COAL MINING RISK ASSESSMENT

Proposed Residential Development,

Denby Lane, Grange Moor

Reference	**KR/CMRA/G23054**
Date	**November 23**
Client Name	**Yorkshire Country Properties**
Version	**1**

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CONFIDENTIALITY & LIMITATIONS STATEMENT

This report is addressed to and may be relied upon by the following:

Yorkshire Country Properties. Tandem Industrial Estate, Wakefield Road, Huddersfield. HD5 0AL.

This Coal Mining Risk Assessment (CMRA) report has been prepared for the sole use and reliance of the above-named parties. This report shall not be relied upon or transferred to any other parties without the express written authorisation of RWO Group. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

The CMRA includes an assessment of third party information which could include; site data provided by Landmark, the Coal Authority (CA) and the British Geological Survey (BGS) and others.

Where a site visit / walkover survey has been undertaken by RWO as part of this CMRA, RWO can only report features present at the site at the time of the visit. RWO cannot be held responsible for any feature/land use etc. associated with the site which may have been present either prior to or following the site visit. RWO cannot and does not guarantee the authenticity or reliability of third-party information it has relied upon.

This Report has been produced in general accordance with the current relevant guidance and practice as set out, on the Coal Authority website, within the Coal Authority Model Repot Template and, CIRIA C758 – Abandoned Mine Workings Manual - Contaminated land risk assessment. This report presents and interprets the factual information reviewed during this investigation and presents a CMRA in which coal mining related hazards and risks have been assessed.

It has been assumed in the production of this report that ground levels will not change significantly from existing. If this is not the case, then amendments to the recommendations made in this report may be required.

DOCUMENT HISTORY

VERSION	PURPOSE/DESCRIPTION	DATE
1	First Issue	16.November.2023

1.0 EXECUTIVE SUMMARY

The site is located off Denby Lane, Grange Moor, Wakefield, approximately 8km east of Huddersfield town centre (NGR SE 145165). The site occupies an area of 0.65 hectares (1.6 acres).

RWO were commissioned by Yorkshire Country Properties to provide a CMRA of the site to support a planning application. It is understood that the site is to be redeveloped with residential dwellings. RWO's investigation included a review of the site geology, coal mining data and a review of a previous GI report by others.

A summary of salient findings of the CMRA is provided in the table below.

Issue	Remarks
Site Location	Denby Lane, Grange Moor, Wakefield. WF4 4ED.
Site Feature	The site occupies an area of 0.65 hectares (1.6 acres). The site surfacing is a mix of overgrown grasses and semi mature to mature shrubs, there are several tree stumps visible where the tree has been felled. There are also a few stockpiles of wood chippings. There are 3 No. mine shafts, all of which are cordoned off with heras fencing. The whole of the site is surrounded by heras fencing with the access from Denby Lane down the track beside the houses.
Geology	Made ground recorded over the extent of the site between 2.00m and 6.10m depth underlain by residual weathered bedrock which becomes more competent with depth of Birstall Rock/Pennine Lower Coal Measures.
Summary of CA Consultants Report	The Consultants Report shows there are 7 No. coal seams recorded as been worked beneath the property from depths as shallow as 5 m bgl. It also indicates that there are probable unrecorded shallow workings beneath the site. 3 No. recorded mine shafts are present within the site.
Review of Abandonment Plans	Abandonment plans for the 2nd Brown Metal (obtained for the site by Lithos, as part of a previous report) show workings in the south-east of the site.
Previous Reports	The Lithos report identified shallow coal workings beneath the site in the 2nd Brown Metal. The 3rd Brown Metals was not encountered by Lithos down to c. 30m bgl, and it was assumed absent. The 3 No. mine entries were confirmed by Lithos as been present within the site, one shaft was capped off with a concrete cap and the other two were backfilled with a mix of ash and clinker.
CMRA	The site has been found to be at risk from shallow workings in the 2nd Brown Metal coal seams and 3 No. mine shafts. There is a possibility that further, previously unrecorded mine entries (shafts, bell pits, shallow crop workings) may be present on the site. Given the presence of shallow seams of worked coal and mine shafts, the site is considered at risk from hazardous ground gas.

Some further work is required to investigate the Coal Mining risk further, most notably the following;

- Drilling and Grout stabilisation of shallow coal workings in the 2nd Brown Metal across the site.
- Stabilisation and capping of the 3 No. mine shafts on site. Development standoff applied.
- A Mine Stabilisation Strategy for the above works.
- An awareness should be maintained and construction/site preparation works and any deeper areas of made ground or unidentified sub-surface feature investigated further by the geotechnical specialist.
- Undertaken a programme of rotary boreholes across the site to investigate the depth and condition of the Brown Metal coal seams;
- At this stage assume CS2 gas protection measures. Obtaining of and review of Lithos Gas risk assessment would be recommended prior to further assessment.

2.0 INTRODUCTION

RWO Associates Ltd (RWO) has been instructed by Yorkshire Country Properties (the Client) to prepare a Coal Mining Risk Assessment (CMRA) for land off Denby Lane, Grange Moor, near Wakefield (the Site) to support a planning application for a proposed residential development.

General notes and limitations relevant to CMRA's are described in the aforementioned limitations statement which should be read in conjunction with this report.

The primary objectives of this CMRA are to

- To present a desk-based review of all available information on the coal mining issues which are relevant to the Site;
- Use the information obtained from the desk-based review to identify and assess the risk to the proposed development from the coal mining legacy, including the cumulative impact of the identified mining issues;
- Set out appropriate mitigation measures to address the coal mining legacy issues affecting the Site, including any necessary intrusive ground investigation, remedial works and/or demonstrate how coal mining issues have influenced the proposed development; and
- Demonstrate to the Local Planning Authority that the Site is, or can be made, safe and stable to meet the requirements of national planning policy with regard to development on unstable land.

3.0 THE SITE

3.1 SITE LOCATION AND FEATURES

Information on the proposed development location is presented in the table below.

Detail	Remarks
Location	Denby Lane, Grange Moor, Wakefield.
Nearest Postcode	WF4 4ED.
National Grid Reference (NGR)	SE 145165
Site Area	0.65 (Ha)
Known services	No information has been provided. However, it is understood from previous works that underground sewers and drainage utilities are present beneath the site

The Site Location Plan is presented Figure 1 in Appendix A to this report, however an extract is also presented below.

Key

Site Location

The site is considered brownfield site due to its historical use as coal mine and quarry. The site is located at the edge of a residential village.

The site surfacing is a mix of overgrown grasses and semi mature to mature shrubs, there are several tree stumps visible where the tree have been cut down. The whole of the site is bounded by fencing with the access from Denby Lane down the track beside the houses. There is a public footpath running parallel with the eastern side of the site.

The site has an approximate area of 0.65 Ha.

The site is located in a predominantly residential/rural area with a number of residential properties to the south and the west.

A review of Google Earth information shows site levels generally fall in a southeasterly direction with levels varying between 231m on the northern boundary to 216m AOD to the southeast.

3.2 PROPOSED DEVELOPMENT

It is understood that the site is currently proposed for development with residential properties, comprising 10 No. dwellings, along with associated roads, drainage and site infrastructure.

A Proposed Development Plan, Figure 2, is presented in Appendix A.

3.3 SITE HISTORY

From 1854 until possibly 1918 the site was occupied by a sandstone quarry and a coal mine. Between 1919 and 1961 the site has filter beds present relating to sewage works. After this it remains relatively unchanged up until present day.

4.0 GEOLOGY

Sources of Information	BGS Online Geology of Britain viewer and BGS GeoIndex. BGS Lexicon of Named Rock Units. BGS 1:10,000 map SE21NW Coal Authority (CA) Interactive Map Viewer. CA Authority Consultant/CON29M Mining Report Ref: 51003385245001 dated 24th October 2023 Envirocheck Report, Ref. 321906427_1_1, dated 24th October 2023, enclosed within Appendix B.
Made Ground	It is considered that areas of made ground will be present on-site due to the previous quarry and coalmine and its associated buildings.
Superficial Geology	No superficial deposits are recorded beneath the site.
Solid Geology	Solid geology is Birstall Rock. These strata are described by the BGS as comprising "fine grained thickly bedded cross bedded sandstone with common pebbles of ironstone, coal sandstone and mudstone, and common streaks of shaly coal. These sandstones are a part of the Pennine Lower Coal Measures Formation The geological map shows the site to be underlain by the Pennine Lower Coal Measures. BGS 1:10,000 scale map SE21SW indicates that the shallowest coal seam beneath the site is the First Brown Metal Coal (0.3-0.7m thick)which is in turn underlain by the Second Brown Metal (also known as Old Hards Coal) (0.3-0.7m thick) approximately 10m below, with the Third Brown Metal (0.2-0.6m thick) again approximately 10m below.
Linear Features	The closest fault (inferred) to the site is c. 200m to the west, trending roughly north-south with the downthrow to the west.
Mining and Quarrying	Mining: According to the CA's Interactive Map Viewer the site is within an area where a coal mining report should be obtained and within a 'development high risk area' Therefore, a Consultants Coal Mining Report has been obtained the contents of which are discussed below. Quarrying: There are 2no. BGS recorded mineral sites on site, Tile Houses (sandstone quarry) and Square Pit (coal mine), plus another 4no. within 500m of the site.

Coal Authority Consultants Mining Report	The Consultants Coal Mining Report identifies the following: • There are 7 No. Coal Seams recorded as having been worked beneath the property between 5m bgl and 237m bgl. The shallowest seams are the Low Fenton (also known as the 2nd Brown Metal/Old Hards) and the Middleton Little (also known as the 3rd Brown Metal), recorded as shallow as 34m bgl. • There are also 2 No. recorded shallow workings to the south of the site at depths of 39mbgl and 245mbgl. • There are probable unrecorded shallow workings below the site. • There are no spine roads recorded at shallow depth. • There are 3 No. mine shafts recorded on the site. • The property is in an area where notices to withdraw support were given in 1943 and 1944. None of the following are recorded within the site; • Coal Outcrops. • Faults, fissures or breaklines. • Coal authority managed tips within 500m of the site. • Remediated sites within 50m of the site • Coal mining subsidence within 50m of the site. • Mine gas issues within 500m of the site. • Mine water treatment schemes recorded within 500m of the site. • Future underground mining.. • Coal mining licensing within 200m of the site. • Court orders relating to coal mining. • Notices given under section 46 of the Coal Mining Subsidence Act 1991.
BGS Boreholes	Boreholes completed on site by Lithos Consulting Limited show made ground to an average depth of 2.5m and a maximum depth of 6.1m. Pennine Lower Coal Measures bedrock was found between 0.90m and 6.1m. Further information on the Lithos GI is provided in Section 4.0 below.
Review of CA Mine Abandonment Plans	Abandonment plans for the 2nd Brown Metal (obtained for the site by Lithos, as part of a previous report) show workings in the south-east of the site.

5.0 PREVIOUS INVESTIGATIONS

RWO have been provided with a previous report for an area of land that included the site as detailed below;

- Geoenvironmental Appraisal, Land at Denby Lane, Grange Moor for Yorkshire County Properties.

It is assumed that the Client has reliance on this report. Two other letter reports were provided however these are summary report issued in advance of the above main report and are therefore considered superseded.

It is noted that the Lithos report site area encompassed our subject site plus the parcel of land immediately to the east, for clarity our site is named 'Area A' in the Lithos report. The Lithos report is presented in Appendix C, however a summary of its salient findings relevant to this CMRA is given below;

- The Desk Study front end of the report identified;
    - 3 No. Mine shafts present within the site
    - Abandonment plans for the 2nd Brown Metal show workings in the south-east of the site.
    - Risk of unrecorded workings across the remainder of the site.
    - 3rd Brown Metal coal anticipated at c. 20 to 22m bgl

- Lithos undertook a ground investigation which comprised the completion of 24 No. trial pits (15 No. in the site), a search to find the 3 No. mine shafts located on site , 4 No. soakaway tests of which 2 No. were in the site and 10 No. rotary open-hole boreholes, 8 No. were on the site.

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- Ground conditions across the site comprised a made ground topsoil 0.2 to 0.4m thick over made ground (typically colliery spoil) identified to depths up to 6.1m bgl in the former quarry area. More localised granular made ground/demolition rubble was encountered in and around the former colliery buildings as well as some reworked materials. Quary highwalls were not identified.

- Natural soils comprised residual weather bedrock both cohesive and granular in nature, over more competent Birstall Rock sandstone at depths between 0.9 and 6.1m bgl.

- Workings up to 1.6m thick within the 2nd Brown Metal coal seam were encountered in 4 No. of the boreholes in the site (PHs 40, 05, 07 & 08), PH04 recorded solid coal of 0.9m thick.

- The three mine shafts were located and showed evidence of been either capped with a 3.0mx3.0mx0.10m concrete pad or been backfilled with ash and clinker.

The main mining conclusions of the Lithos Report relevant to the site were;

- The three mine entries present in the west of site, all of which were located and surveyed in, will require drilling to confirm their depth, followed by remediation, likely by grouting and capping in accordance with Coal Authority, Local Authority and NHBC guidance/requirements.
- Shallow mineworkings have been encountered in the 2nd Brown Metal coal at shallow depth. A programme of drilling and grouting will be required across the site.
- The site may be affected by sources of hazardous gas. A programme of gas monitoring was underway at the time of writing the Lithos report and it was reported that a Hazardous Gas Risk Assessment will be issued upon completion of monitoring in May 2023. RWO have not received any such report.

Lithos recommend some further mining related work is required which included:

- A specification for drilling and grouting works will be required, including the requirements for remediating the three mine entries on site.

6.0 IDENTIFICATION AND ASSESSMENT OF THE SITE SPECIFIC COAL MINING RISK

Following the review of the factual data the table below summarises the potential risks associated with coal mining legacy for the proposed development site.

Coal Mining Issue	Yes	No	Risk Assessment
Underground coal mining (recorded ay shallow depths)	x		CA mining report records shallow working at 5m bgl, 34mbgl and 48mbgl. Lithos GI confirms the presence of shallowest workings in the 2nd Brown Metal. Lithos does not identify the 3rd Brown Metal beneath the site.
Underground coal mining (probable at shallow depths)	x		Potential for unrecorded workings in the 1st & 2nd and 3rd Brown Metal seams. Unrecorded workings in the 2nd Brown Metal confirmed by Lithos. 1st and 3rd Brown Metal not identified.
Mine entries (shaft and adits)	x		3 no. shafts recorded on site. Confirmed as been present by Lithos GI. Possibility of unrecorded mine entries, bell pits etc.
Record of past mine gas emissions or potential for mine gas emissions.		x	No recorded of mine gas emissions. Shallow mine workings are considered a potential source of hazardous gases.
Recorded coal mining surface hazard		x	No faults, fissures recorded on or close to the site.
Surface mining (opencast workings)	x		No recorded opencast mining on site, although there are opencast workings offsite to the east. Given the likely shallow bedrock there is the possibility of unrecorded small-scale crop working/opencast, and it is possible that former quarry/ponds was historic opencast extraction.

7.0 PROPOSED MITIGATION STRATEGY

This CMRA has identified coal mining related risk from recorded and unrecorded shallow underground workings and the presence of recorded mine shaft. There is also a potential risk from unrecorded mine entries and shallow bell pits/crop working.

Lithos has undertaken a comprehensive ground investigation for the client and this report identified shallow coal workings beneath the site in the 2nd Brown Metal and as such a programme of Drill & Grout stabilisation would be required.

The 1st Brown Metal was not identified on the site, it is possible that that this was removed in the sandstone quarry, and not recorded, if ever present within the site. The 3rd Brown Metals was not encountered by Lithos down to c. 30m bgl, and it assumed absent or possibly deeper than anticipated and is not considered a significant risk.

Of the 3 No. mine entries, confirmed by Lithos as been present within the site, one shaft was capped off with a concrete cap and the other two were backfilled with a mix of ash and clinker. These mine shafts will require to be suitably treated and capped, it is recommended that a suitable zone of 'development standoff' is applied, calculated as a 45° angle from rock head.

A suitable specification for the treatment of the shallow mine workings and shafts will be required to mitigate the risk to the site from the shallow mine workings and mine shafts and allow safe development of the site.

There is a possibility that further, previously unrecorded mine entries (shafts, bell pits, shallow crop workings) may be present on the site. Therefore, an awareness should be maintained and construction/site preparation works and any deeper areas of made ground or unidentified sub-surface feature investigated further by the geotechnical specialist.

Given the presence of shallow seams of worked coal and mine shafts, the site is considered at risk from hazardous ground gas. It is understood that Lithos undertook a programme of ground gas monitoring at the site, however RWO has not been made aware of the findings.

However, references made to the CL:AIRE document '*Good Practice for Risk Assessment for Coal Mine Gas Emissions*' dated October 2021, suggests that the GSV approach based on the results of gas monitoring may not be suitable for mine gas risk assessments if high risk factors are present, and that reference should be made to the conceptual site model so that there is not sole reliance on the gas data.

Shallow mine workings and mine shafts are considered potential high-risk scenarios.

At this stage it is recommended that a precautionary approach is taken, and therefore, at least CS-2 ground gas protection measures are recommended at this time across the site.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The site has been found to be at risk from shallow workings in the 2nd Brown Metal coal seams and 3 No. mine shafts.

There is a possibility that further, previously unrecorded mine entries (shafts, bell pits, shallow crop workings) may be present on the site.

Given the presence of shallow seams of worked coal and mine shafts, the site is considered at risk from hazardous ground gas.

8.2 Recommendations

RWO recommends the following;

- Drilling and Grout stabilisation of shallow coal workings in the 2nd Brown Metal across the site.
- Stabilisation and capping of the 3 No. mine shafts on site. Development standoff applied.
- A Mine Stabilisation Strategy for the above works.
- An awareness should be maintained and construction/site preparation works and any deeper areas of made ground or unidentified sub-surface feature investigated further by the geotechnical specialist.
- Undertaken a programme of rotary boreholes across the site to investigate the depth and condition of the Brown Metal coal seams;
- At this stage assume CS2 gas protection measures. Obtaining of and review of Lithos Gas risk assessment would be recommended prior to further assessment.

RWO Group
November 23

Appendix A Figures

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Site Location

RWO	**TITLE:** Site Location Plan Denby Lane, Grange Moor	**CLIENT:** Yorkshire Country Properties	**PROJECT NO:** G23054	**APPROVED BY:** CR	**DATE:** 14 / 11 / 2023
			FIGURE NO: 1	**DRAWN BY:** KR	**SCALE:** NTS

RWO	TITLE: Proposed Development Plan Extract Denby Lane, Grange Moor	CLIENT: Yorkshire Country Properties	DRAWN BY: KR	APPROVED BY: CR	PROJECT NO: G23054	
			DATE: 14 / 11 / 2023		FIGURE NO: 2	SCALE: NTS

Appendix B - CA Consultants Mining Report

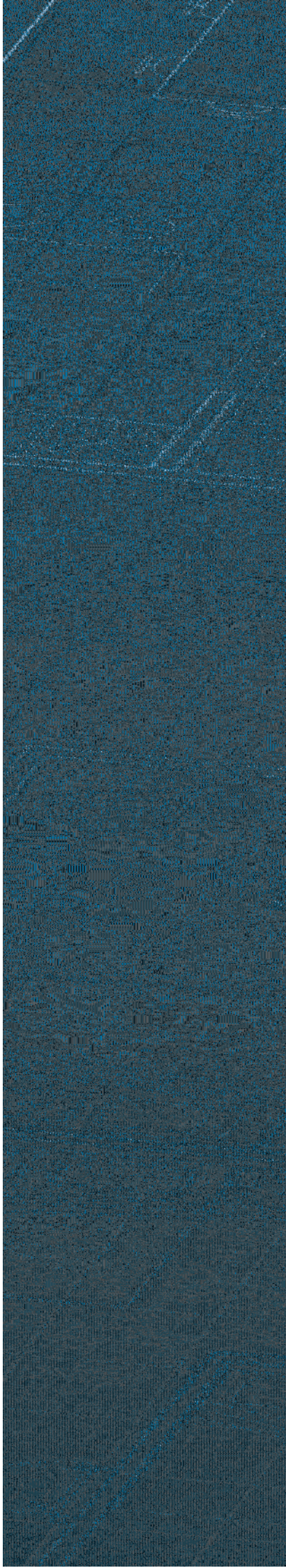
The Coal Authority

Consultants

Coal Mining Report

Grange Moor
Wakefield
Kirklees
WF4 4EG

Date of enquiry:	**24 October 2023**
Date enquiry received:	**24 October 2023**
Issue date:	**24 October 2023**
Our reference:	**51003385245001**
Your reference:	**G23054**



Consultants

Coal Mining Report

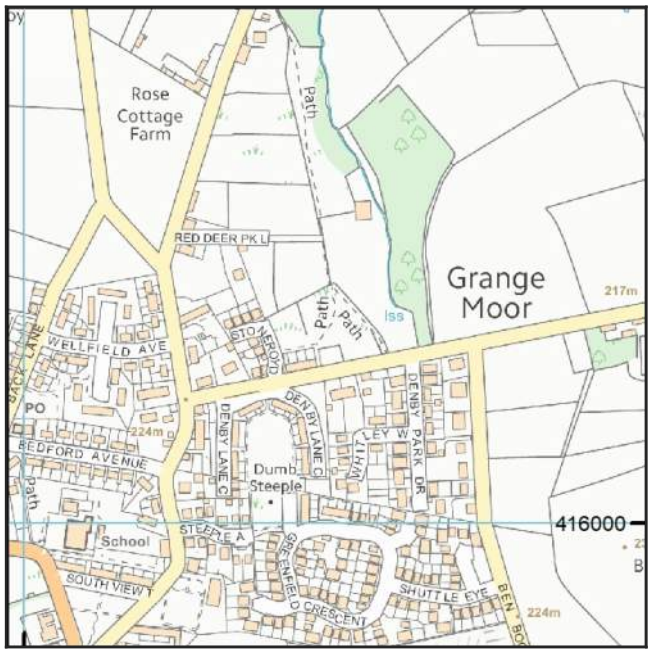
This report is based on and limited to the records held by the Coal Authority at the time the report was produced.

Client name

RWO ASSOCIATES (GEOTECHNICAL) LTD

Enquiry address

Grange Moor
Wakefield
Kirklees
WF4 4EG



Approximate position of property

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Section 1 – Mining activity and geology

Past underground mining

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
unnamed	LOW FENTON	Coal	6O4A	5	Beneath Property	4.8	East	61	1865
unnamed	MIDDLETON LITTLE	Coal	6O4F	34	Beneath Property	2.4	East	74	1906
unnamed	MIDDLETON LITTLE	Coal	6O4G	39	South	2.5	East	74	1906
unnamed	MIDDLETON MAIN	Coal	6042	48	Beneath Property	3.2	North-East	107	1845
unnamed	WHEATLEY LIME	Coal	6O4J	72	Beneath Property	1.6	South-East	82	1841
unnamed	SILKSTONE	Coal	6O4N	107	Beneath Property	2.8	South-East	61	1883
unnamed	TOP BEESTON	Coal	6O4P	153	Beneath Property	2.6	East	71	1939
unnamed	BLACK BED	Coal	6O4Q	237	Beneath Property	2.5	East	61	1945
unnamed	BLACK BED	Coal	6Z3F	245	South	2.5	East	41	1943

Probable unrecorded shallow workings

Yes.

Spine roadways at shallow depth

No spine roadway recorded at shallow depth.

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Shaft	422416-004	422336 416216	located by Lithos Consulting in 2022 and found to be a square sandstone brick lined mine entry 4.0m x 2.4m in size, backfilled with colliery spoil	Coal	
Shaft	422416-005	422342 416206	located by Lithos Consulting in 2022 and found to be a double brick lined circular mine entry, c.2.6m in diameter, backfilled with colliery spoil	Coal	
Shaft	422416-029	422315 416186	has been capped to an unknown specification. There is some uncertainty as to whether this feature is in fact a well. Located by Lithos Consulting in 2022 and a concrete square pad 3m x 3m c 0.1m was observed. Suspected shaft/well cap	Coal	

Abandoned mine plan catalogue numbers

The following abandoned mine plan catalogue numbers intersect with some, or all, of the enquiry boundary:

1574	12066	FGB275
10063	5016	NE777
GCR21	FGB18	NE166

Our records show we have more plans than those shown above which could affect the enquiry boundary.

Please contact us on 0345 762 6848 to determine the exact abandoned mine plans you require based on your needs.

Outcrops

No outcrops recorded.

Geological faults, fissures and breaklines

No faults, fissures or breaklines recorded.

Opencast mines

Please refer to the “Summary of findings” map (on separate sheet) for details of any opencast areas within 500 metres of the enquiry boundary.

Coal Authority managed tips

None recorded within 500 metres of the enquiry boundary.

Section 2 – Investigative or remedial activity

Please refer to the 'Summary of findings' map (on separate sheet) for details of any activity within the area of the site boundary.

Site investigations

Distance to site investigation (m)	Direction
Within	N/A

See Section 4 for further information.

Remediated sites

None recorded within 50 metres of the enquiry boundary.

Coal mining subsidence

The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.

There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Mine gas

None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes

None recorded within 500 metres of the enquiry boundary.

Section 3 – Licensing and future mining activity

Future underground mining
None recorded.

Coal mining licensing
None recorded within 200 metres of the enquiry boundary.

Court orders
None recorded.

Section 46 notices
No notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

Withdrawal of support notices
The property is in an area where notices to withdraw support were given in 1943 and 1944.

The property is not in an area where a notice has been given under section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.

Payments to owners of former copyhold land
The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

Section 4 – Further information

The following potential risks have been identified and as part of your risk assessment should be investigated further.

Future development

If development proposals are being considered, technical advice relating to both the investigation of coal and former coal mines and their treatment should be obtained before beginning work on site. All proposals should apply specialist engineering practice required for former mining areas. No development should be undertaken that intersects, disturbs or interferes with any coal or coal mines without first obtaining the permission of the Coal Authority.

MINE GAS: Please note, if there are no recorded instances of mine gas within 500m of the enquiry boundary, this does not mean that mine gas is not present within the vicinity. The Coal Authority Mine Gas data is limited to only those sites where a Mine Gas incident has been recorded. Developers should be aware that the investigation of coal seams, mine workings or mine entries may have the potential to generate and/or displace underground gases. Associated risks both to the development site and any neighbouring land or properties should be fully considered when undertaking any ground works. The need for effective measures to prevent gases migrating onto any land or into any properties, either during investigation or remediation work, or after development must also be assessed and properly addressed. In these instances, the Coal Authority recommends that a more detailed Gas Risk Assessment is undertaken by a competent assessor.

Development advice

The site is within an area of historical coal mining activity. Should you require advice and/or support on understanding the mining legacy, its risks to your development or what next steps you need to take, please contact us.

Site investigations

The site is within an area of previous interest. It is close to where the Coal Authority has received information relating to past site investigations.

The site requires further investigation and may influence how you approach your risk assessment.

For further information on specific site or ground investigations in relation to any issues raised in Section 4, please call us on 0345 762 6848 or email us at groundstability@coal.gov.uk.

Section 5 – Data definitions

The datasets used in this report have limitations and assumptions within their results. For more guidance on the data and the results specific to the enquiry boundary, please **call us on 0345 762 6848** or **email us at groundstability@coal.gov.uk.**

Past underground coal mining

Details of all recorded underground mining relative to the enquiry boundary. Only past underground workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination, will be included.

Probable unrecorded shallow workings

Areas where the Coal Authority believes there to be unrecorded coal workings that exist at or close to the surface (less than 30 metres deep).

Spine roadways at shallow depth

Connecting roadways either, working to working, or, surface to working, both in-seam and cross measures that exist at or close to the surface (less than 30 metres deep), either within or within 10 metres of the enquiry boundary.

Mine entries

Details of any shaft or adit either within, or within 100 metres of the enquiry boundary including approximate location, brief treatment details where known, the mineral worked from the mine entry and conveyance details where the mine entry has previously been sold by the Authority or its predecessors British Coal or the National Coal Board.

Abandoned mine plan catalogue numbers

Plan numbers extracted from the abandoned mines catalogue containing details of coal and other mineral abandonment plans deposited via the Mines Inspectorate in accordance with the Coal Mines Regulation Act and Metalliferous Mines Regulation Act 1872. A maximum of 9 plan extents that intersect with the enquiry boundary will be included. This does not infer that the workings and/or mine entries shown on the abandonment plan will be relevant to the site/property boundary.

Outcrops

Details of seam outcrops will be included where the enquiry boundary intersects with a conjectured or actual seam outcrop location (derived by either the British Geological Survey or the Coal Authority) or intersects with a defined 50 metres buffer on the coal (dip) side of the outcrop. An indication of whether the Coal Authority believes the seam to be of sufficient thickness and/or quality to have been worked will also be included.

Geological faults, fissures and breaklines

Geological disturbances or fractures in the bedrock. Surface fault lines (British Geological Survey derived data) and fissures and breaklines (Coal Authority derived data) intersecting with the enquiry boundary will be included. In some circumstances faults, fissures or breaklines have been known to contribute to surface subsidence damage as a consequence of underground coal mining.

Opencast mines
Opencast coal sites from which coal has been removed in the past by opencast (surface) methods and where the enquiry boundary is within 500 metres of either the licence area, site boundary, excavation area (high wall) or coaling area.

Coal Authority managed tips
Locations of disused colliery tip sites owned and managed by the Coal Authority, located within 500 metres of the enquiry boundary.

Site investigations
Details of site investigations within 50 metres of the enquiry boundary where the Coal Authority has received information relating to coal mining risk investigation and/or remediation by third parties.

Remediated sites
Sites where the Coal Authority has undertaken remedial works either within or within 50 metres of the enquiry boundary following report of a hazard relating to coal mining under the Coal Authority's Emergency Surface Hazard Call Out procedures.

Coal mining subsidence
Details of alleged coal mining subsidence claims made since 31 October 1994 either within or within 50 metres of the enquiry boundary. Where the claim relates to the enquiry boundary confirmation of whether the claim was accepted, rejected or whether liability is still being determined will be given. Where the claim has been discharged, whether this was by repair, payment of compensation or a combination of both, the value of the claim, where known, will also be given.

Details of any current 'Stop Notice' deferring remedial works or repairs affecting the property/site, and if so the date of the notice.

Details of any request made to execute preventative works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991. If yes, whether any person withheld consent or failed to comply with any request to execute preventative works.

Mine gas
Reports of alleged mine gas emissions received by the Coal Authority, either within or within 500 metres of the enquiry boundary that subsequently required investigation and action by the Coal Authority to mitigate the effects of the mine gas emission. Please note, if there are no recorded instances of mine gas reported, this does not mean that mine gas is not present within the vicinity. The Coal Authority Mine Gas data is limited to only those sites where a Mine Gas incident has been recorded.

Mine water treatment schemes
Locations where the Coal Authority has constructed or operates assets that remove pollutants from mine water prior to the treated mine water being discharged into the receiving water body.

These schemes are part of the UK's strategy to meet the requirements of the Water Framework Directive. Schemes fall into 2 basic categories: Remedial – mitigating the impact of existing pollution or Preventative – preventing a future pollution incident.

Mine water treatment schemes generally consist of one or more primary settlement lagoons and one or more reed beds for secondary treatment. A small number are more specialised process treatment plants.

Future underground mining
Details of all planned underground mining relative to the enquiry boundary. Only those future workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination will be included.

Coal mining licensing
Details of all licenses issued by the Coal Authority either within or within 200 metres of the enquiry boundary in relation to the under taking of surface coal mining, underground coal mining or underground coal gasification.

Court orders
Orders in respect of the working of coal under the Mines (Working Facilities and Support) Acts of 1923 and 1966 or any statutory modification or amendment thereof.

Section 46 notices
Notice of proposals relating to underground coal mining operations that have been given under section 46 of the Coal Mining Subsidence Act 1991.

Withdrawal of support notices
Published notices of entitlement to withdraw support and the date of the notice. Details of any revocation notice withdrawing the entitlement to withdraw support given under Section 41 of the Coal Industry Act 1994.

Payment to owners of former copyhold land
Relevant notices which may affect the property and any subsequent notice of retained interests in coal and coal mines, acceptance or rejection notices and whether any compensation has been paid to a claimant.

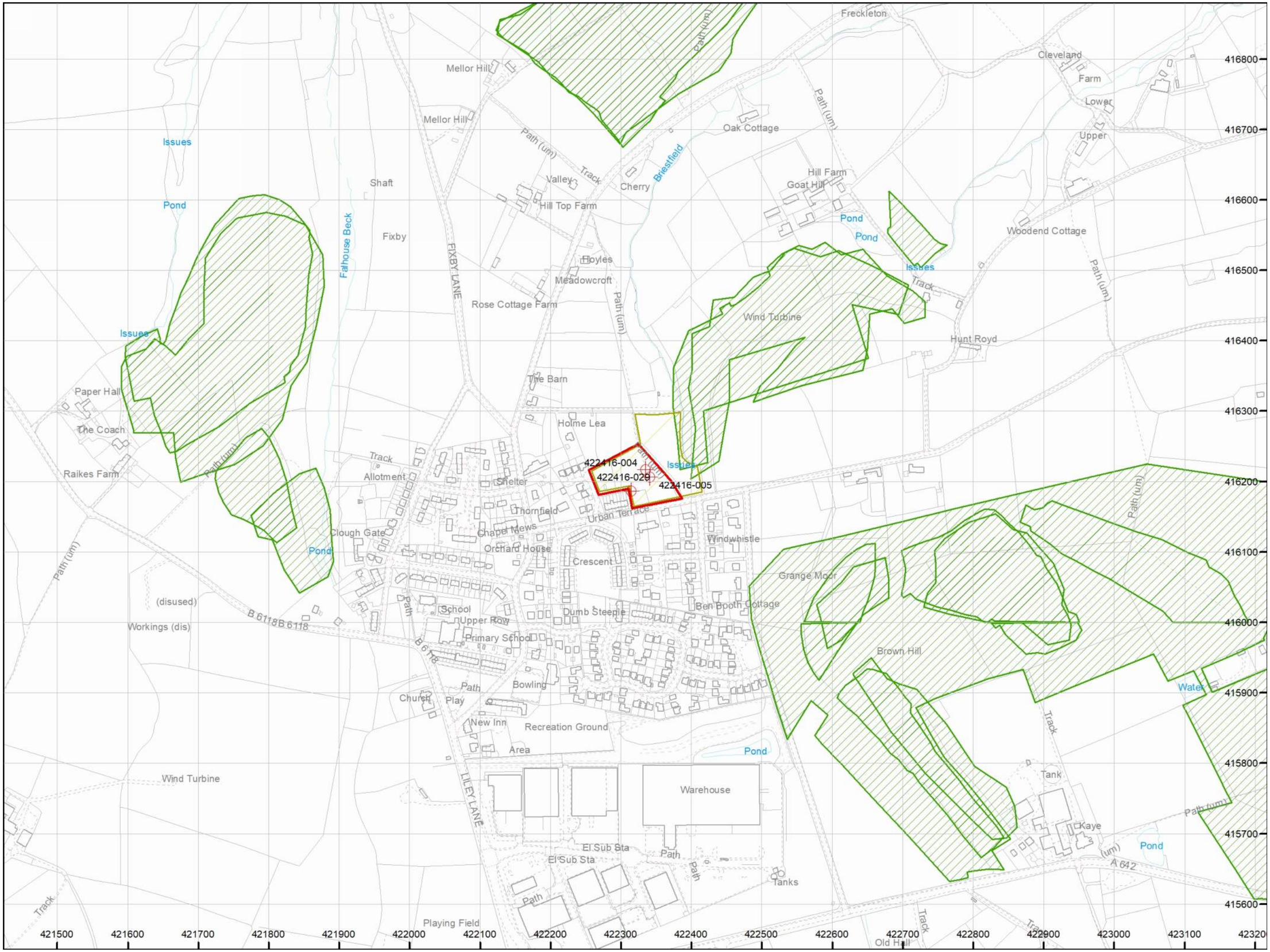
The Coal Authority

Summary of findings

The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

- Approximate position of the enquiry boundary shown
- Disused mine shaft
- Unlicensed opencast site
- Site investigations



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Appendix B Previous Reports

Geoenvironmental Appraisal

Land at Denby Lane, Grange Moor

For Yorkshire Country Properties

Report no: 4511/1

Date: December 2022

Tel: 01937 545330 • info@lithos.co.uk • www.lithos.co.uk

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	4511	**Site area/ha**	1.3
Client:	Yorkshire Country Properties	**NGR:**	SE 223 162
Site:	Denby Lane, Grange Moor	**Nearest postcode:**	WF4 4EF

The site is located off Denby Lane, approximately 8km east of Huddersfield town centre, and currently comprises two parcels of land, divided in the centre by a public footpath and c.1-2m high retaining wall. The eastern parcel of land comprises a cropped grass field; the western parcel of land comprises overgrown scrubland that has recently been cleared.

Historically, the western parcel of land has been associated with 'Tile Houses' Quarry and the former 'Square Colliery'. The eastern parcel of land has remained largely undeveloped, with the exception of a former sewage works in the centre of the field between c. 1961 and 1999.

Lithos were commissioned by Yorkshire Country Properties to provide a geoenvironmental appraisal of the site, which it is understood is to be redeveloped with housing. Lithos' investigation included a review of 3rd party reports, the site's history and environmental setting, and a ground investigation comprising 25 trial pits and 10 rotary open probeholes.

A summary of salient geoenvironmental issues is provided in the table below.

Issue	Remarks
Made ground	Made ground was encountered in 20 of 25 pits and in 8 of 14 probeholes, predominantly in the west of site, to an average depth of 2.5m, max of 6.1m. Made ground typically comprised a dark grey Ash with Gravel of mudstone, coal, clinker and occasional burnt shale (Colliery Spoil).
Natural ground	Natural ground was predominantly encountered in the east of site, and typically comprised topsoil (c.300mm thick) underlain by a firm slightly sandy slightly gravelly Clay (Cohesive Residual Soils). Granular Residual Soils were encountered in 6 trial pits to depths of between 1.6m and 3.1m. Pennine Lower Coal Measures bedrock was encountered within 5 trial pits in the east of site from depths of between 0.9m and 2.6m. Within the probeholes, bedrock was encountered from depths of between 1.0m and 6.1m (average depth to top of bedrock of 2.9m).
Mining & quarrying	Shallow mineworkings have been encountered within the 2nd Brown Metal coal seam between 9.9m and 11.5m depth, with a thickness ranging from between 0.5m and 1.6m. Mitigation against the risk of subsidence associated with shallow workings in the 2nd Brown Metal coal will be required across the entire western parcel, and in an area c.1,200m^2 in size in the south of the eastern field. All 3 known mine entries have been located and surveyed in. These will require drilling to confirm their depth and details of backfill followed by treatment in accordance with the Coal Authority, local authority (most notably highways) and NHBCs requirements in advance of starting works on site. The possibility of further unrecorded shafts and bell pits, particularly in the north of site where the 2nd Brown Metal coal is shallowest, cannot be discounted.
Contamination	Testing suggests the topsoil is chemically suitable for re-use. Made ground encountered in the west of site has yielded elevated concentrations of inorganic determinands. This made ground should be isolated beneath 600mm thick surface cover of "clean" soil. Alternatively, this material could be placed beneath areas of hardstanding, where it will be satisfactorily isolated from end users. Demolition rubble encountered in TP11 yielded elevated concentrations of organic and inorganic contaminants. In addition, a strong hydrocarbon odour was noted during trial pitting. This 'hot-spot' of fuel contaminated soil should be "chased out" by excavation and disposed of off-site.
Hazardous gas	The site is in an area where <1% of homes are estimated to be above the radon action level. Multiple potential sources of hazardous gas have been identified at this site (backfilled quarry/opencast, shallow mineworkings). Consequently, a period of gas monitoring is underway to determine whether special precautions against hazardous gas are required. A Hazardous Gas Risk Assessment will be issued upon completion of monitoring in May 2023.
Preparatory works	Topsoil strip and stockpile (eastern field only) Treatment of mine entries in accordance with approved specification Programme of drilling and grouting Turnover and compaction of made ground in the western field, with likely redistribution of some material in the eastern field to raise site levels and create a level development platform Excavation of hydrocarbon contamination 'hot-spot' in the west of site.

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	4511	**Site area/ha**	1.3
Client:	Yorkshire Country Properties	**NGR:**	SE 223 162
Site:	Denby Lane, Grange Moor	**Nearest postcode:**	WF4 4EF

Issue	Remarks
Foundations	All plots in the east of site can be founded on traditional strip and trenchfill foundations at a minimum depth of 900mm in cohesive soils or 750mm in granular soils. Where shallow mineworkings are present in the east of site, foundations will need to be reinforced. In the west of site, given the thickness of made ground, the majority of plots will require piled foundations. Due to the presence of shallow underground workings within the 2nd Brown Metal coal, piled foundations will need to be taken through the grouted workings to competent bedrock below. Where made ground is <2.5m thick in the west of site, reinforced strips/raft foundations may be a viable option, founding on engineered fill.
Groundwater & excavations	Groundwater was encountered in TP06 at 3.1m depth. Groundwater monitoring to date indicates that groundwater lies at between 2.3 and 4.0m bgl. Shallow excavations should remain stable in the short term, however, deeper excavations within the colliery spoil are likely to be unstable and may require shoring.
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. Based on observations made during the investigation, soakaways will not provide a suitable drainage solution for surface water run-off at this site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SuDS), and there may be a need for surface water balancing.
Highways	Based on visual inspection of the shallow natural materials and published guidance, the Cohesive Residual Soils should provide a CBR of at least 3%. Where the made ground is re-engineered it is considered that a CBR value of at least 3% should be achievable. However, this should be verified by field trials. Consultation with the adopting authority, regarding the specification of the highways, is strongly recommended.

Significant developer abnormals relating to geoenvironmental issues at the site are:

- In order to create a level development platform between the two parcels of land, it is likely the Colliery Spoil in the west of site will need excavating and placing on land in the east. A soil inversion, using clean naturally occurring soils in the east will be required to achieve this.
- Three mine entries are present in the west of site, all of which have been located and surveyed in. These will require drilling to confirm their depth, followed by remediation, likely by grouting and capping in accordance with Coal Authority, Local Authority and NHBC guidance.
- Shallow mineworkings have been encountered in the 2nd Brown Metal coal at shallow depth. A programme of drilling and grouting will be required.
- Underground sewers and drainage utilities are present beneath the site; these will require an easement or diversion.
- Hydrocarbon and inorganic contamination has been encountered within demolition rubble in the footprint of a former colliery building in the west of site. This material will require 'chasing out' by excavation with subsequent disposal off-site.
- The site may be affected by sources of hazardous gas. As such, a programme of gas monitoring is underway. A Hazardous Gas Risk Assessment will be issued upon completion of monitoring in May 2023.

Some further work is required, most notably:

- Cable percussion boreholes should be undertaken within the footprint of the former Tile Houses Quarry in the west of site (Area A) to determine the full extent of backfill and assess the nature and composition of backfilled materials.
- A Materials Management Plan (MMP) will be required to allow for the re-use of natural and made ground on site.
- Given the proximity of Briestfield Beck along the site's eastern boundary, it is recommended that a Silt and Surface Water Management Plan is developed prior to construction activities commencing.
- A remediation strategy will be required.
- A specification for drilling and grouting works will be required, including the requirements for remediating the three mine entries on site.

CONTENTS

APPENDICES

Appendix A - General notes

01	Environmental setting
02	Ground investigation fieldwork
03	Geotechnical testing
04	Contamination laboratory analysis & interpretation
05	Hazardous gas
06	Soakaways

Appendix B - Drawings

Drawing	Revision	Title
4511/1	-	Site location plan
4511/3	-	Site features
4511/3A	-	Historical site features
4511/4	-	Site photographs
4511/5	-	Preliminary conceptual site model
4511/6	-	Exploratory hole locations
4511/7	-	Revised conceptual site model
4511/8	-	Site areas
4511/9	-	Old Hard coal (2nd Brown Metal Coal) abandonment plan
4511/10	-	Green Lane (Middleton Little Coal) abandonment plan
4511/11	-	Green Lane (Middleton Little Coal) abandonment plan
4511/12	-	Hunt Royd opencast abandonment plan
4511/14	-	Area of shallow mineworkings
4511/15	-	Cross-sections

Appendix C - Commission

Appendix D - Historical OS plans#

Appendix E - Search responses#

From	Date	Content
Landmark	15 09 2022	Environmental search data
Coal Authority	15 09 2022	Mining report

Appendix F to H - Exploratory records

Appendix F	TP01 to TP25
Appendix G	PH01 to PH10
Appendix H	Shaft searches

Appendix I – Soakaway test results

Appendix J - Chemical test results

Appendix K – Dot and Box plots

Appendix L - Geotechnical test results

Appendix M - Gas monitoring results

Some of this data is not included within the paper or PDF copies of this report; by request, it can be provided on a CD.

FOREWORD (GEOENVIRONMENTAL APPRAISAL REPORT)

This report has been prepared for the sole internal use and reliance of the Client named on page 1. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Lithos Consulting Limited (Lithos); such authorisation not to be unreasonably withheld. If any unauthorised third party comes into possession of this report, they rely on it at their peril and the authors owe them no duty of care and skill.

This report has been reviewed by a Competent Person, as defined in the National Planning Policy Framework. We ensure that all projects are managed by individuals with necessary experience, relevant qualifications, and current membership of a relevant professional organisation. Records of engineers, project managers and reviewers involved in this project are maintained by us. Lithos QA/QC procedures for all our work forms an integral part of our ISO9001 accreditation and as such is regularly audited.

The report presents observations and factual data obtained during our site investigation and provides an assessment of geoenvironmental issues with respect to information provided by the Client regarding the proposed development. Further advice should be sought from Lithos prior to significant revision of the development proposals.

The report should be read in its entirety, including all associated drawings and appendices. Lithos cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context. However, it should be noted that in order to keep the number of pages to a minimum, some information (e.g. full copy of the Landmark/Groundsure Report) is not included in the PDF; by request it can be provided on a CD.

The findings and opinions conveyed in this report (including review of any third-party reports) are based on information obtained from a variety of sources as detailed within this report, and which Lithos believes are reliable. Reasonable care and skill has been applied in examining the information obtained. Nevertheless, Lithos cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

Intrusive investigation can only investigate shallow ground beneath a small proportion of the total site area. It is possible therefore that the intrusive investigation undertaken by Lithos, whilst fully appropriate, may not have encountered all significant subsurface conditions. Consequently, no liability can be accepted for conditions not revealed by the exploratory holes. Any opinion expressed as to the possible configuration of strata between or below exploratory holes is for guidance only and no responsibility is accepted as to its accuracy.

It should be borne in mind that the timescale over which the investigation was undertaken may not allow the establishment of equilibrium groundwater levels. Particularly relevant in this context is that groundwater levels are susceptible to seasonal and other variations and may be higher during wetter periods than those encountered during this commission.

Where the report refers to the potential presence of invasive weeds such as Japanese Knotweed, or the presence of asbestos containing materials, it should be noted that the observations are for information only and should be verified by a suitably qualified expert.

Lithos cannot be responsible for the consequences of changing practices, revisions to waste management legislation etc that may affect the viability of proposed remediation options.

The report represents the findings and opinions of experienced geoenvironmental consultants. Lithos does not provide legal advice and the advice of lawyers may also be required.

Lithos standard terms and conditions apply to the report, a copy of the terms and conditions is available on request or can be found with our proposal in Appendix C.

GEOENVIRONMENTAL APPRAISAL
of land off
DENBY LANE, GRANGE MOOR

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Yorkshire Country Properties to carry out a geoenvironmental appraisal of land off Denby Lane, Grange Moor.

1.1.2 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:

- A review of third party reports
- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- A mining risk assessment in accordance with Coal Authority guidance.
- An intrusive ground investigation comprising 25 trial pits and 10 boreholes
- Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
- A qualitative assessment of contamination risks
- Recommendations for the necessary site preparatory and remediation works

1.1.3 Primary aims of this investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable Yorkshire Country Properties to obtain budget costs for: foundations; gas protection measures; and site preparatory and remediation works.

1.2 The proposed development

1.2.1 It is understood that consideration is being given to redevelopment of the site with traditional 2 storey domestic dwellings, associated gardens, POS, adoptable roads and sewers. No site layout has been provided at this stage.

1.3 Report format and limitations

1.3.1 All standard definitions, procedures and guidance are contained within Appendix A, which includes background, generic information on:

- Assessment of the site's environmental setting
- Ground investigation fieldwork
- Geotechnical testing
- Contamination testing
- Hazardous gas
- Soakaways

1.3.2 General notes and limitations relevant to all Lithos geoenvironmental investigations are described in the Foreword and should be read in conjunction with this report. The text of the report draws specific attention to any modification to these procedures and to any other special techniques employed.

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 4511/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	8 km east of Huddersfield town centre
NGR	SE 223 162
Approximate area	1.29ha (3.2 acres)
Known services	Underground sewer, drainage, and electricity. Gas utilities runs parallel to the sites southern boundary.

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on the 23rd September 2022.

2.2.2 The site is currently accessed off Denby Lane in the south and comprises two parcels of land divided by a public footpath. Access to the site can also be gained off Red Deer Park Lane in the north.

2.2.3 Existing salient features, at the time of the walkover are presented on Drawing 4511/3 in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current Access	Off Denby Lane
Topography	Uneven ground with a steep slope (1 in 4) along the northern boundary of the western field. Gentle slope to the northeast in the eastern field (1 in 20). Eastern field lies c.2m lower than the western field.
Approximate areas	12,900m^2 grass
Nature of boundaries	North – slope with line of trees along northern boundary of the west field, gravel track parallel to the northern boundary of the east field. East – wooden post and wire fencing South – dilapidated stone wall with Heras fencing in front along southern boundary of west field, wooden post & wire fencing along southern boundary of the east field. West – trees & Heras fencing
Surrounding land uses	North – gravel track with wooden portal frame barn and metal storage container directly north East – woodland with open fields beyond South – Denby Lane with housing beyond West – housing off Denby Lane & Stoneroyd

2.2.4 The eastern parcel of land comprises an overgrown grassed field bound by mature woodland and Briestfield Beck in the east, Denby Lane in the south, a public footpath to the west and open fields in the north.

2.2.5 The western parcel of land comprises an area of dense vegetation, which was being cleared at the time of the walkover. Field boundaries comprise open fields to the north, a public footpath to the east, Denby Lane to the south and houses to the west.

2.2.6 Topography of the site is variable and can be divided into the eastern and western field:

- The eastern field has a gentle slope of 1 in 20 to the northeast.
- The western slope has uneven ground.

- A steep slope (1 in 4) is present along the northern boundary of the western field.
- The eastern slope lies c.2m below the level of the western field.

2.2.7 A selection of site photographs is included on Drawing 4511/4.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1855 have been examined. Some of these plans are presented in Appendix D to this report.

3.2 The table below provides a summary of the salient points relating to the history of the site. It is not the intention of this report to describe in detail all the changes that have occurred on or adjacent to the site. Significant former uses/operations are highlighted in **bold** text for ease of reference.

Date	Site	Surrounding land
1855	'**Sandstone Quarries**' in the west of site. Old **coal pit** in the centre south.	Red Deer Park directly north. Un-named road running east to west along the northern and southern boundaries. Two buildings directly northwest. **Coal pit** c.100m southeast. **Sandstone quarry** c.140m southwest. **Well** c.40m south & 35m northwest.
1893	**Square Colliery** in the southwest of site comprising a **spoil heap** and at least 3 **buildings**. **Footpath** along eastern boundary of colliery. **Well** in the far east of site.	No significant changes
1907	Square colliery no longer shown, however, shaft is labelled in the east of the former colliery site. Building in the far northeast of site, associated with 'Red Deer Park' directly north.	Houses constructed directly southwest.
1919	**Filters** present in the west of site. Shaft in centre east now labelled 'Old Coal Shaft' Road parallel to southern boundary labelled '**Denby Lane**'	No significant changes
1930	No significant changes	**Sewage works** adjacent to the eastern boundary. Houses constructed c.40m southwest **Well** c.40m south no longer shown
1961	'**Works**' in east of site. Filter beds no longer shown.	**Poultry house** including 2 x **ponds**, located 180m east.
1966	No significant changes	**Tank** c.40m northwest Houses constructed directly south of site.
1976		**Well** c.35m northwest no longer shown
1989	**Tank** in centre-east of site, '**issues**' in the east. Footpath running N-S through centre of site.	No significant changes
1993	Two buildings shown in the southwest of site.	
1999	Tanks and works no longer shown.	

3.1.2 Given the above, the site's former uses can be divided into two areas:

- **Area A** - Western parcel – former quarry pre-1855 and 'Square Colliery' between c.1893 and 1907.
- **Area B** - Eastern parcel – former sewage works between c.1961 and 1999.

4 ENVIRONMENTAL SETTING

4.1 General

4.1.1 Notes describing how the site's environmental setting has been assessed are included in Appendix A to this report. Reference has been made to publicly available Government held digital data via QGIS (an Open Source Geographic Information System). Extracts from the response received from Landmark, and responses from the Coal Authority, are presented in Appendix E. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 77) 1:10,000 BGS map (Sheet SE21NW)	Drift soils – None recorded. Solid (bedrock) – Birstall Rock. Shallowest coal seam – 2nd Brown Metal coal at c.5m depth. See further details in Section 4.3 below. Strata dip – c.2° east. Faults - None.
Mining	Coal Authority	This site is located within a Coal Mining Development High Risk Area Past and present workings – Shallow workings at 5m, recorded in the 2nd Brown Metal coal. Opencast – Hunt Royd, former opencast directly east. Mine entries – 3 mine entries in the west. Further details in Section 4.3 below.
Quarrying	Historical OS plans	'Tile Houses' quarry, excavating Birstall Rock Sandstone on site. 'Dumb Steeple' quarry located 160m southwest.
Landfills	Envirocheck Report	No known landfills within 250m. However, there is a backfilled quarry on site, and a backfilled former opencast quarry directly east.
Radon	Public Health England	The site lies in an area where 1-3% of homes are estimated to be above the action level. Further details in Section 13.
Hydrogeology	Environment Agency electronic open data via QGIS	Groundwater Source Protection Zone? None. Aquifer: Secondary A Aquifer (Solid). Groundwater abstractions? None recorded. Soil leaching potential - High. Pollution incidents? None of significance.
Hydrology	Environment Agency Envirocheck Report	Nearest watercourse(s) – Briestfield Beck flowing north along the site's eastern boundary. Within the Smithy Brook from source to River Calder water body. Water quality – ecologically moderate, chemical fail. Pollution incidents? Nearest is 'other sewage' into freshwater stream/river 199m east on 4th June 1995. Abstractions? None recorded. Discharge consents? Sewage discharge (Yorkshire Water Services) into unknown watercourse between 1st – 31st July 1986 & 1st January – 30th June 1982 3m northwest. Sewage effluent discharge into unknown watercourse by Wpc controller, 3m northwest, no dates supplied.
Flood risk	Environment Agency electronic open data via QGIS	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. In accordance with Chapter 14 of the National Planning Policy Framework, a site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency).

4.2 Landfills

4.2.1 Whilst there are no recorded landfills within 250m of the site, a backfilled opencast sandstone quarry dating back to c.1855 is present in the west of site. A backfilled coal opencast is also present directly east of site, shown on CA data and the BGS 1:10,000 geological map.

4.3 Coal & mining

4.3.1 In July 2011 the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology relating to coal mining development areas. This Section (and Sections 9.8 & 15.2) provides the necessary mining risk assessment required by the proposed planning application.

4.3.2 This site is located within a Coal Mining Development **High Risk Area** - an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.

4.3.3 Multiple sources of information have been used to analyse the coal mining beneath this site. Whilst the reports/maps refer to the same coal seam, they have been given different names. For clarity, these are summarised below:

- **1st Brown Metal** – also known as 'Metal Coal' on BGS 1:10,000 map.
- **2nd Brown Metal** – called the 'Old Hards Coal' on abandonment plans and BGS Geological maps. Referred to as the 'Low Fenton Coal' in the CA Consultants Mining Report.
- **3rd Brown Metal** – also known as the 'Stone Coal' on BGS 1:10,000 map.
- **Middleton Little Coal** – also known as the 'Green Lane Seam' on BGS 1:10,000 map, or Green Lane Bed on Abandonment Plans.
- **Middleton Main Coal** – shown as 'New Hard Seam' on abandonment plans.

4.3.4 Geological maps suggest that two coal seams underlie the site at shallow depth. These are the:

- 2nd Brown Metal coal c. 0.3m – 0.7m thick outcropping directly north of site.
- 3rd Brown Metal coal c.0.2 – 0.6m thick seam outcropping c,190m to the north of site. Shown to lie c.15m beneath the 2nd Brown Metal.

4.3.5 Given dip and topography, both coal seams are expected to underlie the entire site. The next significant coal seam beneath these two coal seams is the Middleton Little coal seam which is anticipated to lie c.30m beneath the 3rd Brown Metal and is therefore not considered to pose a significant risk to surface stability if it was worked.

4.3.6 A CA mining report states that:

- Past underground mining has been recorded in 7 seams beneath the site between 5m and 245m depth. Shallow workings (at <30m depth) are recorded in the Low Fenton (2nd Brown Metal) coal at 5m depth, last worked in 1865.
- There are probable unrecorded shallow workings.
- There are 3 mine entries recorded on site.
- The Low Fenton coal outcrops 34.5m north of the site and is workable.
- There are no recorded faults, fissures or breaklines recorded.
- There is an unlicenced opencast directly east of site, the boundary of which appears to be within the far north eastern corner of site.
- The coal authority has not received a damage notice of claim for the property, or any property within 50m of the site boundary since 31st October 1994.
- There are no recorded incidences of mines gas within 500m of the enquiry boundary.

- There are no mine water treatment schemes recorded within 500m of the enquiry boundary.
- The property is in an area where notices to withdraw support were given in 1943 and 1944, however these have been cancelled as a notice was given under section 41 of the Coal Industry Act 1994.

4.3.7 The Coal Authority report refers to workings within the Low Fenton seam. Given the depth and line of outcrop provided by the CA, it is clear the Low Fenton is the 2nd Brown Metal coal seam.

4.3.8 The CA have limited mine entry data for all 3 shafts. Whilst the locations and treatment descriptions are provided, the depth and diameter of each shaft has not been recorded. Details are provided in the table below.

Shaft Ref.	Grid reference	Treatment description
422416-004	422336, 416216	Filled to an unknown specification.
422416-005	422343, 416206	Capped to an unknown specification.
422416-029	422315, 416186	Capped to an unknown specification. There is some uncertainty as to whether this is in fact a well.

4.3.9 Prior to finding recorded shafts (i.e. those referenced in the CA mining report), the CA will expect Yorkshire Country Properties layout to assume a potential no-build "zone of influence" around each shaft based on the following calculation:

(0.5 x assumed shaft diameter) + departure + drift depth = zone of influence

4.3.10 It is worth noting that CA shaft positions are often only approximate, and in some cases the same shaft has been recorded in multiple locations, or some other feature such as a chimney has erroneously been recorded as a shaft.

4.3.11 Given the presence of recorded shallow workings beneath the site, Lithos have obtained abandonment plans for any recorded workings at less than 50m depth beneath the site, these are;

CA Plan Ref.	Plan Title	Details
CA Ref. 3360_999999_1OF4	Workings in the Old Hards and New Hards Seam.	55 yards (50m) to the New Hards Coal.
CA Ref. 3360_999999_2 OF4	Workings in the Green Lane Seam.	42 yards (38m) to the green lane seam from square colliery. 1 in 24 dip to the southeast.
CA Ref. 5016_000000_	Workings in the Green Lane Bed.	Square shaft down cast 40 yards (37m).
CA Ref. NE364_999999_	Hunt Royd opencast plan, showing workings in the 1st Brown Metal and Old Hards.	1st Brown Metals at c.3.5m depth. Old Hards seam at c.12.0m in the south of the quarry (deepest point).

4.3.12 Whilst the BGS 1:10,000 geological map suggests the 3rd Brown metal should lie c.15m beneath the 2nd Brown Metal, the BGS Technical Report WA/98/6 suggests the 3rd Brown Metal is absent in the Grange Moor area. Furthermore, there is also a suggestion that the 3rd Brown Metal was only worked via opencast methods. Therefore, if present beneath the site, is unlikely to be worked and may explain why there are no recorded workings within this coal seam within the CA Report or Abandonment Plans.

4.4 Mineral safeguarded areas

4.4.1 The site is underlain by coal and might therefore be considered by the Local Authority to lie within a Mineral Safeguarding Area (MSA).

4.4.2 MSAs are areas of known mineral resources that are of sufficient economic or conservation value to warrant protection for generations to come. The purpose of MSAs is not to preclude automatically other forms of development, but to make sure that mineral resources are adequately and effectively considered in land-use planning decisions.

4.4.3 Specialist guidance on Mineral Safeguarding "A Guide to Mineral Safeguarding in England" has been produced by The Coal Authority and the British Geological Survey.

4.4.4 Paragraph 210 of the National Planning Policy Framework (NPPF) requires Local Authorities, when preparing Local Plans to:

- Define Minerals Safeguarding Areas and adopt appropriate policies in order that known locations of specific minerals resources of local and national importance are not needlessly sterilised by non-mineral development, whilst not creating a presumption that resources defined will be worked; and define Minerals Consultation Areas based on these Minerals Safeguarding Areas.
- Set out policies to encourage the prior extraction of minerals, where practicable and environmentally feasible, if it is necessary for non-mineral development to take place.

4.4.5 NPPF Paragraph 211 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.

4.4.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require Yorkshire Country Properties to consider the opportunity to recover (extract) the coal. Applicants submitting planning applications may need to demonstrate to the Local Authority that they will extract the coal, unless:

- It can be shown it is not economically viable to do so, or
- It is not environmentally acceptable to do so, or
- The need for the development outweighs the need to extract the coal, or
- The coal will not be sterilised by the development

4.4.7 The viability of coal extraction at this site is considered later in this Report (Section 16.7) in light of the findings of Lithos' intrusive mining investigation, which comprised the drilling of 10 rotary probeholes to depths of between 6.0m and 30.0m (see Section 9.8).

4.5 Agriculture

4.5.1 Historical plans show that the east of the site has most recently been occupied by arable farmland. Generally farming is not considered likely to have caused significant ground contamination. However, activities such as slurry spreading, the discharge of chemicals to ground, and unregulated burial are known to have occurred on farmland. Potential contaminants associated with farming activity could include any of the following.

Agricultural activity	Potential contaminant
Slurry pits, manure heaps, septic tanks	Methane, metals, nitrates, oxygen depletion
Sewage farming, slurry spreading	Methane, metals, nitrates, oxygen depletion
Tracks (if built up with crushed demolition rubble etc)	Metals, asbestos, hydrocarbons
Plant & animal protection	Pesticides & herbicides
Soil conditioners	Metals, sulphates, PAH
Waste burial, land levelling, backfilling ponds/quarries	Methane, metals, PAH etc
Naturally occurring contaminants	Arsenic, metals

4.5.2 Whilst it is likely that pesticides have been applied during arable use of the land, these are not likely to include the persistent organochloride pesticides such as Dieldrin, Aldrin, DDT etc. Pesticides routinely used on arable crops the UK (Phenoxy Acetic acid herbicide or PAAH) rapidly degrade in soils or leach via rainwater infiltration to groundwater. It is highly unlikely these would be detected by soil sampling and therefore it is not proposed to undertake analysis of these.

4.5.3 The generation of ground gas in quantities with the potential to impact upon the proposed development would only occur with the presence of significant quantities of organic matter. Ground gas monitoring is not considered necessary unless significant quantities of organic matter are identified during the ground investigation.

5 PREVIOUS INVESTIGATION FINDINGS

5.1 General

5.1.1 Yorkshire Country Properties have provided Lithos with a copy of the following reports:

- Report 1 - Phase 1 Geo-environmental Report on Proposed Residential Development at Denby Lane, Grange Moor, Ref. E21/7792/R001, issued by Haigh Huddleston & Associates in July 2021.
- Report 2 - Phase 1 Geo-environmental Report on Proposed Residential Development at Denby Lane, Grange Moor (Phase 2), Ref. E21/7792/R002, issued by Haigh Huddleston & Associates in May 2022.

5.1.2 These reports include a review of data from a Groundsure EnviroInsight report and historical OS maps dating back to 1854. Sections 1 to 4 of this Lithos Report include similar content to both reports, but with further detail.

5.2 Summary of Haigh Huddleston's findings – Report 1

5.2.1 This report details the findings of a desk study undertaken on the eastern parcel of land.

5.2.2 Within this report, sources of contamination included infill material from Hunt Royd opencast directly east, ground gas from shallow coal workings and infill material associated with the former sewage works on site. No mention of the adjacent Square Colliery is noted.

5.2.3 Haigh Huddleston recommended that a Stage II Ground Investigation is undertaken to confirm foundation design, identify contamination and identify any made ground or shallow workings.

5.3 Summary of Haigh Huddleston's findings – Report 2

5.3.1 Report 2 details the findings of a desk study undertaken on the western parcel of land.

5.3.2 Sources of contamination identified within this report included infill materials associated with the former on-site mine and sandstone quarry, shallow coal workings, hazardous gas and organic material associated with the infilled pond/reservoir.

5.3.3 Similar to Report 1, Haigh Huddleston recommended that a Stage II Ground Investigation is undertaken. In addition to confirming foundation design, identifying contamination, identifying made ground and shallow workings, the 3 recorded on-site mine entries will also need locating.

5.4 Lithos comments

5.4.1 Within the site history section in Report 1, Haigh Huddleston have identified that the site was shown as a field labelled sandstone quarries and old coal pit in 1855. From analysing the historical maps obtained by Lithos, it is clear the sandstone quarry and old coal pit is referring to the western parcel of land. From c.1931 the site is then shown as a sewage works with filter beds.

5.4.2 Within the coal mining section in Report 2, Haigh Huddleston have detailed depths and assumed diameters of the 3 shafts recorded in the west of site, reproduced in the table below.

Shaft Ref.	Details
422416-004	Grange Moor Colliery Square Shaft. Assumed diameter of 3m and depth of 109.7m to the Silkstone coal seam. Infilled to an unknown specification.
422416-005	Grange Moor Colliery Shaft. Assumed diameter of 3m and depth of 107.9m to the Silkstone coal seam. This has been capped to an unknown specification.
422416-029	Potential well. Actual diameter of 1.5m and depth of 2.8m. This has been capped to an unknown specification and is a suspected well.

5.4.3 It is unknown where the information regarding the depth and diameter of each shaft/well was obtained as this is not shown on the Consultants Mining Report obtained by either Haigh Huddleston or Lithos.

5.4.4 Haigh Huddleston recommended that a Stage II Ground Investigation is undertaken on both parcels of land, which should include:

- Site clearance to enable access to all areas of the development
- Site scrape to establish the locations of mineshafts, extent of former quarrying, pond, sewage works, adjacent quarrying and potential bell pits.
- Trial pitting to determine the nature of underlying strata and allow samples to be taken for analysis
- Rotary boreholes to determine the presence of shallow mineworkings and the depth and nature of fill within the sandstone quarry.

5.4.5 Prior to the commission of this report, the site has been cleared to allow access. Furthermore, Lithos agree that trial pitting, rotary openhole drilling and a shaft search is required during a site investigation, however, a full site scrape should be done at the time of the topsoil strip, not during the site investigation phase.

6 PRELIMINARY CONCEPTUAL SITE MODEL

6.1.1 An assessment of potential contaminants associated with the former uses has been undertaken with reference to CLR8 and the following DETR Industry Profile: Sewage Works and Sewage Farms. As a consequence of this assessment, anticipated potential contaminants, within soil and/or groundwater include:

- Inorganics (metals, asbestos associated with made ground)
- TPH & PAH (fuels, oils associated with machinery use and maintenance within the colliery & Sewage works)

6.1.2 Historical plans show the presence of 3 mine shafts, a backfilled sandstone quarry, backfilled pond and sewage works which will be targeted during the ground investigation.

6.1.3 A preliminary conceptual site model, presented as Drawing 4511/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 4 inclusive of this report.

6.1.4 Clearly, the conceptual model will be subject to modification in light of data arising from the proposed intrusive ground investigation.

7 GROUND INVESTIGATION DESIGN

7.1 Anticipated ground conditions & potential issues

7.1.1 Based on the data reviewed in Section 4 (Environmental Setting) and 5 (Previous Investigation Findings), anticipated ground conditions are expected to comprise:

Anticipated condition	Remarks
Made ground	Made ground anticipated in the western parcel of land (Area A), within the footprint of 'Square Colliery' and 'Tile Houses' quarry). Possible made ground in the east (Area B) associated with the former sewage works.
Natural soils	Shallow Residual Soils (weathered bedrock)
Bedrock	Birstall Rock (sandstone) anticipated at shallow depth.
Mineworkings	• 2nd Brown metal anticipated to lie between c.5m and 7m depth beneath site, abandonment plans suggest this is worked in the southwest. • 3rd Brown metal anticipated at c. 20 to 22m depth beneath site, possibly worked.
Groundwater	Possible shallow groundwater in bedrock.

7.1.2 Based on the data above and that in Sections 2 (Site Description) and 3 (History), potential ground-related issues associated with this site are likely to include:

Type of issue	Specific issue	Remarks
Potential on-site contamination sources	1. Reworked topsoil (inorganics, organics) 2. Mine entries 3. Backfilled 'Tile Houses' sandstone quarry 4. Former Square Colliery 5. Former sewage works	1. Associated with farming (eastern parcel of land 2. Backfilled to an unknown specification (western parcel of land) 3. Located on the western parcel of land 4. Likely relict structures and made ground (western parcel of land) 5. Possible relict structures and made ground (eastern parcel of land)
Potential off-site contamination sources	1. Backfilled opencast quarry directly east of site, former coal pit c.100m southeast & former sandstone quarry c.140m southwest.	1. Possible sources of migrating hazardous gas
Potential geotechnical hazards	1. Relict buried obstructions 2. Deep MG 3. Steep slopes/topography 4. Shallow workings 5. Shafts	1. Associated with the former 'Square Colliery' in the west and sewage works in the east. 2. Associated with the backfilled 'Tile House' quarry and 3 backfilled shafts in the west. 3. Slope of 1 in 4 along the northern boundary & c.1m to 2m difference in topography between the east and western fields. 4. Shallow workings anticipated in the 2nd Brown Metal. 5. 3 recorded mine entries in the west.
Other potential constraints	1. Briestfield Beck 2. Underground utilities	1. Briestfield Beck slows north along the site's eastern boundary, which will require easement 2. Underground sewer and drainage utility will require easement/diversion.

