

North City Family & Fitness Centre, Manchester

Geological Report, Ground Source System Design

Doc No: EP2012b-RP-01

Rev: P01

Date: 04th June 2021

Project Revision Sheet

Revision	Status / Details	Prepared by	Reviewed by	Date
P01	Initial issue for comment	D.Stone	A.Schilling	04/06/2021



1.0 Contents

1.0 Contents3

2.0 Introduction4

3.0 Design Requirements4

3.1 Quality & Standards4

4.0 Geology.....4

4.1 Summary of Anticipated Geology.....4

4.2 Groundwater6

4.3 Estimated Thermal Properties6

4.4 Relevant Body Searches6

4.5 Obstacles to Construction6

5.0 Ground Loop Design6

5.1 Building Loads (as determined by ENERCRET)6

5.2 System Design6

5.2 System Design (cont.)8

5.2 System Design (cont.)8

5.3 Summary.....10



2.0 Introduction

We have pleasure in providing the Ground Source System Design for the following project.

Project Number	GSS-050
Customer Name	ENERCRET Ltd
Project Address	North City Family & Fitness Centre Manchester, M9 4DA
Building Type	Leisure Centre
Borehole Schematic	1 x 30 boreholes
Author	Lee Hormell

3.0 Design Requirements

Company	ENERCRET Ltd
Ground Source System Designer	Lee Hormell
Ground Loop Design Software	GHLEPRO Version 5

3.1 Quality & Standards

During the design and installation of this project we have considered the most up to date versions of the following quality and standards publications which are specifically applicable to ground source array installation.

Organisation	Reference
Environmental Agency	Environmental good practice guide for ground source heating and cooling
IGSHPA	General code of practice for closed loop installations
GSHPA	Verticle borehole standards
BDA	Code of safe drilling practice
Coal Authority	Guidance on managing the risk of hazardous gases when drilling or piling near coal measures

4.0 Geology

4.1 Summary of Anticipated Geology

ENERCRET Ltd commissioned Hydro Geo to carry out a full borehole prognosis report. (See appendix HYDRO GEO REPORT). In brief the summary of the underlying Geology at North City Family and Friends Fitness Centre is as set out in the table below.

Summary of Anticipated Underlying Geology						
- A preliminary sequence of geological units beneath the site is displayed in the table below, assuming a position of 386224,401800 and assumed ground level of approximately 78mAOD at the site. The bedrock is assumed to be dipping 10° to the south-west. - Thicknesses of all geological formations have been estimated using available investigation records and structural contours. A best estimate has been made from the available data, but depths in the field may vary. The bedrock is heavily faulted.						
Group	Period	Unit	Lithological Colour and Description	Estimated Thickness (m) Estimated/ (Range)	Depth to Base (mBGL)	Elevation of Base (mAOD)
Quaternary	Modern	Made Ground	Made ground is an area where the pre-existing (natural or artificial) land surface is raised by artificial deposits. The purpose of the made ground is often unspecified. Variable composition.	1	1	77
		Devensian Till	Boulder Clay – Diamicton Clay to sandy clay, unsorted, with common pebbles, cobbles and some boulders.	24	25	53
		Glaciofluvial Sheet Deposits/Ice Contract Deposits	Sand and gravel / Mainly sand with some gravels	20	45	33



			(local boreholes record loose soils or 'quicksand')			
Permian	Cumbrian Coasts Group	Manchester Marls Formation	Red marl (calcareous mudstone and siltstone) with thin beds of fossiliferous marine limestone and dolomite; locally green; sandy in places especially in top part; local breccias and pebbly beds.	17.6	62.6	15.4
	Appleby Group	Collyhurts Sandstone Formation	A soft red sandstone with abundant beds of "millet seed" sand grains alternating with beds of fine-grained sharp sand; some interbedded grey sandstones locally.	140 (115-260)	202.6 (177.6-322.6)	-124.6 (99.6 – 244.6)
	UNCONFORMITY					
Carboniferous	Warwickshire Group	Etruria Formation	Red, purple, brown, ochreous, green, grey and commonly mottled mudstone, with lenticular sandstones and conglomerates referred to as 'espleys'. Common pedogenic horizons, but coal seams are rare. Subordinate, lenticular sandstones and conglomerates commonly consist mostly of volcanic and lithic clasts. Intrusions of dolerite sills and dykes and extrusion of a small volume of volcaniclastic rocks are present in south Staffordshire and south Nottinghamshire.	70 (0-90)	272.6 (177.6-412.6)	-194.6 (-99.6- -334.6)
	Pennine Coal Measures Group	Pennine Upper Coal Measures Formation	Interbedded grey mudstone, siltstone and pale grey sandstone, commonly with coal seams, but no mudstones containing marine fossils are present.	>300	>572.5 (>477.6)	-494.6 (<-399.6)

4.2 Groundwater

The report indicates the following groundwater conditions are likely to be encountered at the project location.

