LITHOS

Geoenvironmental Appraisal

Land at Pit Lane, Wombwell

For Crest Nicholson Yorkshire

Report no: 4721/1

Date: September 2023

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	4721	**Site area/ha**	8.3 ha
Client:	Crest Nicholson Yorkshire	**NGR:**	SE 387 029
Site:	Pit Lane, Wombwell	**Nearest postcode:**	S73 8QD

The site is located off Pit Lane, Wombwell, approximately 5.4km southeast of Barnsley town centre, and currently comprises of two areas (Areas A & B) of arable farmland. The larger of the two (Area A) is divided into three fields by hedgerows, with the smaller Area B comprising a single field. Both areas have remained undeveloped throughout history.

Lithos were commissioned by Crest to provide a geoenvironmental appraisal of the site, which it is understood is to be redeveloped with housing. Lithos' investigation included a review of the site's history and environmental setting, and a ground investigation comprising 38 trial pits with soakaway testing in 4 pits, 12 deep mining investigation Probeholes and 14 shallow Probeholes with monitoring well installations.

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

Issue	Remarks
Made ground	None encountered.
Natural ground	Topsoil, typically 300mm thick, present across the entire site. Underlying soils comprises Cohesive Residual Soil (firm to stiff slightly sandy/gravelly Clay) underlain by Granular Residual Soil (clayey/sandy Gravel). Bedrock was encountered in all of the rotary Probeholes and the majority of trial pits from between 1.6m & 3.0m depth (average 2.3m) and predominantly comprises very weak Siltstone and medium strong Sandstone. A thin (up to 300mm thick), weathered coal was encountered in two trial pits from 0.5m depth and three probeholes from 1.8m depth in the north and east. Further 'flashes' of coal were recorded in PH10 at 3.0m & 29m depth.
Contamination	The majority of the existing Topsoil is considered suitable for re-use. However, a single elevated concentration of lead (1,100mg/kg) was recorded in one sample of Topsoil recovered from TP07. As such, it is recommended that additional testing is undertaken on a grid like pattern to delineate the lead contaminated Topsoil in the area of TP07.
Mining & quarrying	The Newhill Coal (0.3 to 0.8m thick) and the Swinton Pottery Coal (thin) are shown to outcrop through the centre and just beyond the eastern boundary of Area A respectively, both dipping to the northeast. No evidence shallow mineworkings (voids/broken ground) was encountered in any of the exploratory holes, with coal absent in the majority of holes (possibly due to localised washouts in the Newhill Coal).
Hazardous gas	Basic radon protection measures will be required for all new dwellings. Wells have been installed in 14 probeholes with monitoring underway to confirm the need for any additional protection measures (carbon dioxide and methane). A hazardous gas risk assessment will be issued on completion of monitoring (9 visits over 6 months) in March 2024
Preparatory works	Topsoil strip and stockpile for re-use. Site regrade with the possible requirement for retaining walls in locally steeply dipping areas.
Foundations	All plots at the site will be founded on traditional strip/trench-fill foundations in Cohesive or Granular Residual Soil, deepened where necessary due to tree influence including where it is proposed to remove existing hedgerows. However, foundations >2.5m depth are considered unlikely due to the shallow depth to bedrock.
Groundwater & excavations	Soakaway testing was carried out within 4 trial pits, all of which were unsuccessful with little or no infiltration over nearly 6 hours of monitoring. Consequently, soakaways will not provide a suitable means of surface water disposal at the site and therefore surface water balancing will be required.
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. Soakaways will not 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
Highways	Shallow Cohesive Residual Soils should provide a CBR value of at least 2%. Where natural soils are re-engineered as part of site re-grade works a CBR of at least 3% should be achievable. These values should be verified prior to, or during, construction

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

- Delineation of highly localised lead contamination.
- Overhead electric cables will require diversion or incorporation into the proposed layout.
- Some site regrade is likely to be required with the need for localised retaining walls and underbuild.

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APPENDICES

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02	Ground investigation fieldwork
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Drawing	Revision	Title
4721/1	-	Site location plan
4721/2	-	Proposed site layout
4721/3	-	Site features
4721/4	-	Site photographs
4721/5	-	Preliminary conceptual site model
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4721/6A	-	Monitoring Well Locations
4721/7	-	Revised conceptual site model
4721/8	-	Published geology and mining high risk areas
4721/9	-	CA Abandonment Plan (Meltonfield Coal)

Appendix C - Commission

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Appendix E - Search responses#

From	Date	Content
Landmark	27th June 2023	Environmental search data
Coal Authority	27th June 2023	Mining report
British Geological Society	1853	Shaft/borehole log

Appendix F & G - Exploratory records

Appendix F	SA01 to SA04 TP01 to TP34
Appendix G	PH01 to PH12 PH101 to PH114 (with monitoring well installations)

Appendix H - Soakaway Infiltration Calculations

Appendix I - Chemical test results

Appendix J - Contaminated land assessment for selection of water supply pipes

Appendix K - Geotechnical test results

Appendix L - Gas monitoring results

Some of this data is not included within the paper or PDF copies of this report but can be provided on request.

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 at
PIT LANE, WOMBWELL

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Crest Nicholson Yorkshire to carry out a geoenvironmental appraisal of land at Pit Lane, Wombwell.

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 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 38 trial pits with soakaway testing in 4 pits, 12 'deep' rotary openhole probeholes and 14 'shallow' probeholes with monitoring well installations.
- 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 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 Crest to obtain budget costs for: foundations; gas protection measures; and site preparatory works.

1.2 The proposed development

1.2.1 It is understood that consideration is being given to redevelopment of the site with traditional two storey domestic dwellings, associated gardens, POS, adoptable roads and sewers.

1.2.2 A sketch site layout showing 229 units has been provided by Crest Nicholson (Drawing reference SK01, dated April 2023) which is reproduced as Drawing 4721/2 in Appendix B to this report.

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 4721/1 presented in Appendix B to this report.

2.1.2 The site can be divided into two separate areas; **Area A,** to the east of an un-named tarmac surfaced track, which is to be redeveloped with housing and the smaller **Area B,** to the west of the track, which may be used for the construction of a drainage basin / attenuation pond.

2.1.3 Site details are summarised in the table below.

Detail	Remarks
Location	5.4km southeast of Barnsley town centre
NGR	SE 387 029
Approximate area	8.3 ha (20.5 acres) **Area A** – 7.4ha (18.3 acres) – proposed residential development **Area B** – 0.9ha (2.2 acres) – proposed drainage basin / attenuation pond
Known services	**Area A –** Underground sewer and overhead electric **Area B –** None

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on 7th July 2023.

2.2.2 **Area A** is divided into 3 fields by hedgerows and a drainage ditch with land sloping down to the west in the central and southern fields. The northern field slopes down to the south. Overhead electric cables cross the central and northern fields on timber poles.

2.2.3 **Area B** comprises a smaller, single field which is relatively flat lying.

2.2.4 At the time of the walkover, the fields were under crop which had subsequently been harvested prior to fieldwork commencing. Following a period of significant heavy rainfall, large areas of standing water were present in the northwest of **Area A** and northeast of **Area B**.

2.2.5 A possible spring was noted in the north of the central field within **Area A,** approximately halfway up the slope.

2.2.6 The fieldwork was undertaken at a time of heavy rainfall and surface water run-off was observed in Area A, flowing from the centre to the west out through the gateway on the un-named tarmac track, finally ponding within Area B.

2.2.7 Existing salient features, at the time of the walkover are presented on Drawing 4721/3 in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current access	**Area A** accessed off Pit Lane through a gap in the grassed bank in the northwest corner and through a gap in the hedgerow to the south from the un-named track. **Area B** accessed through a gap in the trees along the eastern boundary from the un-named track. The un-named track can be accessed from Pit Lane to the north and from Hough Lane to the south. However, locked gates prevent unauthorised access to the track from either end.
Topography	**Area A** – Undulating land that typically slopes down to the west at c. 1 in 14 (central and southern fields). The northernmost field slopes down to the southwest from Pit Lane at c 1 in 18, steeper in the far northwest corner at c. 1 in 8. **Area B** – relatively flat lying.
Approximate areas	**Area A:** 68,000m^2 cropped fields 6,000m^2 grass, trees and hedgerows around the perimeter and internal field boundaries **Area B:** 7,400m^2 cropped fields 1,700m^2 grass, trees and hedgerows around the perimeter
Nature of boundaries	**Area A:** North – overgrown grass banks and hedgerows East – garden fences, overgrown grass and hedgerows South – overgrown grass, hedgerows, garden fences and sporadic trees West – grass banks, hedgerows and sporadic trees **Area B:** North, east, south & west – Trees and hedgerows
Surrounding land uses	North – arable land and rough grassland beyond Pit Lane East – residential dwellings (Windmill Road and Windmill Court) South – playing fields and residential dwellings (Cowley Grn and Pashley Croft) West – unnamed tarmac surfaced track separating Areas A & B, with allotments, scrapyard, open fields, and railway line beyond.

2.2.8 A selection of site photographs is included on Drawing 4721/4.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1854 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	Area	Site	Surrounding land
1855	A	Three arable fields.	Summer Lane immediately north. Hough Lane c. 120m south
	B	Single arable field.	**Wombwell Main Colliery** recorded c. 50m north with associated shafts and infrastructure. A railway runs from the Colliery northwards.
1892	A	No significant changes.	Residential dwellings immediately northwest. Un-named track immediately west leading from Hough Lane to the Brick Yard (between Areas A & B). **Sand Pit, Brick Yard, Kilns** c. 60m northwest. Housing immediately south extending to Hough Lane. **Smithy** and **Gasometer** c. 75m northwest with **Coke Ovens** beyond. Reservoir c. 100m southeast. Football and cricket ground c. 100m south. **Old quarry** c. 300m east.
	B		A school labelled in the vicinity of Wombwell Main Colliery c. 50m north. Wombwell Main Colliery expanded. **Quarry** and two old quarries c. 150m to 200m west.
1903	A		Wombwell train station and residential dwellings covering the majority of the cricket ground c. 50m southeast.
	B		**Railway** directly west, running southeast to northwest.
1930	A		Allotments immediately west over the unnamed track. Residential dwellings immediately east. **Sewage Filter Beds** immediately northwest. Residential dwellings near Wombwell train station expanded west, football ground no longer labelled. Reservoir c. 100m southeast now disused. Miners' welfare recreation ground 100m southeast. **Wombwell Foundry** (iron & brass) c. 200m south. Reservoir and water cooler shown c. 240m northwest.
	B		Colliery c. 50m north expanded to include additional **shafts, tanks,** and **kilns.** **Old shaft** shown c. 100m west. Sludge Pits c. 130m north.
1962	A	**Overhead services** recorded west to northeast	Significant residential development immediately northeast and east. **Quarry** from c. 25m north. Ponds and roadways from c. 50m north. Significant residential development immediately c. 150m southwest. Scrap yard immediately west.
	B	No significant changes.	Drain labelled directly north. Quarry c. 150m to 200m west now disused.
1980	A		Housing immediately south no longer shown. Quarry from c. 25m north no longer shown.
	B		Wombwell Main Colliery, quarries, ponds, housing, and sewage filter beds no longer recorded to the northwest, area now comprises arable land. Drain labelled c. 30m north of Area B.

Date	Area	Site	Surrounding land
2000	A		New residential dwellings shown immediately south (Cowley Grn and Pashley Croft).
	B		Quarry c. 150m to 200m west now infilled.
2006	A		Further residential dwellings directly east (Windmill Court).
	B		No significant changes.
2023	A		Wombwell Foundry c. 200m south absent, now residential dwellings.
	B		No significant changes.

3.3 Internet research indicates the first two shafts at Wombwell Main Colliery were sunk from 1853 to the Barnsley Coal, later advanced to deeper seams with the addition of a third shaft to increase output from the mine. The colliery operated until closure in May 1969.

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 responses received from Landmark and 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 87) 1:10,000 BGS map (SE 30 SE) BGS shaft/borehole logs	**Drift soils** - None recorded. **Solid (bedrock)** - Pennine Middle Coal Measures (Mudstone with Sandstone bands) underlying area A, with Wooley Edge Rock (Sandstone) underlying Area B. **Shallowest coal seam** – **Newhill Coal** outcrops along the western boundary and the **Swinton Pottery Coal** outcrops close to northern boundary of Area A. No shallow coal beneath Area B. **Strata dip** - 5 degrees to the northeast. **Faults** - None within 250m. Published geology and mining features are shown on Drawing 4721/8.
Mining	Coal Authority	Further details in Section 5 below.
Quarrying	Historical OS plans	Closest recorded adjacent to Wombwell Main Colliery, c. 50m north, between 1962 and 1980. Quarry recorded c. 150m west between 1892 and 1962. 'Old quarries' recorded 25m north, 150m west and 300m east.
Radon	Envirocheck report Environment Agency electronic open data via QGIS UK Health Security Agency	The site lies in an area where between 3% and 5% of homes are estimated to be above the action level. Further details in Section 13.5.
Hydrogeology		**Groundwater Source Protection Zone** - No. **Aquifer** - Secondary A (Solid). No drift recorded. **Groundwater abstractions** - None within 1km. **Groundwater vulnerability** - high. **Pollution incidents** - None of significance.
Hydrology		**Water quality -** The site lies within the 'Dove from Source to River Dearne' Water Body which has a moderate ecological status and a failed chemical status. **Nearest watercourse(s)** - Unnamed drain located directly north of Area B. Drainage ditch separating northern and central fields in Area A. **Pollution incidents** - None of significance. **Abstractions** - None of significance. **Discharge consents** - None of significance.
Flood risk		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 Known or suspected areas of landfill in the vicinity of the proposed development site are summarised below:

Location	NGR (proximity to site)	Remarks	Source of data
Quarry Tip	SE 318 026 (170m west of Area B)	Waste type: Household First input: 31/12/1953 Last input: 31/07/1971 Current land use: Wombwell Wood Operated by: Wombwell Urban District Council	EA electronic open data via QGIS*

* QGIS is an Open Source Geographic Information System.

4.2.2 The above landfill appears to have been taken over by Edgar Allen Balfour Steels Ltd in the 1970s and renamed as 'Former Quarry'. Dates of operation are unknown although the site is recorded to have accepted household waste with the permit surrendered in 1995.

4.2.3 The layout provided by Crest suggests no residential dwellings are to be located within Area B; the closest proposed plots (Area A) lie greater than 250m from the infilled land.

4.2.4 As such, significant gas generation and migration from waste within the landfill is considered unlikely to affect any of the proposed plots based on the current layout.

4.3 Agriculture

4.3.1 Historical plans show that the site has comprised 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
Equipment maintenance	Hydrocarbons, metals
Waste burial, land levelling, backfilling ponds/quarries	Methane, metals, PAH etc
Naturally occurring contaminants	Arsenic, metals

4.3.2 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.

4.3.3 The generation of ground gas from previous farming activities 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 COAL & MINING

5.1 General

5.1.1 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 9.6 & 15.2) provides the necessary mining risk assessment required by the proposed planning application.

5.1.1 Coal has been mined in Yorkshire for centuries, and there are also likely to be unrecorded mineworkings which pre-date the requirement for abandonment plans (Coal Mines Regulation Act of 1872). Early mining methods included drifts or adits from outcrop. Where mining extended further from the crop, bell pits were often sunk, and as the coal got deeper still, shafts were used to access gallery workings (pillar & stall).

5.1.2 The shafts associated with bell pits are typically only about 1.2m in diameter, and the bell pit itself was typically 5m to 10m in diameter (bell pit size would have been constrained by roof stability). Consequently, bell pits are often closely spaced; the most intensive concentration of shafts recorded to date (66 per acre) was at the Middleton Broom Opencast site.

5.1.3 As coal was removed during bell pitting, the unsupported strata above assumed an inverted slope of stability, generating a bee-hive shape around the base of the shaft which forms the characteristic vertical section. The depth limit of bell pit mining is almost certainly 15m, and this is considered a deep bell pit; the vast majority were probably less than half this depth.

5.1.4 At greater depths, pillar and stall workings appear to have been the preferred method, and such workings were often accessed via a single shaft. Consequently, shafts associated with such workings are more widely spaced; but rarely exceeded one quarter of a mile (400m) shaft to shaft, due to problems with ventilation and underground haulage. It was customary to view the life expectancy of an individual pit as about three to five years and at any one time several new pits would be sinking to replace those currently operating.

5.1.5 Up until the last decades of the eighteenth century, coal mining almost always represented a short-term interruption to ongoing use of land for agricultural purposes. The right to sink shafts and extract coal was usually conditional upon restoration of the surface after coal extraction was complete. This not only involved filling the shaft, but also required that any subsequent settlement of shaft fill material did not result in depressions in the field surface. Consequently, it was usual to fill the shaft and heap excess arisings into a dome over the shaft eye. Over subsequent years, the dome supplied material to compensate for settlement of the shaft fill. In the normal course of events, at the conclusion of the recovery period, any remaining spoil accumulations above ground level would have been planed-off to leave a relatively stable, level surface where the shaft had been.

5.2 Geology & coal

5.2.1 Geological maps from the BGS suggest that two coal seams underlie Area A at shallow depth. These are the:

- Swinton Pottery Coal, a 'thin' seam, outcropping on/beyond the eastern boundary of Area A.
- Newhill Coal (about 0.3m to 0.76m thick) outcropping along the western boundary of Area A.

5.2.2 The Meltonfield (or Wath Wood) Coal is shown to lie c. 45m below the Newhill seam, separated by 40m of Woolley Edge Rock (sandstone). A BGS borehole (Ref. SE30SE7/B) located c. 150m northwest of Area B recorded the Meltonfield (or Wath Wood) at c. 41.5m depth with a thickness of c. 1.1m.

5.2.3 The Consultants Mining report from the Coal Authority suggests that the Newhill Coal outcrops on site, shown in the centre south (between 30m and 100m from the BGS recorded outcrop) and extending c. 150m into the site.

5.2.4 Given dip and topography, the Newhill Coal is expected to underlie the majority of Area A at shallow depth (based on the BGS recorded outcrop).

5.2.5 The area in the centre south where the CA record the Newhill Coal outcrop is shown to lie within a **High Risk** Development Area - areas with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.

5.2.6 Approximate coal outcrops from both the BGS maps and the Coal Authority, together with areas of High Risk are shown on Drawing 4721/8. It should be noted that seam outcrops plotted on geological maps have been known to be inaccurate by distances in excess of 100m.

5.2.7 A CA mining report states that:

- There are recorded workings beneath **Area A** in 13 seams, the shallowest, at around 66m depth, being the Two Foot Coal with an extraction thickness of 1.7m, last worked in 1950.
- There are no known shallow workings.
- There **are** spine roadways recorded at shallow depth (within 30m) within the site boundary.
- There are no recorded mine entries within 100m of the site boundary.
- One coal seam (Newhill) outcrops through the centre of the central and southern fields of Area A (*this is in a different location to that shown on BGS plans which places the Newhill coal outcrop in the south of Area A*).
- There are no geological faults, fissures or breaklines.
- There are no opencast mines within 500m of the site boundary.
- There are no CA managed tips within 500m of the site boundary.
- The CA has not received a damage notice for the site, or any property within 50m, since October 1994.
- There are four recorded mines gas emissions within 500m of the site's boundary. The closest of which is 246m to the north-west.
- The site is not in an area where an entitlement to withdraw support has been given.
- There is no coal mining licensing within 200m of the site boundary.

5.2.8 The mining reports suggests there are no known shallow workings (i.e. at less than 30m depth). However, it should be noted that it did not become a statutory requirement to maintain and preserve plans of abandoned mines until the Mine (Coal) Regulations Act of 1872 and consequently there may be mineworkings beneath the site for which the Coal Authority have no records.

5.2.9 There are several mine entries recorded c. 100m to 200m west/northwest of the site. Whilst none of these shafts are recorded as being 'close' to the site, it is worth noting that CA shaft positions are often only approximate. 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.

5.2.10 A spine roadway at <30m depth is recorded beneath the site. Liaison with the Coal Authority suggests that this is associated with the Meltonfield Coal and is shown on CA abandonment plan reference NE185 which is copied as Drawing 4721/9 in Appendix B to this report.

5.2.11 Review of the plan shows that there are no workings in the Meltonfield Coal beneath the site associated with the spine roadways, 3 of which run beneath the northwest of the site. It is possible that the coal was not worked due to excessive groundwater requiring extensive pumping.

5.2.12 However, roadways are typically of greater height than the associated coal seam, and could easily be in the order of 2m high. These could remain open for many years and as such could present a risk to surface stability if at shallow depth.

5.2.13 Overlaying the abandonment plan on the topographic survey shows the spine roadways to lie at least 50m below existing ground level, which based on a depth to rockhead of less than 3m (see Section 9.2) would provide a sufficient thickness of competent cover.

5.2.14 The depth of cover decreases to the north of the site where the Meltonfield coal is shallower and topography falls to less than 68m AOD, it is therefore considered that where the CA mining report refers to the Spine Roadway at <30m depth, this is located to the north beyond the site boundary.

5.3 Mining risks

Mining risks – Summary

5.3.1 The table below summarises the potential risks associated with coal mining legacy for the proposed development site, identified from list sources of information.

Coal mining issue	Yes	No	Risk assessment
Coal outcrop(s)	X		Newhill Coal outcropping in the west (or centre) of Area A which could be a potential combustion risk
Coal mining geology (fissures)		X	-
Record of past mine gas emissions or potential	X		Mines gas remedial works recorded from c. 100m west/northwest (shafts) with potential for gas migration from deep underground workings
Mine entries (shafts and adits)	X		Possible unrecorded bell pits
Underground coal mining (**recorded** at shallow depths)		X	-
Underground coal mining (**probable** at shallow depths)	X		Possible unrecorded workings in the Newhill Coal
Surface mining (opencast workings)		X	-
Recorded coal mining surface hazard		X	-
Spine roadways at shallow depth (<30m)		X	Spine roadway typically >50m depth beneath the site, likely <30m depth to the north

5.3.2 For those issues identified as "yes" a more detailed discussion and assessment of the risks, both individually and cumulatively, to the application site and the proposed development is provided below.

5.3.3 Risks include:

- Mines gas
- Combustion
- Unrecorded mine entries
- Collapse of shallow mineworkings, with consequent subsidence affecting surface stability

5.3.4 Current UK guidance, CIRIA C758D[1], provides information and guidance for engineers and geologists with respect to the design of: mining investigations; foundations; and remedial measures.

[1] *CIRIA C758D:2019. Abandoned mine workings manual*

Mining risks – gas

5.3.5 Gas monitoring and a hazardous gas risk assessment will be required (see Section 13).

5.3.6 The CA mining report states that "the site is within an area of previous interest. It is close to where the Coal Authority has investigated and subsequently remediated the effects of mine or ground gas emissions following specific reported hazards".

5.3.7 However, further liaison with the Coal Authority has confirmed that the site is not known to be affected by mines gas (see correspondence dated 27th September 2023 in Appendix E).

Mining risks – combustion

5.3.8 Where coal is exposed during any site preparatory earthworks, or within excavations (likely near outcrop), care should be taken to avoid the potential for spontaneous coal combustion.

5.3.9 If any foundation excavation comes 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 mass concrete fill placed as soon as possible after exposing the seam to prevent the ingress of air.

5.3.10 Any ground investigation and/or drilling for grouting purposes should be carried out to HSE and Coal Authority guidelines to minimise the risk of coal combustion and potential for migration of mine gases into neighbouring properties.

Mining risks – mine entries

5.3.11 The Coal Authority indicates there are no recorded mine entries on site.

5.3.12 However, it is possible that unrecorded "shallow" shafts (possibly bell pits) are present (particularly immediately down dip of outcrop of the coal seams), and consideration could be given to a geophysical survey. The success of geophysics would be dependent on the "contrast" between shaft backfill and the surrounding ground (i.e. the survey is likely to be more successful if shaft backfill is significantly different material or less dense than the surrounding ground). Follow-up intrusive investigation (pitting) would be recommended to determine the cause of any anomalies identified by the geophysics.

5.3.13 A topsoil strip will be required prior to construction and the exposed surface should be carefully inspected for evidence of unrecorded mine entries.

5.3.14 The Coal Authority discourage development over, or adjacent to, shafts. However, such features are typically of less concern where they only extend to relatively shallow seams. The recommended no build zone around deep shafts is usually defined by a line drawn up at 45° from the top of the shaft, where it intercepts rock head.

5.3.15 Once located, each shaft should be accurately positioned by survey to provide grid co-ordinates, proved to its base, pressure grouted and then be capped off at rockhead level.

5.3.16 Detailed cap design is beyond the scope of this report but should also include gas venting measures.

5.3.17 The shaft cap should be designed to support the depth of fill above plus any surcharge loads. The cap should be a least twice the internal diameter of the shaft and be designed by a competent structural engineer.

5.3.18 At all shaft locations bedrock is likely to lie within 3m of ground level. Consequently, these shafts should be capped at or below rockhead.

Mining risks – shallow underground mineworkings

5.3.19 The Coal Authority has records of **known** mineworkings beneath the site although these lie at depth (>60m) and are therefore unlikely to affect surface stability.

5.3.20 Spine roadways associated with the Meltonfield Coal recorded in the CA mining report at shallow depth are anticipated to lie at depths from at least 50m beneath the site.

5.3.21 **Unrecorded** mineworkings in the Newhill Coal may be present beneath the majority of Area A (based on the location of outcrop shown on BGS plans) or the east of Area A (based on the outcrop shown on the CA mining report, which could affect surface stability. Coal extraction is likely to have occurred via bell pits and/or pillar and stall methods and, if present, these could result in unpredictable subsidence.

5.3.22 Individual pillars may collapse at any time, leading to settlement in the overlying strata. As the mine roof degrades and collapse the void migrates upwards, sometimes causing a surface collapse or crown hole.

5.3.23 The vertical distance through which a void can migrate is difficult to assess. Made ground and superficial deposits are considered to have no inherent strength and the assumption is generally made that if a void reaches the base of these formations, it will reach the surface.

5.3.24 CIRIA C758D[2] notes that given the limited evidence of structural damage caused by pillar failure, compared with that resulting from roof collapses, engineering assessment of the potential for surface instability has focused on the latter. Failure of roof strata results in the progressive transmission of the void upwards through overlying rock. The extent of 'void migration' can be influenced by factors such as: strata dip; bulking characteristics of the collapsed rock or soil; capability for arching of the collapsed zone; groundwater flow and the presence of strong and intact rock layers with the ability to span that may attenuate the upward movement.

5.3.25 The limit height on the void migration, where no appreciable surface subsidence results, is often termed 'acceptable cover', with its determination based upon a criterion reflecting the worked thickness of the seam and the rock cover. The acceptable cover criterion is generally represented as '*ht*', where '*h*' is the thickness of rock above the workings expressed as a multiple of '*t*', the worked thickness. This has been a popular approach because the two elements can be reasonably well determined via conventional ground investigation.

5.3.26 Most evaluations of required bedrock cover come from the examination of Coal Measures mines. In these, it has been observed that the height of migration in bedrock might, exceptionally, extend to 10 times the height of the original extraction. Consequently, the 10*t* criterion has, for over 30 years, been adopted by the industry as providing reasonable assurance against surface subsidence resultant from roof collapse in old, room and pillar mines. However, collapses might attenuate within a lesser cover and there will be circumstances where using the 10*t* criterion could be considered overly conservative.

5.3.27 That said, a Coal Authority Technical Guidance Note[3] which describes a subsidence event that affected a number of properties on a housing estate in northeast England in 2016, concluded that the 10 times rock cover guidance is only a 'rule of thumb' for crown hole collapses. Other subsidence mechanisms can occur, such as pillar failure, for which the 10 times rock cover rule of thumb is not an appropriate guide.

[2] *CIRIA C758D:2019. Abandoned mine workings manual*

[3] *Coal Authority, TGN01/2019. Findings from a large subsidence event on a residential estate.*

5.3.28 Mitigation of the risks posed by any shallow mineworkings will be required, and this could be achieved in one of two ways (see also Section 15.2):

- Consolidation, via drilling & grouting
- Extraction of the remaining coal

6 PRELIMINARY CONCEPTUAL SITE MODEL

6.1.1 A preliminary conceptual site model, presented as Drawing 4721/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 5 inclusive of this report.

6.1.2 Potential contaminant linkages are shown on the preliminary conceptual site model.

6.1.3 The conceptual model will likely be subject to modification in light of data arising from the proposed intrusive ground investigation; see Section 7.2.

7 GROUND INVESTIGATION DESIGN

7.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	None anticipated.
Natural soils	Veneer of topsoil overlying residual soils derived from the complete weathering of bedrock (clay/gravel).
Bedrock	Coal Measures primarily comprising mudstone and siltstone, with sandstone bands across the centre of Area A. Woolley Edge Rock sandstone underlying Area B. See Drawing 4721/8 in Appendix B.
Mineworkings	Potential unrecorded shallow workings associated coal outcrops within Area A.
Groundwater	Likely within the residual soils and within bedrock at depth.

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)	1. Associated with farming
Potential off-site contamination sources	1. Colliery 2. Shafts 3. Quarry 4. Sewage filter beds	1. Made ground and associated contamination 2. Migration of hazardous gas 3. Infilled land and migration of hazardous gas 4. Organic matter
Potential geotechnical hazards	1. Shallow workings 2. Unrecorded shafts	1. Surface instability due to collapse of unrecorded underground workings 2. Bell pits
Other potential constraints	1. Underground and overhead utilities	1. Requires standoff and/or 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
About 38 trial pits	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of shallow soils, including any made ground • Suitability of the ground for founding structures and highways
Within 4 trial pits	To determine whether soakaways could be utilised for storm water drainage
12 deep probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings
14 shallow probeholes	To install monitoring wells across the site in order to: • Monitor for hazardous gas • Determine groundwater levels

7.2.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site. A nominal 45m 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.

8.2 Exploratory hole location constraints

8.2.1 No access was available to a linear belt running roughly northeast-southwest through Area A due to the presence of overhead electric cables. However, ground conditions here are not anticipated to vary significantly from those across the remainder of the site.

8.3 Scope of works

8.3.1 Fieldwork was supervised by Lithos between 24th and 31st July 2023 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 01 to 34	1.3m to 3.3m	Vane tests in cohesive soils
Soakaway tests	SAs 01 to 04	2.0m to 2.6m	-
Rotary open-hole probeholes	PHs 01 to 12	15.0m to 42.0m	-
	PHs 101 to 114	4.5m to 9.0m	Monitoring wells installed

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

8.3.3 Exploratory hole logs are presented in Appendices F & G 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

8.3.4 Exploratory hole locations are shown on Drawings 4721/6 and 4721/6A 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 & G.

9.1.2 Typical ground conditions encountered at the site are described below in Section 9.2 (natural ground), with a summary provided in the tables on pages 16 to 18.

9.1.3 No made ground was encountered in any of the exploratory holes during the investigation.

9.2 Natural ground

9.2.1 Natural ground was encountered in all of the exploratory holes, and typically comprised:

- **Topsoil:** clay was identified across the site to a typical depth of 300mm.
- **Cohesive Residual Soil:** firm to stiff slightly sandy/gravelly Clay encountered across the site to between 1.3m and 2.5m depth (average 2.0m).
- **Granular Residual Soil:** encountered as sandy/clayey Gravel in the majority of trial pits to between 1.6m and 2.8m depth.
- **Coal Measures:** encountered in the majority of holes at between 1.6m and 2.8m depth (average 2.3m) predominantly as weak, thinly laminated Siltstone, locally comprising very weak Mudstone and medium strong Sandstone.

9.2.2 A thin (up to 300mm thick), weathered **Coal** was encountered in two trial pits (TPs 11 & 16) from 0.5m depth and two probeholes (PHs 110 & 113) from 1.8m depth in the north and east. Further 'flashes' of coal were recorded in PH10 at 3.0m & 29m depth.