7.2 Ground investigation design & strategy

7.2.1 The preliminary conceptual site model was used as a basis for design of an appropriate ground investigation, the scope of which is summarised below.

Exploratory holes	Purpose
TPs 1 to 22	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of made ground • Nature, degree and extent of contamination • Proportion of undesirable elements e.g., biodegradable matter, foundations etc • Suitability of the ground for founding structures and highways
Including 4 TPs	To determine whether soakaways could be utilised for storm water drainage
PHs 01 to 08	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings and to install monitoring wells across the site in order to: • Monitor for hazardous gas • Determine groundwater levels and assess flow direction
3 x shaft searches	To locate the recorded mine entries and obtain further information regarding their size and backfill materials.

7.2.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site and to target potential areas of interest identified in Section 3 above. A nominal 20m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

7.2.3 The number of representative samples taken will be reflective of the geological complexity actually encountered. However, in general about 3 samples will be taken from most trial pits.

8 FIELDWORK

8.1 Objectives

8.1.1 The original investigation strategy is outlined in Section 7.2 above.

8.1.2 The additional exploratory holes listed below were advanced in light of ground conditions actually encountered.

Exploratory holes	Purpose
TP23	To determine the extent of the adjacent opencast quarry in Area B, ensuring it does not extend within the site boundary.
TP24	To locate the recorded well in Area B.
TP25	To enable better delineation of the depth and lateral extent of made ground in Area A.

8.2 Scope of works

8.2.1 Fieldwork was supervised by Lithos between the 10th and 13th October 2022 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 01 to 23	0.5m to 3.5m	TP19 extended to locate the quarry highwall.
Shaft search	422416-029, 005, 004	0.6m to 1.5m	All three shafts encountered

Technique	Exploratory holes	Final depth(s)	Remarks
Soakaway tests	Within TPs 02, 07, 10 & 22	2.3m to 2.9m	No tests reached 75% empty
Rotary open-hole probeholes	PHs 01 to 10, 01A, 05A, 07A & 08A	6.0m to 30m	Monitoring wells installed in 6 holes

8.2.2 Notes describing ground investigation techniques, in-situ testing and sampling are included in Appendix A to this report.

8.2.3 Exploratory hole logs are presented in Appendices F to H to this Report. These logs include details of the:

- Samples taken
- Descriptions of the solid strata, and any groundwater encountered.
- Results of the in-situ testing
- The monitoring wells installed

8.2.4 Exploratory hole locations are shown on Drawing 4511/6 presented in Appendix B; exploratory holes were picked-up by a surveyor and co-ordinates/ground levels are included on the logs.

9 GROUND CONDITIONS

9.1 General

9.1.1 A complete record of strata encountered beneath the proposed development site is given on the various exploratory hole records, presented in Appendices F to H.

9.1.2 The site can be divided into two areas based on site history and ground conditions. These areas are shown on Drawing 4511/8 and are summarised below:

Site area	General location	Area (m^2)
A	Former Square Colliery & Tile Houses Quarry	6,700
B	Former Sewage Works/open field	6,200

9.1.3 Typical ground conditions encountered at the site are described below in Sections 9.2 (made ground) and 9.5 (natural ground), with a summary provided in the table on pages 14 to 17.

9.2 Made ground

9.2.1 The made ground on site is a heterogeneous mixture of materials and it is unlikely, even with a huge amount of sampling, that it could be accurately characterised. Nonetheless, the bulk of the made ground can be categorised as one of the following broad types:

- **Made Ground Topsoil:** encountered in 16 trial pits to between 0.2m and 0.4m depth, typically as a dark grey ashy Sand with gravel of clinker, coal, mudstone and sandstone.
- **Granular Made Ground:** encountered in 3 trial pits to a maximum depth of 1.2m. In Area A (TP11), this was encountered within the footprint of a former colliery building and comprised a light grey slightly clayey Sand with gravel of brick, mudstone, sandstone and coal. In Area B (TPs 03 & 04), this was encountered within the footprint of the former sewage works as a dark grey Sand with gravel of sandstone, mudstone and brick.
- **Demolition Rubble:** encountered only in Area A, within TP11 from between 1.2m and 1.9m depth as a sandy Gravel of concrete, coal, glass and wood with frequent full and half bricks.

- **Reworked Natural Ground:** encountered in Area A, within TPs 15 to 18 & 20 to depths of between 1.9m and 3.3m. Typically comprised a light brown sandy fine to coarse Gravel of sandstone.
- **Relict Topsoil:** encountered in TP12 (Area A), beneath colliery spoil, from between 2.1m and 2.4m depth as a dark brown sandy slightly gravelly clay with rare rootlets.

9.2.2 Review of the trial pit logs suggest made ground thicknesses beneath the site vary between 0.3m and 6.1m; average 2.6m. The thickest made ground (PH07) was encountered in the footprint of the former 'Tile Houses' quarry. Made ground in excess of 2m deep was encountered in the majority of exploratory holes in the west of site.

9.2.3 The approximate distribution of deep made ground is shown on Drawing 4511/8. Made ground is typically restricted to the west of site (Area A); associated with the former Square Colliery.

9.3 Obstructions

9.3.1 Obstructions associated with former colliery buildings in the Area A were encountered in TP11 to 1.9m depth. Other obstructions should be anticipated within the footprints of former colliery buildings.

9.3.2 In Area B, relict obstructions associated with the former sewage works appear to have been grubbed up and removed off site.

9.4 Quarry Highwalls

9.4.1 Trial pits excavated to target the former quarry highwall in Area A (TP16, 17 & 21) did not fully penetrate the overlying made ground, as a result the highwalls (if present) were not observed. If the highwalls are present, they must be in excess of 3m below existing ground levels.

9.5 Natural ground

9.5.1 Natural ground was encountered in the majority of the exploratory holes, and typically comprised:

- **Topsoil:** encountered in 10 trial pits to between 0.2m and 0.5m depth, predominantly in Area B field as a dark brown slightly gravelly Sand.
- **Cohesive Residual Soils:** a firm light orangish brown mottled grey slightly sandy slightly gravelly Clay encountered in 12 trial pits to depths of up to 3.1m.
- **Granular Residual:** encountered in 6 trial pits to depths of between 1.6m and 3.1m. Typically comprised a light brown sandy angular to subangular fine to coarse Gravel of sandstone.

9.5.2 Birstall Rock (sandstone) bedrock was encountered in 5 trial pits, from depths of between 0.9m and 2.6m. Within the probeholes, bedrock was encountered from depths of between 1.0m and 6.1m (average depth to the top of bedrock of 2.9m).

9.5.3 The 2nd Brown Metal was encountered in TPs 05 & 06 between 1.9m and 2.6m depth, in the north of Area B. The 2nd Brown Metal was also encountered in all probeholes (where taken deep enough). The coal seam was worked in 5 of 10 holes, mostly in Area A, and in the far south of Area B.

Summary of Ground Conditions – Trial Pits

Hole	Final depth	Depth to Base of Made Ground	Depth to Base of										Depth to Coal Measures Bedrock	Remarks
			Made Ground						Natural Soils					
			Made Ground Topsoil	Granular Made Ground	Demolition Rubble	Colliery Spoil	Reworked Natural Ground	Relict Topsoil	Topsoil	Cohesive Residual Soil	Granular Residual Soil	Coal (2nd Brown Metal)		
TP01	3.10	0.3	0.3	-	-	-	-	-	-	2.4	3.1	-	-	-
TP02	2.3	-	-	-	-	-	-	-	0.3	0.9	-	-	0.9	-
TP03	2.1	0.8		0.8	-	-	-	-	0.3	1.6	-	-	1.6	From 1.8m, becoming difficult to excavate.
TP04	3.0	0.7	-	0.7	-	-	-	-	0.3	1.20	-	-	1.2	-
TP05	2.80	-	-	-	-	-	-	-	0.2	1.9	-	2.2	2.2	-
TP06	3.1	-	-	-	-	-	-	-	0.3	1.9	-	2.6	2.6	-
TP07	2.6	-	-	-	-	-	-	-	0.3	1.6	2.6	-	-	-
TP08	2.2	-	-	-	-	-	-	-	0.3	2.2	-	-	-	Cohesive residual soil feels soft, likely due to high sand content.
TP09	3.1	3.1	0.3	-	-	3.1	-	-	-	-	-	-	-	From 3.1m, difficult to excavate further.
TP10	2.3	-	-	-	-	-	-	-	0.4	-	2.3	-	-	-
TP11	2.5	1.9	-	1.2	1.9	-	-	-	-	-	2.5	-	-	Between 1.4m and 1.9m, brick wall in western face of pit. Strong hydrocarbon odour between 1.2m and 1.9m depth.
TP12	3.1	2.1	0.4	-	-	2.1	-	2.4	-	3.1	-	-	-	At 3.1m, scraping on possible bedrock.

Hole	Final depth	Depth to Base of Made Ground	Depth to Base of										Depth to Coal Measures Bedrock	Remarks
			Made Ground						Natural Soils					
			Made Ground Topsoil	Granular Made Ground	Demolition Rubble	Colliery Spoil	Reworked Natural Ground	Relict Topsoil	Topsoil	Cohesive Residual Soil	Granular Residual Soil	Coal (2nd Brown Metal)		
TP13	3.5	3.5	0.2	-	-	3.5	-	-	-	-	-	-	-	-
TP14	3.0	2.1	0.3	-	-	2.1	-	-	-	-	3.0	-	-	Difficult to excavate beyond 3.0m.
TP15	3.1	3.1	0.3	-	-	1.0, 3.1	1.9	-	-	-	-	-	-	-
TP16	2.6	2.6	0.3	-	-	2.0, 2.6	2.4	-	-	-	-	-	-	Between 0.3m and 2.0m, spalling of trial pit walls.
TP17	2.9	2.9	0.3	-	-	0.9	2.9?	-	-	-	-	-	-	-
TP18	3.2	3.2	0.4	-	-	-	3.2	-	-	-	-	-	-	From 3.2m, difficult to excavate further.
TP19	1.6	0.3	0.3	-	-	-	-	-	-	-	1.6	-	-	At 1.6m, refusal on bedrock.
TP20	3.3	3.3	0.2	-	-	-	3.3	-	-	-	-	-	-	-
TP21	3.2	3.2	0.2	-	-	3.2	-	-	-	-	-	-	-	-
TP22	2.9	2.9	0.3	-	-	2.9	-	-	-	-	-	-	-	-
TP23	1.0	-	-	-	-	-	-	-	0.5	1.0	-	-	-	At 0.8m, black plastic pipe running N-S in east of pit.
TP24	0.5	-	-	-	-	-	-	-	0.3	0.5	-	-	-	-
TP25	0.5	-	-	-	-	-	-	-	0.3	0.5	-	-	-	-
422416-029 search	0.6	0.6	-	-	-	0.6	-	-	-	-	-	-	-	At 0.4m, concrete square pad 3.0m x 3.0m x 0.1m encountered. Suspected shaft/well cap.
422416-005 search	1.0	0.8	0.2	-	-	0.8	-	-	-	-	-	-	-	At 0.8m, double brick lined, circular mine

Hole	Final depth	Depth to Base of Made Ground	Depth to Base of										Depth to Coal Measures Bedrock	Remarks
			Made Ground						Natural Soils					
			Made Ground Topsoil	Granular Made Ground	Demolition Rubble	Colliery Spoil	Reworked Natural Ground	Relict Topsoil	Topsoil	Cohesive Residual Soil	Granular Residual Soil	Coal (2nd Brown Metal)		
														entry encountered. c.2.6m in diameter. Backfilled with Colliery Spoil.
422416-004 search	1.5	1.5	0.2	-	-	1.5	-	-	-	-	-	-	-	At 0.8m, square sandstone brick lined mine entry encountered. 4.0m x 2.4m in size. Backfilled with colliery spoil.

Summary of Ground Conditions - Probeholes

Hole	Final depth	Depth to base of Overburden (mbgl)		Depth to Rock (mbgl)	2nd Brown Metal						Remarks
		Made Ground	Residual Soils		Depth to base of Solid Coal (mbgl)	Thickness (m)	Depth to base of Solid Coal (mbgl)	Thickness (m)	Depth to base of workings (mbgl)	Thickness (m)	
PH01	12.00	-	1.8	1.8	-	-	8.8	0.7	-	-	-
PH01A	6.0	-	1.8	1.8	-	-	-	-	-	-	Monitoring well installed.
PH02	10.0	-	1.0	1.0	4.1	0.1	6.9	0.5	-	-	Monitoring well installed.
PH03	9.0	-	3.1	3.1			3.8	0.7	-	-	Monitoring well installed.
PH04	15.30	3.7	-	3.7	-	-	-	-	10.4	0.5	Flush lost 0.7m above soft ground (workings).
PH05	13.0	2.0	-	2.0	-	-	-	-	10.0	0.5	Loss of flush & soft drilling between 9.3m and 10.0m depth.
PH05A	6.0	2.0	-	2.0	-	-	-	-	-	-	Monitoring well installed.
PH06	15.0	4.2	-	4.2	-	-	10.6	0.9	-	-	-
PH07	15.3	6.1	-	6.1	-	-	-	-	11.5	1.6	-
PH07A	6.0	6.0	-	-	-	-	-	-	-	-	Monitoring well installed.
PH08	30.0	3.0	-	3.0	-	-	-	-	11.0	1.0	-
PH08A	6.0	3.0	-	3.0	-	-	-	-	-	-	Monitoring well installed.
PH09	13.5	-	3.5	3.5	-	-	-	-	10.5	0.9	-
PH10	11.8	-	3.0	3.0	-	-	7.7	0.7	-	-	-

9.6 Visual & olfactory evidence of organic contamination

9.6.1 Olfactory evidence of hydrocarbon contamination was encountered between 1.2m and 1.9m depth in TP11. Samples of the affected soil was scheduled for chemical testing to determine the nature and extent of the identified contamination.

9.7 Groundwater

9.7.1 No significant inflows of groundwater were encountered during the investigation. However, a groundwater seepage was encountered in TP06 at 3.1m depth.

9.7.2 Groundwater levels recorded in the monitoring wells are summarised below.

Hole	Response zone (depth range & strata)	Groundwater body	Typical standing water level	
			m bgl	m AoD#
PH01a	3.0 – 6.0m (mudstone)	-	ND	ND
PH02	2.0 – 3.0m (mudstone)	Bedrock aquifer (Solid)	2.30	209.35
PH03	4.5 – 7.5m (mudstone)		4.00	205.80
PH05a	3.0 – 6.0m (sandstone & mudstone)		3.25	213.20
PH07a	3.0 – 6.0m (colliery spoil)	-	ND	ND
PH08a	3.0 – 6.0m (sandstone & mudstone)		ND	ND

levelled-in by survey

9.7.3 Dip data to date suggests a water table is present within bedrock. After an initial dip to record standing water level, the wells were bailed-out to establish an approximate rate of **recharge**. Findings were:-

Hole	Vol. removed /litres	Water level lowered by /m	From / to m bgl	Water level recovered to /m bgl	After / mins	Recovery rate
PH02	2	0.43	2.30 to 2.73	2.69	50	Slow
PH03	15	3.09	4.00 to 7.09	6.82	46	Fast
PH05a	12	1.97	3.25 to 5.22	4.45	23	Fast

Note: In a 50mm diameter well pipe there is approximately 2 litres of water per metre of water column.

9.7.4 It is apparent from the above that permeability of the ground is quite high – unsurprising given that all well response zones intercepted bedrock. Groundwater levels are considered to be reflective of the true water table (rather than "trapped" waters associated with drilling or surface water run-off).

9.7.5 These results will be required by the foundation designer, drainage designer, and groundworker (especially if/where deep excavation is required).

9.8 Stability

9.8.1 Stability of excavations within natural ground was generally good. However, excavations within deep made ground showed signs of instability (spalling and collapse).

9.9 Mining and/or quarrying investigation

Shallow workings (rotary probeholes)

9.9.1 It is clear from the desk study that the site is likely to be underlain by shallow mineworkings associated with the 2nd Brown Metal Coal.

9.9.2 The conjectured outcrop of the coal seam is shown on Drawing No. 4511/14 in Appendix B to this report.

9.9.3 Ten probeholes were drilled to determine whether the site is underlain by unrecorded shallow mine workings. The strata encountered are summarised below.

Hole	Final depth (m)	Depth to rockhead (m)	Evidence of workings	Thickness of coal (m)	Thickness of workings (m)	10 x cover present?
PH01	12.0	1.8	No	0.7	-	N/A
PH02	10.0	1.0	No	0.1, 0.5	-	N/A
PH03	9.0	3.1	No	0.7	-	N/A
PH04	15.3	3.7	Yes	-	0.5	Yes*
PH05	13.0	2.0	Yes	-	0.5	Yes*
PH06	15.0	4.2	No	0.9	-	No*
PH07	15.3	6.1	Yes	-	1.6	**No**
PH08	30.0	3.0	Yes	-	1.0	**No**
PH09	13.5	3.5	Yes	-	0.9	**No**
PH10	11.8	3.0	No	0.7		**No**

* Whilst working thicknesses were recorded as 0.5m, there is unlikely to be enough competent cover given the recorded thickness of coal ranges between 0.7m and 0.9m.

* This probehole likely encountered a pillar, as surrounding boreholes identified shallow workings.

9.9.4 Analysing the data obtained from the 10 mining investigation probeholes, it is apparent that:

- The 2nd Brown Metal coal seam underlies the entire site. It is shallowest in the north, encountered from 1.9m depth, and deeper to the south/southwest, encountered at a maximum depth of 11.5m.
- 5 of the 10 holes (50%) advanced through the 2nd Brown Metal seam encountered evidence of workings. Significant broken ground / soft push (c. >1.0m) were encountered in PH07 & PH08.
- Typical seam thickness of the 2nd Brown Metal seam is 0.7m; maximum recorded was 0.9m.
- The thickness of competent (rock) cover above the 2nd Brown Metal is typically less than 10 x seam thickness. Working thicknesses ranged from 0.5m to 1.5m thick.

9.9.5 Analysis of probehole data suggests that shallow workings within the 2nd Brown Metal coal are present across the entire western parcel of land (Area A), and across an area c.1,200m^2 in size in the far south of the eastern parcel (Area B), as shown on Drawing 4511/11. Where shallow mine workings have been identified, it is considered there is not enough competent cover in any of the holes, using the maximum thickness of solid coal encountered of 0.9m.

9.9.6 A further 4 probeholes were taken to shallow depth to enable the installation of gas monitoring wells.

Mine entry search

9.9.7 As discussed in Section 4.3 there are 3 known mine entries within the site's boundary. Prior to any excavation, each mine entry was set out by a surveyor, based on co-ordinates included within the CA's Consultant's Mining Report, and consideration was given to Desk Study data to ensure the pegged position was appropriate.

9.9.8 Topsoil and subsoil was stripped from about 25m^2 of land where the CA suggest that each recorded mine entry is located. All 3 recorded shafts have been located and surveyed, with details provided in the table below.

Shaft Ref	Details	Coordinates
422416-029	Concrete square pad 3.0m x 3.0m x 0.1m. Suspected shaft/well cap.	422315.01, 416186.03
422416-005	Double brick lined circular mine entry, c.2.6m in diameter. Backfilled with Colliery Spoil.	422342.00, 416206.01
422416-004	Square sandstone brick lined mine entry 4.0m x 2.4m in size. Backfilled with Colliery Spoil.	422335.99, 416216.01

9.9.9 Between 0.4m and 0.8m of made ground was encountered above the shaft positions, which typically comprised a dark grey Ash with gravel of clinker, coal and mudstone (Colliery Spoil).

9.9.10 Details of the mine entries, along with illustrative photographs, are shown in Appendix H.

9.10 Revised conceptual ground model (ground conditions)

9.10.1 The Preliminary Conceptual Site Model has been revised in light of data obtained during the ground investigation, most notably with respect to:

- The nature and distribution of made ground, including the presence of significant buried obstructions
- The strength, nature and depth of underlying natural strata
- The presence of coal/shallow workings
- The nature and distribution of contamination (based on visual/olfactory evidence only)

9.10.2 Further refinement of the Conceptual Site Model is presented in Sections 12.4, where the results of laboratory testing for contaminants have been considered.

10 SOAKAWAY TEST RESULTS

10.1 UK Guidance

10.1.1 General notes about soakaways, including their location, design, and Lithos' test methodology are presented in Appendix A.

10.1.2 UK guidance does not explicitly state that soakaways cannot be constructed in made ground, but such construction is not generally considered good practice. There may be a risk of settlement caused by wash out of fine soil particles if soakaway waters are allowed to infiltrate into made ground. Furthermore, UK guidance does state that the soakaways should not be built where the presence of contamination could result in pollution of groundwater.

10.1.3 Given water table depth and topography it is considered unlikely that springs will appear down-gradient.

10.1.4 CIRIA C753[1] recommends that soakaways should not be constructed 'in ground where the water table reaches a level within 1m below the base of the soakaway at any time of the year'.

10.1.5 BRE Digest 365[2] "Soakaway Design" advises that each soakaway pit should be filled and allowed to drain three times to near empty on the same or consecutive days.

[1] *CIRIA C753. The SUDS Manual (2015).*
[2] *BRE Digest 365. Soakaway Design (1991).*

10.2 Field tests

10.2.1 Four soakaway tests were carried out in general accordance with BRE Digest 365 "Soakaway Design". The locations of the soakaways are shown on Drawing 4511/6, presented in Appendix B to this report.

10.2.2 The water level did not fall to 25% effective depth within 3 hours in any soakaway test undertaken. The tests were therefore not considered suitable for calculation of an infiltration rate in accordance with BRE Digest 365.

10.3 Discussion & conclusions

10.3.1 Drainage Engineers could use the infiltration rates reported above to determine the feasibility of soakaways as a solution for the discharge of surface water run-off. However, regard must be made to seasonal groundwater levels; UK guidance indicates that the seasonally high groundwater table must be at least 1m below the base the soakaway.

10.3.2 Increasing the soakaway effective depth might offer a solution, but consideration should be given to the cost of excavation (especially given the strong nature of the bedrock).

10.3.3 It should be noted that soakaway percolation in bedrock is predominately via joints within the rock mass. The relatively small-scale soakaway test pits may not intercept such joints, and this can result in variable test results. It is possible that the larger surface area associated with soakaway construction during development will intercept such joints; although this cannot be guaranteed.

10.3.4 Soakaways are generally only considered to provide a satisfactory solution for the disposal of surface water where the vast majority of tests yield reasonable infiltration rates, which is not the case at this site.

10.3.5 Consequently, soakaways will **not** provide a suitable drainage solution; and there will be a need for surface water balancing.

10.3.6 Drainage solutions are discussed further in Section 15.8.

11 CONTAMINATION (ANALYSIS)

11.1 General

11.1.1 As mentioned in section 9 above, the site's former uses can be divided into two areas:

- Area A - Western parcel – former 'Tile Houses' quarry pre-1855 and 'Square Colliery' between c.1893 and 1907.
- Area B - Eastern parcel – former sewage works between c.1961 and 1999.

11.1.2 The site's former usage is likely to have given rise to some ground contamination. Furthermore, significant thicknesses of made ground were encountered in many of the exploratory locations during the ground investigation.

11.1.3 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 6.

11.1.4 In the context of risks to human health associated with residential redevelopment, the Tier 1 Soil Screening Values referenced in this report have been derived via the CLEA default conceptual site model (CSM) used for generating SGVs, but amended, where appropriate, to be more specific to redevelopment within the planning process.

11.1.5 Where available, Category 4 Screening Levels (C4SL) have also been referenced.

11.1.6 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

11.2 Testing scheduled

11.2.1 Based on the above assessment, Lithos submitted a test schedule (summarised in the table below) to a UKAS accredited laboratory. Account has also been taken of visual and olfactory evidence recorded during the ground investigation.

Type of sample	No. of samples	Determinands
Made ground	30	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Calorific Value (CV) Water soluble sulphate, chloride, nitrate and magnesium TOC, Speciated Polycyclic Aromatic Hydrocarbons (PAH), Banded Total Petroleum Hydrocarbons (TPH)
Topsoil	6 3	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Speciated Polycyclic Aromatic Hydrocarbons (PAH) Clay/sand/silt content and visible contaminants, sharps (glass etc) to check compliance with BS3882:2015

11.2.2 Account was taken of previous uses in specific areas, with calorific value analysis concentrated on samples recovered from the vicinity of the former Square Colliery.

11.3 Soil contamination results

11.3.1 The soil contamination test results are summarised in the tables on pages 24 to 28.

11.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix J to this report.

Summary of degree of soils contamination (inorganics)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens** end-use.												
			pH	As ∞	B~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg*	Ni	Se	Vn	Zn$	CV	Asbestos
				37	5	26	4000	100	200	199	109	434	584	200	2	
TP06	2.20	Colliery Spoil	-	-	-	-	-	-	-	-	-	-	-	-	**22.5**	**-**
TP09	0.80	Colliery Spoil	5.4	**97**	0.3	< 0.1	7.3	37	46	0.2	15	0.6	21	58	**15.7**	N.D.
TP13	0.50	Colliery Spoil	5.7	**53**	0.4	< 0.1	14	44	58	0.1	23	0.6	22	68	-	N.D.
TP13	2.90	Colliery Spoil	4.2	**150**	0.7	0.1	15	60	44	0.1	36	1.5	39	48	**8.3**	N.D.
TP14	0.80	Colliery Spoil	5.7	**80**	0.6	0.4	12	65	62	0.2	24	< 0.5	26	**240**	-	N.D.
TP15	0.70	Colliery Spoil	4.7	34	0.3	< 0.1	16	35	29	0.1	23	0.8	24	63	**4.5**	N.D.
TP15	2.50	Colliery Spoil	5.1	35	0.4	0.1	16	34	26	0.1	39	1	23	68	-	**-**
TP16	0.90	Colliery Spoil	4.1	**90**	1.9	< 0.1	28	57	41	< 0.1	19	< 0.5	51	52	-	**-**
TP17	0.50	Colliery Spoil	6.2	**69**	0.4	0.2	15	67	50	0.1	45	< 0.5	48	63	**7.8**	N.D.
TP21	1.70	Colliery Spoil	3.8	**230**	0.5	< 0.1	16	74	56	0.3	17	2	36	30	**7.9**	N.D.
TP22	1.00	Colliery Spoil	3.5	**210**	0.6	< 0.1	10	46	43	0.2	8.8	1.9	22	24	**9.7**	N.D.
TP11	1.40	Demolition Rubble	7.8	**43**	0.5	0.2	15	**190**	**200**	0.1	22	0.6	34	140	-	N.D.
TP03	0.60	Granular Made Ground	6.8	**48**	1	0.3	32	61	120	0.2	20	< 0.5	38	100	-	N.D.
TP04	0.50	Granular Made Ground	6.8	31	0.9	0.4	28	58	85	0.8	18	< 0.5	38	170	-	N.D.
TP11	0.60	Granular Made Ground	7.4	27	0.3	0.1	13	40	71	0.1	21	0.6	26	54	-	N.D.
TP12	0.30	Made Ground Topsoil	7.0	**37**	1.1	0.7	29	**120**	170	0.2	24	0.7	40	**220**	-	N.D.
TP13	0.10	Made Ground Topsoil	6.1	**59**	1.2	0.4	13	55	110	0.2	19	0.6	32	140	-	N.D.
TP14	0.20	Made Ground Topsoil	5.9	**110**	0.7	0.2	13	78	86	0.2	24	1.3	38	88	-	N.D.
TP16	0.20	Made Ground Topsoil	5.6	**64**	0.6	0.5	14	55	85	0.3	17	0.5	25	**220**	-	N.D.
TP19	0.20	Made Ground Topsoil	5.7	**61**	0.9	0.5	14	47	130	0.2	16	0.7	30	120	-	N.D.
TP20	0.10	Made Ground Topsoil	6.5	**64**	1	0.6	18	79	180	0.2	20	< 0.5	37	**330**	-	N.D.

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens** end-use.												
			pH	As ∞	B~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg*	Ni	Se	Vn	Zn$	CV	Asbestos
				37	5	26	4000	100	200	199	109	434	584	200	2	
TP22	0.20	Made Ground Topsoil	6.4	**130**	0.7	0.2	15	79	160	0.3	21	1.5	45	140	-	N.D.
TP12	2.20	Made Ground Topsoil	6.1	**52**	0.7	0.2	14	66	63	0.2	36	0.8	33	75	-	N.D.
TP02	0.20	Topsoil	5.9	**48**	0.6	0.2	17	49	74	0.1	16	< 0.5	39	170	-	N.D.
TP03	0.20	Topsoil	7.1	**58**	0.7	0.5	20	69	120	0.2	25	< 0.5	41	110	-	N.D.
TP05	0.10	Topsoil	6.2	**46**	0.7	0.5	44	57	90	0.3	21	< 0.5	36	96	-	N.D.
TP06	0.20	Topsoil	6.4	**45**	0.6	0.4	35	53	96	0.2	23	< 0.5	41	100	-	N.D.
TP07	0.20	Topsoil	5.8	**45**	1.1	0.6	50	59	92	0.4	23	0.6	40	120	-	N.D.
TP08	0.20	Topsoil	4.6	30	0.4	0.1	16	35	31	0.1	19	< 0.5	24	48	-	N.D.
TP10	0.30	Topsoil	6.6	**44**	1.5	0.4	19	54	80	6.4	20	0.8	39	110	-	N.D.

Key	
36	Parameter tested for and found to be in excess of Tier 1 value.
179	Parameter tested for and found to be > 5 x Tier 1 value.
12	Parameter tested for but not found to be in excess of Tier 1 value.
	Parameter not tested for.
♣	Tier 1 Value is pH dependent.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.
ND	No fibres detected (asbestos screen)

Source of guidance trigger level	
With the exception of those annotated with one of the symbols below (∞, $, ~), all Soil Screening Values in brackets above have been derived using CLEA v1.071.	
∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
$	MAFF. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
~	Engineering judgement (Lithos). Boron is a phytotoxic, although most phytotoxic compounds can pose a risk to human health if sufficient concentrations are present. However, plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.

Summary of degree of soils contamination (organics - Topsoil)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens (and no cover)** end use					
			% TOC	PAH		TPH - C6 to C40		
				B(a)P ∞	Naphthalene	GRO~ C_6 to C_{10}	DRO◊ C_{10} to C_{21}	LRO C_{21} to C_{40}
				5	6	22	215	3299
TP02	0.2	Topsoil	9.9	0.1	< 0.1	-	-	-
TP03	0.2	Topsoil	9.9	0.14	< 0.1	< 0.1	<33	144
TP05	0.1	Topsoil	7.5	< 0.1	< 0.1	-	-	-
TP06	0.2	Topsoil	6.4	0.1	< 0.1	-	-	-
TP07	0.2	Topsoil	8.4	< 0.1	< 0.1	-	-	-
TP08	0.2	Topsoil	9.4	< 0.1	< 0.1	-	-	-
TP10	0.3	Topsoil	8.1	0.1	< 0.1	-	-	-

Key		Source of guidance trigger level	
60	Parameter tested for and in excess of Tier 1 concentration.	All Soil Screening Values in brackets above have been derived using CLEA v1.071. Values assume contaminants located in a sandy loam, with 6% soil organic matter (SOM).	
0.3	Parameter tested for but not in excess of Tier 1 concentration.	~	Assumes all GRO is aromatic fraction C7 to C8.
	Contaminant not tested for.	◊	Assumes all DRO is aliphatic fraction C10 to C12.
		∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).

Summary of degree of soils contamination (organics – Made Ground)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens and 600mm** cover end use					
			% TOC	PAH		TPH - C6 to C40		
				B(a)P ∞	Naphthalene	GRO~ C_6 to C_{10}	DRO◊ C_{10} to C_{21}	LRO C_{21} to C_{40}
				25	6	23	218	5000
TP09	0.8	Colliery Spoil	35.0	0.04	0.05	< 0.1	142	100
TP13	0.5	Colliery Spoil	15.0	< 0.03	< 0.03	< 0.1	52	23
TP13	2.9	Colliery Spoil	21.0	< 0.03	< 0.03	< 0.1	<30	<20
TP14	0.8	Colliery Spoil	19.0	< 0.03	< 0.03	< 0.1	25	28
TP15	0.7	Colliery Spoil	12.0	< 0.03	< 0.03	< 0.1	<32	<20
TP15	2.5	Colliery Spoil	11.0	< 0.03	< 0.03	< 0.1	24	<24#
TP16	0.9	Colliery Spoil	< 0.5	< 0.03	< 0.03	< 0.1	<30	<20
TP17	0.5	Colliery Spoil	23.0	< 0.03	< 0.03	< 0.1	<30	<20
TP21	1.7	Colliery Spoil	20.0	< 0.03	< 0.03	< 0.1	53	37
TP22	1.0	Colliery Spoil	20.0	< 0.03	0.03	< 0.1	33	32
TP11	1.4	Demolition Rubble	7.0	9.5	0.45	< 0.1	**573**	1367
TP03	0.6	Granular Made Ground	10.0	0.1	< 0.03	< 0.1	<36	107
TP04	0.5	Granular Made Ground	7.7	0.24	< 0.03	< 0.1	25	355
TP11	0.6	Granular Made Ground	8.1	< 0.03	< 0.03	< 0.1	30	<31
TP12	0.3	Made Ground Topsoil	16.0	0.13	< 0.03	< 0.1	44	100
TP13	0.1	Made Ground Topsoil	20.0	0.07	< 0.03	< 0.1	44	153
TP14	0.2	Made Ground Topsoil	20.0	0.05	< 0.03	< 0.1	46	50
TP16	0.2	Made Ground Topsoil	17.0	0.19	0.03	< 0.1	45	137
TP19	0.2	Made Ground Topsoil	18.0	0.06	< 0.03	< 0.1	<34	62
TP20	0.1	Made Ground Topsoil	14.0	0.49	< 0.03	< 0.1	48	72
TP22	0.2	Made Ground Topsoil	18.0	0.26	< 0.03	< 0.1	36	34

Key		Source of guidance trigger level	
60	Parameter tested for and in excess of Tier 1 concentration.	All Soil Screening Values in brackets above have been derived using CLEA v1.071. Values assume contaminants located in a sandy loam, with 6% soil organic matter (SOM).	
0.3	Parameter tested for but not in excess of Tier 1 concentration.	~	Assumes all GRO is aromatic fraction C7 to C8.
	Contaminant not tested for.	◊	Assumes all DRO is aliphatic fraction C10 to C12.
		∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).

11.4 Inorganic determinands

11.4.1 Of the 11 samples of Colliery Spoil, 1 sample of Demolition Rubble, 3 samples of Granular Made Ground, 9 samples of Made Ground Topsoil and 6 samples of Topsoil analysed for inorganic parameters, 5 can be classified as uncontaminated and 25 could be classified as contaminated.

11.4.2 These samples have been classified by comparison with Tier 1 Soil Screening Values for an end use including domestic gardens and any area where plants are to be grown (the most sensitive of proposed end-uses).

11.4.3 The most common contaminants are arsenic (max. concentration of 230mg/kg in TP21 at 1.7m depth), copper (max. concentration of 190mg/kg in TP11 at 1.4m depth), lead (200mg/kg in TP11 at 1.4m depth) and zinc (max. concentration 330mg/kg in TP20 at 0.1m depth).

Arsenic

11.4.4 Current UK guidance regarding the statistical analysis of soil contamination data obtained during a site investigation is provided by CL:AIRE[3], and uses two-way confidence intervals and graphical summaries, to assist assessors when determining whether or not a dataset is adequate to answer the question posed; e.g. "is existing site topsoil suitable for retention & re-use?". To answer such a question, it is necessary to recover and test a large number of samples (a minimum of 10; ideally 20+) in order to undertake meaningful statistical analysis.

11.4.5 However, in the context of site investigation to assess the significance of contamination on brownfield sites which are typically underlain by heterogenous made ground, some remediation is almost always required (placement of soil cover, excavation of gross contamination etc). Consequently, in such circumstances, it is not usually necessary to demonstrate that made ground soils are "clean" and therefore there is no need to test large numbers of samples and undertake statistical analysis. Heterogenous made ground sample results can simply be compared directly with appropriate screening values (e.g. Lithos Tier 1 values).

11.4.6 The difference between the old and new approaches, including how Lithos apply the statistical assessment is detailed in Generic Note 04, included as Appendix A to this report.

11.4.7 Statistical analysis of Demolition Rubble and Granular Made Ground cannot be undertaken due to insufficient samples.

11.4.8 However, Lithos can confirm that statistical assessment of Colliery Spoil, Made Ground Topsoil and Topsoil is appropriate because:

- There is a well understood, robust CSM which identifies possible source areas
- Sampling locations are relatively evenly spread across the site and only random sample data has been included in the assessment
- Samples are considered by strata type
- Although a minimum of 10 samples was not taken from each strata type, each material type was consistent across the areas where the samples were taken.

11.4.9 Statistical analysis assumes that a given stratum is reasonably homogenous in terms of composition, the distribution of contaminants and the degree of contamination; the CSM indicates that this is a reasonable assumption at this site.

11.4.10 The Dot and Box Plots are presented in Appendix K and the results are summarised below.

[3] *CL:AIRE, 2020.Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration.*

Made Ground -Colliery Spoil & Made Ground Topsoil

Contaminant	Critical concentration	Mean	Upper confidence level (95%)	Lower confidence level (5%)	Range of 'true' mean	Mean lies above critical concentration (Y/N)
Colliery Spoil - Arsenic	37	**120**	178	71	**71-178**	Y
Made Ground Topsoil -Arsenic	37	**75**	98	54	**54-98**	Y

All concentrations are in mg/kg
Notes: Values in **bold** indicate that the true mean range exceeds the relevant Tier 1 value.

Natural Ground - Topsoil

Contaminant	Critical concentration	Mean	Upper confidence level (95%)	Lower confidence level (5%)	Range of 'true' mean	Mean lies above critical concentration (Y/N)
Arsenic	37	**43**	50	38	**38-50**	Y

All concentrations are in mg/kg
Notes: Values in **bold** indicate that the true mean range exceeds the relevant Tier 1 value.

11.4.11 Statistical analysis indicates that the true mean for Arsenic in Topsoil, Made Ground Topsoil and Colliery Spoil is elevated compared with relevant Lithos tier 1 screening values.

11.4.12 Colliery Spoil, Made Ground Topsoil, Demolition Rubble and Granular Made Ground are not considered to be suitable for placement in garden areas given the presence of undesirable surface materials (clinker, ash, brick, burnt shale etc). Therefore, these soils will need isolating beneath clean cover or beneath surface hardstanding and no further analysis of arsenic contamination is considered necessary.

11.4.13 However, topsoil, which was only encountered in Area B, is considered suitable for re-use in terms of textural classification. Therefore, further analysis of arsenic via bio-accessibility testing was undertaken on the three samples of topsoil with the highest arsenic concentrations.

Bio-accessibility (Arsenic)

11.4.14 Bio-accessibility laboratory analysis is performed using a physiologically based extraction test (PBET), with subsequent analysis of the extract for arsenic. The laboratory analysis is based on the arsenic bio-accessibility calculation methodology outlined by Ruby et al (1996) and developed by BARGE (Bio-accessibility Research Group Europe).

11.4.15 The CLEA model used to derive the C4SL of 37mg/kg assumes that 100% of the arsenic present in the soil is accessible to be absorbed in the digestive tract, i.e. 100% of the arsenic in the soil could be absorbed and metabolised in the body.

11.4.16 In reality, arsenic may either be strongly bound to the surface of the soil within the crystalline lattice of soil minerals, or be present in an insoluble form. Consequently, not all of the "total" arsenic identified within a soil sample may be in the bio-accessible or potentially harmful form.

11.4.17 Given the proposed end use of this development (residential dwellings with gardens), and the potential use of topsoil (i.e. at surface in gardens), the key exposure pathway for arsenic is oral ingestion (90%), although consumption via home grown produce also contributes to exposure from Arsenic (8.5%)

Laboratory results:

Sample	Total As (mg/kg)	Gastric bio-accessibility (% As)	Gastro Intestinal bio-accessibility (% As)
TP03, 0.2m	58	1.2	2.0
TP02, 0.2m	48	1.3	2.7
TP05, 0.1m	46	1.2	2.4

11.4.18 The 3 samples returned a maximum bio-accessible fraction of arsenic at 2.7%. A conservative estimate of a maximum bio-accessible fraction of arsenic at 3% was input into the CLEA model and a site-specific screening value of 359mg/kg for arsenic was generated.

11.4.19 As a sensitivity check, a bio-accessible fraction of arsenic at 6% and 10% was also inputted into the CLEA model, which generated additional site-specific screening values of 238mg/kg and 220mg/kg respectively.

11.4.20 Consequently, the soil identified at this site is considered suitable for use as garden topsoil, despite recording a maximum "total" arsenic concentration in excess of the C4SL screening value of 37mg/kg.

11.4.21 Due to the site-specific risk assessment with regard to re-use of topsoil here, there will be implications relating to removal of topsoil off-site for disposal or re-use on a different development. Topsoil is not considered chemically suitable for re-use off-site.

Lead

11.4.22 Elevated lead (200mg/kg) was identified in TP11 at 1.4m depth, associated with the demolition rubble encountered within this area.

11.4.23 Given the demolition rubble was only encountered in a single trial pit, and appears to be localised, the demolition rubble should be 'chased out' by excavation and placed beneath hardstanding, or isolated beneath at least 600mm clean soil cover.

Copper and Zinc

11.4.24 Two elevated concentrations of copper (190mg/kg and 120mg/kg) were identified in TP11 at 1.4m and TP12 at 0.3m.

11.4.25 Zinc and copper are phytotoxic metals; phytotoxicity describes the inhibitive and toxic effect high concentrations of some substances can have on plant growth.

11.4.26 Most substances are harmful to human health at lower concentrations than would be detrimental to plant growth. However, there are three notable exceptions - boron, copper and zinc. Plants are the more sensitive receptor to these elements i.e. detrimental effects are seen in plants at concentrations which do not present a risk to human health. Consequently, for zinc and copper, consideration and protection of flora would also be protective of human health.

11.4.27 Allowable concentrations of heavy metals in arable soils are set out in Defra's Code of Good Agricultural Practice 2009[4]. For example, the value for zinc is 200mg/kg, and is based on a continued annual application of heavy metal rich fertiliser (sludge); as such it is not representative of activity in a standard UK garden.

[4] *Defra – Protecting our Water, Soil & Air – A Code of Good Agricultural Practice for farmers, growers and land managers. 2009*

11.4.28 Lithos have also derived values for zinc and copper in relation to risks to human health, using the CLEA model, assuming a residential end use with consumption of home grown produce in a sandy loam soil with 6% SOM. The reported values are 2,170mg/kg for zinc and 2,400mg/kg for copper, ten times greater than the potential phytotoxic concentration.

11.4.29 On balance, given the context of a residential development and the concentrations recorded, zinc and copper are not considered significant and no special remedial measures are considered necessary.

Calorific value

11.4.30 The calorific value of 7 samples of Colliery Spoil, have yielded an average CV of 10.9 MJ/kg. Materials whose CVs exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn.

11.4.31 To determine the likelihood of the material burning, the samples of Colliery Spoil were scheduled for Cairney Combustion Susceptibility Testing. The test involves applying a heat source (i.e. Bunsen burner flame) and grading the samples from A to F depending on the reaction, with A meaning the sample burns vigorously and F meaning it does not glow (i.e. it is inert).

11.4.32 The 3 samples tested yielded results of C to D indicating the sample ignites but does not continue to burn on removal of the heat source.

Asbestos

11.4.33 No asbestos fibres were identified in any of the 27 samples screened.

Organic determinands

11.4.34 Area A is brownfield and underlain by made ground which has yielded elevated concentrations of a number of inorganic determinands. Consequently, for organic compounds, the Tier 1 Soil Screening Values used in this report have been derived with reference to a CSM that assumes a minimum 600mm of clean soil cover will be placed in gardens/landscaped areas (Lithos Scenario B).

11.4.35 Area B is essentially greenfield and therefore for organic compounds, the Tier 1 Values used in this report have been derived with reference to a CSM that assumes a residential with gardens end use, with no clean soil cover will be placed in gardens/landscaped areas (Lithos Scenario A).

11.4.36 Lithos have used the CLEA model to derive risk-based screening values for hydrocarbons, in accordance with the methodology detailed by the TPHCWG, and reviewed by a UK workshop of experts with respect to UK adoption of the method.

11.4.37 However, these screening values assume a Soil Organic Matter (SOM) of 6% (equivalent to a TOC of 3.5%). Many organic contaminants are more mobile when the SOM is lower, and consequently comparison of soil results with lower screening values may be required.

11.4.38 In order to check the validity of Lithos' Tier 1 Soil Screening Values, the average TOC for each common fill type (beyond any areas of obvious hydrocarbon impact) have been determined.

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Colliery Spoil	>5%	No
Demolition Rubble		
Granular Made Ground		

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Made Ground Topsoil		
Topsoil		

Hydrocarbons (TPH & PAH)

Demolition Rubble

11.4.39 A single elevated concentration of TPH was identified in TP11 at 1.4m depth (demolition rubble). During the investigation, a strong hydrocarbon odour was also noted in this exploratory hole.

11.4.40 Demolition Rubble was only encountered within TP11 and appeared to be isolated within the footprint of a former colliery building. It is therefore not considered to be representative of material across the site.

11.4.41 No fuel sources were identified within the vicinity of TP11 during the desk study phase, or during the site walkover, therefore it is likely that this contamination is localised.

11.4.42 Typically, assessment of TPH where olfactory evidence of hydrocarbons has been identified would be undertaken in accordance with a 3-step approach, (outlined in Generic Note 04 in Appendix A).

11.4.43 However, given that the contamination appears to be localised to a single ground type, was only encountered in one trial pit, is not considered representative of other ground types across site and contains large obstructions (i.e. brick walls, concrete etc) that are not considered suitable as near surface materials; it is clear remediation will be required and no further assessment of the TPH contamination is considered necessary.

All other ground types

11.4.44 Given the absence of visual/olfactory evidence of any hydrocarbon contamination across the majority of the site, only a simple banded TPH (cf full speciation) was initially scheduled on 22 samples of soil taken across the site.

11.4.45 Assessment of TPH associated with a fuel/oil source would normally be undertaken in accordance with a 3-step approach, (outlined in Generic Note 04 in Appendix A) on fully speciated TPH results. However, although only banded TPH analysis has been scheduled here, 21 of the 22 fractions did not exceed their respective Tier 1 criteria, even if it is conservatively assumed all of each fraction is either aliphatic or aromatic.

Polycyclic Aromatic Hydrocarbons (PAH)

11.4.46 There are numerous PAH compounds. The USEPA identified 16 PAHs that are considered to represent the most problematic in terms of toxicology, fate and behaviour. The UK have also focused on these 16 and these are included in the laboratory report where speciated PAH analysis has been scheduled.

11.4.47 Speciated PAH analysis has been undertaken in order to determine concentrations of the key "marker" compounds: benzo(a)pyrene (considered the most toxic of the PAHs); and naphthalene (the most mobile and volatile of the PAHs).

11.4.48 Speciated analysis has confirmed the absence of significant concentrations of both benzo(a)pyrene and naphthalene in the soils beneath this site.

11.5 Topsoil

11.5.1 Topsoil typically 300mm thick is present across **Area B**. Testing suggests this material is chemically suitable for re-use.

11.5.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth.

BS3882 Topsoil testing

11.5.3 The clay/sand/silt content of 3 topsoil samples recorded from Area B, have been determined to check compliance with BS3882[5] requirements.

11.5.4 The presence of visible contaminants, sharps (glass etc) was assessed by the Engineer in the field (inspection of initial trial pit arisings; none were identified. BS3882 considers visual contaminants to comprise 'undesirable potentially injurious foreign object(s) visible to the naked eye'.

11.5.5 All three samples assessed were taken from the eastern field where the topsoil appeared suitable for re-use. Topsoil within the **western** field will **not** be suitable for re-use given the number of unsuitable materials within the soil (e.g. brick, clinker, ash).

11.5.6 It should be noted that this is a reduced suite of analysis, and no N-P-K etc. testing has been undertaken.

11.5.7 The results are summarised below:

Parameter	BS3882 Specification	TP02, 0.2m	TP07, 0.2m	TP08, 0.2m
Retained on 2mm sieve	< 30%	28	4	10
Retained on 20mm sieve	< 10%	**13**	1	0
Retained on 50mm sieve	0%	0	0	0
Clay content	5 to 35%	8	13	15
Silt content	0 to 65%	20	28	29
Sand content	0 to 90%	44	55	46
Visible contaminants	< 0.5%	0	0	0

Note: Values in **bold** type fail the required specification for multipurpose topsoil

11.5.8 The above results suggest that the topsoil at this site generally complies to the standards set out in BS3882. In terms of textural classification, the topsoil falls into the 'clay loam' class.

12 CONTAMINATION (QUALITATIVE RISK ASSESSMENT & REMEDIATION)

12.1 Topsoil

12.1.1 Topsoil, typically 300mm thick underlies Area B. Testing suggests this material is chemically suitable for re-use.

12.1.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth.

[5] *BS3882:2015. Specification for topsoil. Published by BSI Standards Limited.*

12.2 Made Ground Topsoil

12.2.1 Made Ground Topsoil is present in Area A. This material contains materials which are not considered desirable surface materials (e.g. children's toys, clinker, brick, metal etc). Given the compressible nature and gas-generating potential of this material if buried at depth, it is recommended that it is placed in garden areas and/or POS, immediately beneath the proposed 600mm cover, and that it is overlain by no more than 1m of soil.

12.3 Summary of significant contamination

Area A

12.3.1 Granular Made Ground was also identified within two trial pits in Area A, within the footprint of a former sewage works. This made ground did not contain any elevated concentrations of inorganic or organic contamination.

Area B

12.3.2 Deep made ground has been identified within Area B (former quarry & colliery), up to a maximum thickness of 6.1m.

12.3.3 This made ground typically comprises Colliery Spoil (ashy Gravel of coal, mudstone and clinker), overlain by Made Ground Topsoil. Demolition Rubble and Granular Made Ground was also locally encountered within Area B.

12.3.4 All made ground types identified within Area B contained elevated concentrations of inorganic contaminants, including one elevated concentration of TPH and a hydrocarbon odour in TP11.

12.3.5 Given the above, made ground encountered within Area B is not considered suitable for re-use and some remediation will be required.

12.4 Revised conceptual ground model (contamination)

12.4.1 The Preliminary Conceptual Site Model has been amended in light of data obtained during the ground investigation, most notably with respect to the distribution of made ground and contaminants.

12.4.2 A revised Conceptual Site Model is presented as Drawing 4511/7 in Appendix B. The Model includes the contaminants described in Section 12.3 above, and potential contaminant linkages (summarised below in Section 12.6) to receptors.

12.5 Environmental setting & end use

12.5.1 As discussed in Section 12.3 above, contamination exists in the soil beneath this site. In order to assess the significance of this contamination, consideration must be given to the site's environmental setting and the proposed end use.

12.5.2 The underlying Pennine Lower Coal Measures is classified as a Secondary A aquifer. The nearest surface watercourse is Briestfield Beck which flows north along the site's eastern boundary. Therefore, the site's environmental setting is considered to be **moderate sensitivity**.

12.5.3 With respect to human health, the proposed end use (residential) is considered **sensitive**.

12.5.4 Transient risks to construction workers can be addressed by the adoption of appropriate health and safety measures, see Section 16.6.

12.6 Contaminant linkages

12.6.1 In terms of a proposed redevelopment of this site, plausible contaminant linkages can be summarised as follows.

Contaminants

12.6.2 Contaminants have been summarised in Section 12.3 above.

Pathways

12.6.3 Potential contaminant pathways include:

- Ingestion
- Dermal contact
- Inhalation of contaminated particulates
- Surface water run-off, including existing drainage infrastructure
- Downward infiltration of leachable/mobile contaminants to groundwater

Receptors

12.6.4 Potential contaminant receptors include:

- The environment – Secondary A aquifer and/or Briestfield Beck watercourse
- End users of the site (residents)

12.6.5 It can be concluded that there are plausible pathways between the soil contaminants summarised in Section 12.3 above and potential receptors. Consequently, some remediation will be required; either treatment/removal of the contaminant, or "breakage" of the pathway.

12.7 Potential remediation options

General

12.7.1 Approval of the recommendations given below should be sought from the appropriate regulatory authorities prior to commencement of site redevelopment.

Combustibility

12.7.2 The Colliery Spoil at this site yielded an average CV of 10.9 MJ/kg. To determine whether the material is combustible, Cairney Combustion Susceptibility Testing was undertaken. Results of the further testing indicated the samples ignite but do not continue to burn on removal of the heat source. Consequently, the Colliery Spoil is not considered combustible.

Inorganic contamination

12.7.3 Made ground (Colliery Spoil, Granular Made Ground and Made Ground Topsoil) encountered within Area A has yielded elevated concentrations of a number of metals; most notably Arsenic, Copper and Zinc. Therefore, where residual made ground remains beneath garden and landscaped areas (i.e. not beneath hardstanding) a **600mm** thick surface cover of "clean" soil comprising 500mm subsoil and 100mm topsoil is recommended. This cover will break potential contaminant linkages between the contaminated made ground and future end-users.

Organic contamination

12.7.4 As discussed in Section 12.3 above, hydrocarbon contamination has been encountered in TP11 (Area A). Such contaminants can be mobile and as such may pose a risk to the environment and human health.

12.7.5 Based on a qualitative review of the data obtained to date, it is considered that some grossly contaminated soil will require removal or treatment.

Groundwater & surface water

12.7.6 As discussed in Section 12.3 above, no significant water contamination has been encountered.

12.7.7 Groundworkers should make all necessary arrangements to prevent off-site migration of contaminants via surface water runoff, inadvertent groundwater disturbance and airborne dust.

12.8 Waste classification

Area A

12.8.1 Disposal of the made ground off site is generally not considered appropriate, economically viable, nor in line with current Government philosophy regarding sustainable development. However, some excess arisings may be generated by excavations for foundations, sewers etc. Disposal to landfill (or an appropriate soil / aggregate transfer station) may be the most practical solution, if redistribution and retention on site is not feasible.

12.8.2 Following excavation and stockpiling, sampling will be required prior to disposal.

12.8.3 As there is no WRAP protocol for soils, the characterisation, sampling and classification of soils arising from brownfield sites has been incorporated within the Environment Agency's Technical Guidance WM3[6]. Classification of soils as non-hazardous or hazardous in accordance with WM3 is quite a complex process, although it ultimately results in a simple classification as hazardous or non-hazardous. Note: inert is not a class under WM3; WAC testing is required to determine whether a waste soil can be considered inert.

12.8.4 If waste soil is classed as hazardous following classification under WM3, and destined for landfill, waste acceptance criteria (WAC) leachate testing will need to be undertaken. Similarly, if waste soil destined for landfill is classed as non-hazardous under WM3, and suspected to be inert, WAC leachate testing will need to be undertaken. However, non-hazardous soil waste can go to a non-hazardous landfill facility; no further testing (e.g. WAC) is required.

12.8.5 WAC analysis is different to the 'routine' laboratory testing (such as that included earlier in this Section) undertaken in order to determine hazardous properties. Lithos typically only include WAC analysis if significant off-site disposal (of soil classified as hazardous waste) is anticipated.

12.8.6 It is critical if material is to be exported from site that this is allocated an appropriate waste code, following the steps within WM3. Waste carriers transporting, and sites accepting, this material should have a corresponding code within their permits. It is the responsibility of those generating the waste (i.e. the Developer), to ensure that the waste is handled and disposed of appropriately.

[6] *Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015*

12.8.7 Soil treatment facilities (STFs) provide an alternative to landfill. STFs are regulated by the Environment Agency and allow soils to be treated and screened (effectively recycled to be used at other sites). Export to an STF does not require WAC testing and suitability of various soil types will be dependent on material waste codes, which may be allocated after consideration of the data in Section 12 but will often need supplementing with further testing after soils have been stockpiled (see also advice in Section 17.3).

12.8.8 Most STFs are permitted to accept soils with waste code 17 05 04 (i.e. soils which do not exhibit hazardous properties). Lithos has a list of permitted STFs and can help identify one local to this development site.

12.8.9 With respect to **asbestos**, waste soils will be classed hazardous if the soil mass contains more than 0.1% asbestos fibres that are free and dispersed. However, WM3 states that where the waste contains identifiable pieces of asbestos (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then the waste is hazardous if the concentration of asbestos in the pieces alone is 0.1%. If a stockpile of soil contained rare fragments of broken asbestos-cement sheeting, the whole stockpile would be classed as hazardous unless all the fragments could be picked-out (even though the concentration of asbestos in the soil mass might be orders of magnitude less than 0.1%).

Area B

12.8.10 Some excess arisings (topsoil & subsoil) may be generated by excavations for foundations, sewers etc. If these are intended for retention and reuse on the site, they would be classed as clean naturally occurring soils and would not be considered waste, under the Waste Framework Directive.

12.8.11 Off-site disposal of surplus clean naturally occurring soils to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[7] any excess natural soil arisings should be suitable for Direct Transfer to another development site, for use either as clean cover material, or bulk fill, without the need for waste legislation to be applied.

13 HAZARDOUS GAS

13.1 General

13.1.1 Consideration of the conceptual site model and potential linkages has enabled a preliminary qualitative assessment of risks associated with gas:-

Source	Receptors	Hazard	Pathway	Initial risk
On-site made ground	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Low**: made ground essentially inert, with little degradable matter
	Buildings	Explosion		
Off-site backfilled opencast (directly east)	Human health	Asphyxiation & explosion	Lateral migration, ingress & accumulation	**Low**: no significant thickness of low permeability soils.
	Buildings	Explosion		
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Low**: no significant thickness of low permeability drift or bedrock above workings
	Buildings	Explosion		

[7] *The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.*

13.1.2 Given the above gas monitoring wells have been installed in 6 boreholes across the site. Details of the installations are given on the probehole logs presented in Appendix G to this the report.

13.1.3 The generation potential of the gas source was initially considered to be Low and this has been confirmed by the monitoring results obtained to date. Consequently, in accordance with CIRIA Report C665[8], given the proposed residential end use, 9 visits have been scheduled.

13.2 Scope of works

13.2.1 To date, the wells have been monitored on one occasion for groundwater levels and soils-gases, and the results are presented in Appendix M.

13.2.2 A standard procedure was followed, in accordance with CIRIA guidance:

- Ambient oxygen concentration
- Atmospheric temperature & pressure
- Methane, oxygen and carbon dioxide concentrations and flow rates using a Gas Data GFM436 infra-red gas analyser
- Standing water level using a dipmeter
- Ambient oxygen concentration (check for instrument drift)

13.3 Monitoring results

13.3.1 The results of the monitoring completed to date are summarised below.

Well	Response zone	methane concentrations (% v/v)	carbon dioxide concentrations (% v/v)	Range of steady flow rates (litre/hour)
PH01a	3.0 – 6.0m (mudstone)	ND	3.4	ND
PH02	2.0 – 3.0m (mudstone)		0.1	
PH03	4.5 – 7.5m (mudstone)		ND	
PH05a	3.0 – 6.0m (sandstone & mudstone)		1.5	
PH07a	3.0 – 6.0m (colliery spoil)		1.3	
PH08a	3.0 – 6.0m (sandstone & mudstone)		2.5	

13.4 Discussion (methane & carbon dioxide)

13.4.1 Generic Note 05 in Appendix A outlines how monitoring results are interpreted.

13.4.2 To date, no significant concentrations of methane or carbon dioxide have been recorded in any boreholes.

13.4.3 A hazardous gas risk assessment incorporating all of the results will be issued on completion of monitoring in May 2023.

[8] *CIRIA C665: Assessing risks posed by hazardous ground gases to buildings (2007).*

13.5 Radon

13.5.1 Requirements with respect radon measures are set out in Building Regulations Approved Document C. Probability bandings (based on the proportion of properties in a given area that exceed the Action Level; currently 200 Bq.m^{-3}) are used to determine whether a property requires no, basic or full measures.

13.5.2 At present Approved Document C advocates basic measures for the probability banding 3% to 10% (full measures if >10%). However, Public Health England would like to see all new build include basic measures.

13.5.3 The Public Health England UK radon map and the Landmark report indicate that the site is in an area where **less than 1%** of homes are estimated to be above the action level.

13.5.4 Consequently, basic radon protection measures are not required. However, in light of Public Health England advice, the Developer might consider providing all new dwellings with basic radon protection measures.

14 GEOTECHNICAL TESTING

14.1 General

14.1.1 A total of 23 samples of soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

14.1.2 The geotechnical laboratory test results are presented in Appendix L to this report.

14.2 Atterberg limits

14.2.1 The plasticity indices of 15 samples of cohesive soil have been determined; results are summarised below.

Soil type	No. samples tested	Moisture content range % (average)	Range of Plasticity Indices % * (average)	Shrinkability
Cohesive Residual Soil	9	20-36 (25)	18-26 (22)	Medium
Colliery Spoil	4	10-19 (16)	5-11 (8)	Low
Reworked Natural Ground	2	12	7-12 (9)	Low

* Modified where appropriate in accordance with Chapter 4.2 of the NHBC Standards

Note. The term Shrinkability is equivalent to the term Volume Change Potential used in Chapter 4.2.

14.2.2 For the purposes of foundation design, it is recommended that all cohesive soils be regarded as being of **Medium** shrinkability.

14.3 Particle size distribution

14.3.1 The grading of 4 samples of Colliery Spoil and 1 sample of Reworked Natural Ground has been determined by wet sieving and the results are summarised in the table below:

Sample & depth	Field description	% passing 37.5mm sieve	% passing 20mm sieve	% passing 2mm sieve	% fines	Material description (based on grading & plasticity)
TP09, 2.8m	Clayey slightly sandy fine to coarse GRAVEL. (Colliery Spoil)	80	57	37	24	Sandy, clayey GRAVEL.

Sample & depth	Field description	% passing 37.5mm sieve	% passing 20mm sieve	% passing 2mm sieve	% fines	Material description (based on grading & plasticity)
TP12, 1.3m	Ashy fine to coarse GRAVEL. (Colliery Spoil).	97	91	64	24	Very sandy very clayey GRAVEL.
TP13, 3.0m	Ashy fine to coarse GRAVEL. (Colliery Spoil).	100	84	54	28	Very sandy very clayey GRAVEL.
TP14, 1.1m	Ashy fine to coarse GRAVEL. (Colliery Spoil).	75	66	47	26	Very sandy very clayey GRAVEL.
TP15, 1.5m	Sandy fine to coarse GRAVEL with a low cobble content. (Reworked Natural Ground).	90	79	44	26	Very clayey, sandy GRAVEL.

14.3.2 NHBC Chapter 4.2 considers shrinkable soils to be those containing more than 35% fines and having a Modified Plasticity Index greater than 10%.

14.3.3 Fines (silt and clay) were found to comprise between 24% and 28% (average 26%) of the material sampled. Therefore, the Colliery Spoil encountered on this site can therefore be regarded as non-shrinkable.

14.3.4 The Reworked Natural Ground was found to contain 26% fines and can also be regarded as non-shrinkable.

14.4 Soluble sulphate and pH

14.4.1 In accordance with BRE SD1[9], this site has been classified as brownfield with a mobile groundwater regime.

14.4.2 It is envisaged foundations will extend through made ground and natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).

14.4.3 The concentrations of sulphate in the aqueous natural soil extracts of 12 samples of residual soils were determined. In addition, 10 samples of made ground were tested as part of the contamination suite. The pH value of each sample has also been determined.

14.4.4 The highest water-soluble sulphate concentration and the lowest pH value for each soil type analysed are shown in the table below.

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Cohesive Residual Soil	9	4.3	58
Granular Residual Soil	3	5.1	28
Colliery Spoil	10	3.5	82

14.4.5 Samples yielded pH values below 5.5, therefore supplementary analysis to determine the concentrations of magnesium, chloride and nitrate is typically considered. The 10 colliery spoil samples yielded magnesium, chloride and nitrate results of less than 10mg/l, and consequently the equivalent sulphate concentrations are negligible.

[9] *BRE Special Digest 1 (2005) – Concrete in aggressive ground.*

14.4.6 It is considered the soluble sulphate concentrations for both the Cohesive and Granular Residual Soils are low enough that magnesium, chloride and nitrate does not need considering.

14.4.7 In accordance with Tables C1 and C2 of SD1, sub-surface concrete should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-4z** in Colliery Spoil and Cohesive Residual Soil and **AC-3z** in Granular Residual Soil.

14.5 Compaction tests

14.5.1 Laboratory compaction tests are useful wherever ground improvement is anticipated, for example to provide a satisfactory CBR beneath proposed highways.

14.5.2 In accordance with BS5930[10] engineered fill is defined as material which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.

14.5.3 Grading and moisture content control the degree to which materials can be effectively compacted. If the grading or moisture content of an in-situ material is not suitable to facilitate its compaction then screening, wetting, or lime addition may be required.

14.5.4 Laboratory compaction testing was scheduled on 4 samples of colliery spoil and 1 sample of Reworked Natural Ground (using a 4.5kg rammer) to determine their suitability for re-engineering.

14.5.5 Laboratory compaction tests are only appropriate if:

- At least 90% of the material passes the 37.5mm sieve; and/or
- At least 70% of the material passes the 20mm sieve

14.5.6 It is apparent from the gradings tabulated, that the samples scheduled for compaction tests are suitable (i.e. at least 70% of the material is finer than 20mm).

14.5.7 The material particle density (Gs) is required in order to plot the 0, 5 and 10% air voids lines on the compaction graph for each material type.

14.5.8 The results are summarised in the tables below:

Sample location & depth	Material description	% passing 37.5mm sieve	% passing 20mm sieve
TP09, 2.8m	Sandy, clayey GRAVEL (Colliery Spoil).	80	77
TP12, 1.3m	Very sandy very clayey GRAVEL (Colliery Spoil).	97	94
TP13, 3.0m	Very sandy very clayey GRAVEL (Colliery Spoil).	100	84
TP14, 1.1m	Very sandy very clayey GRAVEL (Colliery Spoil).	75	91
TP15, 1.5m	Very clayey, sandy GRAVEL (Colliery Spoil).	91	89

Sample location & depth	Material description	Gs (Mg/m^3)	MDD (Mg/m^3)	OMC (%)	Allowable mc range for 95% MDD & <5% air voids	Typical in-situ moisture content (%)
TP09, 2.8m	Sandy, clayey GRAVEL (Colliery Spoil).	2.65	1.81	12	12 – 17	16

[10] *BS5930 (2015) - Code of practice for ground investigations.*

Sample location & depth	Material description	Gs (Mg/m³)	MDD (Mg/m³)	OMC (%)	Allowable mc range for 95% MDD & <5% air voids	Typical in-situ moisture content (%)
TP12, 1.3m	Very sandy very clayey GRAVEL (Colliery Spoil).	2.18	1.43	18	17 – 21	
TP13, 3.0m	Very sandy very clayey GRAVEL (Colliery Spoil).	2.24	1.45	19	18 – 23	
TP14, 1.1m	Very sandy very clayey GRAVEL (Colliery Spoil).	2.12	1.43	16	16 – 20	
TP15, 1.5m	Very clayey, sandy GRAVEL (Reworked Natural Ground).	2.41	1.72	12	11 – 16	12

14.5.9 It is apparent that the in-situ moisture content of both the Colliery Spoil and Reworked Natural Ground is generally within the allowable moisture content range to achieve 95% MDD and less than 5% air void. On this basis it is considered that both the Colliery Spoil and Reworked Natural Ground is generally suitable for re-engineering.

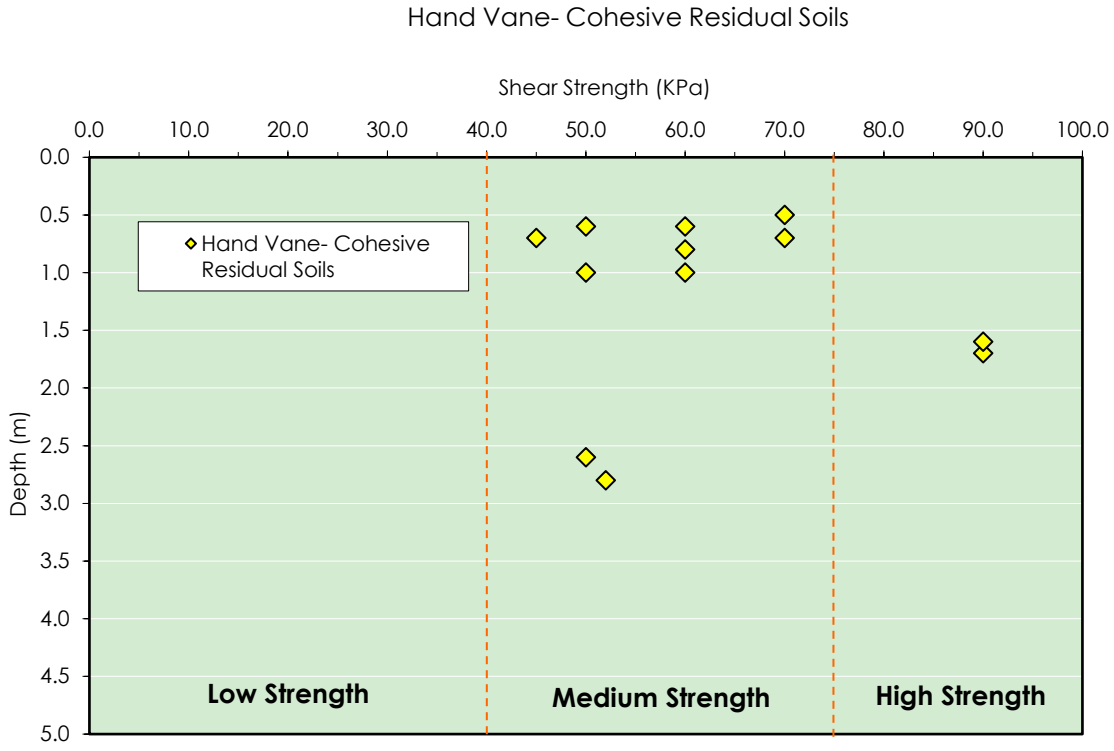
14.6 Undrained shear strength testing

Hand shear vane testing

14.6.1 Hand shear vane testing was undertaken within trial pits in-situ to around 1.0m depth and from larger blocks of excavated clay below that depth.

