Central Queensland Coal Project

Appendix 4b - Geotechnical Assessment

Supplementary
Environmental Impact
Statement

Pits Adjacent to Bruce Highway - Slope Stability Assessment

Central Queensland Coal Project

M30133

Prepared for
Central Queensland Coal

10 May 2018

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Executive Summary

This report presents a desktop study on the feasibility of open cut mining operations on either side of the Bruce Highway approximately 25 km northwest of Marlborough, Central Queensland.

Project Details

The proposed development comprises the opening of pit walls parallel to the highway on both sides for a total length of approximately 3 km. The maximum depth of the portions of the pits near the highway is approximately 150m. The total width of the corridor between the pits is approximately 200m, ie the distance from the road centreline to each pit wall is approximately 100m.

Pits on either side of the highway will not be open concurrently and will be backfilled with spoil once the coal has been extracted.

Safety berms will be provided between the highway and the pit walls.

Overburden (surficial soils and weathered rock) will be excavated using standard earthmoving plant with a batter slope of 1H:1V. Rock cuts will be excavated with 45m deep benches and 10m berms with pre-splitting to reduce disturbance.

Geotechnical Information

Most of the geotechnical information supplied is derived from exploration boreholes which were drilled primarily to provide information on the quality and distribution of the coal seams in the project area. Selected boreholes near the highway alignment were re-analysed to provide geotechnical logs. This work was performed by a qualified experienced engineering geologist with R.P.E.Q. certification.

Rock strength properties were derived from logs, downhole sonic velocity tests and laboratory tests on cores from other boreholes in the project area.

Cross sections showing identified coal seams were provided and these together with the re-worked logs were used to prepare geotechnical cross sections for slope stability and deformation analyses. These cross sections were judged to provide a better indication of bedding inclination across the cross sections than could be determined based on the supplied borehole logs.

Geotechnical Analysis Slope Stability

Slope stability analyses were undertaken using GeoStudio software. This software package is preferred by DTMR and availability and expertise with package is a requirement for GE2 and GE3 certification. Initial analyses were performed using a simplified model prepared before detailed mapping of coal seams was made available. The results showed factors of safety in excess of 1.5 for pit depths up to 100m and in excess of 1.3 for pit depths up to 150m using rock strength parameters supplied by AMEC.

Following this analysis, further investigation of rock strength and elastic modulus properties was undertaken and a Hoek-Brown strength model was adopted with rock strength values derived from downhole sonic velocity tests. These were in general somewhat lower than typical laboratory strength values, hence it was judged that the strength model adopted was conservative and could potentially be improved by further investigation and testing.

The analysis produced the following results with probable lower bound strength values:

- 2D circular slip failures produced FOS > 1.5 (As per DTMR requirement) for pit depths to 150m;
- Planar wedge failures produced FOS > 1.5 for pit depths to approximately 125m and > 1.4 for pit depths to 150m;
- Seismic stability is not critical;
- 3D wedge failures not analysed but not considered plausible; and
- Analyses were done with pore pressure coefficient (Ru) = 0.15 as per DTMR requirements (this is considered to be conservative).

Geotechnical Analysis Deformation

Finite element deformation analyses were performed using Plaxis software. This software package is preferred by DTMR and availability and expertise with package is a requirement for GE2 and GE3 certification. Mohr Coulomb modelling was used for overburden and spoil and Hoek-Brown modelling for rock and coal seams.

The analysis showed maximum horizontal and vertical deflections at the highway centreline of 25mm and 8mm respectively. These results are preliminary but indicate that horizontal movement and settlement of the highway alignment is not likely to be significant.

Slope Monitoring

A slope monitoring programme including instrumentation would be required prior to commencement of excavations. This will most likely include installation of inclinometers.

Conclusions

The desktop study has shown that excavation of coal mining pits on either side of the highway is feasible without disruption to the highway. Additional geotechnical investigation is recommended, particularly if pit depths exceed 125m. Requirements for additional investigation would need to be discussed with DTMR before proceeding.

Limitations

This report is a desktop study based on information primarily obtained for the purpose of resource extraction.

This report does not form part of a certified pit design.

Table of Contents

Appendices

Tables

Figures

1 Introduction

This report provides a desktop study of pit stability and likely ground movements associated with proposed mining works approximately 25km northwest of Marlborough, Central Queensland (Refer Figure 1-1). The proposed works comprise the excavation and re-filling of coal mine pits on either side of the Bruce Highway.

Detailed pit designs have not been prepared. The geotechnical information provided has been largely derived from coal exploration boreholes which were drilled to determine the spatial distribution and quality of coal seams. Selected boreholes were re-logged to provide geotechnical information and these logs together with geological commentary are presented in Appendix A.

Figure 1-1 Project Location

This report is a desktop study based on existing information and should not be considered as a final pit wall design. Slope stability and deformation analyses have been prepared for a range of material strength parameters and pit excavation sequences.

Preliminary details of the proposed pits are provided in Section 2.

The information used in the preparation of this report is summarised in Section 3.

Geotechnical Conditions are described in Section 4.

Slope stability and deformation modelling are described in Sections 5 and 6.

2 Pit Configuration

The draft pit designs comprise:

- Box cut in overburden 1H:1V
- Safety berms 10m high with 1.5H:1V slopes
- Rock excavation with 0.5H:1V cut slopes and 10m berms at maximum 50m intervals.

Rock slopes along the road alignment are to be excavated using pre-splitting techniques. The configuration was adopted based on likely available drilling equipment. Slope stability and deformation analyses were performed using geometries based on the concept sketch shown in Figure 2-1. Figure 2-2 shows a typical section for Year 2032, Figure 2-3 shows a typical section for Year 2033. Pits will be back-filled with spoil following extraction of the coal.

At no time will pits be open on both sides of the highway.

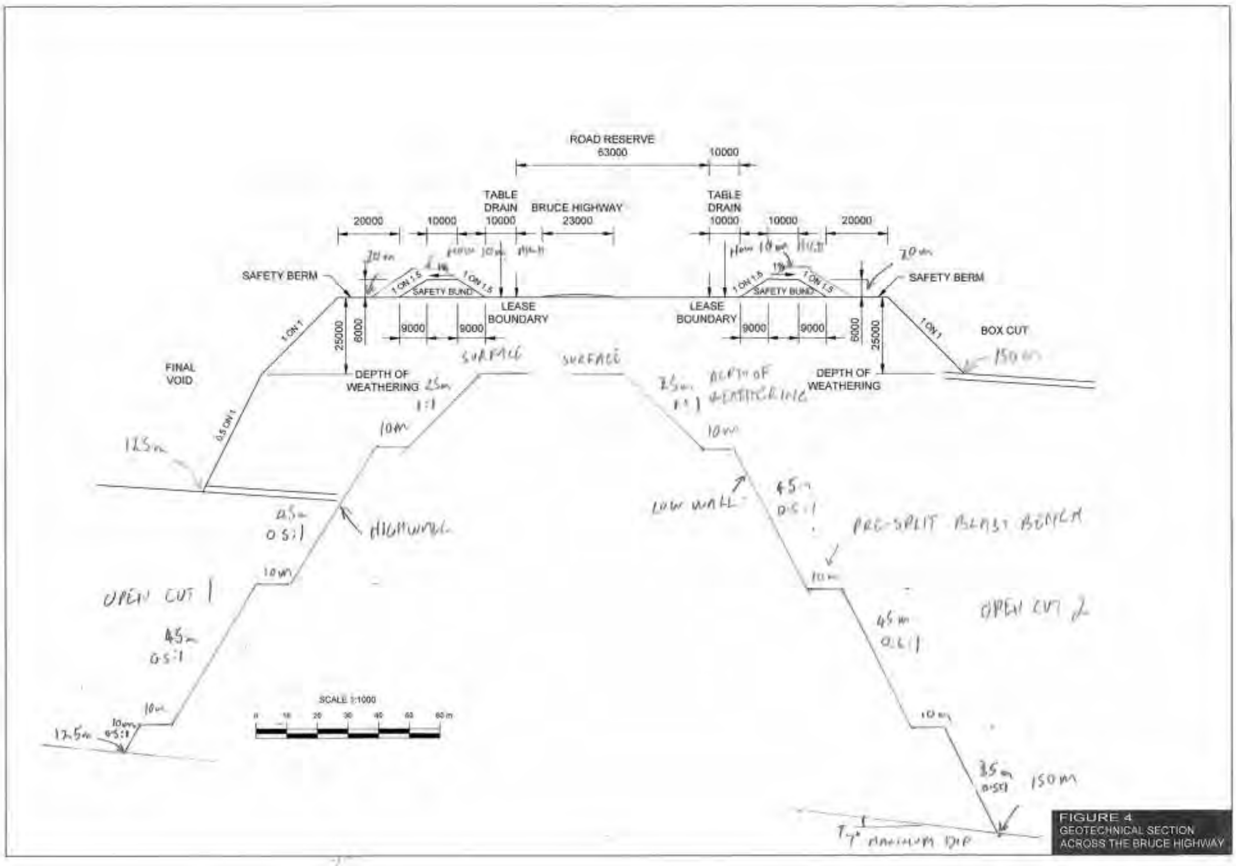

Figure 2-1 Concept Pit Design

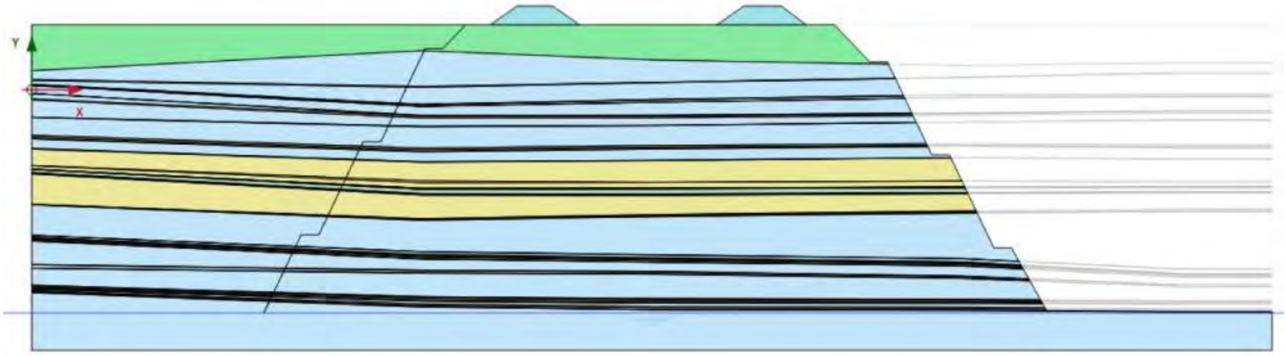

Figure 2-2 Pit excavation year 2032

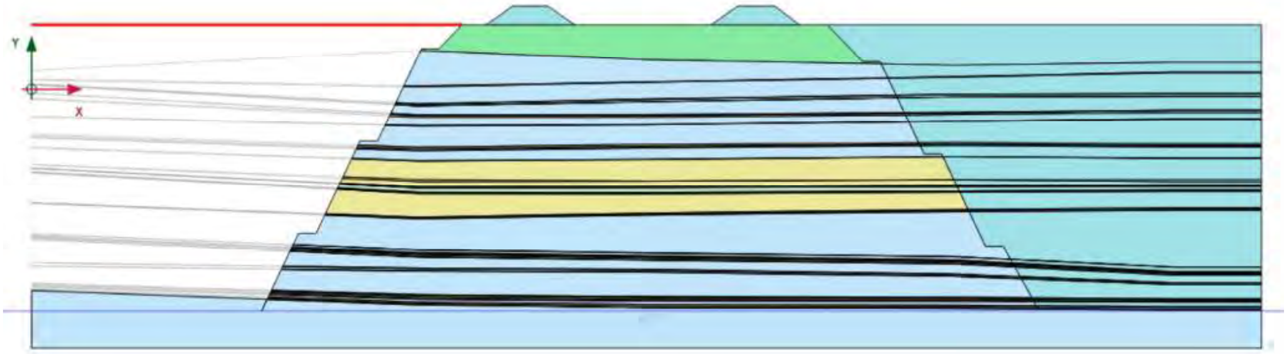

Figure 2-3 Pit excavation year 2033

3 Information Supplied

3.1 Reports

The following reports have been supplied:

- Geotechnical Assessment of Bruce Highway (AMEC 2018)
- Geotechnical Assessment of Open Cut Mining Adjacent to the Bruce Highway, STYX Project (AMEC 2017 a)
- Groundwater Investigations for the Styx Trial Pit (AMEC 2014)
- Geotechnical Report for the Styx Coal Project (AMEC 2017 b)
- Preliminary Investigations for Sediment Dam, Water Storage Dam, Train Loadout and Haul Road, Styx Coal Project (AMEC 2017 c)

3.2 Boreholes

A large number of exploration boreholes have been drilled across the project, however these provide limited geotechnical information due to the absence of detailed geotechnical logging and the remoteness of the boreholes from the highway. A total of 10 boreholes near the highway were re-logged by an engineering geologist; the re-worked logs are presented in AMEC 2018 (Refer Appendix A). Detailed logging of discontinuities was not provided, however some core photos were provided although these do not cover the full cored depth of the boreholes.

Unconfined Compressive strength values derived from downhole sonic velocity logging were provided on some logs.

3.3 Pit Cross Sections

Pit geometries were provided in three stages:

1. Initial sketches provided by George Klenowski (Refer Figure 2-1)
2. Cross Sections with mapped coal layers provided by Michael McShane
3. Cross Sections with revised coal layers provided by Adriaan Benson (Refer Figure 3-1)

A total of five cross sections were provided as shown in Figure 3-1. Stability and deformation models were prepared for Cross Section 5 which had the deepest proposed excavation (Refer Figure 3-2 and Figure 3-3).

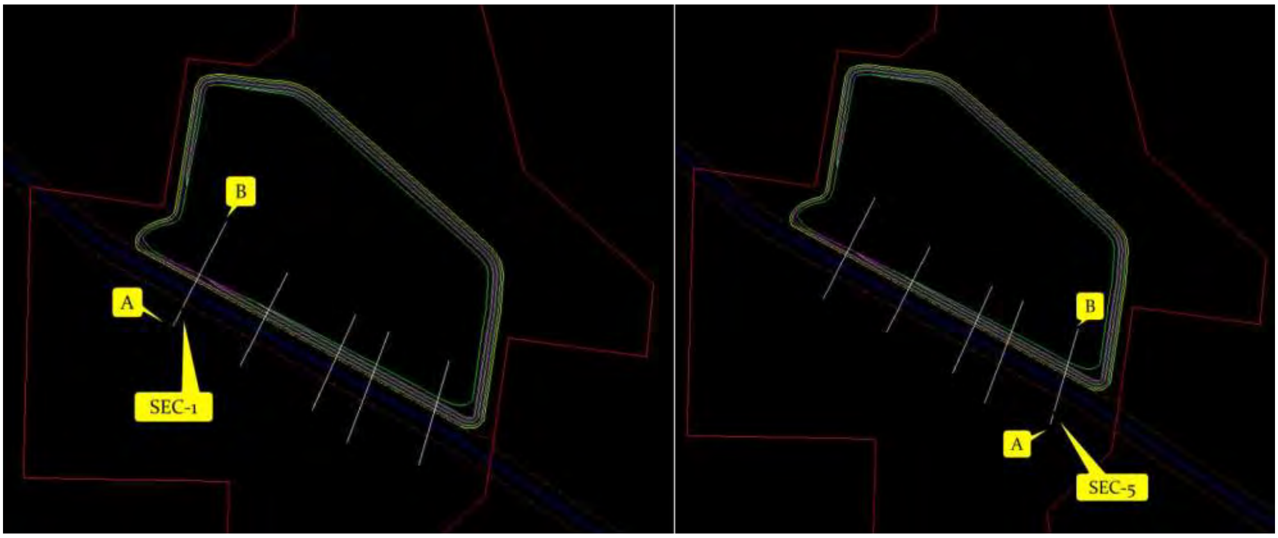

Figure 3-1 Location of Cross Sections

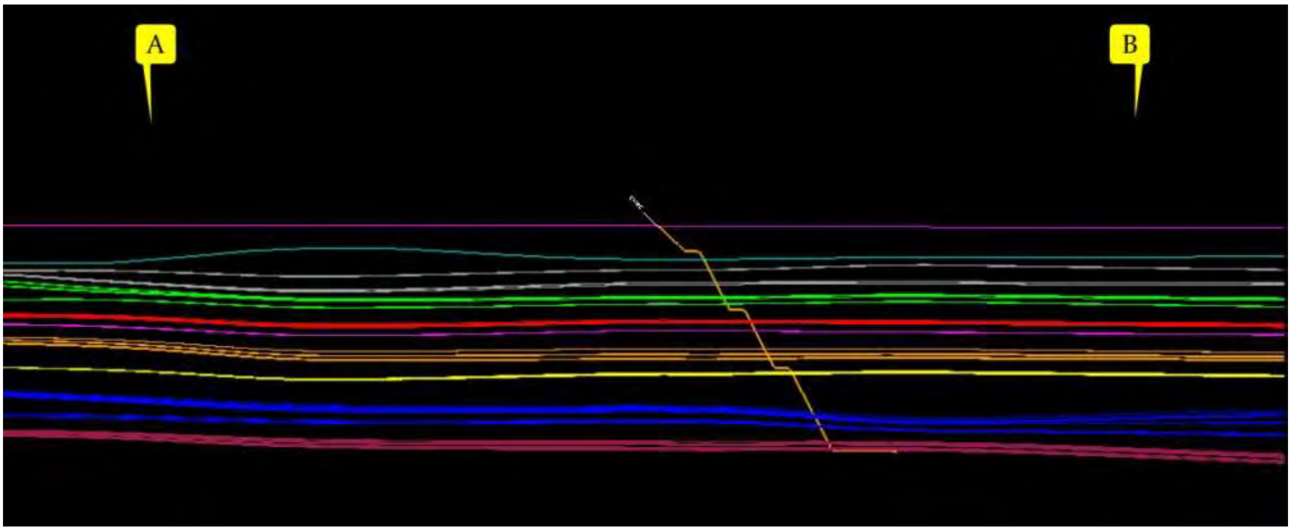

Figure 3-2 XSect 5 NE side

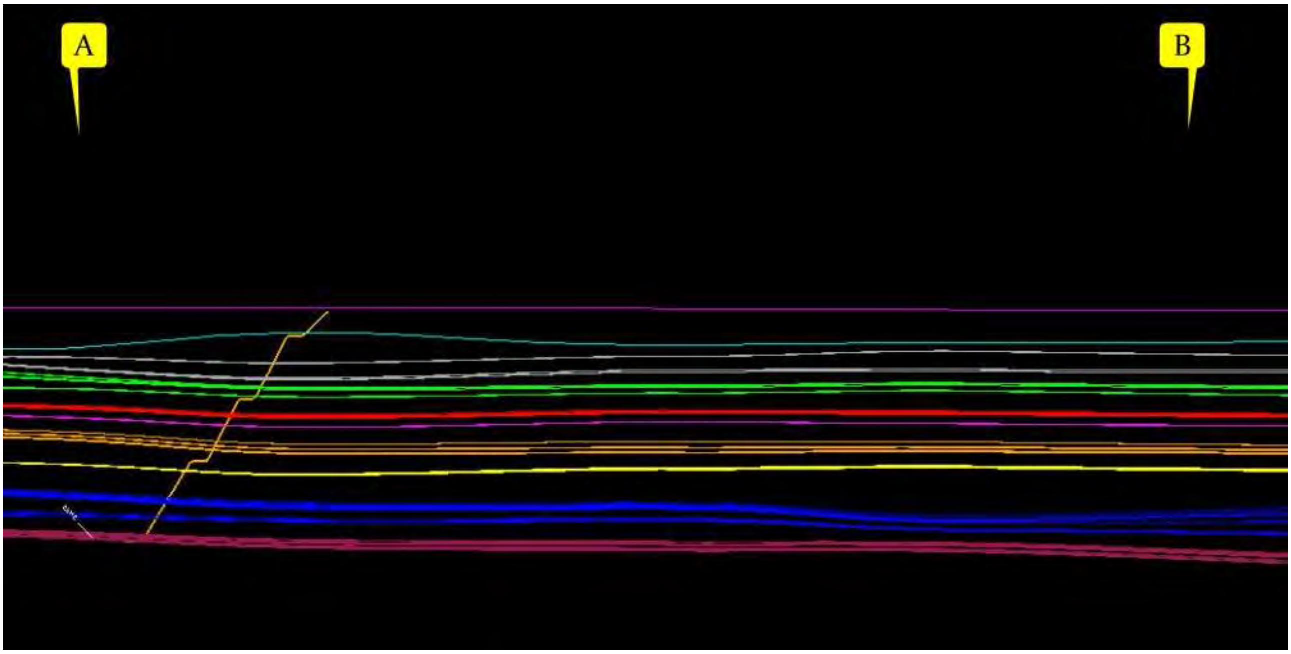

Figure 3-3 XSect 5 NW Side

4 Geotechnical Conditions

4.1 Geology

The local geology is described in Appendix A.

4.2 Material Parameters

4.2.1 Overburden

Refer Table 4-1.

4.2.2 Spoil

Refer Table 4-1.

4.2.3 Rock Strength and Modulus

Initial rock strength parameters were supplied by AMEC (2018) and are summarised in Table 4-1 below. These parameters were used in the initial stability model (Refer Section 5.4.1).

Table 4-1 Initial Material Properties

Material	Density (kN/m3)	Angle of Internal Friction φ (degrees)	Cohesion (kPa)
Overburden (clay and CW rock)	19.6	25	40
Spoil	18.6	34	0
Mudstone CW	18.6	24	60
Mudstone MW	18.6	25	200
Mudstone Fr	19.6	38	200
Siltstone CW	24.5	43	60
Shale Fr Competent	24.5	15	38 400
Sandstone HW	19.6	38	60
Sandstone Fr Weak	24.5	40	200
Sandstone Fr, Competent	24.5	28	27 200
Coal Fr	14.7	35.5	420
Coal CW	11.8	22	0
Soot	11.8	9	0
Intraformational Shear Zone	-	25	9

Additional stability modelling was undertaken based on Hoek-Brown strength parameters (Refer Appendix F). Typical values were derived from lab testing on core samples taken from project boreholes (not the boreholes with geotechnical logs provided). The following process was adopted:

- Determine intact rock modulus from sonic velocity tests (Assume Poisson's Ratio 0.2);
- Obtain UCS from laboratory test;
- Assign GSI, mi and D parameters based on qualitative assessment of core; and
- Calculate equivalent Mohr-Coulomb parameters using RocLab software.

The measured and derived rock properties are summarised in Table 4-2

Table 4-2 Rock Strength Parameters from Laboratory Tests

Sample	Rock Type / Failure Mechanism	Sonic Velocity (m/s)	UCS (MPa)	Young's Modulus (GPa)	GSI	mi	d	c (MPa)	Φ (deg)
STX084RR - GT001	Sandstone Shear Failure	3333	25.2	18.20	70	17	0	2.00	41.0
STX084RR - GT002	Sandstone Conical Failure	2323	4.6	8.30	40	17	0	0.23	32.1
STX084RR - GT003	Siltstone shear failure	n/a	5.02	n/a	n/a	n/a	n/a	n/a	n/a
STX084RR - GT004	Sandstone Shear Failure	3458	24.5	21.01	50	17	0	1.43	35.1
STX084RR - GT005	Sandstone Shear Failure	2938	20.9	14.25	70	17	0	1.66	41.0
STX084RR - GT007	Sandstone Shear Failure	3049	5.43	16.09	30	17	0	0.23	29.0
STX084RR - GT008	Mudstone Shear Failure	2938	18.4	13.62	30	7	0	0.57	21.8
STX084RR - GT009	Siltstone Shear Failure	3731	36.6	25.76	40	7	0	1.37	24.7
STX084RR - GT010	Sandstone Shear Failure	3004	18	15.20	70	7	0	1.21	33.1
STX084RR - GT011	Sandstone Shear Failure	3080	19.3	16.92	50	17	0	1.13	35.1
STX084RR - GT012	Sandstone Shear Failure	3223	30.5	16.88	50	17	0	1.78	35.1
STX084RR - GT013	Mudstone shear Failure	2702	19.6	12.54	40	7	0	0.74	24.7
STX090RR - GT001	Mudstone shear Failure	2144	3.56	6.74	30	7	0	0.11	21.8
STX090RR - GT002	Sandstone Conical Failure	n/a	6.25	n/a	n/a	n/a	n/a	n/a	n/a
STX090RR - GT003	Sandstone Shear Failure	2825	19.4	12.91	40	17	0	0.98	32.1
STX090RR - GT004	Mudstone Shear Failure	3072	22.8	15.15	40	7	0	0.86	24.7
STX090RR - GT005	Mudstone Shear Failure	2861	16.1	13.19	40	7	0	0.60	24.7
STX090RR - GT006	Siltstone Axial Failure	2984	11.7	14.29	40	7	0	0.44	24.7
STX090RR - GT007	Sandstone Shear Failure	2974	21.5	14.55	40	17	0	1.08	32.1
STX090RR - GT010	Mudstone Shear Failure	2929	12	13.88	40	7	0	0.45	24.7

GSI, mi and d are Hoek-Brown parameters, Mohr Coulomb c and φ derived using RocLab Software

UCS and sonic velocity measured in tests on core

4.2.4 Composite Strength Model

Core logs showed mixed sandstone/siltstone/mudstone in many instances making it impractical to model individual rock strata. In addition, the initial slope stability modelling showed failure surfaces passing through the flat dipping strata at steep angles, hence a composite strength model was used with parameters defined in Table 4-3 on the following page. UCS values were determined from those shown on bore logs, these values were in turn derived from down-hole sonic tests as described in AMEC (2018).

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Table 4-3 Composite Strength Properties

Material Type	Bulk Density (kN/m^3)	c(kPa)	Φ(deg)	E' (GPa)	v	σ_{ci} (MPa)	m_i	GSI	D
Spoil	18.6	0	34	N/A Mohr Coulomb model only					
Overburden	19.6	40	25	N/A Mohr Coulomb model only					
Mixed Sedimentary High	24	0.75	30.5	15	0.3	15	10	50	0
Mixed Sedimentary Low	14.7	350	24.6	10	0.3	10	10	30	0
Coal	14.7	670	21.8	10	0.3	10	7	30	0
Sandstone Fr	24	2375	41	15	0.3	30	17	70	0

4.2.5 Discontinuities

Bedding is generally uniform with an average dip of 3°. Maximum dip is about 7°. Partings occur along bedding planes. Jointing is generally widely spaced. Limited core photo data and geophysical logging of boreholes did reveal occasional discontinuities with steeper apparent dips, the persistence of such discontinuities is unlikely to be sufficient to permit the formation of other than small wedges.

To date no significant faults or dykes have been encountered during geological investigations.

5 Slope Stability Modelling

5.1 Introduction

Slope stability modelling was undertaken using the GeoStudio software package. Cross section geometries for the detailed model were generated from AutoCad files derived from 3d mining software used to map coal measures. These were supplied as AutoCad files and imported into GeoStudio as pictures. The stratigraphy between coal beds was filled in by referring to geotechnical borehole logs with sonic logs used to select appropriate strength properties.

5.2 Failure Modes Considered

5.2.1 2D Slip Circle Failure in Overburden

Overburden failure surfaces were modelled together with 2D rock failure surfaces. Where a lower FOS was calculated in the overburden this was noted in the results summary in Table 5-2.

5.2.2 2D Failure Surface in Rock

5.2.2.1 Circular Failure Surfaces

These were modelled using the Morgenstern and Price method.

5.2.2.2 2D Planar Failures

These were modelled assuming the presence of a thin layer with properties equivalent to the intra formational sheared zone as described in Table 4-1. At this stage there is no information as to whether such zones are continuous between beds. Zones were modelled at several locations at the top of coal seams.

5.2.3 3D Wedge Failure

Wedge failures have not been modelled. Occasional steeply dipping discontinuities were observed in core photos, however it is considered unlikely that the persistence of such discontinuities will be large enough to allow the development of large wedge failures affecting the highway. Small wedge failures in benches may be possible.

5.2.4 Toppling Failure

Toppling failures were not modelled and are considered unlikely considering the 0.5H:1V cut slopes.

5.3 Material Parameters

Material Parameters used are described in Section 4.2. Rock parameters were determined based on rock type and UCS derived sonic velocities from boreholes.

5.4 2D Slip Surface Models

5.4.1 Initial Model

5.4.1.1 Model Configuration

Initial modelling was done using pit geometry and stratigraphy based on borehole information (Borehole STX050). The boreholes with geotechnical logs did not provide sufficient information to determine the dip and dip direction of the bedding; for this preliminary study two models were prepared with zero bedding dip and constant 7° dip across the section as shown in Figure 5-1 and Figure 5-2 on the following page.

Material strength parameters from Table 4-1 were used. Fresh sandstone was modelled using the “weak” strength values ie $c=200$ kPa, $\varphi=40°$.

A perched water table was modelled, ie pore pressures were only considered in the overburden.

Additional modelling for the detailed model was undertaken using a pore pressure coefficient (R_u) of 0.15 as per Section 3.3.2 of the DTMR Geotechnical Design Standard.

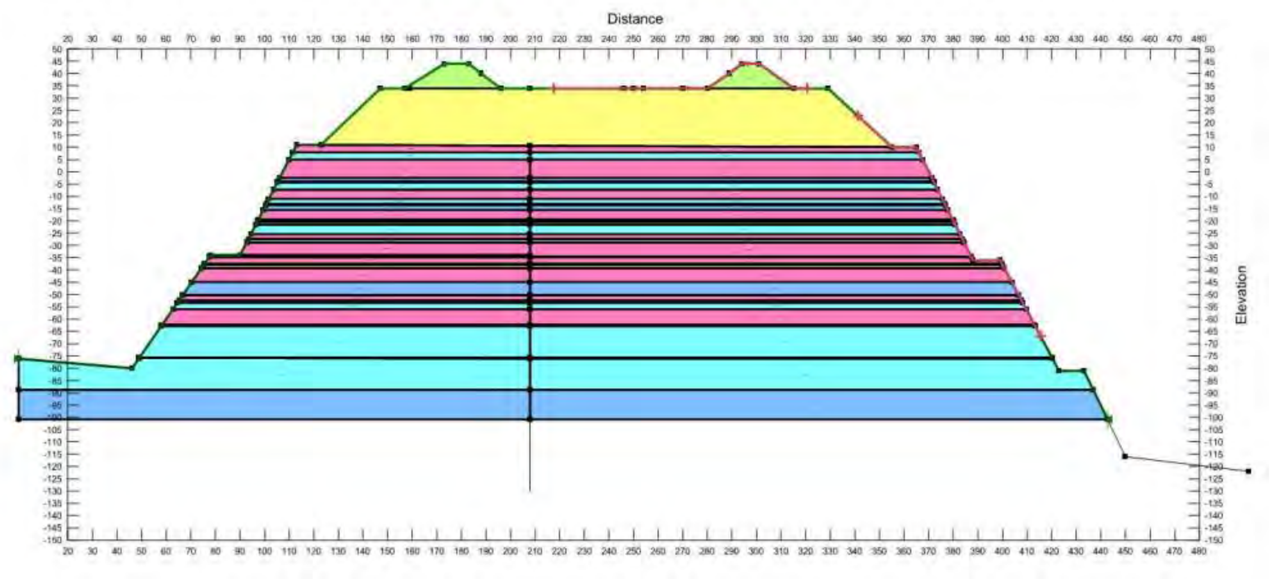


Figure 5-1 Initial Slope Stability Model Zero Bedding Dip

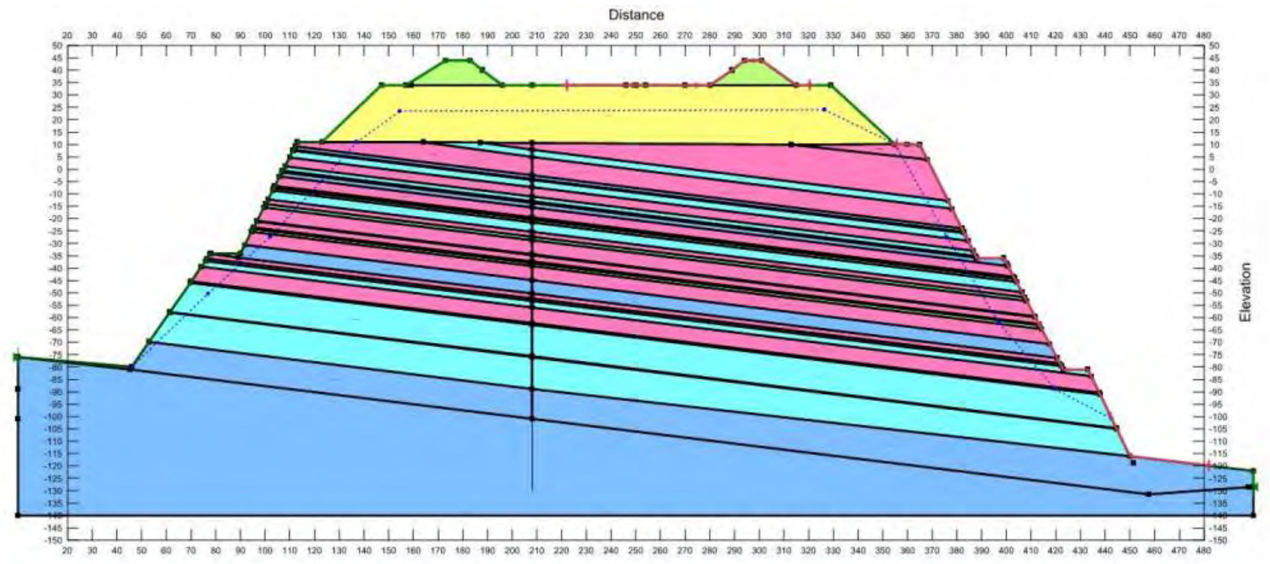


Figure 5-2 Initial Slope Stability Model 7° Bedding Dip

5.4.1.2 Results

The results of the preliminary slope stability analysis are summarised in Table 5-1.

Table 5-1 Slope Stability Results Preliminary Model

Model Geometry	Pit Depth	Water Table	FOS	Comments
Zero Dip	100m	Perched 11m deep	1.52	Refer Figure 5-3
	150m	Perched 11m deep	1.33	Refer Figure 5-4
7°Dip	100m	Perched 11m deep	1.57	Refer Figure 5-5
7°Dip	150m	Perched 11m deep	1.34	Refer Figure 5-6

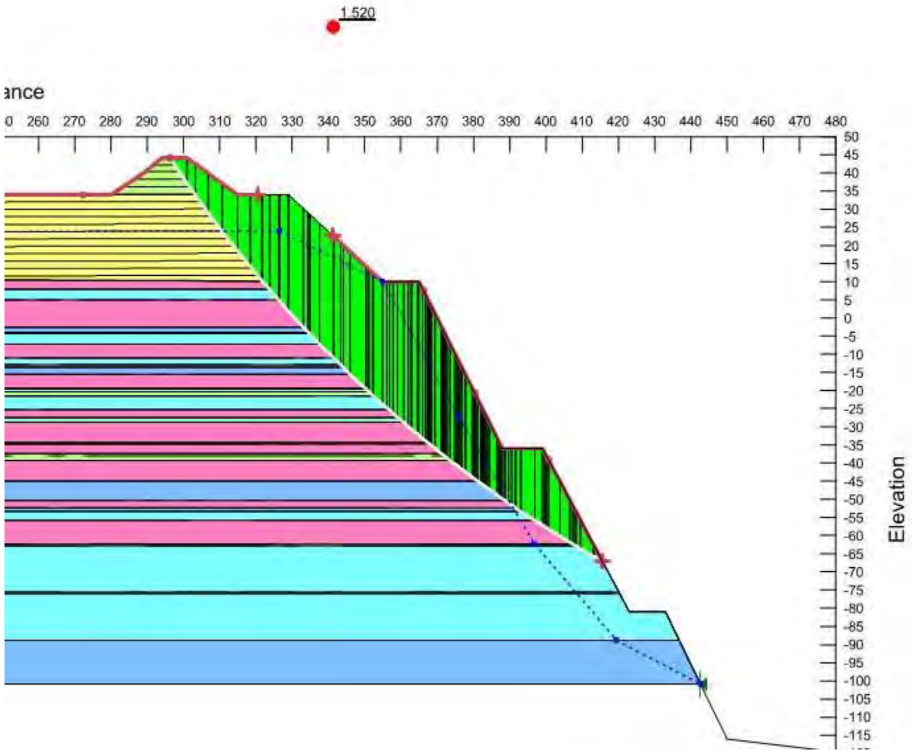


Figure 5-3 Failure Surface Zero Dip 100m pit depth

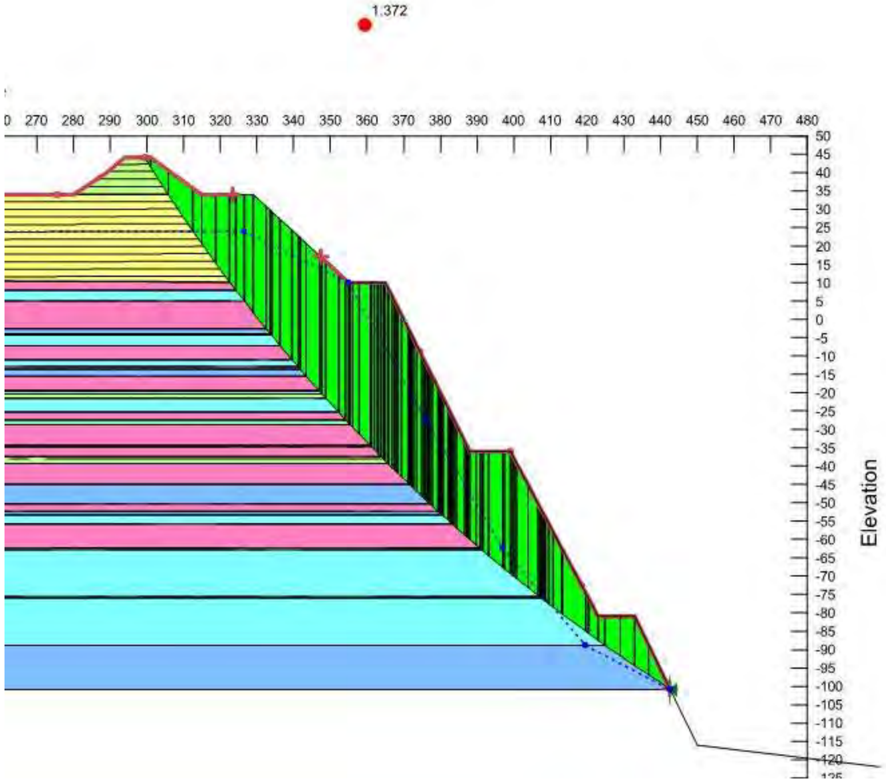


Figure 5-4 Failure Surface Zero Dip 150m pit depth

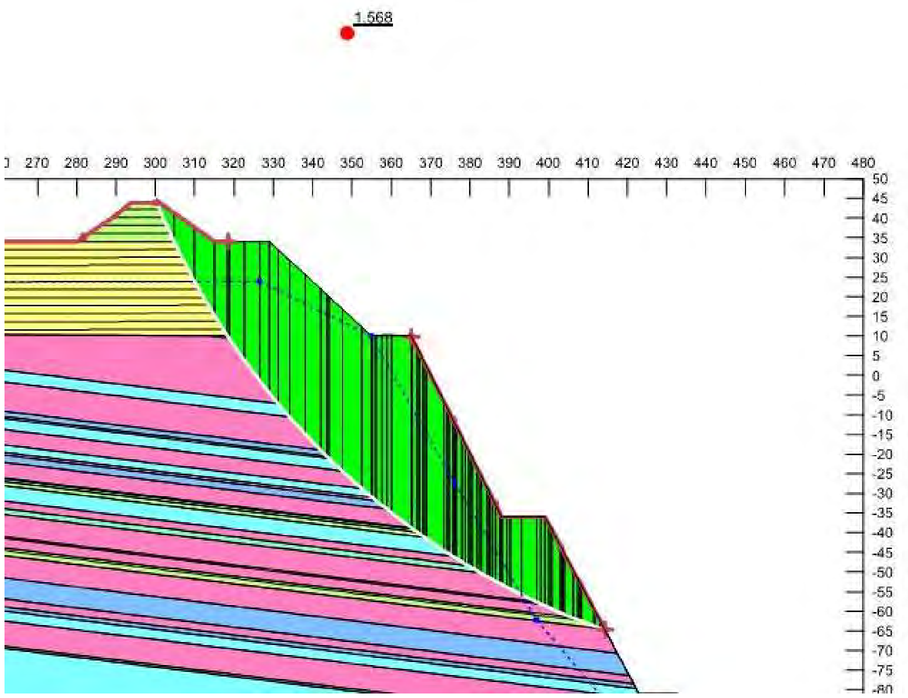


Figure 5-5 Failure Surface 7° Dip 100m pit depth

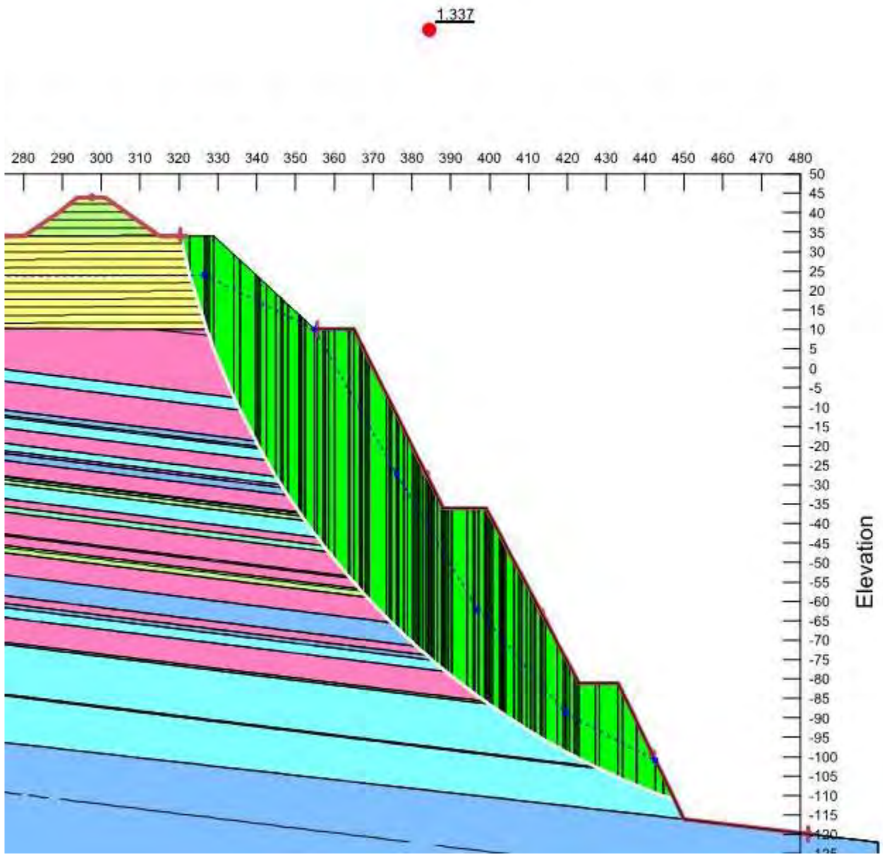


Figure 5-6 Failure Surface 7° Dip 150m pit depth

5.4.1.3 Discussion

The initial modelling showed factors of safety in excess of 1.5 for pit depth up to 100m and in excess of 1.3 for pit depths up to 150m. Further stability modelling was done using a model based on Hoek brown material parameters and stratigraphy based on 3D modelling of coal seams as described in Section 3.3.

5.4.2 Detailed Model

5.4.2.1 Model Setup

Following receipt of cross sections with coal seam depths derived from 3D pit modelling a revised slope stability analysis was performed. Hoek-Brown strength parameters were derived from logs and UCS values from sonic velocities. As many of the logs showed finely interbedded sandstone, siltstone and mudstone, a mixed sedimentary model was adopted as described in Section 4.2.4.

A perched water table was modelled, i.e. pore pressures were only considered in the overburden.

Additional modelling was undertaken using a pore pressure coefficient (R_u) of 0.15 as per Section 3.3.2 of the DTMR Geotechnical Design Standard.

5.4.2.2 Results

A summary of results is presented in Table 5-2. These analyses are for open pits.

Table 5-2 Slope Stability Results Revised Model

Model Geometry	Pit Depth	Water Table	FOS	Comments
High Strength RHS	100m	Perched	1.54/2.00	Lower value is failure in overburden Refer Figure 5-7
High Strength LHS	Full Depth	Perched	2.07	Refer Figure 5-8
Low Strength RHS	Full Depth	Perched	1.02	Refer Figure 5-9
Low Strength RHS	100m	Perched	1.34	Refer Figure 5-10
Probable Lower Bound Strength RHS	Full Depth	Perched	1.54/1.65	Lower value is failure in overburden Refer Figure 5-11
Probable Lower Bound Strength RHS	Full Depth	Perched	1.63	Refer Figure 5-12
Probable Lower Bound Strength RHS	100m	R_u 0.15	1.62/1.91	Lower value is failure in overburden Refer Figure 5-13
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	1.56	Refer Figure 5-14
Planar Failure RHS	100m	R_u 0.15	1.73	Refer Figure 5-15
Planar Failure RHS	125m	R_u 0.15	1.43	Unfavourable geometry on dipping coal seam Refer Figure 5-16
Planar Failure RHS	Full Depth	R_u 0.15	1.44	Figure 5-17
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	1.41	Pseudo static seismic 0.08g Refer Figure 5-18

Table 5-3 Slope Stability Results – Pit Filling

Model Geometry	Pit Depth	Water Table	FOS	Comments
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	1.88	Pit filled to bottom of 2nd bench Refer Figure 5-19.
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	2.80	Pit filled to bottom of 1st bench Refer Figure 5-20.

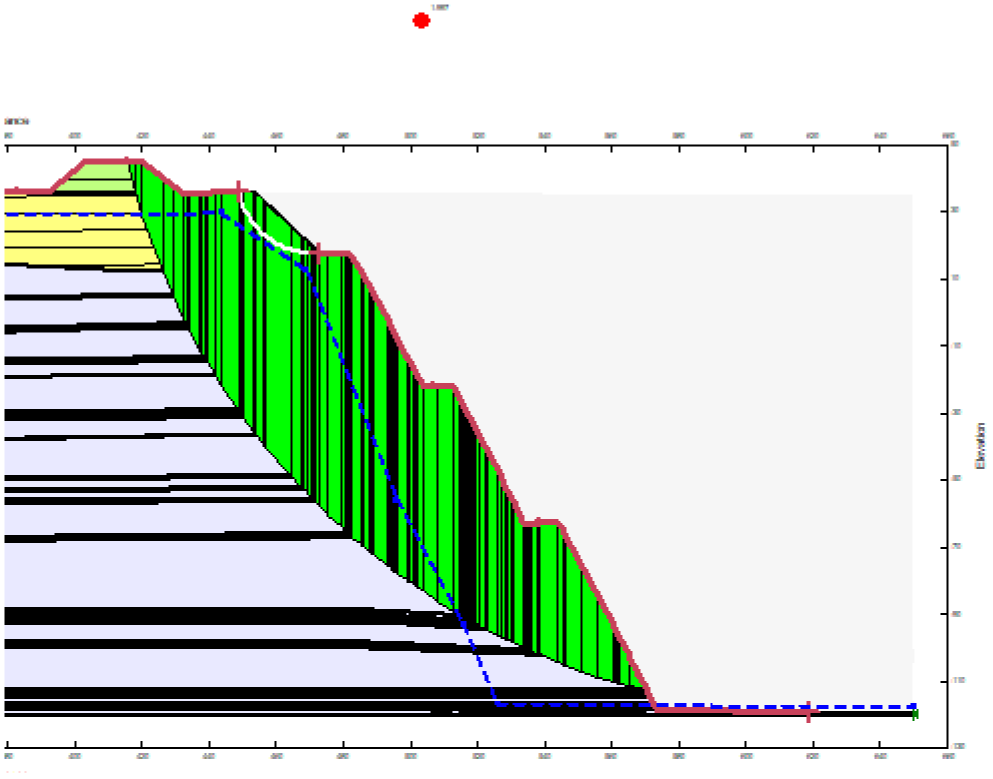


Figure 5-7 High Strength Model 150m Pit RHS

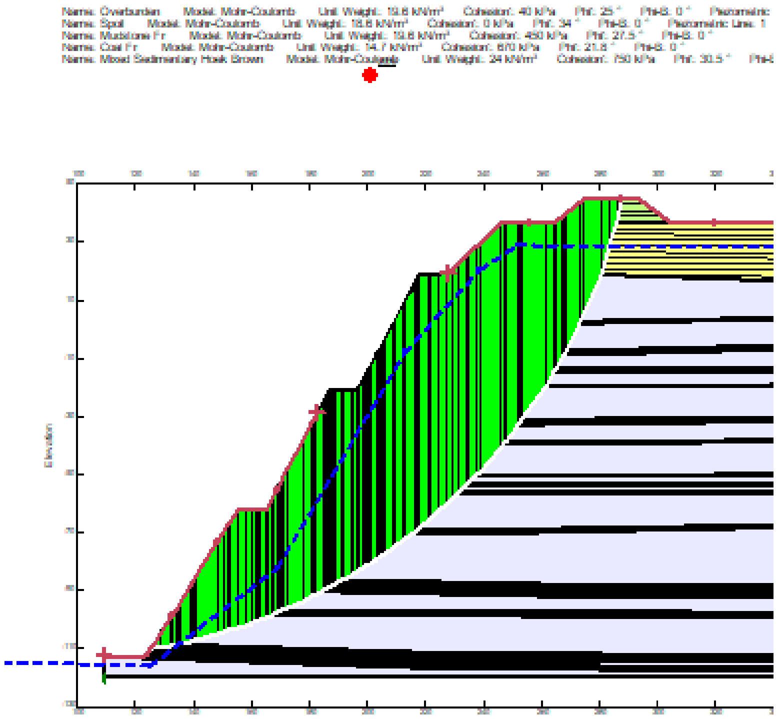


Figure 5-8 High Strength Model 150m Pit LHS

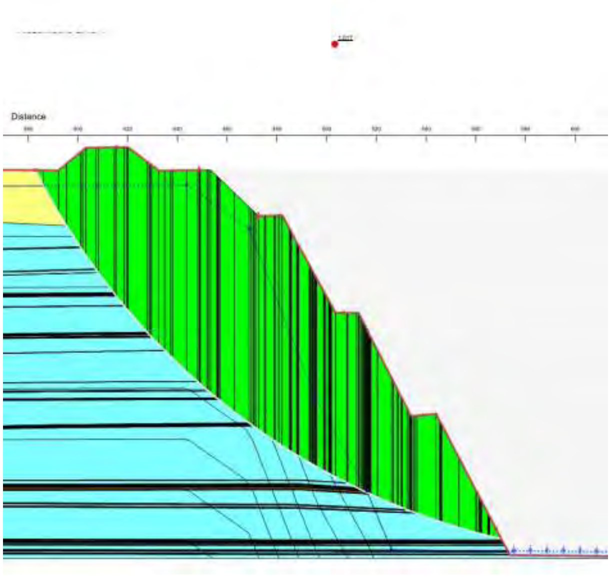


Figure 5-9 Low Strength Model Full Depth \ Pit RHS

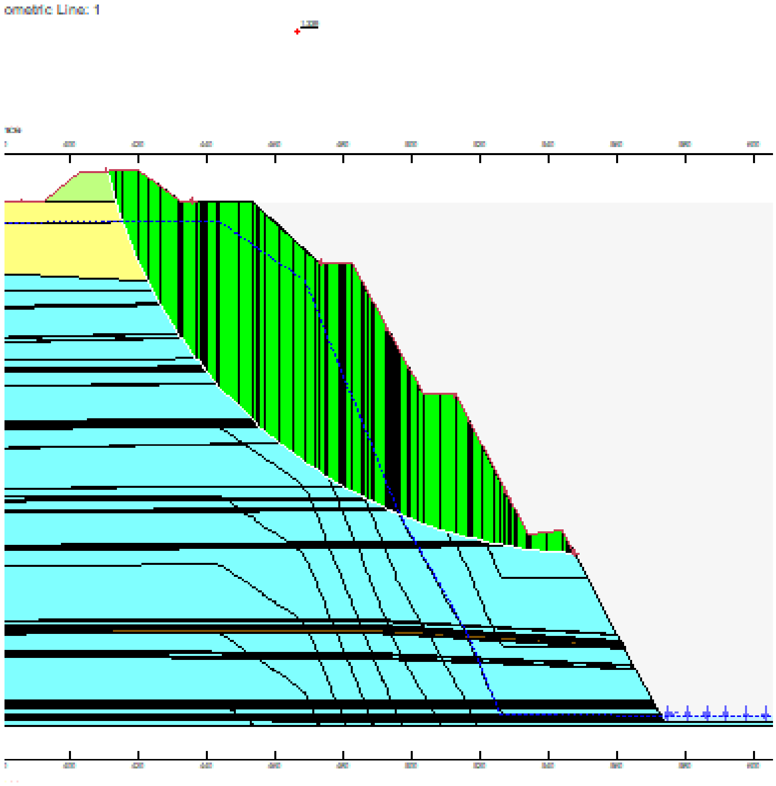


Figure 5-10 Low Strength Model 150m Pit RHS

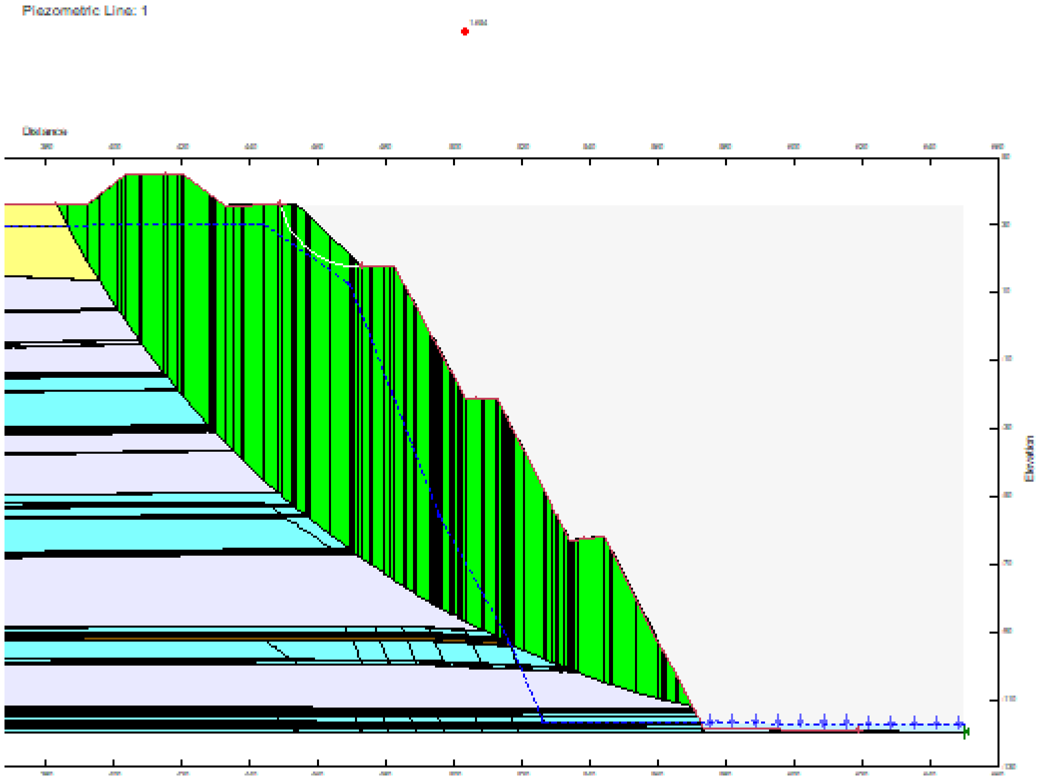


Figure 5-11 Lower Bound Strength RHS

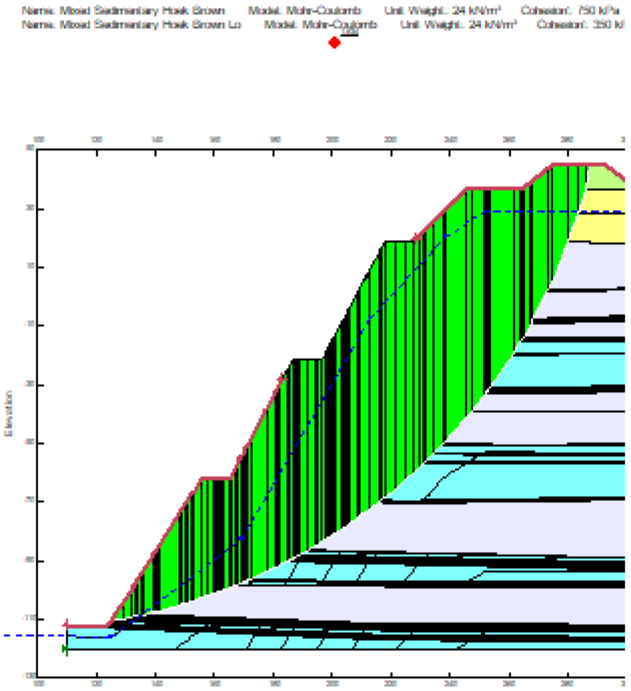


Figure 5-12 Lower Bound Strength LHS

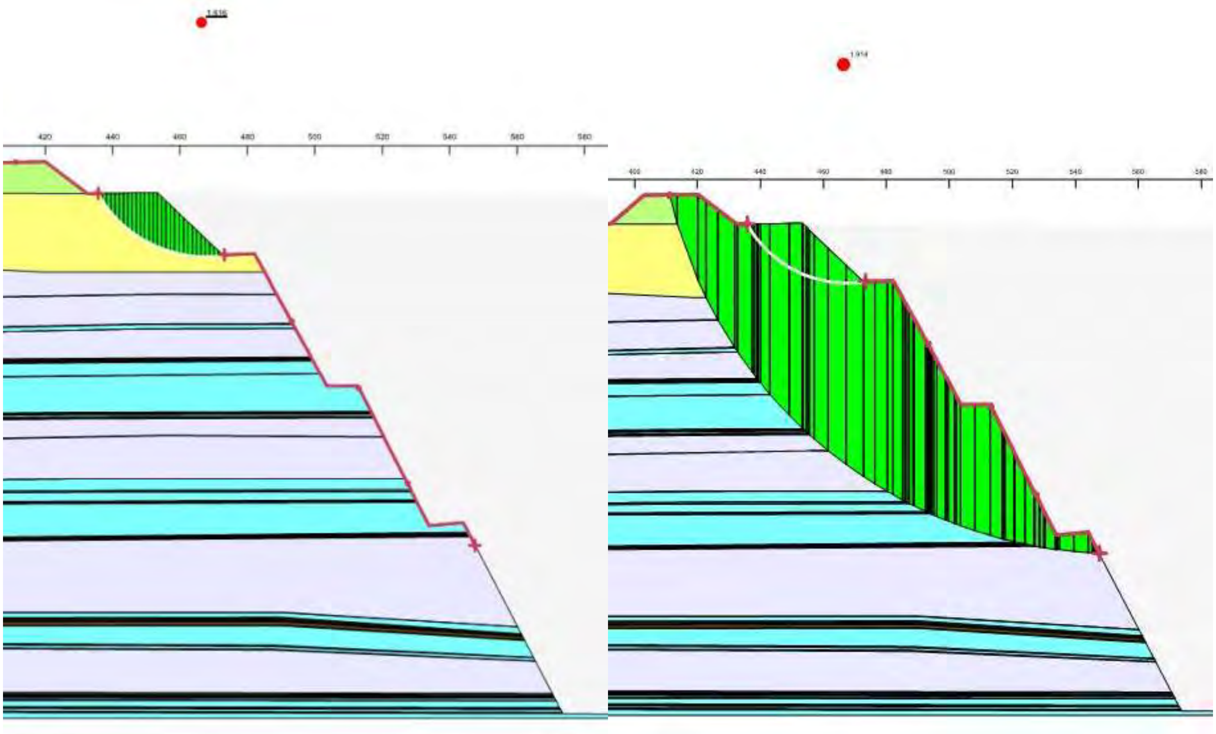


Figure 5-13 Lower Bound Strength R_u 0.15 100m deep pit RHS

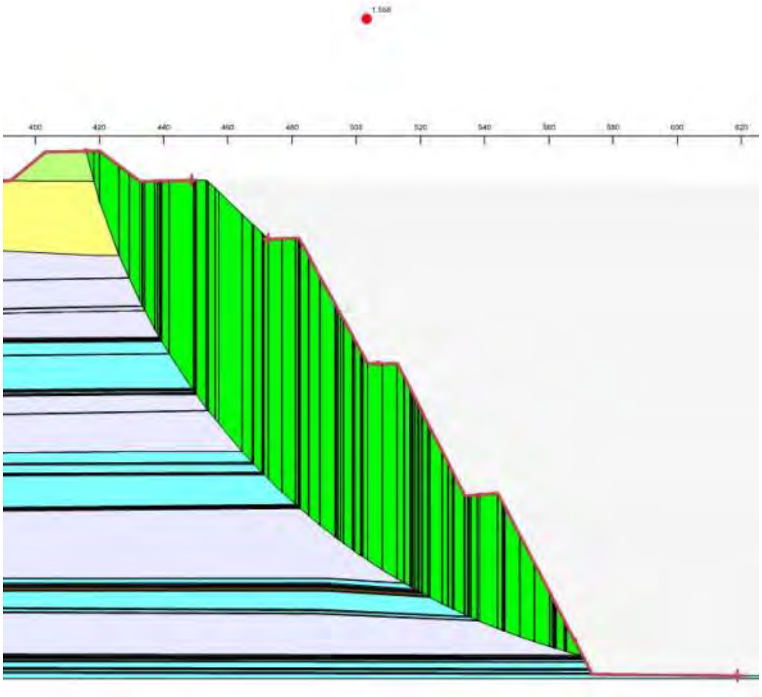


Figure 5-14 Lower Bound Strength R_u 0.15 full depth pit RHS

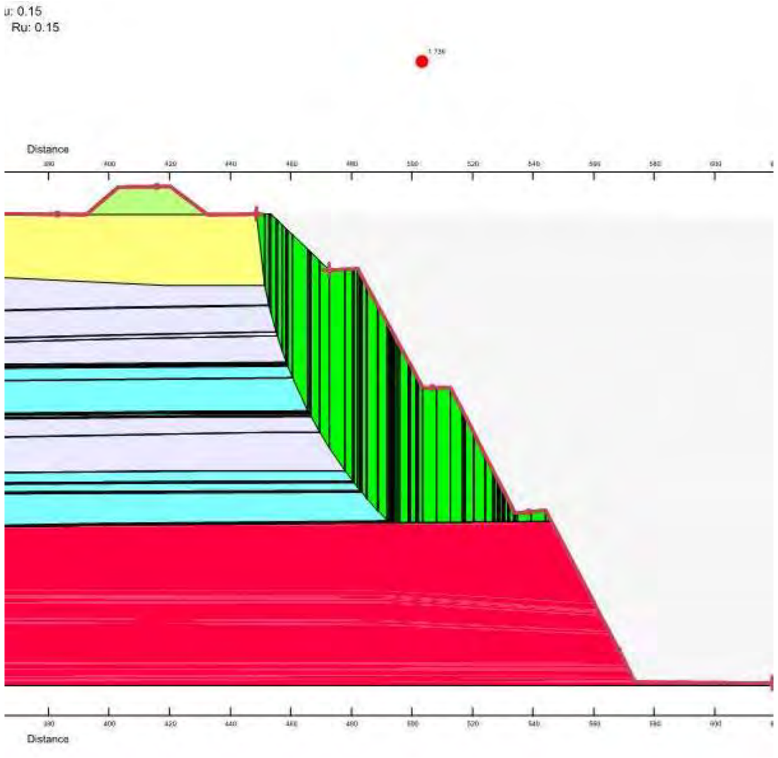


Figure 5-15 Planar Failure 100m deep pit

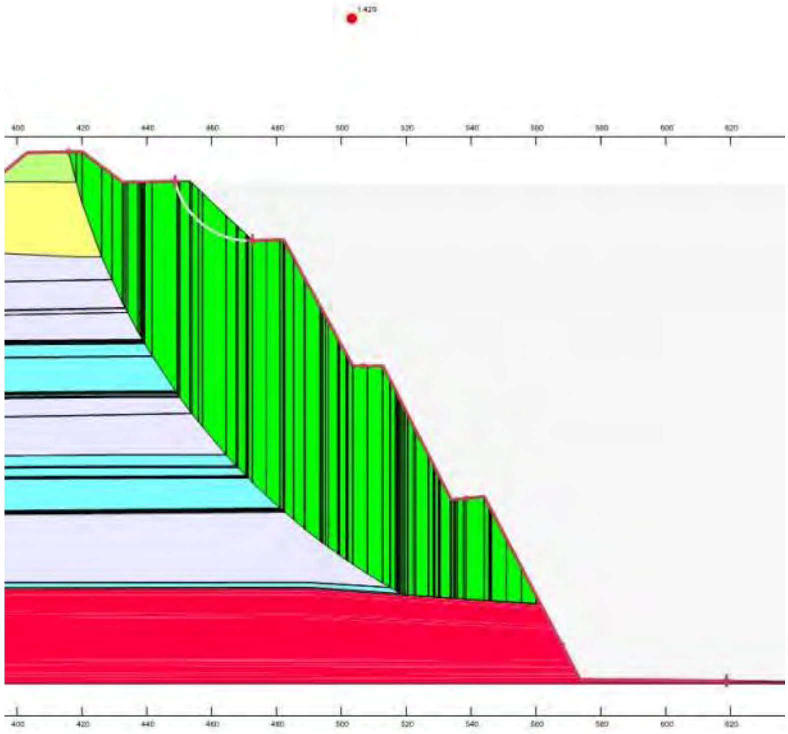


Figure 5-16 Planar Failure Unfavourable Dip

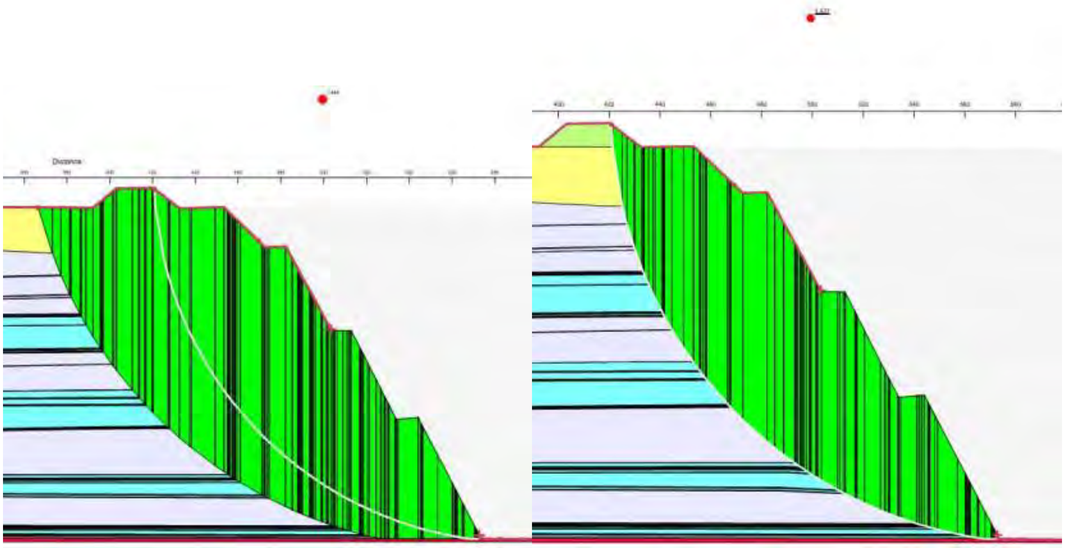


Figure 5-17 Planar Failure bottom coal seam

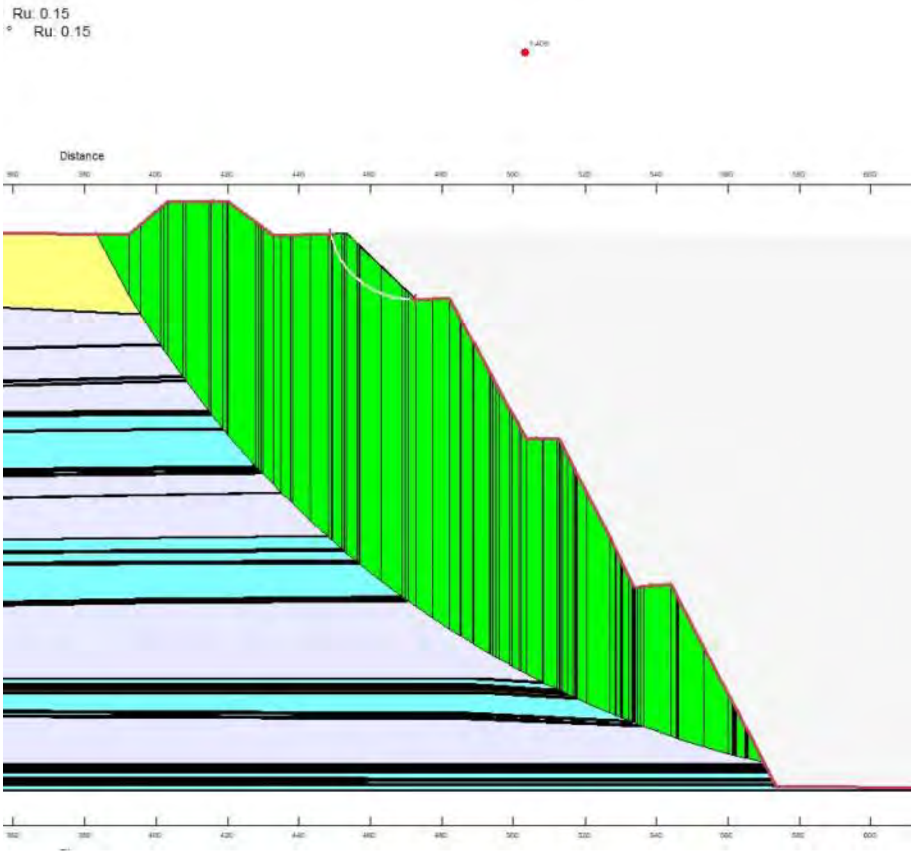


Figure 5-18 Full Depth Pit RHS Pseudo Static 0.08g

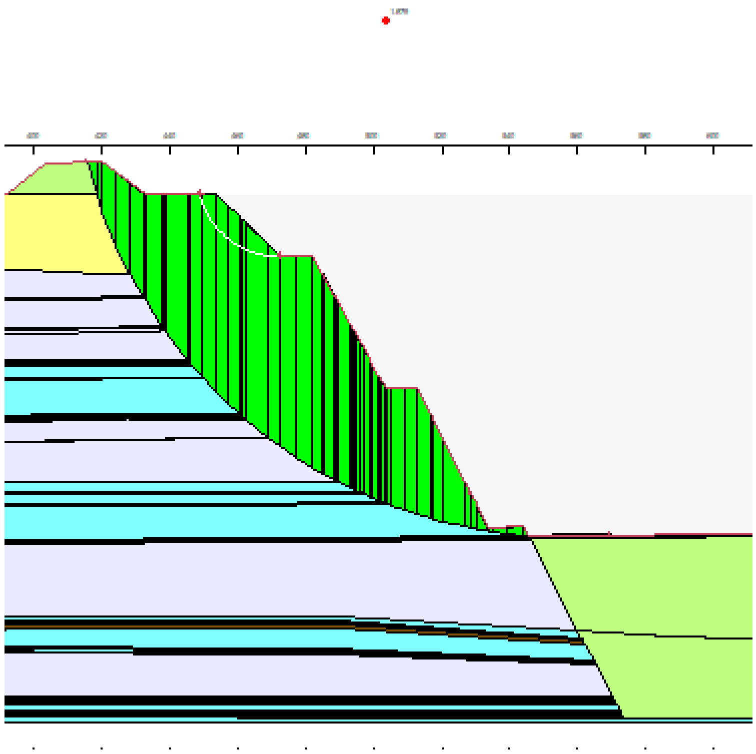


Figure 5-19 Partial Pit Filling Stage 1

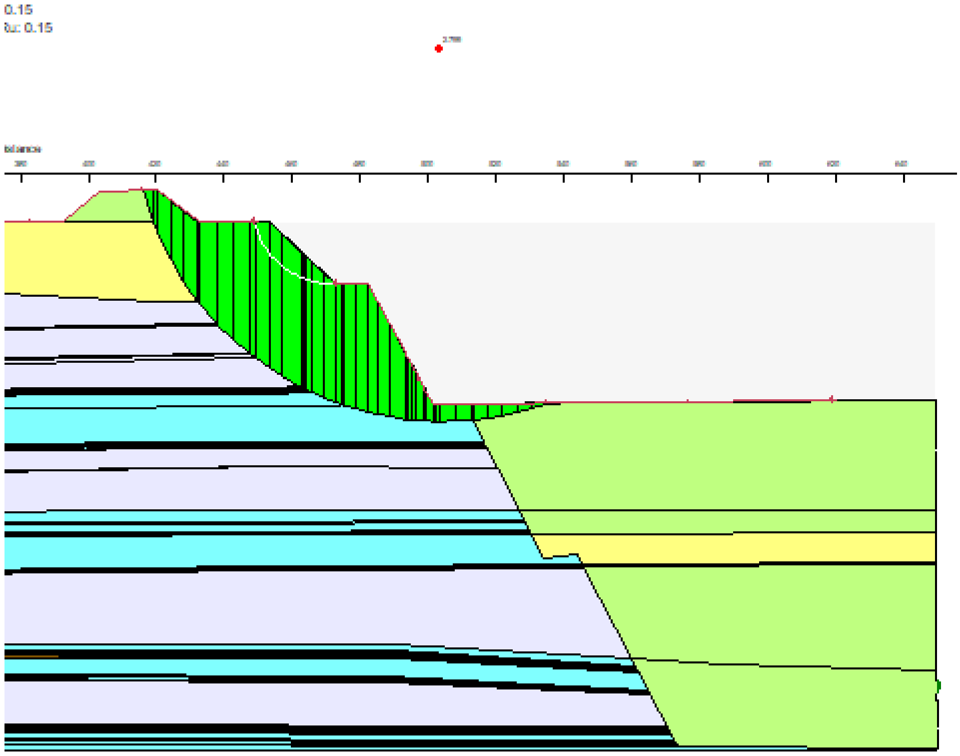


Figure 5-20 Partial Pit Filling Stage 2

6 Deformation Modelling

6.1 Introduction

Deformation modelling was undertaken using PLAXIS 2D software. The cross section geometry was identical to the geometry used to develop the slope stability model described in Section 5.4.2.

6.1.1 Material Properties

The following material models were used:

> Spoil and Overburden	Mohr Coulomb Model
> Rock and Coal	Hoek Brown Model

The material properties used are summarised in Table 4-3.

6.1.2 Excavation Sequence

Table 6-1 Plaxis Model Sequence

Phase	Description	Comments
Initial Phase	Initial Conditions	No construction
Phase 1	Construct Safety Bunds	
Phase 2	Excavate to base of overburden RHS	
Phase 3	Excavate to bottom of 1st bench RHS	
Phase 4	Excavate to middle of 2nd bench RHS	Base of coal seam approx. 100m deep
Phase 5	Excavate to middle of 3rd bench RHS	
Phase 6	Excavate to bottom of deepest mapped coal seam RHS	Full pit depth
Phase 7	Fill to bottom of 1st bench	
Phase 8	Fill to base of overburden	
Phase 9	Fill to original ground level	
Phase 10	Excavate to base of overburden LHS	
Phase 11	Excavate to approx. RL -10 LHS	
Phase 12	Excavate to approx. RL -65 LHS	
Phase 13	Excavate to bottom of deepest mapped coal seam	

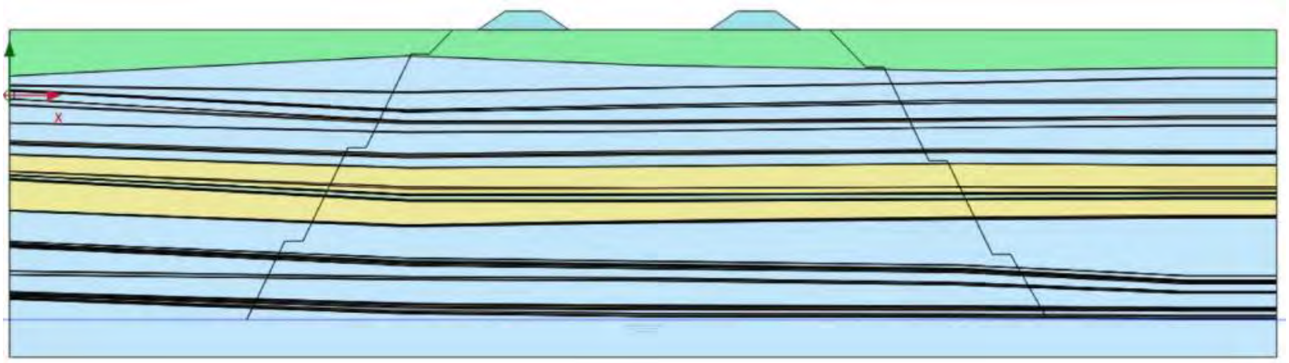


Figure 6-1 Plaxis Model Initial Phase

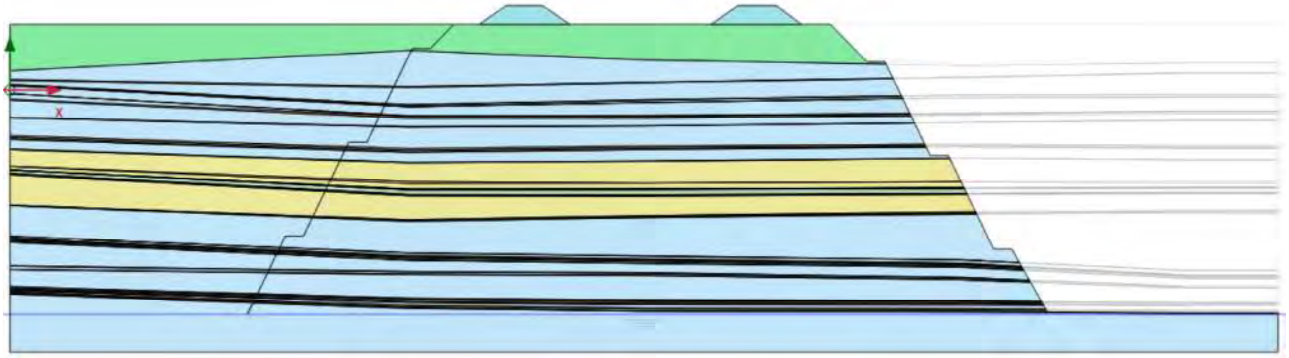


Figure 6-2 Plaxis Model Full Depth Excavation RHS

6.1.3 Initial Stress Conditions

Three initial stress states were considered, namely:

- Automatic determination of K_0
- Isostatic Conditions ($\sigma_H=\sigma_V$)
- Locked in Stresses ($\sigma_H=2\sigma_V$)

6.1.4 Calculated Deformations

Deformations were output for points as described in Table 6-2. Additional deformation information including deformed mesh, deformation contours etc is available from the Plaxis model but has not been presented here. It is understood that the primary concern is horizontal and vertical movement at the highway alignment.

Table 6-2 Deformation Points

Point Number	Location
A	Road centreline
B	Top of cut in overburden
C	Inside of 1st bench
D	Outside of 1st bench
E	Inside of 2nd bench
F	Outside of 2nd bench
G	Inside of 3rd bench
H	Outside of 3rd bench
I	Bottom of cut (lowest coal bed)

6.2 Results

Calculated deformations are presented in Table 6-3 to Table 6-6.

6.2.1 Isostatic Model

Table 6-3 Calculated Horizontal Deformations (mm) Isostatic Stress Condition

	A	B	C	D	E	F	G	H	I
Phase 1	0.1	1.4	0.2	-0.1	0.1	0.1	0.1	0.1	0.0
Phase 2	0.3	0.9	0.0	4.1	0.7	0.7	0.5	0.5	0.2
Phase 3	1.9	3.2	3.2	5.4	4.3	3.5	2.4	2.2	0.9
Phase 4	3.8	6.1	6.3	4.4	9.7	10.0	3.8	3.3	1.4
Phase 5	6.5	10.0	10.2	2.3	14.7	15.0	15.3	16.0	2.0
Phase 6	7.7	12.3	13.0	0.6	17.2	17.6	21.0	22.1	3.6

Table 6-4 Calculated Vertical Deformations[1] (mm) Isostatic Stress Condition

	A	B	C	D	E	F	G	H	I
Phase 1	-0.1	0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0
Phase 2	-0.2	2.7	3.4	4.1	2.1	2.2	1.2	1.2	0.4
Phase 3	-0.5	3.1	4.3	5.4	5.2	6.9	3.9	4.2	1.5
Phase 4	-1.0	2.1	3.3	4.4	4.8	6.1	5.0	5.8	2.2
Phase 5	-1.8	0.2	1.3	2.3	2.8	4.1	4.3	6.1	3.0
Phase 6	-2.3	-1.2	-0.2	0.6	0.7	1.9	3.5	5.3	3.8

Table 6-5 Calculated Horizontal Deformations (mm) $\sigma_H=2\sigma_V$

	A	B	C	D	E	F	G	H	I
Phase 1	0.2	1.5	0.3	0.2	0.2	0.2	0.1	0.1	0.0
Phase 2	0.4	1.0	0.3	-0.4	0.8	0.7	0.5	0.5	0.2
Phase 3	4.6	8.4	9.7	9.7	8.4	6.6	3.9	3.6	1.3
Phase 4	12.2	19.9	21.7	21.6	28.1	29.2	16.8	16.7	2.4
Phase 5	21.3	36.2	40.1	39.9	48.5	49.7	51.9	54.1	5.3
Phase 6	24.7	48.2	48.0	59.5	59.5	60.6	65.4	67.6	12.0

---

[1] +ve up, -ve down

Table 6-6 Calculated Vertical Deformations (mm) Isostatic $\sigma_H=2\sigma_V$

	A	B	C	D	E	F	G	H	I
Phase 1	-0.2	0.0	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0
Phase 2	-0.2	0.0	3.5	4.5	2.1	2.2	1.2	1.2	0.4
Phase 3	-0.9	0.0	3.2	4.2	4.4	6.6	3.9	4.3	1.4
Phase 4	-3.0	0.0	-1.4	-0.1	2.9	5.0	5.6	6.2	1.9
Phase 5	-6.9	0.0	-11.8	-10.7	-3.2	0.4	5.0	8.3	5.7
Phase 6	-8.6	0.0	-20.8	-19.3	-7.3	-3.2	3.4	7.4	8.0

6.3 Discussion

The deflection calculations show maximum lateral movements of 8mm and 25mm respectively at the highway centreline for isostatic and $\sigma_H=2\sigma_V$ stress conditions. Calculated settlements (vertical deformation) are 2mm and 9mm.

Deflections of this order of magnitude are unlikely to significantly affect the performance of the highway pavement and drainage.

7 Conclusions

7.1 Pit Stability

7.1.1 Acceptable Factor of Safety

DTMR Geotechnical Design Standards Minimum Requirements require a minimum factor of safety of 1.5 for long-term stability (Section 3.3). No acceptable factor of safety is provided for temporary works or short term conditions although a lower factor of safety of 1.3 is referenced for fill slopes in other parts of the document. As the proposed works differ from those normally undertaken by or for DTMR it is not clear whether a factor of safety less than 1.5 would be acceptable.

No factor of safety for seismic conditions is supplied; the document does state that the relevance of seismic stability issues shall be investigated. Limited slope stability modelling using a pseudo static acceleration of 0.08g indicates that seismic factors of safety are well in excess of the value typically used in dam studies (1.1).

7.1.2 Pore Pressure Conditions

Groundwater investigations indicate a perched water table in the overburden material (i.e. not affecting the sedimentary rocks and coal layers. DTMR Geotechnical Design Standards require analyses to be performed using a minimum pore pressure coefficient (R_u) of 0.15, both cases have been considered.

7.1.3 Discussion of Results

A summary of the results is provided in Table 5-2. The most critical section is the high wall on the north-eastern side of the pit. Using probable lower-bound strength parameters in excess of 1.5 were obtained for all circular failure surfaces.

Factors of safety as low as 1.02 were obtained for lowest strength parameters (considered an unlikely scenario).

Planar wedge failures along a postulated low strength shear zone produced factors of safety as low as 1.43 for the full depth pit and 1.73 for a 100m deep pit.

For planned pit depths greater than 100m additional geotechnical investigations are recommended; it is probable that these would give more certainty to pit designs with depths greater than approximately 120m (Refer Section 7.4).

7.2 Deformations

A deformation study was undertaken using Plaxis finite element software. The results can only be considered indicative, however they indicate likely maximum horizontal deflections at the highway centreline of the order of 25mm.

7.3 Construction Feasibility

This report does not provide comments on construction feasibility. It should be noted that the assumption has been made that rock slopes will be pre-split. This should minimise disturbance to the rock, a disturbance factor (d) of zero has been assumed for Hoek-Brown strength parameters used in modelling.

7.4 Recommendations for Additional Investigation

On the basis of the desktop evaluation and prior to DTMR and regulatory negotiations we suggest the following as a minimum scope for further additional investigation work. We strongly recommend that this scope is discussed with all stake holders prior to commencement of further investigation.

We propose that four geotechnical holes are drilled by specialist drilling contractors to 165m depth (pit depth plus 10%) with SPT sampling in the upper soil horizons at 1.5m depth intervals and rock coring as soon as 2 consecutive SPTs achieve refusal. These holes will be logged to AS1726 by an experienced geologist or geotechnical engineer at site. Particular attention needs to be given to logging of the structural defects within the core.

The cores will be photographed and then wrapped and stored carefully to preserve moisture levels. Representative cores will be selected for geomechanical analysis to further understand the rock strength and deformation parameters. Laboratory testing is likely to include:

- CU triaxials for weathered overburden material;
- Rock triaxials with appropriate cell pressures considering the depth of the pits; and
- Shear box tests on sheared zones if encountered.

A geotechnical investigation report will then be written that will use both this desktop study plus the new information from the borehole investigation to supplement the geotechnical model and stability analysis.

7.5 Slope Monitoring

A properly designed monitoring system will be required, details will need to be discussed and finalised. This may include the following items:

- Surface monitoring points (x,y,z movements) with baseline as required;
- Inclinometers to full pit depth (either inside or outside safety bunds); and
- Regular inspections.

Instruments would be monitored on a regular basis and following each blast.

APPENDIX

A

GEOLOGICAL REPORT

1.0 GEOLOGY

This report covers the geological and geotechnical assessment of open cut pits adjacent to the Bruce Highway at the Central Queensland Coal Project (Figure 1).

1.1 Introduction

The Central Queensland Coal Project lies within the Styx Coal Measures. Unconsolidated overburden comprises soil, colluvium and Tertiary Clay. Depth of weathering adjacent to the Bruce Highway ranges from 11.86 m to 28.50 m.

1.2 Geological Setting

The Project area is in the Styx Basin, a small, Early Cretaceas, intracratonic sag basin which covers an area of about 300 km^2 onshore and 500 km^2 offshore. The coal bearing strata are known as the Styx Coal Measures and consist of quartzose, calcareous, lithic and pebbly conglomerate, sandstone, siltstone, mudstone, carbonaceous shale and coal seams. Figure 2 shows the typical coal seams stratigraphy. The depositional environment was freshwater, deltaic to paludal, with occasional marine incursions.

The Styx Coal Measures occur as basin infill in a half graben geometry which has a plunge to the north. The deposit has north and east dipping components.

The full sequence of coal is about 6 m occurring within a sequence of about 120 m of coal bearing strata. A typical mining section across the Bruce Highway is shown in Figure 3.

1.3 Stratigraphy

The Styx Coal Measures comprise multiple coal seams which are generally interbedded with sandstone, siltstone and mudstone. Bedding thickness varies. Partings are present along bedding planes. Lensing of coal seams also occurs.

Multi-seam mining will be required with parting operations which minimise dilution.

1.4 Geological Structure

Bedding is generally uniform with an average dip of 3°. Maximum dip is about 7°. Partings occur along bedding planes. Jointing is generally widely spaced.

To date no significant faults or dykes have been encountered during geological investigations.

2.0 GEOTECHNICAL ASSESSMENT

2.1 Introduction

Ten exploratory drill holes have been geotechnically logged with sonically derived uniaxial strength values where sonic logs have been completed. These holes are adjacent to the Bruce Highway (Figure 4).

Definitions of rock, soil and degrees of chemical weathering are included in Table 1.

2.2 Shear Strength Values

An extensive assessment of shear strength values (friction Ø and cohesion c) and densities of soils and rock types has been completed to determine representative values for stability analyses (Table 2).

TABLE 2 - SHEAR STRENGTH VALUES

MATERIAL	DENSITY (t/m3)	FRICTION (DEG)	COHESION (kPa)
Overburden (clay and CW rock)	2.0	25	40
Spoil	1.9	34	0
Mudstone CW	1.9	20	100
Mudstone HW	1.9	24	60
Mudstone MW	1.9	25	200
Mudstone Fr	2.0	38	200
Siltstone CW	2.0	43	60
Shale Fr, competent *	2.5	15	38 400
Sandstone HW	2.0	38	60
Sandstone Fr, weak	2.5	40	200
Sandstone Fr, competent *	2.5	28	27 200
Coal Fr	1.5	35.5	420
Coal CW	1.2	22	0
Soot	1.2	9	0
Intraformational Shear Zone		25	9

* Reference - Goodman, R.E., 1998. Introduction to Rock Mechanics. John Wiley and Sons, New York, p.478.

2.3 Rock Strength Testing

Rock strengths have been determined by converting sonic velocity to sonically derived uniaxial compressive strength (UCS). There is no site specific conversion formula for the mine site. A general formula which is used in the Bowen Basin and is based on regression analysis of numerous tests on very weak rock to very strong rock is:-

$$\text{UCS} = 3330e^{-0.0499t}$$

Where t = interval transit time (reciprocal of velocity) in microseconds per foot

TABLE 1 - DEFINITIONS OF ROCK, SOIL AND DEGREES OF CHEMICAL WEATHERING

(A) GENERAL DEFINITIONS – ROCK AND SOIL

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces.

Note: Since ‘strong’ and ‘permanent’ are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one.

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by such gentle mechanical means as agitation in water.

The two principal classes of soil are:

(a) Residual soils – soils which have been formed in-situ by the chemical weathering of parent rock. Residual soil may retain evidence of the original rock texture or fabric or, when mature, the original rock texture may be destroyed.

(b) Transported soils – soils which have been moved from their places of origin and deposited elsewhere. The principal agents of erosion, transport and deposition are water, wind, ice and gravity. Two important types of transported soil in engineering geology and materials investigation are:

(c) Slopewash – a soil, often including angular rock fragments and boulders, which has been transported downslope predominantly under the action of gravity assisted by water. The principal forming process is that of soil creep in which the soil moves after it has been weakened by saturation. It may be water borne for short distances.

(d) Alluvium – a soil which has been transported and deposited by running water. The larger particles (sand and gravel size) are water worn.

(B) ROCK WEATHERING DEFINITIONS

COMPLETELY WEATHERED ROCK (CW)	Rock which retains most of the original rock texture (fabric) but the bond between its mineral constituents is weakened by chemical weathering to the extent that the rock will disintegrate when immersed and gently shaken in water. In engineering usage this is a soil.
HIGHLY WEATHERED ROCK (HW)	Rock which is weakened by chemical weathering to the extent that dry pieces about the size of 50mm diameter drill core can be broken by hand across the rock fabric. Highly weathered rock does not readily disintegrate when immersed in water.
MODERATELY WEATHERED ROCK (MW)	Rock which exhibits considerable evidence of chemical weathering, such as discolouration and loss of strength but which has sufficient remaining strength to prevent dry pieces about the size of 50mm diameter drill core (of inherently hard rock) being broken by hand across the rock fabric. Moderately weathered rock does not ring when struck with a hammer.
SLIGHTLY WEATHERED ROCK (SW)	Rock which exhibits some evidence of chemical weathering, such as discolouration, but which has suffered little reduction in strength. Except for some inherently soft rocks, slightly weathered rock rings when struck with a hammer.
FRESH WITH LIMONITE STAINED JOINTS (Fr St)	Joint faces coated or stained with limonite but the blocks between joints are unweathered.
FRESH ROCK (Fr)	Rock which exhibits no evidence of chemical weathering. Joint faces may be clean or coated with clay, calcite, chlorite or other minerals.

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the predominant degree of weathering first (eg. CW-HW).

The various degrees of weathering are not absolute strength parameters as some rocks are weak, even when fresh, to the extent that they can be broken by hand across the fabric.

Fresh drill cores of some rock types, mainly shale, siltstone, and silty or tuffaceous sandstone may disintegrate after exposure to the atmosphere due to slaking, desiccation, expansion or contraction, stress relief or a combination of any of these factors.

In drill holes where the sonic velocity has been recorded in microseconds per metre the formula is:-

UCS = $3330e^{-0.0499(t/3.28084)}$

Where t = interval transit time (reciprocal of velocity) in microseconds per metre

Laboratory UCS testing has been completed on 17 fresh cores of sandstone, siltstone and mudstone. Results are listed in Table 3 and details are included in Appendix 2.

TABLE 3 - LABORATORY UCS RESULTS

NO.	ROCK TYPE	UCS (MPa)
1.	Sandstone	25.2
2.	Sandstone	4.6
3.	Siltstone	5.02
4.	Sandstone	24.5
5.	Sandstone	20.9
6.	Sandstone	5.43
7.	Mudstone	18.4
8.	Siltstone	36.6
9.	Sandstone	18.0
10.	Sandstone	19.3
11.	Sandstone	30.5
12.	Mudstone	19.6
13.	Mudstone	3.56
14.	Sandstone	19.4
15.	Mudstone	22.8
16.	Mudstone	16.1
17.	Siltstone	11.7
18.	Sandstone	21.5
19.	Sandstone	7.76
20.	Mudstone	12.0

The rock types and strengths at the Central Queensland Coal Project are very similar to the rock types in the Rangal Coal Measures of the Bowen Basin. Prolonged exposure of mudstone and siltstone could result in surface fretting.

2.4 Geotechnical Logging

The ten exploratory holes in Figure 4 have geological logs which have been used to compile geotechnical logs with sonically derived UCS valves where available. The logs and representative core photographs are included in Appendix 1.

Details of geotechnical holes including depths of weathering are listed in Table 4. A summary of geological and geophysical logs for the geotechnical holes is included in Table 5.

TABLE 4 - DETAILS OF GEOTECHNICAL DRILL HOLES

HOLE	EASTING * (m)	NORTHING * (m)	ELEVATION ** (m)	DATE COMPLETED	TOTAL DEPTH (m)	DEPTH OF WEATHERING (m)
STX00505	773657.01	7486063.69	35.21	09-11-14	81.46	28.50
STX050C	774009.06	7485907.95	33.65	12-09-10	136.23	24.70
STX080	773422.08	7486312.65	33.10	10-02-10	128.84	25.14
STX104CR	774002.01	7486199.69		14-11-11	110.60	23.85 ?
STX113CR	773631.50	7486178.54	32.88	19-01-12	134.80	25.13
STX120	774153.54	7485901.99	34.08	10-03-11	197.88	23.50
STX124	772998.69	7486388.85	32.41	20-04-11	77.60	26.60
STX126B	771954.70	7487131.7	37.23	11-05-11	74.60	11.86
STX127	771431.56	7487323.69	37.23	13-05-11	74.60	16.82
STX132C	772585.31	7486943.74	31.50	04-06-11	74.60	19.40

* MGA 94 ** A.H.D.

TABLE 5 - SUMMARY OF GEOLOGICAL AND GEOPHYSICAL LOGS FOR GEOTECHNICAL DRILL HOLES

HOLE	GEOLOGICAL LOG	DENSITY	SONIC	AC TV	VERTICALITY
STX00505	Y	Y	N	N	Y
STX050C	Y	Y	Y	Y	Y
STX080	Y	Y	Y	N	Y
STX104CR	Y	Y	Y	N	Y
STX113CR	Y	Y	Y	Y	Y
STX120	Y	-	-	-	-
STX124	Y	Y	Y	N	Y
STX126B	Y	Y	N	N	N
STX127	Y	Y	Y	N	N
STX132C	Y	N	N	N	N

Geotechnical logging and core photographs indicate that the strata are generally competent. Local zones of fragmented core occur. No significant geological structures were observed. Minor structures include cross bedding, calcite veins and siderite bands. Bedding dip is shallow and bedding plane partings are common. Steeply dipping joints are rare.

3.0 HYDROGEOLOGY

Groundwater investigations at the Central Queensland Coal Project were completed by Australian Mining Engineering Consultants in 2014. The water table occurs at a depth of about 10.0 m. Pump out tests were completed by air lifting water and measuring flow rates using a V-notch weir. Average flow rates varied from 0.03 litres/sec to 0.075 litres/sec. Flow rates were very low indicating the lack of any significant aquifer in the area. Table 6 summarises the groundwater quality.

TABLE 6 - WATER QUALITY TEST RESULTS

HOLE NO.	pH	CONDUCTIVITY µS/cm	SALINITY (ppm)
STX00104 (0835)	6.9	2.23	13.3
STX00104 (0910)	7.6	2.02	11.9
STX00104 (0950)	7.6	2.45	15.1
STX00103	6.8	1.97	11.9
STX170	7.1	0.18	0.9
STX00204	6.8	2.05	12.7
STX00205 (1350)	7.5	2.21	13.0

Testing indicates that the groundwater is of potable water quality, being of neutral pH and with a very low salinity.

Pump-out tests were completed to determine transmissivity and storativity values (Table 7).

TABLE 7 - SUMMARY OF PUMP OUT TEST RESULTS

PRODUCTION HOLE	OBSERVATION HOLE	GRAPH TYPE	TRANSMISSIVITY (m^2/day)	STORATIVITY (Ratio)
STX00104		Recovery	0.013	
	STX170	Drawdown	9.504	0.0000044
	STX00103	Drawdown	2.066	0.0000008
	STX00204	Drawdown	5.165	0.0000002

Results show very low transmissivity and storativity values, indicating lack of any significant aquifers.

FIGURES

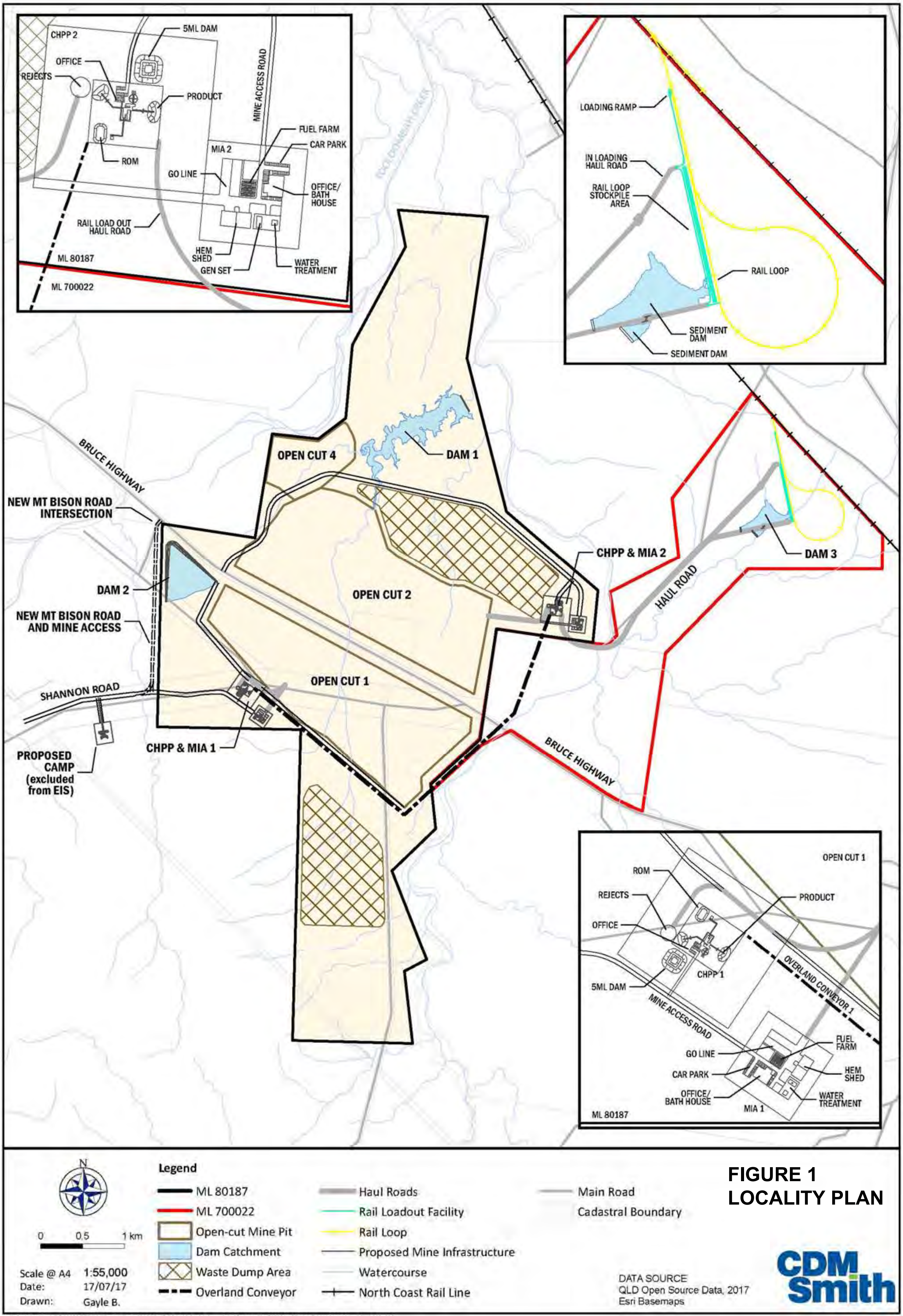


FIGURE 1
LOCALITY PLAN

Scale @ A4 1:55,000
Date: 17/07/17
Drawn: Gayle B.

DATA SOURCE
QLD Open Source Data, 2017
Esri Basemaps

CDM Smith

BRUGGEMANNGD B:\BES150160 Styx Coal\GIS\DATA\MXD\FINAL\02 EIS Preparation\BES150160.03-072 R1 project area layout.mxd 7/17/2017

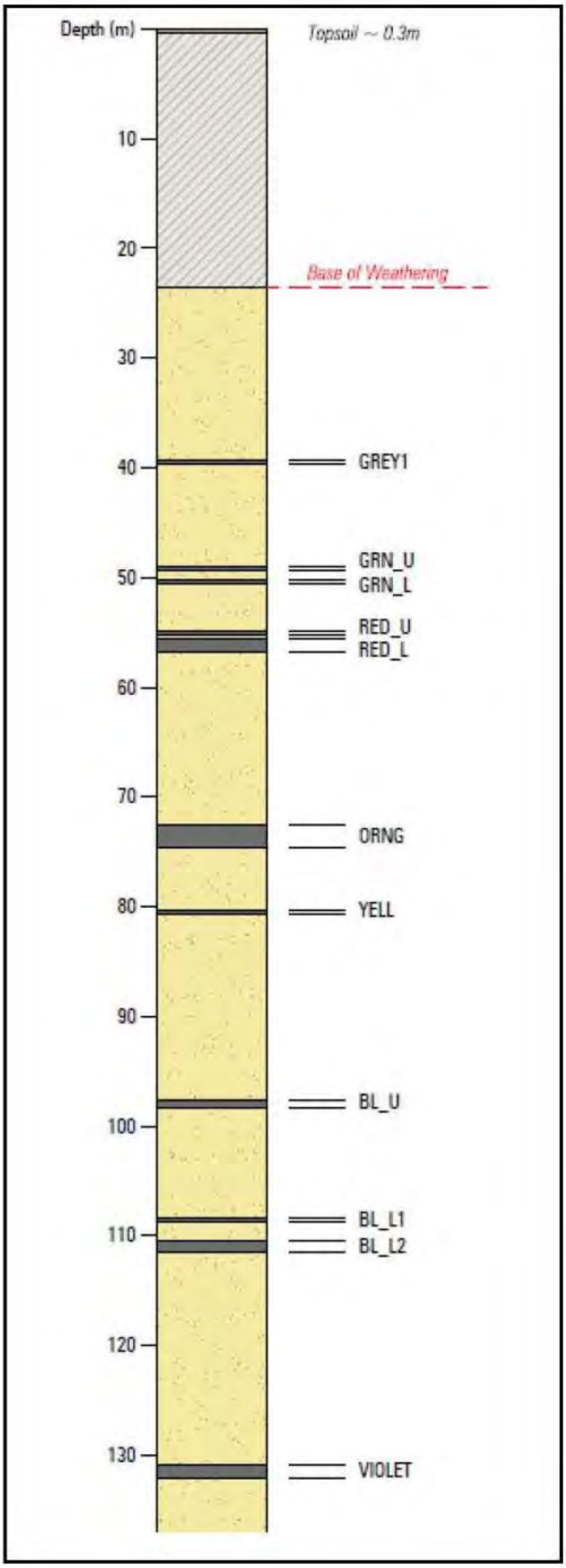


FIGURE 2 : TYPICAL STRATIGRAPHY, STYX COAL MEASURES

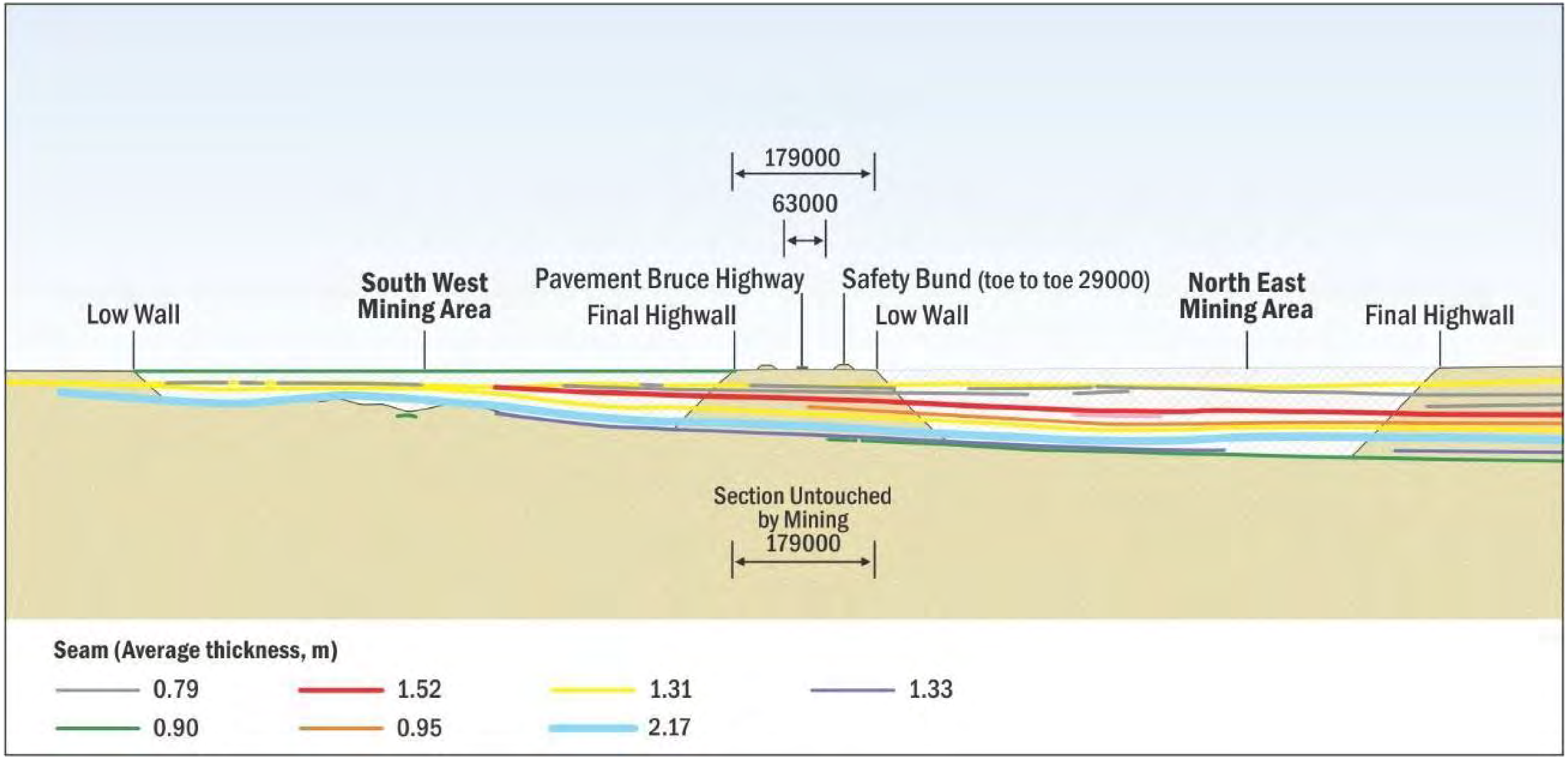


FIGURE 3 : MINING SECTIONS ACROSS THE BRUCE HIGHWAY

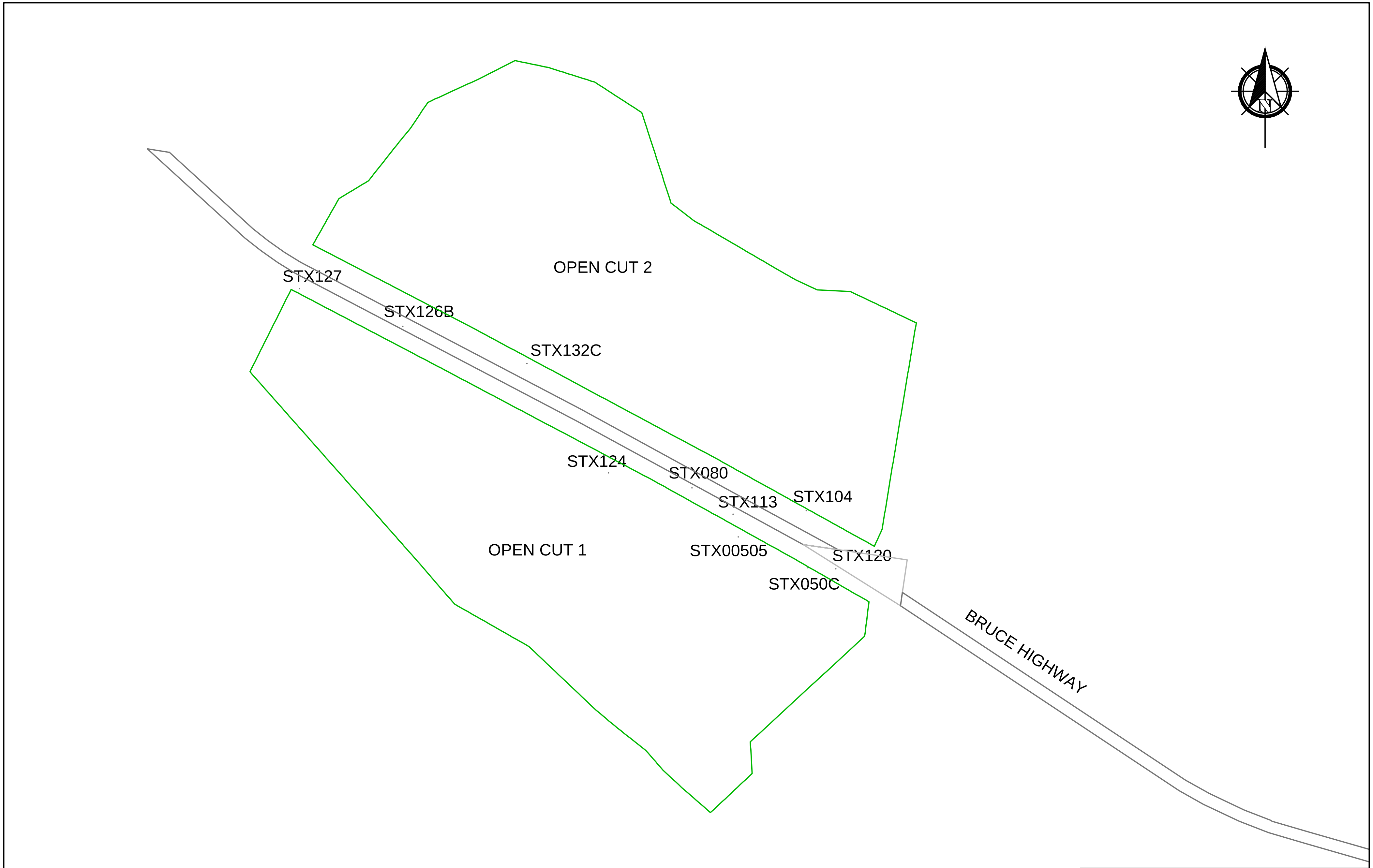


FIGURE 4
LOCATIONS OF
GEOTECHNICAL DRILL HOLES

APPENDIX 1

GEOTECHNICAL LOGS AND CORE PHOTOGRAPHS

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 657.01 N 7 486 063.69	BOREHOLE No: STX00505 SHEET 1 OF 5
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 35.21	DRILLING DATE: 09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR- ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
SOIL, dark brown		1.00			N.A.			N.A.
SAND, medium brown		5 10 15 20						

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 657.01 N 7 486 063.69	BOREHOLE No: STX00505 SHEET 2 OF 5
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 35.21	DRILLING DATE: 09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SAND, medium brown		25			N.A. Base of weathering 28.50			N.A.
SANDSTONE, light grey, fresh, fine to medium grained		28.50 30 35 40			INDETERMINATE			No sonic log

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 657.01
N 7 486 063.69

BOREHOLE No: STX00505

SHEET 3 OF 5

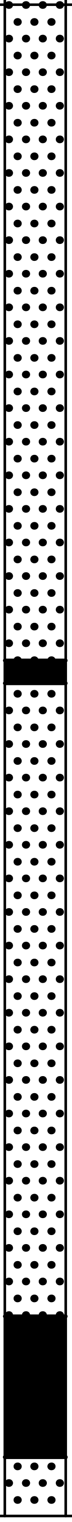
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 35.21

DRILLING DATE: 09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, light grey, fresh		45			**INDETERMINATE**			No sonic log
COAL, fresh		48.68						
SANDSTONE, light grey, fresh		48.98 50 55						
COAL, undifferentiated, fresh		57.36						
SANDSTONE, light grey, fresh		59.22 60						



45
50
55
60

REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 657.01
N 7 486 063.69

BOREHOLE No: STX00505

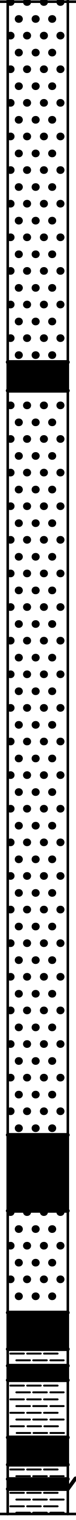
SHEET 4 OF 5

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 35.21

DRILLING DATE: 09/11/14



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, fresh			**INDETERMINATE**			No sonic log
COAL, fresh	64.77					
SANDSTONE, light grey, fresh	65.15					
	70					
COAL, undifferentiated, fresh	74.99					
SANDSTONE, light grey, fresh	75.99					
COAL, undifferentiated, fresh	77.34					
MUDSTONE, fresh	77.82					
COAL, fresh	78.04					
MUDSTONE, dark grey, fresh	78.23					
COAL, fresh	78.99					
MUDSTONE, fresh	79.35					
COAL, fresh	79.54					
	79.67		MUDSTONE, fresh			
	80					

R.L. DEPTH: 65, 70, 75, 80

10 20 40 60 80 100

65 70 75 80

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 657.01 N 7 486 063.69	BOREHOLE No: STX00505 SHEET 5 OF 5
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 35.21	DRILLING DATE: 09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, fresh	80.05			INDETERMINATE			No sonic log
COAL, fresh	80.30						
SANDSTONE, light grey, fresh							
END OF HOLE 81.46 m							
	85						85
	90						90
	95						95
	100						100

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

NO CORE PHOTOGRAPHS AVAILABLE

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No:
STX050C

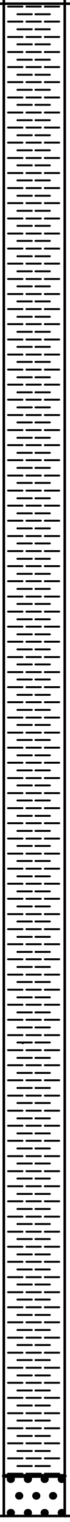
SHEET 1 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY,
GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.65

DRILLING DATE:
12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAYSTONE, dark blackish brown, weak, moderately weathered		5 10 15 18.93			**INDETERMINATE**			**N.A.**
CLAYSTONE, brown, moderately weathered		19.54						
SANDSTONE, weathered		20						

REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No: STX050C

SHEET 2 OF 7

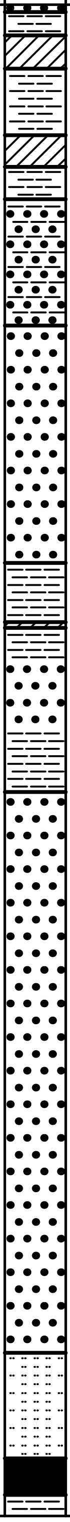
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

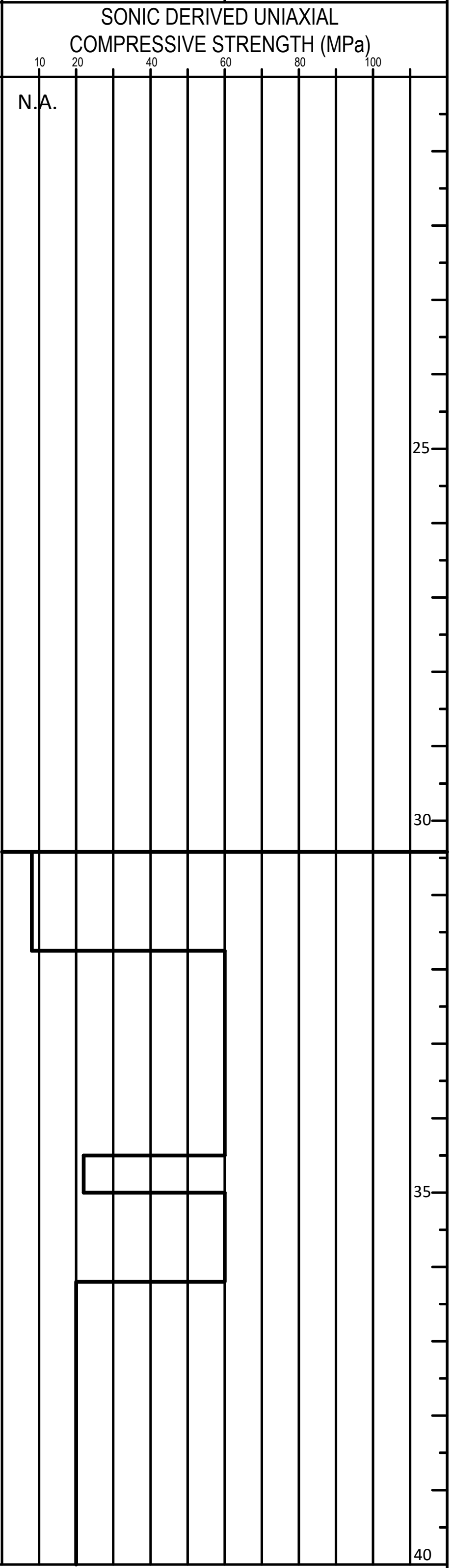
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 33.65

DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, weathered	20.10		INDETERMINATE		
CLAYSTONE, MUDSTONE, brownish grey, weathered	20.41				
Core loss	20.41–20.85				
Core loss	21.73–22.15				
SANDSTONE, MUDSTONE, slightly weathered	22.58				
SANDSTONE, light grey, fresh, moderately weak	24.25		Base of weathering 24.70		
	25				
Mainly MUDSTONE, grey, fresh, moderately weak. Minor SANDSTONE Core loss	27.39				
	30				
SANDSTONE, light grey, fresh, moderately strong	30.42				
	35				
SILTSTONE, grey, fresh, moderately strong	37.84				
COAL, fresh, weak	39.24				
MUDSTONE, fresh,	39.72				
	40				





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No:
STX050C

SHEET 3 OF 7

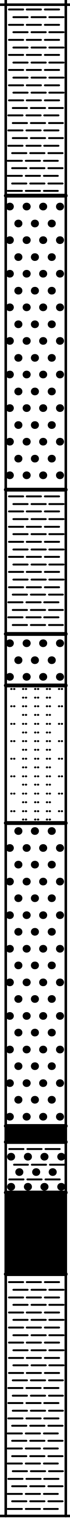
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

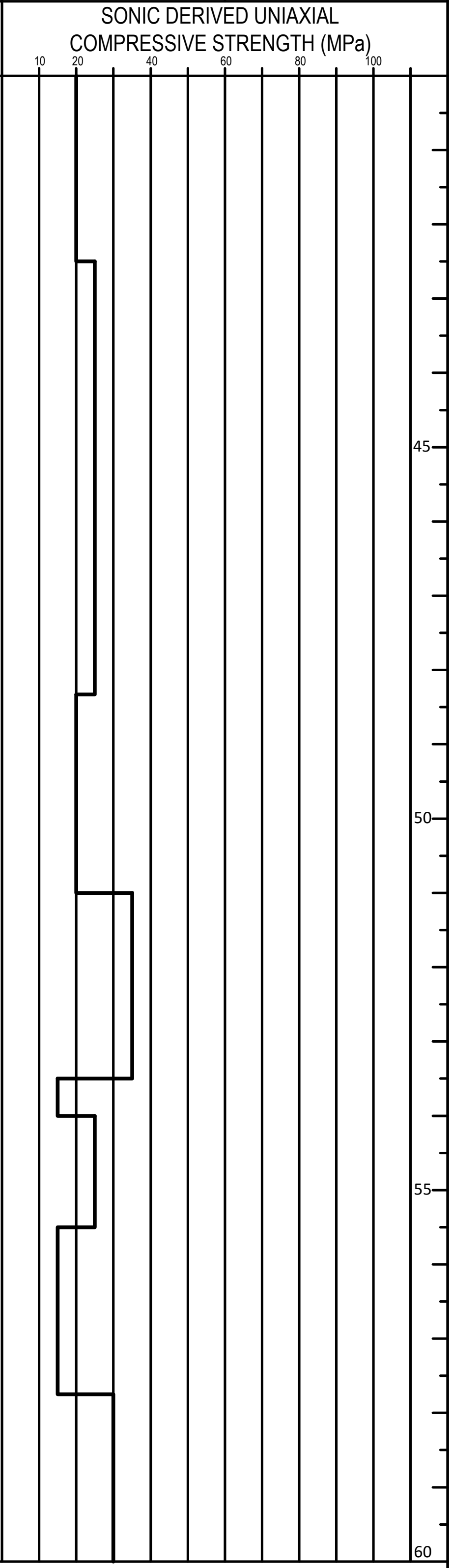
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.65

DRILLING DATE:
12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
MUDSTONE, dark brown, fresh, weak to strong				**INDETERMINATE**		
SANDSTONE, light grey, fresh, moderately strong		42.53 45				
MUDSTONE, carbanaceous, dark brown, fresh, weak Coal		46.42				
SANDSTONE, light grey, fresh Coal		48.33				
SILTSTONE, mid grey, fresh, moderately weak Coal Coal Coal		49.01 50				
SANDSTONE, light grey, fresh, mainly moderately strong		50.83				
COAL, fresh		54.84 55				
SANDSTONE, MUDSTONE, fresh		55.05				
Mainly COAL, fresh, broken		55.72				
Mainly MUDSTONE, dark grey, fresh, moderately weak Coal		56.80 60				