Anticipated Groundwater Depth	30m-40m
Expected Rest Water Level	30m-40m
Risk of Artesian Conditions	Aquifer is confined but not expected to overflow Preventative measures should be applied
Aquifer Classification	Principal

4.3 Estimated Thermal Properties

The estimated thermal properties are based on the most concentrated formation (Chester Formation) expected to be encountered on site which is also detailed in report HYG105 and including the ground water movement within this formation.

Quantity	Estimated Value
Thermal Conductivity	3.4 W.mK ¹ within the collyhurst formation
Undisturbed Ground Temperature	11.1°C
Conductivity Test	Required

4.4 Relevant Body Searches

A search of the available records has indicated that the site has the following mining history and requirements.

Historic Mining Activity & Type	None
Coal Authority Reporting Area	No
Historic Coal Mining	None
Likely Depth to Seams	None
Development High Risk Area	No
Proximity to Mine Access	None
Historic Surface Works	None
Notes	None

4.5 Obstacles to Construction

With the information available and the analysis undertaken there appears to be no

Geological or Hydro-Geological barriers to construction at the required depths. However, these conditions can never be fully determined until we have commenced the drilling works as the conditions will be generally site specific.

5.0 Ground Loop Design

5.1 Building Loads (as determined by ENERCRET)

	Total Heating	Total Cooling	Peak Heating	Peak Cooling
Jan	53570		149	
Feb	47137		131	
March	47830		133	
April	48975		136	
May	44985		125	
June	52621		146	
July	54215		150	
August	51856		144	
September	54163		150	
October	53534		149	
November	53904		149	
December	54278		150	

5.2 System Design

Ground Loop Array – Option 1

Simulated by:	GHLEPRO
Date:	28/05/2021
Simulated by:	Lee Hormell



GLHEPRO Software System Parameters	
Active borehole length	210m
Borehole radius	0.075m
Borehole spacings	7m
Borehole geometry	Rectangular Configuration – 1 x 30 line
Soil type currently used	Average Rock
Thermal conductivity of ground	3.462 W/ (m.°K)
Volumetric heat capacity of ground	2678.21 kJ (°K.m³)
Volumetric heat capacity of fluid	4066.4348 kJ/ (°K.m³)
Undisturbed Ground Temperature	11°C
Borehole Thermal Resistance	0.086 °K/ (W/m)
Fluid Type Currently Entered	15% Glycol/Water
Mass Flow Rate of Fluid	7.5 l/s

Borehole Information Calculated Simulation Results	
Design length of each borehole	210m
Total borehole length	6300m
Distance between borehole centres	7m

AVERAGE MONTHLY TEMPERATURES

The end of the month temperatures calculated on the monthly loads.

Maximum average °C = 8.85 at Month 8

Minimum Average °C = 0.19 at Month 290



5.2 System Design (cont.)

Ground Loop Array – Option 2

Simulated by:	GHLEPRO
Date:	28/05/2021
Simulated by:	Lee Hormell

GLHEPRO Software System Parameters	
Active borehole length	161m
Borehole radius	0.075m
Borehole spacings	7m
Borehole geometry	Rectangular Configuration – 42 : 6 x 7
Soil Type Currently Used	Average Rock
Thermal Conductivity of Ground	3.462 W/ (m.°K)
Volumetric heat capacity of Ground	2678.21 kJ/ (°K.m³)
Volumetric heat capacity of Fluid	4066.4348 kJ / (°K.m³)
Undisturbed Ground Temperature	11°C
Borehole Thermal Resistance	0.082 °K/ (W/m)
Fluid Type Currently Entered	15% Glycol/Water
Mass Flow Rate of Fluid	7.5 l/s