9.3 Visual & olfactory evidence of organic contamination

9.3.1 No evidence of significant organic contamination was noted in any of the exploratory holes.

9.3.2 Selected samples were scheduled for chemical testing to confirm the suitability of existing topsoil for re-use; see Section 11.

9.4 Stability

9.4.1 Stability of excavations within natural ground was generally good, although some minor instability was locally encountered in granular soils.

Summary of ground conditions (Trial Pits)

Hole	Depth to base (mbgl)							Depth to bedrock (m)
	Final depth (m)	Topsoil	Cohesive Residual Soil	Thin Coal	Granular Residual Soil	Cohesive Residual Soil	Granular Residual Soil	
SA01	2.6	0.3	2.3	-	>2.6	-	-	-
SA02	2.5	0.3	2.1	-	2.3	-	-	2.3
SA03	2.5	0.3	2.1	-	>2.5	-	-	-
SA04	2.0	0.3	0.5	-	0.8	1.3	1.6	1.6
TP01	2.2	0.3	2.0	-	-	-	-	2.0
TP02	2.3	0.3	1.3	-	1.5	2.0	2.2	2.2
TP03	3.1	0.3	2.2	-	2.8	-	-	2.8
TP04	1.3	0.3	>1.3	-	-	-	-	-
TP05	2.2	0.3	2.1	-	-	-	-	2.1
TP06	3.3	0.3	2.0	-	2.4	-	-	2.4
TP07	3.1	0.3	2.3	-	2.8	-	-	2.8
TP08	2.6	0.3	2.2	-	2.4	-	-	2.4
TP09	2.6	0.3	1.8	-	2.3	-	-	2.3
TP10	2.7	0.3	-	-	0.7	1.8	2.3	2.3
TP11	2.8	0.3	0.5	0.8	-	2.2	>2.8	-
TP12	2.7	0.3	2.2	-	2.5	-	-	2.5
TP13	2.1	0.3	1.8	-	2.0	-	-	2.0
TP14	2.8	0.3	1.2	-	1.7	-	-	1.7
TP15	2.9	0.2	1.4	-	2.3	-	-	2.3
TP16	2.9	0.2	2.1	2.3	-	2.5	-	2.5
TP17	2.8	0.2	2.0	-	-	-	-	2.0
TP18	2.9	0.3	1.8	-	2.6	-	-	2.6
TP19	1.8	0.3	1.7	-	-	-	-	1.7
TP20	2.9	0.3	2.2	-	2.6	-	-	2.6
TP21	2.9	0.2	2.1	-	2.4	-	-	2.4
TP22	3.0	0.2	1.9	-	2.3	-	-	2.3

Hole	Depth to base (mbgl)							Depth to bedrock (m)
	Final depth (m)	Topsoil	Cohesive Residual Soil	Thin Coal	Granular Residual Soil	Cohesive Residual Soil	Granular Residual Soil	
TP23	3.0	0.2	1.6	-	2.3	-	-	2.3
TP24	2.7	0.2	1.9	-	2.4	-	-	2.4
TP25	2.6	0.3	2.2	-	>2.6	-	-	-
TP26	3.1	0.3	2.4	-	2.7	-	-	2.7
TP27	2.8	0.3	2.4	-	-	-	-	2.4
TP28	2.8	0.2	2.1	-	2.5	-	-	2.5
TP29	2.6	0.3	1.5	-	1.9	-	-	1.9
TP30	2.9	0.3	2.4	-	-	-	-	2.4
TP31	2.5	0.2	2.3	-	-	-	-	2.3
TP32	2.7	0.2	1.3	-	2.4	-	-	2.4
TP33	2.2	0.2	1.7	-	2.0	-	-	2.0
TP34	2.8	0.2	2.2	-	2.5	-	-	2.5

Summary of ground conditions (Probeholes)

Hole	Final depth (mbgl)	Depth to bedrock (mbgl)	Depth to Coal (mbgl)	Thickness of Coal (mbgl)	Thickness of competent cover (m)	Groundwater (mbgl)	Remarks
PH01	42.0	2.4	-	-	n/a	11.5	Deep probeholes for investigation of mineworkings
PH02	39.0	2.6	-	-	n/a	38.5	
PH03	18.0	2.6	-	-	n/a	-	
PH04	15.0	1.8	-	-	n/a	5.3	
PH05	18.0	1.9	-	-	n/a	-	
PH06	15.0	1.8	-	-	n/a	-	
PH07	18.0	1.9	-	-	n/a	7.3	
PH08	15.0	2.1	-	-	n/a	12.0	
PH09	39.0	2.1	-	-	n/a	-	
PH10	36.0	2.3	2.3	0.2	0.0	24.0	
PH11	18.0	1.6	-	-	n/a	-	
PH12	18.0	1.8	-	-	n/a	-	
PH101	4.5	2.4	-	-	n/a	-	Shallow probeholes with monitoring well installation
PH102	4.5	2.6	-	-	n/a	-	
PH103	4.5	3.0	-	-	n/a	-	
PH104	4.5	1.8	-	-	n/a	3.1	
PH105	4.5	1.7	-	-	n/a	-	
PH106	4.5	1.8	-	-	n/a	-	
PH107	4.5	1.9	-	-	n/a	-	
PH108	4.5	2.0	-	-	n/a	-	
PH109	9.0	2.2	-	-	n/a	-	
PH110	4.5	2.5	2.8, 3.2	0.1, 0.2	0.3, 0.7	-	
PH111	4.5	1.5	-	-	n/a	-	
PH112	4.5	1.9	-	-	n/a	-	
PH113	4.5	1.8	1.8	0.3	0.0	-	
PH114	4.5	1.8	-	-	n/a	-	

9.5 Groundwater

9.5.1 No significant inflows of groundwater were encountered during the investigation.

9.5.2 Groundwater levels recorded in the monitoring wells on one visit to date (12th September 2023) are summarised below.

Hole	Response zone (depth range & strata)	Groundwater body	Typical standing water level	
			m bgl	m AoD#
PH101	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	3.56	69.55
PH102	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	2.52	76.93
PH103	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	-	Dry	-
PH104	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	1.33	77.71
PH105	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	0.84	72.81
PH106	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	-	Dry	-
PH107	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	4.14	81.80
PH108	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	-	Dry	-
PH109	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	-	Dry	-
PH110	3.0 – 4.5m (Coal & Mudstone)	-	Dry	-
PH111	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	-	Dry	-
PH112	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	2.50	76.64
PH113	2.5 - 4.5m (Coal & Mudstone)	Bedrock	3.46	82.09
PH114	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	Bedrock	0.88	73.07

levelled-in by survey to inform foundation design

9.5.3 Dip data to date suggests a shallow water table. Wells will be monitored on 8 further visits as part of the gas monitoring.

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

9.6 Mining investigation

Shallow workings (rotary probeholes)

9.6.1 It is clear from the desk study that the site is possibly underlain by shallow unrecorded mineworkings associated with the Newhill Coal and Swinton Pottery seams together with a spine roadway at shallow depth (<30m).

9.6.2 The conjectured outcrop of the Newhill and Swinton Pottery seams are shown on Drawing 4721/8 in Appendix B to this report although there is some contradiction on the position of the outcrops between BGS plans and the Coal Authority mining report.

9.6.3 Consequently, a mining investigation has been undertaken comprising the drilling of 12 deep (between 15m & 42m depth) rotary open-hole probeholes (PH01 to PH12). The strata encountered are shown in the table on page 18.

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

- A thin (up to 300mm thick) seam of coal (likely the Newhill Coal) underlies the far east of Area A, outcropping approximately 70m further west than that shown on BGS plans
- The Swinton Pottery coal was not encountered and as such likely outcrops off site to the east.
- None of the 12 deep holes (or 14 shallow holes) advanced encountered evidence of workings (voids, broken ground etc).
- The outcrops shown on BGS plans and the CA mining report are inconsistent with the findings of the rotary Probeholes.

9.6.5 Given the number of deep probeholes drilled, and the absence of any evidence of workings (voids or broken ground), it is considered highly unlikely that the site is underlain by shallow mineworkings, although consideration could be given to further drilling to remove any residual uncertainty.

9.6.6 A further 14 probeholes (PH101 to PH114) were taken to shallow depth (typically to 4.5m, but up to 9.0m) to enable the installation of gas monitoring wells.

9.7 Revised conceptual ground model (ground conditions)

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

- The strength, nature and depth of underlying natural strata
- The nature and distribution of contamination (based on visual/olfactory evidence only)

9.7.2 Further refinement of the Conceptual Site Model is presented in Section 12.3, 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 CIRIA C753[4] 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'.

10.1.3 BRE Digest 365[5] "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.

10.2 Field tests

10.2.1 Soakaway tests were carried out in general accordance with BRE Digest 365 "Soakaway Design". The locations of the soakaways are shown on Drawing 4721/6 presented in Appendix B to this report.

10.2.2 Infiltration rates for each soakaway would, where possible, be calculated in accordance with BRE Digest 365. This design takes into account time for the water level to fall from 75% to 25% of its effective depth. The effective depth is the difference between the starting water level and the soakaway pit base depth.

10.2.3 However, drainage rates were poor, with each of the tests failing to achieve the 75% effective depth after >4.5hours.

10.2.4 Consequently, it has not been possible to calculate infiltration rates. Details of each test undertaken are summarised in the table below, and copies of associated field data sheets are presented in Appendix H to this report.

Soakaway	Stratum	Infiltration rate (m/s)	Remarks
SA01	Cohesive Residual Soil from 0.5m to 2.3m Granular Residual Soil from 2.3m to > 2.6m	N/A	Still >75% full after c. 6 hrs
SA02	Cohesive Residual Soil from 0.5m to 2.1m Granular Residual Soil from 2.1m to 2.3m Mudstone from 2.3m to >2.5m		Still >75% full after c. 5.5 hrs
SA03	Cohesive Residual Soil from 0.5m to 2.1m Granular Residual Soil from 2.1m to >2.5m		Still >75% full after c. 5 hrs
SA04	Cohesive Residual Soil from 0.5m to 1.3m Granular Residual Soil from 1.3m to 1.6m Sandstone from 1.6m to >2.3m		Still >75% full after c. 4.5 hrs

10.3 Discussion & conclusions

10.3.1 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.

10.3.2 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).

[4] *CIRIA C753. The SuDS Manual (2015).*
[5] *BRE Digest 365. Soakaway Design (1991).*

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 Consequently, soakaways are not considered a suitable drainage solution; and there may be a need for surface water balancing. It is understood that Crest are proposing to install an underground storage tank in Area A with a possible attenuation pond in Area B.

10.3.5 Drainage solutions are discussed further in Section 15.8.

11 CONTAMINATION (ANALYSIS)

11.1 General

11.1.1 The site has been used as arable farmland and has not been the subject of a past potentially contaminative industrial land use.

11.1.2 However, sampling of the topsoil has been undertaken to confirm its suitability for re-use.

11.1.3 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 7.1.

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.

Type of sample	No. of samples	Determinands
Topsoil	15	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID TOC & Speciated Polycyclic Aromatic Hydrocarbons (PAH)
	5	Clay/sand/silt content and visible contaminants, sharps (glass etc) to check compliance with BS3882:2015

11.3 Soil contamination results

11.3.1 The soil contamination test results are summarised in the table on page 23 .

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

Summary of degree of soils contamination

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 garden**s end-use.															
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Vn	Zn $	% TOC	PAH		Asbestos I.D.
																B(a)P ∞	Naphthalene	
				37	5	26	4000	100	200	199	109	434	584	200		5	10	
TP01	0.1	Topsoil	6.7	35	1.0	0.3	20	56	73	0.2	20	0.6	42	100	8.0	<0.1	<0.1	N.D.
TP02	0.1	Topsoil	6.7	26	0.8	0.3	16	42	55	0.1	16	0.5	31	82	7.5	<0.1	0.1	N.D.
TP03	0.1	Topsoil	6.7	20	0.8	0.2	28	34	50	<0.1	23	1.9	46	95	5.3	<0.1	<0.1	N.D.
TP06	0.1	Topsoil	6.4	21	1.3	0.3	25	40	59	0.1	21	2.3	48	86	6.7	<0.1	<0.1	N.D.
TP07	0.1	Topsoil	6.8	37	1.0	0.4	27	51	**1100**	0.4	32	2.2	49	110	9.2	<0.1	<0.1	N.D.
TP10	0.1	Topsoil	6.6	32	0.7	0.3	27	**390**	67	0.2	27	1.4	49	110	9.2	<0.1	<0.1	N.D.
TP11	0.1	Topsoil	6.7	36	0.9	0.3	26	56	68	0.2	28	1.8	48	110	11	<0.1	<0.1	N.D.
TP13	0.1	Topsoil	6.8	22	0.9	0.2	25	39	42	<0.1	23	1.5	40	140	8.9	<0.1	<0.1	N.D.
TP18	0.1	Topsoil	6.6	17	1.0	0.3	21	41	46	0.1	24	1.1	37	81	5.3	<0.1	<0.1	N.D.
TP20	0.1	Topsoil	6.9	19	0.7	0.3	26	36	52	<0.1	22	1.8	44	85	5.3	<0.1	<0.1	N.D.
TP22	0.1	Topsoil	6.8	11	0.8	0.3	27	32	54	<0.1	22	1.5	44	100	3.6	<0.1	<0.1	N.D.
TP24	0.1	Topsoil	6.6	13	0.7	0.2	21	24	35	<0.1	22	0.9	32	90	3.3	<0.1	<0.1	N.D.
TP27	0.1	Topsoil	6.9	10	0.8	0.3	24	28	39	<0.1	20	0.8	34	96	3.5	<0.1	<0.1	N.D.
TP29	0.1	Topsoil	7.1	16	0.9	0.3	27	30	46	<0.1	24	1.5	38	90	3.3	<0.1	<0.1	N.D.
TP30	0.1	Topsoil	6.6	13	0.8	0.2	23	25	42	<0.1	22	0.9	32	83	3.3	<0.1	<0.1	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.
♣	Tier 1 Value is pH dependent.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.
N.D.	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.

Inorganic determinands

11.3.3 Of the 15 samples of Topsoil analysed for inorganic parameters, 13 can be classified as uncontaminated and two could be classified as contaminated.

11.3.4 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).

11.3.5 The elevated contaminants include lead (1,100mg/kg) in one sample recovered from TP07 and copper (390mg/kg) in one sample recovered from TP10.

11.3.6 Current UK guidance regarding the statistical analysis of soil contamination data obtained during a site investigation is provided by CL:AIRE[6], 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.

11.3.7 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.

11.3.8 Lithos can confirm that statistical assessment of 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
- A minimum of 10 samples have been taken (actually 15 here)

11.3.9 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.

11.3.10 The Dot and Box Plots for key compounds, including lead and copper, are presented in Appendix I and the results are summarised below.

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)
Lead	200	62	212	75	75 to 212	No
Copper	100	62	112	15	15 to 112	No
Arsenic	37	22	27	17	17 to 27	No
Benzo(a)pyrene	5.0	0.03	0.03	0.03	0.03	No

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

11.3.11 Statistical analysis indicates that the true mean for lead and copper in the Topsoil is slightly elevated compared with relevant Lithos tier 1 screening values.

11.3.12 However, Copper is a phytotoxic metal; phytotoxicity describes the inhibitive and toxic effect high concentrations of some substances can have on plant growth.

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

11.3.13 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 copper, consideration and protection of flora would also be protective of human health.

11.3.14 Allowable concentrations of heavy metals in arable soils are set out in Defra's Code of Good Agricultural Practice 2009[7]. The value for copper 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.

11.3.15 Lithos have also derived a value for 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 value is 2,400mg/kg, ten times greater than the potential phytotoxic concentration.

11.3.16 On balance, given the context of a residential development and the relatively low concentrations recorded in one sample (TP10), copper is not considered significant and no special remedial measures are considered necessary.

11.3.17 The methods of statistical analysis outlined in CLR7 relate to Soil Guideline Values and are not strictly applicable to phytotoxic metals. However, in theory there is no reason why the tests cannot be applied to these contaminants.

Asbestos

11.3.18 No visual evidence of asbestos-containing materials (ACMs), such as broken fragments of asbestos-cement sheeting, was noted during the excavation of trial pits.

11.3.19 No asbestos fibres were identified in any of the 15 samples screened.

Organic determinands

11.3.20 This site 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 placed in gardens/landscaped areas (Lithos Scenario A).

11.3.21 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.

11.3.22 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.

11.3.23 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?
Topsoil	>3.5%	No

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

Hydrocarbons (TPH & PAH)

11.3.24 Given the absence of a plausible source or any visual/olfactory evidence of any hydrocarbon contamination, no TPH analysis was scheduled on any of the samples of Topsoil.

11.3.25 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.

11.3.26 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).

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

BS3882 Topsoil testing

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

11.3.29 The clay/sand/silt content of 5 topsoil samples have been determined to check compliance with BS3882[8] requirements.

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

11.3.31 The results are summarised below:

Parameter	BS3882 Specification	TP01	TP06	TP10	TP20	TP24
Retained on 2mm sieve	< 30%	12	6	13	5	18
Retained on 20mm sieve	< 10%	2	0	0	0	4
Retained on 50mm sieve	0%	0	0	0	0	0
Clay content	5 to 35%	21	29	25	29	22
Silt content	0 to 65%	34	39	37	41	33
Sand content	0 to 90%	33	26	25	25	27
Visible contaminants	< 0.5%	0	0	0	0	0

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

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

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

12 CONTAMINATION (QUALITATIVE RISK ASSESSMENT & REMEDIATION)

12.1 Topsoil

12.1.1 Topsoil, typically 300mm thick underlies the entire site. Testing suggests this material is generally chemically suitable for re-use. The exception to this is the topsoil in the vicinity of TP07, where isolated elevated lead concentrations have been recorded. Additional testing on a grid pattern radiating from TP07 is required to delineate the lead contamination.

12.1.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth. However, full testing in accordance with BS3882 Specification for Topsoil has not been undertaken to date.

12.2 Summary of significant contamination

12.2.1 Topsoil, typically 300mm thick, underlies the site and is generally considered suitable for re-use.

12.2.2 However, a single highly elevated concentration of lead (1,100mg/kg) was identified in one sample (TP07) which is not consistent with the remainder of the results (73mg/kg or less).

12.2.3 This result is likely a sampling or recording error, or could be associated with a very localised concentration of lead (e.g. from lead shot associated with field sports).

12.2.4 Nonetheless, these concentrations are not considered acceptable with Topsoil in garden or landscaped areas and as such some preparatory works will be necessary to render the site suitable for development; see Section 16.2.

12.2.5 No areas of significant organic (hydrocarbon) contamination have been identified.

12.3 Revised conceptual ground model (contamination)

12.3.1 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.

12.3.2 A revised Conceptual Site Model is presented as Drawing 4721/7 in Appendix B. The Model includes the contaminants described in Section 12.2 above, and potential contaminant linkages (summarised below in Section 12.5) to receptors.

12.4 Environmental setting & end use

12.4.1 It is apparent from Section 12.2 above, that only limited contamination has been identified to date in the soils beneath this site. However, supplementary testing is recommended to delineate the extent of the localised lead contamination, before determining an appropriate course of action.

12.4.2 In order to assess the significance of this contamination, consideration must be given to the site's environmental setting and the proposed end use.

12.4.3 The underlying Coal Measures strata is classified as a Secondary A aquifer. The nearest surface watercourse is an un-named drain on the northern boundary. Therefore, the site's environmental setting is considered to be of **moderate sensitivity**.

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

12.4.5 Transient risks to construction workers can be addressed by the adoption of appropriate health and safety measures, see Section 16.5.

12.5 Contaminant linkages

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

Contaminants

12.5.2 Contaminants (elevated lead) have been summarised in Section 12.2 above.

12.5.3 Gas monitoring is ongoing. Assessment of ground gas risks will be provided upon completion of the monitoring.

Pathways

12.5.4 Potential contaminant pathways include:

- Ingestion
- Dermal contact
- Inhalation of contaminated particulates
- Surface water run-off, including existing drainage infrastructure

Receptors

12.5.5 Potential contaminant receptors include:

- The environment – Secondary A (Solid) aquifer and/or watercourse (drain) on northern boundary
- End users of the site (residents)

12.5.6 It can be concluded that there are plausible pathways between the soil contaminants summarised in Section 12.2 above and potential receptors. Consequently, some remediation will likely be required (subject to results of additional testing); either treatment/removal of the contaminant, or "breakage" of the pathway.

12.6 Potential remediation options

General

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

Inorganic contamination

12.6.2 An elevated concentration of lead (1,100mg/kg) has been identified in one sample of Topsoil, no further elevated concentrations were recorded in any of the remaining 14 samples tested, with no results >73mg/kg.

12.6.3 Consequently, the elevated concentration recorded considered highly localised, possibly from lead shot associated with field sports.

12.6.4 Further sampling and testing of samples of Topsoil recovered from the area of TP07 is recommended, prior to determining an appropriate course of action.

Organic contamination

12.6.5 No areas of gross organic contamination were encountered during the site works. However, localised areas of more onerous contamination than that identified to date may be present on site.

12.7 Waste classification

12.7.1 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.

12.7.2 Off-site disposal of surplus clean naturally occurring soils to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[9] 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.

12.7.3 Disposal of the localised contaminated Topsoil off site is generally not considered appropriate, economically viable, nor in line with current Government philosophy regarding sustainable development. However, 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.

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

12.7.5 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[10]. 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.

12.7.6 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.

12.7.7 It should be noted that Inert Waste has a TOC threshold of 3% which is typically exceeded by most topsoil; the Topsoil at this site typically has a TOC value of >3.5%.

12.7.8 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.

12.7.9 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.

12.7.10 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 12.2 but will often need supplementing with further testing after soils have been stockpiled (see also advice in Section 12.7).

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

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

12.7.11 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.

12.7.12 Contractors exporting waste from the site should review the site investigation data and make their own assessment. Alternatively, Lithos could undertake this assessment once exported waste streams have been identified.

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
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Low**: no significant thickness of low permeability drift or bedrock above workings
	Buildings	Explosion		
Off-site mine shafts & landfill	Human health	Asphyxiation & explosion	Vertical & lateral migration, ingress & accumulation	**Low**: no significant thickness of low permeability drift or bedrock
	Buildings	Explosion		

13.1.2 Given the above gas monitoring wells have been installed in 14 probeholes across the site (PHs 101 to 114). 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[11], given the proposed residential end use, 9 visits have been scheduled over a 6-month period.

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 L.

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

- Ambient oxygen concentration (check for instrument drift)
- 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

13.3 Monitoring results

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

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

Well	Response zone	Recorded methane concentrations (% v/v)	Recorded carbon dioxide concentrations (% v/v)	Recorded steady flow rates (litre/hour)
PH101	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	0.2	none detected
PH102	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	2.2	none detected
PH103	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	4.3	none detected
PH104	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	0.9	none detected
PH105	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	1.7	none detected
PH106	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	0.3	none detected
PH107	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	0.5	none detected
PH108	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	0.9	none detected
PH109	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	ND	none detected
PH110	3.0 – 4.5m (Coal & Mudstone)	none detected	4.9	none detected
PH111	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	0.9	none detected
PH112	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	2.6	none detected
PH113	2.5 - 4.5m (Coal & Mudstone)	none detected	5.3	none detected
PH114	1.5 – 4.5m (Cohesive Residual Soil & Mudstone)	none detected	2.5	none detected

13.4 Discussion (methane & carbon dioxide)

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

13.4.2 A hazardous gas risk assessment incorporating all of the results will be issued on completion of monitoring in March 2024.

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, the UK Health Security Agency (HSA) would like to see all new build include basic measures.

13.5.3 In December 2022, the British Geological Survey (BGS), deployed a revised dataset which increased accuracy and also the number of properties falling within radon affected areas. This revised dataset is now referenced by maps on the HSA website.

13.5.4 The HSA website radon map indicates that the site is in an area where **3% to 5%** of homes are estimated to be above the action level, and **basic** radon protection measures are required in new dwellings.

13.5.5 In accordance with BR211:2015[12], basic radon measures simply comprise a barrier (membrane) laid within the floor construction, which is linked to a damp-proof course (DPC) within the walls of the building. The DPC to cavity walls should be in the form of a cavity tray to prevent radon entering the building through the cavity. Sealing of joints in the barrier and sealing around service penetrations are also required. A 1200-gauge polythene membrane should suffice, and sub-floor ventilation is not essential.

[12] *BRE Report BR211, 2015: "Radon: Guidance on protective measures for new buildings"*

13.5.6 However, a building site is a harsh environment and barriers can easily become damaged during construction by operatives or equipment moving across or working over a completed section of barrier. As a consequence, where there is a risk of puncturing the membrane, stronger materials such as thicker or reinforced polyethylene sheet should be considered, and it should be ensured that the membrane is well protected with sand or lean mix concrete before advancing construction.

13.5.7 BRE211:2015 highlights the importance of good practice and workmanship to ensure radon membranes are installed to a high standard and suggests regular supervision and inspection. Whilst there are no specific statutory requirements to inspect radon barriers, BRE and Lithos strongly recommend a programme of inspections.

13.5.8 It is not deemed necessary to inspect each barrier before it is covered but Lithos would suggest the first plot is inspected and 1 in 20 plots thereafter.

14 GEOTECHNICAL TESTING

14.1 General

14.1.1 A total of 34 samples of natural 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 K 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	15	13 to 34 (21)	19 to 36 (30)	Medium

* 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 Soluble sulphate and pH

14.3.1 In accordance with BRE SD1[13], this site has been classified as greenfield with a mobile groundwater regime.

14.3.2 It is envisaged foundations will extend to depths of about 1m through natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract), in addition to acid-soluble sulphate and total sulphur.

14.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 22 samples were determined.

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

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

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Granular Residual Soil	6	5.0	28
Cohesive Residual Soil	13	5.1	100
Coal Measures Bedrock	1	6.1	16
Coal	2	4.7	31

14.3.5 The majority of the samples yielded pH values above 5.5, with pH values of <5.5 recorded in 5 samples of Cohesive Residual Soil, two samples of Granular Residual Soil and two samples of Coal.

14.3.6 To check for the presence of pyrite, three samples of Granular Residual Soil, two samples of Coal and one sample of Coal Measures (Siltstone) were tested for water-soluble sulphate (2:1 soil/water extract), total Sulphur and total Sulphate as summarised in the table below:

Hole ID	Depth (mbgl)	Concentration of:				
		Soluble sulphate (mg/l)	Total Sulphate (%)	Total Sulphur (%)	Total Potential Sulfate (%)	Oxidisable Sulfides OS (%)
TP10	0.5	28	0.07	0.03	0.09	0.06
SA04	0.7	12	0.02	< 0.01	0.03	0.02
TP32	1.4	12	0.03	0.01	0.03	0.02
TP11	0.7	31	0.09	0.10	0.30	0.27
TP16	2.2	21	0.03	0.08	0.24	0.22
TP17	2.5	16	0.03	0.01	0.03	0.01

14.3.7 Oxidisable sulfide results are less than 0.3%, which suggest that pyrite is not present in any significant quantities.

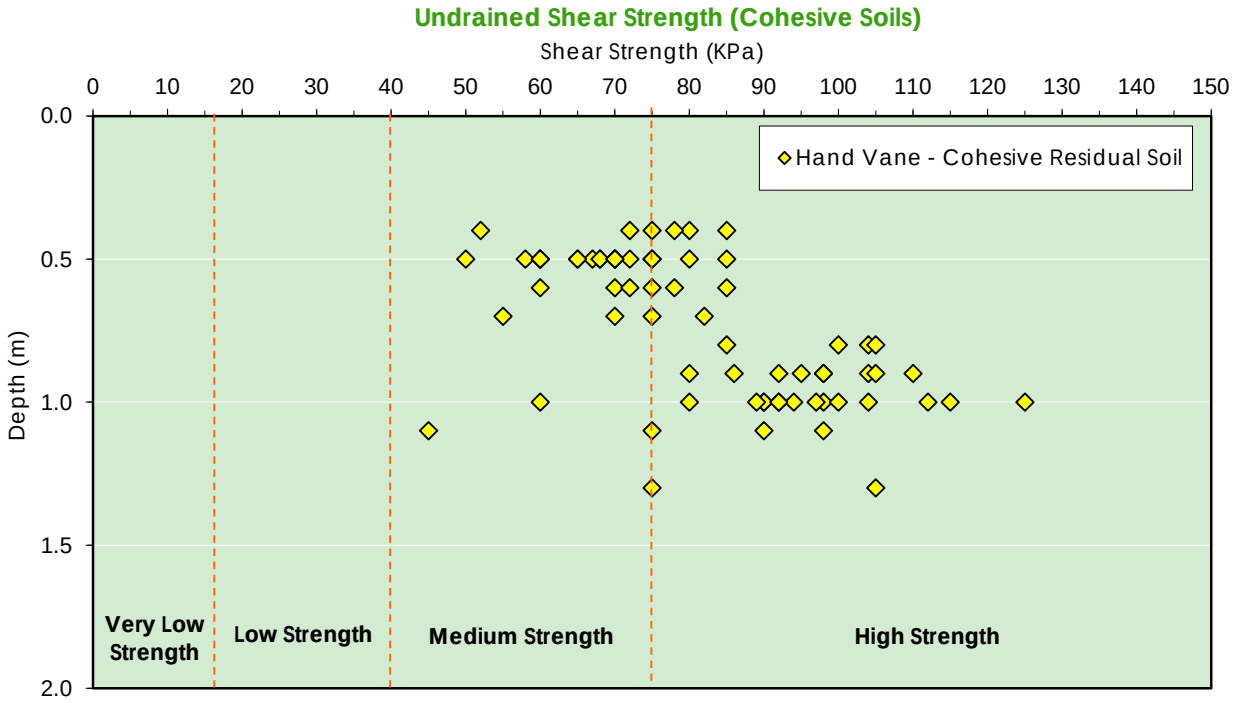
14.3.8 In accordance with Table C1 of SD1, sub-surface concrete should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-1**.

14.4 Undrained shear strength testing

Hand shear vane testing

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

14.4.2 The results are summarised within the plot below and show the Cohesive Residual Soil is medium to high strength, with an undrained shear strength (Su) typically greater than 60kPa below 0.5m depth. Below around 0.75m depth, Su is typically greater than 85kPa.



15 GEOTECHNICAL ISSUES

15.1 Conceptual site model

15.1.1 A Revised Conceptual Site Model is presented as Drawing 4721/7 in Appendix B.

15.1.2 Ground conditions across the site typically comprise Cohesive Residual Soils (medium to high strength sandy/gravelly Clay) overlying Granular Residual Soils (clayey Sand / Gravel).

15.1.3 Coal Measures bedrock was encountered in the majority of holes from between 1.6m and 2.8m depth (average 2.3m) predominantly as weak, thinly laminated Siltstone, locally comprising very weak Mudstone and medium strong Sandstone.

15.1.4 Coal, likely the Newhill Coal, up to 300mm thick, was encountered at shallow depth (<3.2m) in two trial pits (TPs 11 & 16) and 3 rotary probeholes (PHs 10, 110 & 113) in the east of Area A.

15.1.5 Given the topography of the site some re-grade is anticipated with likely retaining walls and underbuild.

15.2 Mining & quarrying

15.2.1 The centre south of the site where the Newhill Coal is shown to outcrop is recorded within a Coal Mining Development High Risk Area, with the remainder of the site recorded as Low Risk.

15.2.2 There are no known quarries on site although a quarry was recorded adjacent to Wombwell Main Colliery (c. 50m north) between 1962 and 1980.

15.2.3 Lithos' mining investigation found **no evidence** of shallow workings (voids, broken ground etc) in any of the 12 deep or 14 shallow Probeholes drilled across the site.

