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COAL MINING INVESTIGATION REPORT

< ENVIRONMENTAL >
< GEOTECHNICAL >

job number	C2812/23/E/5254	date	16.06.2023
site address	Land North of Cooper Lane, Hoylandswaine, Sheffield, S36 7JE		
written by	S. Alexander	checked by	T. Merry
issued by	S. Alexander		



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Report on a Geotechnical Investigation



Location: Land North of Cooper Lane,
Hoylandswaine, Sheffield, South Yorkshire, S36 7JE

For: Envision Support Ltd.

Report No. C2812/23/E/5254

Report date: June 2023

For and on behalf of **Rogers Geotechnical Services Ltd**

	
Scott Alexander BSc FGS Geo-environmental Engineer	Tobias Merry MSci (Hons), FGS Graduate Geo-environmental Engineer

Report Summary¹

Item	Comments	Section
Development	Construction of new residential development	1.
Geology	Artificial Geology – Made/Infilled Ground Superficial Geology – None Recorded Solid Geology – Pennine Lower Coal Measures Formation	4.
Strata Conditions	Infilled ground to between 6.0m and 7.90m overlying mudstone, siltstone and sandstone of Pennine Lower Coal Measures. Thin coal seam of thickness between 0.10m and 0.50m thick recorded in all boreholes.	5. & 5.1
Groundwater	Perched groundwater recorded at the base of the quarry in all boreholes.	5.2
Foundation Design	Piled foundation solution, drilled piles, through the base of the quarry to depth of ca. 10m below existing ground level. Ground floor suspended between foundation positions.	7.1
Coal Risk Assessment	Intact coal seam. No evidence of adit found in any of the rotary boreholes.	8.

¹ This summary should not be relied upon to provide a comprehensive review. All of the information contained in this document should be considered.

1. Introduction

It is understood that the site is to be developed by the construction of a new residential building. Consequently, a site investigation has been undertaken in accordance with the instruction from the Envision Support Ltd to determine the presence of potential underground coal mining workings identified within the coal mining risk assessment and to determine the ultimate depth of the historical backfilled quarry beneath the site. This work was required in order to determine the nature of the underlying soils, to assess their engineering properties and to assist in the design of safe and economical foundations for the proposed development. This report describes the work undertaken, presents the data obtained and discusses the ground conditions in relation to the proposed works.

1.1 Previous Reports

A desk study with Coal Mining Risk assessment has been completed for the site reference C2812/22/E/4293, August 2022. The desk study and mining risk assessment has revealed the presence of a potential infilled quarry and the presence of a potential adit beneath the site which may introduce instability to any proposed developments on the site. There were records of recorded workings beneath the site, however it was highlighted that there existed two coal seams which may be at or close to the surface. The shallowest of which, the Whinmoor Coal, is thought to have been the subject of opencast quarrying and the deeper seam, the Cumberworth Thin, may have been worked by underground methods.

2. Limitations

The recommendations made and opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site and of the laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between borehole positions, these are for guidance only and no liability can be accepted for their accuracy.

This report has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of issue. It should be appreciated that this report only considers the geotechnical aspects of the site and not environmental or ground gas (carbon dioxide, methane or radon) issues.

3. Fieldworks

The fieldworks were undertaken on the 15th May 2023 and included the following:

- Acquisition of Coal Authority Permit to investigate mine workings
- Set out of drilling locations by GPS
- Seven rotary boreholes drilled via water flush methods.
 - Three locations drilled via open hole rotary methods to prove the base of the opencast. These were subsequently followed-on via rotary coring methods to collect samples for pile design. Once the target depth was reached boreholes were extended via open hole methods to 30m or termination depth.

- Four of the locations were drilled via rotary open hole methods only to prove/disprove the presence of an adit beneath the site.
 - Installation of ground gas monitoring standpipes.

The investigatory locations are shown on the site plan which is presented in Appendix 1 to this report.

4.1 Acquisition of Coal Authority Permit

In order to undertake this investigation, it was necessary to obtain permission to enter or disturb Coal Authority interests. This permission was granted on the 10th May 2023 as permit reference number 26650, which is presented in Appendix 2 to this report. In accordance with the joint Coal Authority and Health and Safety Executive positioning statement, and under the requirements of the permit, the works were undertaken employing water flush drilling techniques. Furthermore, the drillers wore gas detectors on their person throughout the works.

4.2 Rotary Boreholes

The boreholes were sunk using a Comacchio 205 rotary drilling rig using rotary open-hole drilling techniques and employing 130mm diameter drag and tricone roller bits to prove the base of the opencast quarry. The borehole was supported by 140mm diameter casing to ensure no loss of flush or collapse of overburden deposits behind the drill string. Where required, casing was advanced during coring to help support the borehole in loose bedrock.

Once casing was installed and suitably seated within competent bedrock the borehole was extended via rotary coring methods using a 101mm core barrel recovering an 87mm rock core sample in 1.5m lengths. Once where total core recovery was below 75% the coring was continued for in 1.5m lengths until suitable core was recovered. The cores recovered were sealed and returned to the laboratory for logging in accordance with BS5930: 2015+A1: 2020, and full descriptions are given on the borehole records, which are attached in Appendix 3.

Once coring was completed the boreholes were extended using an 87mm tri cone roller to a maximum depth of 30m to prove or disprove the presence of potential further unrecorded coal mining workings. During drilling the rates of penetration and flush returns were noted by the operatives.

The investigation was undertaken using water flush drilling techniques in accordance with the Coal Authority and Health and Safety Executive positioning statement. Drill chippings brought to surface in the flush returns were inspected by the driller on a screen, which forms part of the re-circulation tanks. In addition, representative disturbed samples of the arisings were taken at regular depth intervals and sealed in plastic containers.