14.6.2 The results are summarised within the plot below and illustrate that the undrained shear strength (Su) of Cohesive Residual Soils typically range between 45 kPa (medium strength) to 90kPa (high strength).

14.6.3 The plot below provides a summary of undrained shear strengths.



15 GEOTECHNICAL ISSUES

15.1 Conceptual site model

15.1.1 Ground conditions can be divided into two areas:

- Area A – Former 'Tile Houses' Quarry and 'Square Colliery' (western parcel of land)
- Area B – Former sewage works (eastern parcel of land)

15.1.2 Area A currently lies c. 1m to 2m higher than Area B and is divided by a public footpath running north to south between the two parcels of land.

15.1.3 A slope of 1 in 4 is also present along the northern boundary.

Area A

15.1.4 Ground conditions within this area of site typically comprised Colliery Spoil (ashy Gravel) over Coal Measures bedrock.

15.1.5 The majority of trial pits excavated within this area did not excavate through the full extent of made ground, particularly in the northwest corner within the footprint of the former quarry. However, rotary open-hole probeholes suggest that made ground depths range from 2.0m to 6.1m.

15.1.6 All but 1 probeholes (PH06) drilled within Area A encountered evidence of mine workings (voids, broken ground) within the 2nd Brown Metal Coal. Depths of workings ranged from 9.5m to 11.5m.

15.1.7 Three recorded mine entries are present in this area of site, all of which were located;

- **422416-004** – located at coordinates 422335.99, 416216.01. Square, sandstone brick lined mine entry 4.0m long x 2.4m wide. Backfilled with a dark grey gravelly Ash.
- **422416-005** – located at coordinates 422342.00, 416206.01. Double brick lined, circular mine entry, c.2.6m in diameter. Backfilled with a dark grey ashy Gravel of clinker, mudstone, coal and rare brick.
- **422416-029** – located at coordinates 422315.01, 416186.03. Concrete square pad 3.0m x 3.0m x 0.1m. Likely well/mine entry cap.

Area B

15.1.8 Ground conditions within Area B typically comprised topsoil underlain by Cohesive Residual Soils (firm slightly sandy slightly gravelly Clay). Granular Residual Soils were encountered in two trial pits beneath the Cohesive Residual Soils.

15.1.9 In the far north of Area B (TPs 05 & 06), the 2nd Brown Metal Coal was identified between 1.9m and 2.6m depth.

15.1.10 4 of 5 probeholes drilled within this area encountered solid coal (2nd Brown Metal) from between 2.9m and 8.8m. The solid coal encountered had a typical thickness of 700mm.

15.1.11 Mineworkings encountered in PH09 in the far south of Area B were recorded between 9.6m and 10.5m depth.

15.1.12 Trial pits excavated within the footprint of the former sewage works buildings in the centre of site encountered made ground to depths of 0.7m and 0.8m, respectively. Made ground typically comprised a dark grey slightly gravelly Sand. Anecdotal evidence suggests all relict obstructions were grubbed up by the current landowner and backfilled with the made ground encountered during this investigation.

15.2 Mining & quarrying

15.2.1 This site is located within a Coal Mining Development High Risk Area.

15.2.2 This site is underlain Pennine Lower Coal Measures bedrock and the shallowest coal seam is the 2nd Brown Metal coal, which outcrops 30m north of site. The next significant coal seam is the 3rd Brown Metal, which is anticipated to lie c.15m beneath the 2nd Brown Metal, however PH08 was advanced to 30m depth and did not encounter the 3rd Brown Metal coal, confirming the BGS Technical Report WA/98/6, which suggests the 3rd Brown Metal is absent in the Grange Moor area.

15.2.3 Lithos' mining investigation found the 2nd Brown Metal coal underlies the entire site at shallow depth.

15.2.4 A total of 10 probeholes were drilled across the site to determine the presence of mineworkings. Evidence of workings (loss of flush, fast drilling, broken ground) were encountered in 5 of 10 probeholes (50%); 4 of 5 probeholes drilled in the west encountered evidence of workings, 1 of 5 probeholes drilled in the east encountered evidence of workings.

15.2.5 Typical seam thickness of the 2nd Brown Metal seam is 0.7m; the maximum recorded seam thickness was 0.9m (PH06).

15.2.6 The thickness of competent (rock) cover above the 2nd Brown Metal is typically less than 10x seam thickness. Working thicknesses ranged from 0.5m to 1.5m thick. It is considered, where shallow mine workings have been identified, there is not enough competent cover, using the maximum thickness of solid coal encountered (0.9m, PH06).

Shallow mineworkings

15.2.7 CIRIA SP32:1984[11] suggests voids resulting from mineral extraction are unlikely to migrate more than 10 times the seam thickness through competent bedrock. CIRIA C758D[12] notes that the use of this 10 times 'rule-of-thumb', as the design basis for treatment depth, has been observed to be successful over many years for a wide range of mineworkings and overlying rock/soil strata scenarios. However, consideration must always be given to site specifics such as nature of roof strata, strata dip, groundwater, extraction ratio etc.

15.2.8 Mitigation against the risk of subsidence associated with the shallow mineworkings will be required across about 60% of the site's total area, as shown on Drawing 4511/14 in Appendix B. This will likely involve consolidation by drilling and grouting, although consideration could also be given to coal extraction (see Section 17.7).

15.2.9 Based on the findings of this investigation and the anticipated nature of the workings, it is considered that the necessary consolidation (grouting) would require drilling holes on a 6m grid with a centre hole (c.4.25m equivalent grid). A viscous grout composed of appropriate proportions of OPC, PFA, sand or pea gravel would then be injected into the workings via these holes.

15.2.10 Further holes would need to be drilled in areas of high grout take (to confirm filling of void space), and in areas where several adjacent holes encountered solid coal (to confirm that the local area is underlain by no workings, rather than pillars).

15.2.11 Drilling and grouting operations should be carried out with engineering supervision and be undertaken in accordance with a Specification for the Treatment of Shallow Mineworkings tailored to the site-specifics.

[11] *CIRIA SP32 (1984) - Construction over abandoned mine workings*
[12] *CIRIA C758D (2019) – Abandoned mine workings manual*

Mine entries

15.2.12 As discussed in Section 4.3 there are 3 known mine entries within the site's boundary.

15.2.13 An area of around 25m^2 was stripped around the recorded CA position of each mine entry, all three mine entries have been located, as detailed in the table below.

Shaft Ref.	Location	Depth encountered (m)	Dimensions (m)	Backfill material
422416-004	422335.99 E, 416216.01 N	0.8	Square mine entry – 4.0m long, 2.4m wide	Dark grey Ash with gravel of mudstone, coal and clinker.
422416-005	422341.00 E, 416206.01 N	0.8	Double brick lined circular mine entry c. 2.6m in diameter	Dark grey Ash with gravel of clinker, mudstone, coal and rare brick.
422416-029	422315.01 E, 416186.03 N	0.4	Concrete square pad 3.0m x 3.0m x 0.1m	-

15.2.14 The location of each mine entry/well are shown on Drawing 4511/6 in Appendix B.

15.2.15 The CA will expect Yorkshire Countryside Properties' layout to assume a no-build "zones of influence" around each shaft based on the following calculation:

Zone of influence = 0.5 x assumed shaft diameter + drift/made ground depth

15.2.16 The zones of influence associated with each shaft are therefore:

Shaft Ref.	Source	Diameter/m	Depth to bedrock/m	Zone of influence (circle of radius)/m
422416-004	CA plans	4.0	4.0?	6.0
422416-005		2.6		5.3
422416-029		<3.0?	4.0?	4.5

15.2.17 The depth of each shaft is unknown, therefore it is recommended that the shafts are drilled to prove their bases. Each shaft should also be capped at or below rockhead. The cap should be a least twice the internal diameter of the shaft and be designed by a competent structural engineer.

15.2.18 It is possible that unrecorded "shallow" shafts (possibly bell pits) may be present at this site, particularly in the far northeast of Area B. Consideration should be given to an inspection of ground conditions undertaken by a competent engineer, following the topsoil strip, to ensure the absence of bell pits.

15.2.19 Whilst the Coal Authority (and NHBC) discourage development over or adjacent to all mine entries, Lithos consider such features to pose a low risk to surface stability where they only extend to relatively shallow workings that require treatment (grouting). Consequently, we would not expect any (previously unrecorded) shallow shafts, encountered during site preparatory works and/or the subsequent construction phase, to result in the need for "no-build" zones and/or revision of the planning-approved layout although Yorkshire Country Properties may choose to do this.

15.2.20 However, where build over a shaft(s) is proposed, Yorkshire Country Properties will need to discuss proposed treatment (which is likely to include both grouting of the shaft backfill, and a cap at rockhead) and bespoke foundation design, by a suitably qualified structural engineer, with the Coal Authority. A Permit to Enter or Disturb Coal Authority Mining Interests will be required prior to construction of any shaft cap.

15.2.21 Proposals to treat the mineworkings and shafts will need to be discussed with both the Local Authority (most notably Highways), the Coal Authority and NHBC well in advance of starting works on site.

15.2.22 Any shafts encountered during the development of this site should be made safe by treatment in accordance with an appropriate Specification (Lithos can prepare this) and a Coal Authority Permit to Enter or Disturb Coal Authority Mining Interests.

15.3 Site regrade and/or ground improvement

15.3.1 Made ground currently underlies Area A to an average depth of 2.5m; maximum of 6.1m. This made ground is of variable and poor strength and is therefore not considered a suitable foundation material. It has also yielded elevated concentrations of a number of inorganic determinands and contains materials (e.g. brick, ash, clinker, coal, etc), which would generally be considered undesirable as a near-surface material in garden areas.

15.3.2 Given the substantial volume of made ground present, export to landfill is not considered economically viable.

15.3.3 Consideration should be given to turnover (excavation, screening and replacement in engineered layers) of the full thickness of made ground beneath the site. Turnover is considered an appropriate ground improvement solution since significant excavation of the made ground will be required in any case to remove the soil/fill grossly contaminated with hydrocarbons and relict foundations.

15.3.4 Because turnover enables inspection of the full thickness of fill, the developer and their prospective property purchasers, are provided with the reassurance that no significant hazard is left undetected. This is considered advantageous from a perception viewpoint. Furthermore, any potential for surface water infiltration, which would drive potential leaching of contaminants, should be reduced by compaction.

15.3.5 Screened and engineered fill should yield CBR values in excess of 3%, thereby reducing abnormals associated with the construction of estate roads and car parking areas. Excavations through the engineered fill, for drainage etc and foundations will not encounter significant obstructions or grossly contaminated ground and should be stable with little overbreak.

15.3.6 Excavation of the uppermost 500mm or so of natural soils beneath made ground could be undertaken in order to generate a sufficient volume of 'clean' subsoil for placement across the proposed development in gardens and landscaped areas. This subsoil would be best placed during the construction phase; i.e. it should be left in stockpile(s) on completion of the site preparatory works.

15.3.7 There are a number of advantages to such a 'soil inversion' operation; most notably:

- Ground levels will remain essentially as existing (i.e. there is no need to raise levels by 600mm to accommodate soil cover in Area A).
- Reduced traffic movements - there should be no need to export any significant volume of made ground off-site, and no need to import subsoil to site.

15.3.8 The above solution is considered to be in line with current government philosophy regarding sustainable development. Turnover works should be undertaken in accordance with the CL:AIRE Code of Practice (v2, March 2011), and a Materials Management Plan (MMP) should be prepared prior to commencement.

15.3.9 Given existing topography (a slope of 1 in 3 along the northern boundary of the western parcel of land, and a c.1-2m height difference between the eastern and western parcel), some site regrade is anticipated, with the need for underbuild and retaining walls.

15.3.10 Careful consideration will need to be given to earthworks design, and implications for slope stability, retaining walls, foundations, highway gradients and drainage

15.3.11 Any digital terrain modelling undertaken, or commissioned, by Yorkshire Country Properties should consider implications for the foundation recommendations outlined below.

15.3.12 Natural ground underlying this site (in the east) is often clayey, therefore consideration should be given to the implication of undertaking earthworks in poor/wet weather when the ground surface is likely to become difficult to cross with heavy machinery.

15.3.13 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 12.8 should apply.

15.4 Foundation recommendations

General

15.4.1 Foundation recommendations assume that development will be two or three storey construction and that line loads will not exceed 90kN/m run. If this is not the case significant alteration to these recommendations will be required.

15.4.2 It is Lithos' understanding that final development levels will differ from ground levels existing at the time of investigation to allow for a level development platform to be created across both parcels of land.

15.4.3 Any digital terrain modelling undertaken, or commissioned, by Yorkshire Country Properties should consider implications for the foundation recommendations outlined below.

15.4.4 Foundation depths (and types) will depend on thicknesses of fill following the anticipated earthworks regrade.

15.4.5 Following the anticipated turnover earthworks, replaced fill materials will not contain obstructions and should be relatively stable with little overbreak. At this stage, it is assumed that fill will be placed with nominal compaction only, and reinforced footings on engineered fill are not currently anticipated.

15.4.6 Made ground is not considered a suitable foundation material and foundations should therefore be taken through these materials into underlying natural strata of adequate bearing capacity.

15.4.7 Sub-surface concrete should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-4z** in Colliery Spoil and Cohesive Residual Soil and **AC-3z** in Granular Residual Soil.

15.4.8 There are a number of foundation solution options for two or three storey residential properties constructed on this site and these are discussed below.

Strip/trench fill footings

15.4.9 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for plots constructed in the east of site. Footings will be founded in firm clay or competent rock. This solution is viable where the made ground is less than about 2.5m thick, and firm clay or competent rock is the founding material.

15.4.10 Shallow mineworkings are present beneath the site which will require consolidation. Even after consolidation, foundations should be "beefed-up" to accommodate any potential time dependant differential settlement.

15.4.11 Further advice regarding reinforcement should be sought from the appointed Structural Engineer, but in the meantime, reference should be made to the table below where made ground is <2.5m thick.

Rock cover above grouted seam	Preferred Foundation
<5 x seam thickness [13]	Raft - designed to span 3m over potential soft spots and cantilever 1.5m at corners. Either stiffened, flat-bottomed rafts a minimum of 300mm thick, on 450mm of compacted Type 1 material, with reinforcement top and bottom. Or, rafts could be of 300mm concrete with a 150mm upstand to allow for wall construction provided that the base of compacted type 1 material lies at a depth of at least 600mm
>5 x seam thickness – 10m	Strip footing OK, but thickened (300mm), and reinforced top and bottom
>10m	Strip footing OK, but needs to be 300mm thick reinforced with one layer of mesh

15.4.12 Away from any shallow workings such as in the northern half of Area B, reinforcement, as a precaution against differential settlement, is recommended only where foundation excavations encounter significant lateral and vertical variations in strata or where foundations are placed above shallow mineworkings. A layer of B385 mesh placed 75mm above the base and on the top of the footing is likely to provide suitable reinforcement, but further advice should be sought from the Structural Engineer.

15.4.13 Whilst strip or trench fill footings generally represent a simple and inexpensive foundation solution, there are a number of potential disadvantages associated with their use on this site:

- The made ground contains elevated concentrations of some inorganic contaminants and a 600mm thick cover of clean subsoil (see Section 12.7) has been recommended. Subject to final remediated development levels, this cover is likely to increase footing depth/underbuild.
- Disposal of arisings will be required.
- Foundation and drainage excavations may encounter obstructions resulting in overbreak.
- Foundation and drainage excavations will almost certainly require shoring in made ground.

15.4.14 In addition to the above, Yorkshire Country Properties should review proposed plot designs and layouts, since deeper excavations for trench fill are likely to be unstable where the centre-lines of parallel trenches are closer than about 2m (assuming 600mm widths). Yorkshire Country Properties should supervise their groundworker to ensure footings are excavated in a controlled and safe manner.

15.4.15 Yorkshire Country Properties or their groundworker should seek further advice from Lithos if unexpected ground conditions are encountered in foundation or sewer excavations, including any conflict between soft ground associated with a backfilled trial pit excavation and the line of a proposed footing.

Granular Residual Soils

15.4.16 The Granular Residual Soils are assumed to have a relative density of at least medium dense (in accordance with BS5930).

15.4.17 A safe bearing capacity of at least 150kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true:

[13] *See s5.6 of Structural Foundations Manual (M F Atkinson) 2nd Ed.*

- A foundation length of 8m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.75m depth
- An angle of shearing resistance of ϕ=32° for the granular deposits

15.4.18 Assuming the foundation geometry detailed above, minimal settlements would be anticipated. This is considered likely to be acceptable, however, further advice should be sought from the Structural Engineer responsible for foundation design.

15.4.19 In accordance with NHBC Standards, a minimum founding depth of 450mm (due to potential frost susceptibility) is required in granular soils. This depth should be taken from finished ground level to the underside of the footing. If finished ground level is to be above existing ground level then the foundation excavation simply needs to ensure that there is sufficient depth of excavation to allow casting of the footing entirely within natural ground (not made ground or topsoil).

15.4.20 However, if the excavation is dug from original ground level in cold conditions when freezing is expected, then foundation depth should be taken from the existing, not finished, ground level.

15.4.21 Where ground level is being raised, it would be prudent to proof roll the exposed granular soils after stripping topsoil (to mitigate any near-surface disturbance), and ideally fill should be placed prior to construction (otherwise the Developer will need to consider the potential for movement associated with placement of the fill).

15.4.22 It should also be noted that the footing may require deepening or stepping in order to allow plot drainage to exit the plot footprint (either over or under the footing).

Cohesive Residual Soils

15.4.23 Atterberg tests suggest that natural cohesive soils at the site are of medium shrinkability. A minimum founding depth of 900mm (not accounting for any existing or proposed vegetation) is therefore required for all soils on the site where strip footings are proposed.

15.4.24 In accordance with NHBC Standards, founding depths in cohesive soils should be taken from original or finished ground level, whichever is the lower, to the underside of the footing.

15.4.25 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 25% of the site may be affected by trees.

15.4.26 Trench fill foundations should be designed in accordance with NHBC Standards, Chapter 4.2. Heave precautions (a suitable approved compressible void former) should be used on the internal face of all external walls where the foundation is within the zone of influence of trees and greater than 1.5m deep.

15.4.27 Any trench fill foundation deeper than 2.5m will need to be designed by a Chartered Engineer, whose status is accepted by NHBC (NHBC Standards, Technical Requirement R5); however, it is likely that the presence of bedrock will result in few, if any, foundations being deeper than 2.5m.

15.4.28 A safe bearing capacity of at least 150kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true

- A foundation length of 10m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.9m depth

- An undrained shear strength of 50kPa for the firm clay (typical minimum recorded on site)

15.4.29 Assuming the foundation geometry detailed above, minimal settlements would be anticipated. This is considered likely to be acceptable, however, further advice should be sought from the Structural Engineer responsible for foundation design.

Bedrock

15.4.30 The bedrock is generally considered to have a safe bearing capacity of at least 300kPa and minimal settlements would be anticipated.

15.4.31 Where rock is encountered at shallow depth foundations should be placed entirely on rock and not partially on rock and partially on soil. This may, depending on surface gradient, necessitate significant deepening of foundations.

Coal

15.4.32 Some excavations for foundations in the far northeast of the site may come into contact with coal. Care should be taken not to unnecessarily overdeepen foundations, in order to minimise the chance of encountering coal.

15.4.33 Where foundation excavations do come into contact with coal, the foundation should be taken through the coal seam, into underlying natural in-situ strata of adequate bearing. The full thickness of coal should then be sealed with concrete to create a trench fill foundation. To prevent the ingress of air, the mass concrete fill should be placed as soon as possible after exposing the seam.

15.4.34 By virtue of the provisions of the Coal Industry Act 1994 interests in unworked coal and coal mines previously vested in the British Coal Corporation are now vested in the Coal Authority. The developer will need to contact the Coal Authority to dig or carry away such coal as they encounter in connection with redevelopment of the site (this is often referred to as incidental coal).

Raft foundations (on engineered fill)

15.4.35 Raft foundations (or heavily reinforced strips) may provide a suitable foundation solution if the full thickness of made ground is subject to turnover (excavation, screening/sorting and replacement in engineered layers, with compaction). Fill would need to be compacted to an End Product Specification to achieve >95% of the maximum dry density (4.5kg rammer) and less than 5% air voids.

15.4.36 If it is intended to construct low-rise buildings which derive direct support from engineered fill, an Earthworks Specification document will be required and this would include definition of fill types and requirements for acceptability & testing, compaction trials, control testing and monitoring of fill performance.

15.4.37 In areas where raft foundations are proposed, the full thickness of made ground should be excavated, screened and placed in engineered layers (turned over). Excavation and screening will enable the removal of all relict foundations, oversize material and any grossly contaminated soil/fill.

15.4.38 Full depth turnover will also allow inspection of the former sandstone quarry **highwalls** (if present), as to date given the thickness of overlying Made Ground, trial pits to target this feature have not been able to do so. If steep quarry highwalls are present, they are likely to prevent the use of ground bearing foundations, where plots straddle or are close to the highwalls.

15.4.39 Deep excavations to remove gross contamination, relict structures, and/or soft ground could result in "hollows" in the natural ground surface. The natural ground around these "hollows" should be overdug in order to ensure that the thickness of fill below each proposed plot does not vary by more than 15%. Where this requires benching of the natural ground, each bench should have a maximum vertical height not exceeding 500mm.

15.4.40 The suitability of made ground for placement as engineered fill should be confirmed by field trials and laboratory testing.

15.4.41 The field trials should be carried out in accordance with Lithos' Specification for Engineered Fill. The field trial will enable estimation of tolerable settlement characteristics and an achievable safe bearing capacity, with a view to establishing new dwellings on raft foundations. It will also yield the following information:

- Number of passes with the compaction plant (to be used during subsequent earthworks)
- Maximum and minimum layer thickness (plant dependent)
- Acceptance criteria; minimum dry density and moisture content range

15.4.42 The engineered fill should achieve at least 95% maximum dry density, with air voids comprising less than 5%; as determined by appropriate laboratory compaction tests.

15.4.43 Raft design should be in accordance with NHBC Standards, Chapter 4.4. Granular sub-base product should be placed in accordance with Table 8/1 of the Highways Agency Specification for Highway Works (1998).

15.4.44 NHBC generally recommend that rafts be founded on a minimum 150mm thickness of DoT granular sub-base product. Granular sub-base should extend laterally for at least 0.5m beyond the raft. The base of the granular sub-base must be at least 600mm below original or finished level, whichever is the lower. At most reclaimed brownfield sites, original level is generally equivalent to the top of engineered fill.

15.4.45 Where rafts are within the influence of mature trees, the depth of crushed stone placed should be equal to 50% of the trench fill foundation depth determined in accordance with NHBC Chapter 4.2.

15.4.46 Placement of blankets of a granular sub-base, directly on top of engineered fill would normally be acceptable immediately after placement of the final layer of fill. However, if placement is delayed, climatic factors can lead to a deterioration of the near surface fill.

15.4.47 Where the engineered fill is cohesive, rainfall, (softening) or sunshine (desiccation) may cause deterioration. Cohesive fill should therefore be "blinded" with granular sub-base within 48 hours of placement of the final layer of fill. Wherever this is not possible, it is recommended that a minimum 300mm depth of fill is excavated from beneath the plot footprint, prior to placement of the granular sub-base. Furthermore, it may be necessary to remove any desiccated material if the engineered fill is left exposed during a prolonged spell of dry weather.

15.4.48 Where the engineered fill is granular, deterioration may be caused by frost (unless the fill contains less than 10% fines). Granular fill should therefore be "blinded" with granular sub-base prior to frosty weather.

Piled foundations

15.4.49 Piled foundations may be an option for dwellings constructed in areas of deeper made ground and/or significant tree influence.

15.4.50 The following general comments relating to piling are provided for guidance, and further advice should be sought from a specialist-piling contractor. Piles are likely to be end bearing in bedrock, therefore in accordance with BS 8004[14] and EC7[15], piling contractors may require further boreholes extended a minimum 5m into competent bedrock using rotary coring techniques.

15.4.51 Should any impenetrable shallow obstructions be encountered, i.e. boulders etc, they should either be grubbed-up, or alternatively the piling layout could be re-designed (although this might also require design of foundations able to span and/or cantilever as necessary).

15.4.52 Given the variable depths to bedrock across Area A, care should be taken to ensure that piles are not allowed to deflect off any steep under-ground gradients within the rock. This could be achieved by socketing and may require pre-drilling and casing of piles. An allowance should also be made for changing piling locations and ground beam design to account for any difficulties encountered with steep rock gradients associated with the former sandstone quarry.

15.4.53 Warranty providers generally require pile lengths to be at least 3m (measured from pile cut off level to pile toe level). Short piles are likely to become dislodged during pile trimming operations, creating additional costs associated with remedial works. Where depths to bedrock vary significantly beneath a plot, pre-boring of piles may be necessary to reach

15.4.54 CIRIA C758D notes that whatever the depth of workings, even if they are thought to be fully filled or the roof strata to be rigid, piles should **not** be terminated immediately above an untreated worked horizon because this could concentrate load on a potentially unstable stratum which may initiate eventual collapse.

15.4.55 The objective of a conventionally spaced, over-site grout treatment grid is to ensure against surface settlements. It will not adequately serve below ground support for individual piles. Grid separations exceeding 3m in partially collapsed or back-stowed workings are prone to uneven grout distribution and leaving isolated untreated areas or discrete void pockets.

15.4.56 It should be recognised that pressurised grout treatments (even if enhanced) are unlikely to achieve full closure or permeation of randomly distributed or occluded voids, especially if water-filled. This consequence of earthworks treatments is well known, but also it is industry wisdom that grout acceptance maximises at about 90-95% of voidage).

15.4.57 Consequently, piles usually need be taken into competent strata **below** any seam floor disruption and heave consequential on the workings. This is likely to result in very significant abnormal cost.

15.4.58 The safe working load that may be supported on a pile is dependent on the pile diameter, its founding depth and the method of installation.

15.4.59 Boreholes indicate that competent bedrock lies at depths of between 2.0m and 6.1m, below current ground levels. However, as stated above, due to the presence of shallow mine workings, piles will need to be taken **through** the grouted workings to competent bedrock below.

15.4.60 In accordance with NHBC Standards, Chapter 4.2, heave precautions should be provided where a plot is within the zone of influence of trees. Table 3b in Chapter 4.2 defines the zone of influence as a function of tree height (between 0.5 and 1.25) dependant on the water demand. Figure 6 in Chapter 4.2 shows where heave precautions are required for pile foundations.

[14] *BS 8004 (2015) - Code of practice for foundations.*
[15] *BS EN 1997-1:2007. Eurocode 7: Geotechnical design – Part 2: Ground investigation & testing*

15.4.61 It is recommended that flexible service connections are used on this site, especially where they enter the buildings, in order to avoid any possible damage due to self-settlement of the weak strata once the site is developed.

15.4.62 Should any impenetrable shallow obstructions be encountered, i.e. old foundation, they should either be grubbed-up, or alternatively the piling layout could be re-designed (although might also require design of foundations able to span and/or cantilever as necessary).

15.4.63 New houses can be built off ring beams designed to span the piles. In order to bond them to the piles, the tops of the piles must be broken out to expose the reinforcement, which can then be tied to that of the beams.

15.4.64 Ground conditions at this site are considered likely to require provision of a piling mat (working platform) and further advice should be sought from the appointed specialist-piling contractor regarding the proposed plant loadings and resulting pressures. This data, together with a knowledge of the strength and variability of the near-surface ground conditions is required in order that design of a mat can be undertaken in accordance with guidance provided in the 2004 BRE document, "BR 470: Working platforms for tracked plant".

15.4.65 The design of working platforms for tracked plant is a geotechnical design process and should be carried out by a competent person. The following parties should have input into the design:

- Permanent works designer, to consider additional uses for platform material as part of the overall development
- Principal contractor, to define any other purposes for which the platform might be used
- Contractor or subcontractor, to specify requirements for the platform, including gradients, ramps and edges

15.4.66 The number of plots affected by piling will depend on layout proposals, however, it is considered unlikely to exceed 50% of the total number.

15.4.67 Piles can provide an enhanced pathway for the vertical migration of mobile contaminants. The Environment Agency may therefore object to the adoption of piles as a foundation solution. However, objection is considered unlikely given the nature of the contamination encountered, and the fact that the colliery spoil is currently resting directly on the underlying bedrock.

15.4.68 Pile design should be undertaken in accordance with the Environment Agency's guidance booklet "Piling into Contaminated Sites".

15.5 Floor slabs

15.5.1 Floors for low rise housing (2-3 storeys) constructed on piled foundations typically utilise reinforced concrete ground beams which rest on pre-cast or in-situ pile caps. A suspended 'Beam and Block' ground floor is then usually constructed using concrete or polystyrene blocks placed between further concrete beams suspended across the ring beams.

15.5.2 Suspended floor slabs should be utilised where the depth of made ground or engineered stone exceeds 600mm in accordance with NHBC Standards Chapter 5.1 (to negate potential settlement problems). The made ground on this site is non-shrinkable, therefore the slabs could be cast in-situ.

15.5.3 It is estimated that the thickness of made ground is likely to exceed 600mm beneath at least 50% of the plots, however, this may increase if made ground from Area A is used to raise levels in Area B.

15.5.4 Where shallow foundations are within the influence of existing or proposed trees (and are underlain by shrinkable soils), NHBC require a suspended floor slab, with sub-floor void. The floor slab is most commonly a precast block and beam construction, but alternatively could comprise a suspended timber floor, or a slab cast on a suitable compressible void former. Ground-bearing and cast in-situ suspended slabs (other than those cast on a void former) are not acceptable where foundations are within the influence of trees.

15.5.5 In accordance with NHBC Standards Chapter 4.2, a minimum void height of 200mm should be adopted for a precast block and beam (or suspended timber) floor; this includes a 150mm ventilation allowance. If a suspended, cast in-situ slab (on a void former) is proposed, a minimum clear void height of 50mm should be adopted; of course, the actual thickness of the void former will be significantly greater.

15.5.6 Beyond the influence of existing or proposed trees, it is considered that the natural ground is generally suitable for the use of ground bearing floors. However, ground bearing slabs should not be cast on topsoil. Where plots are elevated for design reasons, the depth of engineered stone below a ground bearing slab should not exceed 600mm, in accordance with NHBC guidance.

15.5.7 The natural ground beneath this site includes cohesive soils and is therefore subject to seasonal variation in moisture content. If ground slabs were constructed on desiccated soil, heave of the slab would occur on re-hydration of the ground. If any significantly desiccated soil is present, a suspended floor slab, with sub-floor void will be required.

15.5.8 It should be noted that NHBC have suffered a significant number of claims resulting from the use of ground bearing floor slabs. Consequently, if ground bearing slabs are proposed, care should be taken to ensure correct and careful construction. For example, if fill to the internal face of the foundation excavation is not properly compacted, subsequent settlement can result in cracking of the slab.

15.5.9 In the unlikely event that coal is exposed beneath the floor void, it would be prudent to prevent air ingress and the potential for spontaneous combustion by blinding with concrete or removing the coal.

15.5.10 Floor slab design should be finalised/take account of the results of the gas monitoring and protection measures required, which will be detailed in Lithos' gas risk assessment, to be issued on completion of monitoring in May 2023.

15.6 Designated concrete mixes

15.6.1 Designated mixes are considered in BRE SD1[16] and BS 8500[17]. However, in addition to soil chemistry (sulphate class), there are a number of other considerations relating to structural design that need to be taken into account when determining an appropriate concrete mix.

15.6.2 Consequently, Yorkshire Country Properties should seek advice from their appointed Structural Engineer.

15.7 Excavations

15.7.1 Based on the results of the investigation it is considered unlikely that major groundwater flows will be encountered in shallow excavations.

15.7.2 Excavations should remain stable in the short term but if left open for any significant period of time may require shoring most notably in made ground.

[16] *BRE Special Digest 1 (2005) – Concrete in aggressive ground.*

[17] *BS 8500-1&2:2015+A2:2019. Concrete. Complementary British Standard to BS EN 206. Method of specifying and guidance for the specifier (1) & Specification for constituent materials and concrete (2).*

15.7.3 Bedrock was encountered in several exploratory holes, especially in the east of site. Based on the exploratory hole logs, excavation greater than 2.5m is likely to prove difficult in the east of site. It would therefore be prudent to allow for excavation of hard rock in any deep excavations such as those that may be required for drainage etc.

15.8 Drainage

15.8.1 On-site soakaway construction will be highly problematic in Area A given the significant thicknesses of made ground encountered. It should be noted that soakaways cannot be allowed to infiltrate into made ground due to the risk of settlement caused by wash out of fine soil particles.

15.8.2 Within Area B, based on observations made during the investigation, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off at the site where natural ground is present at shallow depth. Consequently, it will be necessary to consider alternative sustainable drainage systems (SUDS), and there may be a need for surface water balancing.

15.8.3 Given water table depth and topography it is considered unlikely that springs will appear down-gradient.

15.8.4 Alternative SuDS options (see CIRIA C753[18] for further details) include:

- Pervious Pavements – provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate into subsurface storage, with subsequent infiltration or controlled discharge. Pavement could be porous (water able to infiltrate across entire surface material; e.g. reinforced grass), or permeable (water infiltrates via joints between concrete blocks).
- Swales – linear grassed features in which surface water can be stored or conveyed. Where suitable, swales can be designed to allow infiltration.
- Basins - a ground depression designed to store surface water that is normally dry, except during and immediately following a rainfall event. There are two types:
  - Infiltration – basin designed to store runoff and infiltrate it gradually into the ground.
  - Detention – an outlet restricts flows, so that the basin fills and provides attenuation.
- Ponds – designed to have permanent pool of water, but with capacity to provide temporary storage-controlled discharge.

15.8.5 Yorkshire Water have published a guide[19] for developers and designers outlining their design requirements for surface water attenuation assets.

15.8.6 With respect to detention basins, which should normally be dry, water table levels should be taken from borehole monitoring wells over 4 consecutive seasons, for at least 3 points in the basin area. The detention basin should be designed to ensure that there is a minimum of 1m of unsaturated soil between the maximum groundwater level and the lowest part of the structure.

15.8.7 Ground conditions must be suitable to allow free drainage from the detention basin all year round by having regard to groundwater levels, and impermeable liners are not to be used.

15.8.8 It is Lithos' understanding that ground does not have to be free-draining (i.e. sands/gravels), but where clay is present the basin needs to be designed to prevent waterlogging - because this renders maintenance (grass cutting) difficult. It would be prudent to seek confirmation of this from Yorkshire Water and/or the appointed drainage designer.

[18] *CIRIA C753 (2015) – The SuDS Manual.*
[19] *Design Requirements for Surface Water Attenuation Assets, February 2017.*

15.8.9 Appropriate design usually comprises a fall across the short axis (to centre of basin), and then along the long axis (possibly inclusive of a pipe in gravel trench) to the outfall.

15.8.10 The guide also discusses required access to flow control chambers, large diameter (i.e. >900mm) surface water storage pipes, and surface water storage tanks.

15.8.11 It is recommended that the developer contact Yorkshire Water Services with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

15.9 Highways

Area A

15.9.1 Made ground is present across the west of site and consultation with the adopting authority, regarding the specification of the highways, is strongly recommended.

15.9.2 Where made ground is present its full thickness (up to a maximum of 2m - from existing ground level or proposed highway formation, whichever is the lower) should be excavated and either:

- replaced with suitable aggregate in accordance with Series 600 (Earthworks) of The Highways Agency (HA) "Specification for Highway Works" 1998; or
- screened, to allow selection of suitable material, before being replaced in engineered layers (in accordance with Series 600). Unsuitable materials include any soft or wet materials, biodegradables including topsoil, wood, scrap metal, frozen material and oversize.

15.9.3 Some refinement of the above advice might be possible after highways design (with consideration of the proposed formation level cf existing ground level), and via inspection (and usually CBR testing) of the proposed formation during site preparatory groundworks.

15.9.4 Any residual made ground materials in the base of the excavation should be inspected and (where necessary) any soft spots removed and replaced with suitable engineered fill.

15.9.5 Where the made ground is re-engineered it is considered that a CBR value of at least 3% should be achievable. However, this should be verified by field trials.

15.9.6 Crushing of demolition/hardstand/foundation arisings will generate aggregate, which (subject to confirmatory testing) should be suitable for use as unbound pavement materials within the highways.

Area B

15.9.7 The natural soils present at shallow depth (anticipated formation) in the east of site are predominantly cohesive. Based on visual inspection of the natural materials and the recorded plasticity indices at the site, published guidance[20] and tables[21] indicate that the Cohesive Residual Soils would be expected to provide a CBR value of at least 3%. This value should be verified prior to or during construction.

[20] *CD225 Design for new pavement foundations Revision 1 (Design Manual for Roads and Bridges)*
[21] *The Structural Design of Bituminous Road, TRRL Laboratory Report 1132 (Table C1, page 36)*

15.9.8 Whilst the CBRs estimated above should be achievable, significant deterioration during/after periods of significant rainfall and/or site trafficking is likely. Consequently, it would be prudent to consider flexibility in the groundworks programme to enable highway construction during prolonged dry/warm weather (typically between May and September) when formation will be least vulnerable to deterioration. Alternatively, a minimum 200mm thickness of suitable granular fill (i.e. a "blanket" of 6F2) could be placed along the line of proposed highways to protect formation during the construction phase.

15.10 External works

15.10.1 Any digital terrain modelling undertaken, or commissioned, by Yorkshire Country Properties should be made available to their Engineering Designer prior to issue of an External Works Drawing.

15.10.2 When designing retaining walls, consideration should be given clause 10.2.3 of NHBC standards which states that flexible retaining walls such as gabion and timber structures should not be used to provide support to homes, garages, roads, drives, car parking areas or drainage systems.

16 REDEVELOPMENT ISSUES

16.1 General

16.1.1 This report has presented options with respect to foundation solutions, treatment of contamination, re-use of topsoil etc that are considered technically feasible and in line with current good practice. Consequently, we would expect to obtain regulatory approval for whichever option is adopted, although this cannot be guaranteed. Copies of this report should be forwarded to the relevant regulatory authorities (Warranty Provider & Local Authority) for their comment/approval.

16.1.2 Even after an appropriate preliminary investigation and ground investigation, with exploratory holes on a closely spaced grid (say trial pits at 30m centres), a geoenvironmental appraisal is typically based on inspection of the ground underlying less than 0.5% of the total site area (and much less at depths in excess of about 3.5m). Consequently, there is always a possibility that unanticipated ground conditions will be encountered during the construction phase.

16.1.3 If unexpected ground is encountered during the construction phase, the Contractor should immediately seek further advice from the Engineer.

16.2 Remediation strategy

16.2.1 Redevelopment of this site will almost certainly be subject to planning conditions relating to remediation and validation. Once a specific, preferred development strategy has been decided, Lithos could liaise with local Planning Authority and Warranty Provider and prepare a detailed Remediation Strategy document for approval.

16.2.2 The Remediation Strategy document would include:

- General background information, including site location, site description and a summary of ground investigation data
- An overview of existing constraints on development and the aims of the proposed remediation works
- Specific details of the anticipated site remediation/preparatory works
- Details of site supervision and verification
- A summary of implications for redevelopment

16.2.3 The Remediation Strategy will describe what is required, but not how it is achieved; the appointed Contractor would normally be expected to undertake an Options Appraisal, and then prepare a Method Statement.

16.2.4 The anticipated remediation works are summarised below:

- General site clearance of surface materials and vegetation
- Excavation of natural soils from Area B to source 'clean' subsoil for use in gardens and landscaped areas in Area A
- Excavation and removal of localised hydrocarbon contamination within the vicinity of TP11 (Area A)
- Backfill of all resultant excavations, with appropriate compaction
- Re-grade of site to levels specified by Yorkshire Country Properties to enable a level development platform between Areas A & B.
- Excavation of up to a maximum depth of 2m beneath proposed adoptable road footprints and controlled re-engineering of selected materials in layers to approximately 650mm below final road levels
- Treatment of mine entries
- Provision of a minimum 600mm thick cover layer of 'clean' soils in all garden and landscaped areas where made ground is present (Made Ground Topsoil and Colliery Spoil in Area A).

16.2.5 Subsoil excavated during the site preparatory works for subsequent use as cover in gardens and landscaped areas, would be best placed during the construction phase; i.e. it should be left in stockpile(s) on completion of the site preparatory works.

16.2.6 A minimum 200mm thickness of suitable granular fill (i.e. a "blanket" of 6F2) could be placed along the line of proposed haul roads to provide a firm and stable running layer for the subsequent construction works.

16.3 Control of excavation arisings

16.3.1 Excavations into made ground are likely to yield contaminated arisings. The groundworker should carefully segregate (and stockpile separately) made ground arisings from arisings of "clean" natural soils, in order that an excessive volume of unsuitable material is not generated.

16.3.2 The groundworker should appreciate the need for good materials management. Most notably the importance of not mixing different materials within a given stockpile; i.e. there should be separate stockpiles of: Topsoil; Granular Made Ground; Colliery Spoil; Made Ground Topsoil; fuel-contaminated soil; excess clean, natural soil arisings; general construction waste etc.

16.3.3 Further characterisation of stockpiled materials is likely to be required if off-site disposal is proposed. See also comments in Section 12.8 regarding asbestos.

16.3.4 Made ground arisings could be:

- Placed in area deliberately left low on completion of the remediation works in order to accommodate construction arisings
- Redistributed beneath concrete oversite, or areas of hardstanding, where they would be satisfactorily isolated from end users; only if suitable (i.e. not compressible, rich in deleterious matter etc)
- Isolated beneath the 600mm thick cover layer in garden or landscaped areas
- Exported from site to a suitably licensed landfill facility

16.3.5 Natural ground arisings should be suitable for use as subsoil in the proposed soil cover.

16.4 Good practice guidance

16.4.1 The construction phase groundworker should follow good environmental practice to minimise the risks of spillage, leakage etc with reference, but not limited, to the following documents:

- CIRIA C741[22]
- EA Pollution Prevention Guidelines[23]:
  - PPG6 - Working at construction and demolition sites
  - PPG2 - Above ground oil storage tank
  - PPG7 – The safe operation of refuelling facilities.
  - PPG21 – Incident Response Planning

16.4.2 Site preparatory works associated with this project are likely to involve the re-use of both natural and made ground soils on site. Therefore, the Contractor should prepare a Materials Management Plan (MMP) in accordance with the CL:AIRE Code of Practice (v2, March 2011) [24].

16.4.3 The MMP will document how all of the materials to be excavated during the proposed site preparatory and remediation earthworks are to be dealt with.

16.5 New utilities

16.5.1 It is strongly recommended that all statutory service bodies are consulted at an early stage with respect to the ground conditions within which they will lay services in order to enable them to assess at an early stage any potential abnormal costs.

16.5.2 Drainage and other utilities should not be placed within any coal seam; the seam should either be removed to below the base of the lowest service, or services should be placed in oversize trenches cut into the seam & backfilled with inert material.

16.5.3 It is recommended that trenches for services including site drainage and water supply are cut over size in order to isolate pipe materials from potential contaminants and to enable maintenance to be conducted in "clean" material.

16.5.4 Water Companies have a statutory duty to supply wholesome water, which could be compromised by the selection of an inappropriate pipe material. For example, compounds such as petroleum hydrocarbons and solvents can permeate commonly used plastics pipes, and/or corrosive chemicals can reduce the service life of metallic pipes. Guidance has been developed for the selection of pipes in brownfield sites and is contained in a UKWIR Report[25].

16.5.5 This site is brownfield, and therefore consideration of soil contaminant concentrations is required. Samples taken must be representative of the soil conditions in which the water pipes are proposed to be laid; normally water pipes are laid 0.7m to 1.3m below finished ground level.

16.5.6 At the time of writing, the proposed route(s), and total length, of water supply pipes were unknown. Consequently, to date laboratory testing of soil samples in line with UKWIR guidance has not been undertaken.

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22 *CIRIA C741 (2015) - Environmental Good Practice on Site*

23 *Whilst this has formally been withdrawn it can still be accessed via the EA archives and provides useful information on managing risks.*

24 *The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.*

25 *UKWIR Report 10/WM/03/21 – 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites'.*

16.5.7 Furthermore, remediation earthworks are anticipated, and ground currently present along proposed supply pipe routes will almost certainly be redistributed. Consequently, to date laboratory testing of soil samples in line with UKWIR guidance has not been undertaken.

16.5.8 At present, it should be noted that the use of 'standard' polyethylene water supply pipes should be acceptable across the majority of Area B, however, if made ground from Area A is to be redistributed across this area, then further testing of soil to be placed should be undertaken.

16.5.9 However, given the proposed remediation works, the Verification Report should include the results of further testing within 15m of the proposed route(s) of water supply pipes. In the meantime, it is considered likely that Yorkshire Water will request the use of Protectaline mains, with plastic coated copper house connections, given that residual organic contaminants will still be present post-remediation, albeit at acceptable concentrations.

16.6 Health & safety issues - construction workers

16.6.1 Access into excavations etc. must be controlled and undertaken in accordance with the CDM Regulations 2015, most notably Regulation 22, to mitigate risk of collapse or asphyxiation.

16.6.2 Before site operations are started, the necessary COSHH statements and Health & Safety Plan should be drafted in accordance with the CDM regulations.

16.6.3 The bulk of the made ground will be retained on site. This made ground contains contaminants at concentrations above the guidance threshold values for an end use that includes domestic gardens. Workers involved in excavations for foundations, drainage, utilities etc are likely to come into direct contact with the made ground.

16.6.4 Although workers will only be exposed to the contaminated soil for a relatively short time, the contaminants represent a risk, and simple precautionary measures are required, i.e. good personal hygiene and basic personal protective equipment.

16.6.5 Consequently, during the remediation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. General guidance on these matters is given in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land".

16.7 Coal extraction

16.7.1 The 2nd Brown Metal Coal (c. 0.7m – 0.9m thick) does underlie the site; typically at depths of around 1.9m in the far northeast. The 2nd Brown metal coal dips south to a maximum depth of c.11.5m.

16.7.2 Prior extraction of coal is encouraged by both the Coal Authority and Planning Authorities, largely because a potential mineral resource will not be sterilised by the development. However, it is worth noting that the UK market for coal is changing (driven by government carbon emission targets) – most notably very few power stations are still burning coal. Consequently, prior extraction of coal has become less attractive in recent times.

16.7.3 There can be financial benefits to extraction, since the extraction contractor would pay the landowner a disturbance allowance for the coal (likely to be between £2 and £4 per tonne), and there would be a saving because grouting would not be required.

16.7.4 Furthermore, any unrecorded mine entries would also be found and removed. Traffic movements (associated with coal export) are expected to be similar to those associated with grouting (import of PFA and cement).

16.7.5 However, coal extraction is not without drawbacks; these include:

- The creation of 'high-walls' around the margins of the extraction area (essentially the whole of the site's perimeter).
- The time required to ensure significant settlement of the replaced overburden (anticipated residual settlement must be less than 25mm) is typically at least 12 months. However, the actual delay to build programme might be longer, since it is impossible to predict the actual time required for ongoing creep settlements to fall to tolerable levels. Prediction is hampered by uncertainties associated with groundwater rebound and the nature of the excavated material with respect to suitability for compaction.
- Local environmental issues associated with noise and dust.
- Public perception issues.
- Concerns that once an initial excavation has been opened, the coal extraction contractor might decide there is insufficient coal remaining and abort further work, or even run into financial difficulties, leaving Yorkshire Country Properties with increased foundation abnormals and no royalties.

16.7.6 Assuming the above factors do not preclude further consideration at the 'first hurdle', the viability of extraction is influenced by physical factors, most notably:

- the presence (or not) of old mineworkings;
- seam thickness (greater the better); and
- seam depth (shallower the better).

16.7.7 As discussed in Section 9.9, old mineworkings exist beneath about 60% of this site, with solid coal only encountered in 5 out of 10 (50%) of the probeholes located within areas underlain by the 2nd Brown Metal coal seam.

16.7.8 This suggests that significant extraction has already occurred, reducing the potential yield from further extraction prior to redevelopment. However, the average thickness of coal is around 0.7m, at depths of between 1.9m and 11.5m.

16.7.9 Extraction is generally considered possible where the overburden above a seam is less than 12 times the seam's thickness. This indicates that the coal extraction should be considered further, however, this is likely only viable in the far north of site where to coal is shallow and has not already been worked.

16.8 Potential development constraints

16.8.1 Topography will require significant regrade earthworks, most notably to create a level development platform between Area A and B.

16.8.2 Some deterioration of the surface is likely to be caused by trafficking, especially after topsoil has been stripped and during/after periods of significant rainfall. Consequently, it would be prudent to consider placement of a minimum 200mm thickness of suitable granular fill (i.e. a "blanket" of 6F2) along the line of proposed highways and any temporary haul roads to protect formation during the construction phase.

16.8.3 It would be prudent to allow flexibility in the groundworks programme to take advantage of any prolonged dry\warm weather (typically between May and September) to enable footings to be cast and blockwork brought up to DPC level well in advance of the build programme (i.e. so it is never necessary to dig deep footings in winter/early spring, when the groundwater table is likely to be higher).

16.8.4 The underground sewer and drainage utilities may present a potential development constraint unless they can be relocated. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required by each service undertaker if they remain in-situ.

16.8.5 Yorkshire Water may seek to restrict changes in site level if the depth of cover above their utilities were adversely affected by any development proposals. This aspect requires further clarification.

16.8.6 Sterile 'no build' zones will be required around the 3 mine shafts. The no-build zone should be derived by assuming a 45° line from the outer edge of the shaft cap at rockhead, running up to the finished ground level.

16.8.7 Briestfield Beck flows north along the site's eastern boundary. It is recommended that a silt and surface water management plan be developed prior to construction activities commencing.

17 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

17.1 General

17.1.1 The site is located approximately 8km east of Huddersfield town centre and currently comprises two parcel of land, divided in the centre by a public footpath and c.1-2m high retaining wall. The eastern parcel of land (Area B) comprises a cropped grass field; the western parcel of land (Area A) comprises overgrown scrubland that has recently been cleared.

17.1.2 It is understood that consideration is being given to redevelopment of the site, however, no site layout has been provided at this stage.

17.1.3 Deep made ground has been encountered in 20 of 25 pits and 8 of 14 probeholes to a maximum depth of 6.1m (average thickness of 2.5m). This made ground was typically encountered in Area A and comprised Colliery Spoil, however, locally Demolition Rubble and Granular Made Ground was encountered.

17.1.4 Natural ground typically comprises Cohesive Residual Soils. In 6 trial pits, Granular Residual Soils were also encountered. Natural ground was absent across the majority of Area A.

17.1.5 Coal Measures bedrock was encountered across the site from between 0.9m to 6.1m depth and typically comprised a Gravel of mudstone. The 2nd Brown Metal Coal was encountered in two trial pits in the north of site from 1.9m depth, this dips to the south to a maximum depth of 11.5m.

17.1.6 Shallow mineworkings were encountered in 5 of 10 probeholes, across the whole of Area A, and across and area c.1,200m^2 in size in the south of Area B.

17.1.7 Three mine entries are present in Area A, these were located during the site investigation.

17.2 Mining

17.2.1 This site is located within a Coal Mining Development High Risk Area.

17.2.2 This site is underlain at shallow depth by the Pennine Lower Coal Measures. The 2nd Brown Metal coal outcrops c. 30m north of site and has been found up to be up to 0.9m thick. The 3rd Brown metal coal is anticipated to lie c.15m beneath the 2nd Brown Metal coal, however PH08 was advanced to 30m depth and did not encounter the 3rd Brown Metal coal, confirming the BGS Technical Report WA/98/6, which suggests the 3rd Brown Metal is absent in the Grange Moor area.

17.2.3 Shallow mineworkings associated with the 2nd Brown Metal coal have been encountered in the west of site (Area A) and across an area c.1,200m^2 in size. The depth of workings ranged from 9.5m to 11.5m depth (maximum recorded thickness of 1.6m).

17.2.4 Mitigation against the risk of subsidence associated with shallow mineworkings in the 2nd Brown Metal, likely via drilling and grouting. Areas requiring treatment are shown on Drawing 2828/14.

17.2.5 All 3 known mine entries in the west of site, associated with Square Colliery, have been located and surveyed in.

17.2.6 The possibility of further unrecorded shafts/bell pits cannot be discounted, this should be noted when undertaking the topsoil strip in the east of site (Area B), where the 2nd Brown Metal coal is the shallowest.

17.3 Hazardous gas

17.3.1 The site is in an area where <1% of homes are estimated to be above the radon action level. Radon protection is not required, but the Developer might consider providing new dwellings with basic measures in light of Public Health England advice.

17.3.2 The site may be affected by potential sources of hazardous gas due to the presence of an adjacent backfilled opencast quarry, deep made ground in Area A and shallow mineworkings across Area A and in the south of Area B.

17.3.3 A period of gas monitoring is currently underway; a Hazardous Gas Risk Assessment will be issued upon completion of monitoring in May 2023.

17.4 Contamination & remediation

17.4.1 Testing suggests the topsoil in Area B is suitable for re-use.

17.4.2 Made ground (Made Ground Topsoil, Colliery Spoil & Granular Made Ground) has yielded elevated concentrations of inorganic determinands. These made ground types also contain materials (e.g. children's toys, metal, brick, ash & clinker) which are considered to be undesirable in garden areas.

17.4.3 It is recommended these soils should be placed beneath 600mm thick surface cover of "clean" soil in garden and landscaped areas. This cover will break potential pollutant linkages between the contaminated made ground and future end-users.

17.4.4 Alternatively, they could be placed beneath hardstanding where they will be satisfactorily isolated from end-users.

17.4.5 Elevated concentrations of lead, arsenic, copper and TPH were encountered within the Demolition Rubble in TP11. This material should be "chased out" by excavation and disposed of off-site.

17.4.6 Whilst this site does not require large-scale remediation works, it is strongly recommended that, in advance of the anticipated infrastructure groundworks, the hot-spot of fuel-contaminated soil is delineated, 'chased-out' by excavation, and placed in a designated stockpile. This work should be supervised by a suitably qualified geoenvironmental engineer such as Lithos.

17.4.7 Given the site's relatively small size, failure to complete such works before groundworks begin is likely to result in the generation of excessive volumes of material that are unsuitable for retention on site.

17.4.8 Area A lies c.1-2m higher than Area B, consideration should be given to turnover and compaction of made ground in Area B to enable site levels to be regraded. Clean soil cover could be sourced from Area A.

17.5 Foundations

17.5.1 The majority of plots in the east of site (Area B) can be founded on traditional strip and trench fill foundations at a minimum depth of 900mm in Cohesive soils and 750mm in Granular Residual Soils.

17.5.2 Where shallow mineworkings are present in Area B, a layer of B385 mesh placed 75mm above the base and on the top of the footing is likely to provide suitable reinforcement, but further advice should be sought from the Structural Engineer.

17.5.3 Plots in the west of site (Area A) will require piled foundations due to the presence of deep made ground. Due to the presence of shallow mineworkings across this area, piled foundations will need to be taken through the grouted workings and into competent bedrock below. Where made ground is <2.5m thick in the west of site, reinforced strip foundations are likely to be suitable.

17.5.4 Subject to any earthworks that are undertaken and appropriately validated, heavily reinforced strip foundations/raft foundations may be a viable option, in accordance with NHBC standards.

17.6 Flooding

17.6.1 The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low.

17.7 Drainage

17.7.1 Due to very slow infiltration rates, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SuDS), and there may be a need for surface water balancing.

17.8 Highways

17.8.1 Based on visual inspection of the shallow natural materials and published guidance, the natural soils in Area B should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

17.8.2 Made ground is present across Area A, and consultation with the adopting authority, regarding the specification of the highways, is strongly recommended.

17.8.3 Where made ground is present it should be excavated and either replaced with suitable aggregate, or screened, to allow selection of suitable material, before being replaced in engineered layers. Where the made ground is re-engineered it is considered that a CBR value of at least 3% should be achievable. However, this should be verified by field trials.

17.9 Further works

17.9.1 In accordance with BS 8004 and EC7, piling contractors may require rotary cored boreholes extended a minimum 5m into competent bedrock using rotary coring techniques.

17.9.2 Cable percussion boreholes should be undertaken within the footprint of the former Tile Houses Quarry in the west of site (Area A) to determine the full extent of backfill and assess the nature and composition of backfilled materials.

17.9.3 Preparation of a Drilling and Grouting Specification should be allowed for.

17.9.4 Drilling and grouting of the workings encountered across the western field (Area A) and southern area of the eastern field (Area B) will be required, in addition to the drilling of the three mine entries to confirm their location, depth and details of backfill.

17.9.5 Production of a Materials Management Plan should be commissioned to enable site regrade works to be undertaken

17.9.6 It is recommended that a silt and surface water management plan be developed prior to construction activities commencing due to the presence of Briestfield Beck which flows north along the site's eastern boundary.

17.9.7 Preparation of a Remediation Strategy should be allowed for.

Appendix A

General Notes

01 - Environmental setting
Generic notes – geoenvironmental Investigations

General

Third party information obtained from the British Geological Survey (BGS), the Coal Authority, the Local Authority etc is presented in the "Search Responses" Appendix of this Geoenvironmental Report.

Geology, mining & quarrying

In order to establish the geological setting of a site, Lithos refer to BGS maps for the area, and the relevant geological memoir. Further information is sourced by reference to current and historical OS plans.

In July 2011, the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology. The CA, using its extensive records has prepared plans for all coalfield Local Planning Authorities, which effectively refines the defined coalfield areas into High Risk and Low Risk areas. **High Risk** areas are likely to be affected by a range of legacy issues that pose a risk to surface stability, including: mine entries; shallow coal workings; workable coal seam outcrops; mines gas; and previous surface mining sites. **Low Risk** areas comprise the remainder of the defined coalfield, and are areas where no known defined risks have been recorded; although there may still be unrecorded issues. Where a site lies within either a High or Low Risk area, a mining report is obtained from the CA.

Landfills

Reference is made to publicly available Government held digital data via **QGIS** (an Open Source Geographic Information System), data from Landmark or Groundsure, and sometimes the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site.

Historical OS plans are also inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Radon

Radon is a colourless, odourless gas, which is radioactive. It is formed in strata that contain uranium and radium (most notably granite), and can move though fissures eventually discharging to atmosphere, or the spaces under and within buildings. Where radon occurs in high concentrations, it can pose a risk to health.

In order to assess potential risks associated with radon gas, Lithos refer to BRE Report BR211[1], and the Public Health England website. Advice on the limitation of exposure of the population to radon in buildings was originally published in 1990 by the National Radiological Protection Board (NRPB), which joined the Health Protection Agency (HPA) in 2005; the HPA updated NRPB advice in July 2010[2]. The HPA became part of Public Health England in 2013.

The HPA recommended that the NRPB radon Action Level for homes be retained, and a new Target Level for radon in homes be introduced. The values of the Action Level and Target Level, expressed as the annual average radon concentration in the home, are 200 Bqm^{-3} and 100 Bqm^{-3} respectively. The Target Level was to provide an objective for remedial action in existing homes and preventive action in new homes.

The term 'radon Affected Area' is defined as those parts of the country with >1% of homes estimated to be above the Action Levels. The NRPB first indicated which parts of the country should be regarded as radon Affected Areas in 1990. A more detailed mapping method was developed by the HPA in conjunction with the British Geological Survey in 2007[3]. The level of protection needed is site-specific and can be determined by reference to this mapping on the Public Health England website, which indicates the highest radon potential within each 1km grid square. Each 1km grid square is classified on the basis of the percentage of existing homes within that grid square estimated to have radon concentrations above the Action Level. There are 6 'bands': <1%; 1 to 3%; 3 to 5%; 5 to 10%; 10 to 30%; and >30%.

The NRPB advised that action should be taken to reduce radon concentrations in existing homes if the radon concentration exceeded the Action Level of 200 Bqm^{-3} in room air averaged over a year; ten times the average UK domestic radon concentration. NRPB advice informed changes in the requirements for radon protection in new buildings.

- **Basic** preventive measures are required in new buildings, extensions, conversions and refurbishments if the probability of exceeding the Action Level is **>3%** in England and Wales, and >1% in Scotland and Northern Ireland.
- Provision for further preventive (**Full**) measures is required in new buildings if the probability of exceeding the Action Level is **>10%**.

At present Building Regulations Approved Document C advocates basic measures for the probability banding 3% to 10%, and full measures if >10%. However, Public Health England would like to see all new build include basic measures.

Action & Target Levels should also be applied to non-domestic buildings with public occupancy exceeding 2,000 hrs/yr and to all schools.

Hydrogeology

Reference is made to publicly available Government held digital data via QGIS, and Landmark or Groundsure with respect to:

- Groundwater quality
- Recorded pollution incidents
- Licensed groundwater abstractions

From April 2010 the EA's Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply), but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey. The maps are split into two different types of aquifer designation:

- Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels
- Bedrock - solid permeable formations e.g. sandstone, chalk and limestone

The maps display the following aquifer designations:

Principal aquifers: These are layers of rock or superficial deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary aquifers: These include a wide range of rock layers or superficial deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into three types:

- **Secondary A** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers
- **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers
- Secondary undifferentiated - In most cases, this is because the rock type in question has previously been designated as both a minor and non-aquifer in different locations due to the variable characteristics.

[1] BRE Report BR211, 2015: "Radon: guidance on protective measures for new buildings.

[2] Limitation of Human Exposure to Radon, Documents of the Health Protection Agency - Radiation, Chemical and Environmental Hazards, RCE-15. July 2010.

[3] Miles JCH, Appleton JD, Rees DM, Green BMR, Adlam KAM and Myers AH (2007). Indicative Atlas of Radon in England and Wales. Chilton, HPA-RPD-033.

Unproductive strata: These are rock layers or superficial deposits with low permeability that have negligible significance for water supply or river base flow.

The EA maps only display the principal and secondary aquifers as coloured areas. All uncoloured areas on the map will be unproductive strata. However, for uncoloured areas on the superficial (drift) designation map it is not possible to distinguish between areas of unproductive strata and areas where no superficial deposits are present; to do this, it is necessary to consult the published geological survey maps.

For the purposes of the EA's Groundwater Protection Policy the following default position applies, unless there is site specific information to the contrary:

- If no superficial (drift) aquifers are shown, the bedrock designation is adopted
- In areas where the bedrock designation shows unproductive strata (the uncoloured areas) the superficial designation is adopted
- In all other areas, the more sensitive of the two designations is used (e.g. If secondary superficial overlies principal bedrock, an overall designation of principal is assumed)

The EA have also designated groundwater Source Protection Zones, which are based on proximity to a groundwater source (springs, wells and abstraction boreholes). The size of a Source Protection Zone is a function of the aquifer, volume of groundwater abstracted and the effective rainfall, and may vary from tens to several thousand hectares.

Hydrology

Reference is made to publicly available Government held digital data via QGIS, and Landmark or Groundsure with respect to:

- Surface water quality
- Recorded pollution incidents
- Licensed abstractions (groundwater & surface waters)
- Licensed discharge consents
- Site susceptibility to flooding

The EA have set **water quality** targets for all rivers. These targets are known as River Quality Objectives (RQOs). The water quality classification scheme used to set RQO planning targets is known as the River Ecosystem scheme. The scheme comprises five classes (RE1 to RE5) which reflect the chemical quality requirements of communities of plants and animals occurring in our rivers.

General Quality Assessment (GQA) grades reflect actual water quality. They are based on the most recent analytical testing undertaken by the EA. There are 6 GQA grades (denoted A to F) defined by the concentrations of biochemical oxygen demand, total ammonia and dissolved oxygen.

The susceptibility of a site to **flooding** is assessed by reference to a Flood Map on the Environment Agency's website. These maps show natural floodplains - areas potentially at risk of flooding if a river rises above its banks, or high tides and stormy seas cause flooding in coastal areas. There are two different kinds of area shown on the Flood Map:

1. Dark blue areas (Flood Zone 3) could be flooded by the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year, or by a river by a flood that has a 1% (1 in 100) or greater chance of happening each year
2. Light blue areas (Flood Zone 2) show the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Where there is no blue shading (Flood Zone 1), there is less than a 0.1% (1 in 1000) chance of flooding occurring each year.

The maps also show all flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, or floods from the sea with a 0.5% (1 in 200) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

The Agency's assessment of the likelihood of flooding from rivers and the sea at any location is based on the presence and effect of all flood defences, predicted flood levels, and ground levels.

It should also be noted that as the floodplain shown is the 1 in 100 year, areas outside this may be flooded by more extreme floods (e.g. the 1 in 1000 year flood). Also, parts of the areas shown at risk of flooding will be flooded by lesser floods (e.g. the 1 in 5 year flood). In some places due to the shape of the river valley, the smaller floods will flood a very similar extent to larger floods but to a lesser depth.

If a site falls within a floodplain, it is recommended that a flood survey be undertaken by a specialist who can advise on appropriate mitigating measures; i.e. raising slab levels, provision of storage etc. In accordance with Chapter 10 of the National Planning Policy Framework, a site-specific flood risk assessment is required for: proposals of 1 hectare or greater in Flood Zone 1, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and any new development in Flood Zones 2 and 3.

COMAH & explosive sites

Lithos obtain information from Landmark or Groundsure with respect to Control of Major Accident Hazards (COMAH) or explosive sites within 1km of the proposed development site. Lithos' report refers to any that are present, and recommends that the Client seeks further advice from the HSE.

Areas around COMAH sites (chemical plants etc) are zoned with respect to the implementation of emergency plans. The HSE are a statutory consultee to the local planning authority for all COMAH sites. The COMAH site may have to revise its emergency action plan if development occurs. This might be quite straightforward or could entail significant expenditure. Consequently, the COMAH site may object to a proposed development (although it is the Local Authority who have final say, and they are likely to place more weight on advice from the HSE).

Preliminary conceptual site model

The site's environmental setting (and proposed end use) is used by Lithos to assess the significance of any contamination encountered during the subsequent ground investigation.

Assessment of contaminated land is based on an evaluation of pollutant linkages (source-pathway-receptor). Contaminants within the near surface strata represent a potential source of pollution. The environment (most notably groundwater), site workers and end users are potential receptors.

Potential pollutant linkages are shown on a preliminary conceptual site model (pCSM). A CSM is essentially a cross-section through a site that reflects both the surface topography and underlying geology, and shows surface features of interest. The most significant sources of contamination are then superimposed onto this cross-section together with potential receptors (human health & controlled waters), and plausible pathways between the two. In addition to environmental issues, the CSM should also highlight geotechnical issues.

A pCSM is prepared after consideration of all available "desk study" data, and before design of the ground investigation. Data reviewed should include historical plans (with superimposition on a current-day plan), previous SI reports, geological maps etc. The pCSM, in conjunction with knowledge of site constraints (buildings, services, slopes etc) is used to design the ground investigation.

The revised CSM takes account of data obtained during the ground investigation, including the distribution of made ground, the nature and distribution of contamination etc.

02 - Ground investigation fieldwork
Generic notes – geoenvironmental investigations

General

Lithos Ground Investigations are undertaken in accordance with current UK guidance including:

- BS5930:2015 "Code of practice for site investigation"
- Eurocode 7: BS EN 1997-1:2004. Geotechnical design - Part 1: General rules
- Eurocode 7: BS EN 1997-2:2007. Geotechnical design - Part 2: Ground investigation and testing
- BS10175:2013 "Code of practice for the identification of potentially contaminated sites"
- "Technical Aspects of Site Investigation" – EA R&D Technical Report P5-065/TR (2000)
- "Development of appropriate soil sampling strategies for land contamination" – EA R&D Technical Report P5-066/TR (2001)
- Contaminated Land Reports 1 to 6, most notably CLR Report No. 4 "Sampling strategies for contaminated land"
- "Guidance on the protection of housing on contaminated land" – NHBC & EA R&D Publication 66 (2000)
- AGS: 1996 "Guide to the selection of Geotechnical Soil Laboratory Testing"

Exploratory hole locations

Exploratory hole locations are selected by Lithos, prior to commencement of fieldwork, to provide a representative view of the strata beneath the site and to target potential contaminant sources identified during the preliminary investigation (desk study). Additional exploratory locations are often determined by the site engineer in light of the ground conditions actually encountered; this enables better delineation of the depth and lateral extent of organic contamination, poor ground, relict structures etc.

Investigation techniques

Ground conditions can be investigated by a number of techniques; the procedures used are in general accordance with BS5930: 2015 and BS1377: 1990. Techniques most commonly used by Lithos include:

- Machine excavated **trial pits**, usually equipped with a backactor and a 0.6m wide bucket. Allows a thorough inspection of the ground; especially the uppermost 1m or so (but able to reach depths of up to c. 4m), with the recovery of representative, disturbed samples. Also used to conduct soakaway testing.
- **Window or windowless** sampling boreholes (**dynamic sampling**). Constraints associated with existing buildings, operations and underground service runs can render some sites partly or wholly inaccessible to a mechanical excavator. In such circumstances, window sampling is often the most appropriate technique. A window sampling drilling rig can be manoeuvred in areas of restricted access and results in minimal disturbance of the ground (a 150mm diameter tarmac/concrete core can be lifted and put to one side). However, it should be noted that window sampling allows only a limited inspection of the ground (especially made ground with a significant proportion of coarse material).
- **Cable percussive** (Shell & Auger) boreholes, typically using 150mm diameter tools and casing. Enables the recovery of soil samples and data from greater depth than is possible via trial pitting or a mini-percussive drill rig. Also enables the installation of better/deeper monitoring wells (cf use of a mini-percussive drill rig) due to the utilisation of temporary steel casing during drilling.
- **Rotary percussive** open-hole probeholes are typically drilled using a tri-cone rock roller or polycrystalline diamond compact (PDC) bit with air as the flushing medium. Probeholes are generally lined through made ground with temporary steel casing to prevent hole collapse. Often used to penetrate bedrock to investigate abandoned shallow mineworkings
- **Rotary cored** boreholes. A rock core is cut by a bit, passes up into the inner barrel and, at the end of the coring run, the core barrel assembly is lifted to the surface. Core drilling is relatively expensive, but essential if quality data is required to assess issues associated with deep excavation, rock slope stability etc.