15.2.4 Coal, likely the Newhill Coal, up to 300mm thick, was encountered at shallow depth (<3.2m) in two trial pits (TPs 11 & 16) and 3 rotary probeholes (PHs 10, 110 & 113) in the east of Area A.

15.2.5 The CA Mining report suggests that a shallow (<30m depth) spine roadway underlies the site, which is associated with the Meltonfield Coal. However, review of the associated abandonment plan for the Meltonfield Coal shows that the roadway lies at least 50m below the site, and is likely only at shallow depth to the north, beyond the site boundary. A copy of the abandonment plan is presented in Appendix B to this report as Drawing 4721/9.

Shallow mineworkings

15.2.6 CIRIA SP32[14] suggests voids resulting from mineral extraction are unlikely to migrate more than 10 times the seam thickness through competent bedrock. CIRIA C758D[15] 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.

15.2.7 Given the absence of any shallow workings, including shallow spine roadways, no mitigation against the risk of subsidence will be required.

Mine entries

15.2.8 No known mine entries (shafts or adits) are recorded within, or adjacent, to the site boundary.

15.2.9 A former adit entrance, associated with the Winter Coal seam, is located c.300m to the northwest with the adit running southeast, passing beneath the north of the site. Where it passes beneath the site the adit is calculated to lie at least 90m below existing ground level and as such is not considered a risk to surface stability.

15.2.10 However, it is possible that unrecorded "shallow" shafts (possibly bell pits) may be present at this site, and consideration should be given to a geophysical survey, although success would be dependent on the "contrast" between shaft backfill and the surrounding ground (i.e. the survey is likely to be more successful if shaft backfill is significantly different material or less dense than the surrounding ground). Follow-up intrusive investigation (pitting) would be recommended to determine the cause of any anomalies identified by the geophysics.

15.2.11 A topsoil strip could also be considered and will be required anyway across the proposed build footprints prior to construction.

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

15.2.12 If bell pits are present, given the likely depth constraints discussed in Section 5, it seems likely they will be limited to the east, beyond the identified outcrop of the Newhill Coal; perhaps <20% of Area A.

15.2.13 Given the absence of loose superficial deposits, it is considered unlikely that such mine entries would have been lined.

15.2.14 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 Crest may choose to do this.

15.2.15 However, where build over a shaft(s) is proposed, Crest 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.

15.2.16 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.

15.2.17 Proposals to treat any 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.

15.3 Site regrade and/or ground improvement

15.3.1 Given the existing topography (much of the site is sloping, with gradients typically around 1 in 14 in the centre and south to 1 in 18 in the north, and up to 1 in 8 in the far northwest, some site regrade is anticipated, with the need for underbuild and retaining walls.

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

15.3.3 Any digital terrain modelling undertaken, or commissioned, by Crest should consider implications for the foundation recommendations outlined below.

15.3.4 Natural ground underlying this site 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.

15.3.5 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 12.7 should apply.

15.4 Foundation recommendations

General

15.4.1 It is understood that consideration is being given to redevelopment of the site with traditional two storey domestic dwellings, associated gardens, POS, adoptable roads and sewers. A site layout has been provided by Crest Nicholson (Drawing reference SK01, dated April 2023) which is reproduced as Drawing 4721/2 in Appendix B to this report.

15.4.2 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.

15.4.3 Finished ground levels are likely to differ from those at the time of the investigation, most notably in existing steeply dipping areas, following anticipated re-grading (see Section 15.3). However, natural ground conditions across the site were fairly consistent and the foundation recommendations given below assume that foundations will be placed in Cohesive/Granular Residual Soils or Coal Measures bedrock.

15.4.4 Any digital terrain modelling undertaken, or commissioned, by Crest should consider implications for the foundation recommendations outlined below.

15.4.5 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.

15.4.6 Sub-surface concrete in contact with the natural ground should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-1**.

Strip/trench fill footings

15.4.7 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses constructed at the site. Footings will be founded in medium to high strength clay or competent rock. This solution is viable where any made ground after site re-grade is less than about 2.5m thick, and medium to high strength clay or competent rock is the founding material.

15.4.8 Reinforcement, as a precaution against differential settlement, is recommended only where foundation excavations encounter significant lateral and vertical variations in strata. One layer of B385 mesh placed 75mm above the base of the footing is likely to provide suitable reinforcement, but further advice should be sought from the Structural Engineer.

15.4.9 Foundations will be required to be placed below a line drawn up at 45^{o} from the base of any service or similar excavation.

15.4.10 Deepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.3.

15.4.11 In order to minimise softening and swelling of cohesive soils or loosening of granular soils, it is recommended that footings are cast as soon as formation level is reached (or alternatively formation could be blinded using concrete with as low a water:cement ratio as possible).

15.4.12 Crest 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.

Cohesive Residual Soil

15.4.13 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.

15.4.14 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.

15.4.15 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 30% of the site may be affected by trees.

15.4.16 The current layout suggests some plots will be built on ground from which hedgerows will be removed. Whilst the hedgerows at the site are relatively low (<2.5m height) and appear to have been maintained at that height by trimming, it is often difficult to definitively prove that they have not desiccated soils to significant depth. In theory, if mature Hawthorn is removed from within the footprint of a plot, founding depth in medium shrinkability clay would be >2.5m.

15.4.17 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.

15.4.18 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.

15.4.19 It would therefore be prudent to prepare a detailed foundation schedule and seek approval from NHBC in order to determine likely foundation abnormals.

15.4.20 A safe bearing capacity of at least 160kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true

- A foundation length of 8m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 900m depth
- An undrained shear strength of 60kPa for the medium strength clay (typical minimum recorded on site)

15.4.21 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.

Granular Residual Soil

15.4.22 The weathered in-situ siltstone, mudstone and sandstone (sand, gravel and cobbles) is assumed to have a relative density of at least medium dense (in accordance with BS5930).

15.4.23 A safe bearing capacity of at least 160kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true:

- A foundation length of 8m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.9m depth
- An angle of shearing resistance of ϕ=32° for the granular deposits

15.4.24 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.

15.4.25 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).

15.4.26 However, founding at shallow depth, whilst desirable from an excavation stability viewpoint, may not provide sufficient bearing capacity due to the lesser depth of (resisting) overburden. Therefore, foundations in Granular Residual Soils should be placed at a minimum depth of 750mm.

15.4.27 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.

15.4.28 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).

15.4.29 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).

Bedrock

15.4.30 The Coal Measures bedrock (siltstone, mudstone and sandstone) 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.

15.4.32 Bedrock at the site locally comprises mudstone which can be easily excavated using a backhoe excavator and will be recovered as a tabular gravel. Where in-situ mudstone is encountered at founding depth (minimum of 450mm), it will provide a suitable founding stratum for two or three storey dwellings and need only be penetrated by the proposed foundation thickness. Note: any overlying residual soil (typically clay with gravel-sized lithorelicts of mudstone) is likely to be a shrinkable soil; Mudstone is not.

Coal

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

15.4.34 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.

15.4.35 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).

Summary of foundation recommendations

15.4.36 In summary, the following foundation solutions are likely to be most appropriate (subject to Crest preferences regarding site preparatory works, final levels & costs associated with each foundation option).

Plot nos	Foundation solution(s)	Remarks (influencing factors)
All	Strips from 900mm depth in Cohesive soils, or from 750mm depth in Granular soils	Medium shrinkability Clays. Footings in Cohesive soils should be deepened near trees. Foundations in rock should be placed entirely in rock, and not partially on residual soils.

15.4.37 Lithos could prepare a detailed Foundation Schedule if provided with: an External Works Drawing (with proposed FFLs & infrastructure details); a topographic survey and a tree survey.

15.4.38 The foundation solutions outlined in the above table assume that ground levels will not change significantly from those existing at present. Where site re-grade results in areas of deep made ground (re-engineered fill) or shallow rock, alternative foundations may be required and further advice should be sought from Lithos.

15.5 Floor slabs

15.5.1 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). Where natural soils are re-engineered on this site these are likely to be shrinkable, therefore the slabs should not be cast in-situ.

15.5.2 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.

15.5.3 In accordance with NHBC Standards Chapter 4.2, a minimum void height of 250mm 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 100mm should be adopted; of course, the actual thickness of the void former will be significantly greater.

15.5.4 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 and should still include a void former. 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.

15.5.5 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.

15.5.6 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.

15.5.7 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.

15.5.8 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 March 2024.

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, Crest 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. However, there may be springs on site, particularly where sandstone strata outcrops and is underlain by low permeability Mudstone. Groundwater control over and above normal site pumping practices may be required for any excavations in excess of 1m deep where springs are encountered.

15.7.2 Groundwater should be controlled in accordance with CIRIA Report R113[18].

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

15.7.4 Bedrock was encountered in the majority of exploratory holes from 1.6m depth, typically from around 2.3m. Based on the exploratory hole logs, excavation greater than c. 3.0m is likely to prove difficult across the majority of the 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.

15.7.5 Excavation of hard rock may also be required for foundation, drainage excavations etc where ground levels are reduced as part of site re-grade works.

15.8 Drainage

15.8.1 Based on the results of in-situ testing, soakaways are not considered 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.

15.8.2 Alternative SuDS options (see CIRIA C753[19] for further details) include:

- 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.

[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).*
[18] *CIRIA Report R113 (1986) - Control of Groundwater for Temporary Works.*
[19] *CIRIA C753 (2015) – The SuDS Manual.*

15.8.3 Yorkshire Water have published a guide[20] for developers and designers outlining their design requirements for surface water attenuation assets.

15.8.4 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.

15.8.5 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.

15.8.6 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.

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

15.8.8 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

15.9.1 This site is greenfield and the routes, formation level and total length, of proposed estate roads are unknown. Consequently, there was no merit in obtaining CBR values at this stage.

15.9.2 The natural soils present at shallow depth (anticipated formation) are predominantly cohesive. Based on visual inspection of the natural materials and the recorded plasticity indices at the site, published guidance[21] and tables[22] indicate that the Cohesive Residual Soils would be expected to provide a CBR value of at least 2%.

15.9.3 Where natural soils are re-engineered as part of site re-grade works a CBR of at least 3% should be achievable.

15.9.4 These values should be verified prior to, or during, construction.

15.9.5 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.

15.9.6 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 Given existing topography, some site regrade is likely to be required with the possible need for retaining walls and underbuild.

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

[20] *Design Requirements for Surface Water Attenuation Assets, February 2017.*
[21] *CD225 Design for new pavement foundations Revision 1 (Design Manual for Roads and Bridges)*
[22] *The Structural Design of Bituminous Road, TRRL Laboratory Report 1132 (Table C1, page 36)*

15.10.3 When designing retaining walls, consideration should be given to 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 If unexpected ground is encountered during the construction phase, the Contractor should immediately seek further advice from the Engineer.

16.2 Remediation statement

16.2.1 Given the absence of any significant contamination, a remediation strategy is not considered necessary. Nonetheless, some preparatory works will be required, most notably:

- General site clearance of surface materials and vegetation
- Topsoil strip & stockpile

16.2.2 Whilst this site does not require large-scale remediation works, it is strongly recommended that, in advance of the anticipated infrastructure groundworks, the lead contaminated Topsoil identified in TP07 is delineated, before determining an appropriate course of action.

16.2.3 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.

16.2.4 Stockpiles of lead contaminated Topsoil should be located in an area where they will not constrain subsequent works before the material's fate has been determined, agreed and actioned.

16.2.5 Further characterisation of stockpiled materials is likely to be required if off-site disposal is proposed.

16.2.6 It should be ensured that the groundworker understands 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; lead contaminated Topsoil; excess clean, natural soil arisings; general construction waste etc.

16.2.7 No areas of gross organic contamination were encountered during the site investigation. However, if any buried drums, "oily", odorous, brightly coloured etc. materials are encountered, further advice should be sought from Lithos.

16.3 Good practice guidance

16.3.1 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[23]
- EA Pollution Prevention Guidelines[24]:
  - PPG6 - Working at construction and demolition sites
  - PPG2 - Above ground oil storage tank
  - PPG7 – The safe operation of refuelling facilities
  - PPG21 – Incident Response Planning

16.3.2 Site earthworks / re-grade associated with this project are likely to involve the re-use of existing natural 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) [25].

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

16.4 New utilities

16.4.1 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.

16.4.2 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.

16.4.3 This site is greenfield, and no previous or current usage of the site or its immediate surroundings is likely to have resulted in significant ground contamination, beyond the area of elevated lead identified in TP07. Furthermore, no significant made ground was encountered in any of the exploratory holes during the ground investigation.

16.4.4 Consequently, the use of 'standard' polyethylene water supply pipes should be acceptable, although Crest should consult Yorkshire Water at the earliest opportunity to confirm this.

16.4.5 This site investigation has enabled completion of Yorkshire Water's Contaminated Land Assessment Form, a copy of which is included in Appendix J.

16.5 Health & safety issues - construction workers

16.5.1 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.

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

16.5.3 No made ground or significant contaminants at concentrations above the guidance threshold values for an end use that includes domestic gardens have been identified beyond the localised elevated lead recorded in TP07.

16.5.4 Workers involved in excavations to remove the lead contaminated soils are likely to come into direct contact with the contamination.

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[23] *CIRIA C741 (2015) - Environmental Good Practice on Site*

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

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

16.5.5 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.

16.5.6 Consequently, during the site preparatory 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".

16.5.7 Once delineated, excavated and isolated beneath clean cover, or disposed of off site, the lead contaminated Topsoil should not pose a risk to ground workers involved in excavations for foundations, drainage, utilities etc.

16.6 Coal extraction

16.6.1 The Newhill Coal (c. 300mm thick) does underlie the far east of the site; typically at from shallow depth.

16.6.2 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.

16.6.3 However, prior coal extraction is not considered feasible or economically viable at this site given:

- the limited area of the site underlain by coal
- the limited thickness of coal encountered (300mm)
- the likely poor quality of the coal at outcrop due to weathering.
- the reduced demand for coal in the UK

16.6.4 Furthermore, extraction would:

- create 'high-walls' around the margins of the extraction area
- require alternative foundations (rafts/piles where backfill was deep (greater than c.2.5m)
- result in settlement of the backfill, requiring time for ongoing creep settlements to fall to tolerable levels, therefore delaying the build programme
- result in local environmental issues associated with noise and dust

16.7 Shallow coal in garden areas

16.7.1 Whilst there is no explicit guidance in NHBC Standards, liaison with NHBC suggests their stance is essentially the same as that they would apply to potentially combustible fills (such as Ash & Clinker). So where significant coal is present at very shallow depth in garden areas (uppermost 1m), it should either be removed, or covered with inert subsoil/topsoil so that it lies at greater than 1m depth.

16.7.2 In theory this could be an issue for up to around 20% of the total area of Area A. However, given seam dip and topography it seems likely that coal will only be present at such shallow depth beneath less than 10% of Area A.

16.7.3 The most pragmatic way of dealing with shallow coal in gardens will be to inspect foundation excavations, and where coal is recorded within the uppermost 1m or so then excavate an inspection pit in the rear garden. Further advice should be sought from Lithos during the construction phase.

16.7.4 As with foundation arisings, the developer will need to contact the Coal Authority to dig or carry away excavated (incidental) coal.

16.8 Potential development constraints

16.8.1 Topography will require significant regrade earthworks, most notably in the far northwest where gradients of up to around 1 in 8 are present.

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 The overhead electric cables 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.

17 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

17.1 General

17.1.1 The site is located off Pit Lane, Wombwell, approximately 5.4km southeast of Barnsley town centre, and currently comprises of two areas (Areas A & B) of arable farmland.

17.1.2 The larger of the two (Area A) is divided into three fields by hedgerows, with the smaller Area B comprising a single field.

17.1.3 It is understood that consideration is being given to redevelopment of the site with traditional two storey domestic dwellings, associated gardens, POS, adoptable roads and sewers.

17.1.4 A sketch site layout showing 229 units has been provided by Crest Nicholson (Drawing reference SK01, dated April 2023).

17.1.5 Ground conditions across the site typically comprise Cohesive Residual Soils (medium to high strength sandy/gravelly Clay) overlying Granular Residual Soils (clayey Sand / Gravel).

17.1.6 Coal Measures bedrock was encountered in the majority of holes from between 1.6m and 2.8m depth (average 2.3m) predominantly as weak, thinly laminated Siltstone, locally comprising very weak Mudstone and medium strong Sandstone.

17.1.7 A thin (up to 300mm thick), weathered **Coal**, likely the Newhill Coal, was encountered in two trial pits (TPs 11 & 16) from 0.5m depth and two probeholes (PHs 110 & 113) from 1.8m depth in the north and east. Further 'flashes' of coal were recorded in PH10 at 3.0m & 29m depth.

17.2 Mining

17.2.1 This site is located primarily within a Coal Mining Development Low Risk Area, with an area of High Risk in the centre south, associated with the outcrop of the Newhill Coal.

17.2.2 Lithos' mining investigation found no evidence of shallow workings (voids, broken ground etc) in any of the 12 deep or 14 shallow Probeholes drilled across the site.

17.2.3 Coal, likely the Newhill Coal, up to 300mm thick, was encountered at shallow depth (<3.2m) in two trial pits (TPs 11 & 16) and 3 rotary probeholes (PHs 10, 110 & 113) in the east of Area A.

17.3 Hazardous gas

17.3.1 The site is in an area where between 3% and 5% of homes are estimated to be above the radon action level. Consequently, **basic** radon protection measures are required in new dwellings.

17.3.2 The shallowest recorded underground mineworkings are shown at c.66m depth beneath the site (Two Foot Coal) with Spine Roadways from c. 50m depth associated with the Meltonfield Coal. No workings are associated with the Meltonfield Coal, possibly as a result of groundwater requiring excessive pumping preventing coal extraction.

17.3.3 Consequently, the risk of mines gas affecting the site is considered Low given the significant thickness of overlying Coal Measures deposits, including low permeability Mudstone layers.

17.3.4 However, wells have been installed in 14 probeholes with monitoring underway to confirm the need for any additional protection measures (carbon dioxide and methane). A hazardous gas risk assessment will be issued on completion of monitoring (9 visits over 6 months) in March 2024.

17.4 Contamination & remediation

17.4.1 No made ground has been identified at the site.

17.4.2 The majority of the existing Topsoil is considered suitable for re-use. However, a single elevated concentration of lead (1,100mg/kg) more than 5 times the Lithos Tier 1 Value (200mg/kg) was recorded in one sample of Topsoil recovered from TP07.

17.4.3 This result is likely a sampling or recording error, or could be associated with a localised concentration of lead (eg from lead shot associated with field sports).

17.4.4 Nonetheless, these concentrations are not considered acceptable with Topsoil in garden or landscaped areas and as such some preparatory works will be necessary to render the site suitable for development.

17.4.5 As such, whilst this site does not require large-scale remediation works, it is strongly recommended that, in advance of the anticipated infrastructure groundworks, the localised elevated lead contaminated Topsoil is delineated, before determining an appropriate course of action.

17.4.6 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.

17.5 Foundations

17.5.1 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses constructed at the site. Footings will be founded in medium to high strength clay or competent rock. This solution is viable where any made ground after site re-grade is less than about 2.5m thick, and medium to high strength clay or competent rock is the founding material.

17.5.2 Where site re-grade results in areas of deep made ground (re-engineered fill) or shallow rock, alternative foundations may be required and further advice should be sought from Lithos.

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 will not 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 shallow Cohesive Residual Soils should provide a CBR value of at least 2%.

17.8.2 Where natural soils are re-engineered as part of site re-grade works a CBR of at least 3% should be achievable.

17.8.3 These values should be verified prior to, or during, construction.

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

Reproduced from OS Explorer map 1:25,000 scale by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office. Crown copyright. All rights reserved. Licence number 100049696.

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CLIENT	CREST NICHOLSON YORKSHIRE
JOB TITLE	PIT LANE, WOMBWELL
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	DP
DATE	18 07 2023
CHECKED	ASw
DATE	18 07 2023
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
SCALE	1:25,000
SHEET	A4
DRAWING NO.	4721/1
REVISION	

NOTES

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM STEN ARCITECTURE DRAWING REFERENCE - PIT LANE, WOMBWELL DRAFT LAYOUT SK01- DATED APRIL 2023

REV.	DESCRIPTION	DATE

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CLIENT

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JOB TITLE

PIT LANE, WOMBWELL

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
DP	18 07 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
ASw	18 07 2023	DRAFT ☐
		FINAL ☑

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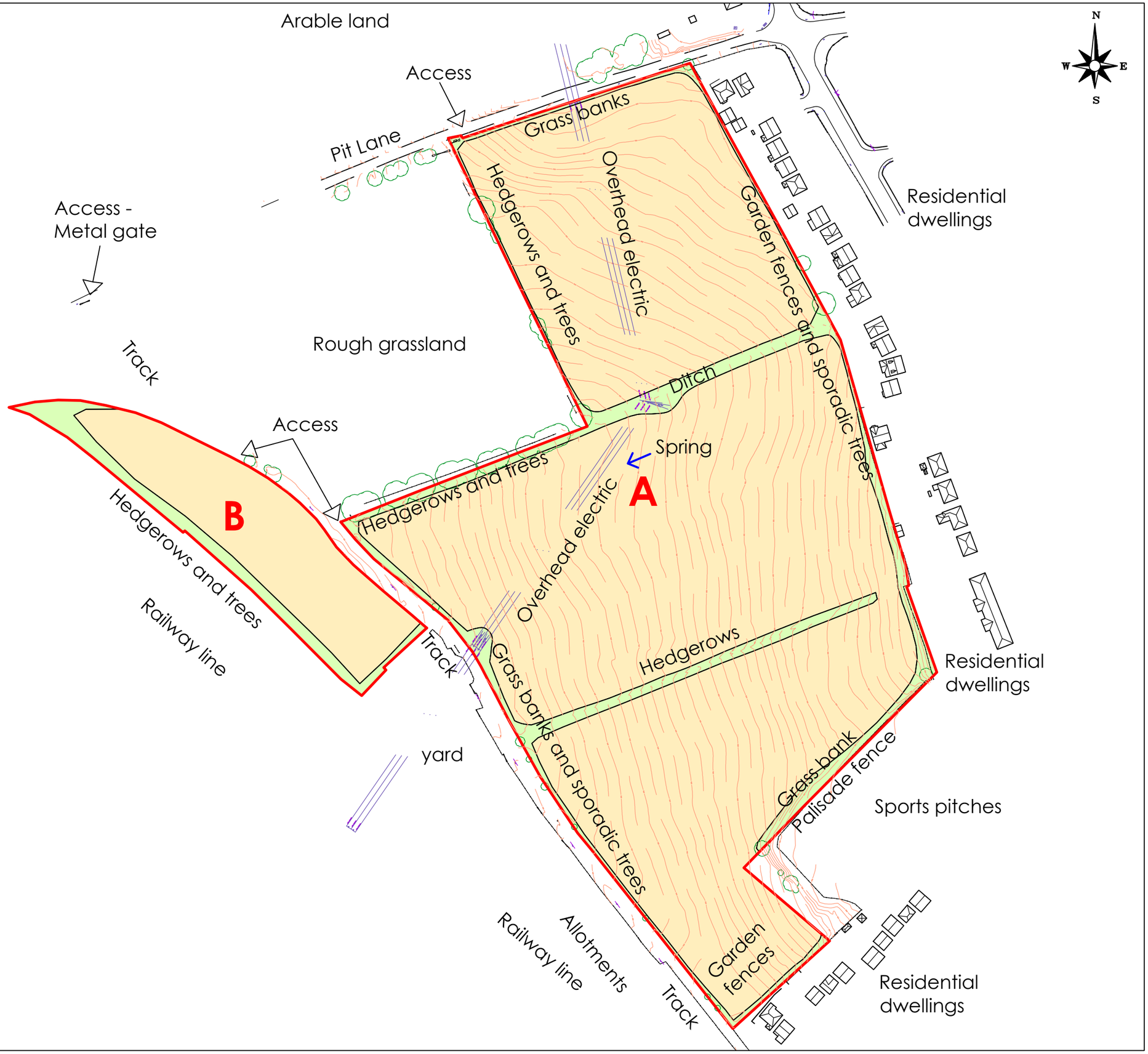

NOTES

- CROPPED FIELD
- GRASS & OVERGROWN AREAS
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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JOB TITLE

PIT LANE, WOMBWELL

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
DP	18 07 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
ASw	18 07 2023	DRAFT ☐
		FINAL ☑

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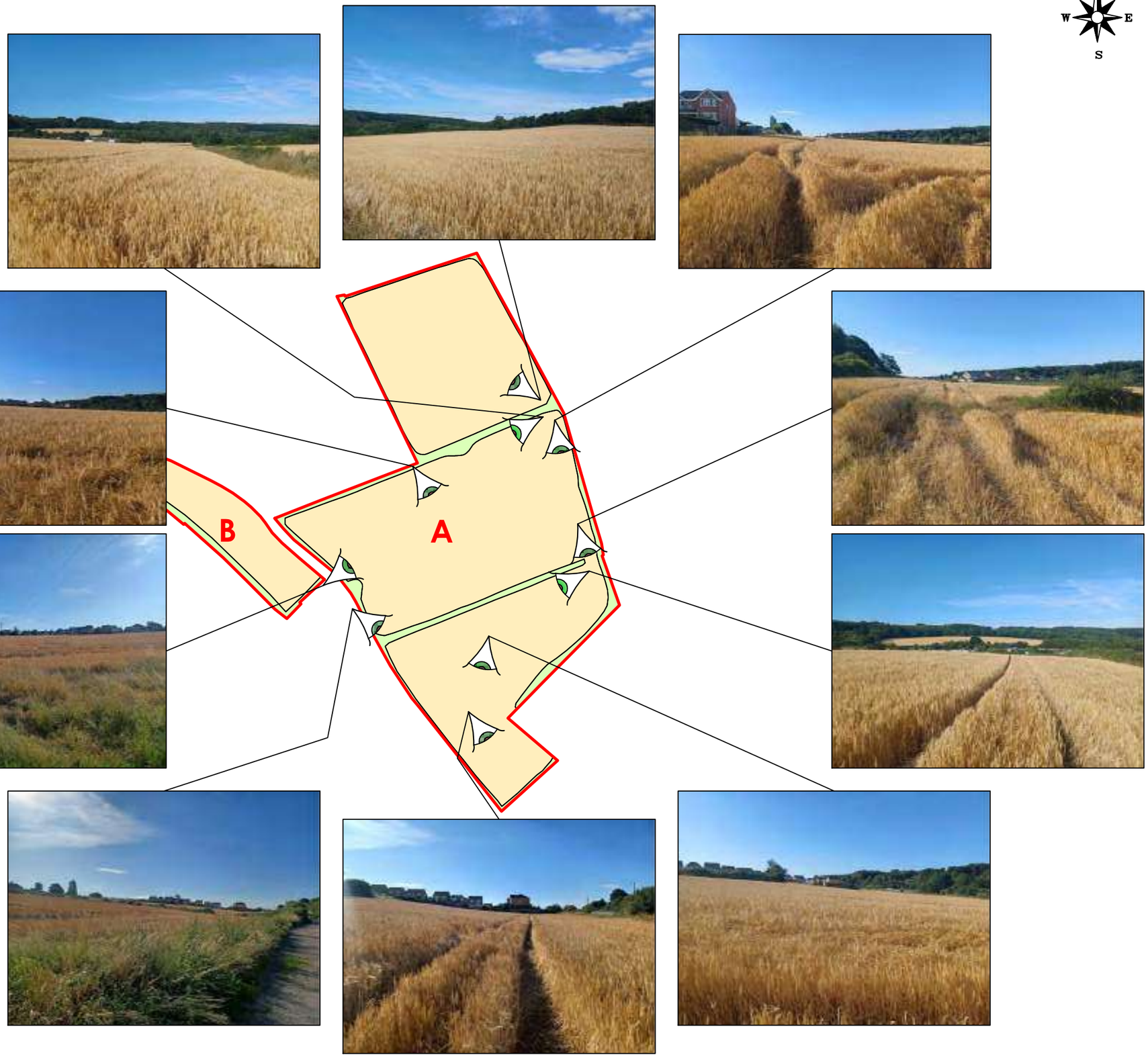

NOTES

- CROPPED FIELD
- GRASS & OVERGROWN AREAS
- APPROXIMATE SITE BOUNDARY
- LOCATION & ORIENTATION OF PHOTOGRAPH

REV.	DESCRIPTION	DATE

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JOB TITLE

PIT LANE, WOMBWELL

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
DP	18 07 2023	FOR COMMENT ☐
		FOR APPROVAL ☐
CHECKED	DATE	DRAFT ☐
ASw	18 07 2023	FINAL ☑

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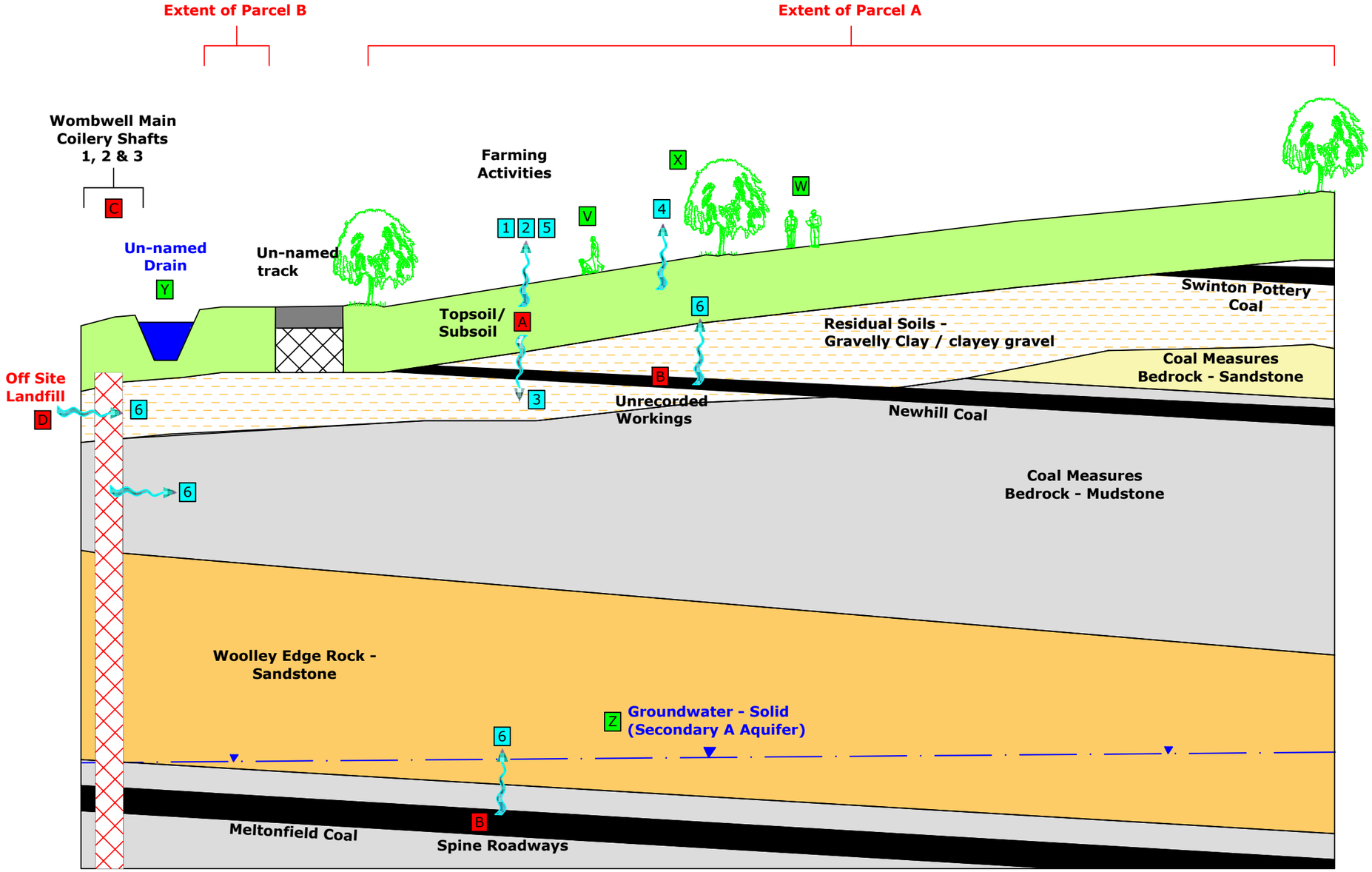