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

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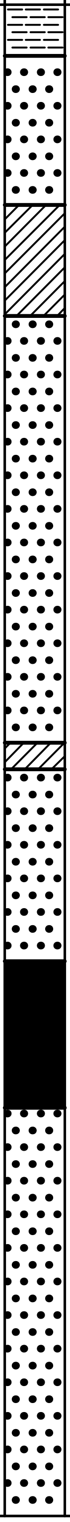
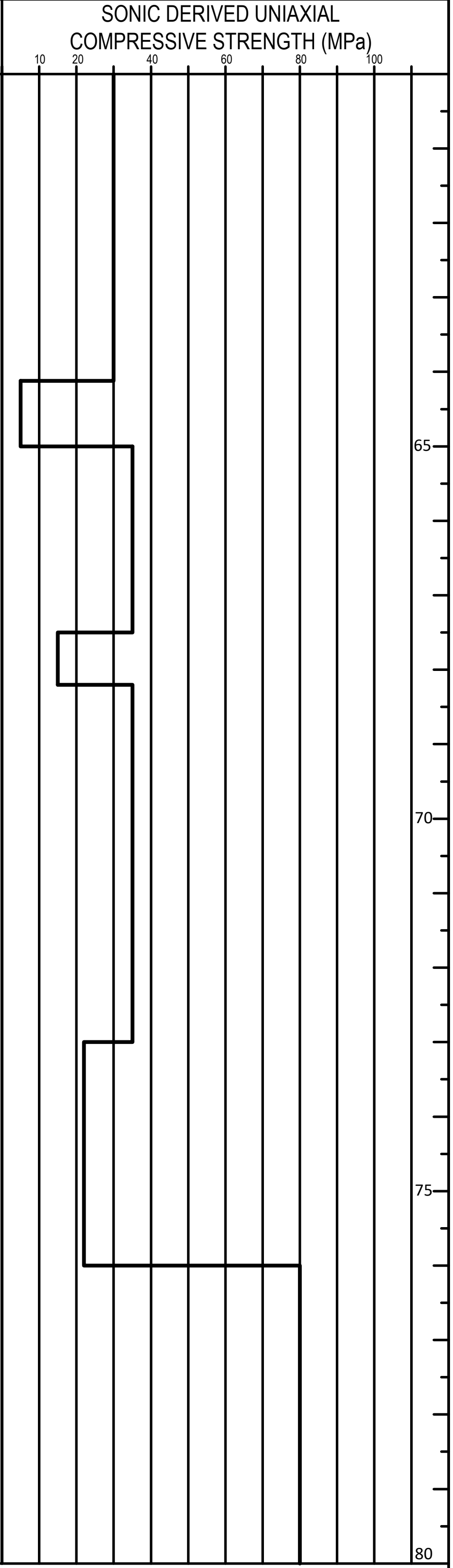
LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 009.06 N 7 485 907.95	BOREHOLE No: STX050C SHEET 4 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 33.65	DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
MUDSTONE, fresh Coal				INDETERMINATE			
Mainly SANDSTONE, light grey, fresh, mainly moderately strong	60.68						
Core loss	62.65						
	64.12						
	65						65
Core loss	69.77 70 70.12						70
COAL, fresh, weak	72.66						
SANDSTONE, light grey, fresh, moderate to strong	74.60 75			Slickensides at 70°, pyrite			75
	80						80





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

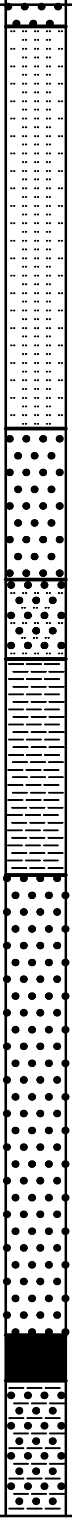
Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

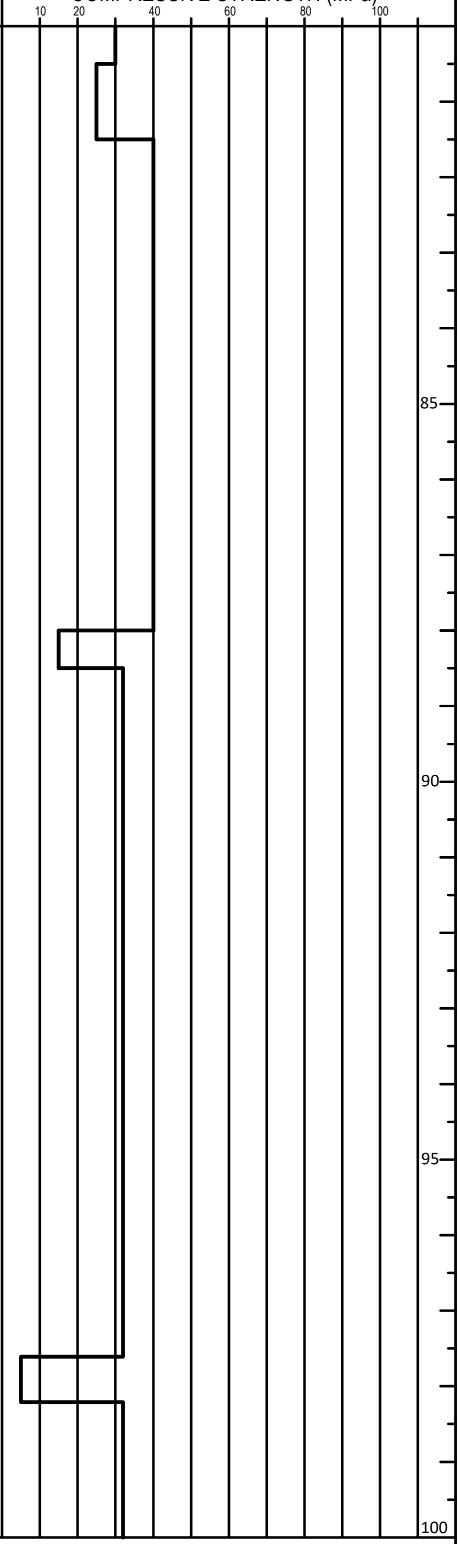
CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 009.06 N 7 485 907.95	BOREHOLE No: STX050C SHEET 5 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 33.65	DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, fresh					
SILTSTONE, grey, fresh, moderately strong Coal	80.29 85		INDETERMINATE		
SANDSTONE, light grey, moderately strong	85.61				
SILTSTONE, grey, SANDSTONE, light grey, fresh, strong	87.61				
MUDSTONE, dark grey, fresh, moderately strong	88.66 90				
SANDSTONE, light grey, moderately strong. Minor SILTSTONE	91.52 95				
COAL, fresh, weak	97.61				
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong	98.21 100				

GRAPHIC LOG



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

CORE TYPE:

CASING DEPTH:

WATER TABLE
DEPTH:
LEVEL:

LOCATION
E 774 009.06
N 7 485 907.95

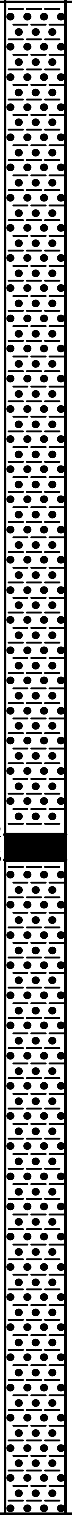
GROUND LEVEL (AHD) 33.65

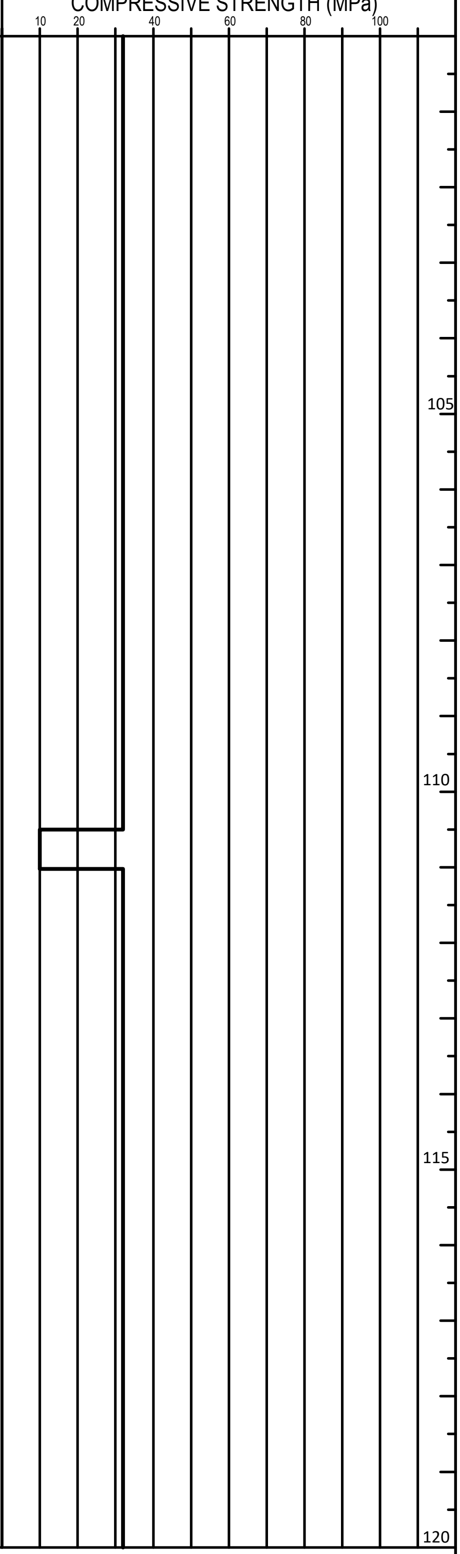
BOREHOLE No: STX050C

SHEET 6 OF 7

DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong					INDETERMINATE			
Coal →					Slickensides at 60°			
		105						
Coal →								
		110						
COAL		111.02						
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong		111.35						
		115						
		120						





REMARKS:
Cored hole

N.A. Not Applicable

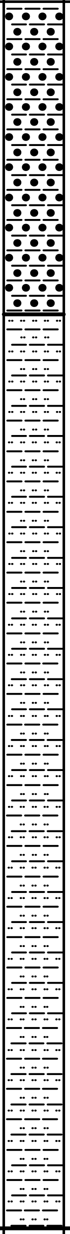
SCALE 1 : 100

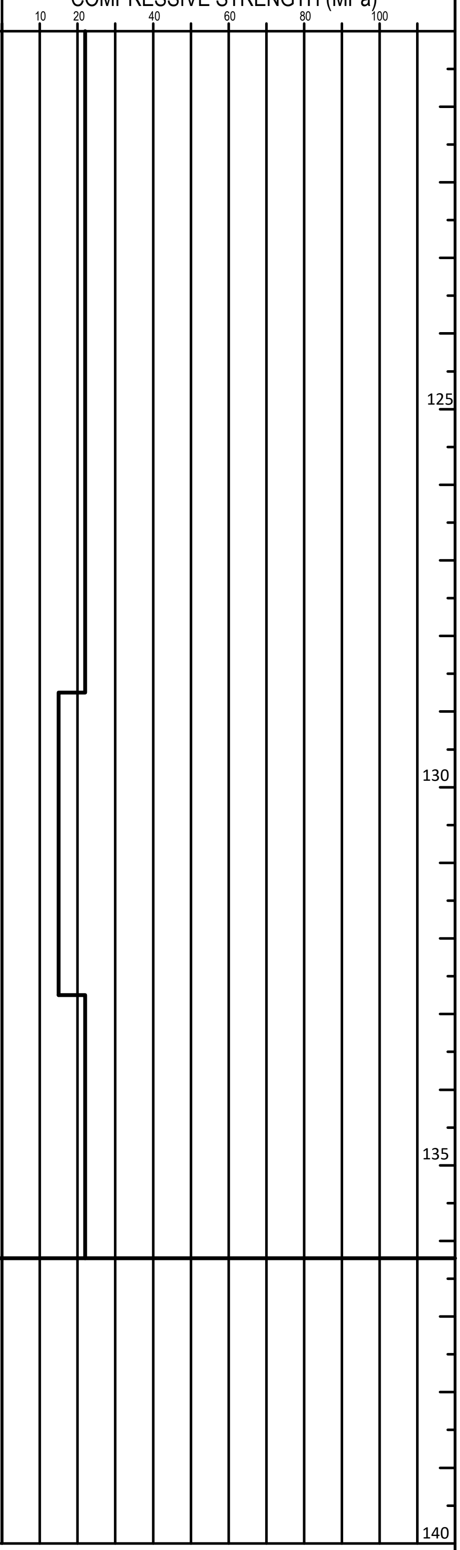
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 009.06 N 7 485 907.95	BOREHOLE No: STX050C SHEET 7 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 33.65	DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong					**INDETERMINATE**			
SILTSTONE, medium grey, MUDSTONE, dark brown		124.14						
		125						
Core loss →								
Coal →								
Coal → Core loss → Coal → Coal →		130						
		135						
END OF HOLE 136.23 m								
		140						





REMARKS:

Cored hole

N.A. Not Applicable

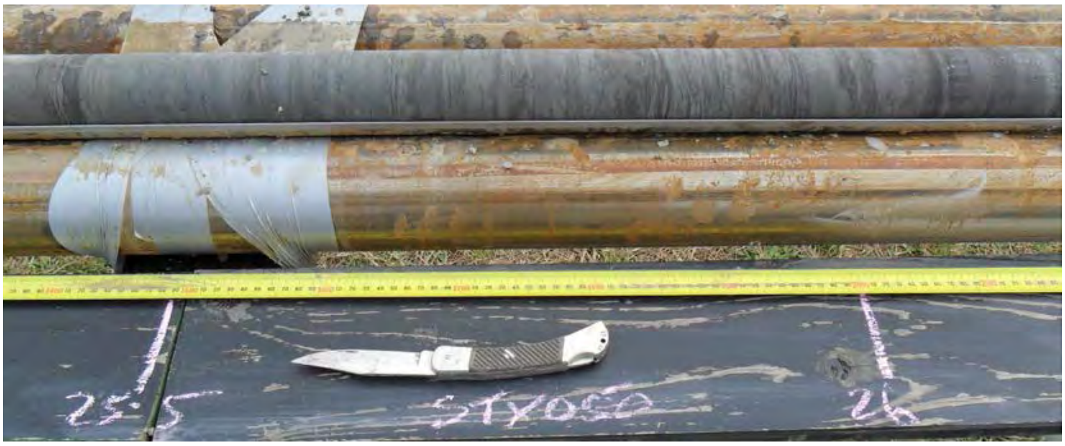
SCALE 1 : 100

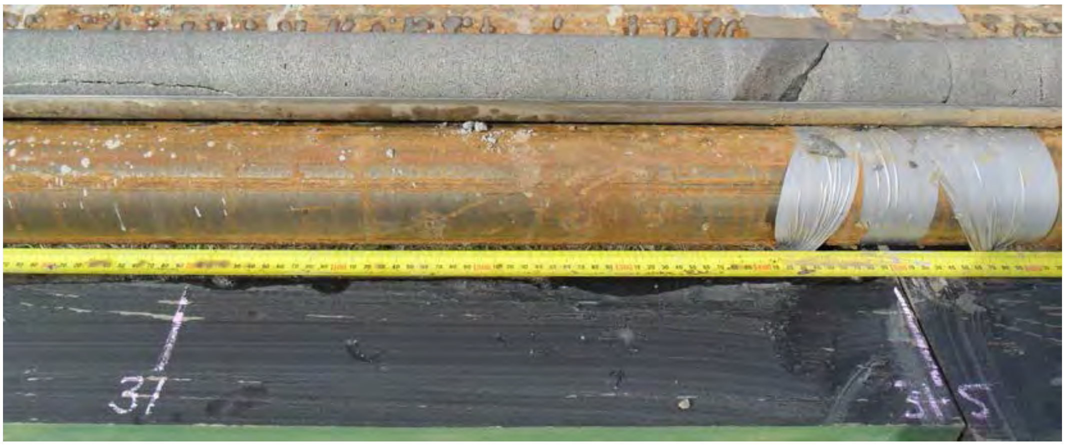
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

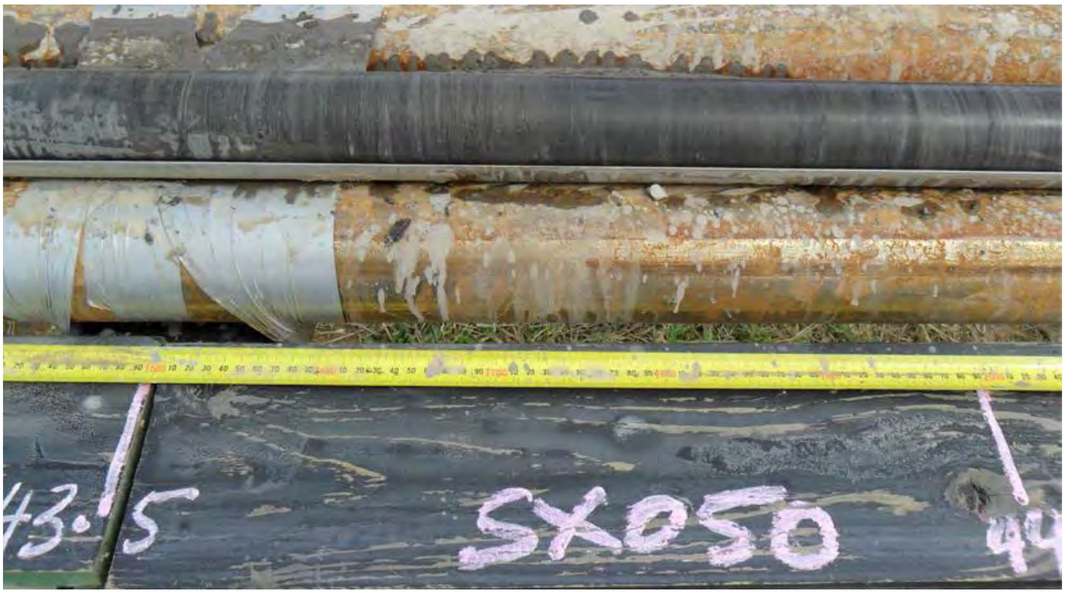
LOGGED BY: Geologist

STX050C

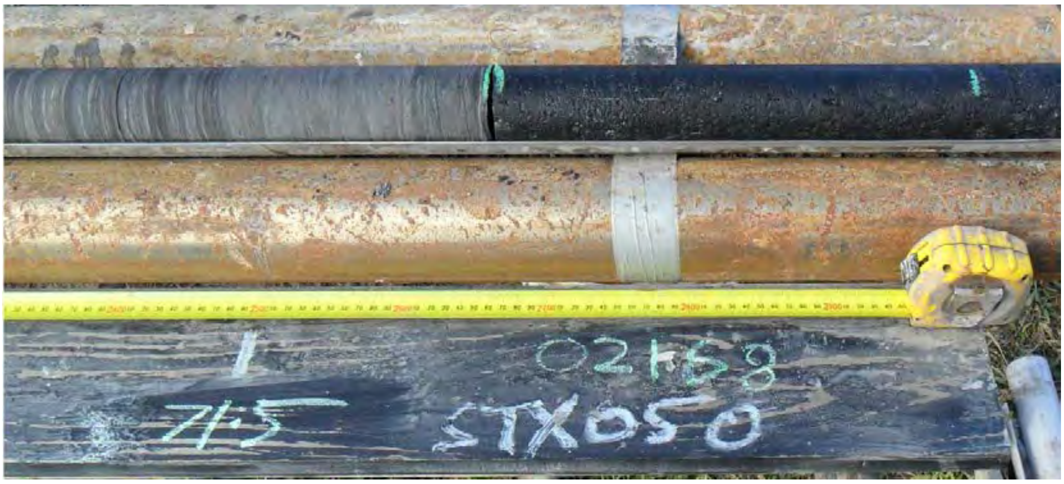

R: 2
C: 2.05
R: 1.61
T.D: 19.85
RUN 2
C: 1.5
R: .88
T.D: 21.45
10 STX050 17.80


25.5
STX050
26

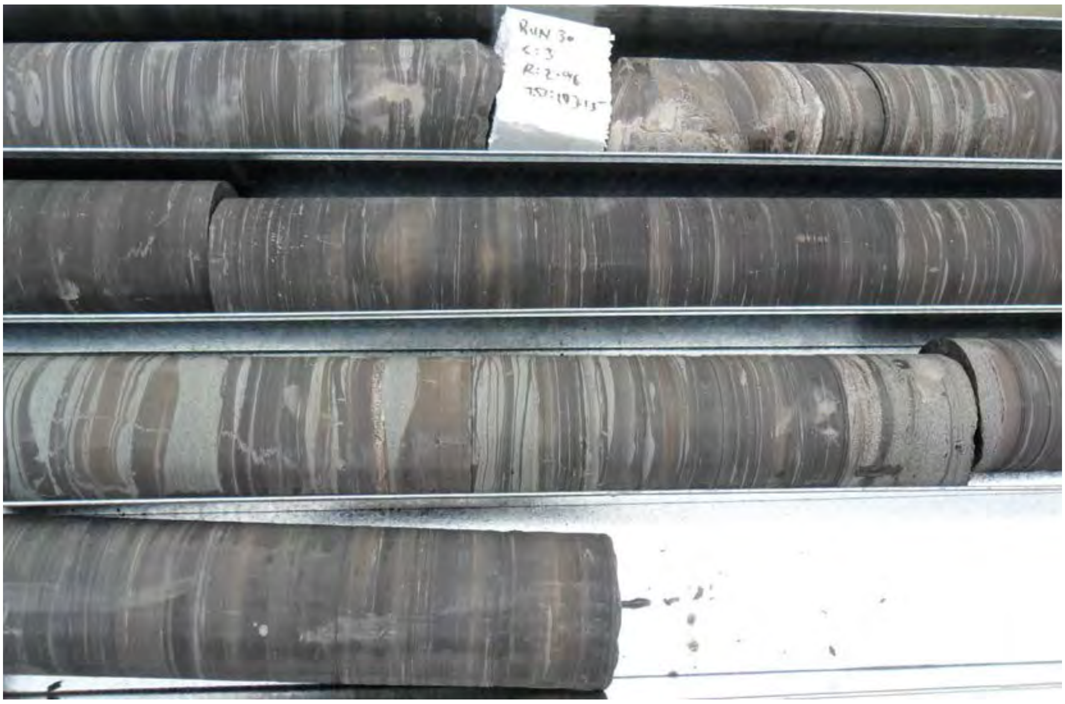

37
37.5


43.5
SX050
44


02166
45.5
STX050


02168
71.5
STX050


8
9.5
STX050
90

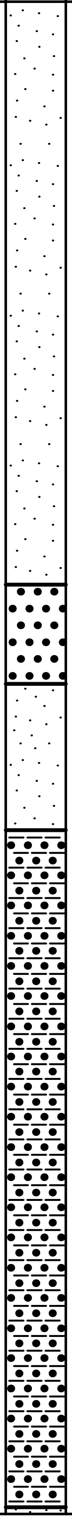

RUN 30
C: 3
R: 2.96
TD: 197.15


STX050
125


134
STX050
134.5

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 422.08 N 7 486 312.65	BOREHOLE No: STX080 SHEET 1 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 33.1	DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, orange brown, pughy		5			**INDETERMINATE**			No sonic log
SANDSTONE, brownish, weathered		7.71						
CLAY, brown		9.02 10						
SANDSTONE, MUDSTONE, brown, weathered, weak		10.96 15						
CLAY, brown		19.91 20						



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 422.08

N 7 486 312.65

BOREHOLE No: STX080

SHEET 2 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

DEPTH:

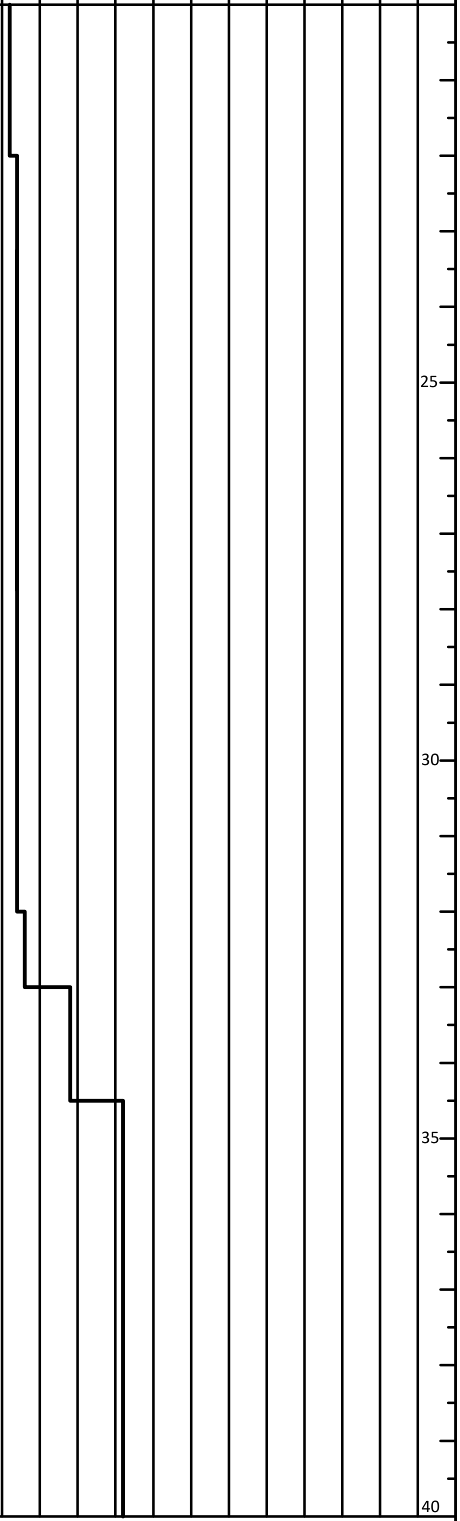
LEVEL:

GROUND LEVEL (AHD) 33.1

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
CLAY, SILT, brown			INDETERMINATE		
SANDSTONE, MUDSTONE, weathered	21.02				
CLAY, brown	21.63				
SANDSTONE, weathered	22.48				
COAL, weathered	23.02				
MUDSTONE, grey, slightly weathered, broken	23.55				
SANDSTONE, light grey, fresh, weak to moderately weak	24.92		← Base of weathering 25.14		
	25				
	30				
	35				
	40				

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No: STX080

SHEET 3 OF 7

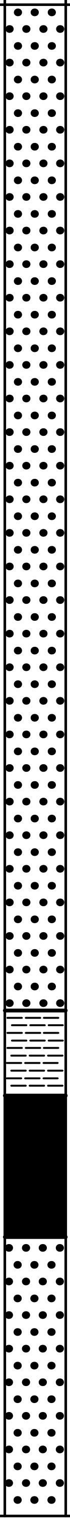
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

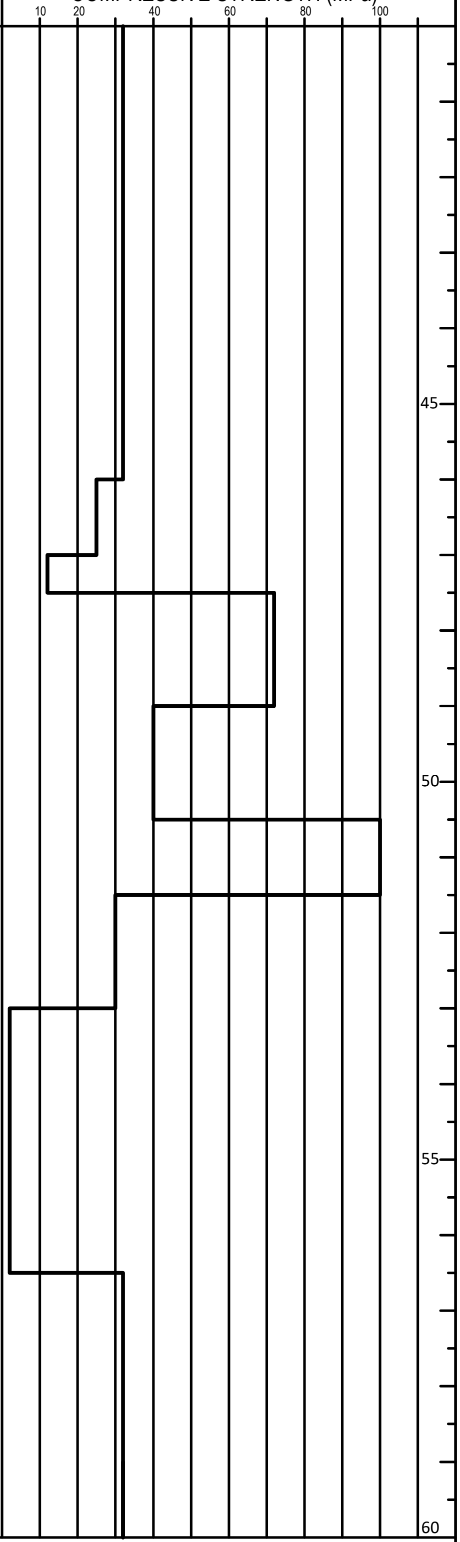
GROUND LEVEL (AHD) 33.1

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, fresh, mainly moderately weak				**INDETERMINATE**		
	45					
	50					
Siderite						
MUDSTONE, grey, brown,fresh, moderately strong	53.31					
COAL, fresh, solid core	54.44					
	55					
SANDSTONE, light grey, moderately strong	56.31					
	60					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

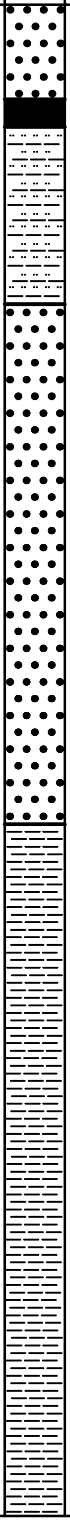
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

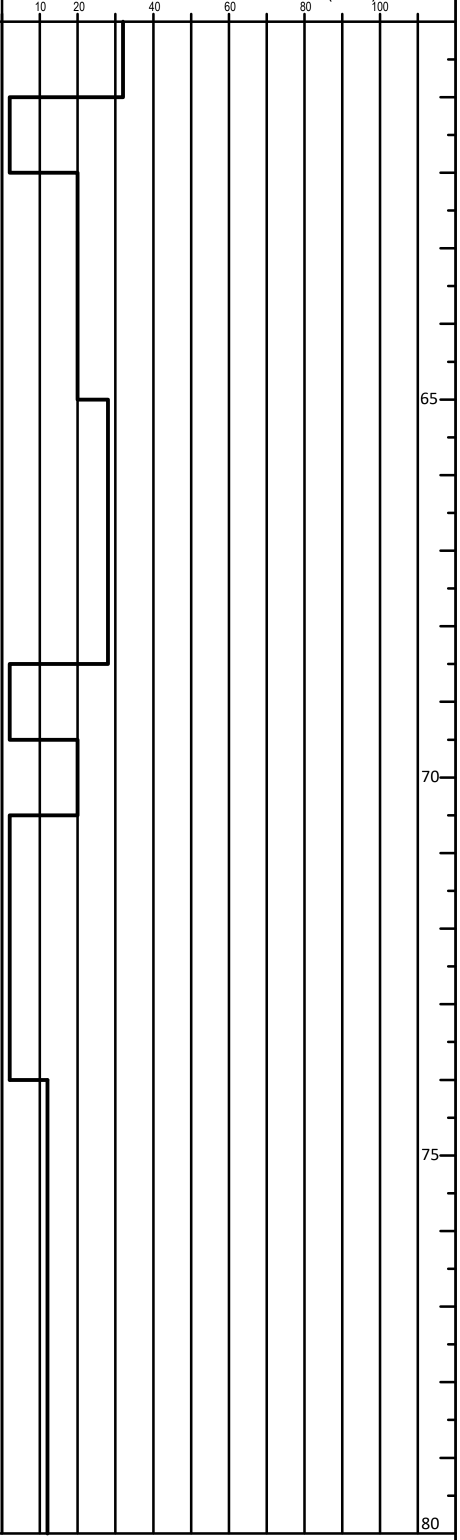
LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 422.08 N 7 486 312.65	BOREHOLE No: STX080 SHEET 4 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 33.1	DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, moderately strong					INDETERMINATE		
COAL, fresh		61.26					
SILTSTONE, MUDSTONE, grey, fresh, moderately strong		61.62			Slickensides 30°		
SANDSTONE, light grey, fresh		63.97			Faults, slickensides 30°		
		65					
		70					
Siderite							
Mainly MUDSTONE, dark grey, fresh, mainly moderately strong		70.85					
Coal Coal							
		75					
Coal							
		80					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:
CASING DEPTH:

LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No:
STX080
SHEET 5 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

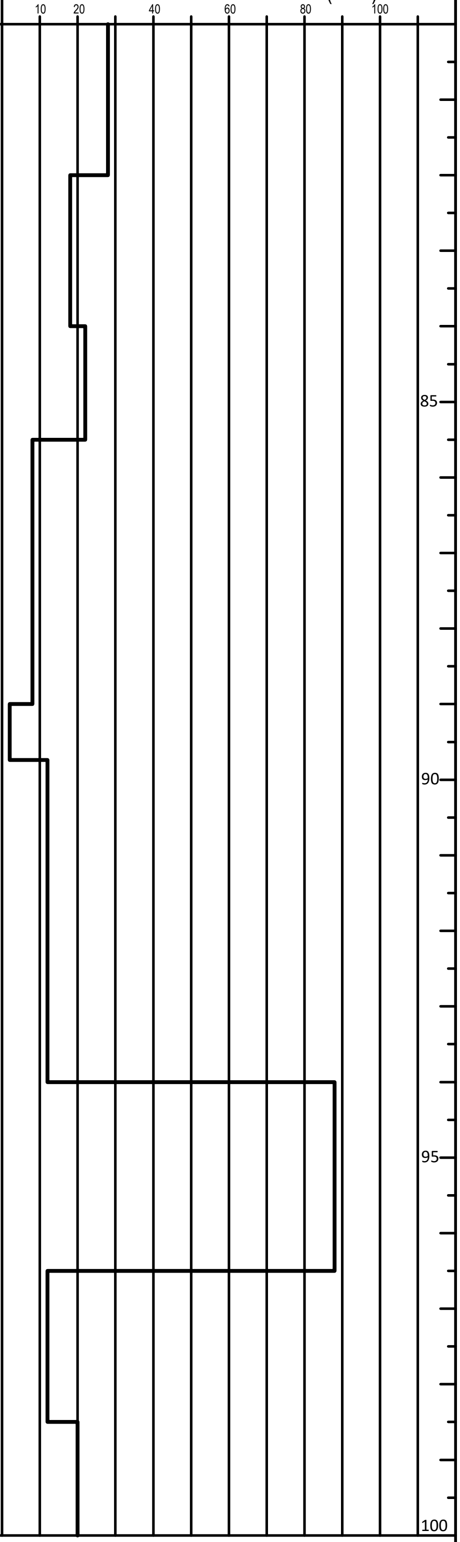
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.1

DRILLING DATE:
10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
MUDSTONE, fresh						
SANDSTONE, light grey, fresh, moderately strong	80.12			INDETERMINATE		
MUDSTONE, dark grey, brown,fresh, moderately weak	83.42 85					
COAL, fresh	89.29					
MUDSTONE, grey, moderately weak	89.74 90					
SANDSTONE, light grey, fresh, moderately weak	90.49 95					
MUDSTONE, dark grey, fresh, moderately weak	97.15 100					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 422.08

N 7 486 312.65

BOREHOLE No: STX080

SHEET 6 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

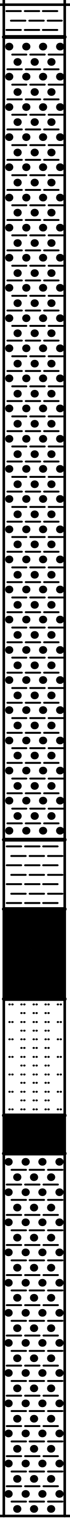
DEPTH:

LEVEL:

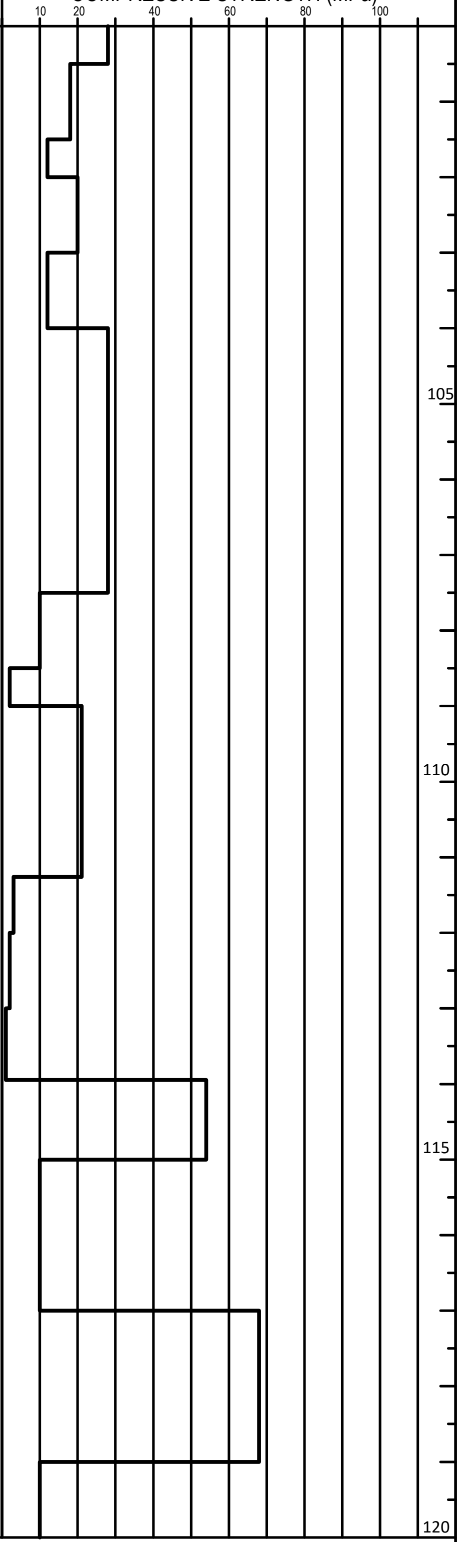
GROUND LEVEL (AHD) 33.1

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
MUDSTONE, fresh				INDETERMINATE		
SANDSTONE, light grey, MUDSTONE, dark grey, fresh Coal → Coal ↘	100.43 105 110					
MUDSTONE, dark grey, fresh, moderately strong	111.05					
COAL, fresh, partially broken	111.97					
SILTSTONE, carbonaceous, grey, fresh, moderately strong	113.16					
COAL, fresh, strong	114.70 115					
Mainly SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong	115.21 120					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 422.08

N 7 486 312.65

BOREHOLE No: STX080

SHEET 7 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

DEPTH:

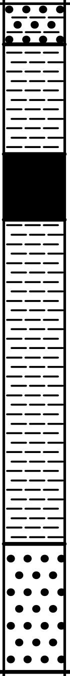
LEVEL:

GROUND LEVEL (AHD) 33.1

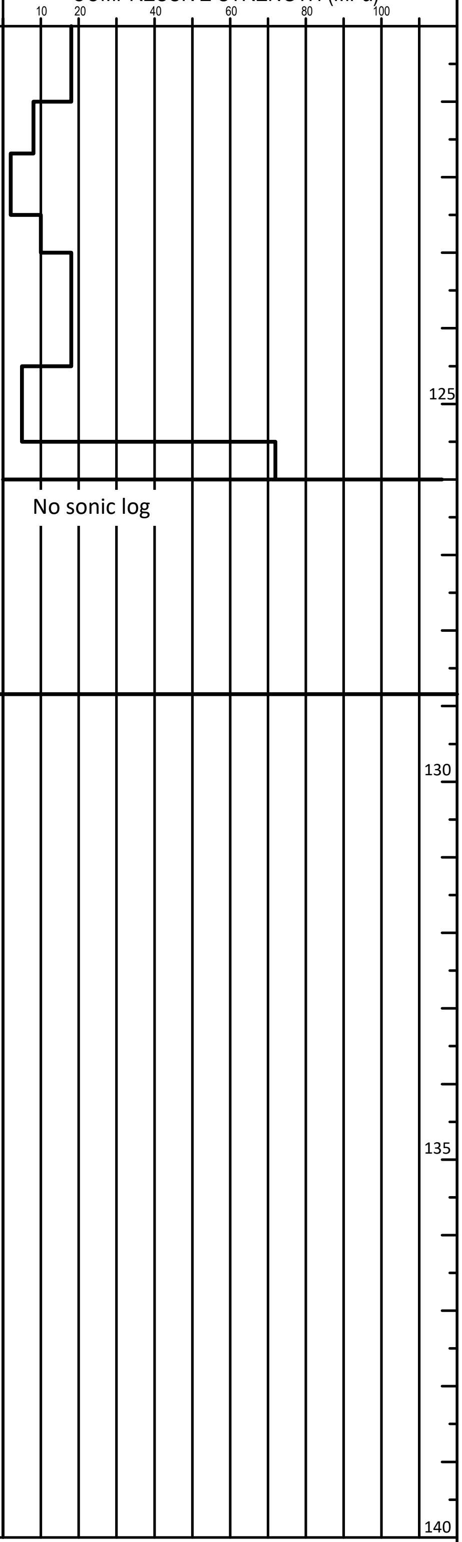
DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, MUDSTONE, fresh			**INDETERMINATE**		
MUDSTONE, dark grey, fresh, moderately strong Coal →	120.54				
COAL, fresh, weak	121.99				
MUDSTONE, dark grey, fresh, moderately weak Coal → Coal →	122.86 125		Slickensides 30°, 60°, faults 10°		
SANDSTONE, light grey, fresh, moderately weak	127.15				
END OF HOLE 128.84 m	130 135 140				

GRAPHIC LOG



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

NO CORE PHOTOGRAPHS AVAILABLE

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No:
STX104CR

SHEET 1 OF 6

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
Not available

DRILLING DATE:
14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100	
No record					**INDETERMINATE**			No sonic log	
		5							5
		10							10
		15							15
		20							20

REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 774 002.01

N 7 486 199.69

BOREHOLE No: STX104CR

SHEET 2 OF 6

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

DEPTH:

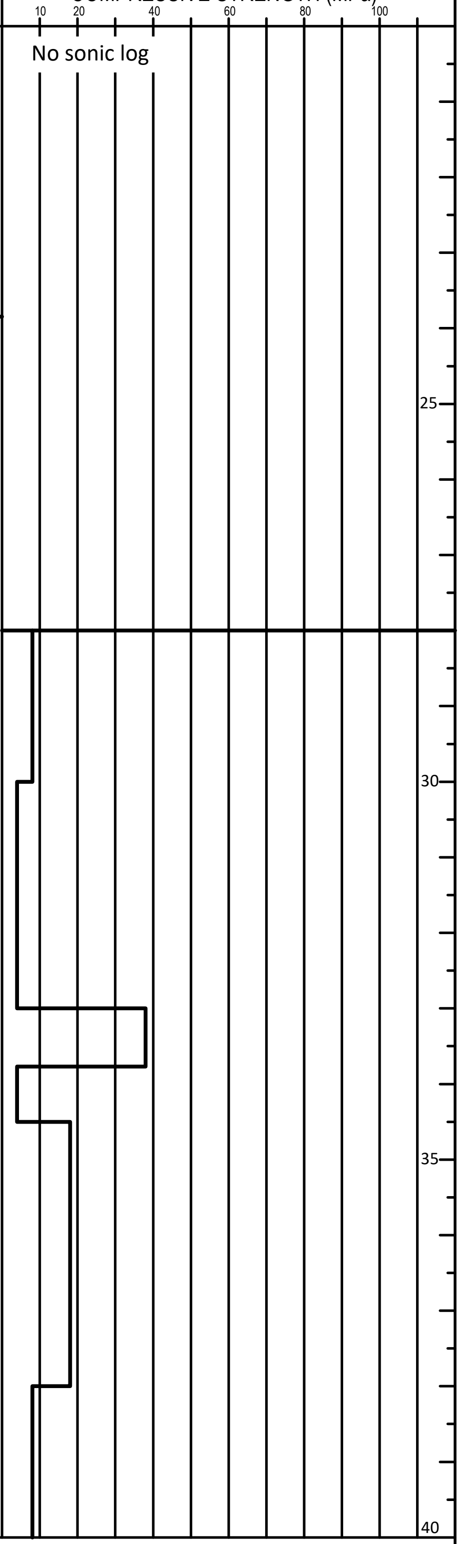
LEVEL:

GROUND LEVEL (AHD) Not available

DRILLING DATE: 14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
No record					**INDETERMINATE**		
SANDSTONE, light grey, fresh, moderately weak Core loss →		23.85 25					
SILTSTONE, medium grey, SANDSTONE, light grey, fresh, weak to moderately weak Coal →		29.14 30 35 40					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

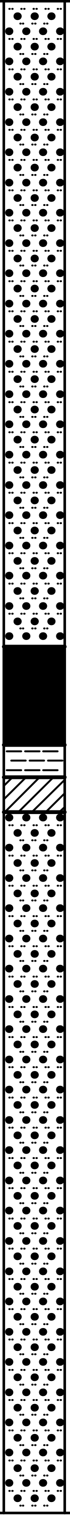
SCALE 1 : 100

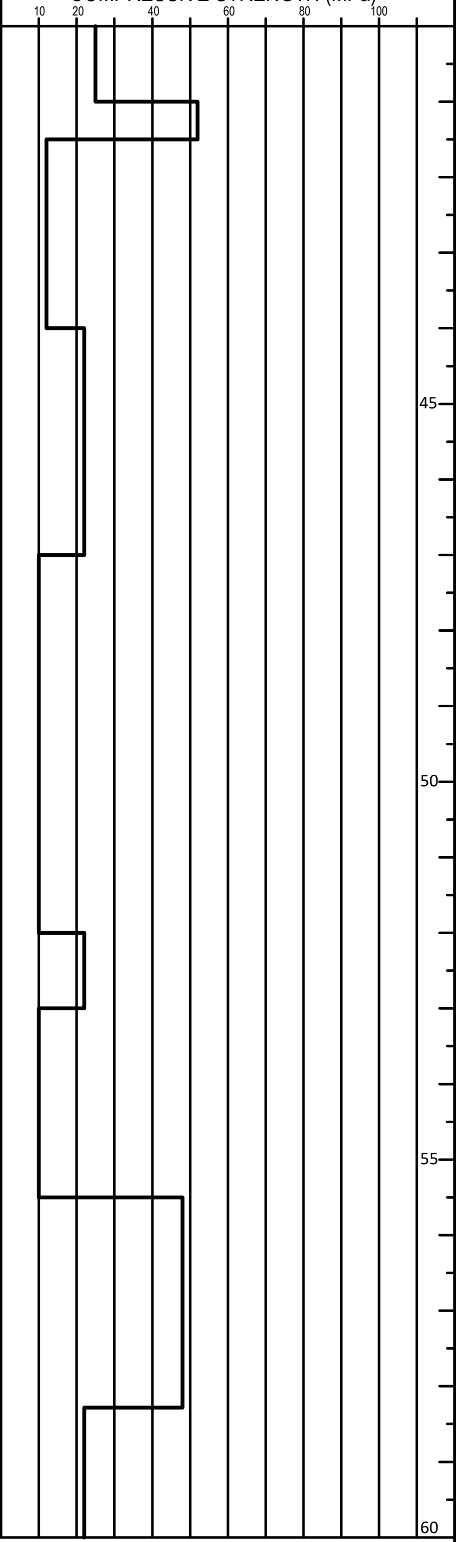
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 002.01 N 7 486 199.69		BOREHOLE No: STX104CR SHEET 3 OF 6
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) Not available		DRILLING DATE: 14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SILTSTONE, medium grey, SANDSTONE, light grey, fresh, moderately weak to weak Core loss Coal Coal		45			**INDETERMINATE**			
COAL, fresh, very weak Mudstone		48.54						
MUDSTONE, weak		49.84 50						
CORE LOSS		50.27						
SANDSTONE, grey, SILTSTONE, medium to dark grey, fresh, moderately weak to very weak Coal		50.73 55 60						





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 774 002.01

N 7 486 199.69

BOREHOLE No: STX104CR

SHEET 4 OF 6

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

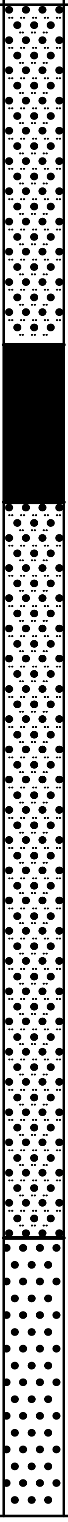
DEPTH:

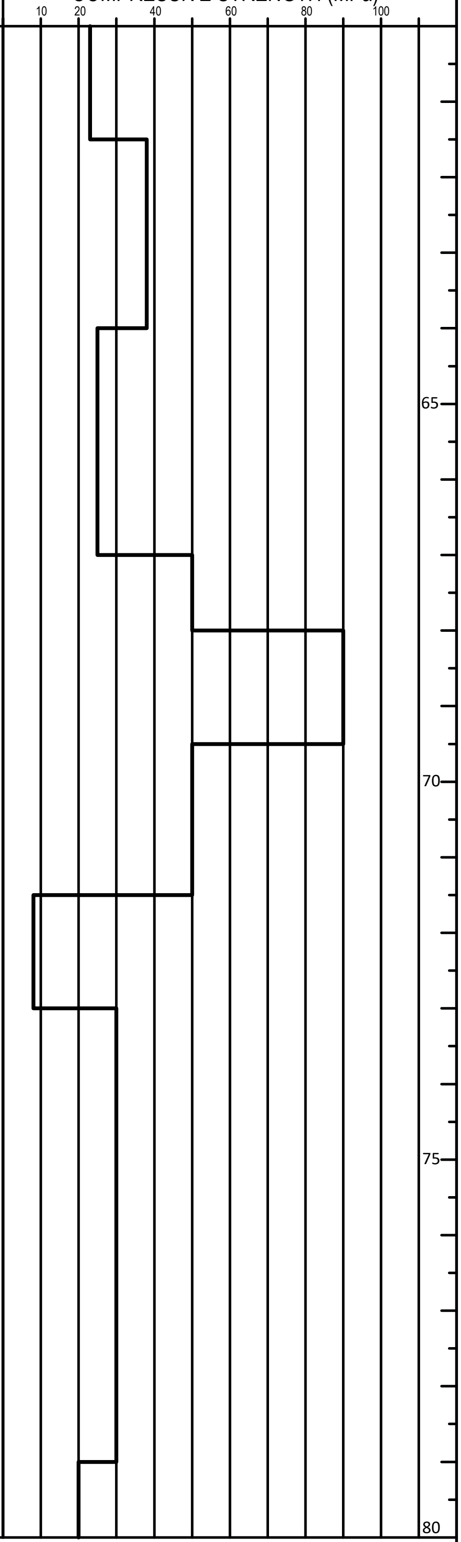
LEVEL:

GROUND LEVEL (AHD) Not available

DRILLING DATE: 14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, grey, SILTSTONE, medium to dark grey, fresh, weak to very weak					INDETERMINATE			
COAL, fresh, very weak		64.64 65						
Mainly SANDSTONE, grey, SILTSTONE, dark grey, fresh, moderately weak to very weak Coal →		66.59 70 75			Faults Dip 30°, faulted Bedding 30°, calcite			
SANDSTONE, grey, fresh, very weak to moderately weak		76.32 80						





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:
CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No: STX104CR
SHEET 5 OF 6

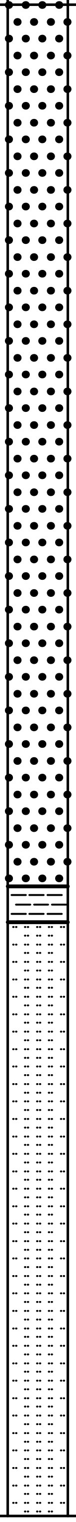
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

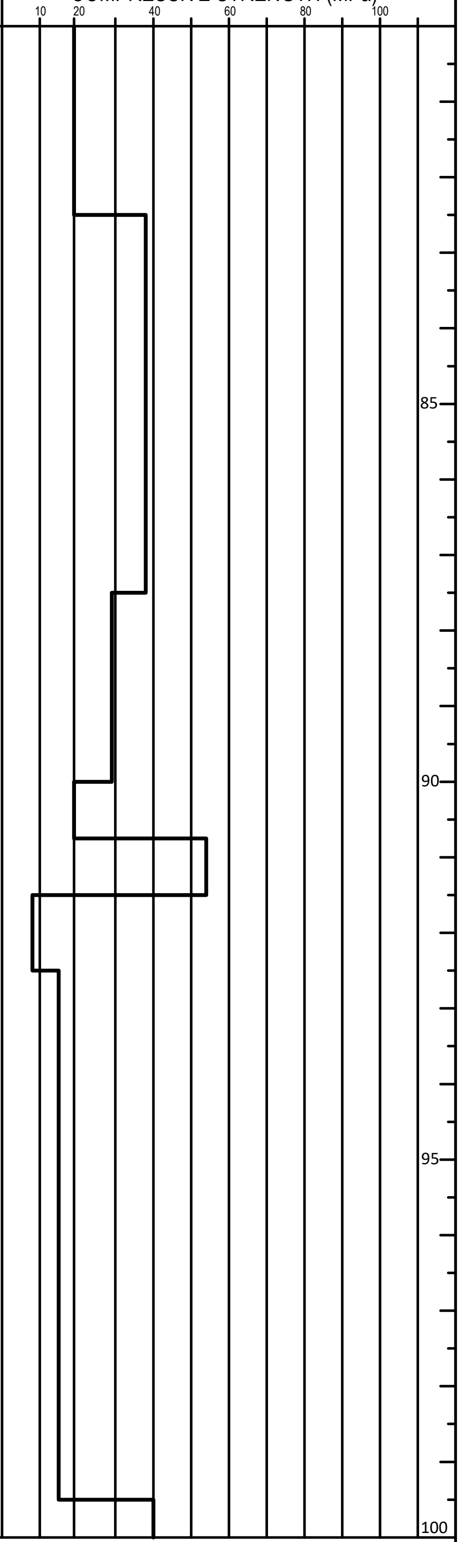
GROUND LEVEL (AHD) Not available

DRILLING DATE: 14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, fresh, weak to moderately weak		85 90			INDETERMINATE		
Coal		91.67					
MUDSTONE, fresh							
Coal		91.67					
SILTSTONE, medium grey, fresh, moderately weak		95					
Coal		100					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No:
STX104CR

SHEET 6 OF 6

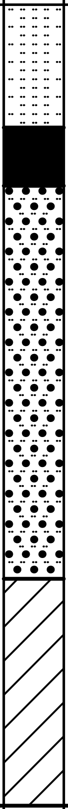
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

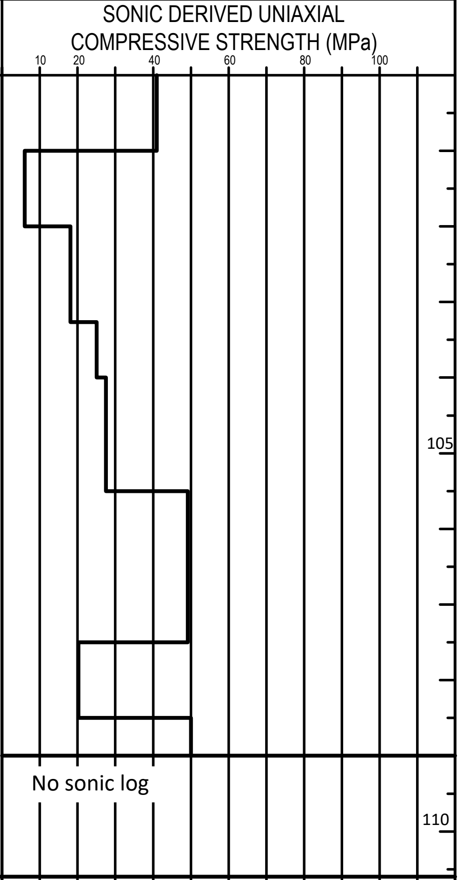
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
Not available

DRILLING DATE:
14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SILTSTONE, medium grey, fresh, moderately weak				**INDETERMINATE**			
COAL, fresh, weak Core loss →	101.63						
SANDSTONE, grey, SILTSTONE, medium grey, fresh, moderately weak Coal →	102.40 105						
Not logged	107.60 110						No sonic log
END OF HOLE 110.60 m	115 120						





REMARKS:
Cored hole

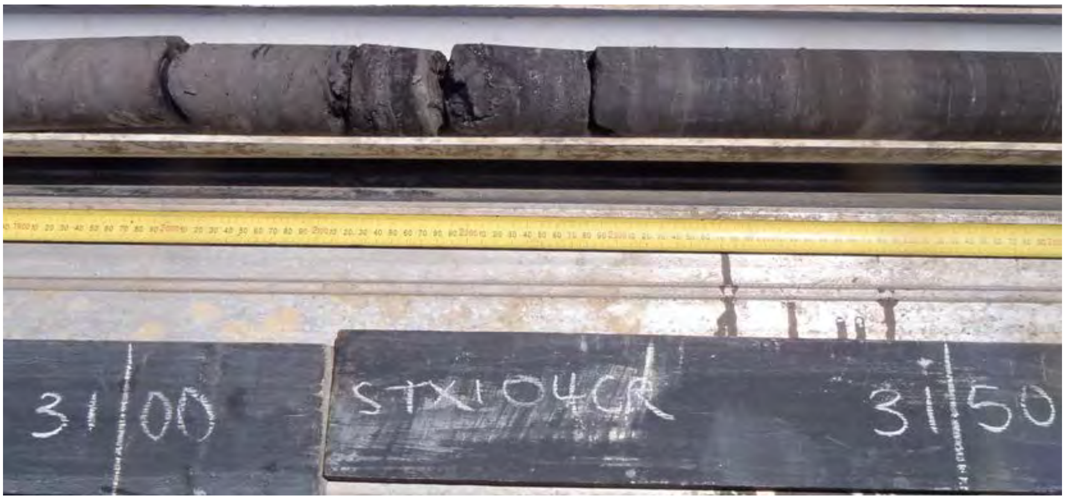
N.A. Not Applicable

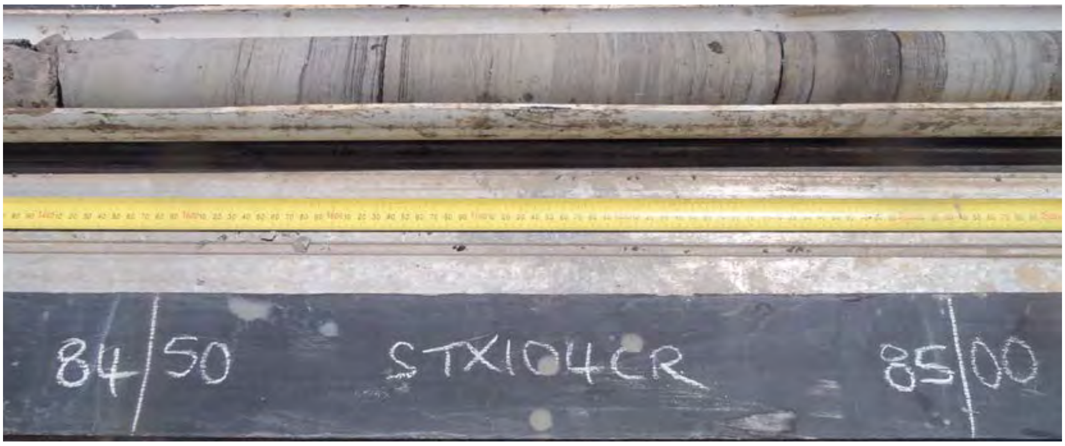
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

STX104CR






93|00
STX104CR
93|50


19378
99|00
STX104CR
99|50


103|50
STX104CR
104|00

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 631.50 N 7 486 178.54	BOREHOLE No: STX113CR SHEET 1 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 32.88	DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, brown, sticky					**INDETERMINATE**			No sonic log
		5						5
		10						10
		11.00						
SILT, brown, loose								
		15						15
SANDSTONE, brown, friable, completely weathered								
		20						20

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 631.50
N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 2 OF 7

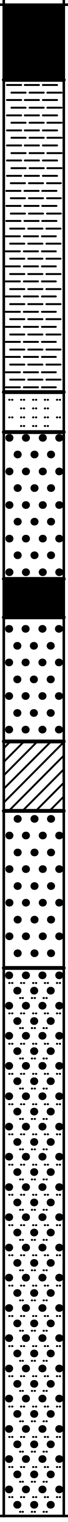
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

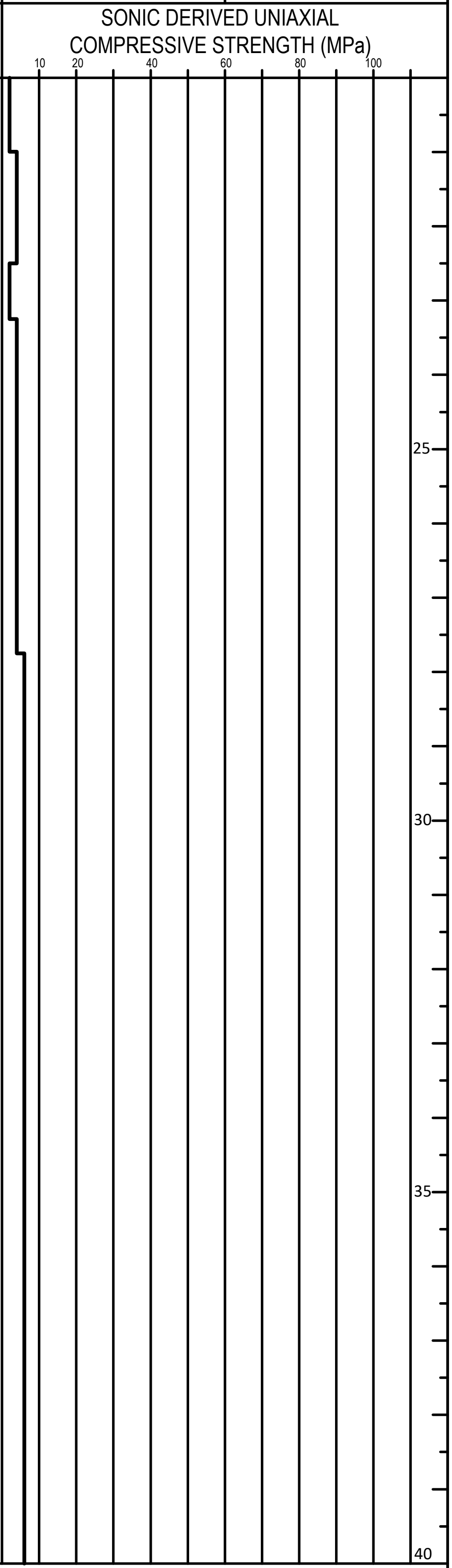
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
COAL, completely weathered				INDETERMINATE		
MUDSTONE, black, completely weathered		21.00				
		25				
SILTSTONE, fresh		25.13		← Base of weathering 25.13		
Mainly SANDSTONE, light grey, fresh, moderately strong Coal → Coal →		25.66				
COAL, fresh, weak		27.60				
Mainly SANDSTONE, grey, fresh, moderately strong Coal → Coal → Coal →		28.11		Slickensides		
Core loss		29.75				
		30				
		30.67				
SANDSTONE, grey, SILTSTONE, medium grey, fresh, weak to moderately weak		32.75				
		35				
		40				





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 631.50

N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 3 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

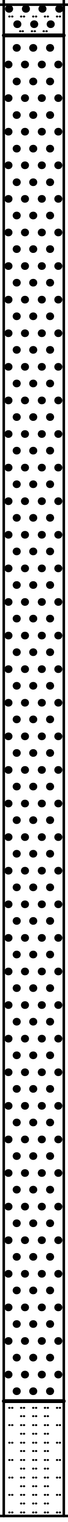
DEPTH:

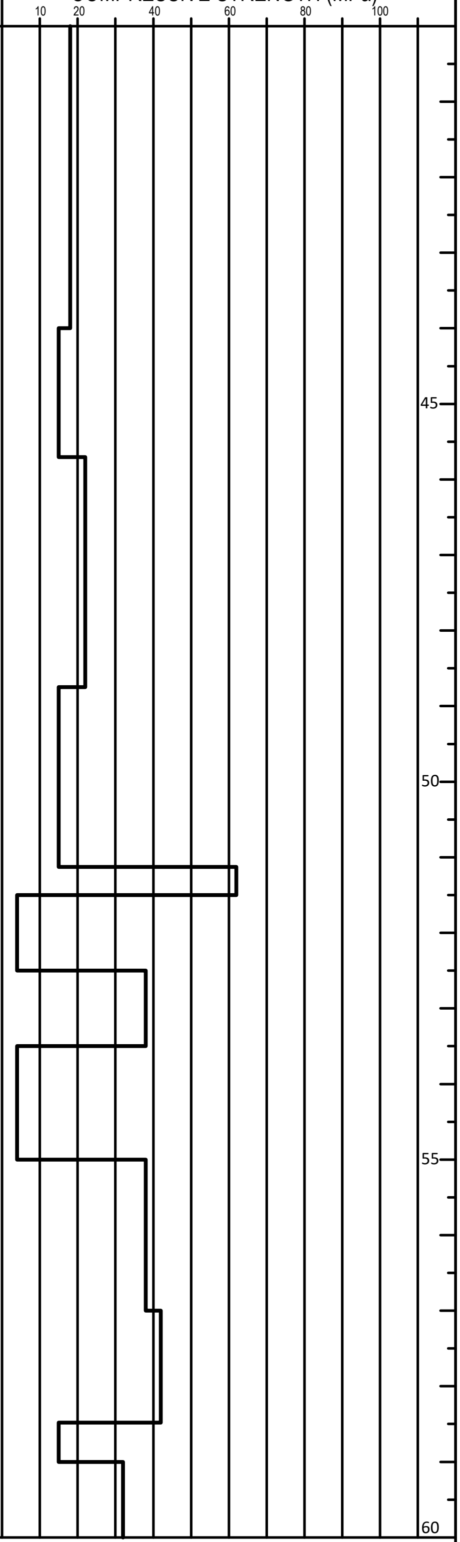
LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, SILTSTONE,				INDETERMINATE			
Mainly SANDSTONE, light grey, fresh, moderately weak to moderately strong	40.41						
	45						45
Coal →							
Coal →							
	50						50
Mudstone →							
	55						55
SILTSTONE, grey, fresh, weak	58.48						
	60						60





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 631.50

N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 4 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

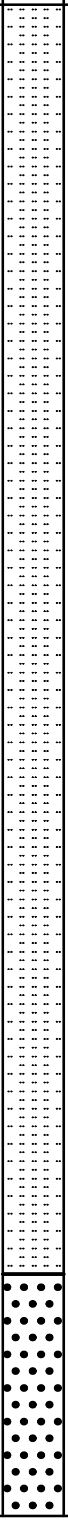
DEPTH:

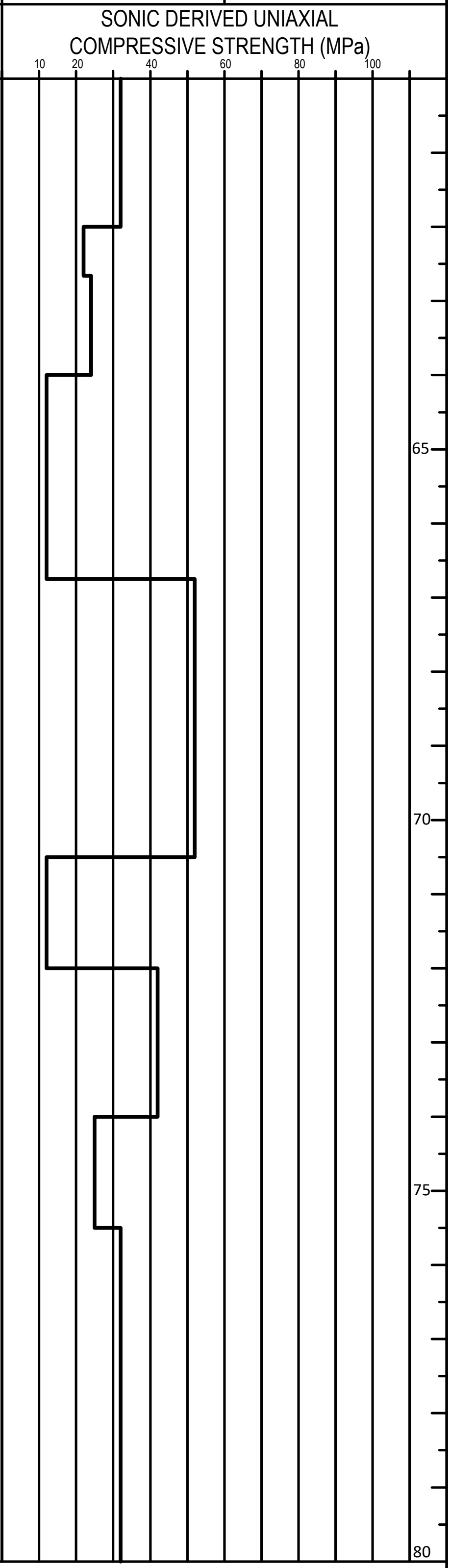
LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Mainly SILTSTONE, grey, fresh, weak to moderately weak Coal Siderite	65 70 75 76.80			INDETERMINATE			
SANDSTONE, carbonaceious, black, fresh, strong Coal Coal Coal	80			Siderite			





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 631.50

N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 5 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE DEPTH:

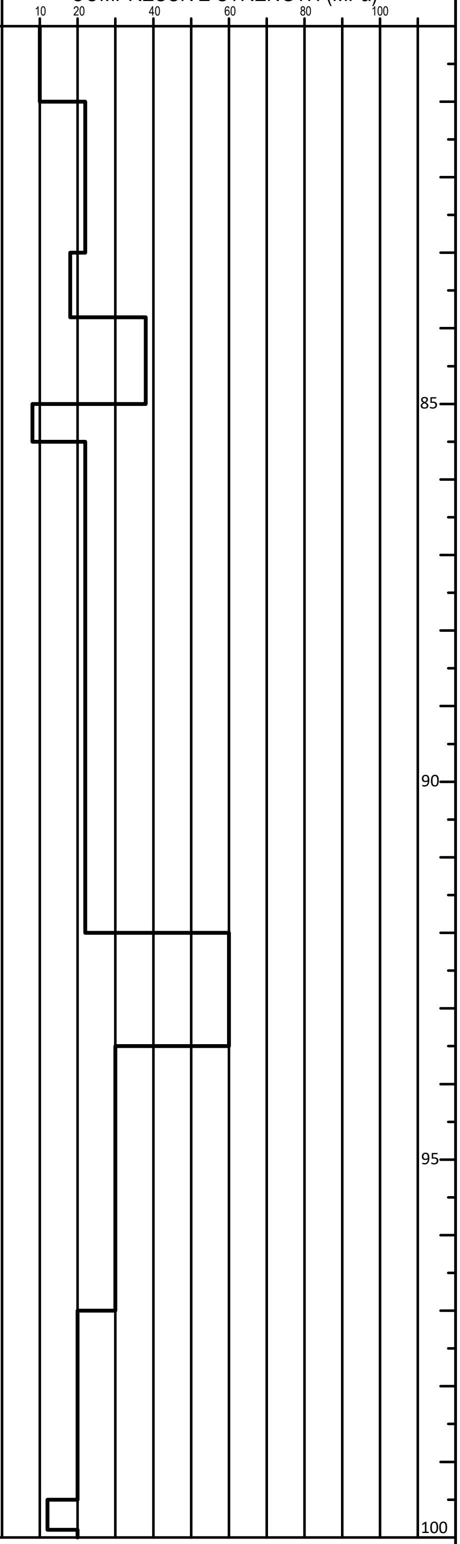
LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
Core loss		▨		**INDETERMINATE**		
SIDERITE Coal		S				
MUDSTONE, black, SANDSTONE, grey, fresh, weak	80.73					
SANDSTONE, grey, fresh, mainly moderately weak	84.09					
	85					
	90					
Mudstone →						
	95					
Core loss →						
SILTSTONE, grey, MUDSTONE, black, fresh, moderately weak	96.96					
Coal →	100					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 631.50
N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 6 OF 7

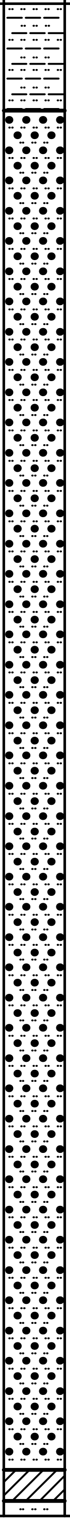
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

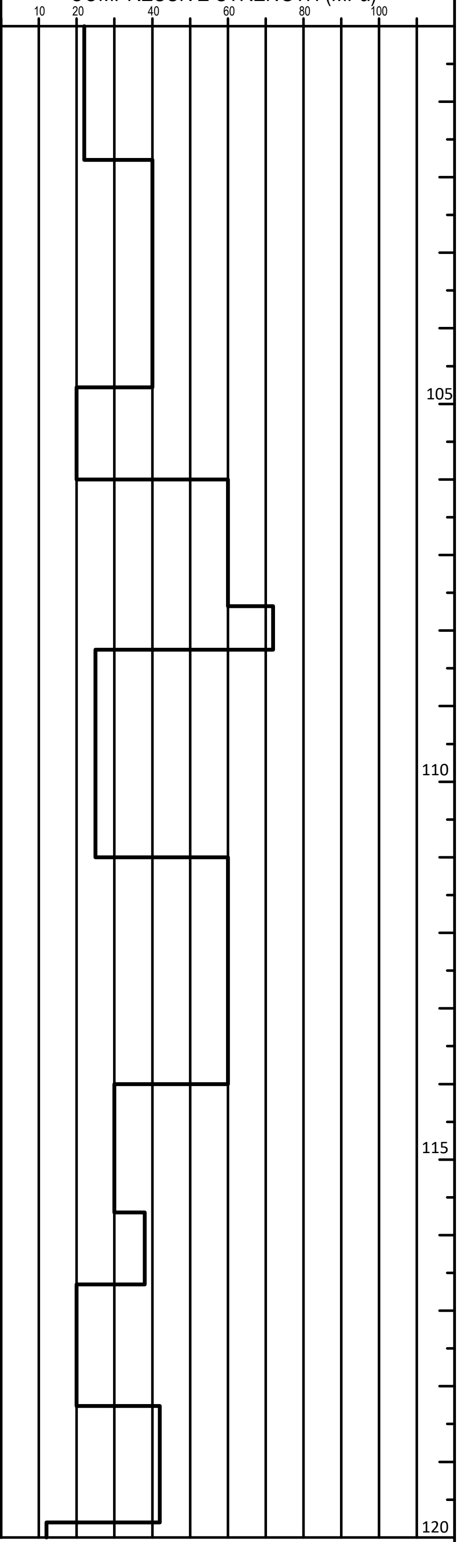
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SILTSTONE, MUDSTONE				**INDETERMINATE**			
SANDSTONE, light grey, SILTSTONE, medium grey, fresh, mainly moderately weak, broken core	101.44						
	105						
	110						
Core loss →	115						
Core loss	119.39 119.80 120						





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:
CASING DEPTH:

LOCATION
E 773 631.50
N 7 486 178.54

BOREHOLE No: STX113CR
SHEET 7 OF 7

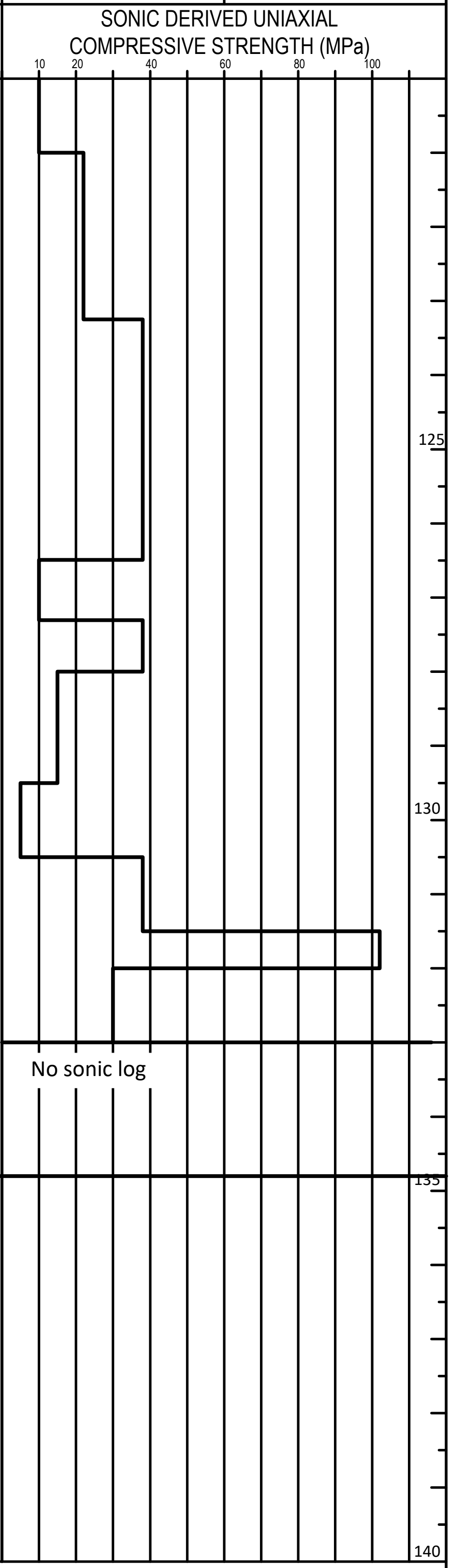
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, SILTSTONE, medium grey, fresh, moderately weak to moderately strong, broken core		125			**INDETERMINATE**		
Core loss		125.80					
COAL, fresh, weak		126.82 126.86					
MUDSTONE, dark grey, SILTSTONE, grey, fresh, weak, broken core Core loss Core loss		127.31					
COAL, fresh, weak Core loss		129.66 130					
SILTSTONE, grey, MUDSTONE, dark grey, fresh, mainly weak,		130.59					
END OF HOLE 134.80 m		135 140					


SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)

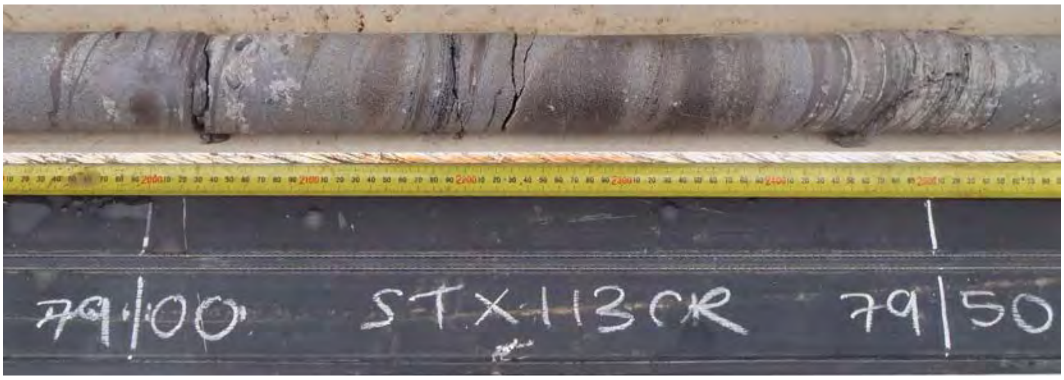
REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist


79.00
STX113CR
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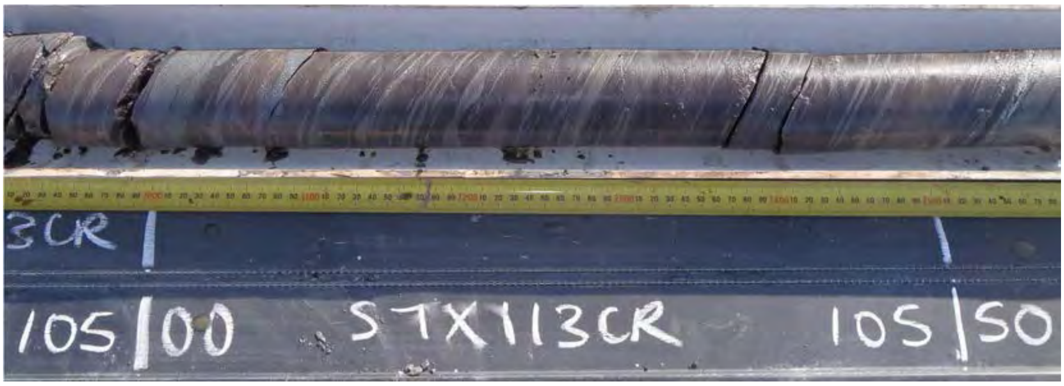
19399
85.50
STX113CR
86.00

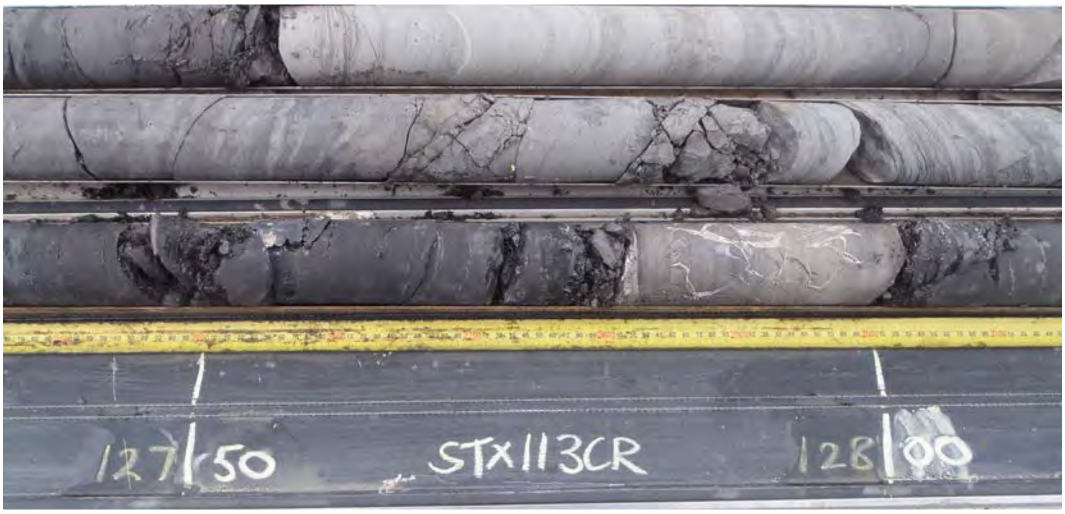

97.00
STX113CR
97.50


101 00 STX113CR 101 50


3CR
105 00 STX113CR 105 50


113 00 STX113CR 113 50


N 18
123|00
STX113CR
123|50


127|50
STX113CR
128|00

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 153.54 N 7 485 901.99	BOREHOLE No: STX120 SHEET 1 OF 10
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 34.08	DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, brown					INDETERMINATE			No sonic log
		5						5
SAND, brown		6.00						
		10						10
		15						15
CLAY, brown		19.00						
		20						20

REMARKS:

Chip hole

N.A. Not Applicable

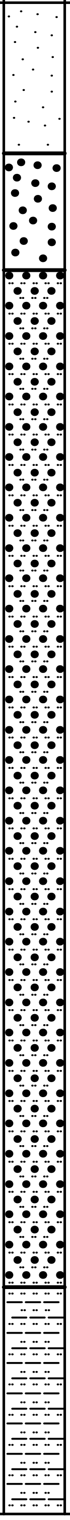
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 153.54 N 7 485 901.99	BOREHOLE No: STX120 SHEET 2 OF 10
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 34.08	DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
CLAY, brown				**INDETERMINATE**			**No sonic log**
SAND, brown	22.00						
SILTSTONE, grey, SANDSTONE, grey, fresh	23.54			Base of weathering 23.50			
	25						25
	30						30
	35						35
MUDSTONE, dark grey, SILTSTONE, grey, fresh,	37.00						
	40						40



REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No:
STX120

SHEET 3 OF 10

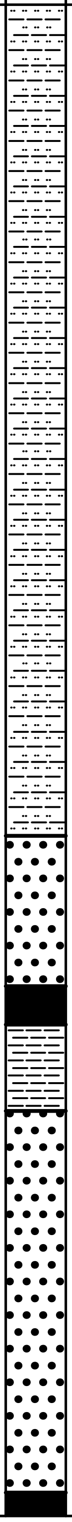
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
34.08

DRILLING DATE:
10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, dark grey, SILTSTONE, grey, fresh		45 50			**INDETERMINATE**			**No sonic log**
SANDSTONE, grey, fresh		51.00						
COAL, fresh		52.99						
MUDSTONE, grey, fresh		53.50						
SANDSTONE, light grey, fresh		54.64 55						
COAL, fresh		59.69 60						



REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 774 153.54

N 7 485 901.99

BOREHOLE No: STX120

SHEET 4 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

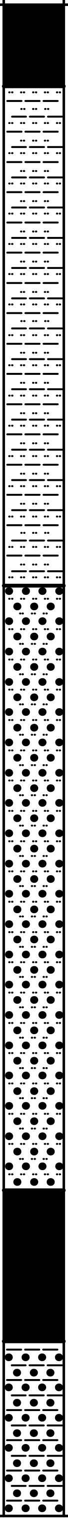
DEPTH:

LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
COAL, fresh					INDETERMINATE			No sonic log
MUDSTONE, dark grey, SILTSTONE, grey, fresh		61.08						
		65						65
SANDSTONE, light grey, SILTSTONE, medium grey, fresh		67.69						
		70						70
		75						75
COAL, fresh		75.69						
SANDSTONE, MUDSTONE, light grey, SILTSTONE, medium grey, fresh		77.69						
		80						80



REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330$e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 153.54 N 7 485 901.99	BOREHOLE No: STX120 SHEET 5 OF 10
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 34.08	DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, light grey, SILTSTONE, medium grey, fresh					**INDETERMINATE**			**No sonic log**
SHALE, MUDSTONE, fresh		84.96 85						
SANDSTONE, light grey, SILTSTONE, grey, fresh		87.69 90 95						
SHALE, MUDSTONE, fresh		98.19 100						

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

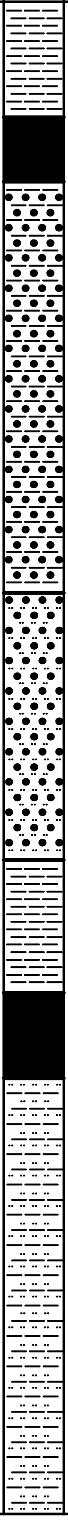
SHEET 6 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, dark grey, fresh				**INDETERMINATE**			**No sonic log**
COAL, fresh		101.53					
SANDSTONE, grey, MUDSTONE, fresh		102.38					
		105					
SANDSTONE, grey, SILTSTONE, dark grey, fresh		107.82					
		110					
MUDSTONE, SHALE, fresh		111.35					
COAL, fresh Siderite →		113.11					
MUDSTONE, dark grey, SILTSTONE, grey, fresh		114.24					
		115					
Siltstone →							
		120					

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

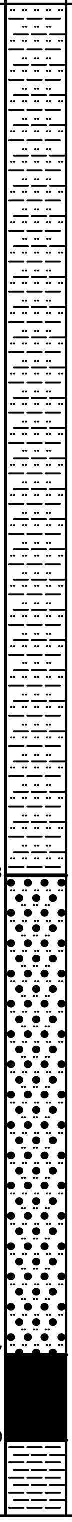
SHEET 7 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, dark grey, SILTSTONE, medium grey, fresh					INDETERMINATE			No sonic log
		125						
Sandstone →								
		130						
SANDSTONE, grey, SILTSTONE, brownish grey, fresh		132.53						
		135						
COAL, fresh		137.87						
MUDSTONE, fresh		139.00						
		140						

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

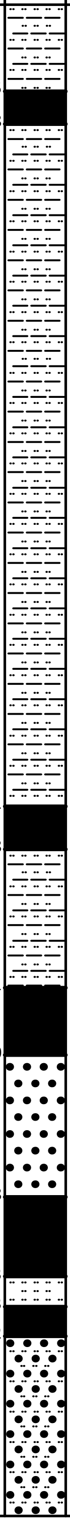
SHEET 8 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, SILTSTONE, fresh	141.15		INDETERMINATE			No sonic log
COAL, fresh	141.58					
MUDSTONE, dark grey, SILTSTONE, grey, fresh Siderite →	145 150 150.61					145 150
COAL, fresh	151.18					
MUDSTONE, SILTSTONE, fresh	153.01					
COAL, fresh	153.90					
SANDSTONE, grey, fresh	155 155.78					155
COAL, fresh	156.83					
SILTSTONE, fresh	157.23					
COAL, fresh	157.62					
SANDSTONE, SILTSTONE, grey, fresh	160					160

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 9 OF 10

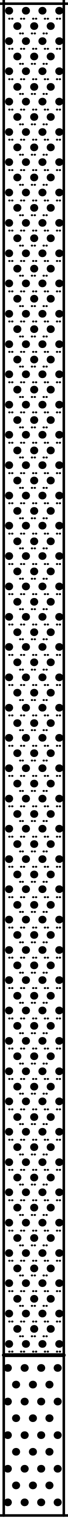
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, grey, SILTSTONE, medium grey, fresh	165 170 175			**INDETERMINATE**			**No sonic log**
SANDSTONE, grey, fresh	177.88 180						



REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 10 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, grey, fresh	185			**INDETERMINATE**			**No sonic log**
MUDSTONE, dark grey, fresh	188.88						
SANDSTONE, medium grey, fresh	189.86 190 195						
END OF HOLE 197.88 m	200						

REMARKS:
Chip hole

N.A. Not Applicable

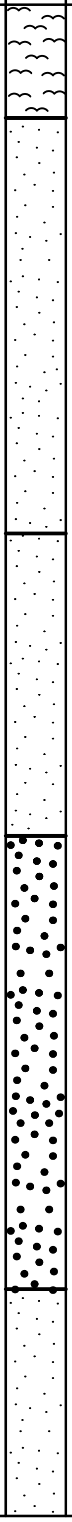
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

NO CORE PHOTOGRAPHS AVAILABLE

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 772 998.69	BOREHOLE No: STX124
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	N 7 486 388.85 GROUND LEVEL (AHD) 32.41	SHEET 1 OF 4 DRILLING DATE: 20/04/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
SOIL, dark brown					INDETERMINATE			No sonic log
CLAY, dark brown		2.00						
		5						
SILT, light brown		7.00						
		10						
SAND, light grey		11.00						
		15						
CLAY, dark grey		17.00						
		20						

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

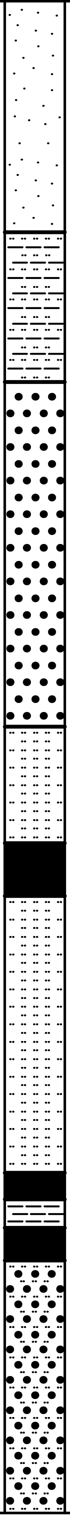
LOCATION
E 772 998.69
N 7 486 388.85

GROUND LEVEL (AHD)
32.41

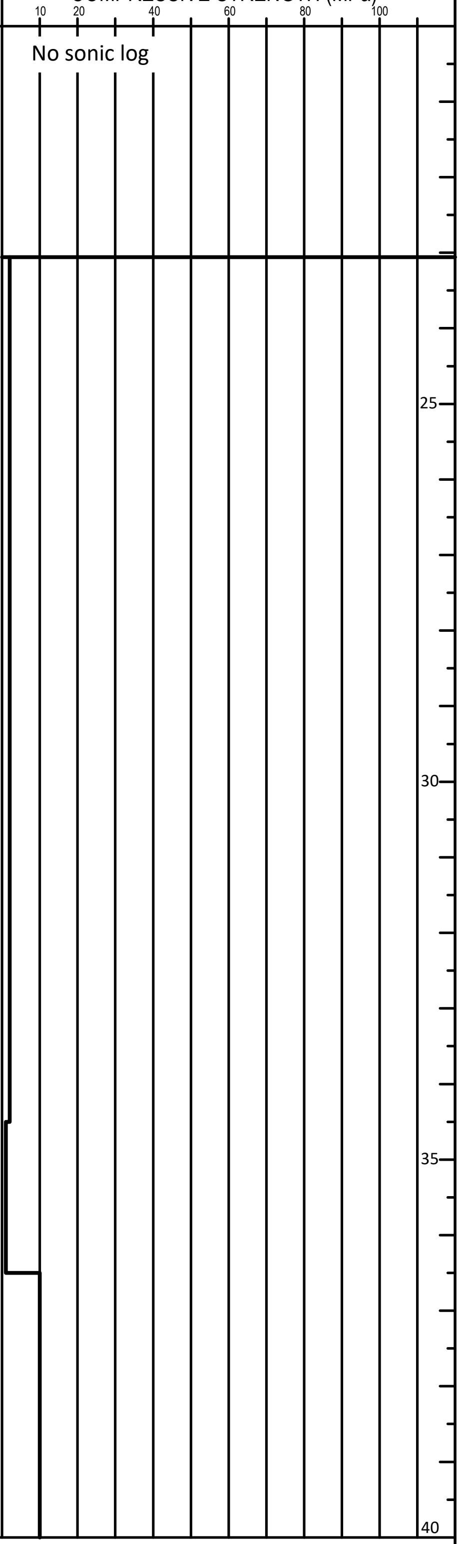
BOREHOLE No:
STX124

SHEET 2 OF 4

DRILLING DATE:
20/04/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
CLAY, dark grey				**INDETERMINATE**		
SILTSTONE, brown, MUDSTONE, black, slighty weathered, broken core	23.06					
SANDSTONE, grey, slightly weathered to fresh, weak Core loss	25.04			Base of weathering 26.60		
SILTSTONE, greyish brown, fresh, weak	29.60 30					
COAL, fresh Mudstone	31.14					
SILTSTONE, greyish brown, fresh, broken core Core loss	31.84 35					
COAL, fresh	35.50					
MUDSTONE, weak	35.85					
COAL, fresh Mudstone	36.23					
SILTSTONE, brownish grey, SANDSTONE, light grey, moderately weak, broken core	36.66 40					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 998.69
N 7 486 388.85

BOREHOLE No:
STX124

SHEET 3 OF 4

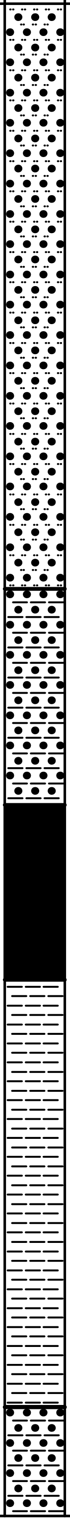
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

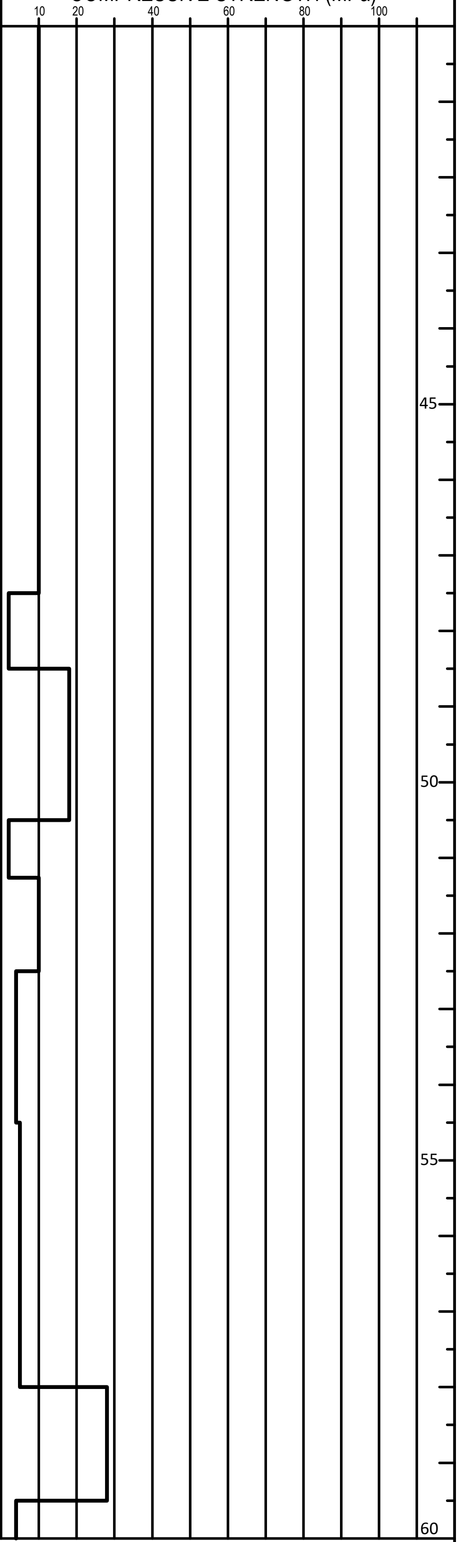
GROUND LEVEL (AHD)
32.41

DRILLING DATE:
20/04/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SILTSTONE, brownish grey, SANDSTONE, grey, fresh, weak, broken core Coal → Coal ↘		45			**INDETERMINATE**		
MUDSTONE, dark grey, SANDSTONE, light grey, fresh, weak, broken core		47.74 50					
COAL, fresh Core loss ↘		50.60					
MUDSTONE, dark grey, weak, broken core Tuff → Siltstone →		52.91 55					
SANDSTONE, light grey, MUDSTONE, dark grey, weak, broken core Coal → Core loss →		58.56 60					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 998.69
N 7 486 388.85

BOREHOLE No: STX124

SHEET 4 OF 4

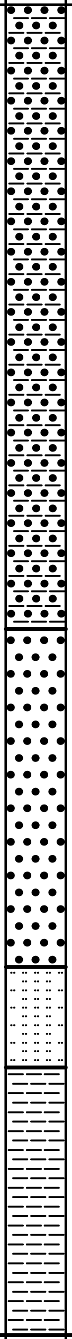
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

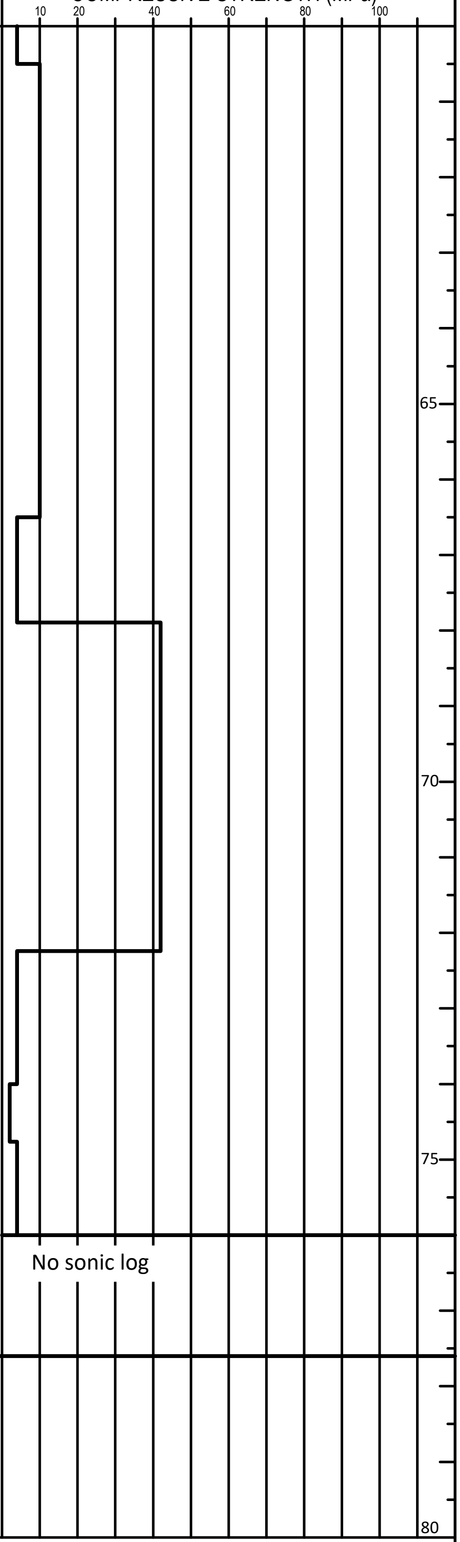
GROUND LEVEL (AHD) 32.41

DRILLING DATE: 20/04/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, MUDSTONE, dark grey, weak, broken core	65			**INDETERMINATE**		
SANDSTONE, light grey, fresh, moderately weak	68.26 70					
SILTSTONE, brownish grey, fresh, weak	72.73					
Coal						
Coal	74.06					
MUDSTONE, dark grey, weak	75			← Core loss		
END OF HOLE 77.60 m	80					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

STX124


24|00
STX124
24|50


33|00
STX124
33|50


39|00
STX124
39|50


42|00
STX124
42|50

STX124


65233
65234
65235
65236
652
52 50
STX124
53 00


64 00
STX124
64 50


70 50
STX124
71 00


75 50
STX124
76 00

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 954.70
N 7 487 131.70

BOREHOLE No:
STX126B

SHEET 1 OF 4

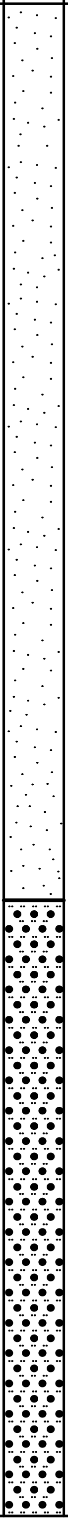
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
37.23

DRILLING DATE:
11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, brown	5 10			**INDETERMINATE**			No sonic log 5 10
SILTSTONE, dark grey, SANDSTONE, grey, fresh, weak to very weak	11.86 15 20			← Base of weathering 11.86			15 20



REMARKS:
Cored hole

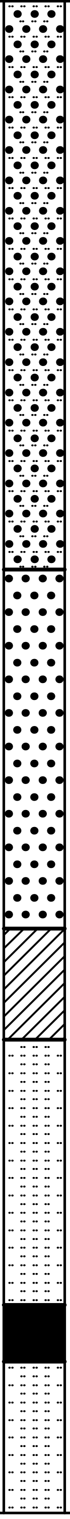
N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 771 954.70 N 7 487 131.70	BOREHOLE No: STX126B SHEET 2 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 37.23	DRILLING DATE: 11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, dark grey, SANDSTONE, light grey, fresh, very weak to moderately weak Coal → Coal → Coal → Core loss → Coal →	25			**INDETERMINATE**			No sonic log
SANDSTONE, grey, fresh, moderately weak	27.52 30						
Core loss	32.27						
SILTSTONE, dark grey, fresh, weak Coal → Coal → Siltstone → Coal →	33.74 35						
COAL, fresh, weak	37.25						
SILTSTONE, dark grey, fresh, very weak Coal ↘	38.00 40						

25

30

35

40

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 771 954.70

N 7 487 131.70

BOREHOLE No: STX126B

SHEET 3 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

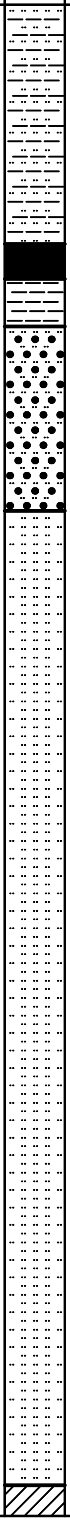
WATER TABLE DEPTH:

LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR- ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, black, SILTSTONE, grey, moderately weak Coal					INDETERMINATE			No sonic log
COAL, fresh, weak		43.17						
MUDSTONE Core loss		43.63						
SILTSTONE, medium grey, SANDSTONE, grey, fresh, weak to very weak		44.26						
		45						45
SILTSTONE, medium grey, fresh, very weak		46.70						
		50						50
		55						55
Core loss		59.60						
		60						60



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 954.70
N 7 487 131.70

BOREHOLE No: STX126B

SHEET 4 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, medium grey, fresh Core loss	60.75			**INDETERMINATE**			No sonic log
SANDSTONE, grey, fresh, mainly moderately weak	62.60 65						65
SILTSTONE, medium grey, fresh, very weak	69.89 70						70
SANDSTONE, grey, fresh, very weak	73.17						
END OF HOLE 74.60 m	75 80						75 80

REMARKS:

Cored hole

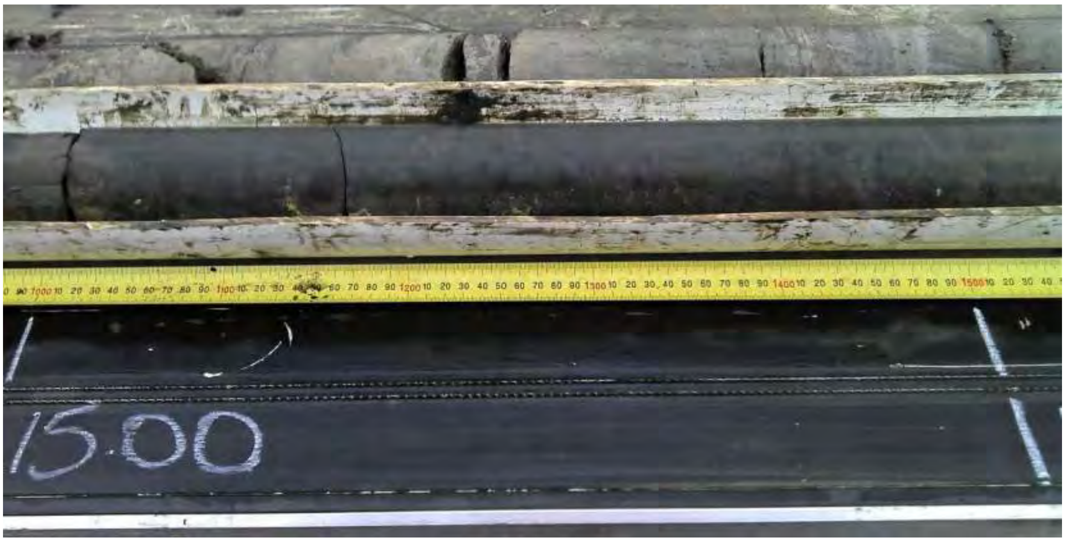
N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

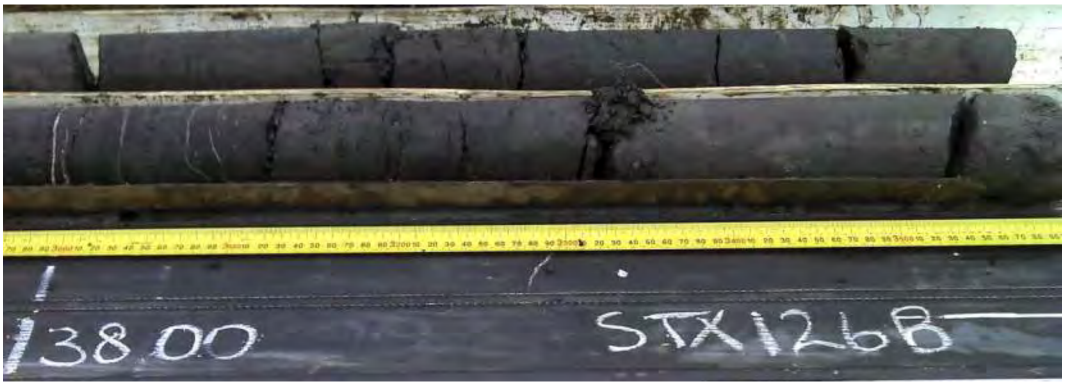
LOGGED BY: Geologist


12.50


15.00


19.00


29.00
12


38.00
STX126B


X126B
58.00


65.00
STX126B


70.00
STX126B

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 431.56
N 7 487 323.69

BOREHOLE No: STX127

SHEET 1 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
SOIL, brown				**INDETERMINATE**			No sonic log
CLAY, red to brown		4.00					
SANDSTONE, brown, highly weathered		14.47					
SILTSTONE, dark grey, SANDSTONE, grey, fresh, very weak		16.82		← Base of weathering 16.82			
Coal		17.61					
		18.57					
Core loss		19.61					

Depth scale: 5, 10, 15, 20

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 431.56
N 7 487 323.69

BOREHOLE No: STX127

SHEET 2 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

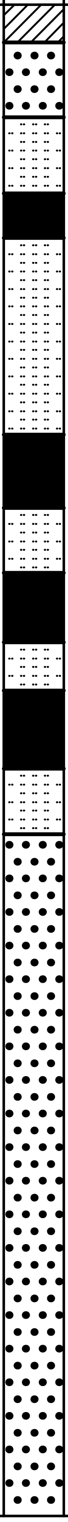
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS
Core loss		INDETERMINATE
SANDSTONE, light grey, fresh, moderately weak Coal	20.50	
SILTSTONE, grey, fresh, very weak	21.49	
COAL, fresh, very weak	22.50	
SILTSTONE, dark grey, fresh, very weak	23.09 25	
COAL, fresh, very weak	25.69	
SILTSTONE, grey, fresh, very weak Core loss	26.66	
COAL, fresh, very weak	27.51	
SILTSTONE, grey, fresh, very weak	28.44	
COAL, fresh, very weak Core loss	29.08 30	
SILTSTONE, grey, fresh, very weak Mudstone	30.11	
SANDSTONE, grey, fresh, moderately weak to very weak	30.98 35 40	

GRAPHIC LOG

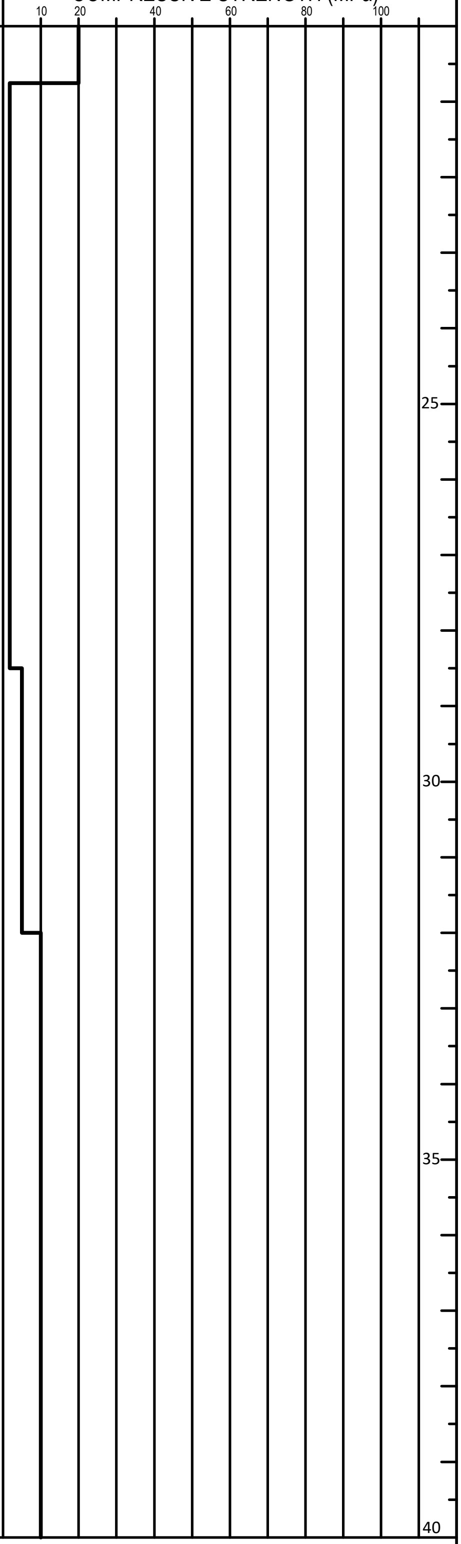


DUR-ABILITY %

FRAC. PER METRE

R.Q.D.