Where installed, gas\groundwater monitoring **wells** typically comprise a lower slotted section, surrounded by a filter pack of 10 mm non-calcareous gravel and an upper plain section surrounded in part by a bentonite seal and in part by gravel or arisings. The top of the plain pipe is cut off below ground level and the monitoring well protected by a square, stopcock type manhole cover set in concrete, or the plain pipe is cut off just above ground level and the well protected by 100mm diameter steel borehole helmet set in concrete. Monitoring well details, including the location of the response zone and bentonite seal are presented on the relevant exploratory hole logs.

In-situ testing

Relative densities of granular materials given on the trial pit logs are based on visual inspection only, they do not relate to any specific bearing capacities.

The relative densities of granular materials encountered in cable percussive boreholes are based on Standard Penetration Test (SPT) results. SPTs are carried out boreholes, in accordance with BS 1377 1990, Part 9 Section 3.3. Where full penetration (600mm) is not possible, N values are calculated by linear extrapolation and are shown on the logs as N* = x. The strength of cohesive deposits is determined using a hand shear vane.

Shear strength test results (hand vane readings) reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

Typically Lithos collect at least three soil samples from each exploratory hole, although in practice a greater number are often taken. The collection of a sufficient number of samples provides a sound basis upon which to schedule laboratory analysis, ensuring:

- A sufficient number of samples from each (common) site material are tested
- Horizontal and vertical coverage of the site is adequate, thereby providing a robust data set for use in the conceptual ground model
- Any localised, significant, but non-pervasive conditions are considered

Made ground and natural soils encountered in the field during a ground investigation often contain a significant proportion of coarse grained material (e.g. brick etc). Soil samples obtained during most investigations are often only truly representative of the in-situ soil mass where there is an absence of particles coarser than medium gravel; i.e the entire soil mass would pass a 20mm sieve.

Representative bulk samples of the **soil mass** are retrieved from coarse soils for specific geotechnical tests (most notably grading and compaction); this typically requires the collection of at least 10kg of soil, and occasionally >50kg. However, in the context of assessing land contamination, it is generally accepted that samples should be representative of the **soil matrix** of the stratum from which they are taken. Consequently, truly representative samples of coarse soils for subsequent contaminant analysis are not obtained - only the finer fraction is placed in sample containers. Coarse constituents not sampled would typically comprise any 'particles' with an average diameter greater than about 20mm (i.e. coarse gravel, cobble and boulder).

At present, neither ISO/IEC 17025 nor MCERTS specify sample pre-treatment with respect to stone removal. Unsurprisingly therefore UKAS accredited testing laboratories do not adopt the same approach to stones[1] – some crush and test the "as received" soil, whilst others sieve out stones and analyse only the residual soil (the sieve size used varies depending on the laboratory).

In essence, samples taken from coarser soils for contaminant analysis are "screened" by the geoenvironmental engineer in the field, and often sieved again by the laboratory during sample preparation. Geoenvironmental engineers do not typically re-calculate soil mass contaminant concentrations by taking account of the unsampled coarse fraction. Likewise, laboratories that remove stones typically report contaminant concentrations based on the dry weight of soil passing the sieve. In the context of land contamination and human health risk assessment, this is considered reasonable, because it is the soil matrix which is of greatest concern. Stones are unlikely to:

- Provide a significant source for plant uptake (consumption of vegetables)
- Remain on vegetables after washing (consumption of vegetables)
- Be eaten (accidentally by an adult, or deliberately by a child)
- Be whipped-up by the wind for dust generation (inhalation)
- Stick to the skin for any length of time (dermal contact)
- Yield toxic vapour (inhalation)

Consequently, Lithos instruct labs to remove all stones >10mm, and to report the results as dry-weight based on the mass of matrix tested. However, the laboratory are given site-specific instruction where coarse stones are coated in say oil, or impregnated with mobile contaminants such as diesel. Where the stones are predominantly natural, or inert (e.g. brick, concrete etc), removal will clearly result in higher reported concentrations, than if the stones were crushed and added to the matrix.

Where the stones include a significant proportion of contaminant-rich material (e.g. slag, fragments of galvanised metal etc) an argument could be made for crushing and analysing. However, provided the stones are stable (i.e. unlikely to disintegrate or degrade) they should not pose a significant risk to human health for the reasons stated above.

Sometimes it is necessary to obtain samples that are not representative of the wider soil matrix, for example when investigating localised, significant, but non-pervasive conditions. Any such unrepresentative samples are annotated with the suffix '*' (eg 2D*, or 4G*). Lithos' site engineer describes both the unrepresentative sample, and the soil mass from which it was been taken.

Sample Containers (for contaminant analysis). Samples of soil for contaminant testing are placed into appropriate containers (see below). Soil samples for organic analysis are stored in cool boxes, at a temperature of approximately 4ºC, until delivery to the selected laboratory.

Anticipated testing	Container(s)
Asbestos identification	1000ml plastic tub
pH & metals	1000ml plastic tub or 250ml glass jars
non-volatile organics	250ml glass jars
Speciated TPH	250ml & 50ml glass jars
VOCs (incl. naphthalene and\or GRO)	50ml glass jar

Sample Containers (for geotechnical analysis). The majority of samples are only scheduled for PI and sulphate testing, for which 500g of sample is required (a full 0.5-litre plastic tub). However, bulk bags are taken where scheduling of compaction or grading tests is proposed.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork. Long-term monitoring of standpipes or piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

It should be borne in mind that the rapid excavation rates used during a ground investigation may not allow the establishment of equilibrium water levels. Water levels are likely to fluctuate with season/rainfall and could be substantially higher at wetter times of the year than those found during this investigation.

Description of strata

Soils encountered during a Lithos investigation are described (logged) in general accordance with BS 5930:2015. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text. The materials encountered in the trial pits are logged, samples taken, and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

[1] *Mark Perrin. Stoned – Sample Preparation for Soils Analysis. Ground Engineering, April 2007.*

03 – Geotechnical laboratory testing
Generic notes – geoenvironmental investigations

General

Soil samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Lithos. All tests are carried out in accordance with BS 1377:1990. The following laboratory testing is routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

Where soft, cohesive soils are encountered, one-dimensional consolidation tests are scheduled in order to assess settlement characteristics, and unconsolidated undrained triaxial compression tests to assess shear strength.

The additional tests are typically only scheduled where significant earthworks regrade is anticipated:

- Grading
- Compaction tests
- Particle density

Test results are presented as received in an Appendix to the Geoenvironmental Report.

Atterberg limits & moisture content

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each "type" of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth. Lithos typically only consider a soil to be shrinkable if the proportion finer than 63µm is >35%. PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003), which advocates the use of modified Plasticity Index (I'p), defined as:

I'p = Ip * (%< 425µm/100)

i.e. if PI is 30%, but the soil contains 80% < 425µm, then: I'p = 30 * 80/100 = 24%.

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs. Lithos apply engineering judgment where PI results are spread over a range of classifications. Consideration is given to:

- The average values for each particular soil type (ie differentiate between residual soil and alluvium)
- The number of results in each class and
- The actual values

Unless the judgment strongly indicates otherwise, Lithos typically adopts a conservative approach and recommends assumption of the higher classification.

Soluble sulphate and pH

Sulphates in soil and groundwater are the chemical agents most likely to attack sub-surface concrete, resulting in expansion and softening of the concrete to a mush. Another common cause of concrete deterioration is groundwater acidity.

The rate of chemical attack depends on the concentration of aggressive ions and their replenishment at the reaction surface. The rate of replenishment is related to the presence and mobility of groundwater.

Lithos refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2005). SD 1 provides definitions of:

- The nature of the site (greenfield, brownfield or pyritic)
- The groundwater regime (static, mobile or highly mobile)
- The design sulphate class (DS class) and
- The aggressive chemical environment for concrete (ACEC class)

Lithos reports clearly state each of the above for the site being considered.

The concentrations of sulphate in aqueous soil/fill extracts are determined in the laboratory using the gravimetric method. The results are expressed in terms of SO_4 for direct comparison with BS 5328:1997. The pH value of each sample was determined by the electrometric method.

SD1 also discusses determination of "representative" sulphate concentration from a number of tests. Essentially if <10 samples of a given soil-type have been tested, the highest measured sulphate concentration should be taken. If >10 samples have been tested, the mean of the highest 20% of the sulphate test results can be taken. With respect to groundwater, the highest sulphate concentration should always be taken.

With respect to pH (soil & groundwater) the value used is the lowest value if <10 samples have been tested and the mean of the lowest 20% if >10 samples have been tested.

Oedometer (Consolidation) tests

Oedometer tests measure a soil's consolidation properties, and are performed by applying different loads to a soil sample and measuring the deformation response. Typically the sample is subject to 5 incremental pressures (4 loading & 1 unloading), and the convention is for each subsequent pressure to be double the previous pressure. BS1377 suggests the **initial** pressure should be:

a) For stiff soils the effective overburden pressure*
b) For firm soils "somewhat less" than the effective overburden pressure
c) For soft soils "appreciably less" than the effective overburden pressure, usually 25 kPa or less
d) For very soft soils very low, typically 5 kPa or 10 kPa

* Effective **overburden pressure** (kNm^{-2}) = depth (m) x soil bulk unit weight (kNm^{-3})

Results from these tests are used to predict how a soil in the field will deform in response to a change in effective stress.

Triaxial tests

This test measures the mechanical properties of a soil by placing the sample between two parallel platens which apply stress in one (usually vertical) direction, with fluid used to apply a confining pressure in the perpendicular directions. During the test, the surrounding fluid is pressurized, and then stress on the platens is increased until the material in the cylinder fails.

From triaxial test data, it is possible to extract fundamental material parameters, including its angle of shearing resistance, apparent cohesion, and dilatancy angle. These parameters are then used in computer models to predict how the material will behave in a larger-scale engineering application.

Quick (single stage, Unconsolidated, Undrained tests) are most appropriate for foundation design. This is because load is applied relatively quickly, and shear strength of the clay will be lowest initially; after the applied load causes some consolidation of the ground (after drainage results in dissipation of short-term excess pore water pressure), the in-situ clays will become progressively stronger and hence the factor of safety will increase. Confining pressure is specified as equivalent to overburden pressure (kNm^{-2}).

Foundations on granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Unconsolidated Undrained triaxial tests are most appropriate for assessment of the stability of fill slopes on clays. Similar to foundations, the application of load gradually increases the strength of the clays and hence the critical case is the short term undrained condition.

Consolidated Undrained (or sometimes **Consolidated Drained**) triaxial tests are most appropriate for assessment of the stability of cut slopes in clays. This is because unloading of the ground leads to short term reduction in pore pressures that approximately balance the unloading, hence the soil strength is largely unchanged. Over time the reduced pore pressures suck water in, which leads in to the progressive increase in pore pressure and loss of strength. The fully drained state is critical, which must be modelled using effective strength parameters and a reasonable estimate of the long term water table conditions.

Slopes formed in granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Determination of analytical suite

An assessment of potential contaminants associated with the former usages of the site is undertaken with reference to CLR 8 "Potential contaminants for the assessment of land" and the relevant DETR Industry Profile(s).

Common contaminants

Common **Inorganic** Contaminants include:

- Metals, most notably cadmium, copper, chromium, mercury, lead, nickel, and zinc
- Semi-metals, most notably arsenic, selenium, and (water soluble) boron
- Non-metals, most notably sulphur
- Inorganic anions, most notably cyanides (free & complex), sulphates, sulphides, and nitrates

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction. Complex cyanide is "bound" in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to UV digestion for determination of both free and total CN.

Thiocyanate (SCN) is a different species combined with sulphur.

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO_4), sulphides etc.

There are 2 forms of chromium (Cr), chromium VI and chromium III. Chromium VI is the more toxic of these. In soils, total chromium is determined by a strong aqua regia acid digestion. Chromium VI is an empirical method based on a water extract test.

Common **Organic** Contaminants include hydrocarbons, phenols, and polychlorinated biphenyls.

Petroleum is a mixture of hydrocarbons produced from the distillation of crude oil, and includes aliphatics (alkanes, alkenes and cycloalkanes), aromatics (benzene and derivatives) and hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen. Petroleum hydrocarbons can be grouped based on the carbon number range:

- GRO – Gasoline Range Organics (typically C_6 to C_{10}). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C_{10} to C_{28})
- LRO - Lubricating Oil Range Organics (typically C_{28} to C_{40})
- MRO – Mineral Oil Range Organics (typically C_{18} to C_{44})

However, it should be borne in mind that the terms "GRO" and "DRO" analysis are purely descriptive terms, the exact definition of which varies. Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from C_5-C_{40}, whereas others define TPH as C_{10}-C_{30}.

The composition of a TPH plume migrating through the ground can vary significantly; this is primarily dictated by the nature of the source (e.g. petrol, diesel, engine oil etc). Furthermore, different hydrocarbons are affected differently by weathering processes, and this can result in further variation in the chemical composition of the TPH.

Gasoline contains light aliphatic hydrocarbons (especially within the C_4 to C_5 range) that are volatile. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present. Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar nitrogen, sulphur and oxygen-containing compounds (NSO) compounds are also present. Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

Polycyclic Aromatic Hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic. PAH compounds are present in both petrol and diesel, although in significantly lower concentrations than in coal tars. Certain PAH compounds are carcinogenic (benzo(a)pyrene) and\or mobile in the environment (naphthalene).

Volatile Organic Compounds (VOCs) are organic chemicals, and most are liquids that readily evaporate on exposure to air. Examples include benzene, toluene, xylene, chloroform etc. Semi-Volatile Organic Compounds (sVOCs) include phenol and benzo(a)pyrene, and have relatively low boiling points. Both groups of chemicals are readily absorbed through skin and some, such as benzene, are believed to be linked to tumour growth.

Phenols are compounds that have a hydroxyl group (-OH) attached to an aromatic ring (ie include a benzene ring and an –OH group). Most are colourless solids. A solution of phenol in water is known as carbolic acid, and is a powerful antiseptic. However, phenol vapour is toxic, and skin contact can result in burns.

Polychlorinated Biphenyls (PCBs) were used in pre-1974 transformers as dielectric fluids. PCB's are of increasing toxicity relative to the degree of chlorination. Acute symptoms of PCB poisoning are irritation of the respiratory tract leading to coughing and shortness of breath. Nausea, vomiting and abdominal pain are caused by ingestion of PCB's.

Dioxins and furans (polychlorinated dibenzodioxins and polychlorinated dibenzofurans) are some of the most toxic chemicals known; in the environment, they tend to bio-accumulate in the food chain. Dioxin is a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD.

Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxin in the environment comes from waste-burning incinerators and also from backyard burn-barrels. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process and with the production of Polyvinyl Chloride (PVC) plastics and with the production of certain chlorinated chemicals (like many pesticides).

Methods of analysis (organic compounds)

TPH by GC-FID is an analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C_{10} to C_{40} (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a broad, 'banded' breakdown of the TPH results into gasoline range organics (GRO), diesel range organics (DRO) and heavier lubricating oil range organics (LRO), or fully speciated results with the reporting of hydrocarbon concentrations in 14 specific carbon bandings based upon behavioural characteristics, e.g. aliphatic C_6 to C_8, aromatic C_{10} to C_{12} etc.

Speciated VOC (by GC-MS) analysis quantifies the concentrations of 30 USA-EPA priority compounds. These include chlorinated alkanes and alkenes (in the molecular weight range chloroethane to tetrachloroethane); trimethylbenzenes; dichlorobenzenes; and the 4 BTEX compounds (benzene, ethyl-benzene, toluene & xylene).

Speciated sVOC by (GC-MS) analysis quantifies the concentrations of a variety of organic compounds, including the 16 USA-EPA priority PAHs, phenols, 7 USA EPA priority PCB congeners, herbicides & pesticides.

Note: PAHs are hydrocarbons and consequently (where present) will be picked-up when scheduling TPH by GC-FID.

Note: Risk assessment models require physiochemical properties (solubilities, toxicities etc) of compounds in order to model their behaviour in the environment. These physiochemical properties cannot be derived from a single "TPH", "GRO" or "DRO" value. However, the carbon banded fractions can be used in risk assessment models.

Current UK guidance

The UK approach to contaminated land is set out in Contaminated Land Report No. 11 (2004) "Model Procedures for the Management of Land Contamination". The approach is based upon risk assessment, where risk is defined as the combination of the probability of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

In the context of land contamination, there are three essential elements to any risk: (1) a contaminant source; (2) a receptor (eg controlled water or people); and (3) a pathway linking (1) and (2). Risk can only exist where all three elements combine to create a pollutant linkage. Risk assessment requires the formulation of a conceptual model which supports the identification and assessment of pollutant linkages.

Lithos adopt a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate UK guidance levels, Lithos risk-derived screening values, or remedial targets. It should be noted that exceedance of Tier 1 does not necessarily mean that remedial action will be required.

Soil screening values used by Lithos

In March 2002 DEFRA and the Environment Agency published a series of technical papers (R&D Publications CLR 7, 8, 9 and 10) outlining the UK approach to the assessment of risk to human health from land contamination. In 2008 CLR 7, 9 and 10 and all corresponding SGV and Tox reports were withdrawn and superseded by new guidance including:

- Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software Handbook (Version 1.071), Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

The approach set out in these documents represents current scientific knowledge and thinking; and includes the Contaminated Land Exposure Model (CLEAv1.06). The Environment Agency are in the process of using this updated approach to regenerate a selection of Soil Guideline Values (SGVs).

CLEA SGVs were derived for standard land use scenarios predominantly in the context of Part IIA, using a conceptual site model (CSM) defined in SR3. Lithos have incorporated amendments to the CSM used to derive SGVs, that more accurately reflect redevelopment within the planning regime; consequently, Lithos have not adopted any published SGV as a screening value.

The CLEA conceptual site model assumes a source located in a sandy loam, with 6% soil organic matter (SOM) - equivalent to 3.5% total organic carbon (TOC). However, where the average TOC value for a particular soil type is significantly lower than the 3.5%, evaluation of Lithos Screening Values should be undertaken and a site specific risk assessment will usually be required. Other CLEA default characteristics adopted by Lithos are:

Sandy Loam characteristics (source)	Default values adopted
Total porosity (fraction)	0.53
Water filled porosity (fraction)	0.33
Air filled porosity (fraction)	0.2

Lithos have derived Screening Values for four different CSMs (scenarios); these are:

A - Residential with gardens, but no cover (or only up to 300mm)

B - Residential with gardens and 600mm 'clean' cover

C - Residential apartments with landscaping (i.e. no home grown produce)

D - Commercial/industrial with landscaping

E – Importation of soil cover

The **exposure** pathways considered for each scenario are detailed in the table below.

Scenario	Land use	Pathways	Justification
A	Residential with garden, but no cover (or only up to 300mm)	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	Minimal cover – insufficient to break any pathways therefore all exposure pathways are relevant.
B	Residential with garden minimum 600mm cover	• Inhalation of indoor vapours • Inhalation of outdoor vapours	The 600mm cover removes the risk from all pathways other than inhalation.
C	Residential apartments with landscaped areas and minimum 300mm cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. However consumption of home grown produce not included as unlikely to be grown in landscaped areas. Where vegetables are to be grown site specific QRA may be required.
D	Commercial/ industrial with landscaped areas no cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumed the commercial development consists of offices to provide a conservative assessment.
E	Importation of soil for cover in garden and landscaped areas	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of outdoor vapours and dust	Material used as cover to break existing pathways therefore all direct and indirect pathways relevant; however cover is **not** placed below plots therefore indoor inhalation is not relevant.

Lithos have assumed the source of contamination is directly below the building foundations; i.e. a depth to source of 0.15m as opposed to the CLEA default of 0.65m. This assumption provides for a more conservative approach than the UK default. This adjustment has been included to account for sites where made ground is re-engineered to enable new buildings to be established on raft foundations. In such situations contamination may lie directly beneath the foundation.

The Soil Screening Values referred to in this document are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part IIA of the Environment Protection Act 1990;
- End uses such as allotments, sports fields, children's playgrounds, care homes, hospitals etc; and
- Controlled waters.

In December 2013 Defra published the results of research project SP1010 – Development of Category 4 Screening Levels (C4SLs) for Assessment of Land Affected by Contamination. The objective of this project was to provide technical guidance in support of Defra's revised Statutory Guidance for Part 2A of the Environmental Protection Act 1990 (Part 2A). The revised Statutory Guidance, published in April 2012, introduced a new four-category system for classifying land under Part 2A where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low. Project SP1010 aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- Demonstration of the methodology, via derivation of C4SLs for 6 substances – arsenic, cadmium, chromium IV, lead, benzene & benzo(a)pyrene.

The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology. Development of C4SLs has been achieved by modifying the toxicological and\or exposure parameters used within CLEA (while maintaining current exposure parameters).

The Part 2A Statutory Guidance was developed on the basis that C4SLs could be used under the planning regime. However, policy responsibility for the National Planning Policy Framework falls to the Department for Communities and Local Government. Defra anticipate that, where they exist, C4SLs will be used as generic screening criteria, and Lithos consider C4SLs to be suitable for use as Tier 1 Screening Values. Lithos have discussed this matter with both NHBC and YALPAG (collection of Yorkshire & Lincolnshire local authorities) and received confirmation that they are satisfied with this approach.

With respect to **inorganic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Inorganic contaminant	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
As	32	37	37	Use (A) in SI Report for initial "screen". If >5 x A, then consider increase of cover to 1,000mm	40	640	37	C4SL adopted
Cd	10	26	26		149	410	26	C4SL adopted
Cr			3,000		3,000	30,000	3,000	Assumes Cr is CrIII
Pb	450	200	200		310	2,330	200	C4SL adopted
Ni	130		127		127	1,700	127	Assessment of health risk only
Se	350		350		595	13,000	434	
Hg	170		169		238	3,640	199	Assumes in an inorganic compound
B			5		5	5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu			80-200		80-200	80-200	80-200	
Zn			200		200	200	200	

With respect to **organic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
Benzene	0.33	0.87	0.9	0.9	3.3	98	N/A	C4SL adopted
Toluene	610		600	3,000	2,700	5,000	N/A	Calculated value over 10,000
Ethyl Benzene	350		350	932	843	5,000	N/A	
Xylenes	240		246	327	321	5,000	N/A	
Phenol	420		412	2,400	519	5,000	N/A	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo(a)pyrene		5	5	25	5.3	76	5	C4SL adopted. Where source is not a coal tar
Naphthalene			8	9	9	1,000	12	
Gasoline Range Organics			30	34	34	5,000	45	See 3-step assessment of TPH below
Diesel Range Organics			151	156	154	5,000	219	
Lubricating Range Org			1,000	5,000	2,000	5,000	1,000	

* *For a residential end use*

The significance of PAHs can be determined by considering indicator compounds. In most cases benzo(a)pyrene (BaP) is adopted as an indicator due to the amount of toxicological data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. A surrogate marker approach can be used to estimate the toxicity of a mixture of PAHs in soil using toxicity data for individual indicator compounds within that mixture. Exposure to the surrogate marker is assumed to represent exposure to all PAHs in that matrix. The surrogate marker approach relies on a number of assumptions:

- Surrogate marker (BaP) must be present in all soil samples
- Profile of the different PAH relative to BaP should be similar in all samples
- PAH profile in the soil samples should be similar to that used in the pivotal toxicity study[1]

[1] SP1010 Appendix E, Provisional C4SIs for benzo(a)pyrene as a surrogate marker for PAHs, CL:AIRE 2013

To assess the PAH profile in a soil sample, the ratio of the seven genotoxic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene), relative to BaP, should be calculated. The ratio relative to BaP should lie within an order of magnitude above and below the mean ratio to BaP.

Naphthalene should also be considered separately against its generic screen. Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than most other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach.

Similarly, **TPH** cannot be assessed as a single "total" value, and reference has been made to the Environment Agency's document P5-080/TR3, "The UK approach for evaluating human health risks from petroleum hydrocarbons in soils". This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down "TPH" into representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the bandings.

The significance of speciated TPH results can be assessed by following the 3 steps outlined in the tables below.

Step	Result	Action
1. Consider indicator compounds: Are BTEX, naphthalene, benzo(a)pyrene above their respective Tier 1 values?	Yes	Remediation or dQRA required
	No	Proceed to Step 2
2. Consider individual TPH fractions: are they above respective screening values?	Yes	Remediation or dQRA required
	No	Proceed to Step 3
3. Assess Cumulative effects: Is the calculated Hazard Index for each source >1	Yes	Remediation or dQRA required
	No	TPH compounds pose no significant risk

Step 1 - Assessing indicator compounds

TPH fraction Indicator compound	End use specific screening value (mg/kg)			
	A: Residential no cover	B: Residential with 600mm cover	C: Residential no gardens	D: Commercial\ industrial
Benzene	0.9	0.9	3.3	98
Toluene	600	3,000	2,700	5,000
Ethyl Benzene	350	932	843	5,000
Xylenes	246	327	321	5,000
Naphthalene	8	9	9	1,000
Benzo(a)pyrene	5	25	5.3	76

Step 2 - Assessing individual TPH fractions

TPH fraction		End use specific screening value (mg/kg)			
		A: Residential no cover	B: Residential with 600mm cover	C: Residential with no gardens	D: Commercial/ industrial
Aliphatic 5-6	GRO	41	41	42	5,000^ per fraction
Aliphatic 6-8	GRO	125	125	125	
Aliphatic 8-10	GRO	31	31	32	
Aliphatic 10-12	DRO	151	156	154	
Aliphatic 12-16	DRO	500^	500^	500^	
Aliphatic 16-21	DRO	1,000^	5,000#	1,000^	
Aliphatic 21-35	LRO	1,000^	5,000#	1,000^	
Aromatic 5-7	GRO	100	123	122	
Aromatic 7-8	GRO	30	34	34	
Aromatic 8-10	GRO	47	50	50	
Aromatic 10-12	DRO	215	287	266	
Aromatic 12-16	DRO	689	1,000*	1,000*	
Aromatic 16-21	DRO	1,000^	5,000#	1,000^	
Aromatic 21-35	LRO	1,000^	5,000#	1,000^	

* Calculated Screening Value exceeded soil saturation limit and could indicate free product, therefore calculated soil saturation limit adopted as a target

^ Calculated Screening Value close to soil saturation limit, screening value selected by Lithos considering visual and olfactory impacts.

Five times the screening value for Scenario A.

Step 3 - Assessing Cumulative Effects

$$HI = \sum_{F_i=1}^{16} HQ\ F_i = \frac{Measured\ concentration\ F_i\ (mg\,kg^{-1})}{SGV\ F_i\ (mg\,kg^{-1})}$$

where HI = Hazard Index
HQ = Hazard Quotient
F_i = Fraction $_i$
SGV = Soil Guideline Value

Other screening values used by Lithos

Tier 1 risk assessment of **hazardous gas** is undertaken through reference to the following documents (and further information is presented in Generic Note No. 5 – Hazardous Gas):

- Approved Document C, Building Regulations 2000
- Boyle & Witherington (2007) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2015 – Code of Practice for the characterisation & remediation from ground gas in affected developments

With respect to the assessment of potential **phytotoxic effects** of contaminants, Lithos refer to "The Soil Code" (MAFF, 1998) for copper and zinc. The CLEA SGV is adopted for nickel due to its human health effects.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, 'Concrete in aggressive ground', 2005.

With respect to the interpretation of the **calorific values**, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that: *"In general … it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn".*

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate or groundwater concentrations with the appropriate water quality standard. Tier 1 Screening Values have been discussed with the Environment Agency, and typically those in **bold** below are adopted.

Analyte	Source of Tier 1 Screening Value (µg/l)			
	Surface water (Abstraction for drinking) 1996	Water Supply Regulations 2000	Water Framework Directive	EA Advice
Arsenic	50	10	**50**	
Selenium	10	**10**		
Cadmium	5	5	**1.5**	
Chromium	50	50	**32**	
Copper	50	2,000	**28**	
Lead	50	10	**7.2**	
Nickel		20	**20**	
Zinc	3,000		**125**	
Boron		**1,000**		
Mercury	1	1	**0.07**	
Petroleum Hydrocarbons				**10**
1,1,1-Trichloroethane			**100**	
1,1 Dichloroethane				**100**
1,2-Dichloroethane		3	**10**	
1,1-Dichloroethene				**100**
Benzene		1	**10**	
Ethylbenzene				**10**
Tetrachloroethene		10	**10**	
Toluene			**50**	
Trichloroethene		10	**10**	
Vinyl Chloride		**0.5**		
Trichloromethane			**2.5**	
Xylenes			**30**	
Chloroethane				**100**

Waste classification & WAC

In the context of waste soils generated by remediation and\or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated 'natural' soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds)
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds)

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

Landfill operators require Waste Acceptance Criteria (WAC) laboratory data, if soil waste is classified as **hazardous**, and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Lithos typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated, for example where redevelopment proposals include basement construction etc. If off-site disposal of soils classified as hazardous waste during redevelopment is anticipated, then WAC analysis should be scheduled at an early stage in the remediation programme. However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous, and these contaminants can often be dealt with by alternative technologies (e.g. by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (e.g. WAC) is required.

Possible action in event of Tier 1 exceedance

Should any of the Tier 1 criteria detailed above be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

1. Undertake further statistical analysis following the approach set out in "*Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008*" in order to determine whether contaminant concentrations of inorganic contaminants within soil\fill actually present a risk (only applicable to assessing the risk to human health).
2. Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.
3. Based on a qualitative risk assessment, advocate an appropriate level of remediation to "break" the pollutant linkage - for example the removal of the contaminated materials or the provision of a clean cover.

Prior to undertaking any statistical analysis the issue of the **averaging area** requires further consideration. The CL:AIRE\CIEH document still refers to CLR 7, which suggests averaging area should reflect receptor behaviour and therefore might be a single garden, or an open area used by the local community as a play area. This approach to averaging areas is considered applicable within the context of Part IIA of the Environmental Protection Act (EPA) 1990, in terms of an existing residential development.

However, Lithos consider the concept of a single garden as an averaging area to be inappropriate with respect to brownfield redevelopment, which is regulated by the planning regime. In this context, contamination across the entire site needs to be characterised by reference to the Conceptual Site Model. Consequently, Lithos gather and analyse sample results by fill type, and\or by former use in a given sub-area of the site, before undertaking statistical analysis; ie the averaging area is associated with the extent of a particular fill type, or an area affected by spillage\leakage.

In terms of brownfield redevelopment, this is considered a more appropriate methodology which provides a more representative sample population for statistical analysis. As such the entire site is considered in terms of the proposed end use, be this residential with, or without gardens.

Analysis by soil\fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil\fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass, ie contamination would normally be more pervasive and significant in granular soils than cohesive soils

05 – Hazardous gas
Generic notes – geoenvironmental investigations

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency). In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 01 – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark Information Group, the Environment Agency and the Local Authority and the British Geological Survey. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Where landfilling has occurred within 250m of the site boundary, the Local Planning Authority may request a landfill gas investigation in accordance with the Town and Country Planning General Development Order, 1988.

Sources

Potential sources of hazardous gas include:

- Landfill sites
- Made ground, especially where significant depths are present
- Shallow mineworkings associated with coal extraction
- Geological strata, including peat, organic silts, coal and limestone (reaction with acidic waters), granite (radon)
- Groundwater can sometimes act as a "carrier" for hazardous gas
- Leakages from pipelines or storage tanks
- Sewers, septic tanks and cess pits

Generation

Wherever biodegradable material is deposited, landfill gas (principally a mixture of methane and carbon dioxide) is likely to be generated by microbial activity. Carbon dioxide is an asphyxiant and toxic; methane is flammable and a mixture containing between 5% and 15% methane by volume in air is explosive. Landfill gas in the ground is unlikely in itself to pose a significant risk, though it may damage vegetation. However, infiltration of landfill gas into confined spaces (e.g. cellars, services, etc) may give rise to considerable risk.

There is no typical figure for the length of time that landfill gas will be evolved, but at many sites significant gas generation continues for at least 15 years after the last deposit of waste.

Migration

Gas migration from a landfill site may occur in several ways. It may migrate through adjacent strata; the distance of migration being dependent on the pressure gradients, volume of gas and permeability of the strata. Where there are faults, cavities and fissures within the strata, gas may move considerable distances. Other migration pathways for gas include man-made features such as mine shafts, roadways and underground services.

Gas migration is influenced by a number of climatic factors, such as atmospheric pressure variations, water table level variations and the influence of a covering of snow or ice over the surface of the site and surrounding area.

Gas monitoring procedure

Lithos adopt a standard gas monitoring procedure, in accordance with CIRIA guidance. This procedure involves the measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration
- Gas emission rate
- Methane, oxygen and carbon dioxide concentrations using an infra-red gas analyser
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism. Where samples of gas are required for laboratory analysis, Gresham Tubes or multi-layer Tedlar / ALTEF sampling bags are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Current guidance

CIRIA Report 151 (1995)[i] identified that there was inadequate guidance on trigger concentrations for ground gases. CIRIA concluded that the most important aspect of a gas regime below or adjacent to a site was the surface emission rate, i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. CIRIA Report C665 (2007)[ii] advocates two methodologies for characterising sites:

A – All developments except low rise housing. The advocated methodology is that proposed by Wilson & Card, 1999[iii]

B – Low rise housing. An alternative (traffic light) methodology, derived by Boyle and Witherington, 2006[iv] for NHBC

Both methodologies refer to Gas Screening Values (GSV); previously referred to as limiting borehole gas volume flow.

A – All developments except low rise housing

(Wilson & Card, 1999)[v] revised Table 28 of CIRIA 149[v] in terms of borehole gas volume flow rate (now GSV) in order to achieve a more consistent design of protection measures. This was done to reflect the importance of recognising the gas surface emission rate. Wilson & Card then developed a method for classifying gassing sites (Table 1 below), which took into account the combined gas concentration and GSV.

Characteristic Situation	Gas Screening Value, CH_4 or CO_2 (l/hr)	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% v/v and carbon dioxide not to exceed 5% v/v	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70 litre/hr otherwise increase to Characteristic Situation 3	Natural soil, high peat/organic content
3	<3.5		Old landfill, inert waste, mineworkings flooded.
4	<15	Quantitative Risk Assessment required to evaluate scope of protection measures.	Mineworkings – susceptible to flooding, completed landfill, inert waste
5	<70		Mineworkings unflooded, inactive
6	>70		Recent landfill site

Notes: Borehole flow rate = volume of gas (regardless of composition) which is escaping from well (l/hr). Gas Screening Value (litre/hour) = gas concentration (%) / 100 x borehole flow rate (l/hr). To facilitate design implementation, the limiting values for both methane and carbon dioxide are identical.

B – Low rise housing.

NHBC have developed a characterisation system similar to that of Wilson & Card above, but specific to low-rise housing development (Boyle and Witherington) (Table 8.7). This approach compares measured gas emission rates with generic "Traffic Lights". The Traffic Lights include "Typical Maximum Concentrations" for initial screening, and risk-based Gas Screening Values (GSVs) for consideration of situations where the Typical Maximum Concentrations are exceeded. Calculations are carried out for both methane and carbon dioxide and the worst case adopted in order to establish the appropriate protection measures.

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light Classification	Methane [1]		Carbon Dioxide [1]	
	Typical Maximum Concentration [5] (%v/v)	Gas Screening Value [2,4,6] (l/hr)	Typical Maximum Concentration [5] (%v/v)	Gas Screening Value [2,3,4,6] (l/hr)
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.13
Red				

Notes:

1. The worst gas-regime identified at the site, either methane or carbon dioxide, recorded from monitoring in the worst temporal conditions, will be the decider for which Traffic Light and GSV is allocated.
2. Generic GSVs are based on guidance contained within "The Building Regulations: Approved Document C" (2004) and assume a sub-floor void of 150 mm thickness.
3. A leak of gas from the sub-floor void into a small room (e.g. downstairs toilet with soil pipe potentially passing into sub-floor void) of dimensions 1.50m × 1.50m × 2.50m, with a total room volume of 5.63m^3 has been considered.
4. The GSV, in litres per hour, is as defined in Wilson and Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.
5. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgment will be required, based on a thorough understanding of the gas regime identified at the site where monitoring in the worst temporal conditions has occurred.
6. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

---

i Harries CR, Witherington PJ and McEntee JM (1995). Interpreting measurements of gas in the ground. CIRIA Report 151

ii CIRIA (2007) – Assessing risks posed by hazardous ground gases to buildings.

iii Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.

iv Boyle & Witherington (2006) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC

v Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.

06 - Soakaways
Generic notes – geoenvironmental investigations

Background

Soakaways have been the traditional way to dispose of stormwater from buildings and paved areas remote from a public sewer or watercourse. In recent years, soakaways have been used within urban, fully-sewered areas to limit the impact on discharge of new upstream building works, and to avoid costs of sewer up-grading outside a development.

Soakaways are increasingly seen as a more widely applicable option alongside other means of stormwater control and disposal. Soakaways must store the immediate stormwater run-off and allow for its efficient infiltration into the adjacent soil. They must discharge their stored water sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent storm. The time taken for discharge depends upon the soakaway shape and size, and the surrounding soil's infiltration characteristics. Soakaways can be constructed in many different forms and from a range of materials.

BRE Digest 365, DG365: 1991 describes design and construction procedures, explains how to calculate rainfall design values and soil infiltration rates, and gives design examples. Further advice is provided in **NHBC** Standards Chapter 5.3 (Section 9 & Appendix F), **Building Regulations** Section 3 of Approved Document H (Drainage & Waste Disposal), and Chapter 13 of **CIRIA's** SUDS Manual (C753:2015).

Soakaways should generally be built on land lower than or sloping away from buildings and be sited **at least 5m** from the foundations of a building.

BRE365 states that '**Groundwater should not rise to the level of the base of the soakaway** during annual variations in the water table' this is further reinforced in Chapter 13 of CIRIA C753:2015 which states that: "*A minimum distance of 1m between the base of the infiltration system and the maximum likely groundwater level should always be adopted. This is to minimise the risk of groundwater rising into the infiltration component and reducing the available storage volume, to protect the functionality of the infiltration process by ensuring a sufficient depth of unsaturated material and to protect the groundwater from any contamination in the run-off*". There may be a requirement to install groundwater monitoring wells at a site in order to monitor seasonal variations in groundwater level at least over a wet winter period.

Soakaways should **not be sited on sloping sites**, an assessment should also be made to ensure that infiltrating water will not cause a rise in groundwater levels, waterlogging of downhill areas or springs, and that slopes are not made unstable.

Made ground (and ground within 5m of deep fill) is not generally regarded as suitable for soakaways, due to the potential for inundation settlement and the leaching of contaminants.

Chalk: CIRIA C574:2002 notes that concentrated ingress of water into the chalk can initiate dissolution, particularly in low-density chalk. For this reason, soakaways should be sited well away from foundations for structures, roads or railways:-

- in areas where dissolution features are known to be prevalent, soakaways should be avoided but, if unavoidable, should be sited at least 20m away from foundations etc
- where the chalk is of low density (weak), or where density is not known, soakaways should be sited at least 10m away from foundations
- where the chalk is of medium density, or higher (moderately weak), soakaways should be sited at least 5m away from foundations

Test methodology

Lithos undertake soakaway tests in general accordance with BRE Digest 365 "Soakaway Design". The BRE Digest recommends that each soakaway pit is filled and allowed to drain three times to near empty; the three fillings to be on the same or consecutive days. However, each test can take over 2 hours to complete. Consequently, at site investigation / feasibility stage, testing is usually undertaken in a 'broad sweep', relatively widely spaced; often only 1 or 2 fills. The drainage designer reviews SI data and if soakaways look feasible, commences design with the incorporation of soakaways. Prior to finalising design, the Drainage Engineer will usually recommend further soakaway testing: (a) within 25m of proposed chamber locations; and (b) to include 3 fills.

Whilst in theory 3 fills is fine, in practice it is often not straightforward. Where drainage rates are quick (draining < 1 hour), allowing 3 fills per pit within a day, even larger water bowsers (say 2,300 gallon/10,000 litre) will run out of water after testing in two pits. Re-filling can take 2 to 3 hours depending on available water supplies etc. So, it is typically only possible to do fully compliant BRE 365 testing in 4 pits a day.

Where infiltration is moderate (a fill drains in say 2 to 4 hours), soakaways may be considered feasible, but it will not usually be possible to complete 3 fills in a day. Therefore, it becomes necessary to leave pits open overnight (usually with a consequent need for herras fencing, site security etc, or the use of stone backfill).

Infiltration rates

Infiltration rates for each soakaway test are calculated (where possible) in accordance with BRE Digest 365. This design takes into account the time of emptying the soakaway pit between 25% and 75% of its effective depth. The effective depth is calculated from the starting water level to the soakaway pit base. Where the water level did not fall to 25% effective depth, the data was interpolated in order to obtain a representative infiltration rate.

Soakaway design

Soakaway design should be carried out by a suitably qualified and experienced Drainage Engineer, in accordance with BRE Digest 365 using the infiltration rates calculated from soakaway testing during a ground investigation.

It is generally assumed that soakaways become impracticable on residential developments when:

- A chamber type design requires a square pit with side length in excess of 1.8m, or an effective depth greater than 1.5m.
- A trench type design requires a length greater than about 10m, or an effective depth greater than 1.5m.

Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

- Standing groundwater level
- Depth to base of permeable strata
- Cost of excavation

Soakaway percolation in some rock types is predominately via the vertical joints within the rock mass. The relatively small-scale soakaway test pits may not intercept such joints and this can result in variable test results. However, it is likely that the larger surface area of a completed soakaway within the development will intercept such joints.

The drainage designer submits designs for approval to:

- The Lead Local Flood Authority (LLFA), usually part of the Local Authority (e.g. NYCC). The LLFA are a consultee to the planning authority. They review the full technical design to ensure that proposals (both plots & highways) are satisfactory. The LLFA may also set standards for soakaway design (NYCC have, and these now require 3 fills and soakaway testing within 25m of proposed chamber locations).
- Local Authority Highways Dept. The Highways Authority adopt highways drainage, so review drainage design (via approval of a Section 38 submission). They also visit site to inspect construction.
- Building warranty provider (e.g. NHBC, Premier etc), if soakaways are proposed for roof & driveway waters.

Appendix B

Drawings

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CLIENT	YORKSHIRE COUNTRY PROPERTIES
JOB TITLE	DENBY LANE, GRANGE MOOR
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	CC
DATE	19 10 2022
CHECKED	AG
DATE	19 10 2022
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
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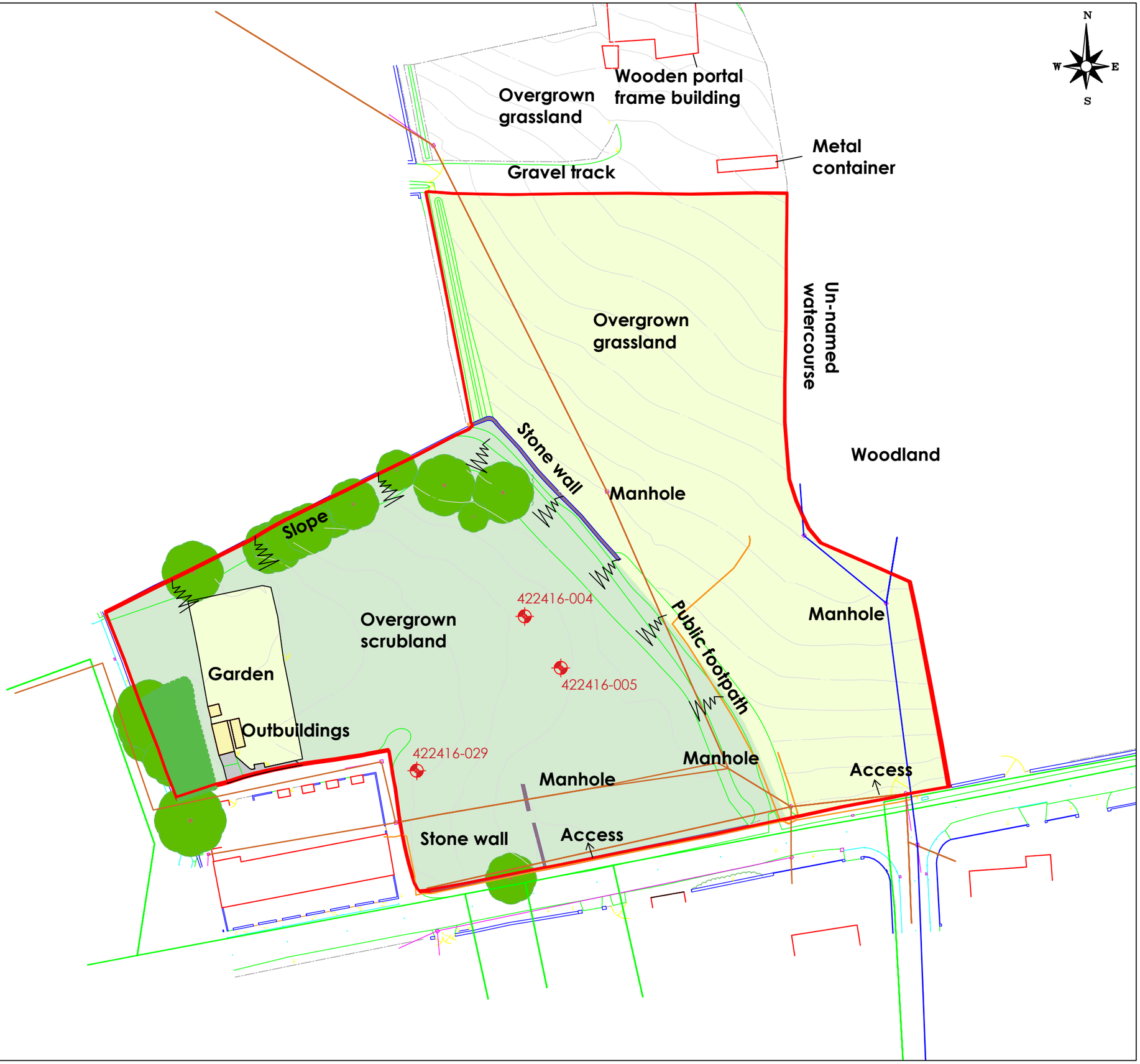
SHEET	A4
DRAWING NO.	4511/1
REVISION	



NOTES

- OVERGROWN SCRUBLAND
- OVERGROWN GRASSLAND
- TREES
- OUTBUILDINGS
- APPROXIMATE SITE BOUNDARY
- MINE ENTRY LOCATION
- SLOPE

REV.	DESCRIPTION	DATE

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CLIENT

YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
CC	19 10 2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	19 10 2022	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:750	A3	4511/3	

NOTES

- 1855 SITE FEATURES
- 1893 SITE FEATURES
- 1907 SITE FEATURES
- 1961 SITE FEATURES
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

HISTORICAL SITE FEATURES

DRAWN	DATE	STATUS
CC	19 10 2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	19 10 2022	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:750	A3	4511/ 3A	

N

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S

NOTES

- OVERGROWN SCRUBLAND
- OVERGROWN GRASSLAND
- TREES
- OUTBUILDINGS
- APPROXIMATE SITE BOUNDARY
- LOCATION & ORIENTATION OF PHOTOGRAPH

REV.	DESCRIPTION	DATE

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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
CC	19 10 2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	19 10 2022	DRAFT ☐
		FINAL ☑

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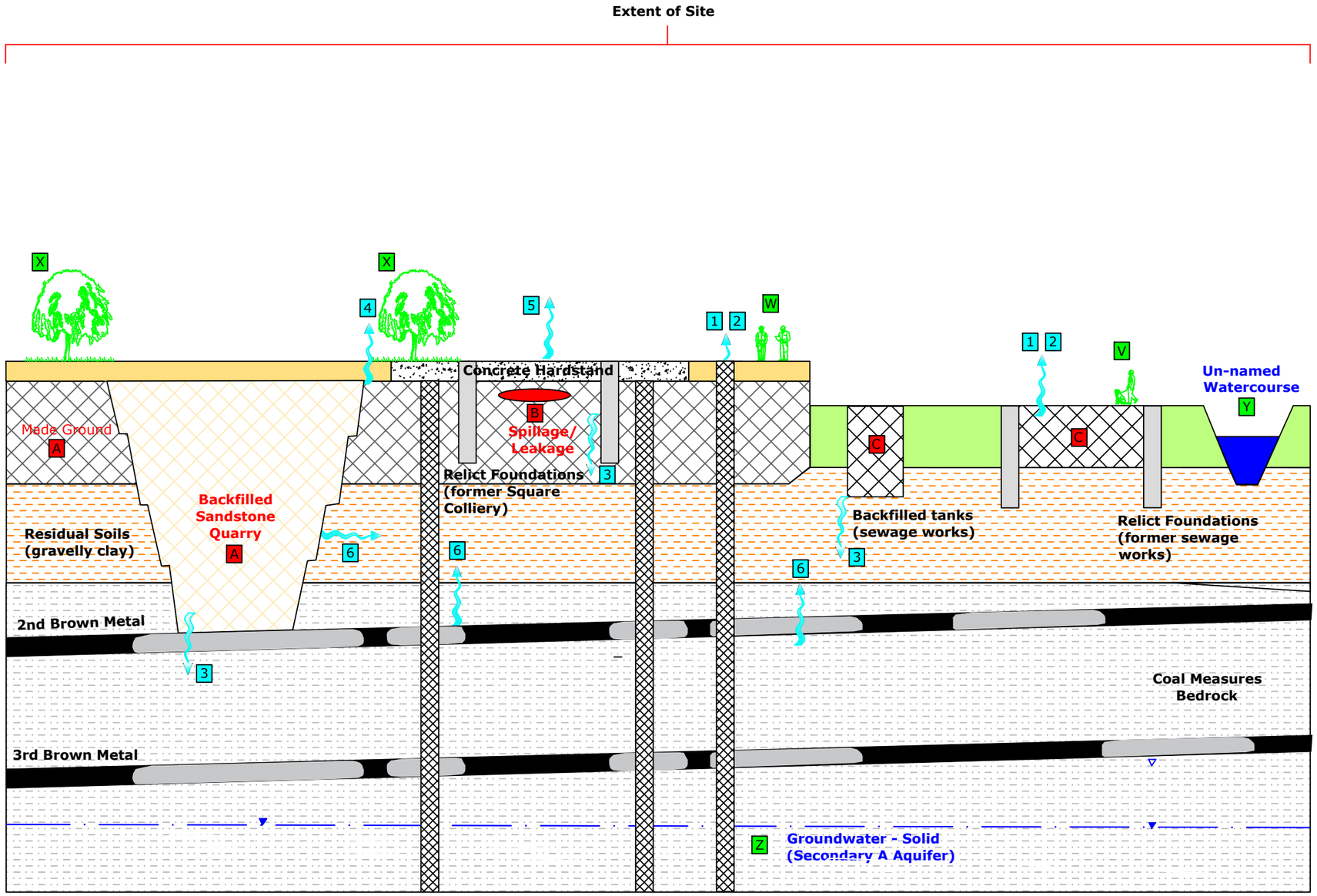

SOURCES	
A	QUARRY/SQUARE COLLIERY MADE GROUND (INORGANICS)
B	LEAKAGE/SPILLAGE (ORGANICS)
C	FORMER SEWAGE WORKS MADE GROUND (INORGANICS/ ORGANICS)

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION/INHALATION
3	LEACHING OF CONTAMINANTS
4	UPTAKE BY PLANTS
5	VOLATILISATION
6	MIGRATION OF GAS

RECEPTORS	
V	END USERS (RESIDENTS)
W	SITE WORKERS
X	VEGETATION
Y	SURFACE WATERS
Z	GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
CC	19 10 2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	19 10 2022	DRAFT ☐
		FINAL ☑

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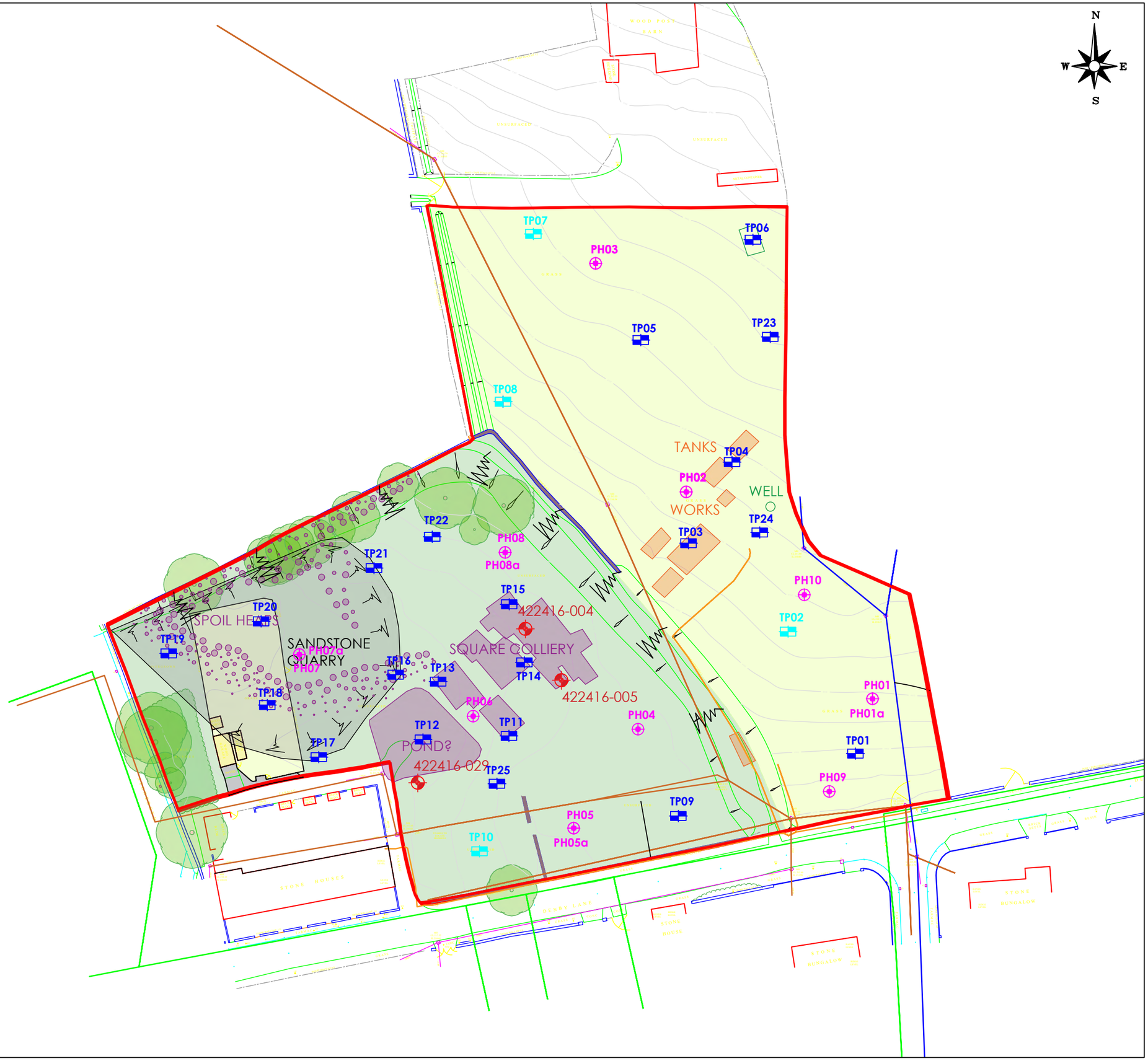

NOTES

- TRIAL PIT LOCATION
- SOAKAWAY PIT LOCATION
- PROBEHOLE LOCATION
- MINE ENTRY LOCATION
- GRASS & OVERGROWN AREAS
- CROPPED FIELD
- LINE OF ELECTRICITY UTILITY
- LINE OF GAS UTILITIY
- LINE OF DRAINAGE UTILITY
- LINE OF SEWER UTILITY

NOTE THAT UTILITY LOCATIONS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION PURPOSES, NOR SHOULD IT BE ASSUMED THAT ALL UTILITIES BENEATH THE SITE ARE SHOWN ON THIS PLAN. THERE MAY BE UTILITIES UNKNOWN TO LITHOS. THIS DRAWING IS NOT AN ALTERNATIVE TO VISUAL INSPECTION, USE OF A CAT DETECTION TOOL AND CAREFUL EXCAVATION.

- APPROXIMATE SITE BOUNDARY

EXPLORATORY HOLE LOCATIONS HAVE BEEN SURVEYED IN (COORDINATES & GROUND LEVEL) ON COMPLETION

REV.	DESCRIPTION	DATE

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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL ☐
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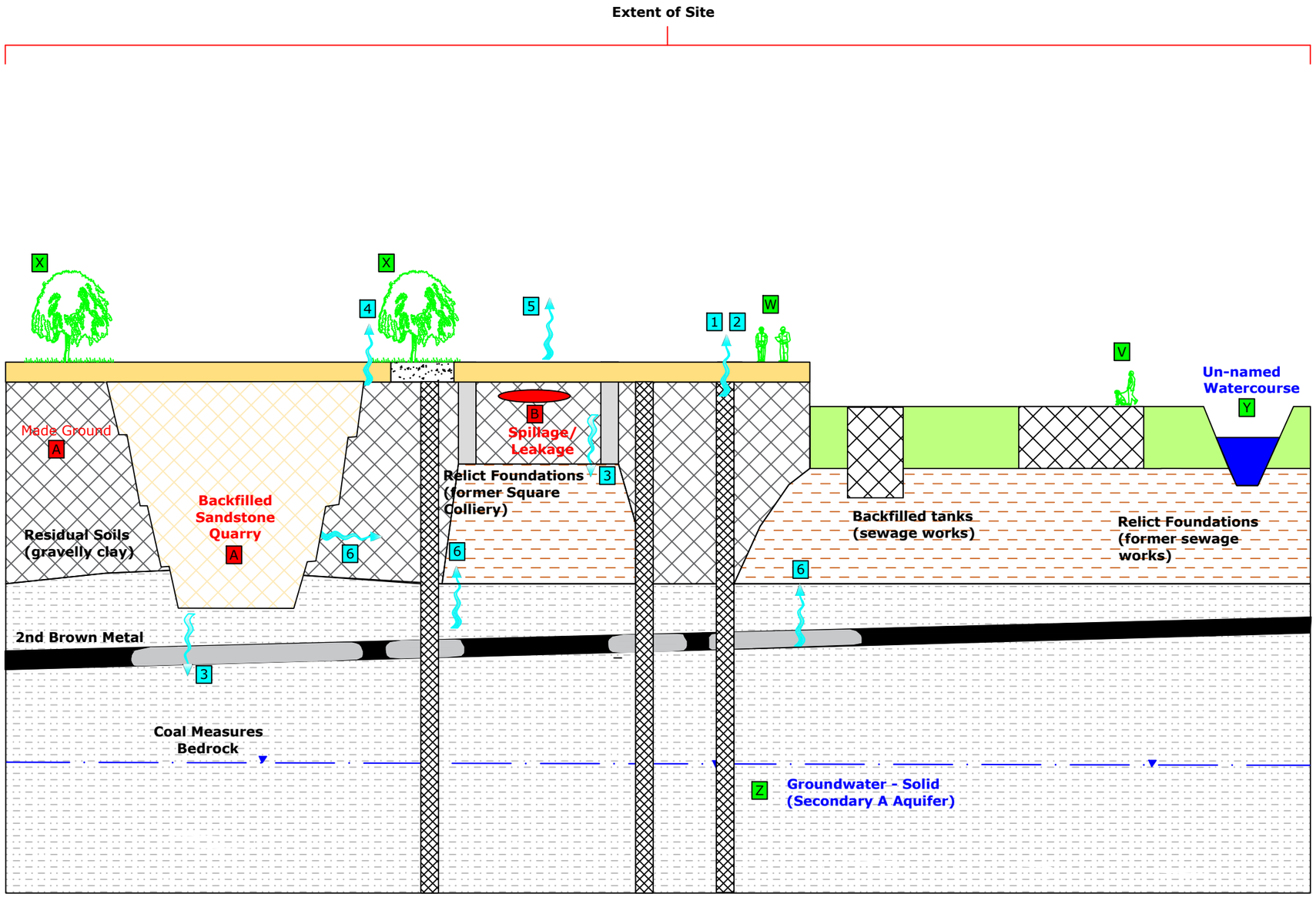

SOURCES	
A	MADE GROUND (INORGANICS)
B	LEAKAGE/SPILLAGE (ORGANICS)

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION/INHALATION
3	LEACHING OF CONTAMINANTS
4	UPTAKE BY PLANTS
5	VOLATILISATION
6	MIGRATION OF GAS

RECEPTORS	
V	END USERS (RESIDENTS)
W	SITE WORKERS
X	VEGETATION
Y	SURFACE WATERS
Z	GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
CC	21 11 2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
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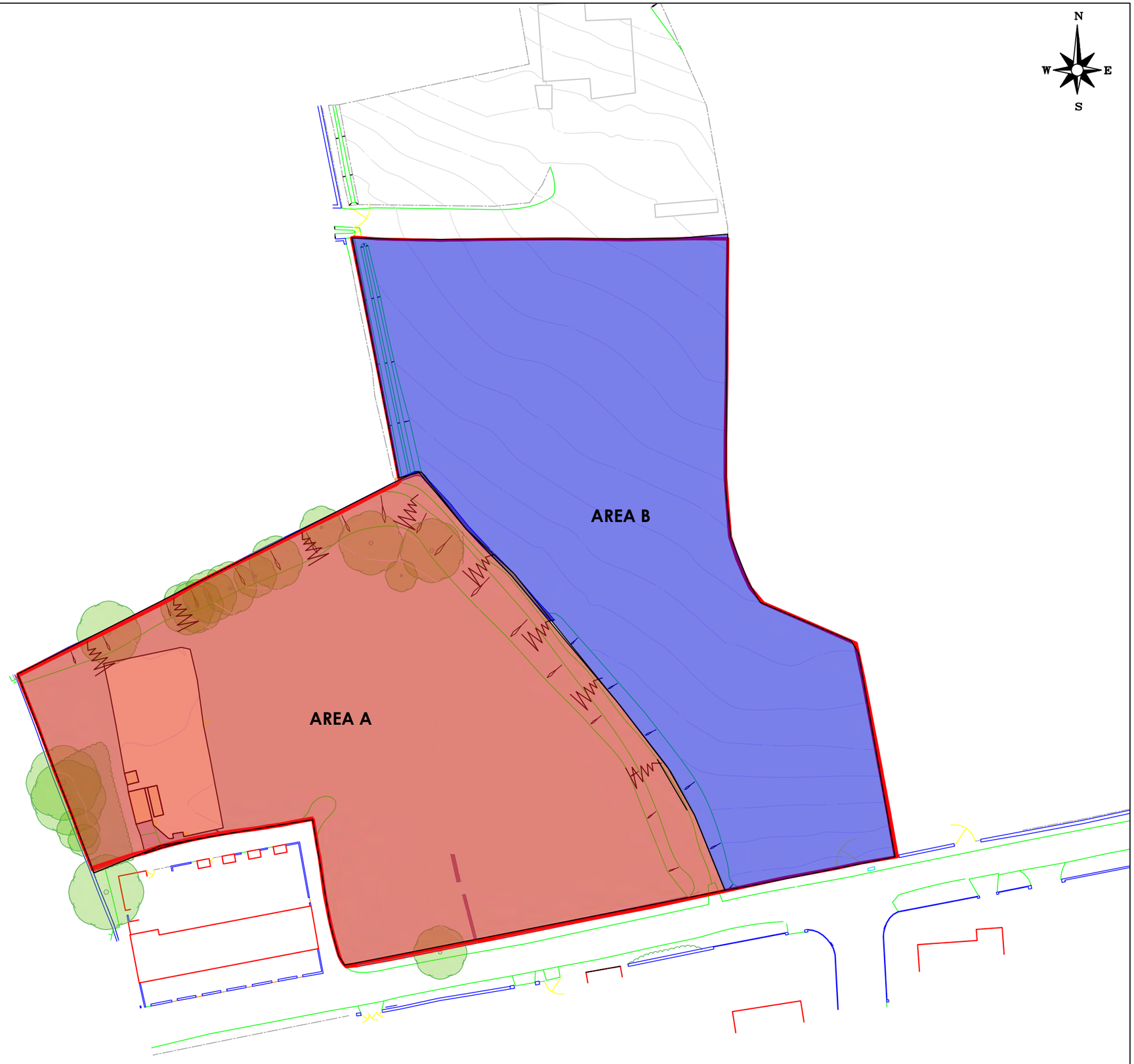

N
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NOTES

AREA A

AREA B

APPROXIMATE SITE BOUNDARY

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JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

SITE AREAS

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL ☐
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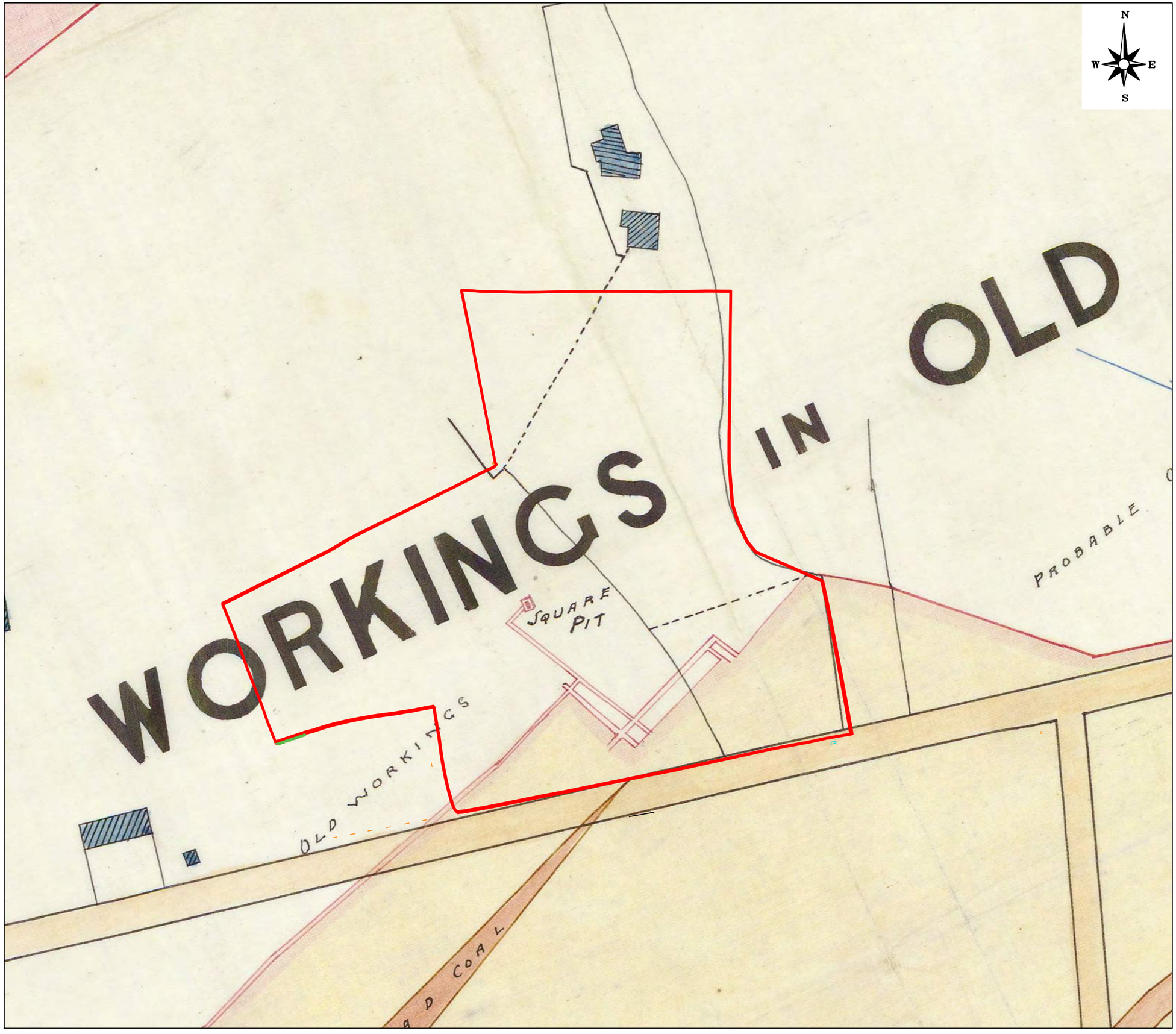

NOTES

APPROXIMATE SITE BOUNDARY

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JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

ABANDONMENT PLAN - OLD HARDS SEAM (LOW FENTON COAL/2ND BROWN METAL)

DRAWN	DATE	STATUS
CC	05 10 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
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		FINAL ☑

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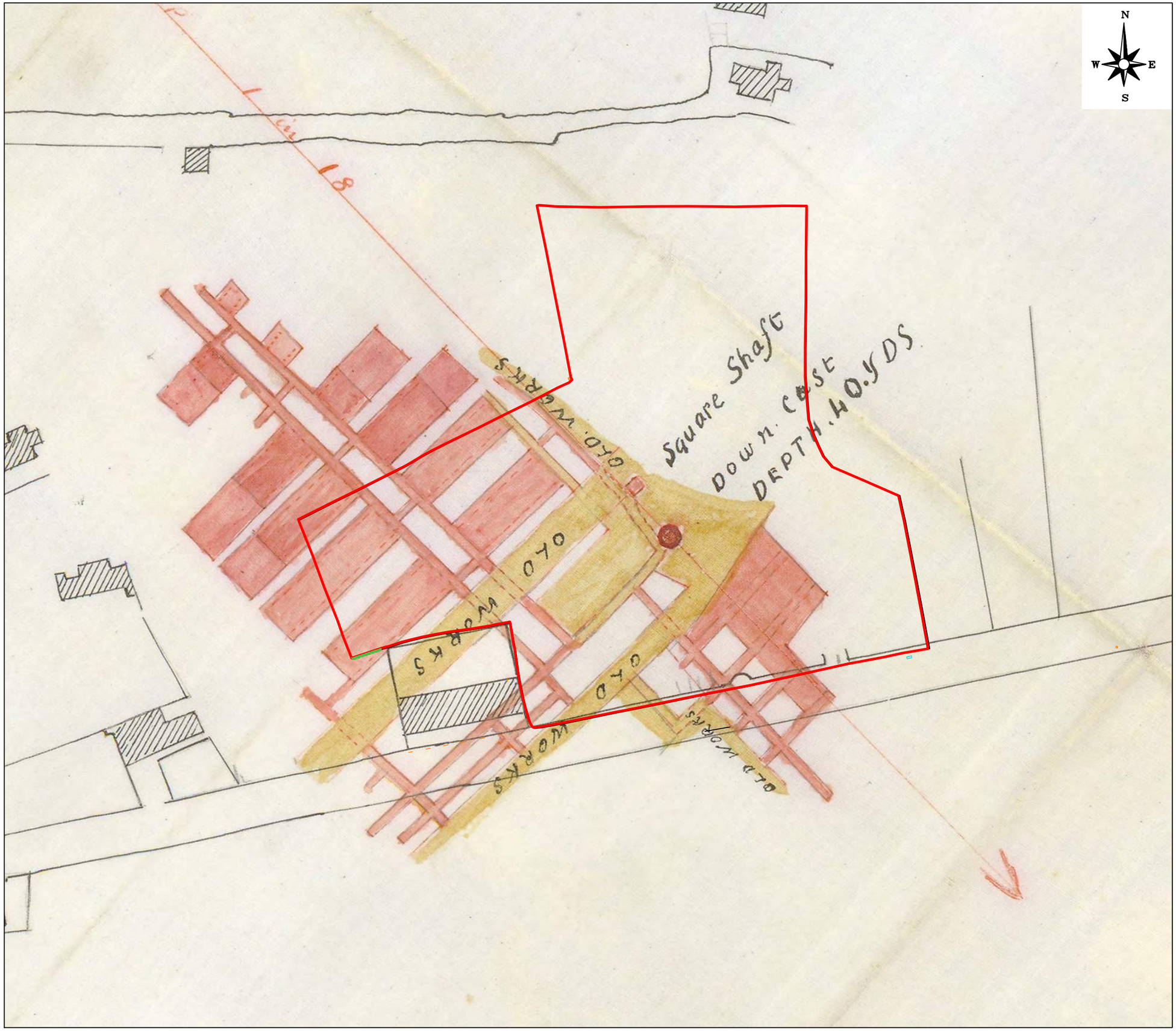