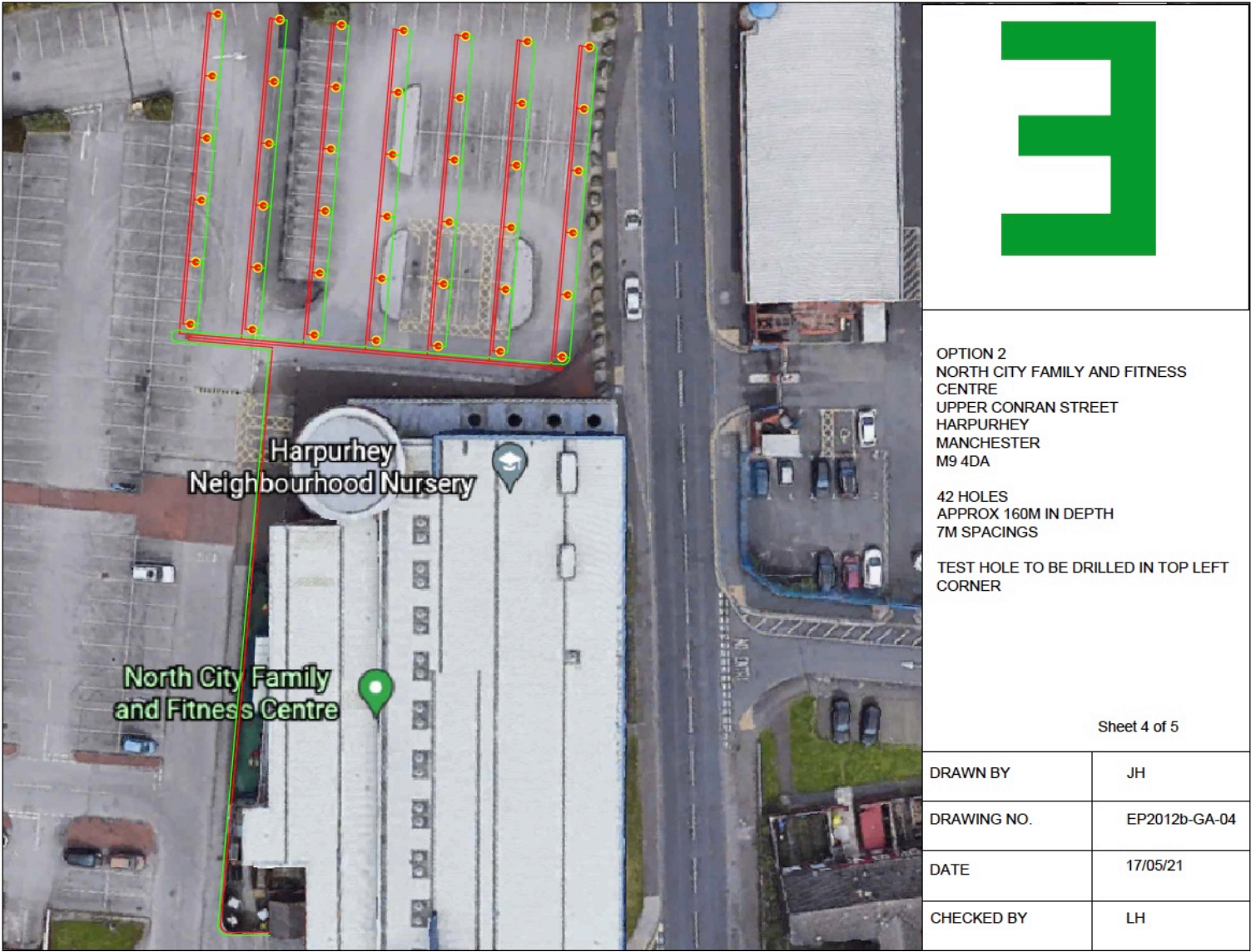
Borehole Information Calculated Simulation Results	
Design length of each borehole	160m
Total borehole length	6720m
Distance between borehole centres	7m

AVERAGE MONTHLY TEMPERATURES

The end of the month temperatures calculated on the monthly loads

Maximum average °C = 9.01 at Month 8

Minimum Average °C = 0.17 at Month 290



5.2 System Design (cont.)

Ground Loop Array – Option 3

Simulated by:	GHLEPRO
Date:	28/05/2021
Simulated by:	Lee Hormell

GLHEPRO Software System Parameters	
Active borehole length	160m
Borehole radius	0.075m
Borehole spacings	10m
Borehole geometry	Rectangular Configuration – 30 : 5 x 6
Soil Type Currently Used	Average Rock
Thermal Conductivity of Ground	3.462 W/ (m.°K)
Volumetric heat capacity of Ground	2678.21 kJ/ (°K.m³)
Volumetric heat capacity of Fluid	4066.4348 kJ / (°K.m³)
Undisturbed Ground Temperature	11°C
Borehole Thermal Resistance	0.082 °K/ (W/m)
Fluid Type Currently Entered	15% Glycol/Water
Mass Flow Rate of Fluid	7.5 l/s