Whilst it was necessary to ensure at least one borehole position was drilled to 30m depth, the required termination depth of the other positions was reviewed during the course of the fieldworks, in accordance with the findings of the geological review and CMRA. A summary of the works completed is presented below:

4.3 Summary of Works

Table 1: Summary of Completed Works			
Location	Dates Drilled	Depth (m)	Comments
BH01	15/05/2023	30	Open hole to 6m. Rotary core to 13.5m. Open hole to 30m Target depth reached.
BH02	16/05/2023	20	Open hole to 6m. Rotary core to 12m. Open hole to 20m Terminated as sufficient data was obtained.
BH03	17/05/23	20	Open hole to 6m. Rotary core to 12m. Open hole to 20m. Terminated as sufficient data was obtained.
BH04	18/05/2023	12	Target depth reached.
BH05	18/05/2023	12	Target depth reached.
BH06	18/05/2023	12	Target depth reached.
BH07	18/05/2023	12	Target depth reached.

4. Geology

The available published geological data for the site has been examined and the following table presents the anticipated geology.

Table 2: Geological Data for the Site			
Strata Type	Strata Name ²	Previous Name ³	Description ³
Infilled Ground	Infilled Ground	-	Infilled ground is an area where the pre-existing land surface has been excavated (worked ground) and subsequently partially or wholly backfilled (made ground). Variable in composition; e.g. a backfilled quarry, landfill. The infilled ground at this site is presumed to be associated with unlicensed opencast mining.
Superficial Geology	N/A	N/A	Not indicated to underlie the site.

² Sources: British Geological Survey (NERC) Map Sheets 87; Barnsley; Solid and Drift Edition, and Geology of Britain Viewer [online resource from www.bgs.ac.uk]

³ Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [online resource from www.bgs.ac.uk]

Solid Geology	Pennine Lower Coal Measures Formation	Grey Measures of Yorkshire and Nottinghamshire	Interbedded grey mudstone, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower part, and more numerous and thicker coal seams in the upper part.
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The geological records indicate that the Whinmoor Coal seam outcrops across the site with the Cumberworth Thin coal seam outcropping to the south and may be present beneath the site. It is of note that the site is bounded by normal faults to the north, and west which appears to form the extents of the opencast quarry from geological records.

Table 3: Summary of Coal Seams within the Vicinity of the Site		
Seam Name	Seam Thickness*	Outcrop Distance from Site*
Whinmoor Coal (W)	0.2m to 1.8m	On site
Cumberworth Thin Coal (CT)	0m to 0.2m	13m to 15m S (from proposed driveway)

In this instance, it is considered that the Whinmoor Coal seam will be revealed at or close to the surface level within the southern section of site, with the projected outcrop of this seam being located in the southern area of the site, away from where the building is to be developed. It is expected that this seam has been subject to mining via opencast methods. Interestingly, the outcrop of the Whinmoor Coal has a bulbous outcrop shape. It is anticipated that prior to the opencast workings, the outcrop could have had a straight linear trend across the centre of the site. However, the outcrop is now shown to follow the deposit of the infilled ground towards the southern boundary.

Stratigraphically, the next seam within the sequence⁴ is the Cumberworth Thin (CT). This seam is expected to be present within 10m depth of the Whinmoor Coal seam. The Cumberworth Thin coal outcrops approximately 15m south of the site, roughly following the trend of Cooper Lane. This seam is indicated to have a thin thickness, reaching only 0.2m where fully formed. Therefore, it is anticipated that such a seam will unlikely have been subject to extensive mining. Nonetheless, if known to be close to the surface, this may have been removed during the opencast workings. However, it is unlikely that such a coal seam shall have been subject to underground workings.

5. Strata Conditions

In accordance with the geology of the area, the succession has been shown to include the following:

Table 4: Generalised Strata Profile			
Depth m below ground level to underside of layer	Strata Type	Positions Layer Revealed	Groundwater Strikes m below ground level
6.00 to 7.90	Quarry Backfill	ALL	Perched water in base of quarry in all boreholes
8.00 to 10.80	Pennine Lower Coal Measures. Interbedded Mudstone, siltstone and sandstone.	ALL	None
8.22 to 10.84	Black intact Coal inferred Cumberworth Thin. Recovered in two leaves in BH02	ALL	None

⁴ In accordance within the Generalised Vertical Section

+12 to +30	Pennine Lower Coal Measures. Interbedded Mudstone, siltstone and sandstone.	ALL	None
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'+' denotes that the strata extended below the termination depth of the investigated positions, thus the extent of the deposit is only proven to the depths indicated.

5.1 General Strata

The intrusive investigation has revealed that the base of the quarry was generally encountered between depths of 6.00m and 7.90m below existing ground level (begl). A coal seam was recorded between 8.22m and 10.84m begl with thicknesses recorded between 0.10m and 0.50m. This was underlain entirely by mudstone, with sandstone and siltstone of the Pennine Lower Coal Measures Formation.

5.2 Groundwater

Groundwater was recorded perched at the base of the quarry during all investigative locations. However, it should be appreciated that the normal rate of boring does not permit the recording of an equilibrium water level for any one strike. Moreover, groundwater levels are subject to seasonal variation or changes on local drainage conditions.

6. Laboratory Testing - Geotechnical

The following programme of laboratory testing has been undertaken on samples obtained during this investigation:

- Uniaxial Compressive Strength ASTM: D2938-95 (2002)
- Point Load Strength Index Test ISRM (1984)

The test results are presented in Appendix 4 and are summarised below:

Test type	Number of tests	Range of results		Comments
Point Load Strength Index	19	Is ₍₅₀₎ Axial	2 to 10 MPa	Assume UCS = Is ₍₅₀₎ *20
Uniaxial Compressive Strength	2	8.7 & 9.9MPa		Indicative of weak rock strength

7. Discussion of Ground Conditions - Geotechnical

It is understood that the site is to be developed by the construction of a new residential building. The precise structural details are not currently known, thus the discussion below is of a generalised nature.

7.1 Foundations

On the basis of the ground conditions encountered it is not recommended that shallow foundations be adopted given the made ground deposits present on the site present in a weak/variable condition. Instead a piled foundation solution should be adopted to transfer loads from the surface to the underlying strata of adequate bearing capacity. To protect against settlements the ground floor shall be suspended between foundation positions.