SOURCES	
A	FARMING RELATED CONTAMINANTS (INORGANICS & ORGANICS)
B	SHALLOW COAL & WORKINGS
C	OFF SITE SHAFTS
D	OFF LANDFILL

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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JOB TITLE

PIT LANE, WOMBWELL

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
DP	18 07 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
ASw	18 07 2023	DRAFT ☐
		FINAL ☑

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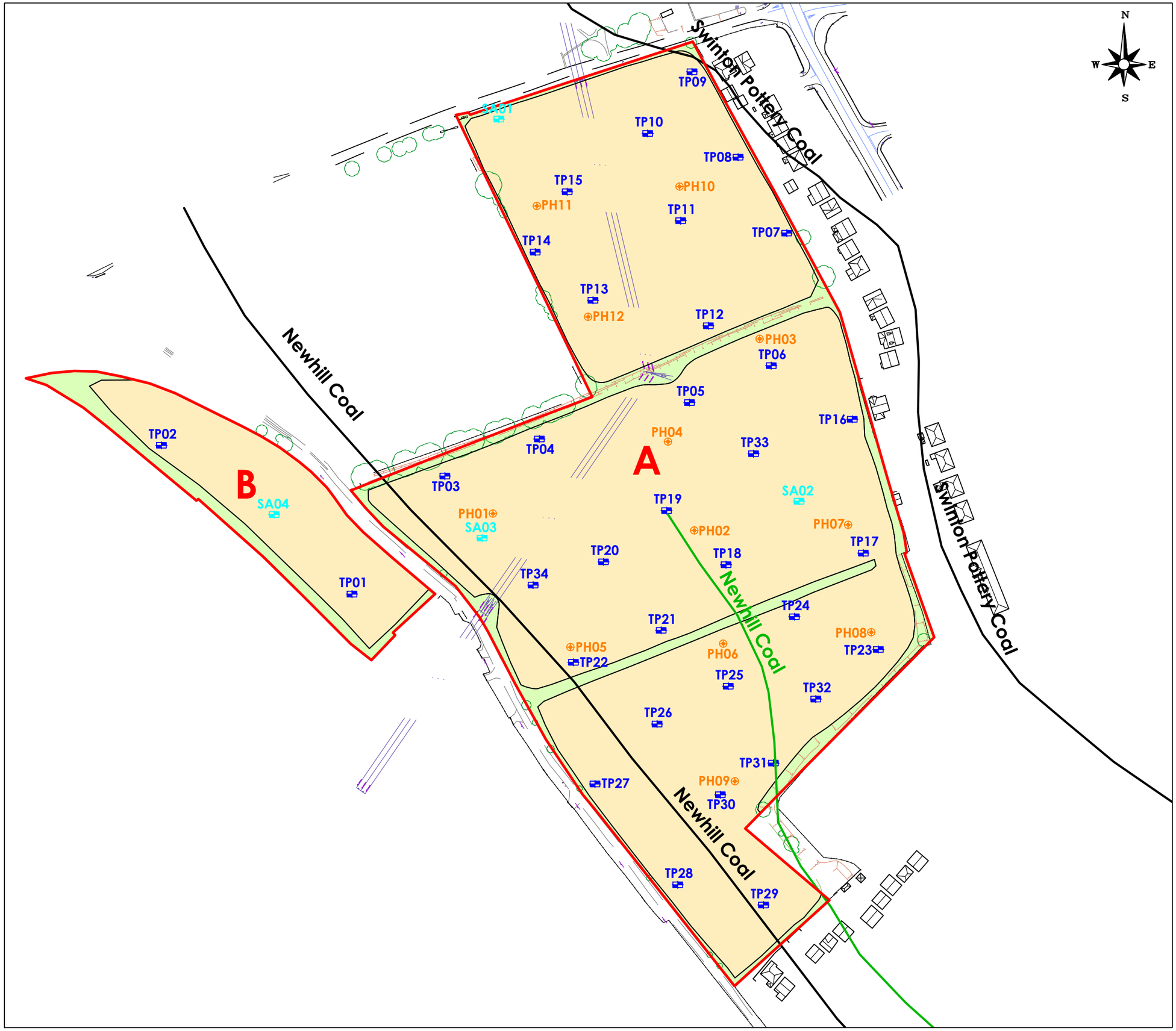

N
W E
S

NOTES

- TRIAL PIT LOCATION
- SOAKAWAY LOCATION
- PROBEHOLE LOCATION
- CA RECORDED COAL SEAM
- BGS RECORDED COAL SEAM
- APPROXIMATE SITE BOUNDARY

EXPLORATORY HOLE LOCATIONS HAVE BEEN SURVEYED IN (COORDINATES & GROUND LEVEL) ON COMPLETION

REV.	DESCRIPTION	DATE

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YORKSHIRE

JOB TITLE

PIT LANE,
WOMBWELL

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
DP	02 08 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
ASw	02 08 2023	DRAFT ☐
		FINAL ☑

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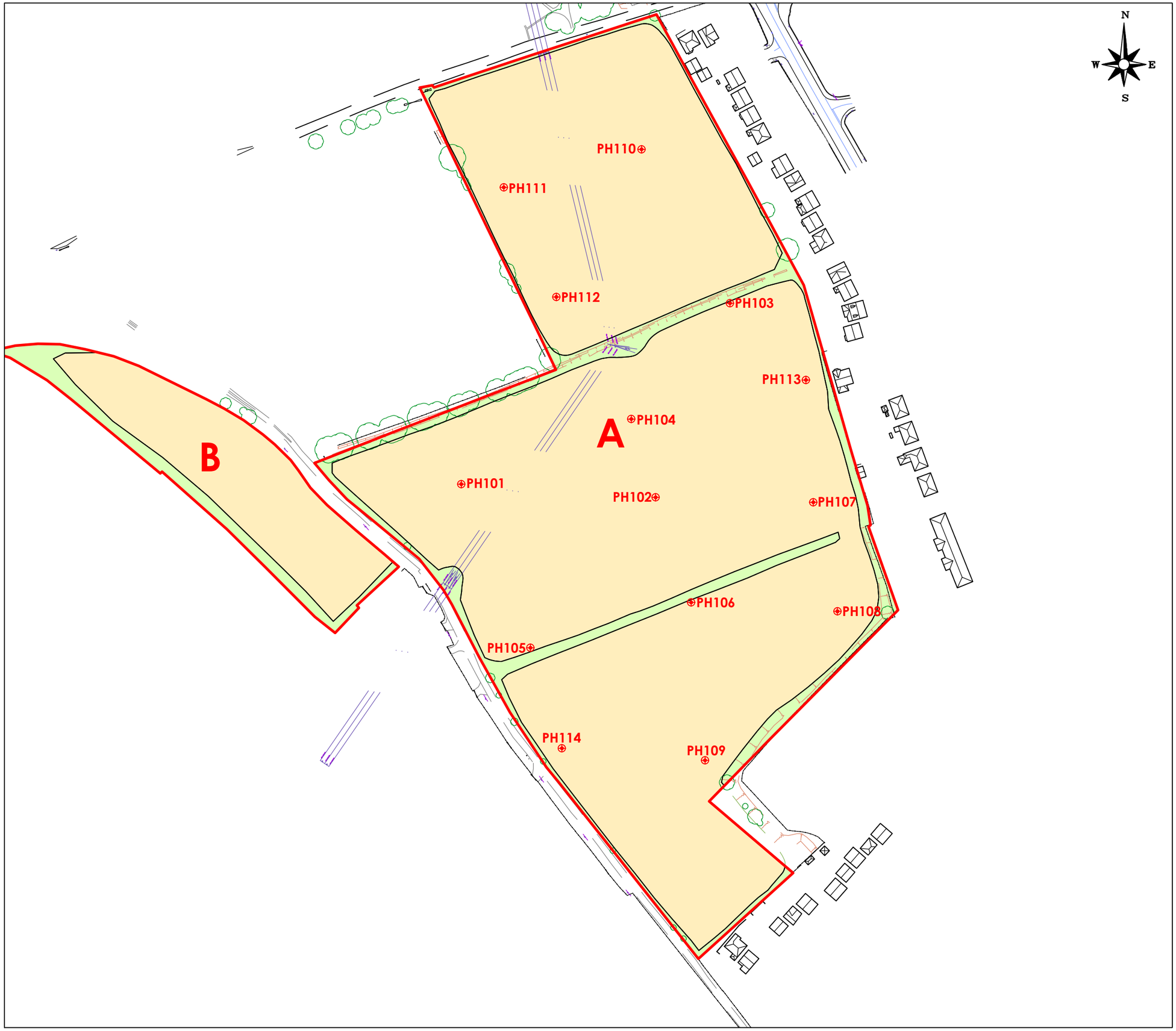

NOTES

- CROPPED FIELD
- GRASS & OVERGROWN AREAS
- MONITORING WELL LOCATION
- APPROXIMATE SITE BOUNDARY

EXPLORATORY HOLE LOCATIONS HAVE BEEN SURVEYED IN (COORDINATES & GROUND LEVEL) ON COMPLETION

MONITORING WELLS ARE ASSOCIATED WITH A CORRESPONDING DEEPER BOREHOLE (PH101 & PH01 etc.),
WITH THE EXCEPTION OF PH113 & PH113 WHICH ARE STANDALONE MONITORING WELL LOCATIONS

REV.	DESCRIPTION	DATE

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JOB TITLE

PIT LANE,
WOMBWELL

DRAWING TITLE

MONITORING WELL LOCATIONS

DRAWN	DATE	STATUS
DP	02 08 23	FOR COMMENT ☐
		FOR APPROVAL ☐
CHECKED	DATE	DRAFT ☑
ASw	02 08 23	FINAL ☐

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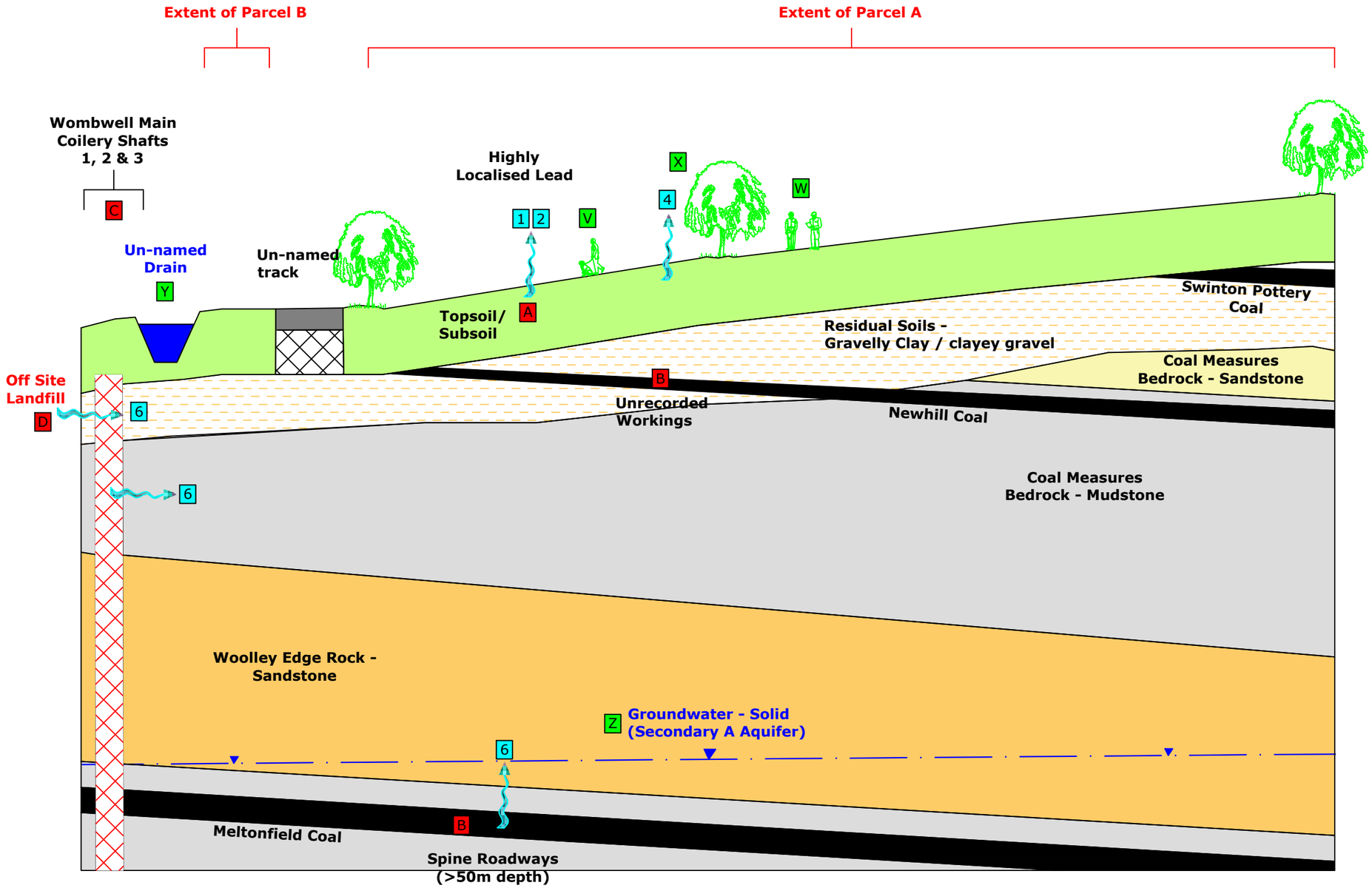

SOURCES	
A	INORGANICS (LOCALISED ELEVATED LEAD)
B	SHALLOW COAL
C	OFF SITE SHAFTS
D	OFF LANDFILL

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION/INHALATION
4	UPTAKE BY PLANTS
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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JOB TITLE

PIT LANE, WOMBWELL

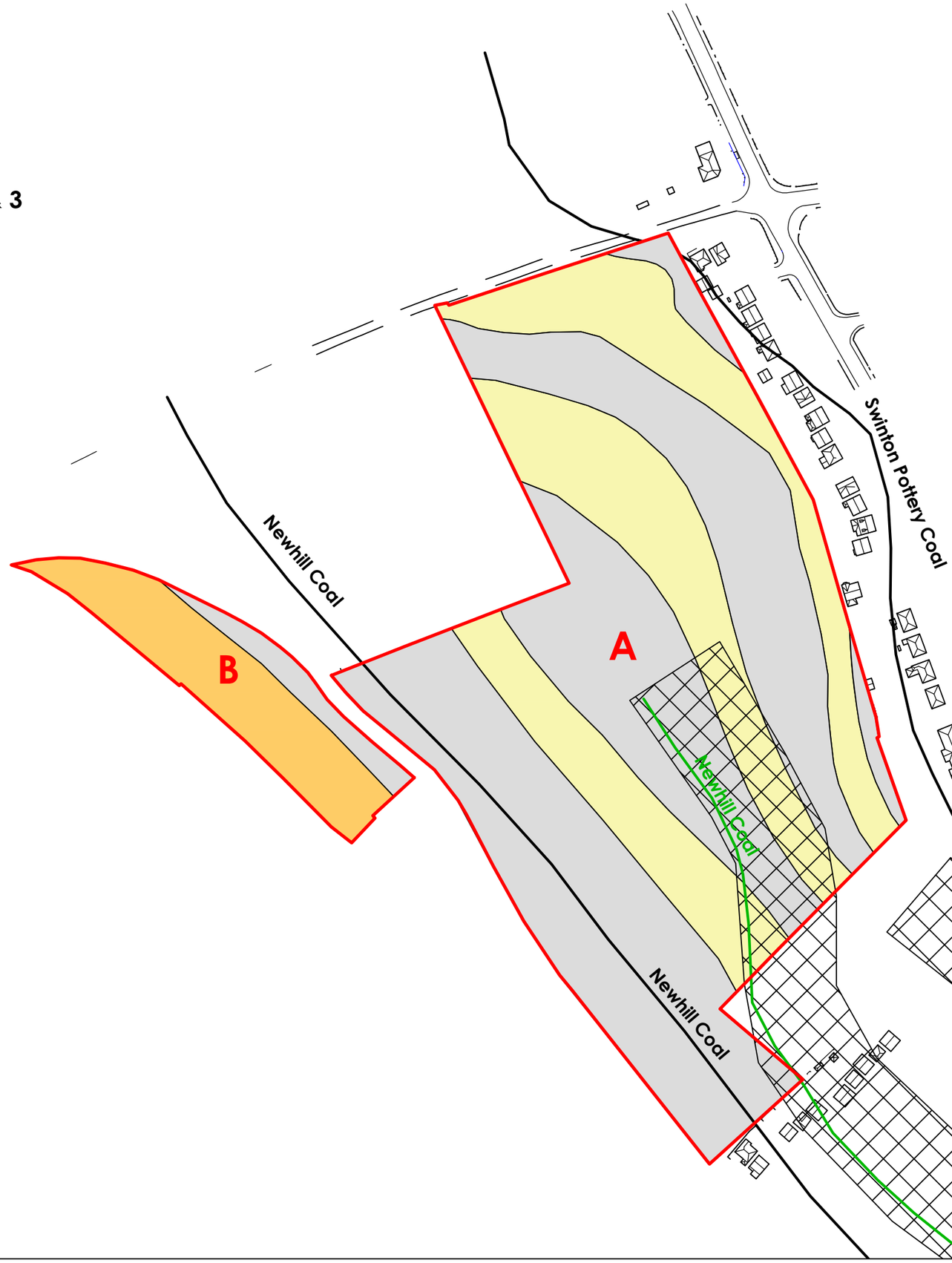
DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
DP	25 08 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
ASw	25 08 2023	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	4721/7	

Wombwell Main
Colliery Shafts 1,2 & 3



NOTES

- PENNINE MIDDLE COAL MEASURES (SANDSTONE)
- PENNINE MIDDLE COAL MEASURES (MUDSTONE)
- WOOLLEY EDGE ROCK(SANDSTONE)
- COAL OUTCROP (FROM CA PLANS)
- COAL OUTCROP (FROM BGS PLANS)
- COAL MINING DEVELOPMENT HIGH RISK AREA
- MINE SHAFT (FROM CA ONLINE VIEWER)
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

info@lithos.co.uk
www.lithos.co.uk

Tel 01937 545330

CLIENT

CREST
NICHOLSON
YORKSHIRE

JOB TITLE

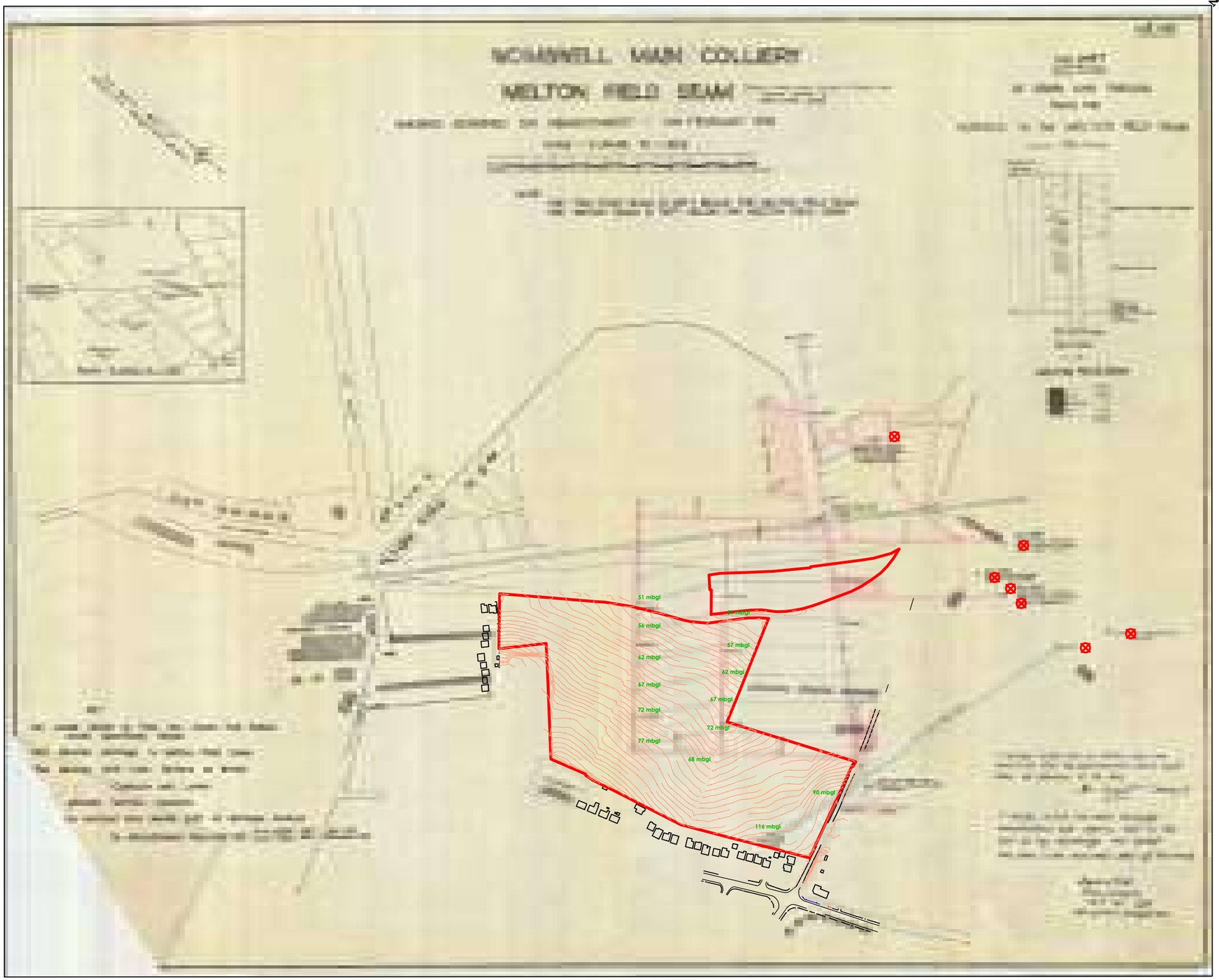
PIT LANE,
WOMBWELL

DRAWING TITLE

GEOLOGY AND MINING HIGH RISK AREAS

DRAWN	DATE	STATUS
DP	18 07 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
ASw	18 07 2023	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:2500	A3	4721/8	



NOTES

APPROXIMATE SITE BOUNDARY

CA Mining plan approximate only, some distortion from original hand drawn survey due to scaling

ADIT (to Winter Coal Seam)

SPINE ROADWAY (Meltonfield Coal)

57mbgl = Approximate depth below existing ground level to spine roadway

MINE SHAFT (FROM CA ONLINE VIEWER)

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

info@lithos.co.uk
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Tel 01937 545330

CLIENT

CREST
NICHOLSON
YORKSHIRE

JOB TITLE

PIT LANE,
WOMBWELL

DRAWING TITLE

CA ABANDONMENT PLAN
(MELTONFIELD COAL)

DRAWN	DATE	STATUS
ASw	25 09 2023	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	25 09 2023	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:5000	A3	4721/9	

Appendix C

Commission

005/4721/LEW

19th May 2023

Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330

www.lithos.co.uk

Mr B Tidmarsh
Crest Nicholson Yorkshire
2175 Century Way
Thorpe Park
Leeds
LS15 8ZB

Dear Ben

Pit Lane, Wombwell

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 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; a sketch layout showing 229 units has been provided.

Review of the information supplied suggests that the site consists of a single parcel of land (c. 7.3 ha) divided into 3 fields to the south of Pit Lane.

Review of Google Maps suggests the site comprises arable fields. Brief review of internet data suggests the site:

- Appears to have remained undeveloped throughout its history;
- Is not located within 250m of a known landfill site;
- Is not within a groundwater source protection zone; and
- Is in an area where the risk of encountering UXO is considered low;

Brief examination of the relevant geological map suggests the site is underlain by interbedded Coal Measures (Sandstone, siltstone & mudstone) likely completely weathered near surface to a sandy gravel/gravelly clay.

The majority of site is located within a Coal Mining Development Low Risk Area, but with an area of **High Risk** in the centre, associated with the inferred outcrop of Newhill Coal Seam. The BGS 1:10,000 geological plan indicates this seam has a thickness of between 0.3m and 0.76m.

The scope of works outlined in this letter should enable us to assess abnormal development issues, associated with the 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: Environmental search data and historical maps (obtained from Landmark or Groundsure), will be reviewed in order to determine whether past land uses have had any effect on the proposed development. In addition, published geological plans of the area will be examined and we will also visit site to undertake a walkover survey.

Given the site's location within a Coal Mining High Risk & Low Risk Area, a consultant's mining report will be obtained. However, Review of the CA's interactive viewer suggests no abandonment plans are available for shallow mineworkings (within 30m of surface) and the risk appears to be associated with potential unrecorded workings in the Newhill seam at/or very near to outcrop.

Fieldwork: We have allowed for 3 day's trial pitting and the drilling of about 12 deep rotary probeholes to check for the presence of mineworkings, and 14 shallow rotary probeholes to allow installation of monitoring wells. All trial pits and boreholes will be supervised and logged by an experienced geoenvironmental engineer.

Trial pitting / trenching will enable us to determine the:

- Nature of any made ground
- Nature, distribution and thickness of shallow soils
- Suitability of the ground for soakaways
- Suitability of the ground for founding structures and highways

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 360º excavator (E\O of £***).

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 (neither considered likely), 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.

Soakaway testing will also be carried out in at least 4 pits in order to assess suitability of the ground for plot and highway surface water drainage. This will provide an 'initial sweep' at relatively wide spacings and often with only 1 or 2 fills.

It should be noted that if the initial soakaway tests yield satisfactory results, in order to obtain approvals from the LLFA, Highways etc, the drainage designer is likely to require further testing: (a) within 25m of proposed chamber locations; and (b) to include 3 fills.

The site is underlain by the Newhill coal seam, and therefore we have allowed for the drilling of 12 deep **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 probeholes within 4 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 absence of coal seams with a history of spontaneous combustion and the site's size / location, we should be able to avoid the need to drill holes within 50m of surrounding residential properties and therefore, in accordance with CA requirements, we should be able to use **air** as the flushing medium.

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.

We have allowed for the provision of heras fencing to secure the drilling rig overnight. At this stage, have assumed that full time 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 all exploratory holes to be picked-up by a **surveyor** (co-ordinates/ground levels will be included on the logs).

Given the possible presence of shallow mineworkings associated with the Newhill seam, we have allowed for the installation of wells in 14 shallow 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, prevents gas migration into sub-floor voids and removes 'obstructions' to farm machinery. 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.

Testing: This will comprise routine **geotechnical** soils analysis, including 15 moisture content & Atterberg limits, and 15 pH & water-soluble sulphate.

This site is greenfield and therefore we could obtain in-situ CBR values from plate tests on site. However, at this stage, we will simply estimate CBR values from strata descriptions and classification test results.

The site is understood to be essentially Greenfield, and therefore testing of potentially **contaminated** samples should only be required if made ground is encountered in the exploratory holes. However, we have allowed for analysis of topsoil (15 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH.

If more significant made ground is encountered, we will inform you immediately and provide costs for the recommended chemical testing.

Within in our proposal we have allowed for the screening (ID) of 15 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.

Visible contaminants, sharps and the clay/sand/silt content of 5 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 completed copy of the **YW** Contaminated Land Assessment Form will be included in an Appendix to our Report. However, the proposed route(s), and total length, of water supply pipes are not currently known and no allowance has been made for laboratory testing of soil samples in line with UKWIR 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 **3 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 last for at least 3 working days and therefore this proposal includes for provision of a Welfare Unit, with the benefit of full canteen facilities, hot water with full size sink, toilet and drying room.

Immediately prior to commencement of fieldwork, a site compound will be established in a location to be agreed with Crest, comprising a welfare cabin for site staff, secured with heras fencing; equipment and plant will be stored here overnight.

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.

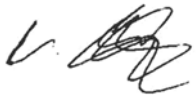
If no other designers or contractors have been appointed, Lithos could perform the role of Principal Contractor but only for the duration of the site investigation outlined in this proposal. If you require us to perform the role of Principal Contractor, please make this clear in your instruction. It 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



Lewis Whiteley
Senior Engineer
for and on behalf of
LITHOS CONSULTING LIMITED

1 DEFINITIONS AND INTERPRETATION

1.1 In this Agreement, unless the context otherwise requires, the following words and expressions have the following meanings:

"Agreement" means these Terms (entitled "Terms and Conditions for the Appointment of Lithos Consulting"), the Proposal, any document recording your unequivocal acceptance of the Proposal and any other documents or parts of other documents expressly referred to in any of the foregoing;

"Documents" means all documents of any kind and includes plans, drawings, reports, programmes, specifications, Bills of Quantities, calculations, letters, e-mails, faxes, memoranda, films and photographs (including negatives), or any other form of record prepared or provided or received by, or on behalf of us, and whether in paper form or stored electronically or on disk, or otherwise;

"Intellectual Property" includes all rights to, and any interests in, any patents, designs, trade marks, copyright, know-how, trade secrets and any other proprietary rights or forms of intellectual property (protectable by registration or not) in respect of any technology, concept, idea, data, programme or other software (including source and object codes), specification, plan, drawing, schedule, minutes, correspondence, scheme, programme, design, system, process logo, mark, style, or other matter or thing, existing or conceived, used, developed or produced by any person;

"Project" means the project described in the Proposal and any enquiry from you on which we have based our Proposal;

"Proposal" means the offer document prepared by us in response to an enquiry or otherwise, in connection with the proposed provision of the Services;

"Services" means the work and services relating to the Project to be provided by us pursuant to the Agreement and as set out in the Proposal and includes any additions or amendments thereto made in accordance with these Terms;

"Terms" means these terms entitled "Lithos Consulting Terms of Appointment" as amended from time to time.

1.2 Words importing the singular only shall also include the plural and vice versa, where the context requires.

1.3 Words importing persons or parties shall include firms, corporations and any organisation having legal capacity and vice versa, where the context requires; and words importing a particular gender include all genders.

1.4 The sub-headings to the clauses of these Terms are for convenience only and shall not affect the construction of the Agreement.

1.5 A reference to legislation includes that legislation as from time to time amended, re-enacted or substituted and any Orders in Council, orders, rules, regulations, schemes, warrants, by-laws, directives or codes of practice issued under any such legislation.

1.6 In the event of conflict between the documents forming part of the Agreement, the Proposal shall prevail, followed by the Terms.

2 APPOINTMENT

2.1 You agree to engage us and we agree to provide the Services in accordance with the provisions of this Agreement.

3 OUR OBLIGATIONS

3.1 We shall perform the Services using the reasonable standard of skill and care normally exercised by qualified members of our profession, performing similar services under similar conditions.

3.2 We shall use all reasonable endeavours to perform the Services in accordance with relevant environmental and safety legislation.

4 YOUR OBLIGATIONS

4.1 Throughout the period of this Agreement you shall afford to us, or procure for our benefit, access to any site where access is required for the performance of the Services.

