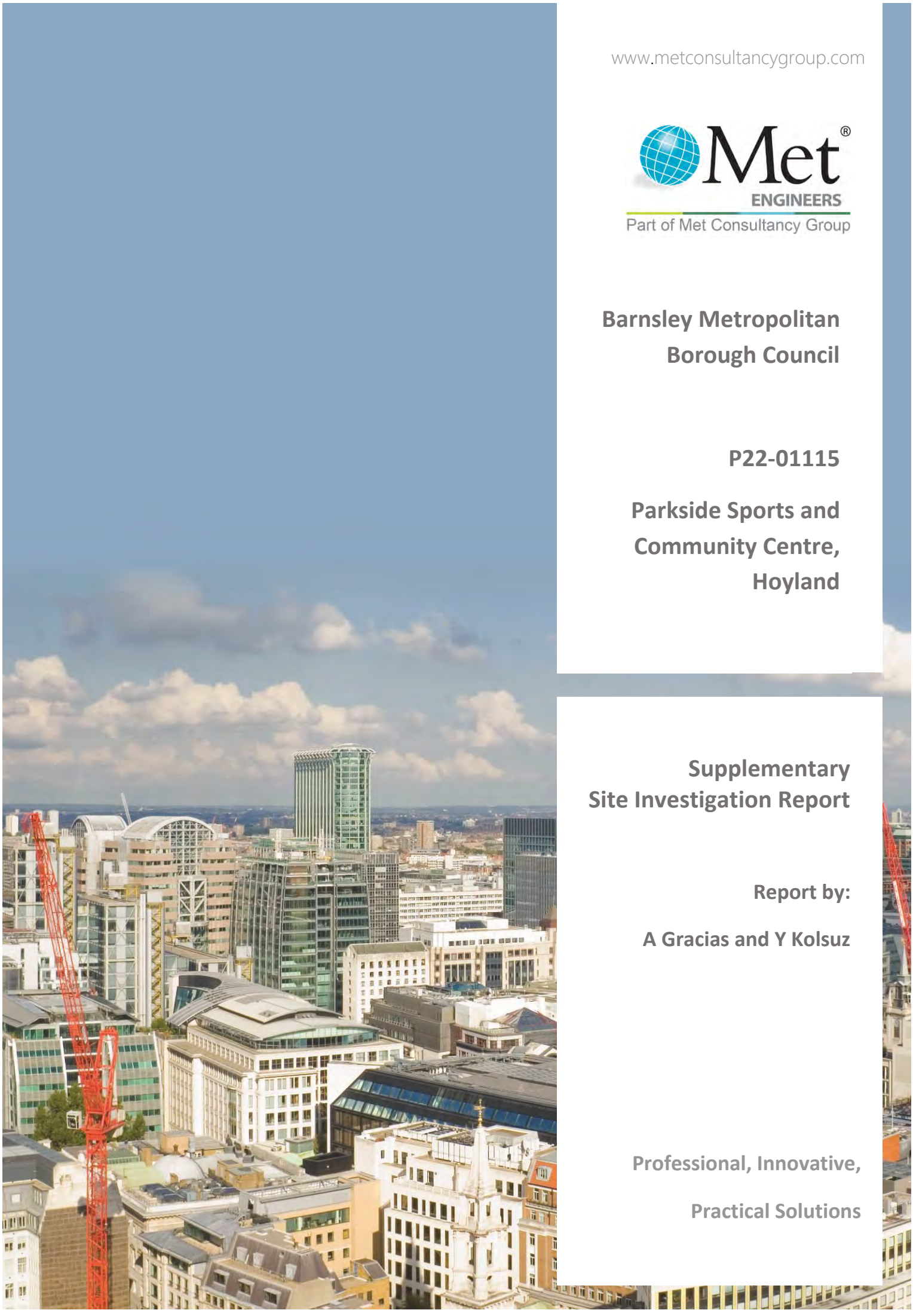

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Barnsley Metropolitan Borough Council

P22-01115

Parkside Sports and Community Centre, Hoyland

Supplementary Site Investigation Report

Report by:

A Gracias and Y Kolsuz

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CONTENTS

1. REVISION RECORD

Report Ref: P22-01115-Met-RP-GE-001 / Phase II Site Investigation Report					
Rev	**Description**	**Date**	**Originator**	**Checked**	**Approved**
1	Interim Report	10/02/2023	A Gracias/ Y Kolsuz	TAW	IFL

Prepared For:	**Prepared By:**
Barnsley Metropolitan Borough Council Place Directorate Gateway Barnsley MBC South Yorkshire S70 9GG	**Met Engineers Ltd** Southgate House Pontefract Road Leeds West Yorkshire LS10 1SW

2. INTRODUCTION

2.1. GENERAL INTRODUCTION

This report presents the findings of a phase II site investigation report of a site between Sheffield Road and Stead Lane, Hoyland, Barnsley, South Yorkshire, S74 0AH (Grid Reference: 436069, 399771) for Barnsley Metropolitan Borough Council.

The phase II site investigation comprised windowless sampler boreholes, a cable percussion borehole, and trial pits to establish the sub-surface strata and remove samples for geotechnical testing. The test results combined with the findings of the intrusions will then be used to make recommendations for the foundations of the proposed development. In addition, this report will confirm any remedial works which may be necessary with respect to land gas. A site plan including positions of the boreholes and trial pits can be found in appendix I of this report.