Given the prevailing ground conditions it is likely that drilled piled (Odex, Symmetrix or similar) will be the most suitable option as piles will be required to penetrate into the bedrock recorded beneath the site. These methods employ down the hole hammers which have the capacity to bore through obstructions and into the underlying hard stratum to form a rock socket. Through the overburden the drill bit is attached to casing which prevents the pile borehole collapsing. When rock is encountered the drilling can continue using open hole drilling techniques. On completion of the boring operations concrete is then pumped into the hole and a steel reinforcing cage can be installed. The steel casing can be removed or left in place.

It is of note that perched groundwater was recorded within the base of the quarry in all locations and the chosen piling contractor shall be made aware of the presence of potential groundwater ingress during piling activity.

In view of the weak near surface soils it will be necessary to construct a working platform. This work should be undertaken in accordance with the procedures and specification given in the BRE publication entitled *Working platforms for tracked plant*.

It is anticipated that the base of the quarry will be encountered between 6m and 7.90m below existing ground level thus piles will need to fully penetrate through this depth. It is likely, based on the ground conditions that piles will be required to reach a depth of ca. 10m to achieve a suitable end-bearing capacity however to verify this the piles shall be designed by a suitably qualified engineer.

8. Risk Assessment

8.1 Coal Instability

In light of the findings of this investigation, the risk to the proposed development is considered with reference to the following ratings and definitions:

- Low - The possibility of instability is unlikely therefore no further action is necessary.
- Moderate - The possibility of instability is likely and further investigation or remedial action may be required.
- High - The possibility of instability is highly likely and further investigation or remedial action will be necessary.

Table 6: Development Specific Risk Assessment

Item	Risk of Instability	Risk Considered	Risk Rating
1	Shallow coal workings	Whinmoor, Cumberworth Thin	Low
2	Adit	Mine entry 426405-005	Low

In view of all the information obtained in this investigation, it is considered that there is a null to negligible risk of ground movement as a consequence of coal workings beneath the site where once the base of the quarry was proven no underground workings related to coal seams have been recorded during the intrusive investigation. Indeed, one coal seam was proven, thought to be the Cumberworth Thin, however this was proven to be intact in all locations and of a thickness which is unlikely to be economically viable.

8.1 Ground Gas

Given the presence of deep made ground beneath the site a period of ground gas monitoring has been carried out for the proposed development. The following table outlines the proven ground gas conditions:

Table 4: Gas monitoring

Location	Date	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Flow (l/h)	Barometric Pressure (mb)	Water Level (m)	Standpipe Depth (m)
BH01	30.05.2023	0.1	3.3	19.4	0.2	1017↑	2.22	5.0
	05.06.2023	0.1	2.1	19.3	0.3	1011↔	2.51	
	12.06.2023	0.0	2.5	17.7	0.4	1001↔	2.60	
BH03	30.05.2023	0.1	10.4	14.8	0.0	1017↑	4.25	5.0
	05.06.2023	0.1	11.4	9.7	0.0	1011↔	4.58	
	12.06.2023	0.1	11.3	6.0	0.0	1001↔	4.50	

↑ - rising pressure ↓ - falling pressure ↔ -steady pressure

This monitoring was undertaken using a Geotechnical Instruments (UK) Ltd. GA5000 (serial No G503524) which was last calibrated on the 1st February 2023. Full details of the ground gas monitoring results completed to date are presented in Appendix 5.

With respect to ground gas, the results of the monitoring visits indicated minimal methane with maximum concentration of 0.1%, with concentrations of carbon dioxide ranging between 2.5% and 11.3%, in association with oxygen levels of between 6.0% and 19.4%. It should be appreciated that on non-contaminated sites there is generally about 20% by volume of oxygen, associated with low levels of carbon dioxide. In addition, a maximum flow rate of 0.4 litres per hour was recorded and will be employed in the following calculations. In addition to the above carbon monoxide was recorded in all boreholes during all visits between 1ppm and 126ppm.

The principal driving force for initiating the movement of gas in the ground is a change in barometric pressure. The most onerous gas condition on a site is usually observed on days of low or falling barometric pressure, preferably below 1000mb. It has been noted that measurements undertaken solely during high pressure conditions may be of lesser value. At this site the readings undertaken to date were at atmospheric pressures of between 1001mb and 1017mb. In order to establish the gas screening value (GSV) for carbon dioxide or methane, the maximum gas concentration (expressed as a decimal) is multiplied by the borehole flow rate (l/hr). In this case 0.1% (0.001) methane was recorded along with 11.4% (0.114) carbon dioxide, in association with a maximum flow rate of 0.4 l/hr. This results in a GSV of 0.0004 l/hr for methane and a GSV of 0.0456 l/hr for carbon dioxide. As the action level of 5.0% for carbon dioxide has been breached on more than one occasion In accordance with table 2 of BS8485: 2015, *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*, the site may be characterised as *Characteristic Situation Level 2*. It is therefore considered that there is a potential risk of harm to end users and site operatives and special precautionary measures are required in accordance to Table 8.6, *Typical scope of gas protection measures*, of CIRIA report C665.

With regard to the number of monitoring visits required reference is made to Tables 5.5a and 5.5b of CIRIA report C665 (2007)⁵. Accepting that the proposed development is of high sensitivity (residential with gardens) and that the generation potential is very low, these tables suggest that 6 readings could be undertaken over a period of 3 months. However, in this case a total of three monitoring visits were undertaken over a three-week time period, at which point monitoring was terminated because it was decided to assume Characteristic Situation Level 2 for the site. Therefore, some remediation will be required.

In this context, it should be noted that the gas screening value threshold for Characteristic Situation level 2, is <0.7 l/hr. Assuming the flow rate remains constant at 0.4l/hr the gas concentration would need to exceed 100% to move into the next risk band, which is not possible. Moreover, by keeping the concentration constant, the flow rate would need to increase to 6 l/hr which represents a significant increase. It is considered that these increases are not feasible given the flow rates and gas concentrations encountered.

As a result of the findings a remediation statement shall be produced to protect against the risks posed by hazardous ground gases.

⁵ Adapted from tables 5.5a and 5.5b of CIRIA C665, 2007, *Assessing risks posed by hazardous ground gas to buildings*, p60.