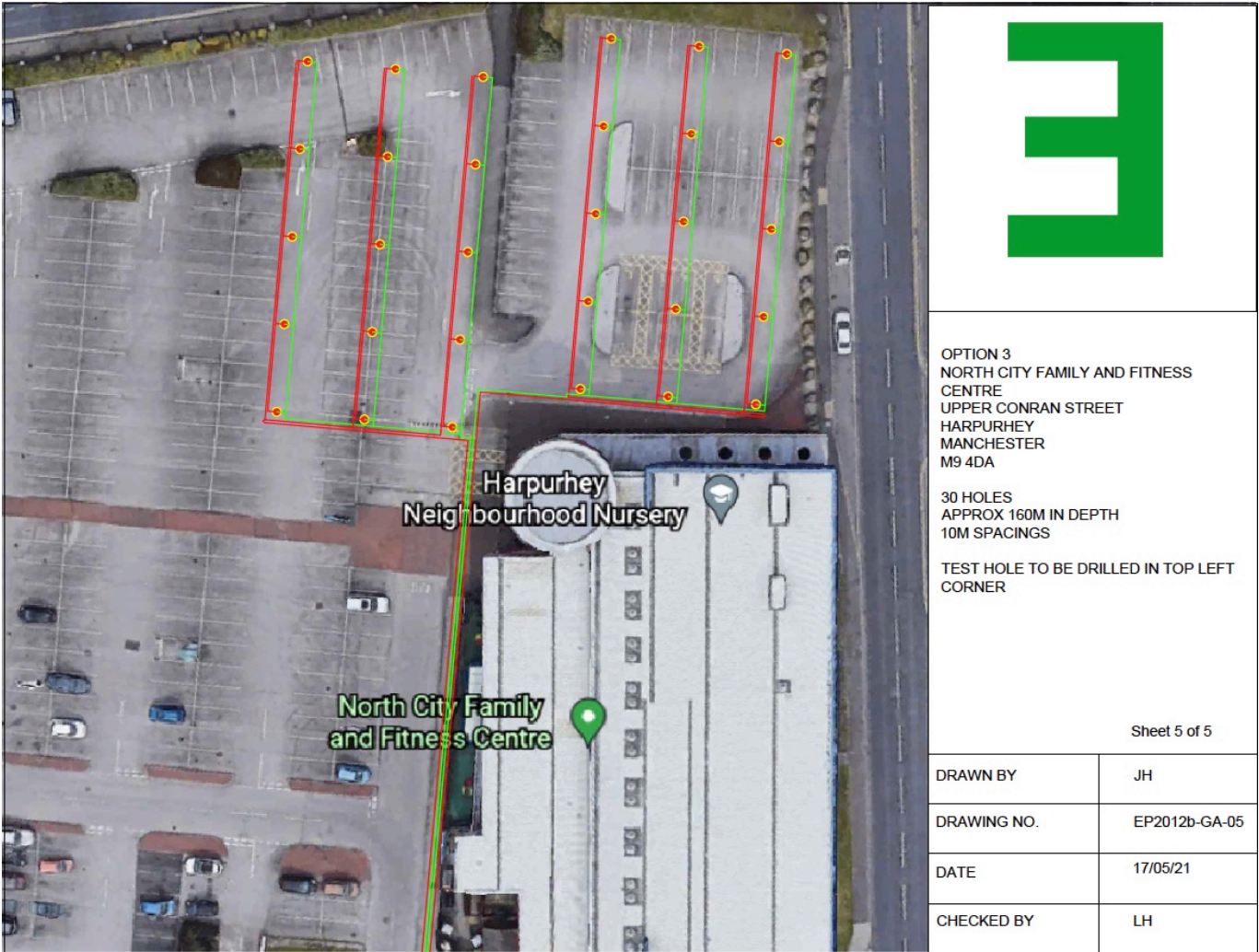
Borehole Information Calculated Simulation Results	
Design length of each borehole	160m
Total borehole length	6720m
Distance between borehole centres	7m

AVERAGE MONTHLY TEMPERATURES

The end of the month temperatures calculated on the monthly loads.