This report should be read in conjunction with the previous reports for the site:

- Desk Study and Phase I Coal Mining Risk Assessment – Applied Geology Limited, dated 24th August 2020 (ref. HOY-AG-VGT-XX-RP-CE-AG3080D-20-AK84)
- Ground Investigation Report – Applied Geology Limited, dated 13th November 2020 (ref. HOY-AG-VGT-XX-RP-CE-AG3080D-20-AL24)

2.2. OBJECTIVES

The intrusive investigation was conducted to assess and confirm the immediate sub-surface ground conditions and extract in-situ soil samples for laboratory testing, in order to determine the geotechnical constraints of the proposed development. In addition, the investigation included gas monitoring to determine whether gas protection measures are required for the proposed development.

2.3. SCOPE OF WORKS

This report comprises the results of a geotechnical ground investigation, and the results of land gas monitoring, with the aim of making foundation recommendations for the proposed development and confirming any potential remedial works required with respect to land gas.

It is understood that during the previous site investigation undertaken by Applied Geology Limited, no elevated concentrations of contaminants were identified, and as such no contamination testing for soil-based contaminants has been carried out as part of this report.

Judgement is based strictly on the findings of the specific boreholes, trial pits and soil samples tested and therefore may not be representative of the site as a whole. The findings of the intrusive investigation will also be used in conjunction with the findings of the previous reports to establish parameters which may be used in formulating a foundation design.

2.4. LIMITATIONS OF THE REPORT

Barnsley Metropolitan Borough Council (the client) has requested that a supplementary ground investigation, CLEA conceptual model and risk assessment be undertaken in order to assess the

suitability of the site for redevelopment. The report is not a comprehensive site characterisation and should not be construed as such.

This report has been prepared for the sole internal use and reliance of Barnsley Metropolitan Borough Council. The report shall not be relied upon or transferred to any other parties without the express written authority of Met Engineers. If any unauthorised third party comes into possession of the report, they rely on it at their own risk and Met Engineers owes them no duty of care.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report and which Met Engineers, believes are reliable. Nevertheless, Met Engineers, cannot and does not guarantee the authenticity or reliability of the information it has relied upon. The information contained in this report is to the best of our knowledge accurate at the date of issue, however, sub-surface conditions, including ground water levels, and may vary over time.

It is possible that the third-party information obtained may not include information from every available source. Assuming such further information sources actually exist, these have not been considered in the formulation of these findings and opinions.

In preparing this report it has been assumed that all past and present occupants and third parties have provided accurate information, especially relating to known or potential hazards. This report does not identify deficiencies or mistakes in the information provided by the user or owner, or from any other source, except where obvious in light of other information. This report is relevant at the date the report was written and should be read in light of any subsequent changes in legislation, statutory requirement or industry practices. The report represents the technical findings and opinions of Met Engineers, and does not constitute any legal advice. As such, the advice of a solicitor may also be required.

3. SITE HISTORY AND ENVIRONMENTAL SETTING

A detailed review of the published history, hydrological, geological and available environmental information was carried out by Applied Geology in a Desk Study and Phase I Coal Mining Risk Assessment (ref. HOY-AG-VGT-XX-RP-CE-AG3080D-20-AK84) dated 24th August 2020. The following is a brief summary of those findings.

The previous reports covered the wider site in its entirety, but this report focuses on the proposed development area alone, which is located in the north west and west of the site. The proposed development area is referred to as 'the site' within this document, with the exceptions of sections 3.2-3.5, and is indicated in appendix I.

3.1. SITE DESCRIPTION

Site Name	Land between Sheffield Road and Stead Lane, Hoyland, Barnsley, South Yorkshire, S74 0AH.
Location	Grid Reference: 436069, 399771
Setting	The site is located approximately 1.4km south west of Hoyland town centre, approximately 6.5km south of Barnsley town centre. and covers an area of land between Sheffield Road and Stead Lane. It is accessed via a padlocked double gate in the north west of the site off Sheffield Road. At the time of the site investigation works carried out in December 2022 and January 2023, the site comprised undeveloped land with grass cover. The perimeter of the site is bound by a mixture of wooden and mesh wire fencing to the north, mesh wire fencing to the west, and open land continuing to sports pitches to the east and south. The site generally slopes down to the south east, and a steep embankment down to the north east is recorded along the eastern site boundary. Trees were observed adjacent to the north of the site. Adjacent land uses include residential housing to the north, Sheffield Road to the west, and undeveloped and to the east and south. In the wider surrounding area, there is residential housing to the north, north west, and east, agricultural land to the east, south east and south, and commercial land use to the west.
Site History	The historical review from the phase I report shows the site to have comprised fields since at least 1850, with opencast mining marked south east of the wider site area during the mid-20th century. The opencast pits have since been backfilled and the land restored back to fields. The surrounding area has remained predominantly agricultural, with numerous former ironstone pits southwest of the site and coal mining and brick works some distance east and southeast of the site. Residential development of Hoyland Common has extended up to the north eastern and north western site boundaries.

Development Proposal	The proposal for the development area includes a community building and associated car parking areas in the north western, central and southern areas. A proposed layout plan is included in appendix VIII.

3.2. GEOLOGY AND SOILS

Geology	Artificial Ground – The Groundsure report identifies infilled ground covering the majority of the site, with additional areas of infilled ground in the surrounding area from 51m south west and 119m west of the site. Superficial Deposits – The Groundsure report does not identify superficial deposits underlying the site or surrounding area. Bedrock Geology – The Groundsure report identifies mudstone, siltstone and sandstone of the Pennine Middle Coal Measures Formation underlying the site and surrounding area. Faults – The Groundsure report identifies 5№ faults within 250m of the site. The nearest is an inferred normal fault present on site. Coal Outcrops – The Coal report identifies 13№ coal seams outcropping within 250m of the site, 5№ of which are present on site (3№ are observed, 2№ are inferred).
Radon	The Groundsure report, which sources information on radon affected areas from the BGS/Public Health England, identifies the western part of the site to be in an area where <1% of properties are above the Action Level and the remainder of the site to be within an area where between 1% and 3% of properties are above the Action Level. Therefore, no precautions against ingress of radon into buildings are considered necessary.
Ground Workings	The Groundsure report identifies numerous ground workings in the vicinity of the site. The nearest of these are recorded as opencast mining across the site. Other workings in the area include pits and heaps associated with Swallow Wood Mine, which undertook underground workings of ironstone.

