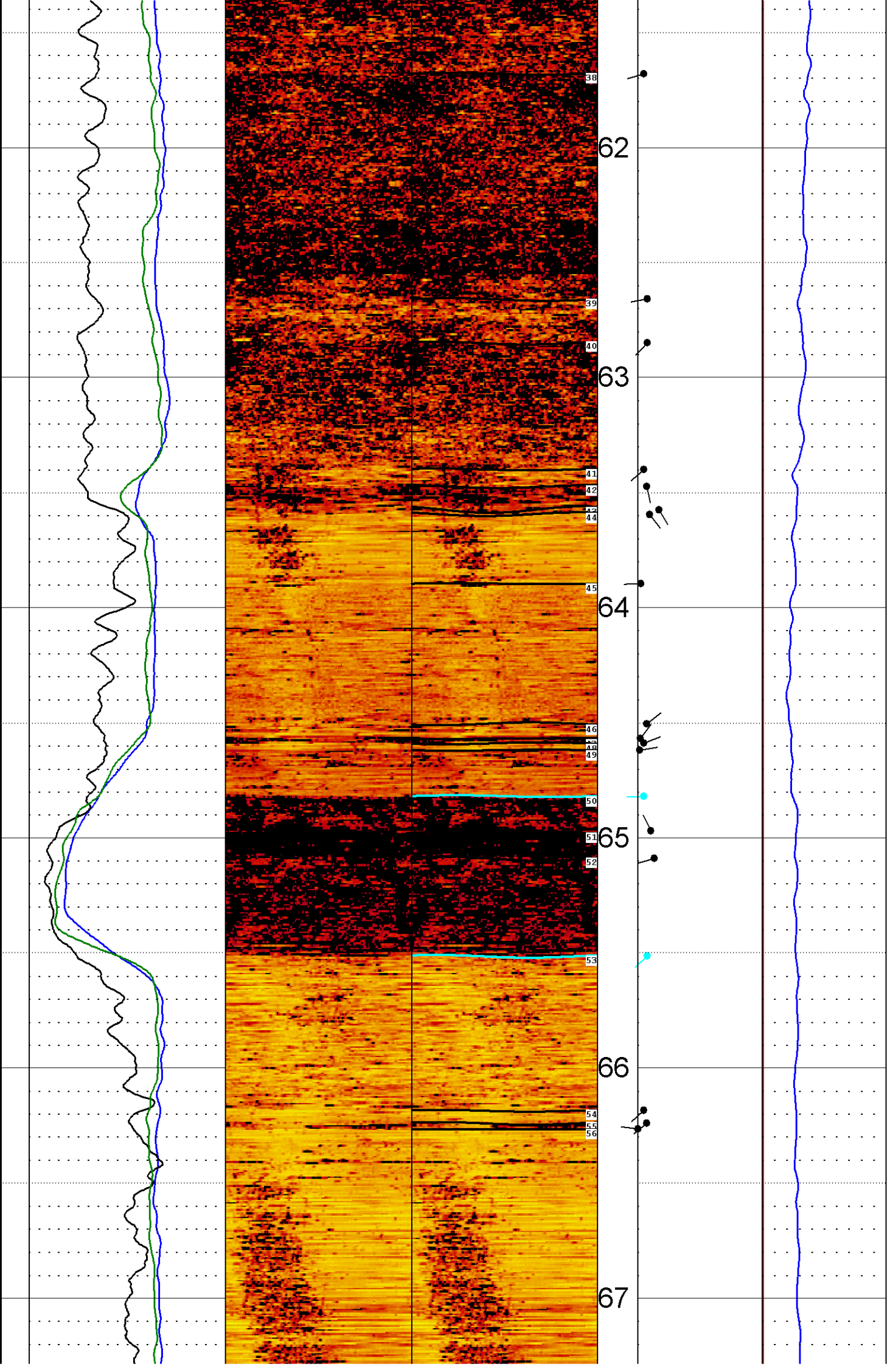
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