4.2 You accept responsibility for ensuring that we are notified in writing of all special site and/or plant conditions, including without prejudice to the generality of the foregoing, the existence and precise location of all underground services, cables, pipes, drains or underground buildings, constructions or any hazards, which you shall clearly mark on the ground or identify on accurate location plans supplied to us prior to the commencement of the Services. You shall also inform us in writing of any relevant operating procedures including any site safe operating procedures and any other regulations relevant to the carrying out of the Services. You shall indemnify us against all costs, losses, claims, demands and expenses arising as a result of any non-disclosure in this respect, including but not limited to indemnification against any action brought by the owner of the land or otherwise.

4.3 If you discover any conflict, defect or other fault in the information or designs provided by us pursuant to the Agreement, you will advise us in writing of such defect, conflict or other fault and we shall have the right to rectify the same or where necessary, to design the solution for rectification of any works carried out by others pursuant the conflicting, defective or in any other way faulty information or designs.

5 COPYRIGHT

5.1 The copyright in all Intellectual Property prepared by or on behalf of us in connection with the Project for delivery to you shall remain vested in us.

5.2 You shall have a non-exclusive licence to copy and use such Intellectual Property for purposes directly related to the Project. Such licence shall enable you to copy and use the Intellectual Property but solely for your own purposes in connection with the Project and such use shall not include any licence to reproduce any conceptual designs or professional opinions contained therein nor shall it include any license to amend any drawing, design or other Intellectual Property produced by us.

5.3 Should you wish to use such Intellectual Property in connection with any other works or for any other purpose not directly related to the Project or wish to pass any Intellectual Property to any third party, you must obtain our prior written consent. The giving of such consent shall be at our absolute discretion and shall be upon such terms as we may require. We shall not be liable to you for the use by any person of such Intellectual Property for any purpose other than that for which the same were prepared by or on our behalf.

5.4 Ownership of any proposals submitted to you that are not subsequently confirmed as part of the Services to be provided for you remain with us and such proposals must not be used as the basis for any future work undertaken by you or a third party and no liability can be accepted howsoever arising from such proposals.

5.5 In the event of you being in default of payment of any fees or other amounts due, we may suspend further use of the licence on giving no less than 2 calendar days' notice of the intention to do so. Use of the licence may be resumed on receipt of the outstanding amounts.

6 CONFIDENTIALITY

6.1 Neither you nor we shall at any time disclose to any person any confidential information concerning the business, affairs, customers, clients or suppliers of the other party or of any member of the group of companies to which the other party belongs, except as permitted by clauses 6.2 and 6.4.

6.2 Each party may disclose the other party's confidential information:

(a) to its employees, officers, representatives, contractors, sub-contractors or advisers who need to know such information for the purposes of exercising the party's rights or carrying out its obligations under or in connection with this Agreement. Each party shall ensure that its employees, officers, representatives, contractors, sub-contractors or advisers to whom it discloses the other party's confidential information comply with this paragraph 6; and

(b) as may be required by law, to a court of competent jurisdiction or any governmental or regulatory authority.

6.3 Neither you nor we shall use any other party's confidential information for any purpose other than to exercise our rights or perform our respective obligations under or in connection with this Agreement.

6.4 Subject to the above and our privacy policy which can be found on www.lithos.co.uk, we shall be permitted to use information related to the Services we provide in connection with the Project for the purposes of marketing its services and in proposals for work of a similar type.

7 ASSIGNMENT

7.1 You may assign the benefit of this Agreement on two occasions with our prior written consent (not to be unreasonably withheld) and any additional assignments shall be with our prior consent.

7.2 We may at any time assign, mortgage, charge, subcontract, delegate, declare a trust over or deal in any other manner with any or all of our rights and obligations under this Agreement.

8 INSURANCE

8.1 We shall maintain a professional indemnity insurance policy covering our liabilities for negligence under this Agreement, with a limit of indemnity of £5,000,000 (FIVE MILLION POUNDS) any one claim, save for pollution and contamination claims and asbestos claims both of which carry £2,000,000 (TWO MILLION POUNDS) in the aggregate cover. This policy is annually renewable and whilst renewal is not automatic, We shall maintain such insurance at all times until six years from the date of the completion (or termination) of the Services under this Agreement, provided such insurance is available at commercially reasonable rates and terms.

8.2 If for any period such insurance is not available at commercially reasonable rates and terms, we shall inform you and shall obtain in respect of such period such reduced level of professional indemnity insurance as is available and as would be fair and reasonable in the circumstances for us to obtain.

9 PAYMENT

9.1 Invoices for services rendered will be submitted for payment in accordance with the Proposal.

9.2 You shall pay you any VAT properly chargeable on the Services and any amount expressed as payable to us under this Agreement is exclusive of VAT unless stated otherwise.

9.3 The due date for payment is the date of the invoice and the final date for payment is 28 days from the date of the invoice.

9.4 If you dispute the amount included for payment in an invoice then you must serve a written notice on us no later than 14 calendar days before the final date for payment. If no notice is given within the required timeframe the amount due shall be the amount stated in the invoice.

9.5 If you fail to pay any monies in accordance with the foregoing payment provisions, we shall be entitled to charge interest on any monies owed to us, such interest to be at a rate of 4% above the base rate of a clearing bank from time to time calculated from the final date for payment to the date of actual payment on a compound basis. The parties acknowledge that our liability under this clause 10.5 is a substantial remedy for the purposes of section 9(1) of the Late Payment of Commercial Debts (Interest) Act 1998.

10 LIMITATIONS ON LIABILITY

10.1 Unless otherwise agreed in writing, our total liability under or in connection with this Agreement whether in contract, tort, negligence, breach of statutory duty or otherwise (other than in respect of personal injury or death) shall be limited to and shall not exceed the lesser of either the level of insurance cover referred to within clause 8.1 above, or 20 times the total value of invoices issued to you for the Services.

10.2 No action or proceedings under or in respect of the Agreement whether in contract, tort, negligence, under statute or otherwise shall be commenced against us after the expiry of a period of six years from the date of the completion (or termination) of the Services under this Agreement.

10.3 Whilst we usually scan for potential exploratory locations with a Cable Avoidance Tool, we shall not be liable for any damage to underground services, cables, pipes, drains or underground buildings, constructions and the like which were either not marked on site or for which accurate plans were not provided.

10.4 We shall not be liable for the cost of rectifying any defect, conflict or other fault in the information or designs provided by us or for the cost of designing a solution for and rectifying any subsequent works carried out by others pursuant to the conflicting, defective or in any other way faulty information or designs, unless we have been advised in writing of the same by you and have been given the opportunity to rectify the same or where necessary, to design the solution for rectification of any subsequent works carried out by others pursuant to the same.

11 DELAY

We shall comply with any timescale agreed for completion of the Services unless delayed or prevented by circumstances beyond our reasonable control and in the event of any such circumstances arising we undertake to complete the Services within a reasonable period, but will not be liable to you for any delay as a result.

12 TERMINATION

12.1 The Agreement may be terminated by either of us in the event of the other making a composition or arrangement with its creditors, becoming bankrupt, or being a company, making a proposal for a voluntary arrangement for a composition of debts, or has a provisional liquidator appointed, or has a winding-up order made, or passes a resolution for voluntary winding-up (except for the purposes of a bona fide scheme of amalgamation or reconstruction), or has an administrator or an administrative receiver appointed to the whole or any part of its assets. Notice of termination must be given to the party which is insolvent by the other party.

12.2 If for any reason our Services are suspended for a period in excess of three calendar months then we shall be entitled to terminate our appointment under this Agreement in respect of the Services by no less than seven days written notice to you.

12.3 If you fail to pay in full any sum due under the terms of this Agreement by the final date for payment for that sum and no effective pay less notice is issued, we may serve written notice to you demanding payment within 14 days of such notice. If you fail to comply with such notice, we shall be entitled to terminate our employment under this Agreement forthwith.

12.4 Any termination of our appointment howsoever caused shall be without prejudice to our rights to require payment for all Services performed up to the date of such termination including but not limited to payment of a fair and reasonable proportion of any figure identified in the Proposal or otherwise for fees in respect of a particular service which Lithos has started, but not completed.

13 THIRD PARTY RIGHTS

The Agreement shall not confer and shall not purport to confer on any third party any benefit or any right to enforce any term of this Agreement for the purposes of the Contracts (Rights of Third Parties) Act 1999 or otherwise.

14 COLLATERAL WARRANTIES & LETTERS OF RELIANCE

We shall consider and may consent to a request from you for us to enter into a collateral warranty or letter of reliance with a third party with regard to the Services provided under this Agreement. The giving of such consent shall be at our absolute discretion and providing we agree to our standard form of collateral warranty or letter of reliance (subject to any reasonable changes to be approved by us at our absolute discretion) and in return for payment of a fee (to be notified at the time of the request).

15 NOTICES

15.1 Any notice provided for in the Agreement shall be in writing and shall be deemed to be properly given if delivered by hand or sent by pre-paid first class post to the address of the relevant party as may have been notified by each party to the other or, in the absence of notification, to our respective registered office addresses.

15.2 Such notice shall be deemed to have been received on the day of delivery if delivered by hand or on the second working day after the day of posting if sent by pre-paid first class post.

16 ENTIRE AGREEMENT

16.1 The Agreement constitutes the complete and entire agreement between us with respect to the Services and supersedes any prior oral and/or written warranties, terms, conditions, communications and representations, whether express or implied and any claim against us in respect of the Services can only be made in contract under the provisions of this Agreement and not otherwise under the law or tort or otherwise.

16.2 No amendments, modifications or variation of this Agreement shall be valid unless made in writing and agreed to by us; such agreement must be recorded in writing by at least one of us.

16.3 We shall not be bound by any standard or printed terms or conditions furnished by you in any of your documents unless we specifically state in writing separately from such documents that we intend such terms and conditions to apply.

17 DISPUTES, JURISDICTION AND GOVERNING LAW

17.1 This Agreement shall be governed by and construed in accordance with English law and we irrevocably and unconditionally submit to the jurisdiction of the English Courts.

17.2 Where the Housing Grants, Construction and Regeneration Act 1996 applies, any dispute between us may be referred to adjudication in accordance with The Scheme for Construction Contracts Regulations 1998 or any amendment or modification thereof being in force at the time of the dispute, as applicable to England, Wales, Scotland and Northern Ireland.

Dan Platford

From: Ben Tidmarsh <Ben.Tidmarsh@crestnicholson.com>
Sent: Friday, June 23, 2023 1:28 PM
To: Lewis Whiteley <Lewis.Whiteley@lithos.co.uk>
Cc: Reg <reg@lithos.co.uk>
Subject: RE: Land off Pit Lane, Wombwell - Stage 2 SI

Afternoon Lewis,

Thank you for the quote.
Please can I book you in for fieldwork to start W/C 10th July

Ben Tidmarsh
Engineering Manager

Crest Nicholson Yorkshire
2175 Century Way, Thorpe Park, Leeds, LS15 8ZB.
E-mail: ben.tidmarsh@crestnicholson.com
DD: 0113 5215934
M: 07989 727105
www.crestnicholson.com

From: Lewis Whiteley <Lewis.Whiteley@lithos.co.uk>
Sent: Friday, May 19, 2023 8:50 AM
To: Ben Tidmarsh <Ben.Tidmarsh@crestnicholson.com>
Cc: Reg <reg@lithos.co.uk>
Subject: [EXTERNAL] RE: Land off Pit Lane, Wombwell - Stage 2 SI

Morning Ben

Please find our SI quote attached (£**k). As always, this allows for a robust scope of works (including rotary probing for mineworkings) that should enable you to submit a bid that is unconditional with respect to ground and discharge ground-related planning conditions.

We would expect to be on site within 4 weeks of instruction (due to the requirements of a CA permit), 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).

We have done a couple of sites in Wombwell so know the area well.

Any queries, please give Reg or myself a call.

Kind Regards

Lewis Whiteley
Senior Engineer
Lithos Consulting Ltd

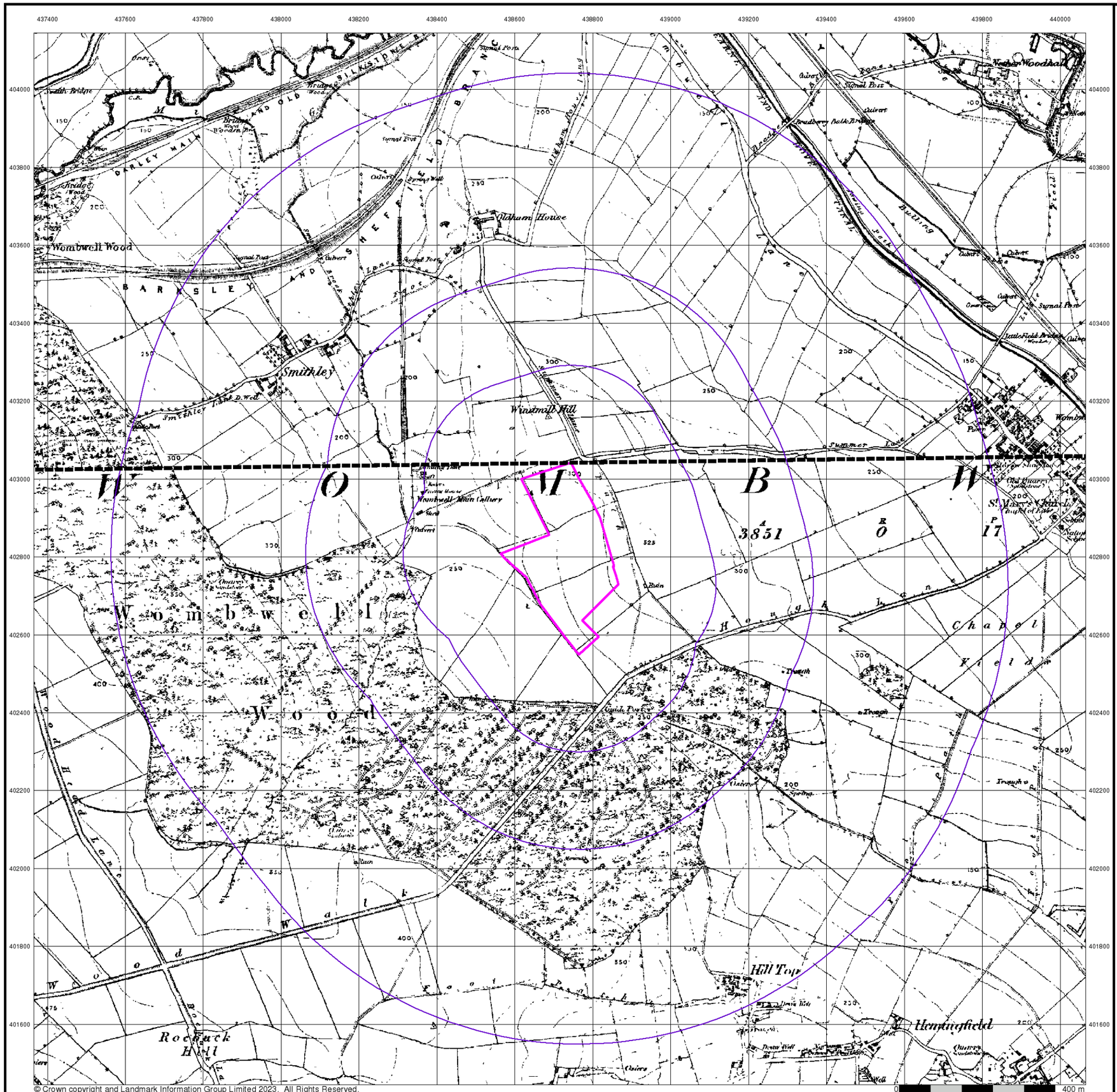
lewis.whiteley@lithos.co.uk
www.lithos.co.uk

Parkhill
Walton Road
Wetherby, LS22 5DZ

M 07951 702 083
DD 01937 543 355

Appendix D

Historical OS Plans



LITHOS CONSULTING

Yorkshire

Published 1854 - 1855

Source map scale - 1:10,560

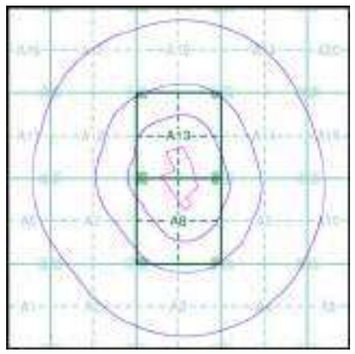
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some 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. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

27500
1854
1:10,560

28300
1855
1:10,560

Historical Map - Slice A



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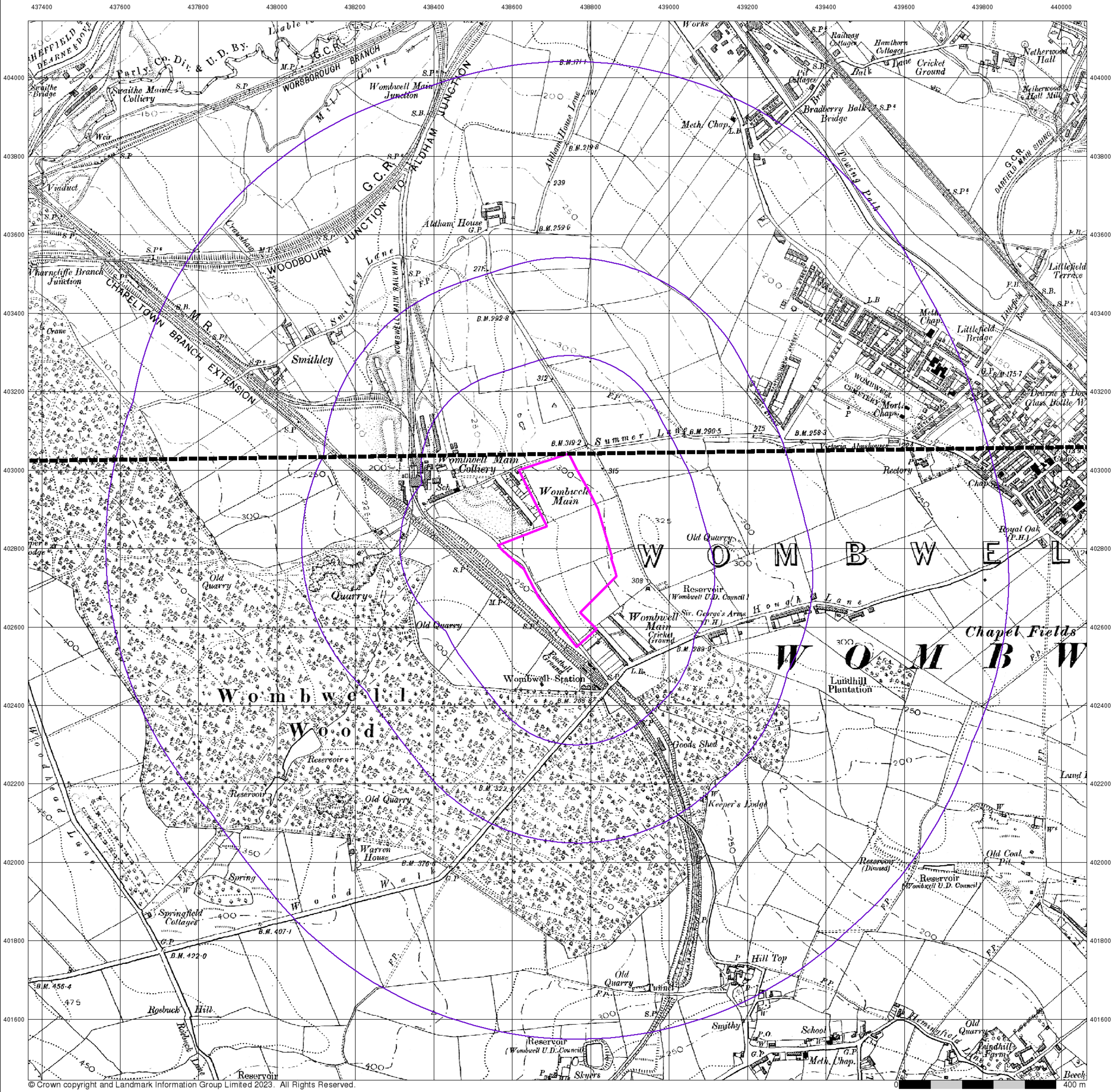
Order Details

Order Number:	313377122_1_1
Customer Ref:	PO20882/CH/4721
National Grid Reference:	438720, 402800
Slice:	A
Site Area (Ha):	7.46
Search Buffer (m):	1000

Site Details

Pit Lane, Wombwell, S73 8QD

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LITHOS CONSULTING

Yorkshire

Published 1905 - 1907

Source map scale - 1:10,560

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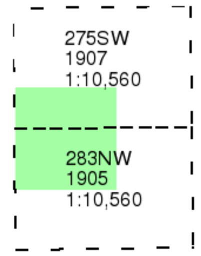
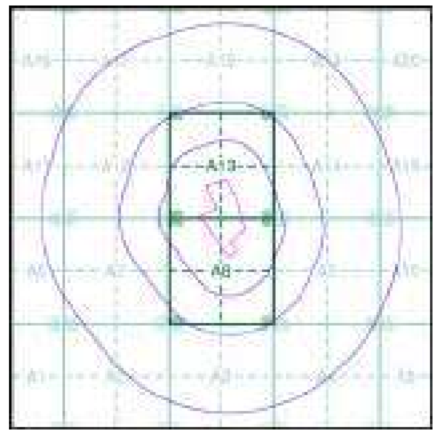
Map Name(s) and Date(s)



Historical Map - Slice A



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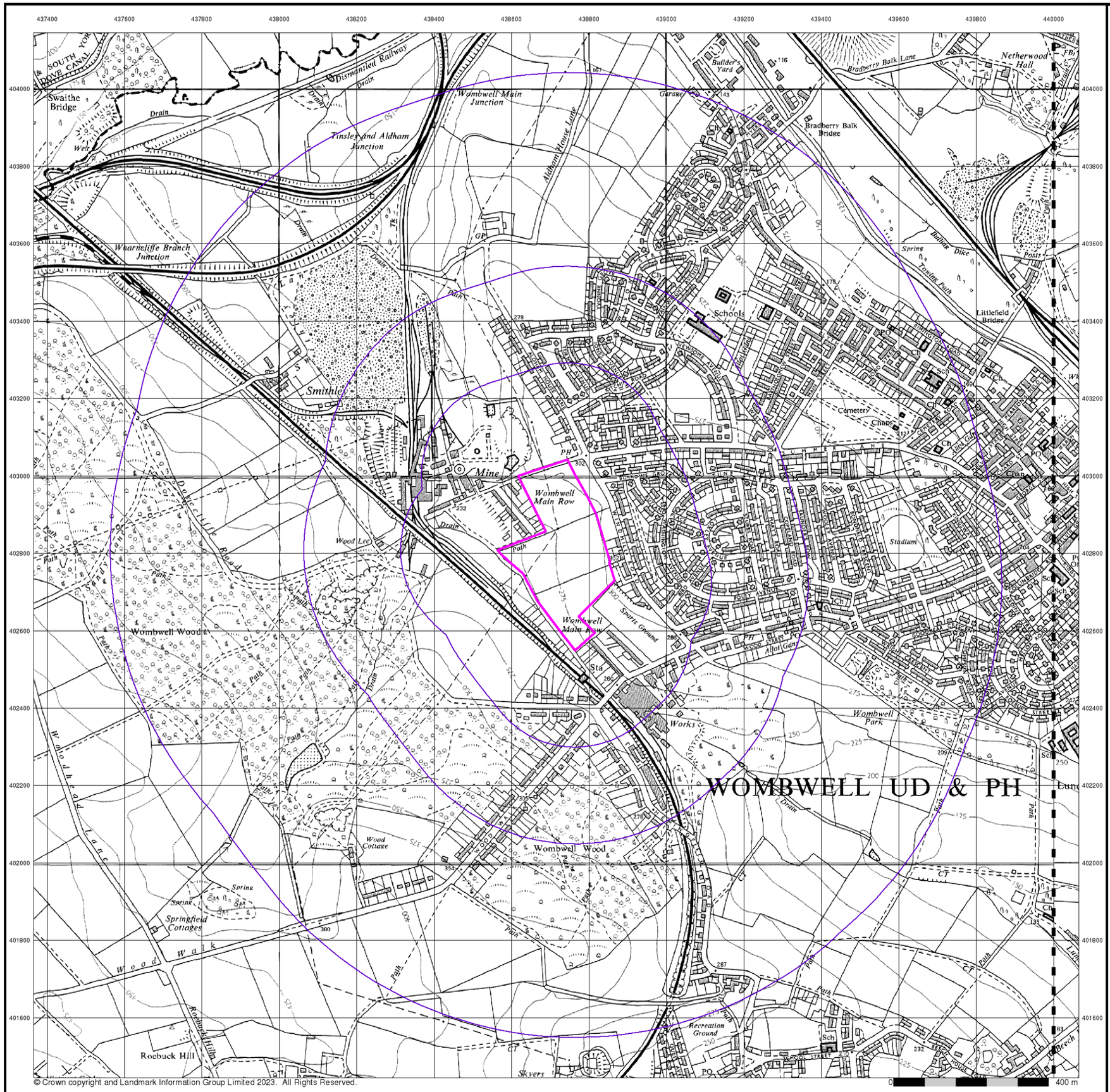


LITHOS CONSULTING

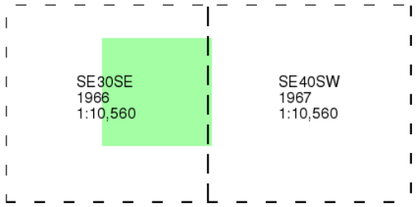
Ordnance Survey Plan

Published 1966 - 1967

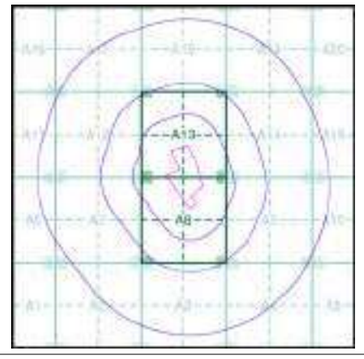
Source map scale - 1:10,000

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; these maps were used to update the 1:10,560 maps. The published date given therefore 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. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



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Customer Ref:	PO20882/CH/4721
National Grid Reference:	438720, 402800
Slice:	A
Site Area (Ha):	7.46
Search Buffer (m):	1000

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Pit Lane, Wombwell, S73 8QD

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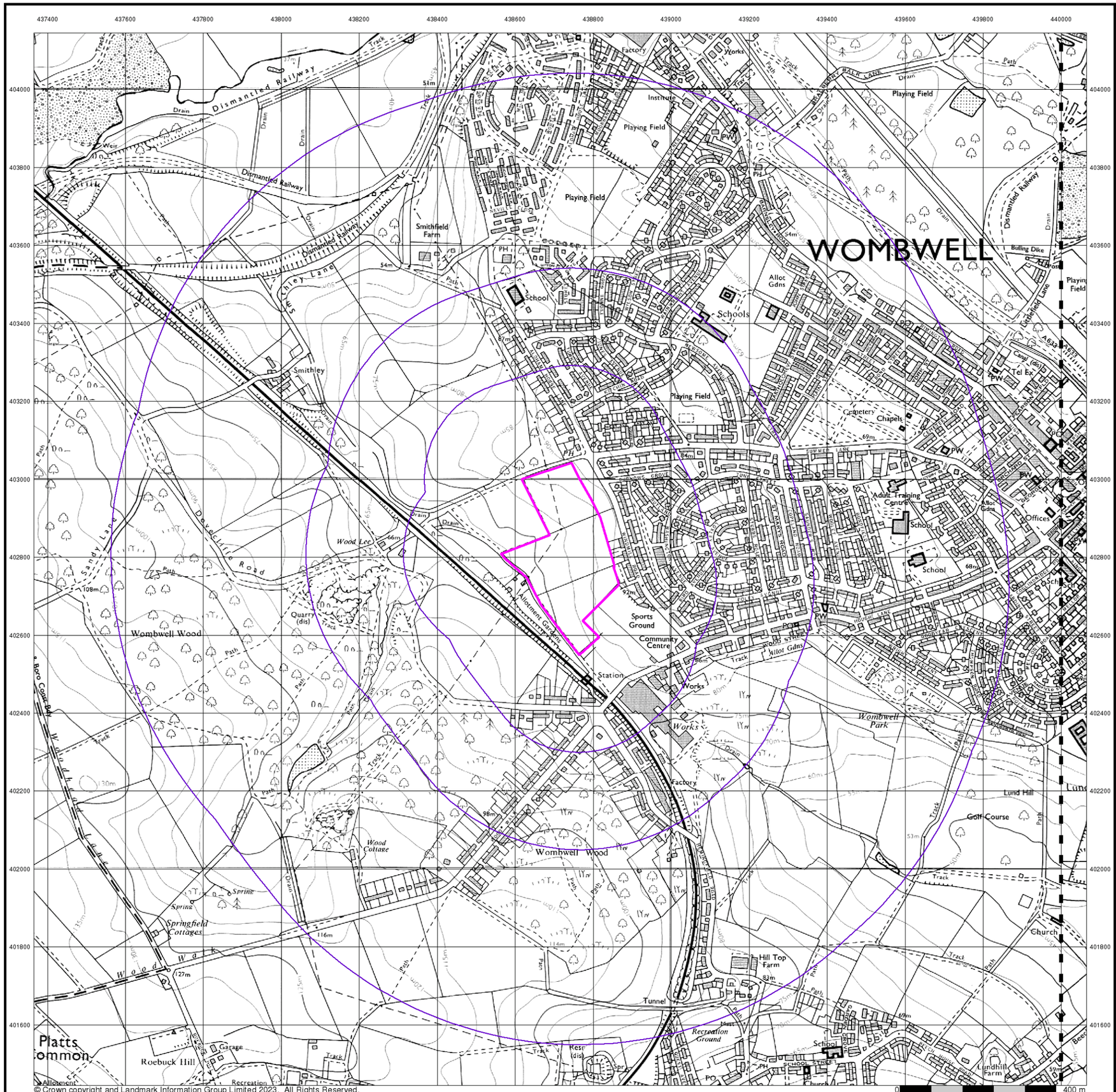
Web: www.envirocheck.co.uk



LITHOS CONSULTING

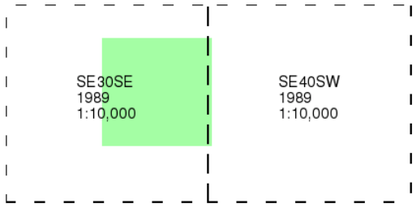
Ordnance Survey Plan

Published 1989

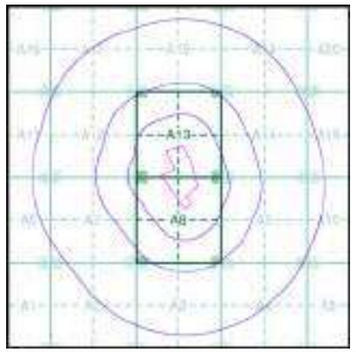
Source map scale - 1:10,000

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; these maps were used to update the 1:10,560 maps. The published date given therefore 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. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



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National Grid Reference:	438720, 402800
Slice:	A
Site Area (Ha):	7.46
Search Buffer (m):	1000

Site Details

Pit Lane, Wombwell, S73 8QD

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Appendix E

Search Responses & other Correspondence

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
313377122_1_1

Customer Reference:
PO20882/CH/4721

National Grid Reference:
438720, 402800

Slice:
A

Site Area (Ha):
7.46

Search Buffer (m):
1000

Site Details:

Pit Lane
Wombwell
S73 8QD

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

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 3				1
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	pg 3		2		3
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 4		Yes		
Pollution Incidents to Controlled Waters	pg 4			1	
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality	pg 4				1
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register					
Water Abstractions	pg 4				(*6)
Water Industry Act Referrals					
Groundwater Vulnerability Map	pg 6	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 6	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	pg 6		Yes	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 7		3	7	32

Summary

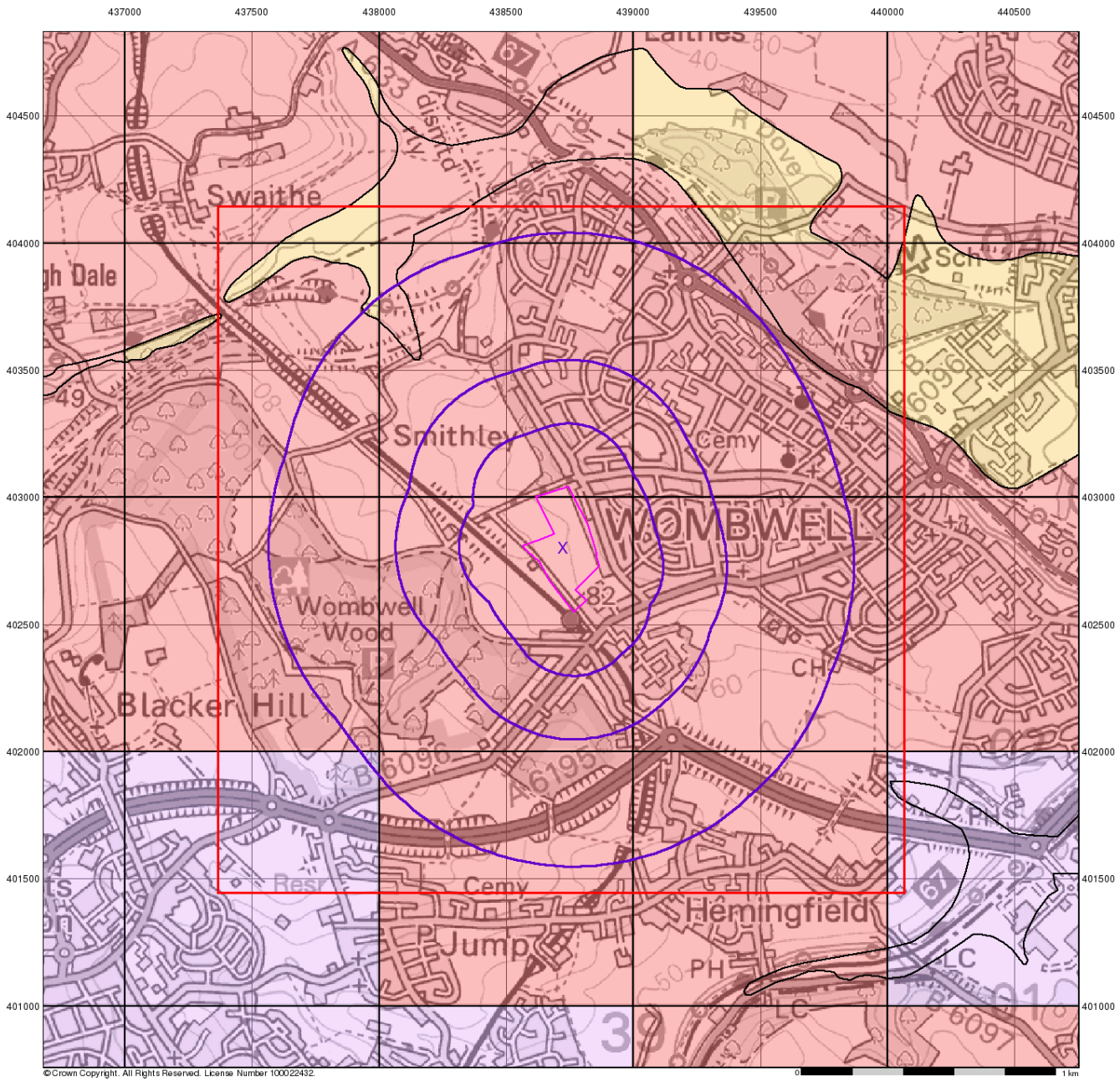
Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites	pg 12			1	
Historical Landfill Sites	pg 12			3	1
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)	pg 13			1	
Licensed Waste Management Facilities (Locations)	pg 13			1	
Local Authority Landfill Coverage	pg 13	1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites	pg 13			2	
Potentially Infilled Land (Non-Water)	pg 13		2	2	2
Potentially Infilled Land (Water)	pg 14		1		5
Registered Landfill Sites	pg 14			2	
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					

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 16	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 16	Yes	Yes		Yes
BGS Recorded Mineral Sites	pg 19		2	9	5
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 22	Yes	n/a	n/a	n/a
Mining Instability	pg 22	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain	pg 22	Yes	Yes	n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 22	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 22	Yes		n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 23	Yes		n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 23	Yes		n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 23	Yes		n/a	n/a
Radon Potential - Radon Affected Areas	pg 24	Yes	n/a	n/a	n/a
Radon Potential - Radon Protection Measures	pg 24	Yes	n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 25		3	7	20
Fuel Station Entries					
Points of Interest - Commercial Services	pg 27		2		6
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 28		4	3	7
Points of Interest - Public Infrastructure	pg 29		2		3
Points of Interest - Recreational and Environmental	pg 29			2	6
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 31		3	1	
Areas of Adopted Green Belt	pg 31	1			
Areas of Unadopted Green Belt					
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 31	1			
Ramsar Sites					
Sites of Special Scientific Interest	pg 31				1
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					



LITHOS CONSULTING

Groundwater Vulnerability

General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

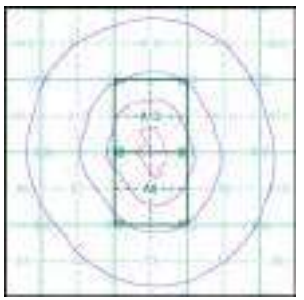
Agency and Hydrological

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

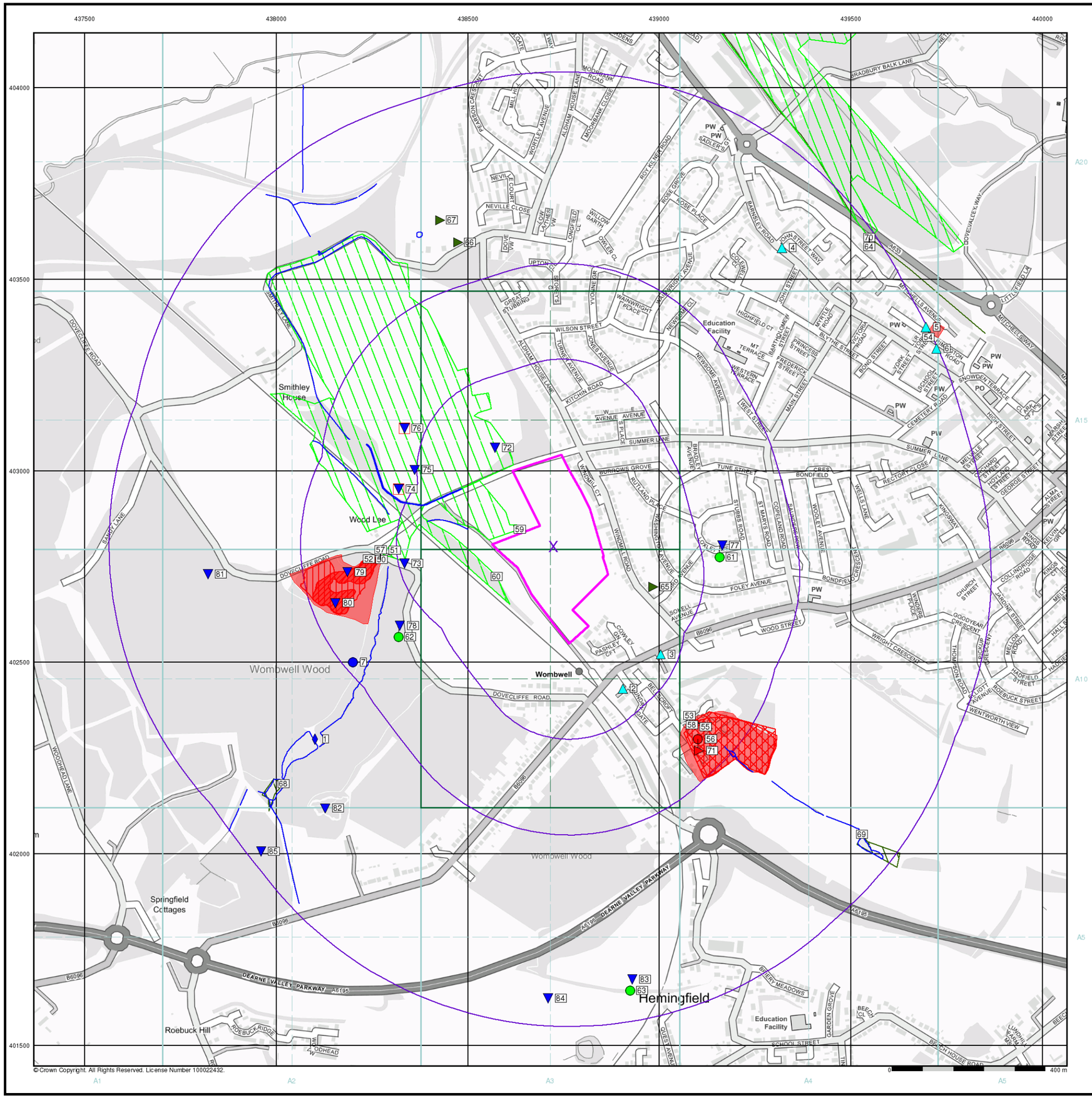
Order Number:	313377122_1_1
Customer Ref:	PO20882/CH/4721
National Grid Reference:	438720, 402800
Slice:	A
Site Area (Ha):	7.46
Search Buffer (m):	1000

Site Details

Pit Lane, Wombwell, S73 8QD

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



LITHOS CONSULTING

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

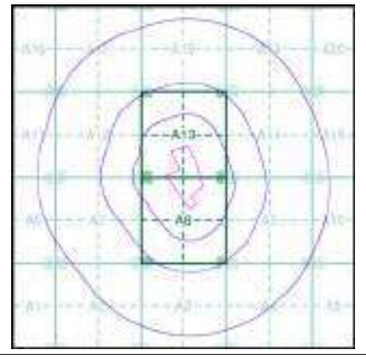
Geological

- 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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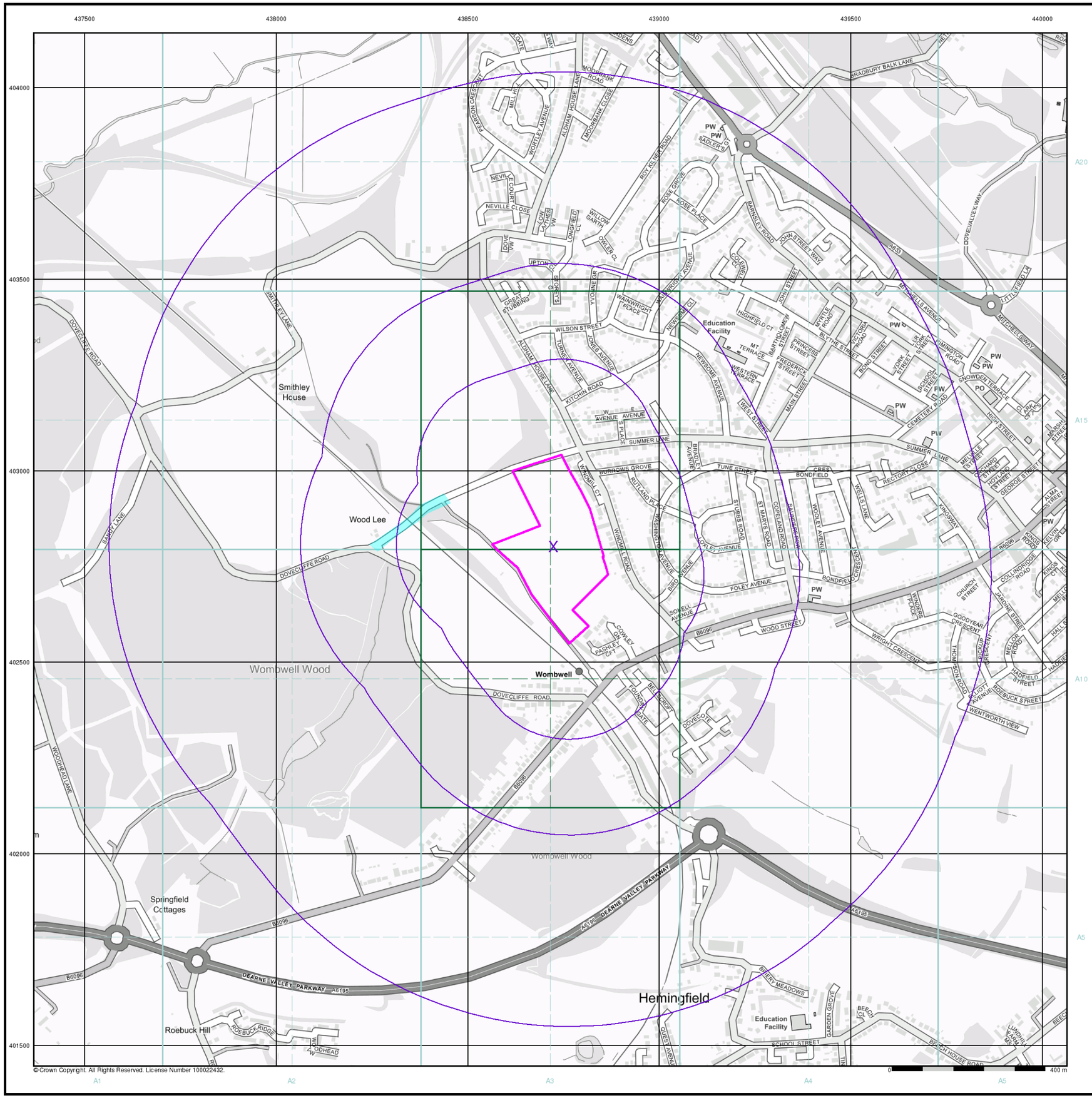


LITHOS CONSULTING

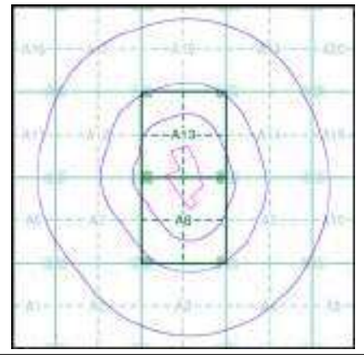
General

- Specified Site
- Specified Buffer(s)
- 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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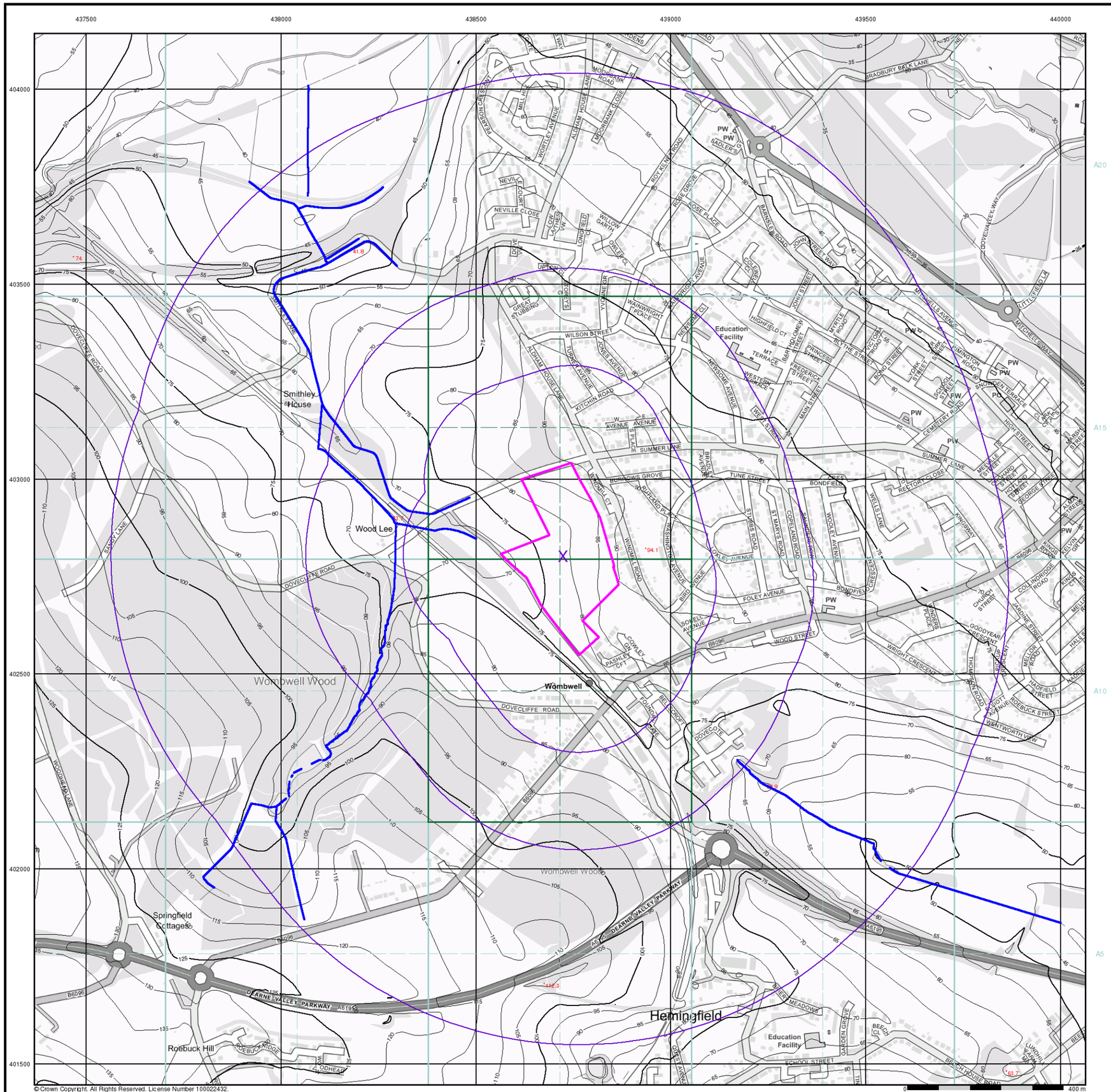


LITHOS CONSULTING

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)

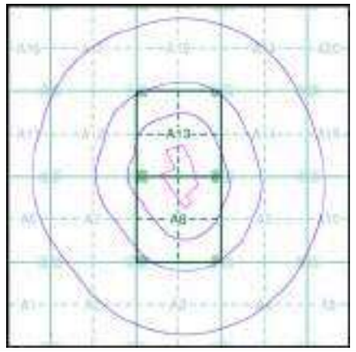
Standard Contour 105 100 95

Master Contour

Spot Height 167.3

- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number:	313377122_1_1
Customer Ref:	PO20882/CH/4721
National Grid Reference:	438720, 402800
Slice:	A
Site Area (Ha):	7.46
Search Buffer (m):	1000

Site Details

Pit Lane, Wombwell, S73 8QD

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

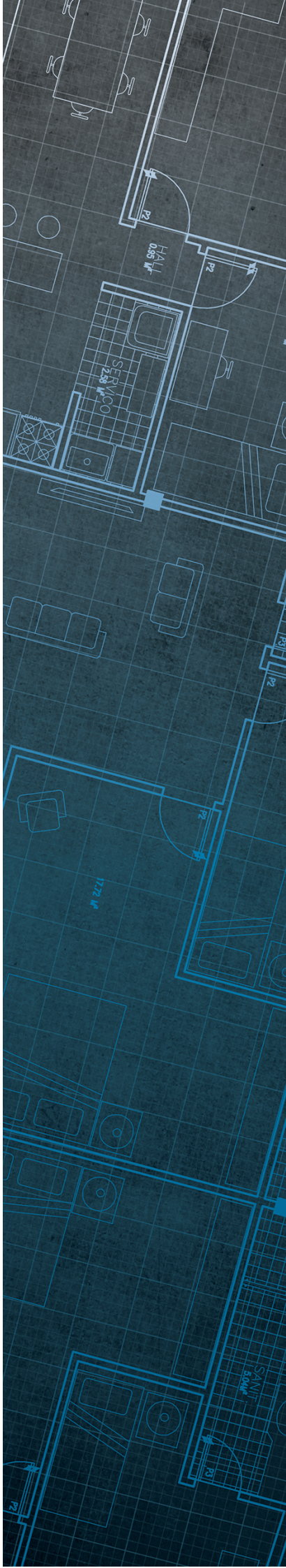
The Coal Authority

Consultants

Coal Mining Report

Pit Lane
Wombwell
Barnsley
S73 8QD

Date of enquiry:	**27 June 2023**
Date enquiry received:	**27 June 2023**
Issue date:	**27 June 2023**
Our reference:	**51003363549001**
Your reference:	**PO20883/CH/4721**



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

Pit Lane
Wombwell
Barnsley
S73 8QD

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	TWO FOOT	Coal	5OV5	66	Beneath Property	0.0	East	170	1950
LUNDHILL	FURNACE	Coal	5NRV	76	South-West	2.2	North-West	84	1960
LUNDHILL	FURNACE	Coal	5NRW	77	Beneath Property	2.2	North-West	86	1950
LUNDHILL	MELTONFIELD	Coal	5NRR	79	South-West	4.3	North-East	101	1951
unnamed	MELTONFIELD	Coal	5OUY	79	West	0.0	East	101	1951
WOMBWELL	FURNACE	Coal	5OVB	101	Beneath Property	4.6	North-East	84	1952
WOMBWELL	BEAMSHAW LOW	Coal	5NRX	108	Beneath Property	4.7	North-East	89	1940
unnamed	BEAMSHAW LOW	Coal	5OV4	129	Beneath Property	4.7	North-East	89	1939
unnamed	TOP HARD BARNSLEY	Coal	5NRT	205	Beneath Property	4.7	North-East	249	1899
unnamed	TOP HARD BARNSLEY	Coal	5OV2	229	Beneath Property	4.2	North-East	213	1864
WOMBWELL	DUNSIL	Coal	5NRY	233	Beneath Property	5.6	North-East	91	1907
WOMBWELL	DUNSIL	Coal	5OV7	242	Beneath Property	4.6	North-East	91	1909
WOMBWELL	SWALLOW WOOD	Coal	5QN6	255	Beneath Property	3.9	North-East	147	1908
BARROW	SWALLOW WOOD	Coal	5QH7	289	North-East	4.4	North-East	130	1965
BARROW	SWALLOW WOOD	Coal	5QC6	294	North-East	7.1	North-East	147	1966
unnamed	LIDGETT	Coal	5NRZ	301	Beneath Property	4.6	North-East	130	1960
unnamed	TOP FENTON	Coal	5NS2	433	Beneath Property	4.6	North-East	109	1953
WOMBWELL	TOP FENTON	Coal	5OVI	446	Beneath Property	4.8	North-East	119	1937
unnamed	PARKGATE	Coal	5NS1	451	Beneath Property	4.8	North-East	117	1915
unnamed	PARKGATE	Coal	5OVE	459	Beneath Property	4.8	North-East	142	1921
unnamed	THORNCLIFFE	Coal	5NS3	472	Beneath Property	4.7	North-East	85	1950
unnamed	THORNCLIFFE	Coal	5OVJ	488	Beneath Property	5.3	North-East	79	1952

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
BARROW	SILKSTONE	Coal	5QF7	516	South-West	4.1	North-East	90	1919
CORTONWOOD	SILKSTONE	Coal	X30	528	South-East	4.9	North-East	90	1980
CORTONWOOD	SILKSTONE	Coal	5QD7	532	South-East	4.7	North-East	95	1971
CORTONWOOD	SILKSTONE	Coal	5QJ6	563	North-East	4.7	North-East	95	1970

Probable unrecorded shallow workings

None.

Spine roadways at shallow depth

Distance to spine roadway (m)	Direction to spine roadway
Within	N/A
Within	N/A

Mine entries

None recorded within 100 metres of the enquiry boundary.

Abandoned mine plan catalogue numbers

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

NE310	NE934	NE279
NE965	NE930	NE556
NE185	NE638	NE552

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
NEWHILL	Coal	Yes	Within	N/A	145

Geological faults, fissures and breaklines

No faults, fissures or breaklines recorded.

Opencast mines

None recorded 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

Distance to gas incident/remediation (m)	Direction
283.9	North-West
246.7	West
246.2	North-West
250.9	West

See Section 4 for further information.

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 a notice to withdraw support was given in 1983.

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.

Mine gas remedial works

The site is within an area of previous interest. It is close to where the Coal Authority has investigated and subsequently remediated the effects of mine or ground gas emissions following specific reported hazards.

The site requires further investigation and may influence your risk assessment. We recommend that you order the **Coal Authority Mine Gas Emission Report**, which will include more information about the hazard.

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

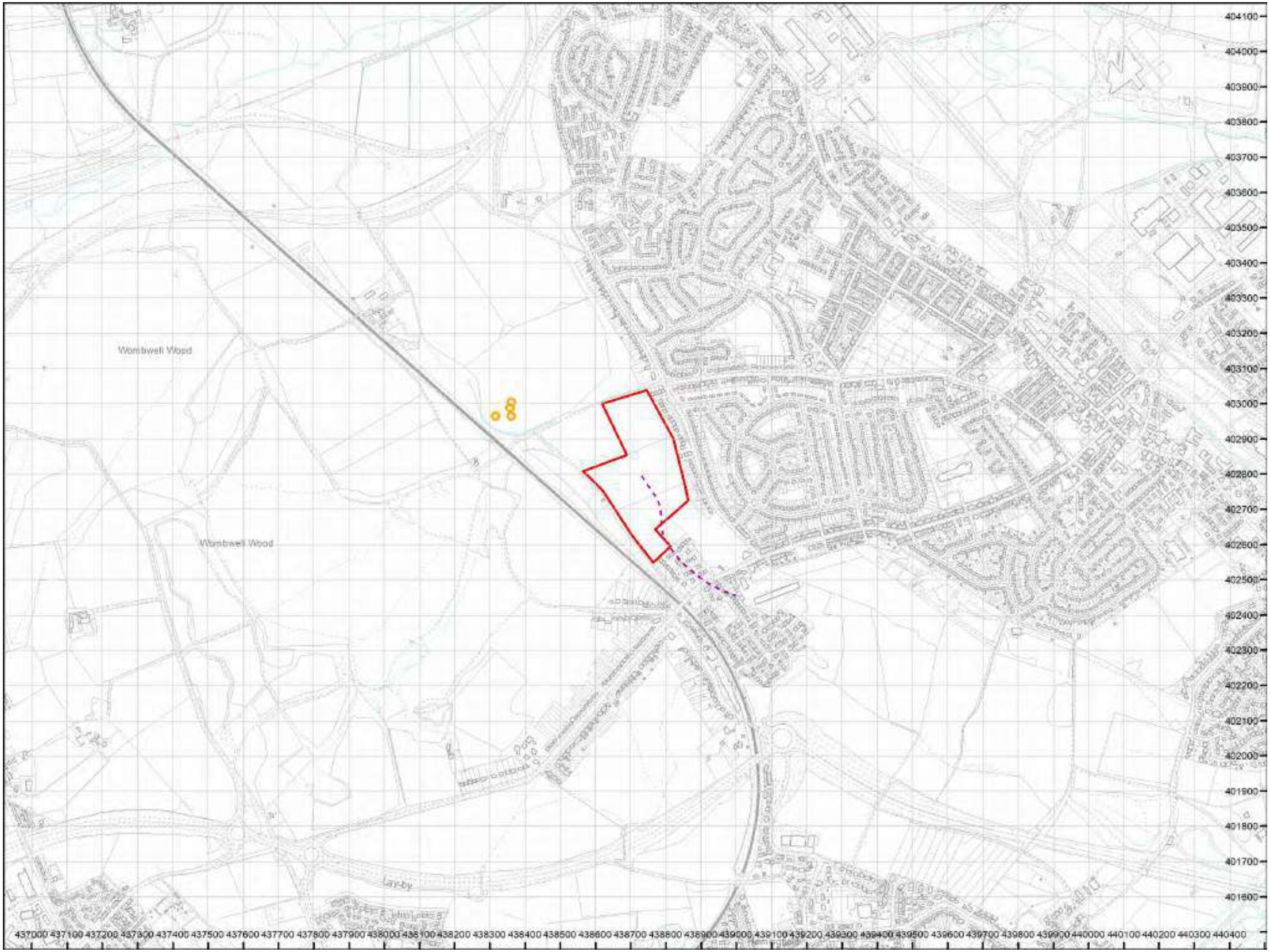
The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

Approximate position of the enquiry boundary shown

Outcrop (Conjectured)

Mine gas remedial works



How to contact us
0345 762 6848 (UK)
+44 (0)1623 637 000 (International)
www.groundstability.com

Alan Swales

Subject: FW: Mine Gas Emission Report Pit Lane, Wombwell, Barnsley S73 8QD
Attachments: L310.4 Wombwell No4.pdf; L310.1 Wombwell No1.pdf; L310.2 Wombwell No2.pdf; L310.3 Wombwell No3.pdf

---

From: Rachel Norton <RachelNorton@coal.gov.uk>
Sent: Wednesday, September 27, 2023 11:35 AM
To: Claire Handley <Claire.Handley@lithos.co.uk>
Subject: Mine Gas Emission Report Pit Lane, Wombwell, Barnsley S73 8QD

Morning Claire.

I'm emailing in reference to the mine gas emission report you have ordered for the above.

Unfortunately we don't have enough information on this one to provide a full report and a refund will be issued; but I can share what we do have available.

At the identified location there are 4 monitoring points associated with abandoned mine entries. Each of shafts, Wombwell Main 1-4, had a small obelisk at surface with monitoring facilities for both gas and water incorporated. The four monitoring points are located at :

L310.1 Wombwell Main No1 Lidgett Downcast shaft – E438361 N402965
L310.2 Wombwell Main No2 Beamshaw shaft – E438361 N403005
L310.3 Wombwell Main No3 Lidgett Upcast shaft – E438317 N402963
L310.4 Wombwell Main No4 Barnsley shaft – E438358 N402990

The shafts were historically monitored and maintained periodically by contractors on behalf on the Coal Authority. During these periodic visits spot readings of gas were taken at the monitoring points, these readings include for oxygen, carbon dioxide, methane and latterly atmospheric pressure. These monitoring points are no longer routinely monitored.