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 431.56
N 7 487 323.69

BOREHOLE No: STX127

SHEET 3 OF 4

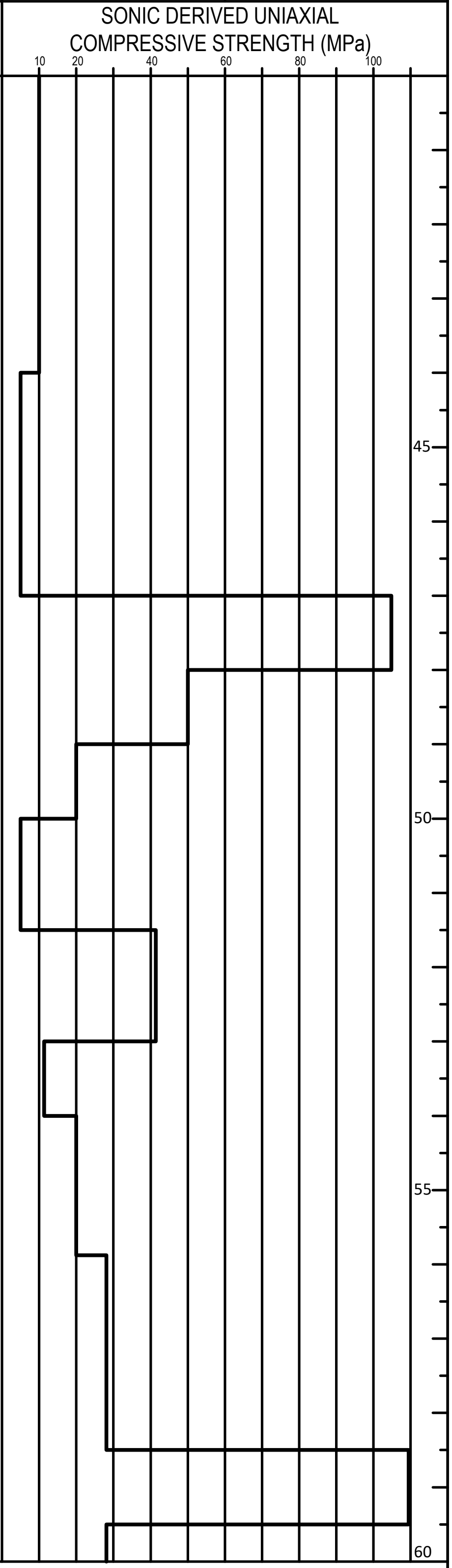
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, grey, fresh, very weak to moderately weak		45			INDETERMINATE		
		49.67					
SILTSTONE, grey, fresh, very weak		50					
		50.76					
SANDSTONE, grey, fresh, moderately weak to moderately strong		55					
Siltstone →							
		60					



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 771 431.56

N 7 487 323.69

BOREHOLE No: STX127

SHEET 4 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

DEPTH:

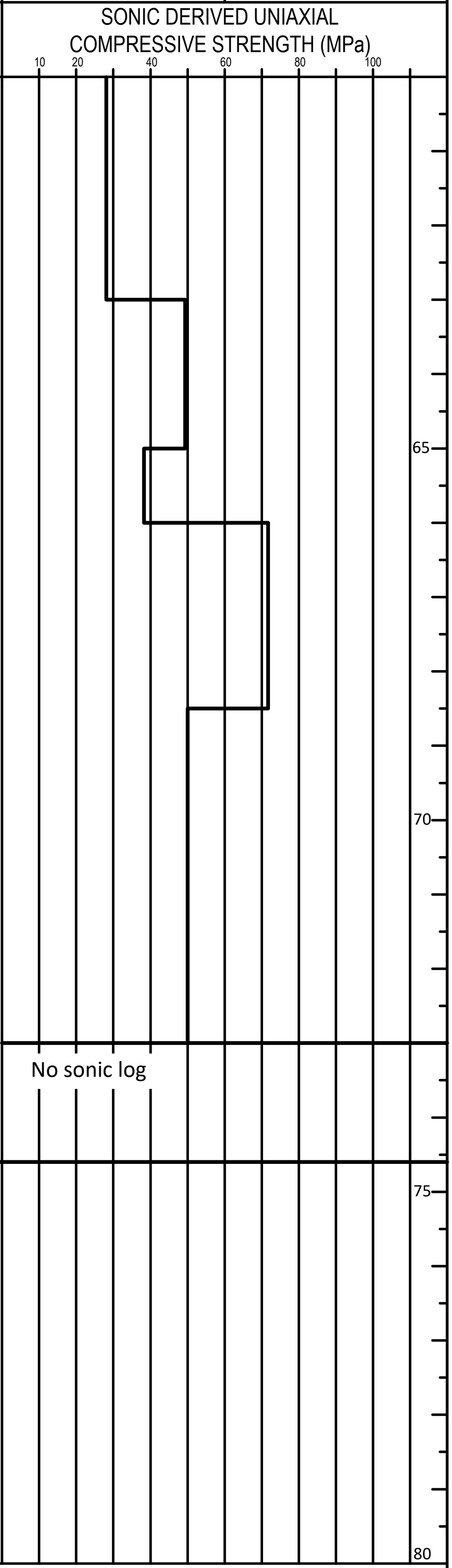
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, grey, fresh, moderately strong Siltstone →					**INDETERMINATE**		
		65					
		70					
END OF HOLE 74.60 m		75					
		80					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

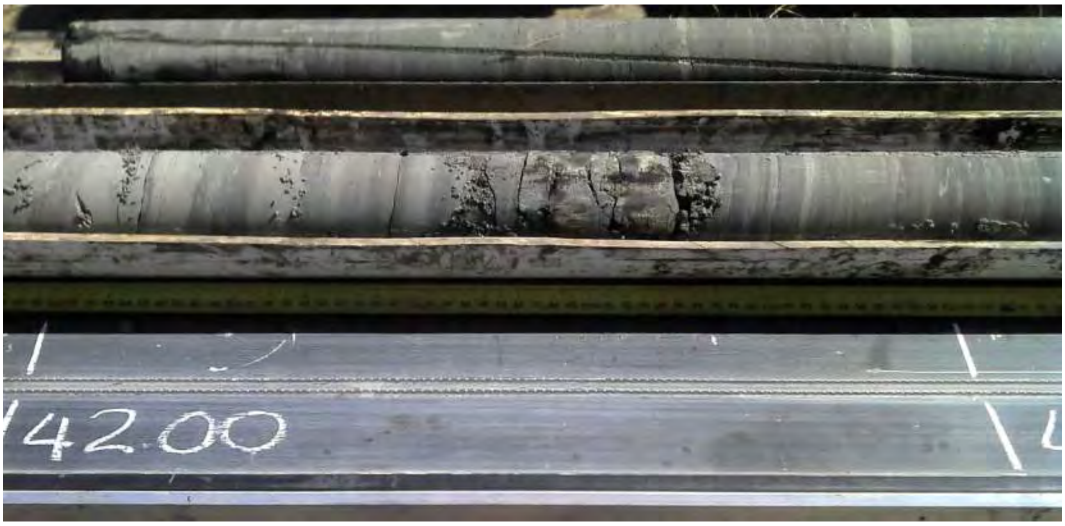
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

STX127


65276
127
27.50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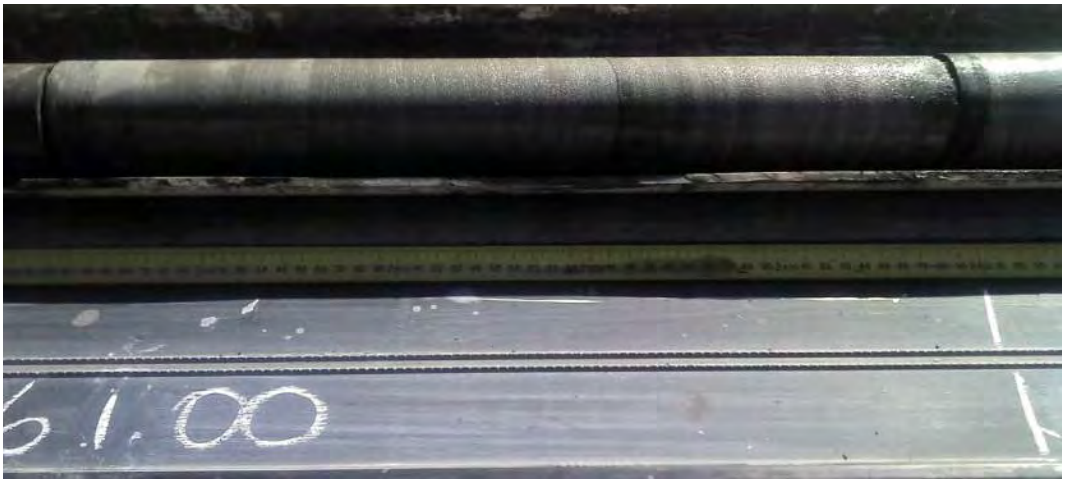
53.00
STX1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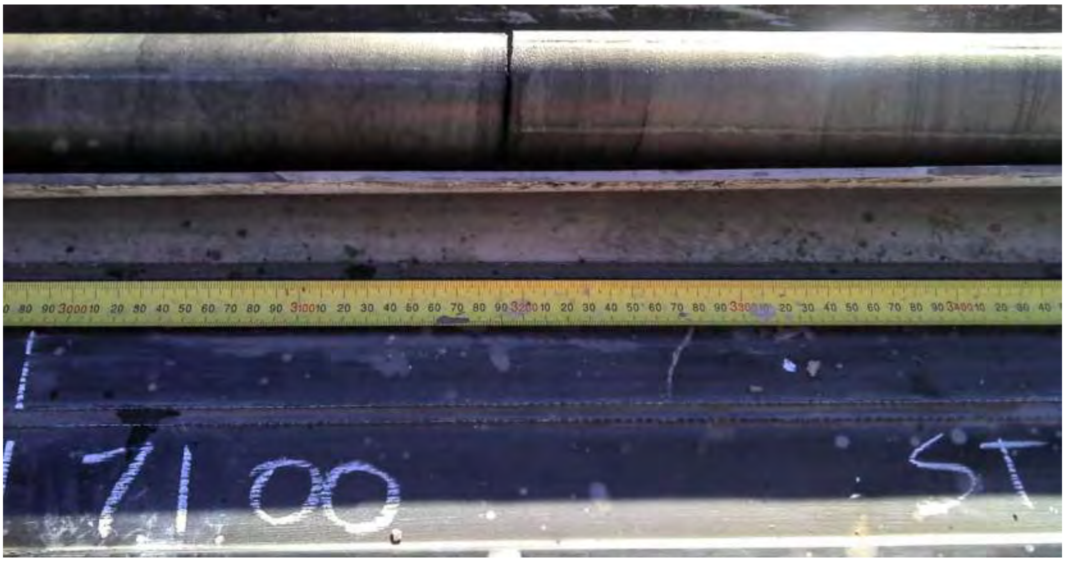

71.00
ST

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 772 585.31 N 7 486 943.74	BOREHOLE No: STX132C SHEET 1 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 31.50	DRILLING DATE: 04/06/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
Not logged		5 10 15	▨		N.A. Assumed base of weathering 19.40			No sonic log
COAL		19.40	■		INDETERMINATE			
MUDSTONE		19.80 20						

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 585.31
N 7 486 943.74

BOREHOLE No: STX132C

SHEET 2 OF 4

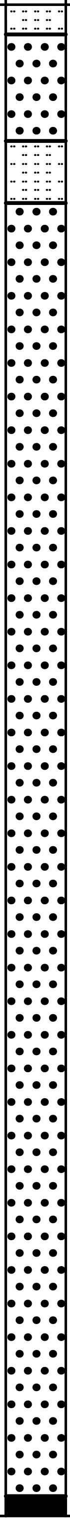
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 31.50

DRILLING DATE: 04/06/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, fresh				INDETERMINATE			No sonic log
SANDSTONE, grey, fresh, very weak Core loss → Coal	20.40						
SILTSTONE, fresh, very weak	21.81						
SANDSTONE, grey, fresh, weak Core loss → Coal → Mudstone → Coal → Coal →	22.63 25 30 35						25 30 35
COAL	39.74 40						40



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 585.31
N 7 486 943.74

BOREHOLE No: STX132C

SHEET 3 OF 4

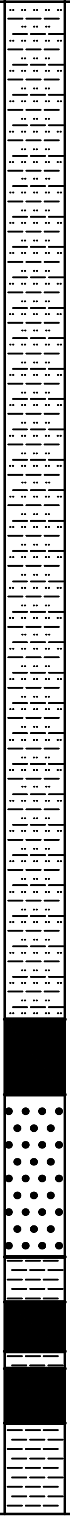
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 31.50

DRILLING DATE: 04/06/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, MUDSTONE, grey, fresh, weak to very weak Mudstone Coal Coal Coal Coal Coal Core loss		45 50			INDETERMINATE			No sonic log
COAL, fresh, very weak		53.46						
SANDSTONE, grey, fresh, very weak		54.60 55						
MUDSTONE, grey, weak		56.60						
COAL, fresh, weak		57.20						
MUDSTONE, grey, weak		57.85						
COAL, fresh, weak		58.08						
MUDSTONE, grey fresh, very weak		58.80 60						



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 585.31
N 7 486 943.74

BOREHOLE No: STX132C

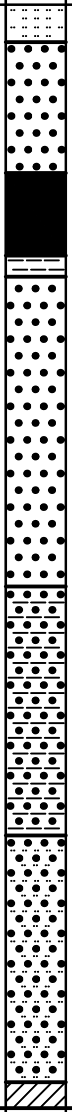
SHEET 4 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 31.50

DRILLING DATE: 04/06/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, weak		60.50		**INDETERMINATE**			No sonic log
SANDSTONE, grey, fresh, moderately weak		62.23					
COAL, weak Mudstone → Mudstone →		63.32					
MUDSTONE		63.60					
SANDSTONE, grey, fresh, weak to very weak Coal → (65) Siltstone → Calcite →		67.70					
MUDSTONE, grey, SANDSTONE, light grey, fresh, weak to very weak		70 71.14					
SANDSTONE, light grey, SILTSTONE, grey, fresh, weak Coal → Core loss				Slickensides			
END OF HOLE 74.60 m		75 80					

REMARKS:

Cored hole

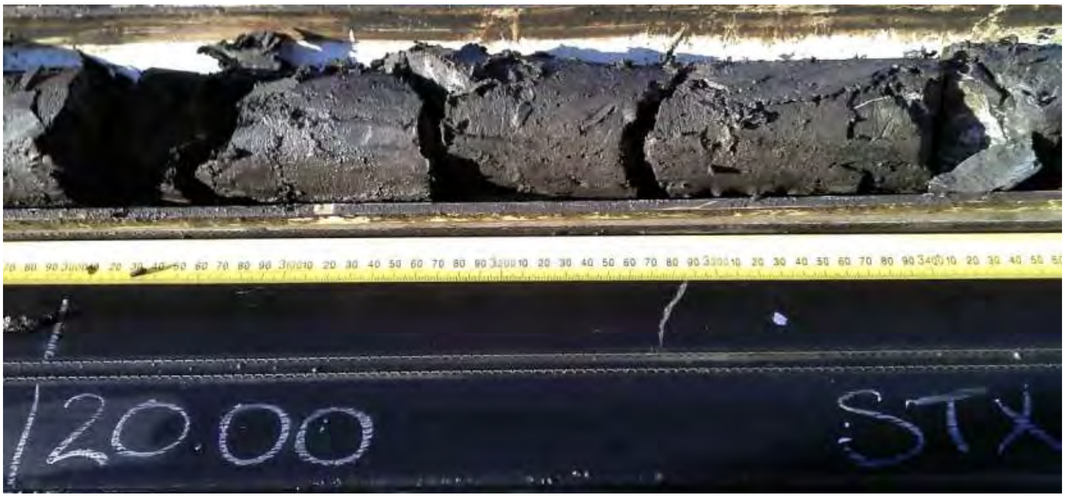
N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

STX132C



STX132C


72.00
STX132


7350
STX132

APPENDIX 2

UCS TESTING DETAILS

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060109- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT001	**Depth (m)**	42.90-43.60
Description	SANDSTONE, medium grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.4	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.47	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3333		
"P" Arrival Time (µsec)	62.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060109	DATE:	13/6/12
BOREHOLE:	STX084RR - GT001	DEPTH:	42.90-43.60

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060109- SON

Test Date 13/06/2012

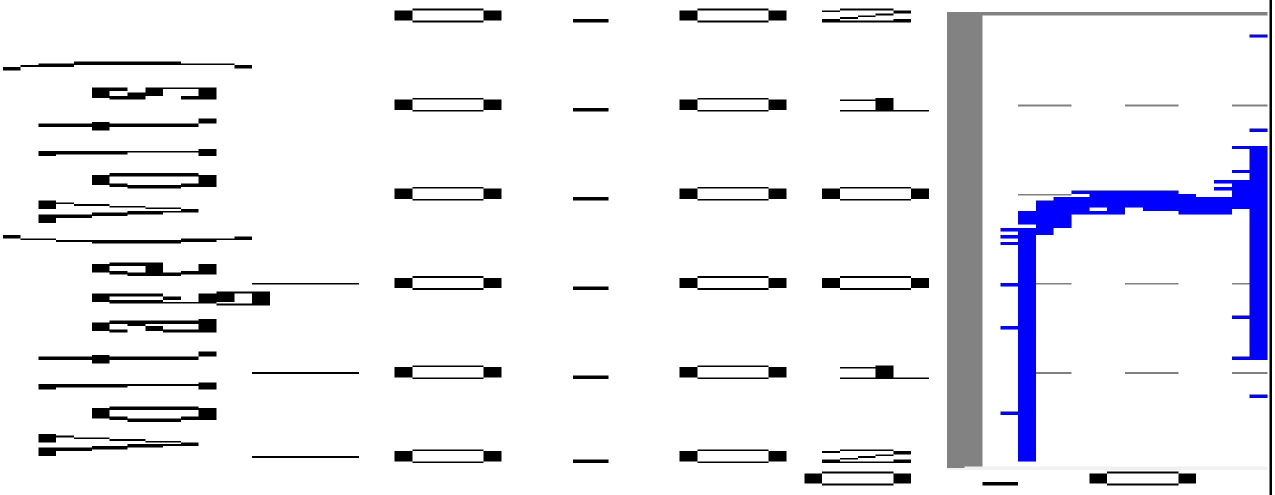
Report Date 14/06/2012

Client ID STX084RR - GT001

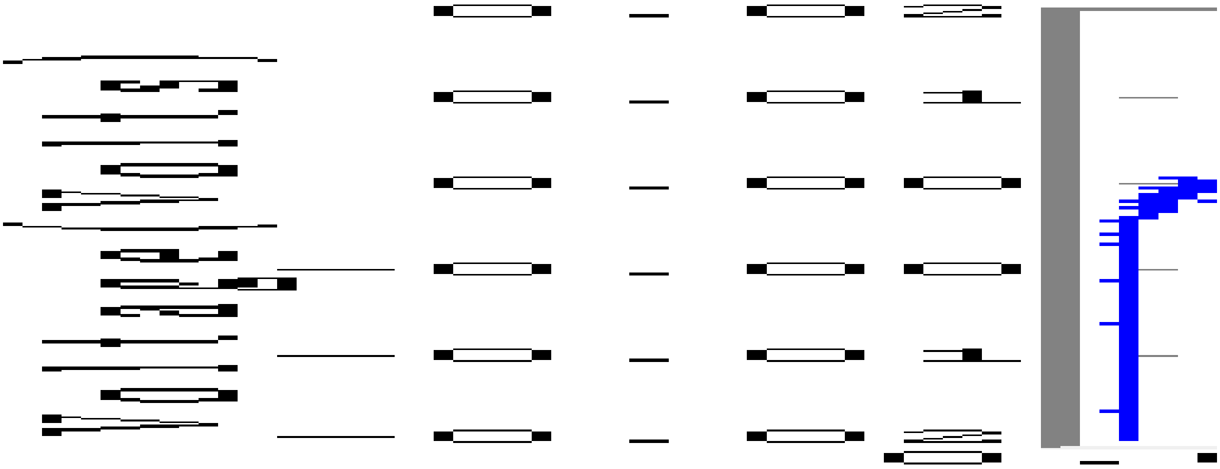
Depth (m) 42.90-43.60

Description SANDSTONE, medium grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

Page 2 of 2 REP04401

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060109-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060109
Client ID	STX084RR - GT001
Depth (m)	42.90-43.60
Description	SANDSTONE, medium grained 100%
Wet Density (t/m^3)	2.47
Moisture Content (%)	4.6
Specimen Length (mm)	160.4
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:53

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060109
DATE: 15/6/2012
BOREHOLE: STX084RR - GT001
DEPTH: 42.90-43.60

UCS (MPa)	25.2

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IES 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Authorised Signatory

James Russell

J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

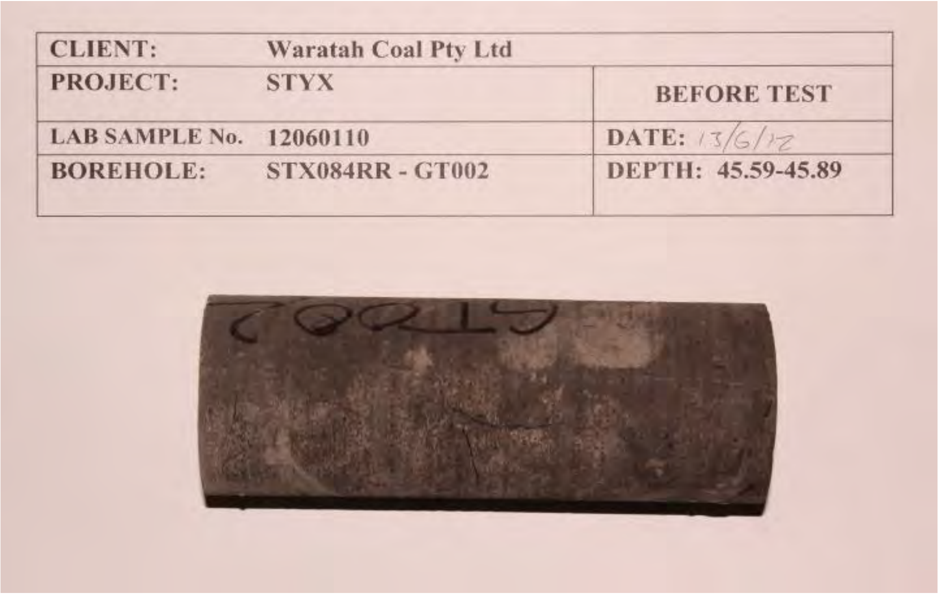
Client	Waratah Coal Pty Ltd	**Report No.**	12060110- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT002	**Depth (m)**	45.59-45.89
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.7	Couplant	Honey
Sample Height (mm)	159.6	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.32	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2323		
"P" Arrival Time (µsec)	82.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	**BEFORE TEST**	
LAB SAMPLE No.	12060110	**DATE:**	13/6/12
BOREHOLE:	STX084RR - GT002	**DEPTH:**	45.59-45.89

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

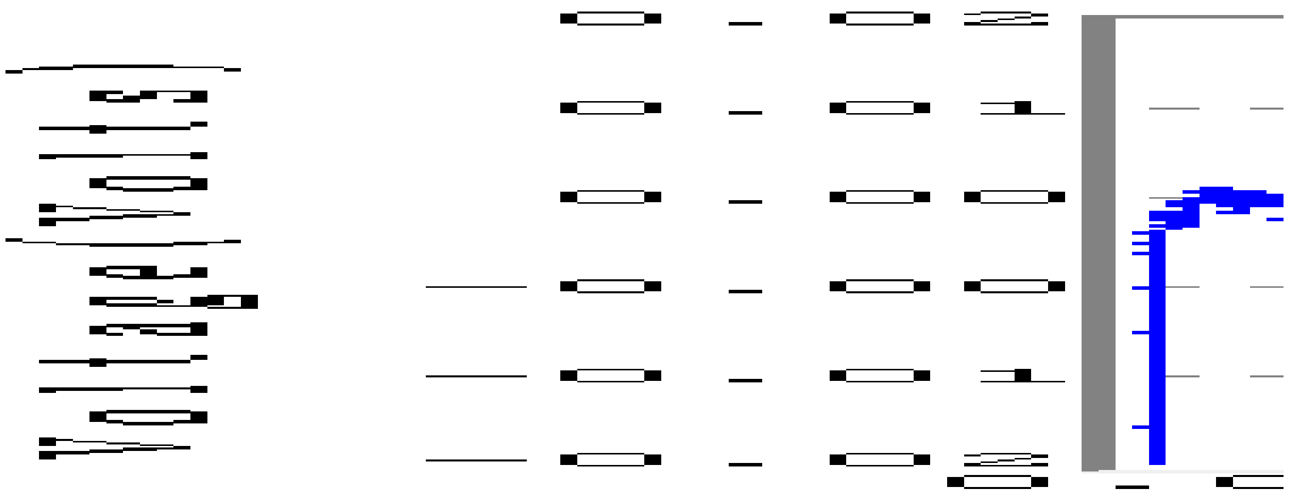
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

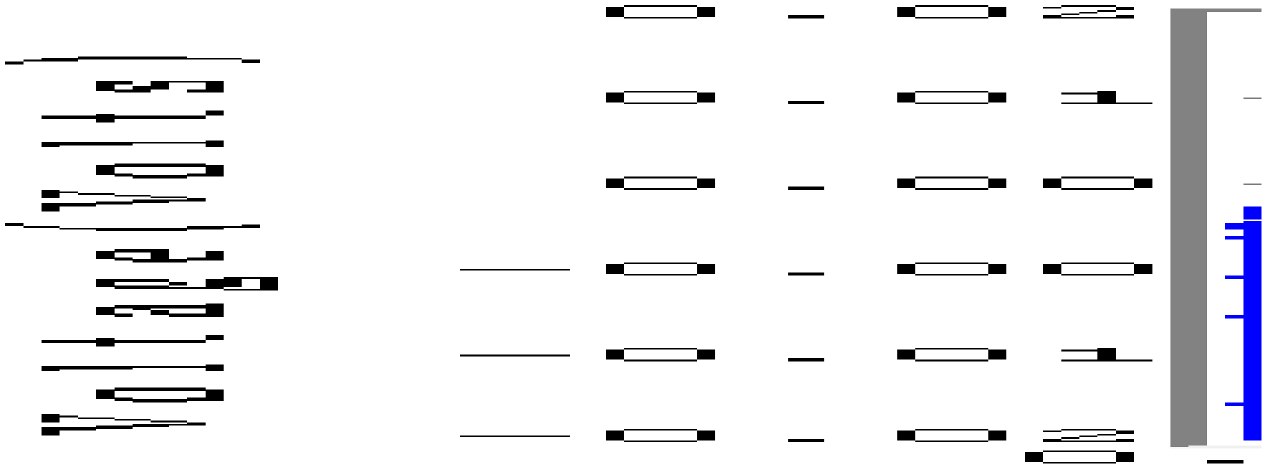
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060110- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT002	**Depth (m)**	45.59-45.89
Description	SANDSTONE, fine grained 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060110-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060110
Client ID	STX084RR - GT002
Depth (m)	45.59-45.89
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.32
Moisture Content (%)	6.7
Specimen Length (mm)	159.6
Specimen Diameter (mm)	60.7
Mode of Failure	Conical
Test Duration (Min:Sec)	1:58

UCS (MPa)	4.60

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IES 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Authorised Signatory

James Russell

J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

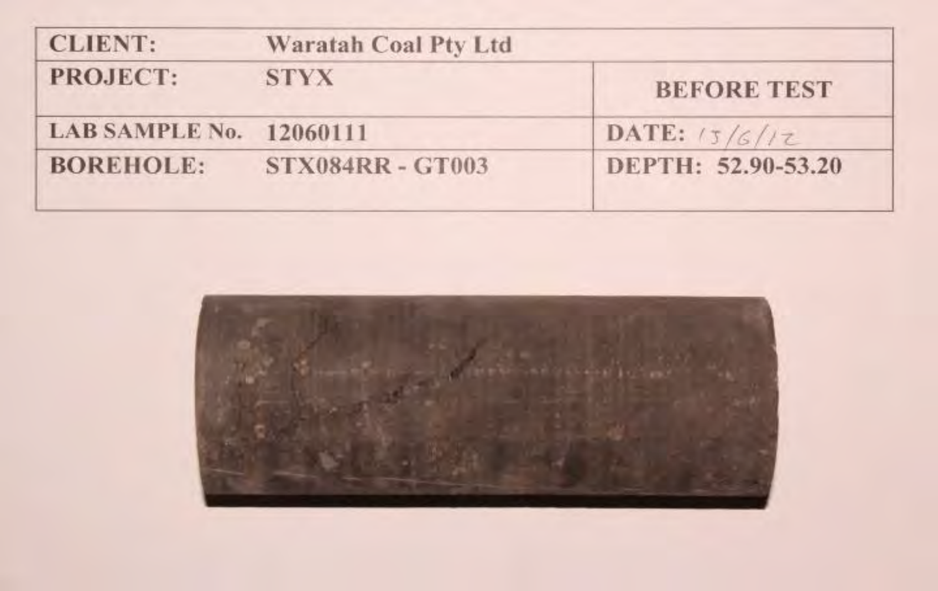
Client	Waratah Coal Pty Ltd	**Report No.**	12060111- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT003	**Depth (m)**	52.90-53.20
Description	SILTSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.40	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	NO TRACE		
"P" Arrival Time (μsec)	N/A	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060111	DATE: 13/6/12
BOREHOLE:	STX084RR - GT003	DEPTH: 52.90-53.20

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060111- SON

Test Date 13/06/2012

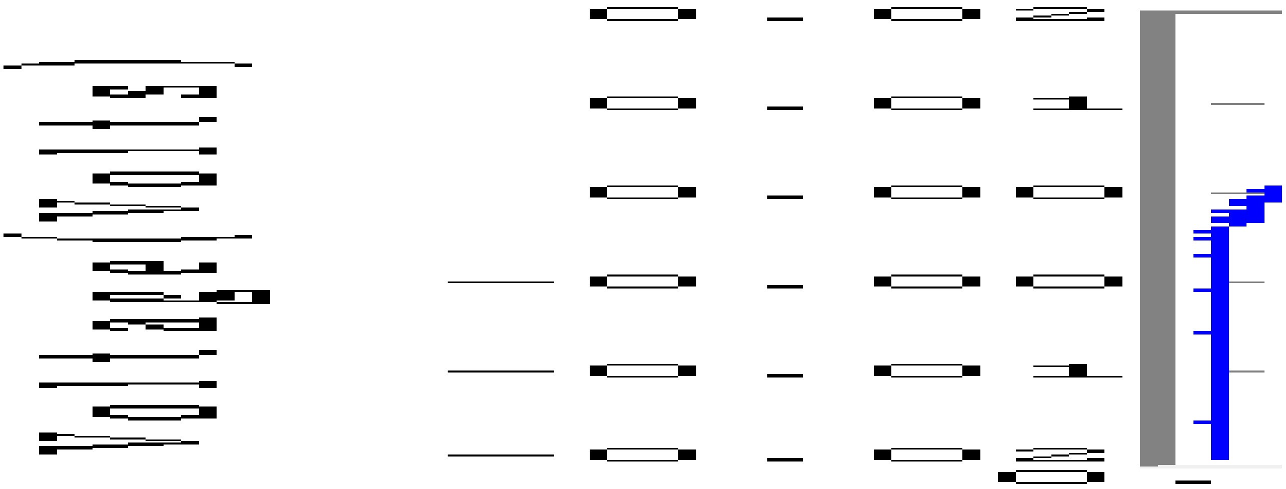
Report Date 14/06/2012

Client ID STX084RR - GT003

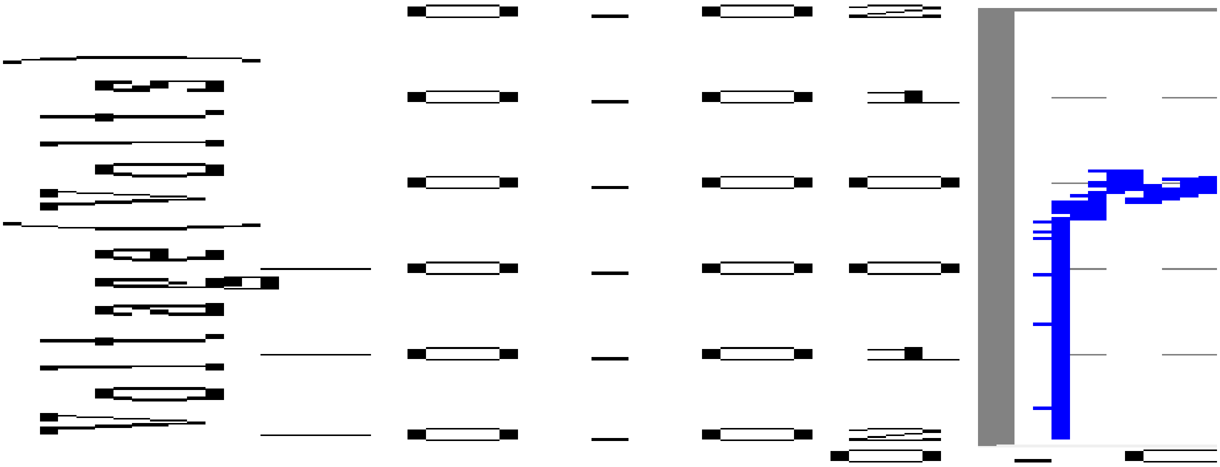
Depth (m) 52.90-53.20

Description SILTSTONE 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060111-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060111
Client ID	STX084RR - GT003
Depth (m)	52.90-53.20
Description	SILTSTONE 100%
Wet Density (t/m^3)	2.40
Moisture Content (%)	6.7
Specimen Length (mm)	160.5
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	3:43
	
UCS (MPa)	5.02

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

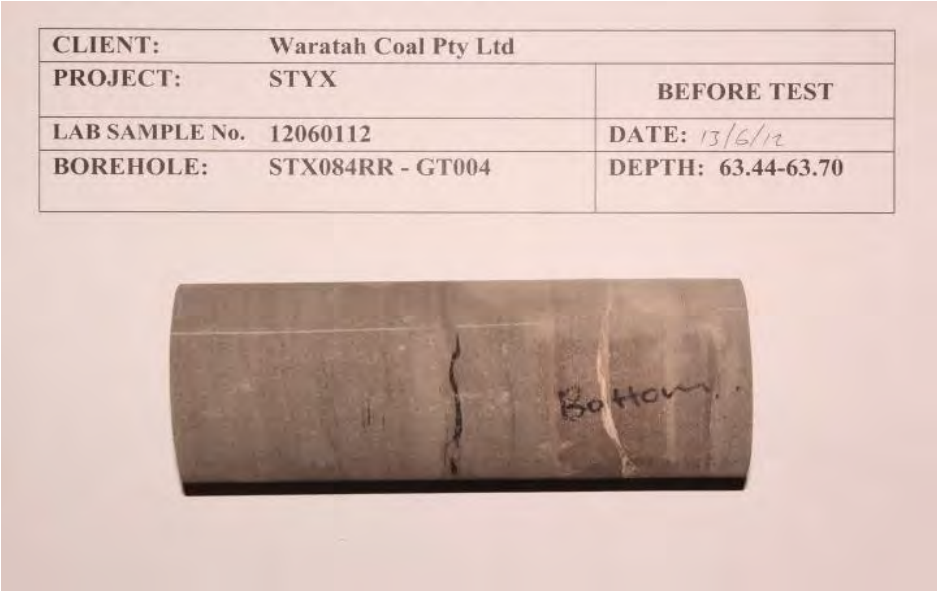
Client	Waratah Coal Pty Ltd	**Report No.**	12060112- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT004	**Depth (m)**	63.44-63.70
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	161.0	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.65	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3458		
"P" Arrival Time (µsec)	60.4	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060112	DATE:	13/6/12
BOREHOLE:	STX084RR - GT004	DEPTH:	63.44-63.70

Notes/Remarks:

Sample/s supplied by client   Photo not to scale   Tested as received   **Page 1 of 2** REP04401

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060112- SON

Test Date 13/06/2012

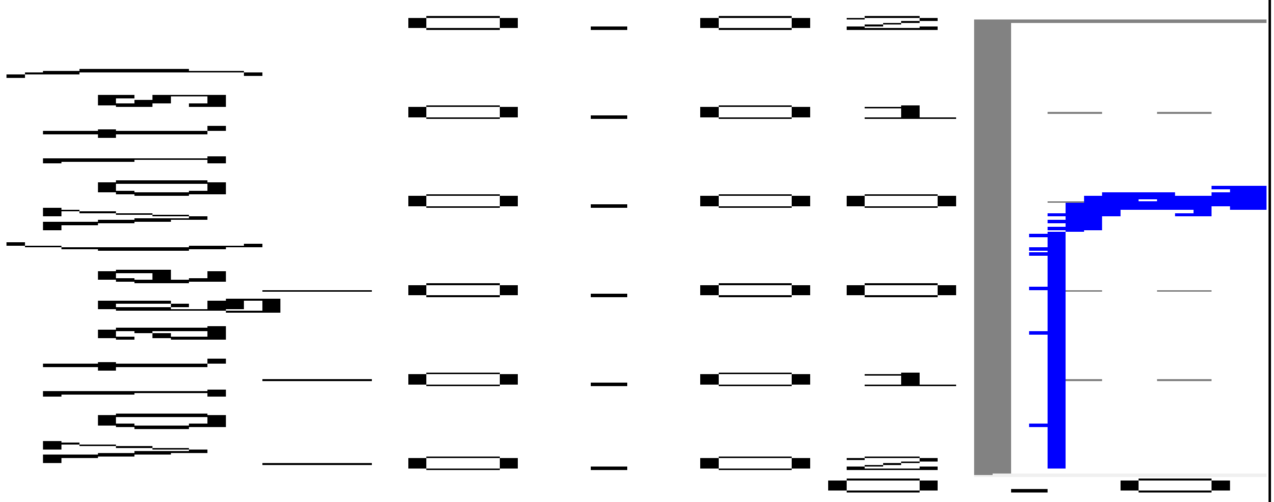
Report Date 14/06/2012

Client ID STX084RR - GT004

Depth (m) 63.44-63.70

Description SANDSTONE, fine grained 100%

"P" WAVEFORM



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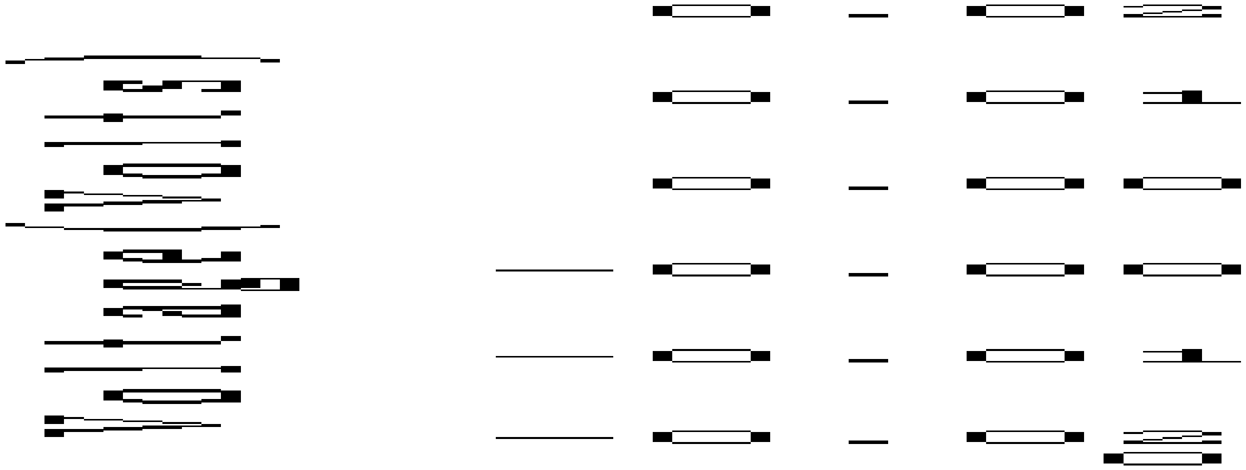

Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060112-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060112
Client ID	STX084RR - GT004
Depth (m)	63.44-63.70
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.65
Moisture Content (%)	4.2
Specimen Length (mm)	161.0
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	8:47

UCS (MPa)	24.5

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

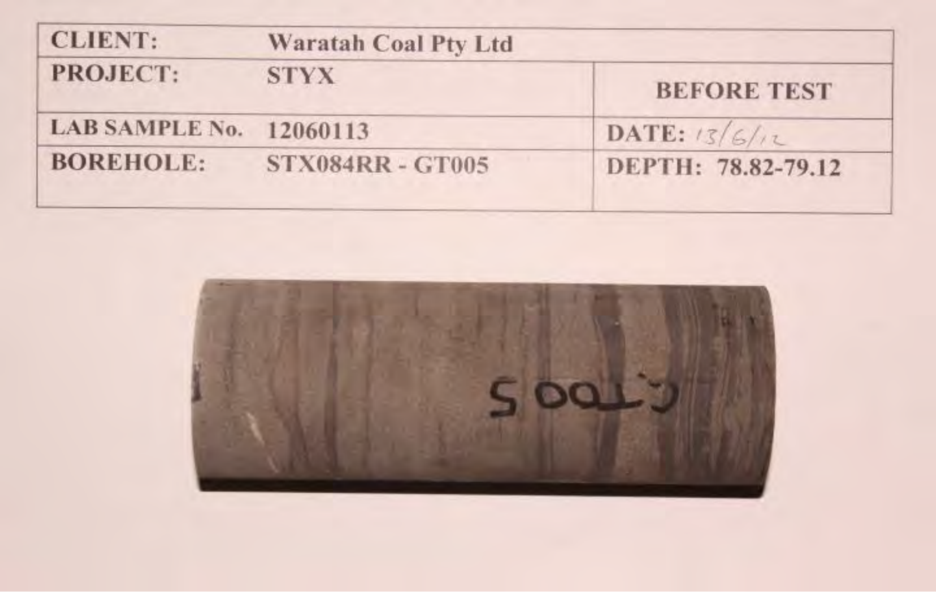
Client	Waratah Coal Pty Ltd	**Report No.**	12060113- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT005	**Depth (m)**	78.82-79.12
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.8	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.49	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2938		
"P" Arrival Time (µsec)	68.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060113	DATE:	13/6/12
BOREHOLE:	STX084RR - GT005	DEPTH:	78.82-79.12

Notes/Remarks:

Sample/s supplied by client

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Tested as received

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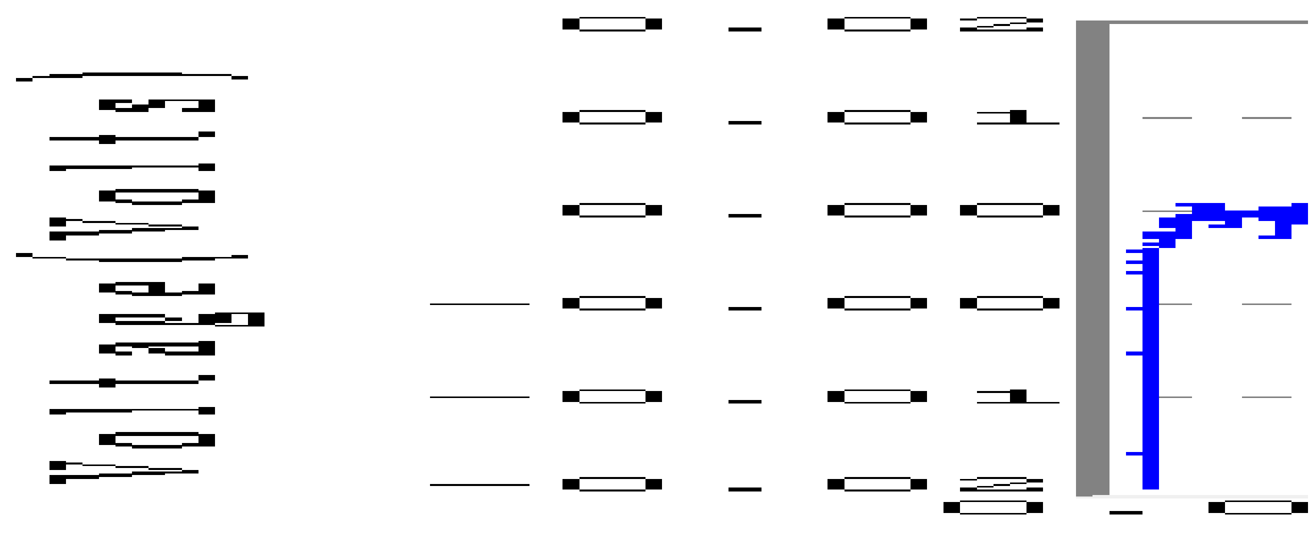
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060113- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT005	**Depth (m)**	78.82-79.12
Description	SANDSTONE, fine grained 100%		

"P" WAVEFORM



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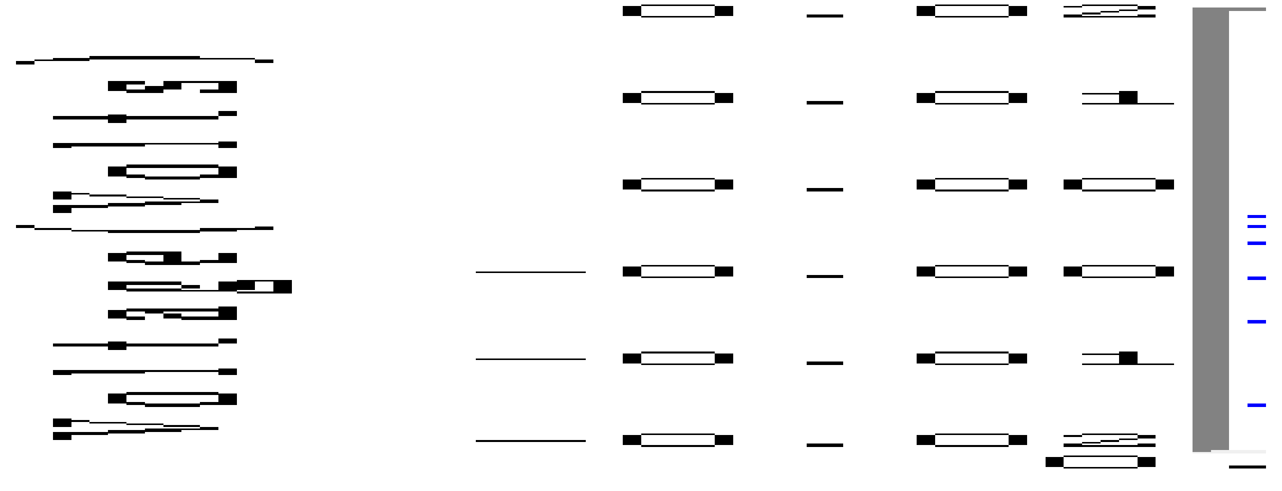

Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060113-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060113
Client ID	STX084RR - GT005
Depth (m)	78.82-79.12
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.49
Moisture Content (%)	4.7
Specimen Length (mm)	160.8
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	7:11

UCS (MPa)	20.9

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - Kelba 1000 kN Load Cell
Photo not to scale

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060115- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT007	**Depth (m)**	98.70-98.92
Description	SANDSTONE, very fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.5	Couplant	Honey
Sample Height (mm)	130.4	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.61	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3049		
"P" Arrival Time (µsec)	56.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060115	DATE: 13/6/12
BOREHOLE:	STX084RR - GT007	DEPTH: 98.70-98.92

Notes/Remarks:

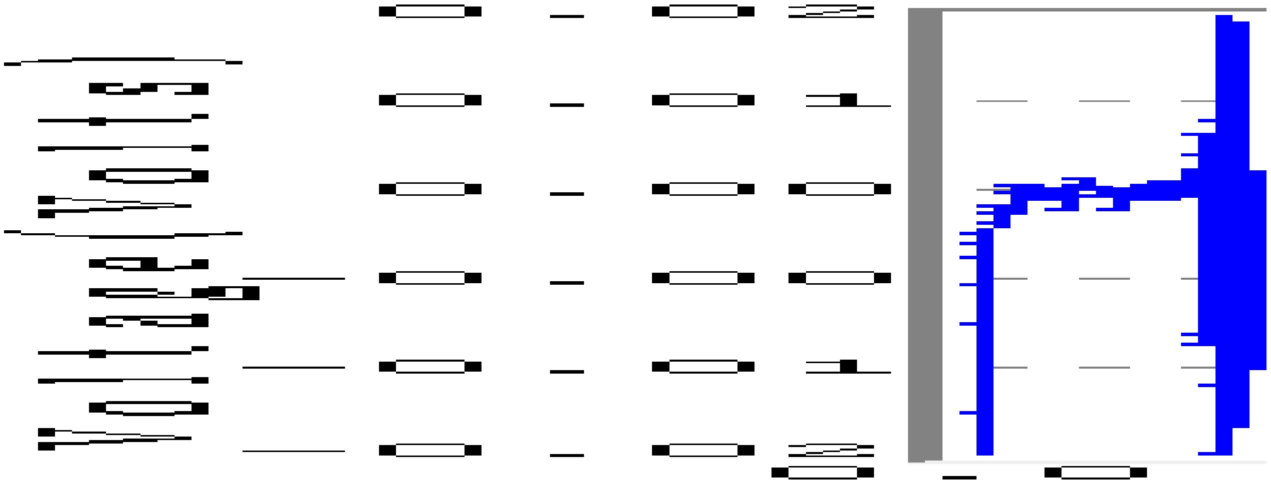
Sample/s supplied by client Photo not to scale Tested as received **Page 1 of 2** REP04401

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060115- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT007	**Depth (m)**	98.70-98.92
Description	SANDSTONE, very fine grained 100%		

"P" WAVEFORM



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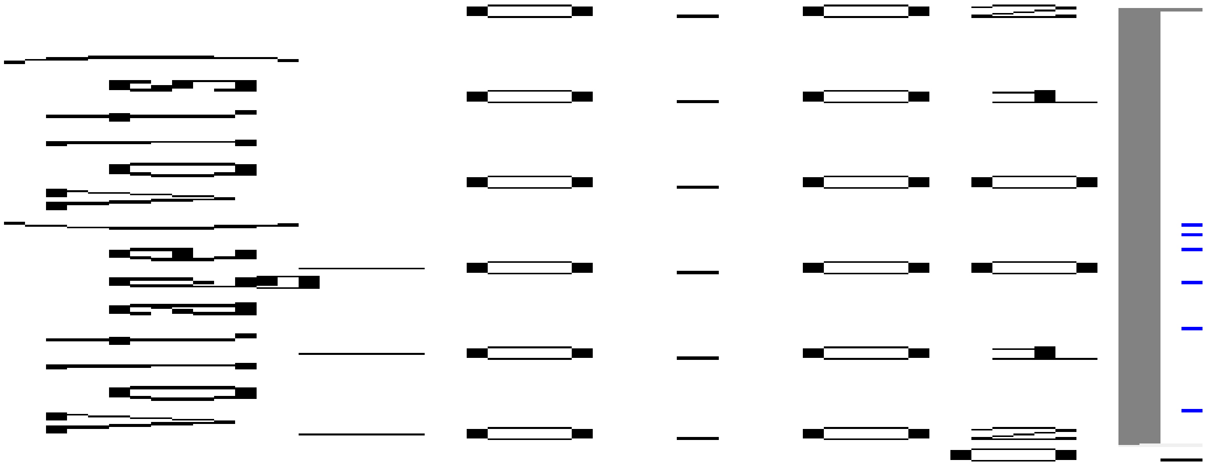

Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060115-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060115
Client ID	STX084RR - GT007
Depth (m)	98.70-98.92
Description	SANDSTONE, very fine grained 100%
Wet Density (t/m^3)	2.61
Moisture Content (%)	4.3
Specimen Length (mm)	130.4 *
Specimen Diameter (mm)	60.5
Mode of Failure	Shear
Test Duration (Min:Sec)	3:0

UCS (MPa)	5.43

NOTES/REMARKS:

Stored and tested as received
* Length to diameter ratio less than 2.5:1
Photo not to scale
Sample/s supplied by the client
Test Apparatus - ELE 1000 kN Compression Machine

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

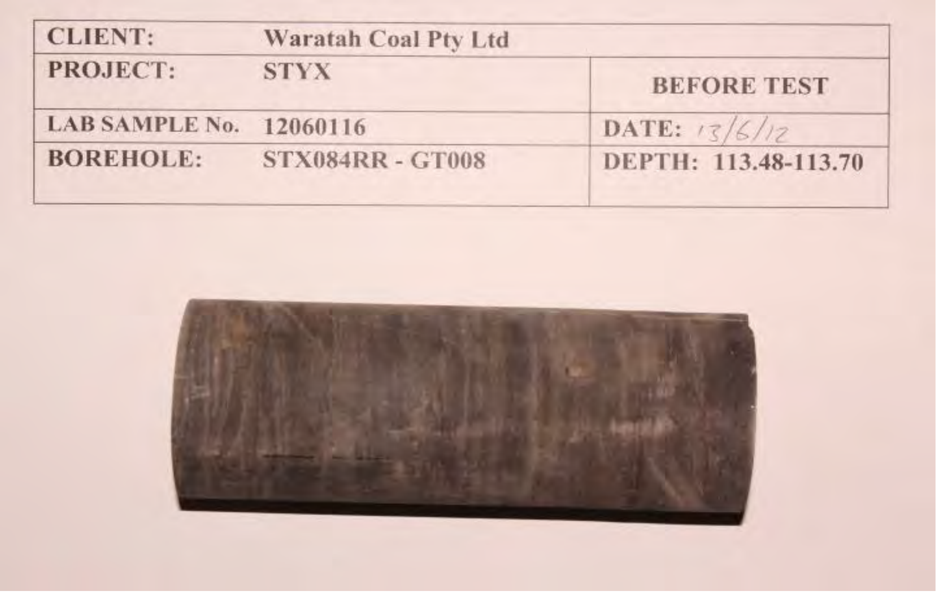
Client	Waratah Coal Pty Ltd	**Report No.**	12060116- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT008	**Depth (m)**	113.48-113.70
Description	MUDSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.5	Couplant	Honey
Sample Height (mm)	160.8	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.38	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2938		
"P" Arrival Time (µsec)	68.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060116	DATE: 13/6/12
BOREHOLE:	STX084RR - GT008	DEPTH: 113.48-113.70

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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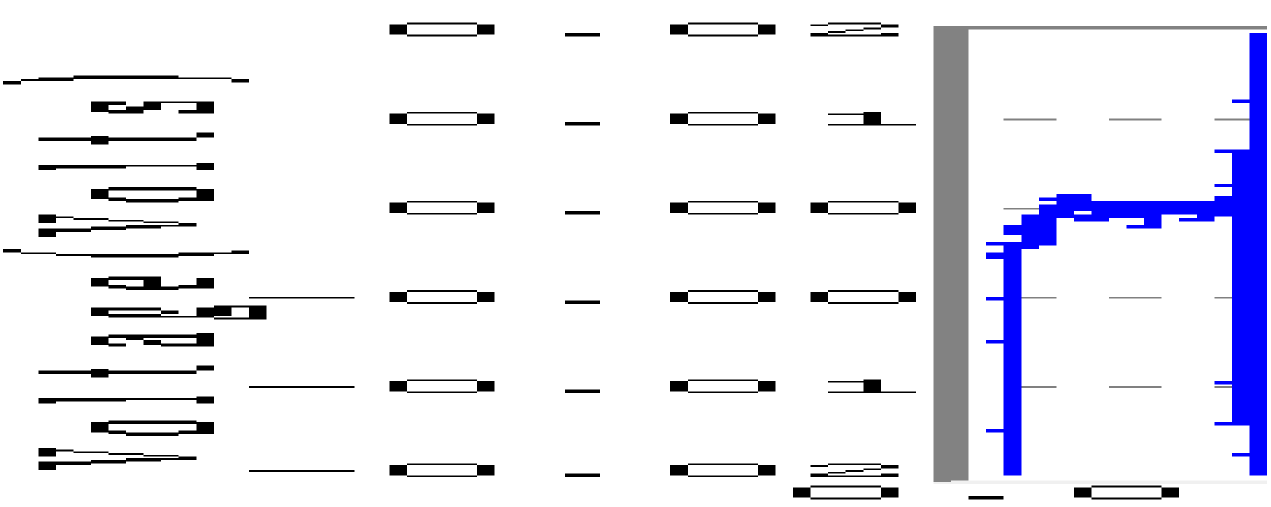
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060116- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT008	**Depth (m)**	113.48-113.70
Description	MUDSTONE 100%		

"P" WAVEFORM



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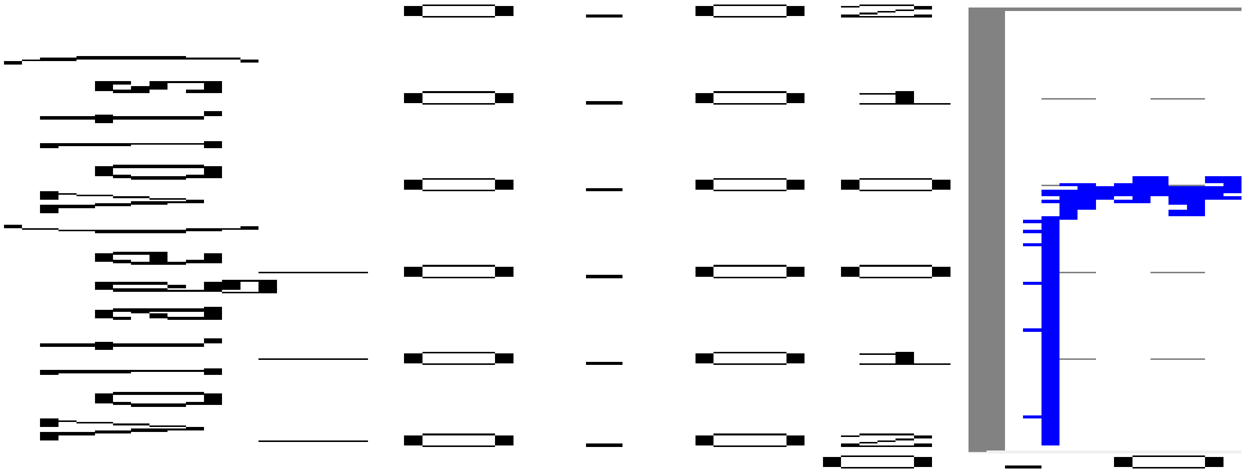

Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060116-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060116
Client ID	STX084RR - GT008
Depth (m)	113.48-113.70
Description	MUDSTONE 100%
Wet Density (t/m^3)	2.38
Moisture Content (%)	1.8
Specimen Length (mm)	160.8
Specimen Diameter (mm)	60.5
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

UCS (MPa)	18.4

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client Test Apparatus - Kelba 1000 kN Load Cell

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Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

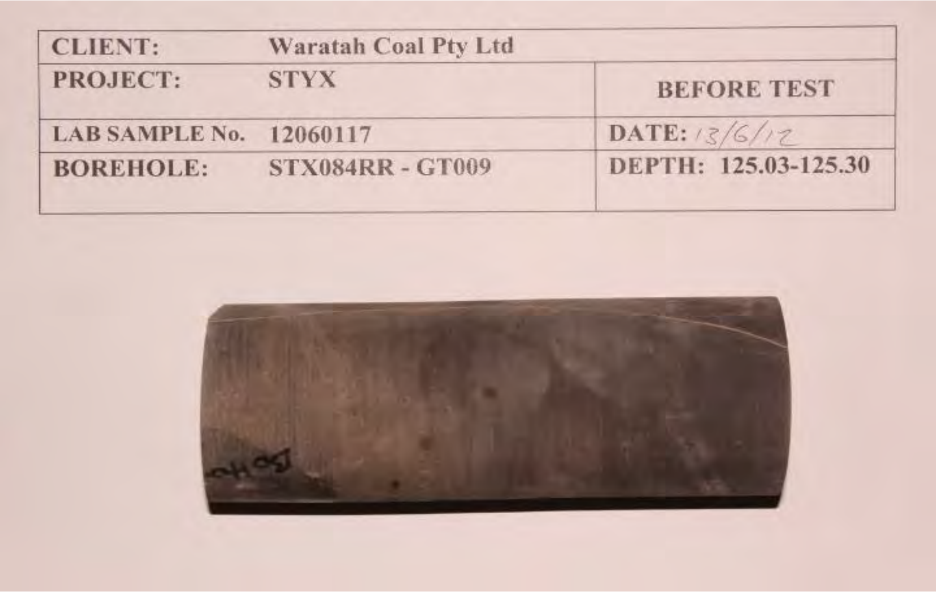
Client	Waratah Coal Pty Ltd	**Report No.**	12060117- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT009	**Depth (m)**	125.03-125.30
Description	SILTSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.5	Couplant	Honey
Sample Height (mm)	162.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.79	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3731		
"P" Arrival Time (µsec)	57.4	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060117	DATE:	13/6/12
BOREHOLE:	STX084RR - GT009	DEPTH:	125.03-125.30

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

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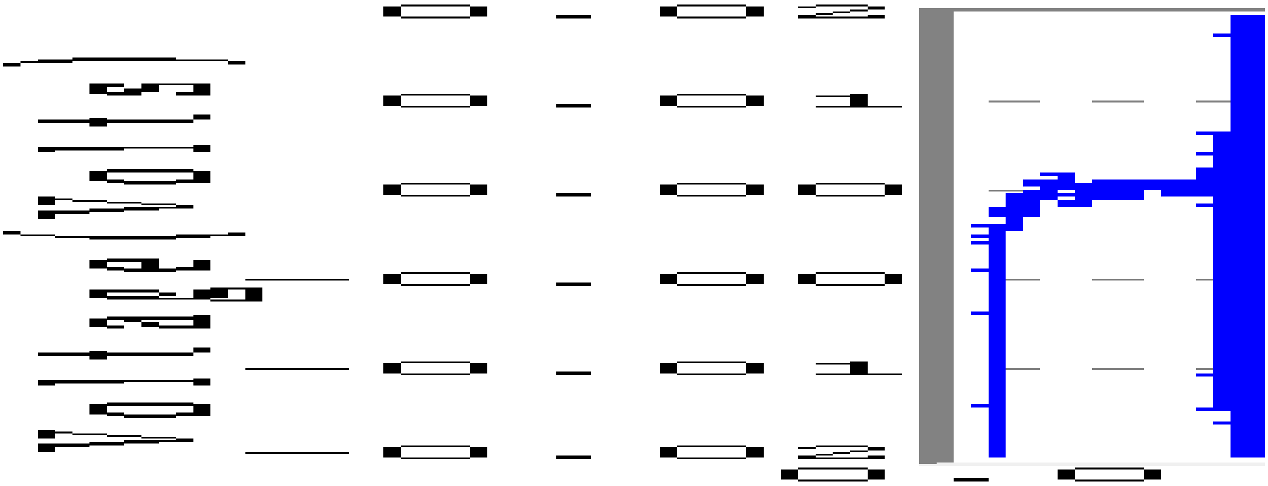
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

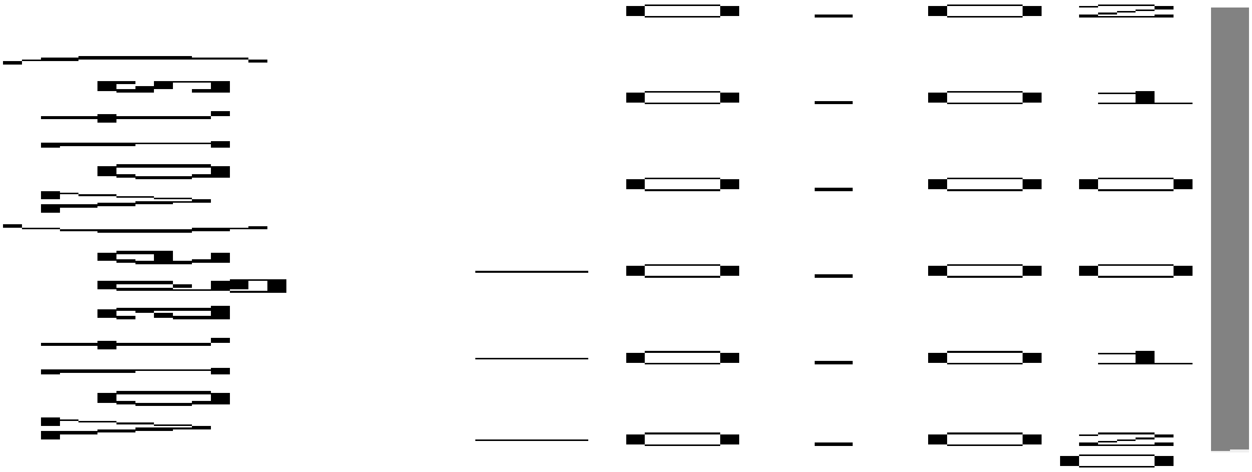
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060117- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT009	**Depth (m)**	125.03-125.30
Description	SILTSTONE 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060117-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060117
Client ID	STX084RR - GT009
Depth (m)	125.03-125.30
Description	SILTSTONE 100%
Wet Density (t/m^3)	2.79
Moisture Content (%)	3.4
Specimen Length (mm)	162.5
Specimen Diameter (mm)	60.5
Mode of Failure	Shear
Test Duration (Min:Sec)	7:15

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060117
DATE: 15/6/2012
BOREHOLE: STX084RR - GT009
DEPTH: 125.03-125.30

UCS (MPa)	36.6

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

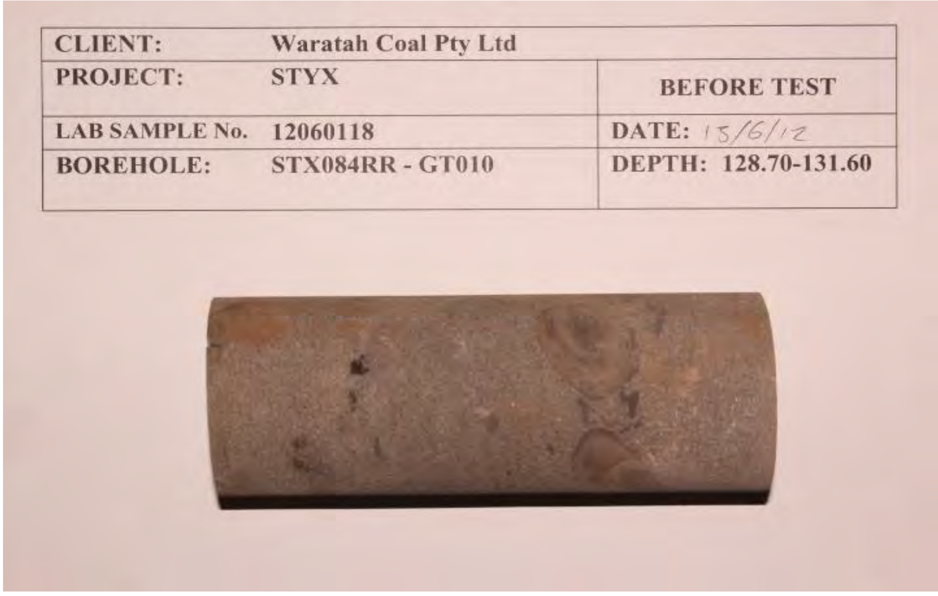
Client	Waratah Coal Pty Ltd	**Report No.**	12060118- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT010	**Depth (m)**	128.70-131.60
Description	SANDSTONE, medium grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	157.6	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.54	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3204		
"P" Arrival Time (µsec)	63.1	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060118	DATE:	13/6/12
BOREHOLE:	STX084RR - GT010	DEPTH:	128.70-131.60

Notes/Remarks:

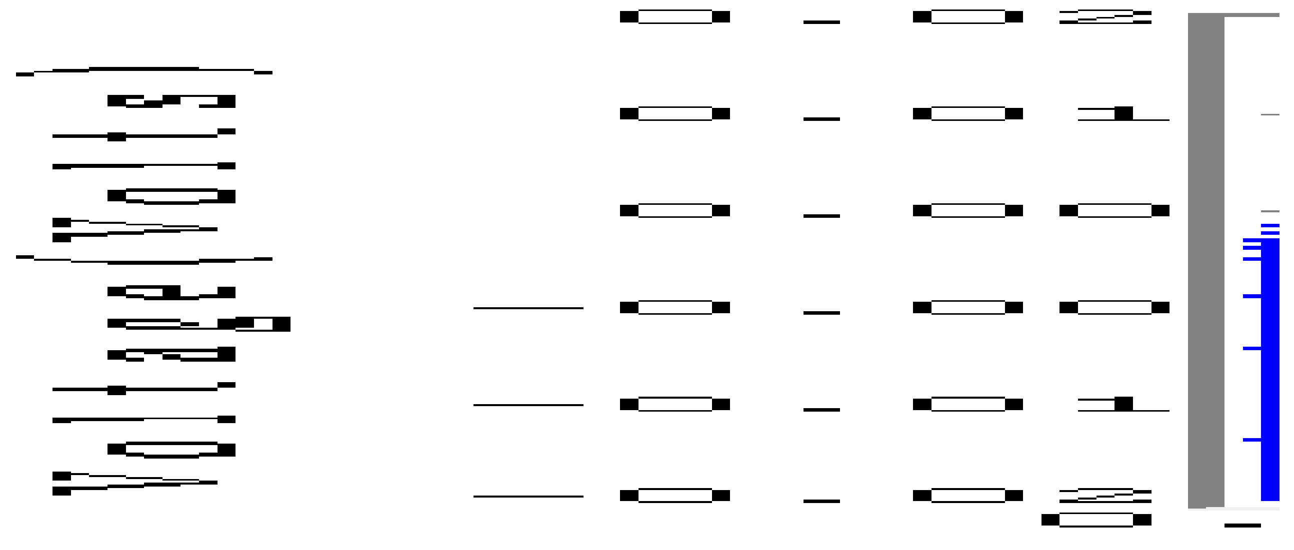
Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

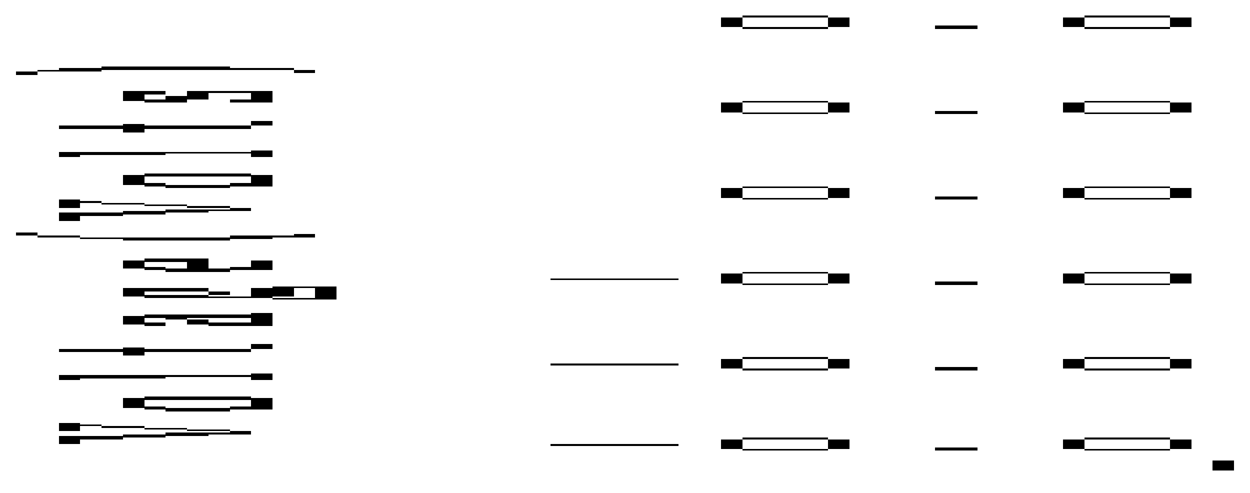
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060118- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT010	**Depth (m)**	128.70-131.60
Description	SANDSTONE, medium grained 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060118-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060118
Client ID	STX084RR - GT010
Depth (m)	128.70-131.60
Description	SANDSTONE, medium grained 100%
Wet Density (t/m^3)	2.54
Moisture Content (%)	3.8
Specimen Length (mm)	157.6
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060118
DATE: 15/6/12
BOREHOLE: STX084RR - GT010
DEPTH: 128.70-131.60

UCS (MPa)	18.0

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - Kelba 1000 kN Load Cell
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Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

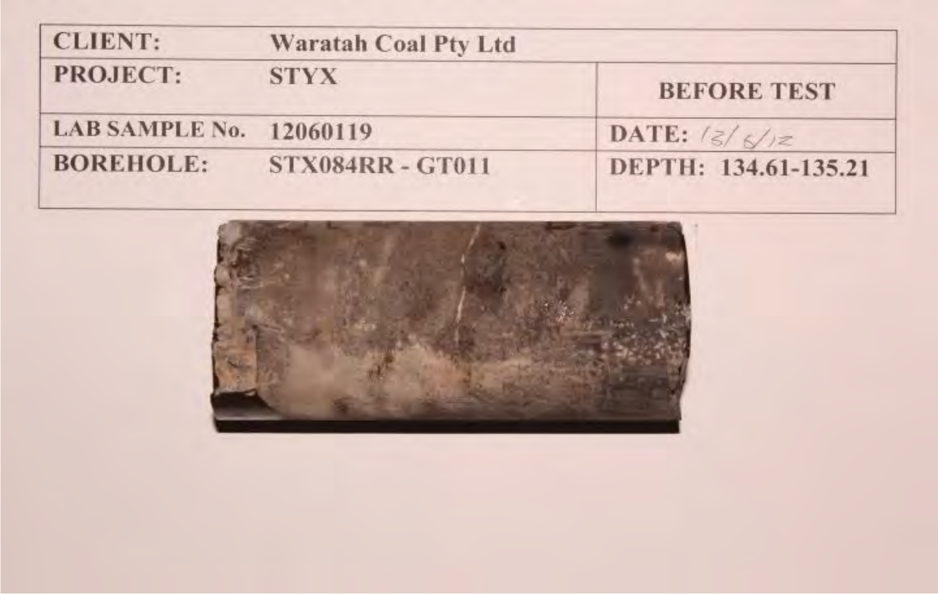
Client	Waratah Coal Pty Ltd	**Report No.**	12060119- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT011	**Depth (m)**	134.61-135.21
Description	SANDSTONE, fine to medium grained 1(	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.4	Couplant	Honey
Sample Height (mm)	133.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.69	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3080		
"P" Arrival Time (µsec)	57.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060119	DATE:	13/6/12
BOREHOLE:	STX084RR - GT011	DEPTH:	134.61-135.21

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060119- SON

Test Date 13/06/2012

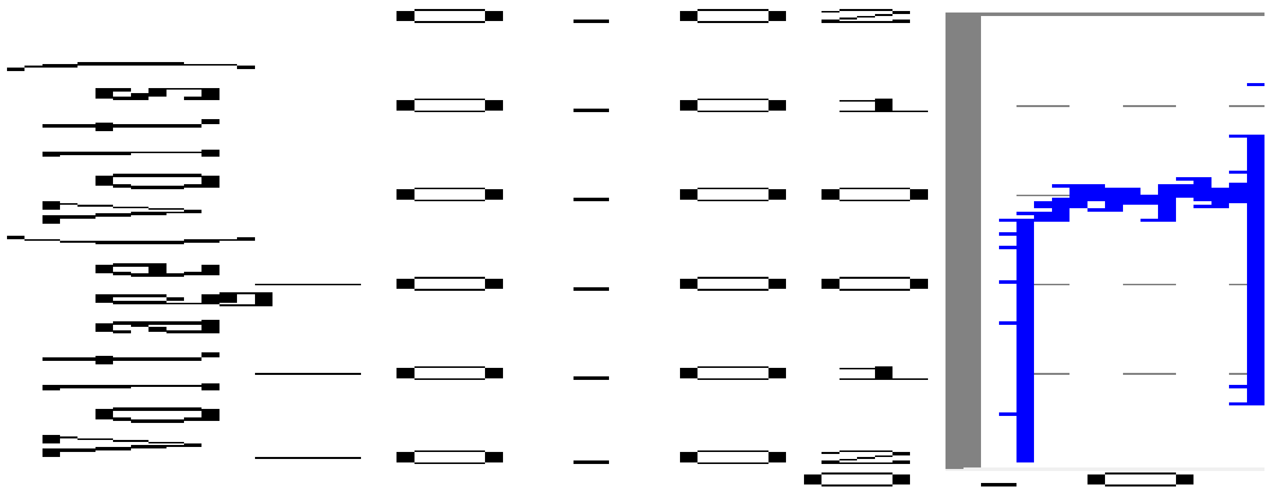
Report Date 14/06/2012

Client ID STX084RR - GT011

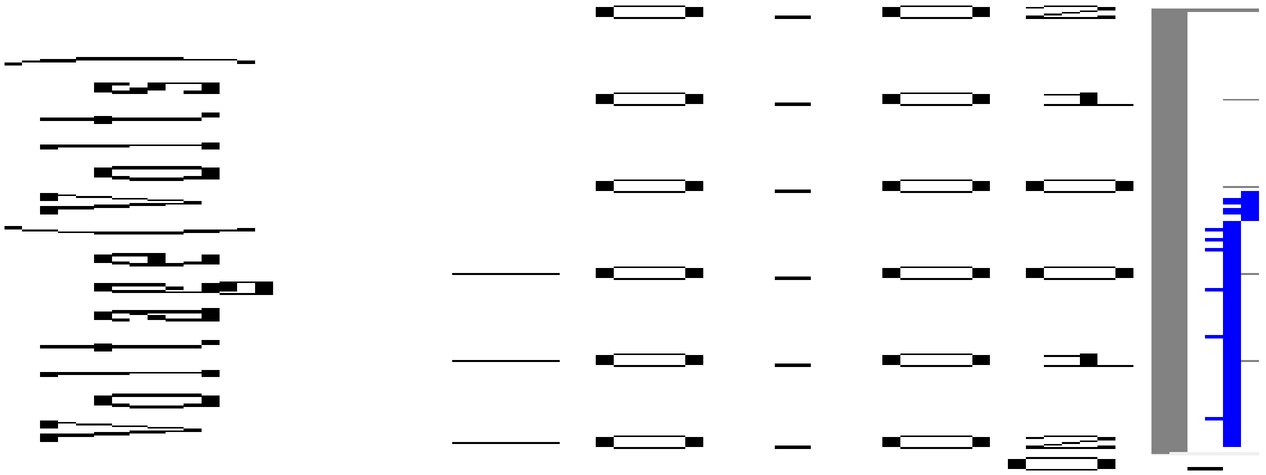
Depth (m) 134.61-135.21

Description SANDSTONE, fine to medium grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060119-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060119
Client ID	STX084RR - GT011
Depth (m)	134.61-135.21
Description	SANDSTONE, fine to medium grained 100%
Wet Density (t/m^3)	2.69
Moisture Content (%)	2.9
Specimen Length (mm)	133.5 *
Specimen Diameter (mm)	60.4
Mode of Failure	Shear
Test Duration (Min:Sec)	5:55

UCS (MPa)	19.3

NOTES/REMARKS:

Stored and tested as received

* Length to diameter ratio less than 2.5:1

Photo not to scale

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

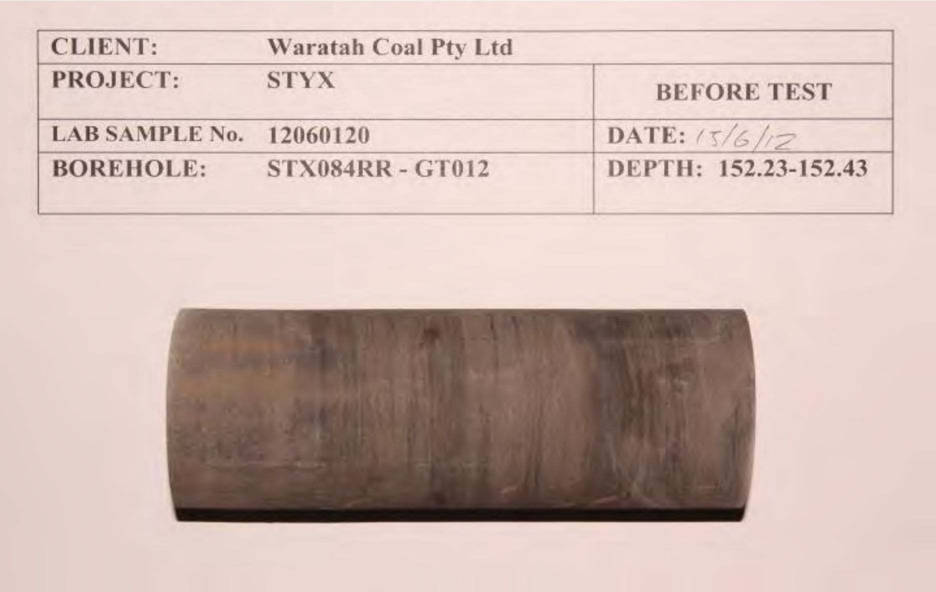
Client	Waratah Coal Pty Ltd	**Report No.**	12060120- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT012	**Depth (m)**	152.23-152.43
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	162.3	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.45	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3223		
"P" Arrival Time (µsec)	64.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060120	DATE:	13/6/12
BOREHOLE:	STX084RR - GT012	DEPTH:	152.23-152.43

Notes/Remarks:

Sample/s supplied by client

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Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060120- SON

Test Date 13/06/2012

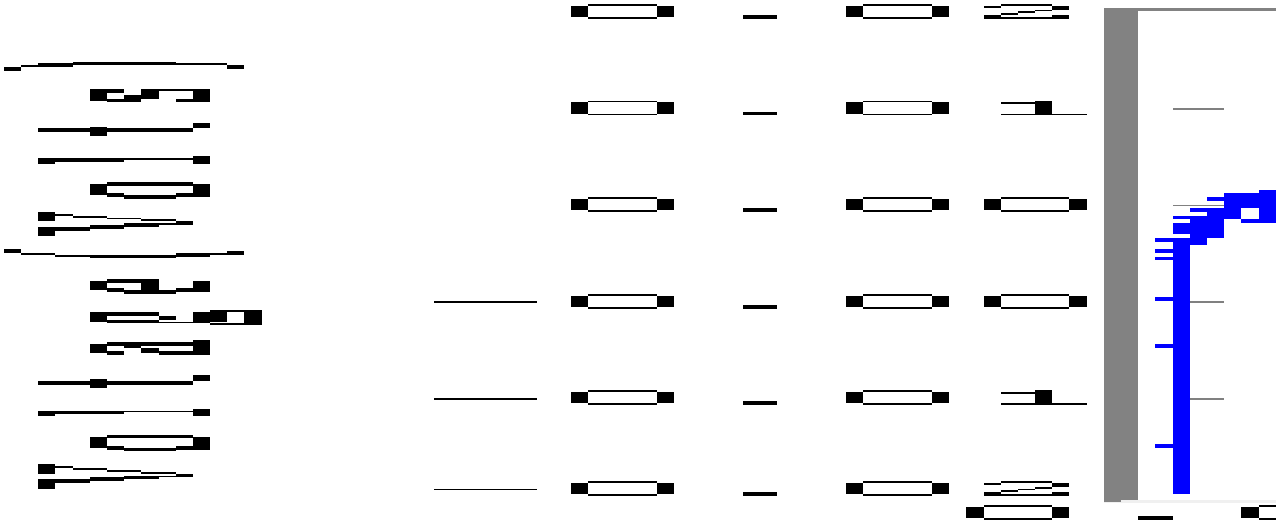
Report Date 14/06/2012

Client ID STX084RR - GT012

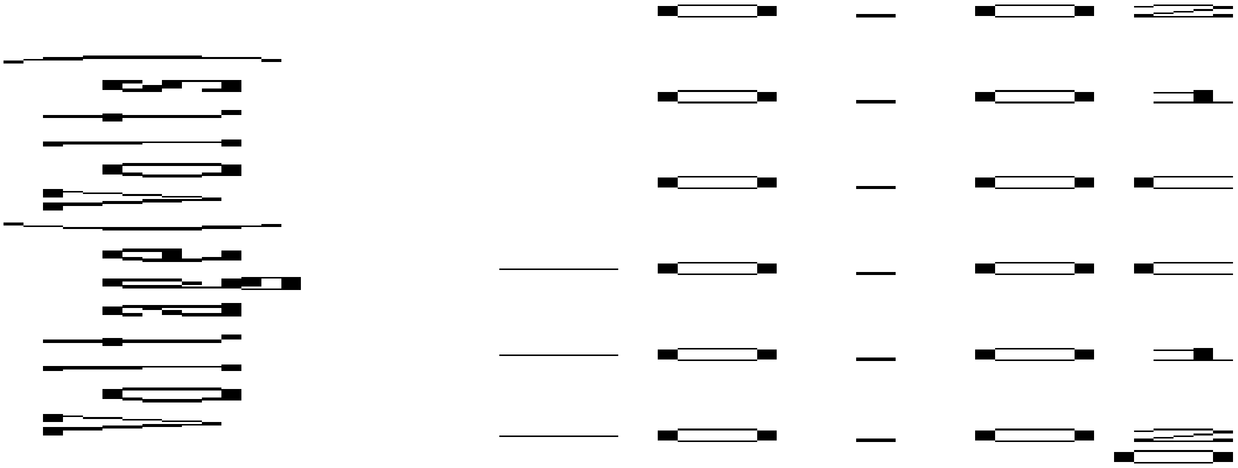
Depth (m) 152.23-152.43

Description SANDSTONE, fine grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060120-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060120
Client ID	STX084RR - GT012
Depth (m)	152.23-152.43
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.45
Moisture Content (%)	3.8
Specimen Length (mm)	162.3
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	8:14

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060120
DATE: 15/6/2012
BOREHOLE: STX084RR - GT012
DEPTH: 152.23-152.43

UCS (MPa)	30.5

NOTES/REMARKS:

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Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060121- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT013	**Depth (m)**	160.15-160.39
Description	MUDSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	162.9	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.59	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2702		
"P" Arrival Time (µsec)	74.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060121	DATE:	13/6/12
BOREHOLE:	STX084RR - GT013	DEPTH:	160.15-160.39

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060121- SON

Test Date 13/06/2012

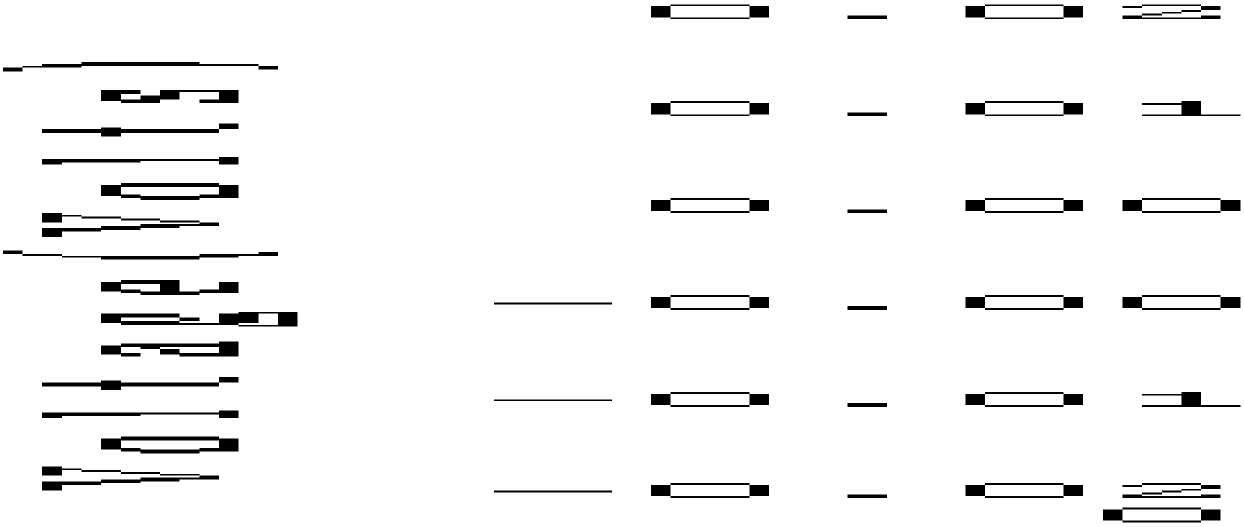
Report Date 14/06/2012

Client ID STX084RR - GT013

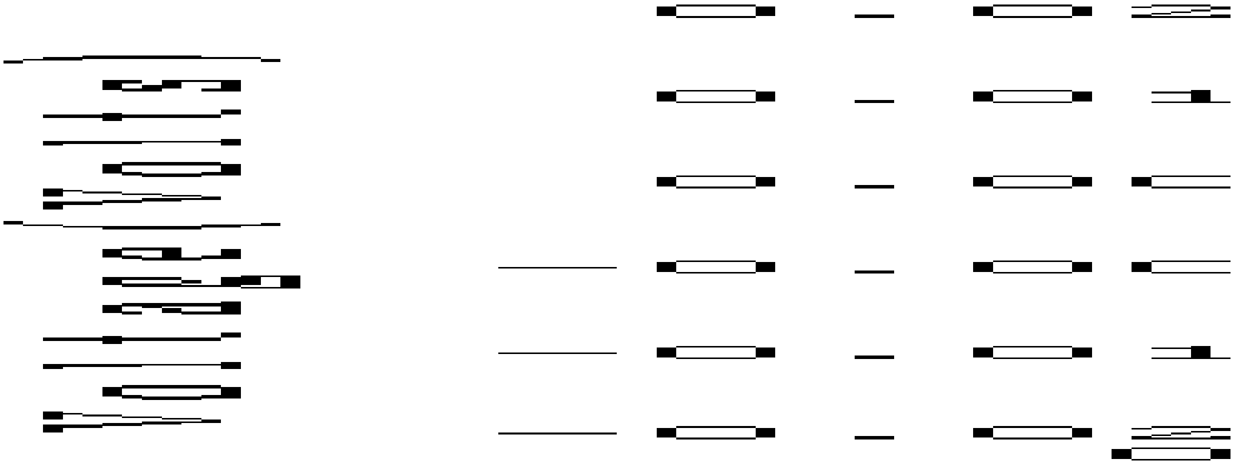
Depth (m) 160.15-160.39

Description MUDSTONE 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060121-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060121
Client ID	STX084RR - GT013
Depth (m)	160.15-160.39
Description	MUDSTONE 100%
Wet Density (t/m^3)	2.59
Moisture Content (%)	2.8
Specimen Length (mm)	162.9
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

UCS (MPa)	19.6

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060122- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT001	**Depth (m)**	20.70-21.00
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	61.0	Couplant	Honey
Sample Height (mm)	161.4	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.21	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2144		
"P" Arrival Time (µsec)	89.1	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060122	DATE: 13/6/12
BOREHOLE:	STX090RR - GT001	DEPTH: 20.70-21.00

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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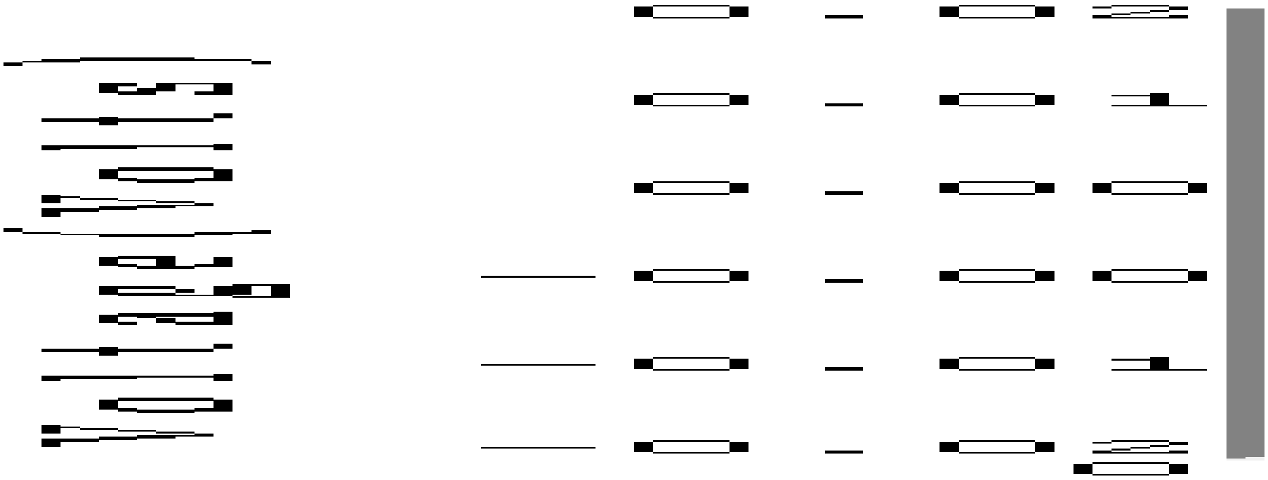
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

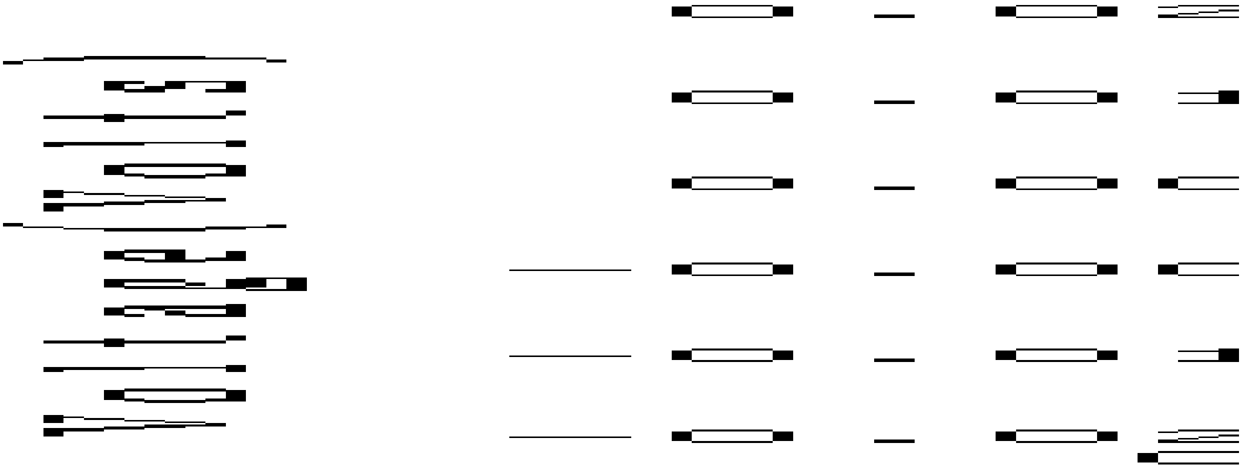
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060122- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT001	**Depth (m)**	20.70-21.00
Description	MUDSTONE		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060122-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060122
Client ID	STX090RR - GT001
Depth (m)	20.70-21.00
Description	MUDSTONE
Wet Density (t/m^3)	2.21
Moisture Content (%)	9.6
Specimen Length (mm)	161.4
Specimen Diameter (mm)	61.0
Mode of Failure	Shear
Test Duration (Min:Sec)	5:0

UCS (MPa)	3.56

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060123-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060123
Client ID	STX090RR - GT002
Depth (m)	31.30-31.60
Description	Medium SANDSTONE
Wet Density (t/m^3)	2.39
Moisture Content (%)	7.3
Specimen Length (mm)	160.6
Specimen Diameter (mm)	60.5
Mode of Failure	Conical
Test Duration (Min:Sec)	3:39

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060123
DATE: 15/6/12
BOREHOLE: STX090RR - GT002
DEPTH: 31.30-31.60

UCS (MPa)	6.25

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060124- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT003	**Depth (m)**	47.26-47.70
Description	Medium SANDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	161.2	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.44	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2825		
"P" Arrival Time (µsec)	71.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060124	DATE: 13/6/12
BOREHOLE:	STX090RR - GT003	DEPTH: 47.26-47.70

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

Trilab
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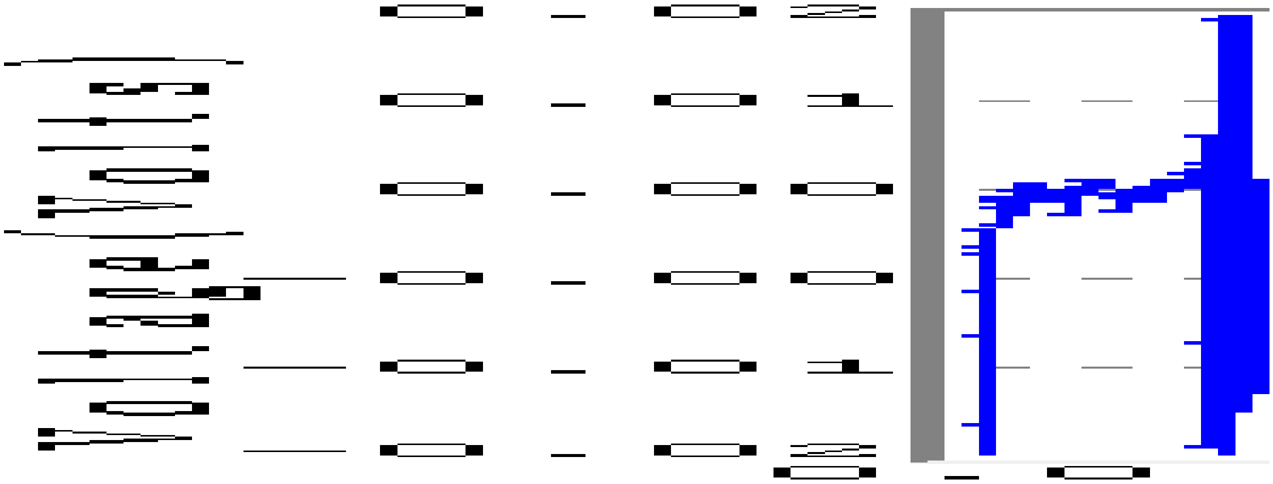
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

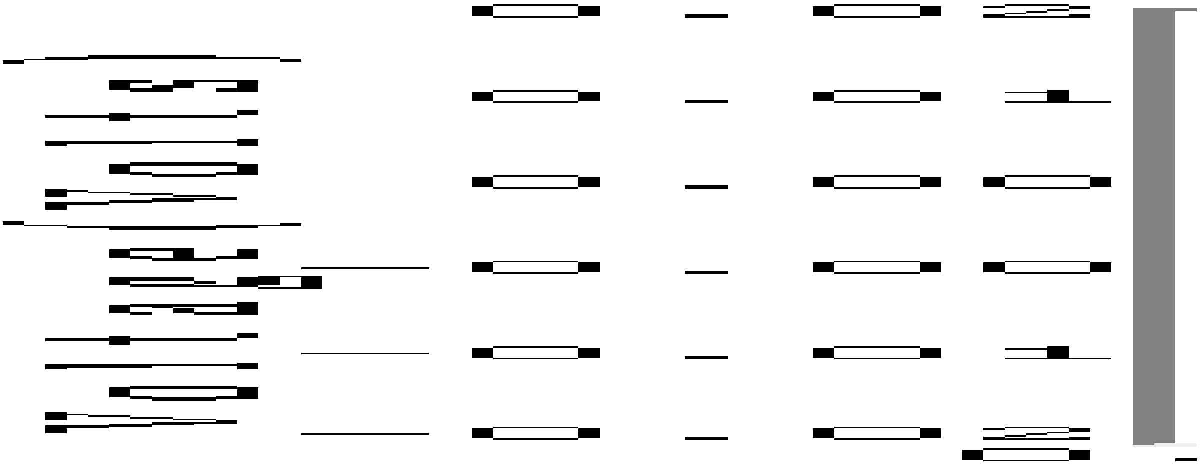
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060124- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT003	**Depth (m)**	47.26-47.70
Description	Medium SANDSTONE		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060124-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060124
Client ID	STX090RR - GT003
Depth (m)	47.26-47.70
Description	Medium SANDSTONE
Wet Density (t/m^3)	2.45
Moisture Content (%)	5.7
Specimen Length (mm)	161.0
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

UCS (MPa)	19.4

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - ELE 1000 kN Compression Machine
Photo not to scale

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Authorised Signatory
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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060125- SON

Test Date 13/06/2012

Report Date 14/06/2012

Client ID STX090RR - GT004

Depth (m) 62.10-62.40

Description MUDSTONE

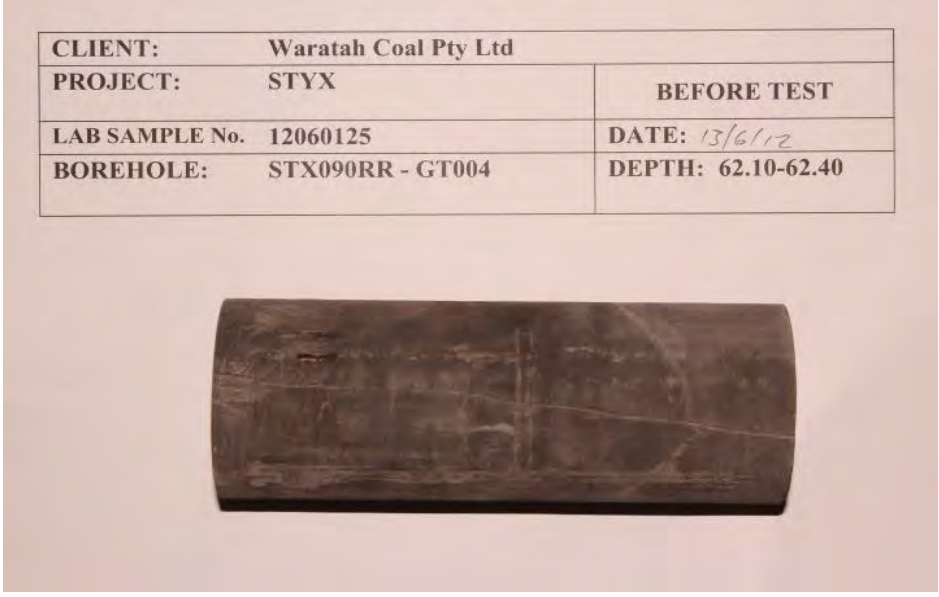
Sample Type Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.1	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.43	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3072		
"P" Arrival Time (μsec)	66.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060125	DATE:	13/6/12
BOREHOLE:	STX090RR - GT004	DEPTH:	62.10-62.40

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

Page 1 of 2 REP04401

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060125- SON

Test Date 13/06/2012

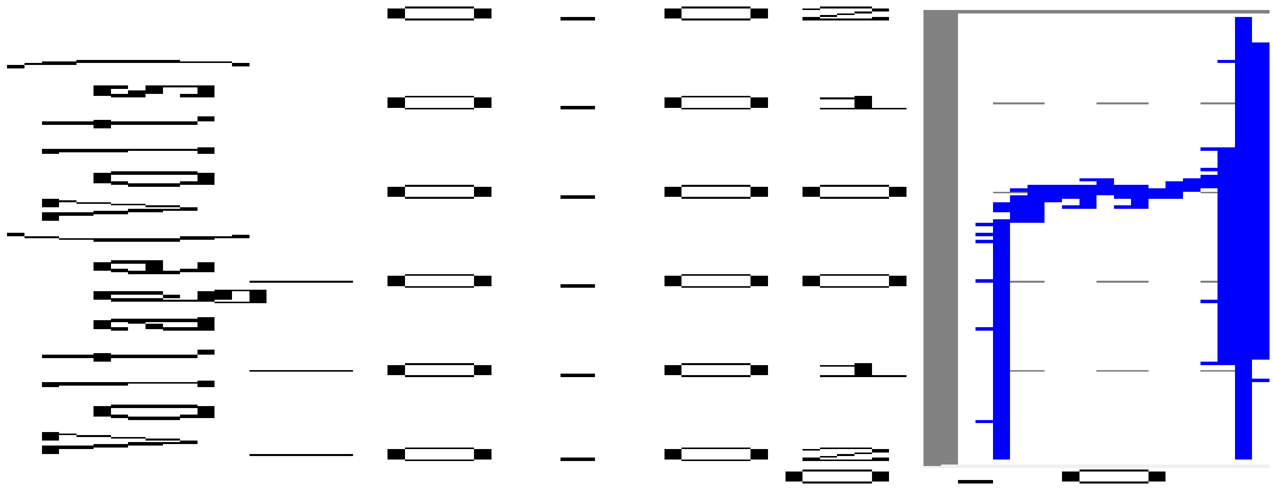
Report Date 14/06/2012

Client ID STX090RR - GT004

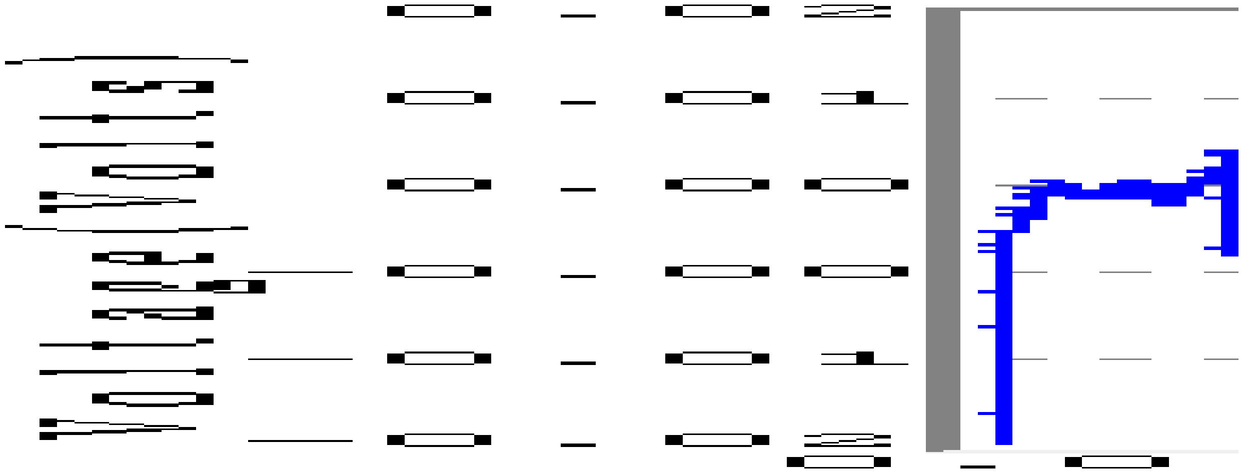
Depth (m) 62.10-62.40

Description MUDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060125-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060125
Client ID	STX090RR - GT004
Depth (m)	62.10-62.40
Description	MUDSTONE
Wet Density (t/m^3)	2.42
Moisture Content (%)	6.2
Specimen Length (mm)	160.1
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:59

UCS (MPa)	22.8

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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Authorised Signatory

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060126- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT005	**Depth (m)**	79.77-80.10
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	158.9	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.43	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2861		
"P" Arrival Time (μsec)	69.4	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060126	DATE:	13/6/12
BOREHOLE:	STX090RR - GT005	DEPTH:	79.77-80.10

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060126- SON

Test Date 13/06/2012

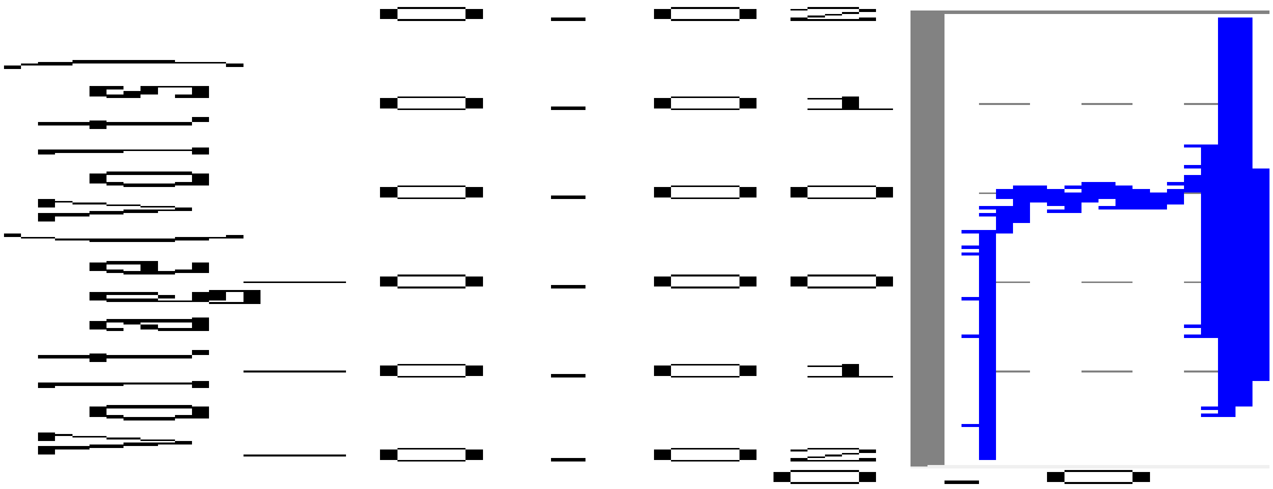
Report Date 14/06/2012

Client ID STX090RR - GT005

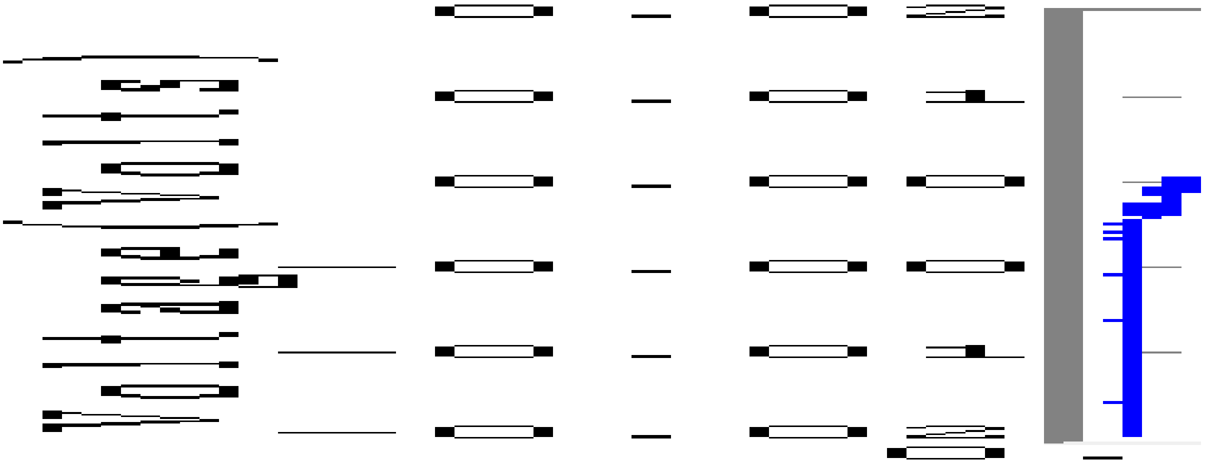
Depth (m) 79.77-80.10

Description MUDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060126-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060126
Client ID	STX090RR - GT005
Depth (m)	79.77-80.10
Description	MUDSTONE
Wet Density (t/m^3)	2.43
Moisture Content (%)	6.4
Specimen Length (mm)	158.9
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

UCS (MPa)	16.1

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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Page: 1 of 1 REP02701

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Laboratory No. 9926

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060127- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT006	**Depth (m)**	87.72-88.09
Description	SILTSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.4	Couplant	Honey
Sample Height (mm)	161.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.42	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2984		
"P" Arrival Time (µsec)	68.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060127	DATE:	13/6/12
BOREHOLE:	STX090RR - GT006	DEPTH:	87.72-88.09

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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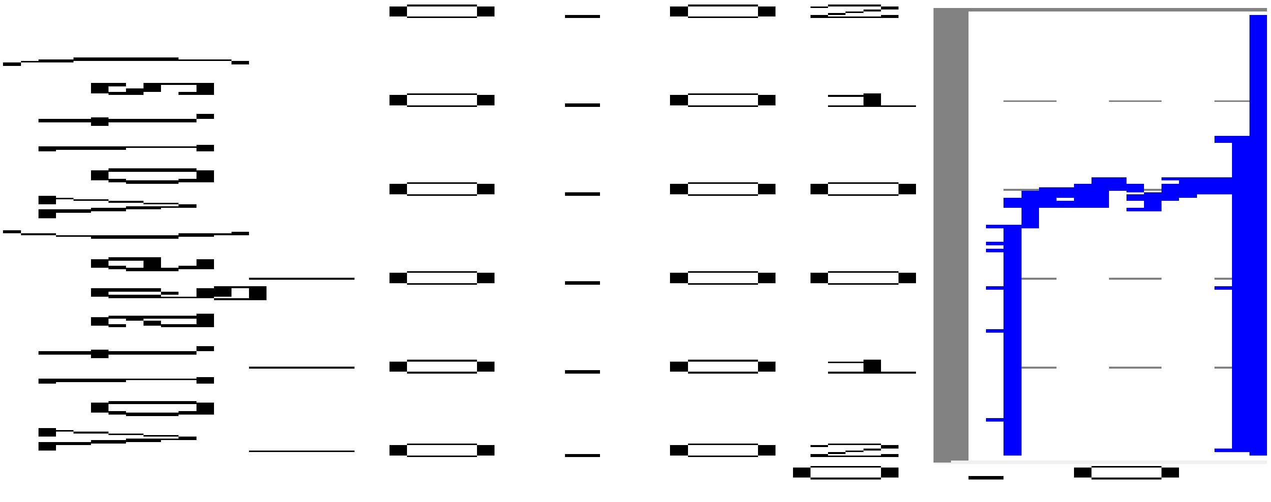
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060127- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT006	**Depth (m)**	87.72-88.09
Description	SILTSTONE		

"P" WAVEFORM



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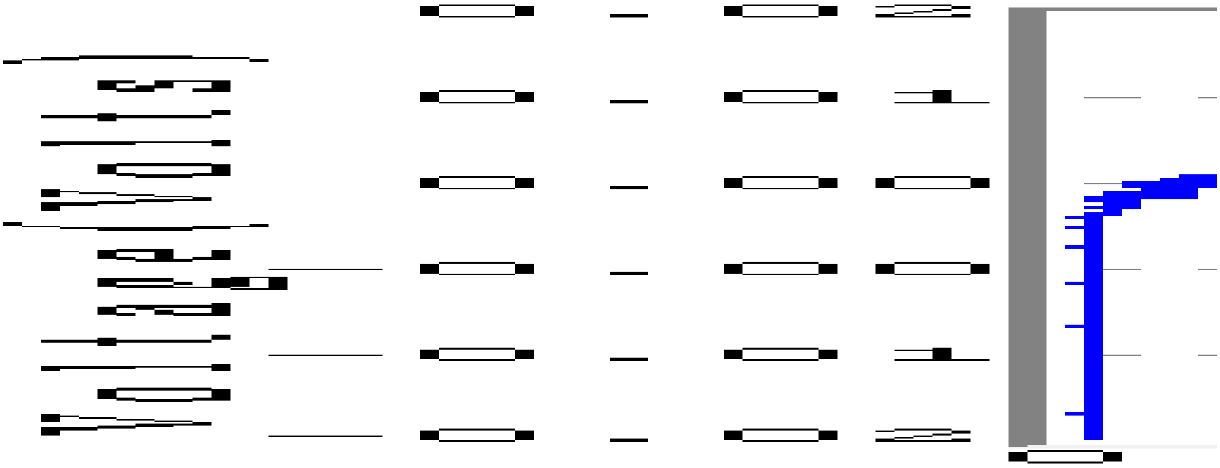

Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060127-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060127
Client ID	STX090RR - GT006
Depth (m)	87.72-88.09
Description	SILTSTONE
Wet Density (t/m^3)	2.42
Moisture Content (%)	5.2
Specimen Length (mm)	161.5
Specimen Diameter (mm)	60.4
Mode of Failure	Axial
Test Duration (Min:Sec)	5:27

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060127
DATE: 15/6/2012
BOREHOLE: STX090RR - GT006
DEPTH: 87.72-88.09

UCS (MPa)	11.7

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

Page: 1 of 1 REP02701

Authorised Signatory

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

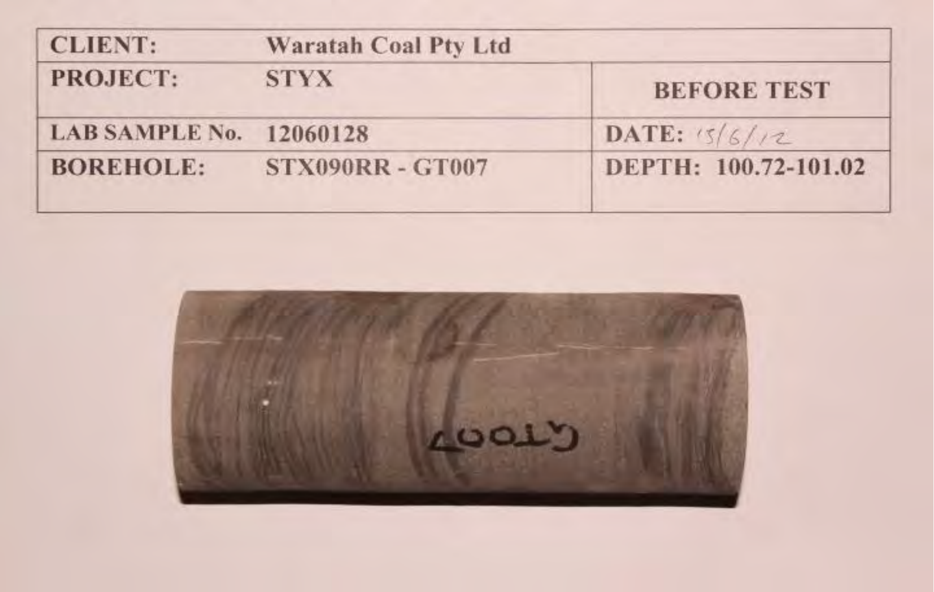
Client	Waratah Coal Pty Ltd	**Report No.**	12060128- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT007	**Depth (m)**	100.72-101.02
Description	Coarse SANDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	159.3	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.48	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2974		
"P" Arrival Time (µsec)	67.5	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060128	DATE:	13/6/12
BOREHOLE:	STX090RR - GT007	DEPTH:	100.72-101.02

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060128- SON

Test Date 13/06/2012

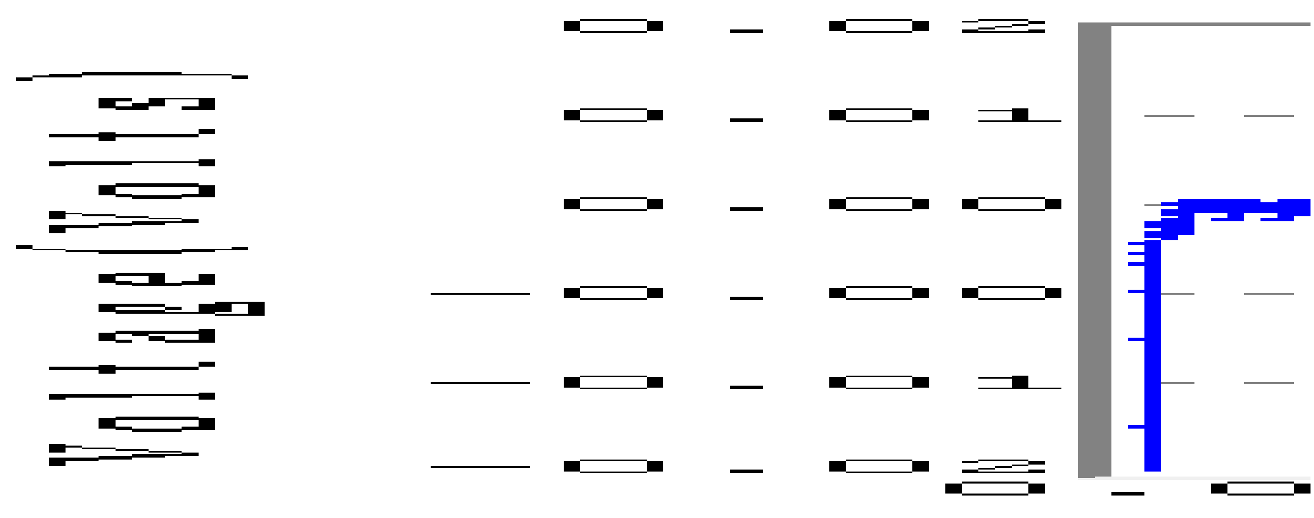
Report Date 14/06/2012

Client ID STX090RR - GT007

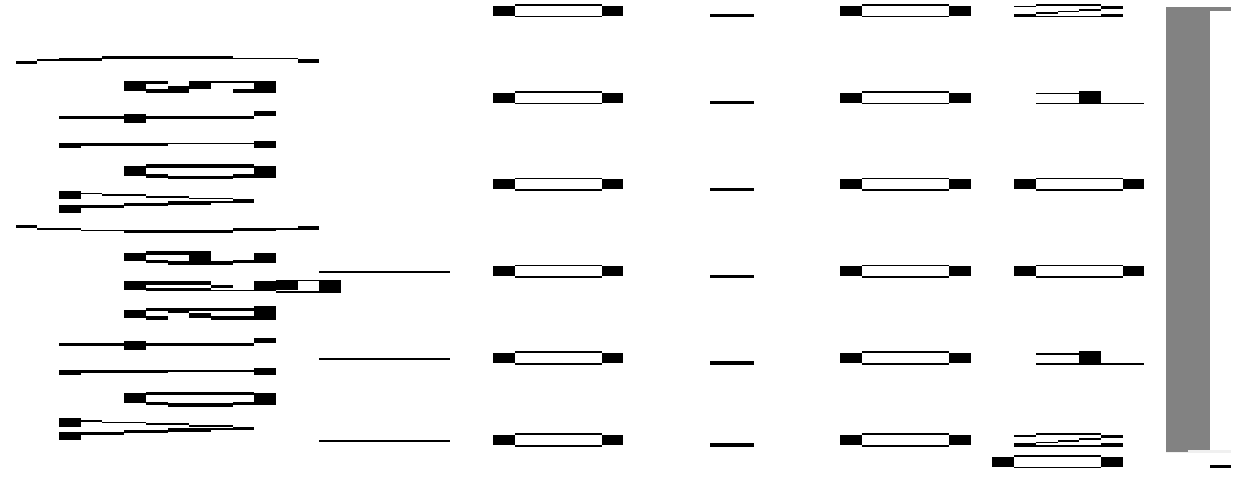
Depth (m) 100.72-101.02

Description Coarse SANDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060128-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060128
Client ID	STX090RR - GT007
Depth (m)	100.72-101.02
Description	Coarse SANDSTONE
Wet Density (t/m^3)	2.48
Moisture Content (%)	4.8
Specimen Length (mm)	159.3
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	5:55

UCS (MPa)	21.5

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - 200 kN Load Cell in Compression Machine

Photo not to scale

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

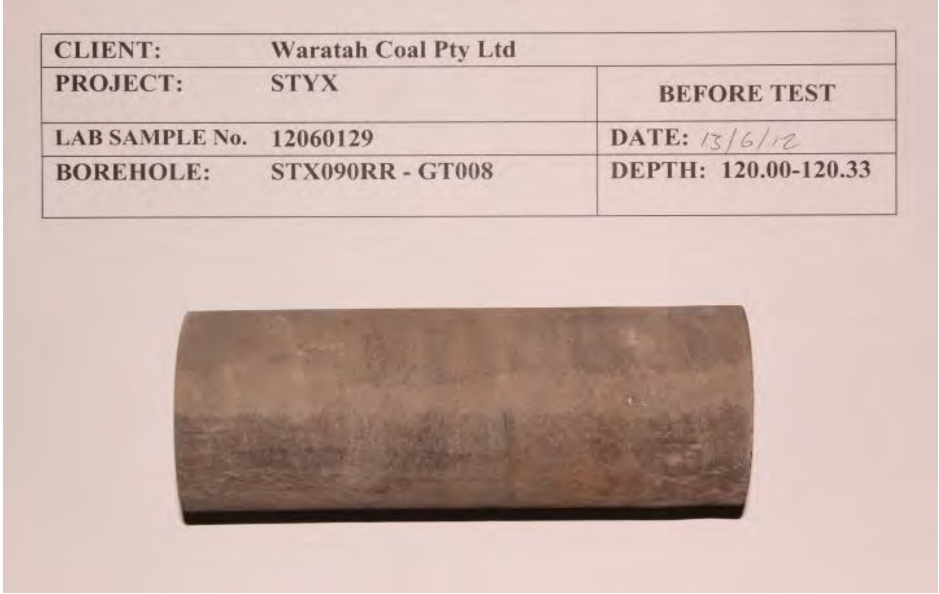
Client	Waratah Coal Pty Ltd	**Report No.**	12060129- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT008	**Depth (m)**	120.00-120.33
Description	Coarse SANDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	159.7	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.56	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2150		
"P" Arrival Time (µsec)	88.2	Young's Modulus (GPa)	7.9
"S" Velocity (m/s)	1075	Poisson's Ratio	0.33
"S" Arrival Time (µsec)	169.3		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060129	DATE: 13/6/12
BOREHOLE:	STX090RR - GT008	DEPTH: 120.00-120.33

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060129- SON

Test Date 13/06/2012

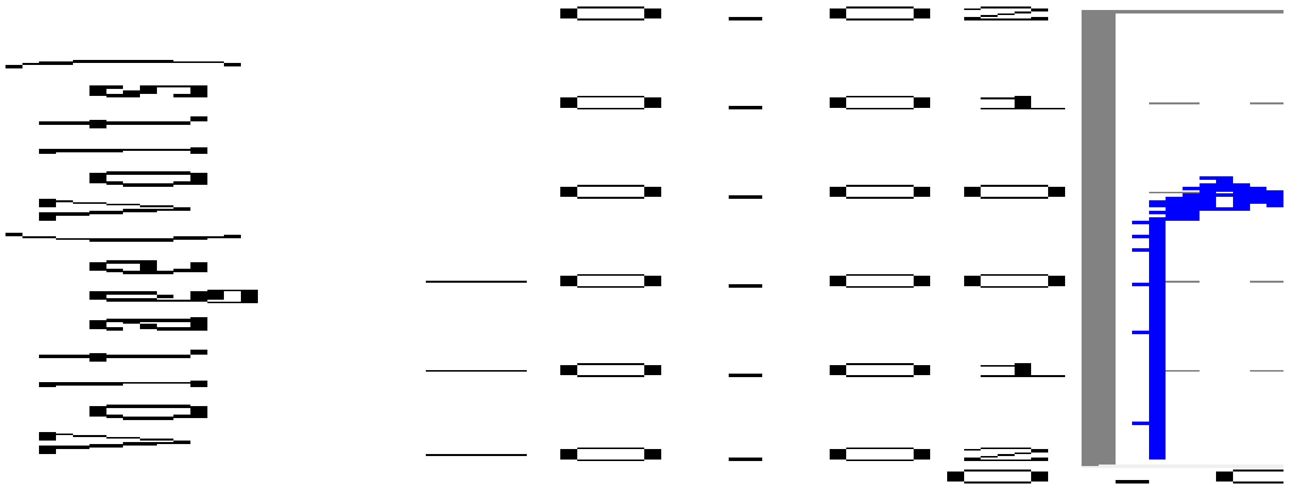
Report Date 14/06/2012

Client ID STX090RR - GT008

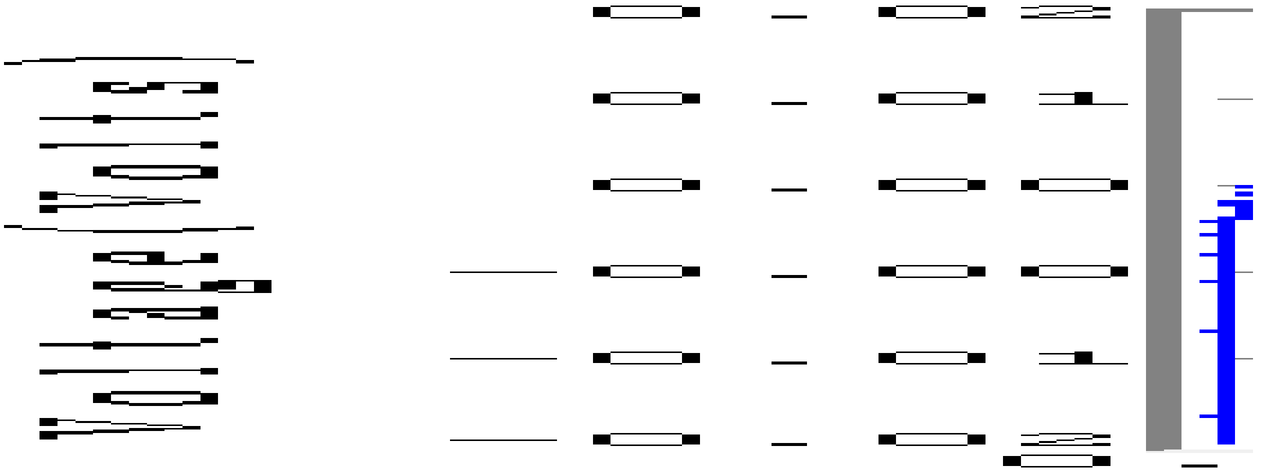
Depth (m) 120.00-120.33

Description Coarse SANDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060129-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060129
Client ID	STX090RR - GT008
Depth (m)	120.00-120.33
Description	Coarse SANDSTONE
Wet Density (t/m^3)	2.56
Moisture Content (%)	3.1
Specimen Length (mm)	159.7
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	3:31

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060129
DATE: 15/6/12
BOREHOLE: STX090RR - GT008
DEPTH: 120.00-120.33

UCS (MPa)	7.76

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Authorised Signatory

James Russell

J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

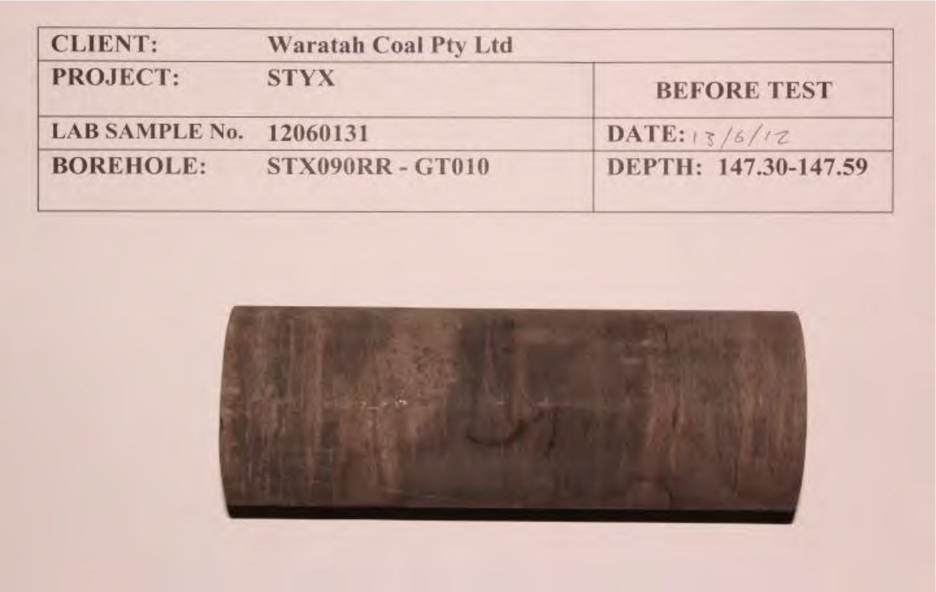
Client	Waratah Coal Pty Ltd	**Report No.**	12060131- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT010	**Depth (m)**	147.30-147.59
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	162.0	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.44	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2929		
"P" Arrival Time (µsec)	69.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060131	DATE: 13/6/12
BOREHOLE:	STX090RR - GT010	DEPTH: 147.30-147.59

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060131- SON

Test Date 13/06/2012

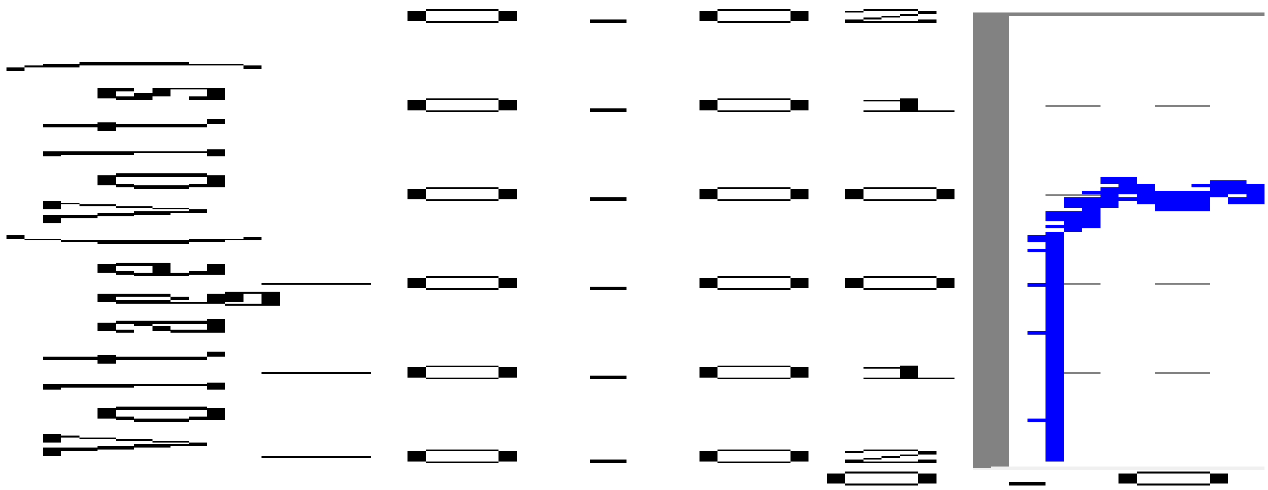
Report Date 14/06/2012

Client ID STX090RR - GT010

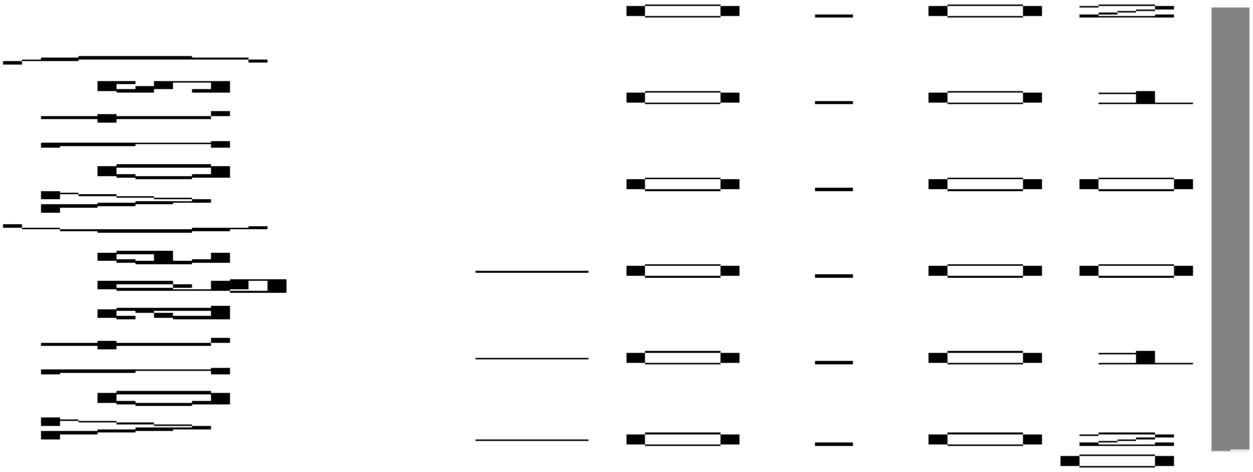
Depth (m) 147.30-147.59

Description MUDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060131-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060131
Client ID	STX090RR - GT010
Depth (m)	147.30-147.59
Description	MUDSTONE
Wet Density (t/m^3)	2.44
Moisture Content (%)	4.8
Specimen Length (mm)	162.0
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	7:0

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	AFTER TEST
LAB SAMPLE No.	12060131	DATE: 15/6/12
BOREHOLE:	STX090RR - GT010	DEPTH: 147.30-147.59

UCS (MPa)	12.0

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - 200 kN Load Cell in Compression Machine
Photo not to scale

Page: 1 of 1 REP02701

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IES 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Authorised Signatory
James Russell
J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated. Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.

Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

GEOTECHNICAL ASSESSMENT OF OPEN CUT MINING ADJACENT TO THE BRUCE HIGHWAY, STYX PROJECT

Prepared For: -
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July 2017

GEOTECHNICAL ASSESSMENT OF OPEN CUT MINING ADJACENT TO THE BRUCE HIGHWAY, STYX PROJECT

CONTENTS

Page

TABLES

FIGURES

APPENDICES

GEOTECHNICAL ASSESSMENT OF OPEN CUT MINING ADJACENT TO THE BRUCE HIGHWAY, STYX PROJECT

1.0 INTRODUCTION

At the Styx Project open cut mining is proposed on both sides of the Bruce Highway. Figure 1 is a locality plan and Figure 2 is the typical stratigraphy of the Styx Coal Measures in this area. Multi-seam mining is proposed with target seams shown in Figure 3.

There will be a final highwall on the south western side of the highway and a box cut on the north eastern side of the highway. Pit voids on each side of the Bruce Highway will only be temporarily opened up.

The average depth of clay and weathered rock in this area is about 25 m. All coal mining will occur below the LOX (oxidation) line.

2.0 DESIGN CRITERIA

Due to the proximity of the Bruce Highway, design criteria need to include proper stability of open cut excavations, permanent post-mining stability, prevention of any damage to the Bruce Highway infrastructure and ongoing erosion control measures.

Figure 4 is a type geotechnical section across the Bruce Highway showing excavations, safety bunds and drainage.

2.1 Open Cut Excavations

Open cut excavations adjacent to the Bruce Highway require safety factors of greater than 1.5, which is the minimum requirement for civil engineering projects. Slope stability analyses for rotational failure have been completed for voids batters adjacent to the Bruce Highway (Figure 4). Shear strength values used in stability analyses are included in Table 1.

TABLE 1 – SHEAR STRENGTH VALUES

MATERIAL	DENSITY (t/m^3)	FRICTION (DEG)	COHESION kPa)
Overburden (soil and weathered rock)	2.0	25	40
Spoil	1.9	34	0
Mudstone, Fr	2.4	35	100
Sandstone, Fr	2.5	40	200
Mudstone/sandstone, Fr, composite	2.45	37.5	150

Stability analyses have been completed for saturated slopes. Safety factors for 1 (horizontal) on 1 (vertical) and 0.5 (horizontal) on 1 (vertical) batters are included in Table 2.

TABLE 2 – SAFETY FACTORS FOR BATTERS

MATERIAL	BATTER ANGLE	SAFETY FACTOR
Soil and weathered rock	1 on 1	2.4
Mudstone/sandstone, Fr, composite	0.5 on 1	3.6

North east of the Bruce Highway the box cut low wall will undercut coal seams bedding planes (Figure 3). Translational failures of low walls occur when there are sheared, intraformational mudstone bands and bedding dips are greater than 10°. Sheared mudstone has a peak friction of 17°, peak cohesion of 25 kPa, residual friction of 9° and residual cohesion of 25 kPa. Geological investigations indicate that there are no sheared, intraformational bands adjacent to the Bruce Highway and bedding dips are to the east at less than 7°. In this area the translational resisting force is greater than the actuating force by a safety factor well above 1.5. During mining the low wall will be regularly monitored. It is recommended that box cut mining proceeds in blocks and buttress spoil is placed against the low wall immediately after coal extraction.

The above safety factors indicate that the batters adjacent to the Bruce Highway will be stable with no impact on the highway. As well, 20 m wide safety berms have been included for additional safety (Figure 4). The distance between the edge of the pits and the Bruce Highway mining lease boundaries is 58 m. The highway is within the road reserve (Figure 4). The pits batters will have no affect on the Bruce Highway.

During mining each pit will be opened up, coal extracted and then backfilled. The south western pit will only have a 200 to 400 m section of highwall exposed to the Bruce Highway at any one time. The final void will be progressively infilled and a sediment trap will be constructed at the northern end. The box cut excavation on the north eastern side will be immediately backfilled after coal extraction using strip two spoil. The mine plan period progress plot is shown in Figure 5. Cut 1 and 2 sections per mining period are included in Appendix 1. Because of the short durations for which the batters adjacent to the Bruce Highway will be open, batter deterioration will be minimised.

The open cut excavations can be free dug to a depth of about 25 m prior to drilling and blasting.

Properly designed production blasts are required to prevent any damage to infrastructure. Peak particle velocity from any blast shall not exceed 45 mm/sec, which will prevent any damage to the Bruce Highway infrastructure. Blast energy can be reduced by increasing the delay sequence and reducing the charge per delay. Safe blasting procedures and monitoring will be implemented while open pit voids are present adjacent to the Bruce Highway. Regular survey monitoring will be completed to ensure ongoing stability of batters.

2.2 Safety Bunds

Safety bunds are required to prevent access to pits, screen off mining operations from the Bruce Highway and control run off water, including any sedimentation. The proposed safety bunds are 6 m high with crest widths of 10 m. Batters are 1.5 (horizontal) on 1 (vertical) which is at the angle of repose. The batters will be topsoiled and seeded to prevent scour and erosion. Crests are to slope at 1% towards the lease. Bunds are to be constructed from track compacted, fresh spoil.

2.3 Drainage

Properly controlled drainage is required to prevent run off water and sediment discharging off the mining lease onto the Bruce Highway road reserve and to prevent erosion of exposed excavated faces. A table drain area with a width of 10 m has been included between the Bruce Highway lease boundaries and the outside toes of the safety bunds (Figure 4). All run off water will be drained inside the lease boundaries and all sediment will be contained. Sediment traps will be installed where required.

Catch drains will be constructed along the highwall edge of the final void south west of the Bruce Highway and along the low wall edge of the box cut north east of the highway. These drains will prevent erosion of exposed faces prior to backfilling.

Any areas which will require topsoiling and seeding will be remediated as soon as possible to prevent scouring.

3.0 CLOSURE REQUIREMENTS

All spoil piles will be made geotechnically stable and be topsoiled and seeded. All voids will be backfilled, topsoiled and seeded, with sediment traps installed where required.

At closure, long term stability of the safety bunds will be assured. Drainage pathways will be remediated, then topsoiled and seeded. Sediment traps will be constructed.

FIGURES

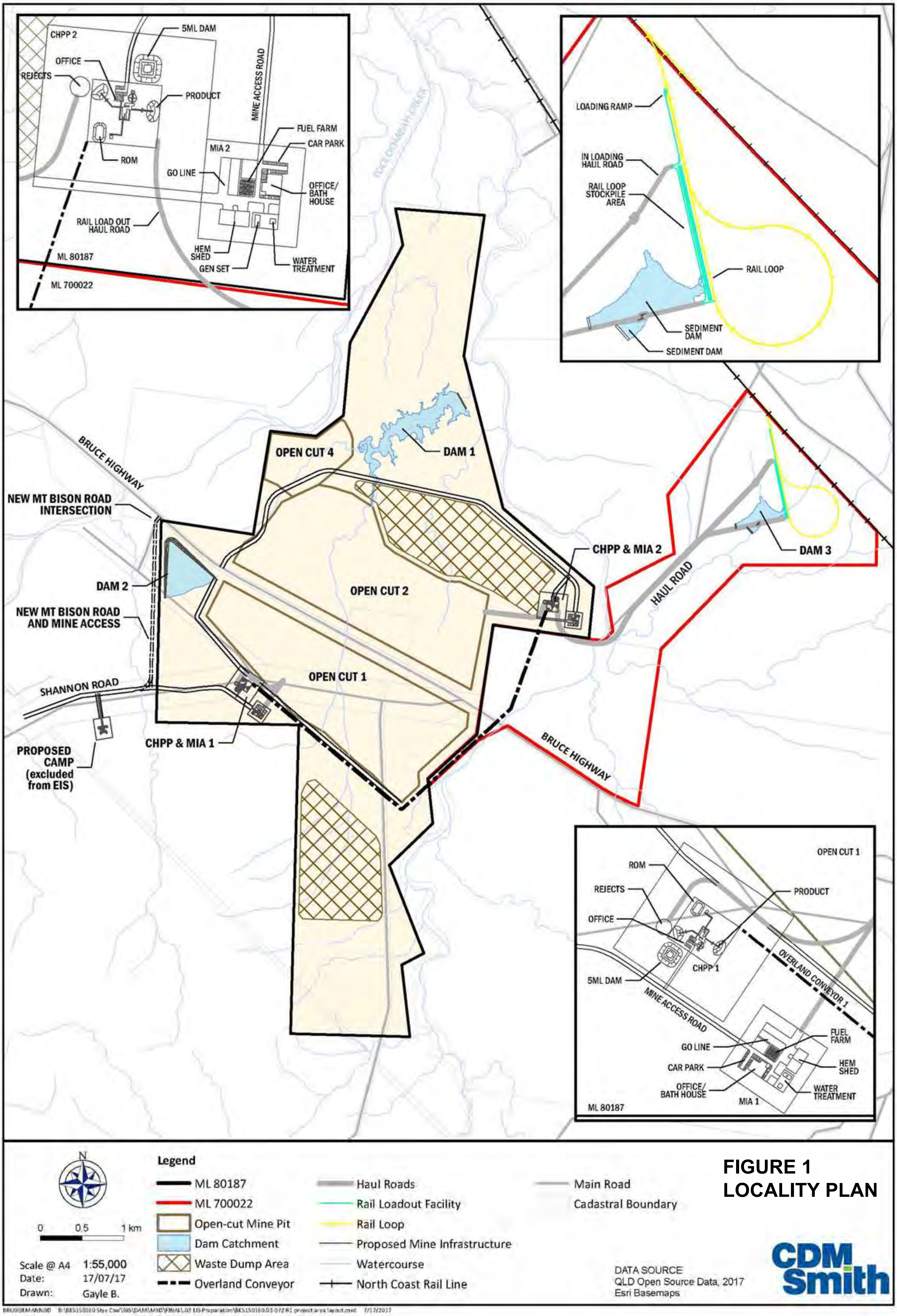


FIGURE 1
LOCALITY PLAN

Scale @ A4 1:55,000
Date: 17/07/17
Drawn: Gayle B.

DATA SOURCE
QLD Open Source Data, 2017
Esri Basemaps

CDM Smith

BRUGGEMANNGD B:\BES150160 Styx Coal\GIS\DATA\MXD\FINAL\.03 EIS Preparation\BES150160.03-072 R1 project area layout.mxd 7/17/2017

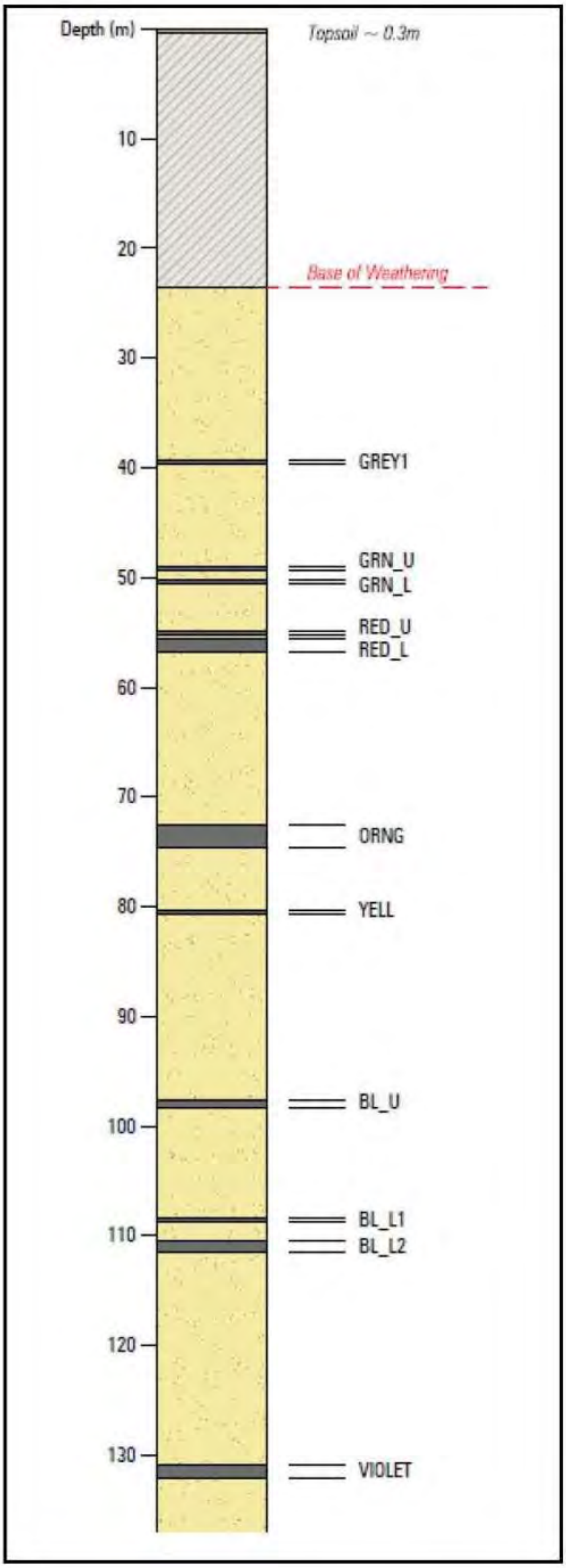


FIGURE 2 : TYPICAL STRATIGRAPHY, STYX COAL MEASURES

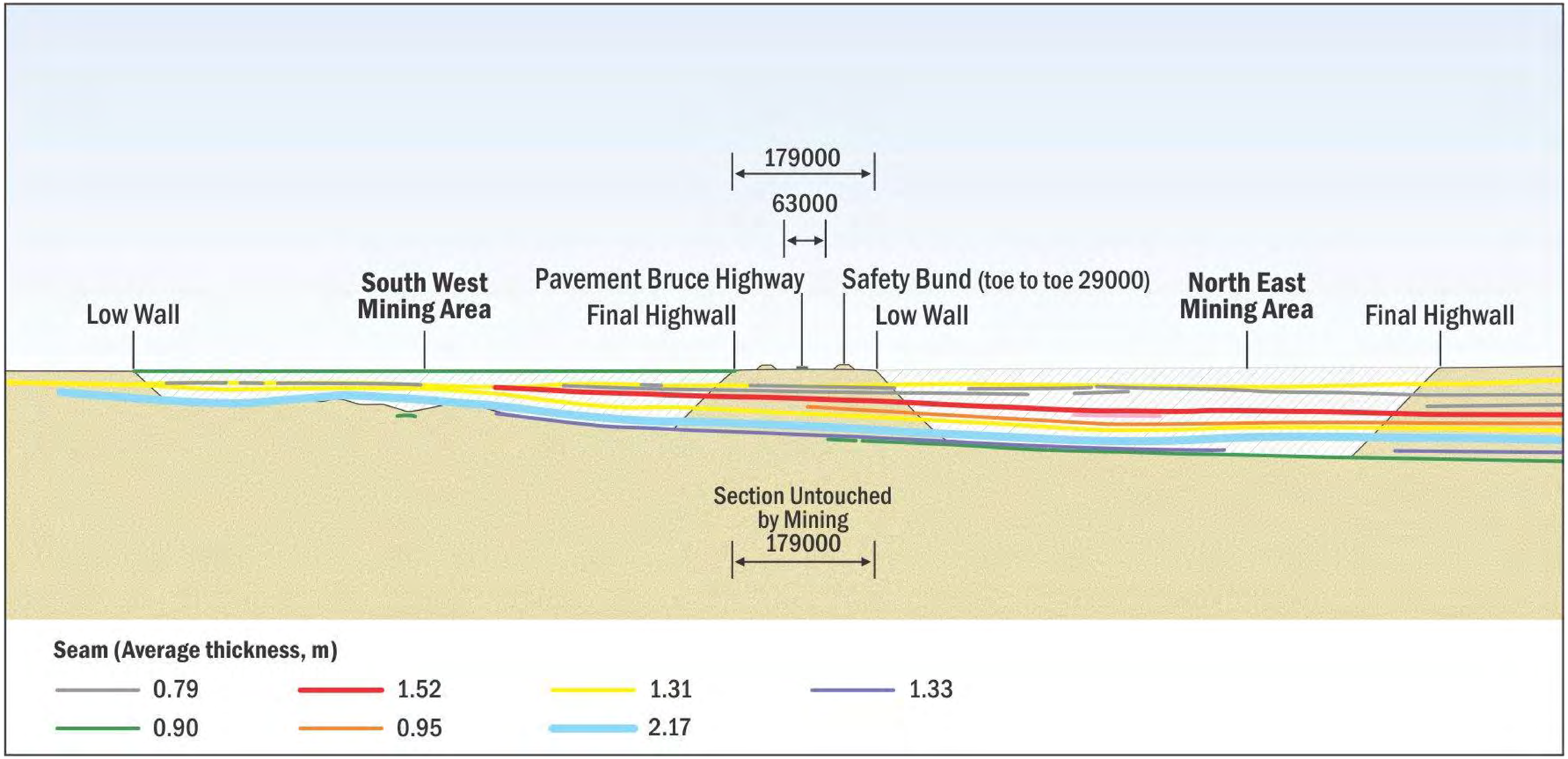


FIGURE 3 : MINING SECTIONS ACROSS THE BRUCE HIGHWAY

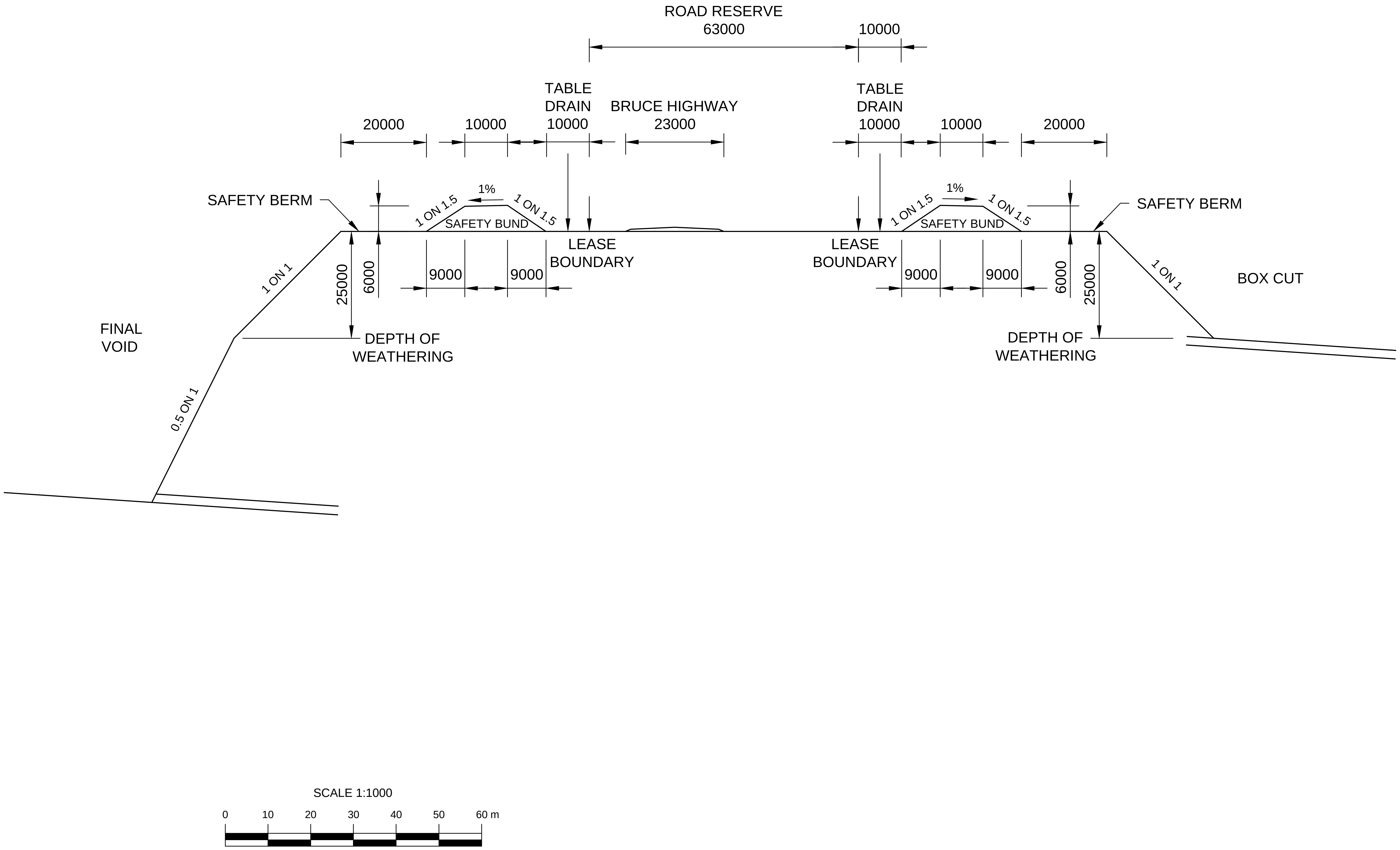
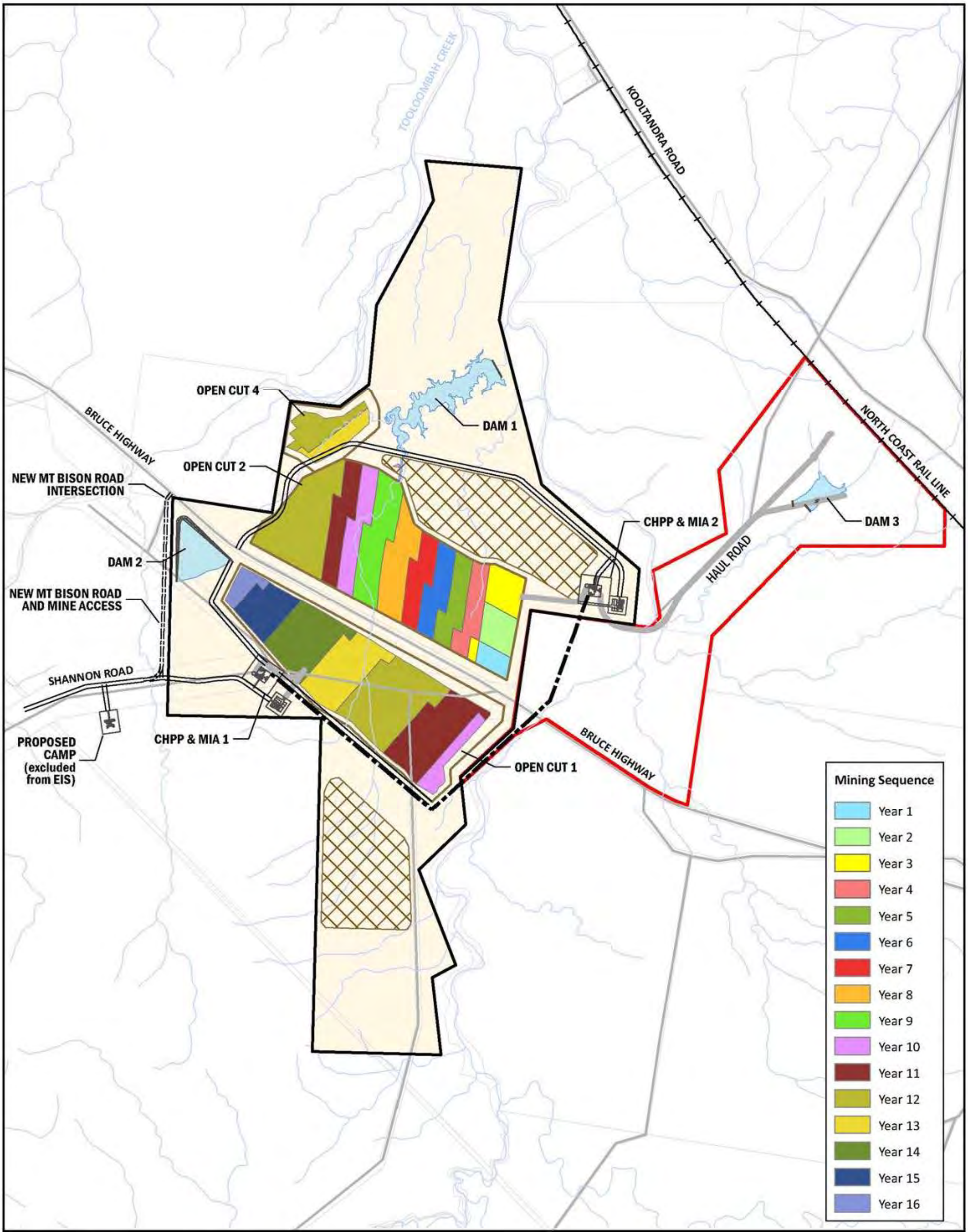


FIGURE 4
GEOTECHNICAL SECTION
ACROSS THE BRUCE HIGHWAY



Scale @ A4 1:55,000
Date: 17/07/17
Drawn: Gayle B.

FIGURE 5
MINE DEVELOPMENT SEQUENCES

DATA SOURCE
QLD Open Source Data, 2017

CDM Smith

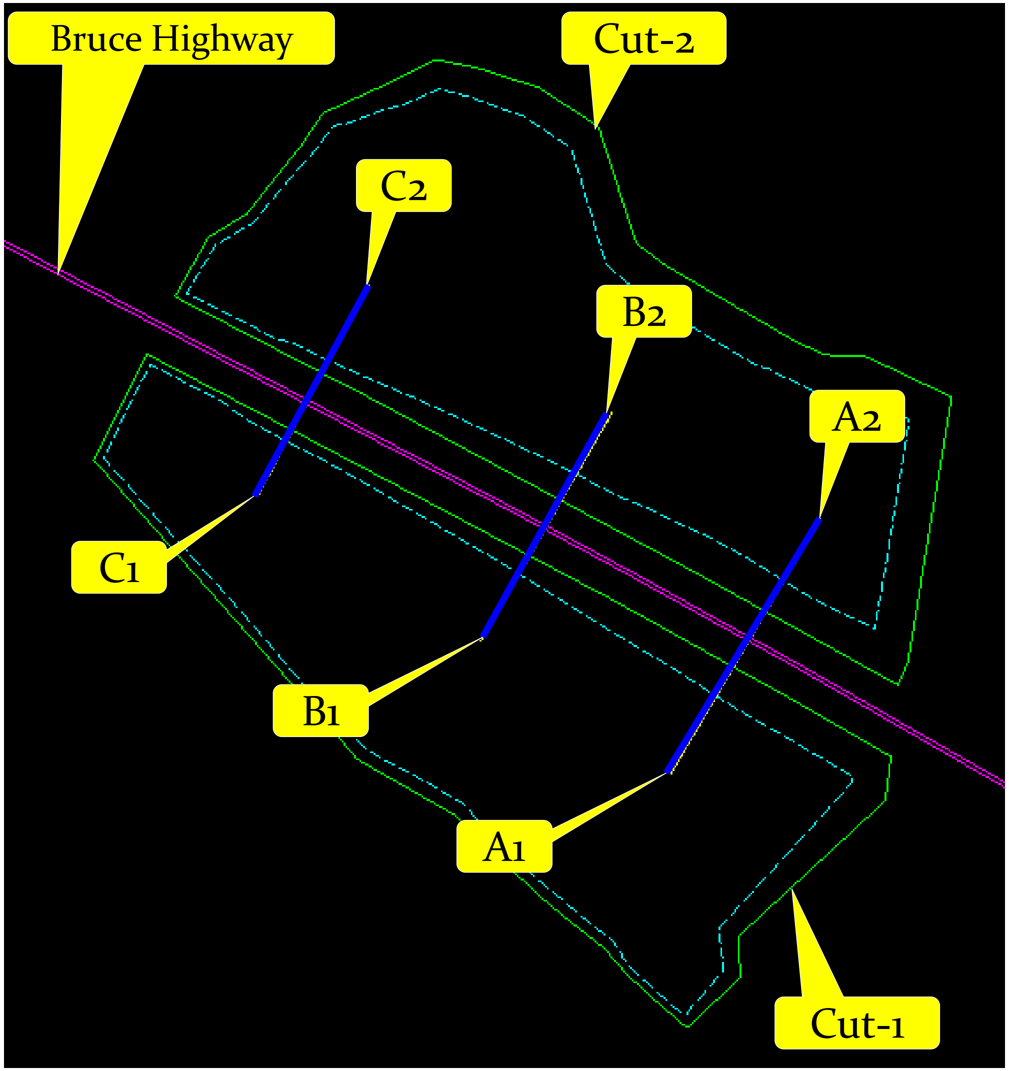
BRUGGEMANNGD B:\BES150160 Styx Coal\GIS\DATA\MXD\FINAL\.03 EIS Preparation\BES150160.03-061 R2 Mine Schedule.mxd 7/17/2017

APPENDIX 1

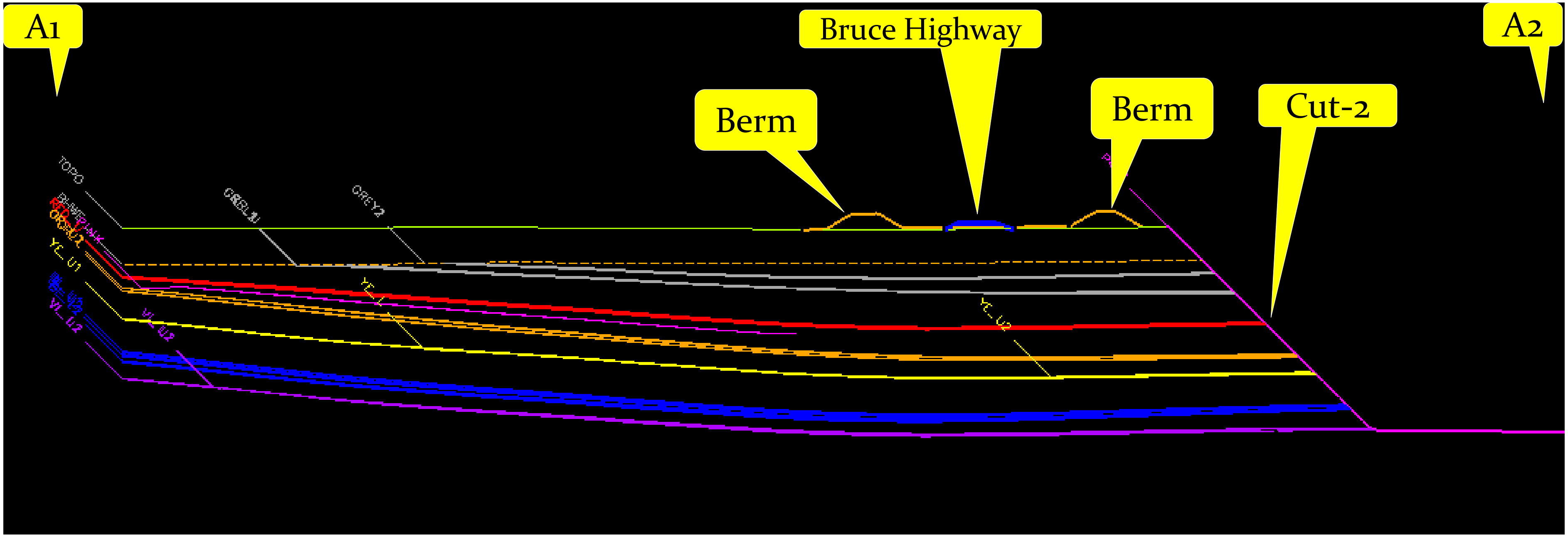
CUT 1 AND 2 SECTIONS PER MINING PERIOD

Cut-1&2 Sections per Mining Period

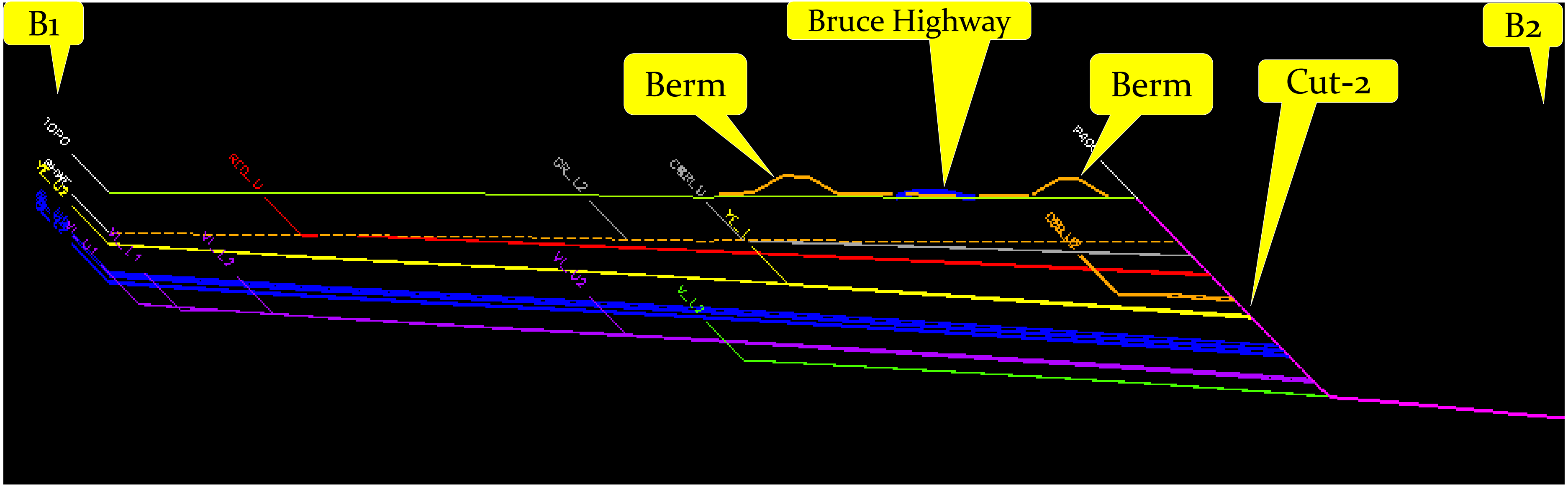
Cross Section Locations Cut-1 & 2



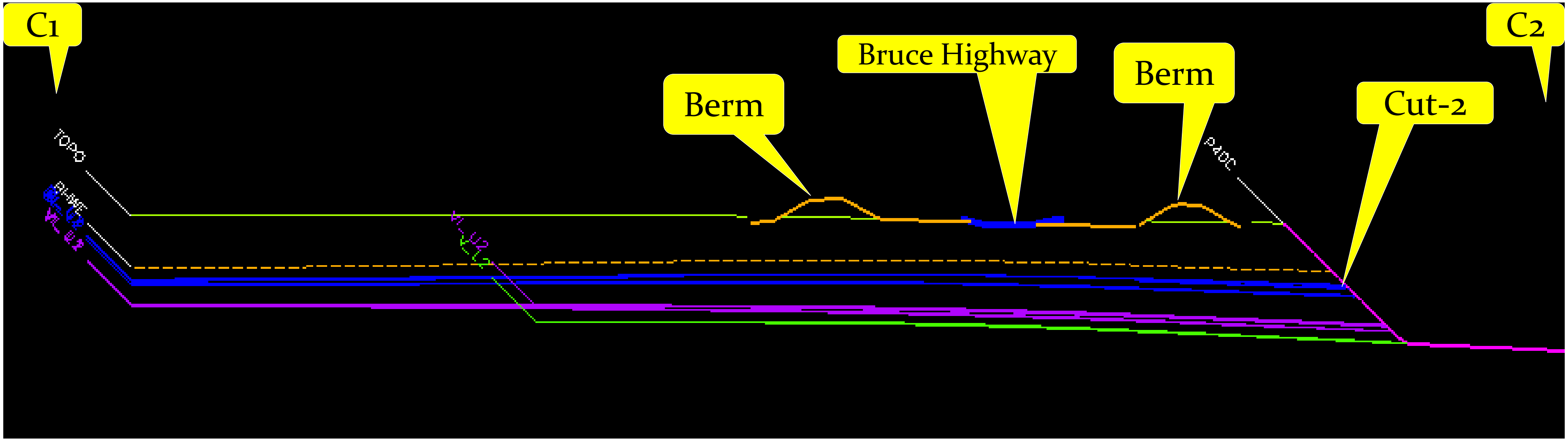
Cross Section Cut-2, Period-04



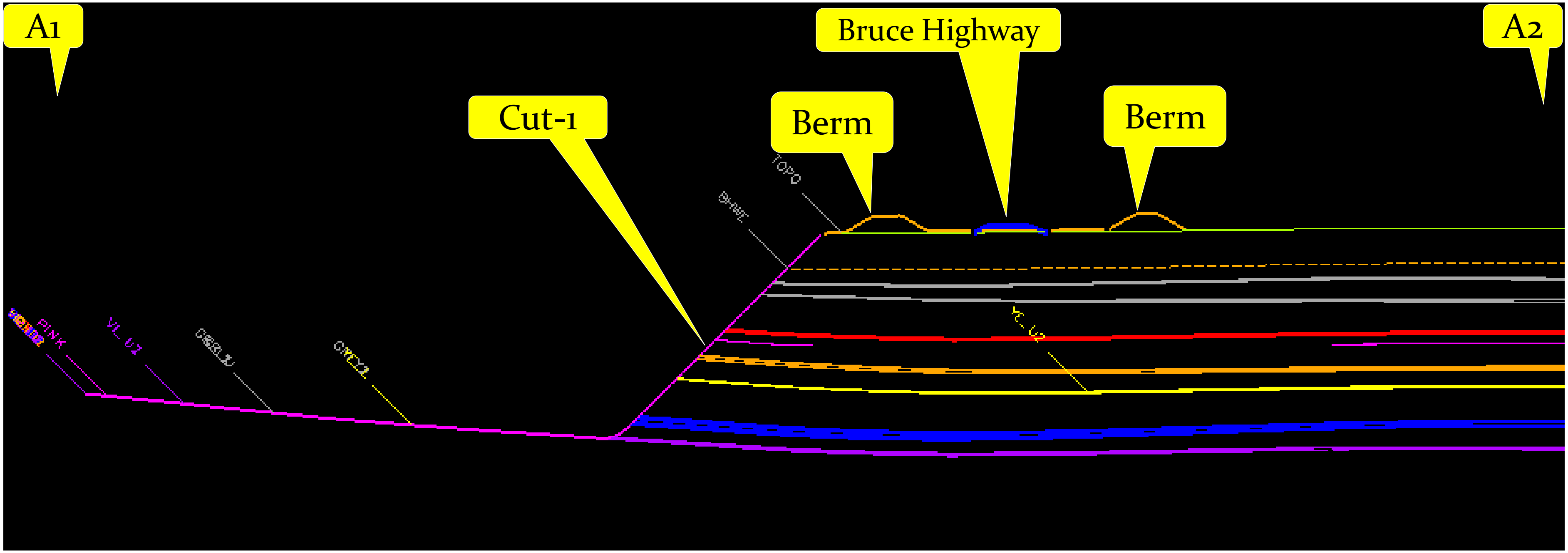
Cross Section Cut-2, Period-07



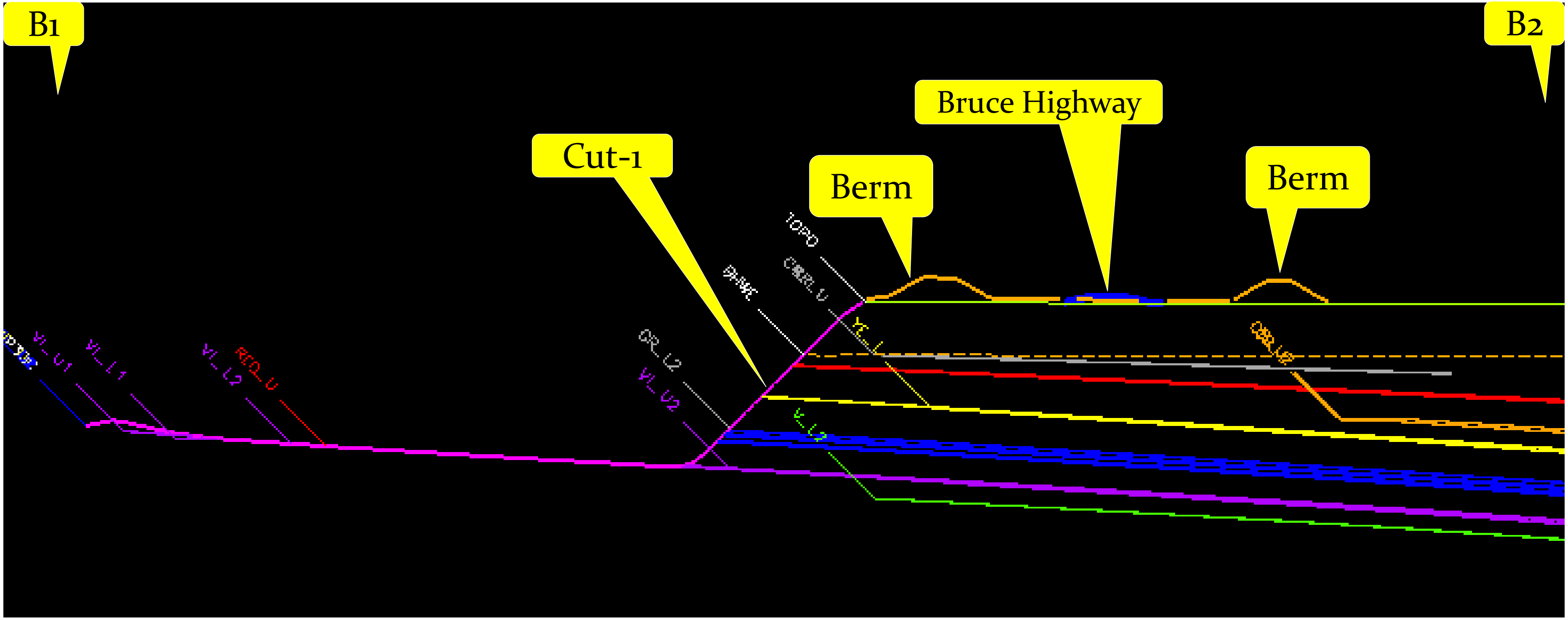
Cross Section Cut-2, Period-10



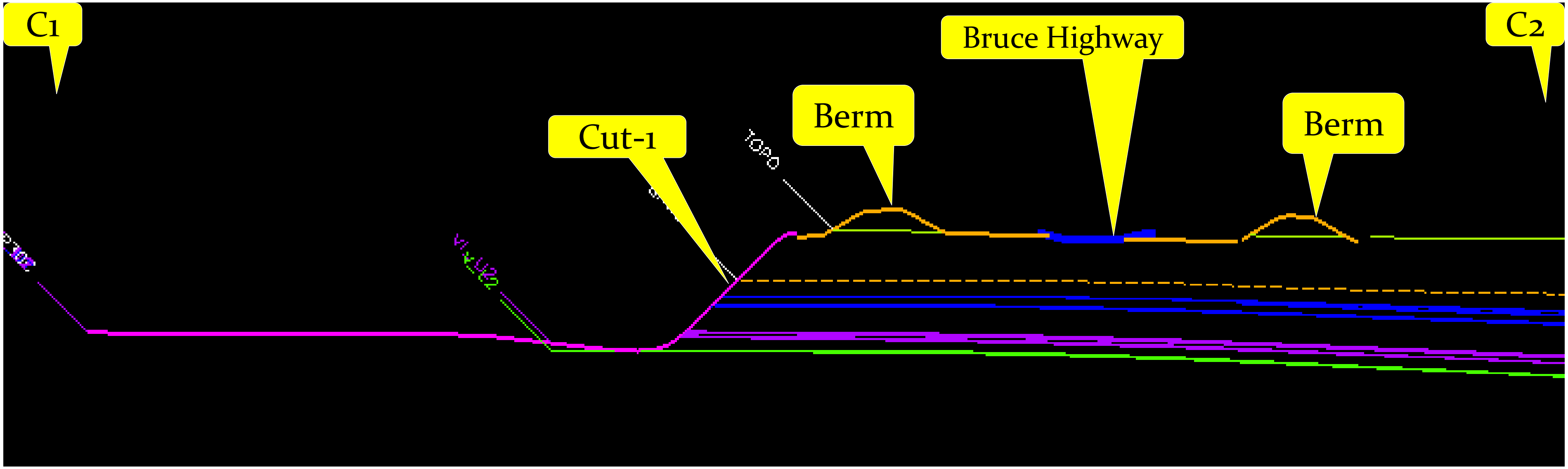
Cross Section Cut-1, Period-11



Cross Section Cut-1, Period-13



Cross Section Cut-1, Period-14


C1

C2

Bruce Highway

Berm

Berm

Cut-1

GROUNDWATER INVESTIGATIONS FOR THE STYX TRIAL PIT

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December 2014

GROUNDWATER INVESTIGATIONS FOR THE STYX TRIAL PIT

CONTENTS

TABLES

FIGURES

APPENDICES

GROUNDWATER INVESTIGATIONS FOR THE STYX TRIAL PIT

1.0 INTRODUCTION

Two pump out tests were completed at the Styx trial pit on 24/11/14 and 25/11/14. The aims were to determine the aquifer characteristics and obtain samples for water quality testing. Figure 1 is a locality plan.

The two production holes were STX104 and STX00205 and holes STX170, STX00103 and STX00204 were observation bores (Figure 2). Groundwater was air lifted using a drilling rig and flow rates were measured with a V-notch weir.

2.0 GEOLOGY

Superficial, dispersive topsoil is underlain by soil and weathered rock. A gravel bed containing water sometimes occurs at the base of weathering. Fresh Cretaceous strata comprise sandstone, mudstone and coal seams. The coal seams are lenticular and vary in thickness.

3.0 WATER QUALITY

Seven water samples were collected for determinations of pH, electrical conductivity and salinity. Water samples were collected from observation bores using balers and at the production bores sites samples were collected at the well head during air lift testing. Table 1 is a schedule of water quality samples.

TABLE 1 - SCHEDULE OF WATER QUALITY SAMPLES

HOLE NO.	DATE, TIME COLLECTED
STX00104	24/11/14, 0835
STX00104	24/11/14, 0910
STX00104	24/11/14, 0950
STX00103	24/11/14
STX170	24/11/14
STX00204	24/11/14
STX00205	24/11/14, 1350

Testing of the water samples was completed at the Cardno laboratory in Mackay, Queensland. The laboratory report is included in Appendix 1 and the results are summarised in Table 2.

TABLE 2 - WATER QUALITY TEST RESULTS

HOLE NO.	pH	CONDUCTIVITY µS/cm	SALINITY (ppm)
STX00104 (0835)	6.9	2.23	13.3
STX00104 (0910)	7.6	2.02	11.9
STX00104 (0950)	7.6	2.45	15.1
STX00103	6.8	1.97	11.9
STX170	7.1	0.18	0.9
STX00204	6.8	2.05	12.7
STX00205 (1350)	7.5	2.21	13.0

Testing indicates that the groundwater is of potable water quality, being of neutral pH and with a very low salinity (Table 2, Appendix 1).

4.0 PUMP OUT TESTING

4.1 General

Two pump out tests were completed by air lifting groundwater using a drilling rig (Figure 3). In the first test hole STX00104 was the production bore, and holes STX170, STX00103 and STX00204 were observation bores (Figure 1). All test results are included in Appendix 2.

Problems occurred during the second test because the casing was not properly seated in the production hole STX00205. Groundwater was air lifted inside and outside of the casing and it was necessary to curtail the test.

4.2 Flow Rates

During pump out test one, flow rate, as measured by V-notch weir varied from 0.09 litre/sec to 0.0004 litre/sec with an average flow rate of 0.03 litre/sec.

In pump out test two flow rate varied from 0.165 litre/sec to 0.075 litre/sec with an average flow rate of 0.15 litre/sec. Reasons for the increased flow rate in this test are the presence of a gravel bed at the base of weathering and a 4.0 m thick coal seam.

The flow rates from both tests were very low, indicating the lack of any significant aquifer in this area.

4.3 Pump Out Test One

This test comprised a production bore, STX00104, and three observation holes, STX170, STX00103 and STX00204, located 100 m, 200 m and 200 m respectively away from the pumped hole (Figure 2). A very low average flow rate of 0.03 litre/sec was achieved during air lift pumping.

Drawdown was measured in all observation holes and recovery was measured in the production bore and all observation holes. All results are in Appendix 2. Because of the very low permeability and storativity of the strata only the drawdown measurements for the observation holes and recovery data from the production bore could be analysed. Pump out test results are summarised in Table 3.

TABLE 3 - SUMMARY OF PUMP OUT TEST ONE RESULTS

PRODUCTION HOLE	OBSERVATION HOLE	GRAPH TYPE	TRANSMISSIVITY (m^2/day)	STORATIVITY (Ratio)
STX00104		Recovery	0.013	
	STX170	Drawdown	9.504	0.0000044
	STX00103	Drawdown	2.066	0.0000008
	STX00204	Drawdown	5.165	0.0000002

Results show very low transmissivity and storativity values, indicating lack of any significant aquifers.

4.4 Pump Out Test Two

Because of casing sealing problems, pump out test two in production hole STX00205 was curtailed. Average air lift flow rate was 0.15 litre/sec and recovery was measured. All results are in Appendix 2.

The recovery graph indicated a transmissivity of 0.042 m^2/day.

5.0 CONCLUSIONS

Pump out testing has confirmed that no significant aquifers occur in the trial pit area. Minor groundwater which is present is of potable water quality.

FIGURES

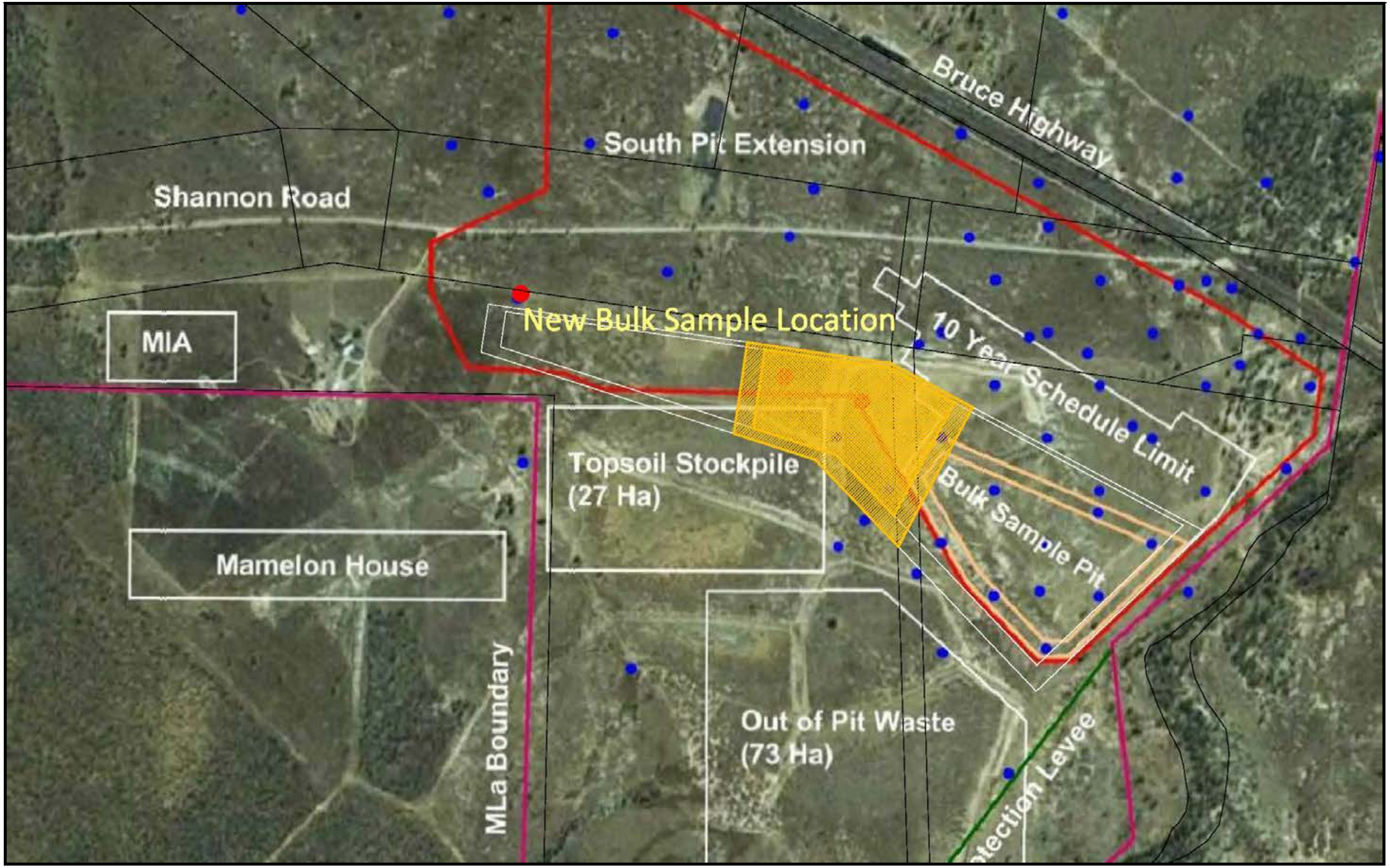

FIGURE 1 : LOCALITY PLAN

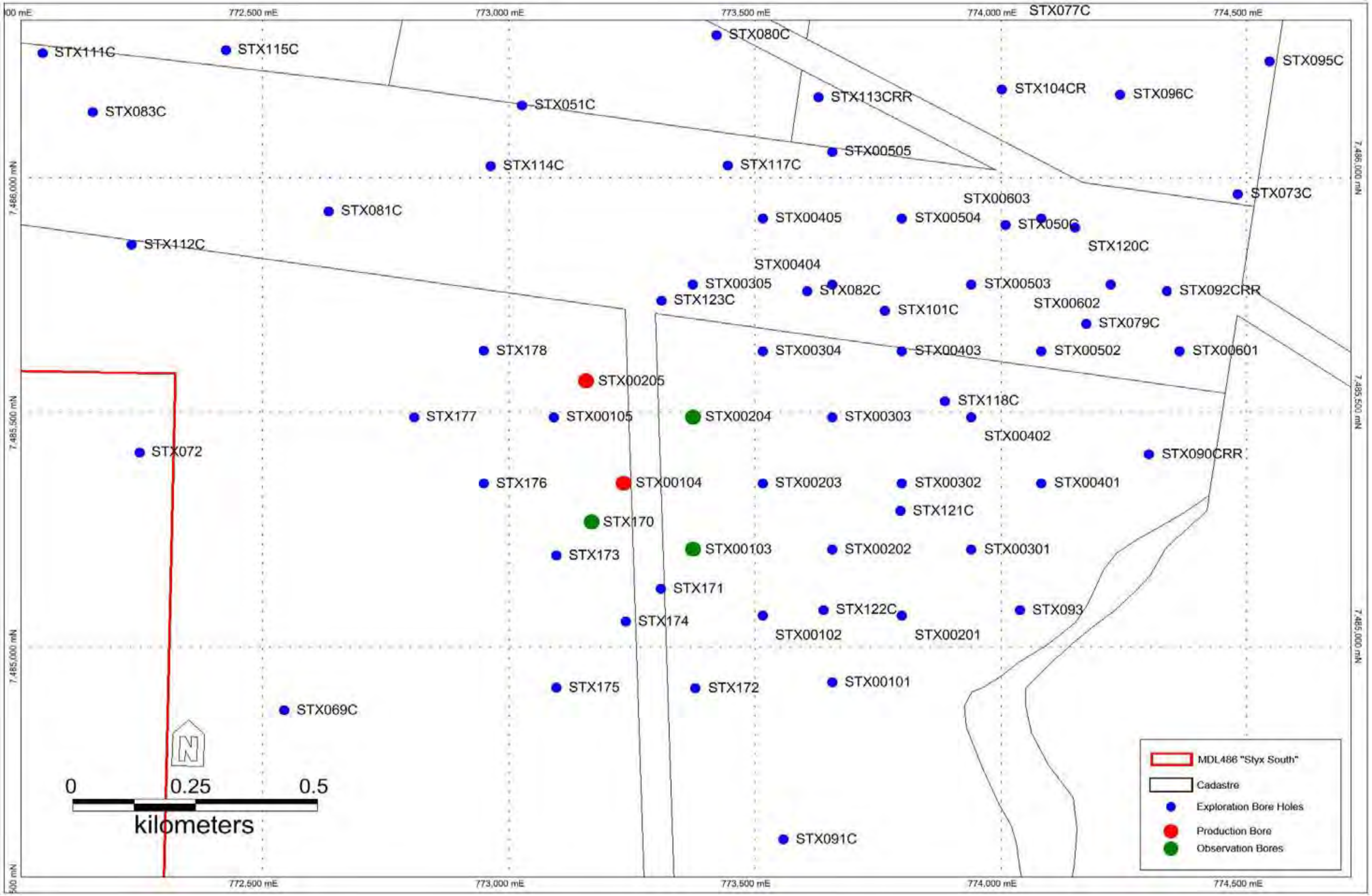

FIGURE 2 : PLAN OF EXPLORATORY DRILLHOLES

FIGURE 3 : DRILLING RIG USED FOR AIR LIFT PUMP OUT TESTING

APPENDIX 1

WATER SAMPLES TEST RESULTS

CARDNO ULLMAN & NOLAN
GEOTECHNIC PTY LTD
71 CONNORS ROAD MACKAY QLD

GEO-QF- UNGR 18 G
(-/1/14)

REPORT ON WATER QUALITY PARAMETERS

Sheet 1 of 1

Mackay Laboratory

CLIENT: AMEC Pty Ltd
JOB NO.: U21834
LAB REF NO.: Refer Below

PROJECT: Styx Trial Pit
SAMPLED BY: Client
DATE: 24.11.14

LOCATION: Refer Below
TESTED BY: DH,SC,KS
DATE: 26.11.14

MATERIAL: Water
CHECKED BY: DH
DATE: 27.11.14

TEST PROCEDURES: -
CLIENT REF: -

SAMPLING LOCATION / TIME	LAB REF NO.	PH	CONDUCTIVITY	SALINITY
		PH	µS/CM	PPM
STX 00104, 8.35 am	14-3531ABC	6.9	2.23	13.3
STX 00104, 9.10 am	14-3532ABC	7.6	2.02	11.9
STX 00104, 9.50 am	14-3533ABC	7.6	2.45	15.1
STX 00103	14-3534ABC	6.8	1.97	11.9
STX 0170	14-3535ABC	7.1	0.18	0.9
STX 00204	14-3536ABC	6.8	2.05	12.7
STX 00205, 1.50pm	14-3537ABC	7.5	2.21	13.0

Signature...

N.J. Richardson

Date 1 / 12 / 2014

APPENDIX 2

PUMP OUT TESTING DATA

TABLE 1 - V-NOTCH WEIR READINGS FOR PUMP OUT TEST ONE

TIME (mins)	V-NOTCH DEPTH (mm)	FLOW RATE (L/sec)
0	28	0.18
20	22	0.10
35	4	0.001
60	3	0.0006
85	2	0.0002

TABLE 2 - V-NOTCH WEIR READINGS FOR PUMP OUT TEST TWO

TIME (mins)	V-NOTCH DEPTH (mm)	FLOW RATE (L/sec)
0	30	0.22
35	23	0.11
45	15	0.04

TABLE 3 - PRODUCTION HOLE STX00104 RECOVERY
SWL = 10.05 m

DATE	TIME (mins)	WATER LEVEL (m)	RECOVERY (m)
24/11/14	5	77.60	-
24/11/14	10	74.81	2.79
24/11/14	20	72.36	5.24
24/11/14	40	67.30	10.60
24/11/14	60	62.73	14.87
24/11/14	75	59.06	18.54
24/11/14	105	55.44	22.16
24/11/14	125	52.02	25.58
24/11/14	145	48.02	29.58
24/11/14	205	39.54	38.06
24/11/14	225	36.54	41.06
24/11/14	240	33.84	43.76
24/11/14	255	32.24	45.36
24/11/14	270	30.24	47.36
24/11/14	300	27.74	49.86
24/11/14	335	25.34	52.26
24/11/14	360	22.84	54.76
24/11/14	375	21.54	56.06
25/11/14	1215	11.09	66.51

TABLE 4 - OBSERVATION HOLE STX170 DRAWDOWN
SWL = 9.85 m

DATE	TIME (mins)	WATER LEVEL (m)	DRAWDOWN (m)
24/11/14	0	9.85	-
24/11/14	20	9.89	0.04
24/11/14	30	9.90	0.05
24/11/14	55	9.92	0.07
24/11/14	75	9.92	0.07
24/11/14	85	9.92	0.07

TABLE 5 - OBSERVATION HOLE STX170 RECOVERY
SWL = 9.85 m

DATE	TIME (mins)	WATER LEVEL (m)	RECOVERY (m)
24/11/14	0	9.92	-
24/11/14	85	9.90	0.02
24/11/14	175	9.89	0.03

TABLE 6 - OBSERVATION HOLE STX00103 DRAWDOWN
SWL = 9.85 m

DATE	TIME (mins)	WATER LEVEL (m)	DRAWDOWN (m)
24/11/14	0	9.85	-
24/11/14	15	9.80	0.05
24/11/14	20	9.82	0.07
24/11/14	26	9.85	0.10
24/11/14	32	9.98	0.13
24/11/14	37	9.95	0.10
24/11/14	46	9.97	0.12
24/11/14	51	10.03	0.18
24/11/14	56	9.98	0.13
24/11/14	61	10.04	0.19
24/11/14	66	9.87	0.02
24/11/14	72	9.95	0.10
24/11/14	77	10.07	0.22

TABLE 7 - OBSERVATION HOLE STX00103 RECOVERY
SWL = 9.85 m

DATE	TIME (mins)	WATER LEVEL (m)	RECOVERY (m)
24/11/14	0	-	-
24/11/14	7	9.98	-
24/11/14	11	10.00	-0.02
24/11/14	16	9.98	0.00
24/11/14	21	9.99	-0.01
24/11/14	26	9.96	0.02
24/11/14	36	9.98	0.00
24/11/14	50	9.94	0.04
24/11/14	60	9.95	0.03
24/11/14	70	10.00	-0.02

TABLE 8 - OBSERVATION HOLE STX00204 DRAWDOWN
SWL = 10.15 m

DATE	TIME (mins)	WATER LEVEL (m)	DRAWDOWN (m)
24/11/14	0	10.15	-
24/11/14	12	10.05	0.10
24/11/14	18	9.98	0.17
24/11/14	24	10.07	0.08
24/11/14	29	9.85	0.30
24/11/14	34	9.88	0.27
24/11/14	41	9.97	0.18
24/11/14	49	10.08	0.07
24/11/14	54	10.04	0.11
24/11/14	58	10.00	0.15
24/11/14	64	9.98	0.17
24/11/14	69	10.03	0.12
24/11/14	74	9.97	0.18

TABLE 9 - OBSERVATION HOLE STX00204 RECOVERY

SWL = 10.15 m

DATE	TIME (mins)	WATER LEVEL (m)	RECOVERY (m)
24/11/14	0	-	-
24/11/14	5	10.02	-
24/11/14	9	10.05	-0.03
24/11/14	14	10.05	-0.03
24/11/14	19	10.04	-0.02
24/11/14	24	10.05	-0.03
24/11/14	34	10.05	-0.03
24/11/14	44	10.05	-0.03
24/11/14	54	10.05	-0.03
24/11/14	64	10.05	-0.03
24/11/14	72	10.04	-0.02

TABLE 10 - PRODUCTION HOLE STX00205 RECOVERY

SWL = 9.93 m

DATE	TIME (mins)	WATER LEVEL (m)	RECOVERY (m)
24/11/14	0	-	-
24/11/14	5	62.00	-
24/11/14	10	54.00	12.00
24/11/14	15	40.00	22.00
24/11/14	30	20.00	42.00
24/11/14	35	17.86	44.14
24/11/14	40	16.34	45.60
24/11/14	45	15.80	46.20
24/11/14	50	16.20	45.80
24/11/14	95	13.80	48.20
24/11/14	125	12.30	49.70
24/11/14	155	12.10	49.90
25/11/14	990	11.18	50.82

GEOTECHNICAL REPORT FOR THE STYX COAL PROJECT

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April 2017

GEOTECHNICAL REPORT FOR
THE STYX COAL PROJECT

CONTENTS

TABLES

FIGURES

APPENDICES

GEOTECHNICAL REPORT FOR
THE STYX COAL PROJECT

1.0 INTRODUCTION

This report describes the geotechnical and hydrogeological conditions for the Styx Coal Project. Type geological sections have been used for geotechnical analysis including rock strength determinations.

Co-ordinates are GDA94 datum and R.L. datum is AHD. Figure 1 is a locality plan.

2.0 WEATHERING

Definitions of rock soil and degrees of chemical weathering are included in Table 1. Superficial, dispersive topsoil is generally underlain by soil and weathered rock. Clay, silt and sand generally occur to a depth of 23 m with weathering extending to a depth of about 28 m.

3.0 GROUNDWATER AND PERMEABILITY

The standing water level is generally about 10 m below the surface. Pump out testing (Reference 1) has shown that there are no significant aquifers in the areas tested. Minor groundwater which is present is of potable water quality (Table 2).

TABLE 2 - WATER QUALITY TEST RESULTS (REFERENCE 1)

HOLE NO.	pH	CONDUCTIVITY μS/cm	SALINITY (ppm)
STX00104 (0835)	6.9	2.23	13.3
STX00104 (0910)	7.6	2.02	11.9
STX00104 (0950)	7.6	2.45	15.1
STX00103	6.8	1.97	11.9
STX170	7.1	0.18	0.9
STX00204	6.8	2.05	12.7
STX00205 (1350)	7.5	2.21	13.0

4.0 GEOLOGICAL SETTING

The Styx Coal Project area is in the Styx Basin, a small, Early Cretaceas, intracratonic sag basin which covers an area of about 300 km^2 onshore and 500 km^2 offshore. The coal bearing strata are known as the Styx Coal Measures and consist of quartzose, calcareous lithic and pebbly conglomerate, sandstone, siltstone, mudstone, carbonaceous shale and coal seams. Figure 2 shows the typical coal seams stratigraphy. The depositional environment was freshwater, deltaic to paludal, with occasional marine incursions.

The Styx Coal Measures occur as basin infill in a half graben geometry which has a plunge to the north. The deposit has north and east dipping components.

The full sequence of coal is about 6 m occurring within a sequence of about 120 m of coal bearing strata.

TABLE 1 - DEFINITIONS OF ROCK, SOIL AND DEGREES OF CHEMICAL WEATHERING

(A) GENERAL DEFINITIONS – ROCK AND SOIL

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces.

Note: Since ‘strong’ and ‘permanent’ are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one.

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by such gentle mechanical means as agitation in water.

The two principal classes of soil are:

(a) Residual soils – soils which have been formed in-situ by the chemical weathering of parent rock. Residual soil may retain evidence of the original rock texture or fabric or, when mature, the original rock texture may be destroyed.

(b) Transported soils – soils which have been moved from their places of origin and deposited elsewhere. The principal agents of erosion, transport and deposition are water, wind, ice and gravity. Two important types of transported soil in engineering geology and materials investigation are:

(c) Slopewash – a soil, often including angular rock fragments and boulders, which has been transported downslope predominantly under the action of gravity assisted by water. The principal forming process is that of soil creep in which the soil moves after it has been weakened by saturation. It may be water borne for short distances.

(d) Alluvium – a soil which has been transported and deposited by running water. The larger particles (sand and gravel size) are water worn.

(B) ROCK WEATHERING DEFINITIONS

COMPLETELY WEATHERED ROCK (CW)	Rock which retains most of the original rock texture (fabric) but the bond between its mineral constituents is weakened by chemical weathering to the extent that the rock will disintegrate when immersed and gently shaken in water. In engineering usage this is a soil.
HIGHLY WEATHERED ROCK (HW)	Rock which is weakened by chemical weathering to the extent that dry pieces about the size of 50mm diameter drill core can be broken by hand across the rock fabric. Highly weathered rock does not readily disintegrate when immersed in water.
MODERATELY WEATHERED ROCK (MW)	Rock which exhibits considerable evidence of chemical weathering, such as discolouration and loss of strength but which has sufficient remaining strength to prevent dry pieces about the size of 50mm diameter drill core (of inherently hard rock) being broken by hand across the rock fabric. Moderately weathered rock does not ring when struck with a hammer.
SLIGHTLY WEATHERED ROCK (SW)	Rock which exhibits some evidence of chemical weathering, such as discolouration, but which has suffered little reduction in strength. Except for some inherently soft rocks, slightly weathered rock rings when struck with a hammer.
FRESH WITH LIMONITE STAINED JOINTS (Fr St)	Joint faces coated or stained with limonite but the blocks between joints are unweathered.
FRESH ROCK (Fr)	Rock which exhibits no evidence of chemical weathering. Joint faces may be clean or coated with clay, calcite, chlorite or other minerals.

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the predominant degree of weathering first (eg. CW-HW).

The various degrees of weathering are not absolute strength parameters as some rocks are weak, even when fresh, to the extent that they can be broken by hand across the fabric.

Fresh drill cores of some rock types, mainly shale, siltstone, and silty or tuffaceous sandstone may disintegrate after exposure to the atmosphere due to slaking, desiccation, expansion or contraction, stress relief or a combination of any of these factors.

5.0 STRATIGRAPHY

The Styx Coal Measures comprise multiple coal seams which are generally interbedded with sandstone, siltstone and mudstone. Bedding thickness varies. Partings are present along bedding planes. Lensing of coal seams also occurs.

Multi-seam mining will be required with parting operations which minimise dilution.

6.0 GEOLOGICAL STRUCTURE

Bedding is generally uniform with an average dip of 3°. Maximum dip is about 7°. Partings occur along bedding planes. Jointing is generally widely spaced.

To date no significant faults or dykes have been encountered during geological investigations.

7.0 GEOTECHNICAL ASSESSMENT

A review of the geological structure and groundwater condition has been completed. Type geological sections and sonic velocity logs have been obtained from 6 typical drillholes (Figure 3). These data which are included in Appendix 1, have been used to determine rock strengths.

7.1 Rock Strength Testing

Rock strengths have been determined by converting sonic velocity to sonically derived uniaxial compressive strength (UCS). There is no site specific conversion formula for the Styx mine site. A general formula which is used in the Bowen Basin and is based on regression analysis of numerous tests on very weak rock to very strong rock is:-

$$\text{UCS} = 3330e^{-0.0499t}$$

Where t = interval transit time (reciprocal of velocity) in microseconds per foot

In drillholes where the sonic velocity has been recorded in microseconds per metre the formula is:-

$$\text{UCS} = 3330e^{-0.0499(t/3.28084)}$$

Where t = interval transit time (reciprocal of velocity) in microseconds per metre

A type geological section with sonic UCS results for hole STX099 is included in Figure 4A to 4D. Analyses indicate that the strengths of fresh strata are comparable to those in the Rangal Coal Measures in the Bowen Basin. Core photographs are included in Appendix 1.

7.2 Highwall and End Walls

A generalised cross section for the pit geometry is shown in Figure 5. Because of the depth of soil and weathering an advance bench is recommended with a batter angle of 1 on 1. The advance bench material is free diggable and could be used for encapsulate tailings and rejects in spoil piles. All highwall drainage should be directed away from the pit void.

Due to the presence of a number of coal seams multi-seam mining is required. Parting material could either be mechanically excavated or drilled and blasted, depending on the strength and thickness of the parting material. A blast bench is required when parting needs to be drilled and blasted. This enables the drilling rig to be positioned adjacent to the highwall.

Recommended batter angle for fresh rock is 0.5 to 1 (Figure 5) with pre-split blasting for increased stability.

7.3 Low Wall

The low wall spoil should be placed at the angle of repose. Because of the depth of soil and weathering it is recommended that box cut spoil is placed at least 20 m back from the low wall edge. The box cut low wall batter angle should be 1 on 1.

If spoil rapidly deteriorates and weakens due to accelerated weathering, a 20 m bench should be constructed in low wall spoil piles at a depth of 40 m.

7.4 Floor

The average bedding dip is 3° with a maximum dip of about 7°. Where there is a soft mudstone floor and the bedding dip is greater than 5°, the floor should be ripped prior to spoil placement.

7.5 Construction Materials

Road base material which has been located for road construction is described in Reference 2.

Prior to construction, embankment materials need to be geotechnically tested for suitability.

8.0 REFERENCES

1. Australian Mining Engineering Consultants, 2014. Groundwater Investigations for the Styx Trial Pit.

2. Australian Mining Engineering Consultants, 2015. Investigations for Road Base, Styx Coal Project.

FIGURES

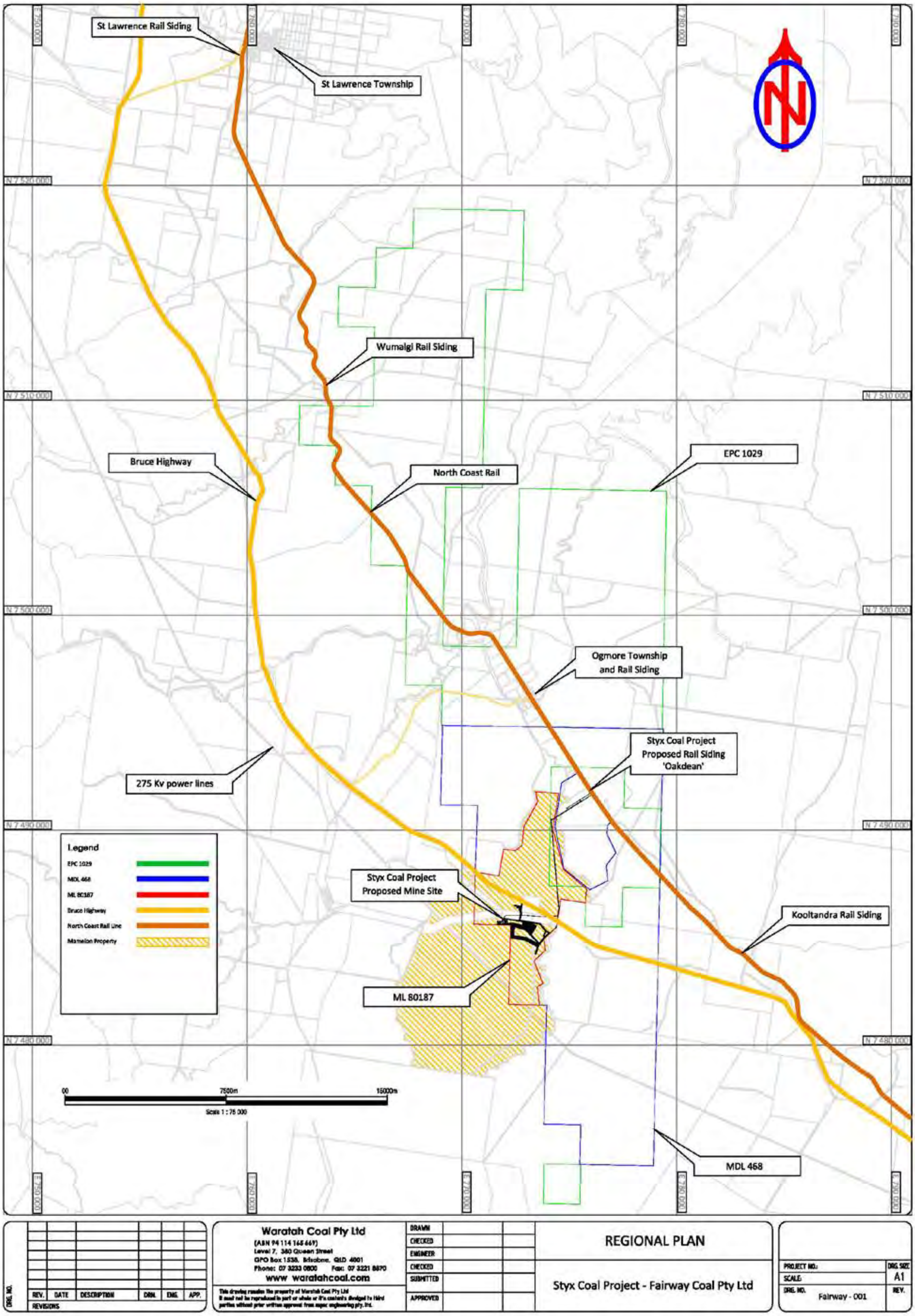


FIGURE 1 : LOCALITY PLAN

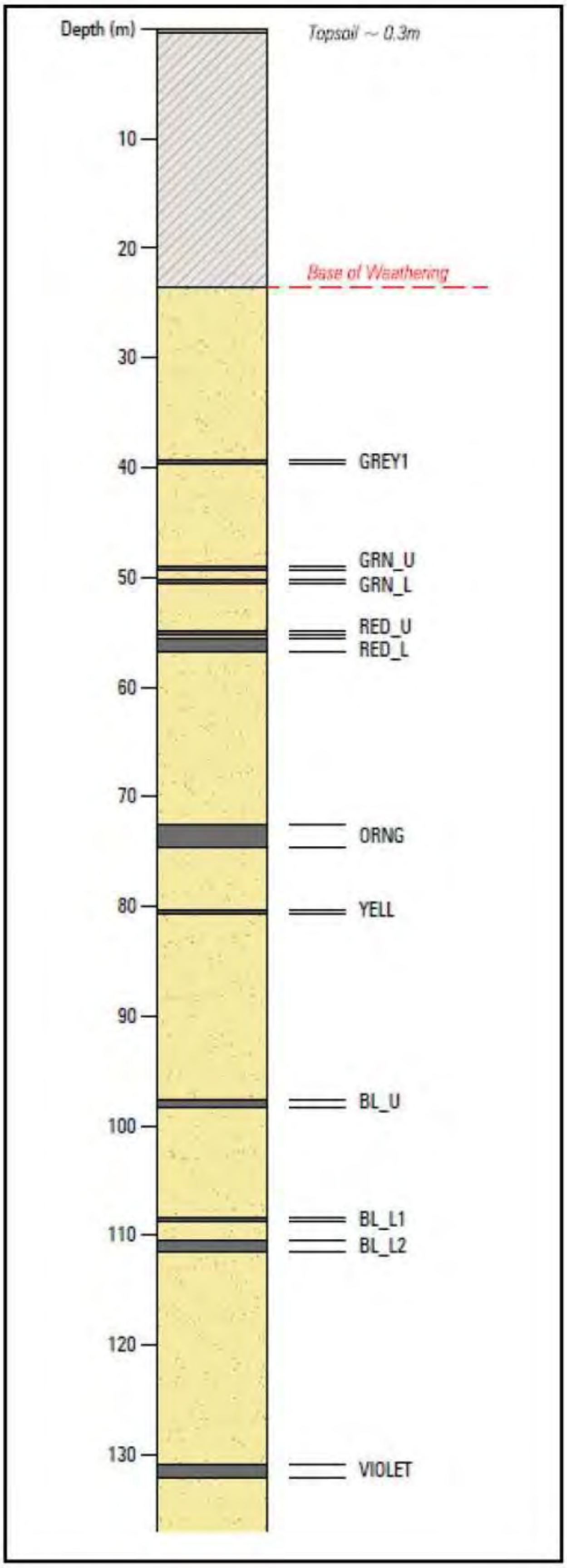


FIGURE 2 : TYPICAL STRATIGRAPHY, STYX COAL MEASURES

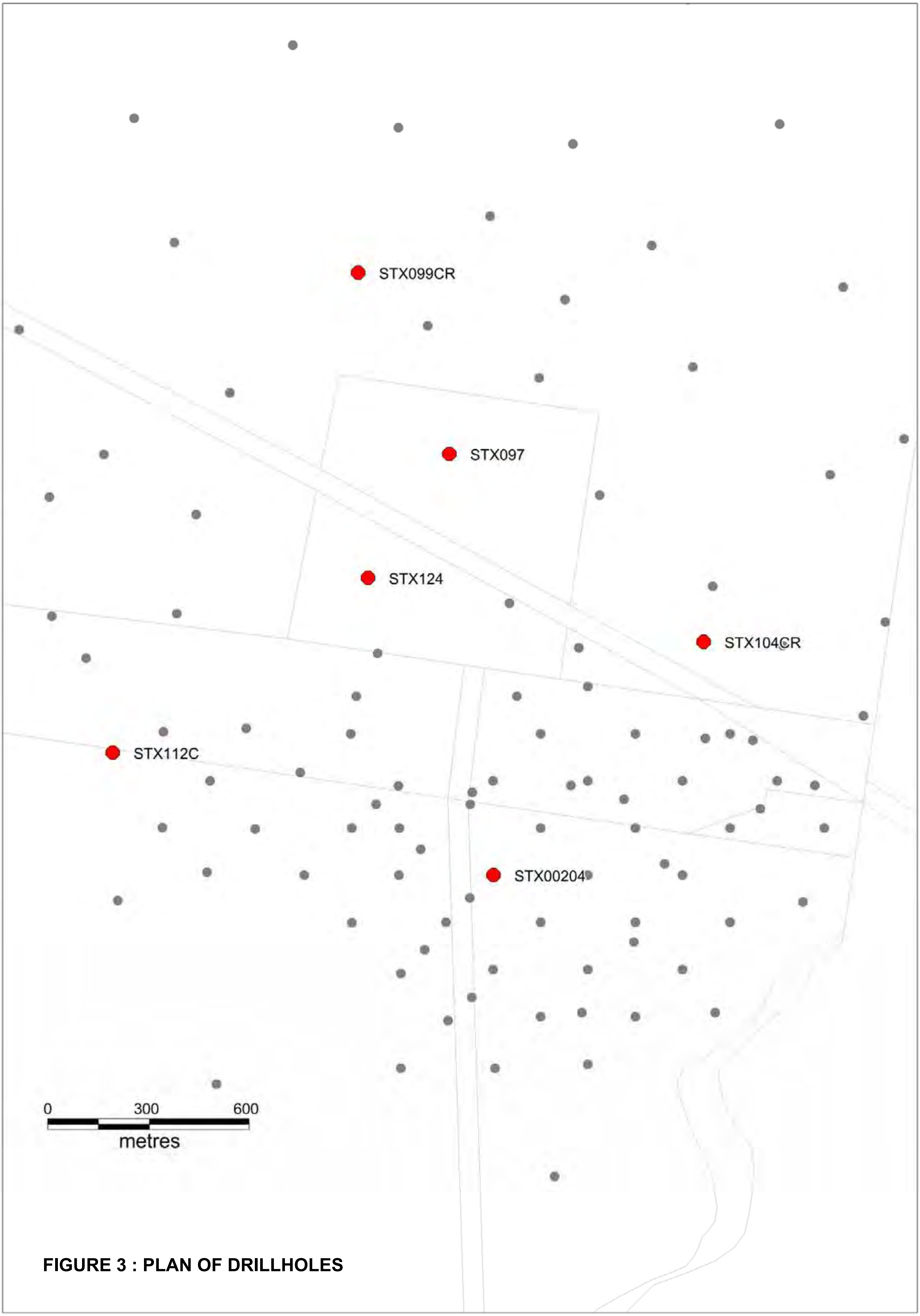


FIGURE 3 : PLAN OF DRILLHOLES

CLIENT :
WARATAH COAL PTY LTD

CORE TYPE: N.A.
CASING DEPTH: 30 m

LOCATION
E 772 969.5
N 7 487 294.1

BOREHOLE No: STX099
SHEET 1

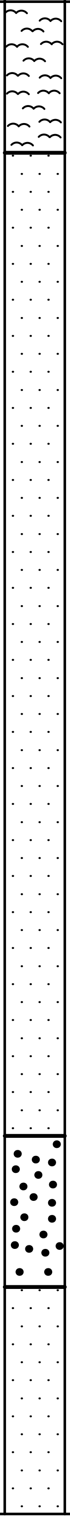
SITE LOCATION / PURPOSE :
STYX COAL PROJECT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 30

DRILLING DATE: 2011

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
SOIL, brown					N.A.			N.A.
CLAY, greyish brown		5 10						
SAND, orange brown		15						
CLAY, grey		20						



REMARKS:
Chip hole

N.A. Not Applicable

FIGURE 4A
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
WARATAH COAL PTY LTD

CORE TYPE: N.A.
CASING DEPTH: 30 m

LOCATION
E 772 969.5
N 7 487 294.1

BOREHOLE No: STX099
SHEET 2

SITE LOCATION / PURPOSE :
STYX COAL PROJECT

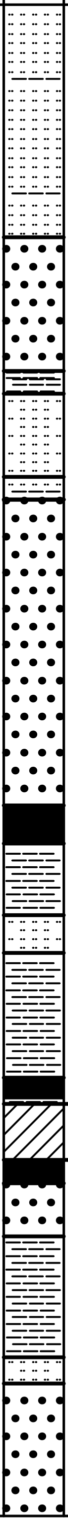
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 30

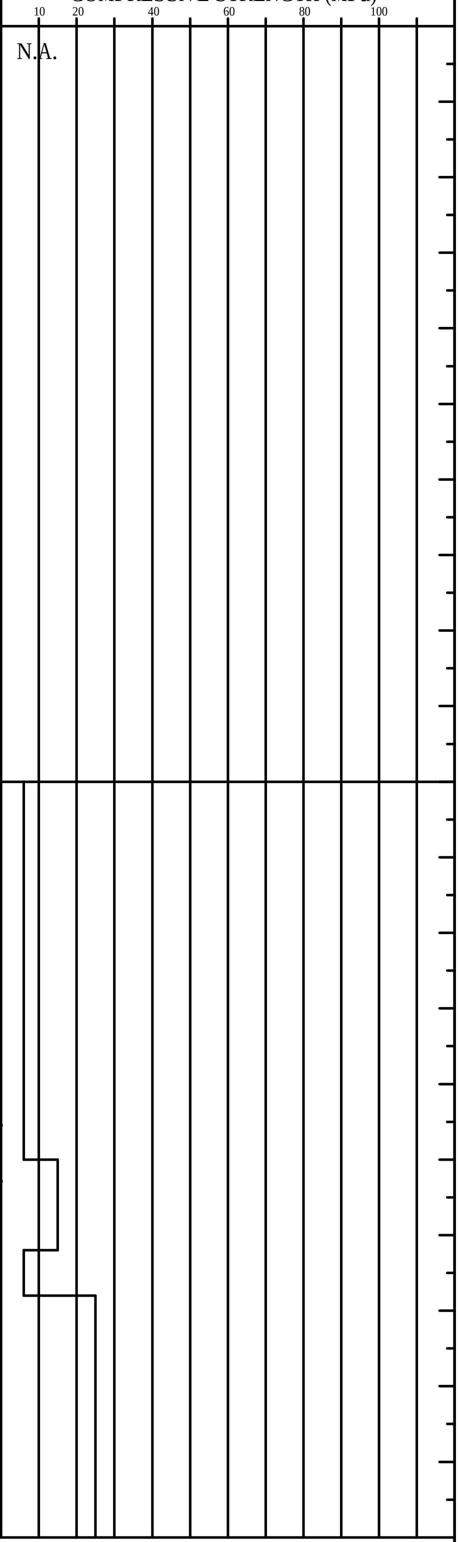
DRILLING DATE: 2011

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SILTSTONE, greyish brown, weathered, minor MUDSTONE, grey, very weak				N.A.		
SANDSTONE, grey, weathered, weak						
MUDSTONE, weathered		25				
SILTSTONE, grey, weathered, weak						
SILTSTONE, MUDSTONE						
SANDSTONE, grey, mainly fresh, weak		30				
COAL, bright, fresh						
MUDSTONE, carbonaceus, grey, fresh, weak						
SILTSTONE, grey, fresh, weak						
MUDSTONE, dark grey, fresh, weak						
COAL, minor MUDSTONE						
NO CORE		35		N.A.		
COAL, bright, fresh				N.A.		
SANDSTONE, grey, fresh, weak						
MUDSTONE, dark grey, fresh, weak						
SILTSTONE, grey, weak						
SANDSTONE, light grey, fresh, weak		40				

GRAPHIC LOG



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Chip hole

N.A. Not Applicable

FIGURE 4B
SCALE 1 : 100

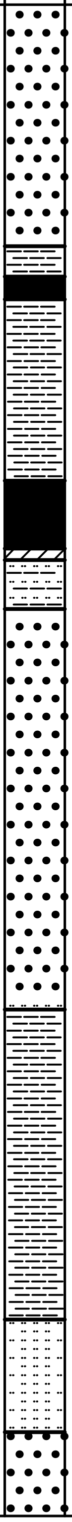
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : WARATAH COAL PTY LTD	CORE TYPE: N.A. CASING DEPTH: 30 m	LOCATION E 772 969.5 N 7 487 294.1	BOREHOLE No: STX099 SHEET 3
SITE LOCATION / PURPOSE : STYX COAL PROJECT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 30	DRILLING DATE: 2011

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS
SANDSTONE, grey, fresh, weak		N.A.
MUDSTONE, fresh, weak		
COAL, bright, fresh		
MUDSTONE, dark grey, fresh, weak	45	
COAL, bright, fresh		
NO CORE		
MUDSTONE, SILTSTONE, fresh, weak		
SANDSTONE, grey, fresh, weak	50	
SILTSTONE		
MUDSTONE, dark grey, fresh, weak	55	
SILTSTONE, medium grey, fresh, weak		
SANDSTONE, grey, fresh, weak	60	

GRAPHIC LOG

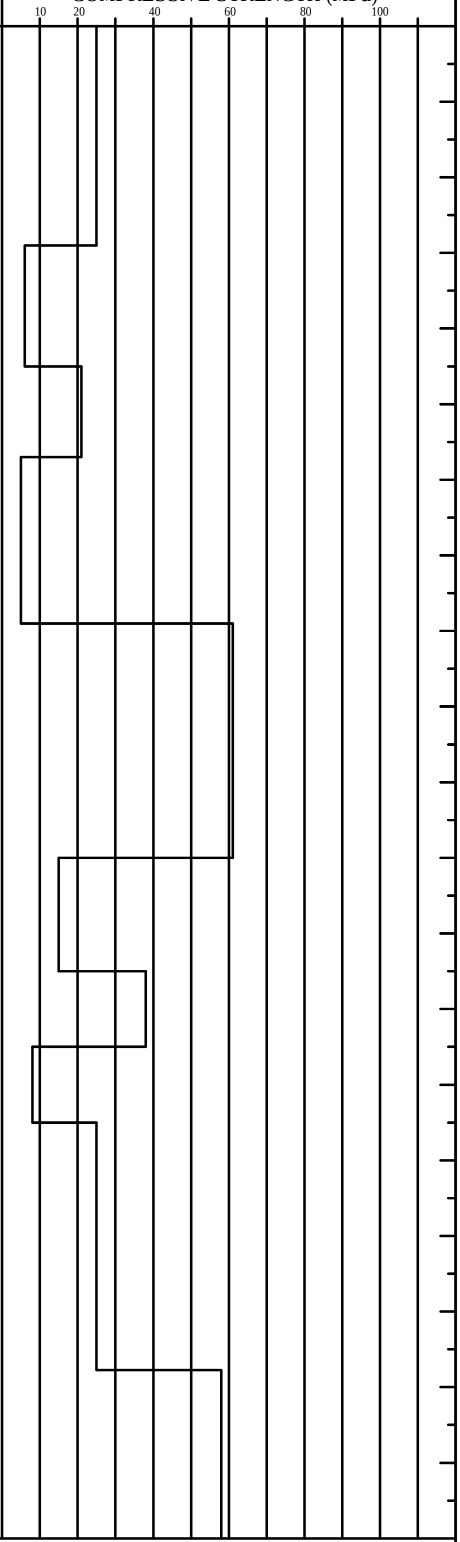


DUR-ABILITY %

FRAC. PER METRE

R.Q.D.

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Chip hole

N.A. Not Applicable

FIGURE 4C

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
WARATAH COAL PTY LTD

CORE TYPE: N.A.

CASING DEPTH: 30 m

LOCATION
E 772 969.5
N 7 487 294.1

BOREHOLE No: STX099

SHEET 4

SITE LOCATION / PURPOSE :
STYX COAL PROJECT

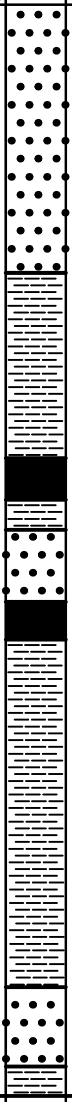
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 30

DRILLING DATE: 2011

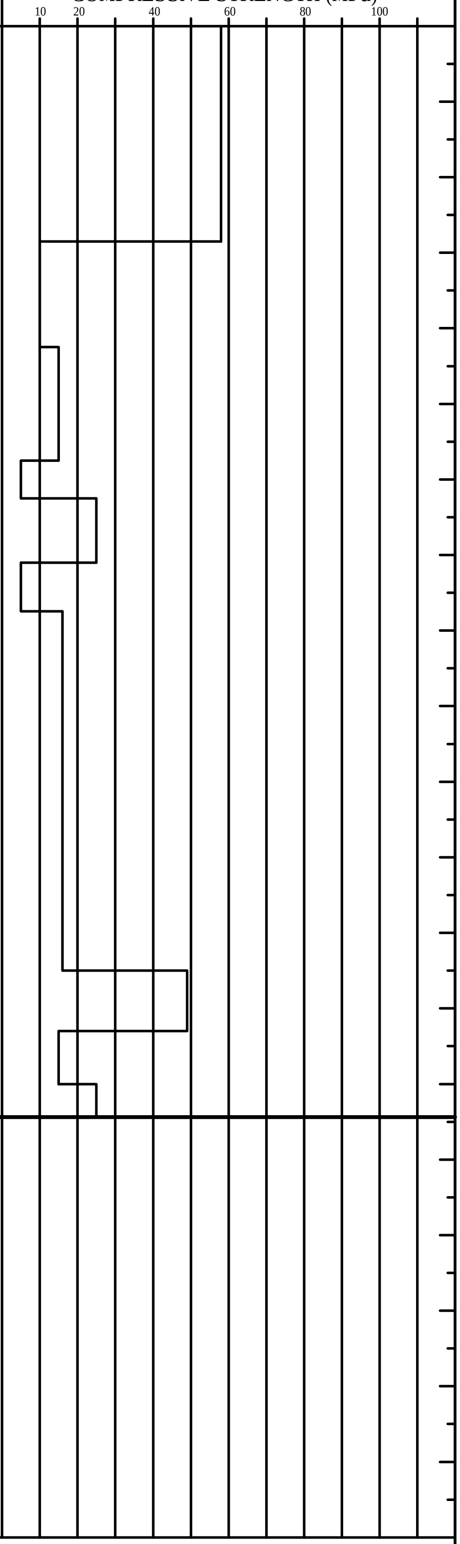
DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, grey, fresh, weak		N.A.		
MUDSTONE, dark grey, fresh, weak	65			
COAL, bright, fresh				
MUDSTONE, fresh, weak				
SANDSTONE, grey, fresh, weak				
COAL, bright, fresh				
MUDSTONE, dark grey, fresh, weak	70			
SANDSTONE, grey, fresh, weak				
MUDSTONE, fresh, weak				
END OF HOLE 74.37 m	75			
	80			

GRAPHIC LOG



DUR-ABILITY %

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Chip hole

N.A. Not Applicable

FIGURE 4D

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

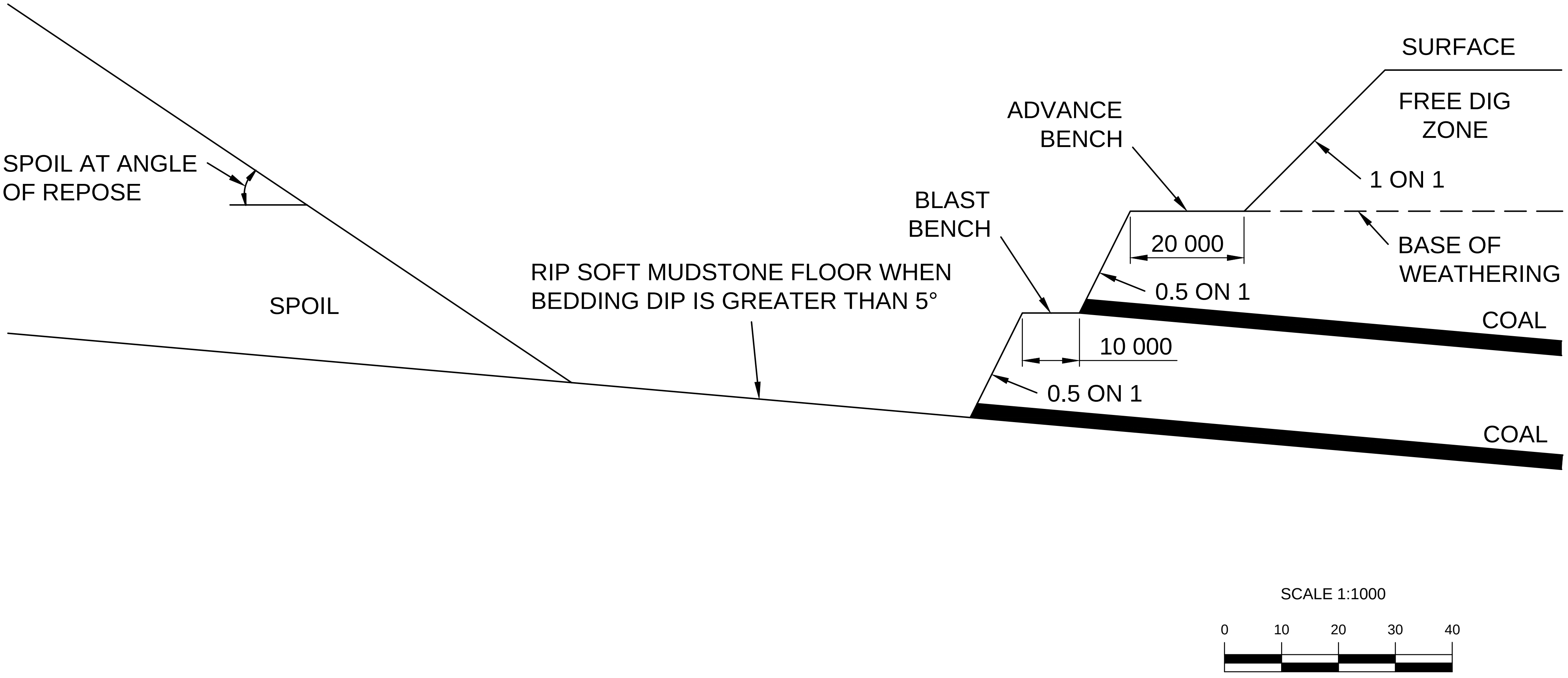


FIGURE 5 : GENERALISED CROSS SECTION THROUGH PIT

APPENDIX 1

DRILLHOLES DATA

WELL
STX002-04

LOG NAME
SONIC LOG

SCALE
1:100

COMPANY WARATAH COAL

LOCATION
MARLBOROUGH

FIELD
MARLBOROUGH

GeoLog Pty Ltd
ABN 34 132 282 190_7 Enterprise Court_Dundowran_PO Box 609_Pialba Qld. 4655__Phone 0413 463 130_Fax (07) 4191 4200_

QLD
AUSTRALIA

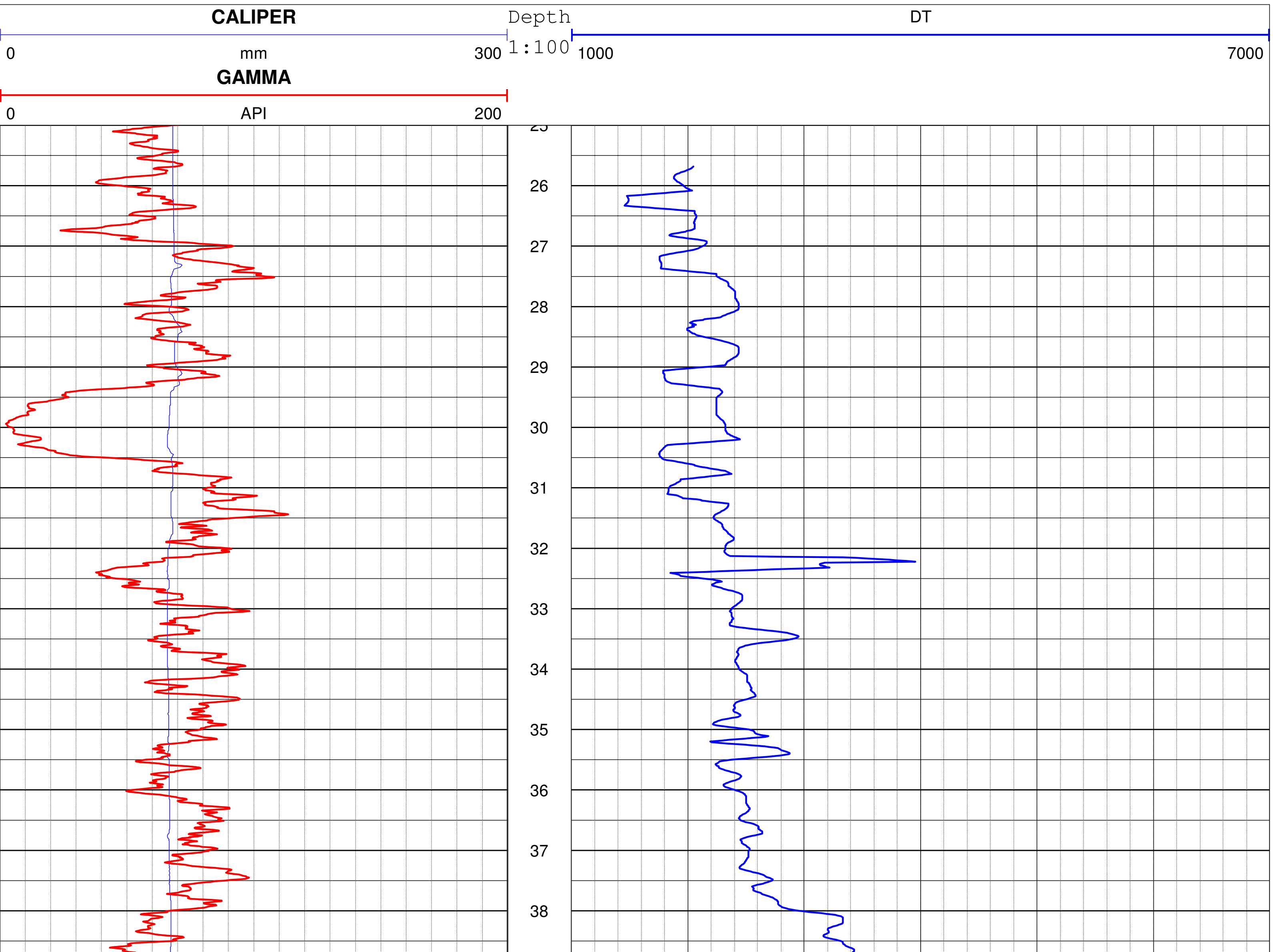
BORE HOLE DETAILS

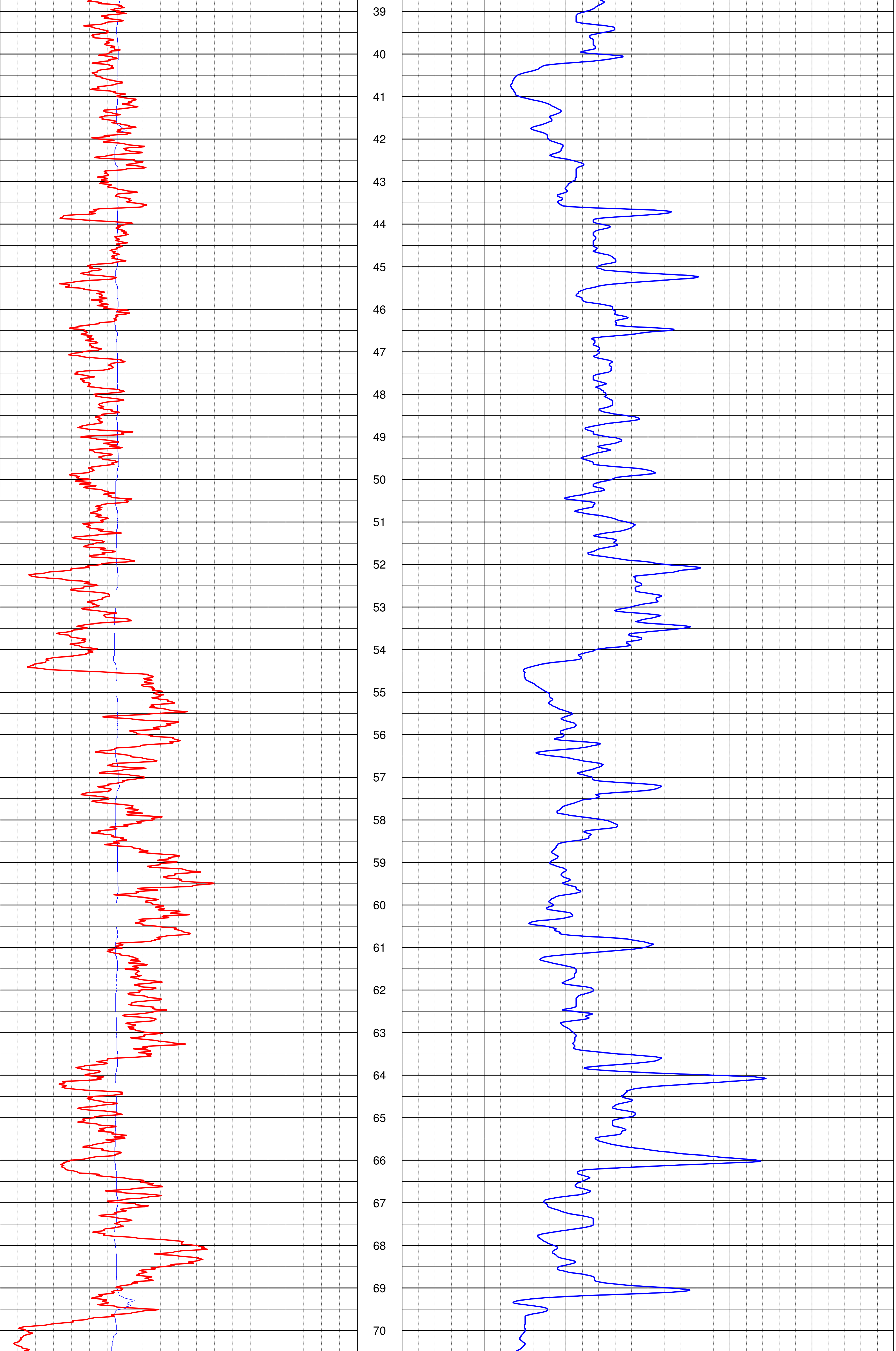
DepthDriller	81.5	(m)	Casing1Size	110	(mm)
DepthLogger	81.5	(m)	Casing1Weight	PVC	
BitSize1	110	(mm)	Casing1To	27	(m)
Bit1From	GL	(m)	Casing 2 Size		(mm)
Bit1To	27	(mm)	Casing 2 Weight		
BitSize2	95	(mm)	Casing 2 To		(m)
Bit2From	27	(m)	FluidDepth		(m)
Bit2To	TD	(m)	Lease ID		
BitSize3		(mm)	Elevation		
Bit3From		(m)	Easting	773375	
Bit3To		(m)	Northing	7485489	

UNIT DETAILS

Engineer		BILL HOUSTON
Witness		JOCHEN SCHMIDT
DATE		22 Oct 14
Unit Number		GL15
Density Sonde	#	8579
Cs137 Source	#	0040/04
Sonic Sonde	#	5759
Deviation Sonde	#	8945
Resistivity Sonde	#	
HiRAT Sonde	#	
Other Sonde	#	

Comments

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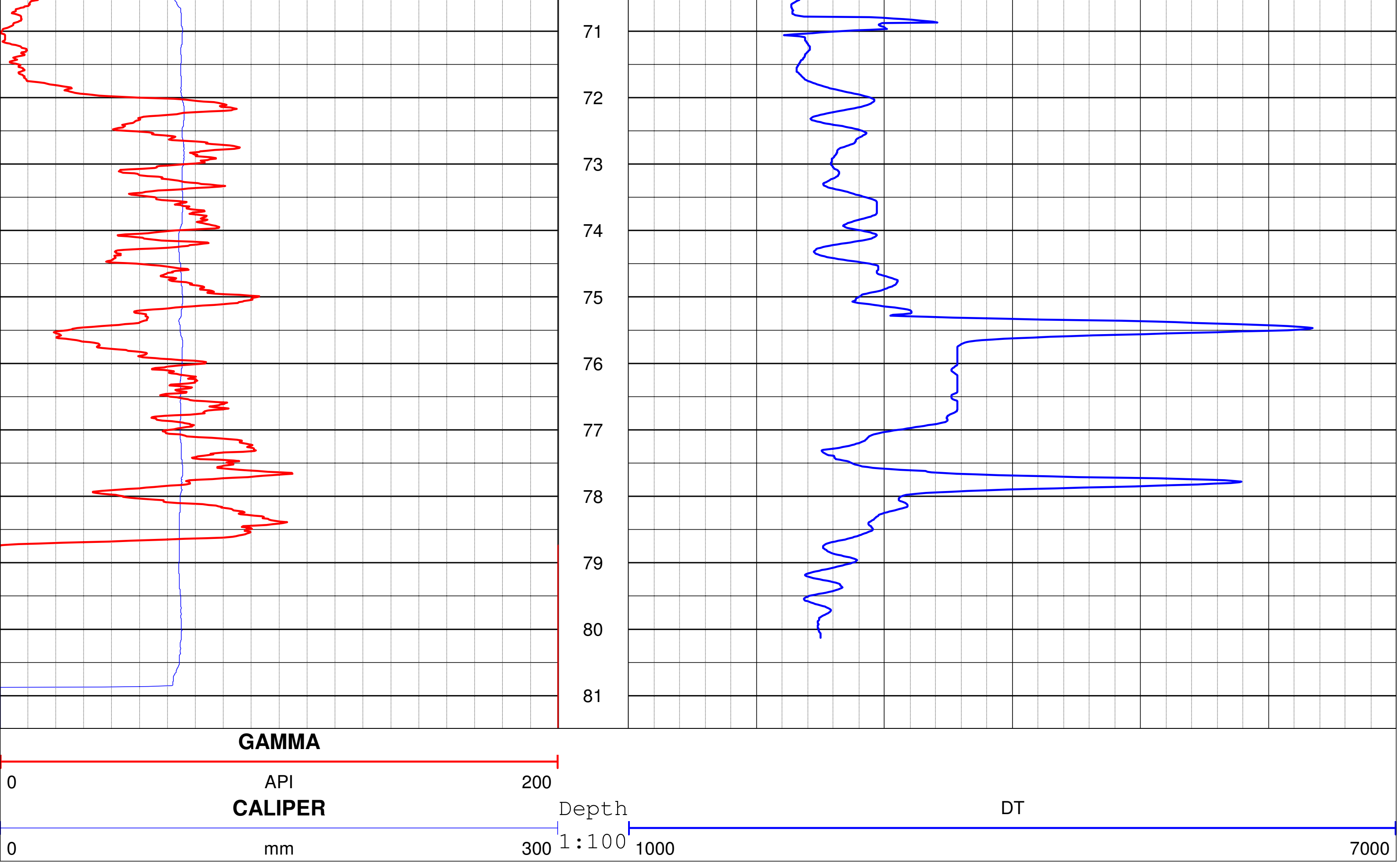
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STX00204 Geology Report
Drill Hole STX00204

Project: WARATAH Hole: STX00204

Base Depth	Thick.	Sample Number	Lithology
1.000	-79.310		SOIL: dark brown, extremely weathered.
6.000	5.000		SAND: medium grey, highly weathered.
28.000	22.000		SILT: medium brown, moderately weathered.
29.350	1.350		SANDSTONE: medium grey, fresh.
30.480	1.130		COAL, undifferentiated: fresh.
54.200	23.720		SANDSTONE, fine to medium grained: light grey, fresh.
54.540	0.340		COAL, undifferentiated: fresh.
69.600	15.060		SANDSTONE, fine grained: light grey, fresh.
70.890	1.290		COAL, undifferentiated: fresh.
71.160	0.270		MUDSTONE: dark grey, fresh.
71.890	0.730		COAL, undifferentiated: fresh.
72.280	0.390		MUDSTONE: dark grey, fresh.
72.550	0.270		COAL, undifferentiated: fresh.
72.900	0.350		MUDSTONE: dark grey, fresh.
73.440	0.540		COAL, undifferentiated: fresh.
74.190	0.750		MUDSTONE: dark grey, fresh.
74.450	0.260		COAL, undifferentiated: fresh.
78.630	4.180		MUDSTONE: dark grey, fresh.
78.890	0.260		COAL, undifferentiated: fresh.
79.120	0.230		MUDSTONE: dark grey, fresh.
79.340	0.220		COAL, undifferentiated: fresh.

79.680	0.340	MUDSTONE: dark grey, fresh.
80.310	0.630	COAL, undifferentiated: fresh.
81.500	1.190	SANDSTONE, fine to medium grained: light grey, fresh.

——— Total Depth: 81.500 metres ———

WELL NAME	LOG NAME	SCALE
STX097	**SONIC**	**1:100**

COMPANY NAME WARATAH COAL

FIELD NAME	PROVINCE
MARLBOROUGH	QUEENSLAND

Geolog Pty. Ltd.
ABN 34 132 282 190
Shed 6, 105 Old Maryborough Road
PO Box 609
Pialba Qld. 4655
Phone 0413 463 130
Fax (07) 4191 4200

WELL DETAIL			CASING DETAIL			OTHER DETAIL	
DepthDriller	74.90	(m)	Casing1Size	98	(mm)	Engineer	RYAN HUNT
DepthLogger	74.21	(m)	Casing1Weight	PVC		Witness	LUCAS
DATE	07 May 11		Casing1To	19.80	(m)	LOCATION	MARLBOROUGH
BitSize1	98	(mm)	Casing 2 Size		(mm)	State	QLD
Bit1From	GL	(m)	Casing 2 Weight			Country	AUSTRALIA
Bit1To	19.80	(m)	Casing 2 To		(m)	Sonde Abbreviation	
BitSize2		(mm)				Other Services1	
Bit2From		(m)				Other Services2	
Bit2To	TD	(m)	NORTHING			Other Services3	
FluidDepth	21	(m)	EASTING			Other Services4	

Comment

SERVICE COMPANY NAME N/A
UNIQUE WELL IDENTIFIER N/A
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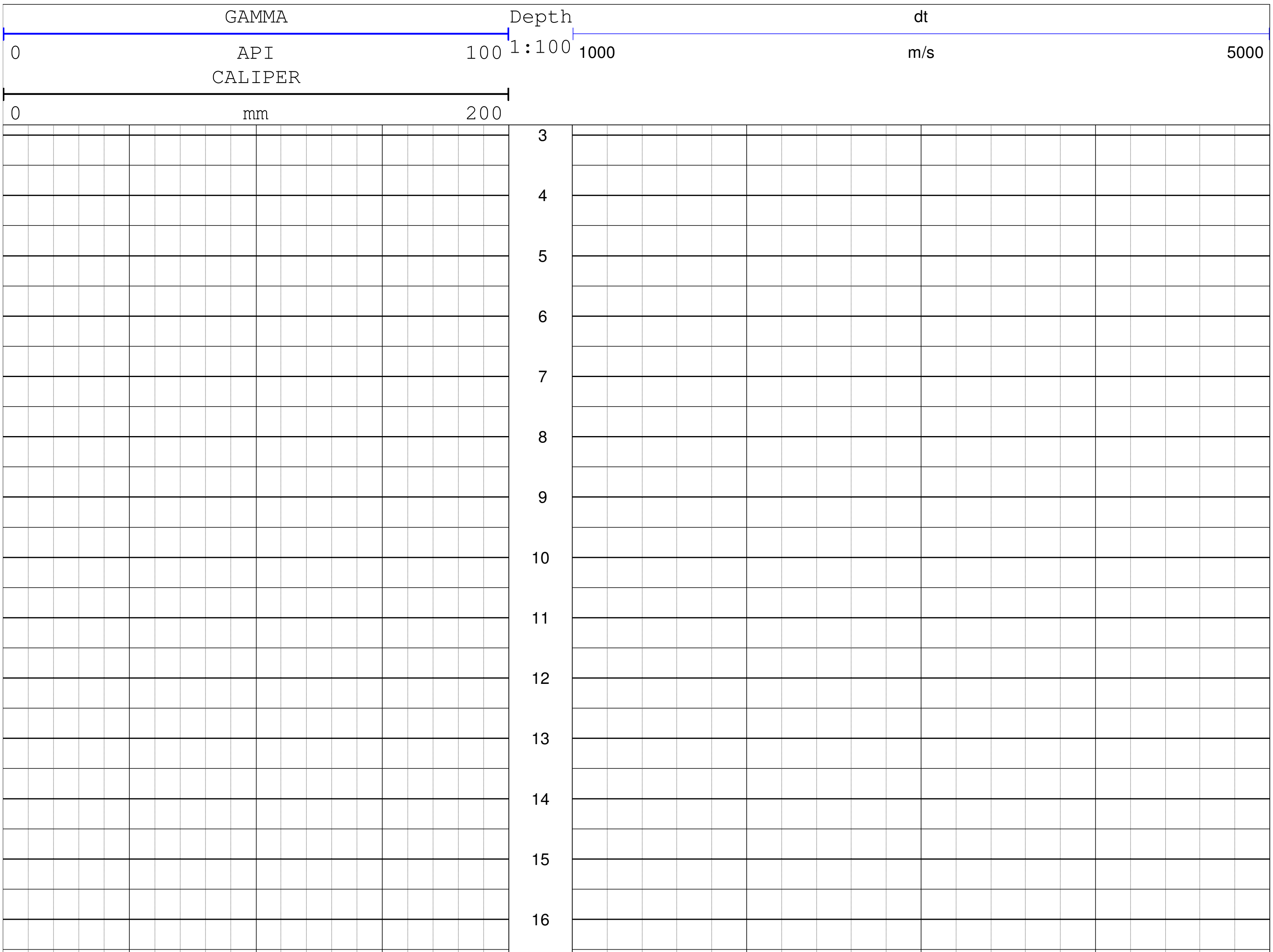

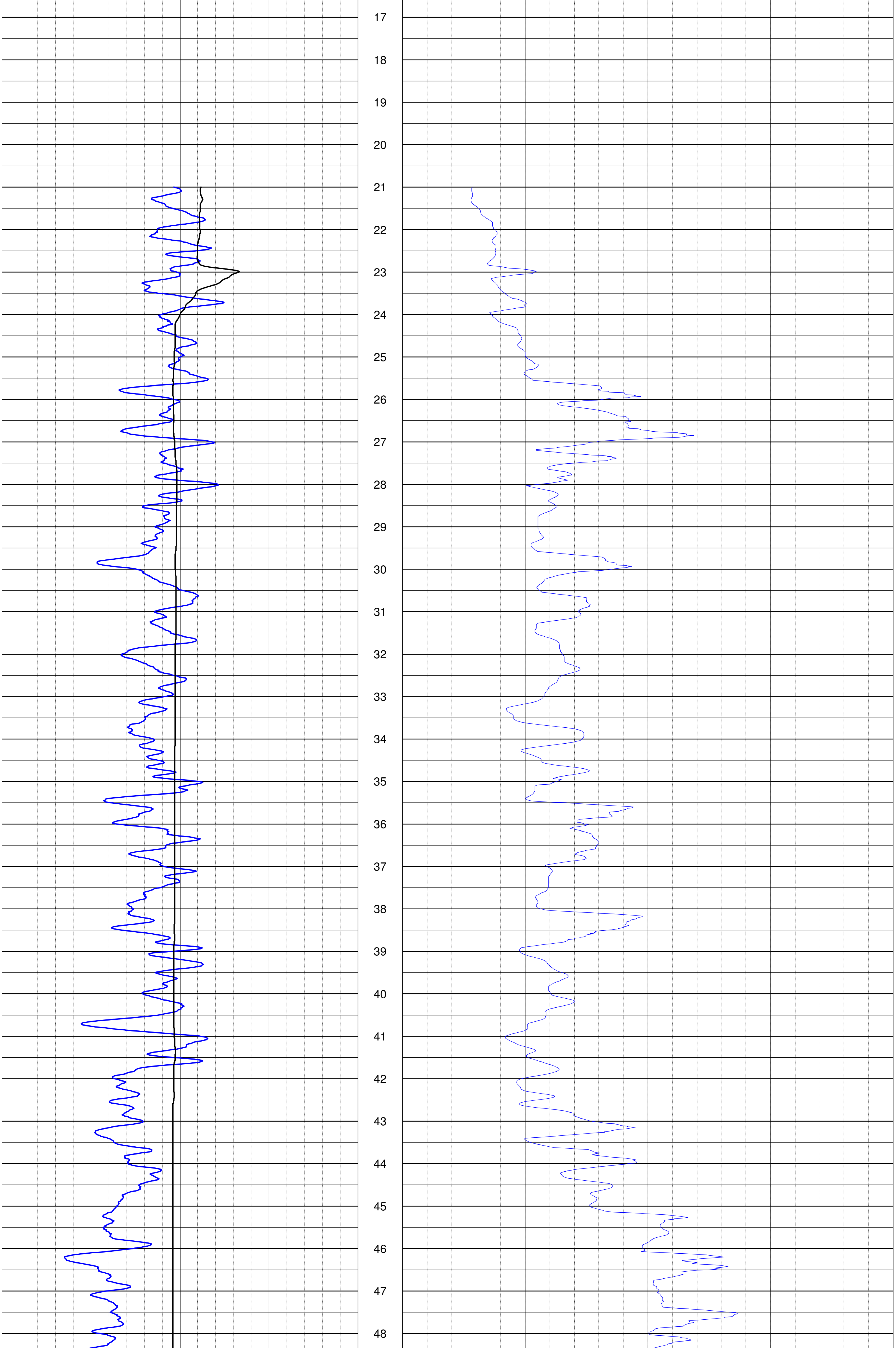
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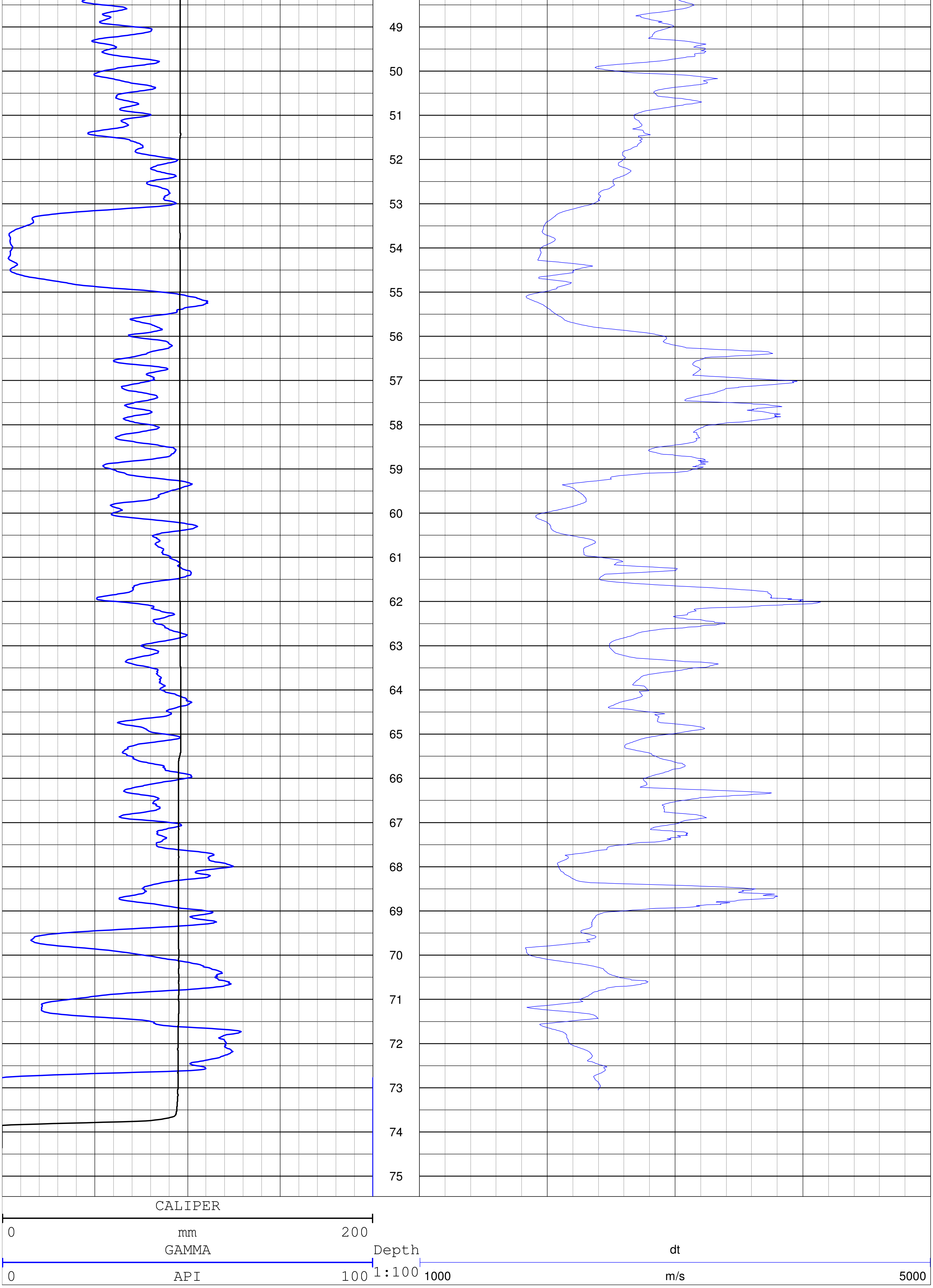
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STX097 Geology Report

Drill Hole STX097

Project: EPC1029 Hole: STX097

Base Depth	Thick.	Sample Number	Lithology
6.000	6.000		CLAY: light brownish brown, fine grained, sandy throughout, highly weathered, minor.
17.000	11.000		CLAY: light brownish orange, fine grained, sandy throughout, highly weathered.
19.700	2.700		CLAY: light greyish grey, fine grained, stony throughout, highly weathered.
20.300	0.600		CORE LOSS: highly weathered.
20.330	0.030		SILTSTONE: medium greyish grey, very weak rock, highly weathered, Start Run 1.
20.540	0.210		SANDSTONE, very fine grained: medium brownish brown, weak rock, highly weathered.
20.600	0.060		CARBONACEOUS SHALE: dark blackish black, coaly, very weak rock, highly weathered, End Run 1, Start Run 2.
23.690	3.090		SILTSTONE: medium greyish grey, stony, very weak rock, highly weathered, End Run 2, Start Run 3.
24.000	0.310		SANDSTONE, very fine grained: medium greyish grey, weak rock, fresh.
24.190	0.190		CARBONACEOUS MUDSTONE: dark greyish grey, very weak rock, fresh.
24.880	0.690		SANDSTONE, fine grained: medium greyish grey, stony throughout, moderately weak rock, fresh.
26.600	1.720		SANDSTONE, fine grained: medium greyish grey, stony bands throughout, moderately strong rock, fresh, End Run 3, Start Run 4.
27.070	0.470		SANDSTONE, very fine grained: medium greyish grey, stony bands throughout, moderately weak rock, fresh.