9. Further Work

- This report should be forwarded to the relevant authorities as soon as practicable to ensure they have sufficient time to review and discuss any issues.
- Detailed design of the sub-structure.
- Discussions with piling contractors regarding their method for foundation solution and requirements for tracked platform.
- Production of Remediation Statement and verification to protect against risk of ground gas.

10. References

- British Standards Institution (1990) BS1377: *British standard methods of test for soils for civil engineering purposes*, B.S.I., London.
- British Standards Institution (2015) BS5930: *Code of practice for site investigations*, B.S.I., London.
- British Geological Survey (NERC) (2023), BGS, Keyworth.
 - Geology of Britain Viewer:
(http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html)
 - Lexicon of Named Rock Units:
(<http://www.bgs.ac.uk/lexicon/>)
- Building Research Establishment (BRE) Special Digest 1 (2005), Third Edition: Concrete in aggressive ground.
 - Part C: *Assessing the aggressive chemical environment.*
 - Part D: *Specifying concrete for general cast-in-situ use.*
- NHBC Standards, Chapter 4.2, *Building near trees*
- Design Manual for Roads and Bridges (1995), HA44/9: Volume 4 Section 1 Part 1, Highways Agency
- Healy, P. and Head, J., 1984. *Construction over abandoned mine workings*. London: Construction Industry Research and Information Association [for] Directorate of Civil Engineering Services, Property Services Agency, Dept. of the Environment.
- Parry, D. and Chiverrell, C., 2019. *Abandoned mine workings manual*. London: CIRIA.

Appendix 1

Site Plan



Notes:

Investigation positions approximated from site operative's notes.



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Client:
Envision Support Ltd.

Job Number:
C2812/23/E/5254

Project Details:
Land North of Cooper Lane,
Hoylandswaine

Scale: Not to scale - reference only



Notes:

Investigation positions approximated from site operative's notes.



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Appendix 2

Coal Authority Permit and Records



The Coal
Authority

Granted Permit Boundary

Permit Ref: 26650

Permit Boundary:



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Appendix 3

Borehole Records



Borehole Log

Borehole No.

BH01

Sheet 1 of 6

Project Name: Land at Cooper Lane, Hoylandswaine Project No. C2812/22/E/5254 Co-ords: 426684.06E - 405716.79N Hole Type RO+RC

Location: Cooper Lane, Hoylandswaine Level: 153.32m aOD Scale 1:25

Client: Envision Solutions Ltd. Dates: 15/05/2023 Logged By SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							MADE GROUND. (Mixed brown and grey sandy gravelly CLAY). [Quarry Backfill]		
								1	
								2	
								3	
								4	
								5	

Continued on Next Sheet

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 13m. Open hole to 30m. 3. Borehole installed with ground gas monitoring well 3. Borehole terminated at target depth.





Borehole Log

Borehole No.

BH01

Sheet 2 of 6

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426684.06E - 405716.79N	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	153.32m aOD	Scale	1:25
Client:	Envision Solutions Ltd.			Dates:	15/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing					Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results								
					87	48	14	0	80	6.75	146.57	<p>Weak grey, dark grey and light grey locally mottled brown thinly to thickly cross laminated slightly to moderately weathered with iron staining SILSTONE with mudstone and coal laminations. [PENNINE LOWER COAL MEASURES FORMATION] FRACTURES. Very closely spaced subhorizontal smooth planar open to moderately wide clean with fractured rock. Localised iron staining on fracture surfaces.</p>
										7.20	146.12	
										7.50	145.82	
				87	34	0	0	0				<p>Extremely weak grey mottled light brown extremely to completely weathered MUDSTONE recovered as clayey slightly sandy angular fine to medium gravel of mudstone and coal. [PENNINE LOWER COAL MEASURES FORMATION] Completely weathered, no visible fractures.</p>
												<p>Extremely weak light greyish brown and brownish grey extremely weathered SILTSTONE and fine sandstone recovered as very soft slightly sandy gravelly clay. Sand is fine to coarse Gravel is fine to medium of siltstone and sandstone lithorelicts. [PENNINE LOWER COAL MEASURES FORMATION] Completely weathered no visible fractures</p>
												<p>Extremely weak light brown and grey extremely to completely weathered SANDSTONE and siltstone recovered as clayey to very clayey gravelly fine to coarse SAND. Gravel is angular to rounded fine to medium of sandstone and siltstone lithorelicts. [PENNINE LOWER COAL MEASURES FORMATION] Completely weathered no visible fractures.</p>
												<p>Extremely weak grey mottled light brown</p>
		9.87	C									
				Dia. (mm)	TCR (%)	SCR (%)	RQD (%)	FI				

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 13m. Open hole to 30m. 3. Borehole installed with ground gas monitoring well 3. Borehole terminated at target depth.





Borehole Log

Borehole No.

BH01

Sheet 5 of 6

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426684.06E - 405716.79N	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	153.32m aOD	Scale	1:25
Client:	Envision Solutions Ltd.			Dates:	15/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							Grey MUDSTONE with light grey siltstone and sandstone. Fast drilling rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers Notes)	21	
								22	
								23	
								24	
								25	

Continued on Next Sheet

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 13m. Open hole to 30m. 3. Borehole installed with ground gas monitoring well 3. Borehole terminated at target depth.





Borehole Log

Borehole No.

BH01

Sheet 6 of 6

Project Name: Land at Cooper Lane, Hoylandswaine Project No. C2812/22/E/5254 Co-ords: 426684.06E - 405716.79N Hole Type RO+RC

Location: Cooper Lane, Hoylandswaine Level: 153.32m aOD Scale 1:25

Client: Envision Solutions Ltd. Dates: 15/05/2023 Logged By SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
									26
									27
									28
									29
					30.00	123.32		End of Borehole at 30.00m	30

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 13m. Open hole to 30m. 3. Borehole installed with ground gas monitoring well 3. Borehole terminated at target depth.





Borehole Log

Borehole No.