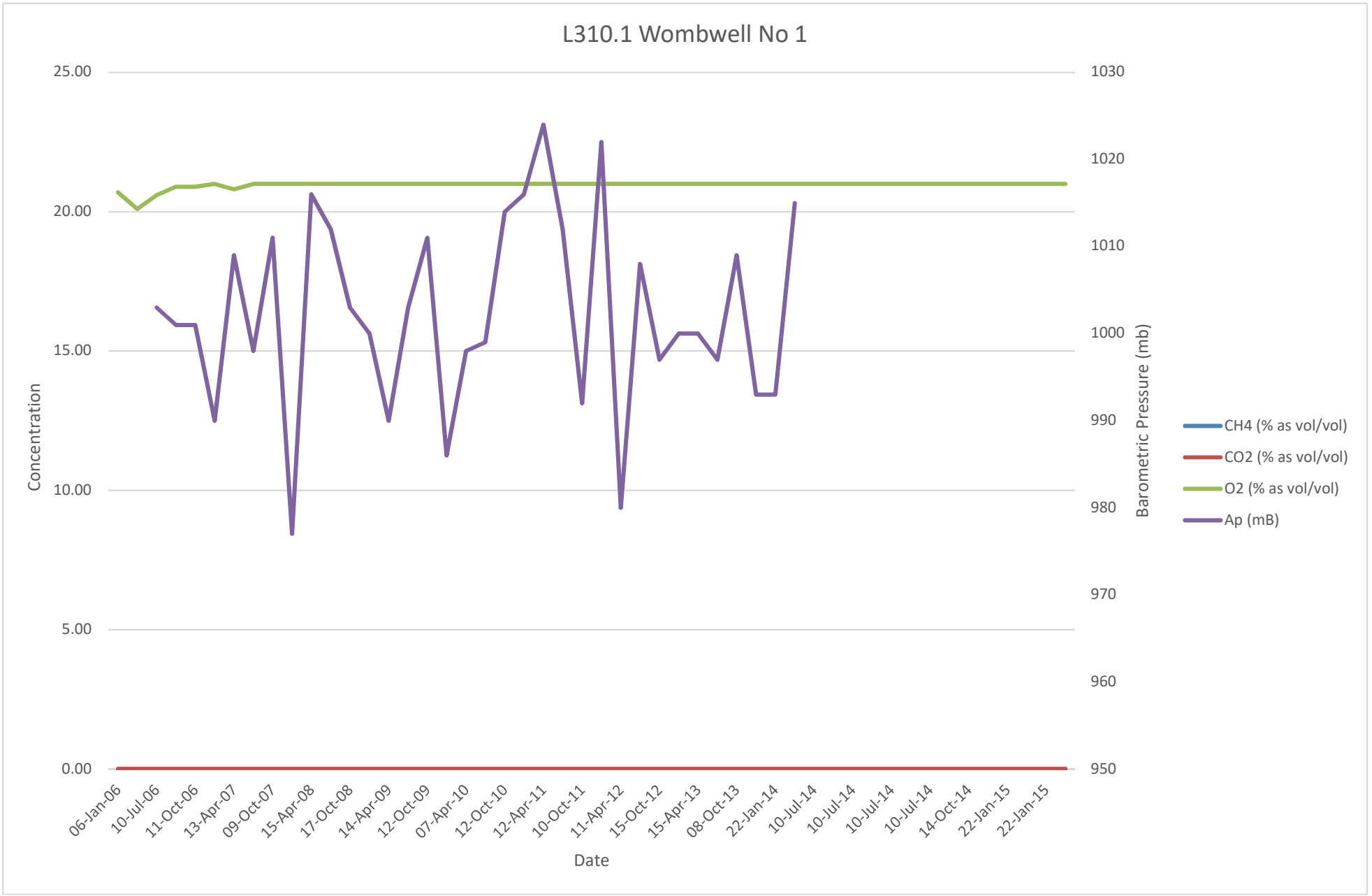
I have attached a graph showing the data collected from the site.

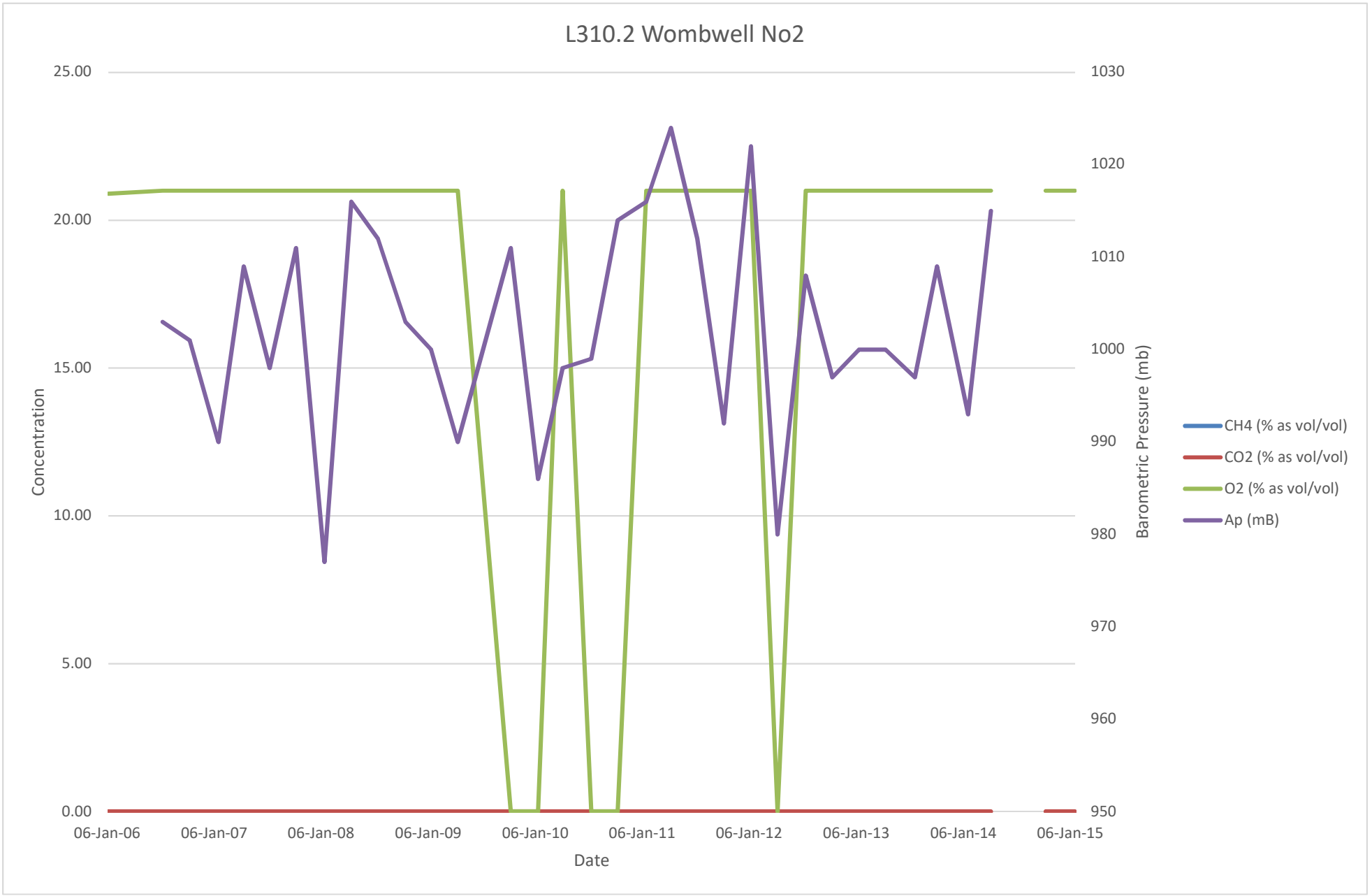
I trust this is of assistance to you.

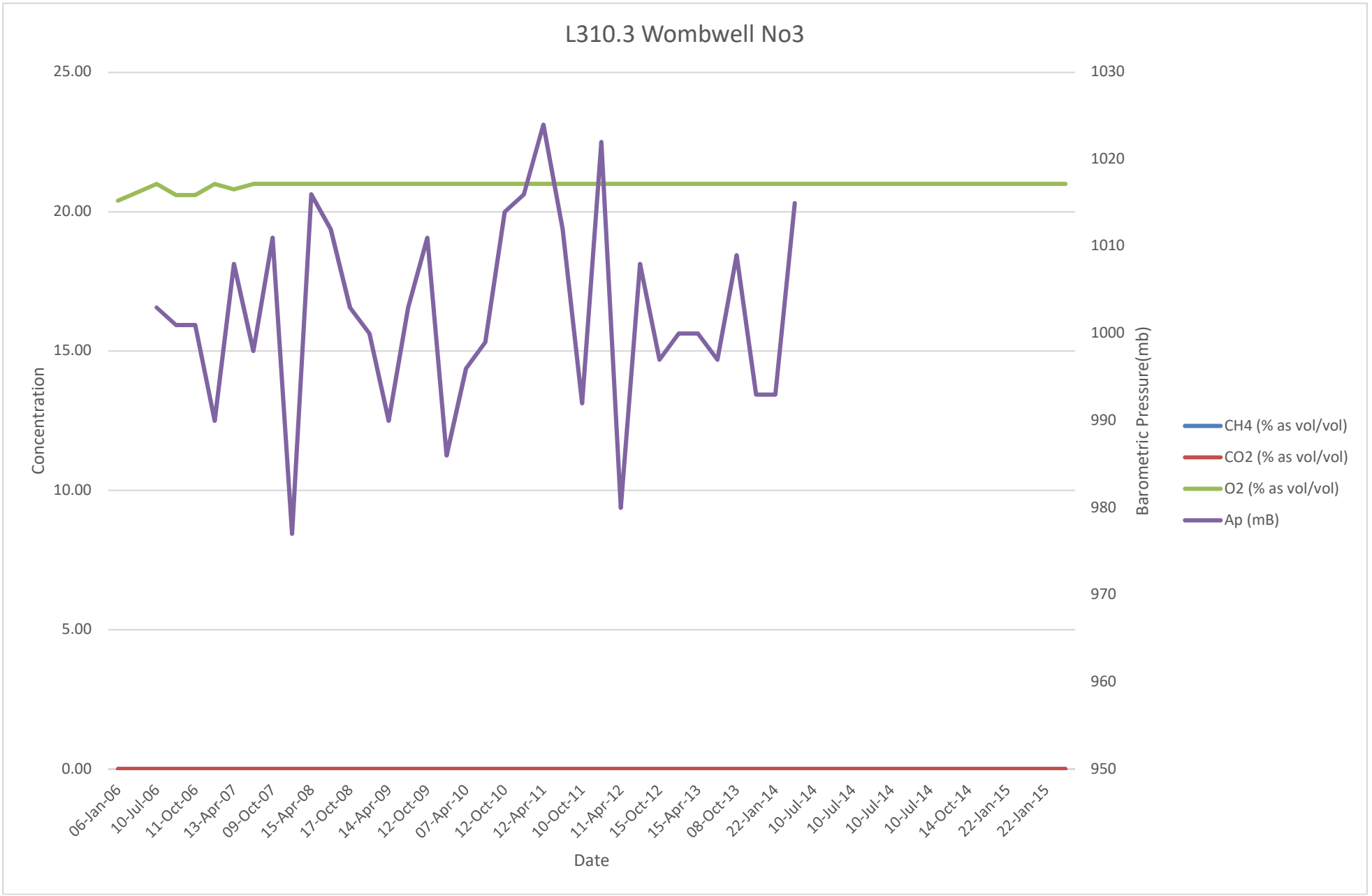
Kind Regards
Rachel

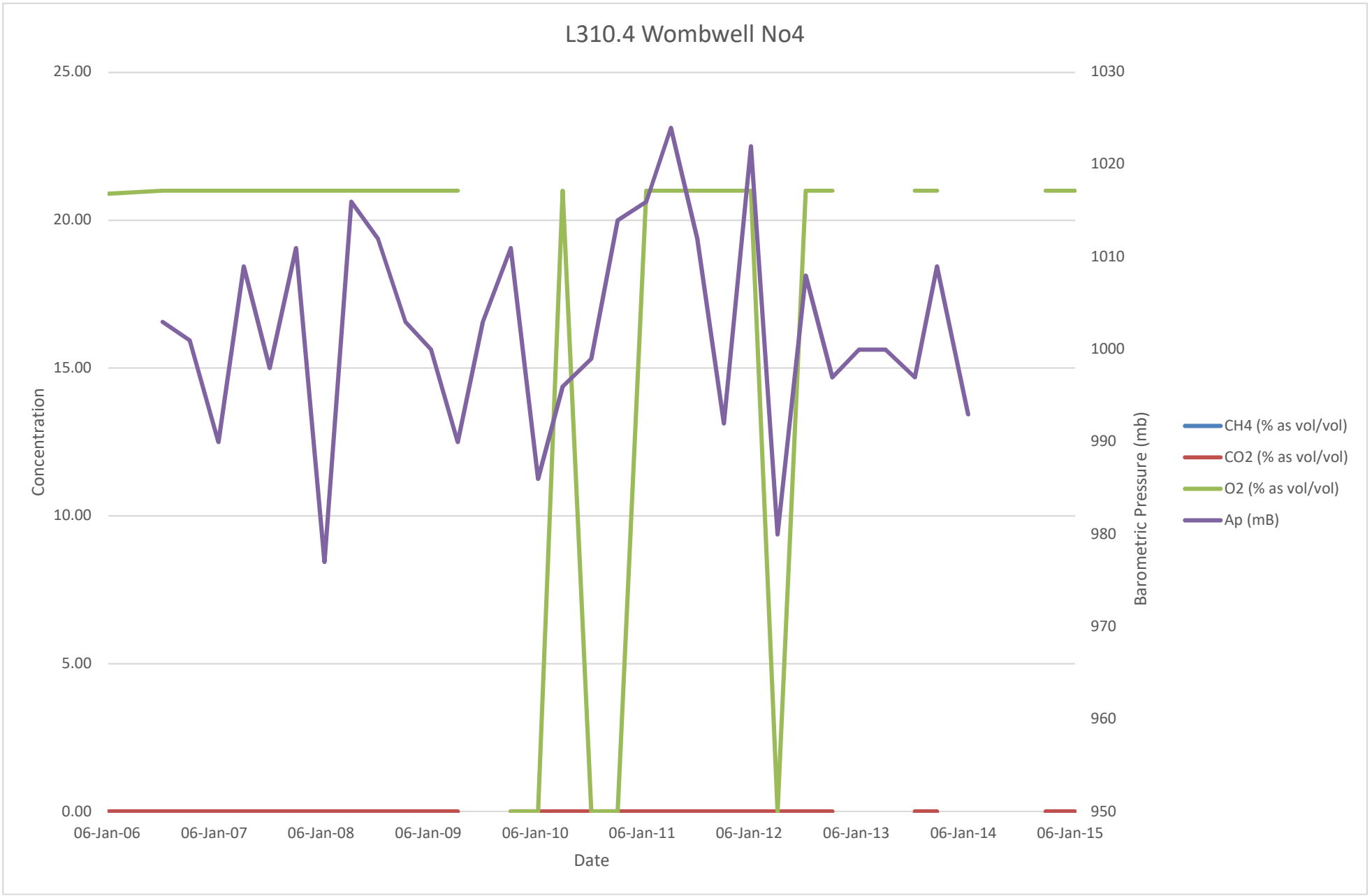
The Coal Authority

Rachel Norton
Project Manager
M : 07500 918700


L310.1 Wombwell No 1
25.00
20.00
15.00
10.00
5.00
0.00
Concentration
1030
1020
1010
1000
990
980
970
960
950
Barometric Pressure (mb)
06-Jan-06
10-Jul-06
11-Oct-06
13-Apr-07
09-Oct-07
15-Apr-08
17-Oct-08
14-Apr-09
12-Oct-09
07-Apr-10
12-Oct-10
12-Apr-11
10-Oct-11
11-Apr-12
15-Oct-12
15-Apr-13
08-Oct-13
22-Jan-14
10-Jul-14
10-Jul-14
10-Jul-14
10-Jul-14
14-Oct-14
22-Jan-15
22-Jan-15
Date
CH4 (% as vol/vol)
CO2 (% as vol/vol)
O2 (% as vol/vol)
Ap (mB)


L310.2 Wombwell No2
25.00
20.00
15.00
10.00
5.00
0.00
Concentration
1030
1020
1010
1000
990
980
970
960
950
Barometric Pressure (mb)
06-Jan-06
06-Jan-07
06-Jan-08
06-Jan-09
06-Jan-10
06-Jan-11
06-Jan-12
06-Jan-13
06-Jan-14
06-Jan-15
Date
CH4 (% as vol/vol)
CO2 (% as vol/vol)
O2 (% as vol/vol)
Ap (mB)


L310.3 Wombwell No3
25.00
20.00
15.00
10.00
5.00
0.00
Concentration
1030
1020
1010
1000
990
980
970
960
950
Barometric Pressure(mb)
06-Jan-06
10-Jul-06
11-Oct-06
13-Apr-07
09-Oct-07
15-Apr-08
17-Oct-08
14-Apr-09
12-Oct-09
07-Apr-10
12-Oct-10
12-Apr-11
10-Oct-11
11-Apr-12
15-Oct-12
15-Apr-13
08-Oct-13
22-Jan-14
10-Jul-14
10-Jul-14
10-Jul-14
10-Jul-14
14-Oct-14
22-Jan-15
22-Jan-15
Date
CH4 (% as vol/vol)
CO2 (% as vol/vol)
O2 (% as vol/vol)
Ap (mB)


L310.4 Wombwell No4
25.00
20.00
15.00
10.00
5.00
0.00
Concentration
1030
1020
1010
1000
990
980
970
960
950
Barometric Pressure (mb)
06-Jan-06
06-Jan-07
06-Jan-08
06-Jan-09
06-Jan-10
06-Jan-11
06-Jan-12
06-Jan-13
06-Jan-14
06-Jan-15
Date
CH4 (% as vol/vol)
CO2 (% as vol/vol)
O2 (% as vol/vol)
Ap (mB)

SE 30 SE/7 07/65 A B

SECTION OF Wombwell Main Collieries at / mile N of No. 1 Shaft & Parkgate No. 3 Shaft & Silkstone

Maps One inch 97 Six inch 285 NW County Yorkshire

Height above O.D. 225 ft. Latitude Longitude

Communicated by Sec. Trans. Sheffield pp. 389-391 Date of Sinking No. 1 to Barnsley 1853 to Silkstone 1854-8 No. 3 to Silkstone 1859

Made by Dip of Strata

Summary of principal records	Thickness			Depth from Surface		
	Soil	0 30	1	-	0 30	1 -
Intermingled measures and shales, hardpan with Thin Coals	Woolley Edge Rock	36 52	119	10	36 82	120 10
	Wath Hard Seam	1 07	3	6	37 89	123 4
	Two Foot Coal, with dirt	1 45	4	9	39 34	128 1
	Abdy Coal	0 19	1	2	39 53	129 3
	Clunch	4 11	13	6	43 64	142 9
	Lower Thin Coal	0 50	1	10	44 14	144 7
	Upper Thick Coal with dirt	2 16	7	5	46 30	151 12
	Barnsley Bed	2 41	7	11	48 71	159 11
	Shiny grey rock with stone band in middle	10 9	35	9	59 80	195 8
	Barnsley Seam (with thick dirt)	2 87	9	5	62 67	205 1
	Swallow Wood Seam	3 68	12	1	66 35	217 2
	Blind end Rock	9 30	30	11	75 65	248 1
	Ludgett Seam	0 91	3	-	76 56	251 1
	Joan Coal	0 46	1	6	77 02	252 7
	Flockton Thick (with thin dirt)	1 47	4	10	78 49	257 5
	Rock	4 88	16	-	83 37	273 5
	Fenton Seam (with thin dirt)	4 11	13	6	87 48	287 -
	Rock with middle band of stone bind	6 82	22	6	94 30	309 6
	Parkgate Seam (with dirt)	3 49	11	5	97 79	321 -
In No. 3 Pit	Thornecliff Thin Seam	0 76	2	6	98 55	323 6
	Rock	15 17	46	6	113 72	370 -
	Silkstone Seam	0 91	3	-	114 63	373 -

Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No
SA01
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438642.16 - 403000.70 Level: 84.83	Date 24/07/2023
Location:	Barnsley	Dimensions (m): Depth 2.60	2.6 × 0.6	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30	84.53		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine of mixed lithologies. (TOPSOIL)
			HVP=65	0.60	84.23		Firm light brown CLAY. (COHESIVE RESIDUAL SOIL)
	0.90	D	HVP=80	1.20	83.63		Stiff orangish brown mottled grey slightly gravelly CLAY. Gravel is subangular fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
	1.40	D	HVP=105	2.30	82.53		Stiff brownish grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
				2.60	82.23		Brownish grey sandy clayey subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL) End of pit at 2.60 m

1
2
3
4

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
SA02
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438798.60 - 402801.54 Level: 83.85	Date 24/07/2023
Location: Barnsley		Dimensions (m): 1.7 × 0.6, Depth 2.50	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	83.55		Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
▼			HVP=68				Firm orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of sandstone. (COHESIVE RESIDUAL SOIL) *Groundwater seepage at 0.3m.*
	1.00	D	HVP=98				
				1.40	82.45		Stiff brownish grey mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.60	D					
				2.10	81.75		Grey sandy clayey subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.30	81.55		Weak dark grey carbonaceous MUDSTONE with occasional ironstone cobbles. Recovered as sandy clayey angular tabular fine to coarse gravel. (COAL MEASURES)
				2.50	81.35		End of pit at 2.50 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m 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
SA03
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438633.42 - 402782.39 Level: 71.93	Date 24/07/2023
Location:	Barnsley	Dimensions (m): Depth 2.50	1.8 × 0.6	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
▼				0.30	71.63		Dark brown slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)
			HVP=70				Stiff orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
							Groundwater seepage at 0.3m.
							At 0.6m, stone land drain in west of pit with water inflow.
	0.80	D	HVP=100				
	1.60	D					
							At 1.9m, 10cm bed of weathered ironstone.
				2.10	69.83		Greyish brown sandy clayey angular to subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.50	69.43		End of pit at 2.50 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m 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 **SA04**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438525.07 - 402794.65 Level: 69.11	Date 24/07/2023
Location:	Barnsley	Dimensions (m): Depth 2.00	1.8 × 0.6	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal. (TOPSOIL)
				0.30	68.81		
	0.40	D					Firm light brown slightly sandy slightly gravelly CLAY. Gravel is subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)
				0.50	68.61		
	0.70	T					Light brown clayey sandy angular to subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				0.80	68.31		
							Stiff orangish brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
				1.30	67.81		
▼							Orangish brown sandy clayey angular to subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL) *Band of orangish brown clay in centre of pit between 1.3m and 2.0m.* *Groundwater seepage at 1.5m.*
				1.60	67.51		Medium strong light brown fine to medium grained SANDSTONE. Recovered as sandy angular tabular fine to coarse gravel with medium cobble content. (COAL MEASURES)
				2.00	67.11		*Unable to excavate beyond 2.0m.* End of pit at 2.00 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 1.5m 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
TP01
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438565.66 - 402753.16 Level: 69.66	Date 24/07/2023
Location: Barnsley		Dimensions (m): Depth 2.20	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Orangish brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is angular to subrounded fine to coarse of sandstone with rare coal. (TOPSOIL)
	0.20	B		0.30	69.36		
	0.70	D	HVP=55				Firm orangish brown mottled light grey sandy CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=92				*Stiff from 1.0m.*
	1.30	D	HVP=75	1.20	68.46		Stiff grey mottled brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone. (COHESIVE RESIDUAL SOIL)
▼				2.00	67.66		Very weak greyish brown thinly laminated SILTSTONE interbedded with fine grained SANDSTONE. Recovered as sandy clayey angular to subangular fine to medium gravel. (COAL MEASURES)
				2.20	67.46		*Groundwater seepage at 2.0m.* *Difficult to excavate beyond 2.2m.* End of pit at 2.20 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 2.0m 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 **TP02**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438466.33 - 402830.70 Level: 68.15	Date 24/07/2023
Location:	Barnsley		Dimensions (m): Depth 2.30	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone. (TOPSOIL)
	0.20	B		0.30	67.85		Stiff light brown slightly sandy slightly gravelly CLAY. Gravel is subangular fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
▼							*Groundwater inflow at 0.4m.*
			HVP=75	0.70	67.45		Stiff brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
	1.00	D	HVP=90				*Locally clay is gravelly from 1.0m.*
				1.30	66.85		Light brown sandy clayey angular to subangular fine to coarse GRAVEL of sandstone with low cobble content. (GRANULAR RESIDUAL SOIL)
				1.50	66.65		Stiff greyish brown slightly gravelly CLAY. Gravel is subangular fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
				2.00	66.15		Greyish brown sandy clayey angular to subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				2.20	65.95		Medium strong light grey fine to medium grained SANDSTONE. Recovered as sandy angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.30	65.85		*Unable to excavate beyond 2.3m.* End of pit at 2.30 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.4m 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 **TP03**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438614.08 - 402814.68 Level: 71.19
Date	24/07/2023		
Location:	Barnsley	Dimensions (m): Depth 3.10	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	70.89		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
▼			HVP=80				Stiff orangish brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL) *Groundwater seepage at 0.3m.* *Occasional sandstone boulders at 0.4m.*
	0.90	D	HVP=92	1.20	69.99		Stiff brown mottled gravel slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone and occasional ironstone. (COHESIVE RESIDUAL SOIL)
	1.50	D		1.80	69.39		Stiff greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
				2.20	68.99		Greyish brown sandy clayey angular to subrounded fine to medium GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.80	68.39		Weak greyish brown thinly laminated SILTSTONE. Recovered as sandy clayey angular tabular fine to medium gravel. (COAL MEASURES)
				3.10	68.09		*Difficult to excavate beyond 3.1m.* End of pit at 3.10 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m 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: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438663.28 - 402834.03 Level: 75.21	Date 24/07/2023
Location: Barnsley		Dimensions (m): Depth 1.30	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	74.91		Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
▼			HVP=80				Stiff orangish brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL) *Groundwater inflow at 0.3m.*
▼	0.80	D	HVP=104				*Groundwater inflow from fissures in clay at 0.9m.*
				1.30	73.91		*Cast iron pipe at 1.3m. Trial pit abandoned.* End of pit at 1.30 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m and 0.9m 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
TP05
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438741.52 - 402853.01 Level: 79.85	Date 24/07/2023
Location: Barnsley		Dimensions (m): Depth 2.20	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
▼				0.30	79.55		Stiff orangish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=67				*Groundwater inflow at 0.3m.*
	0.70	D					*Clay is gravelly from 0.8m.*
							Clay is dark grey between 1.2m and 1.3m.
				1.60	78.25		Firm greyish brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
	1.80	D					
				2.10	77.75		Medium strong grey fine to medium grained SANDSTONE. Recovered as sandy angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.20	77.65		*Unable to excavate beyond 2.2m.*
							End of pit at 2.20 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m 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
TP06
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438784.12 - 402872.20 Level: 82.30	Date 24/07/2023
Location: Barnsley		Dimensions (m): Depth 3.30	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.20	B		0.30	82.00		
			HVP=75				Stiff orangish brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL)
				0.80	81.50		Stiff light grey mottled brown CLAY. (COHESIVE RESIDUAL SOIL)
	1.00	D	HVP=94				*Occasional gravel and cobble size pockets of black clay from 1.0m.*
				1.40	80.90		Stiff greyish brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.70	D					
				2.00	80.30		Greyish brown sandy clayey angular to subrounded fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
	2.20	T					
				2.40	79.90		Weak greyish brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				3.30	79.00		*Difficult to excavate beyond 3.3m.* End of pit at 3.30 m

1 2 3 4

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 **TP07** Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438792.16 - 402941.29 Level: 84.99
Date	25/07/2023		
Location:	Barnsley	Dimensions (m): Depth 3.10	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	84.69		Dark brown slightly sandy slightly gravel CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of sandstone and rare coal. (TOPSOIL)
			HVP=75				Stiff orangish brown mottled light grey slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
	1.00	D	HVP=100				*Clay is slightly gravelly from 1.2m.*
							Locally clayey sandy angular subangular fine to coarse gravel of sandstone from 1.4m to 1.6m.
	1.70	D		1.80	83.19		Stiff brownish grey slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
				2.30	82.69		Brownish grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.80	82.19		Very weak greyish brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				3.10	81.89		End of pit at 3.10 m

1 2 3 4

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
TP08
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438766.89 - 402980.85 Level: 86.60	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.60	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	86.30		Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
	0.70	D	HVP=82				Stiff orangish brown mottled light grey slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
							Occasional sandy fine to coarse gravel of ironstone from 0.9m
							Clay is slightly gravelly from 1.1m.
	1.40	D					
				1.70	84.90		Stiff greyish brown slightly sandy gravelly CLAY. Gravel is subangular fine to coarse of siltstone. (COHESIVE RESIDUAL SOIL)
				2.20	84.40		Brownish grey sandy clayey angular subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.40	84.20		Weak brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.60	84.00		*Difficult to excavate beyond 2.6m.*
							End of pit at 2.60 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

Trial Pit Log

Trialpit No **TP09** Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438742.81 - 403025.31 Level: 87.22	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.60	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	86.92		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subangular fine to medium of mixed lithologies. (TOPSOIL)
			HVP=85				Stiff orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
			HVP=110	1.20	86.02		Stiff brownish grey slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.60	D		1.80	85.42		Grey sandy very clayey angular to subangular fine to coarse GRAVEL of siltstone (GRANULAR RESIDUAL SOIL)
				2.30	84.92		Weak grey thinly laminated SILSTONE with occasional ironstone nodules. Recovered as sandy angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.60	84.62		End of pit at 2.60 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.

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Trial Pit Log

Trialpit No
TP10
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438719.77 - 402993.23 Level: 85.37	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.70	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular subrounded fine to coarse of sandstone. (TOPSOIL)
	0.20	B					
				0.30	85.07		Orangish brown sandy very clayey subangular tabular fine to coarse GRAVEL of sandstone with medium cobble content. (GRANULAR RESIDUAL SOIL)
	0.50	T					
				0.70	84.67		Stiff light brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=125				*Slightly gravelly from 1.3m.*
				1.80	83.57		Brown sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.30	83.07		Weak greyish brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.70	82.67		End of pit at 2.70 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
TP11
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438736.95 - 402947.74 Level: 83.32	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.80	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	83.02		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal. (TOPSOIL)
			HVP=75	0.50	82.82		Stiff orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
	0.70	T		0.80	82.52		Black sandy very clayey angular to subangular fine to medium GRAVEL of coal. (THIN COAL)
			HVP=60	1.10	82.22		Firm orangish brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL)
	1.30	D		2.20	81.12		Stiff greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone. (COHESIVE RESIDUAL SOIL)
				2.80	80.52		Grey sandy clayey angular to subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
							End of pit at 2.80 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

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP12**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438751.40 - 402892.99 Level: 80.69
Date	25/07/2023		
Location:	Barnsley	Dimensions (m): Depth 2.70	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30	80.39		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal. (TOPSOIL)
▼			HVP=70				Stiff orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL) *Groundwater seepage at 0.5m.*
				0.90	79.79		Stiff brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.10	D	HVP=75				
				1.80	78.89		Stiff grey slightly sandy very gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.90	D					
				2.20	78.49		Grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.50	78.19		Very weak greyish brown thinly laminated SILTSTONE. Recovered as sandy clayey angular tabular fine to coarse gravel. (COAL MEASURES)
				2.70	77.99		*Difficult to excavate beyond 2.7m.* End of pit at 2.70 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.5m 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:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438691.23 - 402906.29 Level: 80.02
Location:	Barnsley	Dimensions (m): Depth 2.10	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	79.72		Dark brown slightly sandy slightly gravel CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.60	D	HVP=78				Stiff orangish brown mottled light grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
							Clay is gravelly from 0.9m.
				1.50	78.52		Stiff brown slightly sandy gravelly CLAY. Gravel is subangular fine to coarse of sandstone and siltstone. (COHESIVE RESIDUAL SOIL)
				1.80	78.22		Brown sandy clayey angular to subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				2.00	78.02		Medium strong brown fine grained SANDSTONE interbedded with dark brown SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.10	77.92		*Unable to excavate beyond 2.1m.* End of pit at 2.10 m

1 2 3 4

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
TP14
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438661.12 - 402931.39 Level: 80.69	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.80	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	80.39		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of sandstone. (TOPSOIL)
			HVP=60	0.60	80.09		Firm brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
	0.90	D	HVP=86				Stiff light brown mottled grey slightly gravelly CLAY. Gravel is subangular fine to medium of sandstone. (COHESIVE RESIDUAL SOIL) *Clay is gravelly from 1.0m.*
	1.40	T		1.20	79.49		Brown sandy clayey angular to subangular tabular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL) *Slight overbreak from 1.5m to 2.1m.*
				1.70	78.99		Medium strong brown fine to medium grained SANDSTONE recovered as sandy angular tabular fine to coarse gravel with medium cobble content. (COAL MEASURES)
				2.10	78.59		Moderate weak brown thinly laminated SILSTONE interbedded with greyish brown fine to medium grained SANDSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES) *Difficult to excavate beyond 2.8m.*
				2.80	77.89		End of pit at 2.80 m

1 2 3 4

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. Overbreak of the sides of the trial pit occurred between 1.5m and 2.1m depth during excavation.