Mining	The Groundsure report identifies historic opencast mining on site, and numerous historic underground workings within 1km of the site, predominantly for ironstone and coal. The closest workings are recorded to be ironstone pits located from 45m south west of the site. In addition, the site is located within a coal mining reporting area and a development high risk area which is understood to relate to the opencast coal workings. The Consultants Coal Mining Report appended to the phase I report records the underground mining of 16№ coal seams beneath the site at top depths of between 38mbgl and 306mbgl. Mine abandonment plans for the coal seam identified at 38mbgl depth (the Swallow Wood Coal seam) show workings beneath the eastern part of the wider site, but not beneath the development area which this report encompasses. The coal authority interactive map does not identify the site as within an area of probably shallow depth underground workings.
Natural Ground Subsidence	Shrink-Swell Clay – The Groundsure report identifies the hazard rating on site as very low. Ground conditions predominantly non-plastic. Landslides – The Groundsure report identifies the hazard rating on site as very low. Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered. Soluble Rocks – The Groundsure report identifies the hazard rating on site as negligible. Soluble rocks are either not thought to be present within the ground, or not prone to dissolution. Dissolution features are unlikely to be present. Compressible Deposits – The Groundsure report identifies the maximum hazard rating on site as **MODERATE.** Compressibility and uneven settlement hazards are probably present. Land use should consider specifically the compressibility and variability of the site. Collapsible Deposits – The Groundsure report identifies the hazard rating on site as very low. Deposits with potential to collapse when loaded and saturated are unlikely to be present. Running Sands – The Groundsure report identifies the maximum hazard rating on site as very low. Running sand conditions are unlikely. No identified constraints on land use due to running conditions unless water table rises rapidly.

Boreholes	The phase I report states that Applied Geology carried out a ground investigation on the opposite side of Sheffield Road for the proposed Hoyland West development, which included areas both within and outside former opencast areas. The closest exploratory holes were approximately 30m south west of the site and encountered topsoil or possible made ground to depths of between 0.40mbgl and 0.45mbgl, underlain by weathered Pennine Middle Coal Measures Formation, comprising firm to very stiff silty clay/clay, to depths of between 1.00mbgl and 3.20mbgl. These were located outside the former opencast area to the west of Sheffield Road.

3.3. ENVIRONMENTAL OVERVIEW

Historical Land Use	The historical review from the phase I report shows the site comprised fields since at least 1850, with opencast mining marked south east of the site during the mid-20th century. The opencast pits have since been backfilled and the land restored back to fields. The surrounding area has remained predominantly agricultural, with numerous former ironstone pits located south west of the site and coal mining and brick works some distance east and south east of the site. Residential development of Hoyland Common has extended up to the north eastern and north western site boundaries.
Current Land Use	There are two relevant current industrial land uses identified by the Groundsure report within 250m of the site, recorded to be electricity substations located from 75m north and 125m north west of the site.
Environmental Permits	The Groundsure report does not identify any environmental permits within 250m of the site.
Pollution Incidents	There is 1№ recorded pollution incident within 250m of the site, which occurred from 175m south west in 07/07/2003. This involved unidentified oils, resulting in minor impact (category 3) on land and water, and no impact (category 4) on air.
Landfill Sites	The phase I report indicates that there are no recorded historical landfill or waste sites within 250m of the site. It should be noted that the Groundsure report and mine abandonment plans identify former opencast pits on site, and geological maps show that most of the site comprises infilled ground. There are no recorded active landfill sites within 250m of the site.
Waste Transfer and Processing Stations	The Groundsure report does not identify any waste transfer and processing stations within 250m of the site.

Hydrogeology	There is a Secondary A aquifer within the bedrock. The site is not within a source protection zone. There are no ground water abstractions within the vicinity of the site.
Hydrology	The Groundsure report records the closest watercourse to the site as a stream, located from approximately 7m north east on the opposite side of Stead Lane. There are no surface water abstractions or licensed discharge consents to controlled waters within 500m of the site.
Flooding	There is no recorded risk of flooding from rivers and the sea (RoFRaS) on the site. The highest risk of groundwater flooding on-site and within 50m is recorded to be negligible. However, in the north east of the site the highest risk of surface water flooding is recorded to be a 1 in 30-year rainfall event with a modelled flood depth of between 0.1m-0.3m.
Unexploded Ordnance	The phase I report indicates that the site is in a low-risk area with regards to unexploded ordnance.
Environmental Sensitivity	The site is not located within a nitrate vulnerable zone. The site is not within an environmentally sensitive area.

3.4. DESK STUDY AND PHASE I COAL MINING RISK ASSESSMENT – APPLIED GEOLOGY LIMITED, 24TH AUGUST 2020 (REF. HOY-AG-VGT-XX-RP-CE-AG3080D-20-AK84)

The phase I desk study recommended that a ground investigation be undertaken to confirm the on-site ground conditions, validate the conceptual site model, locate the highwalls associated with the former opencast pits on site, and confirm the ground conditions outside the opencast boundary.

The report recommended that a number of trial pits and windowless sampler boreholes be undertaken to achieve these aims, with contamination testing to appropriately classify the materials, and a suite of geotechnical testing.