Maximum average °C = 8.33 at Month 8

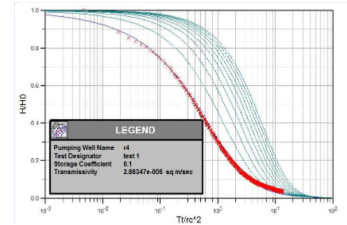
Minimum Average °C = 0.30 at Month 290



5.3 Summary

This system has been designed in accordance with the industry standards (IGSHPA/GSHPA). Critical Building energy loads were provided by Enercret and key geological data obtained through Hydro Geo Ltd. Critical design parameters such as the rock and soil classification have been utilised in the modelling of this ground loop array.

However, based on the site's underlying geological and hydrogeological conditions in particular the amount of ground water movement in the sandstone units I would expect the actual thermal conductivity of the ground to be higher than the publicised rock and soil classification figures and figures used in the GHLEPRO design software. Ground water plays an important part in the performance of any ground loop array and with the site being around the second most important aquifer in England, the Collier formation this means an enhanced overall performance than predicted within the constraints of the software.

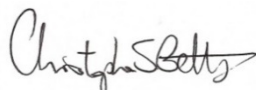


Upper Conran Street, Harpurhey, Manchester M9 4DA

On Behalf of

ENERCRET Ltd

Quality Management

Prepared by:	David Dascombe BSc MSc FGS	
Reviewed & Authorised by:	Chris Betts BSc MSc FGS C.Geol	 
Date:	June 2021	
Revision:	FINAL	
Project Number:	[Status]	
Document Reference:	HYG913 R 210603 DD North City Family Geological Summary.docx	
Document File Path:	X:\HYG913 North City Family & Fitness Centre\Reports\Geological Summary\HYG913 R 210603 DD North City Family Geological Summary.docx	



COPYRIGHT © Hydrogeo

This report has been produced by Hydrogeo within the terms of the contract with the client and taking account of the resources devoted to it by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

Hydrogeo Ltd,
Unit 4 Waddington House,
Llanover Business Centre, Llanover,
Abergavenny NP7 9HA
T: 01873 856 813
E: info@hydrogeo.co.uk
W: www.hydrogeo.co.uk

Data Sources
▪ Ordnance Survey (OS) maps for the site; ▪ BGS Geology of Britain viewer (online); ▪ BGS Geological Map, 1:50,000 Series Sheet 85, Manchester, Bedrock (2010); ▪ BGS Hydrogeological Map, Sheet 19 (1:100,000), Hydrogeological Map of Clwyd and the Cheshire Basin (1989); ▪ BGS, Geology of the Manchester district – a brief explanation of the geological map, 1:50,000 Sheet 85 Manchester (England and Wales); ▪ BGS Lexicon of named rock units (online); ▪ BGS Borehole Records (online); ▪ Banks. D, An Introduction to Thermogeology: ground source heating and cooling, (2012); ▪ Quarterly Journal of Engineering Geology and Hydrogeology, Vol. 46, An overview of the results of 61 in situ thermal response tests in the UK (17 July 2013).

Disclaimer

Hydrogeo Limited has undertaken a geological report on behalf of the client. A desk study review of available information has been carried out by an experienced geologist/hydrogeologist and the results of this work are displayed in this report. No responsibility can be accepted for the local conditions which alter the interpretation and predictions of the published data.

The report has been prepared based on limited geological and hydrogeological information. Although we have applied our experience and expertise to the interpretation of the data available, no guarantee can be made as to the depth of geology encountered. Advancement of boreholes has an inherent risk. Developers should be aware that it is possible that difficult strata could be encountered.

It is the responsibility of the contractor to check for buried services and underground obstructions, including drainage systems prior to drilling.

- The sequence of geological units beneath the site is displayed in the table below, assuming a position of 386224,401800 and assumed ground level of approximately 78mAOD at the site. The bedrock is assumed to be dipping 10° to the south-west.
- Thicknesses of all geological formations have been estimated using available investigation records and structural contours. A best estimate has been made from the available data, but depths in the field may vary. The bedrock is heavily faulted. Thermal conductivity values are based on literature values.