28.550	1.480		SANDSTONE, very fine grained: medium greyish grey, stony bands throughout, moderately weak rock, fresh.
29.600	1.050		CARBONACEOUS MUDSTONE: dark blackish black, sandy bands throughout, moderately weak rock, fresh, End Run 4, Start Run 5.
29.610	0.010		SILTSTONE: dark greyish grey, sandy, moderately weak rock, fresh.
30.230	0.620		SILTSTONE: dark greyish grey, stony lenses in part, moderately weak rock, fresh.

Base Depth	Thick.	Sample Number	Lithology
30.890	0.660		SILTSTONE: dark greyish grey, sandy in part, weak rock, fresh.
32.390	1.500		SANDSTONE, fine grained: medium greyish grey, stony in part, moderately strong rock, fresh.
32.600	0.210		SILTSTONE: medium greyish grey, pebbly sideritic bands, moderately weak rock, fresh, End Run 5, Start Run 6.
33.090	0.490		SILTSTONE: medium greyish grey, sandy interbedded with, moderately strong rock, fresh.
33.320	0.230		CARBONACEOUS SILTSTONE: dark blackish black, coaly, very weak rock, fresh.
33.580	0.260		SILTSTONE: medium greyish grey, coaly wisps in part, weak rock, fresh.
34.040	0.460		SANDSTONE, fine to medium grained: light greyish grey, moderately weak rock, fresh.
34.120	0.080		CARBONACEOUS MUDSTONE: dark brownish brown, coaly, very weak rock, fresh.
37.520	3.400		SANDSTONE, fine grained: medium greyish grey, stony coaly in part, moderately weak rock, fresh, End Run 6, Start Run 7.

38.090	0.570		SANDSTONE, fine grained: dark greyish grey, coaly lenses throughout, moderately weak rock, fresh.
39.910	1.820		SILTSTONE: medium greyish grey, sandy throughout, weak rock, fresh, with joints, minor calcite on slickensides, End Run 7, Start Run 8.
40.630	0.720		SANDSTONE, very fine grained: medium greyish grey, stony, moderately strong rock, fresh.
40.720	0.090		CARBONACEOUS SILTSTONE: dark greyish grey, coaly lenses, weak rock, fresh.
40.920	0.200		COAL, dull <1% bright: dark blackish black, pyritic, very weak rock, fresh.
41.100	0.180		CARBONACEOUS MUDSTONE: dark blackish black, stony lenses, very weak rock, fresh.
41.600	0.500		SILTSTONE: medium greyish grey, moderately weak rock, fresh, with joints, minor on slickensides, End Run 8, Start Run 9.
41.860	0.260		SILTSTONE: medium greyish grey, sandy, moderately weak rock, fresh.

Drill Hole STX097

Project: EPC1029 Hole: STX097

Base Depth	Thick.	Sample Number	Lithology
41.980	0.120		CARBONACEOUS MUDSTONE: dark blackish black, coaly, very weak rock, fresh.
42.100	0.120		COAL, <10% bright: dark blackish black, very weak rock, fresh.
42.150	0.050		CARBONACEOUS MUDSTONE: dark brownish brown, very weak rock, fresh.
42.270	0.120		SANDSTONE, fine to medium grained: light brownish brown, coaly lenses, very weak rock, fresh.
43.170	0.900		SILTSTONE: medium greyish grey, carbonaceous wisps throughout, very weak rock, fresh.

Base Depth	Thick.	Sample Number	Lithology
43.440	0.270		COAL, dull tending to stony: dark blackish black, weak rock, fresh.
44.600	1.160		SANDSTONE, fine grained: medium greyish grey, stony throughout, weak rock, fresh, calcite vein, End Run 9, Start Run 10.
44.700	0.100		SILTSTONE: medium greyish grey, moderately strong rock, fresh.
47.600	2.900		SANDSTONE, fine grained: medium greyish grey, moderately strong rock, fresh, with joints, calcite on slickensides, End Run 10, Start Run 11.
50.600	3.000		SANDSTONE, fine to medium grained: light greyish grey, carbonaceous wisps throughout, moderately strong rock, fresh, calcite vein, End Run 11, Start Run 12.
51.500	0.900		SANDSTONE, fine grained: light greyish grey, carbonaceous wisps throughout, moderately strong rock, fresh.
53.120	1.620		SILTSTONE: medium greyish grey, moderately weak rock, fresh.
53.260	0.140	64996	SILTSTONE: medium greyish grey, sandy bands throughout, moderately weak rock, fresh, Roof Sample.
53.600	0.340	64997	COAL, <10% bright: dark blackish black, very weak rock, fresh, End Run 12, Start Run 13.
53.890	0.290	64997	COAL, dull <1% bright: dark blackish black, very weak rock, fresh.
54.400	0.510	64998	COAL, dull <1% bright: dark blackish black, very weak rock, fresh.
54.900	0.500	64999	COAL, <10% bright: dark blackish black, very weak rock, fresh.

55.160	0.260	65000	CARBONACEOUS SILTSTONE: dark blackish black, very weak rock, fresh, Floor Sample.
55.300	0.140		SILTSTONE: medium greyish grey, very weak rock, fresh.
55.700	0.400		SANDSTONE, very fine grained: medium greyish grey, weak rock, fresh.
56.600	0.900		SANDSTONE, fine to medium grained: medium greyish grey, moderately strong rock, fresh, End Run 13, Start Run 14.
59.200	2.600		SANDSTONE, fine to medium grained: light greyish grey, carbonaceous wisps in part, moderately strong rock, fresh.
59.360	0.160		CARBONACEOUS MUDSTONE: dark blackish black, very weak rock, fresh.
59.600	0.240		SILTSTONE: medium greyish grey, very weak rock, fresh, End Run 14, Start Run 15.
59.810	0.210		SILTSTONE: medium greyish grey, weak rock, fresh.
60.010	0.200		COAL, 10-40% bright: dark blackish black, very weak rock, fresh.
61.040	1.030		CARBONACEOUS SILTSTONE: medium greyish grey, coaly bands in part, very weak rock, fresh, disseminated throughout.
62.600	1.560		SILTSTONE: medium greyish grey, calcareous wisps near middle of unit, moderately weak rock, fresh, End Run 15, Start Run 16.
63.180	0.580		SILTSTONE: medium greyish grey, sandy lenses throughout, moderately weak rock, fresh.
65.600	2.420		SANDSTONE, very fine grained: medium greyish grey, stony lenses throughout, moderately weak rock, fresh, siderite bands, End Run 16, Start Run 17.
67.490	1.890		SANDSTONE, very fine grained: medium greyish grey, stony bands throughout, moderately weak rock, fresh.
67.620	0.130		COAL, 10-40% bright: dark blackish black, very weak

rock, fresh.

68.400	0.780		CARBONACEOUS SILTSTONE: dark greyish grey, coaly lenses near top of unit, very weak rock, fresh.
68.600	0.200		SANDSTONE, fine grained: medium greyish grey, moderately weak rock, fresh, End Run 17, Start Run 18.

Drill Hole STX097

Project: EPC1029 Hole: STX097

Base Depth	Thick.	Sample Number	Lithology
68.830	0.230		SANDSTONE, fine grained: light greyish grey, stony lenses near base of unit, moderately weak rock, fresh.
68.910	0.080		SIDERITE: light brownish brown, moderately weak rock, fresh.
69.530	0.620		SILTSTONE: dark greyish grey, sandy lenses, weak rock, fresh.
69.620	0.090		COAL, <10% bright: dark blackish black, very weak rock, fresh.
69.700	0.080		SANDSTONE, fine to medium grained: dark greyish grey, weak rock, fresh.
70.040	0.340		COAL, 40-60% bright: dark blackish black, weak rock, fresh.
70.680	0.640		CARBONACEOUS SILTSTONE: dark brownish brown, coaly lenses, weak rock, fresh, Roof Sample.
71.040	0.360	65251	SILTSTONE: medium greyish grey, sandy lenses near base of unit, moderately weak rock, fresh.
71.330	0.290	65252	COAL, 10-40% bright: dark blackish black, very weak rock, fresh.
71.380	0.050	65252	CARBONACEOUS MUDSTONE: dark brownish brown, calcareous wisps in part, very weak rock, fresh.
71.600	0.220	65252	COAL, 10-40% bright: dark blackish black, calcareous wisps in part, very weak rock, fresh, End Run 18,

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                          Start Run 19.

71.840   0.240 65253    SILTSTONE: dark blackish black, moderately weak rock,
                          fresh, with joints, on slickensides, Floor Sample.

72.490   0.650          SILTSTONE: dark greyish grey, coaly lenses near top
                          of unit, moderately weak rock, fresh, with joints,
                          on slickensides.

74.600   2.110          SILTSTONE: dark greyish grey, sandy laminae
                          throughout, weak rock, fresh, with disturbed
                          bedding, with joints, on slickensides, SDBNTO. END
                          OF HOLE.

              ────────── Total Depth: 74.600 metres ──────────
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WELL NAME	**LOG NAME**	**SCALE**
STX099	**SONIC**	**1:100**

COMPANY NAME **WARATAH**

FIELD NAME	**PROVINCE**
MARLBOROUGH	**QLD**

Geolog Pty. Ltd.
ABN 34 132 282 190

Shed 6, 105 Old Maryborough Road
PO Box 609
Pialba Qld. 4655

Phone 0413 463 130
Fax (07) 4191 4200

WELL DETAIL			*CASING DETAIL*			*OTHER DETAIL*	
DepthDriller	121.5	(m)	**Casing1Size**	130	(mm)	**Engineer**	TOM HUTCHINSON
DepthLogger	120.6	(m)	**Casing1Weight**	PVC		**Witness**	ROWAN
DATE	10 Dec 11		**Casing1To**	30	(m)	**LOCATION**	MARLBOROUGH
BitSize1	180	(mm)	**Casing 2 Size**		(mm)	**State**	QLD
Bit1From	0	(m)	**Casing 2 Weight**			**Country**	AUSTRALIA
Bit1To	30	(m)	**Casing 2 To**		(m)	**Sonde Abbreviation**	
BitSize2	99	(mm)				**Other Services1**	
Bit2From	30	(m)				**Other Services2**	
Bit2To	TD	(m)	**NORTHING**			**Other Services3**	
FluidDepth	14	(m)	**EASTING**			**Other Services4**	

Comment

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SERVICE COMPANY NAME	
UNIQUE WELL IDENTIFIER	N/A
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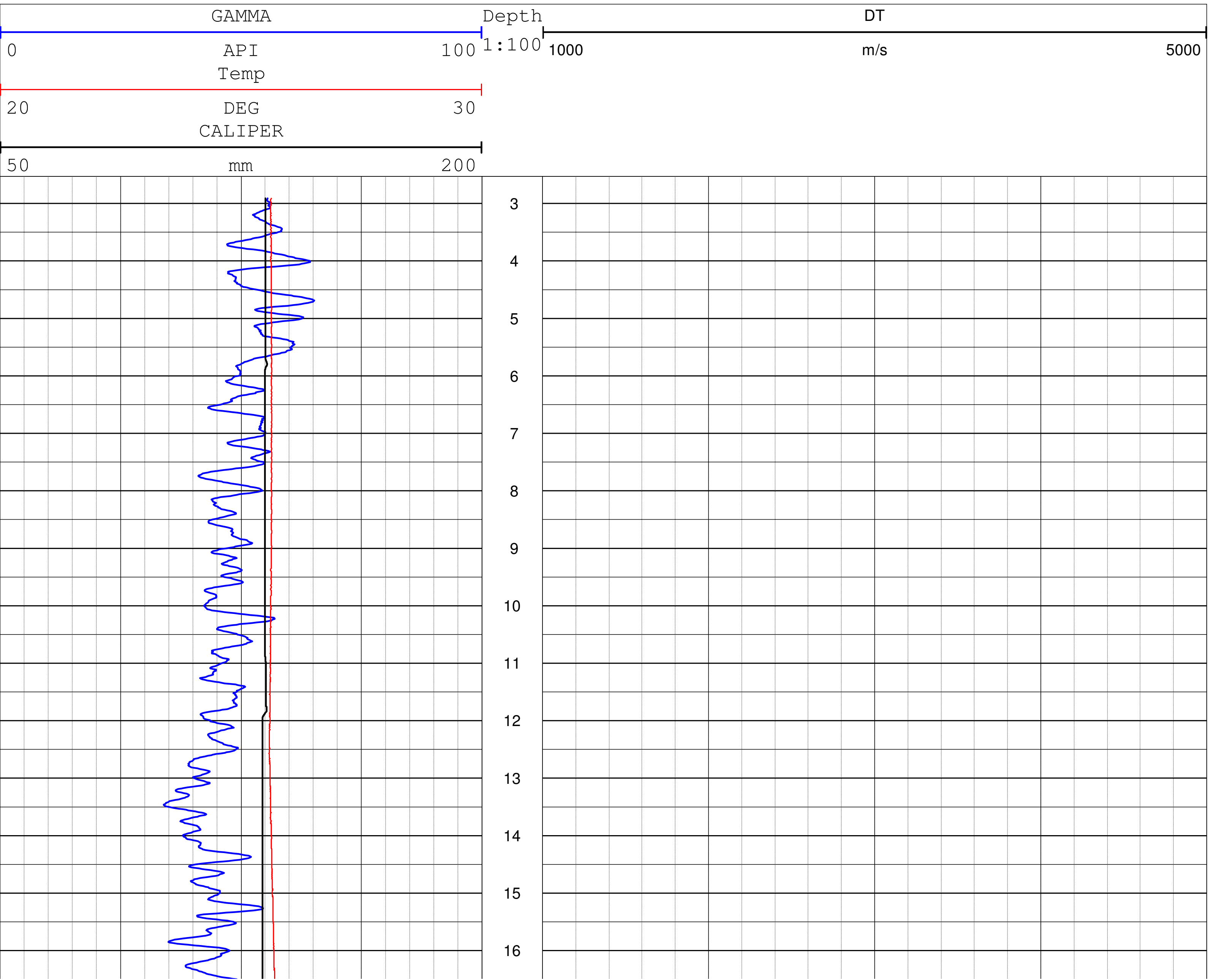

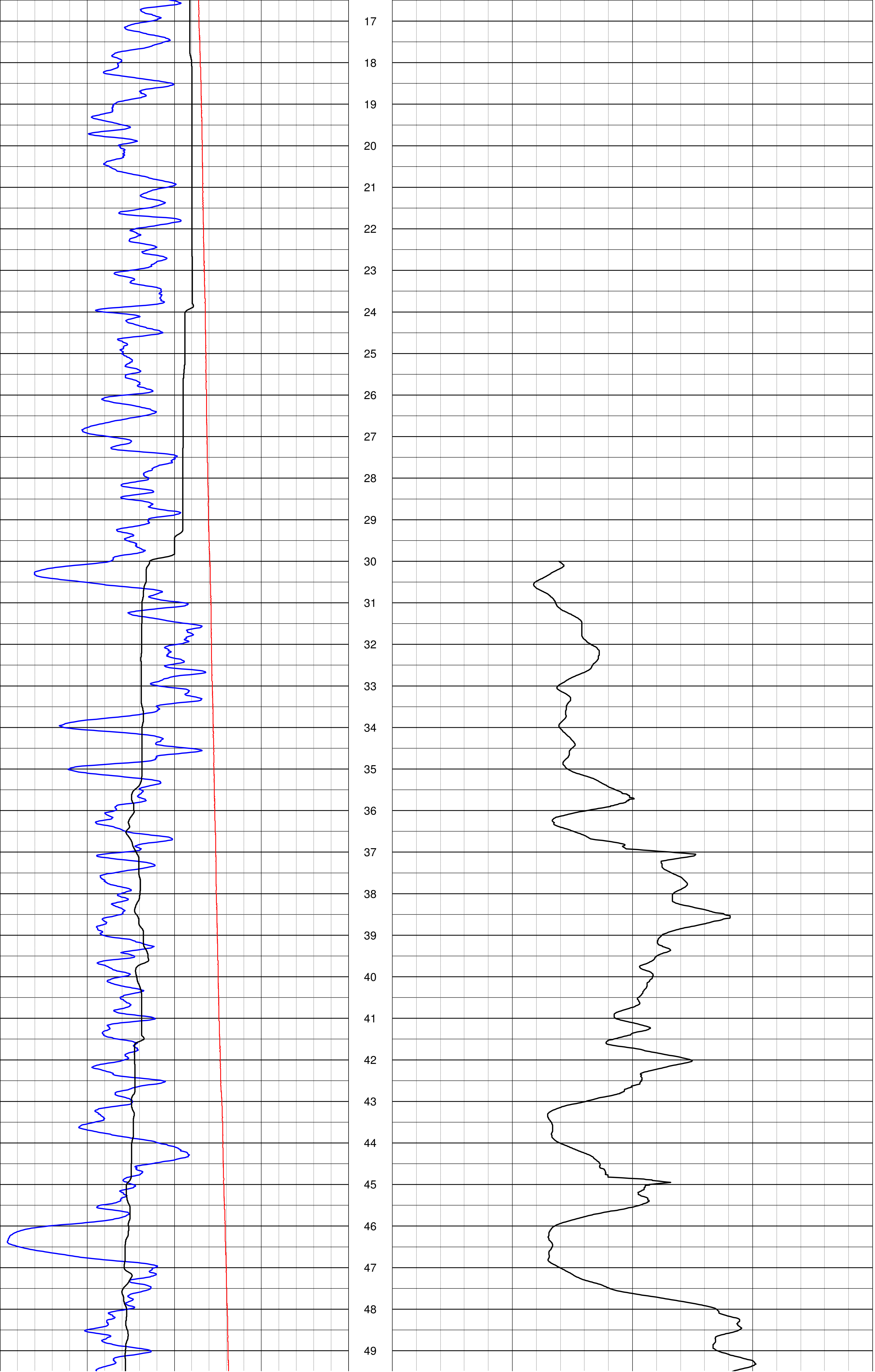
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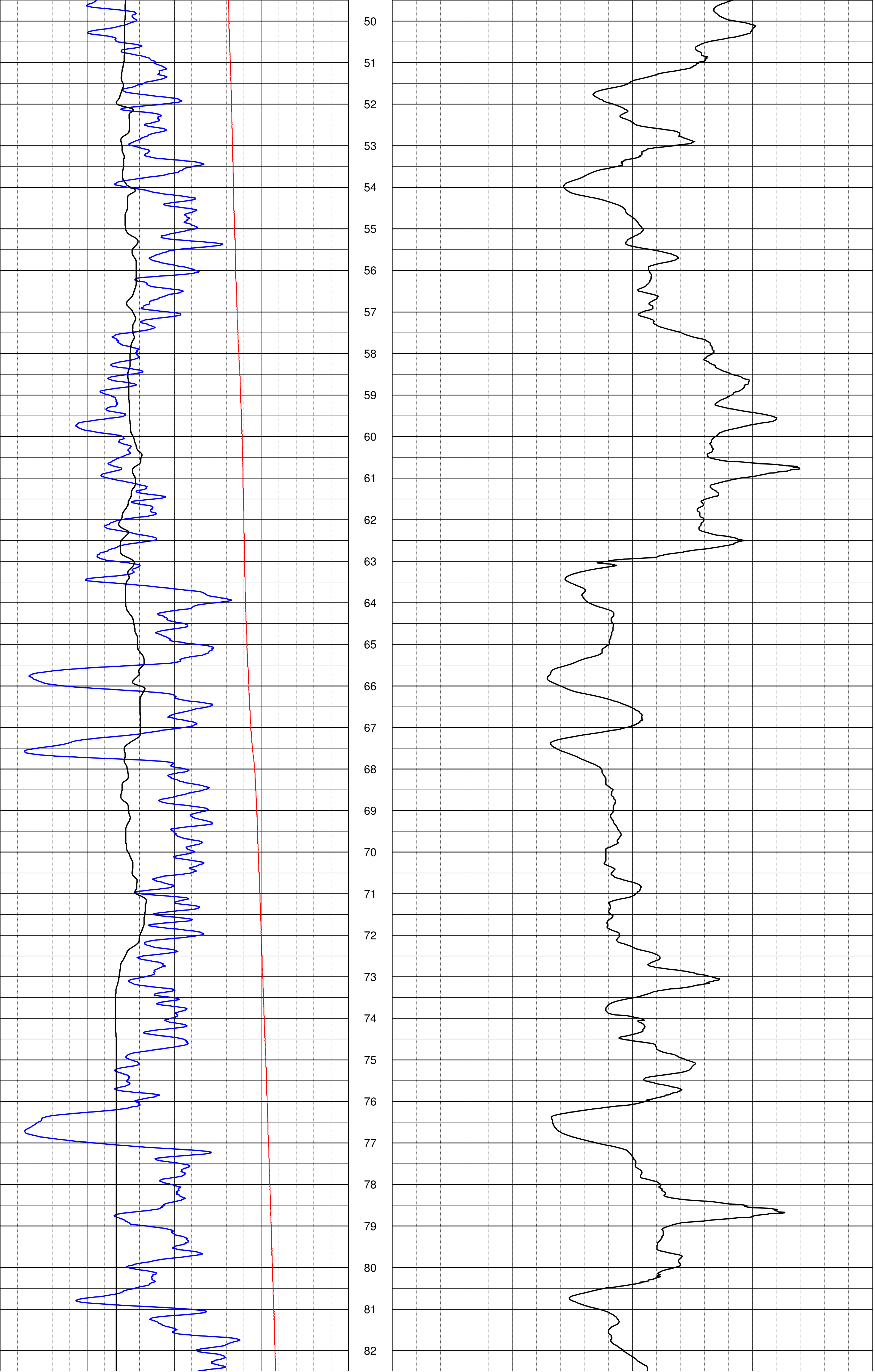
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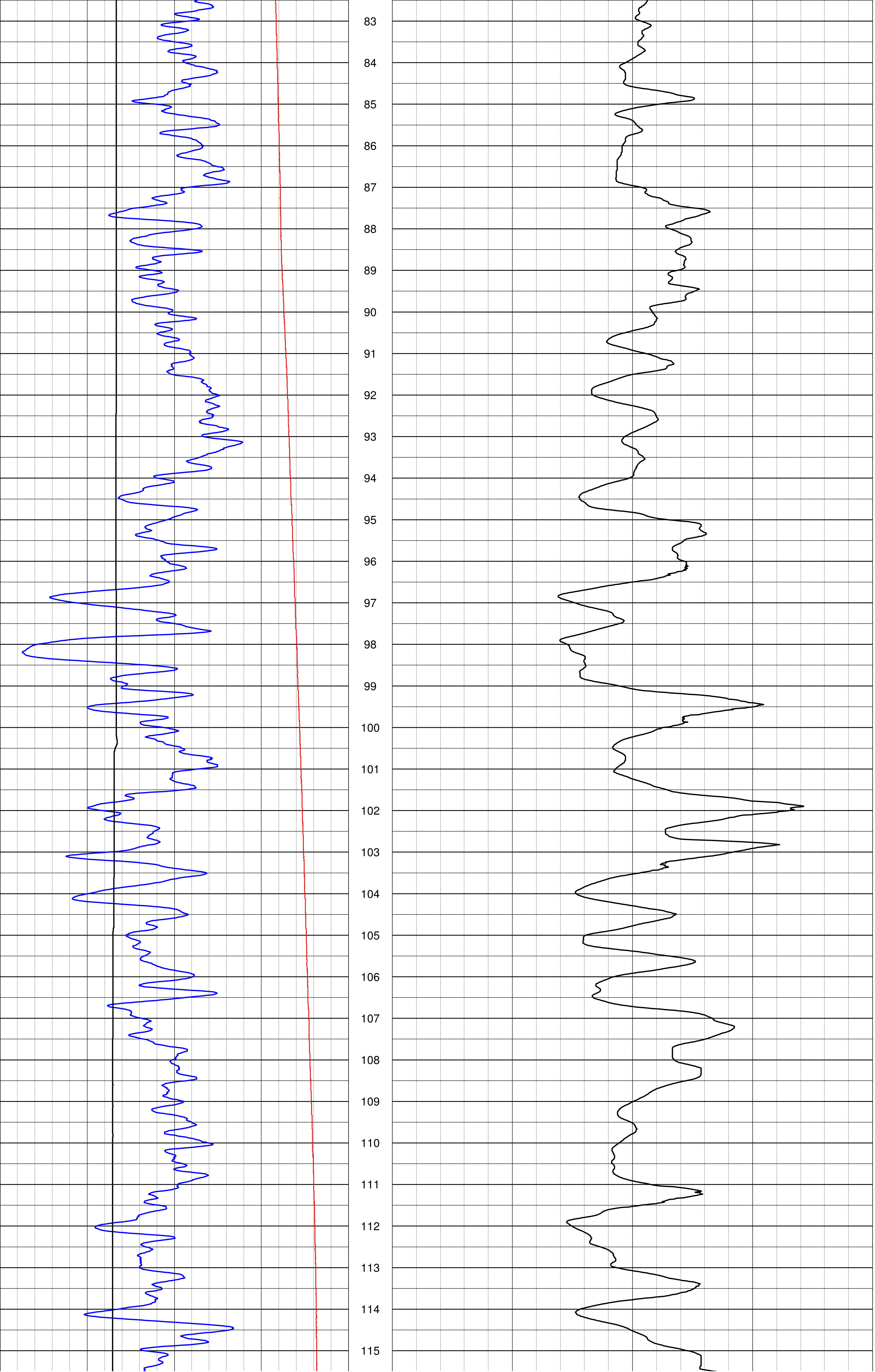
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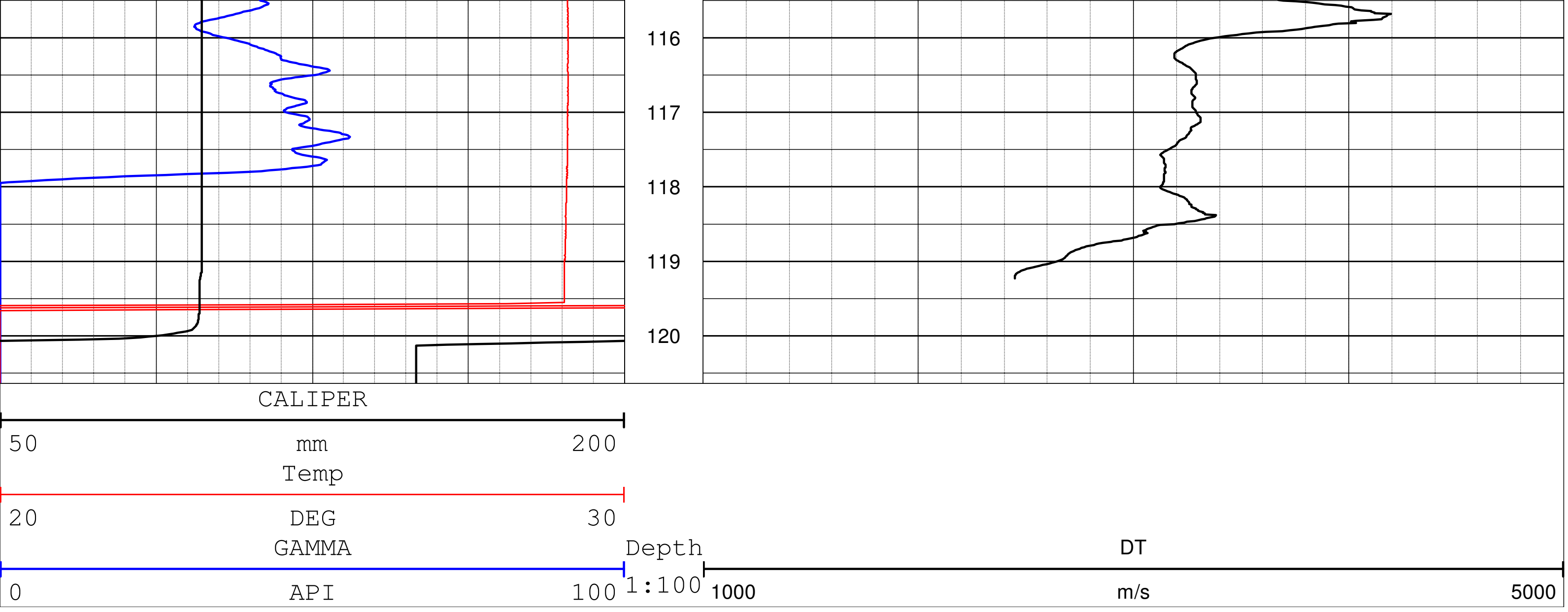
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STX099 Geology Report
Drill Hole STX099

Project: EPC1029 Hole: STX099

Base Depth	Thick.	Sample Number	Lithology
2.000	2.000		SOIL: dark brown.
6.000	4.000		CLAY: dark greyish brown.
15.000	9.000		CLAY: medium brownish grey.
17.000	2.000		SAND: light orangy brown.
20.000	3.000		CLAY: dark grey.
20.750	0.750		SILTSTONE: medium grey, muddy, broken core, weak rock, slightly weathered, SOR.
22.320	1.570		SILTSTONE: medium brownish grey, sandy, broken core, very weak rock, highly weathered.
22.910	0.590		MUDSTONE: medium grey, very broken core, very weak rock, highly weathered.
23.110	0.200		SILTSTONE: medium grey, broken core, weak rock, moderately weathered.
23.600	0.490		SANDSTONE, very fine grained: light grey, layers stony, broken core, weak rock, slightly weathered, very thinly bedded 10-30mm, EOR/SOR.
24.880	1.280		SANDSTONE, very fine grained: light grey, layers stony, broken core, weak rock, slightly weathered.
25.050	0.170		CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, very weak rock, moderately weathered.
25.140	0.090		CARBONACEOUS MUDSTONE: dark blackish grey, broken core, very weak rock, moderately weathered.
26.310	1.170		SILTSTONE: medium grey, layers sandstone, broken core, weak rock, slightly weathered.
26.540	0.230		MUDSTONE: dark grey, sandy, broken core, very weak rock, slightly weathered.

26.600	0.060		SANDSTONE, fine grained: light grey, broken core, weak rock, slightly weathered, EOR/SOR.
28.850	2.250		SANDSTONE, fine grained: light grey, bands laminae mudstone, broken core, weak rock, fresh, laminated <10mm, with laminae, with veins, calcite.
29.370	0.520		SANDSTONE, very fine grained: light grey, laminae mudstone, broken core, weak rock, fresh, laminated <10mm, with laminae, with veins, calcite, EOR/SOR.
30.470	1.100		SANDSTONE, very fine grained: medium grey, laminae mudstone siltstone, broken core, weak rock, fresh.

Drill Hole STX099

Project: EPC1029 Hole: STX099

Base Depth	Thick.	Sample Number	Lithology
30.580	0.110	65321	SANDSTONE, very fine grained: medium grey, laminae mudstone siltstone, broken core, weak rock, fresh.
30.670	0.090	65322	COAL, <10% bright: fresh.
30.820	0.150	65322	COAL, 10-40% bright: fresh.
30.870	0.050	65322	COAL, 40-60% bright: fresh.
30.960	0.090	65322	COAL, 10-40% bright: fresh.
31.030	0.070	65322	COAL, <10% bright: fresh.
31.080	0.050	65322	COAL, 10-40% bright: fresh.
31.180	0.100	65323	CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
31.600	0.420		CARBONACEOUS MUDSTONE: dark grey, broken core, weak rock, fresh.
32.020	0.420		CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
32.190	0.170		SILTSTONE: medium brownish grey, sandy lenses coal, broken core, weak rock, fresh, EOR/SOR.

32.650	0.460		SILTSTONE: medium brownish grey, broken core, weak rock, fresh.
33.030	0.380		CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
34.240	1.210		MUDSTONE: dark blackish grey, broken core, weak rock, fresh.
34.300	0.060	65324	COAL, dull <1% bright: fresh.
34.370	0.070	65324	COAL, <10% bright: fresh.
34.420	0.050	65324	COAL, 10-40% bright: fresh.
34.460	0.040	65324	COAL, <10% bright: very broken core, fresh.
34.540	0.080		SILTSTONE: medium brownish grey, broken core, weak rock, fresh.
35.360	0.820		CORE LOSS: fresh, EOR/SOR.
35.550	0.190	65325	COAL, <10% bright: very broken core, fresh.
36.360	0.810		SANDSTONE, very fine grained: light grey, layers siltstone, broken core, weak rock, fresh.
37.850	1.490		MUDSTONE: dark blackish grey, bands siltstone, broken core, weak rock, fresh.

Drill Hole STX099

Project: EPC1029 Hole: STX099

Base Depth	Thick.	Sample Number	Lithology
38.230	0.380		SILTSTONE: medium brownish grey, broken core, weak rock, fresh.
39.400	1.170		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
39.420	0.020		CORE LOSS: fresh, EOR/SOR.
40.650	1.230		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
40.900	0.250		SANDSTONE, fine grained: light grey, nodules

Base Depth	Thick.	Sample Number	Lithology
			sideritic, broken core, weak rock, fresh.
41.450	0.550		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
41.600	0.150		SANDSTONE, fine grained: light grey, nodules sideritic, broken core, weak rock, fresh.
42.100	0.500		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
42.400	0.300		SANDSTONE, fine grained: light grey, laminae mudstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
42.420	0.020		CORE LOSS: fresh, EOR/SOR.
43.200	0.780		SANDSTONE, fine grained: light grey, layers siltstone, broken core, weak rock, fresh.
43.630	0.430		MUDSTONE: dark brownish grey, laminae siltstone, broken core, weak rock, fresh.
43.700	0.070	65326	COAL, <10% bright: fresh.
43.820	0.120	65326	COAL, 10-40% bright: fresh.
44.170	0.350		CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh, EOR/SOR.
46.140	1.970		MUDSTONE: dark brownish grey, layers siltstone, broken core, weak rock, fresh.
46.290	0.150	65327	MUDSTONE: dark brownish grey, broken core, weak rock, fresh.
46.400	0.110	65328	COAL, dull <1% bright: fresh.
46.530	0.130	65328	COAL, 10-40% bright: fresh.
46.600	0.070	65328	COAL, 40-60% bright: fresh.
46.670	0.070	65328	COAL, 10-40% bright: fresh.

46.790	0.120	65328	COAL, <10% bright: fresh.
46.990	0.200	65328	COAL, 10-40% bright: fresh.
47.060	0.070	65328	COAL, <10% bright: fresh.
47.170	0.110	65328	COAL, 10-40% bright: fresh.
47.290	0.120	65328	CORE LOSS: fresh, EOR/SOR.
47.630	0.340	65329	CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
48.000	0.370		SILTSTONE: medium brownish grey, broken core, weak rock, fresh.
51.420	3.420		SANDSTONE, fine grained: light grey, mudstone, broken core, weak rock, fresh, EOR/SOR.
52.820	1.400		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
52.990	0.170		SANDSTONE, fine grained: light grey, laminae mudstone, broken core, weak rock, fresh.
53.050	0.060		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
53.290	0.240		SILTSTONE: medium brownish grey, very broken core, very weak rock, fresh.
57.420	4.130		MUDSTONE: dark grey, lenses coal, broken core, weak rock, fresh, EOR/SOR.
58.850	1.430		SILTSTONE: medium grey, layers mudstone sandstone, broken core, weak rock, fresh.
60.420	1.570		SANDSTONE, fine to medium grained: light grey, layers mudstone, broken core, weak rock, fresh, EOR/SOR.
62.370	1.950		SANDSTONE, fine to medium grained: light grey, broken core, weak rock, fresh, with veins, calcite, EOR/SOR.
63.520	1.150		SANDSTONE, fine to medium grained: light grey, broken core, weak rock, fresh.

63.900	0.380		SILTSTONE: medium brownish grey, laminae mudstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
64.030	0.130	65330	COAL, 10-40% bright: fresh.
64.070	0.040	65330	COAL, dull <1% bright: fresh.

Drill Hole STX099

Project: EPC1029 Hole: STX099

Base Depth	Thick.	Sample Number	Lithology
65.370	1.300		MUDSTONE: dark grey, laminae siltstone, broken core, weak rock, fresh, laminated <10mm, with laminae, EOR/SOR.
65.770	0.400		MUDSTONE: dark grey, laminae siltstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
65.940	0.170	65331	MUDSTONE: dark grey, laminae siltstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
65.960	0.020	65332	COAL, 10-40% bright: fresh.
65.990	0.030	65332	COAL, dull tending to stony: fresh.
66.090	0.100	65332	COAL, <10% bright: fresh.
66.150	0.060	65332	COAL, 10-40% bright: fresh.
66.230	0.080	65332	COAL, undifferentiated: dark black, shaly, fresh.
66.410	0.180	65332	COAL, 10-40% bright: fresh.
66.520	0.110	65332	COAL, undifferentiated: dark black, shaly, fresh.
66.770	0.250	65333	MUDSTONE: dark brownish grey, broken core, weak rock, fresh.
66.930	0.160		MUDSTONE: dark brownish grey, broken core, weak rock, fresh.
67.670	0.740		SANDSTONE, very fine grained: medium grey, laminae siltstone, broken core, weak rock, fresh.

67.810	0.140	65334	SANDSTONE, very fine grained: medium grey, broken core, weak rock, fresh.
67.900	0.090	65335	COAL, 10-40% bright: fresh.
68.030	0.130	65335	COAL, 40-60% bright: fresh.
68.180	0.150	65335	COAL, 10-40% bright: fresh.
68.270	0.090	65335	COAL, <10% bright: fresh.
68.370	0.100	65336	MUDSTONE: dark grey, broken core, weak rock, fresh, EOR/SOR.
71.370	3.000		MUDSTONE: dark grey, laminae siltstone sandstone, broken core, weak rock, fresh, laminated <10mm, with laminae, EOR/SOR.
73.030	1.660		MUDSTONE: dark grey, laminae siltstone sandstone, broken core, weak rock, fresh, laminated <10mm, with laminae.

Drill Hole STX099

Project: EPC1029 Hole: STX099

Base Depth	Thick.	Sample Number	Lithology
74.110	1.080		SANDSTONE, fine grained: medium grey, laminae mudstone, broken core, weak rock, fresh.
74.370	0.260		MUDSTONE: dark brownish grey, broken core, weak rock, fresh.

——— Total Depth: 74.370 metres ———

WELL NAME	LOG NAME	SCALE
STX104	**SONIC**	**1:100**

COMPANY NAME	**WARATAH COAL**
FIELD NAME	PROVINCE
MARLBOROUGH	QUEENSLAND

Geolog Pty. Ltd.
ABN 34 132 282 190

Shed 6, 105 Old Maryborough Road
PO Box 609
Pialba Qld. 4655

Phone 0413 463 130
Fax (07) 4191 4200

WELL DETAIL			CASING DETAIL			OTHER DETAIL	
DepthDriller	77.64	(m)	Casing1Size	108	(mm)	Engineer	RYAN HUNT
DepthLogger	77.50	(m)	Casing1Weight	PVC		Witness	LEO
DATE	16 Jun 11		Casing1To	22	(m)	LOCATION	MARLBOROUGH
BitSize1	108	(mm)	Casing 2 Size		(mm)	State	QLD
Bit1From	GL	(m)	Casing 2 Weight			Country	AUSTRALIA
Bit1To	22	(m)	Casing 2 To		(m)	Sonde Abbreviation	
BitSize2		(mm)				Other Services1	
Bit2From		(m)				Other Services2	
Bit2To	TD	(m)	NORTHING			Other Services3	
FluidDepth	6	(m)	EASTING			Other Services4	

Comment

SERVICE COMPANY NAME N/A

UNIQUE WELL IDENTIFIER N/A

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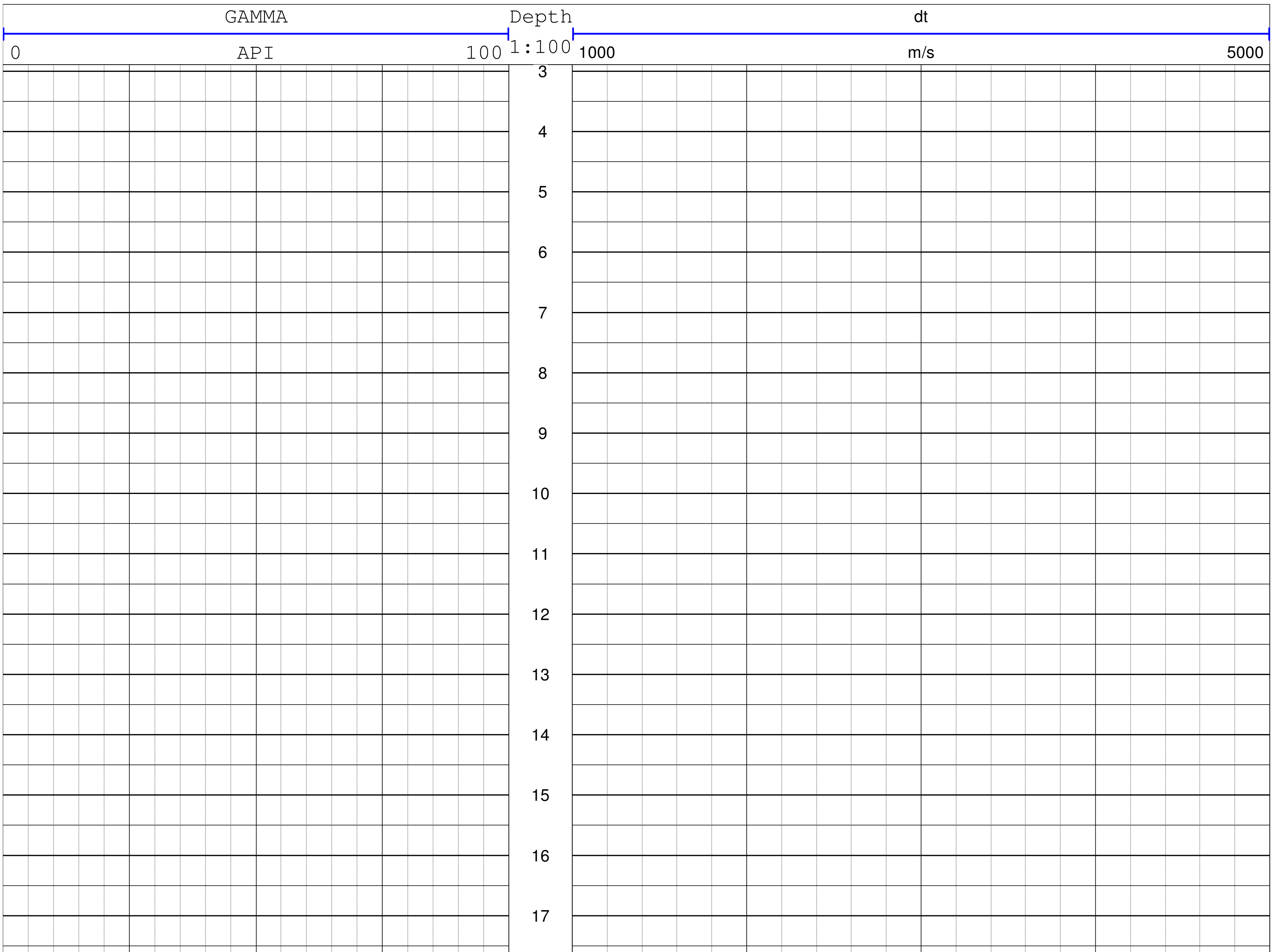

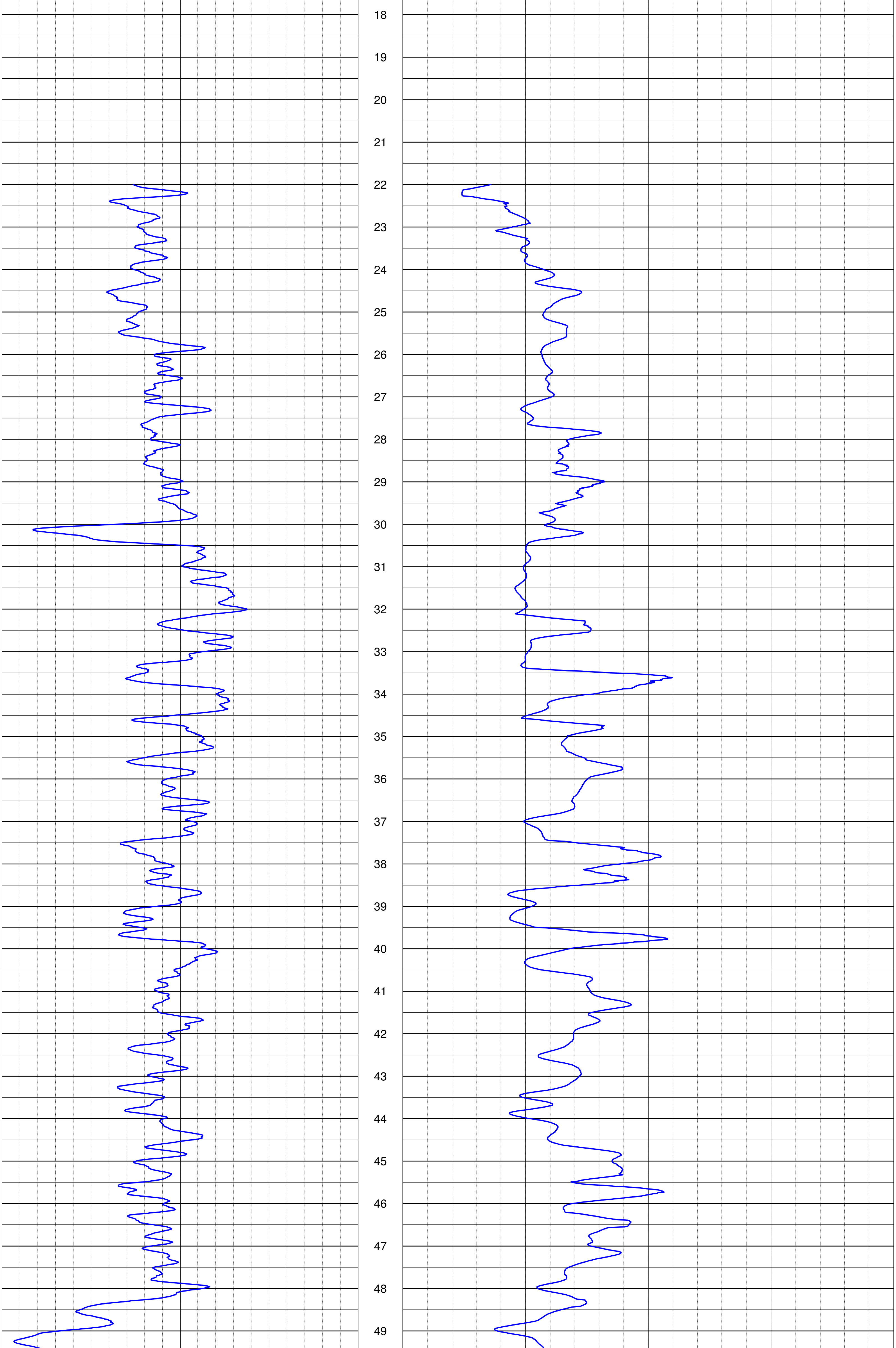
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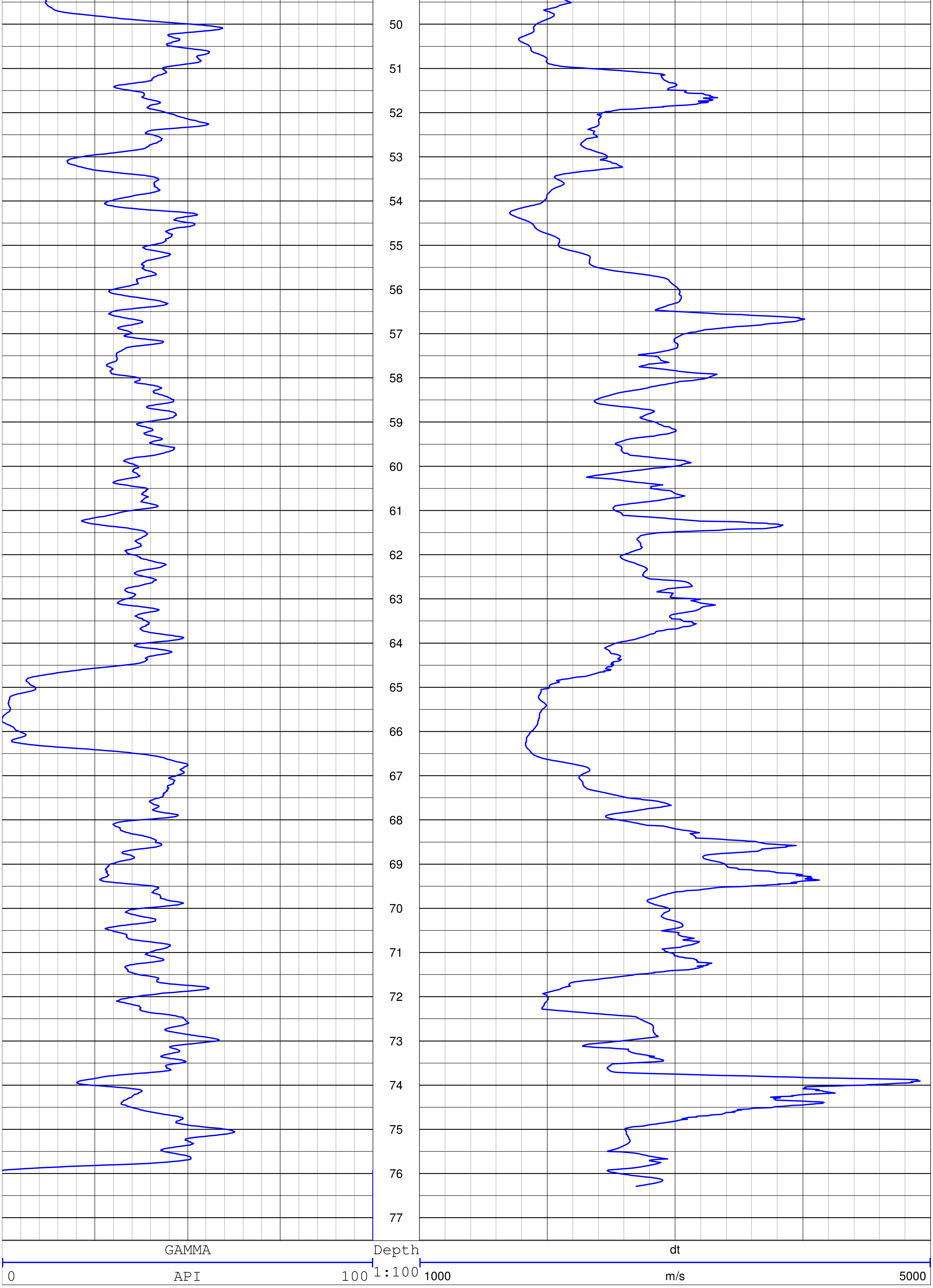
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1:100
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m/s
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STX104C Geology Report
Drill Hole STX104C

Project: EPC1029 Hole: STX104C

Base Depth	Thick.	Sample Number	Lithology
23.220	23.220		SANDSTONE, fine to medium grained: medium greyish grey, calcareous in part, weak rock, fresh.
23.369	0.149		CORE LOSS: fresh, End Run 1, Start Run 2.
23.849	0.480		SANDSTONE, fine grained: light greyish grey, moderately weak rock, fresh.
24.059	0.210		SANDSTONE, fine to medium grained: light greyish grey, moderately weak rock, fresh.
24.369	0.310		SANDSTONE, fine grained: light greyish grey, stony bands in part, weak rock, fresh.
24.859	0.490		SANDSTONE, fine to medium grained: light greyish grey, carbonaceous wisps in part, moderately weak rock, fresh.
25.779	0.920		SANDSTONE, fine to medium grained: light greyish grey, stony sideritic bands, moderately weak rock, fresh.
25.827	0.048		SANDSTONE, fine grained: light greyish grey, stony throughout, moderately weak rock, fresh, CSLNIP.
25.956	0.129		CORE LOSS: fresh, End Run 2, Start Run 3.
27.406	1.450		SANDSTONE, very fine grained: medium greyish grey, sideritic stony bands, moderately weak rock, fresh.
29.148	1.742		SANDSTONE, fine grained: medium greyish grey, carbonaceous stony bands, moderately weak rock, fresh, End Run 3, Start Run 4.
30.039	0.891		SILTSTONE: medium greyish grey, coaly lenses, very weak rock, fresh.
30.169	0.130	17651 RF	CARBONACEOUS SILTSTONE: medium greyish grey, coaly bands, moderately weak rock, fresh.
30.429	0.260	17652	COAL, 10-40% bright: dark blackish black, very weak

Base Depth	Thick.	Sample Number	Lithology
			rock, fresh.
31.359	0.930		SILTSTONE: medium greyish grey, carbonaceous wisps, weak rock, fresh.
31.399	0.040		SILTSTONE: medium greyish grey, carbonaceous, weak rock, fresh.
32.309	0.910		CARBONACEOUS SILTSTONE: dark greyish grey, sandy wisps in part, very weak rock, fresh.
32.419	0.110		SANDSTONE, fine grained: light greyish grey, carbonaceous throughout, very weak rock, fresh, CAIP. End Run 4, Start Run 5.
33.249	0.830		CARBONACEOUS SILTSTONE: dark greyish grey, very weak rock, fresh.
33.669	0.420		SANDSTONE, fine grained: medium greyish grey, calcareous bands, moderately weak rock, fresh, strata dipping at 30°.
33.929	0.260		SANDSTONE, fine grained: medium greyish grey, moderately weak rock, fresh, strata dipping at 20°, with slumping, moderately spaced.
34.529	0.600		CARBONACEOUS SILTSTONE: dark greyish grey, very weak rock, fresh.
34.629	0.100		CARBONACEOUS SILTSTONE: medium greyish grey, calcareous bands, moderately weak rock, fresh.
35.319	0.690		SILTSTONE: dark greyish grey, very weak rock, fresh.
35.369	0.050		SANDSTONE, fine to medium grained: medium greyish grey, stony laminae, moderately weak rock, fresh, End Run 5, Start Run 6.
35.589	0.220		SILTSTONE: medium greyish grey, sideritic, very weak rock, fresh.
36.649	1.060		SILTSTONE: medium greyish grey, carbonaceous in part,

			very weak rock, fresh.
36.829	0.180		CARBONACEOUS SILTSTONE: medium greyish grey, carbonaceous bands throughout, moderately weak rock, fresh.
37.519	0.690		SILTSTONE: medium greyish grey, sandy in part, weak rock, fresh.
38.049	0.530		SANDSTONE, fine to medium grained: medium greyish grey, moderately weak rock, fresh, with disturbed bedding.
38.349	0.300		SILTSTONE: medium greyish grey, very weak rock, fresh.
38.369	0.020		CARBONACEOUS SILTSTONE: dark greyish grey, very weak rock, fresh, End Run 6, Start Run 7.
38.919	0.550		CARBONACEOUS SILTSTONE: dark greyish grey, very weak rock, fresh.
38.989	0.070		CARBONACEOUS MUDSTONE: dark blackish black, coaly bands, very weak rock, fresh.
39.189	0.200		SANDSTONE, fine grained: medium greyish grey, carbonaceous throughout, moderately weak rock, fresh.

Base Depth	Thick.	Sample Number	Lithology
39.819	0.630		SANDSTONE, fine grained: medium greyish grey, sideritic in part, moderately weak rock, fresh.
40.309	0.490		CARBONACEOUS MUDSTONE: dark greyish grey, very weak rock, fresh.
41.369	1.060		SANDSTONE, fine grained: medium greyish grey, carbonaceous bands, moderately weak rock, fresh, End Run 7, Start Run 8.
41.449	0.080		CORE LOSS: fresh.
42.179	0.730		SILTSTONE: medium greyish grey, moderately weak rock,

			fresh.
42.339	0.160		SILTSTONE: dark greyish grey, carbonaceous throughout, moderately weak rock, fresh.
43.149	0.810		SILTSTONE: medium greyish grey, moderately weak rock, fresh.
43.219	0.070		COAL, <10% bright: dark blackish black, very weak rock, fresh.
43.359	0.140		CARBONACEOUS MUDSTONE: dark blackish black, very weak rock, fresh.
43.659	0.300		SILTSTONE: medium greyish grey, moderately weak rock, fresh.
43.739	0.080		CARBONACEOUS MUDSTONE: dark blackish black, very weak rock, fresh.
43.769	0.030		COAL, <10% bright: dark blackish black, very weak rock, fresh.
44.369	0.600		SANDSTONE, very fine grained: medium greyish grey, very weak rock, fresh, End Run 8, Start Run 9.
44.529	0.160		SILTSTONE: medium greyish grey, very weak rock, fresh.
45.639	1.110		SANDSTONE, fine to medium grained: medium greyish grey, carbonaceous laminae throughout, moderately weak rock, fresh.
47.279	1.640		SANDSTONE, very fine grained: medium greyish grey, carbonaceous sideritic bands, moderately weak rock, fresh, End Run 9, Start Run 10.
48.549	1.270		SANDSTONE, very fine grained: medium greyish grey, stony carbonaceous throughout, weak rock, fresh.
48.839	0.290	17653	COAL, dull tending to stony: dark blackish black, calcareous in part, very weak rock, fresh.

48.979	0.140	17654INT	CARBONACEOUS MUDSTONE: dark blackish black, coaly bands, very weak rock, fresh.
49.479	0.500	17655	COAL, 10-40% bright: dark blackish black, very weak rock, fresh.
49.849	0.370	17656	COAL, <10% bright: dark blackish black, very weak rock, fresh.
50.279	0.430		CARBONACEOUS MUDSTONE: medium greyish grey, weak rock, fresh, End Run 10, Start Run 11.
50.729	0.450		CORE LOSS: fresh.
51.149	0.420		CARBONACEOUS MUDSTONE: medium greyish grey, very weak rock, fresh.
51.389	0.240		SANDSTONE, fine to medium grained: medium greyish grey, calcareous bands, moderately weak rock, fresh, strata dipping at 20°.
52.239	0.850		SILTSTONE: medium greyish grey, very weak rock, fresh.
53.259	1.020		CARBONACEOUS MUDSTONE: dark blackish black, calcareous coaly throughout, very weak rock, fresh, strata dipping at 30°.
53.369	0.110		SANDSTONE, very fine grained: medium greyish grey, weak rock, fresh, End Run 11, Start Run 12.
53.809	0.440		SANDSTONE, very fine grained: medium greyish grey, carbonaceous in part, very weak rock, fresh.
53.929	0.120		COAL, dull tending to stony: dark blackish black, very weak rock, fresh.
54.229	0.300		SILTSTONE: medium greyish grey, carbonaceous wisps in part, very weak rock, fresh.
55.029	0.800		SILTSTONE: medium greyish grey, very weak rock, fresh.
56.369	1.340		SANDSTONE, fine to medium grained: medium greyish grey, very weak rock, fresh, End Run 12, Start Run 11.

57.259	0.890		SANDSTONE, fine grained: medium greyish grey, moderately weak rock, fresh.
59.129	1.870		SANDSTONE, fine grained: medium greyish grey, stony carbonaceous throughout, moderately weak rock, fresh.
59.369	0.240		SILTSTONE: medium greyish grey, sandy laminae, very weak rock, fresh, End Run 11, Start Run 12.

Drill Hole STX104C

Project: EPC1029 Hole: STX104C

Base Depth	Thick.	Sample Number	Lithology
59.499	0.130		SILTSTONE: medium greyish grey, very weak rock, fresh.
60.269	0.770		SANDSTONE, fine grained: medium greyish grey, stony laminae throughout, very weak rock, fresh.
60.279	0.010		SANDSTONE, very fine grained: medium greyish grey, stony bands, very weak rock, fresh, with faults, fault fault.
62.369	2.090		SANDSTONE, fine grained: medium greyish grey, stony sideritic bands, weak rock, fresh, End Run 12, Start Run 13.
63.775	1.406		SANDSTONE, very fine grained: medium greyish grey, very weak rock, fresh.
64.645	0.870		SILTSTONE: medium greyish grey, very weak rock, fresh.
65.095	0.450	17657	COAL, dull <1% bright: dark blackish black, very weak rock, fresh.
65.515	0.420	17658	COAL, dull <1% bright: dark blackish black, very weak rock, fresh, End Run 13, Start Run 14.
66.135	0.620	17659	COAL, dull <1% bright: dark blackish black, very weak rock, fresh.
66.585	0.450	17660	COAL, dull <1% bright: dark blackish black, very weak rock, fresh.

66.695	0.110		CARBONACEOUS MUDSTONE: dark blackish black, weak rock, fresh.
66.945	0.250		SILTSTONE: medium greyish grey, very weak rock, fresh.
67.725	0.780		SANDSTONE, fine grained: medium greyish grey, stony bands near top of unit, moderately weak rock, fresh.
67.945	0.220		SANDSTONE, fine grained: medium greyish grey, weak rock, fresh, with faults.
68.515	0.570		SANDSTONE, fine grained: medium greyish grey, near base of unit, moderately weak rock, fresh, strata dipping at 30°, with faults, End Run 14, Start Run 15.
71.515	3.000		SANDSTONE, fine grained: medium greyish grey, sideritic coaly bands, moderately weak rock, fresh, strata dipping at 30°, minor calcite, End Run 15, Start Run 16.

Drill Hole STX104C

Project: EPC1029 Hole: STX104C

Base Depth	Thick.	Sample Number	Lithology
71.965	0.450		CARBONACEOUS SILTSTONE: dark greyish grey, very weak rock, fresh.
72.025	0.060		CARBONACEOUS SHALE: dark blackish black, very weak rock, fresh.
72.305	0.280		CARBONACEOUS MUDSTONE: dark blackish black, coaly bands, very weak rock, fresh.
72.345	0.040		COAL, <10% bright: dark blackish black, very weak rock, fresh.
72.815	0.470		CARBONACEOUS SILTSTONE: dark greyish grey, very weak rock, fresh.
74.515	1.700		SILTSTONE: medium greyish grey, very weak rock, fresh, End Run 16, Start Run 17.

75.075	0.560	SILTSTONE: medium greyish grey, weak rock, fresh.
76.315	1.240	SILTSTONE: medium greyish grey, sandy laminae, very weak rock, fresh.
76.485	0.170	SANDSTONE, fine grained: medium greyish grey, carbonaceous wisps, very weak rock, fresh.
77.515	1.030	SANDSTONE, very fine grained: medium greyish grey, stony laminae throughout, very weak rock, fresh, End Run 17, Start Run 18.

———— Total Depth: 77.515 metres ————

WELL NAME	LOG NAME	SCALE
STX112	**SONIC**	**1:100**

COMPANY NAME WARATAH COAL

FIELD NAME	PROVINCE
MARLBOROUGH	QUEENSLAND

Geolog Pty. Ltd.
ABN 34 132 282 190
Shed 6, 105 Old Maryborough Road
PO Box 609
Pialba Qld. 4655
Phone 0413 463 130
Fax (07) 4191 4200

WELL DETAIL			*CASING DETAIL*			*OTHER DETAIL*	
DepthDriller	77.10	(m)	Casing1Size	78	(mm)	Engineer	RYAN HUNT
DepthLogger	76.47	(m)	Casing1Weight	STEEL		Witness	LUCAS
DATE	16 May 11		Casing1To	TD	(m)	LOCATION	MARLBOROUGH
BitSize1	78	(mm)	Casing 2 Size		(mm)	State	QLD
Bit1From	GL	(m)	Casing 2 Weight			Country	AUSTRALIA
Bit1To	TD	(m)	Casing 2 To		(m)	Sonde Abbreviation	
BitSize2	T	(mm)				Other Services1	
Bit2From		(m)				Other Services2	
Bit2To	TD	(m)	NORTHING			Other Services3	
FluidDepth	TOP	(m)	EASTING			Other Services4	

Comment

SERVICE COMPANY NAME	N/A
UNIQUE WELL IDENTIFIER	N/A

Comment1

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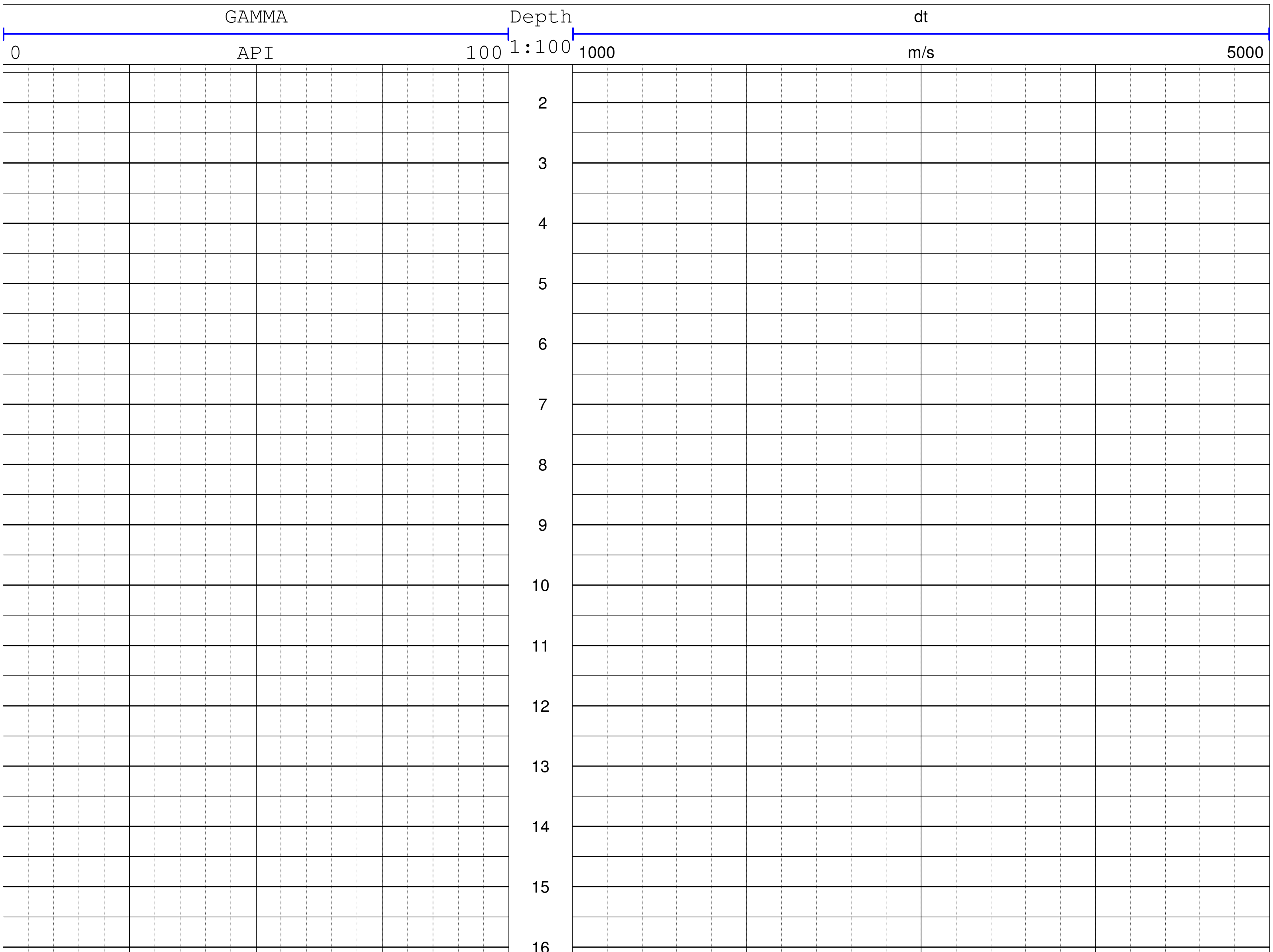

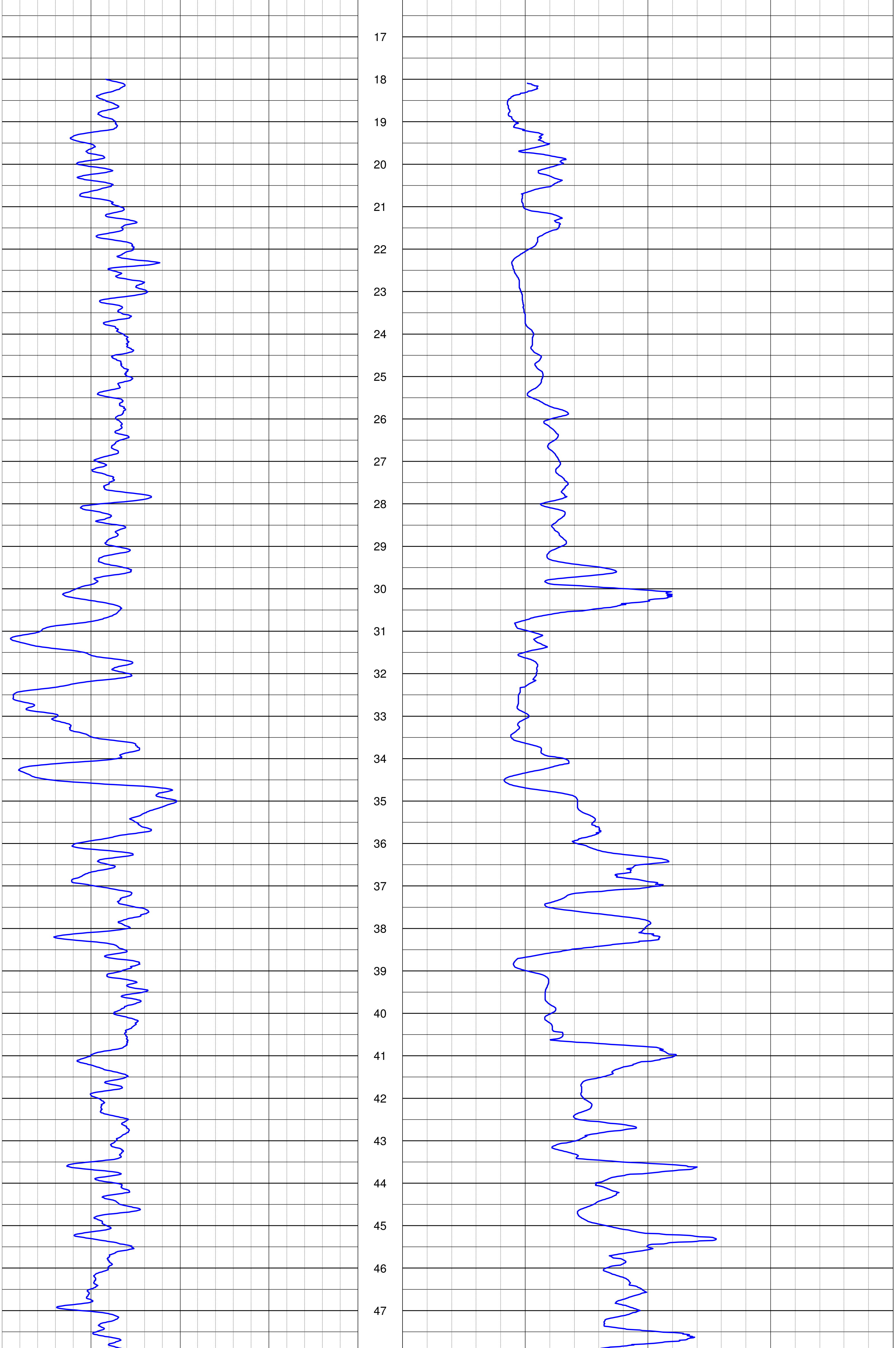
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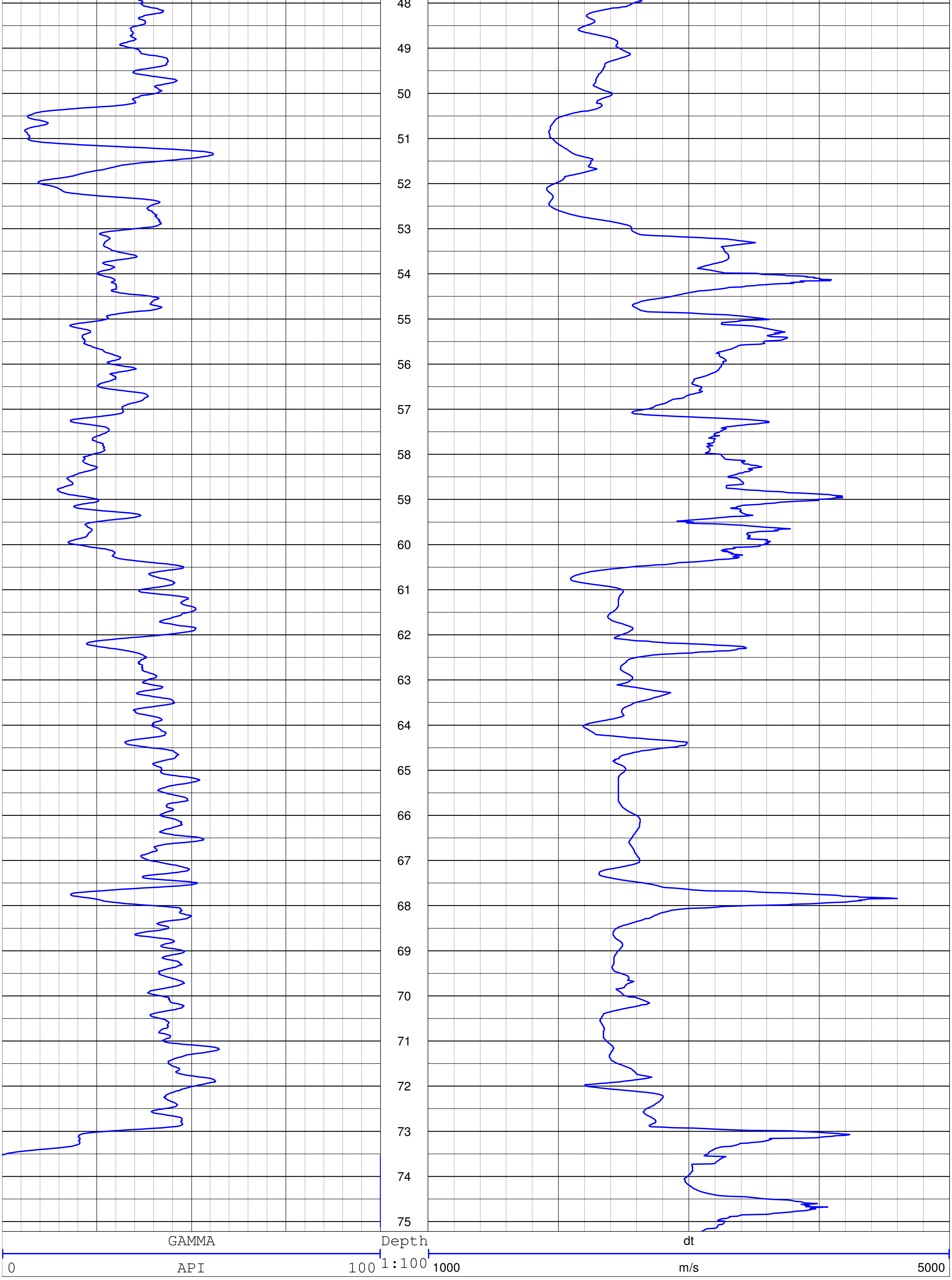
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Waratah Coal
STX
Drill Hole STX112

1	1		SOIL: dark brown.								
2	1		SAND: light greyish brown.								
3	1		CLAY: medium brown.								
5	2		SAND: ligh	medium t	granules.						
7	2		SAND: ligh	fine grained.							
11	4		SAND: ligh	fine to medium grained.							
13	2		SAND: me	fine graine	silty.						
15	2		CLAY: medium greyish brown.								
17	2		CLAY: dark brownish grey.								
18	1		COAL	undifferentiated							
20	2		MUDSTONE: dark brownish grey.								
21	1		MUDSTONE: dark blackish grey.								
24	3		MUDSTON	laminae si	very broke	weak rock	slightly we	laminated	with lamin	with bedding breaks dipping at 1	
27	3		MUDSTON	laminae si	broken co	weak rock	fresh	laminated	with lamin	with bedding breaks dipping at 1	
27.19	0.19		MUDSTON	laminae sa	broken co	weak rock	fresh	laminated	with lamin	with bedding breaks dipping at 5	
28.23	1.04		SANDSTON	fine graine	laminae m	broken co	moderatel	fresh	laminated	with lamin	with fractures dipping
29.95	1.72		MUDSTON	laminae sa	broken co	weak rock	fresh	laminated	with lamin	with shearing dipping at 25°.	
30	0.05		SANDSTON	fine graine	broken co	moderatel	fresh.				
30.45	0.45		SANDSTON	fine graine	interbedd	broken co	moderatel	fresh	with bedding breaks dipping at 10°.		
30.63	0.18		MUDSTON	solid core	weak rock	fresh.					
30.88	0.25	65151	MUDSTON	interbedd	broken co	weak rock	fresh.				
31	0.12	65152	COAL	dull <1% bright: fresh.							
31.09	0.09	65152	COAL	<10% bright: fresh.							
31.22	0.13	65152	COAL	dull <1% bright: fresh.							
31.38	0.16	65152	COAL	10-40% bright: fresh.							
31.52	0.14	65152	COAL	<10% bright: fresh.							
32.32	0.8	65153	CARBONA	lenses coa	broken co	weak rock	fresh	with fractures dipping at 15°.			
32.48	0.16	65154	COAL	dull <1% bright: fresh.							
32.73	0.25	65154	COAL	<10% bright: fresh.							

32.92	0.19	65154	COAL	dull <1% bright: fresh.						
33.03	0.11	65154	COAL	10-40% bright: fresh.						
33.17	0.14	65154	COAL	<10% bright: fresh.						
33.26	0.09	65155	CARBONAC	broken co	weak rock	fresh.				
33.44	0.18	65156	COAL	<10% bright: fresh.						
34.16	0.72	65157	CARBONAC	broken co	weak rock	fresh	with shearing dipping at 45°.			
34.36	0.2	65158	COAL	dull <1% bright: fresh.						
34.48	0.12	65158	COAL	<10% bright: fresh.						
34.6	0.12	65158	COAL	10-40% bright: fresh.						
34.66	0.06	65158	COAL	dull <1% bright: fresh.						
34.98	0.32	65159	CARBONAC	broken co	weak rock	fresh.				
35.48	0.5		CARBONAC	broken co	weak rock	fresh.				
35.71	0.23		CARBONAC	broken co	weak rock	fresh.				
35.86	0.15	65160	CARBONAC	laminae sa	broken co	moderatel	fresh.			
36.03	0.17	65161	COAL	dull <1% bright: fresh.						
36.08	0.05	65161	COAL	<10% bright: fresh.						
36.16	0.08	65161	COAL	dull <1% bright: fresh.						
36.32	0.16	65162	CARBONAC	broken co	weak rock	fresh.				
37.36	1.04		SANDSTON	fine graine	bands silts	broken co	weak rock	fresh	with shearing dipping at 55°.	
38.46	1.1		CARBONAC	laminae si	broken co	weak rock	fresh	laminated	with lamin	with shearing dipping at 45°.
38.57	0.11		CARBONAC	broken co	weak rock	fresh.				
38.64	0.07		SANDSTON	very fine g	laminae m	broken co	weak rock	fresh.		
38.7	0.06		CARBONAC	broken co	weak rock	fresh.				
39	0.3		SILTSTONE	broken co	moderatel	fresh.				
39.51	0.51		CARBONAC	lenses coa	broken co	weak rock	fresh	with fractures.		
40.2	0.69		CARBONAC	very broke	weak rock	fresh.				
40.48	0.28		CARBONAC	sandstone	very broke	weak rock	fresh	laminated	with disturbed bedding.	
40.63	0.15		CARBONAC	broken co	weak rock	fresh	with fractures dipping at 35°.			
41.43	0.8		MUDSTON	laminae si	broken co	weak rock	fresh	with bedding breaks dipping at 10°.		
41.61	0.18		CARBONAC	lenses coa	very broke	weak rock	fresh	with shearing dipping at 50°.		

42	0.39		MUDSTON	lenses silts	broken co	weak rock	fresh	with veins	calcite.		
42.44	0.44		SILTSTONE	lenses san	broken co	weak rock	fresh.				
42.72	0.28		SANDSTON	fine graine	lenses silts	broken co	moderatel	fresh.			
45	2.28		SILTSTONE	bands mu	broken co	moderatel	fresh	with shearing dipping at 45°.			
48	3		SANDSTON	fine graine	bands mu	broken co	moderatel	fresh	with veins	calcite.	
48.56	0.56		SANDSTON	fine graine	laminae si	broken co	weak rock	fresh.			
49.1	0.54		CARBONAC	laminae sa	broken co	weak rock	fresh	laminated	with laminae.		
49.2	0.1		SIDERITE: r	broken co	moderatel	fresh	with fractu	calcite.			
49.94	0.74		CARBONAC	lenses san	broken co	weak rock	fresh	with shearing dipping at 45°.			
50.08	0.14		SIDERITE: r	broken co	moderatel	fresh.					
50.1	0.02		CARBONAC	broken co	weak rock	fresh.					
50.37	0.27	65163	CARBONAC	laminae sa	broken co	weak rock	fresh	laminated	with lamin	with bedding breaks.	
50.44	0.07	65164	COAL	dull <1% bright: fresh.							
50.49	0.05	65164	COAL	dull tending to stony: fresh.							
50.91	0.42	65164	COAL	<10% bright: fresh.							
51.05	0.14	65164	COAL	dull <1% bright: fresh.							
51.15	0.1	65164	COAL	<10% bright: fresh.							
51.26	0.11	65164	COAL	dull <1% bright: fresh.							
51.51	0.25	65165	CARBONAC	broken co	weak rock	fresh	with bedding breaks.				
51.83	0.32		CARBONAC	broken co	weak rock	fresh.					
52.43	0.6	65337	COAL	dull <1% b	lenses carl	broken co	weak rock	fresh.			
53.42	0.99		SANDSTON	fine graine	laminae m	broken co	moderatel	fresh	very thinly	with laminae.	
54	0.58		CORE LOSS: fresh.								
57	3		SANDSTON	fine graine	bands silts	solid core	moderatel	fresh.			
60	3		SANDSTON	fine to me	bands silts	broken co	moderatel	fresh.			
61.02	1.02		SANDSTON	fine to me	bands silts	broken co	moderatel	fresh.			
61.3	0.28		MUDSTON	lenses silts	broken co	moderatel	fresh.				
62.53	1.23		SILTSTONE	broken co	weak rock	fresh	with shearing dipping at 15°.				
63	0.47		SILTSTONE	bands san	broken co	weak rock	fresh	with bedding breaks dipping at 5°.			
66	3		SILTSTONE	laminae m	broken co	weak rock	fresh	very thinly	with lamin	with veins	calcite.
68	2		SILTSTONE	muddy	broken co	weak rock	fresh	with veins	calcite.		

68.61	0.61	SANDSTON	very fine g	silty	broken co	weak rock	silty matri	fresh.
68.96	0.35	SILTSTONE	bands san	broken co	weak rock	fresh	very thinly	with current bedding.
69	0.04	CORE LOSS: fresh.						
72	3	SILTSTONE	bands mu	broken co	weak rock	fresh	with shearing dipping at 50°.	
73.61	1.61	SANDSTON	fine to me	siltstone fi	broken co	weak rock	fresh.	
75.51	1.9	SANDSTON	fine grain	bands mu	broken co	weak rock	fresh.	

—————————— Total Depth: 75.510 metres ——————————

WELL NAME	LOG NAME	SCALE
STX124	**SONIC**	**1:100**

COMPANY NAME **WARATAH COAL**

FIELD NAME	PROVINCE
MARLBOROUGH	QUEENSLAND

Geolog Pty. Ltd.
ABN 34 132 282 190

Shed 6, 105 Old Maryborough Road
PO Box 609
Pialba Qld. 4655

Phone 0413 463 130
Fax (07) 4191 4200

WELL DETAIL			*CASING DETAIL*			*OTHER DETAIL*	
DepthDriller	77.60	(m)	Casing1Size	102	(mm)	Engineer	RYAN HUNT
DepthLogger	77.18	(m)	Casing1Weight	PVC		Witness	LUCAS
DATE	25 Apr 11		Casing1To	22.8	(m)	LOCATION	MARLBOROUGH
BitSize1	102	(mm)	Casing 2 Size		(mm)	State	Queensland
Bit1From	G.L.	(m)	Casing 2 Weight			Country	Australia
Bit1To	22.8	(m)	Casing 2 To		(m)	Sonde Abbreviation	
BitSize2		(mm)				Other Services1	
Bit2From		(m)				Other Services2	
Bit2To	TD	(m)	NORTHING			Other Services3	
FluidDepth	TOPPED	(m)	EASTING			Other Services4	

Comment

SERVICE COMPANY NAME	N/A
UNIQUE WELL IDENTIFIER	N/A

Comment1

Comment3

Comment4

Comment5

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Comment7

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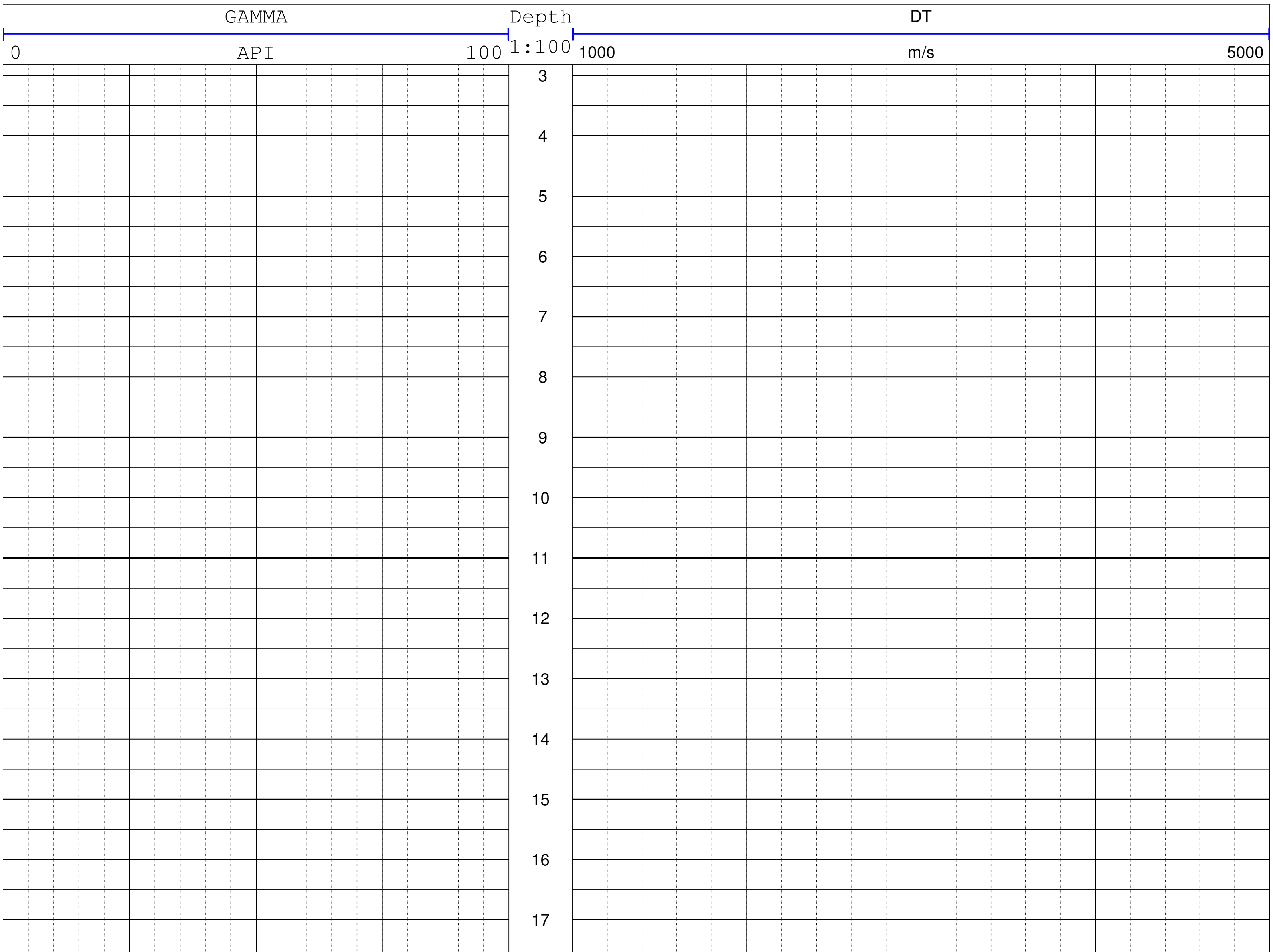

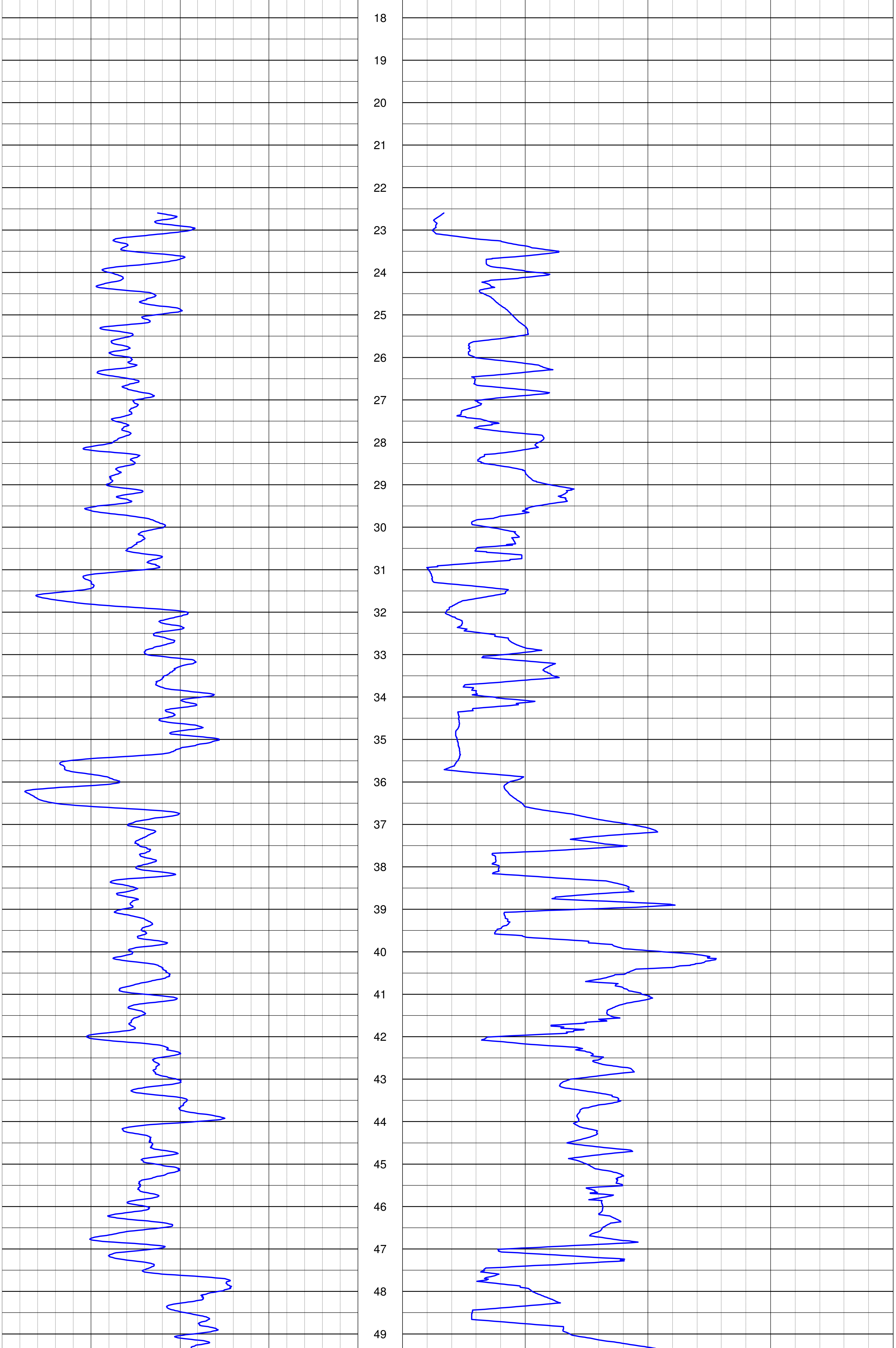
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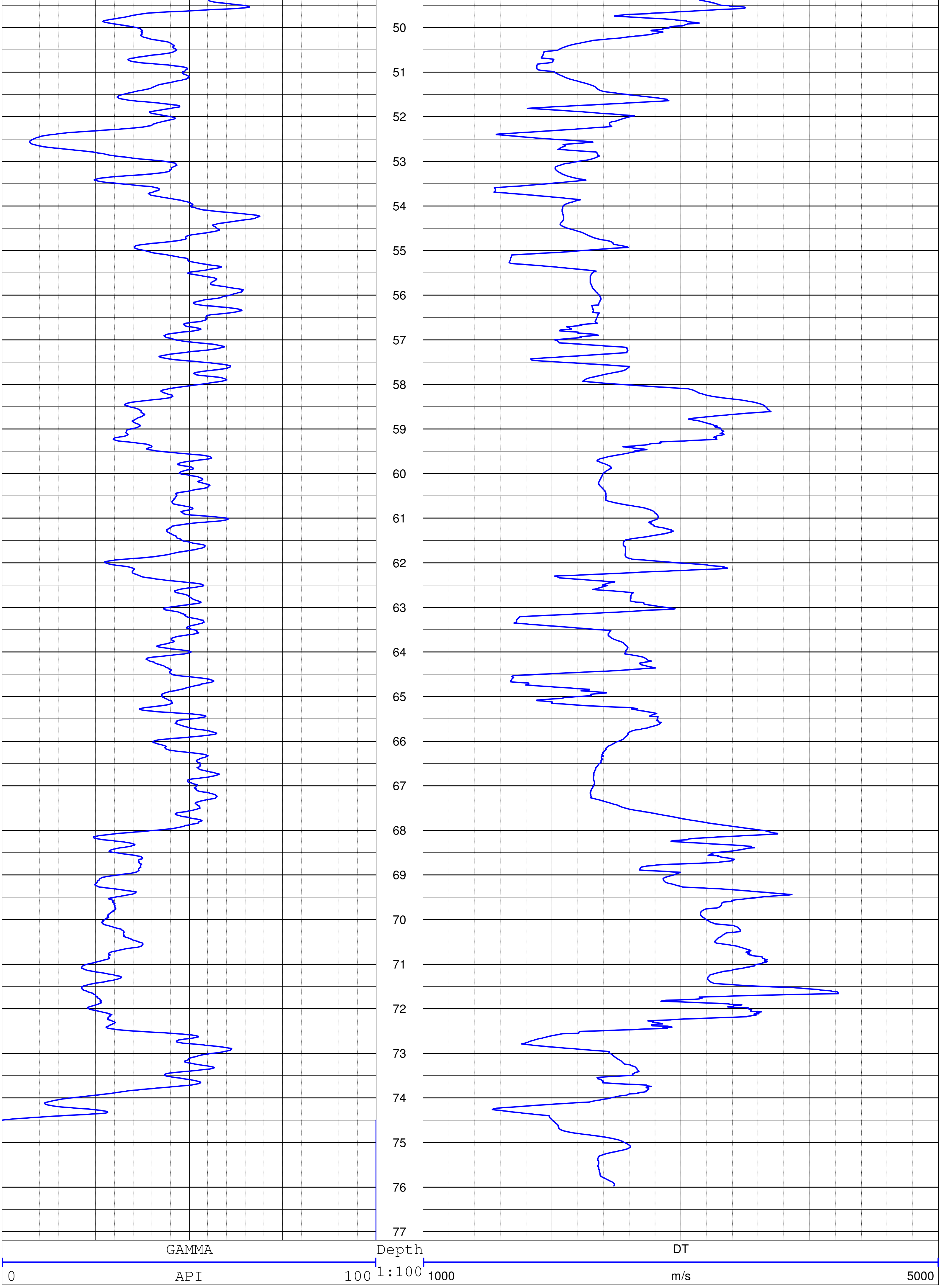
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GAMMA
Depth
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API
100
1:100
1000
m/s
5000

STX124 Geology Report
Drill Hole STX124

Project: EPC1029 Hole: STX124

Base Depth	Thick.	Sample Number	Lithology
2.000	2.000		SOIL: dark brown.
7.000	5.000		CLAY: dark greyish brown.
11.000	4.000		SILT: light yellowish brown.
17.000	6.000		SAND: light grey.
23.000	6.000		CLAY: dark grey.
23.300	0.300		SILTSTONE: medium brownish grey, muddy, broken core, weak rock, moderately weathered.
23.440	0.140		SILTSTONE: medium brownish grey, lenses coal, broken core, weak rock, slightly weathered.
23.600	0.160		COAL, <10% bright: fragmented core, slightly weathered.
23.710	0.110		CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, slightly weathered.
23.910	0.200		SILTSTONE: medium greyish brown, muddy, broken core, weak rock, slightly weathered.
24.530	0.620		CARBONACEOUS MUDSTONE: dark greyish black, lenses coal, broken core, weak rock, slightly weathered.
24.590	0.060		COAL, dull <1% bright: slightly weathered.
25.040	0.450		SILTSTONE: medium greyish brown, broken core, weak rock, slightly weathered.
26.550	1.510		SANDSTONE, fine grained: light grey, broken core, moderately weak rock, slightly weathered.
26.600	0.050		CORE LOSS: slightly weathered.
29.600	3.000		SANDSTONE, fine grained: light grey, laminae mudstone siltstone, broken core, weak rock, fresh, medium bedded 100-300mm, bands, interlaminated with.

30.990	1.390		SILTSTONE: medium greyish brown, bands sandstone, broken core, weak rock, fresh.
31.140	0.150	65223	SILTSTONE: medium greyish brown, broken core, weak rock, fresh.
31.250	0.110	65224	COAL, <10% bright: fresh.
31.360	0.110	65224	COAL, dull <1% bright: fresh.
31.440	0.080	65225	TUFF: medium reddish brown, fresh.
31.520	0.080	65226	COAL, dull <1% bright: fresh.

Drill Hole STX124

Project: EPC1029 Hole: STX124

Base Depth	Thick.	Sample Number	Lithology
31.560	0.040	65226	COAL, <10% bright: fresh.
31.650	0.090	65226	COAL, 10-40% bright: fresh.
31.710	0.060	65226	COAL, <10% bright: fragmented core, fresh.
31.840	0.130	65226	COAL, dull <1% bright: fresh.
32.090	0.250	65227	CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
32.440	0.350		SILTSTONE: dark greyish brown, bands carbonaceous mudstone, broken core, weak rock, fresh.
35.100	2.660		SILTSTONE: dark greyish brown, laminae sandstone mudstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
35.240	0.140		CORE LOSS: fresh.
35.500	0.260	65228	SILTSTONE: light greyish brown, broken core, weak rock, fresh.
35.640	0.140	65229	COAL, <10% bright: fresh.
35.680	0.040	65229	COAL, 10-40% bright: fresh.

35.760	0.080	65229	COAL, <10% bright: fresh.
35.850	0.090	65229	COAL, dull <1% bright: fragmented core, fresh.
36.230	0.380	65230	CARBONACEOUS MUDSTONE: dark greyish brown, broken core, weak rock, fresh.
36.340	0.110	65231	COAL, <10% bright: fresh.
36.530	0.190	65231	COAL, dull <1% bright: fresh.
36.660	0.130	65231	COAL, <10% bright: fresh.
36.860	0.200	65232	CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
37.160	0.300		SILTSTONE: medium greyish brown, broken core, weak rock, fresh.
38.550	1.390		SANDSTONE, fine grained: light grey, broken core, moderately weak rock, fresh.
41.600	3.050		SANDSTONE, fine grained: light grey, broken core, moderately weak rock, fresh.
42.130	0.530		SANDSTONE, fine grained: light grey, broken core, moderately weak rock, fresh.
42.220	0.090		COAL, dull <1% bright: fresh.

Base Depth	Thick.	Sample Number	Lithology
42.350	0.130		SHALE: dark blackish brown, lenses coal, broken core, weak rock, fresh.
44.020	1.670		SILTSTONE: medium greyish brown, bands mudstone, broken core, weak rock, fresh.
44.600	0.580		SILTSTONE: medium brownish grey, laminae mudstone sandstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
47.600	3.000		SANDSTONE, very fine grained: medium brownish grey, laminae mudstone sandstone, broken core, weak rock,

Base Depth	Thick.	Sample Number	Lithology
			fresh, laminated <10mm, with laminae.
47.740	0.140		COAL, dull <1% bright: fresh.
49.810	2.070		MUDSTONE: dark grey, laminae sandstone siltstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
50.140	0.330		SANDSTONE, fine grained: light grey, broken core, weak rock, fresh.
50.260	0.120		SIDERITE: medium reddish grey, broken core, moderately weak rock, fresh.
50.600	0.340		CARBONACEOUS MUDSTONE: dark brownish grey, broken core, weak rock, fresh.
52.210	1.610		SANDSTONE, very fine grained: light grey, bands siltstone, broken core, weak rock, fresh.
52.340	0.130	65233	SANDSTONE, very fine grained: light grey, lenses siltstone, broken core, weak rock, fresh.
52.440	0.100	65234	COAL, 10-40% bright: fresh.
52.550	0.110	65234	COAL, <10% bright: fresh.
52.710	0.160	65235	TUFF: dark reddish grey, fresh.
52.850	0.140	65236	COAL, 10-40% bright: fresh.
52.910	0.060		CORE LOSS: fresh.
53.070	0.160	65237	CARBONACEOUS MUDSTONE: dark grey, broken core, weak rock, fresh.
53.470	0.400		CARBONACEOUS MUDSTONE: dark grey, broken core, weak rock, fresh.
55.240	1.770		CARBONACEOUS MUDSTONE: dark grey, bands siltstone, broken core, weak rock, fresh.

56.600	1.360	MUDSTONE: dark blackish grey, laminae sandstone siltstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
57.500	0.900	MUDSTONE: dark grey, laminae siltstone sandstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
57.550	0.050	TUFF: light whitish grey, fresh.
58.560	1.010	SILTSTONE: medium brownish grey, bands mudstone, broken core, weak rock, fresh.
59.480	0.920	SANDSTONE, fine grained: light grey, broken core, moderately weak rock, fresh.
59.550	0.070	COAL, <10% bright: fresh.
59.580	0.030	CARBONACEOUS MUDSTONE: dark blackish grey, broken core, weak rock, fresh.
59.600	0.020	CORE LOSS: fresh.
61.210	1.610	MUDSTONE: medium grey, laminae siltstone sandstone, broken core, weak rock, fresh, laminated <10mm, with laminae.
62.600	1.390	SANDSTONE, fine grained: light grey, laminae siltstone mudstone, broken core, weak rock, fresh, very thinly bedded 10-30mm, with laminae.
65.600	3.000	SILTSTONE: medium greyish brown, muddy, broken core, weak rock, fresh.
68.260	2.660	MUDSTONE: dark brownish grey, silty, broken core, weak rock, fresh.
68.600	0.340	SANDSTONE, very fine grained: light grey, laminae mudstone, broken core, weak rock, fresh.
71.600	3.000	SANDSTONE, fine grained: light grey, broken core, moderately weak rock, fresh, with joints 0 - 100mm dipping at 50°, calcite.
72.730	1.130	SANDSTONE, fine grained: light grey, broken core, moderately weak rock, fresh.
73.750	1.020	SILTSTONE: medium brownish grey, bands mudstone,

Base Depth	Thick.	Sample Number	Lithology
			broken core, weak rock, fresh, with disturbed bedding.
73.950	0.200	65238	SILTSTONE: medium brownish grey, bands mudstone, broken core, weak rock, fresh.
74.060	0.110	65239	COAL, dull <1% bright: fresh.
74.150	0.090	65239	COAL, 10-40% bright: fresh.
74.220	0.070	65239	COAL, dull <1% bright: fresh.
74.380	0.160	65239	COAL, 10-40% bright: fresh.
74.400	0.020	65239	CORE LOSS: fresh.
74.600	0.200	65240	CARBONACEOUS MUDSTONE: dark blackish grey, lenses coal, broken core, weak rock, fresh.
74.950	0.350		CARBONACEOUS MUDSTONE: dark blackish grey, broken core, weak rock, fresh.
77.600	2.650		MUDSTONE: dark grey, laminae siltstone sandstone, broken core, weak rock, fresh.

——————— Total Depth: 77.600 metres ———————

PRELIMINARY INVESTIGATIONS FOR SEDIMENT DAM, WATER STORAGE DAM, TRAIN LOADOUT AND HAUL ROAD, STYX COAL PROJECT

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May 2017

PRELIMINARY INVESTIGATIONS FOR SEDIMENT DAM, WATER STORAGE DAM, TRAIN LOADOUT AND HAUL ROAD, STYX COAL PROJECT

CONTENTS

TABLES

FIGURES

APPENDICES

APPENDIX 1 : LABORATORY TEST RESULTS

PRELIMINARY INVESTIGATIONS FOR SEDIMENT DAM, WATER STORAGE DAM AND TRAIN LOADOUT, STYX COAL PROJECT

1.0 INTRODUCTION

Preliminary investigations were completed by J. Blanning (Project and Mining Director, Waratah Coal Pty Ltd), D. McCabe (Rail and Port Director, Waratah Coal Pty Ltd) and G. Klenowski (Senior Geotechnical Engineer, Australian Mining Engineering Consultants (AMEC)) on 8 March 2017. A sediment dam site, two water storage dam sites and a train loadout area were inspected. A haul road route has also been assessed.

Figure 1 is a site plan showing inspection locations. GPS co-ordinates of these locations are listed in Table 1 and shown in Figure 2.

TABLE 1 – GPS CO-ORDINATES (GDA94) OF INSPECTION LOCATIONS

POINT	LOCATION	EASTING (m)	NORTHING (m)	COMMENTS
1	Dam 1, Sediment	770 777	7 487 806	Sediment Dam, downstream end of sump
2	Dam 1, Sediment	770 775	7 487 802	Sediment Dam Sample 1
3	Dam 1, Sediment	770 779	7 487 780	Sediment Dam Sample 2
4	Dam 1, Sediment	770 770	7 487 771	Sediment Dam Sump
5	Dam 2, Water Storage, Option 1	773 614	7 489 249	Option 1
6	Dam 2, Water Storage, Option 2	773 520	7 489 084	Option 2
7	Train Loadout	778 137	7 489 110	Preferred Location

2.0 SEDIMENT DAM

The sediment dam site is located in a natural sump at the topographically lowest area for run off water, prior to discharging off the mine site (Figures 1 and 2). The site is shown in Figures 3 and 4. A dam embankment and spillway are required at this site.

Good quality, non-dispersive, impervious material is needed for embankment construction. The material shall be a well graded sandy, silty clay as defined below:-

Liquid Limit W_L	30% to 60%
Plasticity Index I_p	15% to 45%

The first 1000 mm placed in contact with the natural foundation shall have a minimum of 20% passing the 75 µm sieve.

Two samples were collected for laboratory testing (Table 1). Sample 1 is a grey alluvial clay which is non-dispersive (Appendix 1) but has large desiccation cracks (Figure 5). Sample 2 is a non-dispersive, brown, silty clay (Figure 6) which has a low plasticity index (Appendix 1). Suitable clay occurs in this area for embankment construction but some mixing may be required to achieve an adequate plasticity index. Geotechnical investigations comprising backhoe trenches are required to determine the depth of the cut off trench and locate suitable embankment material.

A spillway is required to divert overflow water. A concrete nib wall would be constructed in a trench located across the spillway crest. The spillway area would need to be topsoiled and seeded. Hydrological analysis is required to size adequate spillway capacity.

3.0 WATER STORAGE DAM

The water storage dam is to be non-referable being less than 10 m high with a storage capacity of less than 750 magalitres. Required storage capacity for mine operation is 350 megalitres. Two options have been inspected.

3.1 Option 1

The right and left abutments are shown in Figures 7 and 8 respectively. The proposed spillway location is on the right bank. Figure 9 is a contour plan of the site. Figure 10 shows the Option 1 reservoir area. The maximum possible dam height in this area is about 6 m. Prior to geotechnical investigations a spillway design should be completed to determine maximum reservoir storage capacity.

A backhoe is required to complete geotechnical investigations which would determine the depth of the cut off trench and locate suitable embankment material. Abundant dispersive clay occurs in this area.

3.2 Option 2

Option 2 is upstream of Option 1 (Figure 2, Table 1). The right abutment is shown in Figure 11 and the left abutment is in the background of Figure 12. The contour plan in Figure 9 indicates that the maximum possible dam height in this area is about 4 m. This site is not suitable for a water storage dam due to inadequate reservoir capacity.

4.0 TRAIN LOADOUT

The proposed train loadout area is shown in Figures 2, 13 and 14. It occurs on slightly elevated topography and ridge gravel is present. These factors can be utilised for the construction of the loadout, the coal stockpile base and the haul road from the wash plant. The ridge gravel requires investigation using backhoe pits and Californian Bearing Ratio (CBR) testing is recommended.

The rail loop option shown in Figure 14 is in a favourable location with respect to topography and sound foundation material, which appears to be ridge gravel.

The coal stockpile base should be well drained with a recommended slope of 3% (Reference 1). Perimeter drainage and a collection sump are needed.

5.0 HAUL ROAD AND WASH PLANT

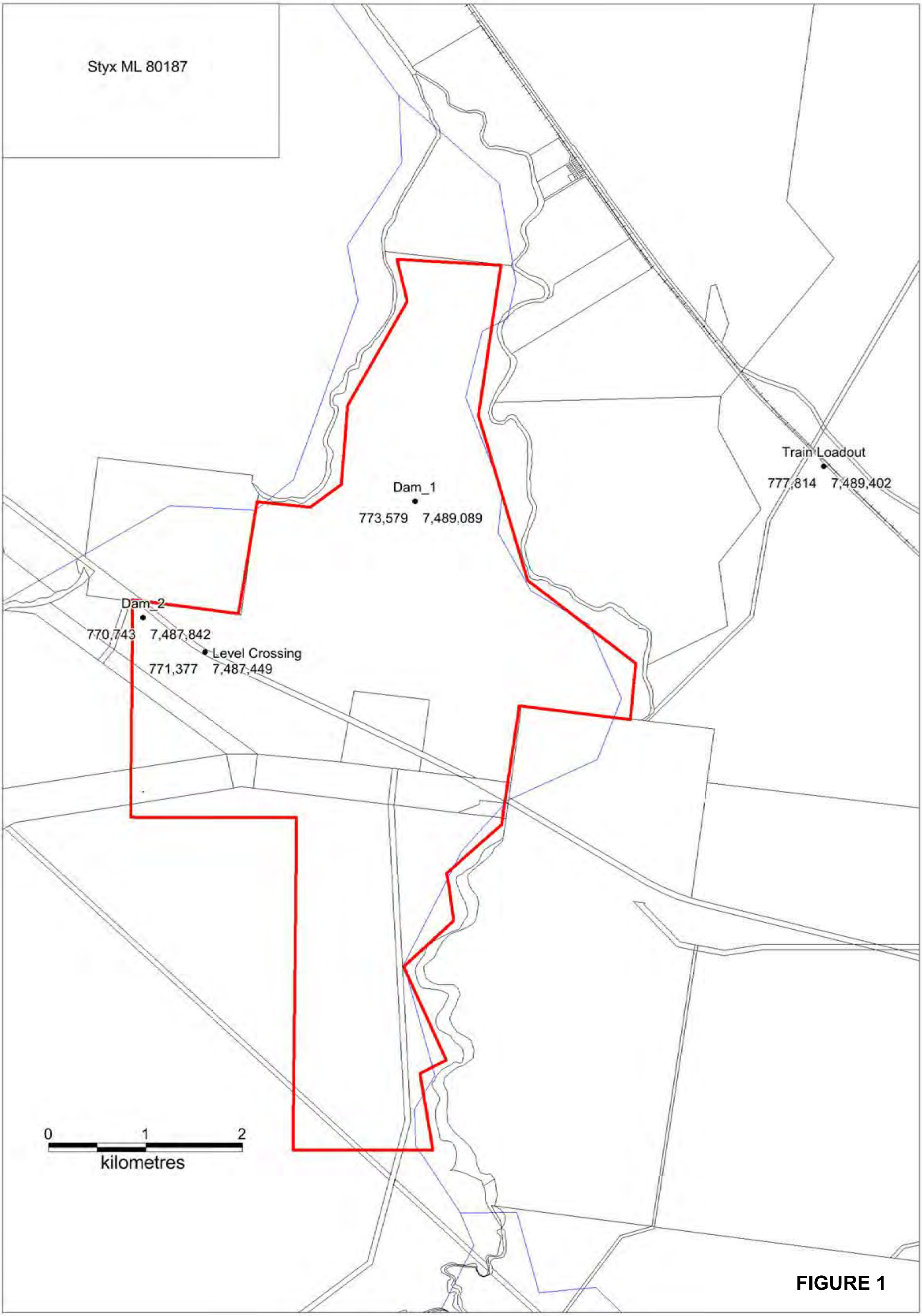
The haul road route in Figure 14 could be shortened and cross Deep Creek at a more favourable angle at right angles to the creek direction (Option 2 in Figure 14). The current crossing in Figure 14 would be expensive and difficult to construct, requiring significant scour protection.

If possible the wash plant could be moved to the south west, away from incised gully topography.