3.5. GROUND INVESTIGATION REPORT – APPLIED GEOLOGY LIMITED, 13TH NOVEMBER 2020 (REF. HOY-AG-VGT-RP-CE-AG308D-20-AL24)

A site investigation was undertaken at the site by Applied Geology Ltd between 21st September 2020 and 24th September 2020 in order to determine ground conditions at the site. At the time of the report, the development proposals for the site comprised sports pitches, temporary car parking, a temporary container pod for changing facilities, and a possible attenuation pond in the south east. The investigation comprised 15№ trial pits excavated to depths of between 1.00mbgl (TP1412A) and 4.60mbgl (TP1409), with soakaway testing in 3№ locations (TP1404, TP1414, and TP1415), 7№ trenches to investigate the opencast boundary which were excavated to depths of between

0.90mbgl (TT2101) and 2.50mbgl (TT2106B), 14№ cone penetration tests, and 10№ driven continuous sampling boreholes drilled to depths of between 1.93mbgl (DCS6102) and 5.45mbgl (DCS6104-DCS6110). The locations of these intrusive locations are provided in appendix A of the report.

Gas monitoring wells were installed within the 6№ boreholes for gas monitoring purposes, which was undertaken over 4№ return visits to the site at roughly weekly intervals, from 30th September 2020 to 23rd October 2020. Within the installation locations, methane concentrations were recorded to be below the level of detection (0.1%). It was noted that within the area of opencast backfill, carbon dioxide concentrations were recorded to be between 0.1% and 8.9%. In addition, oxygen concentrations ranged from between 6.5% (depleted) and 21.8%. A maximum flow rate of 0.1l/hr was recorded.

Reworked topsoil generally comprising slightly gravelly clay with frequent rootlets was identified across the whole site to depths of between 0.20mbgl and 0.35mbgl, with an average thickness of 0.30m. A thin layer of made ground, described as reworked natural material derived from the opencast mining, was recorded to depths of between 0.50mbgl and 0.75mbgl in the area of the western opencast highwall. This material generally comprised sandy gravelly clay with rare cobbles of mudstone and siltstone.

The opencast backfill material was identified in the general area of the opencast workings as shown on the abandonment plans provided within the initial phase I report. This material generally comprised gravelly clay with occasional to frequent cobbles of mudstone, siltstone, and locally ironstone, and the report interprets this as reworked natural coal measures. The backfill material was proven to a depth of 5.45mbgl, the depth at which the boreholes terminated.

Around the perimeter of the site, strata of the Pennine Middle Coal Measures Formation were encountered at top depths of between 0.9mbgl and 3.0mbgl. In the west of the site, the proposed development area, where opencast materials were absent, a weathered upper layer was present to a general depth of 2.00mbgl, comprising slightly sandy clay with occasional becoming frequent graces of mudstone, siltstone, and locally coal. Rock strength horizons were identified beneath the weathered clay. In the east of the site, weathered bedrock comprising very weak siltstone with locally thin bands of clay and ironstone nodules were encountered below the reworked topsoil.

A coal seam was identified in the north east of the site, within trial pit TP1401, at depths of between 2.30mbgl and 2.70mbgl.

During the works, no groundwater was encountered in any of the locations.

18№ soil samples were submitted for laboratory analysis for contamination testing, including testing for heavy metals, PAH, pH and SOM, and 4№ leachate soil suites were undertaken for heavy metals, PAH and pH. In addition, 2№ topsoil samples were submitted for pesticide screening tests. The test results were screened against a public open space (parks) land use assuming 2.5% SOM for all soils, and no exceedances for the contaminants tested for were identified.

A suite of geotechnical testing was undertaken on soil and rock samples, including the following:

- Natural moisture content tests

- Atterberg limit tests
- Particle size distribution tests
- Compaction tests
- Particle density tests
- Remoulded CBR tests
- Unconsolidated undrained triaxial tests
- Shear strength by direct shear tests
- One-dimensional consolidation tests
- BRE “special digest 1 suites

4. INTRUSIVE INVESTIGATION

4.1. FIELDWORK

The intrusive investigation comprised 1№ cable percussion borehole, 5№ windowless sampler boreholes, and 6№ trial pits excavated by JCB. The cable percussion borehole and trial pits were carried out on 16th December 2022, and the windowless sampler boreholes were carried out on 20th January 2023; the locations of which can be found on the plan provided within appendix I. The intrusions specifically targeted the area of the proposed building and the approximate location of the opencast mining highwall, which overlaps the footprint of the proposed building, to give a good overview of the underlying strata, and further delineate the extents of the opencast workings. The weather was clear and snow.

It should be noted that a number of the trial pits were backfilled due to unstable trial pit sides as a result of backfilled material associated with the historical opencast mining. The windowless sampler boreholes, with the exception of WS02 and WS05, were terminated due to refusals on cobbles/boulders associated with the historical opencast mining backfill.

Grass overlying topsoil comprising soft slightly sandy slightly gravelly clay was identified in all intrusive locations to depths of between 0.20mbgl (WS04) to 0.50mbgl (WS01, WS03 and TP06). Made ground was identified in all trial pit locations (with the exception of TP03 to depths of between 0.80mbgl (TP05) and 1.20mbgl (TP06), and generally comprised silty sandy gravelly clay with a moderate cobble/boulder content and anthropogenic materials recorded including fragments of plastic wood, brick, rope, and ceramic.

Reworked ground and opencast fill material comprising sand, gravel and clay with grey cobbles and boulders to depths ranging from 0.80mbgl (WS05) to 8.00mbgl (CP01).

No superficial deposits were recorded during the site investigation. Grey silty sandy gravelly clay deposits were identified under the northern and western areas of the site with typical thicknesses ranging between 0.80m (WS05) and 2.50m (TP03). This is interpreted as probably completely weathered bedrock.