NOTES

APPROXIMATE SITE BOUNDARY

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JOB TITLE

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DRAWING TITLE

ABANDONMENT PLAN - GREEN LANE BED (MIDDLETON LITTLE)

DRAWN	DATE	STATUS
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		FOR APPROVAL ☐
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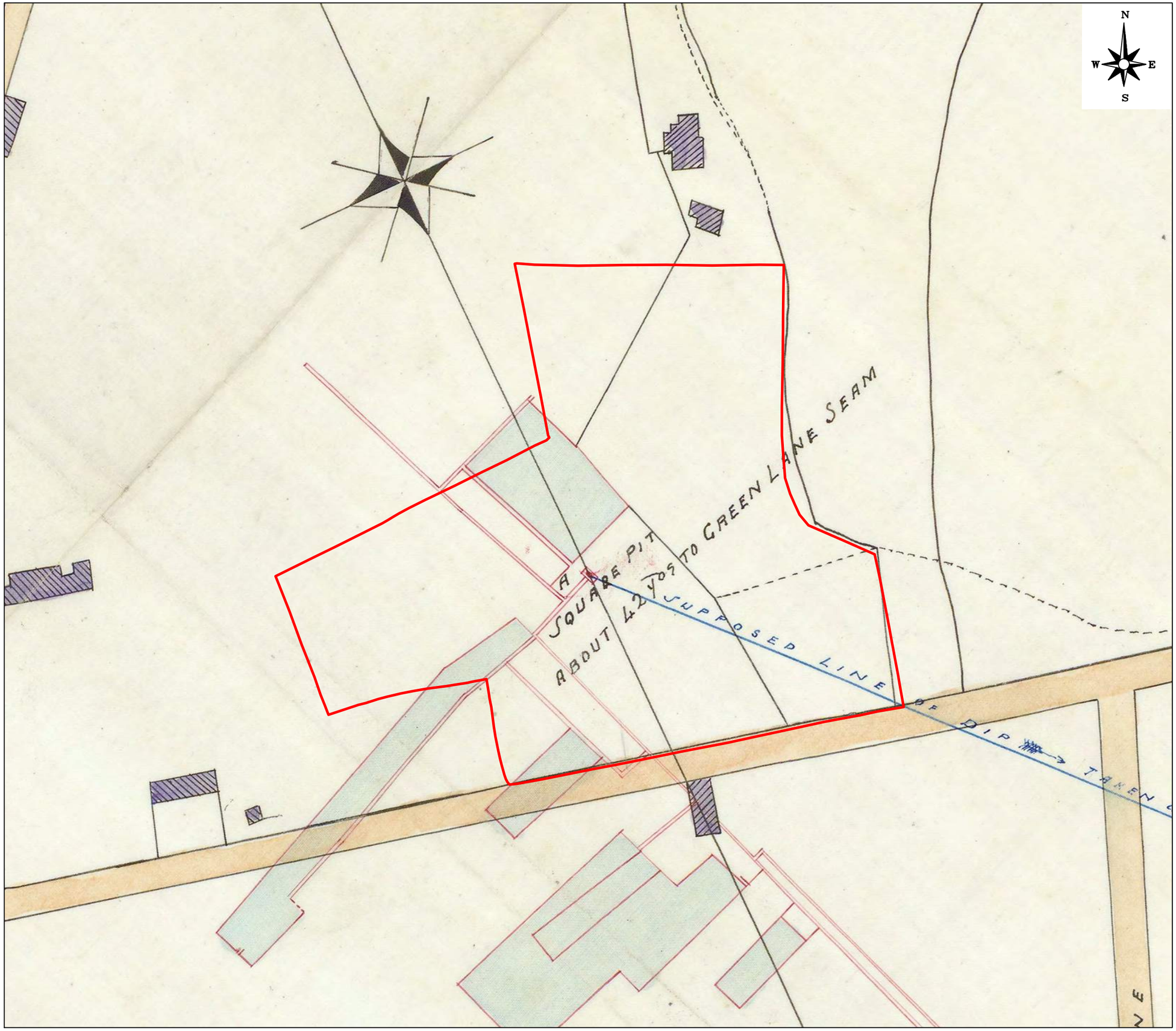

NOTES

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JOB TITLE

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DRAWING TITLE

ABANDONMENT PLAN - GREEN LANE BED (MIDDLETON LITTLE)

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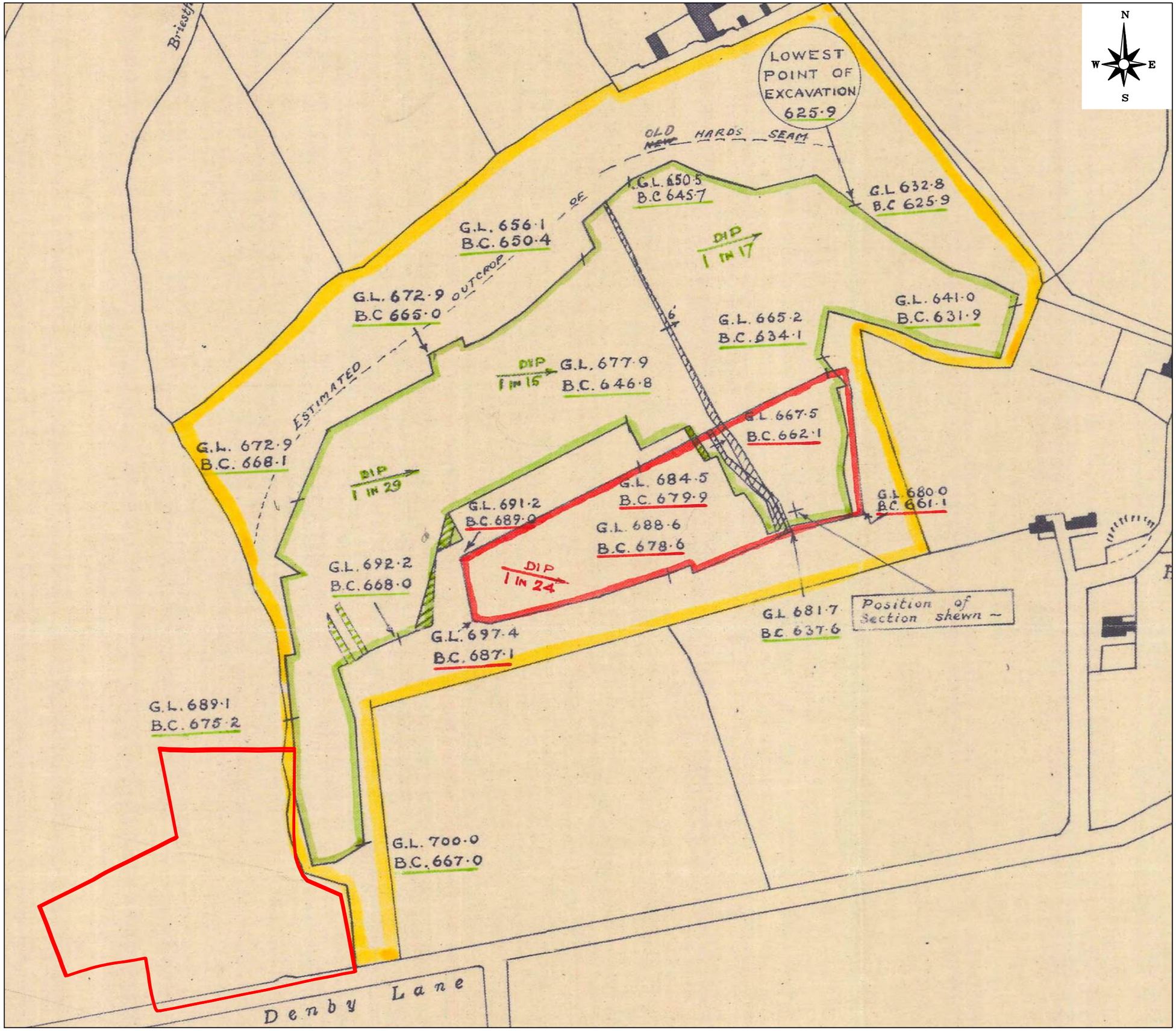

NOTES

1ST BROWN METALS	OLD ~~NEW~~ HARDS	
~	285	
~		
DIP 1 IN 24	DIP 1 IN 17	
G.L. 680·0 B.C. 661·1	G.L. 632·8 B.C. 625·9	

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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Tel 01937 545330

CLIENT

YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

ABANDONMENT PLAN - HUNT ROYD OPENCAST

DRAWN	DATE	STATUS
CC	05 10 22	FOR COMMENT ☐
		FOR APPROVAL ☐
CHECKED	DATE	DRAFT ☐
GLM	05 10 22	FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:2000	A3	4511/12	

NOTES

- TRIAL PIT LOCATION
- SOAKAWAY PIT LOCATION
- PROBEHOLE LOCATION
- MINE ENTRY LOCATION
- GRASS & OVERGROWN AREAS
- CROPPED FIELD
- AREA OF SHALLOW MINEWORKINGS
- APPROXIMATE LOCATION OF COAL OUTCROP
- APPROXIMATE SITE BOUNDARY

EXPLORATORY HOLE LOCATIONS HAVE BEEN SURVEYED IN (COORDINATES & GROUND LEVEL) ON COMPLETION

REV.	DESCRIPTION	DATE

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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

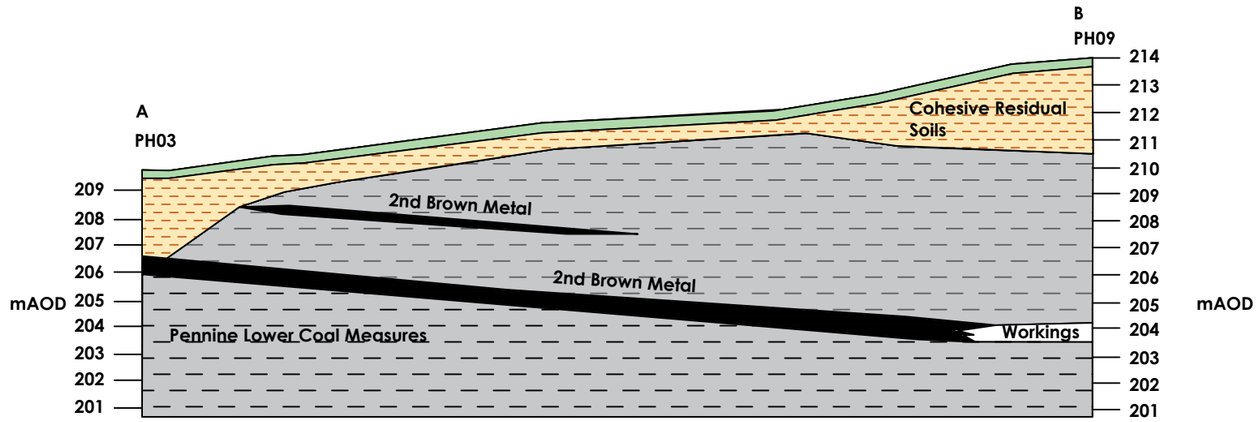
DENBY LANE, GRANGE MOOR

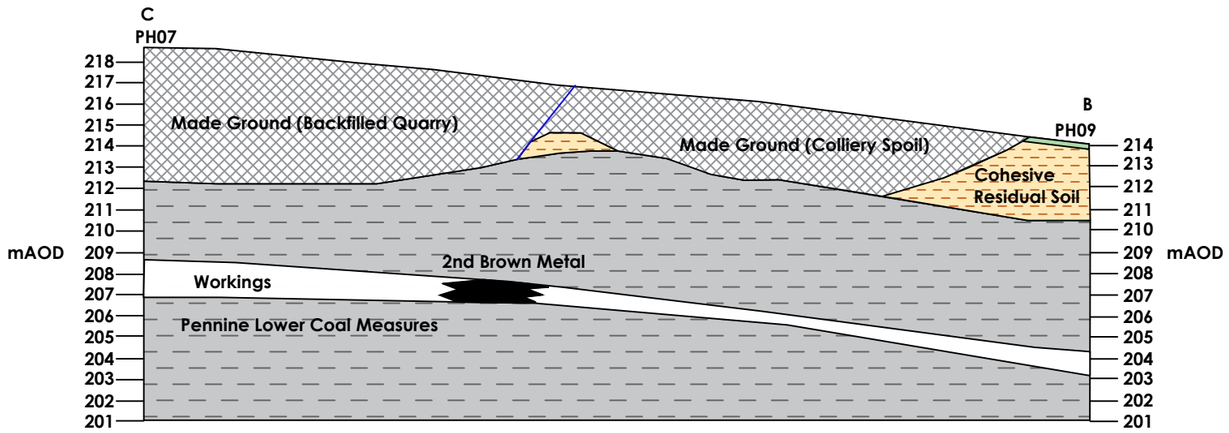
DRAWING TITLE

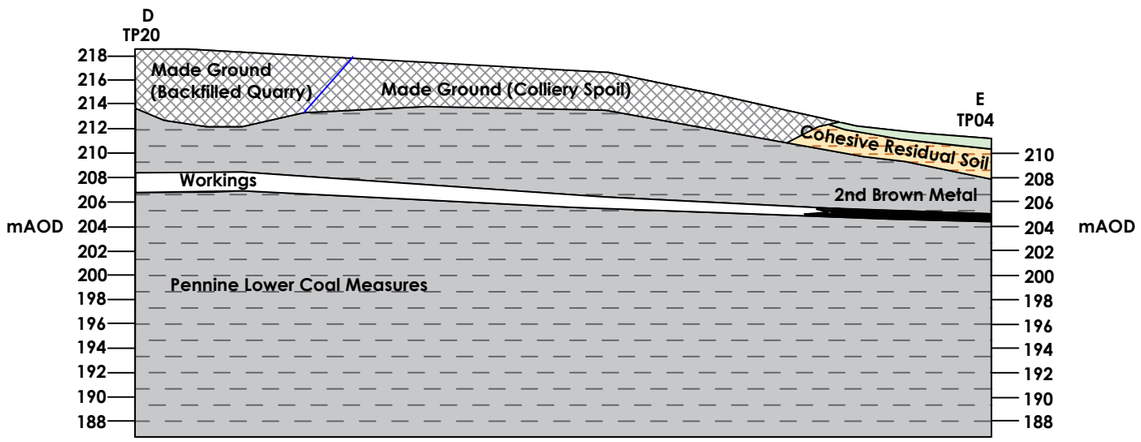
AREA OF SHALLOW MINEWORKINGS

DRAWN	DATE	STATUS
CC	05 10 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	05 10 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:750	A3	4511/14	







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YORKSHIRE COUNTRY PROPERTIES

JOB TITLE

DENBY LANE, GRANGE MOOR

DRAWING TITLE

CROSS SECTIONS

NOTES

REV.	DESCRIPTION	DATE

STATUS

FOR COMMENT ☐ FOR APPROVAL ☐ DRAFT ☐ FINAL ☑

DRAWN	DATE
CC	16 11 2022
APPROVED	DATE
AG	16 11 2022

SCALE	SHEET
NOT TO SCALE	A3

DRAWING NO.	REVISION
4511/15	

Appendix C

Commission

002/4511/GLM

29th July 2022

Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330

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Mr O Bottomley
Yorkshire Country Properties
Suite 3
39 Huddersfield Rad
Holmfirth
HD9 3JH

Dear Oliver

Denby Lane, Grange Moor

Further to your recent invitation, please find attached our proposal for undertaking a site investigation on the above land. We understand that proposed development will include 'traditional' two/three storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; a sketch layout has been provided.

Review of the information supplied suggests that the site consists of a single parcel of land of (c. 1.3 hectares). Review of Google Maps suggests that the east comprises a single grassed field, whilst the west if heavily overgrown with weeds, brambles and shrubs; the far-west is occupied by a garden.

Lithos has been provided with copies of two desk study reports, both issued to YCP by Haigh Huddleston and dated July 2021 & May 2022. The July 2021 report covers the north and east of the site whilst the May 2022 report covers the west.

Review of the Haigh Huddleston reports and available information suggests that the site:

- Has been occupied with a number of developments from c. 1880 to c. 1990, including a colliery, a sewage works, and further un-named buildings. Sandstone **quarries** and a **coal pit** are also shown on old maps.
- Is not located within 250m of a known landfill site.
- Is not within a groundwater source protection zone.
- Is in an area where the risk of encountering UXO is considered low.
- Is located within a Coal Mining Development **High Risk** Area. Three mine entries are shown on a CA plan.

Brief examination of the relevant geological map suggests the site is directly underlain by Birstall Rock Sandstone; likely completely weathered near surface to a sandy gravel. The 1st, 2nd, & 3rd Brown Metal coals are expected to underlie the site at shallow depth.

The scope of works outlined in this letter should enable us to assess abnormal development issues, associated with ground. However, the nature of site investigation is such that it is not always possible to foresee all the potential issues. Consequently, it is sometimes necessary to recommend additional work, but where this occurs we will inform you immediately, provide costs, and seek your further instruction. We have visited site and reviewed available internet data and our geological maps in order to minimise the likelihood of further work.

We will need a Promap or topo survey in CAD format, to provide a base plan for technical drawings etc. If you do not have one, we could obtain at cost plus £ .

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, LCRM etc). Our Report may not be fully compliant with Eurocode 7 (EC7) and will not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. Our ground appraisal is intended to assist others as they proceed with design of the proposed development.

This proposal allows for the following works:

Desk study: We will complete a more detailed review of the Haigh Huddleston reports. In addition, published geological plans of the area will be examined and visit site to undertake a walkover survey.

Review of the CA's interactive viewer suggests abandonment plans should be available for known shallow mineworkings beneath the site and we will obtain copies of these plans. There are also 3 recorded mine entries, and we will also obtain CA data relating to these.

Fieldwork: We have allowed for 2 days trial pitting and 3 days rotary openhole drilling to check for the presence of mineworkings and searching for the three known mine entries. All works will be logged and supervised by an experienced geoenvironmental engineer.

This proposal has been put together without a recent site visit. If ground conditions are found to be significantly wet/boggy at the time of the investigation, it may be necessary to hire additional resources (bog mats, tracked excavators, tractors, stone etc) in order for works to continue. We will discuss the requirement for any such items and associated costs with you prior to ordering.

Trial pitting / trenching will enable us to determine the:

- Nature of any made ground , including:
  - visual/olfactory evidence of potential contamination and the proportion of undesirable elements e.g. biodegradable matter, relict foundations etc
  - the proportion of "oversize", boulder-sized material
  - the location and extent of the quarry, with some trenching to locate the quarry high wall
- Location of mine entries (1 day; see below)
- Nature, distribution and thickness of shallow soils beyond the former quarry
- Suitability of the ground for soakaways
- Suitability of the ground for founding structures and highways

We will also attempt to locate each of the 3 **mine entries** during this phase of fieldwork. CA conjectured positions (co-ordinates are included in their mining report) will be set-out by a surveyor prior to commencement. In addition the shafts might be tentatively identified by tell-tale signs at surface (i.e. grass die-back, depressions etc), and our Engineer will inspect land in the vicinity of each pegged position for such features.

Given the expected absence of significant made ground in the vicinity of the 3 mine entries, the search will be conducted by stripping of topsoil, and a nominal 300mm of subsoils working in panels about 4m wide and 20m to 40m in length. We will search a minimum radius of 25m from the CA's conjectured position.

If located, photographs will be taken, and the mine entry's location will be taped in from three salient points, the position will be marked on the surface to allow subsequent surveying. We will also recover samples of any backfill for sulphate analysis to assist with specification of the anticipated concrete cap.

It impossible to say how long it will take to find each mine entry, although the CA co-ordinates for the capped/filled shafts should be accurate and we would therefore expect location within a day (allowed for in Item B of this proposal). If this turns out not to be the case, we should be able to search an area within 25m of the CA's plotted position within 2 to 3 days. Consequently, a day rate (Days 2, 3 etc, if required) of **£ /day** should be allowed for the shaft search; likely maximum duration 4 days.

We have assumed that it will be possible to excavate the pits and move around site using a wheeled JCB 3CX-type excavator, but this proposal has been put together without a recent site visit. If ground conditions are found to be significantly wet/boggy at the time of the investigation, it may be necessary to hire a tracked 360° excavator (E\O of £).

We understand that a public footpath crosses the site and, based on review of Google earth, it may not be possible to cross this using heavy plant; in the event that a tracked 360° is required there may be an additional cost associated with remobilising a low-loader to move the excavator from one half of the site to the other (to be confirmed following a site visit).

Representative soil samples of natural and man-made ground, including any contaminated samples, will be taken during the works. In-situ shear strengths of any cohesive soils encountered will be determined by the use of a hand-held shear vane.

We will make every effort to compact arisings and 'sweep' them over each trial pit. However, you should be aware that on completion of the investigation, "graves" of spoil (each about 3m long by 1m wide) unsuitable for trafficking, will be left up to 400mm proud at each trial pit location. At this stage, no allowance has been made for any further reinstatement such as removal of excess arisings, replacement of turf etc.

If the pitting encounters significant thicknesses of made ground or very soft/loose deposits (the former is possible), boreholes may be required to obtain geotechnical data from greater depth. We will advise you of any need for boreholes within 2 days of completion of the pitting.

Based on anticipated ground (quarries and mineworkings), **soakaways** are considered unlikely to provide a satisfactory solution for surface water drainage, but testing would remove any ambiguity with respect to Yorkshire Water queries. However, no allowance has been made for soakaway testing at this stage. If required, or considered feasible based on the ground actually encountered, soakaway tests could be undertaken for an additional fee of about £ .

The site is underlain by the 1st Brown Metal Coal Seam, and therefore we have allowed for the drilling of about 8 **rotary probeholes** to check whether old mineworkings are present and pose a significant risk to surface stability of the site.

If a potential risk is perceived to exist, further probeholes may be required to delineate the extent of workings in order to obtain fixed price quotations for the necessary consolidation works. Furthermore, we have assumed that it will be possible to advance the 8 probeholes within 3 days but there is a chance that it may take longer in which case we will inform you before leaving site, and seek your further instruction. Each day of additional drilling would cost £ (inclusive of supervision) provided it were instructed whilst the drilling rig was still on site.

It will be necessary to submit an application (with the associated fee) to the Coal Authority (CA) for 'Permission to enter CA mining interests'; and we have allowed for this. You should note that the CA have updated the application process and as of 4th October 2021, developers (clients) must submit a signed copy of the **CA's T&Cs** (copy enclosed) before the CA will commence work on permit issue which can take up to 4 weeks. Lithos can perform the role of Agent.

Given the proximity of surrounding housing (within 50m of much of the general site area), and in accordance with CA requirements we have had to assume that the probeholes will need to be advanced using water as the flushing medium (as reinforced by recent CA guidance on managing the risk of hazardous gas). Our drilling sub-contractor will need to locate the wash outs close to the site, and procure a standpipe and licence from Yorkshire Water.

With reference to the control, management and disposal of surplus water and flush arising from the works, (and in order to avoid additional costs associated with the provision of a telehandler to transfer a weir tank between boreholes, and the provision of a pump to transfer surplus water from the weir tank to an approved disposal point), we have made provision for a sand bag bund at the foot of the drilling mast, at each borehole to contain the majority of the drill cuttings. However, we have assumed that potentially discoloured surplus water will be allowed to flow and settle into the field.

At this stage, we have assumed that overnight security will not be required, but this will be reviewed following a site visit. If required, security would be an E\O of £ per night. We have allowed for overnight security (guard) for plant outside normal working hours (nights & weekends).

We have allowed for all exploratory holes to be picked-up by a **surveyor** (co-ordinates/ground levels will be included on the logs).

Given the likely presence of shallow mineworkings, a backfilled quarry and an area of backfilled opencast within 250m of the site, we have allowed for the installation of wells in 6 probeholes and monitoring for hazardous **gas** (and any shallow groundwater).

The generation potential of this gas source is considered likely to be Low. Therefore, in accordance with CIRIA Report C665, we have initially allowed for 9 visits over a 6-month period. A hazardous gas risk assessment will be issued on completion of monitoring.

We strongly recommend that groundwater / gas wells be decommissioned after monitoring has been completed. Decommissioning involves removal of the metal covers, unscrewing the upper 1m to 2 m of pipework and filling the void / remaining well with bentonite.

Decommissioning of monitoring wells removes the potential for groundwater pollution caused by accidental spillages during the construction phase and prevents gas migration into sub-floor voids. Subject to your instruction, we will decommission accessible wells after the last monitoring visit for an E\O price of £ +VAT. We will contact you to seek instruction following issue of our gas risk assessment dip results.

Testing: This will comprise routine **geotechnical** soils analysis, including 10 moisture content & Atterberg limits, and 10 pH & water-soluble sulphate. We will also schedule 5 compaction tests on samples of made ground to assess suitability for use in earthworks ground improvement.

This site is brownfield and therefore likely to be underlain by made ground which in turn is likely to be subject to re-engineering prior to the construction of new estate roads. Consequently, there is no merit in obtaining CBR values at this stage.

Appropriate **chemical analyses**, based on our review of existing reports and knowledge of the site's history, have been allowed for; this will comprise 22 samples for a suite including heavy metals, speciated PAH, and banded TPH (with supplementary speciation as/where appropriate). In the event that ground contamination is more significant or different to that anticipated, it might be necessary to carry out additional chemical testing.

Within in our proposal we have allowed for the screening (ID) of 22 samples for asbestos. In the event that positive IDs are reported, it is likely that we will need to schedule further analysis (asbestos quantification), in order to determine the significance of the results. Asbestos quantification is currently a relatively expensive test and consequently we have not allowed for it at this stage. We will inform you immediately after receipt of results if we consider asbestos quantification is required.

The visible contaminants, sharps and the clay/sand/silt content of 3 topsoil samples will be determined to check compliance with BS3882 requirements.

Reporting & timescales: In order to provide you with sufficient information to enable assessment of abnormal costs at the earliest opportunity we will issue a concise overview report within 3 days of fieldwork completion.

On completion of the desk study, fieldwork and laboratory testing a comprehensive, factual and interpretative report will be issued. This will contain exploratory hole logs, laboratory test results, copies of all relevant correspondence and drawings of the site. The report will include qualitative risk assessment with respect to both controlled waters and human health. The report will also include consideration of foundation types.

At the time of writing, fieldwork could be commenced within 4 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion. This report will comment on issues associated with hazardous gas, but the gas risk assessment will not be issued until monitoring is completed.

This report will include a **mining risk assessment** in accordance with Coal Authority guidance.

A copy of the final report will be issued to the relevant regulatory authorities on receipt of written instruction from yourselves.

Invoicing: The attached proposal provides a breakdown of the costs associated with this project. This breakdown is for information only and the proposal can be regarded as a lump sum price of **£** plus VAT. Variation will only occur in the event that a given item is not undertaken or that substantial additional works are recommended, in which case we will inform you immediately, provide costs for the required works, and seek your prior consent. Revision of the costings provided may be required if works are not instructed within 6 months of the date this proposal was issued.

Our proposal allows for submission of the report to the Local Authority and NHBC, and for submission of a single piece of subsequent correspondence with each regulator to address any queries they may have. Any further meetings, correspondence etc, would be chargeable.

We will submit invoices for this project on completion of each Item(s) instructed.

Please note if following instruction of the works outlined in this proposal, it is necessary to subsequently **postpone or cancel**, this should be done at least 3 working days before Lithos are due to commence intrusive investigation on site. We reserve the right to charge a cancellation fee in the event of later notification to cover plant / drill rig costs and abortive consultancy time. The cancellation fee will not exceed £ plus VAT.

Health, safety & welfare: The works outlined above will be carried out in accordance with Lithos' task- and site- specific Risk Assessments and Method Statements.

Details of welfare will be included within the Method Statements. However, this investigation is expected to be completed within three working day and therefore it is not considered reasonably practicable to provide formal welfare facilities, and our proposal makes no allowance for so doing.

Utility plans are required in order to protect operatives from the hazards associated with striking buried services and avoid potentially substantial disruption\repair costs. We will make every effort not to damage any services (including review of utility plans and use of a CAT detector). However, Lithos cannot accept liability for damage to any underground services that are not accurately marked on plans made available to us prior to commencement of our field investigation, or have not been accurately marked on the ground by a responsible third party (e.g. utility company, site owner).

Most developers have copies of the necessary utility plans (including electricity, gas, water, drainage & telecom), and it would be appreciated if you could forward these prior to the proposed fieldworks. However, if you do not have the necessary plans, Lithos will obtain them direct from each of the utility companies.

Under the **CDM** Regulations 2015, Lithos must be provided with pre-construction information already in your possession, or information that can reasonably be obtained through sensible enquiry. This information must be relevant to the project, have an appropriate level of detail, and be proportionate to the nature of the risks.

If no other designers or contractors have been appointed, Lithos could perform the role of Principal Contractor but only for the duration of the site investigation outlined in this proposal. If you require us to perform the role of Principal Contractor, please make this clear in your instruction. It should be noted that we are not suitably qualified to perform this role where other designers or contractors are also appointed.

It is anticipated that the site investigation outlined in this proposal will be undertaken several months before any construction is commenced on site. Consequently, our works can be considered in isolation and, given the anticipated number of person days on site, this site investigation is not notifiable to the HSE.

Terms & conditions: This work will be undertaken in accordance with our Standard Terms and Conditions, a copy of which are enclosed.

It is hoped the above is sufficient for your present needs. However, should you require any further information, please contact the undersigned.

Yours sincerely

George Morton
Principal Engineer
for and on behalf of
LITHOS CONSULTING LIMITED

Charlotte Copley

Subject: FW: 4511 - Denby Lane, Grange Moor - SI Report tender

---

From: Oliver Bottomley <oliver@yorkshirecountryproperties.co.uk>
Sent: 08 September 2022 13:27
To: Reg <Reg@lithos.co.uk>
Cc: Adam Gombocz <Adam.Gombocz@lithos.co.uk>; Kevin Caine <kevin@yorkshirecountryproperties.co.uk>; Michael May <mike@yorkshirecountryproperties.co.uk>
Subject: RE: 4511 - Denby Lane, Grange Moor - SI Report tender

Hello George

As discussed, this morning, please proceed with the coal authority application to allow us to drill the mine shafts at Denby Lane, Grange Moor to enable drilling to commence on the 10th October 2022.

Attached is your written order.

Also attached are the safe to dig drawings for the site.

Kind regards
for and on behalf of Yorkshire Country Properties Ltd.

Oliver Bottomley
Land / Development Manager

Office | 01484 598455
Sales | 01484 599454
Mobile | 07709 181782
Email | oliver@yorkshirecountryproperties.co.uk

Suite 3 | 39 Huddersfield Road | Holmfirth | HD9 3JH

From: Reg <Reg@lithos.co.uk>
Sent: 01 August 2022 15:38
To: Oliver Bottomley <oliver@yorkshirecountryproperties.co.uk>
Cc: Adam Gombocz <Adam.Gombocz@lithos.co.uk>
Subject: 4511 - Denby Lane, Grange Moor - SI Report tender

Afternoon Oliver

Apologies for the delayed issue, but SI quote now attached (£). As always, this allows for a robust scope of works (including rotary probeholes & gas monitoring) that should enable you to submit a bid that is unconditional with respect to ground and discharge ground-related planning conditions.

The cost is relatively high due to need for an intrusive mining investigation and gas monitoring / risk assessment.

We would expect to be on site within 2 to 3 weeks of instruction, with a summary of initial findings issued within 2 to 3 days of fieldwork completion. Our final SI Report should be available within 8 weeks of instruction (although a quicker turnaround might be possible).

I've also provided further comments to your enquiry e-mail in green below.

Any queries, please call.

Regards

Mark Perrin
Director
Lithos Consulting Ltd
M 07703 396 635
DD 01937 545 331
www.lithos.co.uk

From: Oliver Bottomley <oliver@yorkshirecountryproperties.co.uk>
Sent: 18 July 2022 14:58
To: Adam Gombocz <Adam.Gombocz@lithos.co.uk>
Subject: Denby Lane, Grange Moor - SI Report tender

Dear Sirs,

We would like to welcome the opportunity for you to tender for the above package for a scheme we are about to begin at Grange Moor, Huddersfield.

The Scheme consists of 2nr fields shown below.

Please price on the supply of labour, plant and materials for the SI report that covers the two sites. Done

Please can you allow for the following:-

West field

1. Mark out existing services crossing the site. Known adoptable sewers crossing southern portion of site. OK

2. Undertake a site walkover to identify if any sign of obvious features i.e. existing mine shafts and extent of historic quarry. OK

3. Set out potential mine shafts as indicated within coal authority report. Site area to be stripped around setting out location. Note 10m departure given by the Coal Authority. OK, but this needs to be done on a day rate as we can't say how long each shaft search will take (could be anything from a couple of hours to 3 days). However, co-ords for the capped shafts should be accurate & we'd therefore expect quick location.

4. Visual inspection to be undertaken to detect if any outline of existing shaft/cap. (Note potential for 3 shafts indicated.) OK

Two of the shafts are reported as being capped and the third has been filled to an unknown specification. Note one of the capped shafts may be a well? Dimension and exact co-ordination of any shaft be taken at the time. OK

a. If shaft positions not obvious following site strip a grid of boreholes should be established within the 10m offset of shaft location. Boreholes to be drilled to prove natural ground/shaft. If not found quickly, we'll search a max. radius of 25m from each shaft. Boreholes should only be required if shaft locations lie within an area of deeper made ground.

b. Exact location and diameter of each shaft to be confirmed. OK, we'll only be able to confirm cap dimensions (cf shaft diameter) if capped.

5. Rotary boreholes to be drilled across the site to provide sufficient coverage. Boreholes to be drilled to a minimum 30m with any coal seams noted and indicating thickness and depths. Any voids to be reported. OK

6. Suggest drilling shaft off suitable frame to establish competency of backfilled and the potential depth of the shafts. We'll review need to drill each shaft in light of CA records, but ordinarily, we wouldn't drill through a shaft cap.

7. Trial trench to the north-western corner to be undertaken to try and expose potential of former quarry / and pond and if an existing high wall is evident on site. OK

8. Chemical samples to be taken from the existing topsoil and any made ground encountered to sufficiently delineate the site from a contamination requirement. OK

9. Suggest minimum 5m gas well installations and with 6 No. visits to provide data for potential risks to future residential development. We've allowed for 6 wells & 9 vits over 6 months in line with UK guidance.

10. Foundation type to be detailed and noted OK

11. Note there is an existing public right of way to the eastern boundary. This will need to be protected to ensure safe movement of pedestrians during the course of the works. OK

East Field

1. Mark out existing services crossing the site. Known adoptable sewers crossing southern portion of site. OK

2. Rotary boreholes to be drilled across the site to provide sufficient coverage. Boreholes to be drilled to a minimum 30m with any coal seams noted and indicating thickness and depths. Any voids to be reported. OK

3. Chemical samples to be taken from the existing topsoil and any made ground encountered to sufficiently delineate the site from a contamination requirement. OK

4. Suggest minimum 5m gas well installations and with 6 No. visits to provide data for potential risks to future residential development.
5. Foundation type to be detailed and noted OK

You should include for everything necessary to complete the insulation ?investigation irrespective of what is detailed above and in the attached to both sections of site.

https://www.dropbox.com/sh/q22sob6llgql68d/AABv6LaXKUOHcAb68bqL3Au4a?dl=0

All work should be in accordance with the Building Regulations, British Standards, British Standard Codes of Practices, NHBC, LABC, Premier and Manufactures Recommendations OK

Terms and Conditions will be as our standard subcontract form and you should include for 2.5% MCD and your price should be fixed for the duration of the contract. Presume these are essentially the same as those issued for our work at Church Fenton? Our price is fixed for the duration of the works and will be that quoted assuming instruction is received within 3 months of quote issue. We do not offer any discount & have not allowed for this.

For the purposed CDM regulations we will be the principle contractor. Prior to awarding any subcontract we will require subcontractors to prove their competence etc. and that they have the necessary resources to carry out the works in a safe and efficient manner. We will require details of insurances and any method statements/risk assessments will have to be provided if deemed necessary. OK

Attendances:
- Allow for all loading and access requirements OK
- Provide all PPE for Health and Safety requirements on a live construction site OK
- All relevant training and site accreditation OK
- Builders works for all associated works OK
- You should include for everything necessary to complete the installations irrespective of what is detailed OK
- For the purpose of the CDM regulations we will be the principle contractor. Prior to awarding any subcontract we will require subcontractors to prove their competence etc. and that they have the necessary resources to carry out the work in a safe and efficient manner. We will require details of insurance and any method statements/risk assessments will have to be provided if deemed necessary

Commencement;
Forecasted for the September 2022 for Subcontractor commencement

Price:
- Due date 12th August 2022
- Labour, Materials & Plant

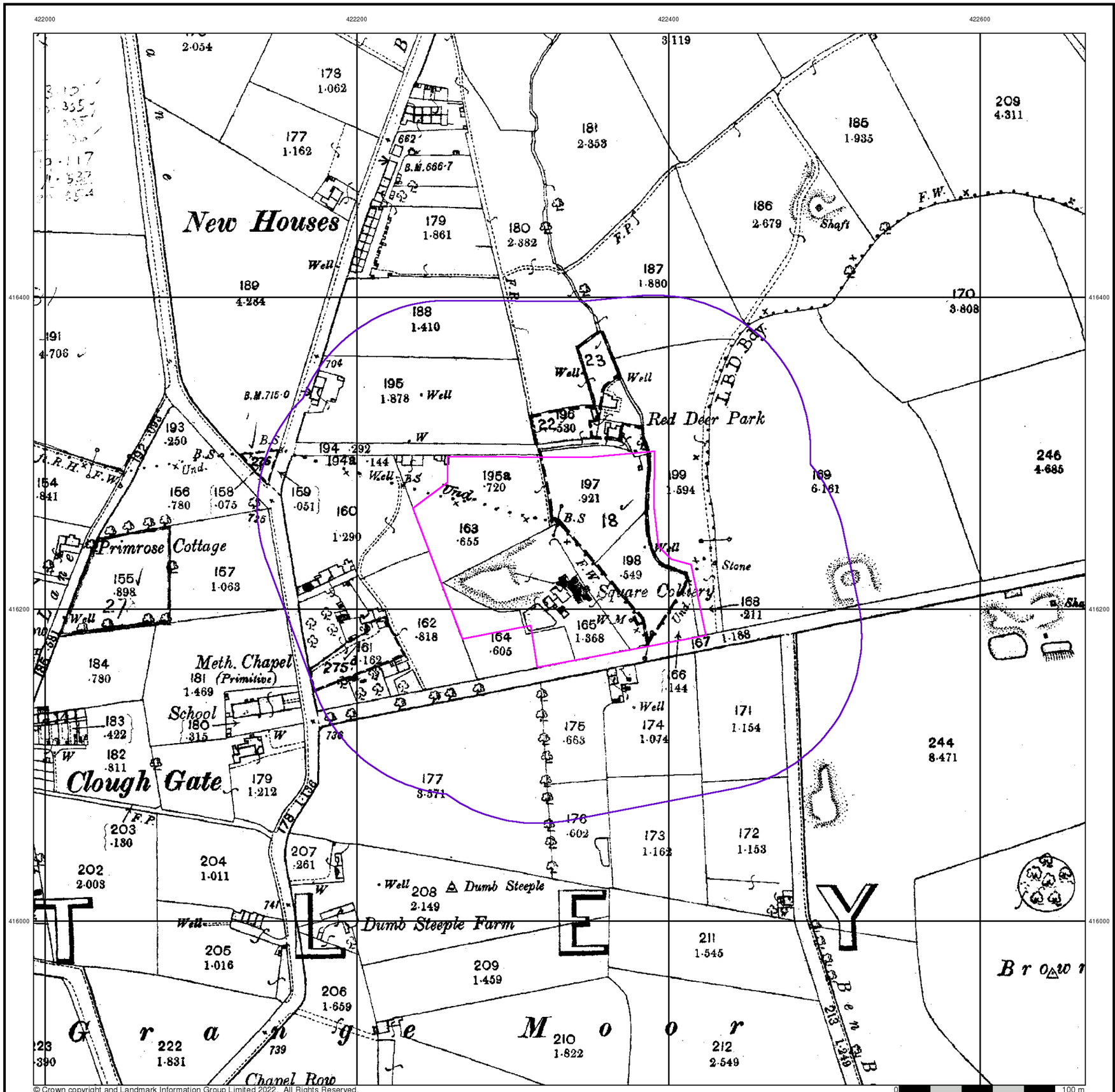
Let me know if you require any further information at this stage

Kind regards
for and on behalf of Yorkshire Country Properties Ltd.

Oliver Bottomley
Land / Development Manager

Appendix D

Historical OS Plans



0 100 m

LITHOS CONSULTING

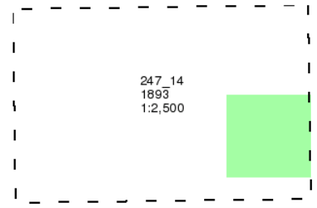
Yorkshire

Published 1893

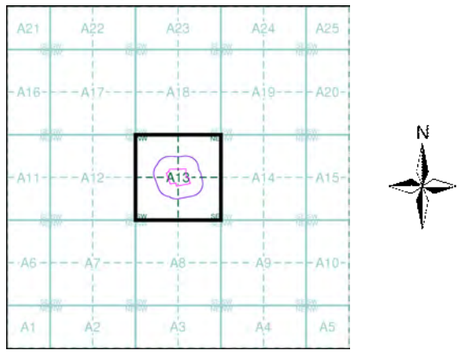
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



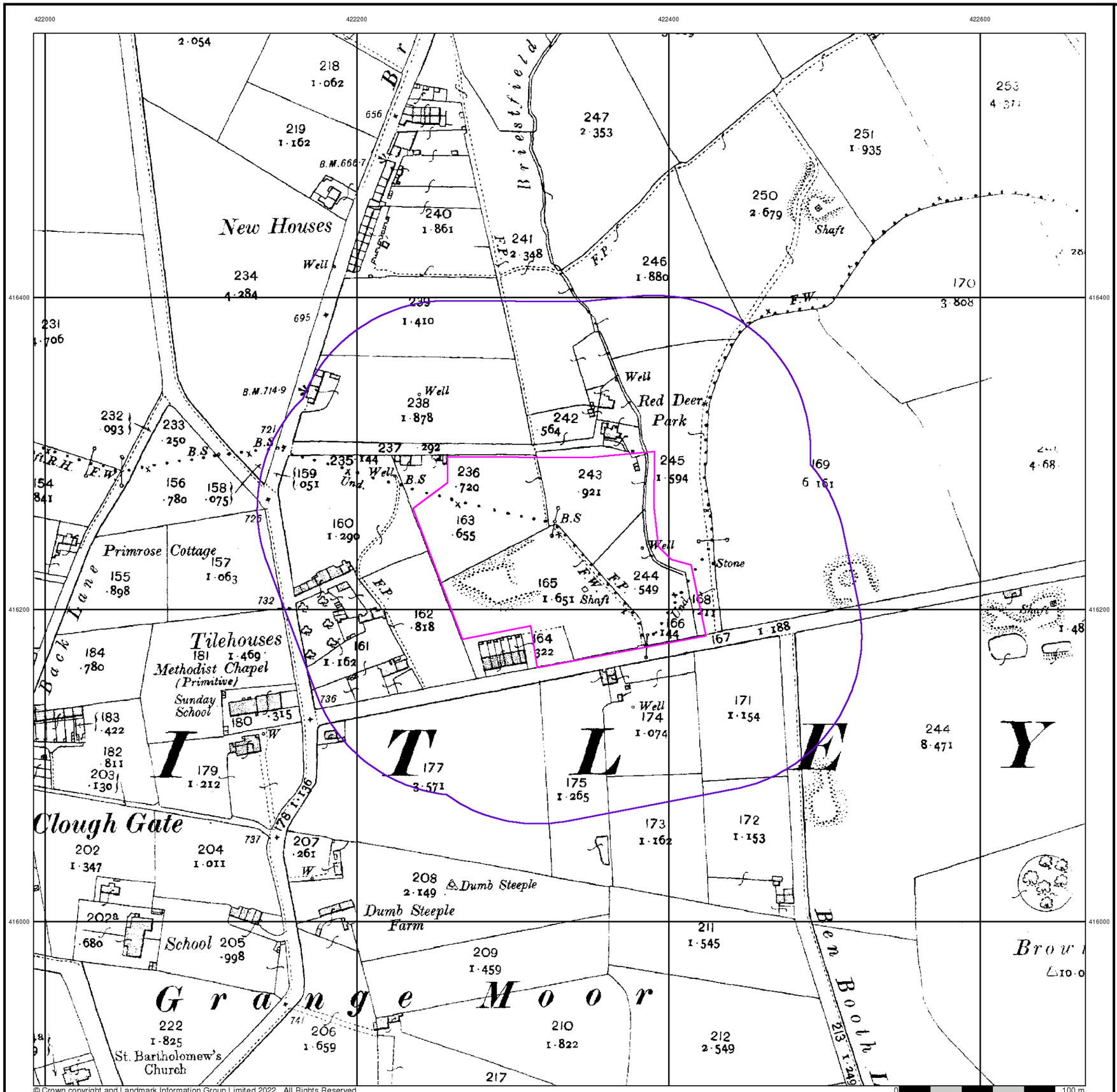
Order Details

Order Number:	301296453_1_1
Customer Ref:	PO19663/JW/4511
National Grid Reference:	422330, 416240
Slice:	A
Site Area (Ha):	1.85
Search Buffer (m):	100

Site Details

Denby Lane, Grange Moor, WF4 4ED

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LITHOS CONSULTING

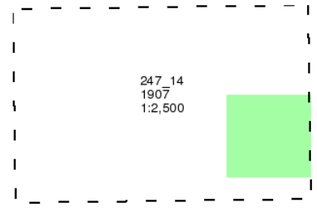
Yorkshire

Published 1907

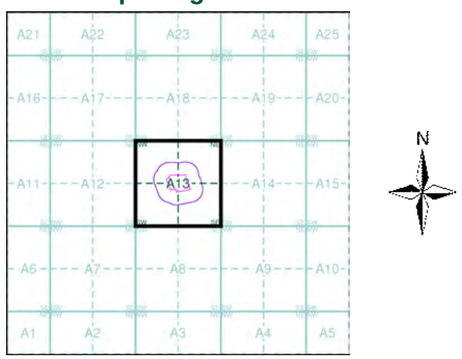
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



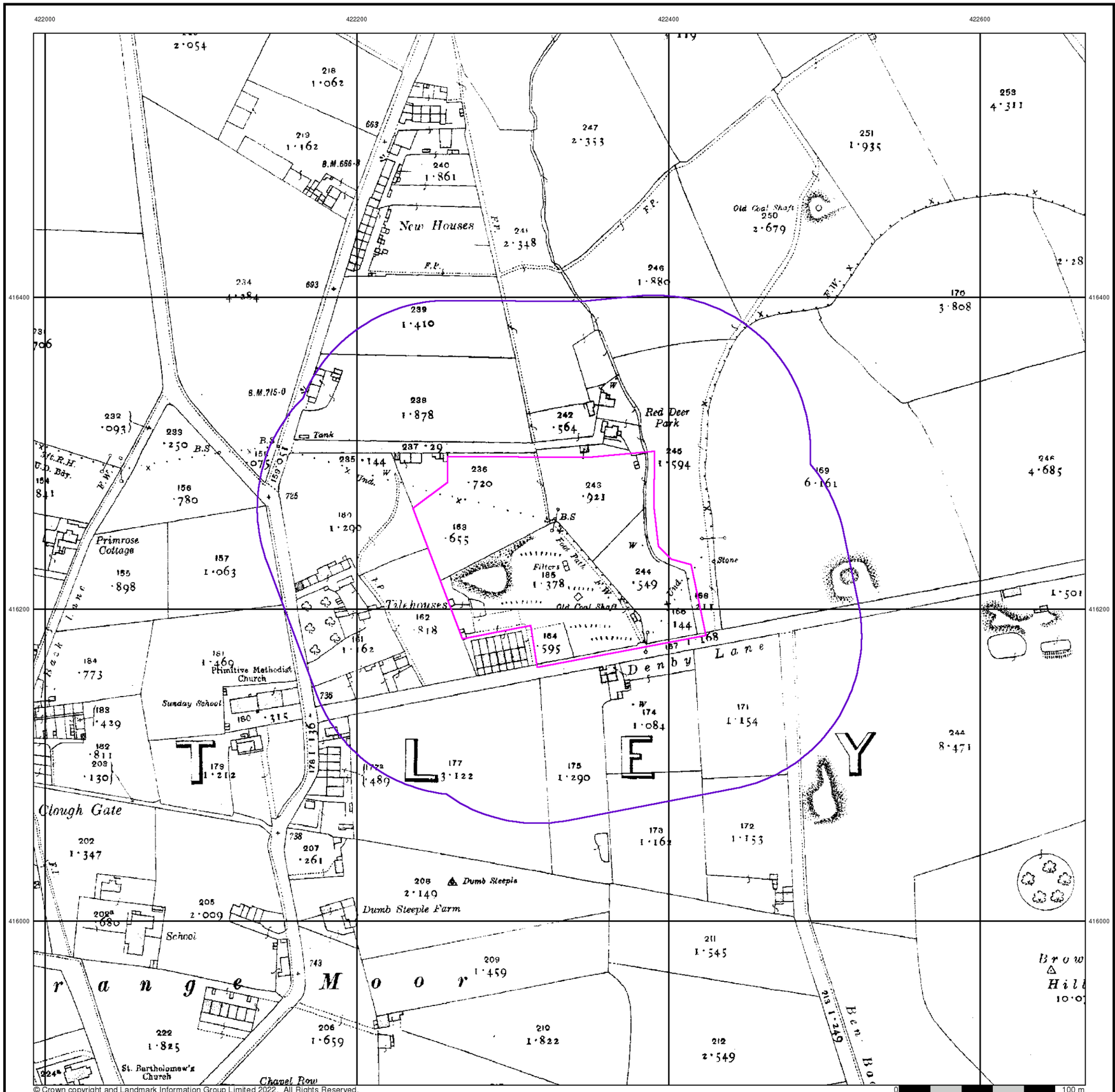
Order Details

Order Number:	301296453_1_1
Customer Ref:	PO19663/JW/4511
National Grid Reference:	422330, 416240
Slice:	A
Site Area (Ha):	1.85
Search Buffer (m):	100

Site Details

Denby Lane, Grange Moor, WF4 4ED

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LITHOS CONSULTING

Yorkshire

Published 1919

Source map scale - 1:2,500

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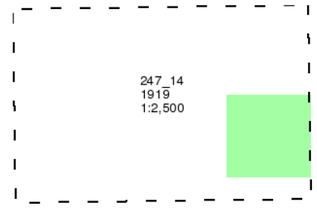
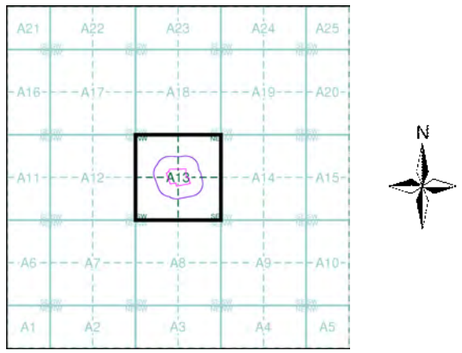


Historical Map - Segment A13



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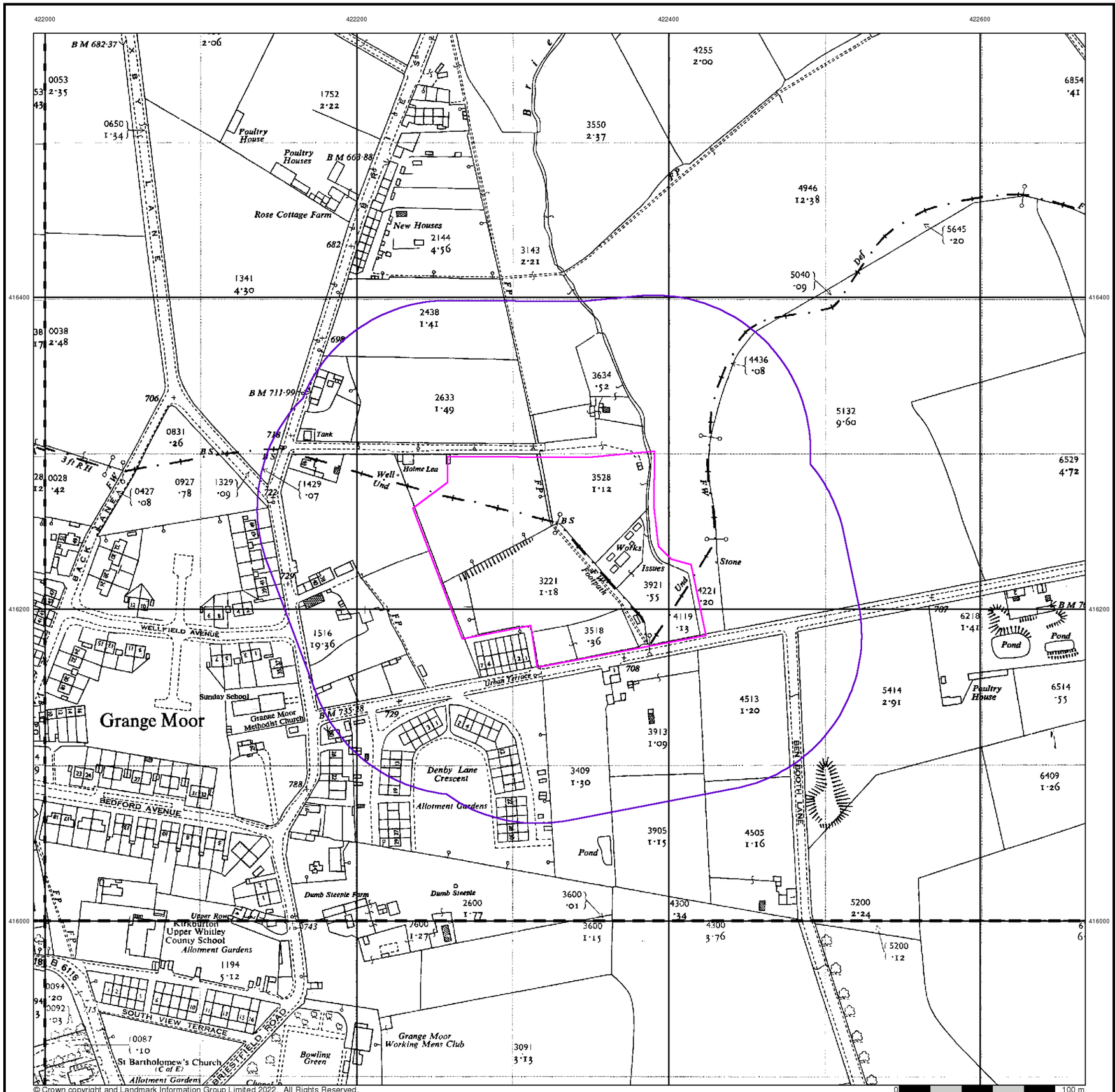


LITHOS CONSULTING

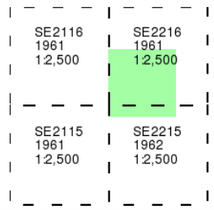
Ordnance Survey Plan

Published 1961 - 1962

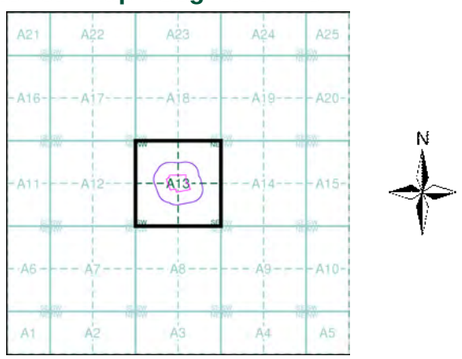
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



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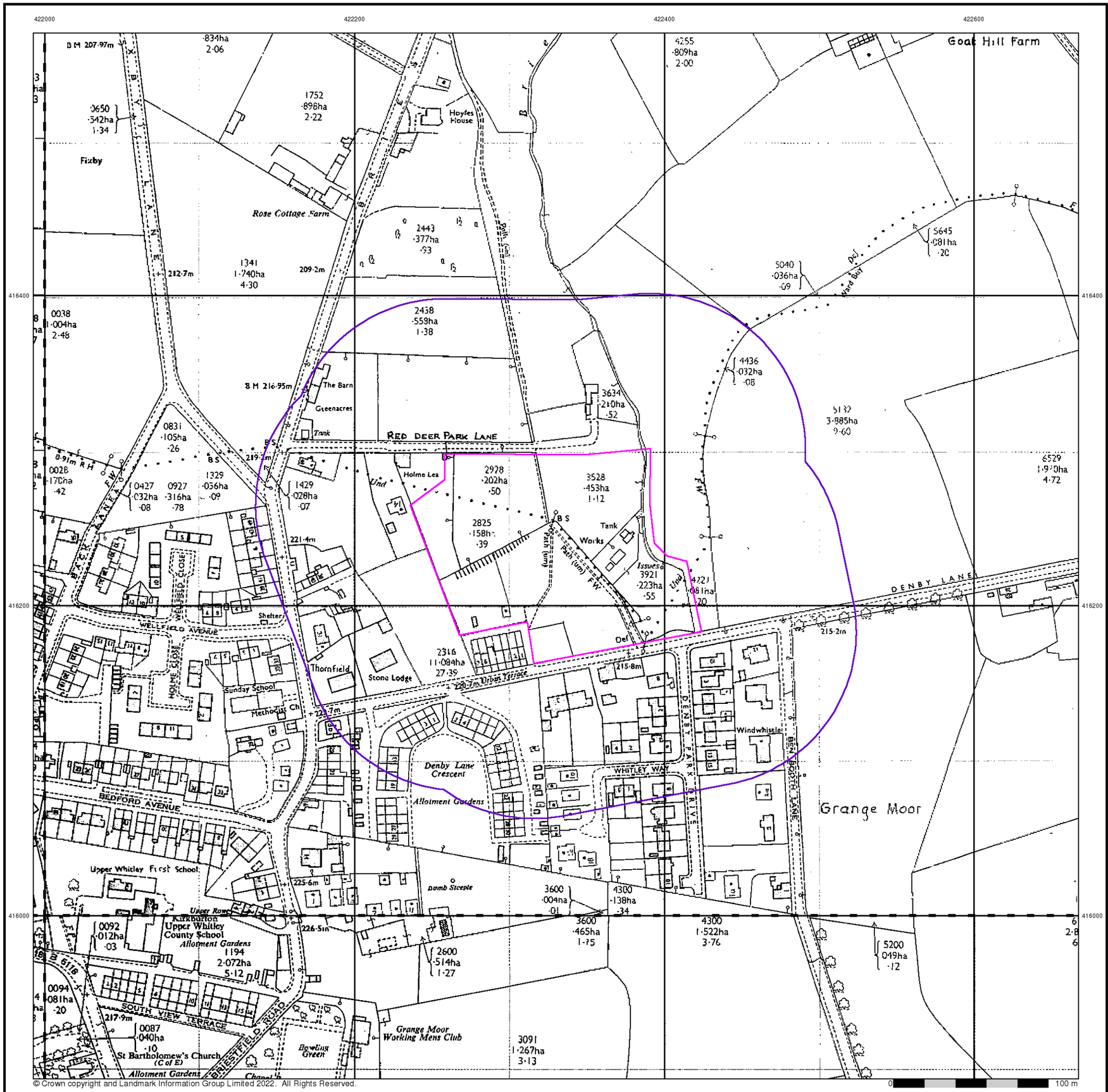

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Additional SIMs

Published 1961 - 1989

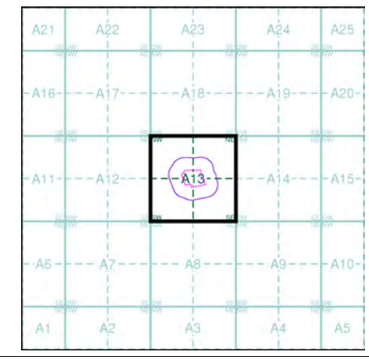
Source map scale - 1:2,500

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SE2116 1961 1:2,500	SE2216 1989 1:2,500
SE2115 1961 1:2,500	SE2215 1962 1:2,500

Historical Map - Segment A13



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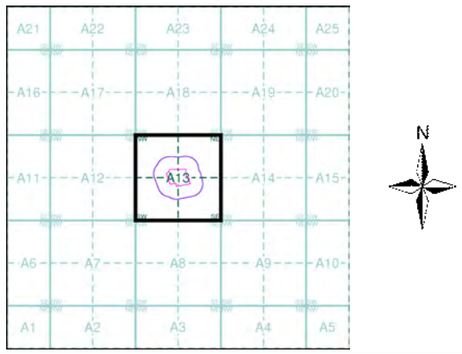
Historical Aerial Photography

Published 1999

This aerial photography was produced by Getmapping, these vertical aerial photographs provide a seamless, full colour survey of the whole of Great Britain

Historical Aerial Photography - Segment A13



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Landmark INFORMATION GROUP

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Appendix E

Search Responses & other Correspondence

Envirocheck® Report:

Datasheet

Order Details:

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301296453_1_1

Customer Reference:
PO19663/JW/4511

National Grid Reference:
422330, 416240

Slice:
A

Site Area (Ha):
1.85

Search Buffer (m):
1000

Site Details:

Denby Lane
Grange Moor
WF4 4ED

Client Details:

Mr M Perrin
Lithos Consulting Ltd
Parkhill
Walton Road
Wetherby
LS22 5DZ

Contents

Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination.
For this reason, Landmark's Site Sensitivity maps and Datasheet(s) place great emphasis on statutory data provided by the Environment Agency/Natural Resources Wales and the Scottish Environment Protection Agency; it also incorporates data from Natural England (and the Scottish and Welsh equivalents) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the Landmark database to a distance defined by the client from a site boundary provided by the client.
In this datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers.