BH02

Sheet 1 of 4

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426689.45E - 405741.37N	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	153.07m aOD	Scale	1:25
Client:	Envision Solutions Ltd.			Dates:	16/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							MADE GROUND. (Mixed brown and grey sandy gravelly CLAY). [Quarry Backfill]		
								1	
								2	
								3	
								4	
								5	

Continued on Next Sheet

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 12m. Open hole to 20m. 3. Ground gas monitoring pipe installed 4. Borehole terminated at target depth





Borehole Log

Borehole No.

BH02

Sheet 3 of 4

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426689.45 - 405741.37	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	153.07m aOD	Scale	1:25
Client:	Envision Solutions Ltd.			Dates:	16/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing							Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Dia. (mm)	TCR (%)	SCR (%)	RQD (%)	FI						
		10.10	C					50	10.40	142.67		Extremely weak dark grey and light brown thinly laminated highly to extremely weathered MUDSTONE with siltstone laminations. [PENNINE LOWER COAL MEASURES FORMATION] No visible fractures.	11	
							120							
								0	10.85	142.22		Extremely weak light greyish brown highly to completely weathered fine SANDSTONE recovered as very soft slightly sandy gravelly to very gravelly clay. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of sandstone lithorelicts. [PENNINE LOWER COAL MEASURES FORMATION] Completely weathered no visible fractures or structure. Black intact COAL. [CUMBERWORTH THIN] FRACTURES. Closely spaced subhorizontal rough planar and stepped tight to partly open parallel to bedding planes.	11	
		11.20	C	87	96	56	14							
		11.67	C					50				Extremely weak grey thinly laminated moderately to highly weathered with		
									12.00	141.07		localised iron staining MUDSTONE. [PENNINE LOWER COAL MEASURES FORMATION] No visible fractures. Black bright intact COAL with yellow iron sulphide. [CUMBERWORTH THIN] Weak grey thinly laminated and thinly bedded moderately to locally completely weathered to clay MUDSTONE with rare ironstone nodules and coal stringers. [PENNINE LOWER COAL MEASURES FORMATION] FRACTURES: Very close to closely spaced subhorizontal smooth planar tight to open parallel to lamination planes. 10.00m-10.15m: Sub-vertical rough, planar to stepped partly open completely weathered to clay along fracture surfaces with iron staining.	12	
												Extremely weak brownish grey mottled brown completely weathered MUDSTONE recovered as very soft slightly sandy gravelly clay. Sand is fine to coarse. Gravel is angular fine to medium of mudstone and coal. [PENNINE LOWER COAL MEASURES FORMATION] Weak grey thinly laminated locally cross-laminated and thinly bedded moderately weathered with iron staining, MUDSTONE with rare ironstone nodules. [PENNINE LOWER COAL MEASURES FORMATION] FRACTURES: Closely spaced subhorizontal smooth planar tight to open parallel to lamination planes. Generally completely fractured between bedding	13	
														14
														15

Continued on Next Sheet

Remarks

1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 12m. Open hole to 20m. 3. Ground gas monitoring pipe installed 4. Borehole terminated at target depth





Borehole Log

Borehole No.

BH02

Sheet 4 of 4

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426689.45E - 405741.37N	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	153.07m aOD	Scale	1:25
Client:	Envision Solutions Ltd.			Dates:	16/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					16.00	137.07		planes Closely spaced subvertical to inclined to 40 degrees to core axis smooth planar partly open to open fresh faces. Dark grey MUDSTONE. Fast drilling rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers Notes)	16
								Grey MUDSTONE with light grey siltstone and sandstone. Fast drilling rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers Notes)	17
					20.00	133.07		End of Borehole at 20.00m	20

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 12m. Open hole to 20m. 3. Ground gas monitoring pipe installed 4. Borehole terminated at target depth





Borehole Log

Borehole No.

BH03

Sheet 2 of 3

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426703.61 - 405740.88	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	152.92m aOD	Scale	1:50
Client:	Envision Solutions Ltd.			Dates:	17/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing							Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Dia. (mm)	TCR (%)	SCR (%)	RQD (%)	FI				
		10.10	C									Weak black intact COAL with mudstone and shale laminations <2mm thick. [CUMBERWORTH THIN]
								0	10.50	142.42		Light brown and dark grey completely weathered interlaminated fine SANDSTONE, SILTSTONE and MUDSTONE recovered as very soft slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine of sandstone and mudstone lithorelicts.
									11.00	141.92		MUDSTONE recovered as very soft slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine of sandstone and mudstone lithorelicts. [PENNINE LOWER COAL MEASURES FORMATION]
		11.35	C	87	100	55	9					
								125	11.55	141.37		
									11.87	141.05		
												8.75-9.00m - Assessed Zone of Core Loss, no recovery.
									12.00	140.92		Extremely weak light grey completely weathered MUDSTONE with coal recovered as slightly clayey slightly sandy angular to sub rounded fine to coarse GRAVEL of mudstone and coal lithorelicts. [PENNINE LOWER COAL MEASURES FORMATION]
												Weak grey thinly laminated and thinly bedded moderately to locally completely weathered to clay MUDSTONE with rare ironstone nodules and coal stringers. [PENNINE LOWER COAL MEASURES FORMATION]
												FRACTURES: Very close to closely spaced subhorizontal smooth planar tight to open parallel to lamination planes. 9.76-9.81m - Grey highly weathered MUDSTONE with ironstone nodules. 9.98-10.01m - Dark grey thinly laminated highly weathered MUDSTONE with coal laminations.
												Extremely weak light brown mottled grey completely weathered SILTSTONE and fine SANDSTONE recovered as sandy slightly gravelly clayey SILT. Sand is fine to coarse. Gravel is angular, fine of siltstone and sandstone lithorelicts. [PENNINE LOWER COAL MEASURES FORMATION]
												Extremely weak dark grey mottled black thinly laminated completely weathered MUDSTONE with coal stringers. [PENNINE LOWER COAL MEASURES FORMATION]
												Completely weathered.
												Extremely weak grey locally mottled light brown completely weathered MUDSTONE recovered as soft slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular fine of mudstone and coal lithorelicts and sub rounded ironstone nodules. [PENNINE LOWER COAL MEASURES FORMATION]
												Weak grey thinly laminated and thinly bedded moderately to locally completely weathered to clay MUDSTONE with rare ironstone nodules and coal stringers. [PENNINE LOWER COAL MEASURES] FRACTURES: Very close to closely spaced subhorizontal smooth planar tight to open parallel to lamination planes.
									20.00	132.92		

Continued on Next Sheet

Remarks

1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 12m. Open hole to 20m. 3. Borehole terminated at target depth





Borehole Log

Borehole No.