Bedrock was deepest beneath the south east of the proposed building, in the area of the opencast workings. The cable percussion borehole in this area identified bedrock at a top depth of 8.00mbgl.

In the area of the opencast workings (the extents of which are marked on the plan provided in appendix I), stepped bedrock was identified in the northern extents of TP05 at a top depth of 3.00mbgl, and potentially in the western extents of TP06 at a top depth of 1.20mbgl. Windowless sampler boreholes WS01 and WS03 in this area terminated on cobbles/boulders associated with the opencast workings and were not able to prove bedrock depth.

Outside of the recorded opencast workings, bedrock was identified at top depths of between 1.90mbgl (WS02) and 3.20mbgl (TP01 and TP02).

Logs of the windowless sampler boreholes, cable percussion borehole, and trial pits can be found in appendix II, III and IV of this report respectively.

Soil samples were removed for geotechnical laboratory analysis from 5№ intrusive locations, CP01, TP01, WS02, WS04 and WS05.

4.2. GROUNDWATER

During the site investigation works, a small amount of perched groundwater was encountered at a depth of 1.0mbgl within WS04. Ground water levels were monitored during gas monitoring rounds. The results of this are provided in section 5.4 of this report.

4.3. GAS MONITORING

Gas and groundwater monitoring equipment was installed in 3№ borehole positions (CP01, WS04 and WS05). Response zones were set from 1.0mbgl to 3.0mbgl in CP01, 1.0mbgl to 0.5mbgl in WS04, and 0.3mbgl to 1.8mbgl in WS05, in order to evaluate the combined gas risk from both the made ground at the surface as well as natural venting from the aquifer.

Monitoring was undertaken using a Geotech GA5000 portable gas analyser which is calibrated on a 6-monthly basis. UKAS calibration certificates can be provided on request. Monitoring is currently ongoing. The results of this monitoring will be presented as an amendment to this report.

VOC screening was carried out using a PID during all gas monitoring rounds. All results are provided in section 5.4.

4.4. LABORATORY TESTING

Samples were obtained during the site investigation and tested at a UKAS accredited laboratory for contaminants including:

- *pH*
- *Water soluble sulphate (2:1)*
- *Atterberg limits*
- *Particle size distribution*

5. CONTAMINATION ASSESSMENT

5.1. GENERAL

Current environmental legislation, in particular Part IIA of the Environmental Protection Act 1990, adopts a risk-based approach to the evaluation of contaminated sites, based on the proposed end use of the site. The commonly accepted approach is to adopt a source-pathway-receptor model where the source of the contaminant is examined in relation to potential receptors (i.e. humans, controlled waters etc.) to determine if there is a pathway (i.e. contaminant linkage) connecting them. If any of these elements (i.e., contaminant, pathway or receptor) are absent or removed, then the risk is considered negligible.

The Department of the Environment, Food and Rural Affairs (DEFRA) have published a series of guidelines in connection with risk assessment. In addition, the Environment Agency has produced the contaminated land exposure model (CLEA) which models guideline values for those elements which pose the greatest risk to human health.[1] Using values derived from CLEA, a site specific, conceptual model has been used to determine any significant contaminant linkages and identify suitable risk management proposals on which remediation design (if any required) can be based. The conceptual model is summarised at the end of this section in tabular form.

By considering the source-pathway-receptors model, an assessment can be made as to whether the source contamination can reach a receptor. The degree and significance of any resulting risk is then determined. The categorisation of the risk is based on consideration of both:

- The likelihood or probability of an event (taking into account both the presence of the source and the receptor, and the integrity of the pathway).
- The severity of the potential consequence (taking into account both the potential severity of the source and the sensitivity of the receptor).

The following categorisation of risk has been adopted in this report:

Very high	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High	Harm is likely to arise to a designated receptor from an identified hazard without appropriate remedial action.
Moderate	It is possible that, without appropriate remedial action, harm could arise to a designated receptor, but it is relatively unlikely that any such harm would be severe and, if harm were to occur, it is more likely that such harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that, at worst, this harm, if realised, would normally be mild.
Negligible	The presence of an identified hazard does not give rise to the potential to cause any significant harm to a designated receptor on this site.

[1] Updated technical background to the CLEA model, Science Report SC050021/SR3, The Environment Agency, 2009

5.2. PRELIMINARY CONCEPTUAL SITE MODEL

The following table provides a list of the potential sources, pathways and receptors that have potential to exist on this site. These have been determined based on the previous phase I report and initial phase II site investigation works, and the latest development proposals.

Potential Source	Contaminants	Receptor	Pathway	Potential Risk
Soil based contaminants (solid)	Heavy metals PAH TPH	Construction workers	Direct contact with soil Ingestion of soils Inhalation of soil dust Inhalation of vapours (PAH and TPH only)	Low
		Maintenance workers End users	Direct contact with soil Ingestion of soils Inhalation of soil dust Inhalation of vapours (PAH and TPH only)	Low
		Off-site residents	Inhalation of soil dust Inhalation of vapours (PAH and TPH only)	Low
		Flora and fauna	Plant uptake	Low
		Buildings and infrastructure	Direct contact with soil	Low
Soil based contaminants (as leachate)	Heavy metals PAH TPH	Flora and fauna	Plant uptake	Low
		Aquifer	Leaching and migration via groundwater	Low
Asbestos within made ground	Asbestos fibres	Construction workers Maintenance workers End users	Inhalation of asbestos fibres	Low
Elevated sulphates in backfill material, any spoil and natural soils on site		Buried concrete	Direct contact	Low
Land gas		Construction workers Maintenance workers End users	Inhalation of vapours	Moderate/High
Radon		Construction workers Maintenance workers End users	Inhalation of gases	Low

Based on the above conceptual site model, the following sources of contamination have been investigated during the supplementary site investigation works in the proposed development area;

- Volatile organic compounds
- Land gas

It is understood that the site has been remediated since the previous site investigation undertaken by Applied Geology Limited, and as such no contamination testing has been carried out as part of this report.