Report Version v53.0

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Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes	Yes	Yes	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 2		3	2	7
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls					
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 4	Yes			
Pollution Incidents to Controlled Waters	pg 5		1	1	15
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality					
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register	pg 7				1
Water Abstractions					
Water Industry Act Referrals					
Groundwater Vulnerability Map	pg 8	Yes	n/a	n/a	n/a
Groundwater Vulnerability - Soluble Rock Risk			n/a	n/a	n/a
Groundwater Vulnerability - Local Information			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 8	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
OS Water Network Lines	pg 8	1		7	18

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites					
Historical Landfill Sites					
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)	pg 12				1
Local Authority Landfill Coverage	pg 12	1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 12	2	5	5	17
Potentially Infilled Land (Water)	pg 14				1
Registered Landfill Sites					
Registered Waste Transfer Sites					
Registered Waste Treatment or Disposal Sites					
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					

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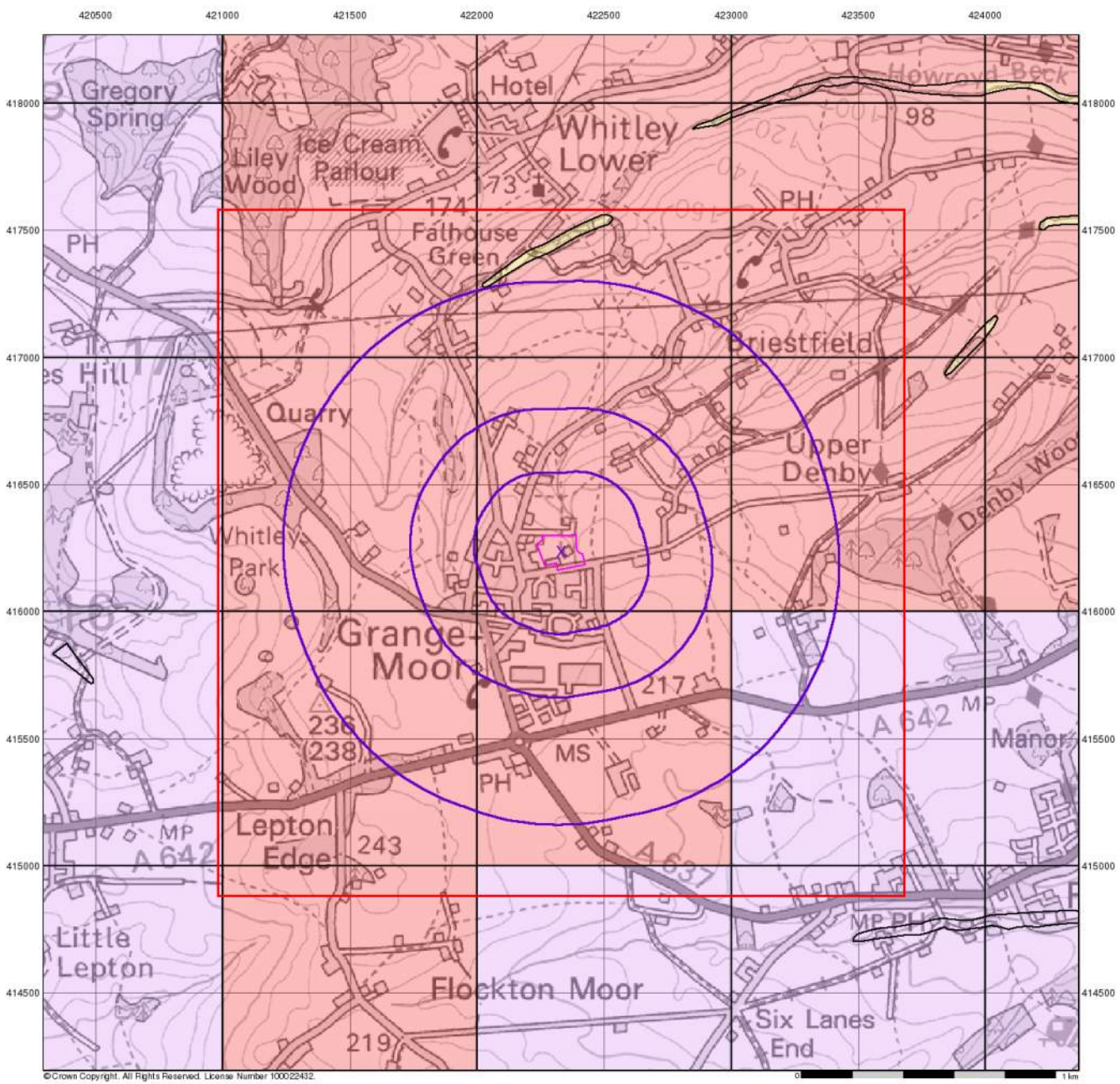
Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Geological					
BGS 1:625,000 Solid Geology	pg 15	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 15	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 21	2	4	4	17
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 26	Yes	n/a	n/a	n/a
Mining Instability	pg 26	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 26	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 26	Yes	Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 26	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 27	Yes	Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 27	Yes	Yes	n/a	n/a
Radon Potential - Radon Affected Areas	pg 27	Yes	n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 28		3	7	16
Fuel Station Entries	pg 30				1
Points of Interest - Commercial Services	pg 30		1	3	7
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 31		2	3	19
Points of Interest - Public Infrastructure					
Points of Interest - Recreational and Environmental	pg 33			2	
Gas Pipelines					
Underground Electrical Cables					

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland	pg 34				1
Areas of Adopted Green Belt	pg 34	1			
Areas of Unadopted Green Belt	pg 34	1			
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 34		1		
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					



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Groundwater Vulnerability

General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

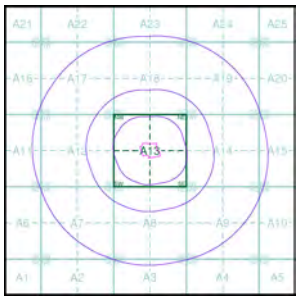
Agency and Hydrological

Bedrock Aquifers	Superficial Aquifers
High Vulnerability, Principal Aquifer	High Vulnerability, Principal Aquifer
High Vulnerability, Secondary Aquifer	High Vulnerability, Secondary Aquifer
Medium Vulnerability, Principal Aquifer	Medium Vulnerability, Principal Aquifer
Medium Vulnerability, Secondary Aquifer	Medium Vulnerability, Secondary Aquifer
Low Vulnerability, Principal Aquifer	Low Vulnerability, Principal Aquifer
Low Vulnerability, Secondary Aquifer	Low Vulnerability, Secondary Aquifer

Unproductive Aquifer

Soluble Rock

Site Sensitivity Context Map - Slice A



Order Details

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Site Details

Denby Lane, Grange Moor, WF4 4ED

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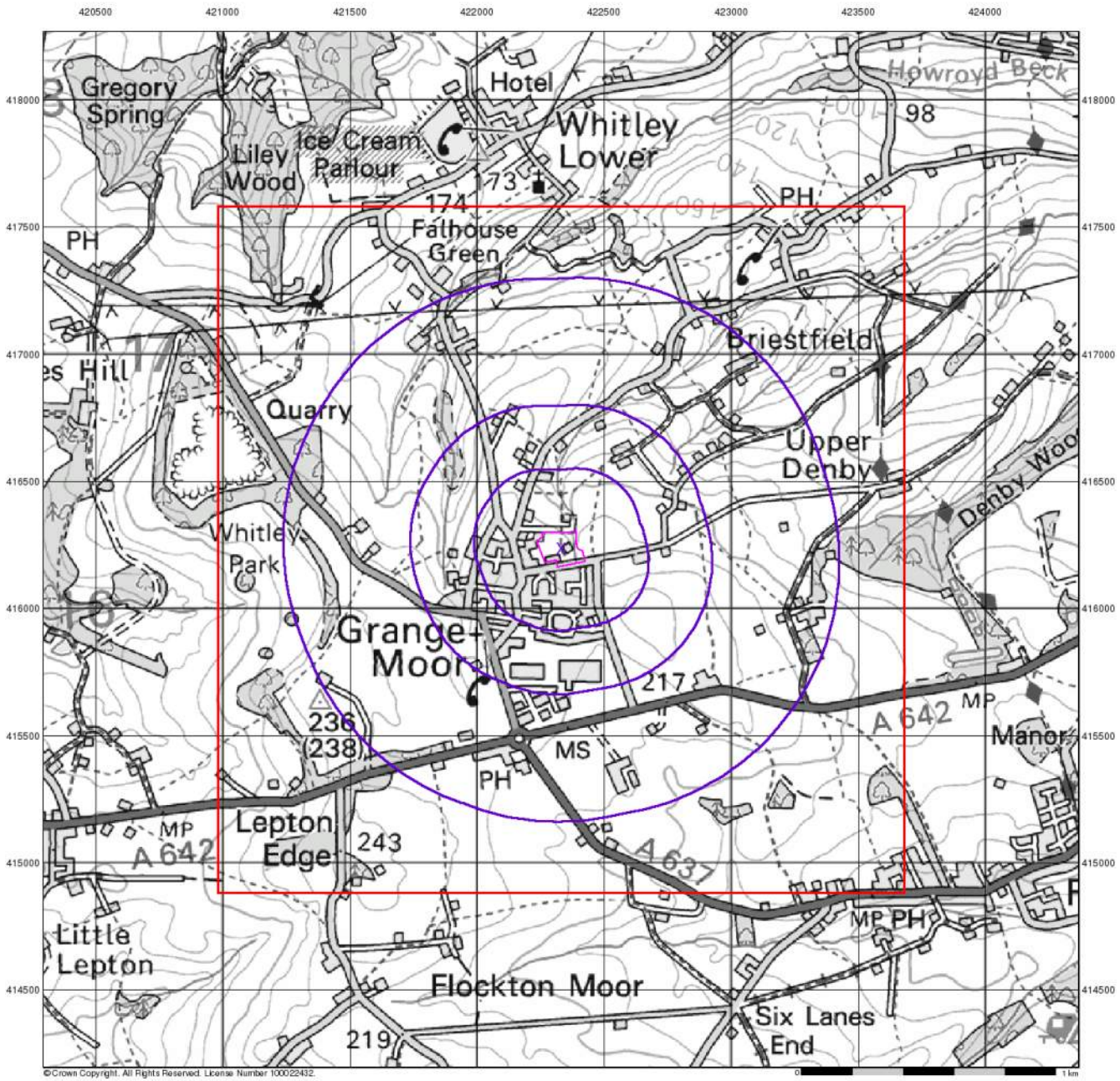

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Source Protection Zones

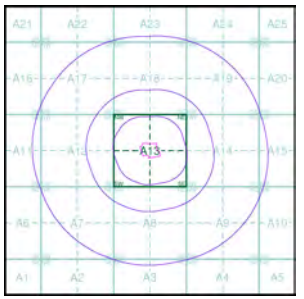
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A



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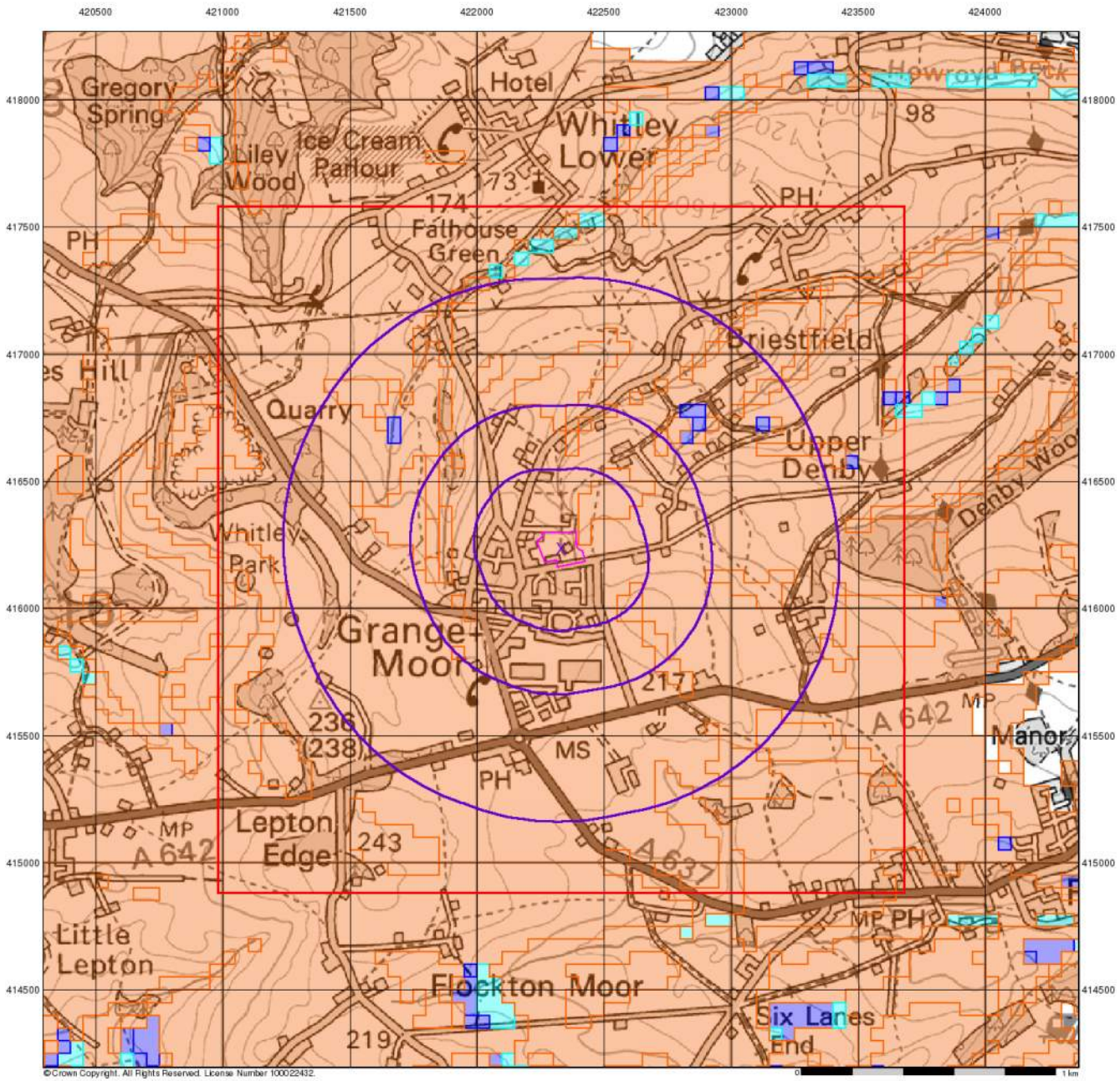

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BGS Flood GFS Data

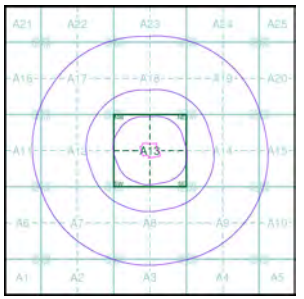
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



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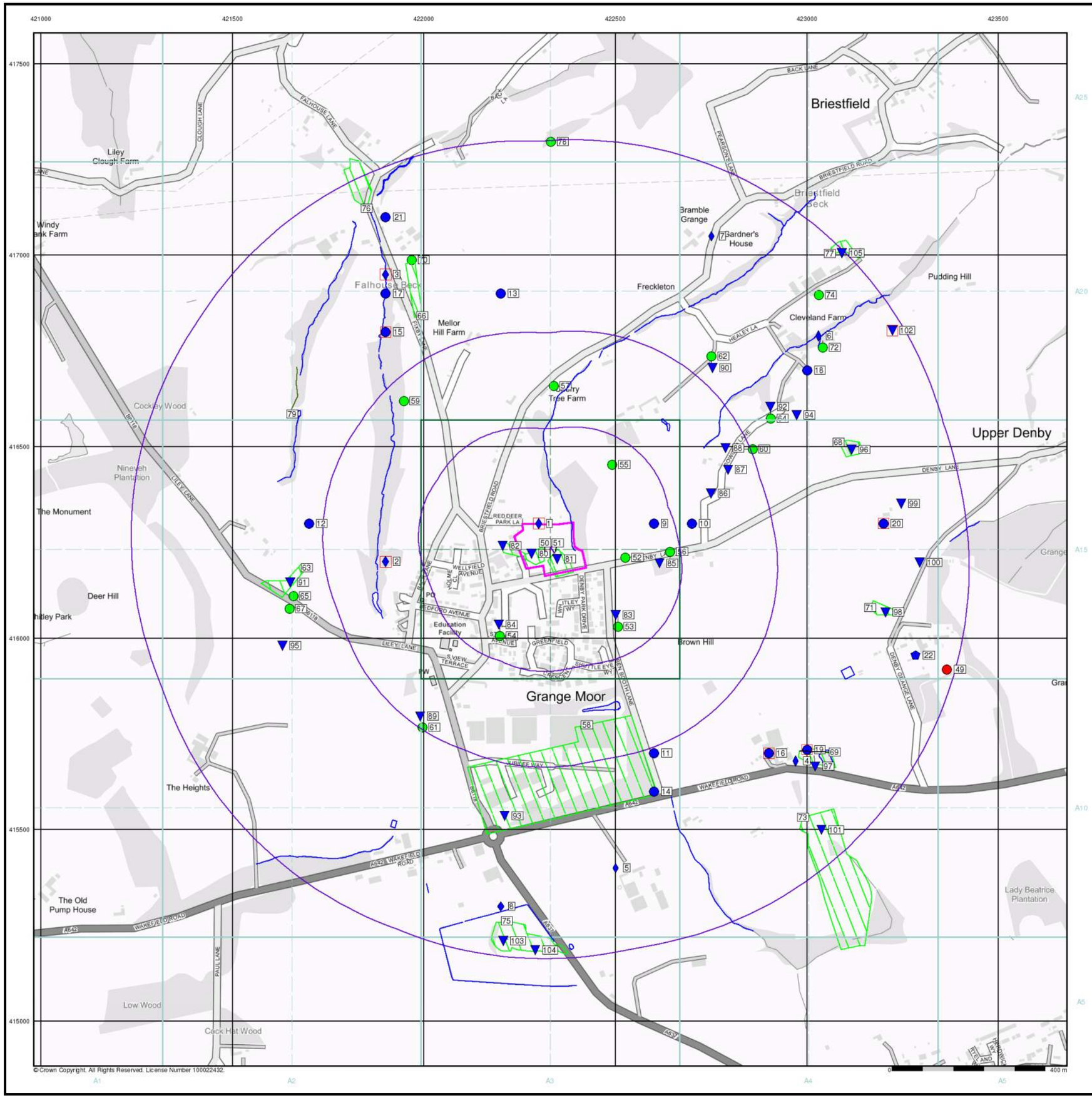

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General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Map ID

Several of Type at Location

Agency and Hydrological

- Contaminated Land Register Entry or Notice (Location)
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Local Authority Integrated Pollution Prevention and Control
- Local Authority Pollution Prevention and Control
- Local Authority Pollution Prevention and Control Enforcement
- Pollution Incident to Controlled Waters
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Registered Radioactive Substance
- River Network or Water Feature
- River Quality Sampling Point
- Substantiated Pollution Incident Register
- Water Abstraction
- Water Industry Act Referral

Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

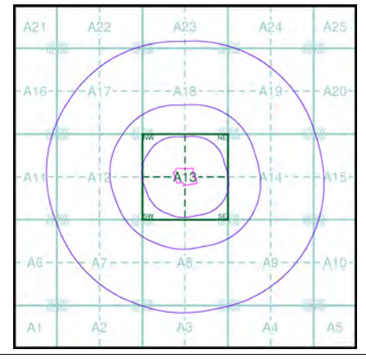
Geological

- BGS Recorded Mineral Site

Waste

- BGS Recorded Landfill Site (Location)
- BGS Recorded Landfill Site
- EA Historic Landfill (Buffered Point)
- EA Historic Landfill (Polygon)
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facility (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Local Authority Recorded Landfill Site (Location)
- Local Authority Recorded Landfill Site
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Slice A



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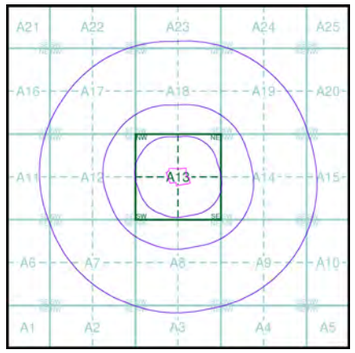
General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



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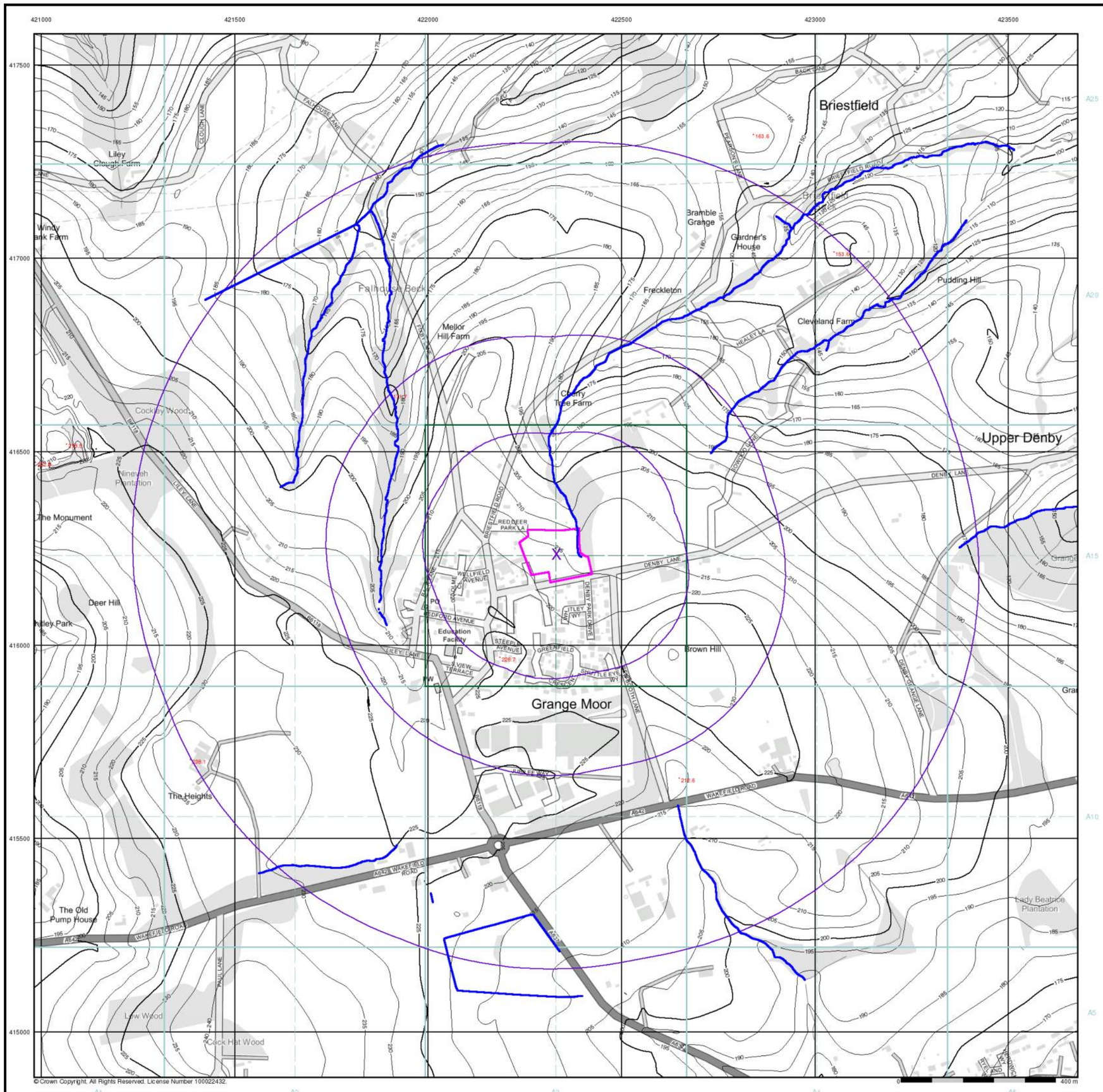

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General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

OS Water Network Data

- Canal
- Reservoir
- Foreshore
- Marsh
- Tidal River
- Inland River
- Drain
- Other
- Lake
- Transfer
- Lock Or Flight Of Locks
- Sea

Contours (height in meters)

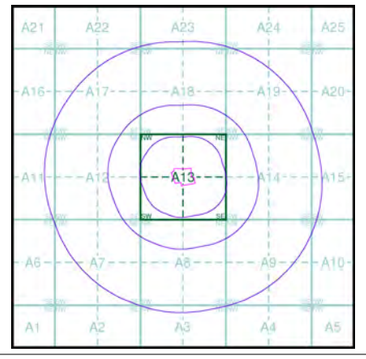
Standard Contour 105 100 95

Master Contour

Spot Height 167.3

- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



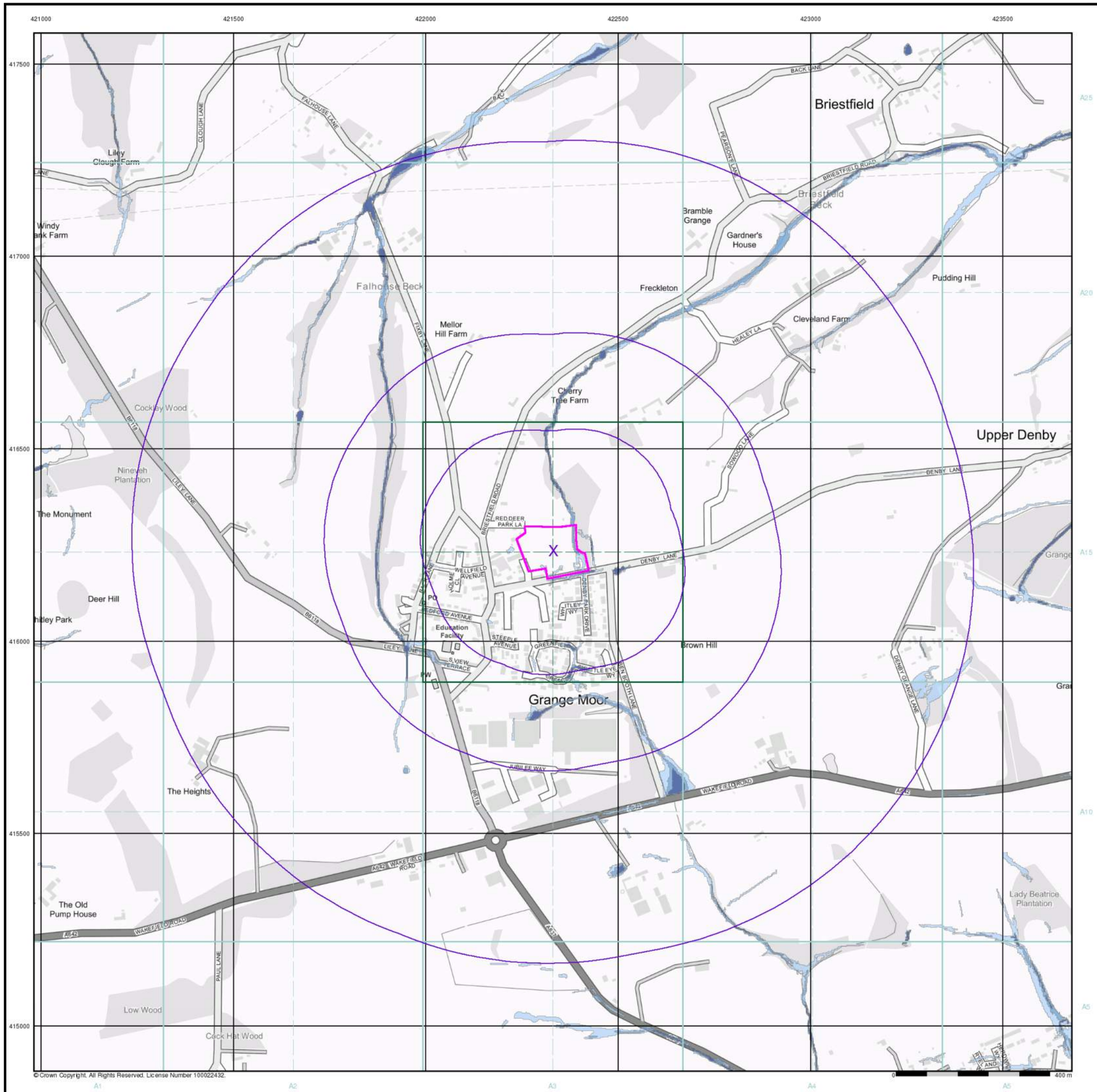
Order Details

Order Number:	301296453_1_1
Customer Ref:	PO19663/JW/4511
National Grid Reference:	422330, 416240
Slice:	A
Site Area (Ha):	1.85
Search Buffer (m):	1000

Site Details

Denby Lane, Grange Moor, WF4 4ED

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LITHOS CONSULTING

General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

Risk of Flooding from Surface Water

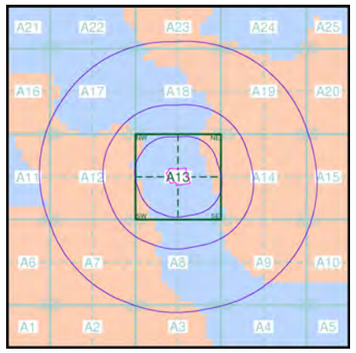
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

EA/NRW Suitability Map - Slice A



Order Details

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Slice:	A
Site Area (Ha):	1.85
Search Buffer (m):	1000

Site Details

Denby Lane, Grange Moor, WF4 4ED

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

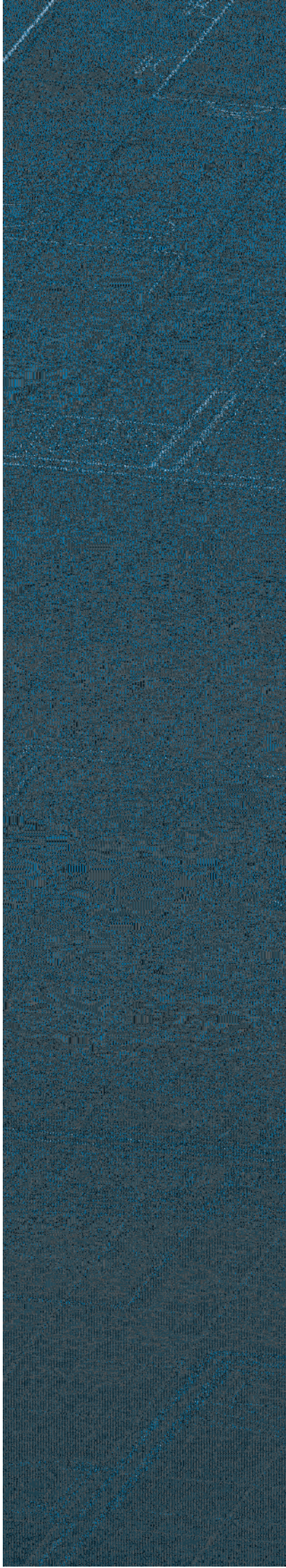
The Coal Authority

Consultants

Coal Mining Report

Denby Lane
Grange Moor
WF4 4ED

Date of enquiry:	**15 September 2022**
Date enquiry received:	**15 September 2022**
Issue date:	**15 September 2022**
Our reference:	**51003311810001**
Your reference:	**PO19664/JW/4511**



Consultants

Coal Mining Report

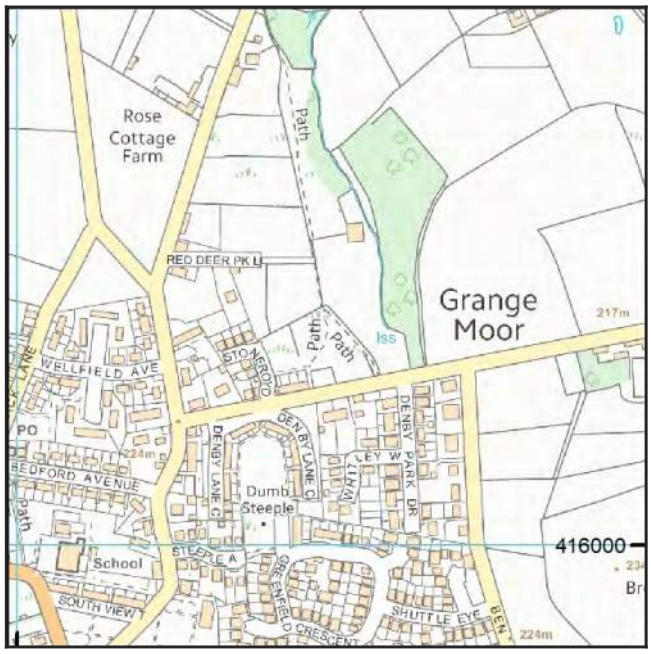
This report is based on and limited to the records held by the Coal Authority at the time the report was produced.

Client name

LITHOS CONSULTING LTD

Enquiry address

Denby Lane
Grange Moor
WF4 4ED



Approximate position of property

How to contact us

0345 762 6848 (UK)
+44 (0)1623 637 000 (International)

200 Lichfield Lane
Mansfield
Nottinghamshire
NG18 4RG

www.groundstability.com

@coalauthority
/company/the-coal-authority
/thecoalauthority
/thecoalauthority

Section 1 – Mining activity and geology

Past underground mining

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
unnamed	LOW FENTON	Coal	6O4A	5	Beneath Property	4.8	East	61	1865
unnamed	MIDDLETON LITTLE	Coal	6O4F	37	Beneath Property	2.4	East	74	1906
unnamed	MIDDLETON LITTLE	Coal	6O4G	39	South	2.5	East	74	1906
unnamed	MIDDLETON MAIN	Coal	6042	48	Beneath Property	3.2	North-East	107	1845
unnamed	WHEATLEY LIME	Coal	6O4J	71	Beneath Property	1.6	South-East	82	1841
unnamed	WHEATLEY LIME	Coal	6O4I	80	South	3.2	South-East	84	1856
unnamed	SILKSTONE	Coal	6O4N	107	Beneath Property	2.8	South-East	61	1883
unnamed	TOP BEESTON	Coal	6O4P	152	Beneath Property	2.6	East	71	1939
unnamed	BLACK BED	Coal	6O4Q	236	Beneath Property	2.5	East	61	1945
unnamed	BLACK BED	Coal	6Z3F	245	South	2.5	East	41	1943

Probable unrecorded shallow workings

Yes.

Spine roadways at shallow depth

No spine roadway recorded at shallow depth.

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Shaft	422416-004	422336 416216	has been filled to an unknown specification	Coal	
Shaft	422416-005	422343 416206	has been capped to an unknown specification	Coal	
Shaft	422416-029	422315 416186	has been capped to an unknown specification. There is some uncertainty as to whether this feature is in fact a well	Coal	

Abandoned mine plan catalogue numbers

The following abandoned mine plan catalogue numbers intersect with some, or all, of the enquiry boundary:

1574	12066	FGB275
10063	5016	NE777
GCR21	FGB18	NE166

Our records show we have more plans than those shown above which could affect the enquiry boundary.

Please contact us on 0345 762 6848 to determine the exact abandoned mine plans you require based on your needs.

Outcrops

Seam name	Mineral	Seam workable	Distance to outcrop (m)	Direction to outcrop	Bearing of outcrop
LOW FENTON	Coal	Yes	34.5	North	90

Geological faults, fissures and breaklines

No faults, fissures or breaklines recorded.

Opencast mines

Please refer to the “Summary of findings” map (on separate sheet) for details of any opencast areas within 500 metres of the enquiry boundary.

Coal Authority managed tips

None recorded within 500 metres of the enquiry boundary.

Section 2 – Investigative or remedial activity

Please refer to the 'Summary of findings' map (on separate sheet) for details of any activity within the area of the site boundary.

Site investigations
None recorded within 50 metres of the enquiry boundary.

Remediated sites
None recorded within 50 metres of the enquiry boundary.

Coal mining subsidence
The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.

There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Mine gas
None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes
None recorded within 500 metres of the enquiry boundary.

Section 3 – Licensing and future mining activity

Future underground mining
None recorded.

Coal mining licensing
None recorded within 200 metres of the enquiry boundary.

Court orders
None recorded.

Section 46 notices
No notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

Withdrawal of support notices
The property is in an area where notices to withdraw support were given in 1943 and 1944.

The property is not in an area where a notice has been given under section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.

Payments to owners of former copyhold land
The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

Section 4 – Further information

The following potential risks have been identified and as part of your risk assessment should be investigated further.

Development advice

The site is within an area of historical coal mining activity. Should you require advice and/or support on understanding the mining legacy, its risks to your development or what next steps you need to take, please contact us.

For further information on specific site or ground investigations in relation to any issues raised in Section 4, please call us on 0345 762 6848 or email us at groundstability@coal.gov.uk.

Section 5 – Data definitions

The datasets used in this report have limitations and assumptions within their results. For more guidance on the data and the results specific to the enquiry boundary, please **call us on 0345 762 6848** or **email us at groundstability@coal.gov.uk.**

Past underground coal mining

Details of all recorded underground mining relative to the enquiry boundary. Only past underground workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination, will be included.

Probable unrecorded shallow workings

Areas where the Coal Authority believes there to be unrecorded coal workings that exist at or close to the surface (less than 30 metres deep).

Spine roadways at shallow depth

Connecting roadways either, working to working, or, surface to working, both in-seam and cross measures that exist at or close to the surface (less than 30 metres deep), either within or within 10 metres of the enquiry boundary.

Mine entries

Details of any shaft or adit either within, or within 100 metres of the enquiry boundary including approximate location, brief treatment details where known, the mineral worked from the mine entry and conveyance details where the mine entry has previously been sold by the Authority or its predecessors British Coal or the National Coal Board.

Abandoned mine plan catalogue numbers

Plan numbers extracted from the abandoned mines catalogue containing details of coal and other mineral abandonment plans deposited via the Mines Inspectorate in accordance with the Coal Mines Regulation Act and Metalliferous Mines Regulation Act 1872. A maximum of 9 plan extents that intersect with the enquiry boundary will be included. This does not infer that the workings and/or mine entries shown on the abandonment plan will be relevant to the site/property boundary.

Outcrops

Details of seam outcrops will be included where the enquiry boundary intersects with a conjectured or actual seam outcrop location (derived by either the British Geological Survey or the Coal Authority) or intersects with a defined 50 metres buffer on the coal (dip) side of the outcrop. An indication of whether the Coal Authority believes the seam to be of sufficient thickness and/or quality to have been worked will also be included.

Geological faults, fissures and breaklines

Geological disturbances or fractures in the bedrock. Surface fault lines (British Geological Survey derived data) and fissures and breaklines (Coal Authority derived data) intersecting with the enquiry boundary will be included. In some circumstances faults, fissures or breaklines have been known to contribute to surface subsidence damage as a consequence of underground coal mining.

Opencast mines
Opencast coal sites from which coal has been removed in the past by opencast (surface) methods and where the enquiry boundary is within 500 metres of either the licence area, site boundary, excavation area (high wall) or coaling area.

Coal Authority managed tips
Locations of disused colliery tip sites owned and managed by the Coal Authority, located within 500 metres of the enquiry boundary.

Site investigations
Details of site investigations within 50 metres of the enquiry boundary where the Coal Authority has received information relating to coal mining risk investigation and/or remediation by third parties.

Remediated sites
Sites where the Coal Authority has undertaken remedial works either within or within 50 metres of the enquiry boundary following report of a hazard relating to coal mining under the Coal Authority's Emergency Surface Hazard Call Out procedures.

Coal mining subsidence
Details of alleged coal mining subsidence claims made since 31 October 1994 either within or within 50 metres of the enquiry boundary. Where the claim relates to the enquiry boundary confirmation of whether the claim was accepted, rejected or whether liability is still being determined will be given. Where the claim has been discharged, whether this was by repair, payment of compensation or a combination of both, the value of the claim, where known, will also be given.

Details of any current 'Stop Notice' deferring remedial works or repairs affecting the property/site, and if so the date of the notice.

Details of any request made to execute preventative works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991. If yes, whether any person withheld consent or failed to comply with any request to execute preventative works.

Mine gas
Reports of alleged mine gas emissions received by the Coal Authority, either within or within 500 metres of the enquiry boundary that subsequently required investigation and action by the Coal Authority to mitigate the effects of the mine gas emission.

Mine water treatment schemes
Locations where the Coal Authority has constructed or operates assets that remove pollutants from mine water prior to the treated mine water being discharged into the receiving water body.

These schemes are part of the UK's strategy to meet the requirements of the Water Framework Directive. Schemes fall into 2 basic categories: Remedial – mitigating the impact of existing pollution or Preventative – preventing a future pollution incident.

Mine water treatment schemes generally consist of one or more primary settlement lagoons and one or more reed beds for secondary treatment. A small number are more specialised process treatment plants.

Future underground mining
Details of all planned underground mining relative to the enquiry boundary. Only those future workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination will be included.

Coal mining licensing
Details of all licenses issued by the Coal Authority either within or within 200 metres of the enquiry boundary in relation to the under taking of surface coal mining, underground coal mining or underground coal gasification.

Court orders
Orders in respect of the working of coal under the Mines (Working Facilities and Support) Acts of 1923 and 1966 or any statutory modification or amendment thereof.

Section 46 notices
Notice of proposals relating to underground coal mining operations that have been given under section 46 of the Coal Mining Subsidence Act 1991.

Withdrawal of support notices
Published notices of entitlement to withdraw support and the date of the notice. Details of any revocation notice withdrawing the entitlement to withdraw support given under Section 41 of the Coal Industry Act 1994.

Payment to owners of former copyhold land
Relevant notices which may affect the property and any subsequent notice of retained interests in coal and coal mines, acceptance or rejection notices and whether any compensation has been paid to a claimant.

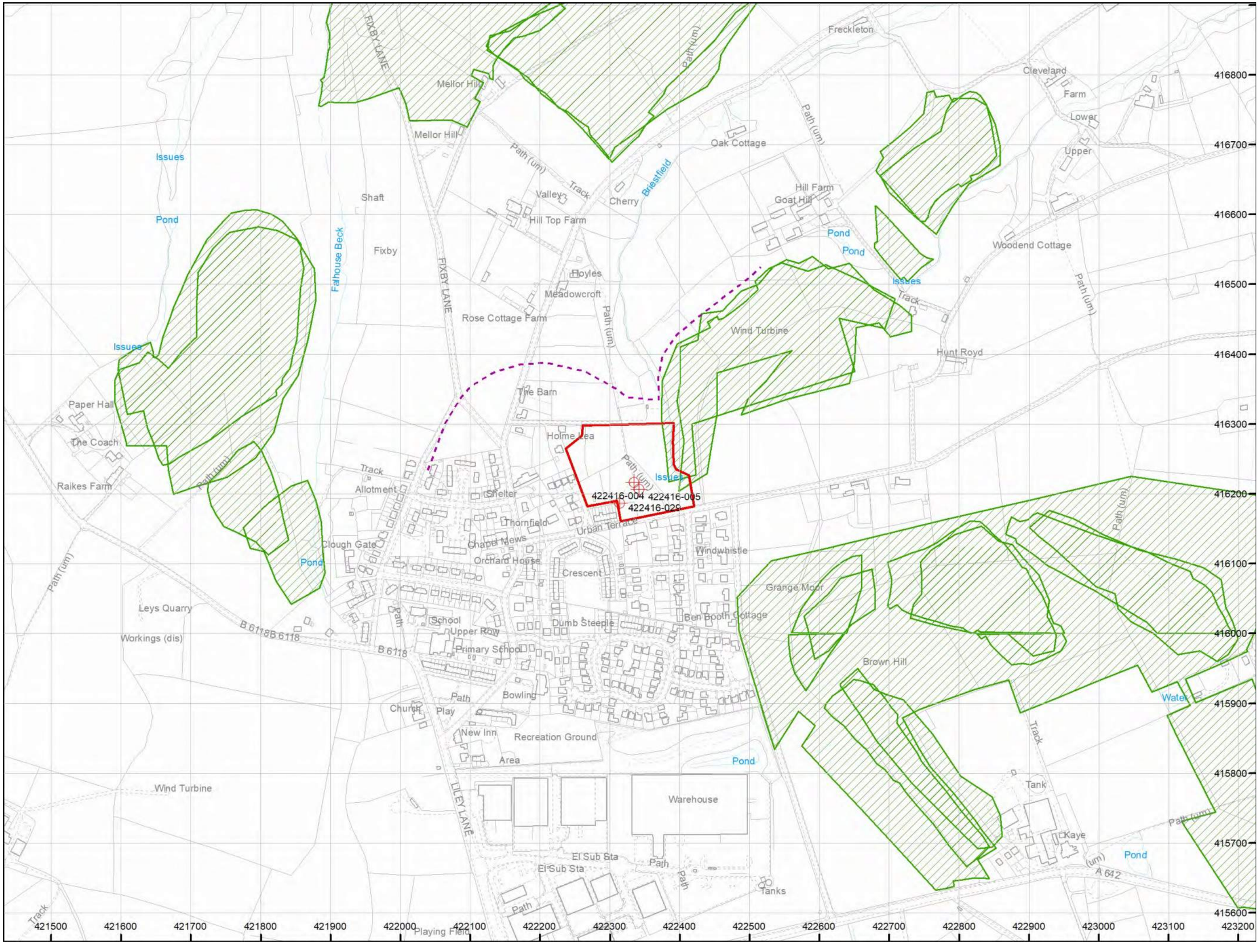
The Coal Authority

Summary of findings

The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

- Approximate position of the enquiry boundary shown
- Disused mine shaft
- Outcrop (Conjectured)
- Unlicensed opencast site



How to contact us
0345 762 6848 (UK)
+44 (0)1623 637 000 (International)
www.groundstability.com

Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP01**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422400.33 - 416191.70 Level: 214.05
Location:	Grange Moor	Dimensions (m): Depth 3.10	2.4 × 0.6
Client:	Yorkshire Country Properties		

Date 12/10/2022

Scale 1:25

Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	213.75		MADE GROUND: Dark brown slightly gravelly SAND with occasional rootlets. Gravel is angular to subrounded fine to coarse of mixed lithologies including sandstone, mudstone, coal and rare brick. (MADE GROUND TOPSOIL)
			HVP=50	0.90	213.15		Firm light orangish brown slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to medium of sandstone, mudstone and coal. (COHESIVE RESIDUAL SOIL)
	1.00	D		1.40	212.65		Firm dark grey sandy CLAY. (COHESIVE RESIDUAL SOIL)
				2.40	211.65		Firm light orangish brown sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mixed lithologies. (COHESIVE RESIDUAL SOIL)
				3.10	210.95		Light grey clayey angular to subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
							End of pit at 3.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP02
Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422387.10 - 416215.52 Level: 212.20	Date 11/10/2022
Location: Grange Moor		Dimensions (m): 2.1 × 0.6, Depth 2.30	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20 0.20	D J&T		0.30	211.90		MADE GROUND: Dark brown slightly gravelly SAND with occasional rootlets. Gravel is angular to subangular fine to medium of predominantly sandstone. (TOPSOIL)
	0.60	D	HVP=60	0.90	211.30		Firm light orangish brown mottled grey sandy slightly gravelly CLAY. Gravel is fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
				1.80	210.40		Weak organgish brown fine grained SANDSTONE. Recovered as slightly sandy angular to subangular fine to coarse gravel with a low cobble content. (BIRSTALL ROCK)
				2.30	209.90		Medium strong light brown SANDSTONE. Recovered as slightly clayey angular to subangular fine to coarse gravel with a low cobble content. (BIRSTALL ROCK)
							End of pit at 2.30 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP03**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422367.68 - 416232.72 Level: 212.15
Location:	Grange Moor	Dimensions (m): Depth 2.10	2.6 × 0.6
Client:	Yorkshire Country Properties		

Date 12/10/2022

Scale 1:25

Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	211.85		MADE GROUND: Dark brown slightly gravelly SAND with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies including sandstone and mudstone with rare brick. (MADE GROUND TOPSOIL)
	0.60	J&T		0.80	211.35		MADE GROUND: Dark grey slightly gravelly SAND. Gravel is angular to subangular fine to coarse of mixed lithologies including sandstone, mudstone and brick. (GRANULAR MADE GROUND)
	1.20	D	HVP=60	1.60	210.55		Firm light orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
				2.10	210.05		Medium strong light brown SANDSTONE. Recovered as slightly sandy angular tabular fine to coarse gravel. (BIRSTALL ROCK) *From 1.8m, becoming difficult to excavate.* End of pit at 2.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP04**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422376.21 - 416248.50 Level: 211.15
Location:	Grange Moor	Dimensions (m): Depth 3.00	2.6 × 0.6
Client:	Yorkshire Country Properties		Date 11/10/2022 Scale 1:25 Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	210.85		MADE GROUND: Dark brown gravelly slightly clayey SAND with occasional rootlets. Gravel is subangular to subrounded fine to medium of sandstone and mudstone. (MADE GROUND TOPSOIL)
	0.50	J&T					MADE GROUND: Dark brown slightly gravelly SAND. Gravel is angular to subrounded fine to coarse of mixed lithologies including sandstone, mudstone, coal and rare brick. (GRANULAR MADE GROUND)
	0.80	D	HVP=50	0.70	210.45		Firm light orangish brown mottled grey sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
				1.20	209.95		Light brown clayey angular to subangular fine to coarse GRAVEL of sandstone and sandstone lithorelicts. (GRANULAR RESIDUAL SOIL)
				3.00	208.15		End of pit at 3.00 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP05**

Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422358.49 - 416272.31 Level: 210.45	Date 11/10/2022
Location: Grange Moor		Dimensions (m): 2.4 × 0.6, Depth 2.80	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	210.25		Dark brown slightly gravelly slightly clayey SAND with occasional rootlets. Gravel is angular to subangular fine to medium of sandstone and mudstone. (TOPSOIL)
							Firm light orangish brown mottled gray sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=70				
	0.80	D					
				1.50	208.95		Stiff dark grey gravelly CLAY. Gravel is angular to sub angular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
			HVP=90				
				1.90	208.55		Black COAL. Recovered as angular tabular fine to coarse gravel. (1st BROWN METAL)
				2.20	208.25		Light greyish brown slightly sandy angular tabular fine to coarse GRAVEL of mudstone lithorelicts. (COAL MEASURES)
				2.80	207.65		End of pit at 2.80 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP06** Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422380.30 - 416291.81 Level: 208.95
Location:	Grange Moor	Dimensions (m): Depth 3.10	2.4 × 0.6
Client:	Yorkshire Country Properties		

Date 11/10/2022 | Scale 1:25 | Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	208.65		Dark brown slightly gravelly slightly clayey SAND with occasional rootlets. Gravel is angular to subangular fine to medium of mixed lithologies. (TOPSOIL)
	0.90	D	HVP=60				Firm light orangish brown mottled grey sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone, mudstone and coal. (COHESIVE RESIDUAL SOIL)
	2.20	T		1.90	207.05		Black COAL. Recovered as angular tabular fine to coarse gravel. (1st BROWN METAL)
				2.60	206.35		Light greyish brown angular to subangular fine to coarse GRAVEL of mudstone. (COAL MEASURES)
▼				3.10	205.85		*At 3.1m, groundwater seepage.* End of pit at 3.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP07** Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422337.45 - 416292.92 Level: 210.15
Location:	Grange Moor	Dimensions (m): Depth 2.60	2.7 × 0.6
Client:	Yorkshire Country Properties		

Date 11/10/2022 | Scale 1:25 | Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20 0.20	B J&T		0.30	209.85		Dark brown slightly gravelly SAND with frequent rootlets. Gravel is angular to subrounded firm to medium of sandstone and mudstone. (TOPSOIL)
			HVP=70				Firm light orangish brown mottled grey sandy slightly gravelly CLAY. Gravel is subangular to subrounded of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
	0.70	D		1.60	208.55		Light grey clayey angular to subangular fine to coarse GRAVEL of mudstone and sandstone lithorelicts. (GRANULAR RESIDUAL SOIL)
				2.60	207.55		End of pit at 2.60 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP08
Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422331.60 - 416260.19 Level: 212.15	Date 11/10/2022
Location: Grange Moor		Dimensions (m): 2.2 × 0.6, Depth 2.20	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20 0.20	B J&T		0.30	211.85		Dark brown slightly gravelly slightly sandy CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.70	D	HVP=45	1.10	211.05		Firm sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
				1.40	210.75		Soft orangish brown very sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL) *Clay is likely firm but feels soft due to high sand content. Unable to obtain hand vane reading.*
			HVP=90	2.20	209.95		Stiff dark grey slight sandy CLAY. (COHESIVE RESIDUAL SOIL) End of pit at 2.20 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP09**

Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422365.80 - 416179.62 Level: 216.25	Date 10/10/2022
Location: Grange Moor		Dimensions (m): 2.5 × 0.6, Depth 3.10	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	215.95		MADE GROUND: Dark brownish grey gravelly SAND with frequent rootlets. Gravel is angular to subrounded fine to coarse of predominantly coal and clinker. (MADE GROUND TOPSOIL)
	0.80	J&T					MADE GROUND: Dark grey gravelly ASH. Gravel is angular to subangular fine to medium of coal and clinker. (COLLIERY SPOIL)
				1.60	214.65		MADE GROUND: Dark grey sandy ashy angular to subangular fine to coarse GRAVEL of mudstone coal and clinker. (COLLIERY SPOIL)
				2.10	214.15		MADE GROUND: Light orangish brown clayey slightly sandy angular to subangular fine to coarse GRAVEL of sandstone with a low cobble content. Cobbles are angular of sandstone. (COLLIERY SPOIL)
	2.50	D					
	2.80	B					
							From 3.1m, difficult to excavate further.
				3.10	213.15		End of pit at 3.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP10**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422327.01 - 416172.02 Level: 216.55	Date 11/10/2022
Location:	Grange Moor	Dimensions (m): Depth 2.30	2.9 × 0.6	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40	216.15		Dark brown slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is angular to subangular fine to medium of sandstone, mudstone and coal. (TOPSOIL)
				2.30	214.25		Light brown sandy angular to subangular fine to coarse GRAVEL of sandstone with a high cobble content. Cobbles are angular of sandstone. (GRANULAR RESIDUAL SOIL) End of pit at 2.30 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP11**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422332.81 - 416195.20 Level: 216.80
Location:	Grange Moor	Dimensions (m): Depth 2.50	2.3 × 0.6
Client:	Yorkshire Country Properties		

Date 10/10/2022

Scale 1:25

Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.60	J&T					MADE GROUND: Light grey gravelly slightly clayey SAND. Gravel is angular to subrounded fine to coarse of mixed lithologies including brick, mudstone, sandstone and coal. (GRANULAR MADE GROUND)
				1.20	215.60		
	1.40	J,K&T					MADE GROUND: Light grey sandy angular to subangular GRAVEL of concrete, coal, glass and wood. Frequent full and half bricks. Occasional cobbles of brick walls up to 30cm in size. (DEMOLITION RUBBLE) *Between 1.2m and 1.9m depth, strong hydrocarbon odour.* *Between 1.4m and 1.9m, brick wall in western face of pit*
				1.90	214.90		
	2.20	D					Light brown sandy, gravelly angular to subangular COBBLES of sandstone. Gravel is angular to subangular fine to coarse of sandstone. (GRANULAR RESIDUAL SOIL) *At 2.5m, difficult to excavate further.*
				2.50	214.30		End of pit at 2.50 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP12
Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422316.01 - 416194.50 Level: 217.65	Date 10/10/2022
Location: Grange Moor		Dimensions (m): 2.7 × 0.6, Depth 3.10	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40	217.25		MADE GROUND: Dark grey ashy slightly gravelly SAND with frequent rootlets. Gravel is angular to subangular fine to coarse of mixed lithologies including coal, clinker and sandstone. (MADE GROUND TOPSOIL)
	0.80	J&T					MADE GROUND: Light grey ashy angluar to subangular fine to coarse GRAVEL of mudstone, coal, clinker and burnt shale. (COLLIERY SPOIL)
	1.30	D&B					
	2.20	J&T		2.10	215.55		Dark brown sandy slightly gravelly CLAY with rare rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (RELICT TOPSOIL)
	2.30	D		2.40	215.25		Firm light orangish brown mottled grey slightly gravelly CLAY. Gravel is angular to subangular fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=50				
	2.70	D					
			HVP=52				
							At 3.1m scraping on likely bedrock.
				3.10	214.55		End of pit at 3.10 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP13**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422318.99 - 416205.69 Level: 217.40	Date 10/10/2022
Location:	Grange Moor	Dimensions (m): Depth 3.50	2.8 × 0.6	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	217.20		MADE GROUND: Dark grey slightly gravelly SAND with occasional rootlets. Gravel is angular to subangular fine to medium of mixed lithologies including sandstone, mudstone, clinker and coal. (MADE GROUND TOPSOIL)
	0.50	J&T		0.70	216.70		MADE GROUND: Light grey ashy angular to subangular fine to coarse GRAVEL of mudstone, coal, clinker and burnt shale. (COLLIERY SPOIL)
	1.80	J&T		2.80	214.60		MADE GROUND: Light brown sandy angular tabular fine to coarse GRAVEL of sandstone with a high cobble content. Cobbles are angular of sandstone. Rare occasional half brick. (COLLIERY SPOIL)
	2.90 3.00	J&T D&B		3.50	213.90		MADE GROUND: Dark reddish grey ash of angular to subrounded fine to coarse GRAVEL of clinker, mudstone, coal, burnt shale and sandstone. (COLLIERY SPOIL)
							End of pit at 3.50 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP14**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422335.81 - 416209.48 Level: 216.70
Location:	Grange Moor	Dimensions (m): Depth 3.00	2.6 × 0.6
Client:	Yorkshire Country Properties		

Date 10/10/2022

Scale 1:25

Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	216.40		MADE GROUND: Dark grey ashy slightly gravelly SAND with occasional rootlets. Gravel is angular to subrounded fine to medium of mixed lithologies including coal, mudstone, sandstone and clinker. (MADE GROUND TOPSOIL)
	0.80	J&T					MADE GROUND: Light grey ashy angular to subangular fine to coarse GRAVEL of mudstone, coal, clinker, burnt shale and sandstone. (COLLIERY SPOIL)
	1.10	D&B					
				2.10	214.60		Light brown slightly clayey angular to subangular fine to coarse GRAVEL of sandstone with frequent angular cobbles of sandstone. (GRANULAR RESIDUAL SOIL)
	2.50	D					*Difficult to excavate beyond 3.0m*
				3.00	213.70		End of pit at 3.00 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP15
Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422332.79 - 416220.79 Level: 216.75	Date 10/10/2022
Location: Grange Moor		Dimensions (m): 2.6 × 0.6, Depth 3.10	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	216.45		MADE GROUND: Dark greyish brown slightly gravelly ashy SAND with occasional rootlets. Gravel is angular to subangular fine to medium of mudstone, coal and clinker. (MADE GROUND TOPSOIL)
	0.70	J&T		1.00	215.75		MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of mudstone, coal and clinker. (COLLIERY SPOIL)
	1.50	D&B		1.90	214.85		MADE GROUND: Light brown sandy angular to subangular fine to coarse GRAVEL of sandstone with a low cobble content. Cobbles are angular of sandstone. (REWORKED NATURAL GROUND)
	2.50	J&T		3.10	213.65		MADE GROUND: Dark grey ashy angular to subrounded fine to coarse GRAVEL of clinker, mudstone and coal. (COLLIERY SPOIL)
							End of pit at 3.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP16**

Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422310.69 - 416207.10 Level: 217.75	Date 12/10/2022
Location: Grange Moor		Dimensions (m): 2.6 × 0.6, Depth 2.60	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	217.45		MADE GROUND: Dark grey gravelly ASH with frequent rootlets.Gravel is angular to subrounded fine to coarse of mixed lithologies including coal, mudstone and clinker. (MADE GROUND TOPSOIL)
							MADE GROUND: Orangish red sandy angular tabular fine to coarse GRAVEL of burnt shale with a medium cobble content. (COLLIERY SPOIL)
							Between 0.3m and 2.0m, spalling of trial pit walls.
	0.90	J&T					
				2.00	215.75		MADE GROUND: Light brown slightly clayey gravelly angular COBBLES of sandstone. Gravel is angular to subangular fine to coarse of sandstone. (REWORKED NATURAL GROUND)
				2.40	215.35		MADE GROUND: Dark grey slightly gravelly ASH. Gravel is angular to subangular fine to coarse of coal, mudstone and burnt shale. (COLLIERY SPOIL)
				2.60	215.15		End of pit at 2.60 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit were unstable between 0.3m and 2.0m depth during excavation.

AGS

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Trial Pit Log

Trialpit No **TP17** Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422295.73 - 416191.00 Level: 217.90	Date 12/10/2022
Location:	Grange Moor	Dimensions (m): Depth 2.90	2.8 × 0.6	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	217.60		MADE GROUND: Dark grey slightly gravelly ASH with frequent rootlets. Gravel is angular to subangular fine to coarse of mixed lithologies including clinker, mudstone, sandstone and brick fragments. (MADE GROUND TOPSOIL)
	0.50	J&T					MADE GROUND: Dark grey gravelly ASH. Gravel is angular to subrounded fine to coarse of mixed lithologies including sandstone, mudstone, coal and clinker. (COLLIERY SPOIL)
				0.90	217.00		POSSIBLE MADE GROUND: Light brown sandy slightly clayey angular to subangular fine to coarse GRAVEL of sandstone (REWORKED NATURAL GROUND)
	1.40	D					
				2.90	215.00		*Between 0.9m and 2.8m, gravel appears to be loose and not always horizontal suggesting possible reworked natural.* End of pit at 2.90 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP18**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422285.71 - 416201.19 Level: 218.35	Date 10/10/2022
Location:	Grange Moor		Dimensions (m): 2.8 × 0.6, Depth 3.20	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							MADE GROUND: Dark grey slightly sandy CLAY with frequent rootlets. (MADE GROUND TOPSOIL)
				0.40	217.95		MADE GROUND: Light grey slightly sandly angular to subangular fine to coarse GRAVEL of mudstone and coal (REWORKED NATURAL GROUND)
				2.90	215.45		POSISBLE MADE GROUND: Light orangish brown clayey angular to subangular fine to coarse GRAVEL of sandstone, mudstone and coal. (REWORKED NATURAL GROUND)
				3.20	215.15		*From 3.2m, difficult to excavate further.* End of pit at 3.20 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP19
Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422266.50 - 416211.20 Level: 218.75	Date 10/10/2022
Location: Grange Moor		Dimensions (m): 2.6 × 0.6, Depth 1.60	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	218.45		MADE GROUND: Dark brown slightly sandy slightly gravelly CLAY with frequent rootlets. Gravel is angular to subrounded fine to coarse of brick, plastic and carpet. (MADE GROUND TOPSOIL)
	0.90	D					Light brown sandy angular tabular fine to coarse GRAVEL of standstone. (GRANULAR RESIDUAL SOIL) *Trial pit extended east to locate quarry highwall.*
				1.60	217.15		*At 1.6m, refusal on bedrock.* End of pit at 1.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP20**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422284.48 - 416217.52 Level: 218.60	Date 10/10/2022
Location:	Grange Moor	Dimensions (m): Depth 3.30	2.6 × 0.6	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	218.40		MADE GROUND: Dark grey slightly gravelly SAND with frequent rootlets. Gravel is angular to subangular fine to medium of predominantly mudstone. (MADE GROUND TOPSOIL)
	0.60	J&T					MADE GROUND: Light grey sandy angular to subangular fine to coarse GRAVEL of mudstone, coal and clinker. (COLLIERY SPOIL)
				3.30	215.30		End of pit at 3.30 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP21
Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422306.51 - 416227.81 Level: 217.40	Date 10/10/2022
Location: Grange Moor		Dimensions (m): 2.7 × 0.6, Depth 3.20	Scale 1:25
Client: Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	217.20		MADE GROUND:Dark grey slightly gravelly ASH with frequent rootlets. Gravel is angular to subangular fine to medium of mudstone, clinker and coal. (MADE GROUND TOPSOIL)
							MADE GROUND:Light grey ashy angular to subangular fine to coarse GRAVEL of mudstone, coal and clinker. (COLLIERY SPOIL)
	1.70	J&T					*Between 1.6m to 1.8m, lense of burnt shale in southern face of pit.*
				3.20	214.20		End of pit at 3.20 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No **TP22**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422317.82 - 416233.91 Level: 216.55
Location:	Grange Moor	Dimensions (m): Depth 2.90	2.6 × 0.6
Client:	Yorkshire Country Properties		

Date 11/10/2022

Scale 1:25

Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	216.25		MADE GROUND: Dark brown slightly gravelly ASH with frequent rootlets. Gravel is angular to subangular fine to coarse of sandstone, mudstone, coal and clinker. (MADE GROUND TOPSOIL)
	1.00	J&T		2.00	214.55		MADE GROUND: Dark grey ashy angular to subangular fine to coarse GRAVEL of mudstone and coal. (COLLIERY SPOIL)
				2.40	214.15		MADE GROUND: Light brown sandy angular to subangular fine to coarse GRAVEL of sandstone with rare fragments of mudstone, coal and clinker. (COLLIERY SPOIL)
				2.90	213.65		MADE GROUND: Dark grey ashy angular to subrounded fine to coarse GRAVEL of sandstone, mudstone, coal, clinker and burnt shale. (COLLIERY SPOIL)
							End of pit at 2.90 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP23
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422383.68 - 416272.86 Level: 209.37	Date 11/10/2022
Location:	Grange Moor		Dimensions (m): Depth 1.00 — 2.6 × 0.6	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.50	208.87		Dark brown slightly gravelly SAND with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)
				1.00	208.37		Firm light orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (COHESIVE RESIDUAL SOIL) *At 0.80m, black pastic pipe c.30cm in diameter in east of pit. Pipe is set in brick surround.* *Shallow trial pit to determine the adjacent quarry extent.* End of pit at 1.00 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

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Trial Pit Log

Trialpit No
TP24
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422381.62 - 416234.77 Level: 211.58	Date 12/10/2022
Location:	Grange Moor	Dimensions (m): Depth 0.50	4.3 × 1.2	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	211.28		Dark brown slight gravelly SAND with frequent rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
				0.50	211.08		Firm light orangish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (COHESIVE RESIDUAL SOIL)
							Shallow trial pit to locate the well shown on historical plans.
							End of pit at 0.50 m

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4
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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP25
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422330.44 - 416185.84 Level: 216.66	Date 12/10/2022
Location:	Grange Moor		Dimensions (m): Depth 0.50 — 2.6 × 1.2	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	216.36		Dark brown slight gravelly SAND with frequent rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
				0.50	216.16		Firm light orangish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (COHESIVE RESIDUAL SOIL)
							Shallow trial pit to determine the extent of made ground.
							End of pit at 0.50 m

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2
3
4
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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

Appendix G

Borehole Logs

LITHOS CONSULTING

Borehole Log

Borehole No.
PH01
Sheet 1 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422391.71 - 416208.01	Hole Type PH
Location: Grange Moor		Level: 212.55	Scale 1:50
Client: Yorkshire Country Properties		Dates: 12/10/2022 - 12/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown OVEBURDEN. (RESIDUAL SOIL)
					1.80	210.75		Light brown SANDSTONE. (COAL MEASURES)
					3.00	209.55		Light grey MUDSTONE. (COAL MEASURES)
					8.10	204.45		Black COAL. (2nd BROWN METAL)
					8.80	203.75		Light grey MUDSTONE. (COAL MEASURES)
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

Borehole No. **PH01**

Sheet 2 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422391.71 - 416208.01	Hole Type PH
Location: Grange Moor		Level: 212.55	Scale 1:50
Client: Yorkshire Country Properties		Dates: 12/10/2022 - 12/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					12.00	200.55		End of borehole at 12.00 m

11 12 13 14 15 16 17 18 19 20

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH01A
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422392.64 - 416206.91	Hole Type PH
Location:	Grange Moor		Level: 212.62	Scale 1:50
Client:	Yorkshire Country Properties		Dates: 13/10/2022 - 13/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown OVERBURDEN. (RESIDUAL SOIL)
					1.80	210.82		Light brown SANDSTONE. (COAL MEASURES)
					3.00	209.62		Light grey MUDSTONE. (COAL MEASURES)
					6.00	206.62		End of borehole at 6.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

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Borehole Log

Borehole No.
PH02
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422367.69 - 416242.17	Hole Type PH
Location:	Grange Moor		Level:	211.65	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	12/10/2022 - 12/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown OVERBURDEN. (RESIDUAL SOIL)
					1.00	210.65		
								Light brown SANDSTONE. (COAL MEASURES)
					2.00	209.65		
								Light grey MUDSTONE. (COAL MEASURES)
					4.00	207.65		
					4.10	207.55		Black COAL. (2nd BROWN METAL)
								Light grey MUDSTONE. (COAL MEASURES)
					6.40	205.25		Black COAL. (2nd BROWN METAL)
					6.90	204.75		Light grey MUDSTONE. (COAL MEASURES)
					10.00	201.65		End of borehole at 10.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

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Borehole No. **PH03**

Sheet 1 of 1

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422349.43 - 416286.95	Hole Type PH
Location: Grange Moor		Level: 209.80	Scale 1:50
Client: Yorkshire Country Properties		Dates: 12/10/2022 - 12/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown OVERBURDEN. (RESIDUAL SOIL)
					3.10	206.70		Black COAL. (2nd BROWN METAL)
					3.80	206.00		Light grey MUDSTONE. (COAL MEASURES)
					9.00	200.80		End of borehole at 9.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH04
Sheet 1 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422357.91 - 416196.51	Hole Type PH
Location:	Grange Moor		Level:	216.15	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	11/10/2022 - 11/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. Likely Colliery Spoil. (COLLIERY SPOIL)
								Between 2.0m and 3.0m, fast drilling.
					3.70	212.45		Light brown SANDSTONE. (COAL MEASURES)
					6.00	210.15		Light grey MUDSTONE. (COAL MEASURES)
								At 9.2m depth, flush lost. Soft ground.
					9.90	206.25		

Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

Borehole No. **PH04**

Sheet 2 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422357.91 - 416196.51	Hole Type PH
Location: Grange Moor		Level: 216.15	Scale 1:50
Client: Yorkshire Country Properties		Dates: 11/10/2022 - 11/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Fast drilling. Suspected coal, no returns. (WORKINGS)
					10.40	205.75		Solid ground. Possible mudstone. (COAL MEASURES)
					15.30	200.85		End of borehole at 15.30 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH05
Sheet 1 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422345.38 - 416177.19	Hole Type PH
Location:	Grange Moor		Level:	216.35	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	13/10/2022 - 13/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. (COLLIERY SPOIL)
					2.00	214.35		Light brown SANDSTONE. (COAL MEASURES)
					5.40	210.95		Light grey MUDSTONE. (COAL MEASURES)
					9.30	207.05		Loss of flush. Possible workings. Soft drilling. (WORKINGS)
					10.00	206.35		Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH05
Sheet 2 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422345.38 - 416177.19	Hole Type PH
Location:	Grange Moor		Level:	216.35	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	13/10/2022 - 13/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Solid ground. (COAL MEASURES)
					13.00	203.35		End of borehole at 13.00 m

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12
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14
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16
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18
19
20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

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Borehole Log

Borehole No.
PH05A
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422346.18 - 416178.25	Hole Type PH
Location:	Grange Moor		Level: 216.45	Scale 1:50
Client:	Yorkshire Country Properties		Dates: 13/10/2022 - 13/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. (COLLIERY SPOIL)
					2.00	214.45		Light brown SANDSTONE. (COAL MEASURES)
					5.40	211.05		Light grey MUDSTONE (COAL MEASURES)
					6.00	210.45		End of borehole at 6.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH06
Sheet 1 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422325.82 - 416199.00	Hole Type PH
Location: Grange Moor		Level: 217.30	Scale 1:50
Client: Yorkshire Country Properties		Dates: 11/10/2022 - 11/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light reddish brown OVERBURDEN. (COLLIERY SPOIL)
					4.20	213.10		Light brown SANDSTONE. (COAL MEASURES)
					7.50	209.80		Light grey MUDSTONE. (COAL MEASURES)
					9.70	207.60		Black COAL.
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH06
Sheet 2 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422325.82 - 416199.00	Hole Type PH
Location:	Grange Moor		Level:	217.30	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	11/10/2022 - 11/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								(2nd BROWN METAL)
					10.60	206.70		Light grey MUDSTONE. (COAL MEASURES)
					15.00	202.30		End of borehole at 15.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH07
Sheet 1 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422291.91 - 416210.99	Hole Type PH
Location:	Grange Moor		Level:	218.35	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	10/10/2022 - 10/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. (COLLIERY SPOIL)
					6.10	212.25		Light grey MUDSTONE. (COAL MEASURES)
					9.90	208.45		

Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

Borehole No. **PH07**

Sheet 2 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422291.91 - 416210.99	Hole Type PH
Location: Grange Moor		Level: 218.35	Scale 1:50
Client: Yorkshire Country Properties		Dates: 10/10/2022 - 10/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey MUDSTONE with coal flashes. (WORKINGS)
								Between 9.9m and 11.0m depth, 50% flush, fast drilling.
					10.60	207.75		Dark grey MUDSTONE with coal flashes. (WORKINGS)
					11.50	206.85		Solid ground. No returns. (COAL MEASURES)
					15.30	203.05		End of borehole at 15.30 m

11 12 13 14 15 16 17 18 19 20

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

Borehole Log

Borehole No. **PH07A**

Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422293.30 - 416208.79	Hole Type PH
Location:	Grange Moor		Level:	218.30	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	13/10/2022 - 13/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. (COLLIERY SPOIL)
					6.00	212.30		End of borehole at 6.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH08
Sheet 1 of 3

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422332.03 - 416230.92	Hole Type PH
Location:	Grange Moor		Level:	216.65	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	10/10/2022 - 10/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. (COLLIERY SPOIL)
					3.00	213.65		Light grey MUDSTONE. (COAL MEASURES)
					4.40	212.25		Light brown SANDSTONE. (COAL MEASURES)
					8.80	207.85		Light grey MUDSTONE. (COAL MEASURES)
					10.00	206.65		Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

Borehole No. **PH08**

Sheet 2 of 3

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422332.03 - 416230.92	Hole Type PH
Location: Grange Moor		Level: 216.65	Scale 1:50
Client: Yorkshire Country Properties		Dates: 10/10/2022 - 10/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Loss of flush. Coal workings. (WORKINGS)
					11.00	205.65		Light brown SANDSTONE. (COAL MEASURES)
					13.10	203.55		Light grey MUDSTONE. Partial returns. (COAL MEASURES)
					14.50	202.15		Light grey MUDSTONE. Full returns. (COAL MEASURES)
					19.40	197.25		Dark grey MUDSTONE. (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH08
Sheet 3 of 3

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422332.03 - 416230.92	Hole Type PH
Location:	Grange Moor		Level:	216.65	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	10/10/2022 - 10/10/2022	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					23.50	193.15		Light grey MUDSTONE. (COAL MEASURES)
					30.00	186.65		End of borehole at 30.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH08A
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422330.80 - 416229.55	Hole Type PH
Location:	Grange Moor		Level: 216.70	Scale 1:50
Client:	Yorkshire Country Properties		Dates: 14/10/2022 - 14/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark grey OVERBURDEN. (COLLIERY SPOIL)
					3.00	213.70		Light grey MUDSTONE. (COAL MEASURES)
					4.40	212.30		Light brown SANDSTONE. (COAL MEASURES)
					6.00	210.70		End of borehole at 6.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

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Borehole Log

Borehole No.
PH09
Sheet 1 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords:	422395.17 - 416184.33	Hole Type PH
Location:	Grange Moor		Level:	214.60	Scale 1:50
Client:	Yorkshire Country Properties		Dates:	12/10/2022 - 12/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown OVERBURDEN. (RESIDUAL SOIL)
					3.50	211.10		Light grey MUDSTONE. (COAL MEASURES)
					9.60	205.00		very fast drilling, no returns. Loss of flush. (WORKINGS)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Ground level inferred from topographic survey.

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Borehole Log

Borehole No.
PH09
Sheet 2 of 2

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422395.17 - 416184.33	Hole Type PH
Location:	Grange Moor		Level: 214.60	Scale 1:50
Client:	Yorkshire Country Properties		Dates: 12/10/2022 - 12/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					10.50	204.10		Solid ground. (COAL MEASURES)
					13.50	201.10		End of borehole at 13.50 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Ground level inferred from topographic survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH10
Sheet 1 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422390.30 - 416222.63	Hole Type PH
Location: Grange Moor		Level: 212.00	Scale 1:50
Client: Yorkshire Country Properties		Dates: 12/10/2022 - 12/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Light brown OVERBURDEN. (RESIDUAL SOIL)
					3.00	209.00		Light grey MUDSTONE. (COAL MEASURES)
					7.00	205.00		Black COAL. (2nd BROWN METAL)
					7.70	204.30		Light grey MUDSTONE. (COAL MEASURES)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Ground level inferred from topographic survey.