Period	Group	Unit	Aquifer	Lithological Colour and Description	Estimated Thickness (m) Estimated / (range)	Depth to base (mBGL)	Elevation of Base (mAOD)	Thermal Conductivity (W m ⁻¹ K ⁻¹)
Modern		Made Ground		Made ground is an area where the pre-existing (natural or artificial) land surface is raised by artificial deposits. The purpose of the made ground is often unspecified. Variable composition.	1	1	77	N/A
Quaternary		Devensian Till	SecU	Boulder Clay – Diamicton Clay to sandy clay, unsorted, with common pebbles, cobbles and some boulders.	24	25	53	1.11 [#]
		Glaciofluvial Sheet Deposits / Ice Contact Deposits	SecA	Sand and gravel / Mainly sand with some gravels (local boreholes record loose soils or 'quicksand')	20	45	33	0.77 (Dry) [#] 2.50 (wet) [#]
Permian	Cumbrian Coast Group	Manchester Marls Formation	Secondary B	Red marl (calcareous mudstone and siltstone) with thin beds of fossiliferous marine limestone and dolomite; locally green; sandy in places especially in top part; local breccias and pebbly beds.	17.6	62.6	15.4	1.88*
	Appleby Group	Collyhurst Sandstone Formation	Principal	A soft red sandstone with abundant beds of "millet seed" sand grains alternating with beds of fine-grained sharp sand; some interbedded grey sandstones locally.	140 (115 – 260)	202.6 (177.6 – 322.6)	-124.6 (-99.6 – -244.6)	3.41*
UNCONFORMITY								
Carboniferous	Warwickshire Group	Etruria Formation	Secondary A	Red, purple, brown, ochreous, green, grey and commonly mottled mudstone , with lenticular sandstones and conglomerates referred to as 'espleys'. Common pedogenic horizons, but coal seams are rare. Subordinate, lenticular sandstones and conglomerates commonly consist mostly of volcanic and lithic clasts. Intrusions of dolerite sills and dykes and extrusion of a small volume of volcanoclastic rocks are present in south Staffordshire and south Nottinghamshire.	70 (0 – 90)	272.6 (177.6 – 412.6)	-194.6 (-99.6 – -334.6)	1.49*

*data from Table 3.1, D. Banks, *An Introduction to thermogeology: ground source heating and cooling*, 2012

**data from Table 3, D. Banks, J. G. Withers, G. Cashmore and C. Dimelow, *Quarterly Journal of Engineering Geology and Hydrogeology*, 46, 281-291, 17 July 2013

Summary of Anticipated Underlying Geology

- The sequence of geological units beneath the site is displayed in the table below, assuming a position of 386224,401800 and assumed ground level of approximately 78mAOD at the site. The bedrock is assumed to be dipping 10° to the south-west.
- Thicknesses of all geological formations have been estimated using available investigation records and structural contours. A best estimate has been made from the available data, but depths in the field may vary. The bedrock is heavily faulted. Thermal conductivity values are based on literature values.

Drilling Risk and Borehole Stability

- **The driller should be made aware of the following risks:**
- Given the local topography and geology, artesian conditions are not expected to be present beneath the site. The hydrogeology map shows the 40mAOD groundwater contour in the Permo-Triassic Sandstone south of the site (30 to 40 m below ground level). Groundwater in the Collyhurst Sandstone may be confined under pressure but is not expected to be artesian.
- A layer of made ground is expected, although its thickness will vary across the site. This made ground may be unstable.
- The site is situated in the vicinity of a historic buried valley. The underlying superficial deposits can be thick and variable in the area.
- An approximately 45m thick layer of superficial Glacial Till (Boulder Clay) and Glacial Sand & Gravel is expected. These superficial deposits may be unstable with flowing sands (labelled quicksands on logs) present.
- Boreholes progressed in the Manchester Marls and Eturia Formation may be susceptible to borehole deformation and failure if the hole is left open.
- The Collyhurst sandstone horizons (uncertain thickness) within the underlying geology may be soft and weakly cemented consolidated resulting in a potential for instability.
- The geology in the vicinity of the site and the surrounding area has been subjected to faulting which has resulted in a complex geological fault structure. If a fault is encountered this could result in broken ground, loss of drill flush and difficult drilling.

Summary

- The site is underlain by a significant thickness of Superficial Deposits related to a buried glacial channel
- There is a potential for drilling/installation issues which will need to be controlled by the driller, including:
 - Unstable made ground and (unconsolidated) superficial deposits
 - Weakly cemented sandstones
 - Borehole deformation in mudstones
 - Loss of flush in sandstone fractures