5.3. RESULTS OF VOC SCREENING

Volatile Organic Compounds

Location	TP01a	TP01b	CP01	CP01	WS02	WS02	WS04	WS05	
Depth (m)	1.00	1.00	1.00–2.00	0-0.40	1.20-1.65	1.50-2.00	0.80	1.50-2.00	
Strata	Made ground	Made ground	Made ground	Made ground	Made ground	Made ground	Made ground	Made ground	
Contaminant (ppm)									**Number Exceeding**
VOCs	0	0	0	0	0	0	0	0	0

5.4. RADON AND LAND GAS

Based on the Groundsure report, within the proposed development area <1% of properties in the area are above the radon action level. Therefore, radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.

Results

Date	BH Number	CH_4 (%)	CO_2 (%)	O_2 (%)	Atmos. Pres.(mb)	Press. Trend (24hrs)	Flow (l/h)	Water (mbgl)	Base Depth (mbgl)	PID PPM
02.02.23	CP01	0	0.1	21.1	1008	↓	-0.1	Dry	3.0	0
	WS04	0	0.1	21.7	1008	↓	-0.6	0.6	1.0	0
	WS05	0	3.2	17.7	1008	↓	-0.1	Dry	1.8	0

Analysis

Instead of monitoring on predetermined dates to a set schedule, it is best practice to gas monitor on occasions where the 'worst-case' scenario is likely to occur. Generally, this is determined to be when sharp falls of atmospheric pressure occur or when low atmospheric pressures are recorded, (below 1000mb). Thus, the remaining gas results will be collected in periods of high to low falling pressure as well as low pressure.

One round of monitoring has been undertaken to date. Five further rounds of monitoring are proposed.

During the first round of monitoring, the maximum concentrations of CH_4 and CO_2 recorded were 0% and 3.2% respectively. The maximum flow rate recorded across the site is considered 0l/h as no positive flow rates were observed. Therefore, the gas screening values (GSVs) for both methane and carbon dioxide are 0l/h and 0l/h respectively. It should be noted that monitoring is still on-going and the above results are to be considered as **PRELIMINARY**, to be confirmed on completion of the monitoring.

5.5. CONTAMINATION SOURCES

It is understood that no elevated concentrations of contaminants were identified during the previous site investigation undertaken by Applied Geology Limited, when screened against intervention values with a "Public open space" end use in mind, and 2.5% SOM.

Based on the above, no contamination testing of soils has been carried out as part of this report. However, as a permanent new building is now proposed as part of the development, Met Engineers feel is it prudent to carry out additional gas monitoring at the site, to confirm whether gas protection measures are required for the proposed development.

Source	Elevated Levels Present?
Heavy metals	No elevated levels identified during previous ground investigation.
Polycyclic aromatic hydrocarbons	No elevated levels identified during previous ground investigation.
Total petroleum hydrocarbons	No elevated levels identified during previous ground investigation.
Asbestos	No elevated levels identified during previous ground investigation.
Land gas	**TBC**
Radon	No
Volatile organic compounds	No

5.6. PATHWAYS

Based on the proposed land use, the possible pathways that exist on site for any possible source of contamination are as follows:

Pathway	Pathway Present	Comments
a- Direct contact with soil or water	Yes	Potential for contact with soil or water during future landscaping and development works.
b- Incidental ingestion	Yes	Potential for ingestion of soils or water during future landscaping and development works.
c- Inhalation of soil dust or asbestos fibres	Yes	Potential for inhalation of soil dust or asbestos during future landscaping and development works and ground disturbance.
d- Leaching and migration of liquids	Yes	Potential for leaching to aquifer as the site with existing soft, vegetative cover.
e- Surface water run-off	No	Wider site area will be covered in vegetation, increasing infiltration.
f- Migration, emission, accumulation and inhalation of land gas or vapours	Yes	Migration and emission of land gas or vapours possible within proposed on site building.
g- Plant uptake or plant uptake followed by ingestion	Yes	Some soft landscaping to be retained within the proposed development area, with existing soft landscaping across the wider site area. However, potential for uptake reduced due to land use.

5.7. RECEPTORS

Based on the identified sources of contamination, and the present pathways, the potential receptors for the development are:

Receptor	Receptor Present	Comments
A- Site worker	Yes	Staff involved in construction works and underground utility works at the site.
B- Maintenance staff	Yes	Carrying out routine maintenance in the future. This assumes workers will visit the site on an infrequent basis and will not carry out intrusive works.
C- Long term site user or future resident	Yes	Long term site users.
D- Off-site resident	Yes	Residential housing located adjacent to the north of the site, and is present in the wider surrounding area.

Receptor	Receptor Present	Comments
E- Flora and fauna	Yes	Flora on retained soft landscaped areas.
F- Aquifer	Yes	Bedrock is a secondary A aquifer, however there are no groundwater abstractions or source protection zones in the vicinity of the site.
G- Surface water	No	No surface water feature within the vicinity of the site.
H- Buildings and infrastructure	Yes	Building substructure, services, drainage etc.