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Borehole Log

Borehole No. **PH10**

Sheet 2 of 2

Project Name: Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422390.30 - 416222.63	Hole Type PH
Location: Grange Moor		Level: 212.00	Scale 1:50
Client: Yorkshire Country Properties		Dates: 12/10/2022 - 12/10/2022	Logged By CC

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					11.80	200.20		End of borehole at 11.80 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Ground level inferred from topographic survey.

Appendix H

Shaft Search Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No
422416-004
Search
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422335.99 - 416216.01 Level: 216.70	Date 12/10/2022
Location:	Grange Moor		Dimensions (m): 4.5 × 2.5 Depth 1.50	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20	216.50		MADE GROUND: Dark grey gravelly ASH with frequent rootlets. Gravel is angular to subrounded fine to coarse of mixed lithologies including coal, clinker, mudstone and sandstone. (MADE GROUND TOPSOIL)
							MADE GROUND: Brownish grey sandy gravelly ASH. Gravel is angular to subrounded fine to coarse of mixed lithologies including coal, clinker, mudstone, sandstone and rare brick. (COLLIERY SPOIL)
							At 0.8m, square sandstone brick lined mine entry. 4.0m long, 2.4m wide. Infilled with MADE GROUND: Dark grey gravelly ASH. Gravel is angular to subangular fine to coarse of mudstone, coal and clinker.
				1.50	215.20		End of pit at 1.50 m

1
2
3
4
5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

DENBY LANE, GRANGE MOOR – SHAFT SEARCH

LITHOS

Shaft 422416-004. Located at coordinates 422335.99, 416216.01

LITHOS CONSULTING

Trial Pit Log

Trialpit No
422416-005
Search
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422342.99 - 416206.01 Level: 216.40	Date 12/10/2022
Location:	Grange Moor		Dimensions (m): 5 × 3 Depth 1.00	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20	216.20		MADE GROUND: Dark greyish brown gravelly ASH with frequent rootlets. Gravel is angular to subangular fine to coarse of mudstone, coal and clinker. (MADE GROUND TOPSOIL)
				0.80	215.60		MADE GROUND: Light greyish brown sandy ashy angular to subrounded fine to coarse GRAVEL of brick, mudstone, glass, coal, sandstone and clinker. (COLLIERY SPOIL)
				1.00	215.40		Firm light orangish brown sandy slightly gravelly CLAY. Gravel is angular to subangular fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL) *At 0.8m, double brick lined circular mine entry encountered. Approximately 2.6m in diameter. Infilled with MADE GROUND: Dark grey ashy GRAVEL of clinker, mudstone, coal and rare brick.* End of pit at 1.00 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

DENBY LANE, GRANGE MOOR – SHAFT SEARCH

LITHOS

Shaft 422416-005. Located at coordinates 422342.00, 416206.01

LITHOS CONSULTING

Trial Pit Log

Trialpit No
422416-029
Search
Sheet 1 of 1

Project Name:	Denby Lane, Grange Moor	Project No. 4511	Co-ords: 422315.01 - 416186.03 Level: 217.60	Date 12/10/2022
Location:	Grange Moor		Dimensions (m): Depth 0.60 — 4 × 4	Scale 1:25
Client:	Yorkshire Country Properties			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.60	217.00		MADE GROUND: Dark grey gravelly ASH. Gravel is angular to subrounded fine to coarse of mixed lithologies including clinker, coal and mudstone. (COLLIERY SPOIL) *Tipped materials on surface including bin bags, childrens toys, metal and wood.* *At 0.4m depth, concrete square pad 3.0m x 3.0m x 0.1m encountered. Likely well/mine entry cap.* End of pit at 0.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Exploratory hole surveyed in (level and co-ordinates) on completion.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

DENBY LANE, GRANGE MOOR – SHAFT SEARCH

LITHOS

Shaft 422416-029. Located at coordinates 422315.01, 416186.03.

Appendix I

Soakaway Test Results

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Yorkshire Country Properties
Engineer	Dan Platford
Job Name:	Denby lane, Grange Moor
Job No.:	4511

Date:	**11 10 2022**
Trial Pit No.	**TP02**
Test No.	**1**

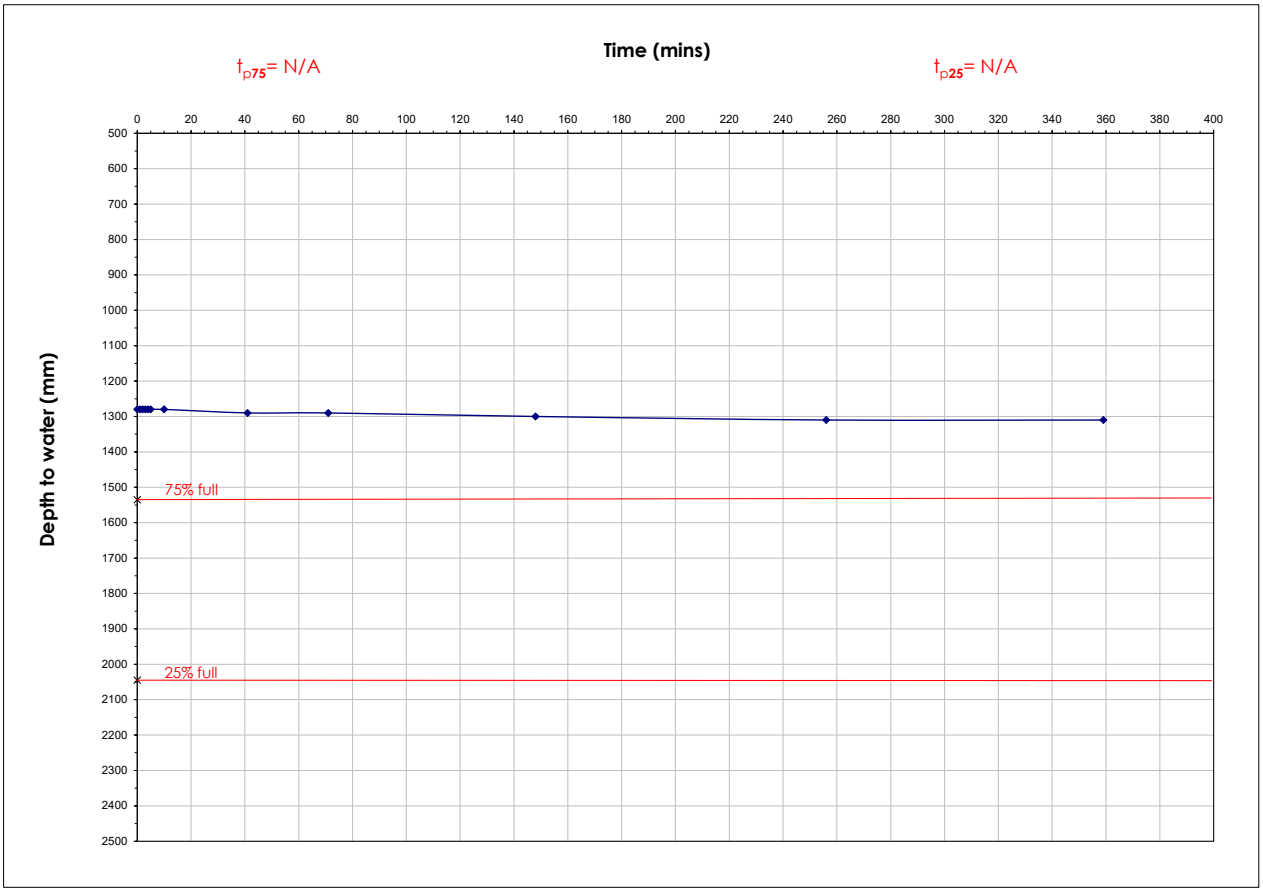
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
08:49	0	1.28	1280
08:50	1	1.28	1280
08:51	2	1.28	1280
08:52	3	1.28	1280
08:53	4	1.28	1280
08:54	5	1.28	1280
08:59	10	1.28	1280
09:30	41	1.29	1290
10:00	71	1.29	1290
11:17	148	1.30	1300
13:05	256	1.31	1310
14:48	359	1.31	1310

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.10	2100
Width	=	0.60	600
Depth	=	2.30	2300

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2045	2.05
0.50	=	1790	1.79
0.75	=	1535	1.54

Depth at start of test (mm)	=	1280
Depth at end of test (mm)	=	1310
Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	4.014
V_{p75-25} - Volume 75 - 25%	=	0.6426

Read from the graph:		
$t_{p\,75}$ (min)	=	N/A
$t_{p\,25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Yorkshire Country Properties
Engineer	Dan Platford
Job Name:	Denby lane, Grange Moor
Job No.:	4511

Date:	**11 10 2022**
Trial Pit No.	**TP07**
Test No.	**1**

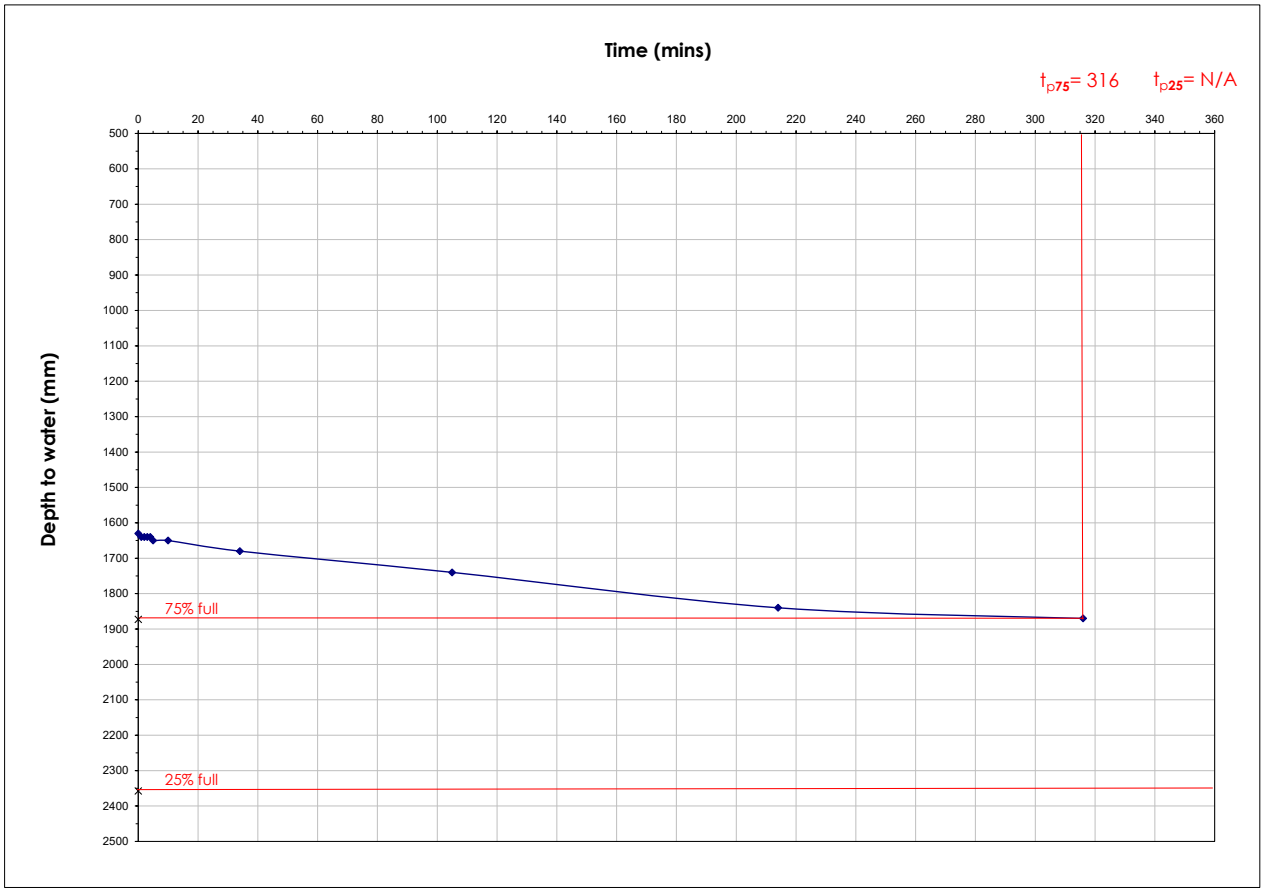
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:35	0	1.63	1630
09:36	1	1.64	1640
09:37	2	1.64	1640
09:38	3	1.64	1640
09:39	4	1.64	1640
09:40	5	1.65	1650
09:45	10	1.65	1650
10:09	34	1.68	1680
11:20	105	1.74	1740
13:09	214	1.84	1840
14:51	316	1.87	1870

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.80	2800
Width	=	0.60	600
Depth	=	2.60	2600

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2357.5	2.36
0.50	=	2115	2.12
0.75	=	1872.5	1.87

Depth at start of test (mm)	=	1630
Depth at end of test (mm)	=	1870
Base area of pit	=	1.68
a_{p50} - 50% internal surface area inc. base	=	4.978
V_{p75-25} - Volume 75 - 25%	=	0.8148

Read from the graph:		
$t_{p\,75}$ (min)	=	316
$t_{p\,25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Yorkshire Country Properties
Engineer	Dan Platford
Job Name:	Denby lane, Grange Moor
Job No.:	4511

Date:	**11 10 2022**
Trial Pit No.	**TP08**
Test No.	**1**

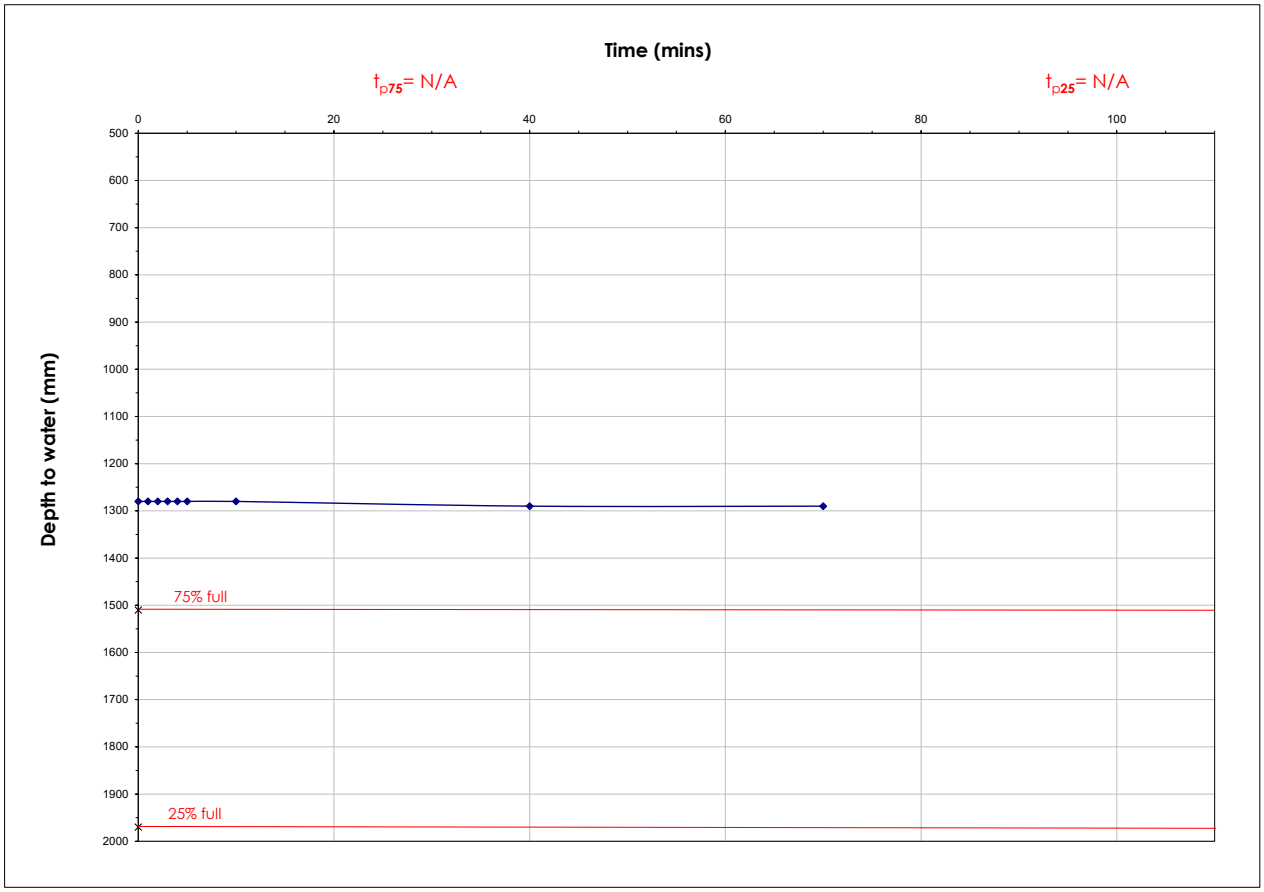
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
13:48	0	1.28	1280
13:49	1	1.28	1280
13:50	2	1.28	1280
13:51	3	1.28	1280
13:52	4	1.28	1280
13:53	5	1.28	1280
13:58	10	1.28	1280
14:28	40	1.29	1290
14:58	70	1.29	1290

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.20	2200
Width	=	0.60	600
Depth	=	2.20	2200

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1970	1.97
0.50	=	1740	1.74
0.75	=	1510	1.51

Depth at start of test (mm)	=	1280
Depth at end of test (mm)	=	1290
Base area of pit	=	1.32
a_{p50} - 50% internal surface area inc. base	=	3.896
V_{p75-25} - Volume 75 - 25%	=	0.6072

Read from the graph:		
$t_{p\,75}$ (min)	=	N/A
$t_{p\,25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Yorkshire Country Properties
Engineer	Dan Platford
Job Name:	Denby lane, Grange Moor
Job No.:	4511

Date:	**11 10 2022**
Trial Pit No.	**TP10**
Test No.	**1**

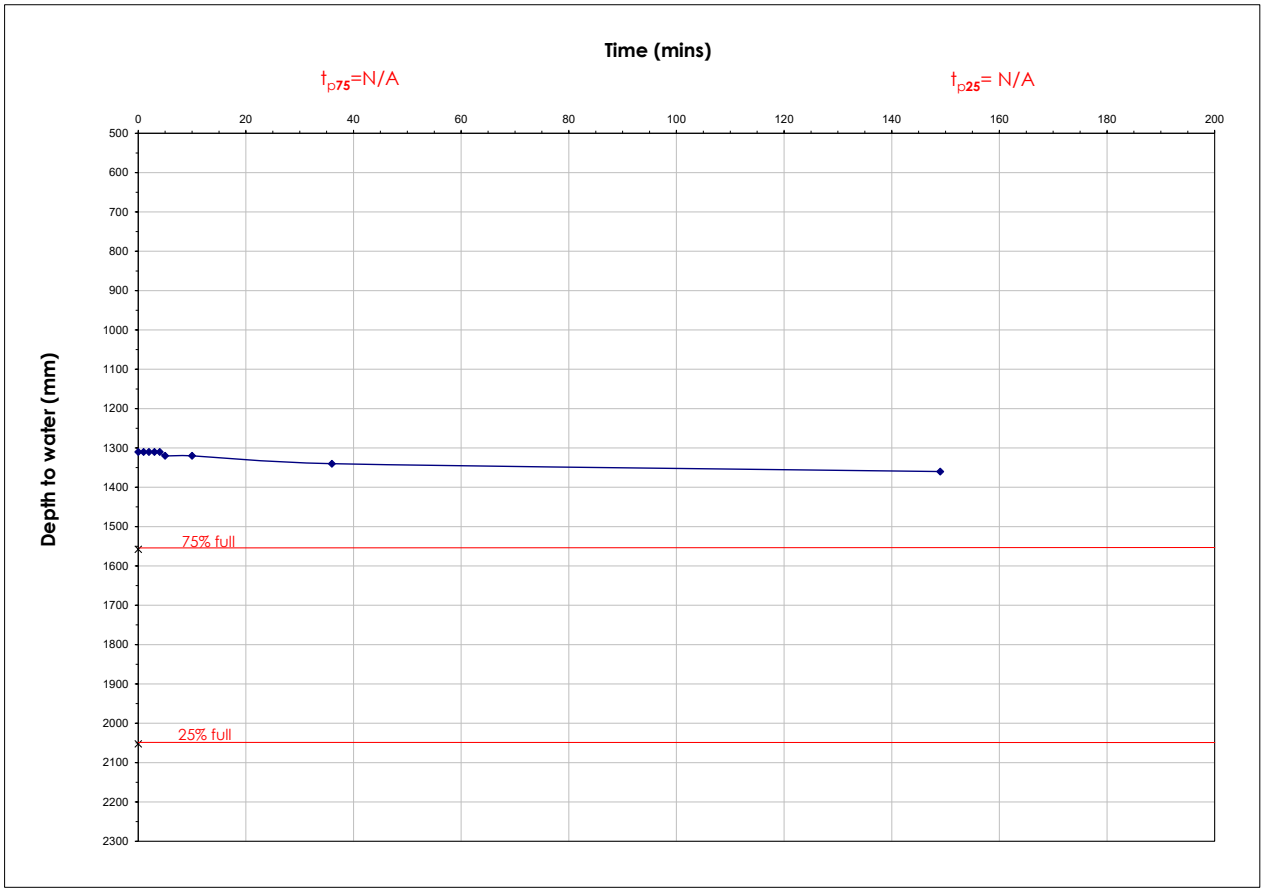
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
12:26	0	1.31	1310
12:27	1	1.31	1310
12:28	2	1.31	1310
12:29	3	1.31	1310
12:30	4	1.31	1310
12:31	5	1.32	1320
12:36	10	1.32	1320
13:02	36	1.34	1340
14:55	149	1.36	1360

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.90	2900
Width	=	0.60	600
Depth	=	2.30	2300

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2052.5	2.05
0.50	=	1805	1.81
0.75	=	1557.5	1.56

Depth at start of test (mm)	=	1310
Depth at end of test (mm)	=	1360
Base area of pit	=	1.74
a_{p50} - 50% internal surface area inc. base	=	5.205
V_{p75-25} - Volume 75 - 25%	=	0.8613

Read from the graph:		
$t_{p\,75}$ (min)	=	N/A
$t_{p\,25}$ (min)	=	N/A



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

Appendix J

Chemical Results

Certificate of Analysis

Certificate Number 22-20871 *Issued:* 25-Oct-22

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 22-20871

Client Reference 4511

Order No PO19787

Contract Title Denby Lane, Grnage Moor

Description 30 Soil samples, 1 Misc sample.

Date Received 17-Oct-22

Date Started 17-Oct-22

Date Completed 25-Oct-22

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

ilac-MRA UKAS TESTING 2139

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

				Lab No	2072614	2072615	2072616	2072617	2072618	2072619
				.Sample ID	TP06	TP09	TP13	TP13	TP14	TP15
				Depth	2.20	0.80	0.50	2.90	0.80	0.70
				Other ID						
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	11/10/2022	11/10/2022	10/10/2022	10/10/2022	10/10/2022	10/10/2022
				Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Preparation										
Stones >10mm	DETSC 1003*	1	% m/m		4.0	29	18	14	25
Moisture Content	DETSC 1004	0.1	%		9.4	9.3	13	11	8.9
Metals										
Arsenic	DETSC 2301#	0.2	mg/kg		97	53	150	80	34
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg		0.3	0.4	0.7	0.6	0.3
Cadmium	DETSC 2301#	0.1	mg/kg		< 0.1	< 0.1	0.1	0.4	< 0.1
Chromium	DETSC 2301#	0.15	mg/kg		7.3	14	15	12	16
Chromium III	DETSC 2301*	0.15	mg/kg		7.3	14	15	12	16
Chromium, Hexavalent	DETSC 2204*	1	mg/kg		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg		37	44	60	65	35
Lead	DETSC 2301#	0.3	mg/kg		46	58	44	62	29
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l		< 10	< 10	< 10	< 10	< 10
Mercury	DETSC 2325#	0.05	mg/kg		0.19	0.09	0.12	0.17	0.07
Nickel	DETSC 2301#	1	mg/kg		15	23	36	24	23
Selenium	DETSC 2301#	0.5	mg/kg		0.6	0.6	1.5	< 0.5	0.8
Vanadium	DETSC 2301#	0.8	mg/kg		21	22	39	26	24
Zinc	DETSC 2301#	1	mg/kg		58	68	48	240	63
Inorganics										
pH	DETSC 2008#		pH		5.4	5.7	4.2	5.7	4.7
Calorific Value	DETSC 5008	1	MJ/kg	22.5	15.7		8.3		4.5
Total Organic Carbon	DETSC 2084#	0.5	%		35	15	21	19	12
Chloride Aqueous Extract	DETSC 2055	1	mg/l		2.2	3.2	3.8	3.8	2.8
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l		1.5	1.9	1.1	4.3	< 1.0
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l		30	58	82	25	34
Sulphate, Total Potential as SO4	*	0.03	%		0.49	0.63	2.7	1.0	0.49
Sulphur as S, Total	DETSC 2320	0.01	%		0.16	0.21	0.90	0.33	0.16
Petroleum Hydrocarbons										
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
EPH (C10-C12)	DETSC 3311	10	mg/kg		15	< 10	< 10	< 10	< 10
EPH (C12-C16)	DETSC 3311	10	mg/kg		54	15	< 10	11	< 10
EPH (C16-C21)	DETSC 3311	10	mg/kg		73	17	10	14	12
EPH (C21-C35)	DETSC 3311	10	mg/kg		100	23	< 10	18	< 10
EPH (C35-C40)	DETSC 3311	10	mg/kg		< 10	< 10	< 10	< 10	< 10
EPH (C10-C40)	DETSC 3311#	10	mg/kg		250	61	29	45	28
PAHs										
Naphthalene	DETSC 3303#	0.03	mg/kg		0.05	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg		0.45	0.06	0.07	0.12	0.08
Anthracene	DETSC 3303	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg		0.21	< 0.03	< 0.03	0.08	< 0.03

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

				Lab No	2072614	2072615	2072616	2072617	2072618	2072619
				.Sample ID	TP06	TP09	TP13	TP13	TP14	TP15
				Depth	2.20	0.80	0.50	2.90	0.80	0.70
				Other ID						
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	11/10/2022	11/10/2022	10/10/2022	10/10/2022	10/10/2022	10/10/2022
				Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Pyrene	DETSC 3303#	0.03	mg/kg		0.17	< 0.03	< 0.03	0.09	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg		0.06	< 0.03	< 0.03	0.04	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg		0.09	< 0.03	< 0.03	0.08	< 0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg		0.11	< 0.03	< 0.03	0.05	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg		0.04	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg		0.04	< 0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg		1.2	< 0.10	< 0.10	0.46	< 0.10

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072620	2072621	2072622	2072623	2072624	2072625
			.Sample ID	TP15	TP16	TP17	TP21	TP22	TP11
			Depth	2.50	0.90	0.50	1.70	1.00	1.40
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	10/10/2022	12/10/2022	12/10/2022	10/10/2022	11/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	26	< 1.0	8.0	10	17	31
Moisture Content	DETSC 1004	0.1	%	9.9	15	11	9.0	10	15
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	35	90	69	230	210	43
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.4	1.9	0.4	0.5	0.6	0.5
Cadmium	DETSC 2301#	0.1	mg/kg	0.1	< 0.1	0.2	< 0.1	< 0.1	0.2
Chromium	DETSC 2301#	0.15	mg/kg	16	28	15	16	10	15
Chromium III	DETSC 2301*	0.15	mg/kg	16	28	15	16	10	15
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	34	57	67	74	46	190
Lead	DETSC 2301#	0.3	mg/kg	26	41	50	56	43	200
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l	< 10	< 10	< 10	< 10	< 10	
Mercury	DETSC 2325#	0.05	mg/kg	0.07	< 0.05	0.12	0.29	0.22	0.14
Nickel	DETSC 2301#	1	mg/kg	39	19	45	17	8.8	22
Selenium	DETSC 2301#	0.5	mg/kg	1.0	< 0.5	< 0.5	2.0	1.9	0.6
Vanadium	DETSC 2301#	0.8	mg/kg	23	51	48	36	22	34
Zinc	DETSC 2301#	1	mg/kg	68	52	63	30	24	140
Inorganics									
pH	DETSC 2008#		pH	5.1	4.1	6.2	3.8	3.5	7.8
Calorific Value	DETSC 5008	1	MJ/kg			7.8	7.9	9.7	
Total Organic Carbon	DETSC 2084#	0.5	%	11	< 0.5	23	20	20	7.0
Chloride Aqueous Extract	DETSC 2055	1	mg/l	3.6	5.2	3.0	6.3	2.0	
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l	< 1.0	< 1.0	2.1	2.2	< 1.0	
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	39	43	29	67	33	
Sulphate, Total Potential as SO4	*	0.03	%	0.52	3.5	0.50	2.5	2.1	
Sulphur as S, Total	DETSC 2320	0.01	%	0.17	1.2	0.17	0.83	0.68	
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
EPH (C10-C12)	DETSC 3311	10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10
EPH (C12-C16)	DETSC 3311	10	mg/kg	11	< 10	< 10	22	15	83
EPH (C16-C21)	DETSC 3311	10	mg/kg	13	< 10	< 10	31	18	490
EPH (C21-C35)	DETSC 3311	10	mg/kg	14	< 10	< 10	37	32	1300
EPH (C35-C40)	DETSC 3311	10	mg/kg	< 10	< 10	< 10	< 10	< 10	67
EPH (C10-C40)	DETSC 3311#	10	mg/kg	40	< 10	23	92	68	1900
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	0.03	0.45
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.97
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.18
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	1.2
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.10	< 0.03	0.21	0.14	0.20	3.4
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	2.2
Fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.14	0.03	0.08	8.6

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072620	2072621	2072622	2072623	2072624	2072625
			.Sample ID	TP15	TP16	TP17	TP21	TP22	TP11
			Depth	2.50	0.90	0.50	1.70	1.00	1.40
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	10/10/2022	12/10/2022	12/10/2022	10/10/2022	11/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.12	< 0.03	0.05	11
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	0.04	0.05	6.5
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	0.10	< 0.03	0.04	8.6
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.07	< 0.03	< 0.03	9.0
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	4.3
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	9.5
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	2.3
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	1.0
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	2.4
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10	< 0.10	0.67	0.17	0.43	71

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072626	2072627	2072628	2072629	2072630	2072631
			.Sample ID	TP03	TP04	TP11	TP03	TP12	TP13
			Depth	0.60	0.50	0.60	0.20	0.30	0.10
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	12/10/2022	11/10/2022	10/10/2022	12/10/2022	10/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	3.0	5.0	7.0	2.0	1.0	8.0
Moisture Content	DETSC 1004	0.1	%	17	18	11	17	20	23
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	48	31	27	58	37	59
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	1.0	0.9	0.3	0.7	1.1	1.2
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.4	0.1	0.5	0.7	0.4
Chromium	DETSC 2301#	0.15	mg/kg	32	28	13	20	29	13
Chromium III	DETSC 2301*	0.15	mg/kg	32	28	13	20	29	13
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	61	58	40	69	120	55
Lead	DETSC 2301#	0.3	mg/kg	120	85	71	120	170	110
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l	< 10	< 10	< 10			
Mercury	DETSC 2325#	0.05	mg/kg	0.21	0.76	0.07	0.20	0.16	0.15
Nickel	DETSC 2301#	1	mg/kg	20	18	21	25	24	19
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	0.6	< 0.5	0.7	0.6
Vanadium	DETSC 2301#	0.8	mg/kg	38	38	26	41	40	32
Zinc	DETSC 2301#	1	mg/kg	100	170	54	110	220	140
Inorganics									
pH	DETSC 2008#		pH	6.8	6.8	7.4	7.1	7.0	6.1
Calorific Value	DETSC 5008	1	MJ/kg						
Total Organic Carbon	DETSC 2084#	0.5	%	10	7.7	8.1	9.9	16	20
Chloride Aqueous Extract	DETSC 2055	1	mg/l	1.8	2.1	3.1			
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l	3.7	5.5	1.1			
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	120	47	28			
Sulphate, Total Potential as SO4	*	0.03	%						
Sulphur as S, Total	DETSC 2320	0.01	%						
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
EPH (C10-C12)	DETSC 3311	10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10
EPH (C12-C16)	DETSC 3311	10	mg/kg	< 10	< 10	< 10	< 10	13	12
EPH (C16-C21)	DETSC 3311	10	mg/kg	16	25	10	23	31	32
EPH (C21-C35)	DETSC 3311	10	mg/kg	86	280	21	120	86	120
EPH (C35-C40)	DETSC 3311	10	mg/kg	19	75	< 10	24	14	33
EPH (C10-C40)	DETSC 3311#	10	mg/kg	130	380	44	170	150	200
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.16	0.31	0.08	0.21	0.29	0.26
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	0.07	< 0.03	0.03	0.04	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.26	0.63	< 0.03	0.42	0.66	0.40

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072626	2072627	2072628	2072629	2072630	2072631
			.Sample ID	TP03	TP04	TP11	TP03	TP12	TP13
			Depth	0.60	0.50	0.60	0.20	0.30	0.10
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	12/10/2022	11/10/2022	10/10/2022	12/10/2022	10/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Pyrene	DETSC 3303#	0.03	mg/kg	0.24	0.59	< 0.03	0.38	0.57	0.34
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.11	0.24	< 0.03	0.14	0.16	0.09
Chrysene	DETSC 3303	0.03	mg/kg	0.17	0.33	0.04	0.23	0.28	0.18
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.20	0.41	0.03	0.22	0.24	0.14
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	0.07	0.16	< 0.03	0.09	0.08	0.06
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.10	0.24	< 0.03	0.14	0.13	0.07
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	0.04	0.12	< 0.03	0.07	0.05	0.04
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	0.04	0.17	< 0.03	0.06	0.05	0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	1.4	3.3	0.12	1.9	2.6	1.5

Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

				Lab No	2072632	2072633	2072634	2072635	2072636	2072638
				.Sample ID	TP14	TP16	TP19	TP20	TP22	TP12
				Depth	0.20	0.20	0.20	0.10	0.20	2.20
				Other ID						
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	10/10/2022	12/10/2022	10/10/2022	10/10/2022	11/10/2022	10/10/2022
				Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Preparation										
Stones >10mm	DETSC 1003*	1	% m/m	15	13	2.0	3.0	2.0	4.0
Moisture Content	DETSC 1004	0.1	%	13	13	25	15	14	26
Metals										
Arsenic	DETSC 2301#	0.2	mg/kg	110	64	61	64	130	52
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.7	0.6	0.9	1.0	0.7	0.7
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	0.5	0.5	0.6	0.2	0.2
Chromium	DETSC 2301#	0.15	mg/kg	13	14	14	18	15	14
Chromium III	DETSC 2301*	0.15	mg/kg	13	14	14	18	15	14
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	78	55	47	79	79	66
Lead	DETSC 2301#	0.3	mg/kg	86	85	130	180	160	63
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l						
Mercury	DETSC 2325#	0.05	mg/kg	0.23	0.33	0.15	0.21	0.26	0.18
Nickel	DETSC 2301#	1	mg/kg	24	17	16	20	21	36
Selenium	DETSC 2301#	0.5	mg/kg	1.3	0.5	0.7	< 0.5	1.5	0.8
Vanadium	DETSC 2301#	0.8	mg/kg	38	25	30	37	45	33
Zinc	DETSC 2301#	1	mg/kg	88	220	120	330	140	75
Inorganics										
pH	DETSC 2008#		pH	5.9	5.6	5.7	6.5	6.4	6.1
Calorific Value	DETSC 5008	1	MJ/kg						
Total Organic Carbon	DETSC 2084#	0.5	%	20	17	18	14	18	15
Chloride Aqueous Extract	DETSC 2055	1	mg/l						
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l						
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l						
Sulphate, Total Potential as SO4	*	0.03	%						
Sulphur as S, Total	DETSC 2320	0.01	%						
Petroleum Hydrocarbons										
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	
EPH (C10-C12)	DETSC 3311	10	mg/kg	< 10	< 10	< 10	< 10	< 10	
EPH (C12-C16)	DETSC 3311	10	mg/kg	17	14	< 10	14	< 10	
EPH (C16-C21)	DETSC 3311	10	mg/kg	29	31	14	34	16	
EPH (C21-C35)	DETSC 3311	10	mg/kg	50	110	52	72	34	
EPH (C35-C40)	DETSC 3311	10	mg/kg	< 10	27	10	< 10	< 10	
EPH (C10-C40)	DETSC 3311#	10	mg/kg	100	180	83	130	65	
PAHs										
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	0.04	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	0.03	< 0.03	0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.15	0.56	0.27	0.75	0.40	0.12
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	0.07	0.03	0.15	0.06	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.15	0.86	0.34	1.4	0.73	0.03

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Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072632	2072633	2072634	2072635	2072636	2072638
			.Sample ID	TP14	TP16	TP19	TP20	TP22	TP12
			Depth	0.20	0.20	0.20	0.10	0.20	2.20
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	10/10/2022	12/10/2022	10/10/2022	10/10/2022	11/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Pyrene	DETSC 3303#	0.03	mg/kg	0.16	0.71	0.30	1.2	0.63	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.06	0.23	0.07	0.60	0.33	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	0.13	0.40	0.16	0.72	0.40	0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.10	0.33	0.10	0.75	0.40	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	0.04	0.14	0.05	0.30	0.16	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.05	0.19	0.06	0.49	0.26	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.09	< 0.03	0.21	0.12	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	0.05	0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	0.09	< 0.03	0.21	0.12	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	0.84	3.7	1.4	6.9	3.6	0.12

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Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072639	2072640	2072641	2072642	2072643	2072644
			.Sample ID	TP02	TP05	TP06	TP07	TP08	TP10
			Depth	0.20	0.10	0.20	0.20	0.20	0.30
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/10/2022	11/10/2022	11/10/2022	11/10/2022	11/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	1.0	1.0	5.0	3.0	5.0	1.0
Moisture Content	DETSC 1004	0.1	%	22	24	21	24	22	22
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	48	46	45	45	30	44
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.6	0.7	0.6	1.1	0.4	1.5
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	0.5	0.4	0.6	0.1	0.4
Chromium	DETSC 2301#	0.15	mg/kg	17	44	35	50	16	19
Chromium III	DETSC 2301*	0.15	mg/kg	17	44	35	50	16	19
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	49	57	53	59	35	54
Lead	DETSC 2301#	0.3	mg/kg	74	90	96	92	31	80
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l						
Mercury	DETSC 2325#	0.05	mg/kg	0.10	0.29	0.20	0.35	0.10	6.4
Nickel	DETSC 2301#	1	mg/kg	16	21	23	23	19	20
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	0.6	< 0.5	0.8
Vanadium	DETSC 2301#	0.8	mg/kg	39	36	41	40	24	39
Zinc	DETSC 2301#	1	mg/kg	170	96	100	120	48	110
Inorganics									
pH	DETSC 2008#		pH	5.9	6.2	6.4	5.8	4.6	6.6
Calorific Value	DETSC 5008	1	MJ/kg						
Total Organic Carbon	DETSC 2084#	0.5	%	9.9	7.5	6.4	8.4	9.4	8.1
Chloride Aqueous Extract	DETSC 2055	1	mg/l						
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l						
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l						
Sulphate, Total Potential as SO4	*	0.03	%						
Sulphur as S, Total	DETSC 2320	0.01	%						
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg						
EPH (C10-C12)	DETSC 3311	10	mg/kg						
EPH (C12-C16)	DETSC 3311	10	mg/kg						
EPH (C16-C21)	DETSC 3311	10	mg/kg						
EPH (C21-C35)	DETSC 3311	10	mg/kg						
EPH (C35-C40)	DETSC 3311	10	mg/kg						
EPH (C10-C40)	DETSC 3311#	10	mg/kg						
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.17	0.10	0.07	0.08	< 0.03	0.30
Anthracene	DETSC 3303	0.03	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.05
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.27	0.15	0.14	0.11	< 0.03	0.46

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Summary of Chemical Analysis
Soil/Misc Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

			Lab No	2072639	2072640	2072641	2072642	2072643	2072644
			.Sample ID	TP02	TP05	TP06	TP07	TP08	TP10
			Depth	0.20	0.10	0.20	0.20	0.20	0.30
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/10/2022	11/10/2022	11/10/2022	11/10/2022	11/10/2022	10/10/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Pyrene	DETSC 3303#	0.03	mg/kg	0.24	0.13	0.13	0.10	< 0.03	0.37
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.13	0.05	0.07	0.04	< 0.03	0.15
Chrysene	DETSC 3303	0.03	mg/kg	0.16	0.07	0.09	0.06	< 0.03	0.19
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.17	0.07	0.10	0.06	< 0.03	0.18
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	0.07	< 0.03	0.04	< 0.03	< 0.03	0.06
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.10	< 0.03	0.05	< 0.03	< 0.03	0.10
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	0.06	< 0.03	0.04	< 0.03	< 0.03	0.04
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	0.06	< 0.03	0.04	< 0.03	< 0.03	0.05
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	1.4	0.57	0.72	0.46	< 0.10	2.0

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Summary of Asbestos Analysis
Soil Samples

Our Ref 22-20871
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

Lab No	Sample ID	Sample Location	Material Type*	Result	Comment*	Analyst
2072615	TP09 0.80		SOIL	NAD	none	Vicky Convery
2072616	TP13 0.50		SOIL	NAD	none	Vicky Convery
2072617	TP13 2.90		SOIL	NAD	none	Vicky Convery
2072618	TP14 0.80		SOIL	NAD	none	Vicky Convery
2072620	TP15 2.50		SOIL	NAD	none	Vicky Convery
2072622	TP17 0.50		SOIL	NAD	none	Vicky Convery
2072623	TP21 1.70		SOIL	NAD	none	Vicky Convery
2072624	TP22 1.00		SOIL	NAD	none	Vicky Convery
2072625	TP11 1.40		SOIL	NAD	none	Vicky Convery
2072626	TP03 0.60		SOIL	NAD	none	Vicky Convery
2072627	TP04 0.50		SOIL	NAD	none	Vicky Convery
2072628	TP11 0.60		SOIL	NAD	none	Vicky Convery
2072629	TP03 0.20		SOIL	NAD	none	Vicky Convery
2072630	TP12 0.30		SOIL	NAD	none	Vicky Convery
2072631	TP13 0.10		SOIL	NAD	none	Vicky Convery
2072632	TP14 0.20		SOIL	NAD	none	Vicky Convery
2072633	TP16 0.20		SOIL	NAD	none	Vicky Convery
2072634	TP19 0.20		SOIL	NAD	none	Vicky Convery
2072635	TP20 0.10		SOIL	NAD	none	Vicky Convery
2072636	TP22 0.20		SOIL	NAD	none	Vicky Convery
2072638	TP12 2.20		SOIL	NAD	none	Vicky Convery
2072639	TP02 0.20		SOIL	NAD	none	Vicky Convery
2072640	TP05 0.10		SOIL	NAD	none	Vicky Convery
2072641	TP06 0.20		SOIL	NAD	none	Vicky Convery
2072642	TP07 0.20		SOIL	NAD	none	Vicky Convery
2072643	TP08 0.20		SOIL	NAD	none	Vicky Convery
2072644	TP10 0.30		SOIL	NAD	none	Vicky Convery
2072645	SP1		Cement	Chrysotile	none	Vicky Convery

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * -not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 22-20871
Client Ref 4511
Contract Denby Lane, Grnage Moor

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2072614	TP06 2.20 SOIL	11/10/22	PT 1L		
2072615	TP09 0.80 SOIL	11/10/22	GJ 250ml, PT 1L		
2072616	TP13 0.50 SOIL	10/10/22	GJ 250ml, PT 1L		
2072617	TP13 2.90 SOIL	10/10/22	GJ 250ml, PT 1L		
2072618	TP14 0.80 SOIL	10/10/22	GJ 250ml, PT 1L		
2072619	TP15 0.70 SOIL	10/10/22	GJ 250ml, PT 1L		
2072620	TP15 2.50 SOIL	10/10/22	GJ 250ml, PT 1L		
2072621	TP16 0.90 SOIL	12/10/22	GJ 250ml, PT 1L		
2072622	TP17 0.50 SOIL	12/10/22	GJ 250ml, PT 1L		
2072623	TP21 1.70 SOIL	10/10/22	GJ 250ml, PT 1L		
2072624	TP22 1.00 SOIL	11/10/22	GJ 250ml, PT 1L		
2072625	TP11 1.40 SOIL	10/10/22	GJ 250ml, GJ 60ml, PT 1L		
2072626	TP03 0.60 SOIL	12/10/22	GJ 250ml, PT 1L		
2072627	TP04 0.50 SOIL	11/10/22	GJ 250ml, PT 1L		
2072628	TP11 0.60 SOIL	10/10/22	GJ 250ml, PT 1L		
2072629	TP03 0.20 SOIL	12/10/22	GJ 250ml, PT 1L		
2072630	TP12 0.30 SOIL	10/10/22	GJ 250ml, PT 1L		
2072631	TP13 0.10 SOIL	10/10/22	GJ 250ml, PT 1L		
2072632	TP14 0.20 SOIL	10/10/22	GJ 250ml, PT 1L		
2072633	TP16 0.20 SOIL	12/10/22	GJ 250ml, PT 1L		
2072634	TP19 0.20 SOIL	10/10/22	GJ 250ml, PT 1L		
2072635	TP20 0.10 SOIL	10/10/22	GJ 250ml, PT 1L		
2072636	TP22 0.20 SOIL	11/10/22	GJ 250ml, PT 1L		
2072637	TP01 0.20 SOIL	12/10/22	GJ 250ml, PT 1L		
2072638	TP12 2.20 SOIL	10/10/22	GJ 250ml, PT 1L		
2072639	TP02 0.20 SOIL	11/10/22	GJ 250ml, PT 1L		
2072640	TP05 0.10 SOIL	11/10/22	GJ 250ml, PT 1L		
2072641	TP06 0.20 SOIL	11/10/22	GJ 250ml, PT 1L		
2072642	TP07 0.20 SOIL	11/10/22	GJ 250ml, PT 1L		
2072643	TP08 0.20 SOIL	11/10/22	GJ 250ml, PT 1L		
2072644	TP10 0.30 SOIL	10/10/22	GJ 250ml, PT 1L		
2072645	SP1 MISC	10/10/22	PT 1L		

Key: P-Plastic T-Tub G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Certificate of Analysis

Certificate Number 22-22300 *Issued:* 16-Nov-22

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 22-22300

Client Reference 4511

Order No PO19787

Contract Title Denby Lane, Grnage Moor

Description 6 Soil samples.

Date Received 17-Oct-22

Date Started 02-Nov-22

Date Completed 16-Nov-22

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

2139

Summary of Chemical Analysis
Soil Samples

Our Ref 22-22300
Client Ref 4511
Contract Title Denby Lane, Grnage Moor

				Lab No	2079961	2079962	2079963	2079964	2079965	2079966
				.Sample ID	TP06	TP09	TP22	TP03	TP02	TP05
				Depth	2.20	0.80	1.00	0.20	0.20	0.10
				Other ID						
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	11/10/2022	11/10/2022	11/10/2022	12/10/2022	11/10/2022	11/10/2022
				Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Metals										
Arsenic Gastric % Bioaccessible (% of Total As)	DETSC 2400*	0	%				1.2	1.3	1.2
Arsenic Gastric mg/kg Bioaccessible	DETSC 2400*	0.5	mg/kg				0.6	< 0.5	< 0.5
Arsenic Gastro Intestinal % Bioaccessible (% of Total As)	DETSC 2400*	0	%				2.0	2.7	2.4
Arsenic Gastro Intestinal mg/kg Bioaccessible	DETSC 2400*	0.5	mg/kg				1.0	0.7	0.9
Arsenic	DETSC 2301#	0.2	mg/kg				49	26	40
Inorganics										
Combustibility	DETSC 2036*	0		c	d	d			

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Combustability Test Results

Screening Test Procedure and Classification

Sample divided into 5 sub-samples. 10g of material was then abstracted from each sub-sample and heated on gauze cloth over a Bunsen burner for 15 minutes. Reactions were observed both during and after heating and the material classified as follows:

Reaction Grade	Description
F	The material did not glow, but there was a slight decrepitation (inert material).
E	The sample glowed but did not ignite (inert material).
D	Volatiles were emitted and/or some bubbling occurred, but the material did not ignite (inert material).
C	Sample ignited, but did not persist burning after the Bunsen burner was withdrawn.
B	Sample ignited, continued burning weakly and smouldered after the Bunsen burner was withdrawn.
A	Sample ignited and continued to burn vigorously after the Bunsen burner was withdrawn.

Information in Support of the Analytical Results

Our Ref 22-22300
Client Ref 4511
Contract Denby Lane, Grnage Moor

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2079961	TP06 2.20 SOIL	11/10/22	PT 1L		
2079962	TP09 0.80 SOIL	11/10/22	GJ 250ml, PT 1L		
2079963	TP22 1.00 SOIL	11/10/22	GJ 250ml, PT 1L		
2079964	TP03 0.20 SOIL	12/10/22	GJ 250ml, PT 1L		
2079965	TP02 0.20 SOIL	11/10/22	GJ 250ml, PT 1L		
2079966	TP05 0.10 SOIL	11/10/22	GJ 250ml, PT 1L		

Key: P-Plastic T-Tub G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Appendix K

Dot and Box Plots

Dot and Box Plot

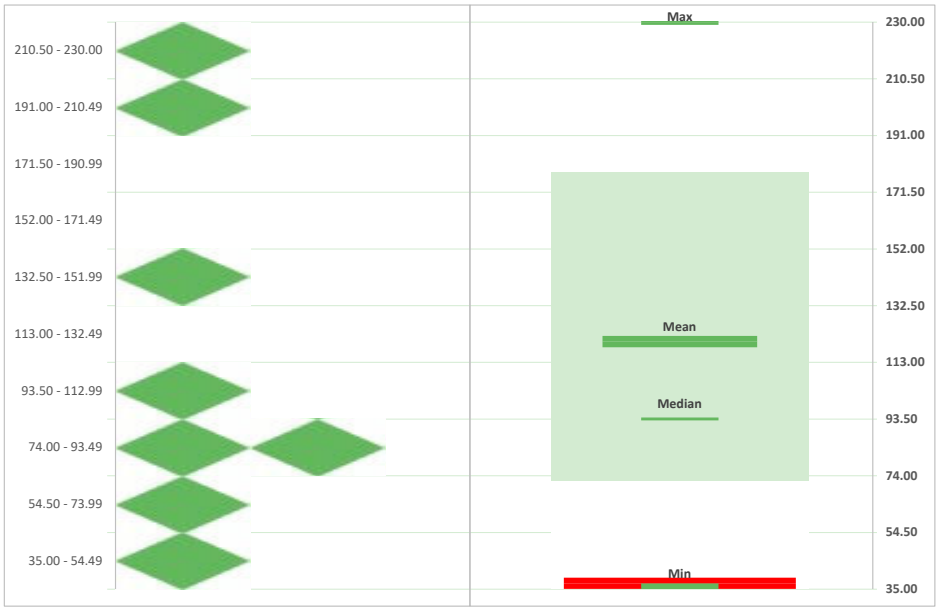
Colliery spoil (no cover)

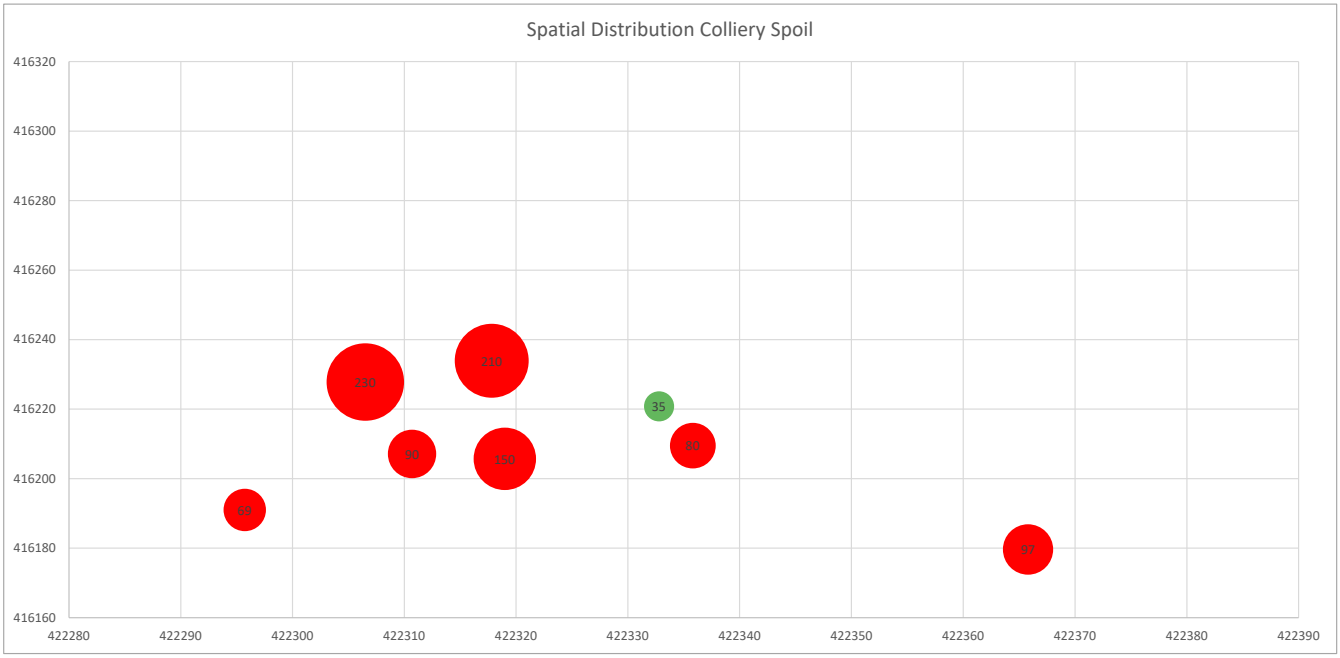
Denby Lane, Grange Moor

Job No: 4511
Engineer: CC
Date: 17 11 2022

Colliery Spoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	37.00
No. samples	8.00
Max	230.00
Mean	120.13
Min	35.00
Median	93.50
Standard Deviation	69.65
Standard Error	24.62
T value	2.36
Upper Confidence Level (95%)	178.35
Upper Confidence Level (80%)	154.97
Lower Confidence Level (5%)	71.86
Transform data	Normal
Upper Confidence Level for chart	95%





Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Dot and Box Plot

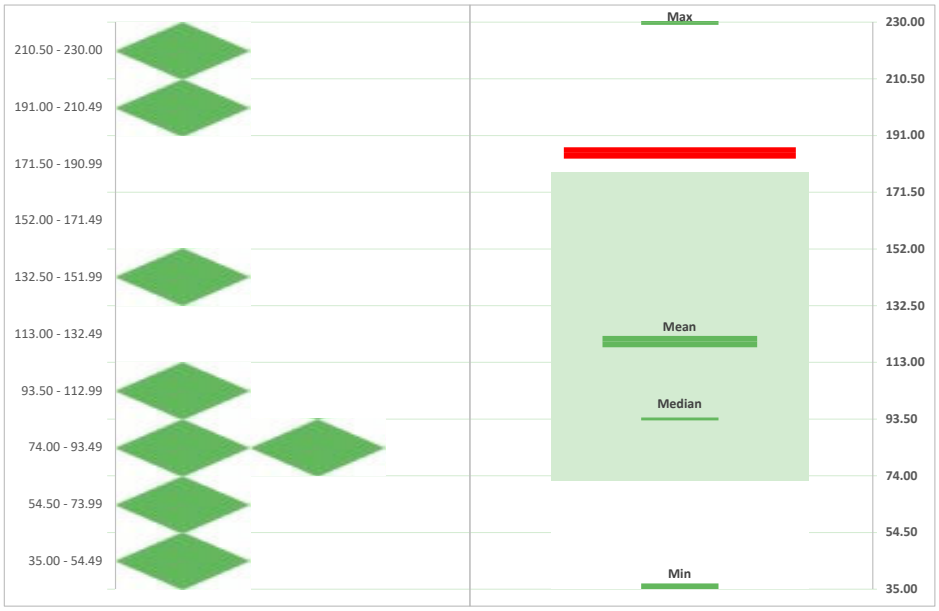
Colliery Spoil - 600mm Cover

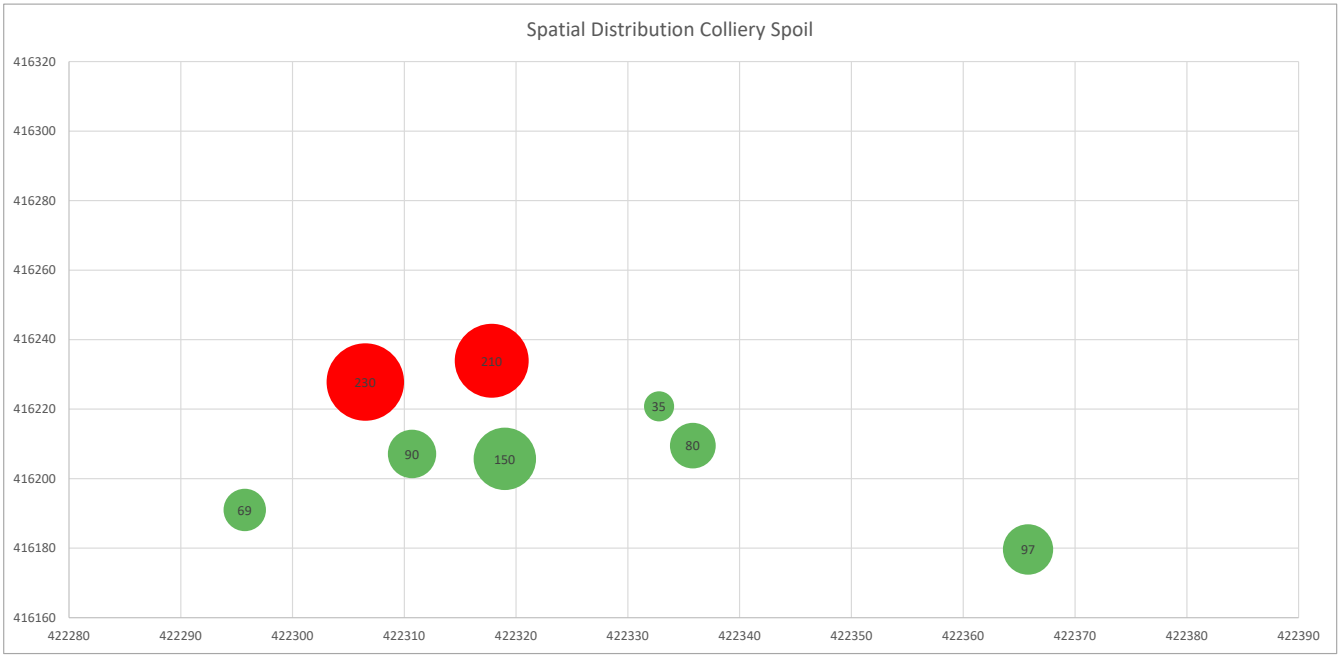
Denby Lane, Grange Moor

Job No: 4511
Engineer: CC
Date: 17 11 2022

Colliery Spoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	185.00
No. samples	8.00
Max	230.00
Mean	120.13
Min	35.00
Median	93.50
Standard Deviation	69.65
Standard Error	24.62
T value	2.36
Upper Confidence Level (95%)	178.35
Upper Confidence Level (80%)	154.97
Lower Confidence Level (5%)	71.86
Transform data	Normal
Upper Confidence Level for chart	95%





Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Dot and Box Plot

Made Ground Topsoil - No Cover

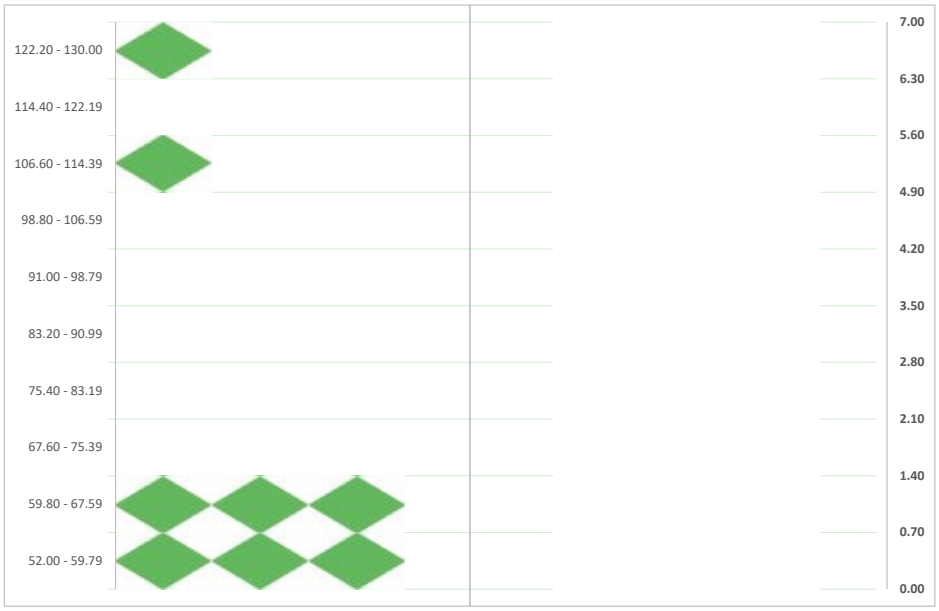
Denby Lane, Grange Moor

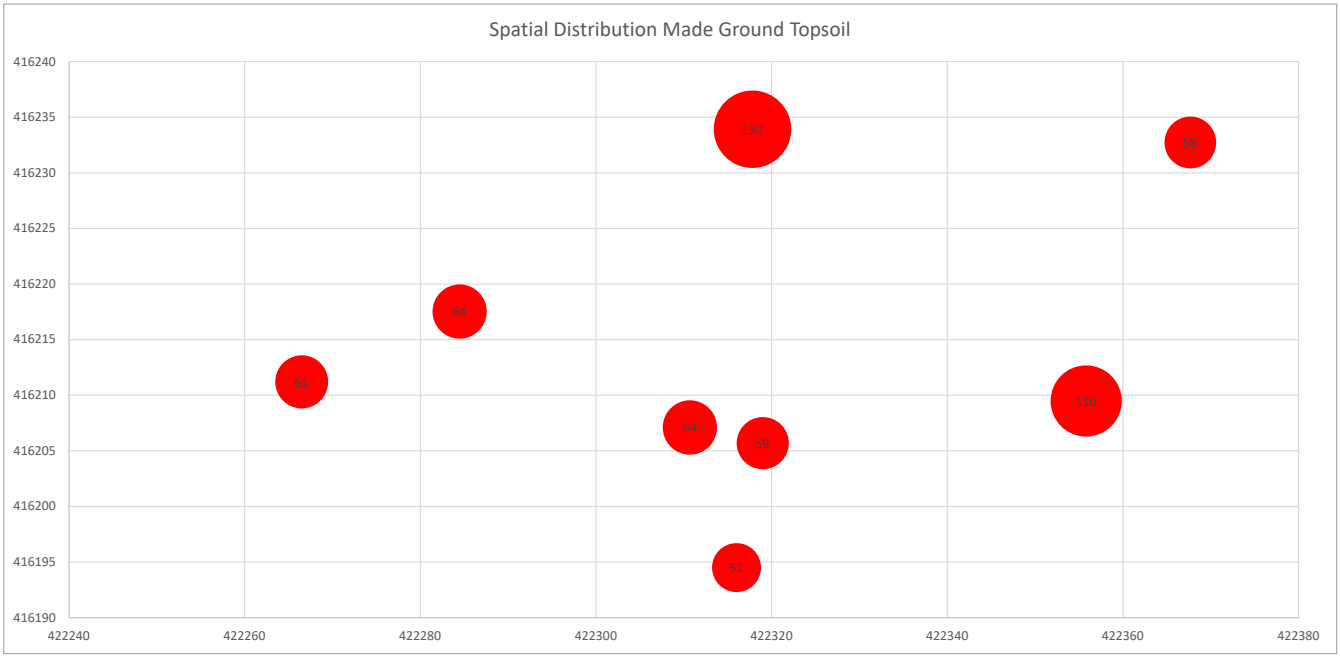
Job No: 4511
Engineer: CC
Date: 17 11 2022

Made Ground Topsoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	37.00
No. samples	8.00
Max	130.00
Mean	74.75
Min	52.00
Median	62.50
Standard Deviation	28.69
Standard Error	10.14
T value	2.36
Upper Confidence Level (95%)	98.73
Upper Confidence Level (80%)	89.10
Lower Confidence Level (5%)	54.87
Transform data	Normal

Upper Confidence Level for chart	95%





Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Dot and Box Plot

Made Ground Topsoil - 600mm Cover

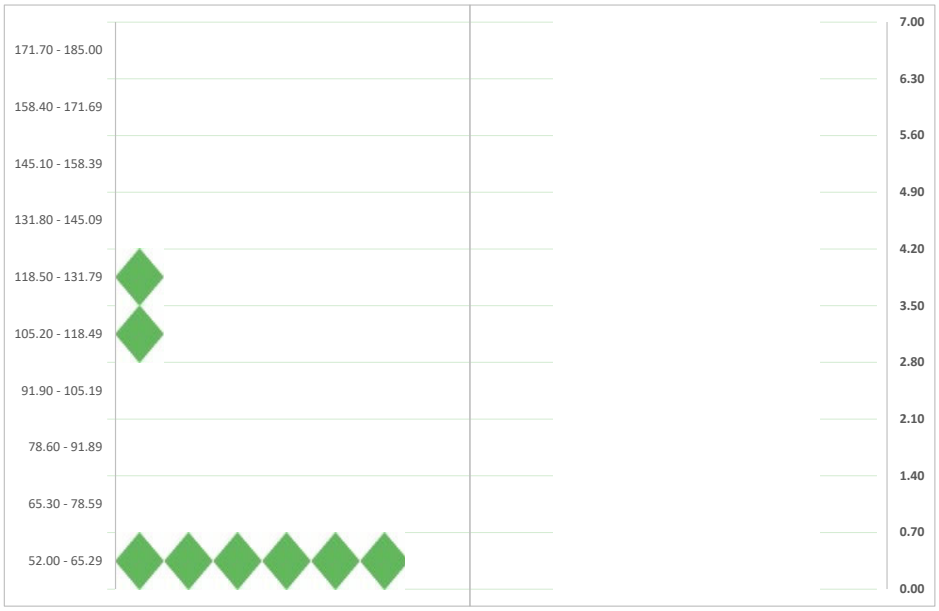
Denby Lane, Grange Moor

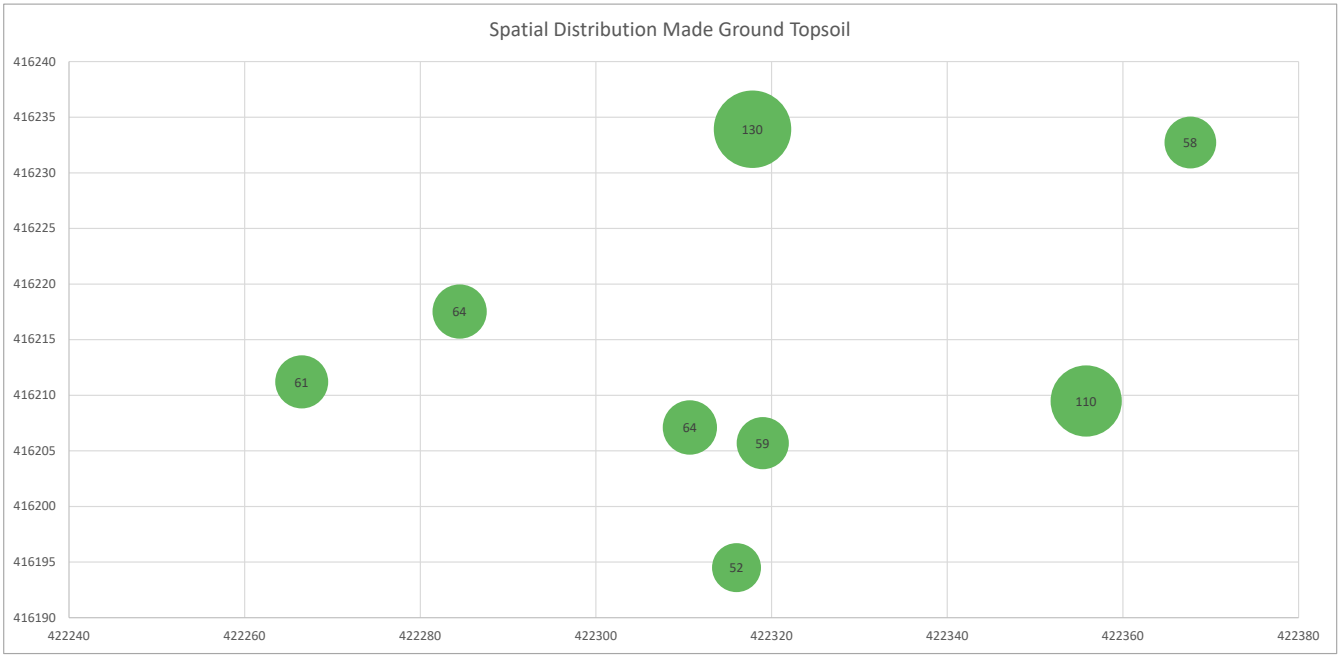
Job No: 4511
Engineer: CC
Date: 17 11 2022

Made Ground Topsoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	185.00
No. samples	8.00
Max	130.00
Mean	74.75
Min	52.00
Median	62.50
Standard Deviation	28.69
Standard Error	10.14
T value	2.36
Upper Confidence Level (95%)	98.73
Upper Confidence Level (80%)	89.10
Lower Confidence Level (5%)	54.87
Transform data	Normal

Upper Confidence Level for chart	95%





Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Dot and Box Plots

Topsoil - No Cover

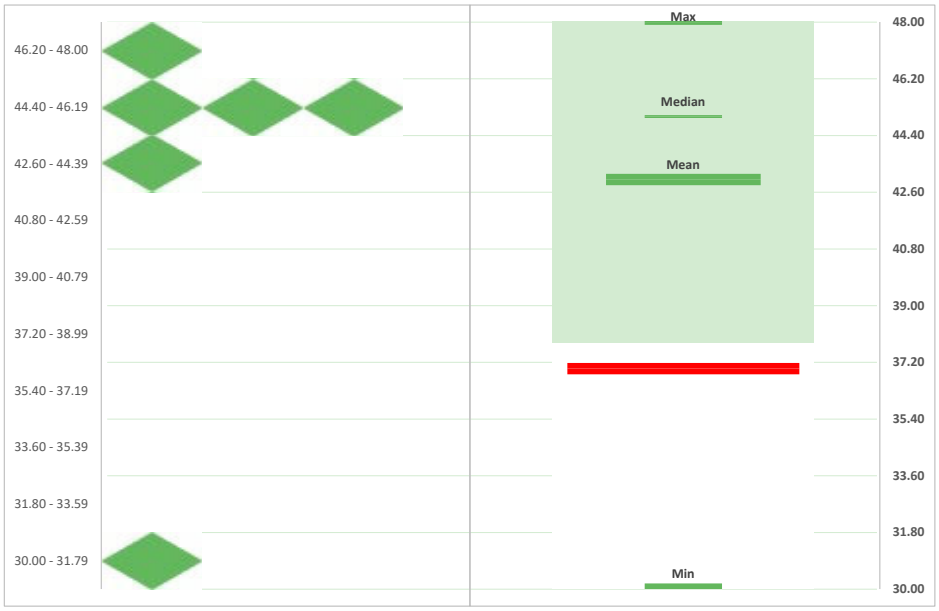
Denby Lane, Grange Moor

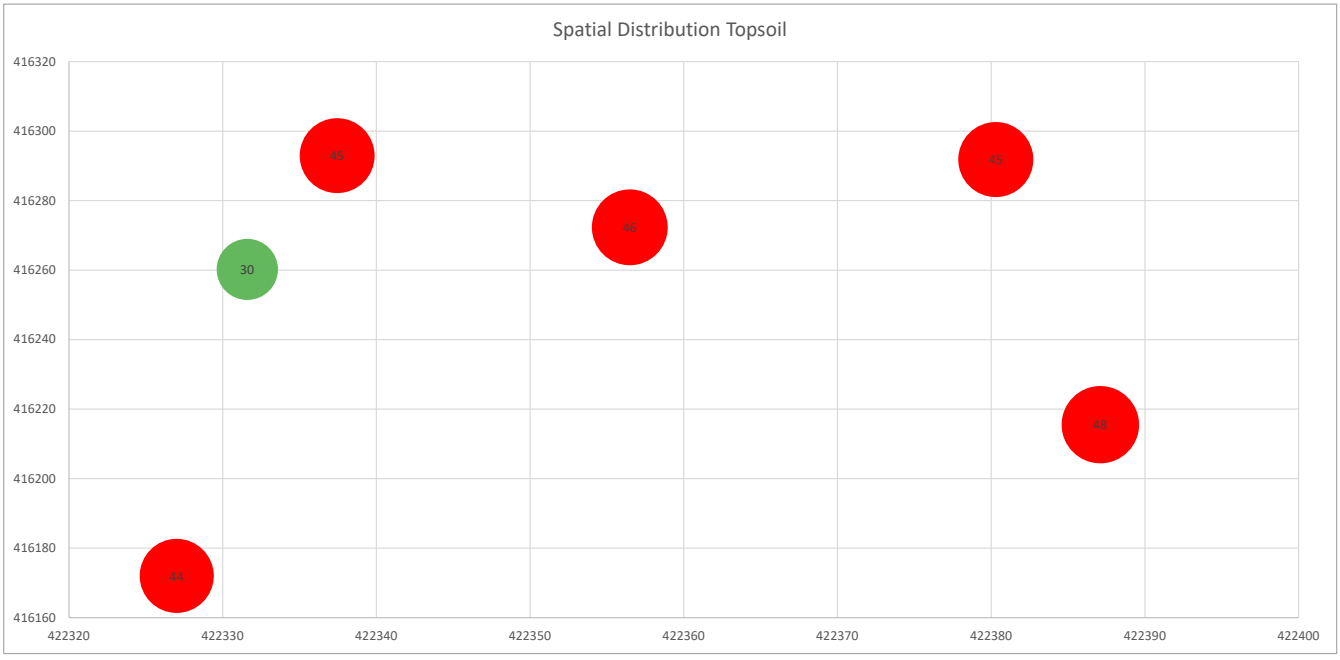
Job No: 4511
Engineer: CC
Date: 17 11 2022

Topsoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	37.00
No. samples	6.00
Max	48.00
Mean	43.00
Min	30.00
Median	45.00
Standard Deviation	6.51
Standard Error	2.66
T value	2.57
Upper Confidence Level (95%)	49.83
Upper Confidence Level (80%)	46.92
Lower Confidence Level (5%)	37.79
Transform data	Normal

Upper Confidence Level for chart	95%





Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Dot and Box Plot

Topsoil - 600mm Cover

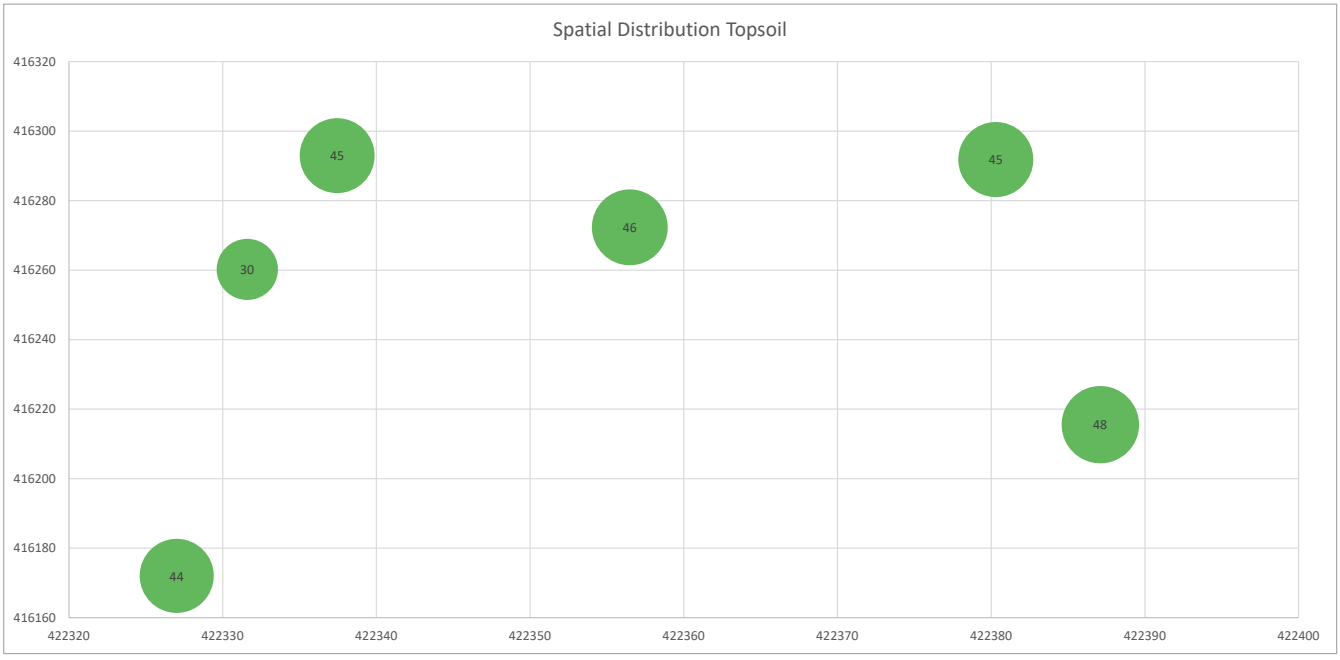
Denby Lane, Grange Moor

Job No: 4511
Engineer: CC
Date: 17 11 2022

Topsoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	185.00
No. samples	6.00
Max	48.00
Mean	43.00
Min	30.00
Median	45.00
Standard Deviation	6.51
Standard Error	2.66
T value	2.57
Upper Confidence Level (95%)	49.83
Upper Confidence Level (80%)	46.92
Lower Confidence Level (5%)	37.79
Transform data	Normal

Upper Confidence Level for chart	95%



Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Appendix L

Geotechnical Test Results

LABORATORY REPORT

4043

Contract Number: PSL22/6698

Report Date: 07 November 2022

Client's Reference: 4511

Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Charlotte Copley/Adam Gombocaz

Contract Title: Denby Lane, Grange Moor

Date Received: 18/10/2022
Date Commenced: 18/10/2022
Date Completed: 7/11/2022

Notes: Opinions and Interpretations are outside the UKAS Accreditation

Checked and Approved Signatories:

A Watkins (Director)	R Berriman (Quality Manager)	S Royle (Laboratory Manager)
L Knight (Assistant Laboratory Manager)	S Eyre (Senior Technician)	T Watkins (Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP01	2	D	1.00		Brown mottled grey slightly gravelly sandy CLAY.
TP02	2	D	0.60		Brown slightly gravelly sandy CLAY.
TP03	3	D	1.20		Brown mottled grey slightly gravelly sandy CLAY.
TP04	3	D	0.80		Brown sandy CLAY.
TP05	2	D	0.80		Brown gravelly sandy CLAY.
TP06	2	D	0.90		Brown mottled grey slightly gravelly sandy CLAY.
TP07	2	D	0.70		Brown mottled grey sandy CLAY.
TP08	2	D	0.70		Brown mottled grey slightly gravelly sandy CLAY.
TP12	6	D	2.70		Brown sandy CLAY.
TP09	4	B	2.80		Brown COLLIERY SPOIL.
TP12	3	D&B	1.30		Brown COLLIERY SPOIL.
TP13	5	D&B	3.00		Brown COLLIERY SPOIL.
TP14	3	D&B	1.10		Brown COLLIERY SPOIL.
TP15	3	D&B	1.50		Brown sandy very clayey GRAVEL.
TP17	2	D	1.40		Brown very gravelly sandy CLAY.
TP02	1	B	0.20		Brown TOPSOIL.
TP07	1	B	0.20		Brown TOPSOIL.
TP08	1	B	0.20		Brown TOPSOIL.