BH03

Sheet 3 of 3

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426703.61E - 405740.88N	Hole Type	RO+RC
Location:	Cooper Lane, Hoylandswaine			Level:	152.92m aOD	Scale	1:50
Client:	Envision Solutions Ltd.			Dates:	17/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							Two sub-vertical rough, planar to stepped partly open completely weathered to clay along fracture surfaces with iron staining. Dark grey MUDSTONE. Fast drilling rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers Notes) End of Borehole at 20.00m	21	
								22	
								23	
								24	
								25	
								26	
								27	
								28	
								29	
								30	

Remarks
 1. Water Flush. 2. Open hole with casing to 6m. Rotary Core to 12m. Open hole to 20m. 3. Borehole terminated at target depth





Borehole Log

Borehole No.

BH04

Sheet 1 of 1

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426699.63E - 405740.80N	Hole Type	RO
Location:	Cooper Lane, Hoylandswaine			Level:	153.04m aOD	Scale	1:75
Client:	Envision Solutions Ltd.			Dates:	18/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							MADE GROUND. (Mixed brown and grey sandy gravelly CLAY Very fast penetration rate. 100% flush returns.) (Drillers notes) [Quarry Backfill]	1	
								2	
								3	
								4	
								5	
								6	
					7.00	146.04	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	7	
					8.00	145.04	Black intact COAL. Very fast penetration rate. 100% flush returns. [CUMBERWORTH THIN] (Drillers notes)	8	
					8.50	144.54	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	9	
								10	
								11	
					12.00	141.04	End of Borehole at 12.00m	12	
								13	
								14	
								15	

Remarks
 1. Water Flush. 2. Borehole terminated at target depth





Borehole Log

Borehole No.

BH05

Sheet 1 of 1

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426701.58E - 405740.87N	Hole Type	RO
Location:	Cooper Lane, Hoylandswaine			Level:	152.98m aOD	Scale	1:75
Client:	Envision Solutions Ltd.			Dates:	18/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							MADE GROUND. (Light and dark brown sandy gravelly CLAY. Very fast penetration rate. 100% flush returns.) (Drillers notes)	1	
								2	
								3	
								4	
								5	
					6.00	146.98	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	6	
								7	
					8.00	144.98	Black intact COAL. Very fast penetration rate. 100% flush returns. [CUMBERWORTH THIN] (Drillers notes)	8	
					8.40	144.58	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	9	
								10	
								11	
					12.00	140.98	End of Borehole at 12.00m	12	
								13	
								14	
								15	

Remarks
 1. Water Flush. 2. Borehole terminated at target depth





Borehole Log

Borehole No.

BH06

Sheet 1 of 1

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426705.64E - 405740.94N	Hole Type	RO
Location:	Cooper Lane, Hoylandswaine			Level:	152.75m aOD	Scale	1:75
Client:	Envision Solutions Ltd.			Dates:	18/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							MADE GROUND. (Mixed brown and grey sandy gravelly CLAY Very fast penetration rate. 100% flush returns.) (Drillers notes) [Quarry Backfill]	1	
					3.00	149.75	MADE GROUND. (Yellow clayey sandy gravel of sandstone. Very fast penetration rate. 100% flush returns.) (Drillers notes) [Quarry Backfill]	3	
					7.50	145.25	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	7	
					8.00	144.75		8	
					8.80	143.95	Black intact COAL. Very fast penetration rate. 100% flush returns. [CUMBERWORTH THIN] (Drillers notes)	9	
							Dark grey MUDSTONE. Very fast penetration rate. 100% flush returns.) [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	10	
					12.00	140.75	End of Borehole at 12.00m	12	

Remarks
 1. Water Flush. 2. Borehole terminated at target depth





Borehole Log

Borehole No.

BH07

Sheet 1 of 1

Project Name:	Land at Cooper Lane, Hoylandswaine	Project No.	C2812/22/E/5254	Co-ords:	426696.87E - 405740.95N	Hole Type	RO
Location:	Cooper Lane, Hoylandswaine			Level:	152.66m aOD	Scale	1:75
Client:	Envision Solutions Ltd.			Dates:	18/05/2023	Logged By	SA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
							MADE GROUND. (Mixed brown and grey sandy gravelly CLAY Very fast penetration rate. 100% flush returns.) (Drillers notes) [Quarry Backfill]	1	
								2	
								3	
								4	
								5	
					6.40	146.26	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	6	
					8.00	144.66	Black intact COAL. Very fast penetration rate. 100% flush returns. [CUMBERWORTH THIN] (Drillers notes)	7	
					8.40	144.26	Light grey MUDSTONE. Very fast penetration rate. 100% flush returns. [PENNINE LOWER COAL MEASURES FORMATION] (Drillers notes)	8	
								9	
								10	
								11	
					12.00	140.66	End of Borehole at 12.00m	12	
								13	
								14	
								15	