5.8. CONCEPTUAL SITE MODEL

Source	Contaminant	Receptor	Pathway	Risk
Soil based contaminants (solid)	Heavy metals	**A – Construction workers[1]** **B – Maintenance workers[1]** **C – Future end users[1]** **D – Off-site residents[1]** **E – Flora and fauna[1]** **F – Aquifer[1]** **H – Buildings and Infrastructure[1]**	**a – Direct contact with soil or water[1]** **b – Incidental ingestion[1]** **c – Inhalation of soil dust or asbestos fibres[1]** **d – Leaching and migration[1]** *e – Surface water run off[2]* **g – Plant uptake/ plant uptake followed by ingestion[1]**	No elevated levels identified during previous ground investigation*
	Polycyclic aromatic hydrocarbons	**A – Construction workers[1]** **B – Maintenance workers[1]** **C – Future end users[1]** **D – Off-site residents[1]** **E – Flora and fauna[1]** **F – Aquifer[1]** **H – Buildings and Infrastructure[1]**	**a – Direct contact with soil or water[1]** **b – Incidental ingestion[1]** **c – Inhalation of soil dust or asbestos fibres[1]** **d – Leaching and migration[1]** *e – Surface water run off[2]* **f – Migration, emission, inhalation of land gas or vapours[1]** **g – Plant uptake or plant uptake followed by ingestion[1]**	No elevated levels identified during previous ground investigation*
	Total petroleum hydrocarbons	**A – Construction workers[1]** **B – Maintenance workers[1]** **C – Future end users[1]** **D – Off-site residents[1]** **E – Flora and fauna[1]** **F – Aquifer[1]** **H – Buildings and Infrastructure[1]**	**a – Direct contact with soil or water[1]** **b – Incidental ingestion[1]** **c – Inhalation of soil dust or asbestos fibres[1]** **d – Leaching and migration[1]** *e – Surface water run off[2]* **f – Migration, emission, inhalation of land gas or vapours[1]** **g – Plant uptake or plant uptake followed by ingestion[1]**	No elevated levels identified during previous ground investigation*
Asbestos in made ground	Asbestos fibres	**A – Construction workers[1]** **B – Maintenance workers[1]** **C – Future end users[1]** **D – Off-site residents[1]**	**c – Inhalation of soil dust or asbestos fibres[1]**	No elevated levels identified during previous ground investigation*
Land gas		**C – Future end users[1]**	**f – Migration, emission, inhalation of land gas or vapours[1]**	**TBC**
Radon[2]		**C – Future end users[1]**	**f – Migration, emission, inhalation of land gas or vapours[1]**	Negligible
Volatile organic compounds[2]		**C – Future end users[1]** **H – Buildings and infrastructure[1]**	**a – Direct contact with soil or water[1]** **f – Migration, emission, inhalation of land gas or vapours[1]**	Negligible

[1] Source/ pathway/ receptor PRESENT on site

[2]*Source/ pathway/ receptor NOT PRESENT on site*

*No elevated concentrations of contaminants were identified during the previous site investigation undertaken by Applied Geology Limited, and as such no contamination testing for soil-based contaminants has been carried out as part of this report.

5.9. CONTAMINATION ISSUES

No elevated concentrations of contaminants were identified during the previous site investigation undertaken by Applied Geology Limited, and as such no contamination testing for soil-based contaminants has been carried out as part of this report.

Gas monitoring is currently ongoing, and the results will be present as an amendment to this report.

5.10. ENVIRONMENTAL SUMMARY

A site induction and appropriate PPE should mitigate any residual risk towards construction workers.

Gas monitoring is currently ongoing, and the results will be present as an amendment to this report.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the engineer immediately prior to commencing any further works.

6. GEOTECHNICAL ASSESSMENT

6.1. GENERAL

The site investigation was required to make recommendations as to a suitable foundation solution for the development. To achieve this aim, 6№ trial pits were excavated to depths of between 2.70mbgl (TP04) and 3.90mbgl (TP05), 5№ windowless sampler boreholes to depths of between 1.00mbgl (WS01 and WS04) and 2.00mbgl (WS02), and a cable percussion borehole to a depth of 8.10mbgl (CP01).

6.2. GEOLOGICAL ASSESSMENT

Artificial Deposits

Grass overlying topsoil comprising soft slightly sandy slightly gravelly clay was identified in all intrusive locations to depths of between 0.20mbgl (WS04) to 0.50mbgl (WS01, WS03 and TP06). Made ground was identified in all trial pit locations (with the exception of TP03 to depths of between 0.80mbgl (TP05) and 1.20mbgl (TP06), and generally comprised silty sandy gravelly clay with a moderate cobble/boulder content and anthropogenic materials recorded including fragments of plastic wood, brick, rope, and ceramic.

Reworked ground and opencast fill material comprising generally loose sand, gravel and clay with sandstone, siltstone and mudstone cobbles and boulders up to 2.2m across, was identified to depths ranging from 0.80mbgl (WS05) to 8.00mbgl (CP01).

Superficial Deposits

No superficial deposits were identified during the site investigation.

Bedrock

Bedrock was deepest beneath the south eastern corner of the proposed building, in the area of the deeper opencast workings. The cable percussion borehole in this area identified bedrock at a top depth of 8.00mbgl.

In the area of shallow workings (the extents of which are marked in green on the plan provided in appendix I), stepped bedrock was identified in the northern extents of TP05 at a top depth of 3.00mbgl, and potentially in the western extents of TP06 at a top depth of 1.20mbgl. Windowless sampler boreholes in WS01 and WS03 in this area terminated on cobbles/boulders associated with the opencast workings and were not able to prove bedrock depth.

Outside of the recorded opencast workings, bedrock was identified at top depths of between 1.90mbgl (WS02) and 3.20mbgl (TP01 and TP02).

6.3. MINING

Backfilled material associated with the historical opencast workings was identified across the site, comprising grey cobbles and boulders in a clayey sand and gravelly matrix, and were recorded to depths ranging from between 2.8mbgl (TP06) and 8.0mbgl (CP01).