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP01	2	D	1.00		25			41	20	21	96	Intermediate Plasticity CI
TP02	2	D	0.60		26			53	25	28	93	High Plasticity CH
TP03	3	D	1.20		26			49	23	26	98	Intermediate Plasticity CI
TP04	3	D	0.80		22			47	24	23	100	Intermediate Plasticity CI
TP05	2	D	0.80		25			54	25	29	79	High Plasticity CH
TP06	2	D	0.90		21			50	24	26	97	High Plasticity CH
TP07	2	D	0.70		20			38	19	19	100	Intermediate Plasticity CI
TP08	2	D	0.70		25			40	22	18	98	Intermediate Plasticity CI
TP12	6	D	2.70		36			51	25	26	100	High Plasticity CH
TP09	4	B	2.80		15			41	23	18	30	Intermediate Plasticity CI
TP12	3	D&B	1.30		18			45	24	21	40	Intermediate Plasticity CI
TP13	5	D&B	3.00		19			52	25	27	41	High Plasticity CH
TP14	3	D&B	1.10		10			49	25	24	35	Intermediate Plasticity CI
TP15	3	D&B	1.50		12			43	21	22	33	Intermediate Plasticity CI
TP17	2	D	1.40		12			38	20	18	65	Intermediate Plasticity CI

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL Professional Soils Laboratory

Denby Lane, Grange Moor

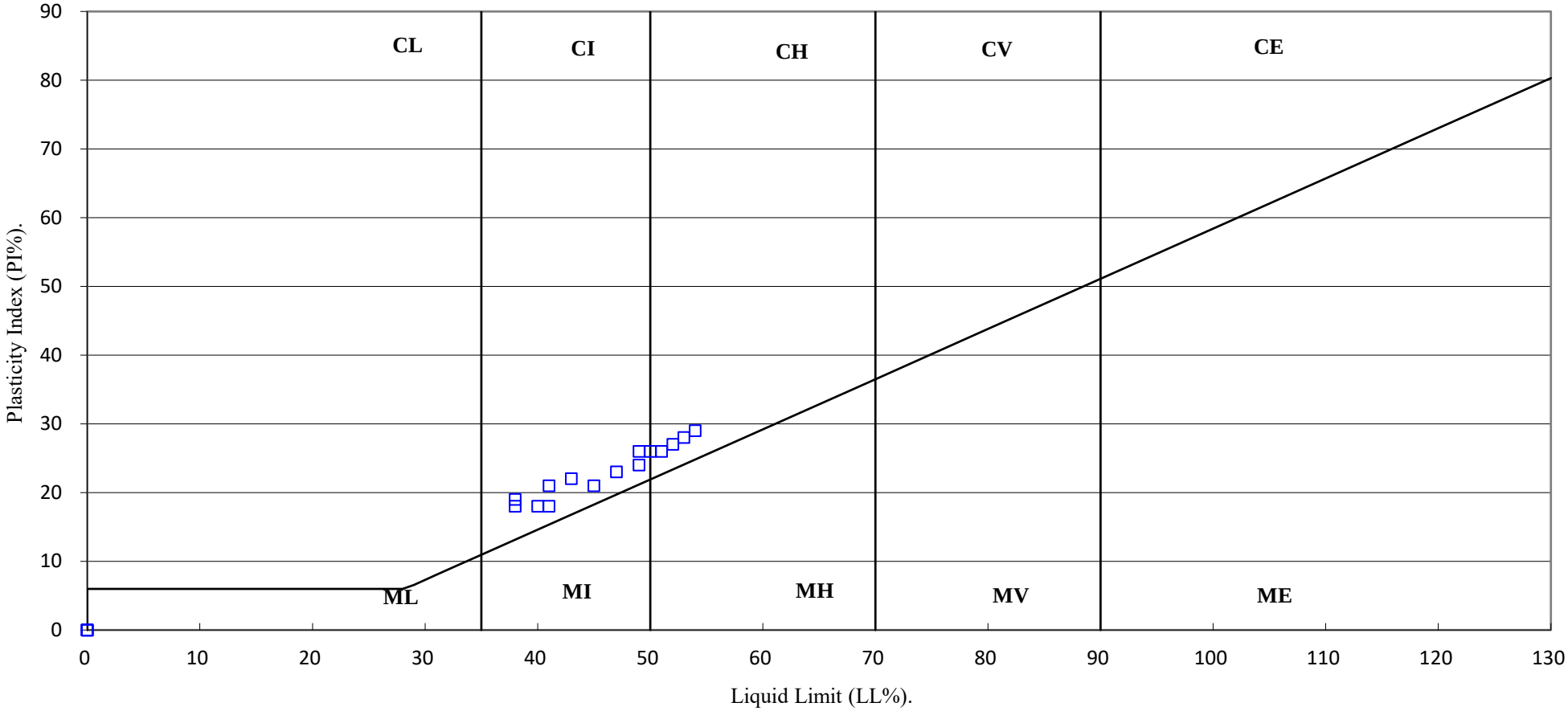
Contract No:

PSL22/6698

Client Ref:

4511

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Denby Lane, Grange Moor**	**Contract No:**
			PSL22/6698
			Client Ref:
			4511

PARTICLE SIZE DISTRIBUTION TEST

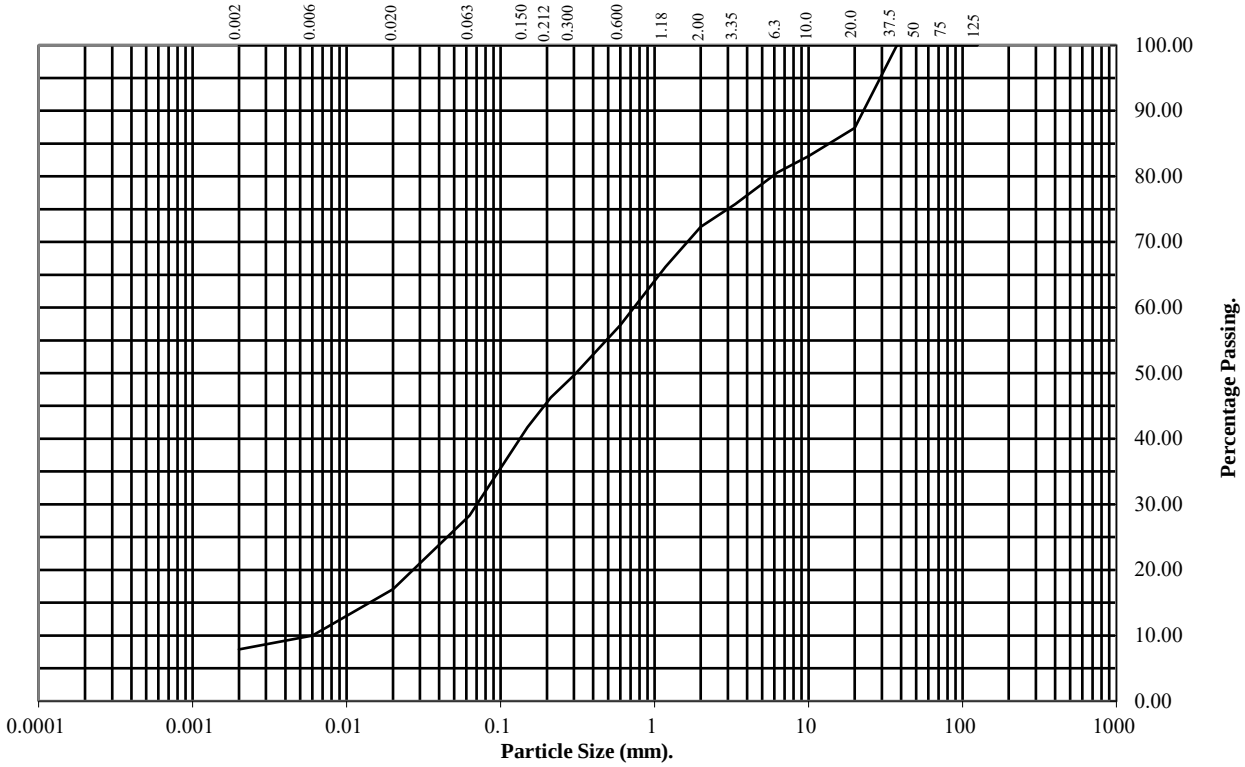
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP02** **Top Depth (m):** **0.20**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	87
10	83
6.3	81
3.35	76
2	72
1.18	66
0.6	57
0.3	50
0.212	46
0.15	42
0.063	28

Particle Diameter	Percentage Passing
0.02	17
0.006	10
0.002	8

Soil Fraction	Total Percentage
Cobbles	0
Gravel	28
Sand	44
Silt	20
Clay	8

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

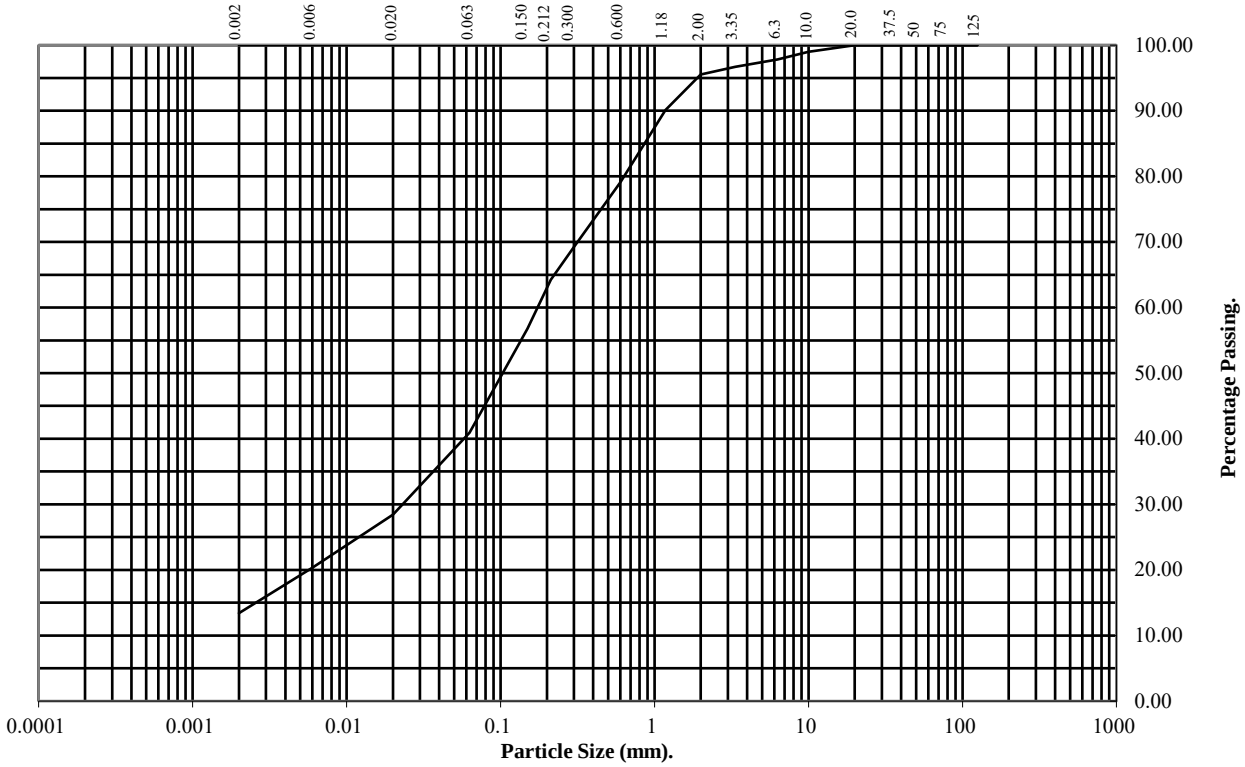
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP07** **Top Depth (m):** **0.20**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	99
6.3	98
3.35	97
2	96
1.18	90
0.6	79
0.3	69
0.212	64
0.15	57
0.063	41

Particle Diameter	Percentage Passing
0.02	28
0.006	20
0.002	13

Soil Fraction	Total Percentage
Cobbles	0
Gravel	4
Sand	55
Silt	28
Clay	13

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

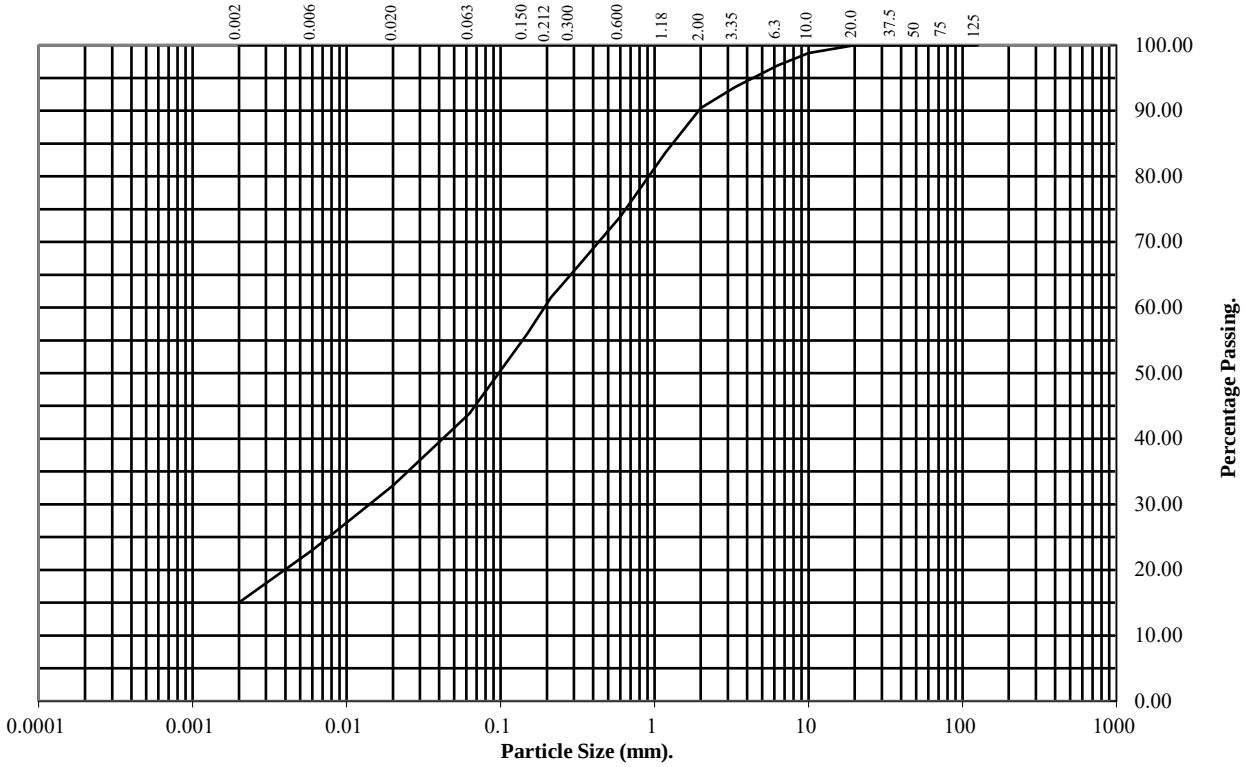
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP08** **Top Depth (m):** **0.20**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	99
6.3	97
3.35	94
2	90
1.18	84
0.6	74
0.3	66
0.212	62
0.15	56
0.063	44

Particle Diameter	Percentage Passing
0.02	33
0.006	23
0.002	15

Soil Fraction	Total Percentage
Cobbles	0
Gravel	10
Sand	46
Silt	29
Clay	15

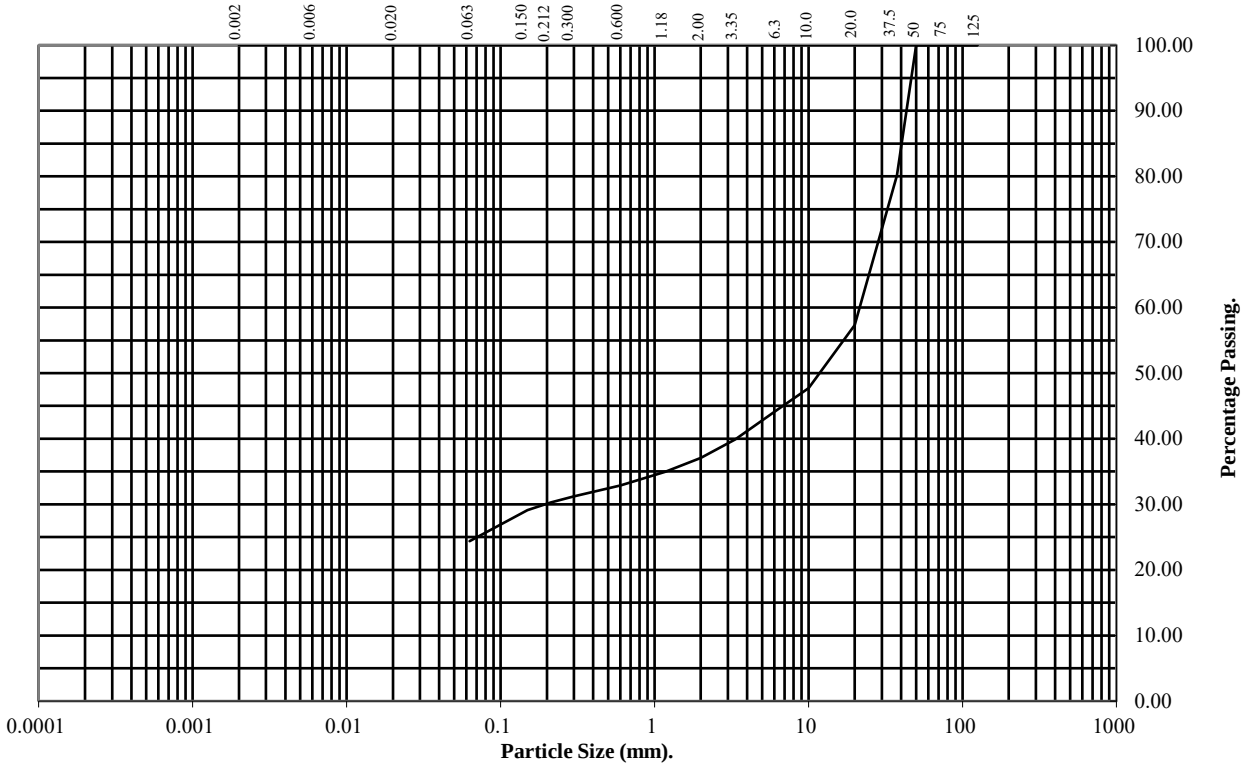
Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number:	**TP09**	**Top Depth (m):**	**2.80**
Sample Number:	**4**	**Base Depth(m):**	
Sample Type:	**B**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	80
20	57
10	48
6.3	44
3.35	40
2	37
1.18	35
0.6	33
0.3	31
0.212	30
0.15	29
0.063	24

Soil Fraction	Total Percentage
Cobbles	0
Gravel	63
Sand	13
Silt/Clay	24

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

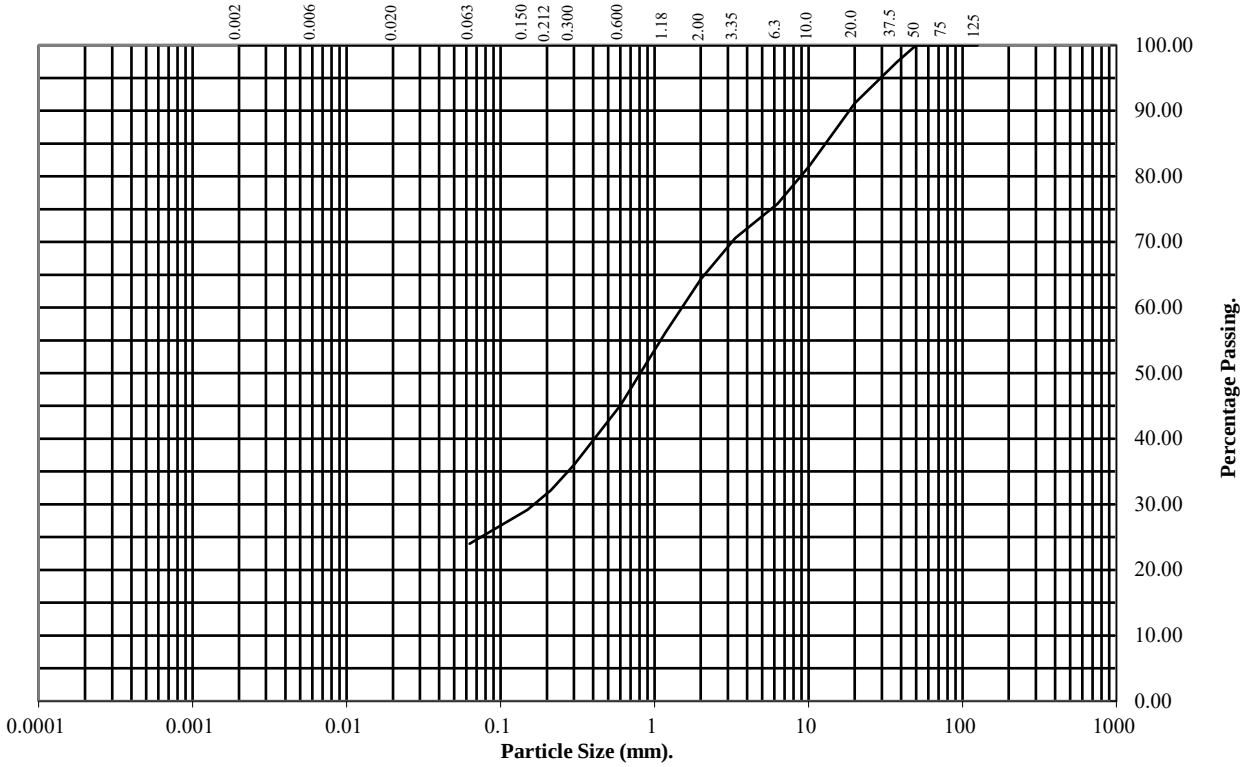
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP12** **Top Depth (m):** **1.30**

Sample Number: **3** **Base Depth(m):**

Sample Type: **D&B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	97
20	91
10	81
6.3	76
3.35	71
2	64
1.18	56
0.6	45
0.3	36
0.212	32
0.15	29
0.063	24

Soil Fraction	Total Percentage
Cobbles	0
Gravel	36
Sand	40
Silt/Clay	24

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

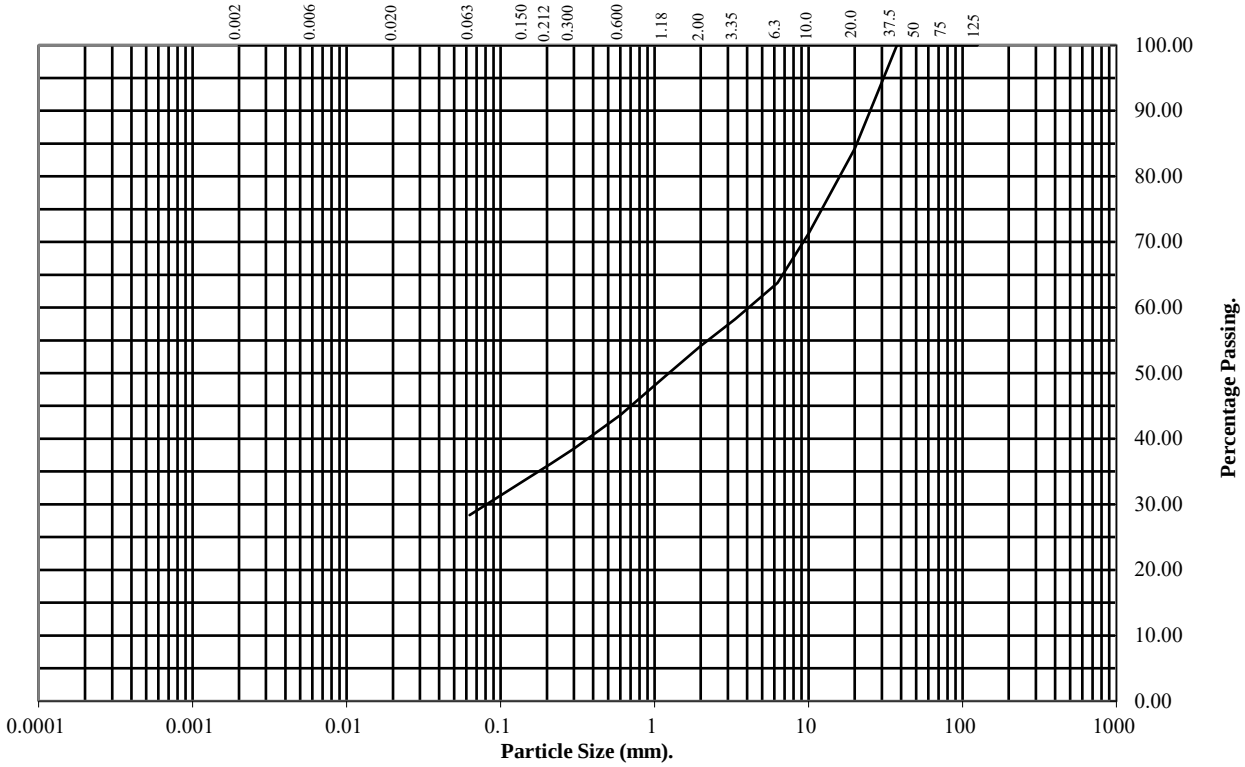
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP13** **Top Depth (m):** **3.00**

Sample Number: **5** **Base Depth(m):**

Sample Type: **D&B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	84
10	71
6.3	64
3.35	58
2	54
1.18	50
0.6	44
0.3	38
0.212	36
0.15	34
0.063	28

Soil Fraction	Total Percentage
Cobbles	0
Gravel	46
Sand	26
Silt/Clay	28

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

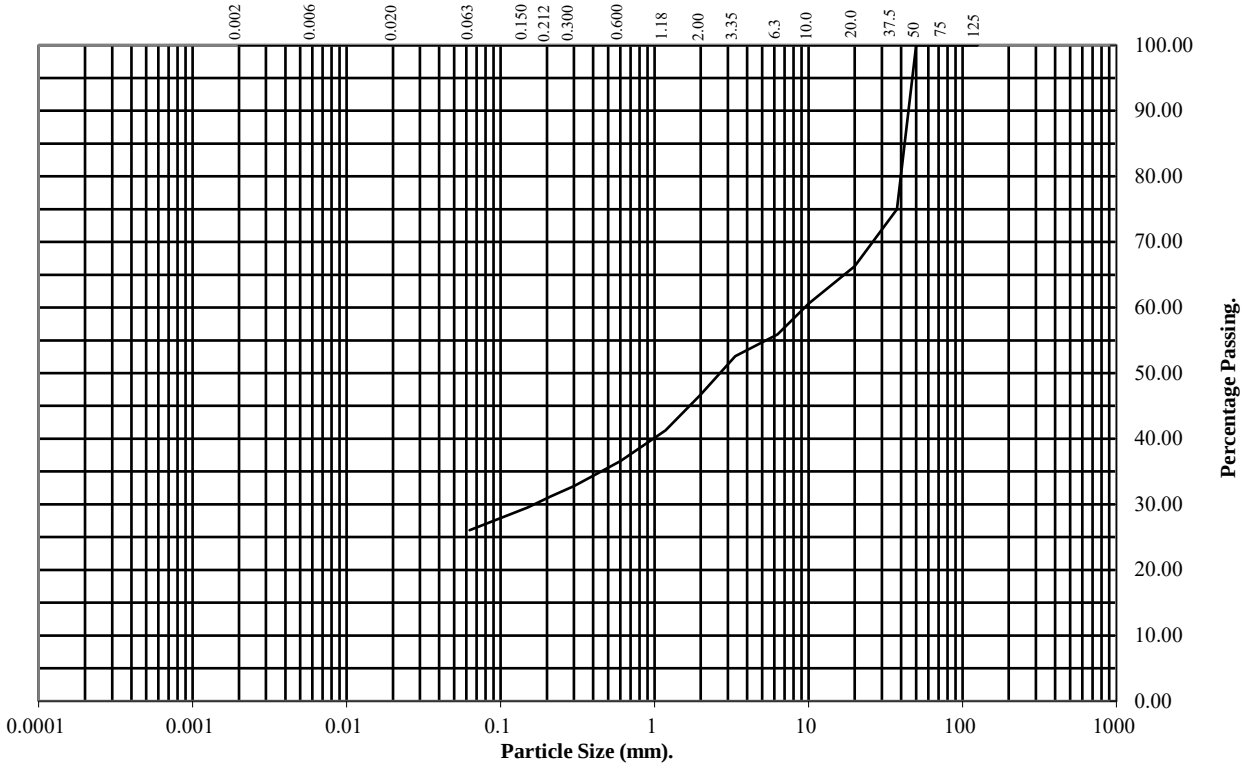
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP14** **Top Depth (m):** **1.10**

Sample Number: **3** **Base Depth(m):**

Sample Type: **D&B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	75
20	66
10	61
6.3	56
3.35	53
2	47
1.18	41
0.6	37
0.3	33
0.212	31
0.15	30
0.063	26

Soil Fraction	Total Percentage
Cobbles	0
Gravel	53
Sand	21
Silt/Clay	26

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

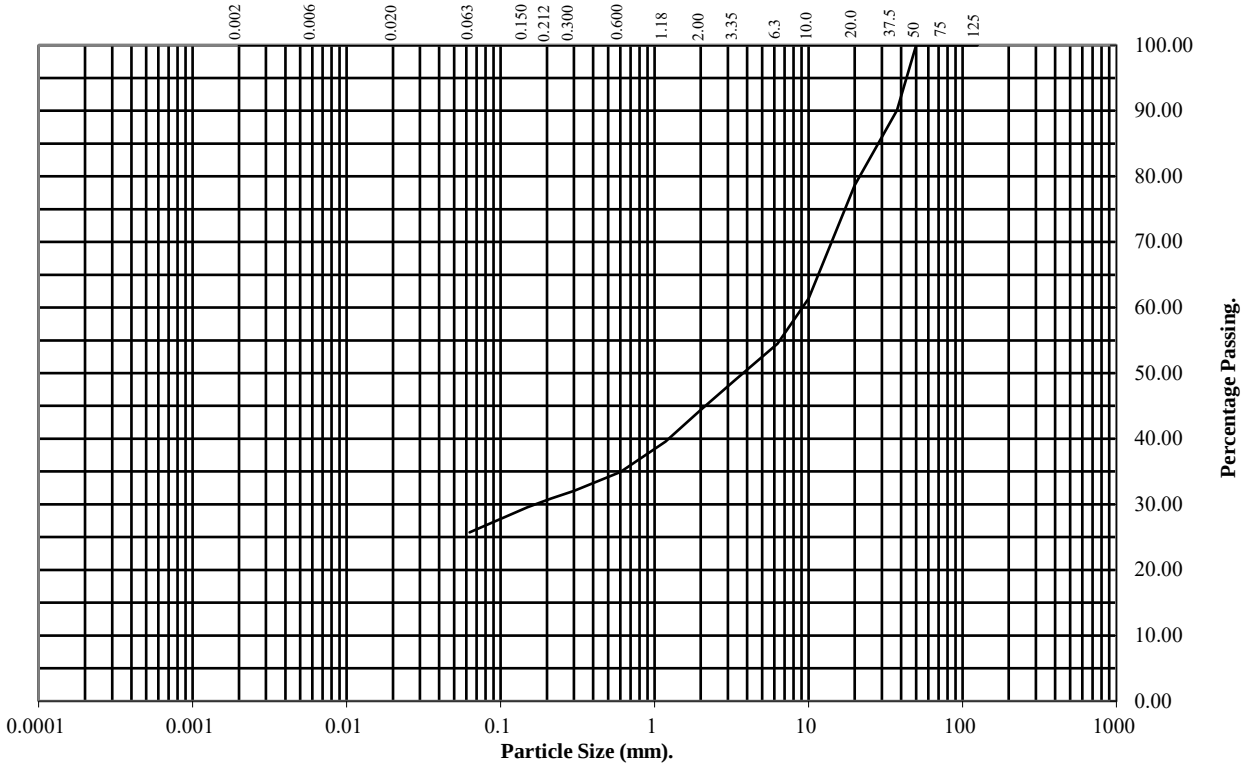
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP15** **Top Depth (m):** **1.50**

Sample Number: **3** **Base Depth(m):**

Sample Type: **D&B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	90
20	79
10	61
6.3	55
3.35	49
2	44
1.18	40
0.6	35
0.3	32
0.212	31
0.15	30
0.063	26

Soil Fraction	Total Percentage
Cobbles	0
Gravel	56
Sand	18
Silt/Clay	26

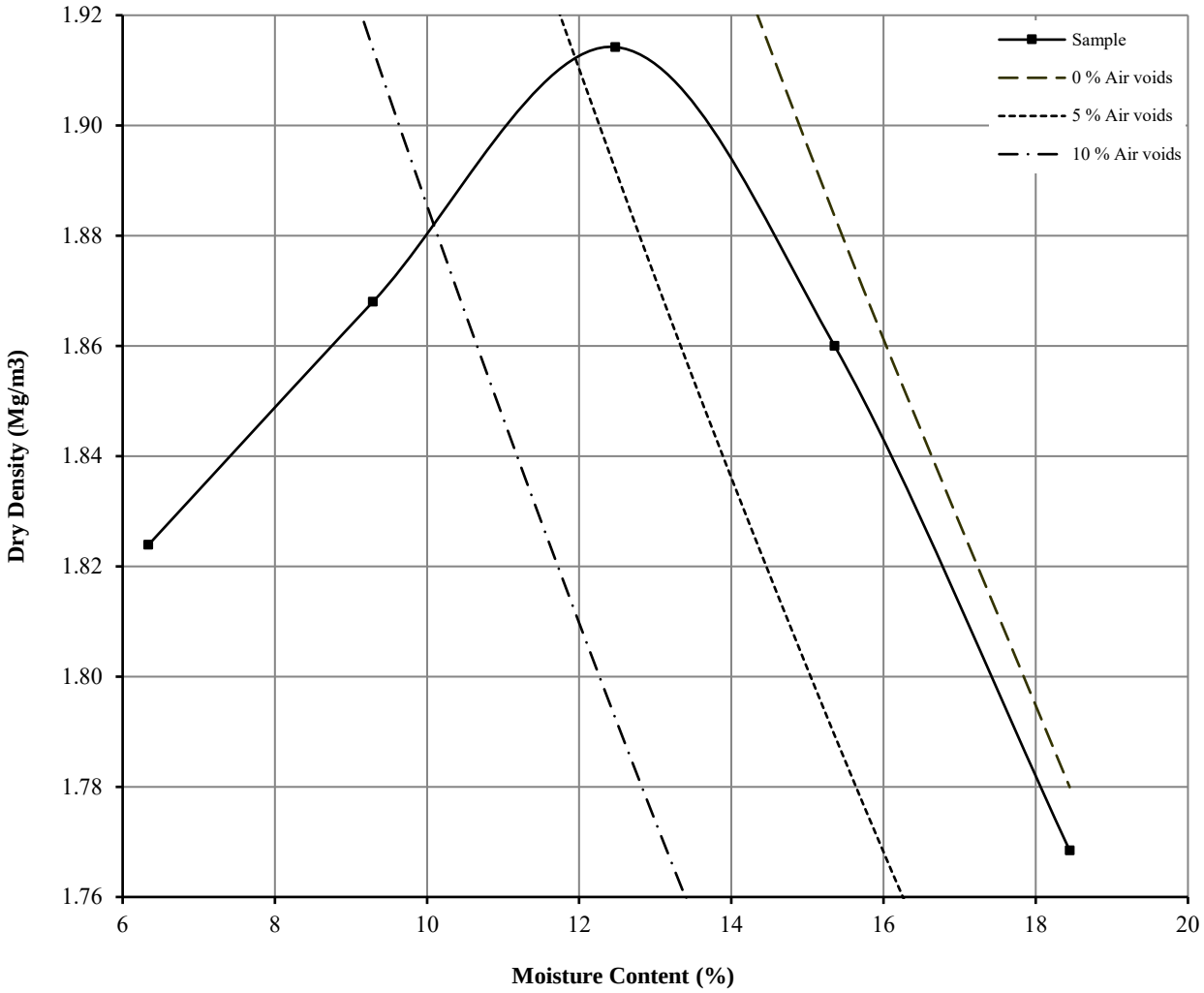
Remarks:

See Summary of Soil Descriptions

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

Non compliance with BS 1377 : Part 4 : Clause 3.6 : 1990

Hole Number:	**TP09**	**Top Depth (m) :**	**2.80**
Sample Number:	**4**	**Base Depth (m) :**	
Sample Type:	**B**		

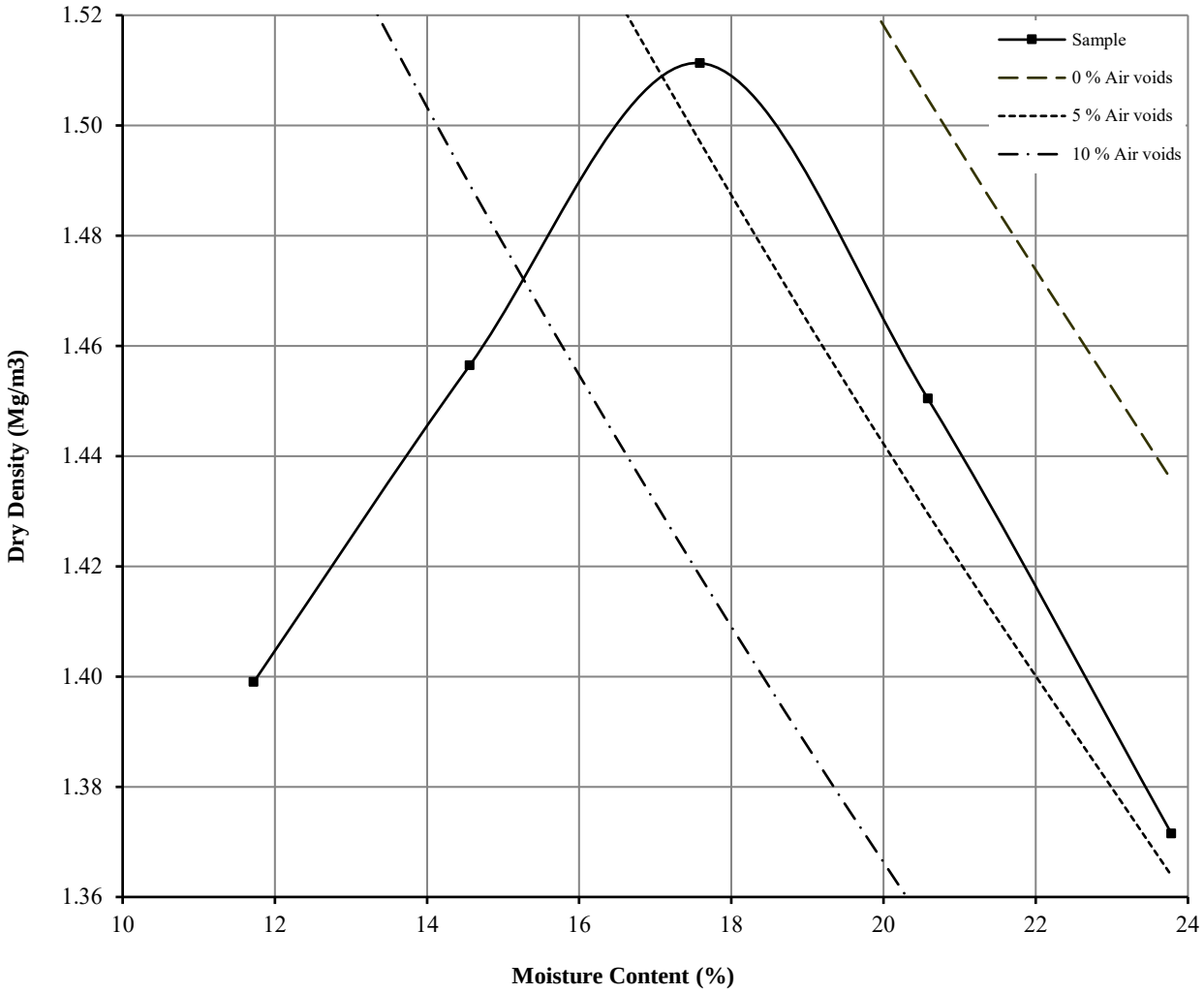


Initial Moisture Content:		15	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.65	Assumed	Material Retained on 37.5 mm Test Sieve (%):		20
Maximum Dry Density (Mg/m3):		1.91	Material Retained on 20.0 mm Test Sieve (%):		23
Optimum Moisture Content (%):		12			
Remarks See summary of soil descriptions					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.6 : 1990

Hole Number:	**TP12**	**Top Depth (m) :**	**1.30**
Sample Number:	**3**	**Base Depth (m) :**	
Sample Type:	**D&B**		



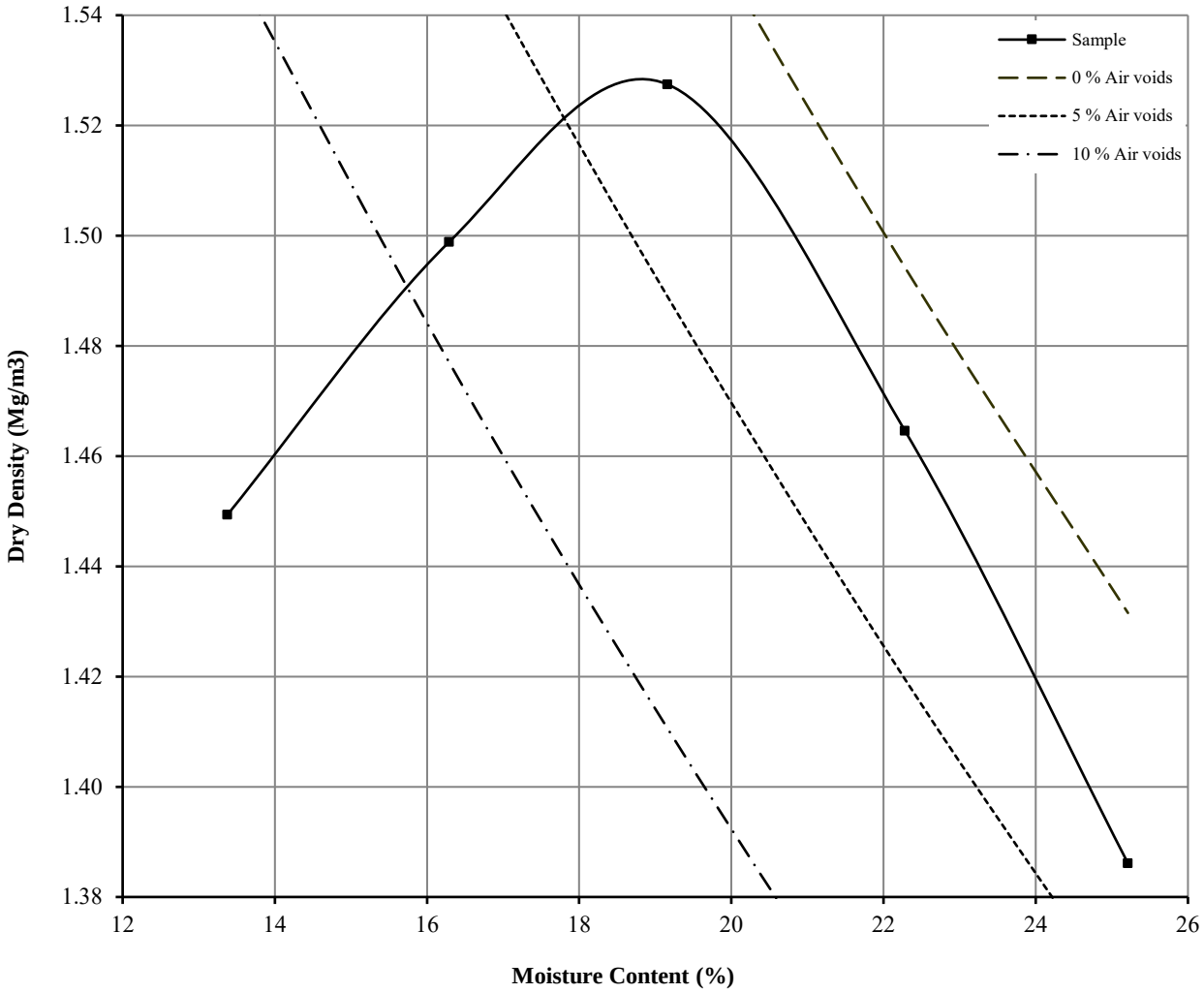
Initial Moisture Content:		18	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.18	Assumed	Material Retained on 37.5 mm Test Sieve (%):		3
Maximum Dry Density (Mg/m3):		1.51	Material Retained on 20.0 mm Test Sieve (%):		6
Optimum Moisture Content (%):		18			
Remarks See summary of soil descriptions					

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Denby Lane, Grange Moor**	**Contract** PSL22/6698 **Client Ref** 4511

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.6 : 1990

Hole Number:	**TP13**	**Top Depth (m) :**	**3.00**
Sample Number:	**5**	**Base Depth (m) :**	
Sample Type:	**D&B**		



Initial Moisture Content:		19	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.24	Assumed	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.53	Material Retained on 20.0 mm Test Sieve (%):		16
Optimum Moisture Content (%):		19			
Remarks See summary of soil descriptions					

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Denby Lane, Grange Moor**	**Contract** PSL22/6698 **Client Ref** 4511

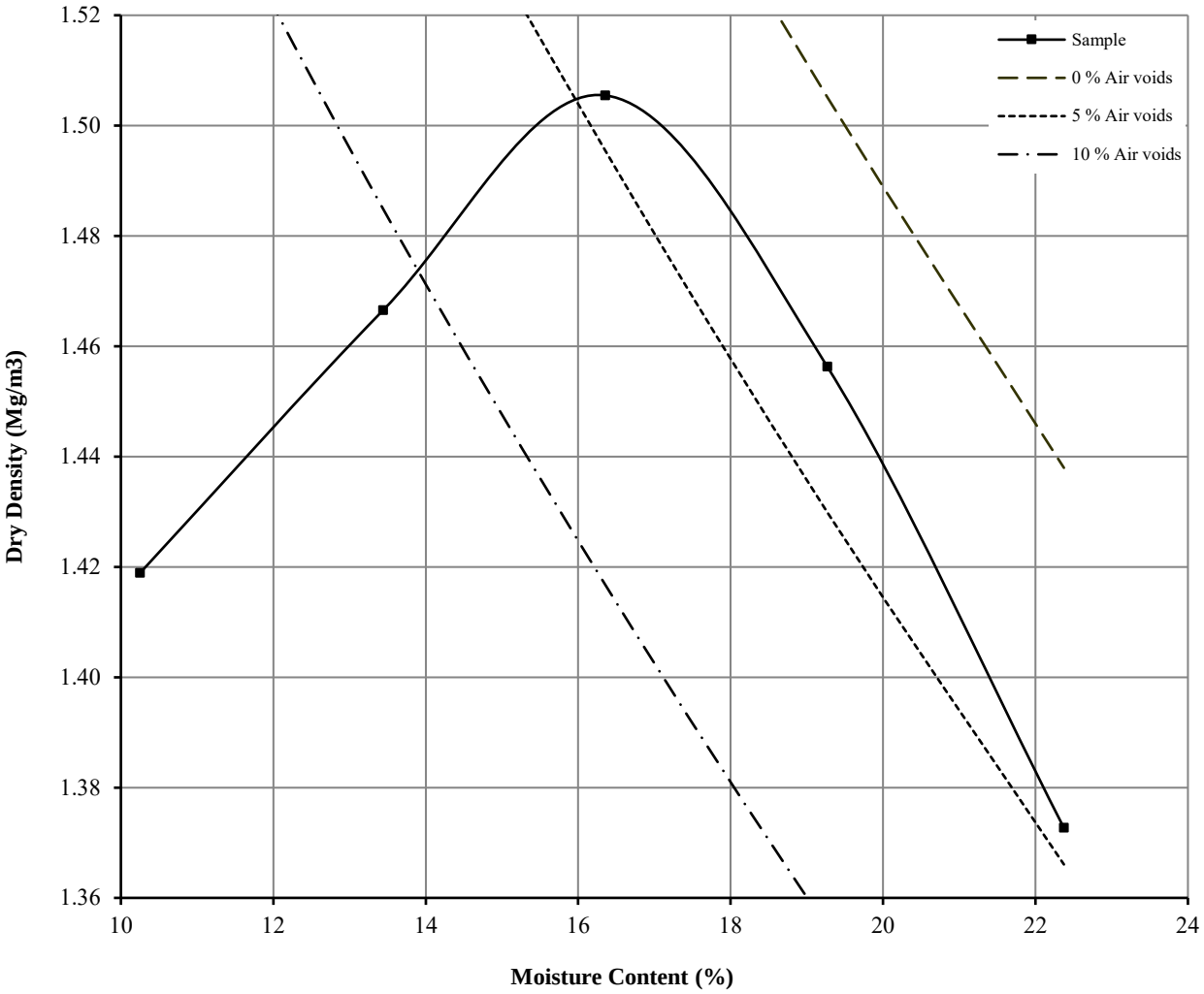
DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

Non compliance with BS 1377 : Part 4 : Clause 3.6 : 1990

Hole Number: TP14 **Top Depth (m) :** 1.10

Sample Number: 3 **Base Depth (m) :**

Sample Type: D&B

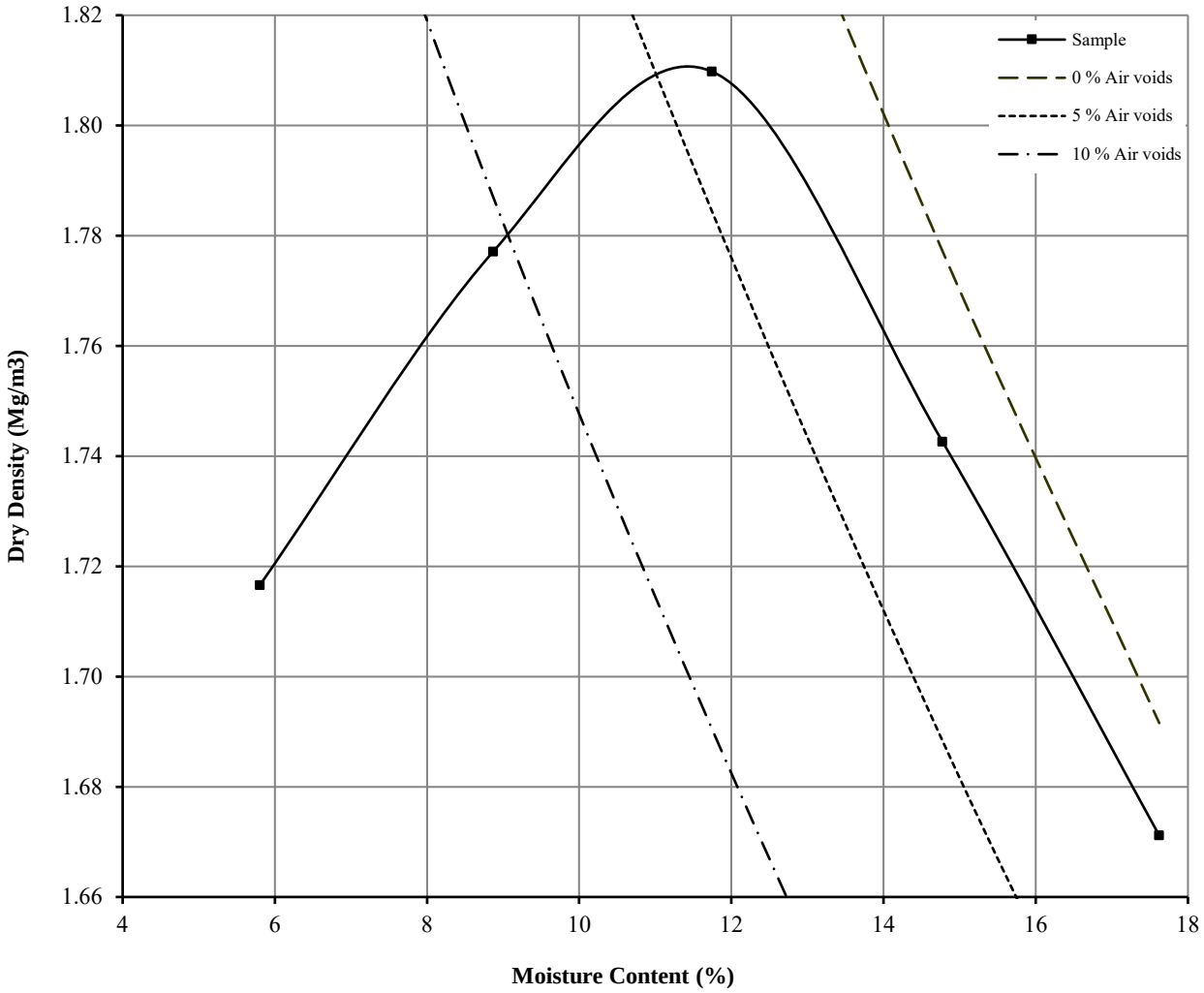


Initial Moisture Content:		10	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.12	Assumed	Material Retained on 37.5 mm Test Sieve (%):		25
Maximum Dry Density (Mg/m3):		1.51	Material Retained on 20.0 mm Test Sieve (%):		9
Optimum Moisture Content (%):		16			
Remarks See summary of soil descriptions					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.6 : 1990

Hole Number:	**TP15**	**Top Depth (m) :**	**1.50**
Sample Number:	**3**	**Base Depth (m) :**	
Sample Type:	**D&B**		



Initial Moisture Content:		12	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.41	Assumed	Material Retained on 37.5 mm Test Sieve (%):		10
Maximum Dry Density (Mg/m3):		1.81	Material Retained on 20.0 mm Test Sieve (%):		11
Optimum Moisture Content (%):		12			
Remarks See summary of soil descriptions					

Certificate of Analysis

Certificate Number 22-22519 *Issued:* 10-Nov-22

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 22-22519

Client Reference PSL22/6698

Order No (not supplied)

Contract Title Denby Lane, Grange Moor

Description 12 Soil samples.

Date Received 04-Nov-22

Date Started 04-Nov-22

Date Completed 10-Nov-22

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

2139

Summary of Chemical Analysis
Soil Samples

Our Ref 22-22519
Client Ref PSL22/6698
Contract Title Denby Lane, Grange Moor

			Lab No	2081037	2081038	2081039	2081040	2081041	2081042	2081043	2081044	2081045	2081046	2081047	2081048
			.Sample ID	TP01	TP02	TP03	TP04	TP05	TP06	TP07	TP08	TP12	TP11	TP14	TP19
			Depth	1.00	0.60	1.20	0.80	0.80	0.90	0.70	0.70	2.70	2.20	2.50	0.90
			Other ID												
			Sample Type	D	D	D	D	D	D	D	D	D	D	D	D
			Sampling Date	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**												
Inorganics															
pH	DETSC 2008#		pH	7.2	4.8	5.7	5.8	5.6	8.2	6.7	4.3	5.6	6.8	5.9	5.1
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	53	54	58	40	22	20	13	41	41	28	23	25

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 22-22519
Client Ref PSL22/6698
Contract Denby Lane, Grange Moor

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2081037	TP01 1.00 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081038	TP02 0.60 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081039	TP03 1.20 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081040	TP04 0.80 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081041	TP05 0.80 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081042	TP06 0.90 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081043	TP07 0.70 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081044	TP08 0.70 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081045	TP12 2.70 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081046	TP11 2.20 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081047	TP14 2.50 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	
2081048	TP19 0.90 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (30 days), pH + Conductivity (7 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Appendix M
Gas Monitoring Results

Visit 1											
Job Title:										**Job No:**	
Denby Lane, Grange Moor										**4511**	
Client:										**Sheet :**	
Yorkshire Country Properties										1 of 2	
Date:		**Arrival Time:**		**Depart Time:**		**Operator:**					
28/10/2022		09:00		10:50		Toby Tapp					

Gas Monitoring Results:

Ambient Concentration (% Volume):	**CH_4:**	ND	**CO_2:**	ND	**O_2:**	20.5	

Monitoring Point	**Groundwater level**	**Concentrations**					**Gas Flow Rates**			**Bottom of well**	**Remarks**
		Initial / Highest		**Steady concentrations**		**Lowest concn**	**Initial / Maximum**	**Steady**	**Time to fall from highest to steady**		
		CH_4	**CO_2**	**CH_4**	**CO_2**	**O_2**					
	(m) bgl	**% v/v**	**(%)**	**% v/v**	**(%)**	**(%)**	**litre/hr**	**litre/hr**	**secs**	**m**	
PH01a	ND	ND	3.4	ND	3.4	**14.8**	ND	ND	ND	5.64	
PH02	2.30	ND	0.1	ND	0.1	20.4	ND	ND	ND	2.78	Bailed 09:26 - 09:28 to 2.73m (2L). Remonitored at 10:18.
PH03	4.00	ND	ND	ND	ND	20.5	ND	ND	ND	7.24	Bailed 09:37 - 09:48 to 7.09m (15L). Remonitored at 10:23.
PH05a	3.25	ND	1.5	ND	1.5	18.7	ND	ND	ND	5.60	Bailed 10:08 - 10:15 to 5.22m (12L). Remonitored at 10:38.
PH07a	ND	ND	1.3	ND	1.3	18.7	ND	ND	ND	5.01	
PH08a	ND	ND	2.5	ND	2.5	16.8	ND	ND	ND	5.56	

Equipment Used:	**Next Calibration Date**
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	08/03/2023

Key	
ND	None Detected
NR	Not Recorded
1.0	Recorded value does not breach trigger levels
5.0	Recorded value breaches trigger level 1
10.0	Recorded value breaches trigger level 2

	Site Data:			**Weather Station Data (Kirkheaton Station)**							**CH_4**	**CO_2**	**O_2**
	Temp (°C):	15 to 16		**Barometric Pressure Trend:**			Falling then Rising						
Time:	09:13	09:58	10:44	01:00	07:00	09:15	10:00	10:45	12:45	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	982	982	982	995	991	992	993	993	996	Trigger level 2	5.0	10.0	10.0

Weather Conditions:	Moderate cloud / Moderate breeze	
Surface Ground Conditions:	Wet	

Remarks:

Visit 1 Bailed

Job Title:	Job No:
Denby Lane, Grange Moor	4511
Client:	Sheet :
Yorkshire Country Properties	2 of 2

Date:	Arrival Time:	Depart Time:	Operator:
28/10/2022	09:00	10:50	Toby Tapp

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.5

Monitoring Point	Groundwater level	Concentrations: Initial / Highest CH_4	Initial / Highest CO_2	Steady concentrations CH_4	Steady concentrations CO_2	Lowest concn O_2	Gas Flow Rates: Initial / Maximum	Steady	Time to fall from highest to steady	Bottom of well	Remarks
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01a	-	-	-	-	-	-	-	-	-	-	
PH02	2.69	ND	ND	ND	ND	20.5	ND	ND	ND	2.78	Bailed 09:26 - 09:28 to 2.73m (2L). Remonitored at 10:18.
PH03	6.82	ND	ND	ND	ND	20.5	33.3	ND	120.0	7.24	Bailed 09:37 - 09:48 to 7.09m (15L). Remonitored at 10:23.
PH05a	4.45	ND	0.4	ND	0.4	20.1	ND	ND	ND	5.60	Bailed 10:08 - 10:15 to 5.22m (12L). Remonitored at 10:38.
PH07a	-	-	-	-	-	-	-	-	-	-	
PH08a	-	-	-	-	-	-	-	-	-	-	

Equipment Used:

Gas Data GFM436 Infrared Gas Analyser
Geotechnical Instruments Dipmeter

Next Calibration Date

08/03/2023

Key

ND	None Detected
NR	Not Recorded
1.0	Recorded value does not breach trigger levels
5.0	Recorded value breaches trigger level 1
10.0	Recorded value breaches trigger level 2

	Site Data:			Weather Station Data (Kirkheaton Station)							CH_4	CO_2	O_2
	Temp (°C):	15 to 16		Barometric Pressure Trend:			Falling then Rising						
Time:	09:13	09:58	10:44	01:00	07:00	09:15	10:00	10:45	12:45	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	982	982	982	995	991	992	993	993	996	Trigger level 2	5.0	10.0	10.0

Weather Conditions:	Moderate cloud / Moderate breeze
Surface Ground Conditions:	Wet

Remarks:


RWO

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4 Park Place
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LS1 2RU
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