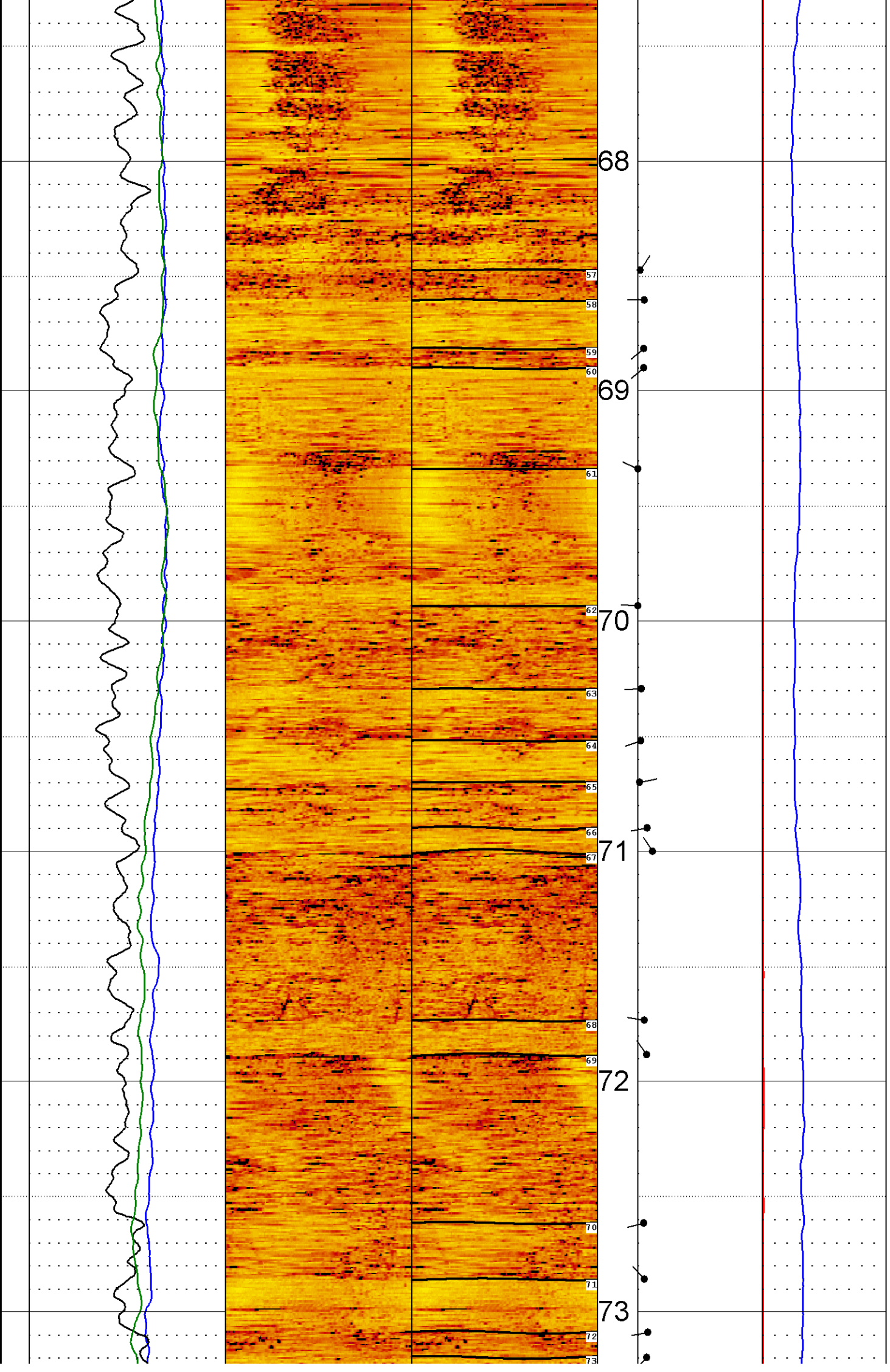
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