Remarks
1. Water Flush. 2. Borehole terminated at target depth



Project Id: C2812/22/E/5254

Project Title: Land at Cooper Lane, Hoylandswaine

Location: Cooper Lane, Hoylandswaine

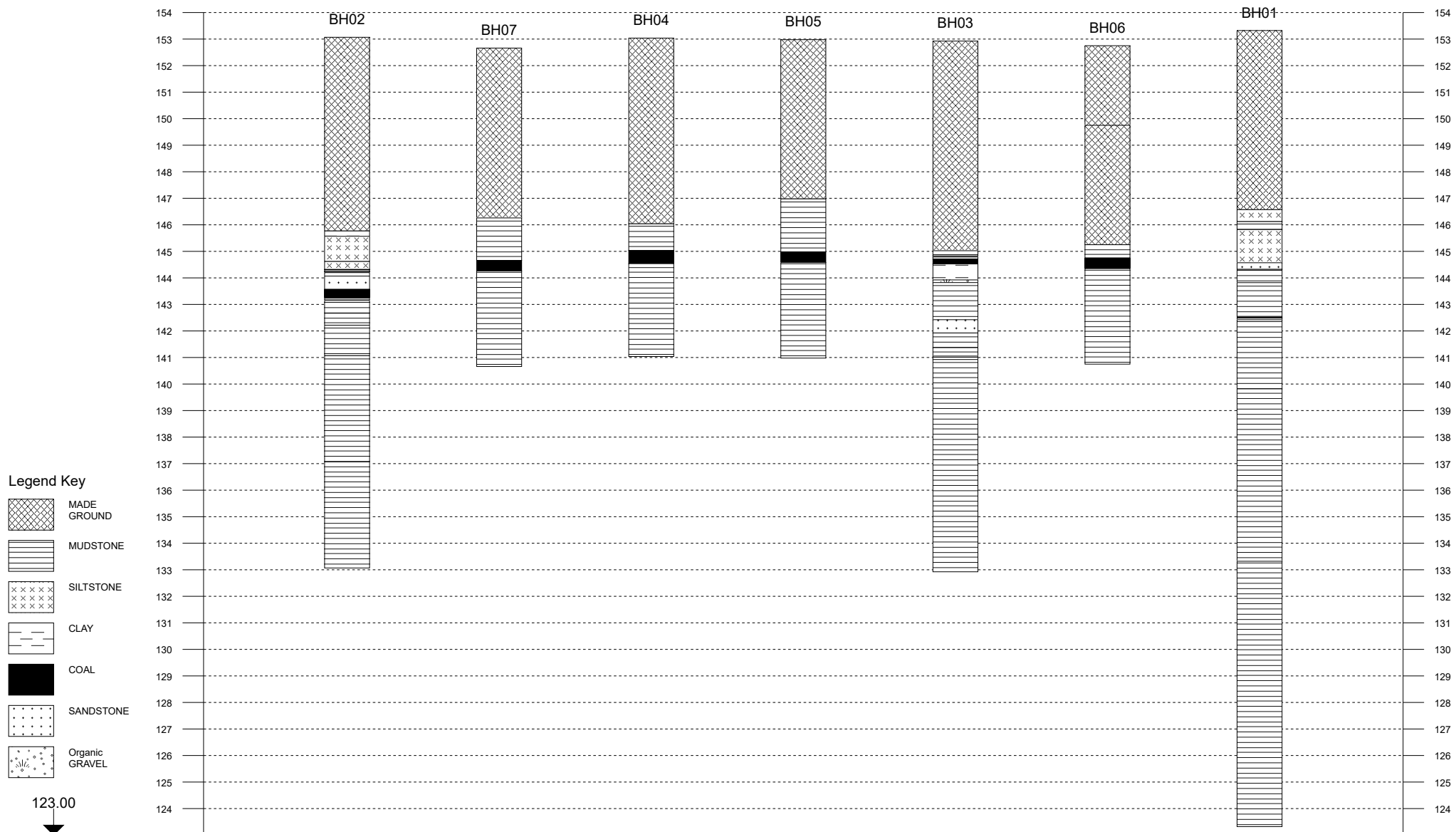
Client: Envision Solutions Ltd.

Title: Section line 1

Vertical Scale: 1:203

Horizontal Scale: Not to scale

Engineer: SA



- Legend Key**
- MADE GROUND
 - MUDSTONE
 - SILTSTONE
 - CLAY
 - COAL
 - SANDSTONE
 - Organic GRAVEL

123.00

Chainage (m)	24.92	27.36	28.26	28.74	29.28	29.78	47.07
Elevation (mAOD)	153.07	152.66	153.04	152.98	152.92	152.75	153.32

Appendix 4

Laboratory Testing – Geotechnical

Environmental
Geotechnical
Specialists



LABORATORY REPORT

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job number	date
site address	
date scheduled	date issued
issued by	

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8948

Schedule of UKAS Accredited Laboratory Tests



1. CLASSIFICATION OF SOIL	BS 1377-2:1990	BS EN ISO 17892	Accredited (A)	Unaccredited (U)
1.1 Moisture / Water content determination				
i. Oven drying	Pt 2 : 3.2	Pt 1 : 2014 Pt 12 : 2018 : 5.3 / 5.5	A	
ii. Saturation m/c of chalk	Pt 2 : 3.3			U
1.2 Index Properties				
i. Liquid limit – cone penetrometer	Pt 2 : 4.3		A	
ii. Plastic limit	Pt 2 : 5.3		A	
iii. Shrinkage limit	Pt 2 : 6.3			U
iv. Linear shrinkage	Pt 2 : 6.5		A	
1.3 Particle Density				
i. Gas jar	Pt 2 : 8.2		A	
ii. Large pycnometer	Pt 2 : 8.3			U
iii. Small pycnometer	Pt 2 : 8.4	Pt 3 : 2015 : 5.1		U
1.4 Density Tests				
i. Linear measurement	Pt 2 : 7.2	Pt 2 : 2014 : 5.1	A	
ii. Immersion in water	Pt 2 : 7.3	Pt 2 : 2014 : 5.2		U
iii. Fluid / Water displacement	Pt 2 : 7.4	Pt 2 : 2014 : 5.3		U
iv. Sand replacement	Pt 9 : 2.1, 2.2			U
v. Core cutter	Pt 9 : 2.4			U
1.5 Particle Size Distribution				
i. Dry Sieve	Pt 2 : 9.2	Pt 4 : 2016 : 5.2	A	
ii. Wet Sieve	Pt 2 : 9.3	Pt 4 : 2016 : 5.2	A	
iii. Sedimentation by pipette	Pt 2 : 9.4	Pt 4 : 2016 : 5.3 / 5.4	A	
iv. Sedimentation by hydrometer	Pt 2 : 9.5			U
2. CHEMICAL TESTS				
ii. Mass loss on ignition	Pt 3 : 4			U
3. COMPACTION RELATED TESTS				
3.1 Dry density/moisture relationship				
i. 2.5kg rammer – 1 litre mould	Pt 4 : 3		A	
- CBR mould	Pt 4 : 3		A	
ii. 4.5kg rammer – 1 litre mould	Pt 4 : 3		A	
- CBR mould	Pt 4 : 3		A	
3.2 Moisture Condition Value				
i. Single point test	Pt 4 : 5.4			U
ii. MCV/moisture content relationship	Pt 4 : 5.5			U
3.3 California Bearing Ratio				
i. Undisturbed sample	Pt 5 : 7		A	
ii. Recompacted sample	Pt 5 : 7		A	
iii. Soaked, inc measurement of swell	Pt 5 : 7		A	
4. COMPRESSIBILITY OF SOIL				
ii. Swelling pressure test	Pt 5 : 3		A	
	Pt 5 : 3			U
5. SHEAR STRENGTH OF SOIL				
i. Hand shear vane	Makers instructions			U
ii. Shear box (100mm square sample)	BS 1377 : Pt 7 : 4			U
iii. Triaxial – quick undrained	BS 1377 : Pt 7 : 8, 9		A	
6. PERMEABILITY				
i. Falling head	K. H. Head Vol 2			U
ii. Constant head	BS 1377 : Pt 6 : 6			U
iii Triaxial cell	BS 1377 : Pt 6 : 6			U
7. ROCK TESTS				
7.1 Classification Tests				
i. Natural moisture content	-			U
ii. Saturated moisture content	-			U
iii. Natural density	-			U
iv. Porosity	-			U
7.2 Strength Tests				
i. Point load index	ISRM '85			U
ii. Uniaxial compression test	ISRM '81			U