Red lines on the site investigation location plan provided in appendix I denote the observed locations of the highwall beneath the proposed development area. It should be noted that the trial pit sides were unstable during the site investigation works due to the nature of the backfill materials, which restricted efforts to identify the extents of the highwall, however, the locations recorded align with those identified in the previous investigation by Applied Geology Limited.

The consultants coal mining report provided within the phase I desk study and coal mining risk assessment identify a coal seam (the Swallow Wood Coal seam) present at 38mbgl depth beneath the site, however, mine abandonment plans also provided within the desk study show workings within this coal seam beneath the wider site area at a depth of 24.43mbgl.

There are no records of the Shallow Wood Coal Seam having been worked beneath the building development area, however should unrecorded workings have taken place, it is determined that sufficient rock cover exists that the risk to the proposed development is negligible. Based on an assumed maximum piled length of 10m in the south eastern corner of the proposed building, there is approximately 14.23m of solid rock above the recorded depth to the Shallow Wood Coal seam within the adjacent opencast workings. Based on an assumed maximum extraction thickness of 106cm, as noted in the consultants coal mining report, a void to rock cover ratio of 1:13.42 has been calculated should unrecorded workings be present.

Based on the above, it is determined that the risk to the proposed development as a result of the migration of crown holes as a result of unrecorded shallow depth coal mining is low. However, should evidence of unrecorded shallow depth coal mining beneath the site be uncovered during supplementary investigation works, remedial measures may be required.

6.4. FOUNDATIONS AND SUBSTRUCTURES

Based on the building location shown in appendix 1, and geological conditions found below the site, a combination of trench filled foundations to depths of between approximately 1.8m and 3.2mbgl in areas outside the opencast workings, and piled foundations with ground beams within the area of opencast workings, are deemed suitable for the proposed development.

The foundations should be designed in conjunction with a piling specialist, and it is recommended that additional ground investigation works in the form of rotary cored boreholes be undertaken to assist with the design.

It should be noted that the opencast backfill material identified across the site is relatively loose, with large cobbles and boulders (up to 2.2m across) and as such, allowances should be made for how the trench filled foundations will be installed avoiding collapse of the excavations.

6.5. GEOTECHNICAL TEST RESULTS

Soil samples were taken from site and submitted for the following geotechnical testing.

Location	TP01a	TP01b	CP01	CP01	WS02	WS02	WS04	WS05
Depth (m)	1.0m	1.0m	1 – 2m	0m	1.20-1.65m	1.5-2m	0.8m	1.5-2m
pH	8.16	4.86	8.30	-	5.97	-	8.75	5.45
SO_4 (2:1) g/l	0.04	0.03	0.01	-	0.07	-	0.02	0.02
SO_4 (acid sol) mg/kg	320	250	-	-	390	-	340	<200

Location	TP01a	TP01b	CP01	CP01	WS02	WS02	WS04	WS05
Depth (m)	1.0m	1.0m	1 – 2m	0m	1.20-1.65m	1.5-2m	0.8m	1.5-2m
Plasticity index	19	25	-	19	-	20	-	-
% <425µm	73	100	-	93	-	94	-	-
Modified plasticity	14	25	-	18	-	19	-	-

Based on the soil sulphate concentrations and pH levels, AC-1s conditions exist for buried concrete in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.[2]

The plasticity index for the soils tested, have been modified as per chapter 4.2 of NHBC guidelines. The results show low to medium volume change soils exist on site. Foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.[3]

Particle size distribution testing has been carried out on the following samples:

- CP01, taken from depths of between 1.00mbgl and 2.00mbgl
- CP01, taken from depths of between 5.00mbgl and 6.00mbgl
- CP01, taken from depths of between 8.10mbgl and 9.00mbgl

The full geotechnical testing certificates are provided within appendix V of this report. In situ SPT results are provided in the windowless sampler borehole and cable percussion logs provided in appendices II and III respectively.

6.6. GROUND FLOOR CONSTRUCTION

Suspended ground floors are preferable for the ground floor of the development.

6.7. GEOTECHNICAL SUMMARY

A foundation solution combining trench filled foundations and piles with ground beams. Additional rotary coring should be undertaken to assist with the piling design.

The foundations should be founded onto the intact siltstone, mudstone or sandstone bedrock found under the site. The trench filled foundations should be taken through the overlying completely weathered bedrock.

Suspended ground floors are preferable for the proposed buildings.

Based on the soluble sulphate levels found, AC-1s conditions exist on site in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.

Low to medium volume change soils exist below the site. Foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the engineer immediately prior to commencing any further.

[2] BRE Special Digest 1, Concrete in Aggressive Ground, BRE Press, 2005
[3] NHBC Standards, Chapter 4.2 Building Near Trees, NHBC, 2014

7. CONCLUSIONS AND RECOMMENDATIONS

In conclusion:

- It is understood that no elevated concentrations of soil-based contaminants were identified during the previous site investigation undertaken by Applied Geology Limited, and as such no contamination testing has been carried out as part of this supplementary investigation.
- Gas monitoring is currently ongoing, and the results will be provided as an amendment to this report.
- The site is underlain by made ground and reworked opencast fill above various strata of the Pennine Middle Coal Measures.
- A combination of trench filled, and piled foundations with ground beams is recommended for the proposed development, along with a suspended ground floor.
- Based on the soluble sulphate levels found, AC-1s conditions exist on site in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.
- Low to medium volume change soils exist below the site. Foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.

Based on these findings, we recommend that the following should be undertaken:

- Additional site investigation works comprising rotary cored boreholes will be required in order to assist with the piled foundation design for the proposed development.