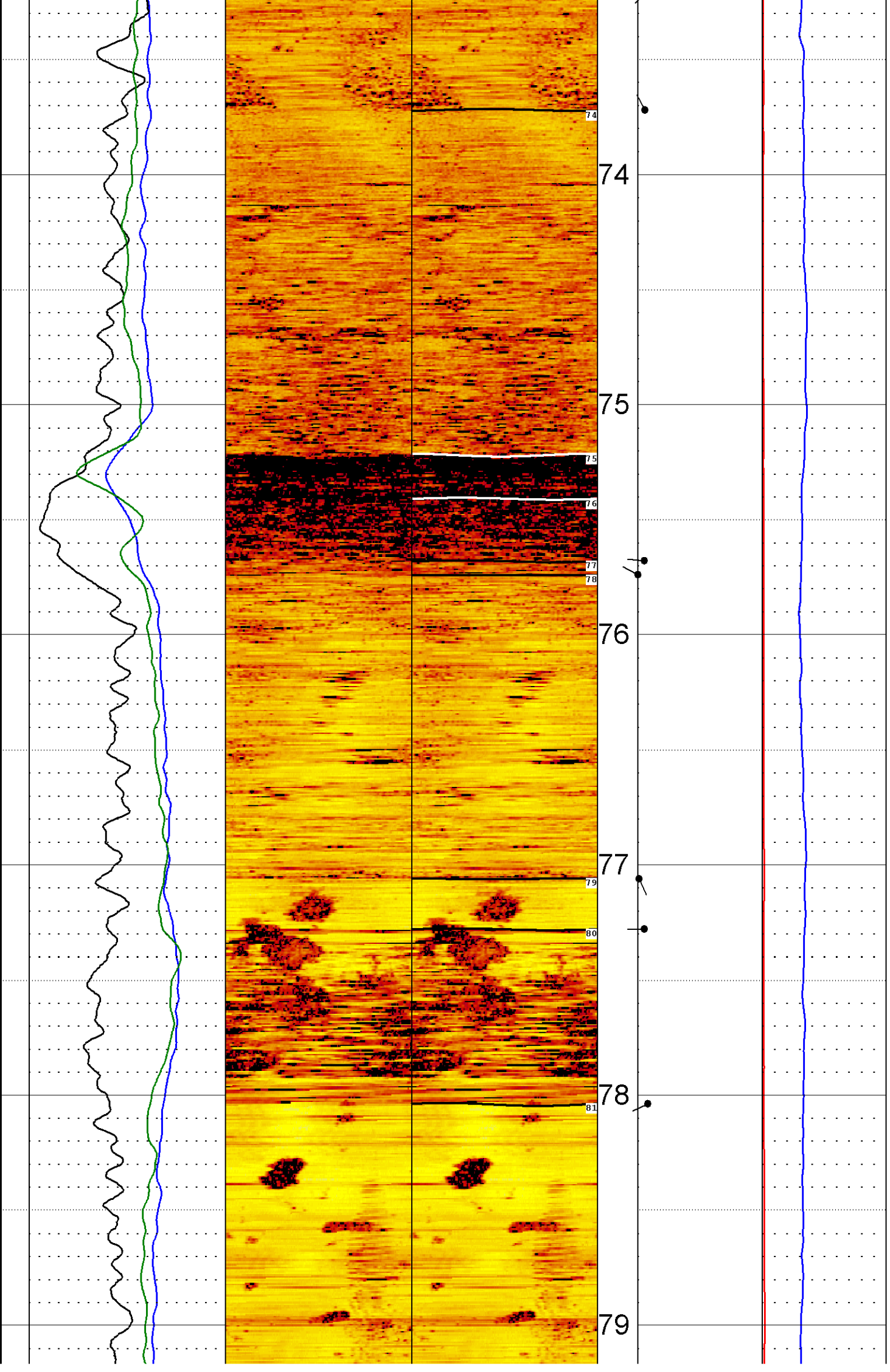
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