6.0 REFERENCES

1. Klenowski, G., 2015. Cost-effective Construction Techniques. AusIMM Bulletin, April 2015, pp. 84 – 86.

FIGURES


Styx ML 80187
Train Loadout
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Dam_1
773,579 7,489,089
Dam_2
770,743 7,487,842
Level Crossing
771,377 7,487,449
0
1
2
kilometres

FIGURE 1

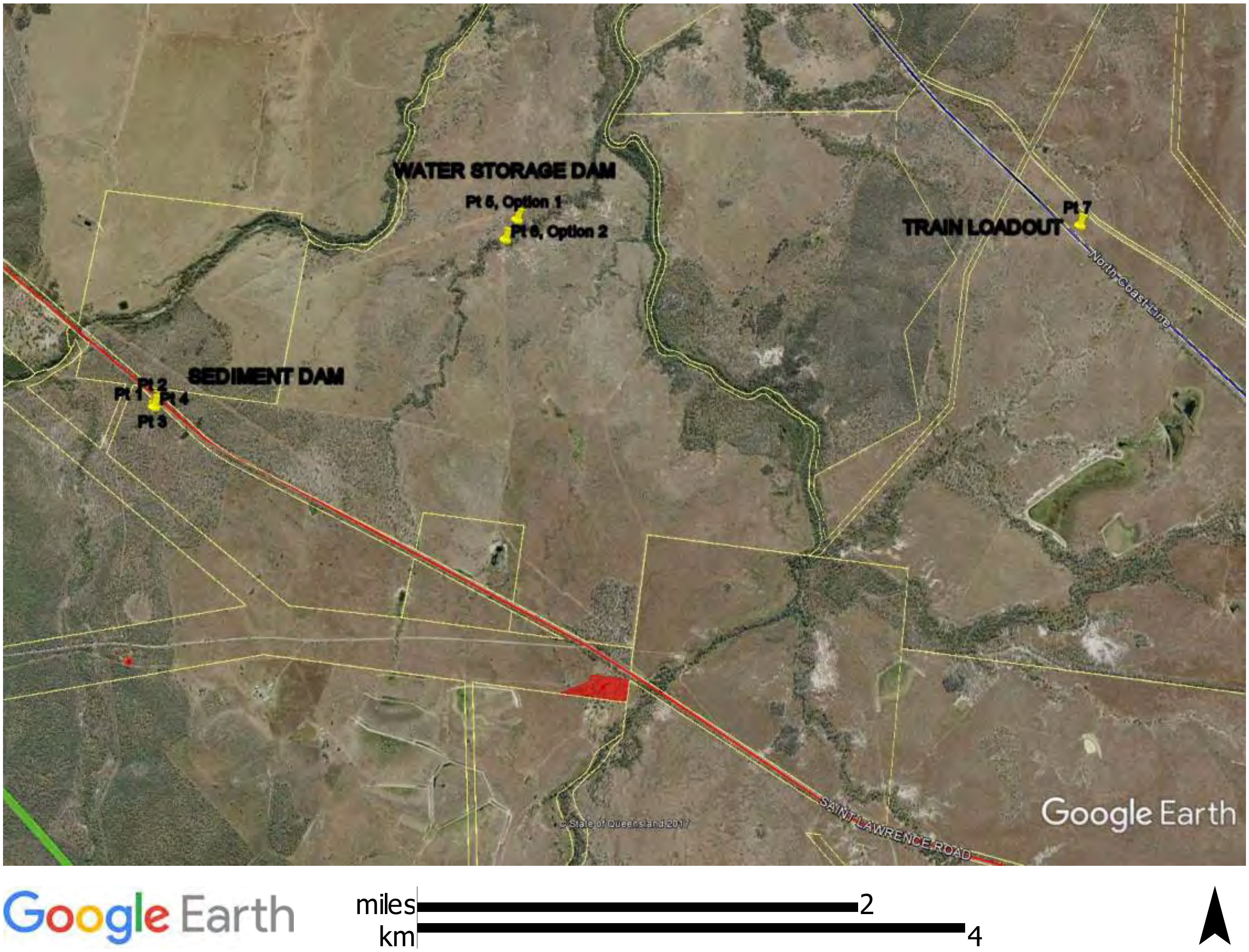


FIGURE 2 : GPS LOCATIONS

FIGURE 3 : SEDIMENT DAM SITE LOOKING UPSTREAM

FIGURE 4 : PONDED WATER IN SUMP AT SEDIMENT DAM SITE

FIGURE 5 : SEDIMENT DAM SITE, SAMPLE 1

FIGURE 6 : SEDIMENT DAM SITE, SAMPLE 2

FIGURE 7 : WATER STORAGE DAM, OPTION 1, RIGHT ABUTMENT

FIGURE 8 : WATER STORAGE DAM, OPTION 1, LEFT ABUTMENT IN BACKGROUND

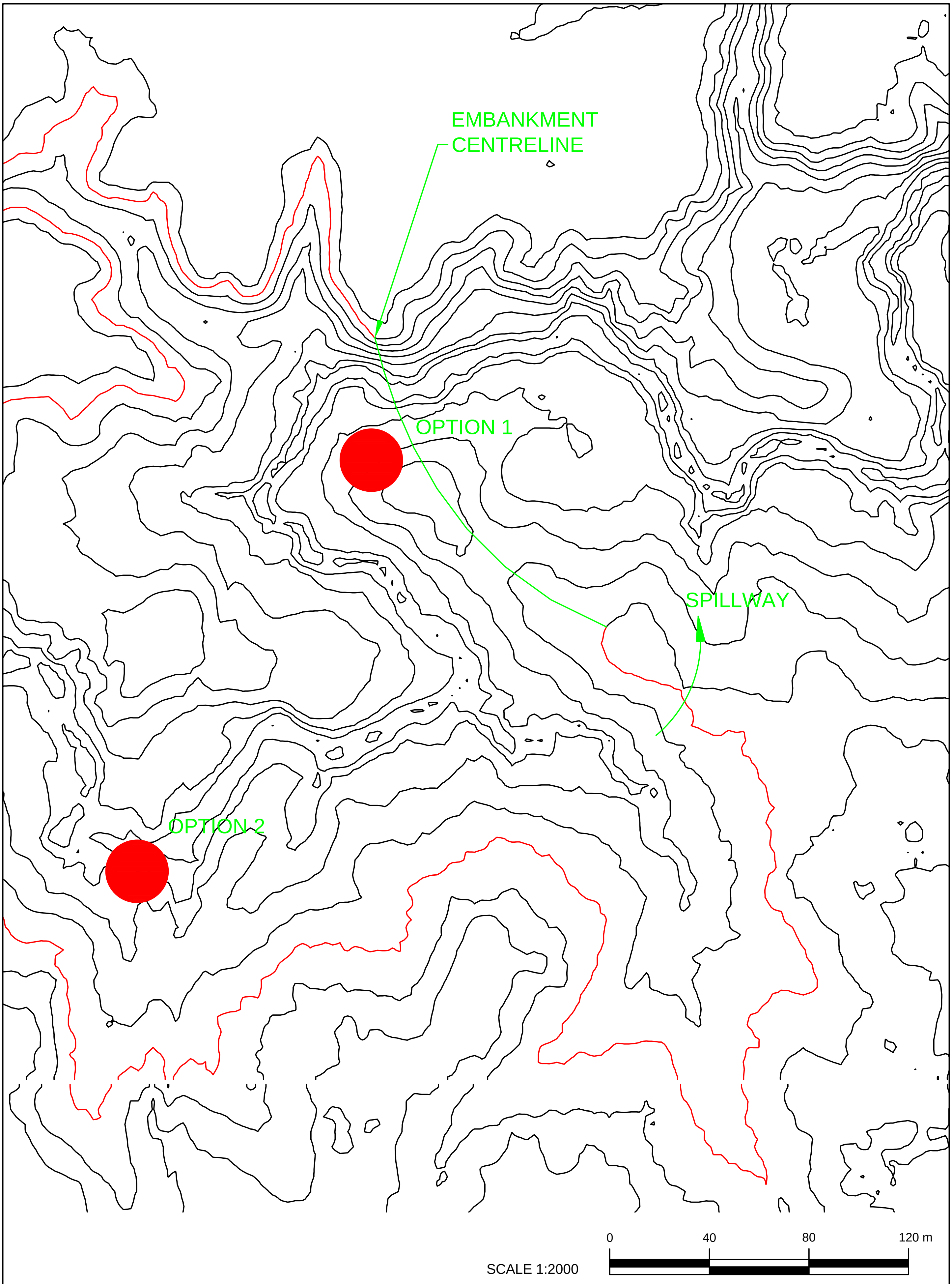


FIGURE 9 : CONTOUR PLAN OF WATER STORAGE DAM OPTIONS

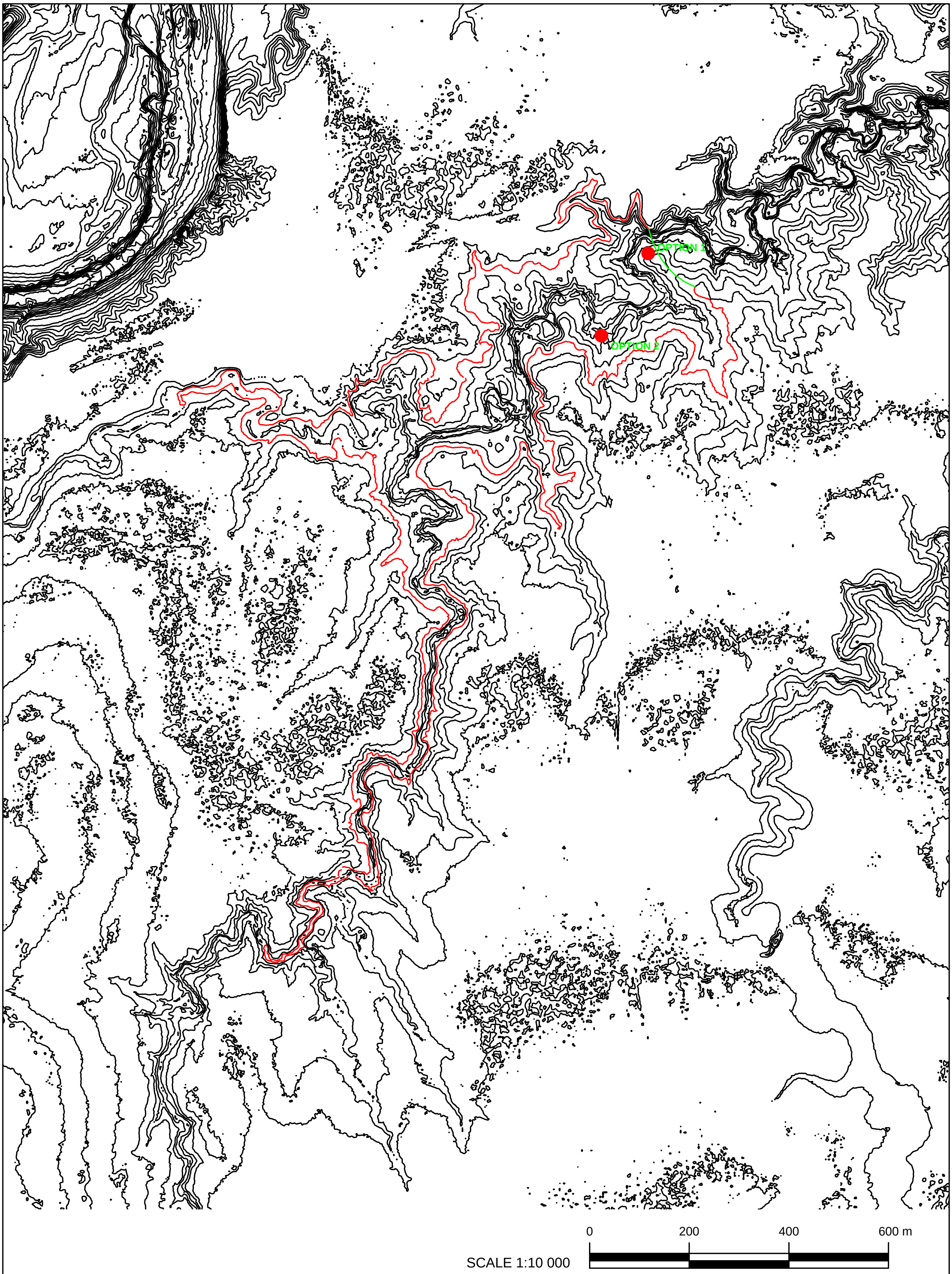
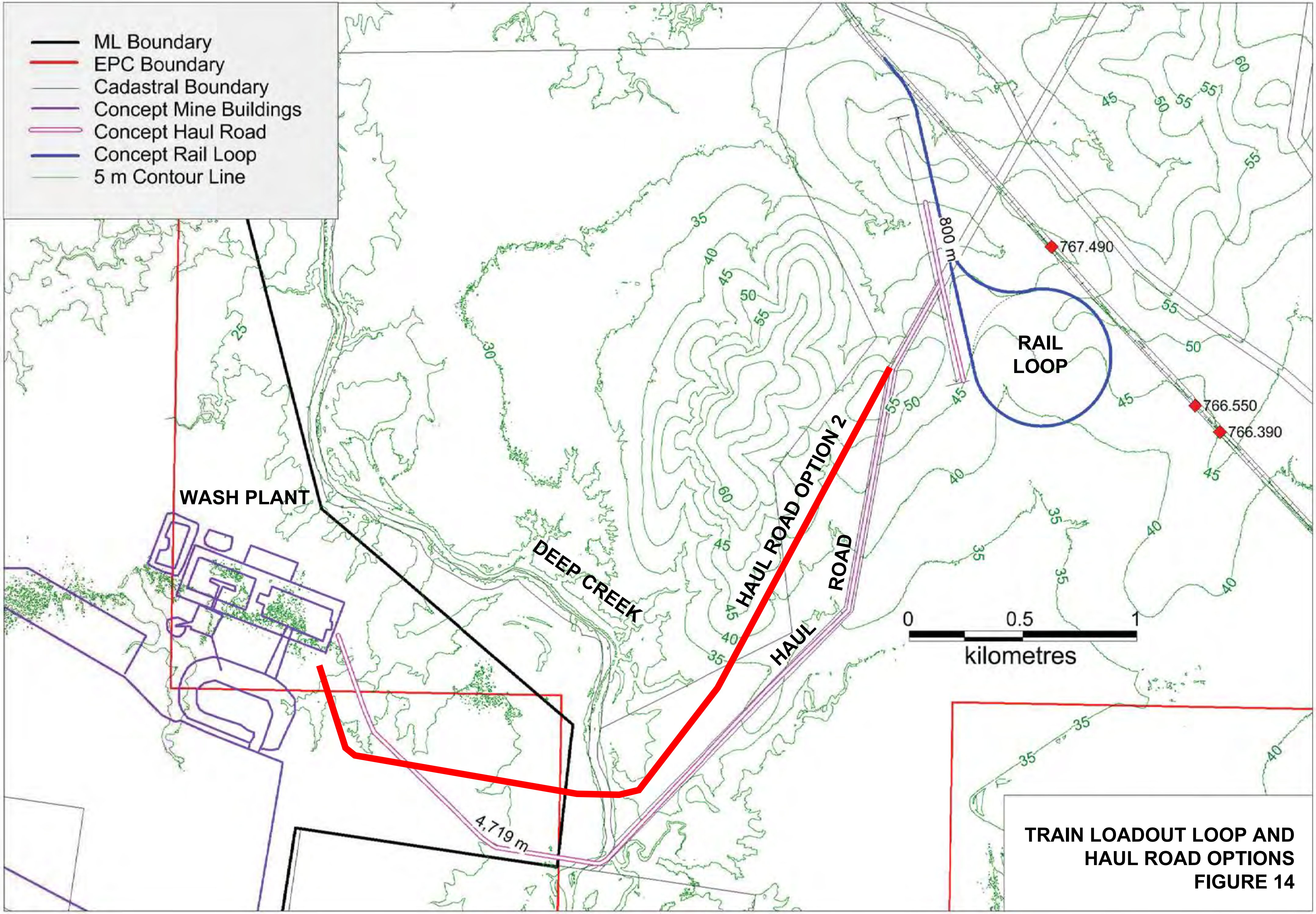


FIGURE 10 : OPTION 1 RESERVOIR AREA

FIGURE 11 : WATER STORAGE DAM, OPTION 2, RIGHT ABUTMENT

FIGURE 12 : WATER STORAGE DAM OPTION 2, LEFT ABUTMENT IN BACKGROUND

FIGURE 13 : TRAIN LOADOUT AREA



TRAIN LOADOUT LOOP AND HAUL ROAD OPTIONS
FIGURE 14

APPENDIX 1

LABORATORY TEST RESULTS

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CARDNO (QLD) PTY LTD

GEO-QF-UNGR 32 G
(-/8/16)

71 CONNORS ROAD MACKAY QLD

REPORT ON EMERSON CLASS NUMBER OF A SOIL

Sheet 1 of 1 Mackay Laboratory

CLIENT: Australian Mining Engineering Consultants **JOB NO.:** U21834 **LAB REF NO.:** 17-0318A

PROJECT: Styx Coal **SAMPLED BY:** AMEC **DATE:** 9.3.17

LOCATION: Sample 1 **TESTED BY:** CD **DATE:** 15.3.17

MATERIAL: Clay **CHECKED BY:** CD **DATE:** 15.3.17

TEST PROCEDURES: AS 1289.3.8.1 **CLIENT REF:** -

Soil Description: Clay; grey

Type of Water Used: Distilled

Temperature of Water: 24 °C

Emerson Class Number: 4

NATA

Accredited No. 910
Certificate No. 17-0318A
Date of Issue 15.3.17

Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australia/national standards.

Authorised Signatory: D. Hoskins

D. Hoskins

Cardno
Shaping the Future

CARDNO (QLD) PTY LTD

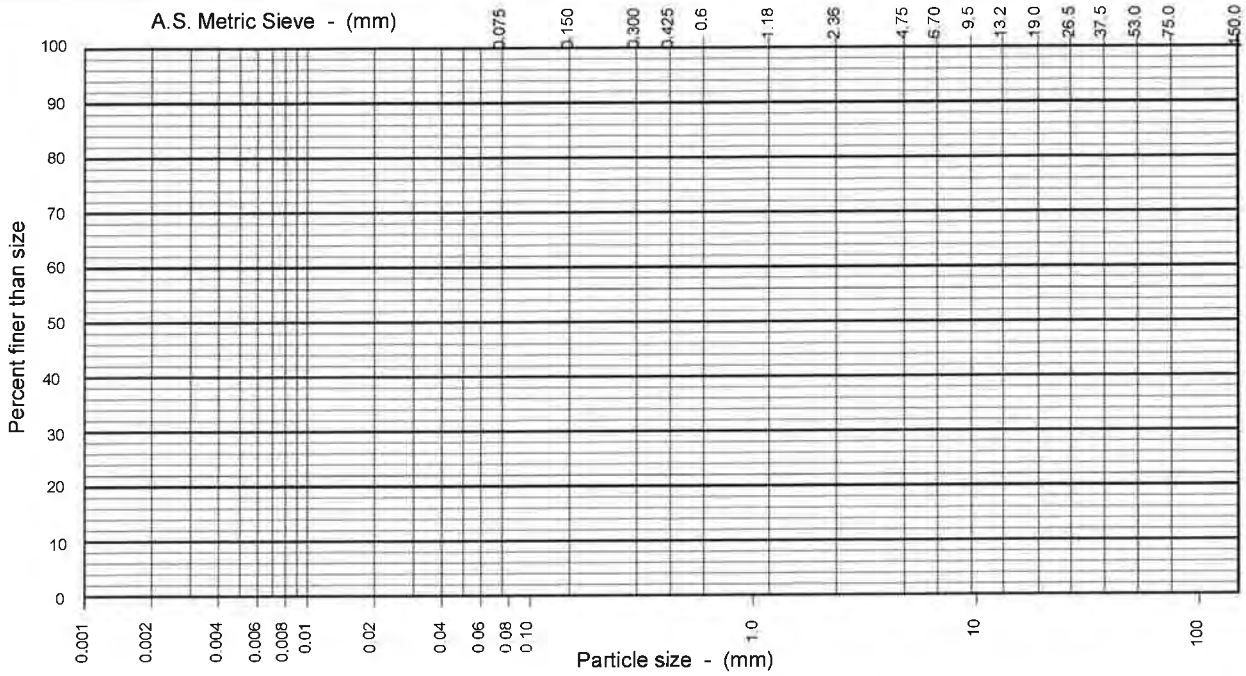
GEO-QF-UNGR 1 G
(-/8/16)

71 CONNORS ROAD MACKAY QLD
REPORT ON SOIL CLASSIFICATION

Sheet 1 of 1

Mackay Laboratory

CLIENT:	Australian Mining Engineering Consultants	**JOB NO:**	U21834	**LAB REF NO:**	17-0319AB
PROJECT:	Styx Coal	**SAMPLED BY:**	Client	**DATE:**	9.3.17
LOCATION:	Sample 2	**TESTED BY:**	CD	**DATE:**	15.3.17
MATERIAL:	Clay; brownish-grey	**CHECKED BY:**	DH	**DATE:**	16.3.17
TEST PROCEDURES:	AS 1289.3.1.1,3.2.1,3.3.1,3.4.1,3.8.1	**CLIENT REF:**	-		



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	
				0	0	0	0	0	0	0

Particle Size (mm)	Percent Passing (%)	Particle Size (mm)	Percent Passing (%)
150.0			
75.0			
37.5			
19.0			
9.5			
4.75			
2.36			
1.18			
0.600			
0.425			
0.300			
0.150			
0.075			

Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Soil Particle Density (g/cm^3)
34	22	12	9.0	-

Classification:

Emerson Class No.: 5 Type of Water Used: Distilled Temp of Water Used: 24°C

Preparation History of Atterberg Limits

Sample : ~~Natural~~/Air Dried/~~Oven~~

Sieved: ~~Wet~~/dry

Linear Shrinkage Data

Length of Mould (mm) : 150

Sample: -

NATA

Accredited No 910
Certificate No 17-0319A
Date of Issue 16 3 17

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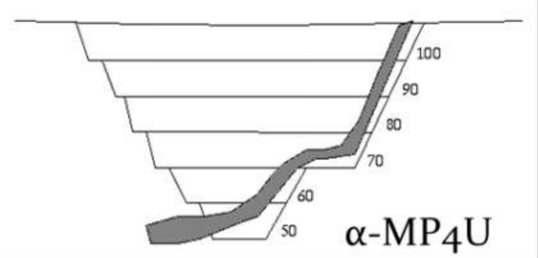
Authorised Signatory D. Hoskins

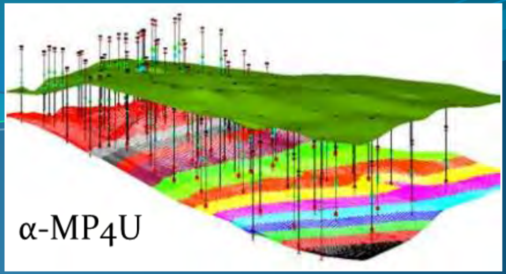
D. Hoskins

APPENDIX

B

PIT CROSS SECTIONS





Styx Bruce Highway Cross-Sections

11 April 2018

Alpha-Mine Planning 4U

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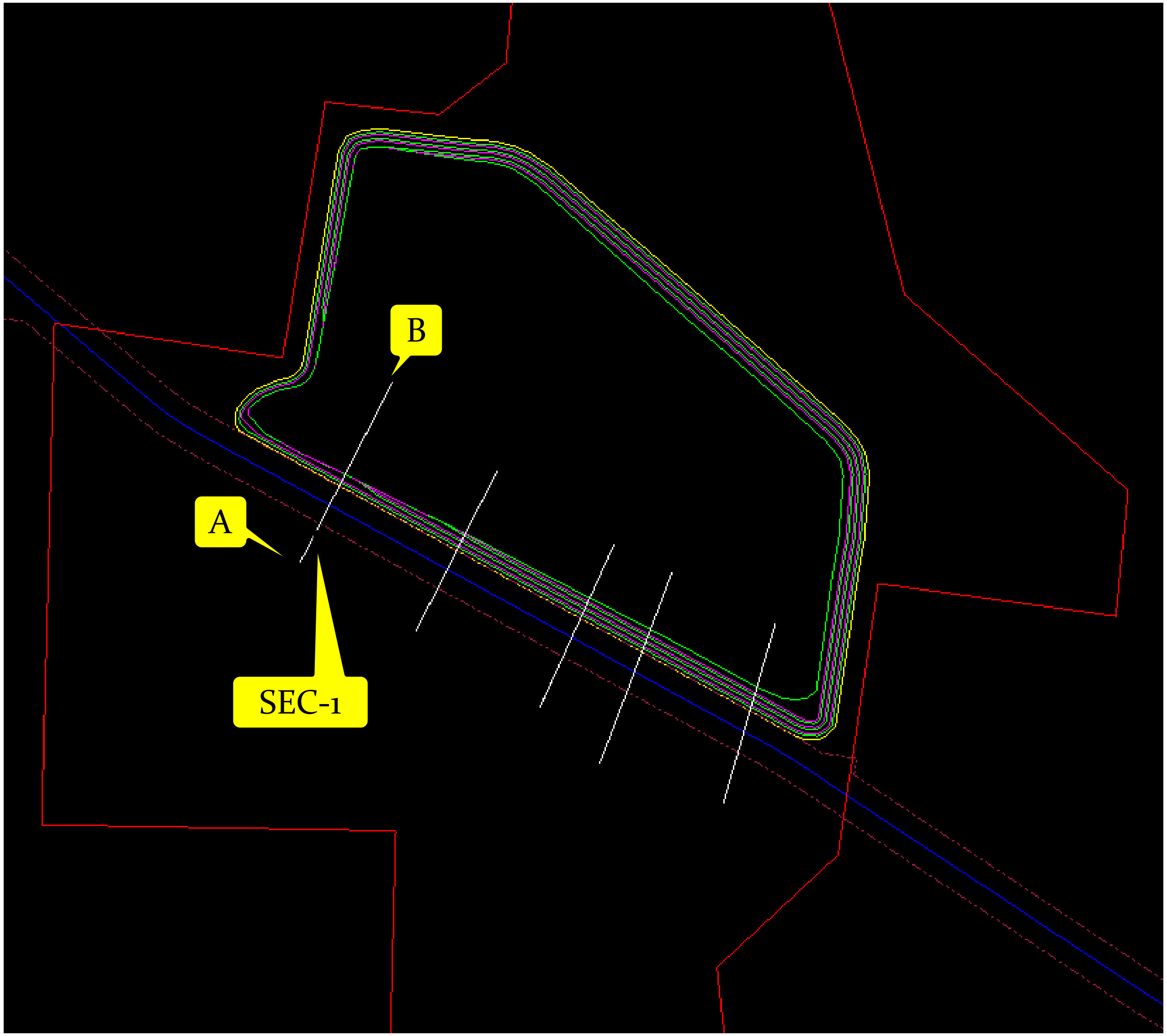
+61 (7) 340 8809

Content

- Cross-sections 1 to 5

Bruce Highway Cross-Sections

Section-1 Year 2030



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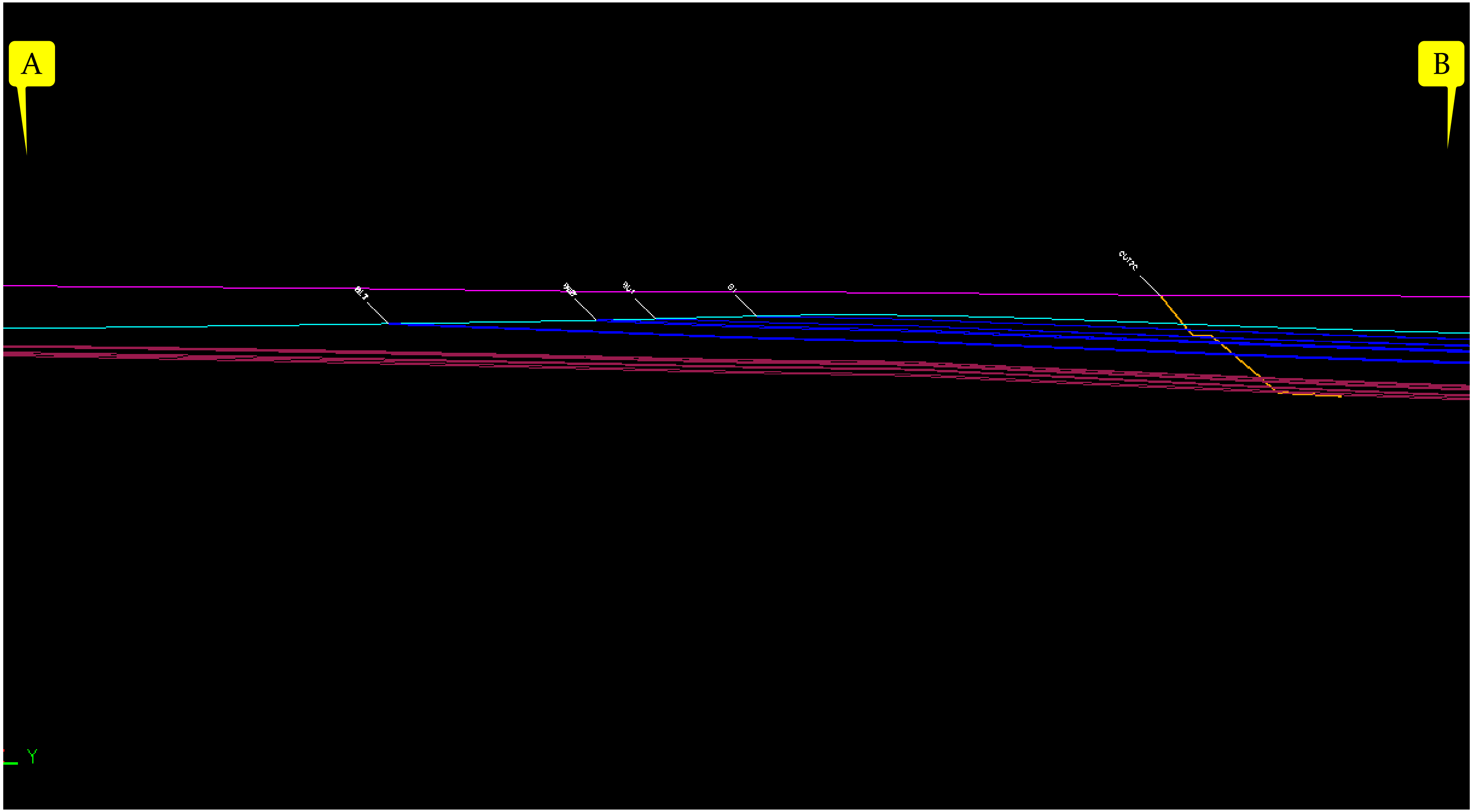
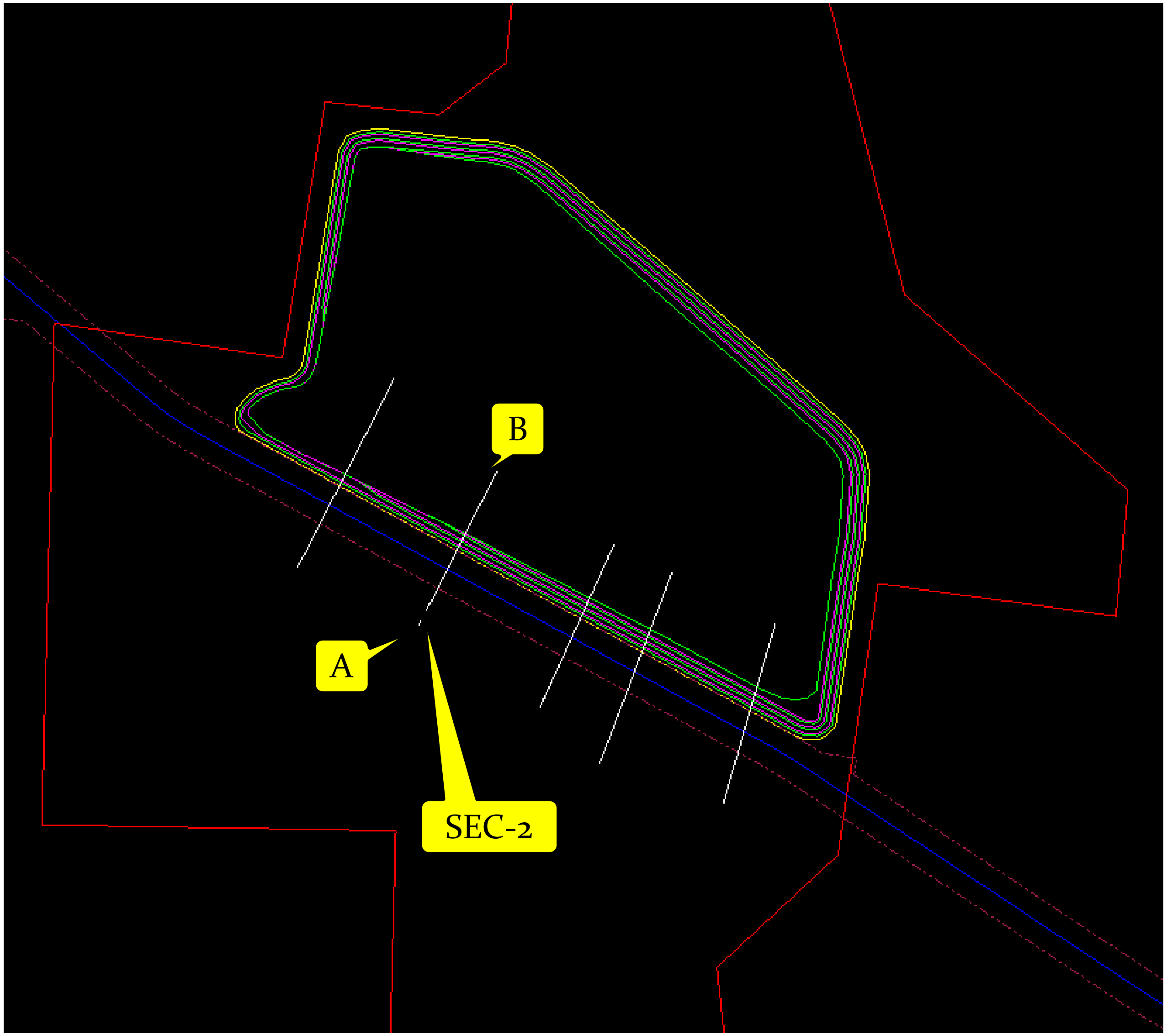


Section-2 Year 2031



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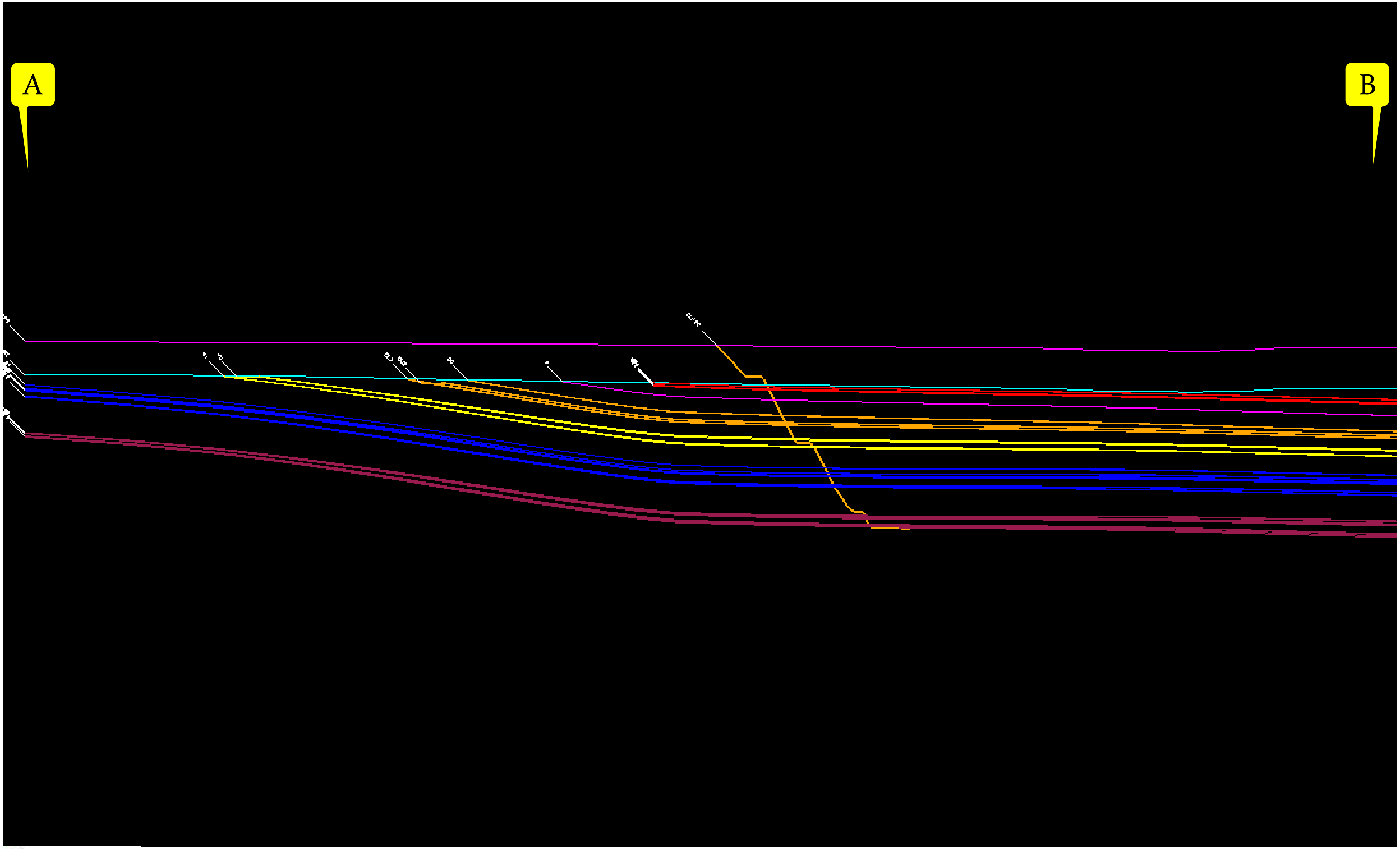

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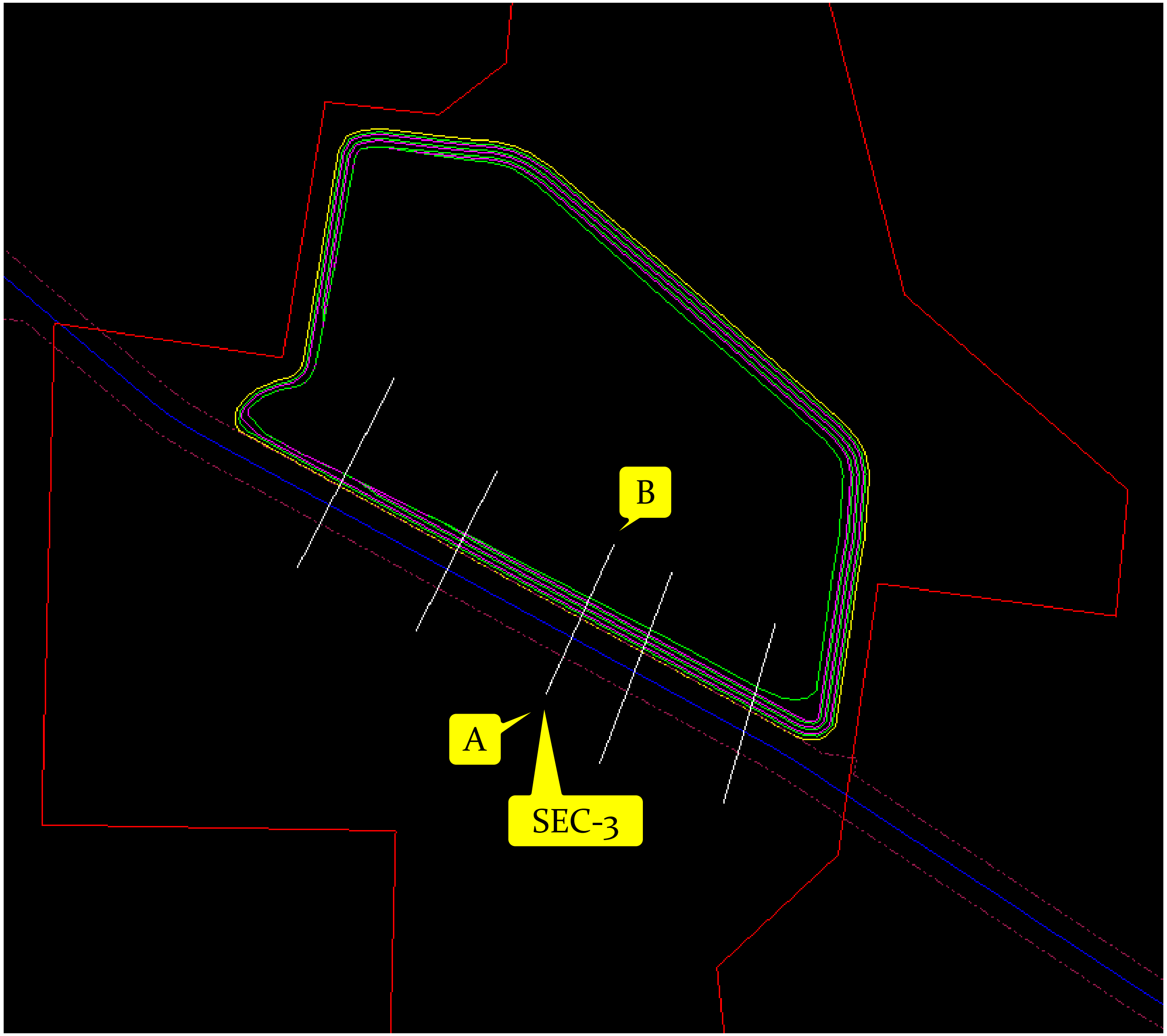

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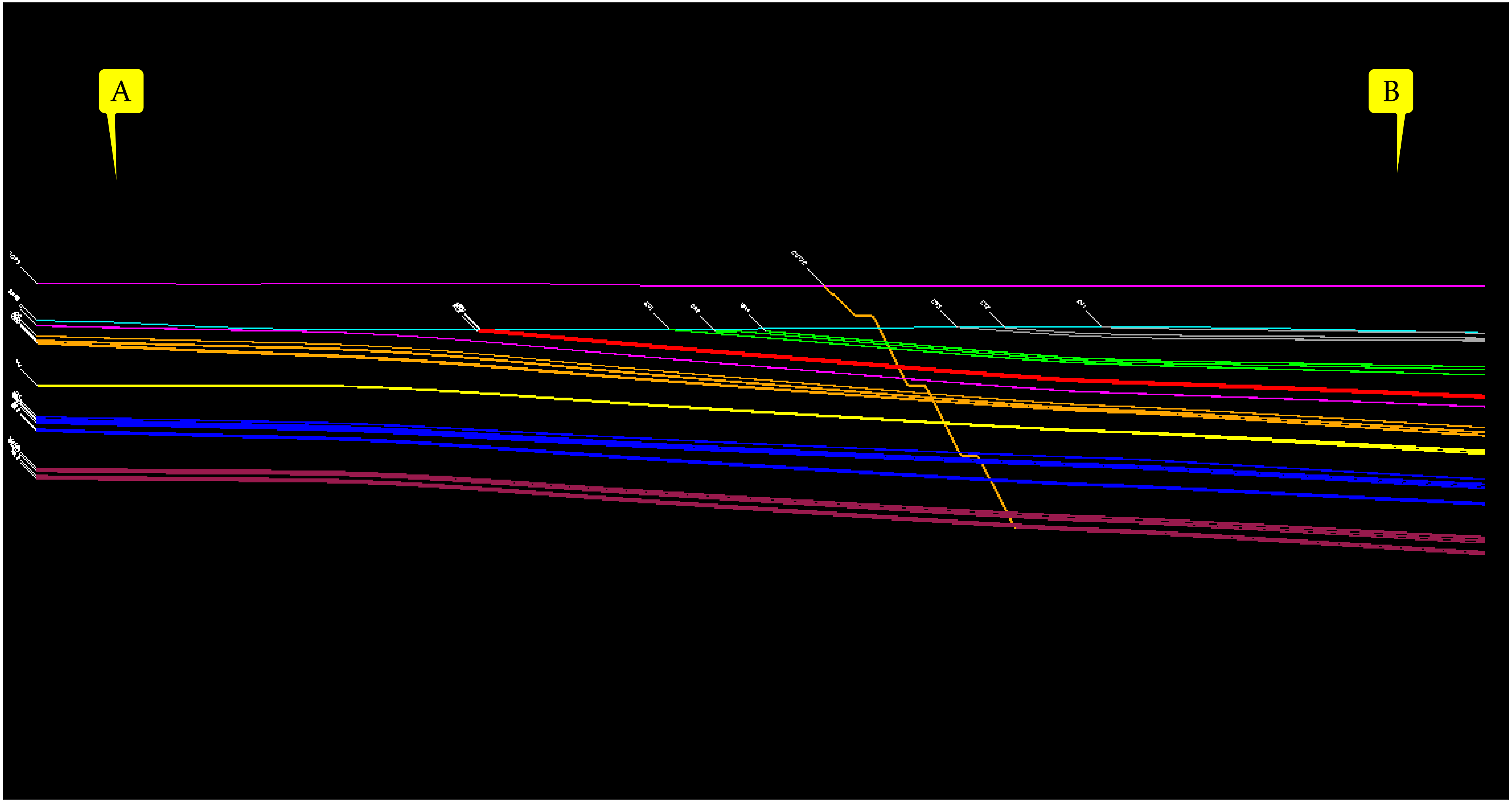

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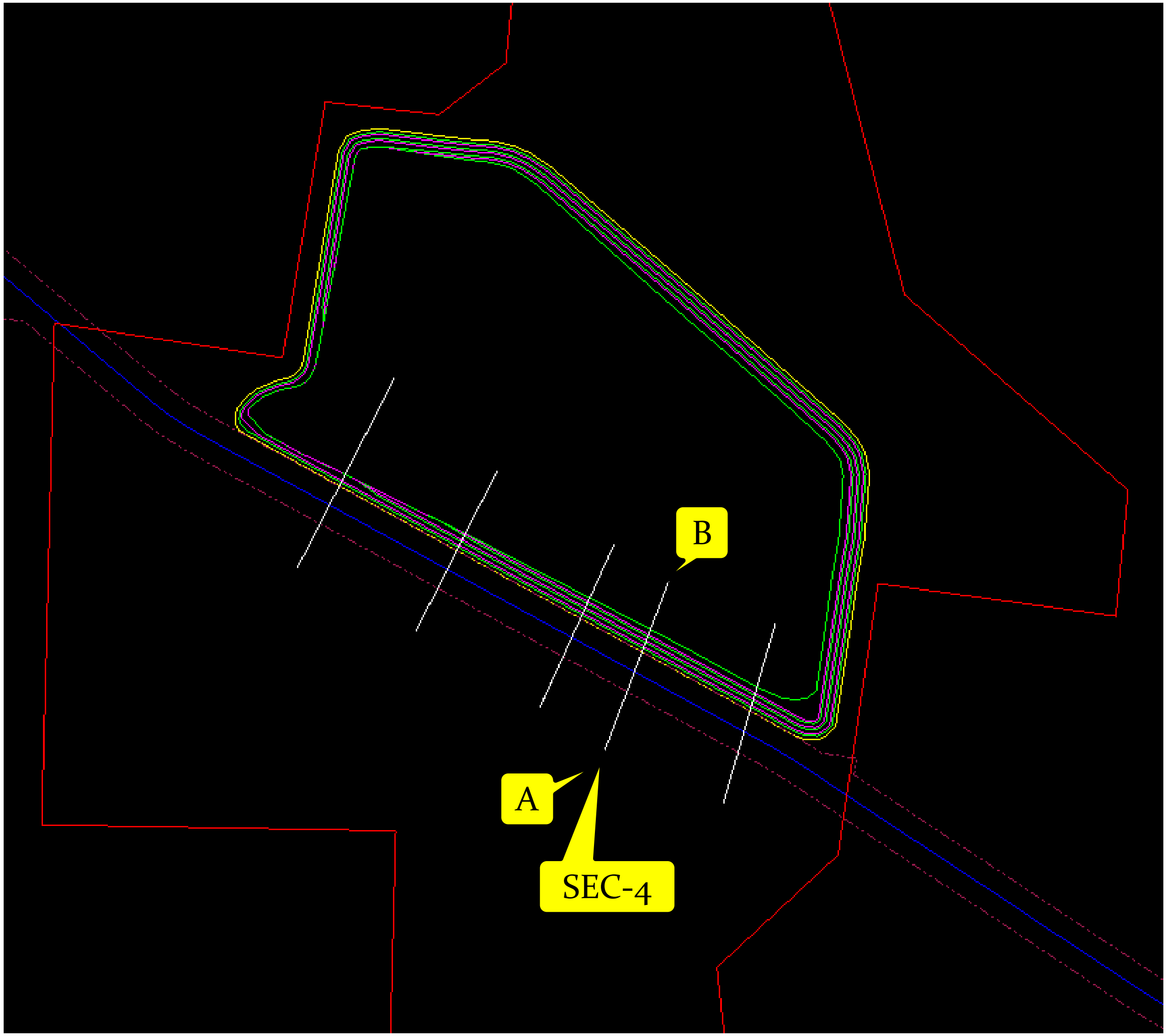

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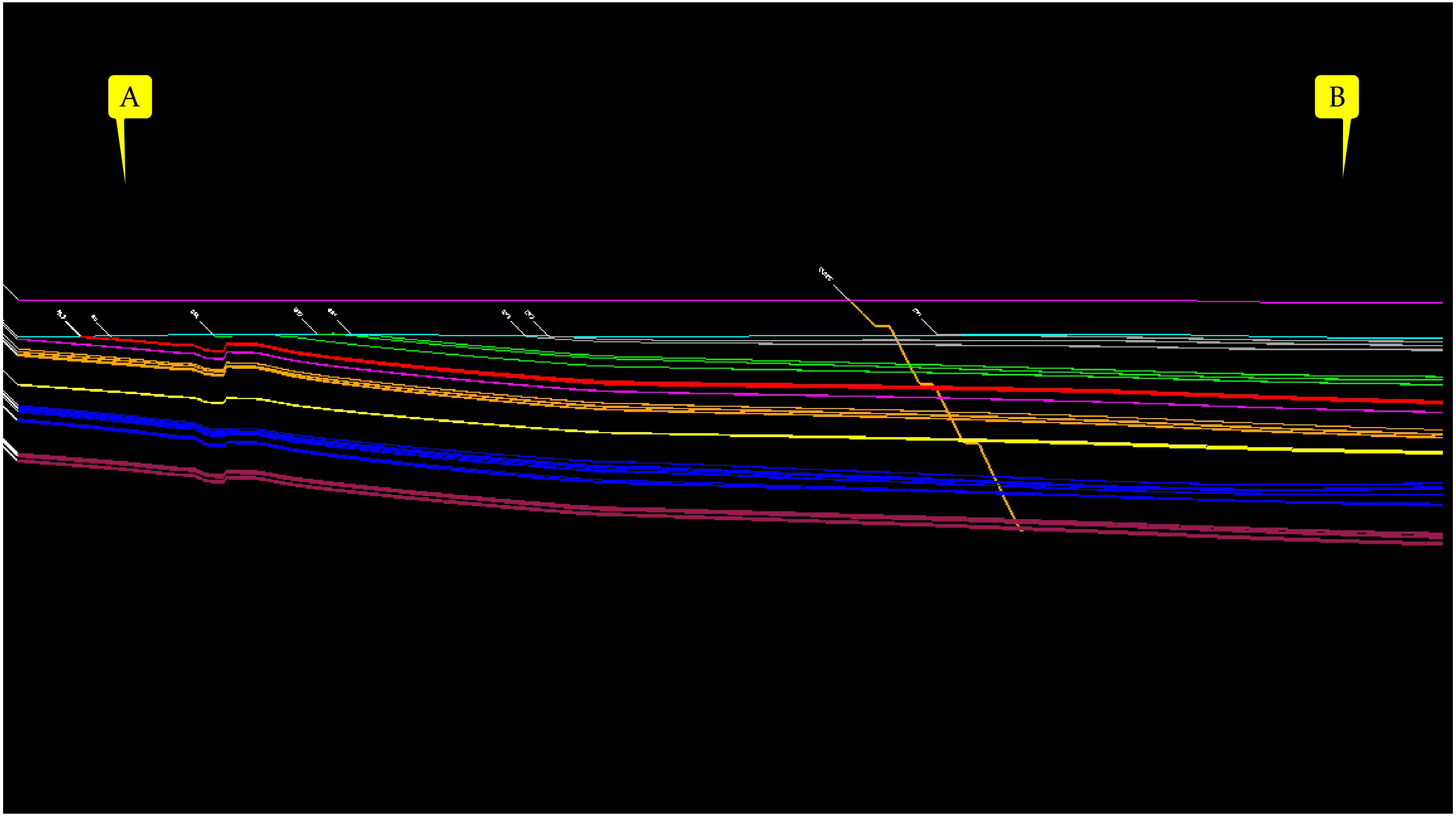

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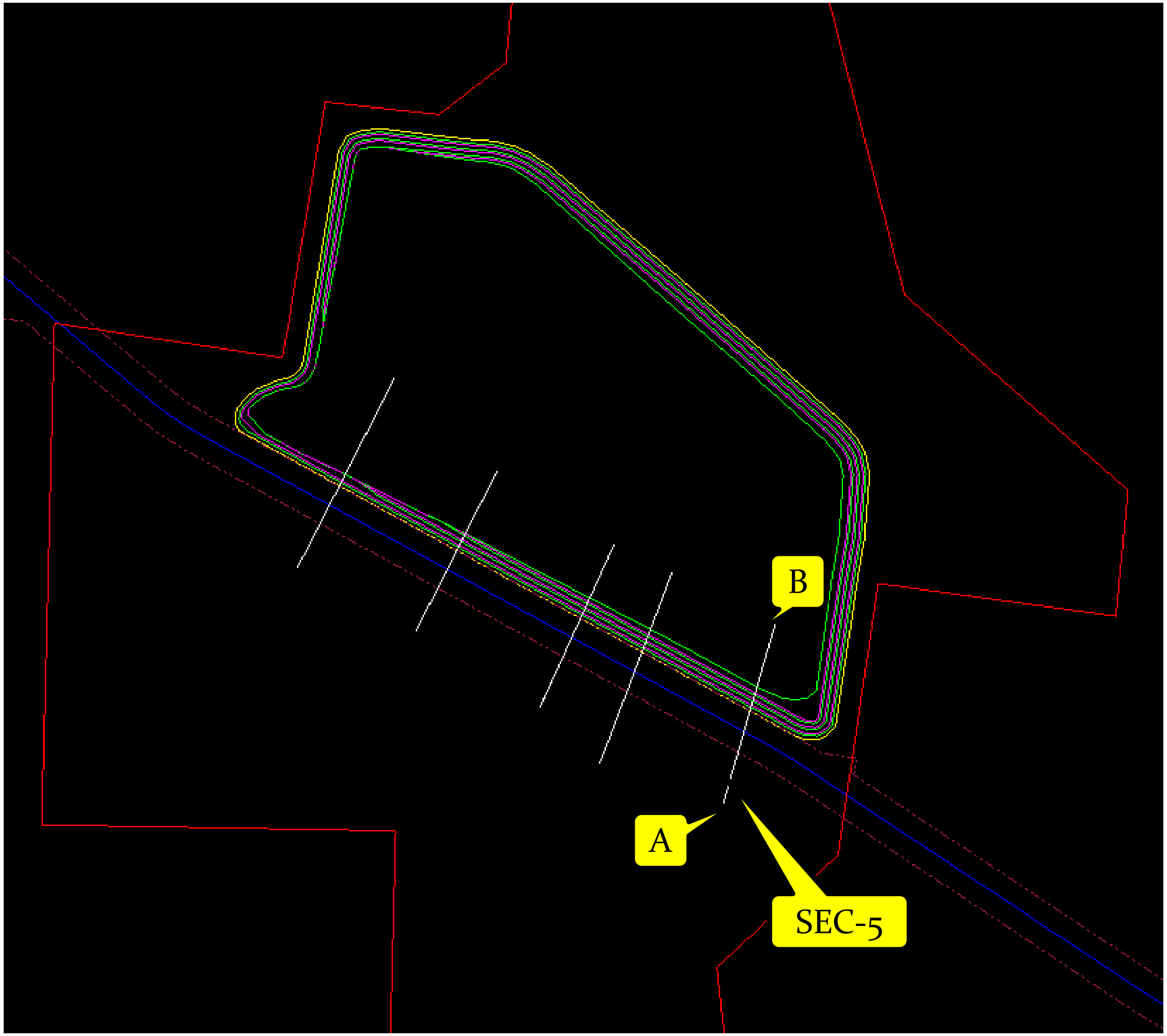

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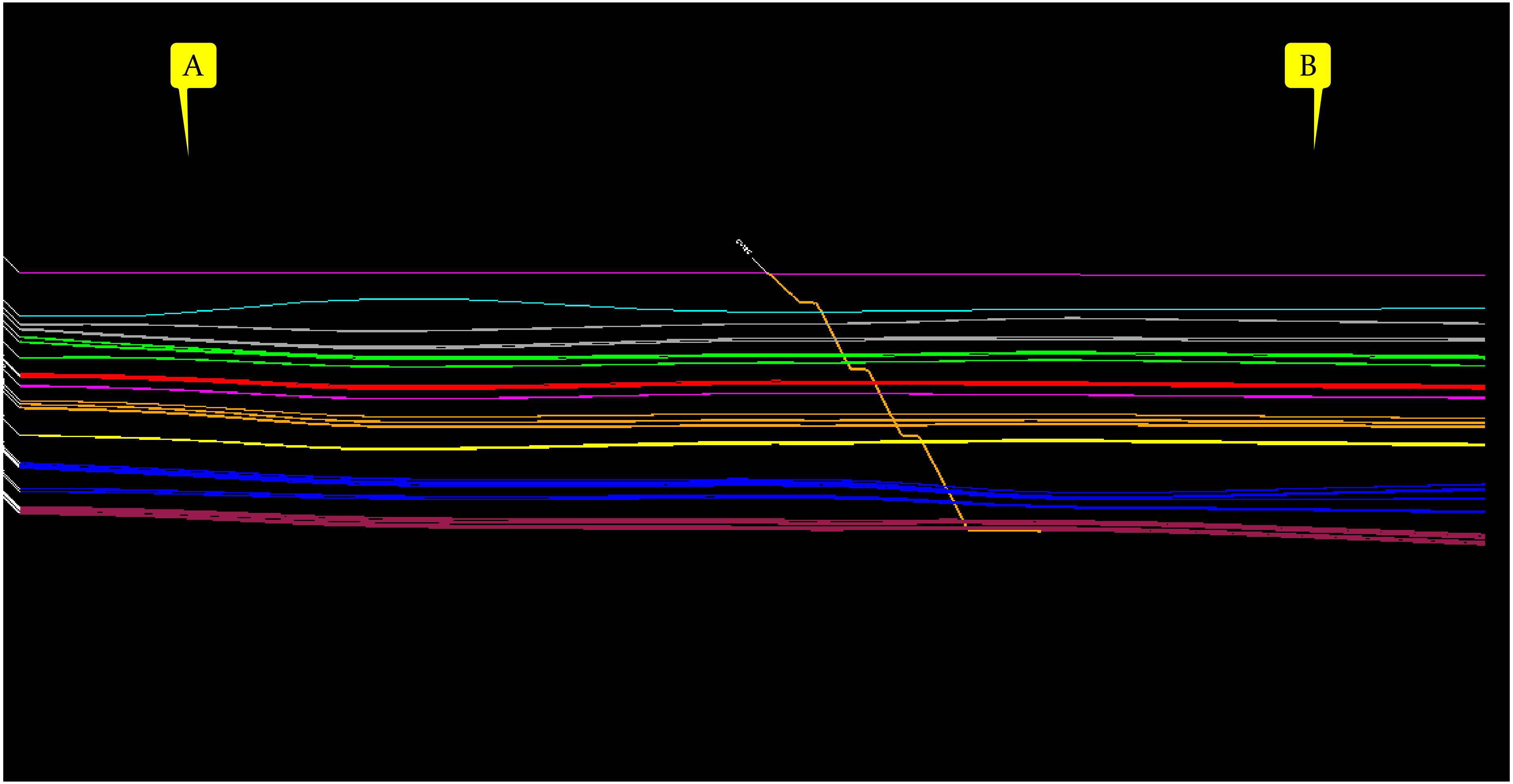

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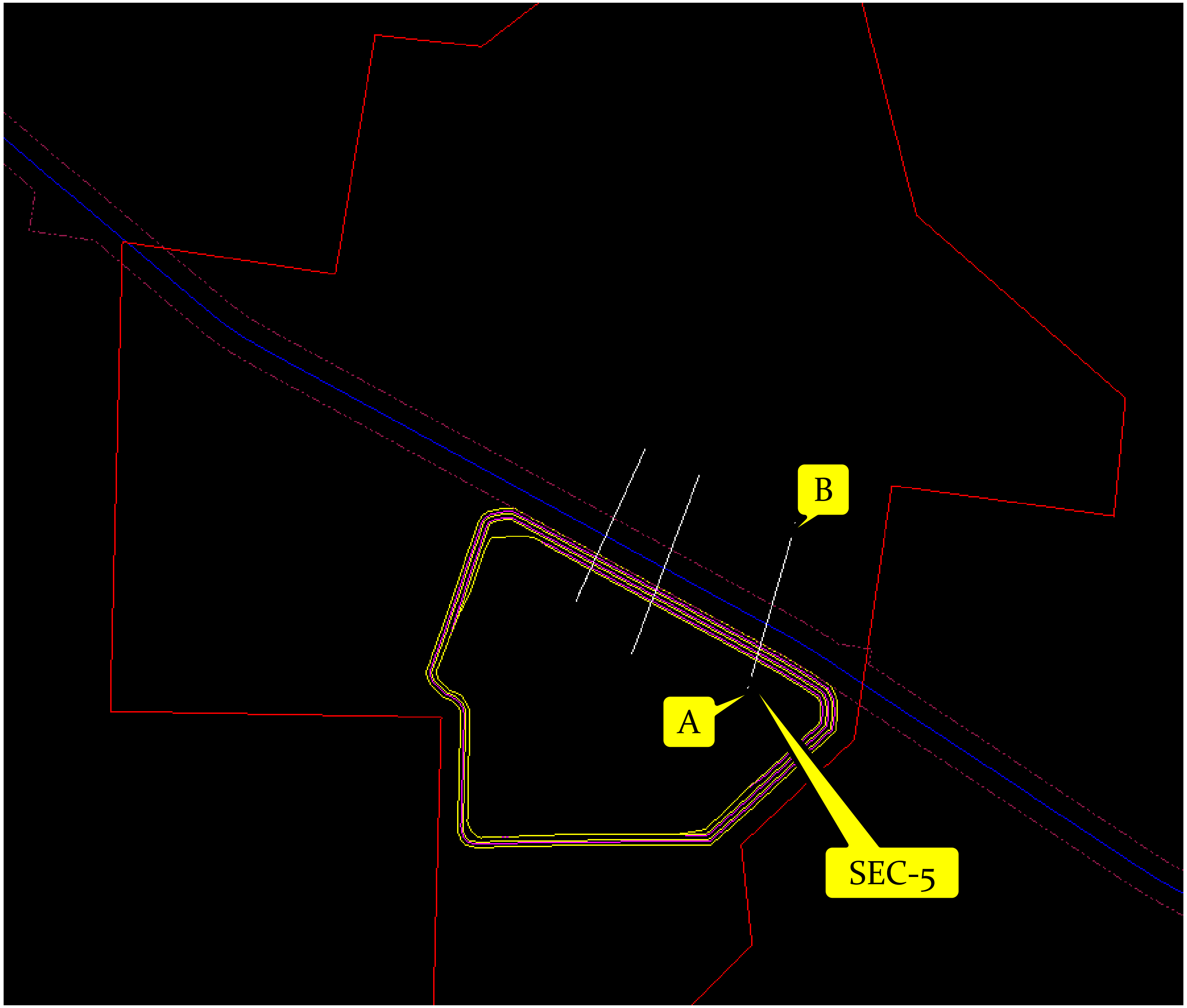

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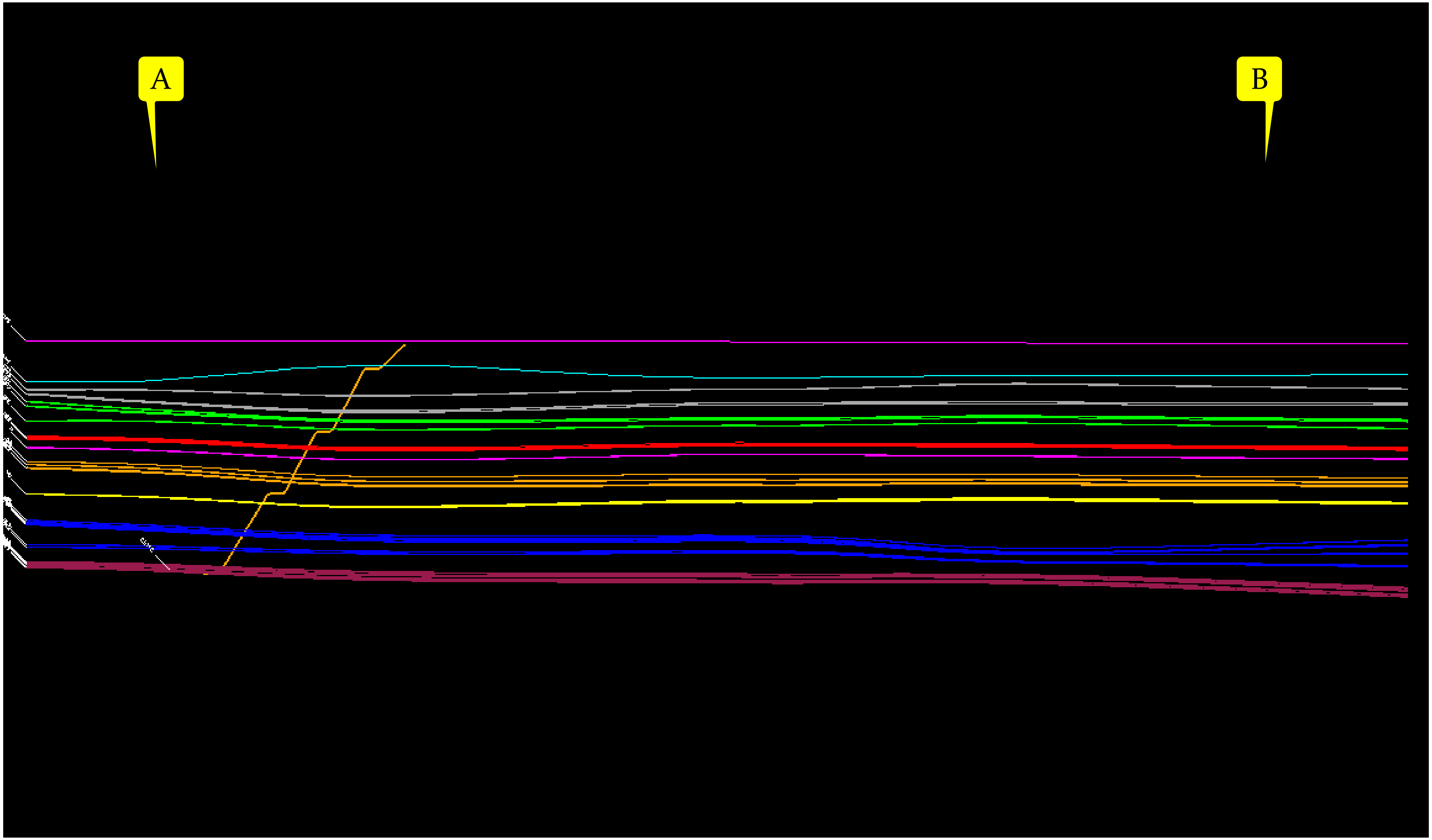

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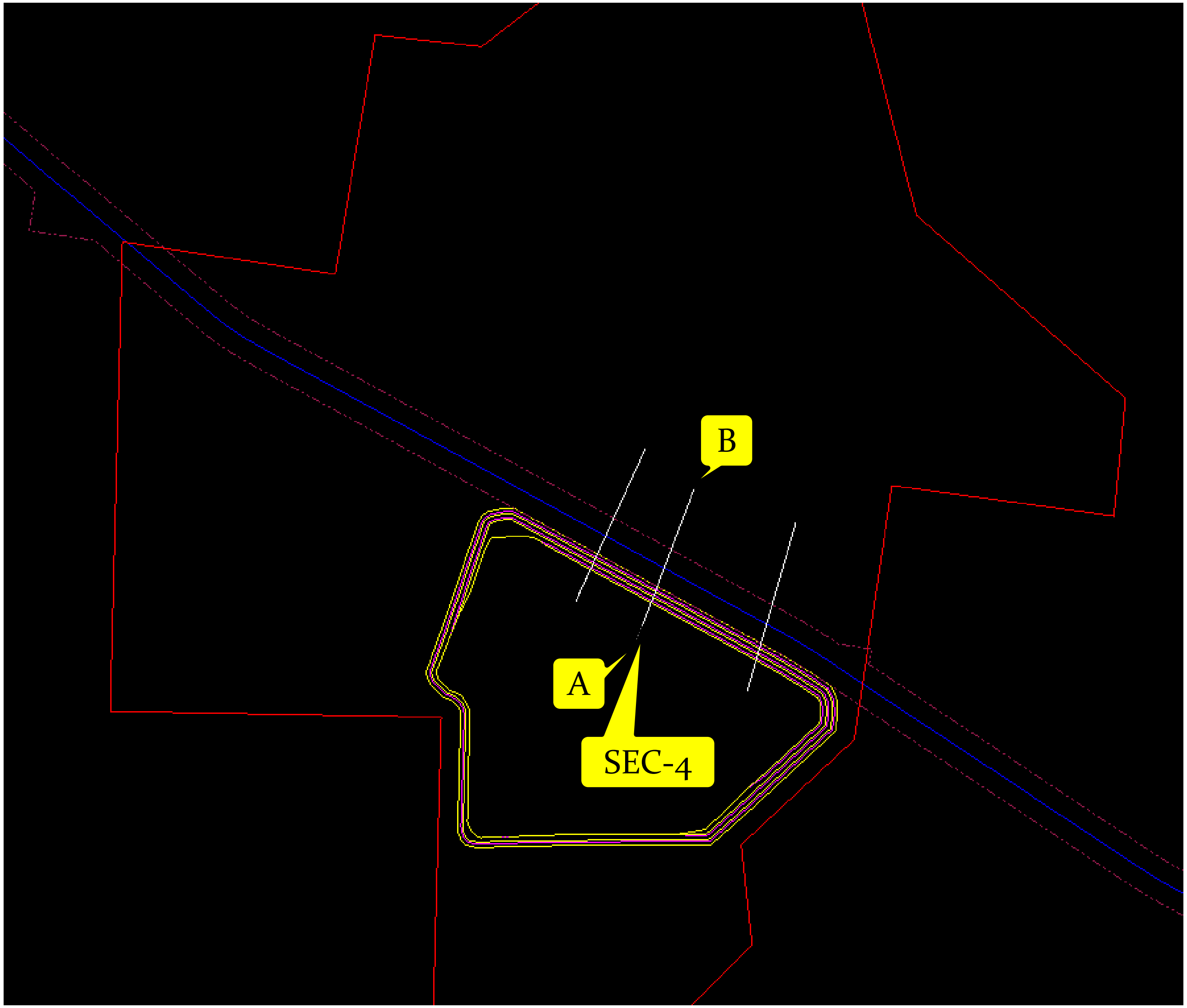

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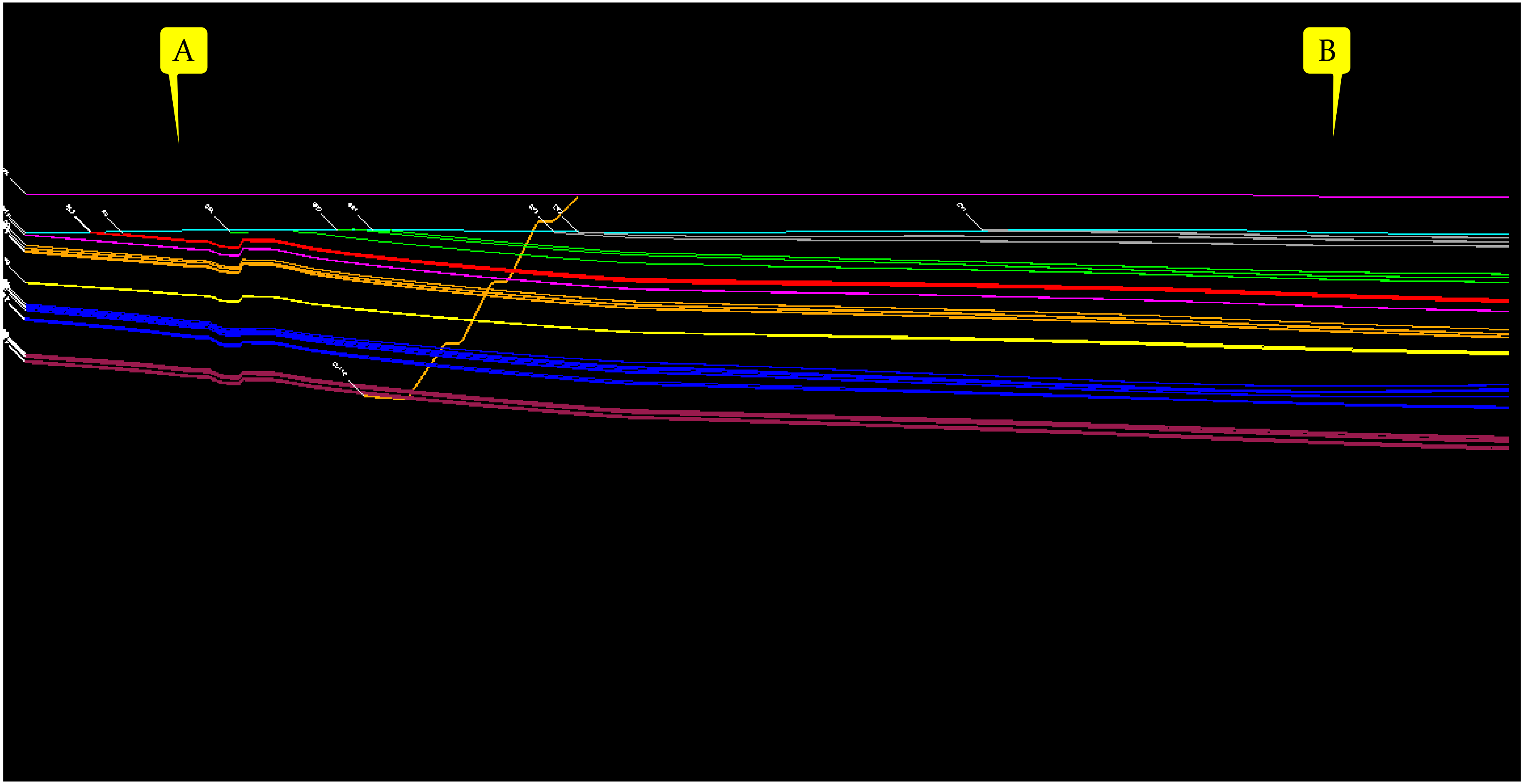

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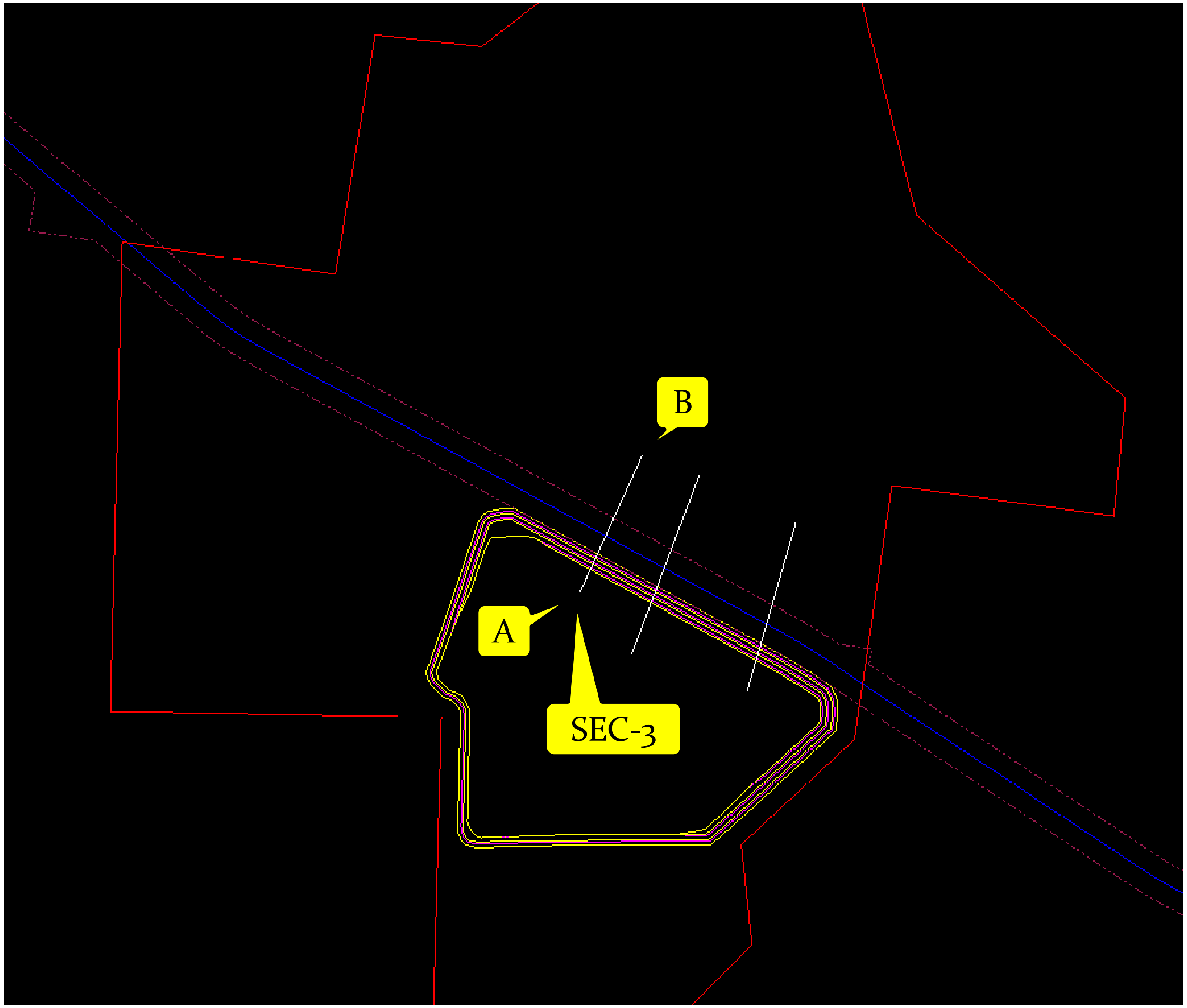

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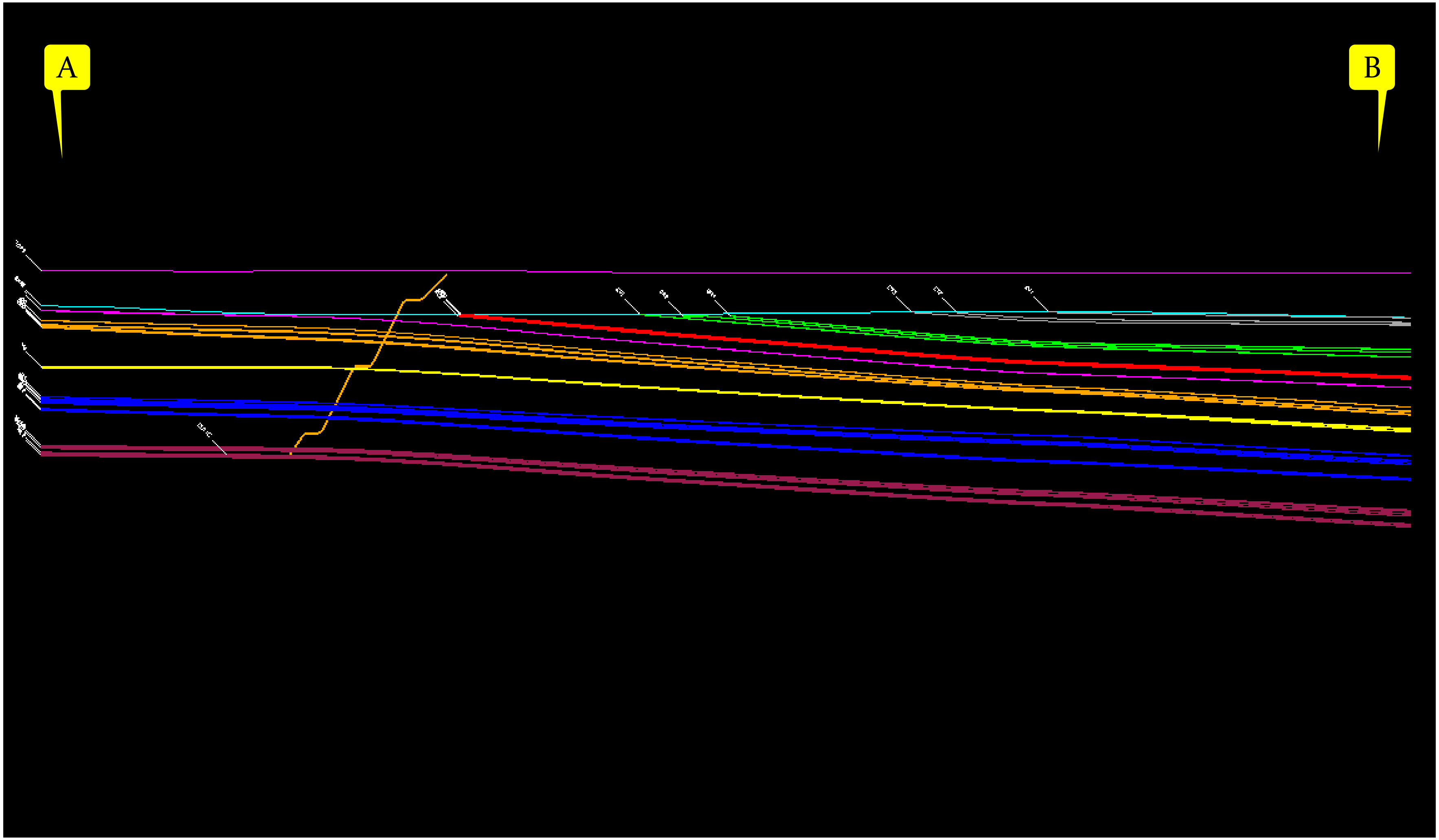

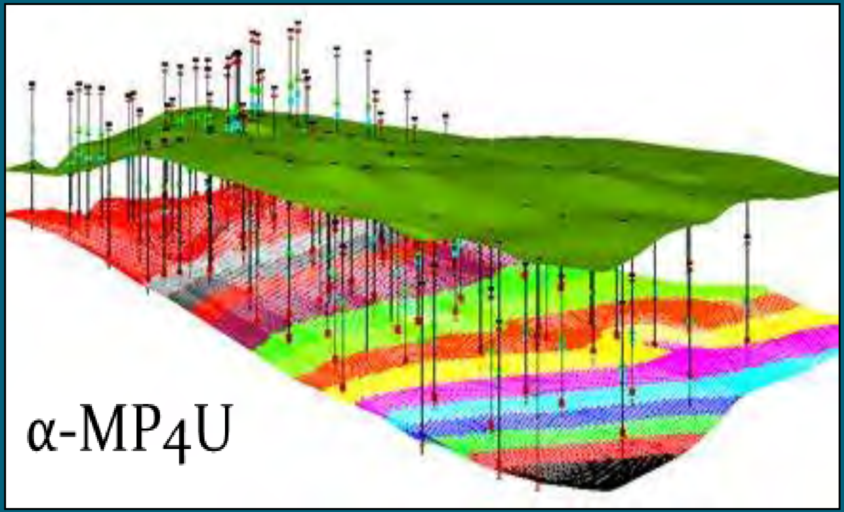

Thank you!

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adriaanben@gmail.com

APPENDIX

C

LABORATORY TEST DATA

Trilab
Soil Rock Calibration

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Ph: +61 7 3265 5656

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Queens Park
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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

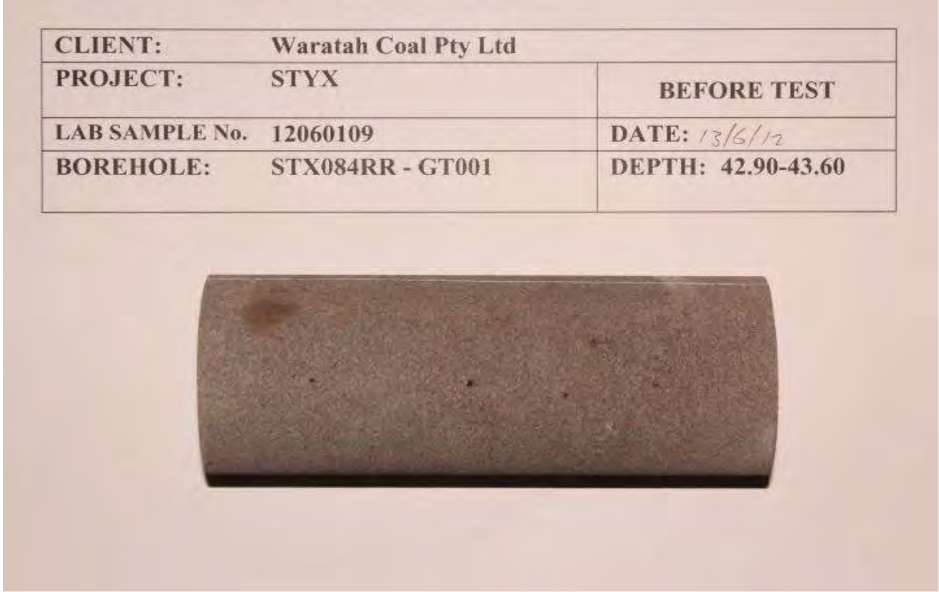
Client	Waratah Coal Pty Ltd	**Report No.**	12060109- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT001	**Depth (m)**	42.90-43.60
Description	SANDSTONE, medium grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.4	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.47	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3333		
"P" Arrival Time (µsec)	62.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060109	DATE:	13/6/12
BOREHOLE:	STX084RR - GT001	DEPTH:	42.90-43.60

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received **Page 1 of 2** REP04401

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
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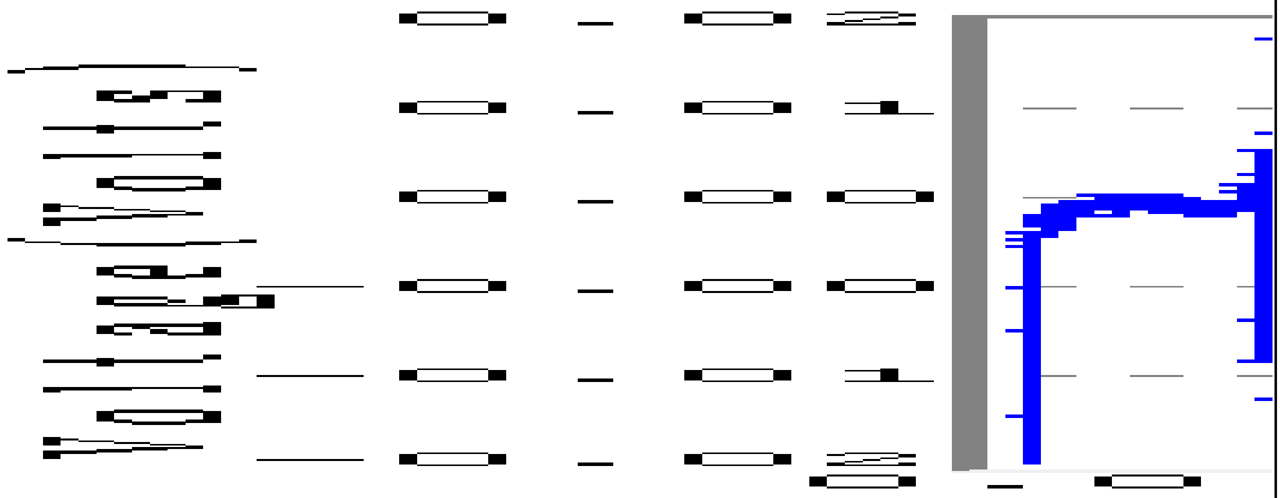
WA 6107
Ph: +61 8 9258 8323

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

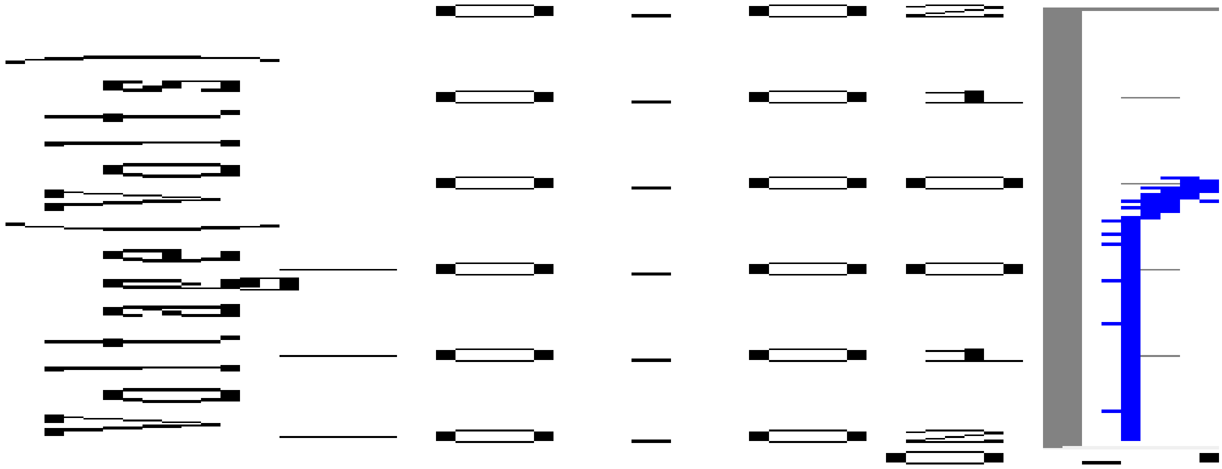
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060109- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT001	**Depth (m)**	42.90-43.60
Description	SANDSTONE, medium grained 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

Trilab
Soil Rock Calibration

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Perth
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Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060109-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060109
Client ID	STX084RR - GT001
Depth (m)	42.90-43.60
Description	SANDSTONE, medium grained 100%
Wet Density (t/m^3)	2.47
Moisture Content (%)	4.6
Specimen Length (mm)	160.4
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:53

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	AFTER TEST
LAB SAMPLE No.	12060109	DATE: 15/6/2012
BOREHOLE:	STX084RR - GT001	DEPTH: 42.90-43.60

UCS (MPa)	25.2

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

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Authorised Signatory
James Russell
J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060110- SON

Test Date 13/06/2012

Report Date 14/06/2012

Client ID STX084RR - GT002

Depth (m) 45.59-45.89

Description SANDSTONE, fine grained 100%

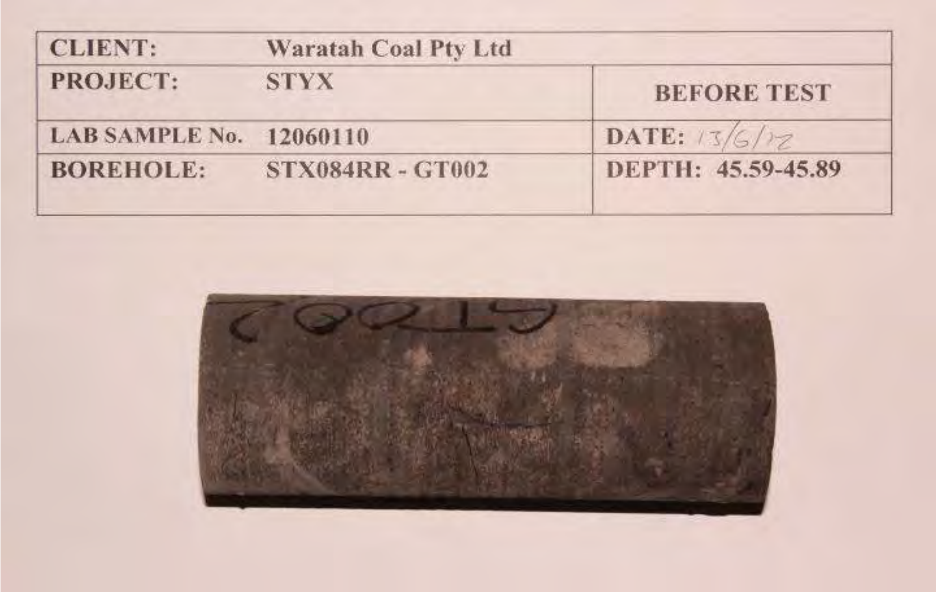
Sample Type Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.7	Couplant	Honey
Sample Height (mm)	159.6	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.32	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2323		
"P" Arrival Time (μsec)	82.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060110	DATE:	13/6/12
BOREHOLE:	STX084RR - GT002	DEPTH:	45.59-45.89

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

Trilab
Soil Rock Calibration

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Ph: +61 8 9258 8323

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060110- SON

Test Date 13/06/2012

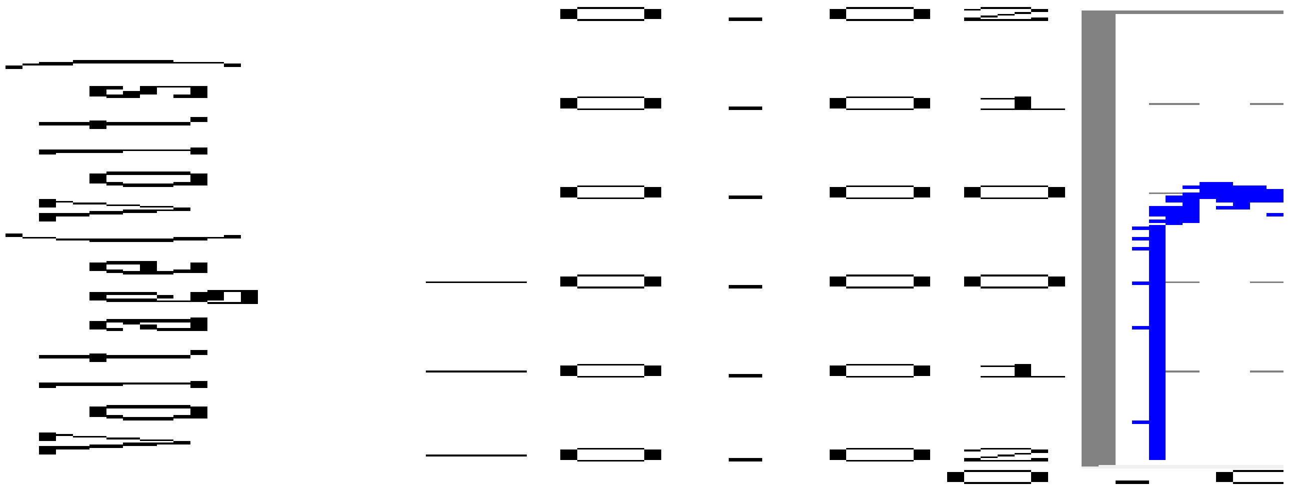
Report Date 14/06/2012

Client ID STX084RR - GT002

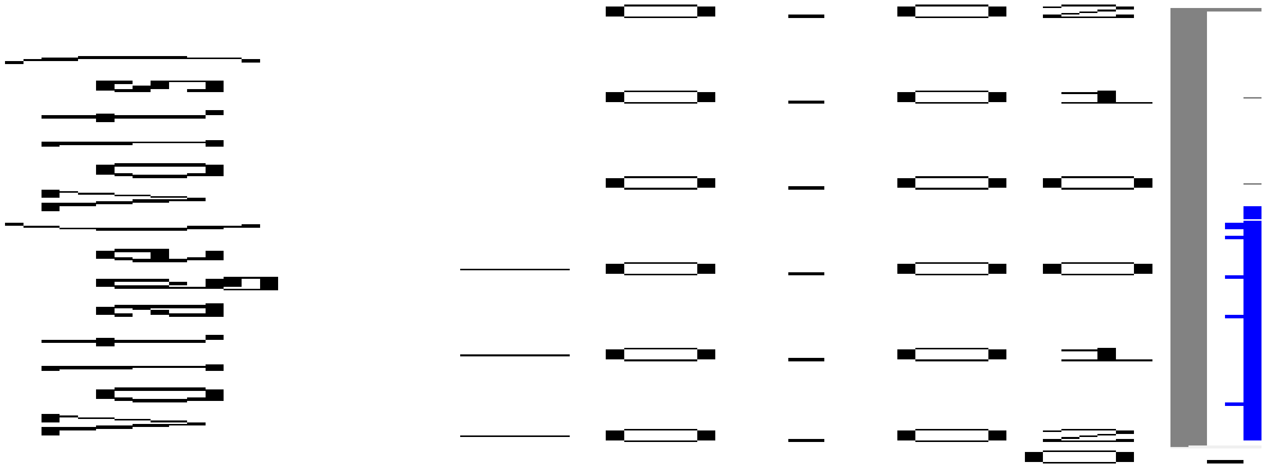
Depth (m) 45.59-45.89

Description SANDSTONE, fine grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

Trilab
Soil Rock Calibration

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Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060110-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060110
Client ID	STX084RR - GT002
Depth (m)	45.59-45.89
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.32
Moisture Content (%)	6.7
Specimen Length (mm)	159.6
Specimen Diameter (mm)	60.7
Mode of Failure	Conical
Test Duration (Min:Sec)	1:58

UCS (MPa)	4.60

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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Authorised Signatory
James Russell
J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

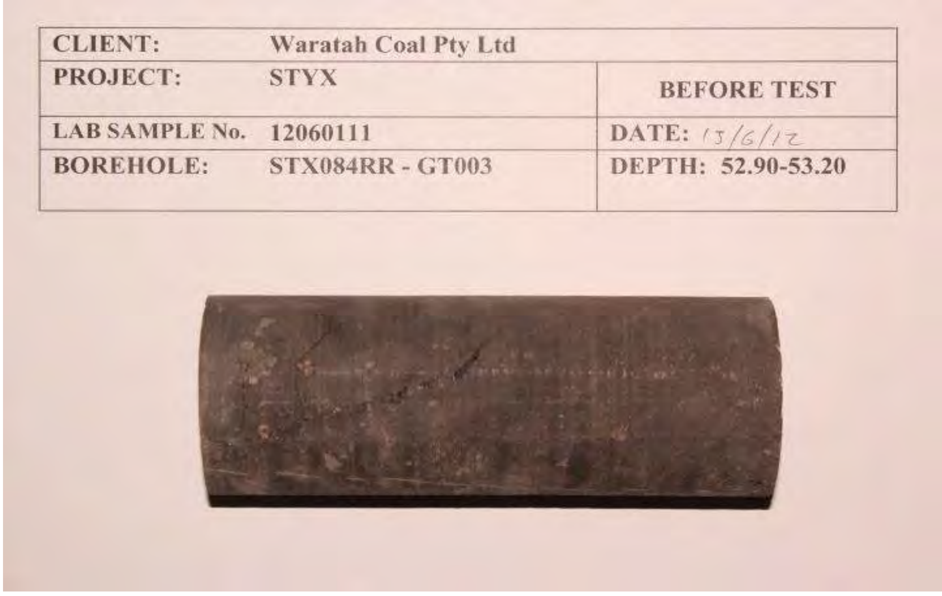
Client	Waratah Coal Pty Ltd	**Report No.**	12060111- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT003	**Depth (m)**	52.90-53.20
Description	SILTSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.40	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	NO TRACE		
"P" Arrival Time (μsec)	N/A	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060111	DATE:	13/6/12
BOREHOLE:	STX084RR - GT003	DEPTH:	52.90-53.20

Notes/Remarks:

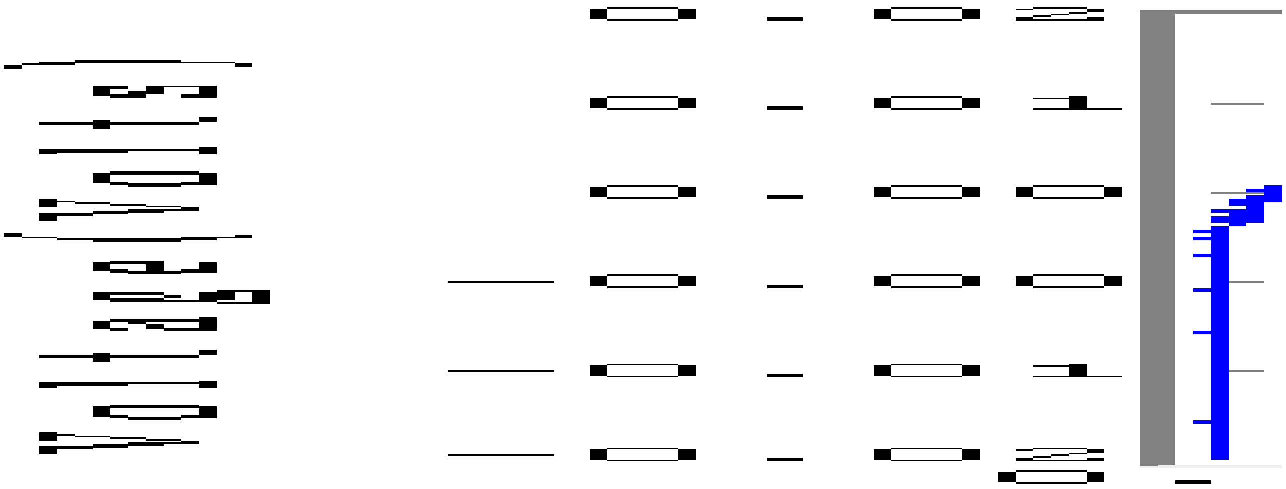
Sample/s supplied by client   Photo not to scale   Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

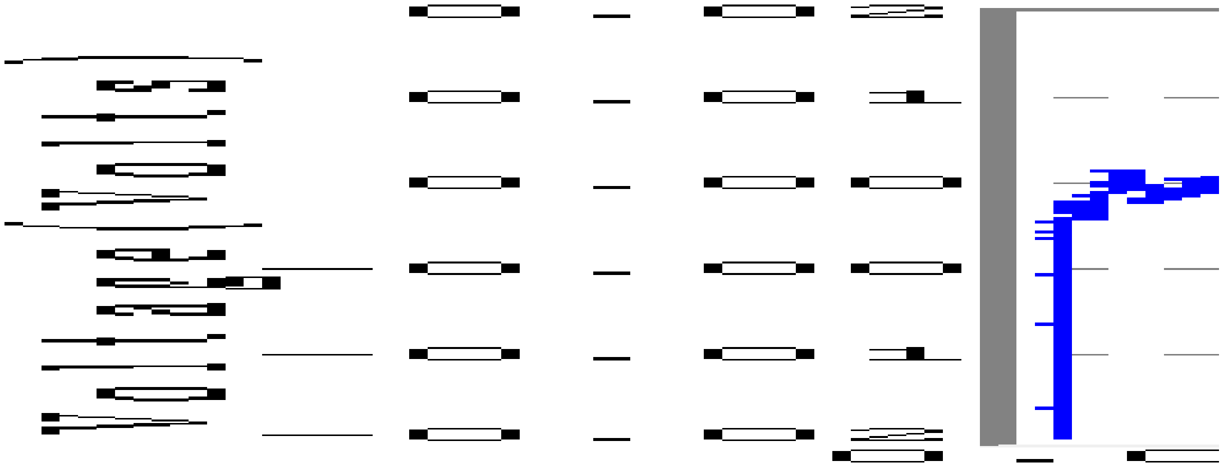
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060111- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT003	**Depth (m)**	52.90-53.20
Description	SILTSTONE 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060111-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060111
Client ID	STX084RR - GT003
Depth (m)	52.90-53.20
Description	SILTSTONE 100%
Wet Density (t/m^3)	2.40
Moisture Content (%)	6.7
Specimen Length (mm)	160.5
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	3:43

UCS (MPa)	5.02

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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Authorised Signatory

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J. Russell

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Laboratory No. 9926

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

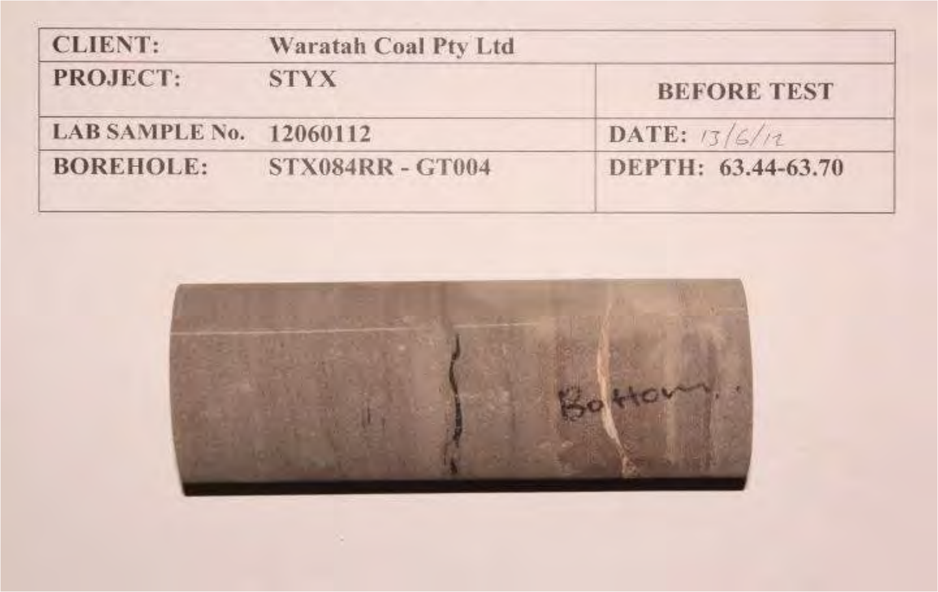
Client	Waratah Coal Pty Ltd	**Report No.**	12060112- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT004	**Depth (m)**	63.44-63.70
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	161.0	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.65	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3458		
"P" Arrival Time (µsec)	60.4	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	**BEFORE TEST**	
LAB SAMPLE No.	12060112	**DATE:**	13/6/12
BOREHOLE:	STX084RR - GT004	**DEPTH:**	63.44-63.70

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060112- SON

Test Date 13/06/2012

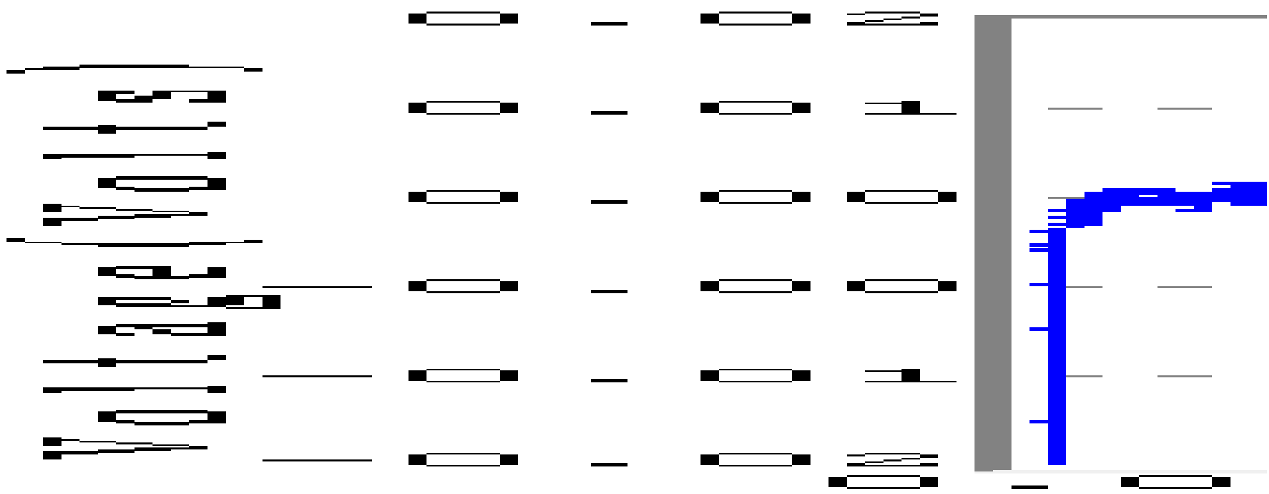
Report Date 14/06/2012

Client ID STX084RR - GT004

Depth (m) 63.44-63.70

Description SANDSTONE, fine grained 100%

"P" WAVEFORM



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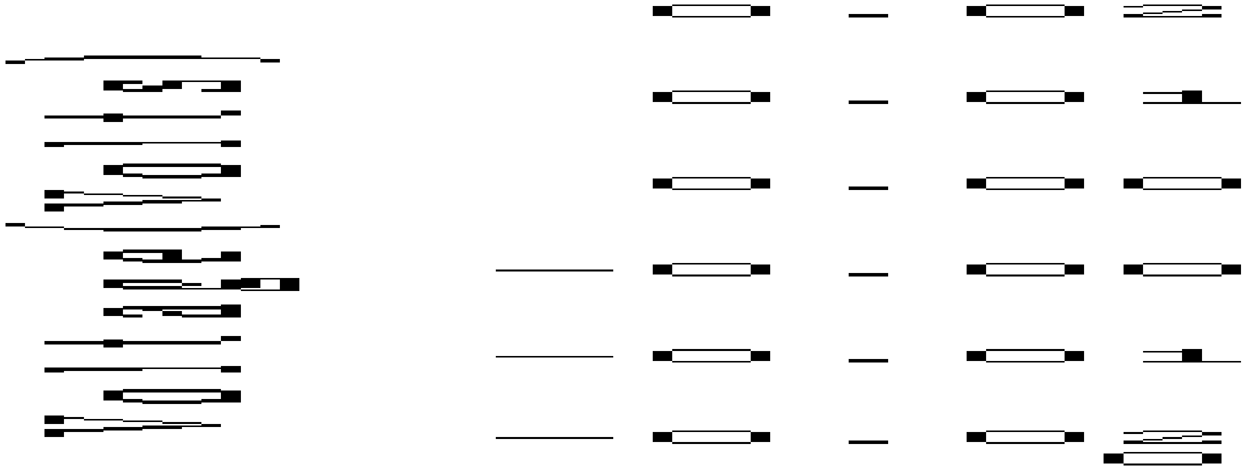

Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060112-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060112
Client ID	STX084RR - GT004
Depth (m)	63.44-63.70
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.65
Moisture Content (%)	4.2
Specimen Length (mm)	161.0
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	8:47

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060112
DATE: 15/6/2012
BOREHOLE: STX084RR - GT004
DEPTH: 63.44-63.70

UCS (MPa)	24.5

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

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Authorised Signatory
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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

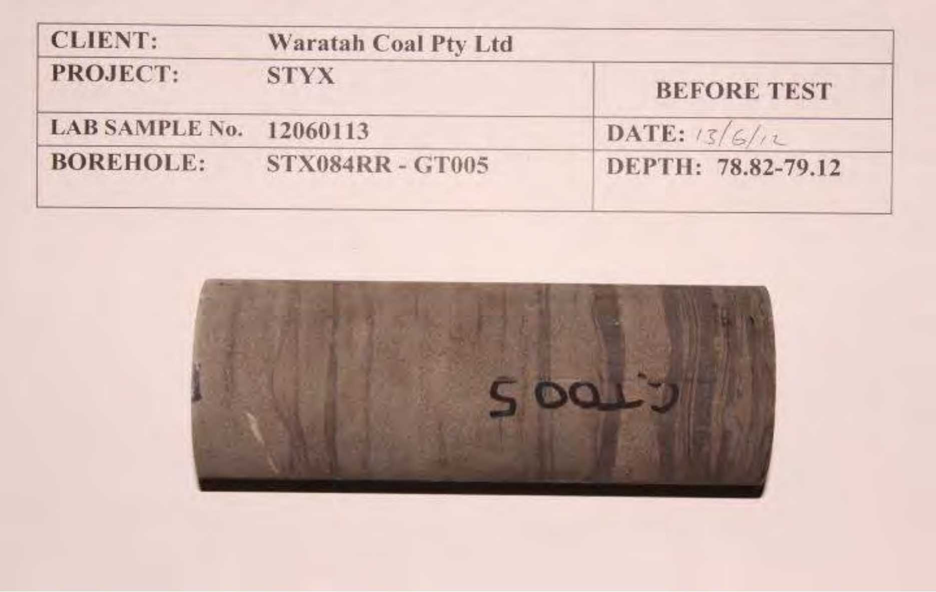
Client	Waratah Coal Pty Ltd	**Report No.**	12060113- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT005	**Depth (m)**	78.82-79.12
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.8	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.49	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2938		
"P" Arrival Time (µsec)	68.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060113	DATE: 13/6/12
BOREHOLE:	STX084RR - GT005	DEPTH: 78.82-79.12

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received **Page 1 of 2** REP04401

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060113- SON

Test Date 13/06/2012

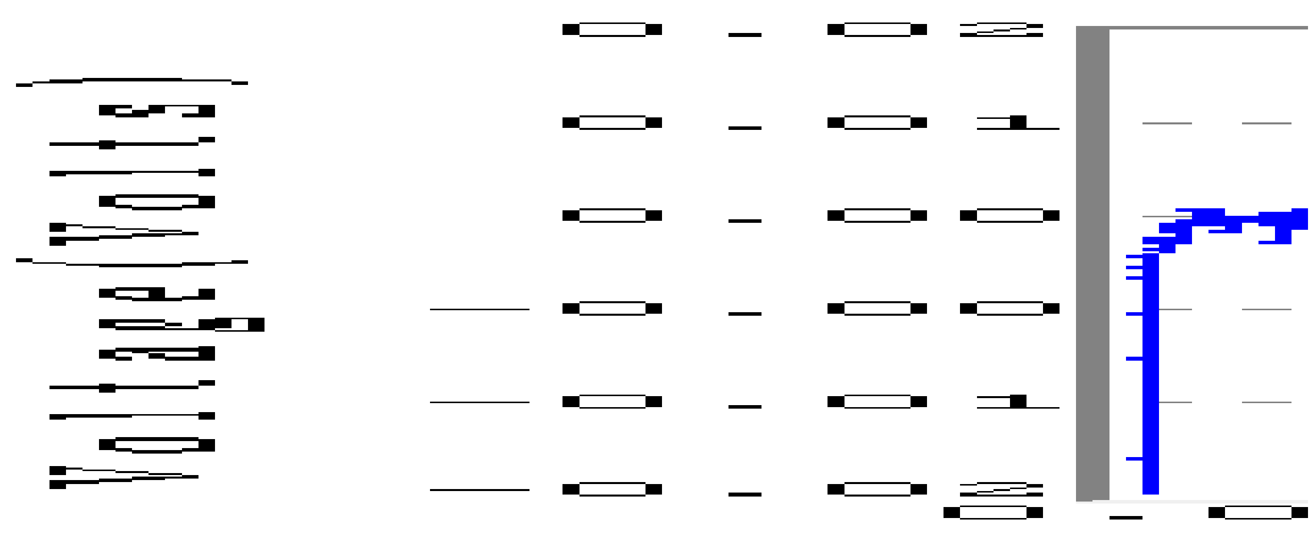
Report Date 14/06/2012

Client ID STX084RR - GT005

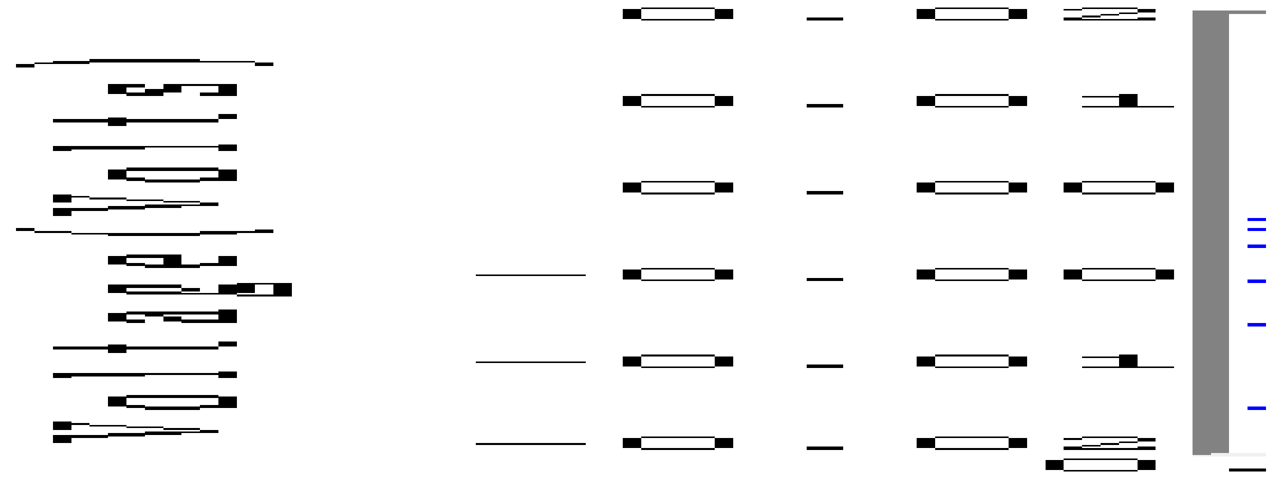
Depth (m) 78.82-79.12

Description SANDSTONE, fine grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060113-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060113
Client ID	STX084RR - GT005
Depth (m)	78.82-79.12
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.49
Moisture Content (%)	4.7
Specimen Length (mm)	160.8
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	7:11

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060113
DATE: 15/6/12
BOREHOLE: STX084RR - GT005
DEPTH: 78.82-79.12

UCS (MPa)	20.9

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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Laboratory No. 9926

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060115- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT007	**Depth (m)**	98.70-98.92
Description	SANDSTONE, very fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.5	Couplant	Honey
Sample Height (mm)	130.4	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.61	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3049		
"P" Arrival Time (µsec)	56.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060115	DATE: 13/6/12
BOREHOLE:	STX084RR - GT007	DEPTH: 98.70-98.92

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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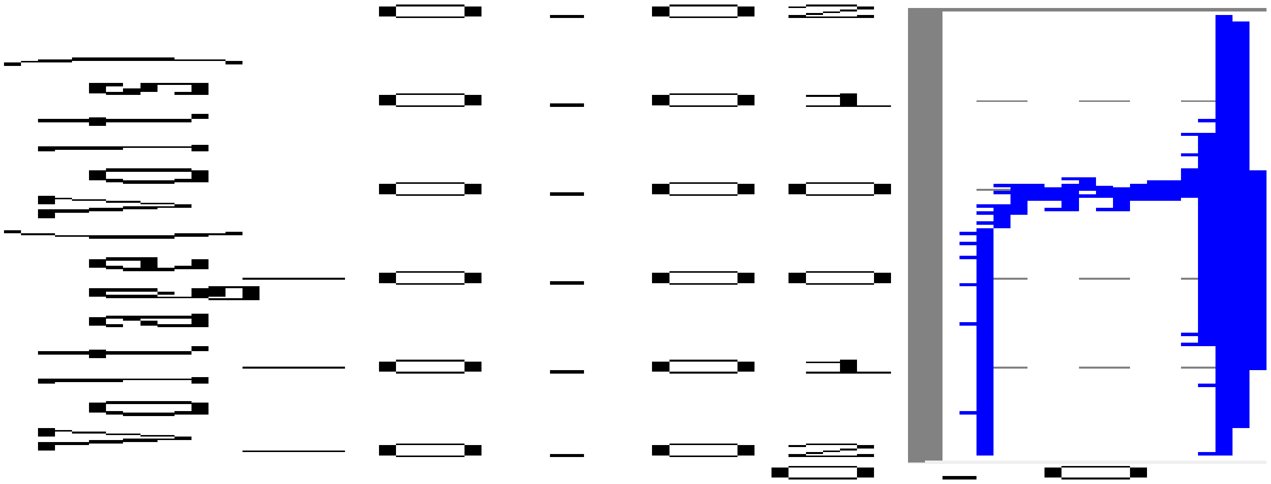
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

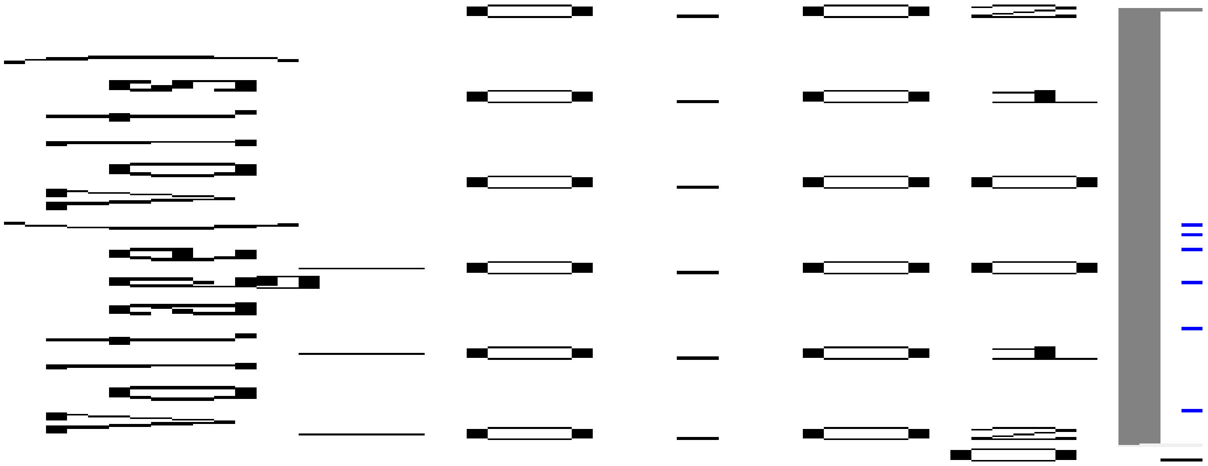
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060115- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT007	**Depth (m)**	98.70-98.92
Description	SANDSTONE, very fine grained 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060115-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060115
Client ID	STX084RR - GT007
Depth (m)	98.70-98.92
Description	SANDSTONE, very fine grained 100%
Wet Density (t/m^3)	2.61
Moisture Content (%)	4.3
Specimen Length (mm)	130.4 *
Specimen Diameter (mm)	60.5
Mode of Failure	Shear
Test Duration (Min:Sec)	3:0

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060115
DATE: 15/6/2012
BOREHOLE: STX084RR - GT007
DEPTH: 98.70-98.92

UCS (MPa)	5.43

NOTES/REMARKS:

Stored and tested as received
* Length to diameter ratio less than 2.5:1
Photo not to scale
Sample/s supplied by the client
Test Apparatus - ELE 1000 kN Compression Machine

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

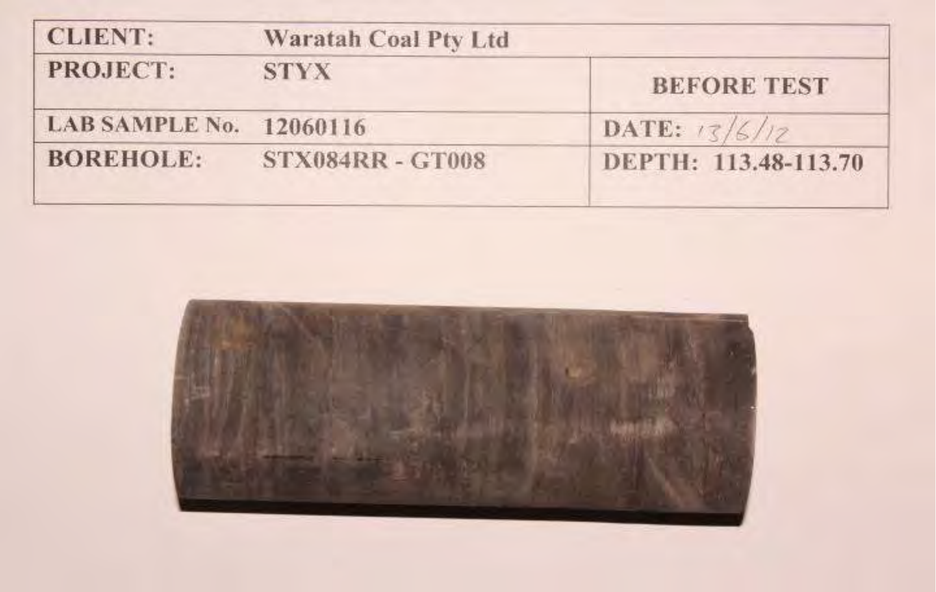
Client	Waratah Coal Pty Ltd	**Report No.**	12060116- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT008	**Depth (m)**	113.48-113.70
Description	MUDSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.5	Couplant	Honey
Sample Height (mm)	160.8	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.38	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2938		
"P" Arrival Time (µsec)	68.6	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	**BEFORE TEST**	
LAB SAMPLE No.	12060116	**DATE:** 13/6/12	
BOREHOLE:	STX084RR - GT008	**DEPTH:** 113.48-113.70	

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060116- SON

Test Date 13/06/2012

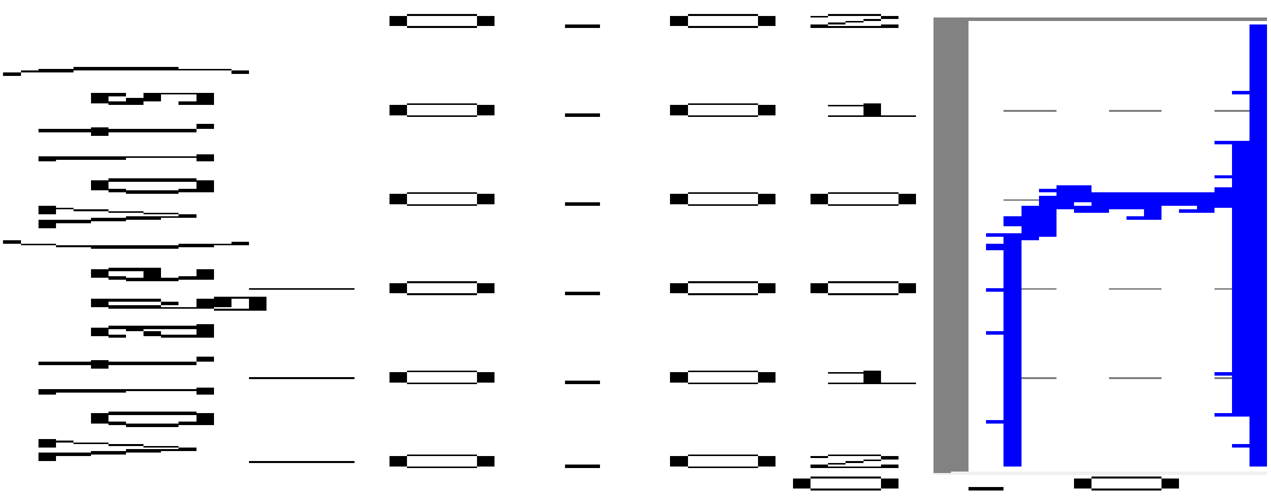
Report Date 14/06/2012

Client ID STX084RR - GT008

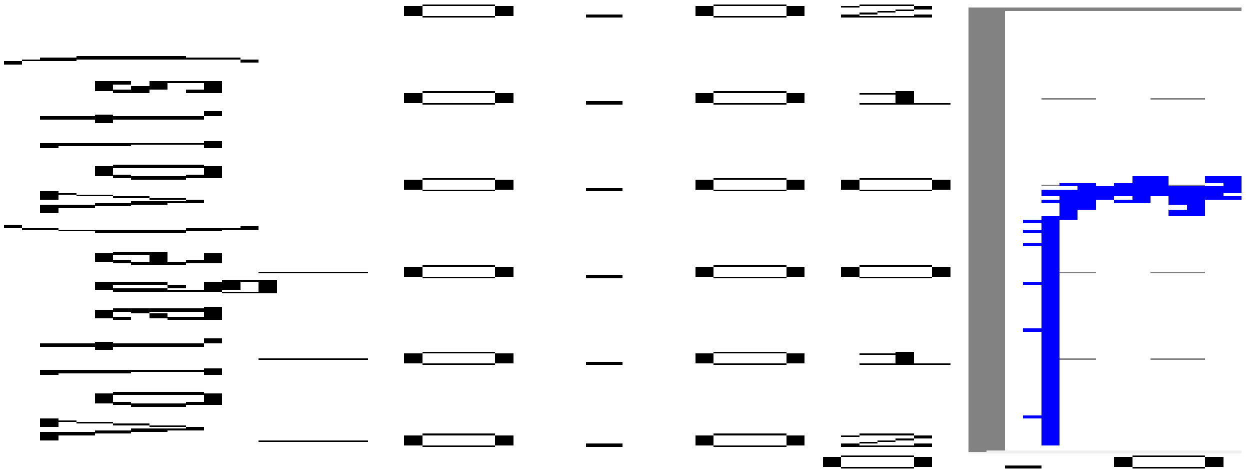
Depth (m) 113.48-113.70

Description MUDSTONE 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060116-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060116
Client ID	STX084RR - GT008
Depth (m)	113.48-113.70
Description	MUDSTONE 100%
Wet Density (t/m^3)	2.38
Moisture Content (%)	1.8
Specimen Length (mm)	160.8
Specimen Diameter (mm)	60.5
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0
	
UCS (MPa)	18.4

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060117- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT009	**Depth (m)**	125.03-125.30
Description	SILTSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.5	Couplant	Honey
Sample Height (mm)	162.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.79	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3731		
"P" Arrival Time (μsec)	57.4	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060117	DATE: 13/6/12
BOREHOLE:	STX084RR - GT009	DEPTH: 125.03-125.30