ENVIRONMENTAL & GEOTECHNICAL





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Disclaimer

The results reported herein relate only to the material supplied to the laboratory.



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GEOTECHNICAL TESTING RESULTS



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Point Load Strength Index Tests Summary of Results

Project No. C2812/22/E/5254	Project Name Land at Cooper Lane, Hoylandswaine
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Borehole No.	Sample			Specimen		Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, D_e mm	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		L_{ne} mm	W mm	Dps mm	Dps' mm			Is MPa	Is(50) MPa	
BH01	9.87	D	C	3	9.87	Weak thinly laminated MUDSTONE	D	L	YES	20.0	87.0	87.0	83.0	0.1	85.0	0.0	0.0	
BH01	10.06	D	C	3	10.06	Weak thinly laminated MUDSTONE	D	L	YES	40.0	87.0	87.0	83.0	0.2	85.0	0.0	0.0	
BH01	11.10	D	C	3	11.10	Weak thinly laminated MUDSTONE	D	L	YES	58.0	87.0	87.0	82.0	2.0	84.5	0.3	0.4	
BH01	11.10	D	C	4	11.10	Weak thinly laminated MUDSTONE	A	P	YES		87.0	55.0	50.0	2.1	74.4	0.4	0.5	
BH01	11.20	D	C	3	11.20	Weak thinly laminated MUDSTONE	D	L	YES	59.0	87.0	87.0	83.0	2.1	85.0	0.3	0.4	
BH01	11.20	D	C	4	11.20	Weak thinly laminated MUDSTONE	A	P	YES		87.0	61.0	48.0	2.2	72.9	0.4	0.5	
BH01	12.20	D	C	3	12.20	Weak thinly laminated MUDSTONE	A	P	YES		87.0	85.0	66.0	3.6	85.5	0.5	0.6	
BH01	12.30	D	C	3	12.30	Weak thinly laminated MUDSTONE	A	P	YES		87.0	72.0	54.0	2.2	77.3	0.4	0.4	
BH02	10.10	D	C	1		Weak thinly laminated MUDSTONE	A	L	NO		87.0	71.0	44.0	0.1	69.8	0.0	0.0	
BH02	11.20	D	C	2		Weak thinly laminated MUDSTONE	D	P	YES	37.0	87.0	87.0	73.0	1.2	79.7	0.2	0.2	
BH02	11.67	D	C	3		Weak thinly laminated MUDSTONE	D	P	YES	85.0	87.0	87.0	80.0	2.6	83.4	0.4	0.5	
BH02	11.67	D	C	4		Weak thinly laminated MUDSTONE	A	L	NO		87.0	82.0	80.0	1.2	94.1	0.1	0.2	
BH02	11.67	D	C	5		Weak thinly laminated MUDSTONE	D	P	YES	44.0	87.0	87.0	82.0	2.5	84.5	0.4	0.5	
BH03	9.10	D	C	1		Weak thinly laminated MUDSTONE	D	L	YES	66.0	87.0	87.0	79.0	1.5	82.9	0.2	0.3	
BH03	9.10	D	C	2		Weak thinly laminated MUDSTONE	A	P	YES		87.0	57.0	49.0	2.1	73.7	0.4	0.5	
BH03	9.25	D	C	3		Weak thinly laminated MUDSTONE	D	L	YES	84.0	87.0	87.0	80.0	2.3	83.4	0.3	0.4	
BH03	9.25	D	C	4		Weak thinly laminated MUDSTONE	A	P	YES		87.0	84.0	59.0	2.6	80.8	0.4	0.5	
BH03	10.10	D	C	4	10.10	Weak thinly laminated MUDSTONE	D	L	YES	68.0	87.0	87.0	79.0	2.2	82.9	0.3	0.4	
BH03	10.10	D	C	5	10.10	Weak thinly laminated MUDSTONE	A	P	YES		87.0	71.0	57.0	2.1	79.5	0.3	0.4	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
 L_{ne} - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P

Diametral

Axial

Block/irregular lump

Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise Detailed legend for test and dimensions, based on ISRM, is shown above. Size factor, $F = (De/50)0.45$ for all tests.	Date Printed 12/06/2023	Approved By Harry	Table sheet 1 1
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End of Report



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Appendix 5

Ground Gas Monitoring