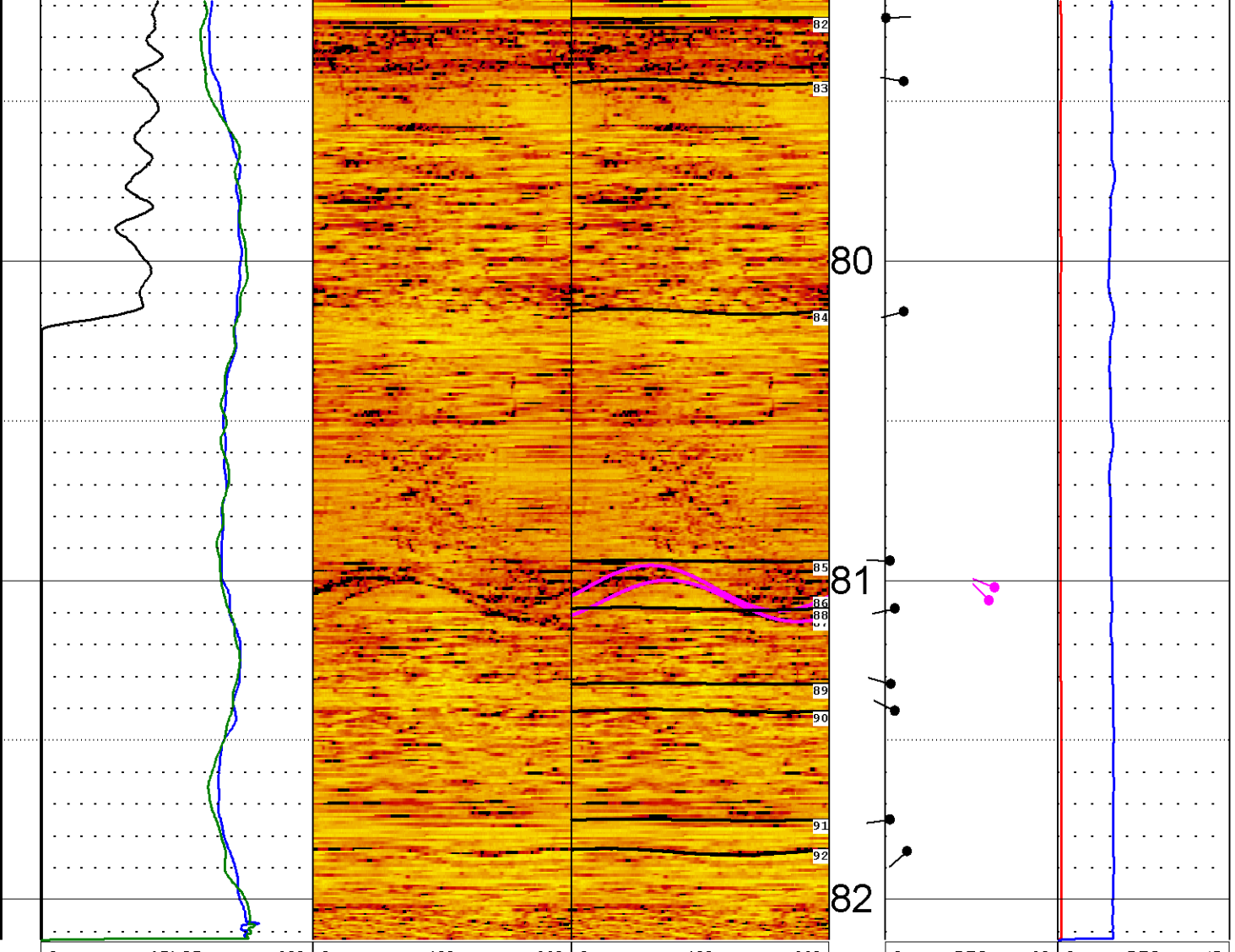
75
76
77
78
79
80
81



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