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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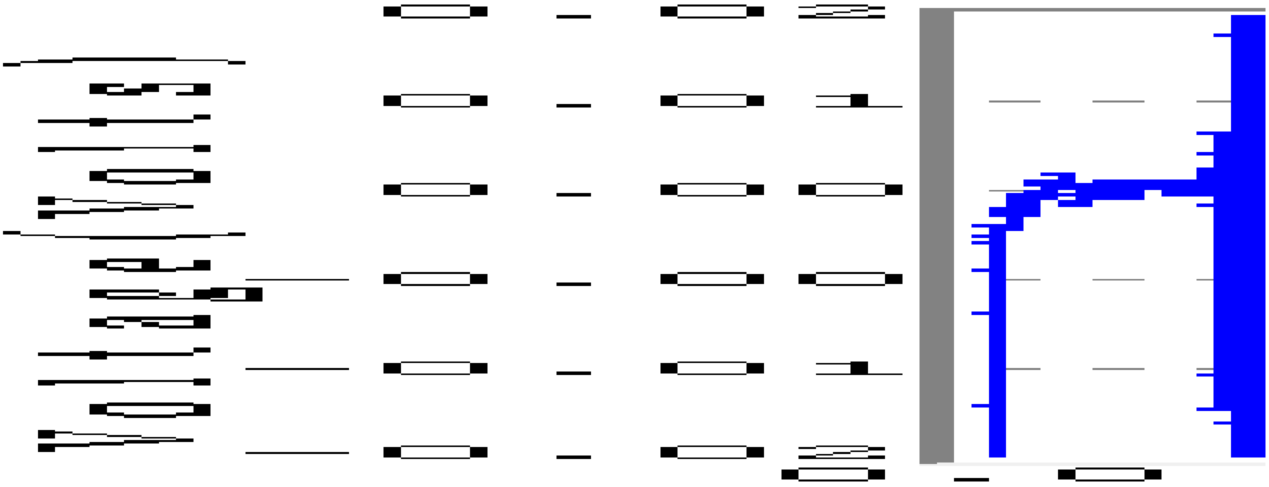
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

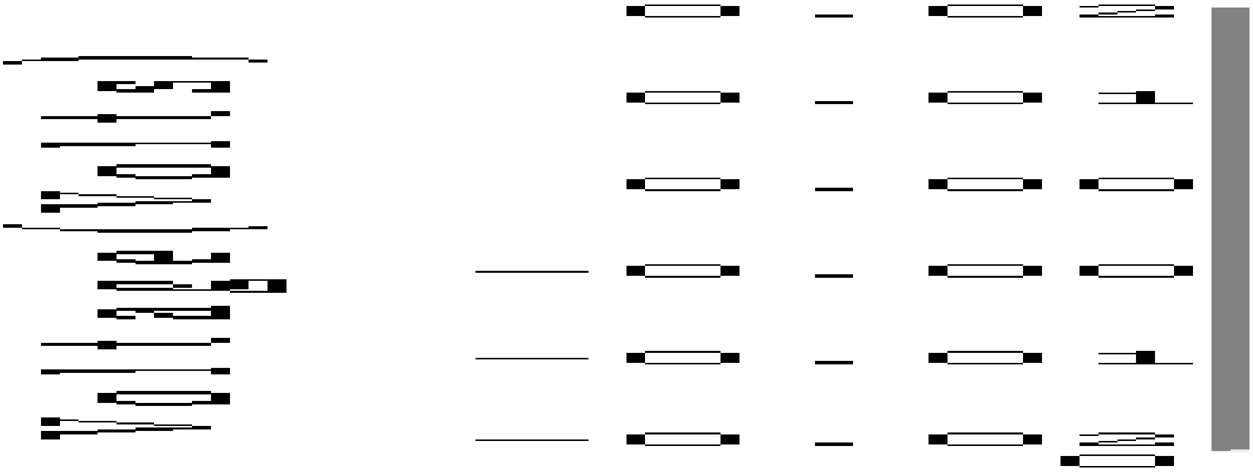
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060117- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT009	**Depth (m)**	125.03-125.30
Description	SILTSTONE 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060117-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060117
Client ID	STX084RR - GT009
Depth (m)	125.03-125.30
Description	SILTSTONE 100%
Wet Density (t/m^3)	2.79
Moisture Content (%)	3.4
Specimen Length (mm)	162.5
Specimen Diameter (mm)	60.5
Mode of Failure	Shear
Test Duration (Min:Sec)	7:15

UCS (MPa)	36.6

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

Page: 1 of 1 REP02701

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Authorised Signatory

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

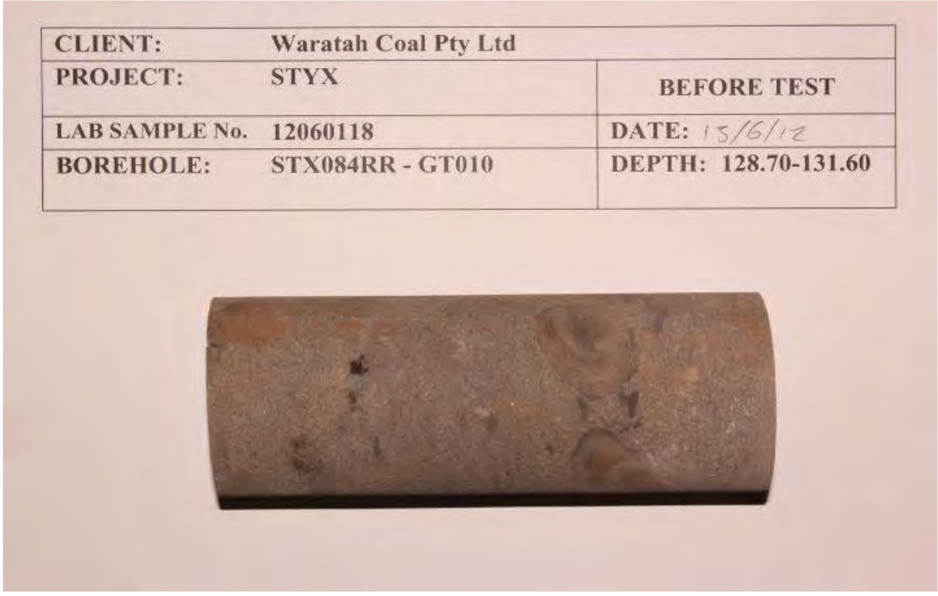
Client	Waratah Coal Pty Ltd	**Report No.**	12060118- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT010	**Depth (m)**	128.70-131.60
Description	SANDSTONE, medium grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	157.6	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.54	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3204		
"P" Arrival Time (µsec)	63.1	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060118	DATE:	13/6/12
BOREHOLE:	STX084RR - GT010	DEPTH:	128.70-131.60

Notes/Remarks:

Sample/s supplied by client

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060118- SON

Test Date 13/06/2012

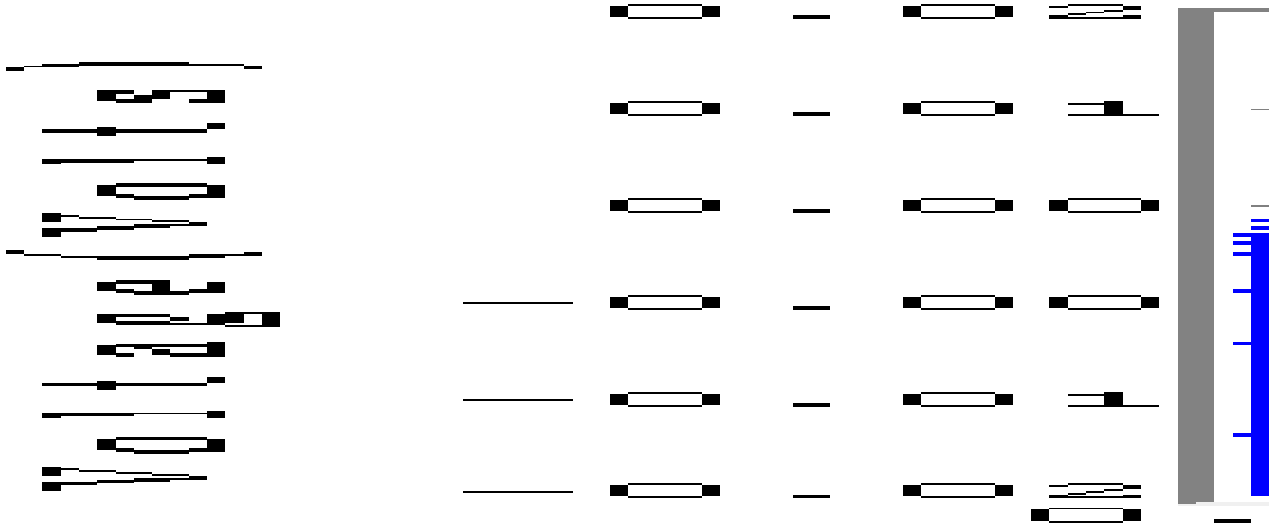
Report Date 14/06/2012

Client ID STX084RR - GT010

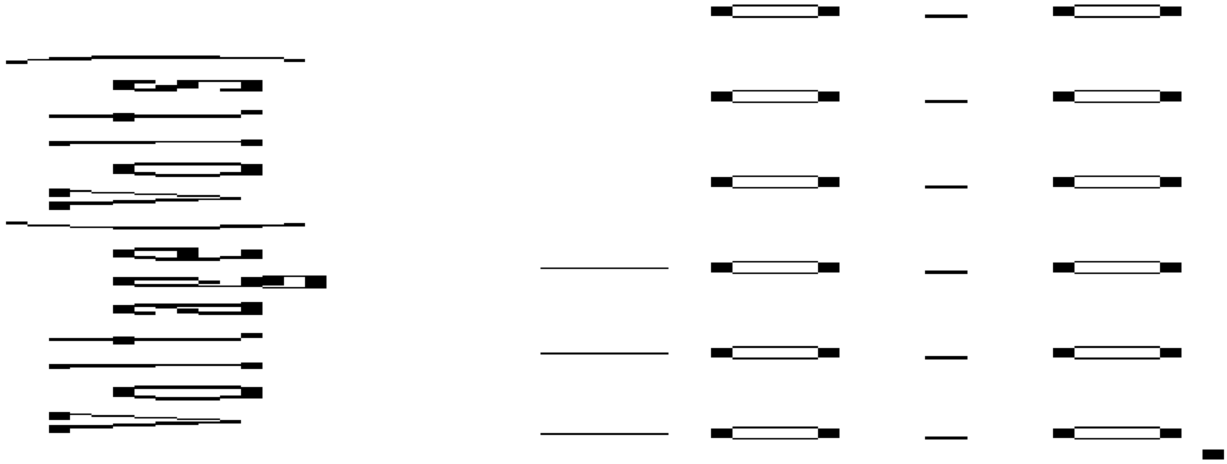
Depth (m) 128.70-131.60

Description SANDSTONE, medium grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060118-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060118
Client ID	STX084RR - GT010
Depth (m)	128.70-131.60
Description	SANDSTONE, medium grained 100%
Wet Density (t/m^3)	2.54
Moisture Content (%)	3.8
Specimen Length (mm)	157.6
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	**AFTER TEST**
LAB SAMPLE No.	12060118	**DATE:** 15/6/12
BOREHOLE:	STX084RR - GT010	**DEPTH:** 128.70-131.60

UCS (MPa)	18.0

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

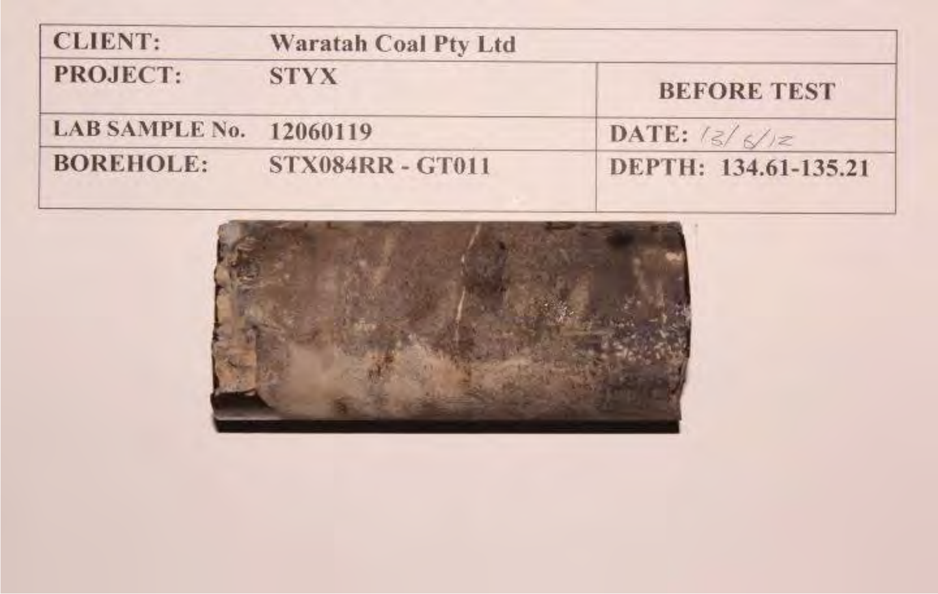
Client	Waratah Coal Pty Ltd	**Report No.**	12060119- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT011	**Depth (m)**	134.61-135.21
Description	SANDSTONE, fine to medium grained 1(	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.4	Couplant	Honey
Sample Height (mm)	133.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.69	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3080		
"P" Arrival Time (µsec)	57.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060119	DATE:	13/6/12
BOREHOLE:	STX084RR - GT011	DEPTH:	134.61-135.21

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060119- SON

Test Date 13/06/2012

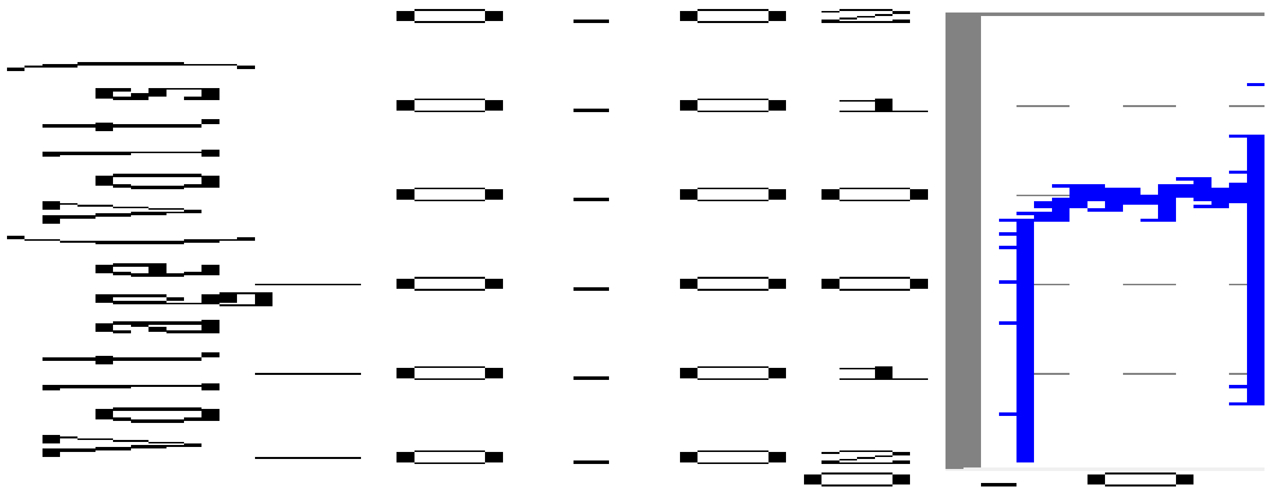
Report Date 14/06/2012

Client ID STX084RR - GT011

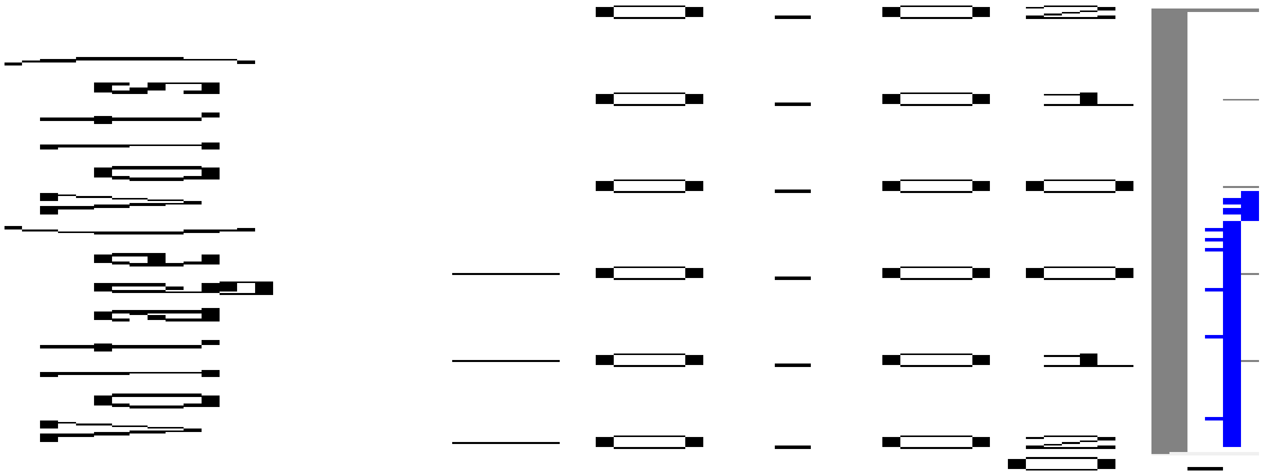
Depth (m) 134.61-135.21

Description SANDSTONE, fine to medium grained 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060119-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060119
Client ID	STX084RR - GT011
Depth (m)	134.61-135.21
Description	SANDSTONE, fine to medium grained 100%
Wet Density (t/m^3)	2.69
Moisture Content (%)	2.9
Specimen Length (mm)	133.5 *
Specimen Diameter (mm)	60.4
Mode of Failure	Shear
Test Duration (Min:Sec)	5:55
	
UCS (MPa)	19.3

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060119
DATE: 15/6/12
BOREHOLE: STX084RR - GT011
DEPTH: 134.61-135.21

NOTES/REMARKS:

Stored and tested as received

* Length to diameter ratio less than 2.5:1

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Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

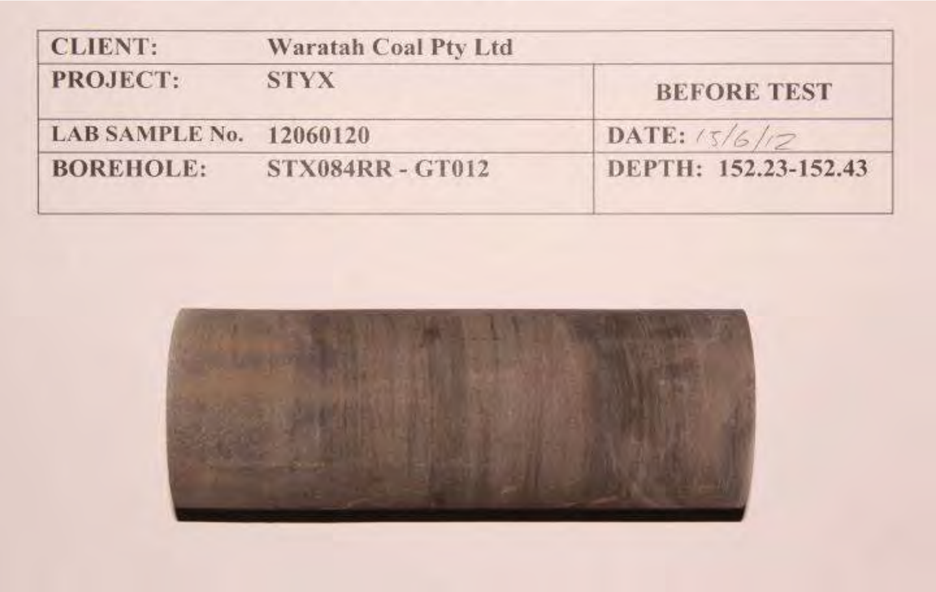
Client	Waratah Coal Pty Ltd	**Report No.**	12060120- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT012	**Depth (m)**	152.23-152.43
Description	SANDSTONE, fine grained 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	162.3	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.45	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3223		
"P" Arrival Time (µsec)	64.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060120	DATE:	13/6/12
BOREHOLE:	STX084RR - GT012	DEPTH:	152.23-152.43

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

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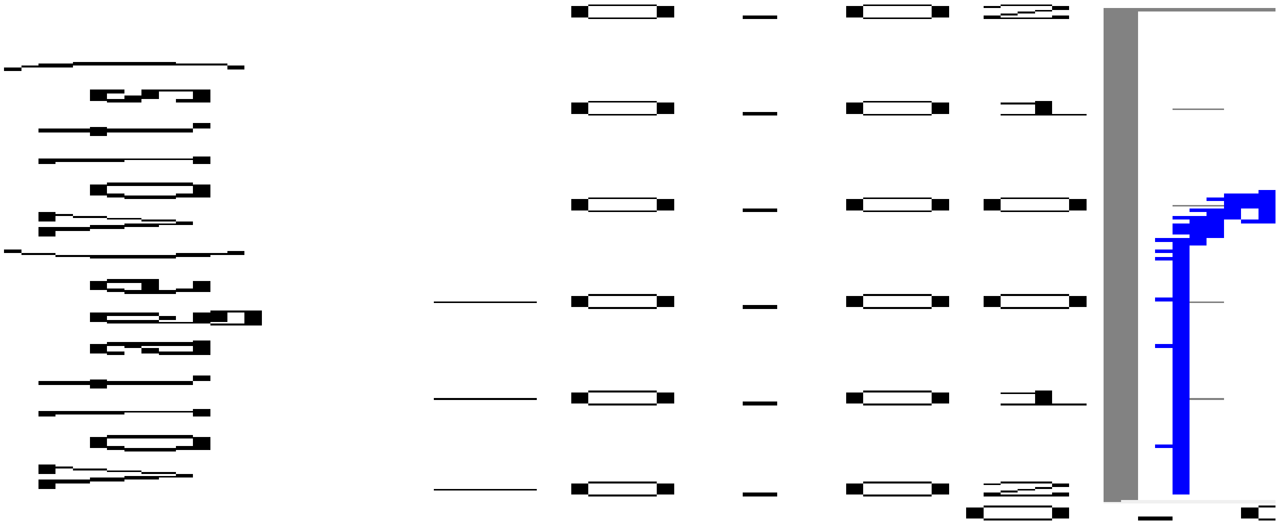
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

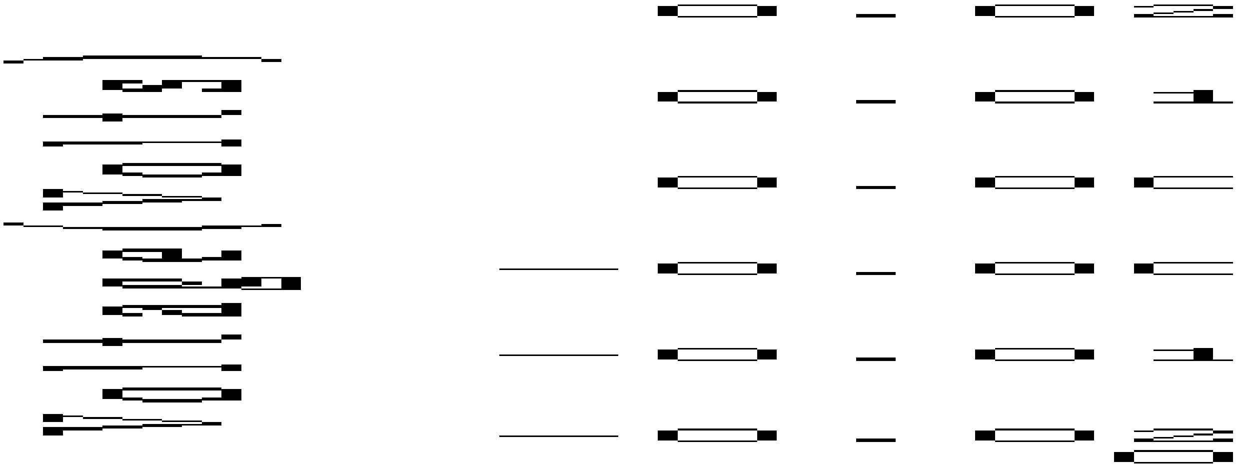
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060120- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT012	**Depth (m)**	152.23-152.43
Description	SANDSTONE, fine grained 100%		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060120-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060120
Client ID	STX084RR - GT012
Depth (m)	152.23-152.43
Description	SANDSTONE, fine grained 100%
Wet Density (t/m^3)	2.45
Moisture Content (%)	3.8
Specimen Length (mm)	162.3
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	8:14

UCS (MPa)	30.5

NOTES/REMARKS:

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Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

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Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060121- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX084RR - GT013	**Depth (m)**	160.15-160.39
Description	MUDSTONE 100%	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	162.9	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.59	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2702		
"P" Arrival Time (µsec)	74.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060121	DATE: 13/6/12
BOREHOLE:	STX084RR - GT013	DEPTH: 160.15-160.39

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060121- SON

Test Date 13/06/2012

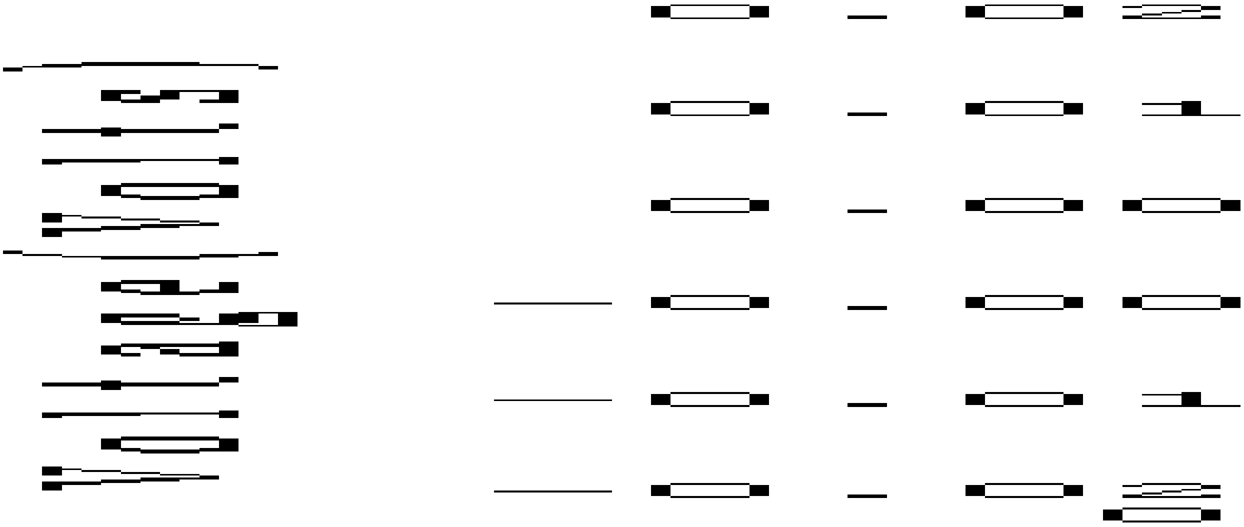
Report Date 14/06/2012

Client ID STX084RR - GT013

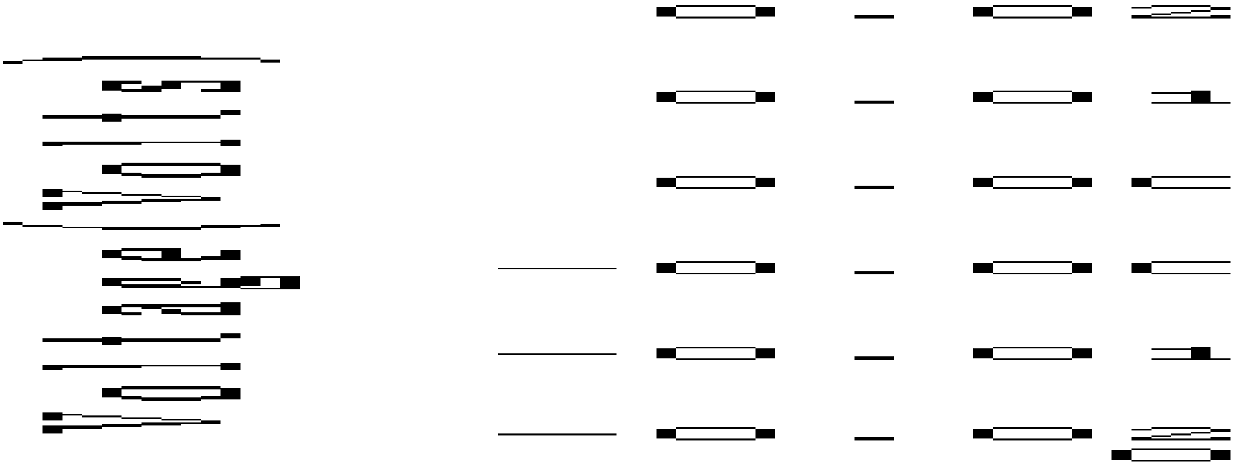
Depth (m) 160.15-160.39

Description MUDSTONE 100%

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060121-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060121
Client ID	STX084RR - GT013
Depth (m)	160.15-160.39
Description	MUDSTONE 100%
Wet Density (t/m^3)	2.59
Moisture Content (%)	2.8
Specimen Length (mm)	162.9
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

UCS (MPa)	19.6

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060122- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT001	**Depth (m)**	20.70-21.00
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	61.0	Couplant	Honey
Sample Height (mm)	161.4	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.21	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2144		
"P" Arrival Time (μsec)	89.1	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (μsec)	N/A		

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060122	DATE: 13/6/12
BOREHOLE:	STX090RR - GT001	DEPTH: 20.70-21.00

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060122- SON

Test Date 13/06/2012

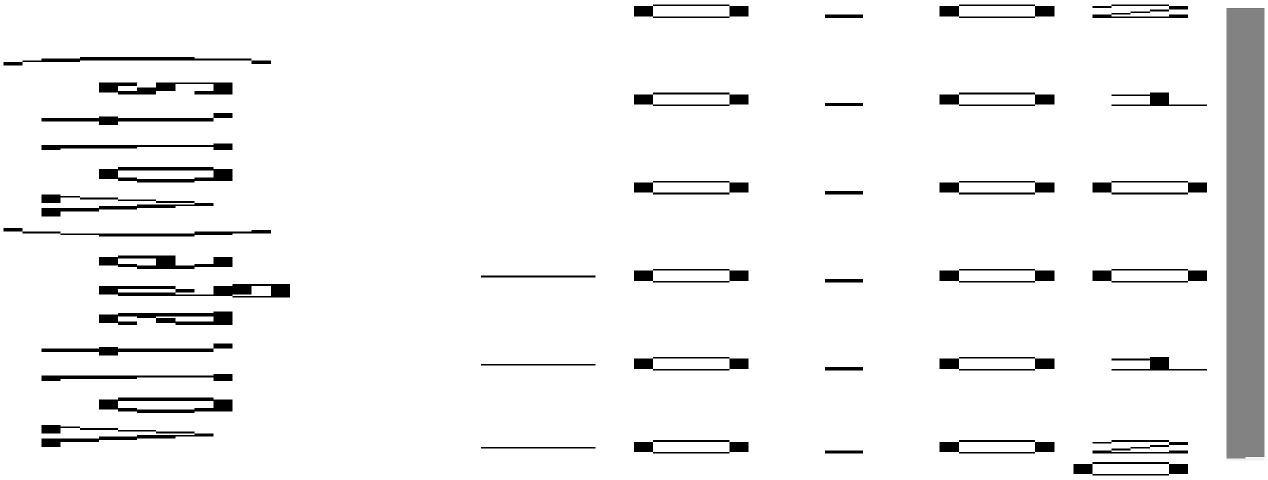
Report Date 14/06/2012

Client ID STX090RR - GT001

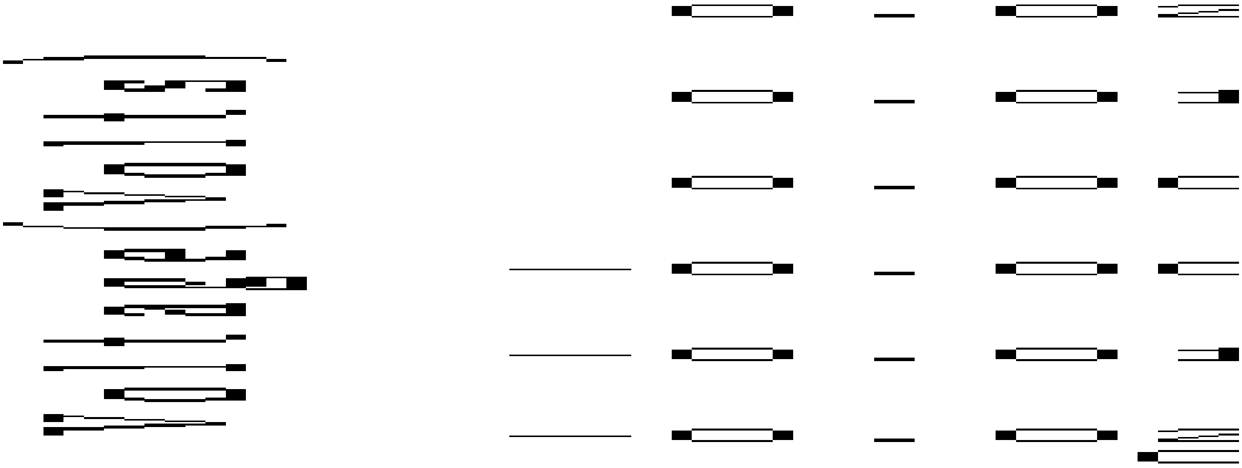
Depth (m) 20.70-21.00

Description MUDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060122-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060122
Client ID	STX090RR - GT001
Depth (m)	20.70-21.00
Description	MUDSTONE
Wet Density (t/m^3)	2.21
Moisture Content (%)	9.6
Specimen Length (mm)	161.4
Specimen Diameter (mm)	61.0
Mode of Failure	Shear
Test Duration (Min:Sec)	5:0

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060122
DATE: 15/6/12
BOREHOLE: STX090RR - GT001
DEPTH: 20.70-21.00

UCS (MPa)	3.56

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - Kelba 1000 kN Load Cell

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060123-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060123
Client ID	STX090RR - GT002
Depth (m)	31.30-31.60
Description	Medium SANDSTONE
Wet Density (t/m^3)	2.39
Moisture Content (%)	7.3
Specimen Length (mm)	160.6
Specimen Diameter (mm)	60.5
Mode of Failure	Conical
Test Duration (Min:Sec)	3:39

UCS (MPa)	6.25

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - Kelba 1000 kN Load Cell

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060124- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT003	**Depth (m)**	47.26-47.70
Description	Medium SANDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	161.2	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.44	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2825		
"P" Arrival Time (µsec)	71.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
BEFORE TEST
LAB SAMPLE No. 12060124
DATE: 13/6/12
BOREHOLE: STX090RR - GT003
DEPTH: 47.26-47.70

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

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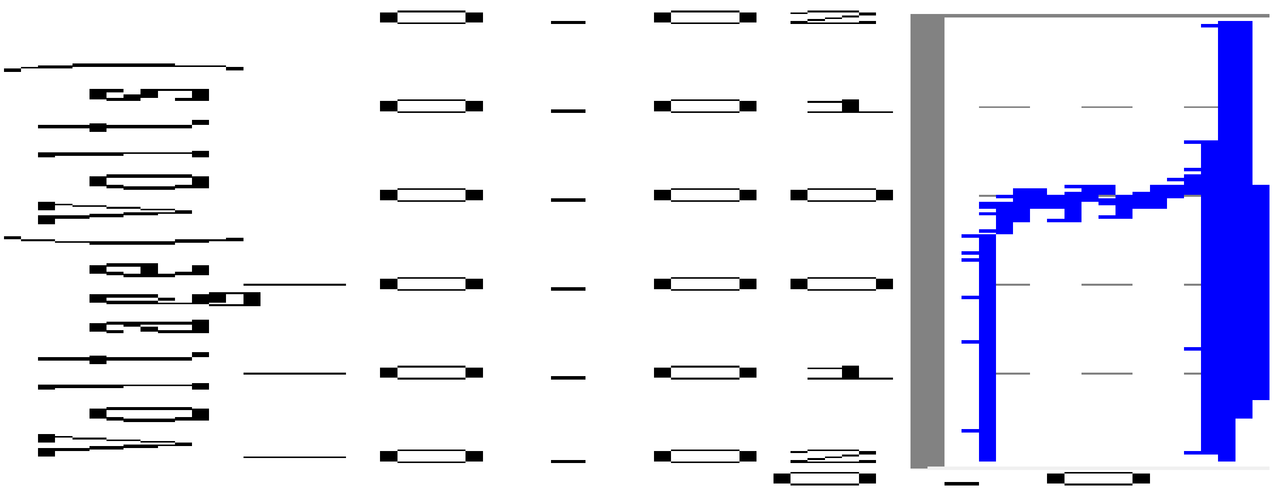
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

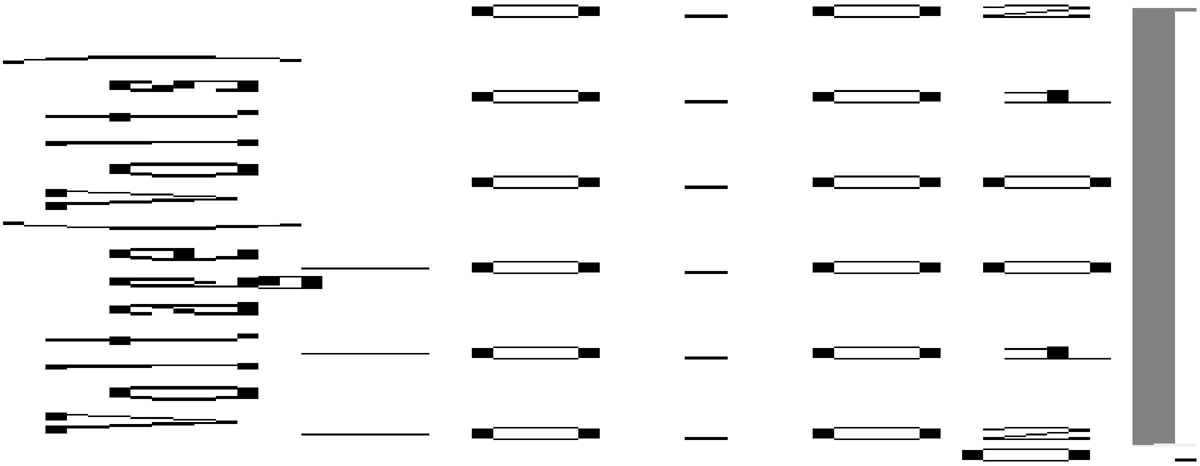
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060124- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT003	**Depth (m)**	47.26-47.70
Description	Medium SANDSTONE		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

Trilab
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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060124-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060124
Client ID	STX090RR - GT003
Depth (m)	47.26-47.70
Description	Medium SANDSTONE
Wet Density (t/m^3)	2.45
Moisture Content (%)	5.7
Specimen Length (mm)	161.0
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060124
DATE: 15/6/2012
BOREHOLE: STX090RR - GT003
DEPTH: 47.26-47.70

UCS (MPa)	19.4

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

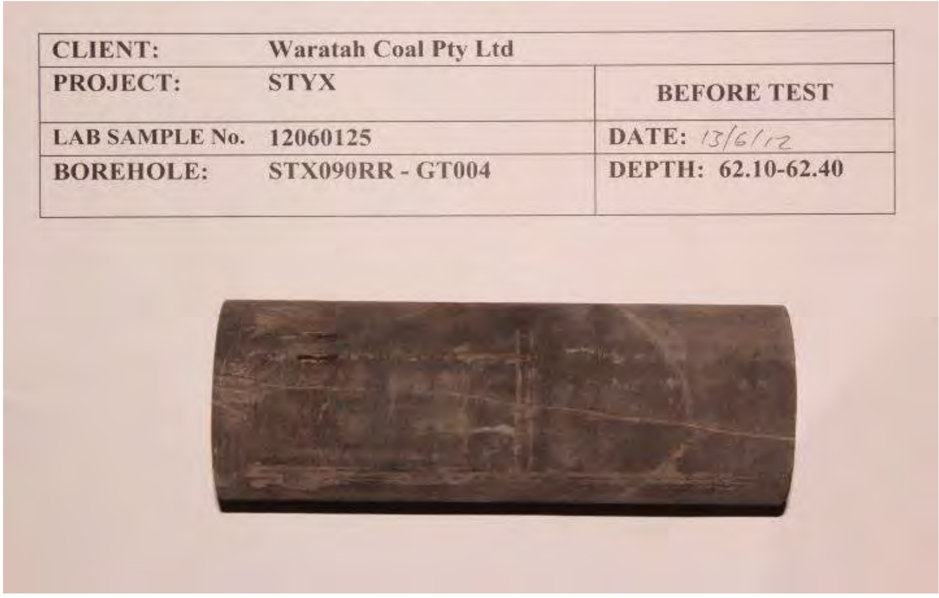
Client	Waratah Coal Pty Ltd	**Report No.**	12060125- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT004	**Depth (m)**	62.10-62.40
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	160.1	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.43	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	3072		
"P" Arrival Time (µsec)	66.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060125	DATE: 13/6/12
BOREHOLE:	STX090RR - GT004	DEPTH: 62.10-62.40

Notes/Remarks:

Sample/s supplied by client   Photo not to scale   Tested as received

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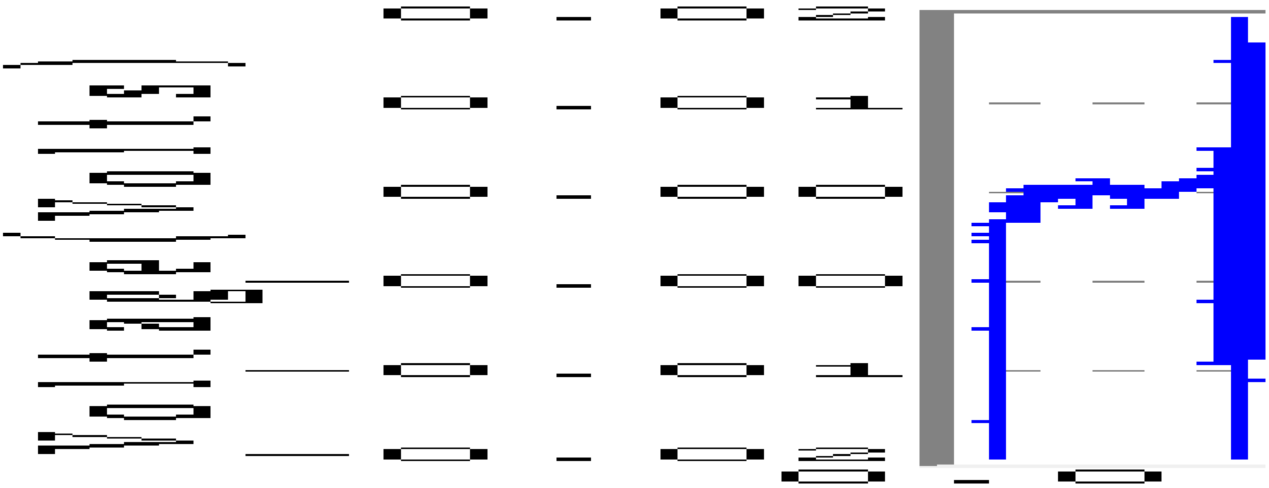
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

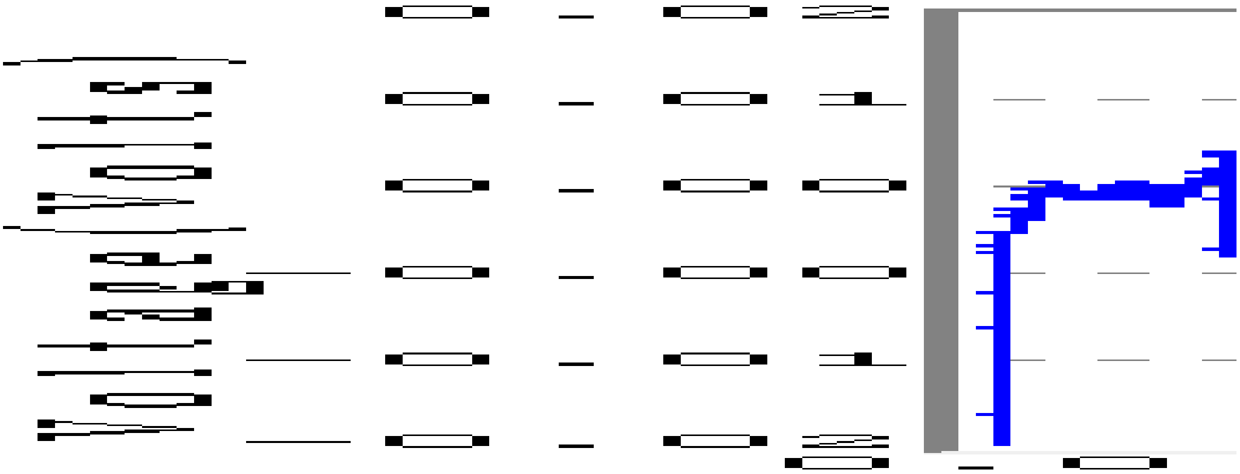
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060125- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT004	**Depth (m)**	62.10-62.40
Description	MUDSTONE		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060125-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060125
Client ID	STX090RR - GT004
Depth (m)	62.10-62.40
Description	MUDSTONE
Wet Density (t/m^3)	2.42
Moisture Content (%)	6.2
Specimen Length (mm)	160.1
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:59

UCS (MPa)	22.8

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

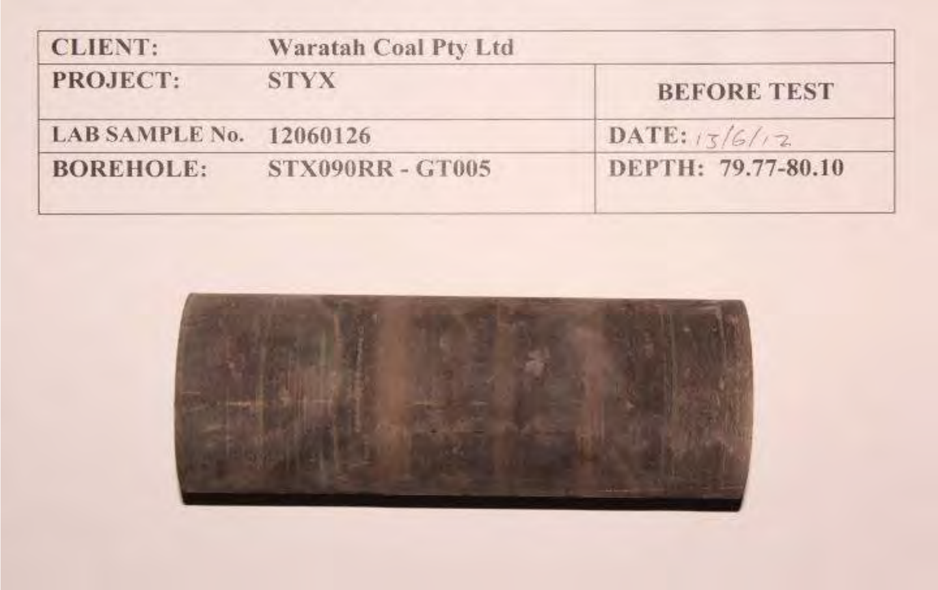
Client	Waratah Coal Pty Ltd	**Report No.**	12060126- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT005	**Depth (m)**	79.77-80.10
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	158.9	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.43	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2861		
"P" Arrival Time (µsec)	69.4	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060126	DATE: 13/6/12
BOREHOLE:	STX090RR - GT005	DEPTH: 79.77-80.10

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060126- SON

Test Date 13/06/2012

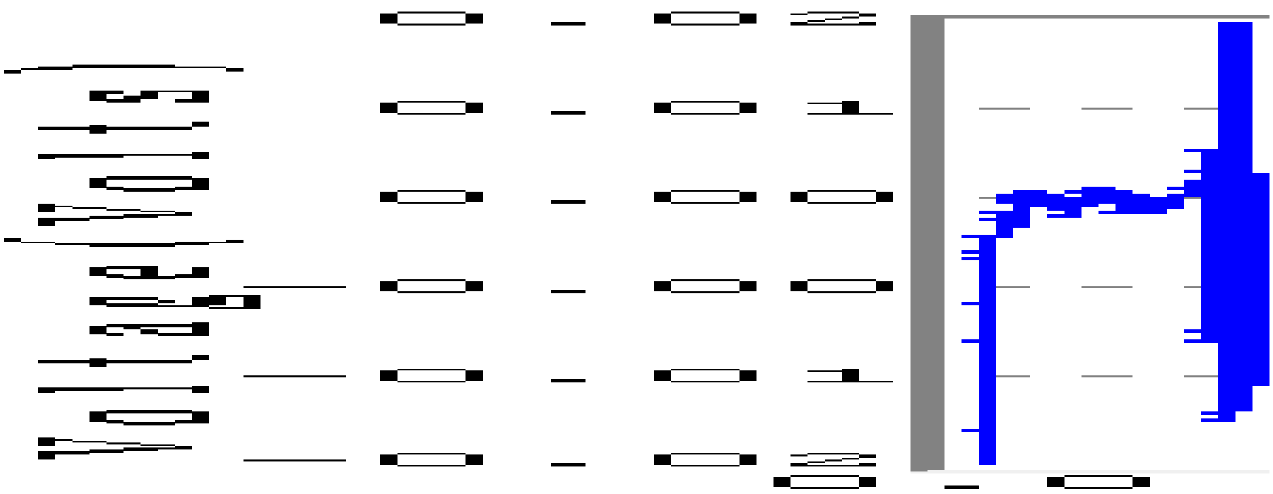
Report Date 14/06/2012

Client ID STX090RR - GT005

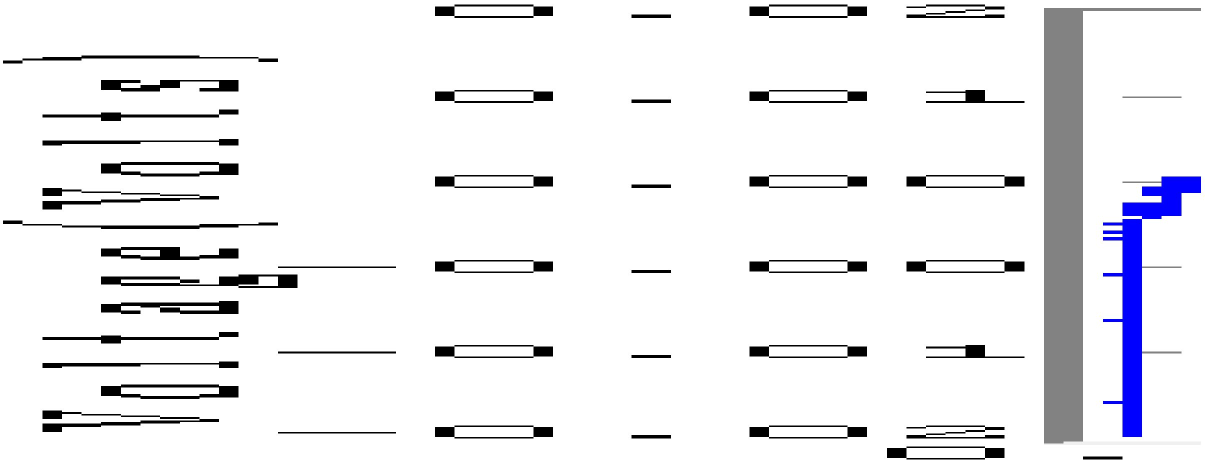
Depth (m) 79.77-80.10

Description MUDSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060126-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060126
Client ID	STX090RR - GT005
Depth (m)	79.77-80.10
Description	MUDSTONE
Wet Density (t/m^3)	2.43
Moisture Content (%)	6.4
Specimen Length (mm)	158.9
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	6:0

UCS (MPa)	16.1

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

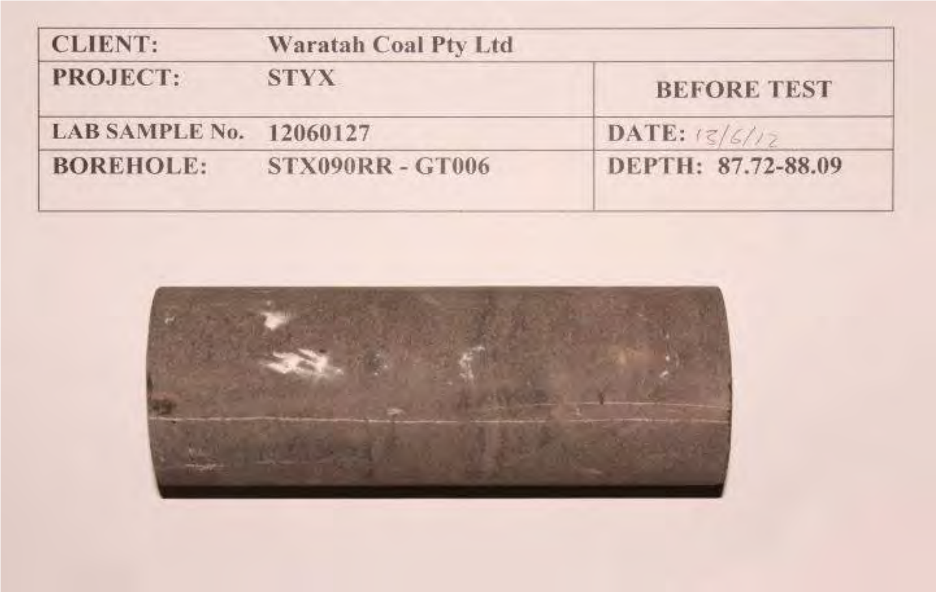
Client	Waratah Coal Pty Ltd	**Report No.**	12060127- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT006	**Depth (m)**	87.72-88.09
Description	SILTSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.4	Couplant	Honey
Sample Height (mm)	161.5	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.42	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2984		
"P" Arrival Time (µsec)	68.0	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	BEFORE TEST
LAB SAMPLE No.	12060127	DATE: 13/6/12
BOREHOLE:	STX090RR - GT006	DEPTH: 87.72-88.09

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received **Page 1 of 2** REP04401

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060127- SON

Test Date 13/06/2012

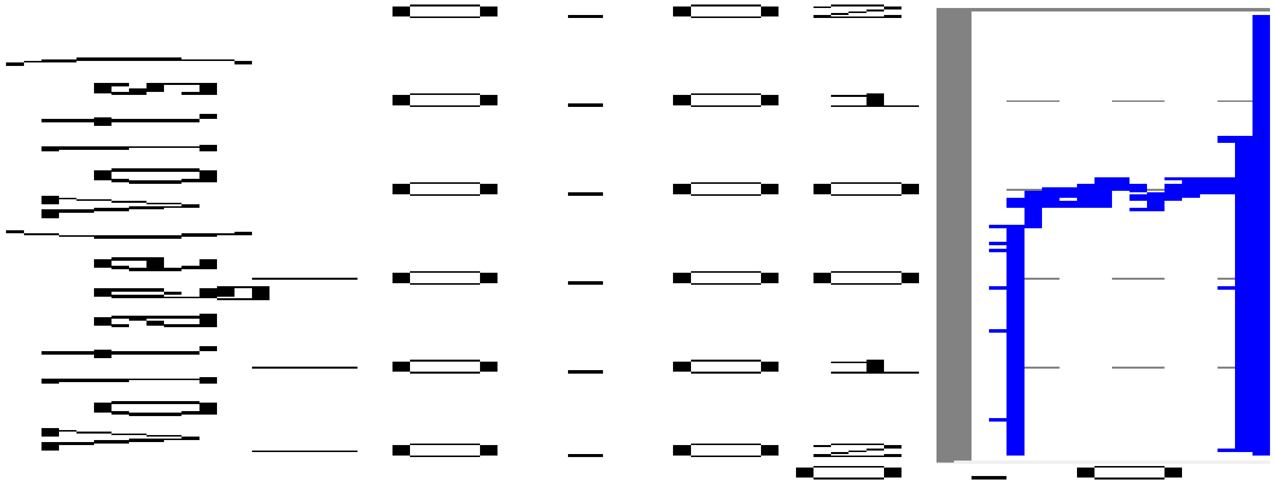
Report Date 14/06/2012

Client ID STX090RR - GT006

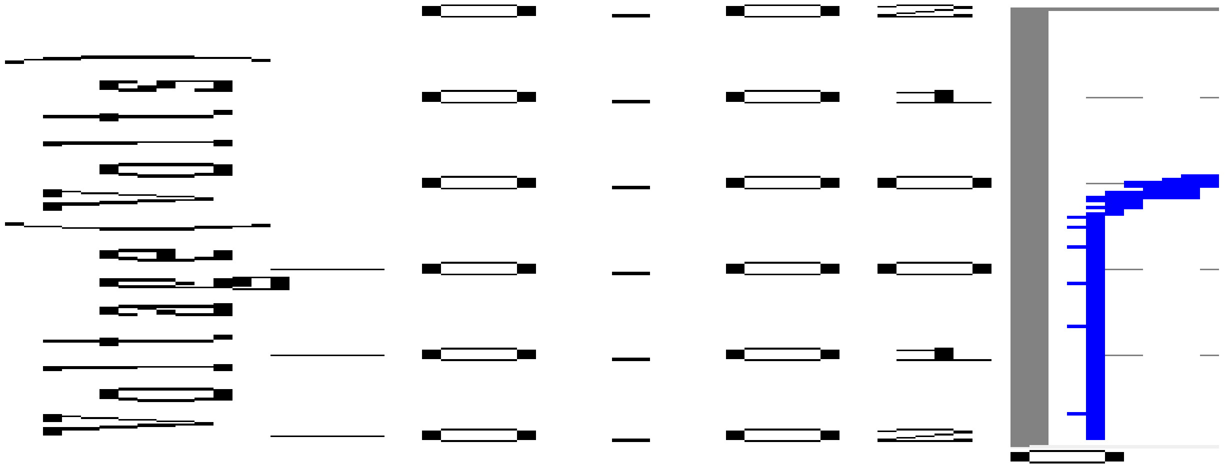
Depth (m) 87.72-88.09

Description SILTSTONE

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060127-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060127
Client ID	STX090RR - GT006
Depth (m)	87.72-88.09
Description	SILTSTONE
Wet Density (t/m^3)	2.42
Moisture Content (%)	5.2
Specimen Length (mm)	161.5
Specimen Diameter (mm)	60.4
Mode of Failure	Axial
Test Duration (Min:Sec)	5:27

CLIENT:	Waratah Coal Pty Ltd	
PROJECT:	STYX	AFTER TEST
LAB SAMPLE No.	12060127	DATE: 15/6/2012
BOREHOLE:	STX090RR - GT006	DEPTH: 87.72-88.09

UCS (MPa)	11.7

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - ELE 1000 kN Compression Machine

Photo not to scale

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Authorised Signatory

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060128- SON

Test Date 13/06/2012

Report Date 14/06/2012

Client ID STX090RR - GT007

Depth (m) 100.72-101.02

Description Coarse SANDSTONE

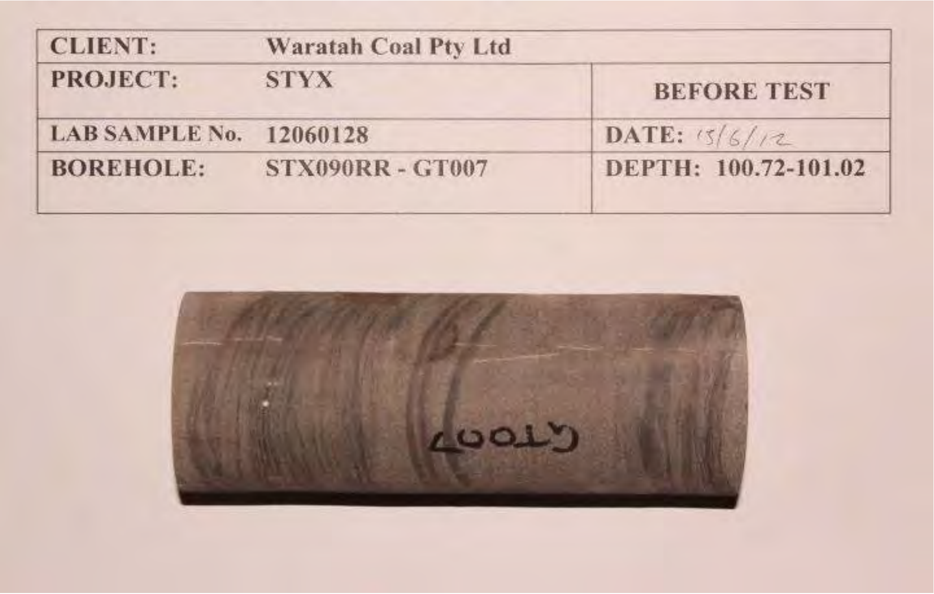
Sample Type Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	159.3	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.48	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2974		
"P" Arrival Time (µsec)	67.5	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060128	DATE:	13/6/12
BOREHOLE:	STX090RR - GT007	DEPTH:	100.72-101.02

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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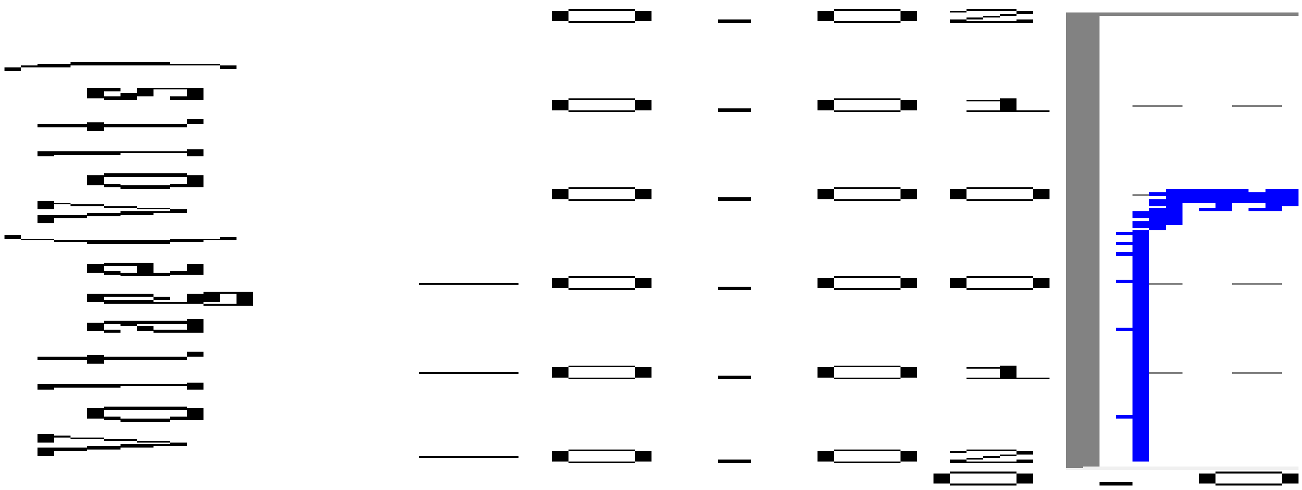
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

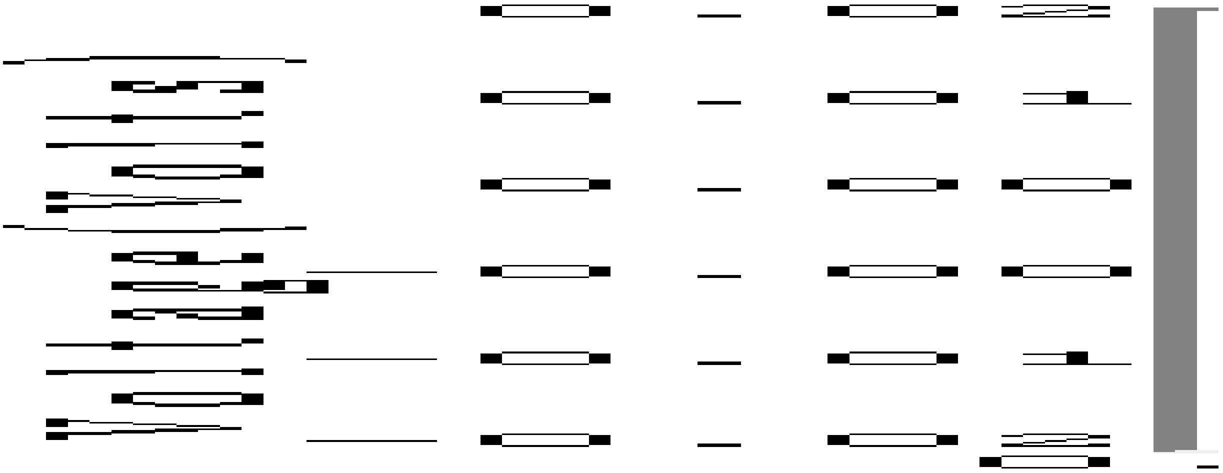
Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060128- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT007	**Depth (m)**	100.72-101.02
Description	Coarse SANDSTONE		

"P" WAVEFORM



"S" WAVEFORM



Notes/Remarks:

Sample/s supplied by client

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060128-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060128
Client ID	STX090RR - GT007
Depth (m)	100.72-101.02
Description	Coarse SANDSTONE
Wet Density (t/m^3)	2.48
Moisture Content (%)	4.8
Specimen Length (mm)	159.3
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	5:55

CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060128
DATE: 15/6/12
BOREHOLE: STX090RR - GT007
DEPTH: 100.72-101.02

UCS (MPa)	21.5

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - 200 kN Load Cell in Compression Machine
Photo not to scale

Page: 1 of 1 REP02701

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

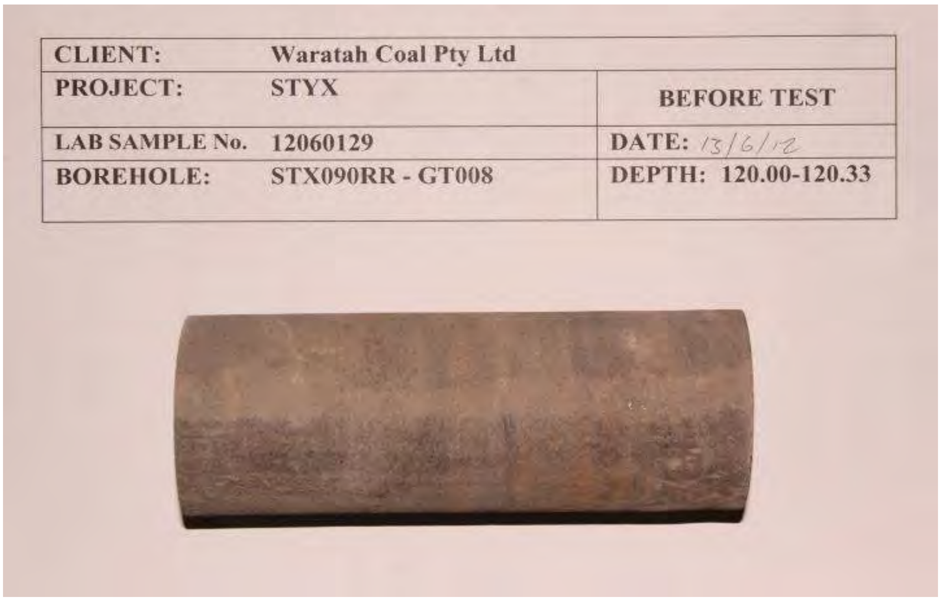
Client	Waratah Coal Pty Ltd	**Report No.**	12060129- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT008	**Depth (m)**	120.00-120.33
Description	Coarse SANDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	159.7	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.56	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2150		
"P" Arrival Time (µsec)	88.2	Young's Modulus (GPa)	7.9
"S" Velocity (m/s)	1075	Poisson's Ratio	0.33
"S" Arrival Time (µsec)	169.3		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	**BEFORE TEST**	
LAB SAMPLE No.	12060129	**DATE:**	13/6/12
BOREHOLE:	STX090RR - GT008	**DEPTH:**	120.00-120.33

Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received

Soil Rock Calibration

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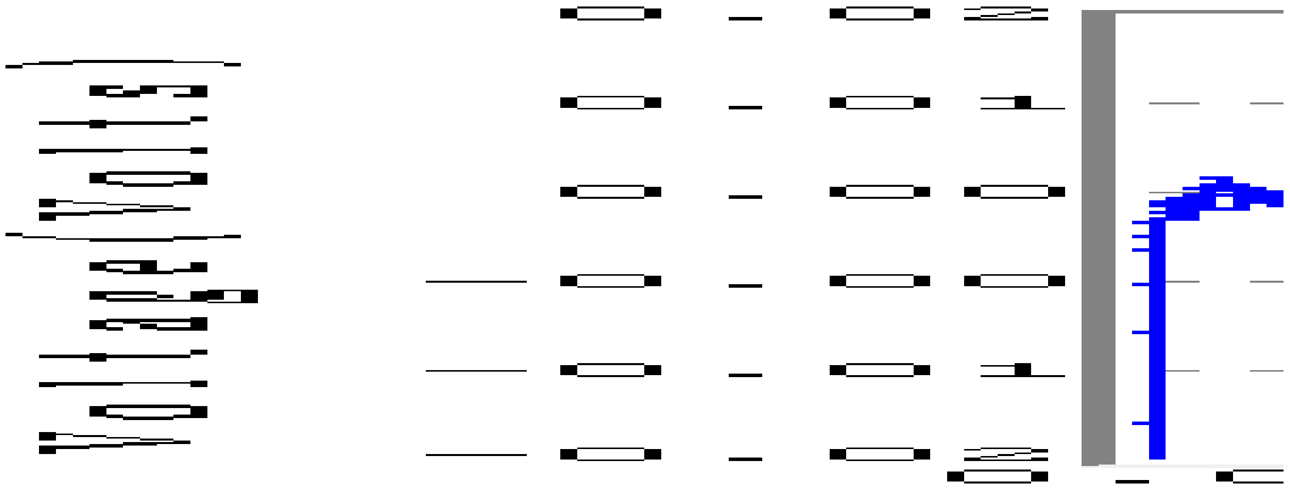
DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client	Waratah Coal Pty Ltd	**Report No.**	12060129- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT008	**Depth (m)**	120.00-120.33
Description	Coarse SANDSTONE		

"P" WAVEFORM



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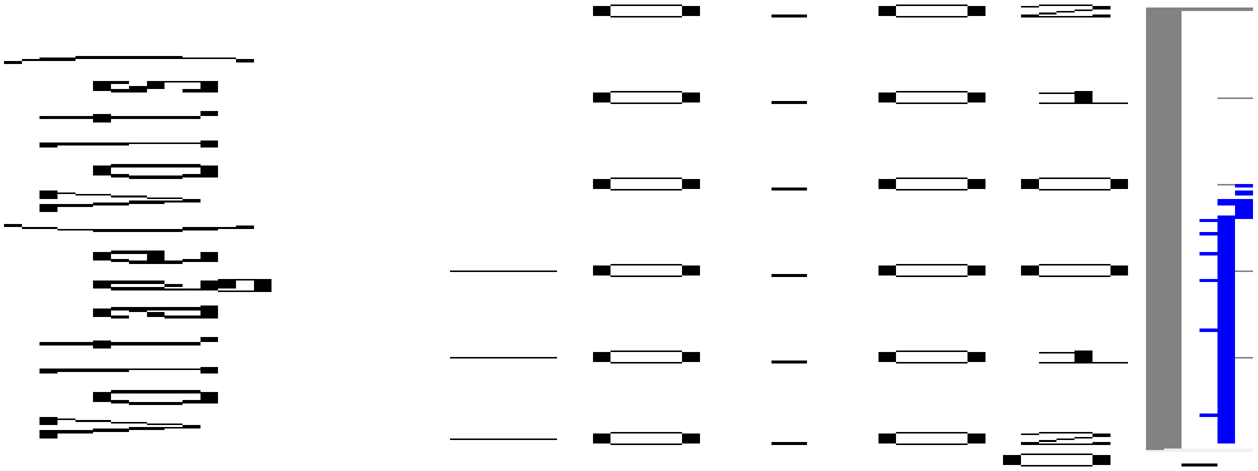

Notes/Remarks:

Sample/s supplied by client

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

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Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060129-UCS

Test Date 15/06/2012

Report Date 18/06/2012

Sample No.	12060129
Client ID	STX090RR - GT008
Depth (m)	120.00-120.33
Description	Coarse SANDSTONE
Wet Density (t/m^3)	2.56
Moisture Content (%)	3.1
Specimen Length (mm)	159.7
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	3:31

UCS (MPa)	7.76

NOTES/REMARKS:

Stored and tested as received

Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02701

Authorised Signatory

James Russell

J. Russell

NATA

Laboratory No. 9926

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

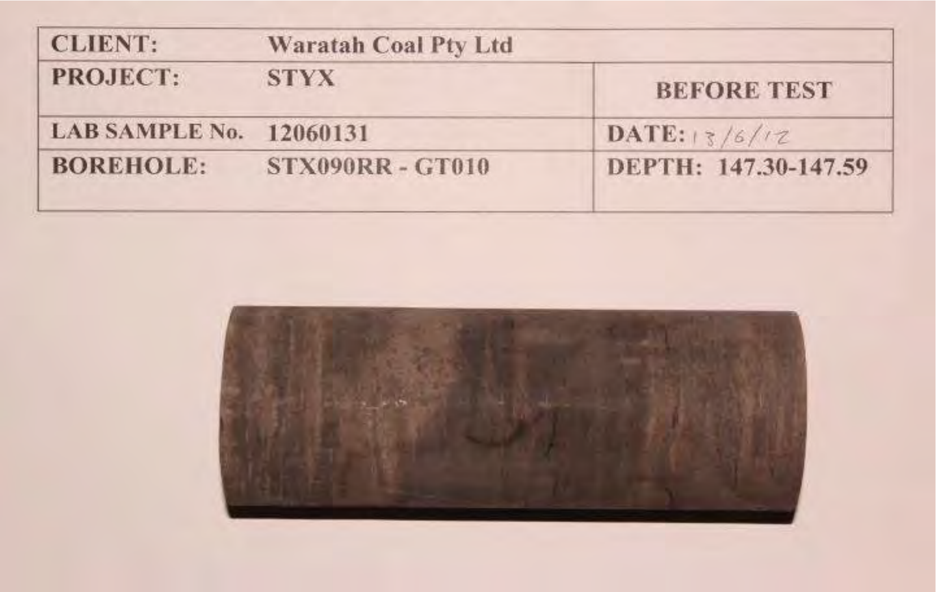
Client	Waratah Coal Pty Ltd	**Report No.**	12060131- SON
Project	STYX	**Test Date**	13/06/2012
		Report Date	14/06/2012
Client ID	STX090RR - GT010	**Depth (m)**	147.30-147.59
Description	MUDSTONE	**Sample Type**	Single Individual Rock Core Specimen

Sample and Test Details

Average Sample Diameter (mm)	60.6	Couplant	Honey
Sample Height (mm)	162.0	Probe Type	63.6mm "P" & "S" Wave
Sample Density (t/m^3)	2.44	Test Apparatus	GCTS- ULT 100 - Ultrasonic Velocity
Applied Axial Stress (MPa)	1.0		

Test Results

"P" Velocity (m/s)	2929		
"P" Arrival Time (µsec)	69.2	Young's Modulus (GPa)	N/A
"S" Velocity (m/s)	NO TRACE	Poisson's Ratio	N/A
"S" Arrival Time (µsec)	N/A		



CLIENT:	Waratah Coal Pty Ltd		
PROJECT:	STYX	BEFORE TEST	
LAB SAMPLE No.	12060131	DATE:	13/6/12
BOREHOLE:	STX090RR - GT010	DEPTH:	147.30-147.59

Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received

DETERMINATION OF THE ULTRASONIC VELOCITY OF ROCK

Test Method: ASTM D2845 - 08 - Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock

Client Waratah Coal Pty Ltd

Project STYX

Report No. 12060131- SON

Test Date 13/06/2012

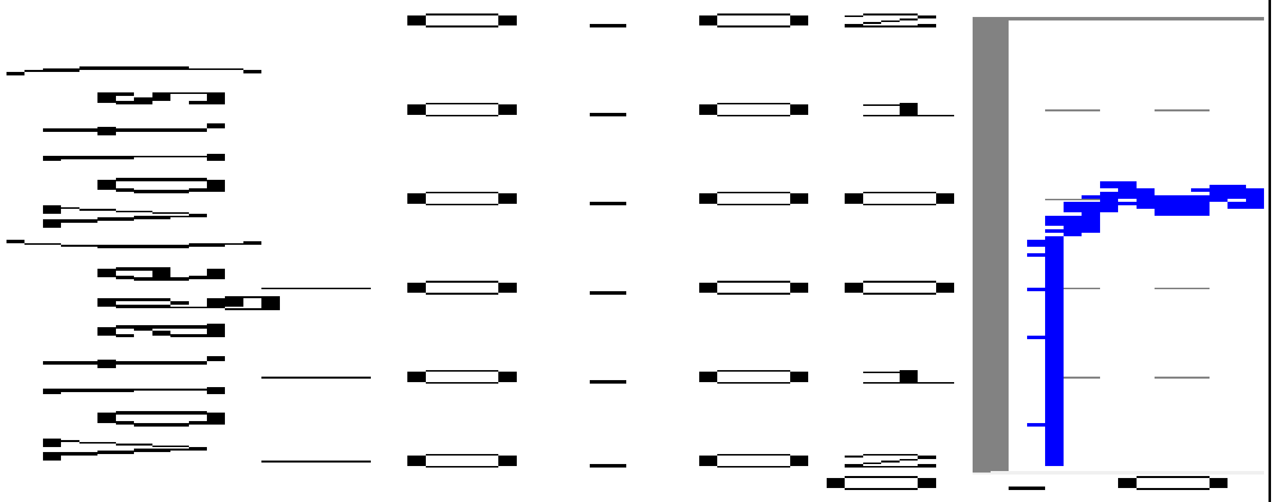
Report Date 14/06/2012

Client ID STX090RR - GT010

Depth (m) 147.30-147.59

Description MUDSTONE

"P" WAVEFORM



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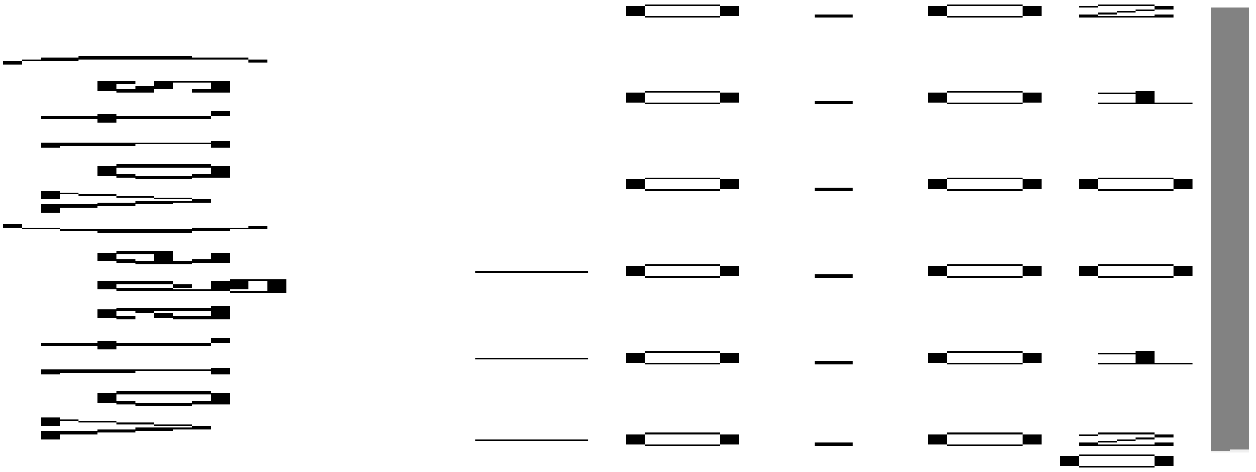

Notes/Remarks:

Sample/s supplied by client

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

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Queens Park
WA 6107
Ph: +61 8 9258 8323

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS1289 4133.4.2.1

Client	Waratah Coal Pty Ltd	**Report No.**	12060131-UCS
Project	STYX	**Test Date**	15/06/2012
		Report Date	18/06/2012

Sample No.	12060131
Client ID	STX090RR - GT010
Depth (m)	147.30-147.59
Description	MUDSTONE
Wet Density (t/m^3)	2.44
Moisture Content (%)	4.8
Specimen Length (mm)	162.0
Specimen Diameter (mm)	60.6
Mode of Failure	Shear
Test Duration (Min:Sec)	7:0


CLIENT: Waratah Coal Pty Ltd
PROJECT: STYX
AFTER TEST
LAB SAMPLE No. 12060131
DATE: 15/6/12
BOREHOLE: STX090RR - GT010
DEPTH: 147.30-147.59

UCS (MPa)	12.0

NOTES/REMARKS:
Stored and tested as received
Sample/s supplied by the client
Test Apparatus - 200 kN Load Cell in Compression Machine
Photo not to scale

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IES 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Authorised Signatory
James Russell
J. Russell

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

APPENDIX

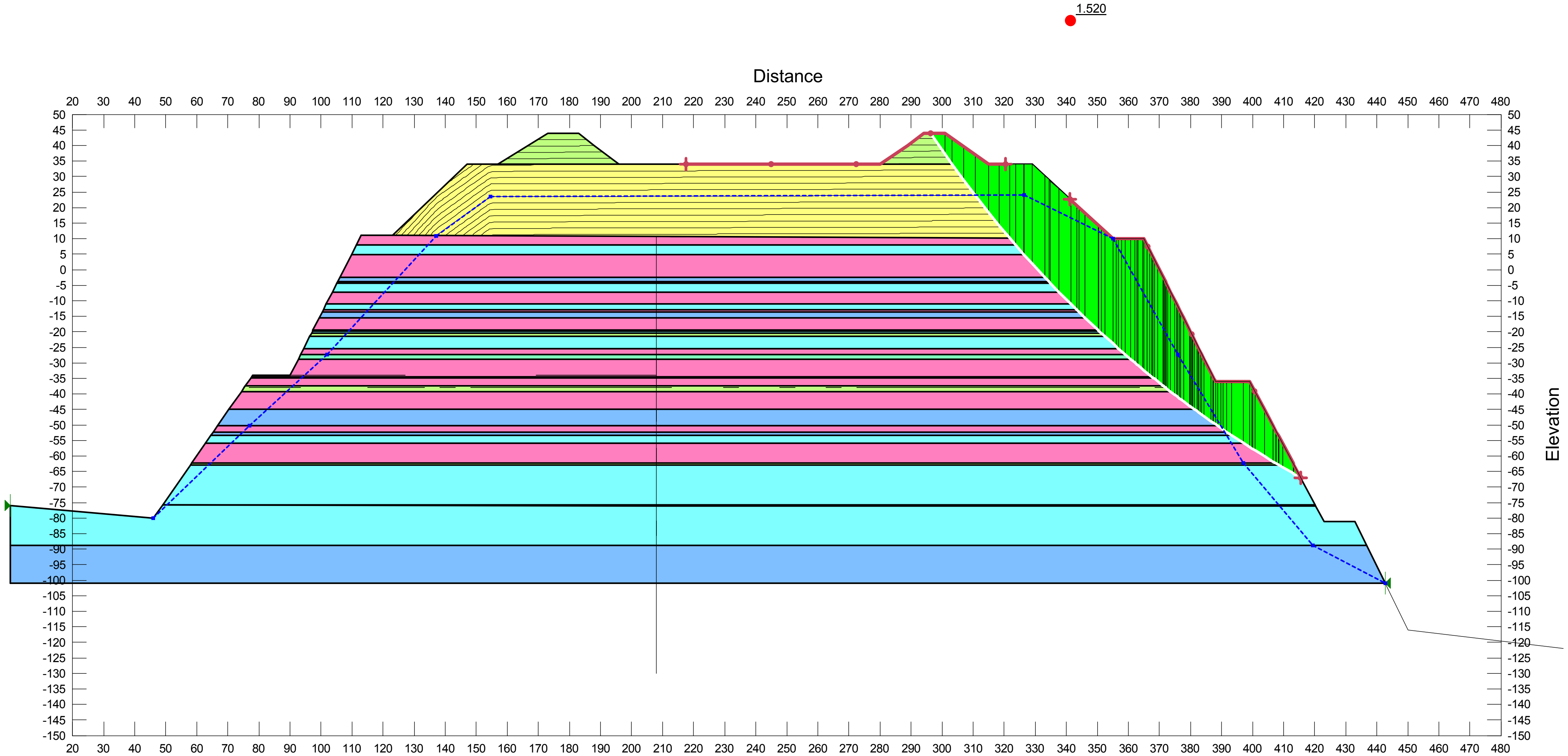
D

RESULTS OF SLOPE STABILITY ANALYSIS

Initial Model

Directory: R:\M30133.0\Geostudio\File Name: CQCoal Run1V3.gszDate: 25/04/2018Time: 11:19:49 AMLast Edited By: Richard Maurice

Name: Overburden   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m³   Cohesion': 40 kPa   Phi': 25 °   Phi-B: 0 °   Piezometric Line: 1
Name: Spoil   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m³   Cohesion': 0 kPa   Phi': 34 °   Phi-B: 0 °   Piezometric Line: 1
Name: Mudstone HW   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m³   Cohesion': 60 kPa   Phi': 24 °   Phi-B: 0 °
Name: Mudstone Fr   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m³   Cohesion': 200 kPa   Phi': 38 °   Phi-B: 0 °
Name: Siltstone CW   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m³   Cohesion': 60 kPa   Phi': 43 °   Phi-B: 0 °
Name: Sandstone Fr   Model: Mohr-Coulomb   Unit Weight: 24.5 kN/m³   Cohesion': 200 kPa   Phi': 40 °   Phi-B: 0 °
Name: Coal Fr   Model: Mohr-Coulomb   Unit Weight: 14.7 kN/m³   Cohesion': 420 kPa   Phi': 35.5 °   Phi-B: 0 °



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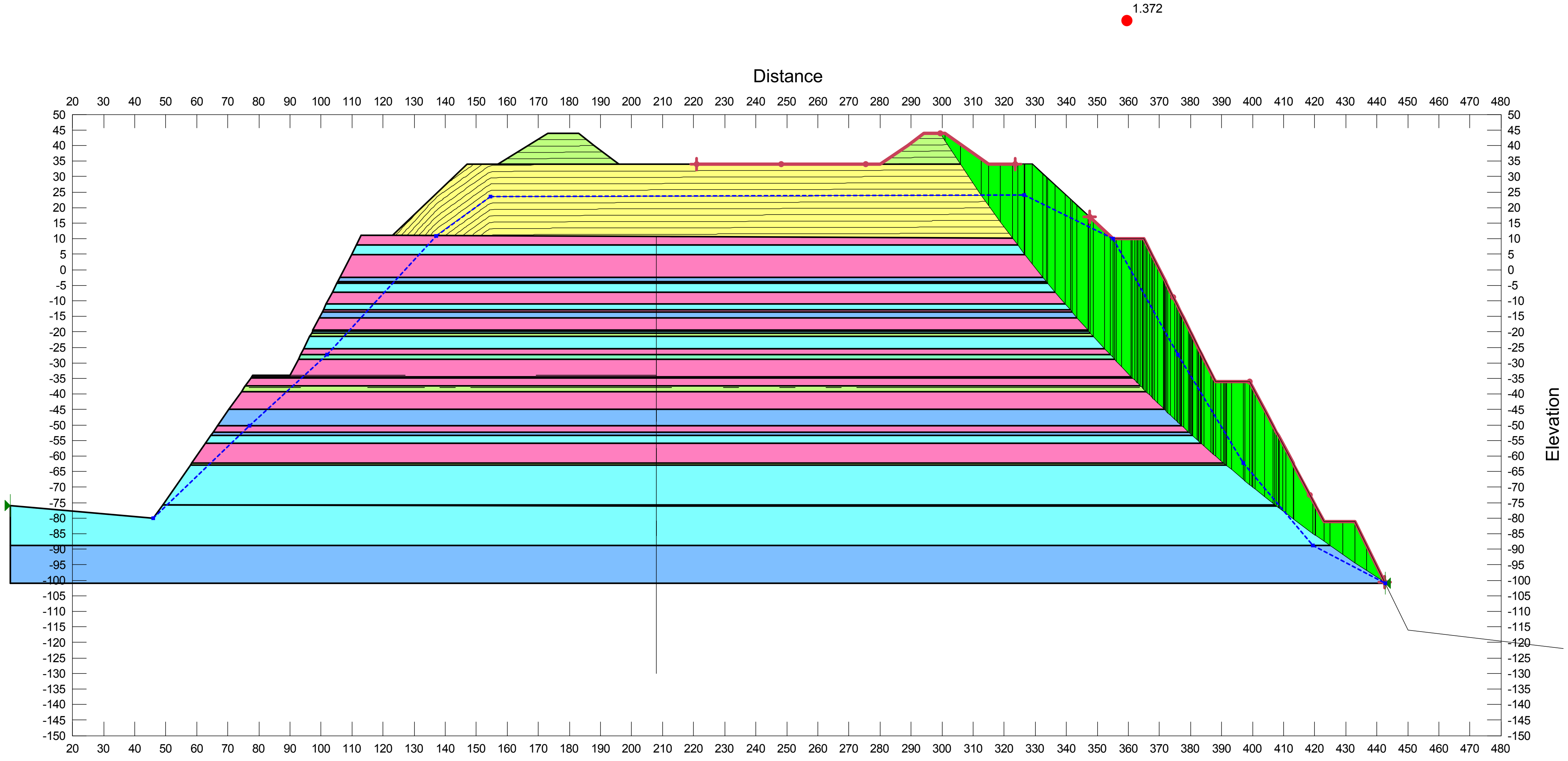
Name: Overburden   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m^3 Cohesion': 40 kPa   Phi': 25 °   Phi-B: 0 °   Piezometric Line: 1
Name: Spoil   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m^3 Cohesion': 0 kPa   Phi': 34 °   Phi-B: 0 °   Piezometric Line: 1
Name: Mudstone HW   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m^3 Cohesion': 60 kPa   Phi': 24 °   Phi-B: 0 °
Name: Mudstone Fr   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m^3 Cohesion': 200 kPa   Phi': 38 °   Phi-B: 0 °
Name: Siltstone CW   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m^3 Cohesion': 60 kPa   Phi': 43 °   Phi-B: 0 °
Name: Sandstone Fr   Model: Mohr-Coulomb   Unit Weight: 24.5 kN/m^3 Cohesion': 200 kPa   Phi': 40 °   Phi-B: 0 °
Name: Coal Fr   Model: Mohr-Coulomb   Unit Weight: 14.7 kN/m^3 Cohesion': 420 kPa   Phi': 35.5 °   Phi-B: 0 °



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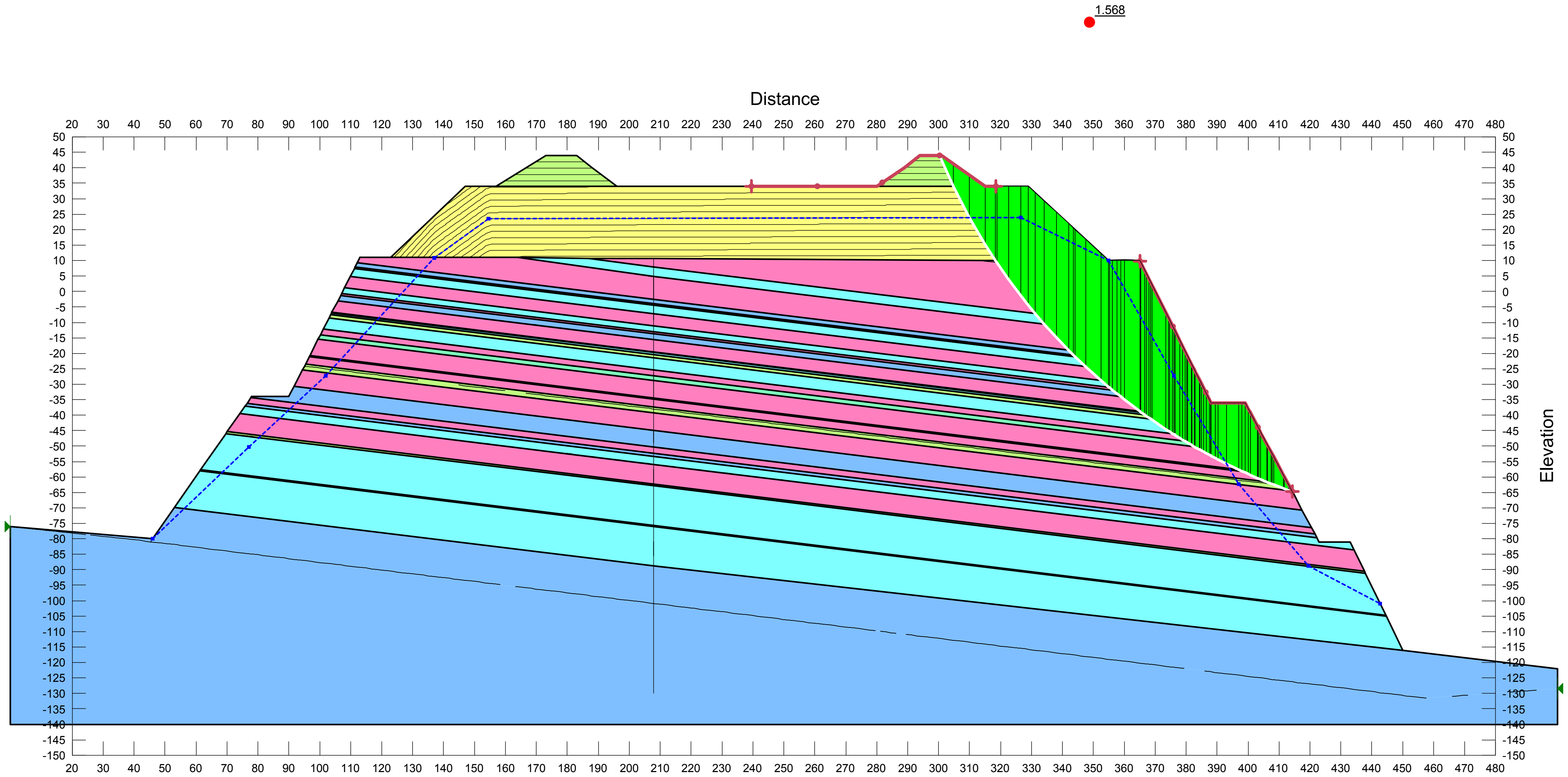
Name: Spoil   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m³   Cohesion': 0 kPa   Phi': 34 °   Phi-B: 0 °   Piezometric Line: 1
Name: Mudstone HW   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m³   Cohesion': 60 kPa   Phi': 24 °   Phi-B: 0 °
Name: Mudstone Fr   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m³   Cohesion': 200 kPa   Phi': 38 °   Phi-B: 0 °
Name: Siltstone CW   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m³   Cohesion': 60 kPa   Phi': 43 °   Phi-B: 0 °
Name: Sandstone Fr   Model: Mohr-Coulomb   Unit Weight: 24.5 kN/m³   Cohesion': 200 kPa   Phi': 40 °   Phi-B: 0 °
Name: Coal Fr   Model: Mohr-Coulomb   Unit Weight: 14.7 kN/m³   Cohesion': 420 kPa   Phi': 35.5 °   Phi-B: 0 °



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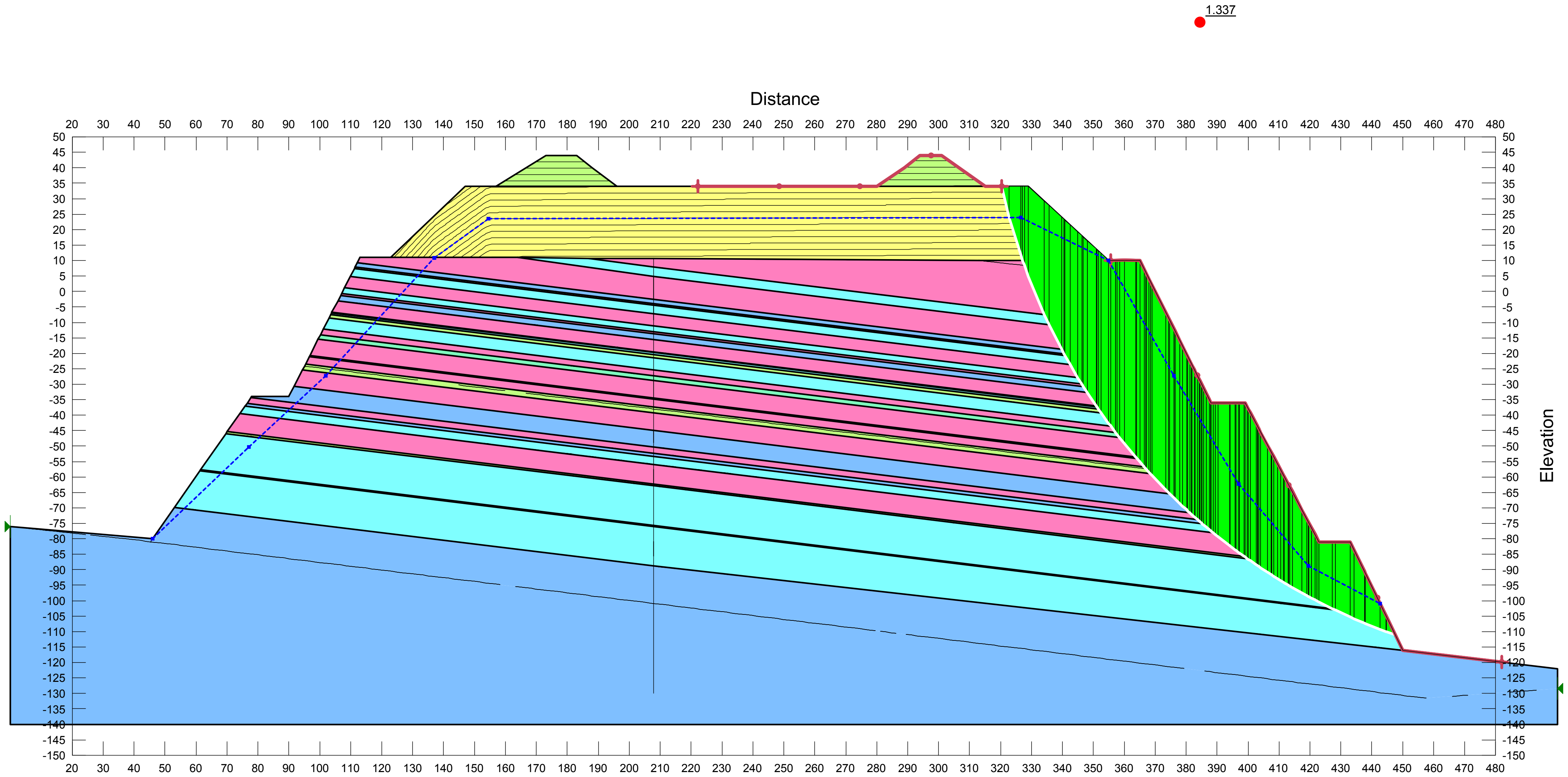
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m^3 Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Piezometric Line: 1
Name: Mudstone HW Model: Mohr-Coulomb Unit Weight: 18.6 kN/m^3 Cohesion': 60 kPa Phi': 24 ° Phi-B: 0 °
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m^3 Cohesion': 200 kPa Phi': 38 ° Phi-B: 0 °
Name: Siltstone CW Model: Mohr-Coulomb Unit Weight: 19.6 kN/m^3 Cohesion': 60 kPa Phi': 43 ° Phi-B: 0 °
Name: Sandstone Fr Model: Mohr-Coulomb Unit Weight: 24.5 kN/m^3 Cohesion': 200 kPa Phi': 40 ° Phi-B: 0 °
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m^3 Cohesion': 420 kPa Phi': 35.5 ° Phi-B: 0 °



Detailed Model

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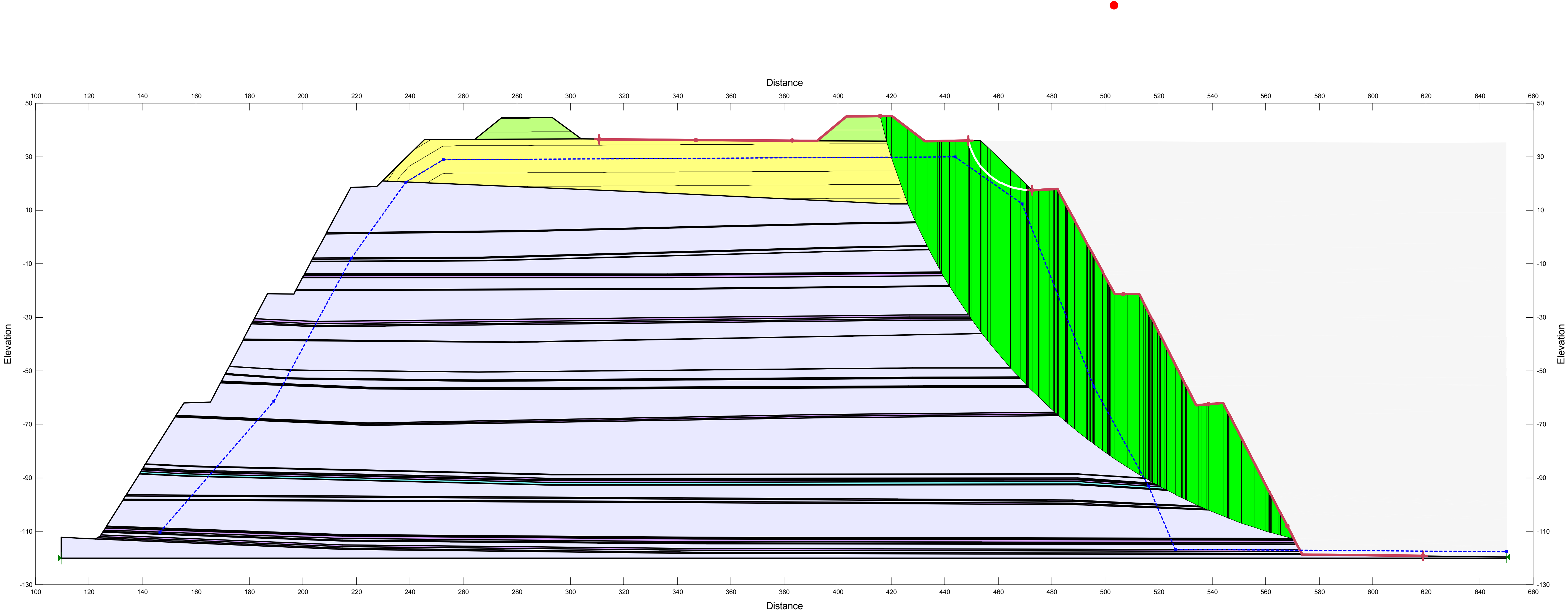
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Piezometric Line: 1
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 °
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 °
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 °



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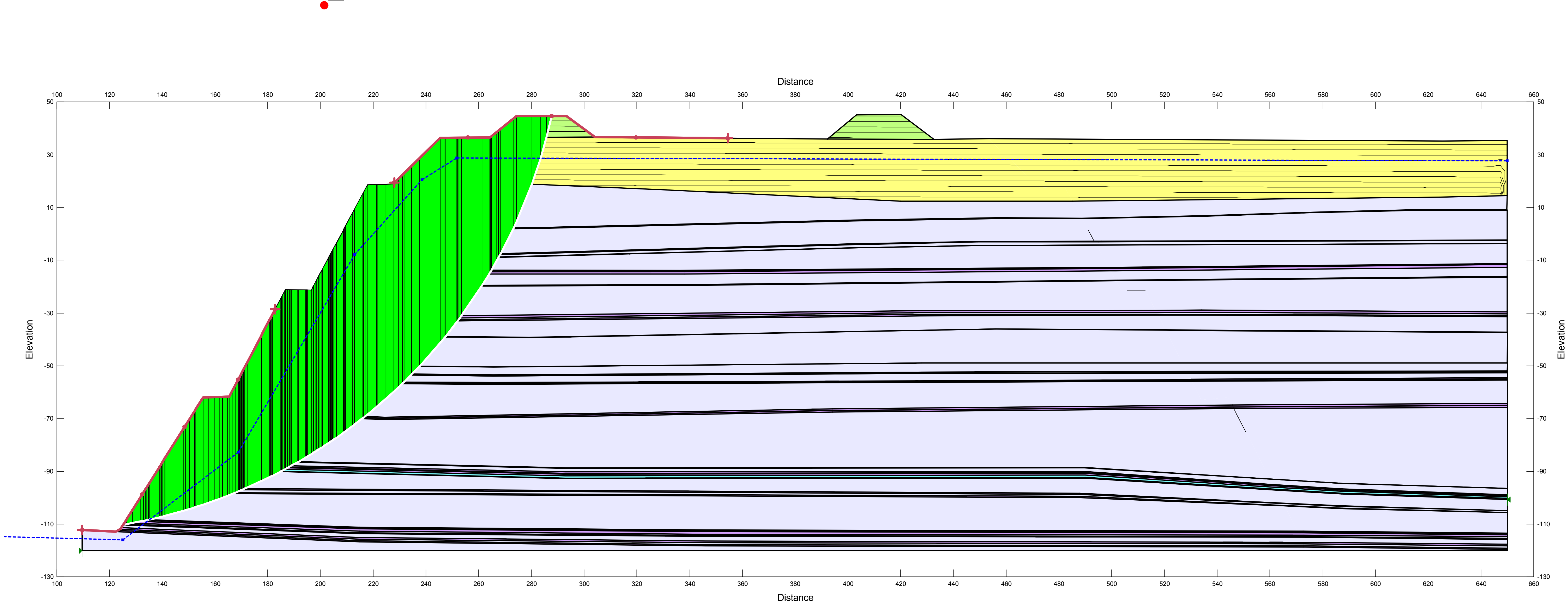
Name: Overburden Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 40 kPa Phi': 25 ° Phi-B: 0 ° Piezometric Line: 1
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Piezometric Line: 1
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 °
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 °
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 °



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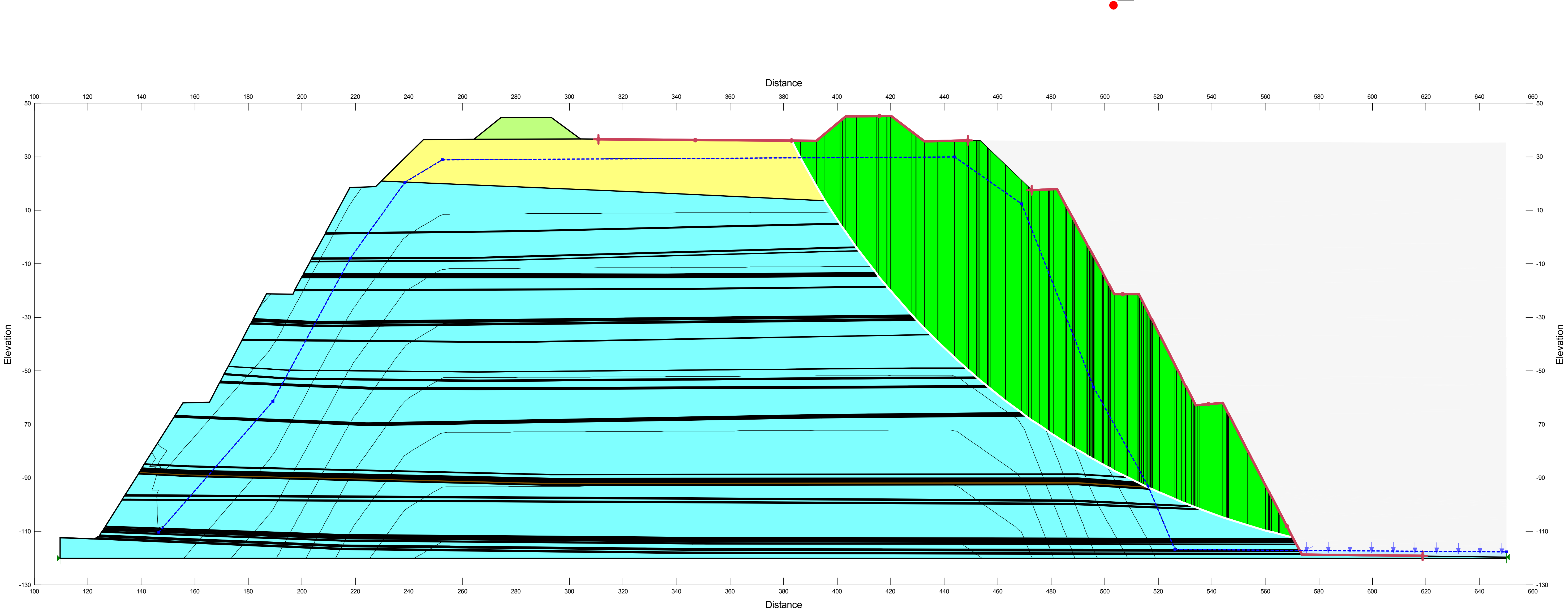
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m^3 Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Piezometric Line: 1

Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m^3 Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 °

Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m^3 Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m^3 Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m^3 Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Piezometric Line: 1



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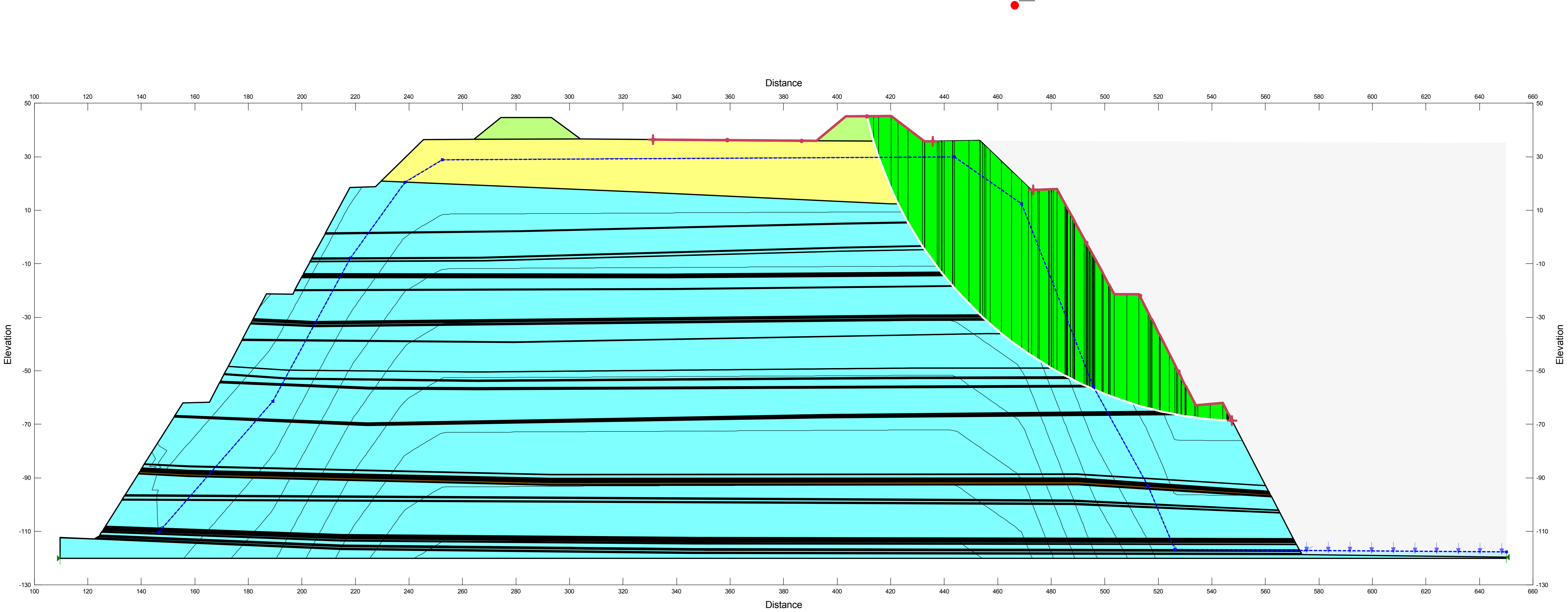
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Piezometric Line: 1

Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 °

Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Piezometric Line: 1



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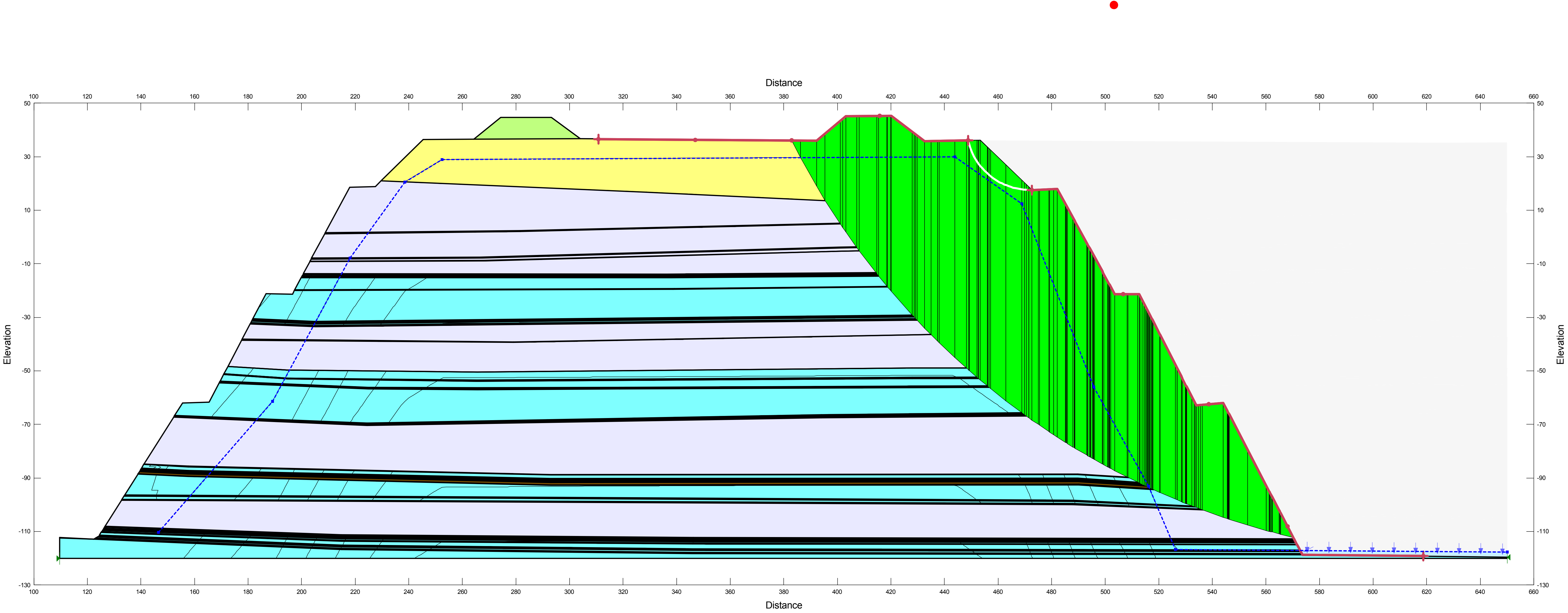
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 °

Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Piezometric Line: 1



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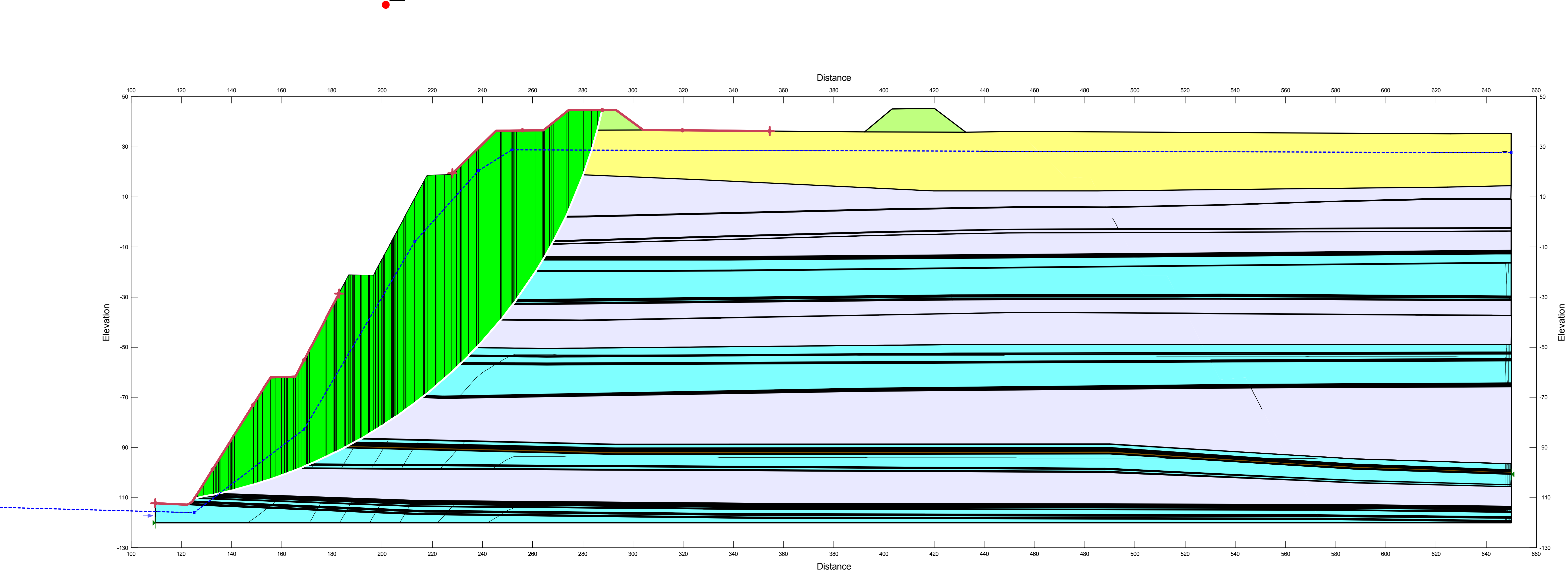
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Piezometric Line: 1

Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 °

Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 °

Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Piezometric Line: 1



Directory: R:\M30133.0\Geostudio\File Name: CQCoal Sect5dMedLowStrRu0.15gsz.gszDate: 30/04/2018Time: 11:31:00 AMLast Edited By: Richard Maurice
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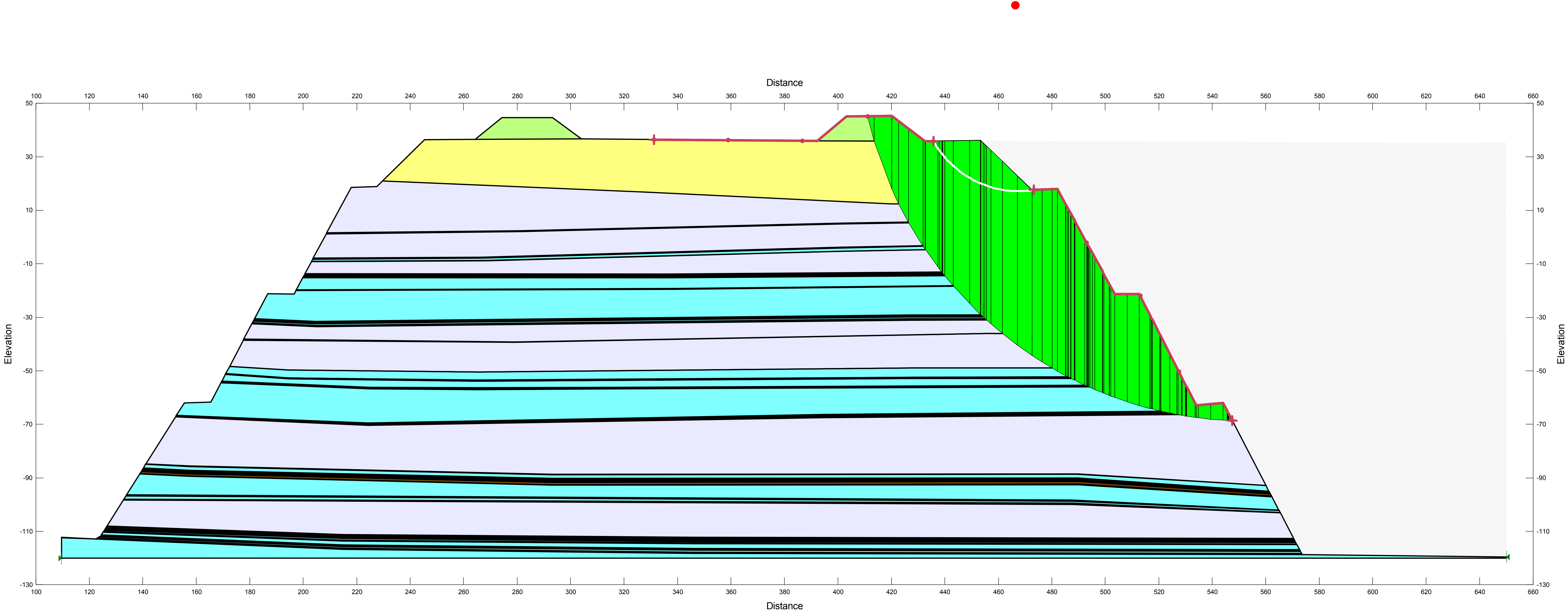
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Ru: 0.15
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Ru: 0.15



Directory: R:\M30133.0\Geostudio\File Name: CQCoal Sect5dMedLowStrRu0.15gsz.gszDate: 30/04/2018Time: 11:31:00 AMLast Edited By: Richard Maurice

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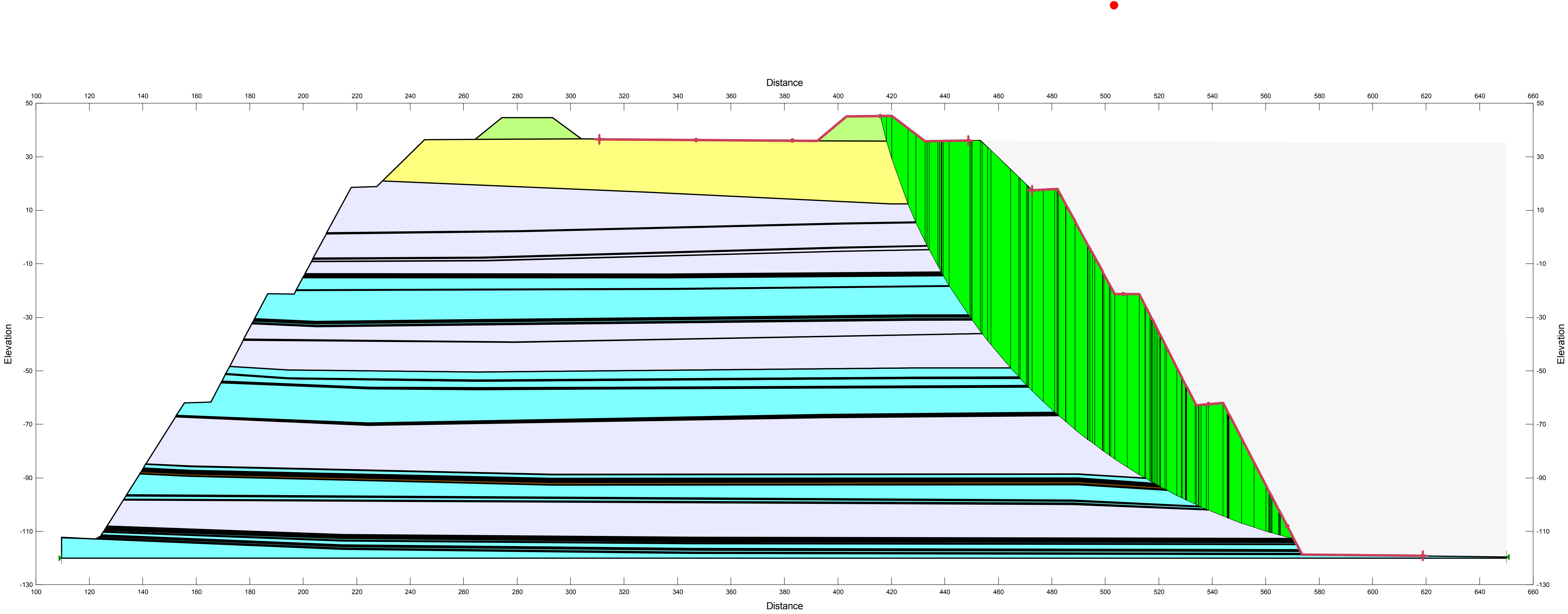
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Ru: 0.15

Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15

Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15

Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15

Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Ru: 0.15



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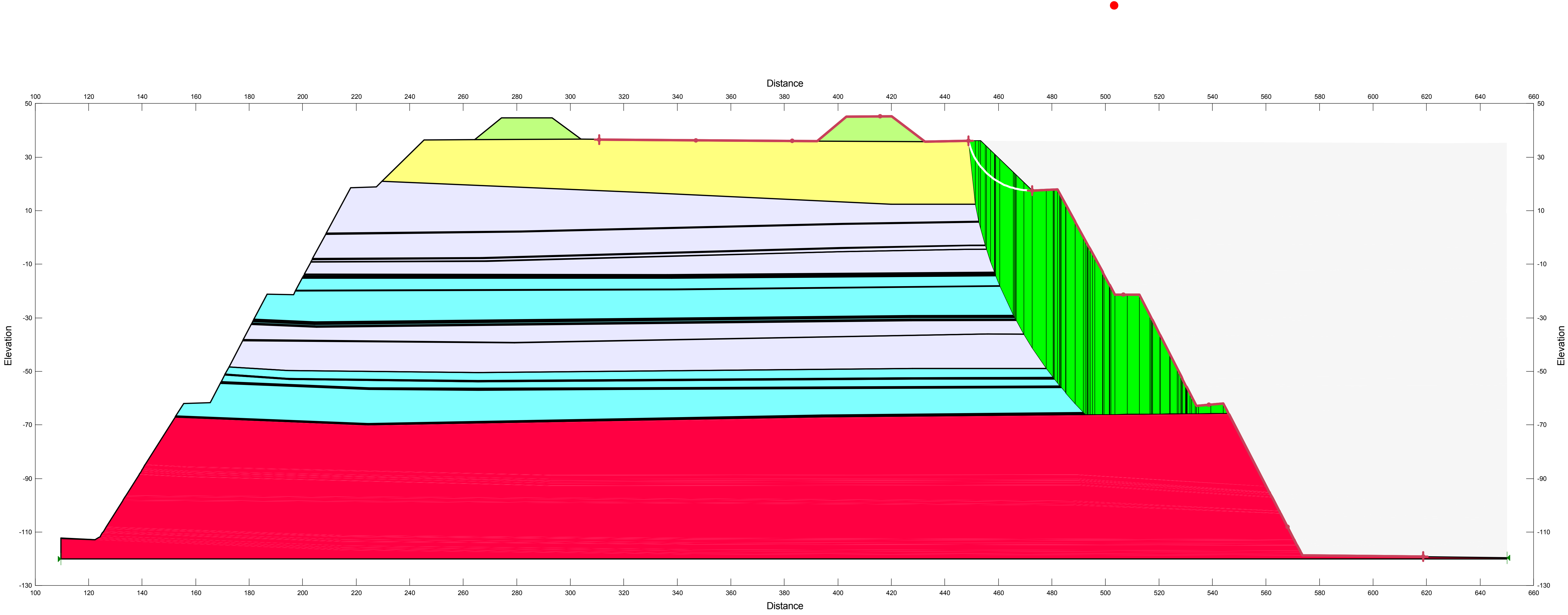
Name: Spoil   Model: Mohr-Coulomb   Unit Weight: 18.6 kN/m³   Cohesion': 0 kPa   Phi': 34 °   Phi-B: 0 °   Ru: 0.15
Name: Mudstone Fr   Model: Mohr-Coulomb   Unit Weight: 19.6 kN/m³   Cohesion': 450 kPa   Phi': 27.5 °   Phi-B: 0 °   Ru: 0.15
Name: Coal Fr   Model: Mohr-Coulomb   Unit Weight: 14.7 kN/m³   Cohesion': 670 kPa   Phi': 21.8 °   Phi-B: 0 °   Ru: 0.15
Name: Mixed Sedimentary Hoek Brown   Model: Mohr-Coulomb   Unit Weight: 24 kN/m³   Cohesion': 750 kPa   Phi': 30.5 °   Phi-B: 0 °   Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Lo   Model: Mohr-Coulomb   Unit Weight: 24 kN/m³   Cohesion': 350 kPa   Phi': 24.6 °   Phi-B: 0 °   Ru: 0.15
Name: Impenetrable   Model: Bedrock (Impenetrable)   Ru: 0



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Name: Overburden Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 40 kPa Phi': 25 ° Phi-B: 0 ° Ru: 0.15
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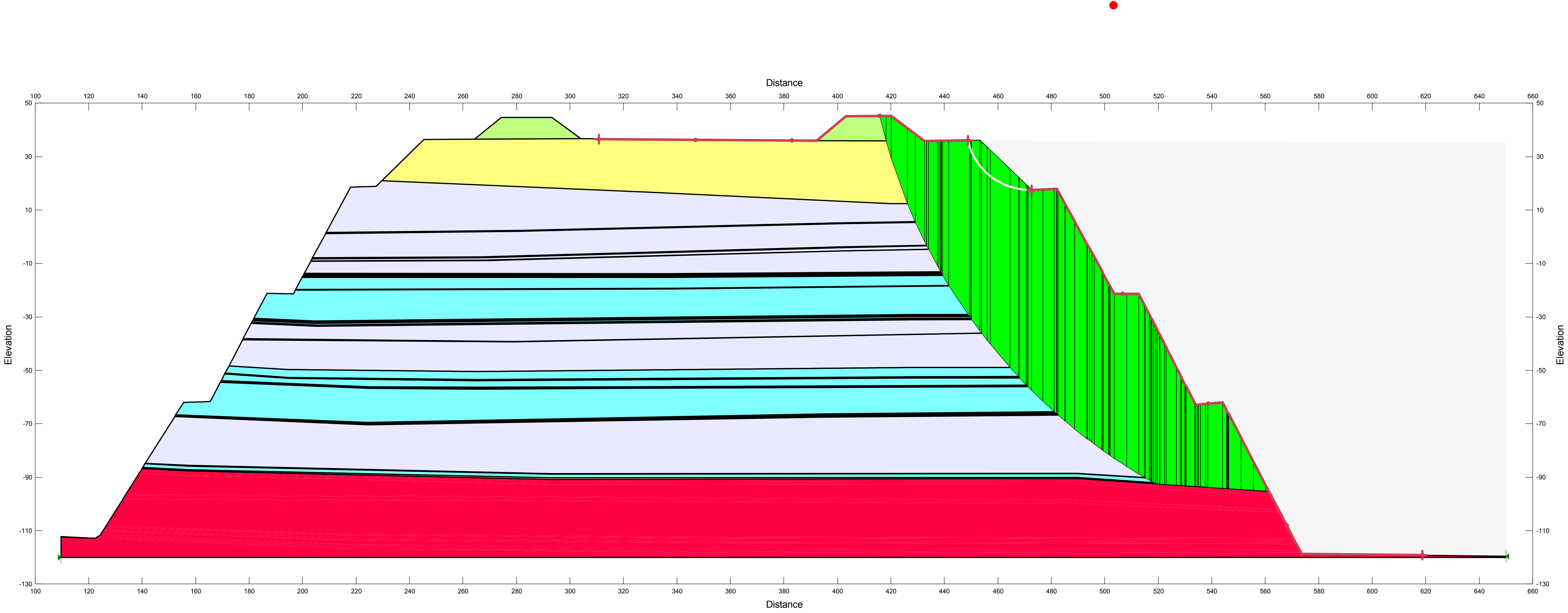
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15
Name: Shear Zone Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion': 9 kPa Phi': 25 ° Phi-B: 0 ° Ru: 0
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Ru: 0.15
Name: Impenetrable Model: Bedrock (Impenetrable) Ru: 0



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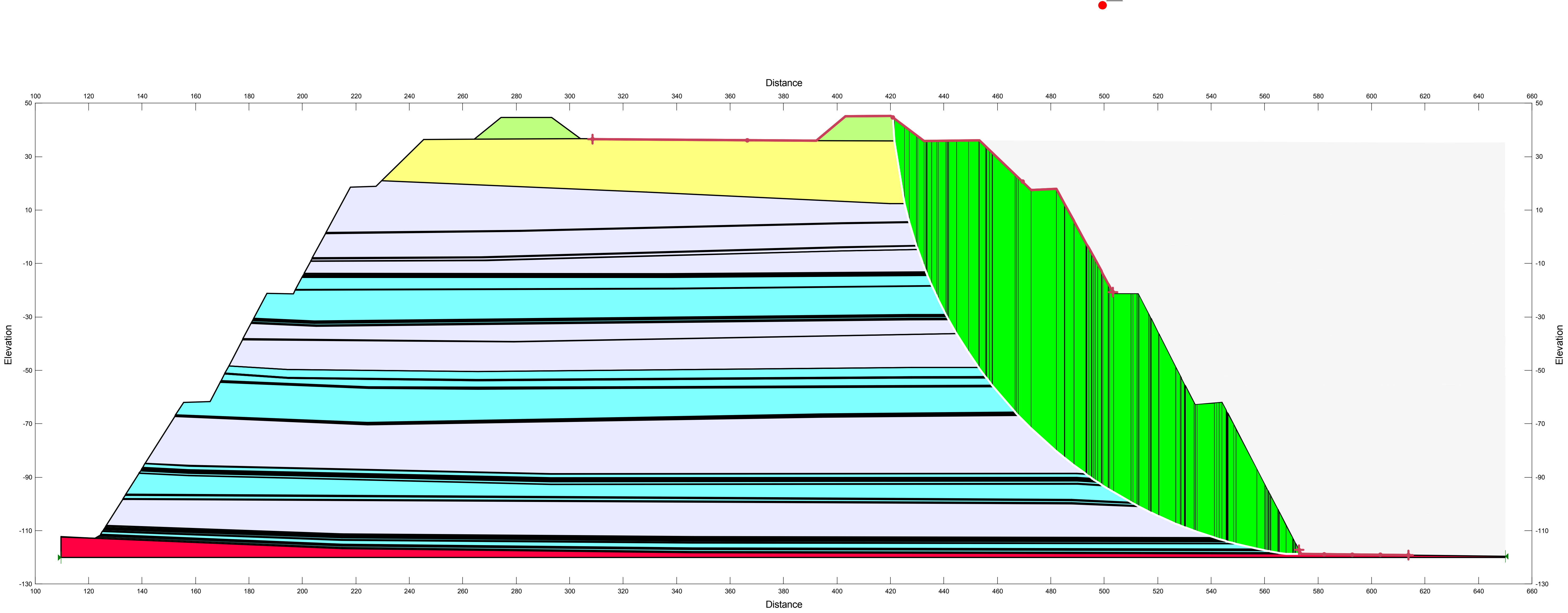
Name: Shear Zone Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion': 9 kPa Phi': 25 ° Phi-B: 0 ° Ru: 0
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Ru: 0.15
Name: Impenetrable Model: Bedrock (Impenetrable) Ru: 0



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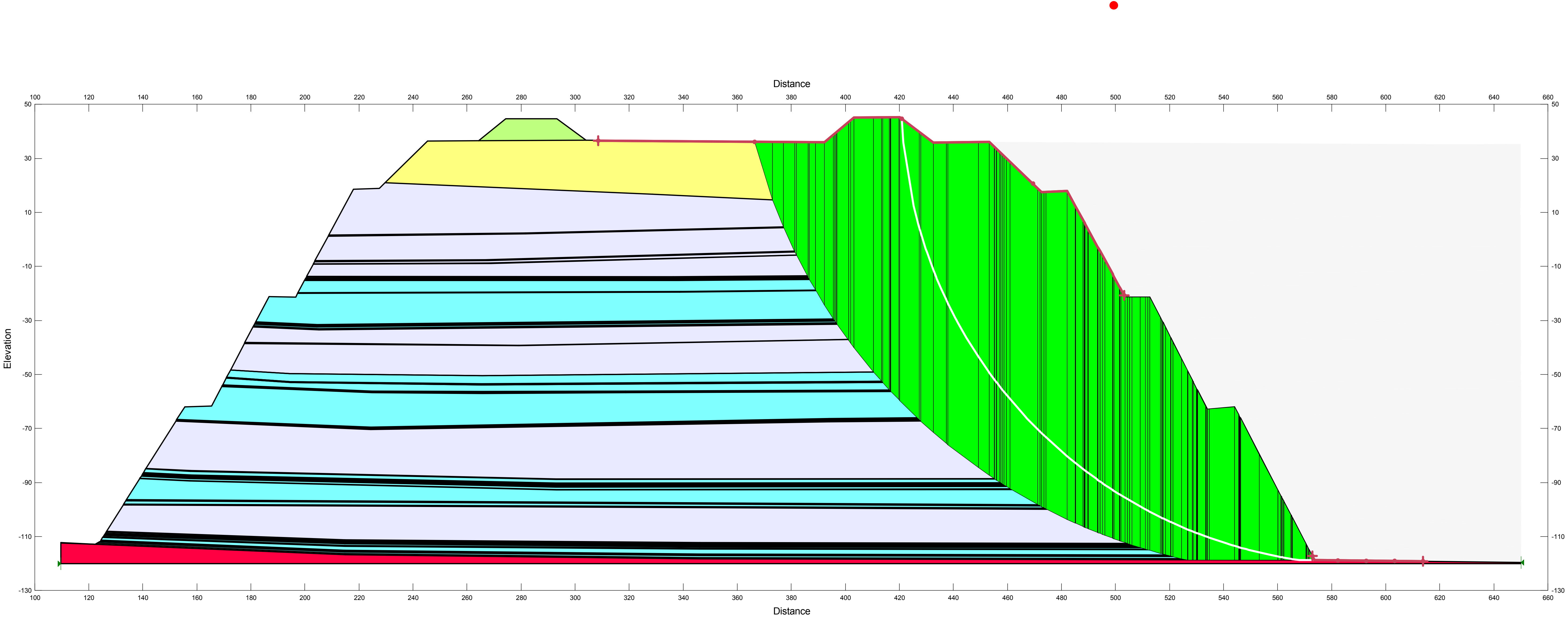
Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Ru: 0.15
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15
Name: Shear Zone Model: Mohr-Coulomb Unit Weight: 18 kN/m³ Cohesion': 9 kPa Phi': 25 ° Phi-B: 0 ° Ru: 0
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Ru: 0.15
Name: Impenetrable Model: Bedrock (Impenetrable) Ru: 0



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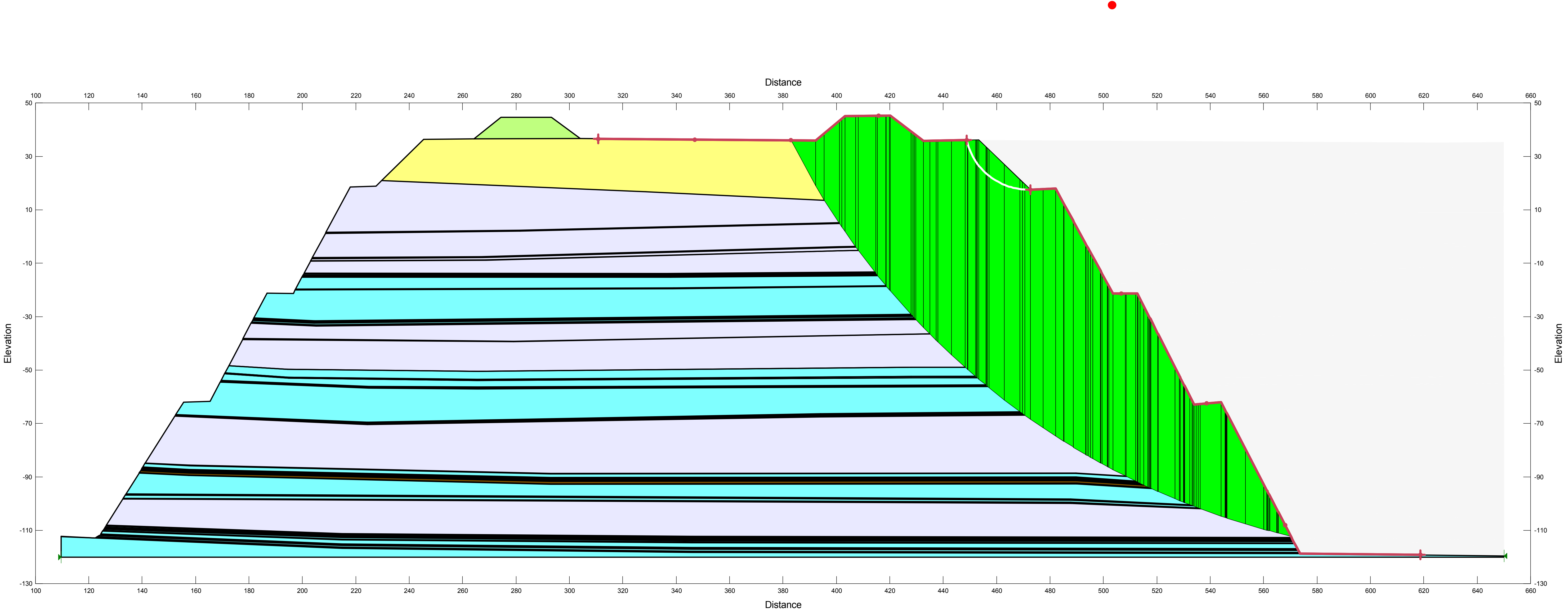
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Lo Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 350 kPa Phi': 24.6 ° Phi-B: 0 ° Ru: 0.15



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Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m^3 Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m^3 Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m^3 Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
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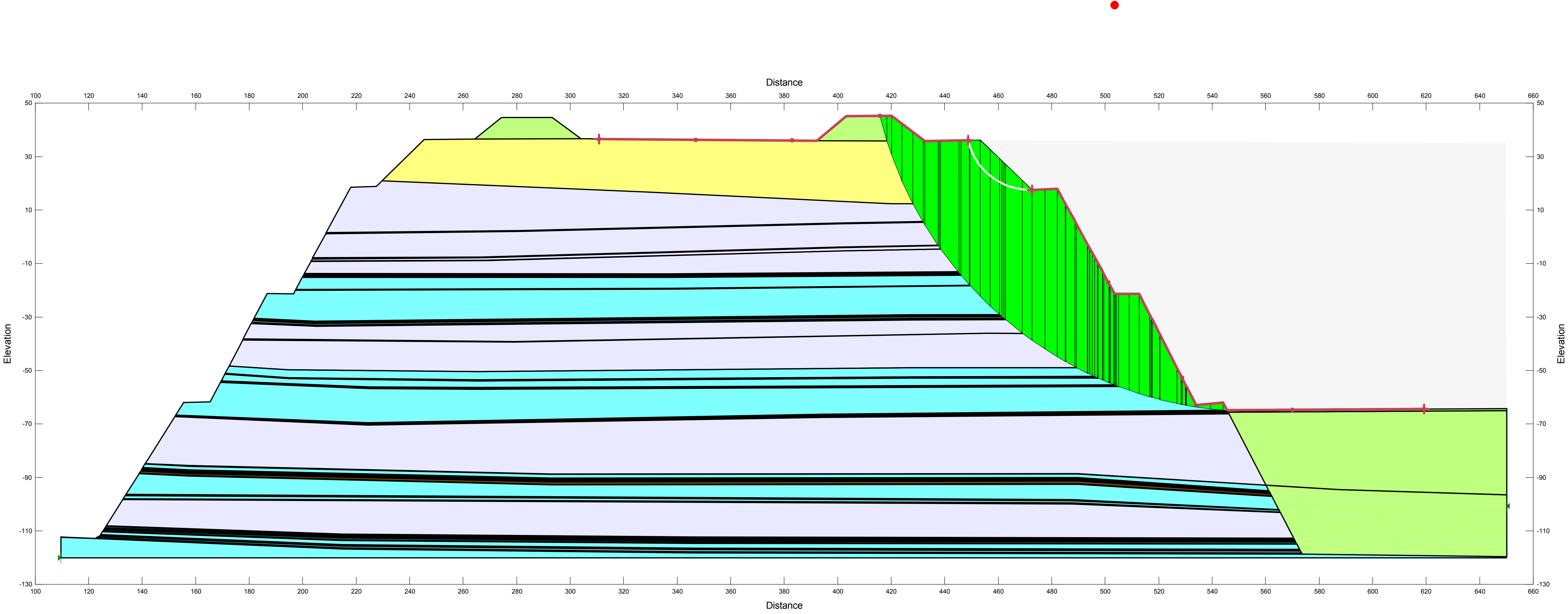

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Name: Spoil Model: Mohr-Coulomb Unit Weight: 18.6 kN/m³ Cohesion': 0 kPa Phi': 34 ° Phi-B: 0 ° Ru: 0.15
Name: Mudstone Fr Model: Mohr-Coulomb Unit Weight: 19.6 kN/m³ Cohesion': 450 kPa Phi': 27.5 ° Phi-B: 0 ° Ru: 0.15
Name: Coal Fr Model: Mohr-Coulomb Unit Weight: 14.7 kN/m³ Cohesion': 670 kPa Phi': 21.8 ° Phi-B: 0 ° Ru: 0.15
Name: Mixed Sedimentary Hoek Brown Model: Mohr-Coulomb Unit Weight: 24 kN/m³ Cohesion': 750 kPa Phi': 30.5 ° Phi-B: 0 ° Ru: 0.15
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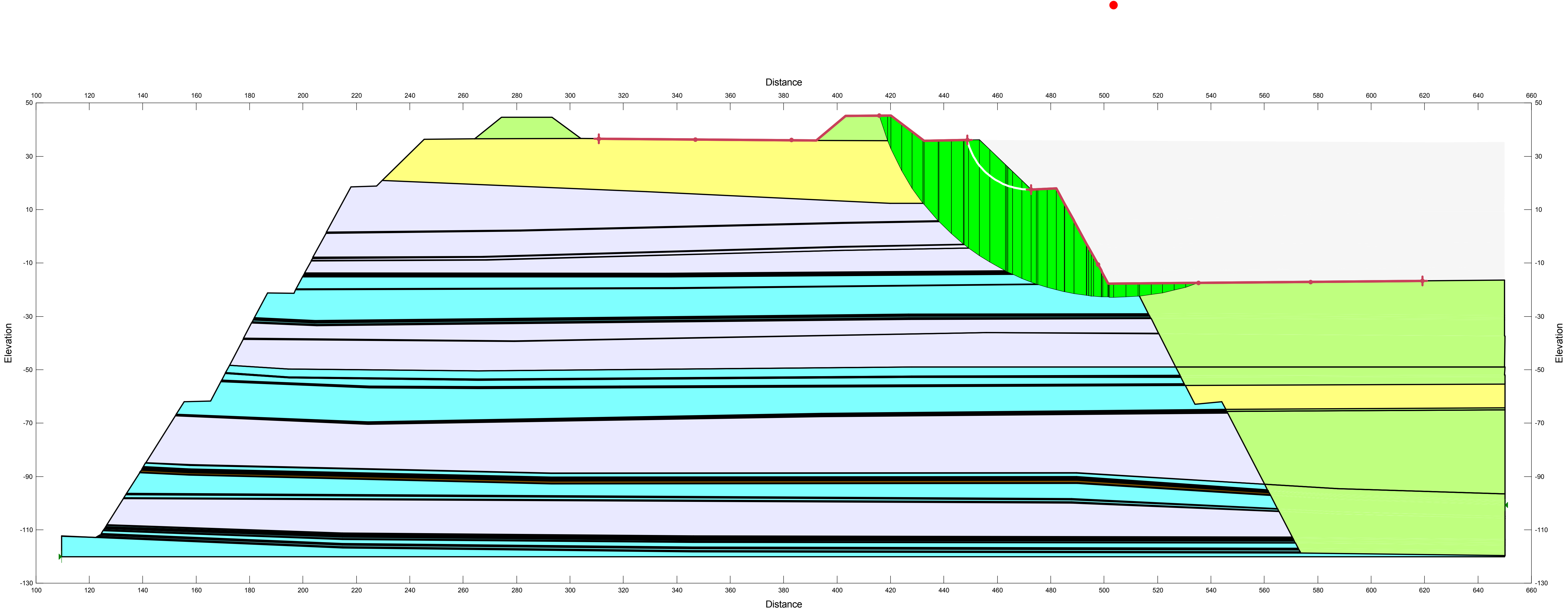
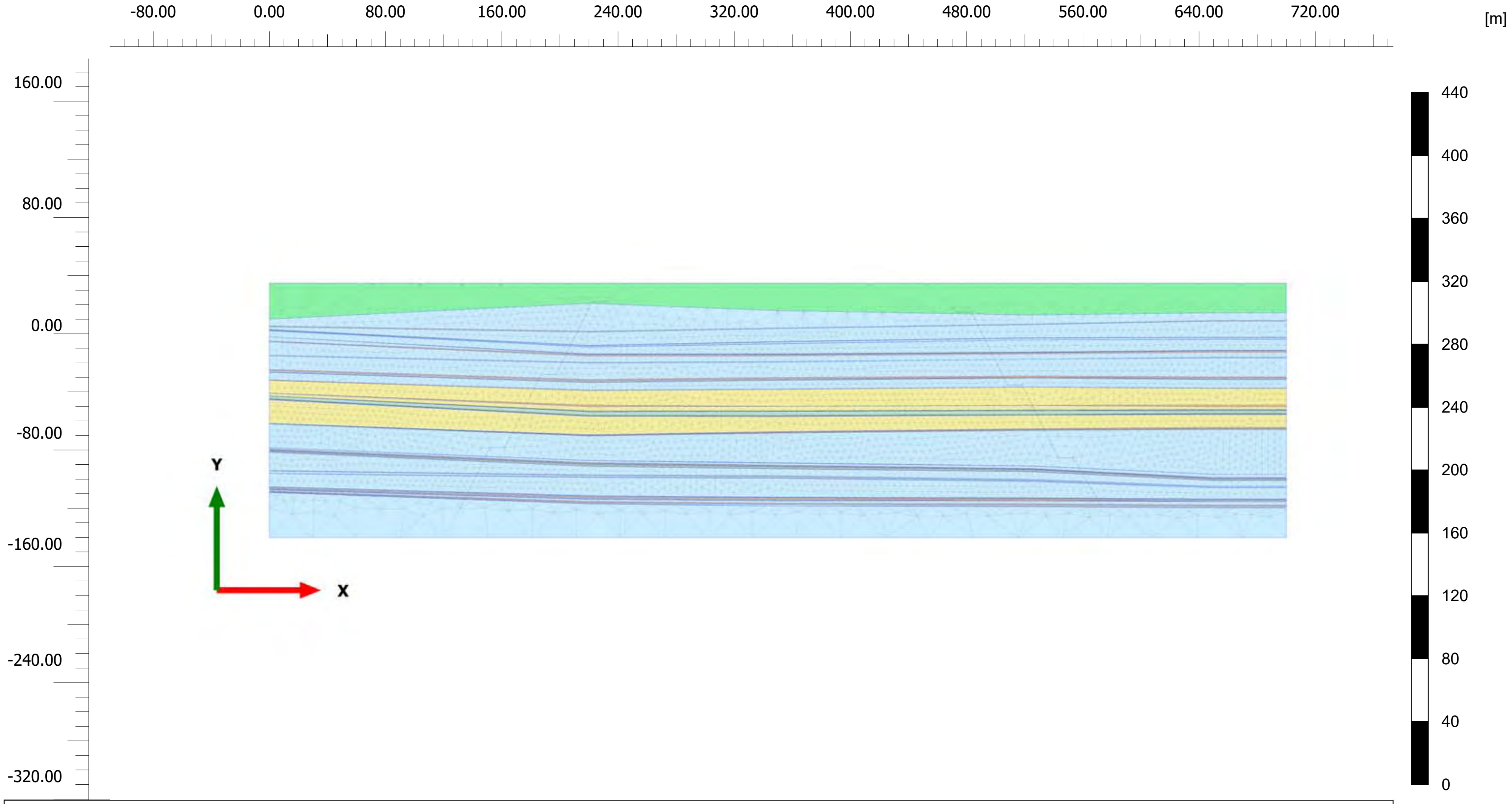


APPENDIX

E

RESULTS OF DEFORMATION ANALYSIS

Isostatic Model

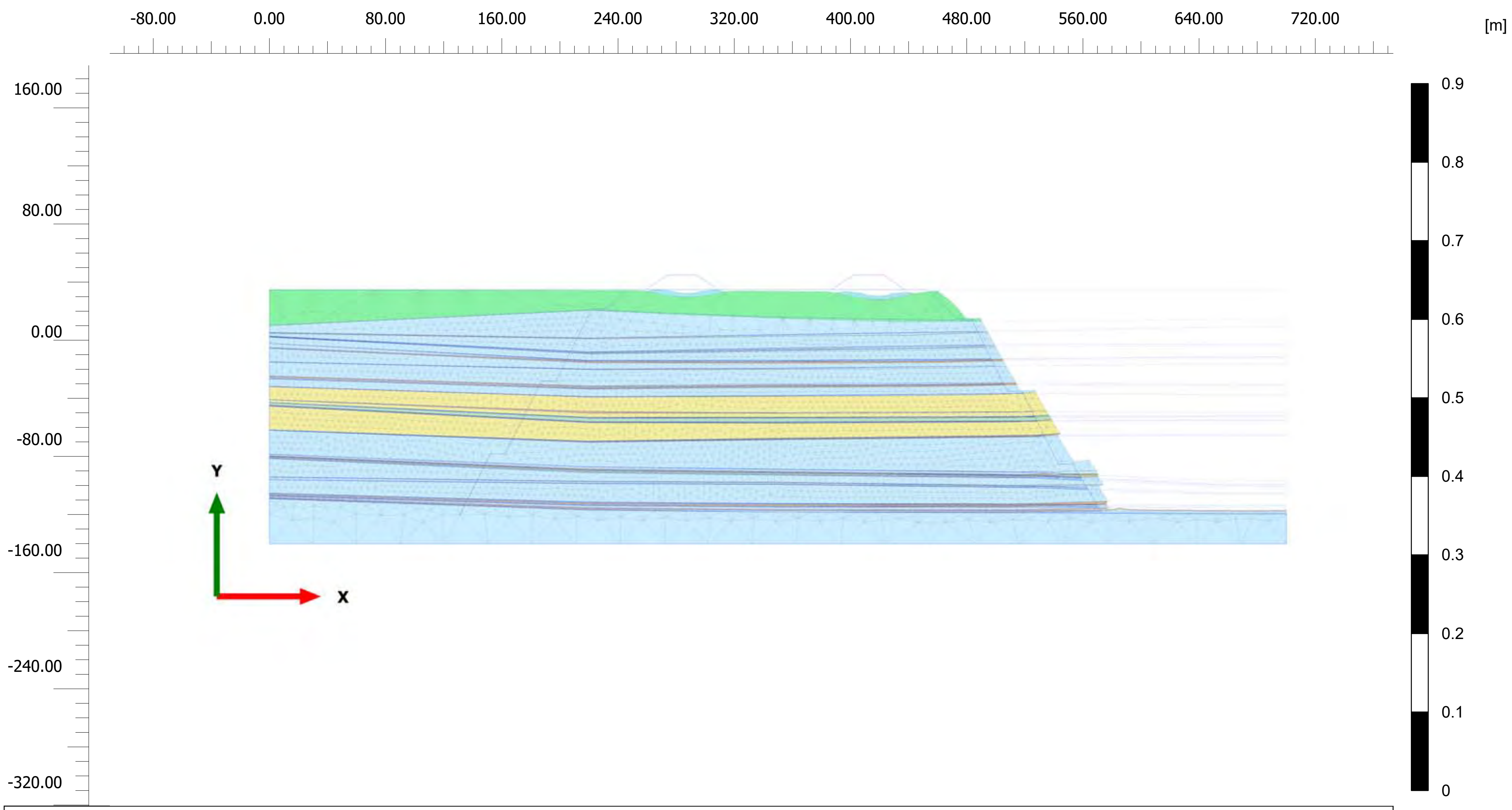


Deformed mesh |u| (at true scale)

Uniform value of 0.000 m

Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5VIsoMod2	*Step* 0	*User name* Cardno Pty Limited	

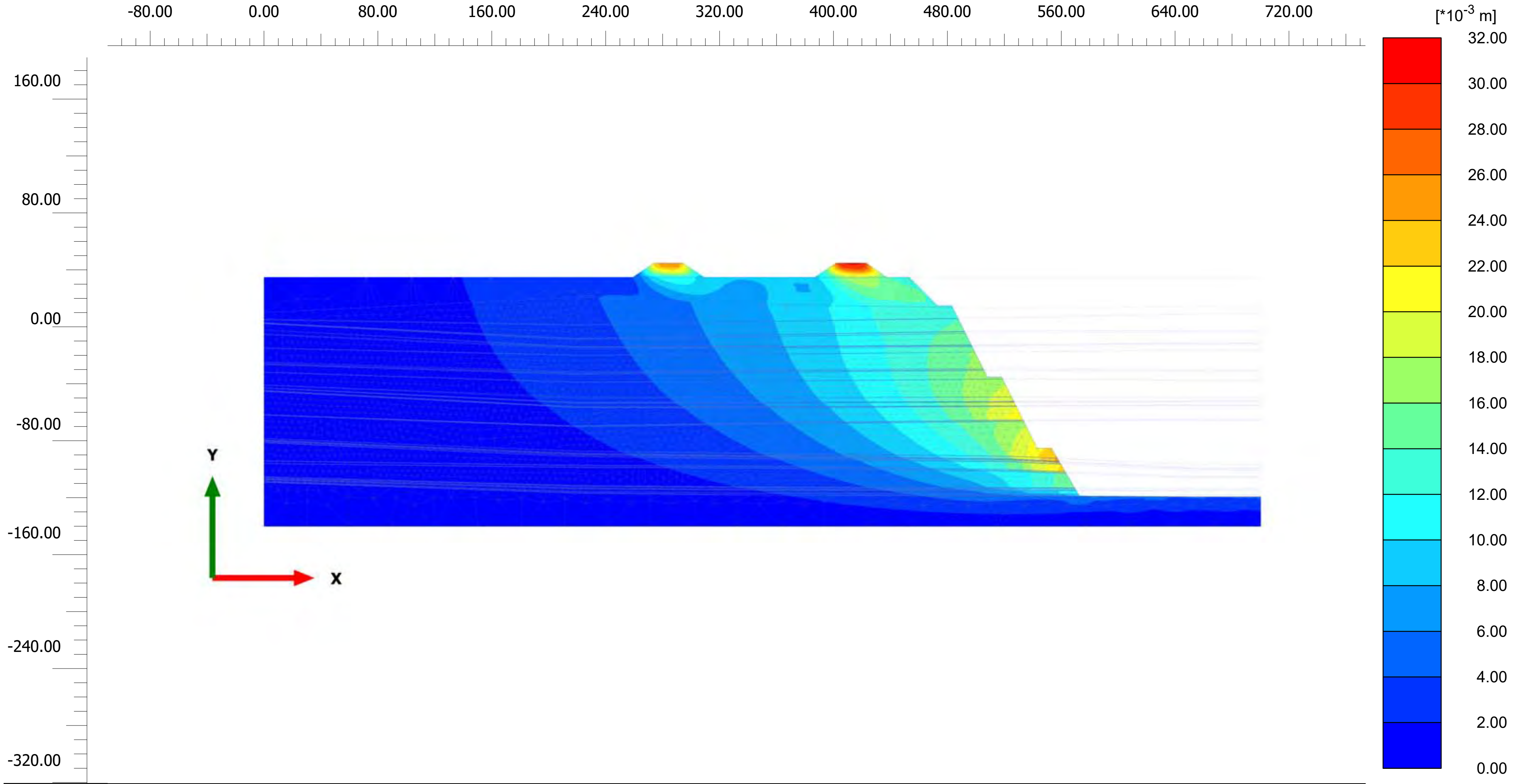
Output Version 2017.0.0.0



Deformed mesh |u| (scaled up 500 times)

Maximum value = 0.03050 m (Element 5 at Node 9483)

Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5VIsoMod2	*Step* 375	*User name* Cardno Pty Limited	



Total displacements |u|

Maximum value = 0.03050 m (Element 5 at Node 9483)

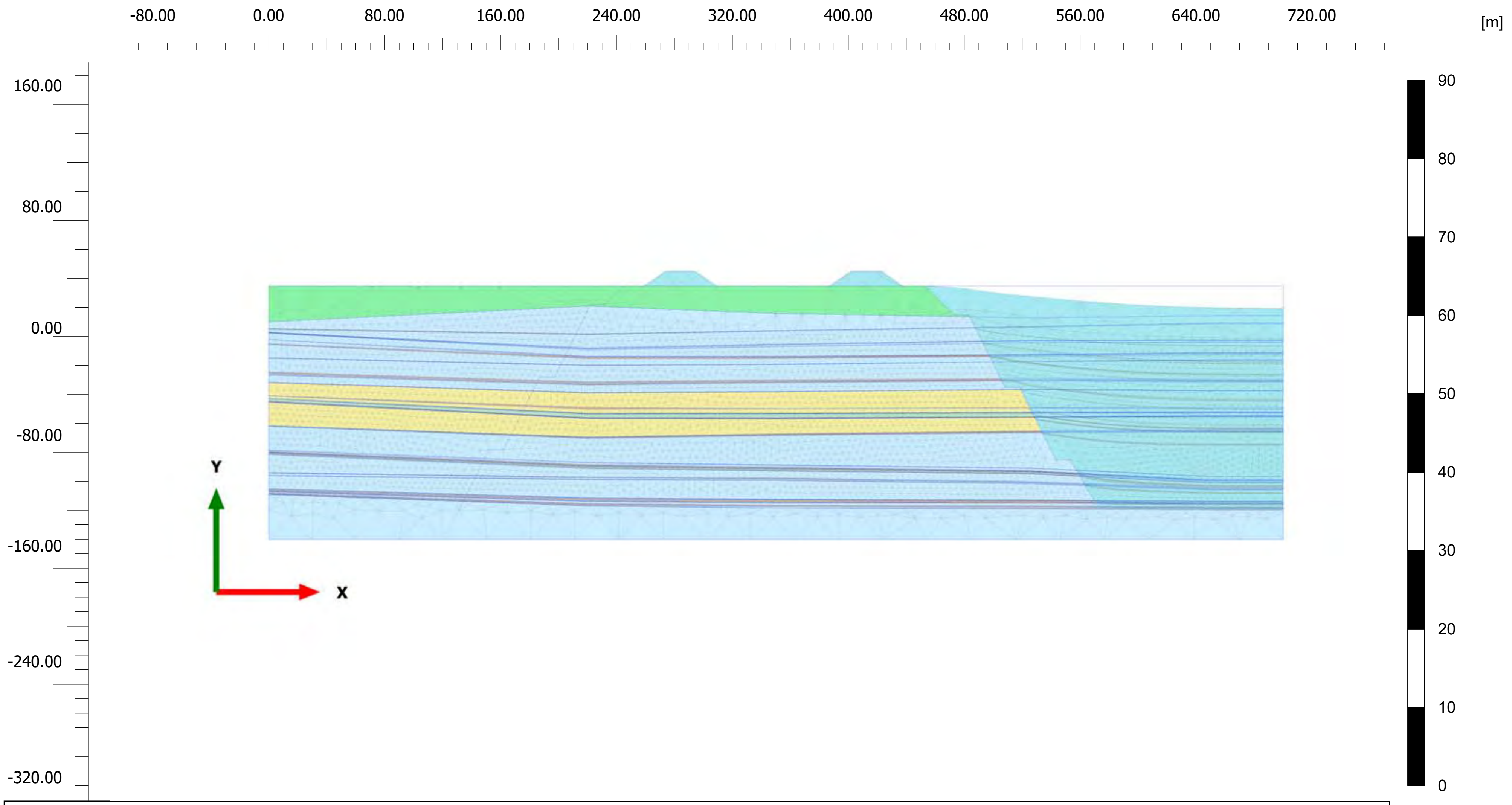
Project description
CQCoal XSect5

Date
9/05/2018

Project filename
CQCoal XSect5VIsoMod2

Step
375

User name
Cardno Pty Limited

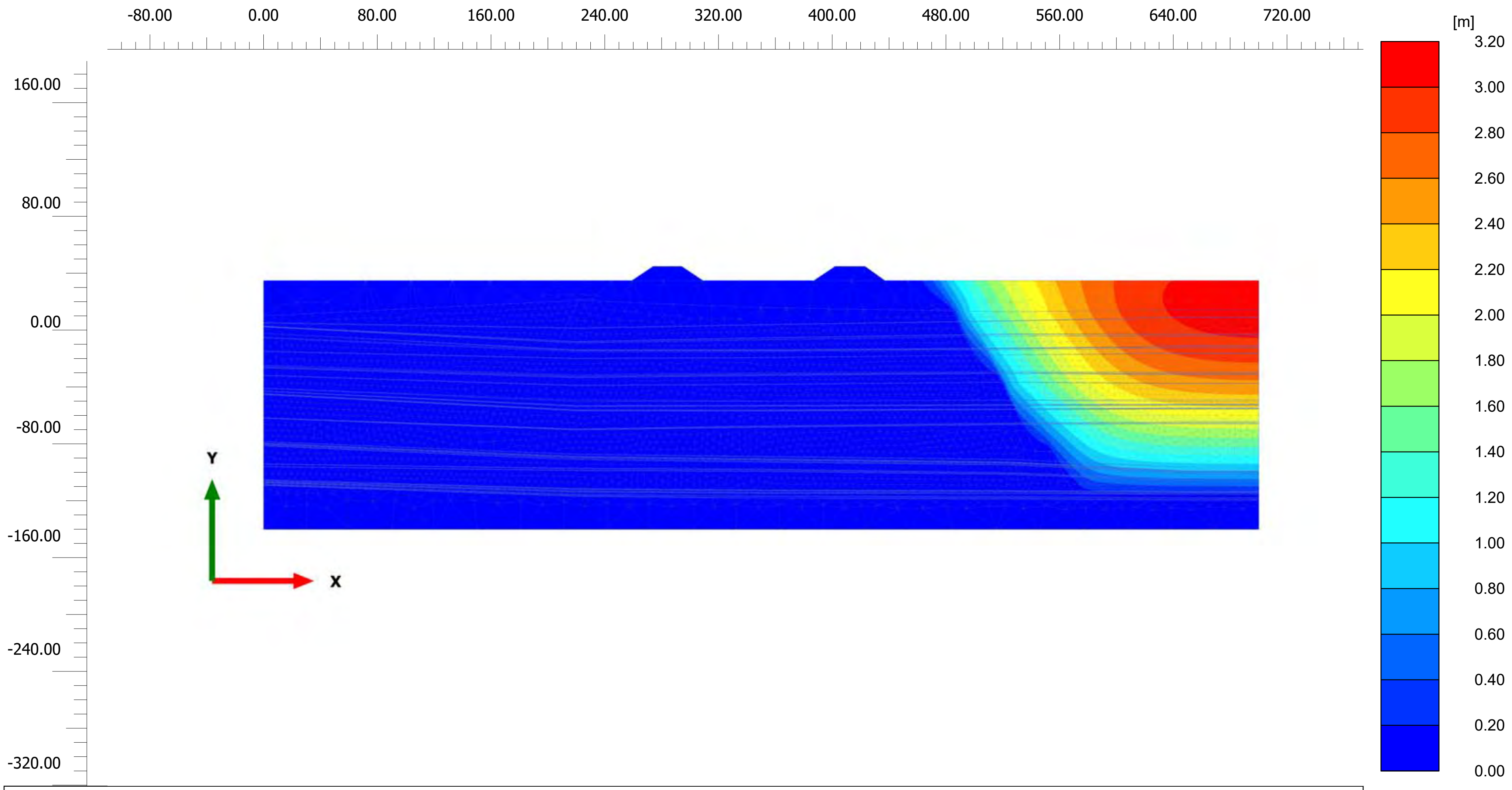


Deformed mesh |u| (scaled up 5.00 times)

Maximum value = 3.116 m (Element 136 at Node 32)

Project description	Date
CQCoal XSect5	9/05/2018

Project filename	Step	User name
CQCoal XSect5VIsoMod2	32	Cardno Pty Limited



Total displacements |u|

Maximum value = 3.116 m (Element 136 at Node 32)

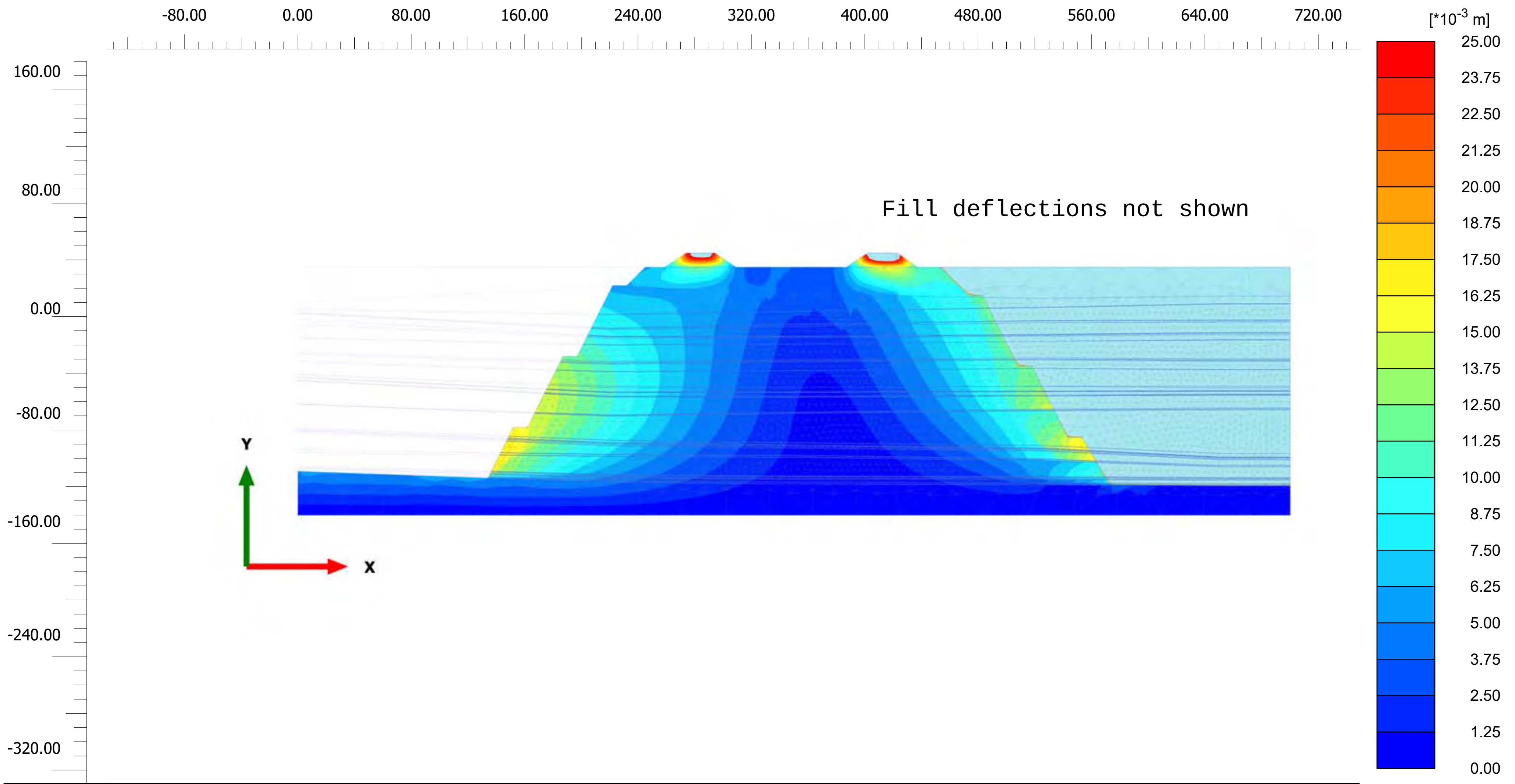
Project description
CQCoal XSect5

Date
9/05/2018

Project filename
CQCoal XSect5VIsoMod2

Step
32

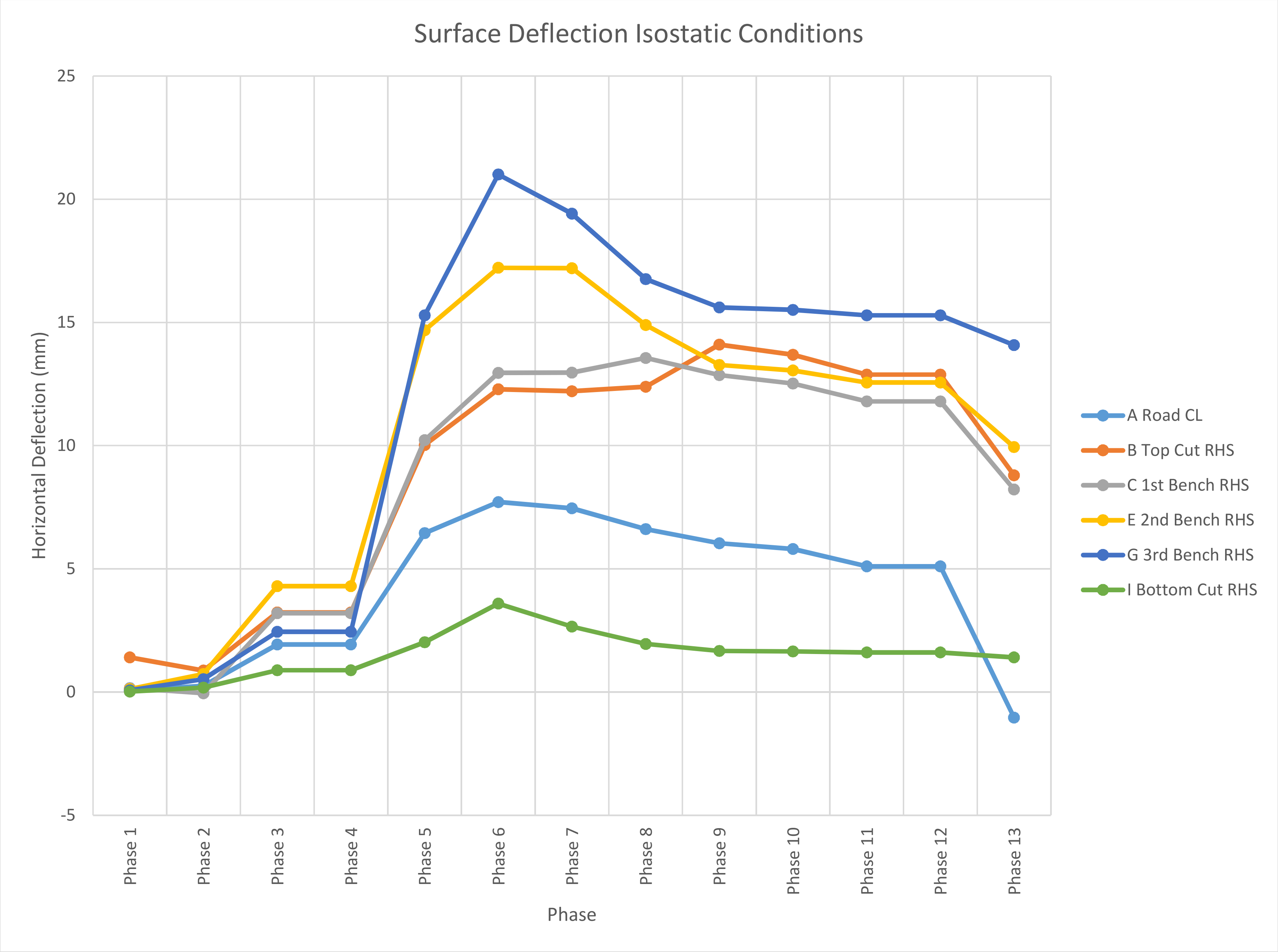
User name
Cardno Pty Limited

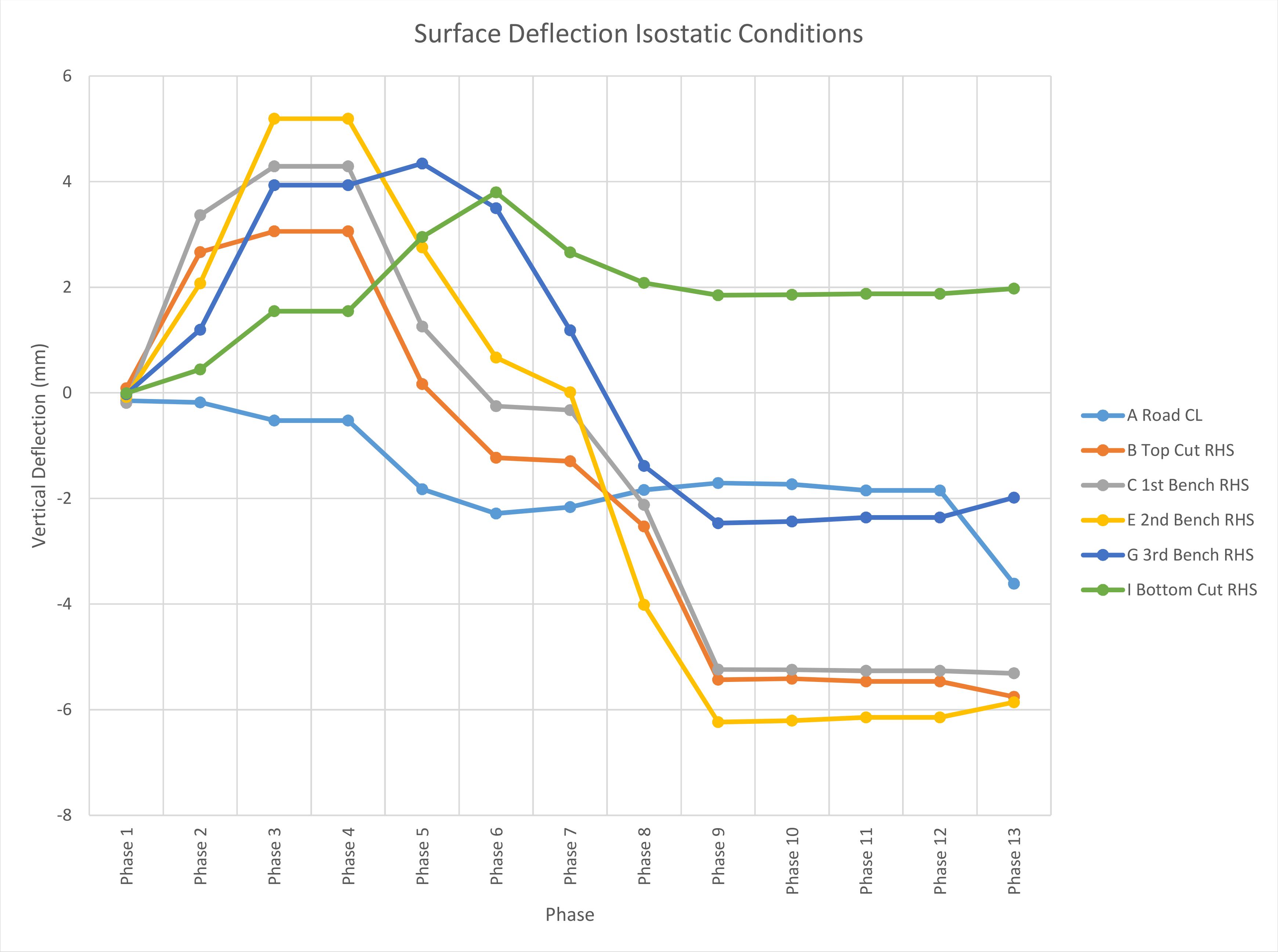


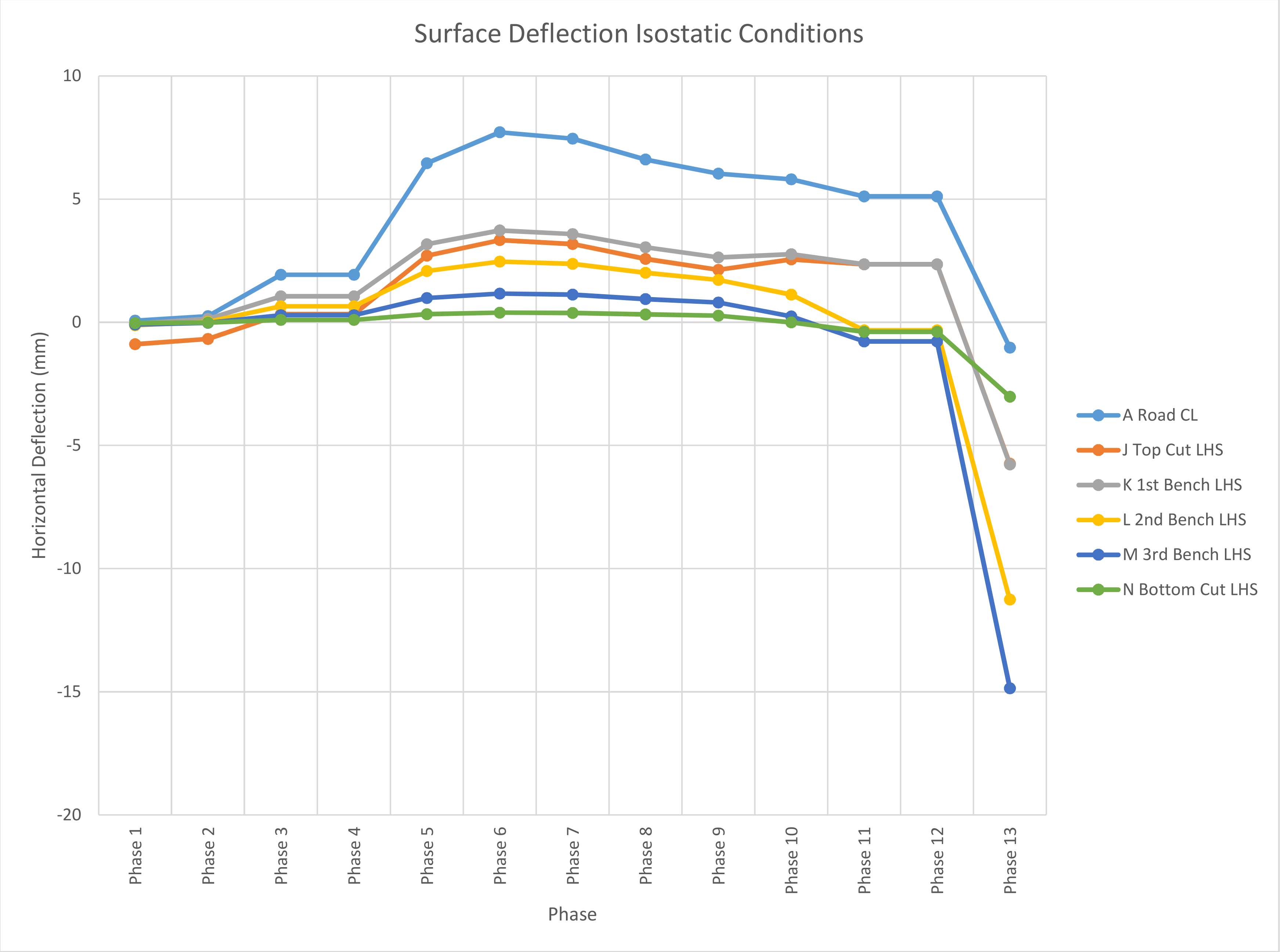
Total displacements |u|

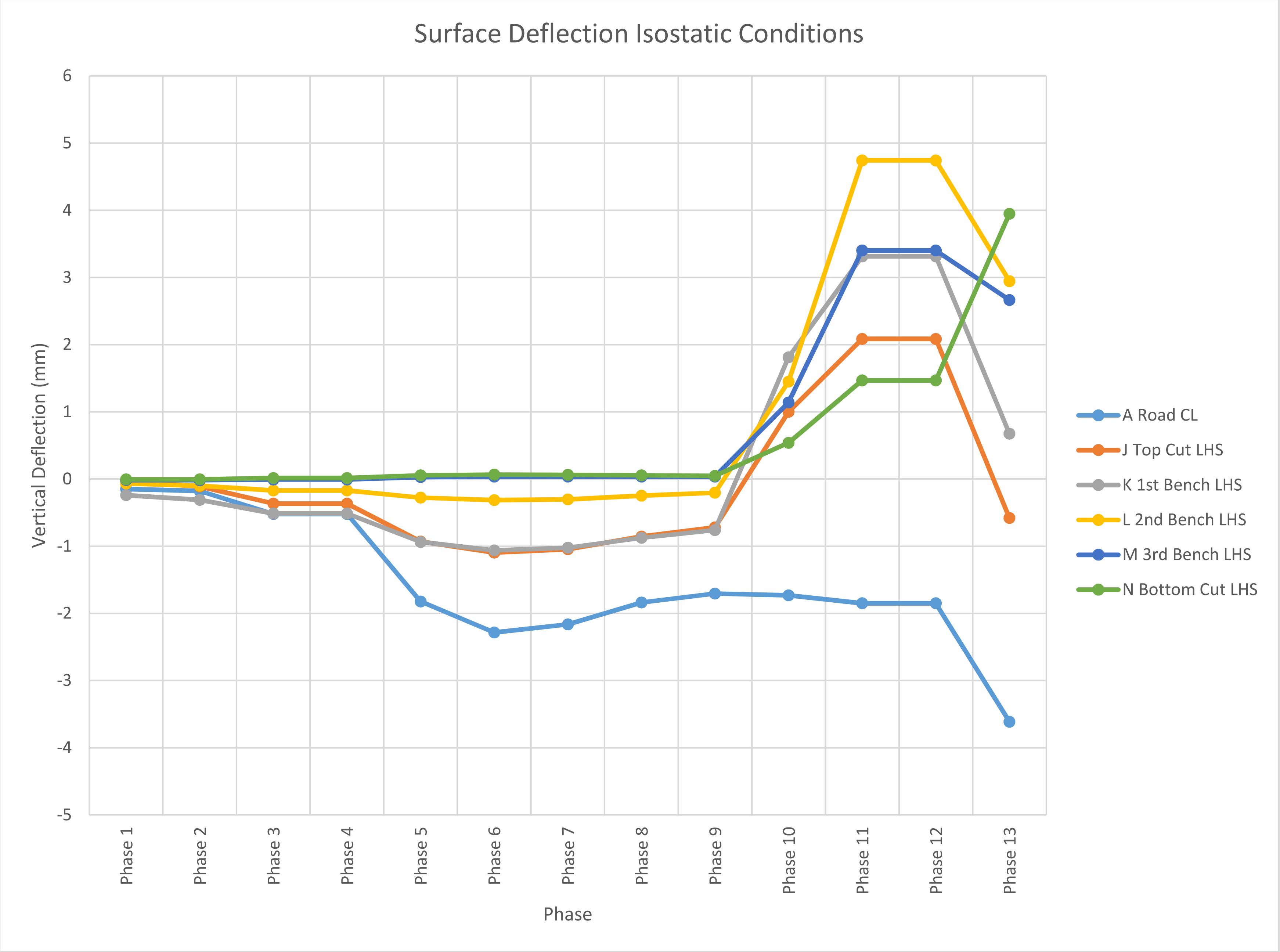
Maximum value = 3.116 m (Element 136 at Node 32)

Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5VIsoMod2	*Step* 217	*User name* Cardno Pty Limited	

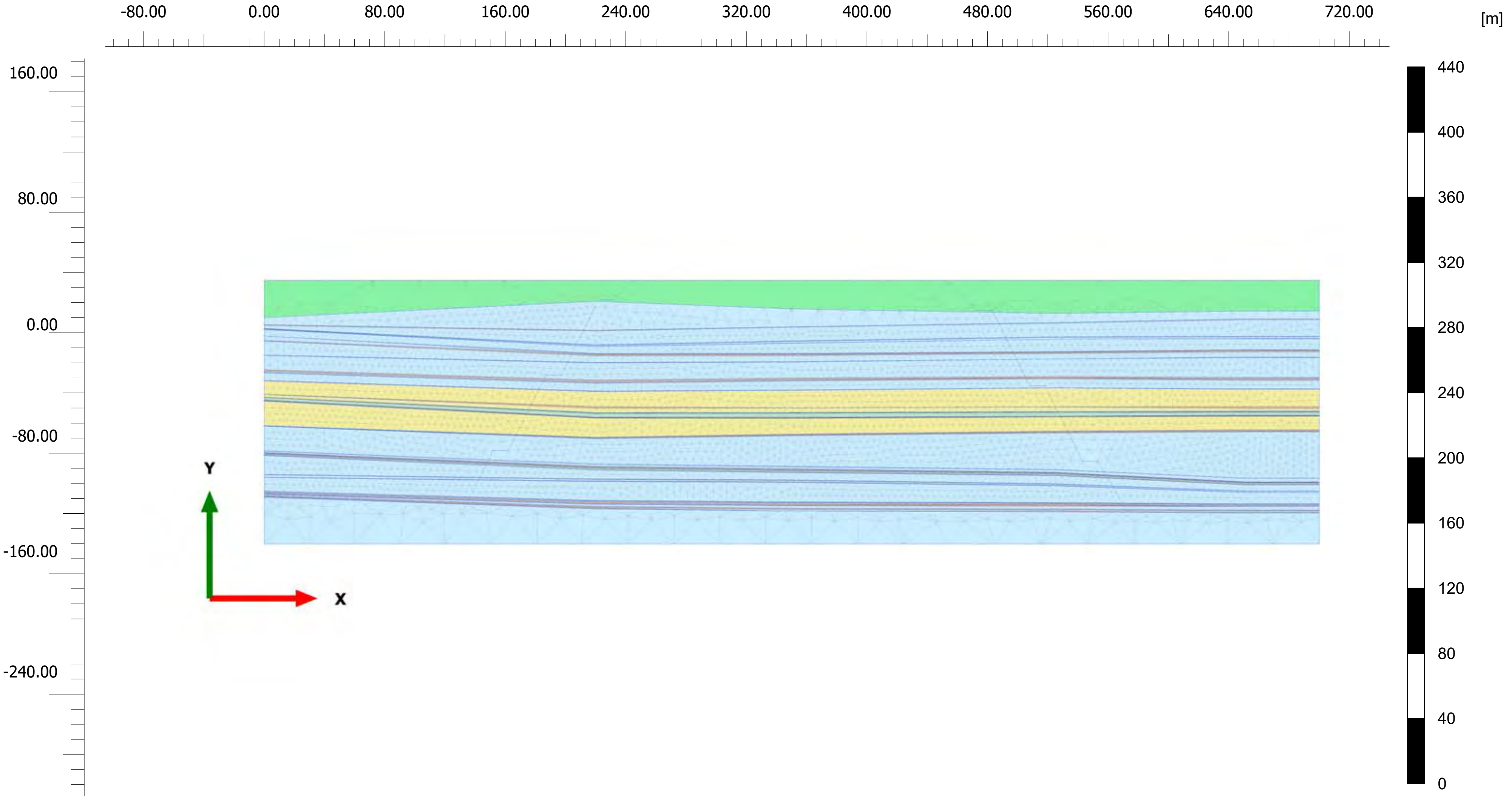

Surface Deflection Isostatic Conditions
Horizontal Deflection (mm)
25
20
15
10
5
0
-5
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
B Top Cut RHS
C 1st Bench RHS
E 2nd Bench RHS
G 3rd Bench RHS
I Bottom Cut RHS


Surface Deflection Isostatic Conditions
Vertical Deflection (mm)
6
4
2
0
-2
-4
-6
-8
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
B Top Cut RHS
C 1st Bench RHS
E 2nd Bench RHS
G 3rd Bench RHS
I Bottom Cut RHS


Surface Deflection Isostatic Conditions
10
5
0
-5
-10
-15
-20
Horizontal Deflection (mm)
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
J Top Cut LHS
K 1st Bench LHS
L 2nd Bench LHS
M 3rd Bench LHS
N Bottom Cut LHS


Surface Deflection Isostatic Conditions
Vertical Deflection (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
J Top Cut LHS
K 1st Bench LHS
L 2nd Bench LHS
M 3rd Bench LHS
N Bottom Cut LHS

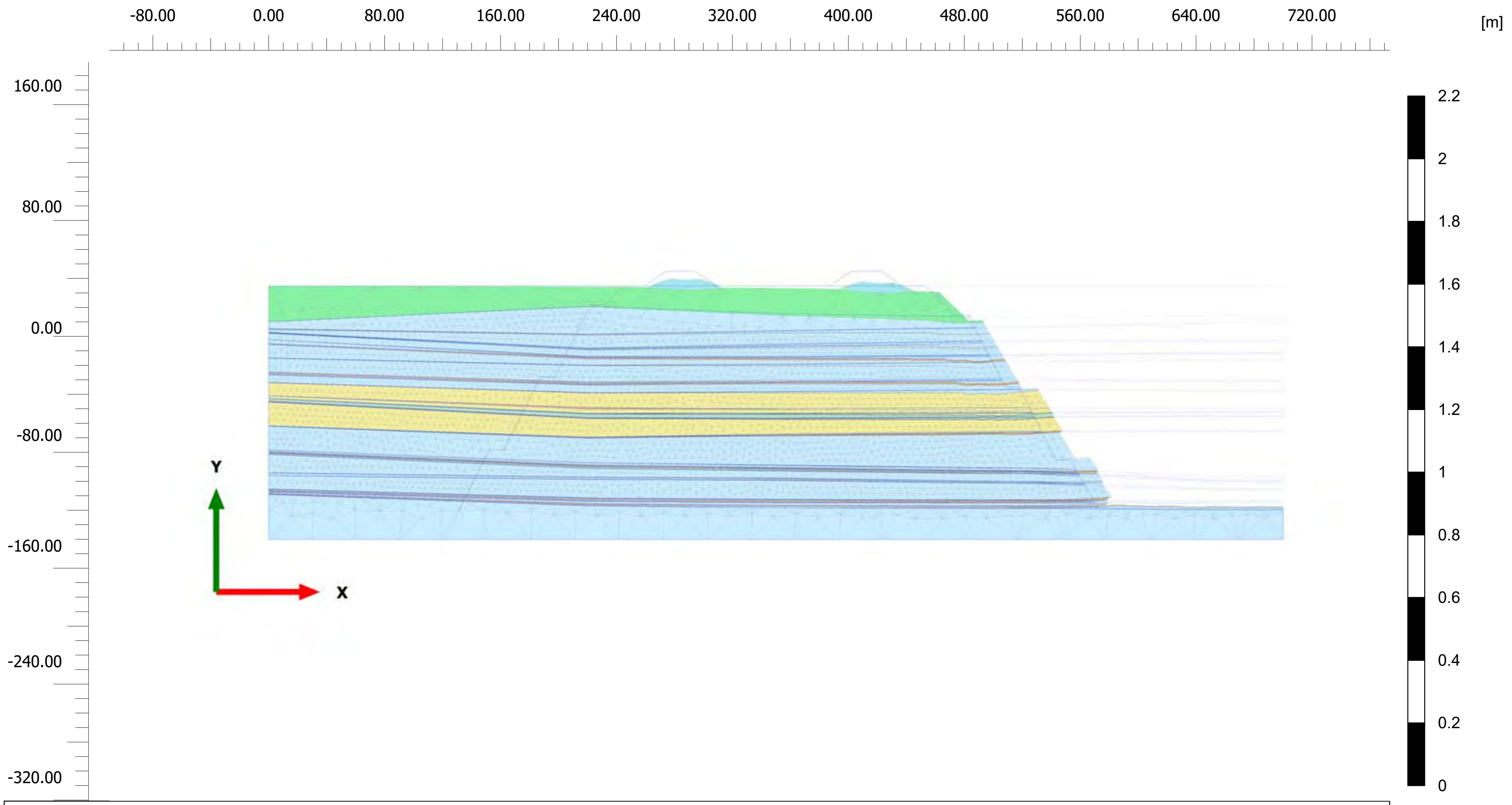
σ_H=2σ_V Model



Deformed mesh |u| (at true scale)

Uniform value of 0.000 m

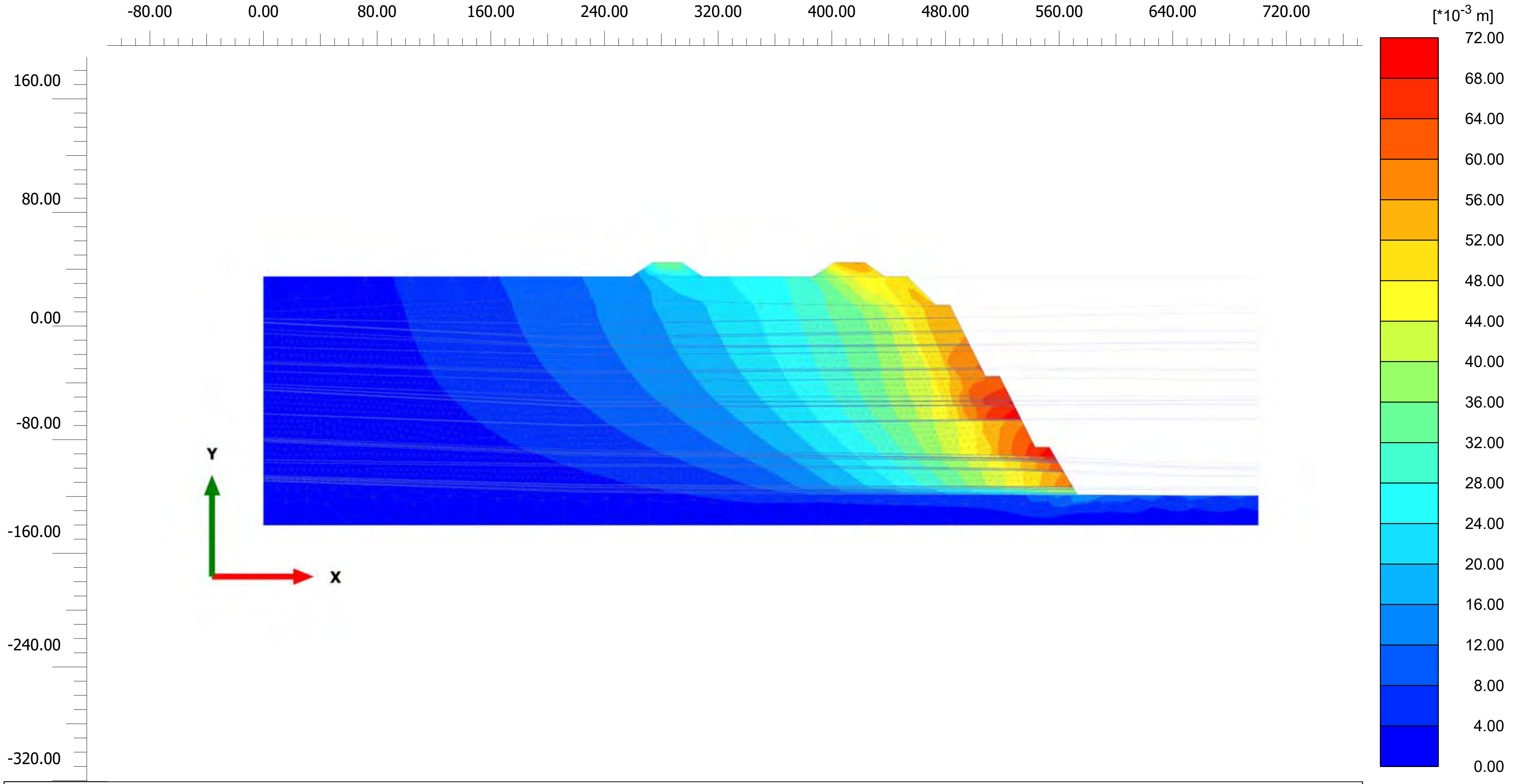
Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5V2H1VMod1	*Step* 0	*User name* Cardno Pty Limited	



Deformed mesh |u| (scaled up 200 times)

Maximum value = 0.07171 m (Element 13202 at Node 98429)

Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5V2H1VMod1	*Step* 168	*User name* Cardno Pty Limited	



Total displacements |u|

Maximum value = 0.07171 m (Element 13202 at Node 98429)

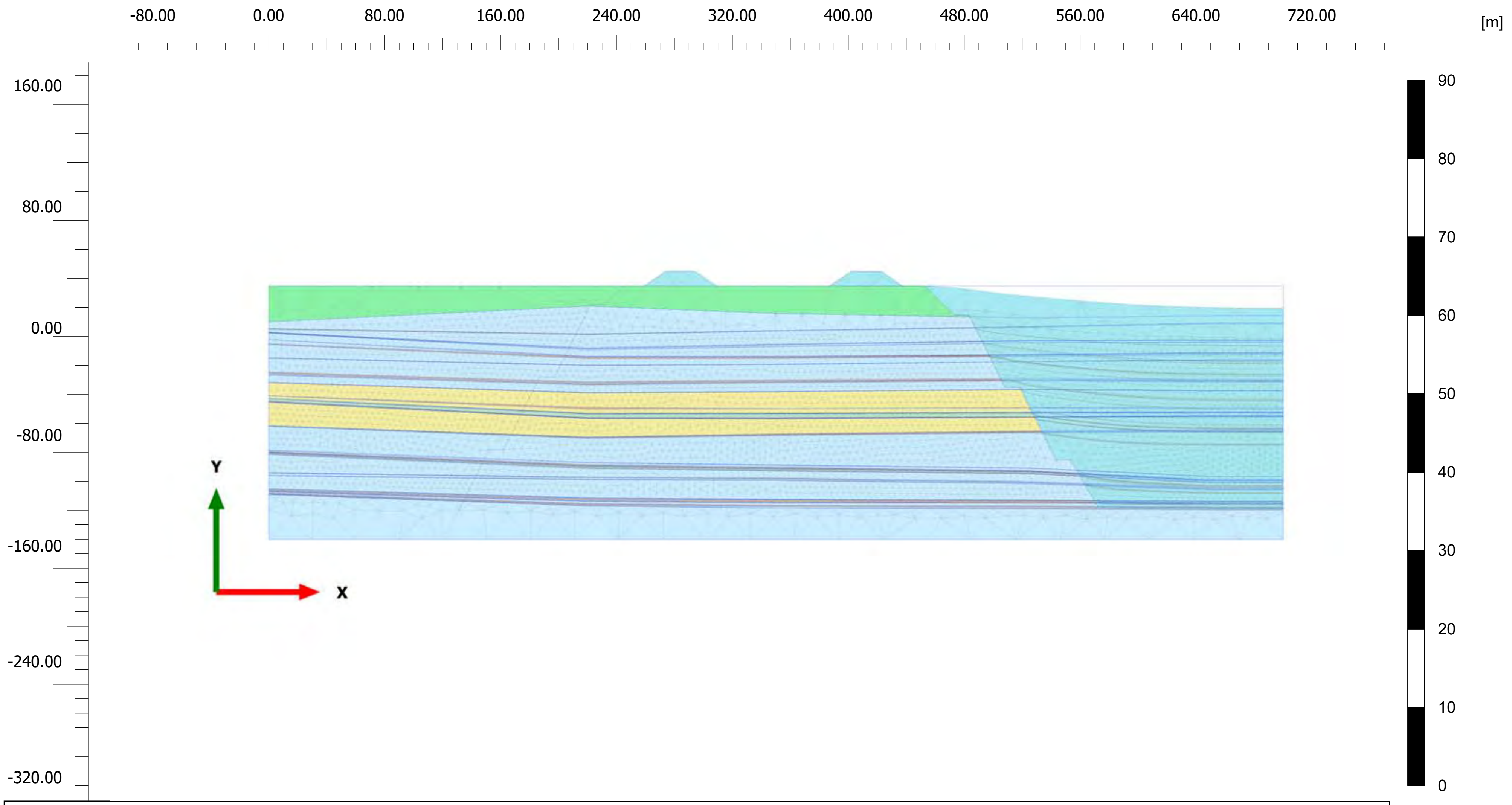
Project description
CQCoal XSect5

Date
9/05/2018

Project filename
CQCoal XSect5V2H1VMod1

Step
168

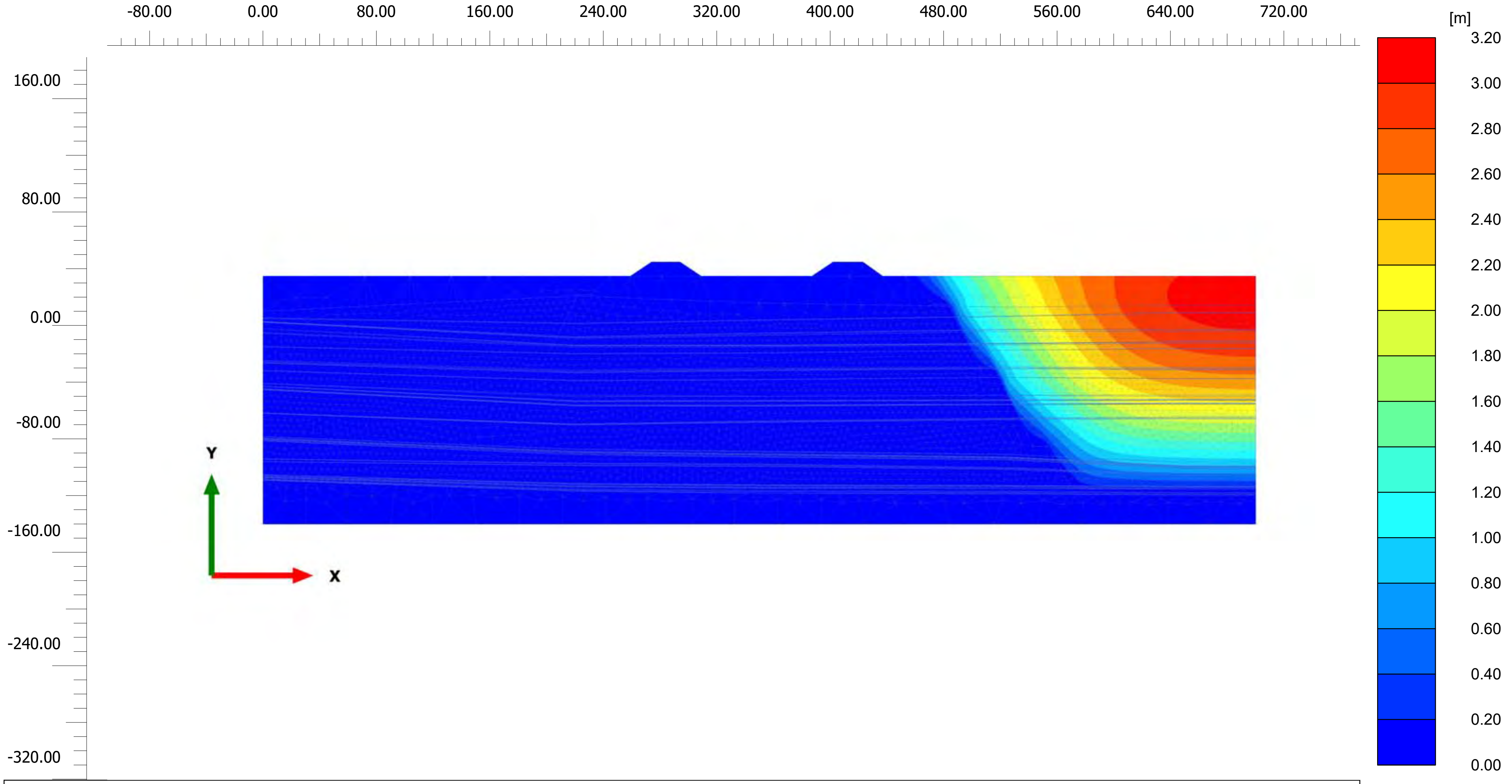
User name
Cardno Pty Limited



Deformed mesh |u| (scaled up 5.00 times)

Maximum value = 3.097 m (Element 136 at Node 32)

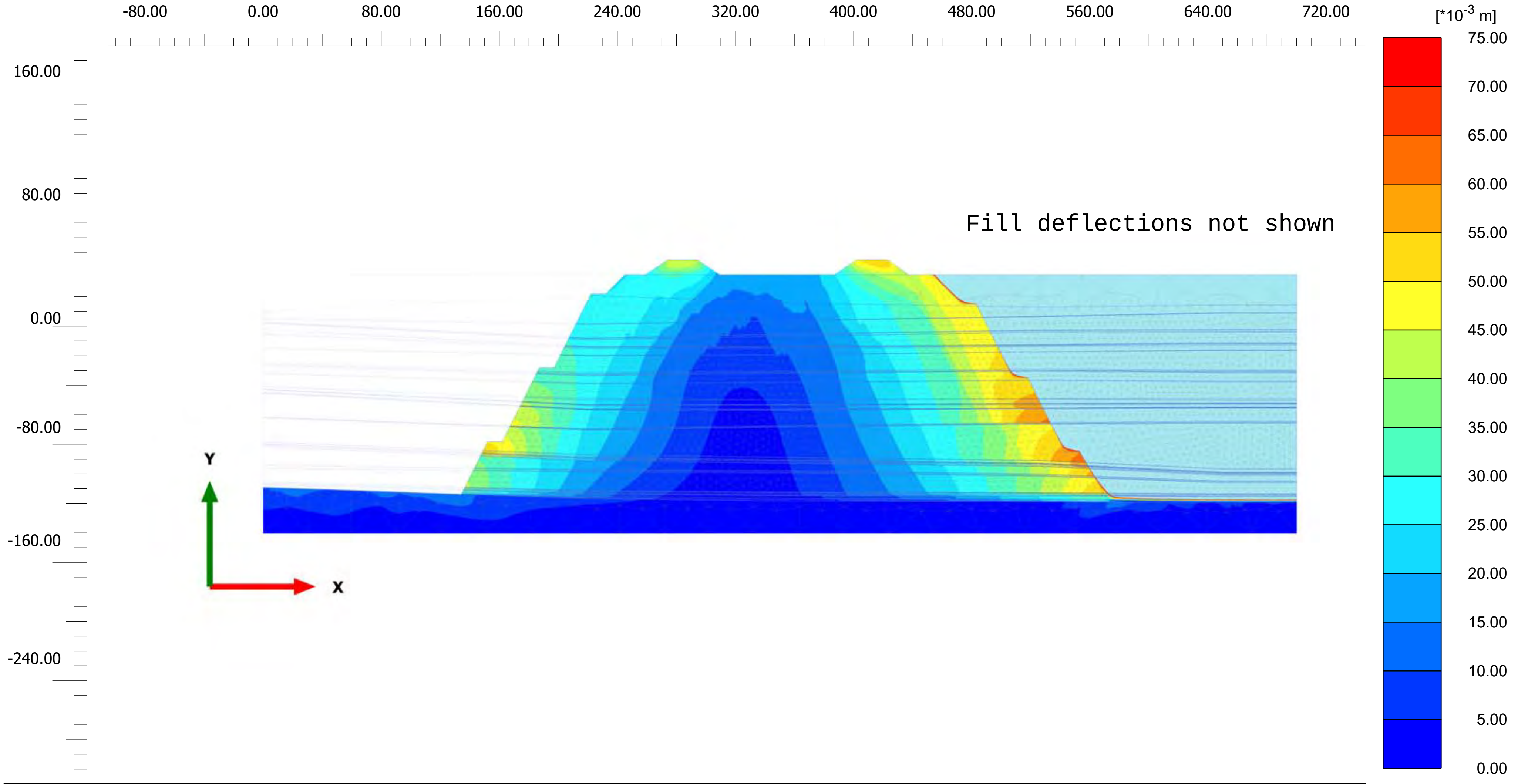
Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5V2H1VMod1	*Step* 27	*User name* Cardno Pty Limited	



Total displacements |u|

Maximum value = 3.097 m (Element 136 at Node 32)

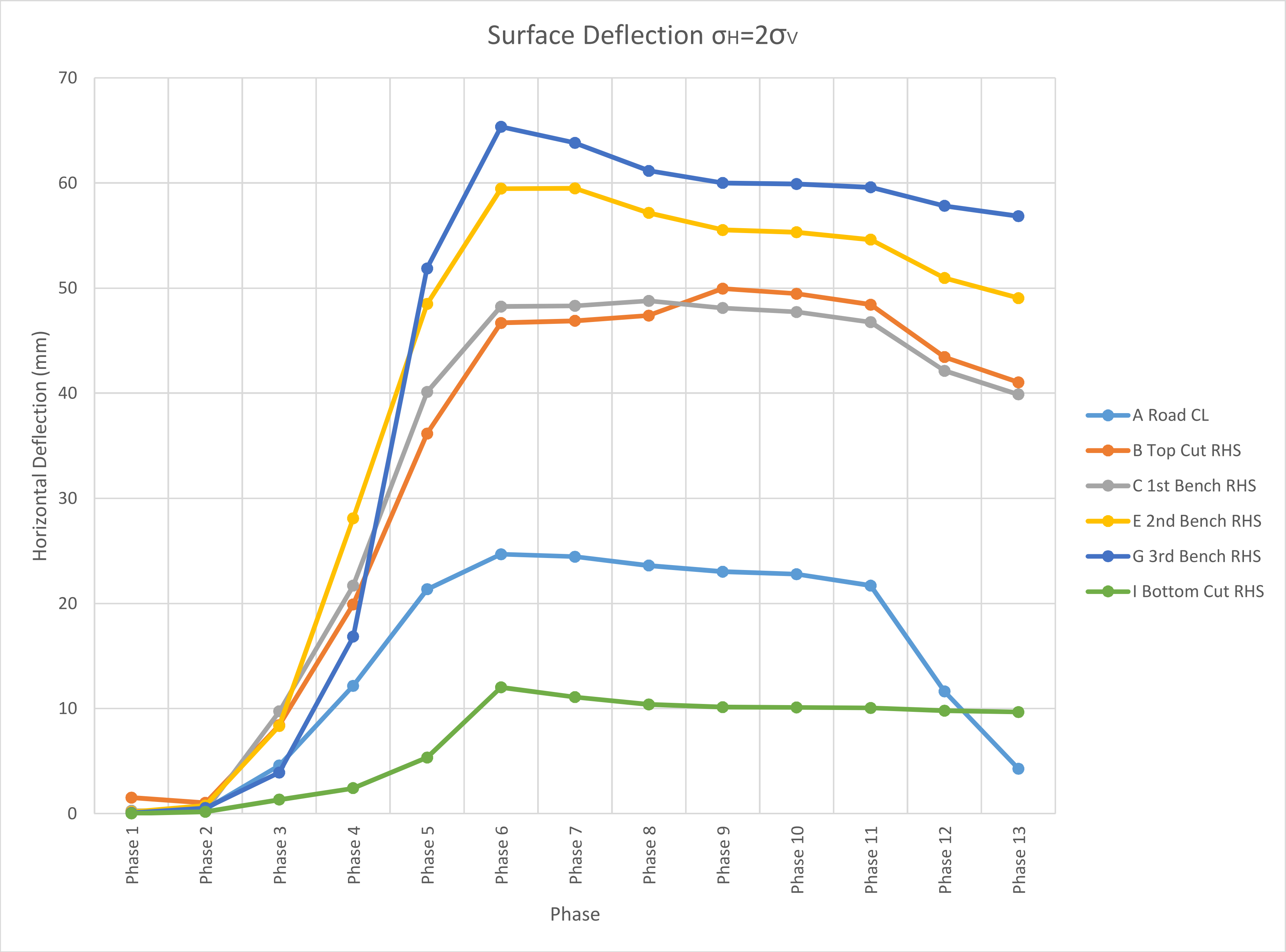
Project description CQCoal XSect5			*Date* 9/05/2018
Project filename CQCoal XSect5V2H1VMod1	*Step* 27	*User name* Cardno Pty Limited	

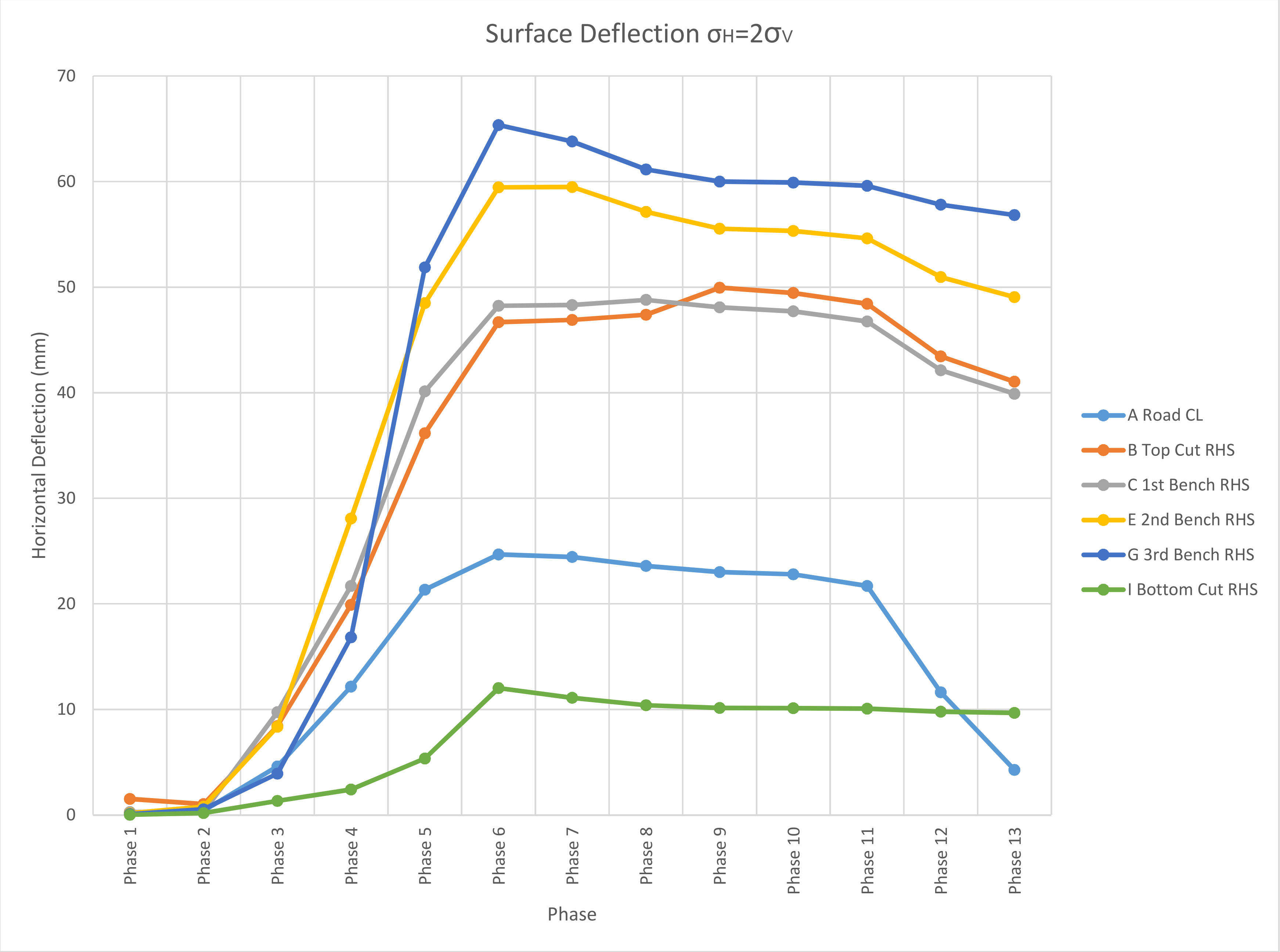


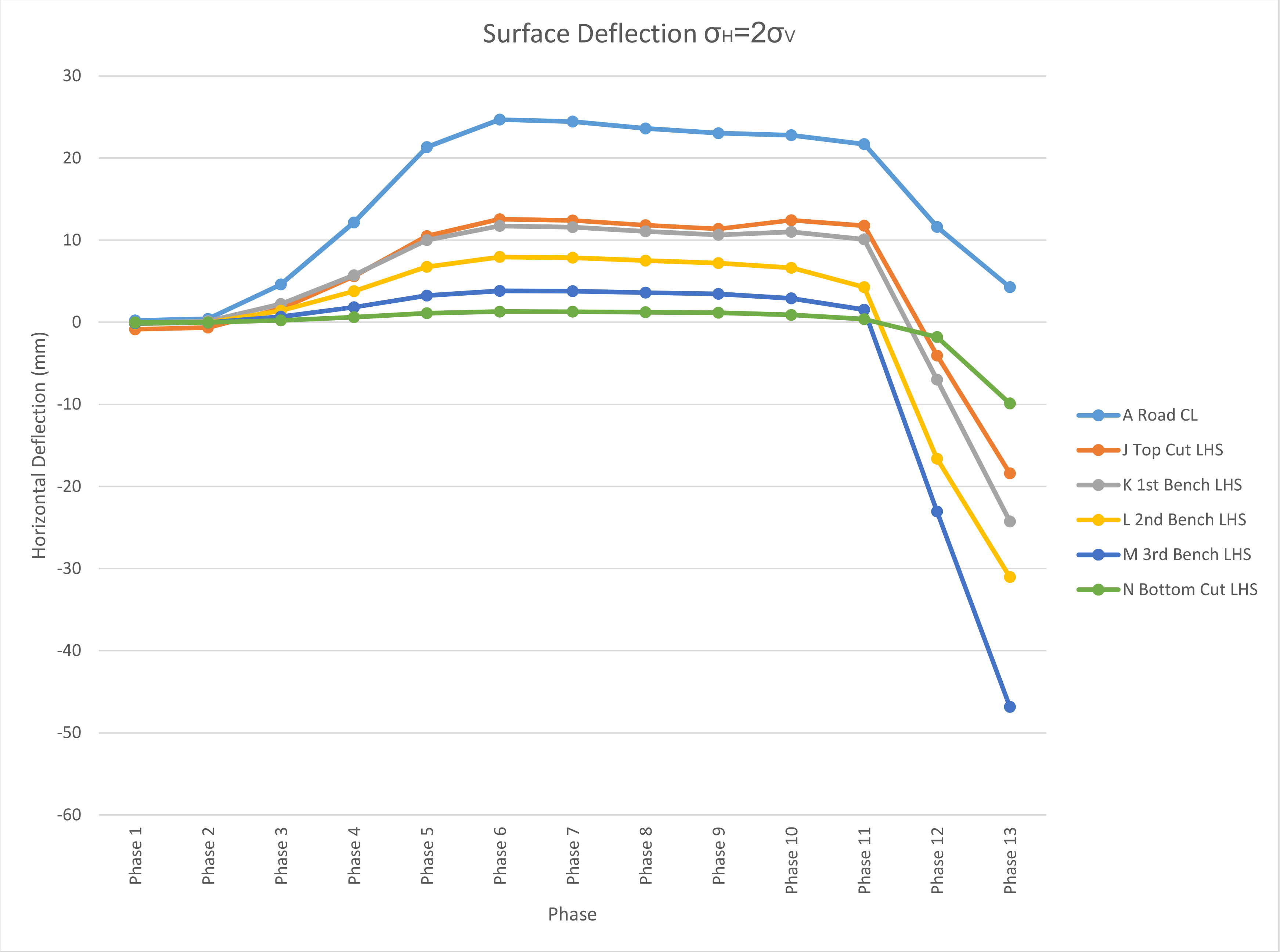
Total displacements |u|

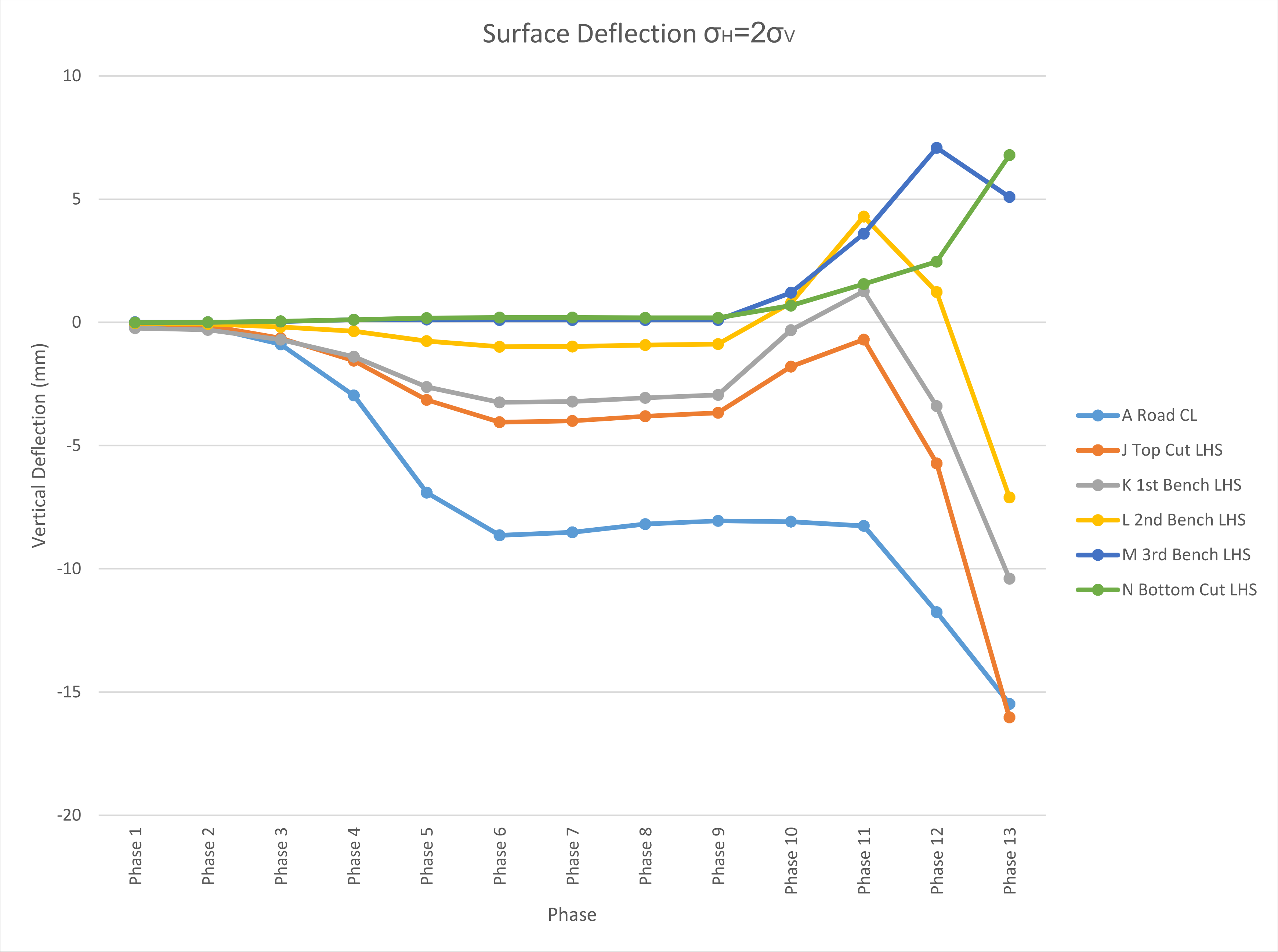
Maximum value = 3.097 m (Element 136 at Node 32)

Project description CQCoal XSect5		*Date* 9/05/2018
Project filename CQCoal XSect5V2H1VMod1	*Step* 1322	*User name* Cardno Pty Limited


Surface Deflection σH=2σV
70
60
50
40
30
20
10
0
Horizontal Deflection (mm)
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
B Top Cut RHS
C 1st Bench RHS
E 2nd Bench RHS
G 3rd Bench RHS
I Bottom Cut RHS


Surface Deflection σH=2σV
Horizontal Deflection (mm)
0
10
20
30
40
50
60
70
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
B Top Cut RHS
C 1st Bench RHS
E 2nd Bench RHS
G 3rd Bench RHS
I Bottom Cut RHS


Surface Deflection σH=2σV
30
20
10
0
-10
-20
-30
-40
-50
-60
Horizontal Deflection (mm)
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
J Top Cut LHS
K 1st Bench LHS
L 2nd Bench LHS
M 3rd Bench LHS
N Bottom Cut LHS


Surface Deflection σH=2σV
10
5
0
-5
-10
-15
-20
Vertical Deflection (mm)
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 6
Phase 7
Phase 8
Phase 9
Phase 10
Phase 11
Phase 12
Phase 13
Phase
A Road CL
J Top Cut LHS
K 1st Bench LHS
L 2nd Bench LHS
M 3rd Bench LHS
N Bottom Cut LHS

APPENDIX

F

DESCRIPTION OF HOEK-BROWN PARAMETERS

HOEK-BROWN FAILURE CRITERION – 2002 EDITION

Evert Hoek
Consulting Engineer, Vancouver, Canada

Carlos Carranza-Torres
Itasca Consulting Group Inc., Minneapolis, USA

Brent Corkum
Rocscience Inc., Toronto, Canada

ABSTRACT: The Hoek-Brown failure criterion for rock masses is widely accepted and has been applied in a large number of projects around the world. While, in general, it has been found to be satisfactory, there are some uncertainties and inaccuracies that have made the criterion inconvenient to apply and to incorporate into numerical models and limit equilibrium programs. In particular, the difficulty of finding an acceptable equivalent friction angle and cohesive strength for a given rock mass has been a problem since the publication of the criterion in 1980. This paper resolves all these issues and sets out a recommended sequence of calculations for applying the criterion. An associated Windows program called "RocLab" has been developed to provide a convenient means of solving and plotting the equations presented in this paper.

1. INTRODUCTION

Hoek and Brown [1, 2] introduced their failure criterion in an attempt to provide input data for the analyses required for the design of underground excavations in hard rock. The criterion was derived from the results of research into the brittle failure of intact rock by Hoek [3] and on model studies of jointed rock mass behaviour by Brown [4]. The criterion started from the properties of intact rock and then introduced factors to reduce these properties on the basis of the characteristics of joints in a rock mass. The authors sought to link the empirical criterion to geological observations by means of one of the available rock mass classification schemes and, for this purpose, they chose the Rock Mass Rating proposed by Bieniawski [5].

Because of the lack of suitable alternatives, the criterion was soon adopted by the rock mechanics community and its use quickly spread beyond the original limits used in deriving the strength reduction relationships. Consequently, it became necessary to re-examine these relationships and to introduce new elements from time to time to account for the wide range of practical problems to which the criterion was being applied. Typical of these enhancements were the introduction of the idea of "undisturbed" and "disturbed" rock masses Hoek and Brown [6], and the introduction of a modified criterion to force the rock mass tensile strength to zero for very poor quality rock masses (Hoek, Wood and Shah, [7]).

One of the early difficulties arose because many geotechnical problems, particularly slope stability issues, are more conveniently dealt with in terms of shear and normal stresses rather than the principal stress relationships of the original Hoek-Brown criterion, defined by the equation:

$$\sigma_1' = \sigma_3' + \sigma_{ci}\left(m\frac{\sigma_3'}{\sigma_{ci}} + s\right)^{0.5} \qquad (1)$$

where σ_1' and σ_3' are the major and minor effective principal stresses at failure

σ_{ci} is the uniaxial compressive strength of the intact rock material and

m and s are material constants, where s = 1 for intact rock.

An exact relationship between equation 1 and the normal and shear stresses at failure was derived by J. W. Bray (reported by Hoek [8]) and later by Ucar [9] and Londe[1] [10].

Hoek [12] discussed the derivation of equivalent friction angles and cohesive strengths for various practical situations. These derivations were based

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[1] Londe's equations were later found to contain errors although the concepts introduced by Londe were extremely important in the application of the Hoek-Brown criterion to tunnelling problems (Carranza-Torres and Fairhurst, [11])

upon tangents to the Mohr envelope derived by Bray. Hoek [13] suggested that the cohesive strength determined by fitting a tangent to the curvilinear Mohr envelope is an upper bound value and may give optimistic results in stability calculations. Consequently, an average value, determined by fitting a linear Mohr-Coulomb relationship by least squares methods, may be more appropriate. In this paper Hoek also introduced the concept of the Generalized Hoek-Brown criterion in which the shape of the principal stress plot or the Mohr envelope could be adjusted by means of a variable coefficient *a* in place of the square root term in equation 1.

Hoek and Brown [14] attempted to consolidate all the previous enhancements into a comprehensive presentation of the failure criterion and they gave a number of worked examples to illustrate its practical application.

In addition to the changes in the equations, it was also recognised that the Rock Mass Rating of Bieniawski was no longer adequate as a vehicle for relating the failure criterion to geological observations in the field, particularly for very weak rock masses. This resulted in the introduction of the Geological Strength Index (GSI) by Hoek, Wood and Shah [7], Hoek [13] and Hoek, Kaiser and Bawden [15]. This index was subsequently extended for weak rock masses in a series of papers by Hoek, Marinos and Benissi [16], Hoek and Marinos [17, 18] and Marinos and Hoek [19].

The Geological Strength Index will not be discussed in the following text, which will concentrate on the sequence of calculations now proposed for the application of the Generalized Hoek Brown criterion to jointed rock masses.

2. *GENERALIZED HOEK-BROWN CRITERION*

This is expressed as

$$\sigma_1' = \sigma_3' + \sigma_{ci}\left(m_b \frac{\sigma_3'}{\sigma_{ci}} + s\right)^a \qquad (2)$$

where m_b is a reduced value of the material constant m_i and is given by

$$m_b = m_i \exp\left(\frac{GSI - 100}{28 - 14D}\right) \qquad (3)$$

s and *a* are constants for the rock mass given by the following relationships:

$$s = \exp\left(\frac{GSI - 100}{9 - 3D}\right) \qquad (4)$$

$$a = \frac{1}{2} + \frac{1}{6}\left(e^{-GSI/15} - e^{-20/3}\right) \qquad (5)$$

D is a factor which depends upon the degree of disturbance to which the rock mass has been subjected by blast damage and stress relaxation. It varies from 0 for undisturbed in situ rock masses to 1 for very disturbed rock masses. Guidelines for the selection of *D* are discussed in a later section.

The uniaxial compressive strength is obtained by setting $\sigma_3' = 0$ in equation 2, giving:

$$\sigma_c = \sigma_{ci} . s^a \qquad (6)$$

and, the tensile strength is:

$$\sigma_t = -\frac{s\sigma_{ci}}{m_b} \qquad (7)$$

Equation 7 is obtained by setting $\sigma_1' = \sigma_3' = \sigma_t$ in equation 2. This represents a condition of biaxial tension. Hoek [8] showed that, for brittle materials, the uniaxial tensile strength is equal to the biaxial tensile strength.

Note that the “switch” at GSI = 25 for the coefficients *s* and *a* (Hoek and Brown, [14]) has been eliminated in equations 4 and 5 which give smooth continuous transitions for the entire range of GSI values. The numerical values of *a* and *s*, given by these equations, are very close to those given by the previous equations and it is not necessary for readers to revisit and make corrections to old calculations.

Normal and shear stresses are related to principal stresses by the equations published by Balmer [20].

$$\sigma_n' = \frac{\sigma_1' + \sigma_3'}{2} - \frac{\sigma_1' - \sigma_3'}{2} \cdot \frac{d\sigma_1'/d\sigma_3' - 1}{d\sigma_1'/d\sigma_3' + 1} \qquad (8)$$

$$\tau = \left(\sigma_1' - \sigma_3'\right)\frac{\sqrt{d\sigma_1'/d\sigma_3'}}{d\sigma_1'/d\sigma_3' + 1} \qquad (9)$$

where

$$d\sigma_1'/d\sigma_3' = 1 + a m_b \left(m_b \sigma_3'/\sigma_{ci} + s\right)^{a-1} \qquad (10)$$

3. *MODULUS OF DEFORMATION*

The rock mass modulus of deformation is given by:

$$E_m(GPa) = \left(1 - \frac{D}{2}\right)\sqrt{\frac{\sigma_{ci}}{100}} \cdot 10^{((GSI-10)/40)} \qquad (11a)$$

Equation 11a applies for $\sigma_{ci} \leq$ 100 MPa. For $\sigma_{ci} >$ 100 MPa, use equation 11b.

$$E_m(GPa) = \left(1-\frac{D}{2}\right)\cdot 10^{((GSI-10)/40)} \qquad (11b)$$

Note that the original equation proposed by Hoek and Brown [14] has been modified, by the inclusion of the factor *D*, to allow for the effects of blast damage and stress relaxation.

4. MOHR-COULOMB CRITERION

Since most geotechnical software is still written in terms of the Mohr-Coulomb failure criterion, it is necessary to determine equivalent angles of friction and cohesive strengths for each rock mass and stress range. This is done by fitting an average linear relationship to the curve generated by solving equation 2 for a range of minor principal stress values defined by $\sigma_t < \sigma_3 < \sigma'_{3\max}$, as illustrated in Figure 1. The fitting process involves balancing the areas above and below the Mohr-Coulomb plot. This results in the following equations for the angle of friction ϕ' and cohesive strength c':

$$\phi' = \sin^{-1}\left[\frac{6am_b(s+m_b\sigma'_{3n})^{a-1}}{2(1+a)(2+a)+6am_b(s+m_b\sigma'_{3n})^{a-1}}\right] \qquad (12)$$

$$c' = \frac{\sigma_{ci}\left[(1+2a)s+(1-a)m_b\sigma'_{3n}\right](s+m_b\sigma'_{3n})^{a-1}}{(1+a)(2+a)\sqrt{1+\left(6am_b(s+m_b\sigma'_{3n})^{a-1}\right)\Big/\left((1+a)(2+a)\right)}}$$

(13)

where $\sigma_{3n} = \sigma'_{3\max}\big/\sigma_{ci}$

Note that the value of $\sigma'_{3\max}$, the upper limit of confining stress over which the relationship between the Hoek-Brown and the Mohr-Coulomb criteria is considered, has to be determined for each individual case. Guidelines for selecting these values for slopes as well as shallow and deep tunnels are presented later.

The Mohr-Coulomb shear strength τ, for a given normal stress σ, is found by substitution of these values of c' and ϕ' in to the equation:

$$\tau = c' + \sigma\tan\phi' \qquad (14)$$

The equivalent plot, in terms of the major and minor principal stresses, is defined by:

$$\sigma'_1 = \frac{2c'\cos\phi'}{1-\sin\phi'} + \frac{1+\sin\phi'}{1-\sin\phi'}\sigma'_3 \qquad (15)$$

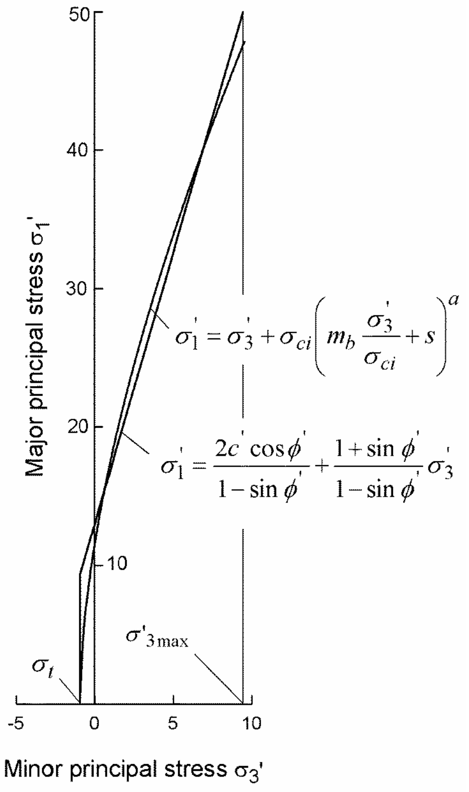

Figure 1: Relationships between major and minor principal stresses for Hoek-Brown and equivalent Mohr-Coulomb criteria.

5. ROCK MASS STRENGTH

The uniaxial compressive strength of the rock mass σ_c is given by equation 6. Failure initiates at the boundary of an excavation when σ_c is exceeded by the stress induced on that boundary. The failure propagates from this initiation point into a biaxial stress field and it eventually stabilizes when the local strength, defined by equation 2, is higher than the induced stresses σ'_1 and σ'_3. Most numerical models can follow this process of fracture propagation and this level of detailed analysis is very important when considering the stability of excavations in rock and when designing support systems.

However, there are times when it is useful to consider the overall behaviour of a rock mass rather than the detailed failure propagation process described above. For example, when considering the strength of a pillar, it is useful to have an estimate of the overall strength of the pillar rather than a detailed knowledge of the extent of fracture propagation in the pillar. This leads to the concept of a global "rock mass strength" and Hoek and Brown [14] proposed that this could be estimated from the Mohr-Coulomb relationship:

$$\sigma'_{cm} = \frac{2c' \cos\phi'}{1 - \sin\phi'} \qquad (16)$$

with c' and ϕ' determined for the stress range $\sigma_t < \sigma'_3 < \sigma_{ci}/4$ giving

$$\sigma'_{cm} = \sigma_{ci} \cdot \frac{(m_b + 4s - a(m_b - 8s))(m_b/4 + s)^{a-1}}{2(1+a)(2+a)} \qquad (17)$$

6. DETERMINATION OF σ'_{3MAX}

The issue of determining the appropriate value of $\sigma'_{3\max}$ for use in equations 12 and 13 depends upon the specific application. Two cases will be investigated:

1. Tunnels – where the value of $\sigma'_{3\max}$ is that which gives equivalent characteristic curves for the two failure criteria for deep tunnels or equivalent subsidence profiles for shallow tunnels.
2. Slopes – here the calculated factor of safety and the shape and location of the failure surface have to be equivalent.

For the case of deep tunnels, closed form solutions for both the Generalized Hoek-Brown and the Mohr-Coulomb criteria have been used to generate hundreds of solutions and to find the value of $\sigma'_{3\max}$ that gives equivalent characteristic curves.

For shallow tunnels, where the depth below surface is less than 3 tunnel diameters, comparative numerical studies of the extent of failure and the magnitude of surface subsidence gave an identical relationship to that obtained for deep tunnels, provided that caving to surface is avoided.

The results of the studies for deep tunnels are plotted in Figure 2 and the fitted equation for both cases is:

$$\frac{\sigma'_{3\max}}{\sigma'_{cm}} = 0.47\left(\frac{\sigma'_{cm}}{\gamma H}\right)^{-0.94} \qquad (18)$$

where σ'_{cm} is the rock mass strength, defined by equation 17, γ is the unit weight of the rock mass and H is the depth of the tunnel below surface. In cases where the horizontal stress is higher than the vertical stress, the horizontal stress value should be used in place of γH.

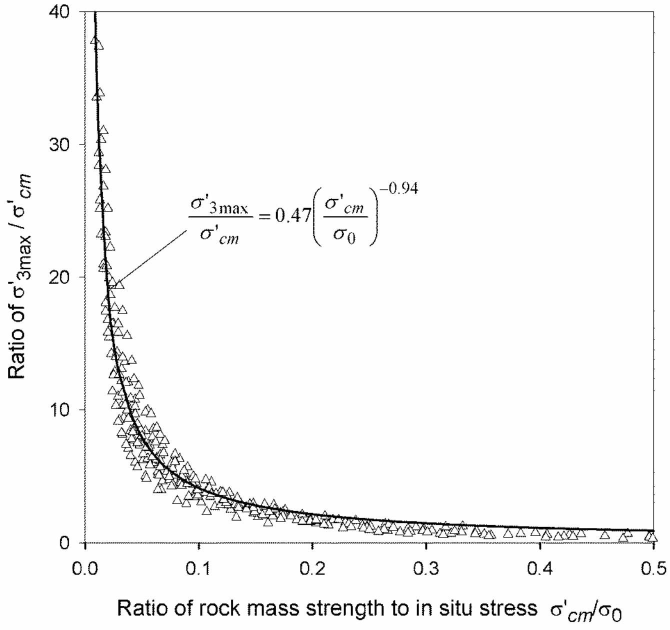

Figure 2: Relationship for the calculation of $\sigma'_{3\max}$ for equivalent Mohr-Coulomb and Hoek-Brown parameters for tunnels.

Equation 18 applies to all underground excavations, which are surrounded by a zone of failure that does not extend to surface. For studies of problems such as block caving in mines it is recommended that no attempt should be made to relate the Hoek-Brown and Mohr-Coulomb parameters and that the determination of material properties and subsequent analysis should be based on only one of these criteria.

Similar studies for slopes, using Bishop's circular failure analysis for a wide range of slope geometries and rock mass properties, gave:

$$\frac{\sigma'_{3\max}}{\sigma'_{cm}} = 0.72\left(\frac{\sigma'_{cm}}{\gamma H}\right)^{-0.91} \qquad (19)$$

where H is the height of the slope.

7. ESTIMATION OF DISTURBANCE FACTOR D

Experience in the design of slopes in very large open pit mines has shown that the Hoek-Brown criterion for undisturbed in situ rock masses ($D = 0$) results in rock mass properties that are too optimistic [21, 22]. The effects of heavy blast damage as well as stress relief due to removal of the overburden result in disturbance of the rock mass. It is considered that the "disturbed" rock mass properties [6], D = 1 in equations 3 and 4, are more appropriate for these rock masses.

Lorig and Varona [23] showed that factors such as the lateral confinement produced by different radii of curvature of slopes (in plan) as compared with their height also have an influence on the degree of disturbance.

Sonmez and Ulusay [24] back-analysed five slope failures in open pit coal mines in Turkey and attempted to assign disturbance factors to each rock mass based upon their assessment of the rock mass properties predicted by the Hoek-Brown criterion. Unfortunately, one of the slope failures appears to be structurally controlled while another consists of a transported waste pile. The authors consider that the Hoek-Brown criterion is not applicable to these two cases.

Cheng and Liu [25] report the results of very careful back analysis of deformation measurements, from extensometers placed before the commencement of excavation, in the Mingtan power cavern in Taiwan. It was found that a zone of blast damage extended for a distance of approximately 2 m around all large excavations. The back-calculated strength and deformation properties of the damaged rock mass give an equivalent disturbance factor D = 0.7.

From these references it is clear that a large number of factors can influence the degree of disturbance in the rock mass surrounding an excavation and that it may never be possible to quantify these factors precisely. However, based on their experience and on an analysis of all the details contained in these papers, the authors have attempted to draw up a set of guidelines for estimating the factor D and these are summarised in Table 1.

The influence of this disturbance factor can be large. This is illustrated by a typical example in which σ_{ci} = 50 MPa, m_i = 10 and GSI = 45. For an undisturbed in situ rock mass surrounding a tunnel at a depth of 100 m, with a disturbance factor D = 0, the equivalent friction angle is $\phi' = 47.16°$ while the cohesive strength is $c' =$ 0.58 MPa. A rock mass with the same basic parameters but in highly disturbed slope of 100 m height, with a disturbance factor of D = 1, has an equivalent friction angle of $\phi' = 27.61°$ and a cohesive strength of $c' =$ 0.35 MPa.

Note that these are guidelines only and the reader would be well advised to apply the values given with caution. However, they can be used to provide a realistic starting point for any design and, if the observed or measured performance of the excavation turns out to be better than predicted, the disturbance factors can be adjusted downwards.

8. *CONCLUSION*

A number of uncertainties and practical problems in using the Hoek-Brown failure criterion have been addressed in this paper. Wherever possible, an attempt has been made to provide a rigorous and unambiguous method for calculating or estimating the input parameters required for the analysis. These methods have all been implemented in a Windows program called "RocLab" that can be downloaded (free) from www.rocscience.com. This program includes tables and charts for estimating the uniaxial compressive strength of the intact rock elements (σ_{ci}), the material constant m_i and the Geological Strength Index (*GSI*).

9. *ACKNOWLEDGEMENTS*

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Table 1: Guidelines for estimating disturbance factor *D*

Appearance of rock mass	Description of rock mass	Suggested value of *D*
	Excellent quality controlled blasting or excavation by Tunnel Boring Machine results in minimal disturbance to the confined rock mass surrounding a tunnel.	*D* = 0
	Mechanical or hand excavation in poor quality rock masses (no blasting) results in minimal disturbance to the surrounding rock mass. Where squeezing problems result in significant floor heave, disturbance can be severe unless a temporary invert, as shown in the photograph, is placed.	*D* = 0 *D* = 0.5 No invert
	Very poor quality blasting in a hard rock tunnel results in severe local damage, extending 2 or 3 m, in the surrounding rock mass.	*D* = 0.8
	Small scale blasting in civil engineering slopes results in modest rock mass damage, particularly if controlled blasting is used as shown on the left hand side of the photograph. However, stress relief results in some disturbance.	*D* = 0.7 Good blasting *D* = 1.0 Poor blasting
	Very large open pit mine slopes suffer significant disturbance due to heavy production blasting and also due to stress relief from overburden removal. In some softer rocks excavation can be carried out by ripping and dozing and the degree of damage to the slopes is less.	*D* = 1.0 Production blasting *D* = 0.7 Mechanical excavation

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