AGS

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Trial Pit Log

Trialpit No
TP15
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438677.80 - 402962.86 Level: 82.40	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.90	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	82.20		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies including rare coal. (TOPSOIL)
			HVP=52	0.60	81.80		Firm orangish brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
	0.80	D	HVP=85				Stiff light brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL) *Clay is gravelly from 1.0m.*
	1.50	T		1.40	81.00		Brownish grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of sandstone and siltstone. (GRANULAR RESIDUAL SOIL)
				2.30	80.10		Weak brown thinly laminated SILTSTONE interbedded with moderate weak greyish brown fine grained SANDSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.90	79.50		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

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP16
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438826.34 - 402844.27 Level: 86.21	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.90	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
▼				0.20	86.01		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)
							Stiff orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
							Groundwater seepage at 0.2m.
			HVP=72				
	0.90	D					
			HVP=95				
							Clay is slightly gravelly from 1.0m.
				1.30	84.91		Stiff brownish grey slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.70	D					
				2.10	84.11		Black sandy clayey angular to subangular fine to medium GRAVEL of coal. (THIN COAL)
	2.20	T					
				2.30	83.91		Very stiff grey CLAY. (COHESIVE RESIDUAL SOIL)
				2.50	83.71		Extremely weak dark grey thinly laminated carbonaceous MUDSTONE. Recovered as sandy clayey angular tabular fine to coarse gravel. (COAL MEASURES)
				2.90	83.31		End of pit at 2.90 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.2m 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 **TP17** Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438832.12 - 402774.53 Level: 86.37	Date 25/07/2023
Location:	Barnsley		Dimensions (m): Depth 2.80	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50	D	HVP=85	0.20	86.17		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded to subrounded fine to medium of mixed lithologies including rare coal. (TOPSOIL)
							Stiff orangish brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=80				
				1.10	85.27		Stiff brown mottled grey slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
	1.40	D					*At 1.2m, thin (5cm) bed of black clay.*
							Clay is slightly gravelly from 1.5m.
				2.00	84.37		Brownish grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (COAL MEASURES)
	2.50	T					
				2.80	83.57		End of pit at 2.80 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:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438760.59 - 402768.51 Level: 80.69	Date 25/07/2023
Location:	Barnsley		Dimensions (m): Depth 2.90	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
▼				0.30	80.39		Firm light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=50				*Groundwater seepage at 0.3m.*
▼				0.70	79.99		Stiff orangish brown mottled light grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
	1.00	D	HVP=104				*Groundwater seepage at 0.7m.*
							Clay is gravelly from 1.5m.
				1.80	78.89		Grey and brown sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.60	78.09		Very weak brown thinly laminated SILTSTONE. Recovered as sandy clayey angular tabular fine to coarse gravel. (COAL MEASURES)
				2.90	77.79		End of pit at 2.90 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m and 0.7m 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
TP19
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438729.57 - 402796.66 Level: 78.73	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 1.80	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
▼				0.30	78.43		Firm orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL) *Groundwater seepage at 0.3m.*
				0.60	78.13		Stiff brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL) *Occasional gravel of ironstone from 1.2m.*
				1.40	77.33		Stiff grey slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of ironstone. (COHESIVE RESIDUAL SOIL)
▼				1.70	77.03		Weak dark brown thinly laminated SILTSTONE with frequent ironstone nodules. Recovered as sandy clayey angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES) *Groundwater seepage at 1.7m.* *Unable to excavate beyond 1.8m due to ironstone.*
				1.80	76.93		End of pit at 1.80 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 0.3m and 1.7m 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: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438696.73 - 402769.99 Level: 76.07	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.90	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal. (TOPSOIL)
	0.20	B		0.30	75.77		Stiff orangish brown mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=70	0.90	75.17		Firm grey and orangish brown CLAY. (COHESIVE RESIDUAL SOIL)
	1.10	D	HVP=45				*At 1.2m, thin (5cm) bed of black clay.*
				1.30	74.77		Stiff brownish grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
	1.50	D					
				2.20	73.87		Greyish brown sandy slightly clayey subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.60	73.47		Weak greyish brown thinly laminated SILTSTONE. Recovered as sandy slightly clayey angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.90	73.17		*Difficult to excavate beyond 2.9m.* 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

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP21
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438726.78 - 402734.30 Level: 77.91	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 2.90	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20	77.71		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets . Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
							Firm orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=58				
				0.60	77.31		Stiff orangish brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL)
							Locally clay is dark grey between 0.6m and 1.0m.
	0.90	D					
			HVP=104				
							Occasional gravel of ironstone from 1.1m.
				1.30	76.61		Stiff brownish grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
	1.60	D					
				2.10	75.81		Grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.40	75.51		Moderately weak greyish brown thinly laminated SILTSTONE. Recovered as angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.90	75.01		End of pit at 2.90 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: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438681.04 - 402717.62 Level: 74.10	Date 25/07/2023
Location: Barnsley		Dimensions (m): Depth 3.00	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	73.90		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal. (TOPSOIL)
							Firm orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=60				
							Clay is stiff from 0.8m.
	1.00	D	HVP=97				*Occasional gravel of ironstone at 1.0m.*
				1.20	72.90		Stiff light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
	1.80	D					
				1.90	72.20		Light brown sandy clayey angular to subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.30	71.80		Extremely weak brownish grey thinly laminated MUDSTONE. Recovered as sandy angular to subangular fine to coarse gravel. (COAL MEASURES)
				3.00	71.10		End of pit at 3.00 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

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP23
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438839.95 - 402724.30 Level: 86.37	Date 26/07/2023
Location:	Barnsley		Dimensions (m): Depth 3.00	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.20	86.17		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
			HVP=78				Stiff orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
	0.70	D	HVP=70	0.80	85.57		Stiff orangish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to coarse of ironstone and siltstone. (COHESIVE RESIDUAL SOIL)
			HVP=115				*Clay is gravelly from 1.3m.*
	1.50	D		1.60	84.77		Brownish grey sandy very clayey angular to subangular tabular fine to coarse GRAVEL of siltstone and ironstone. (GRANULAR RESIDUAL SOIL)
							Gravel is slightly clayey from 1.9m.
				2.30	84.07		Very weak brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				3.00	83.37		End of pit at 3.00 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

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP24
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438796.20 - 402741.40 Level: 84.04	Date 26/07/2023
Location: Barnsley		Dimensions (m): Depth 2.70	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10 0.15	J&T B		0.20	83.84		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (TOPSOIL)
			HVP=68				Firm light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
							Clay is stiff from 0.6m.
							Clay is gravelly from 0.8m.
				1.00	83.04		Stiff light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone and sandstone. (COHESIVE RESIDUAL SOIL)
	1.20	D					
							Clay is brown from 1.5m.
	1.70	D					
				1.90	82.14		Brown sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone and sandstone. (GRANULAR RESIDUAL SOIL)
▼				2.40	81.64		Weak brown thinly laminated SILTSTONE interbedded with brown fine grained SANDSTONE. Recovered as sandy angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.70	81.34		*Groundwater seepage at 2.4m.*
							Difficult to excavate beyond 2.7m.
							End of pit at 2.70 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 2.4m 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

Trial Pit Log

LITHOS CONSULTING

Trialpit No **TP25** Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438761.72 - 402705.19 Level: 80.01
Location:	Barnsley	Dimensions (m): Depth 2.60	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	79.71		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.70	D	HVP=75				Stiff orangish brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL) *Locally clay is slightly sandy from 0.6m.*
			HVP=90	1.00	79.01		Stiff light grey mottled light brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
				1.40	78.61		Stiff grey mottled brown slightly gravelly CLAY. Gravel is subangular to subrounded fine of siltstone. (COHESIVE RESIDUAL SOIL)
				2.20	77.81		Greyish brown sandy clayey angular to subangular tabular fine to coarse GRAVEL. (GRANULAR RESIDUAL SOIL)
				2.60	77.41		End of pit at 2.60 m

1 2 3 4

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
TP26
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438724.65 - 402685.47 Level: 76.98	Date 26/07/2023
Location: Barnsley		Dimensions (m): Depth 3.10	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30	76.68		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
			HVP=60				Firm orangish brown mottled grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of ironstone. (COHESIVE RESIDUAL SOIL)
	0.90	D	HVP=98				
				1.50	75.48		Stiff light brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
	1.80	D					*Clay is gravelly from 2.0m.*
				2.40	74.58		Greyish brown sandy slightly clayey angular to subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
	2.50	T		2.70	74.28		Moderately weak brown thinly laminated SILTSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
				3.10	73.88		*Difficult to excavate beyond 3.1m.* End of pit at 3.10 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
TP27
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438692.30 - 402654.26 Level: 73.82	Date 26/07/2023
Location: Barnsley		Dimensions (m): Depth 2.80	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
				0.30	73.52		Firm light brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=60				
				0.60	73.22		Stiff orangish brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
							Locally clay is gravelly from 0.8m.
▼	1.10	D	HVP=98				*Groundwater seepage at 1.1m.*
							Clay is gravelly from 1.6m.
	2.20	D					
				2.40	71.42		Very weak greyish brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.80	71.02		End of pit at 2.80 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 1.1m 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
TP28
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438735.38 - 402601.68 Level: 75.52	Date 26/07/2023
Location: Barnsley		Dimensions (m): Depth 2.80	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20	75.32		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
				0.50	75.02		Firm brown slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
	0.60	D	HVP=85				Stiff orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
			HVP=90				
				1.30	74.22		Stiff grey mottled brown slightly sandy slightly gravelly CLAY. Gravel is subangular fine to medium of siltstone and sandstone. (COHESIVE RESIDUAL SOIL)
							Clay is gravelly from 1.8m.
				2.10	73.42		Grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
	2.30	T					
				2.50	73.02		Weak brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.80	72.72		End of pit at 2.80 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 **TP29** Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438780.07 - 402591.17 Level: 78.68
Date	26/07/2023		
Location:	Barnsley	Dimensions (m): Depth 2.60	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal. (TOPSOIL)
				0.30	78.38		Firm light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone and siltstone. (COHESIVE RESIDUAL SOIL)
			HVP=70	0.60	78.08		Stiff orangish brown mottled light grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
	1.00	D	HVP=92				*Locally clay is gravelly.*
				1.50	77.18		Brownish grey sandy slightly clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
	1.60	T		1.90	76.78		Moderately weak brown thinly laminated SILTSTONE with occasional ironstone nodules. Recovered as sandy angular tabular fine to coarse gravel with low cobble content . (COAL MEASURES)
▼							*Groundwater seepage at 2.5m.*
				2.60	76.08		*Difficult to excavate beyond 2.6m.* End of pit at 2.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 2.5m 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 **TP30**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438757.61 - 402648.61 Level: 79.04
Location:	Barnsley	Dimensions (m): Depth 2.90	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.20	B		0.30	78.74		Stiff orangish brown mottled light grey slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of ironstone. (COHESIVE RESIDUAL SOIL)
			HVP=72				
			HVP=112				
							Clay is gravelly from 1.3m.
	1.50	D					
				1.70	77.34		Stiff brownish grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
				2.10	76.94		Brownish grey sandy slightly clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (COHESIVE RESIDUAL SOIL)
				2.40	76.64		Moderately weak greyish brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.90	76.14		*Difficult to excavate beyond 2.9m.* End of pit at 2.90 m

1 2 3 4

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
TP31
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438785.26 - 402665.11 Level: 81.43	Date 26/07/2023
Location: Barnsley		Dimensions (m): Depth 2.50	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20	81.23		Dark brown slightly sandy CLAY with occasional rootlets. (TOPSOIL)
			HVP=72	0.70	80.73		Stiff orangish brown mottled light grey CLAY. (COHESIVE RESIDUAL SOIL)
	0.80	D	HVP=105				Stiff grey mottled brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of siltstone and ironstone. (COHESIVE RESIDUAL SOIL)
							Clay is gravelly from 1.2m.
				1.40	80.03		Stiff light grey slightly sandy CLAY. (COHESIVE RESIDUAL SOIL)
▼	1.80	D					*At 1.4m, thin (5cm) bed of black clay.*
							Groundwater seepage at 1.9m.
				2.30	79.13		Strong light brown fine to medium grained SANDSTONE. Recovered as sandy gravelly angular tabular cobbles. (COAL MEASURES)
				2.50	78.93		*Unable to excavate beyond 2.5m.* End of pit at 2.50 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 1.9m 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
TP32
Sheet 1 of 1

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438807.33 - 402698.51 Level: 83.79	Date 26/07/2023
Location: Barnsley		Dimensions (m): Depth 2.70	Scale 1:20
Client: Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20	83.59		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone. (TOPSOIL)
	0.50	D					Firm brown slightly sandy gravelly CLAY. Gravel is subangular fine to coarse of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=105	0.80	82.99		Stiff light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone and siltstone. (COHESIVE RESIDUAL SOIL)
	1.40	T		1.30	82.49		Brown sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone and sandstone. (GRANULAR RESIDUAL SOIL)
							Gravel is clayey between 1.9m and 2.2m.
				2.40	81.39		Weak brown thinly laminated SILTSTONE. Recovered as sandy slightly clayey angular tabular fine to coarse gravel with low cobble content. (COAL MEASURES)
				2.70	81.09		*Difficult to excavate beyond 2.7m.* End of pit at 2.70 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

Trial Pit Log

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Trialpit No **TP33**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438774.91 - 402826.33 Level: 82.25
Location:	Barnsley	Dimensions (m): Depth 2.20	Scale 1:20
Client:	Crest Nicholson Yorkshire		Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	82.05		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of mixed lithologies including rare coal and ceramic. (TOPSOIL)
			HVP=65				Firm orangish brown mottled grey CLAY. (COHESIVE RESIDUAL SOIL)
	0.90	D	HVP=98	0.80	81.45		Stiff grey mottled brown slightly gravelly CLAY. Gravel is subangular fine of siltstone. (COHESIVE RESIDUAL SOIL)
							At 1.5m, 5cm bed of ironstone gravel.
				1.70	80.55		Brownish grey sandy clayey angular to subangular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
▼	1.90	T		2.00	80.25		Medium strong brown fine to medium grained SANDSTONE interbedded with brown SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.20	80.05		*Groundwater seepage at 2.0m.* *Unable to excavate beyond 2.2m.* End of pit at 2.20 m

1 2 3 4

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 2.0m 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
TP34
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438660.05 - 402757.88 Level: 73.19	Date 26/07/2023
Location:	Barnsley		Dimensions (m): Depth 2.80	Scale 1:20
Client:	Crest Nicholson Yorkshire			Logged LEW

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20	72.99		Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.50	D	HVP=70				Stiff orangish brown mottled light grey slightly gravelly CLAY. Gravel is angular to subrounded fine to coarse of ironstone. (COHESIVE RESIDUAL SOIL)
							At 0.5m, stone land drain.
			HVP=89				*Locally clay is gravelly.*
				1.40	71.79		Stiff light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of siltstone. (COHESIVE RESIDUAL SOIL)
	1.70	D					
				2.20	70.99		Greyish brown sandy slightly clayey angular to subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.50	70.69		Very weak greyish brown thinly laminated SILTSTONE. Recovered as sandy angular tabular fine to coarse gravel. (COAL MEASURES)
				2.80	70.39		End of pit at 2.80 m

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4

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

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Borehole Log

Borehole No.
PH01
Sheet 1 of 3

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438639.11 - 402795.10	Hole Type PH
Location:	Barnsley		Level:	72.78	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.40	70.38		Grey MUDSTONE (COAL MEASURES)
	▼				11.40	61.38		Dark grey MUDSTONE (COAL MEASURES) *At 11.50m, Ground water encountered.*
					17.40	55.38		Grey SILTSTONE (COAL MEASURES)

Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 11.50m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH01
Sheet 2 of 3

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438639.11 - 402795.10	Hole Type PH
Location:	Barnsley		Level:	72.78	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					20.50	52.28		Dark grey SILTSTONE (COAL MEASURES)
					22.00	50.78		Grey SANDSTONE (COAL MEASURES)
					28.30	44.48		Dark grey SANDSTONE (COAL MEASURES)
								Continued on next sheet

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 11.50m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

Borehole No. **PH01**

Sheet 3 of 3

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438639.11 - 402795.10	Hole Type PH
Location:	Barnsley		Level:	72.78	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					42.00	30.78		End of borehole at 42.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 11.50m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH02
Sheet 1 of 2

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438744.03 - 402786.35	Hole Type PH
Location:	Barnsley		Level:	79.48	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.60	76.88		Grey MUDSTONE (COAL MEASURES)
					19.00	60.48		Dark grey SILTSTONE (COAL MEASURES)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 38.50m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

LITHOS CONSULTING			Borehole No. **PH02** Sheet 2 of 2
Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438744.03 - 402786.35	Hole Type PH
Location: Barnsley		Level: 79.48	Scale 1:100
Client: Crest Nicholson Yorkshire		Dates: 26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					33.00	46.48		Light grey SANDSTONE (COAL MEASURES)
	▼							*At 38.50m, Ground water encountered.*
					39.00	40.48		End of borehole at 39.00 m

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 38.50m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH03
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438778.12 - 402886.16	Hole Type PH
Location:	Barnsley		Level:	81.80	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.60	79.20		Dark grey MUDSTONE (COAL MEASURES)
					11.40	70.40		Dark grey SILTSTONE (COAL MEASURES)
					15.00	66.80		Grey SANDSTONE (COAL MEASURES)
					16.20	65.60		Dark grey SILTSTONE (COAL MEASURES)
					18.00	63.80		End of borehole at 18.00 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

LITHOS CONSULTING

Borehole Log

Borehole No.
PH04
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438730.33 - 402832.60	Hole Type PH
Location:	Barnsley		Level:	79.02	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	77.22		Greyish brown MUDSTONE (COAL MEASURES)
	▼				5.30	73.72		Grey SILTSTONE (COAL MEASURES) *At 5.30m, Ground water encountered.*
					8.60	70.42		Dark grey SILTSTONE (COAL MEASURES)
					15.00	64.02		End of borehole at 15.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 5.30m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

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Borehole Log

Borehole No.
PH05
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438679.47 - 402725.51	Hole Type PH
Location:	Barnsley		Level:	79.85	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.90	77.95		Dark brownish grey MUDSTONE (COAL MEASURES)
					10.50	69.35		Dark grey SILTSTONE (COAL MEASURES)
					18.00	61.85		End of borehole at 18.00 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

LITHOS CONSULTING

Borehole Log

Borehole No.
PH06
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438759.14 - 402727.36	Hole Type PH
Location:	Barnsley		Level:	80.37	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	78.57		Grey MUDSTONE (COAL MEASURES)
					4.90	75.47		Dark grey MUDSTONE (COAL MEASURES)
					15.00	65.37		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.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH07
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438824.24 - 402789.27	Hole Type PH
Location:	Barnsley		Level:	85.88	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.90	83.98		Dark grey MUDSTONE (COAL MEASURES)
	▼							*At 7.30m, Ground water encountered.*
					16.10	69.78		Grey SILTSTONE (COAL MEASURES)
					17.80	68.08		Dark grey SILTSTONE (COAL MEASURES)
					18.00	67.88		End of borehole at 18.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 7.30m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

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Borehole Log

Borehole No.
PH08
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438836.25 - 402733.25	Hole Type PH
Location:	Barnsley		Level:	86.43	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.10	84.33		Dark brownish grey MUDSTONE (COAL MEASURES)
	▼							*At 12.00m, Ground water encountered.*
					13.00	73.43		Grey SANDSTONE (COAL MEASURES)
					15.00	71.43		End of borehole at 15.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 12.00m depth.
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:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438768.49 - 402652.37	Hole Type PH
Location:	Barnsley		Level:	80.17	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.10	78.07		Dark brownish grey MUDSTONE (COAL MEASURES)
					15.20	64.97		Dark grey SILTSTONE (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.

AGS

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Borehole Log

Borehole No.
PH09
Sheet 2 of 2

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438768.49 - 402652.37	Hole Type PH
Location:	Barnsley		Level:	80.17	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					31.00	49.17		Grey SANDSTONE (COAL MEASURES)
					39.00	41.17		End of borehole at 39.00 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.
PH10
Sheet 1 of 2

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438736.35 - 402965.51	Hole Type PH
Location:	Barnsley		Level:	84.46	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.30	82.16		
					2.50	81.96		Black Coal (THIN COAL)
								Dark grey MUDSTONE (COAL MEASURES)
								At 3.00m, Flash of Coal encountered.
					14.20	70.26		Dark grey SILTSTONE (COAL MEASURES)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 24.00m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

Borehole Log

Borehole No. **PH10**

Sheet 2 of 2

Project Name: Pit Lane, Wombwell	Project No. 4721	Co-ords: 438736.35 - 402965.51	Hole Type PH
Location: Barnsley		Level: 84.46	Scale 1:100
Client: Crest Nicholson Yorkshire		Dates: 31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	▼				22.70	61.76		Grey SANDSTONE (COAL MEASURES) *At 24.00m, Ground water encountered.*
					26.00	58.46		Dark grey SILTSTONE (COAL MEASURES) *At 29.00m, Flash of Coal encountered.*
					36.00	48.46		End of borehole at 36.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 24.00m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH11
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438661.97 - 402955.45	Hole Type PH
Location:	Barnsley		Level:	81.63	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.60	80.03		Dark brownish grey MUDSTONE (COAL MEASURES)
					7.10	74.53		Brownish grey SILTSTONE (COAL MEASURES)
					10.40	71.23		Dark grey SILTSTONE (COAL MEASURES)
					12.90	68.73		Grey SANDSTONE (COAL MEASURES)
					16.20	65.43		Dark grey SILTSTONE (COAL MEASURES)
					18.00	63.63		End of borehole at 18.00 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.
PH12
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438688.69 - 402897.66	Hole Type PH
Location:	Barnsley		Level:	79.31	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	77.51		Dark brownish grey MUDSTONE (COAL MEASURES)
					10.80	68.51		Brownish grey SILTSTONE (COAL MEASURES)
					18.00	61.31		End of borehole at 18.00 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.
PH101
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438641.46 - 402796.25	Hole Type PH
Location:	Barnsley		Level:	73.11	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.40	70.71		Grey MUDSTONE (COAL MEASURES)
					4.50	68.61		End of borehole at 4.50 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

Borehole No. **PH102**

Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438742.73 - 402789.40	Hole Type PH
Location:	Barnsley		Level: 79.45	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates: 26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.60	76.85		Grey MUDSTONE (COAL MEASURES)
					4.50	74.95		End of borehole at 4.50 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.
PH103
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438781.51 - 402890.56	Hole Type PH
Location:	Barnsley		Level:	82.10	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					3.00	79.10		Dark grey MUDSTONE (COAL MEASURES)
					4.50	77.60		End of borehole at 4.50 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.
PH104
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords: 438730.05 - 402830.19	Hole Type PH
Location:	Barnsley		Level: 79.04	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates: 27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
	▼							Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	77.24		Greyish brown MUDSTONE (COAL MEASURES)
								At 3.10m, Ground water encountered.
					4.50	74.54		End of borehole at 4.50 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater encountered at 3.10m depth.
3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
PH105
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438677.53 - 402710.99	Hole Type PH
Location:	Barnsley		Level:	73.65	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.70	71.95		Dark brownish grey MUDSTONE (COAL MEASURES)
					4.50	69.15		End of borehole at 4.50 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.
PH106
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438761.28 - 402734.64	Hole Type PH
Location:	Barnsley		Level:	80.77	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	78.97		Grey MUDSTONE (COAL MEASURES)
					4.50	76.27		End of borehole at 4.50 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.
PH107
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438824.92 - 402786.81	Hole Type PH
Location:	Barnsley		Level:	85.94	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.90	84.04		Dark grey MUDSTONE (COAL MEASURES)
					4.50	81.44		End of borehole at 4.50 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.
PH108
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438837.50 - 402730.01	Hole Type PH
Location:	Barnsley		Level:	86.45	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.00	84.45		Dark brownish grey MUDSTONE (COAL MEASURES)
					4.50	81.95		End of borehole at 4.50 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.
PH109
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438765.18 - 402655.62	Hole Type PH
Location:	Barnsley		Level:	79.86	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	28/07/2023 - 28/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
						79.86		Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.20	77.66		Dark brownish grey MUDSTONE (COAL MEASURES)
					9.00	70.86		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.
PH110
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438735.41 - 402970.74	Hole Type PH
Location:	Barnsley		Level:	84.73	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					2.50	82.23		
					2.80	81.93		Dark grey MUDSTONE (COAL MEASURES)
					2.90	81.83		Black Coal (THIN COAL)
					3.20	81.53		Dark grey MUDSTONE (COAL MEASURES)
					3.40	81.33		Black Coal (THIN COAL)
					4.50	80.23		Dark grey MUDSTONE (COAL MEASURES)
								End of borehole at 4.50 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.
PH111
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438663.60 - 402950.95	Hole Type PH
Location:	Barnsley		Level:	81.57	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.50	80.07		Dark brownish grey MUDSTONE (COAL MEASURES)
					4.50	77.07		End of borehole at 4.50 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.
PH112
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438691.01 - 402893.81	Hole Type PH
Location:	Barnsley		Level:	79.14	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	31/07/2023 - 31/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.90	77.24		Dark brownish grey MUDSTONE (COAL MEASURES)
					4.50	74.64		End of borehole at 4.50 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.
PH113
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438821.11 - 402850.57	Hole Type PH
Location:	Barnsley		Level:	85.55	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	26/07/2023 - 26/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	83.75		
					2.10	83.45		Black Coal (THIN COAL)
								Dark grey MUDSTONE (COAL MEASURES)
					4.50	81.05		End of borehole at 4.50 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.
PH114
Sheet 1 of 1

Project Name:	Pit Lane, Wombwell	Project No. 4721	Co-ords:	438693.92 - 402658.65	Hole Type PH
Location:	Barnsley		Level:	73.95	Scale 1:100
Client:	Crest Nicholson Yorkshire		Dates:	27/07/2023 - 27/07/2023	Logged By DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown OVERBURDEN (COHESIVE RESIDUAL SOIL)
					1.80	72.15		Dark brownish grey MUDSTONE (COAL MEASURES)
					4.50	69.45		End of borehole at 4.50 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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Appendix H

Soakaway Infiltration Claculations

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Crest Nicholson Yorkshire
Engineer	DP
Job Name:	Pit Lane, Wombwell
Job No.:	4721

Date:	**24/07/2023**
Trial Pit No.	**SA01**
Test No.	**1**

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:12	0	1.27	1270
09:14	2	1.28	1280
09:16	4	1.28	1280
09:18	6	1.28	1280
09:22	10	1.29	1290
09:31	19	1.29	1290
09:44	32	1.29	1290
10:15	63	1.29	1290
11:58	166	1.29	1290
13:39	267	1.29	1290
15:05	353	1.29	1290

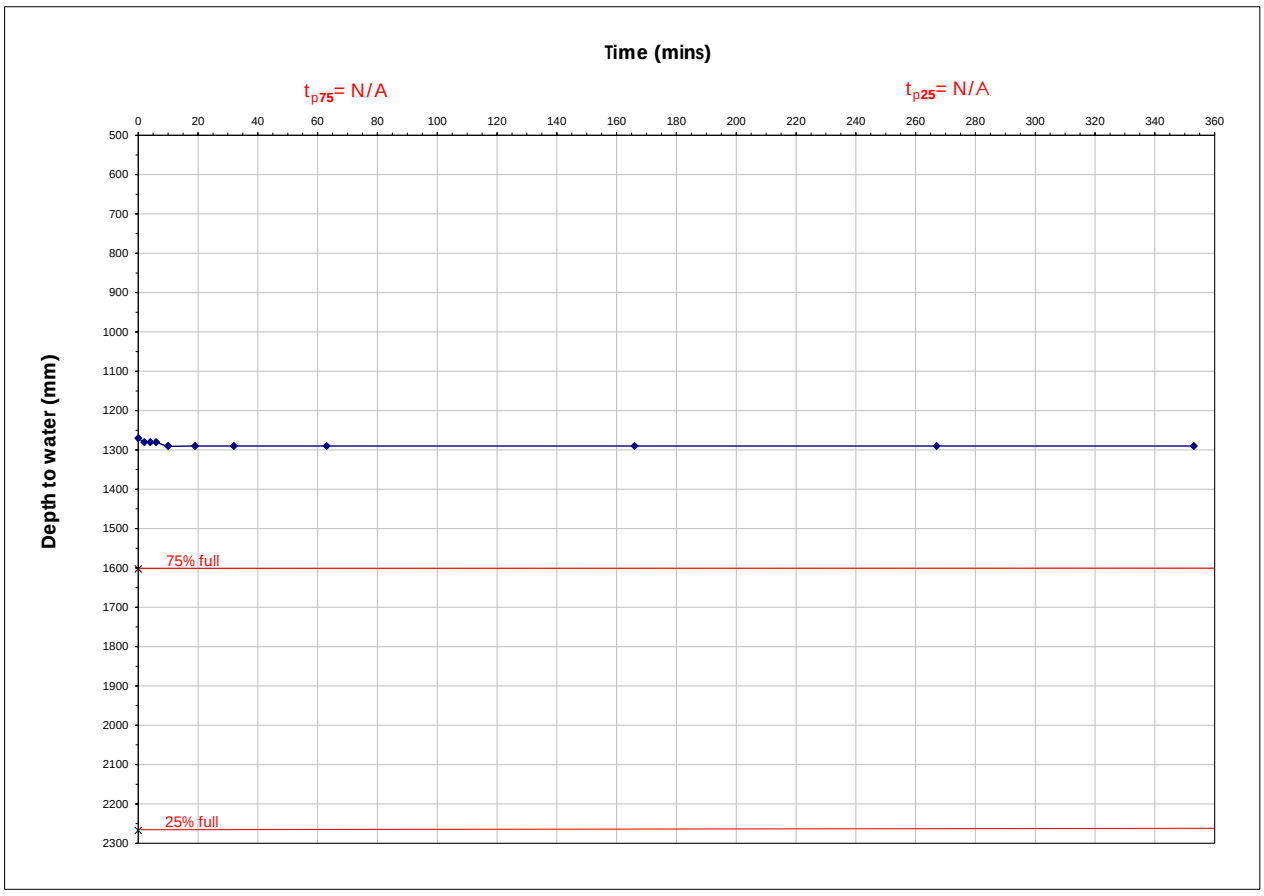
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.60	2600
Width	=	0.60	600
Depth	=	2.60	2600

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2267.5	2.27
0.50	=	1935	1.94
0.75	=	1602.5	1.60

Depth at start of test (mm)	=	1270
Depth at end of test (mm)	=	1290

Base area of pit	=	1.56
a_{p50} - 50% internal surface area inc. base	=	5.816
V_{p75-25} - Volume 75 - 25%	=	1.0374

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:	Crest Nicholson Yorkshire
Engineer	DP
Job Name:	Pit Lane, Wombwell
Job No.:	4721

Date:	**24/07/2023**
Trial Pit No.	**SA02**
Test No.	**1**

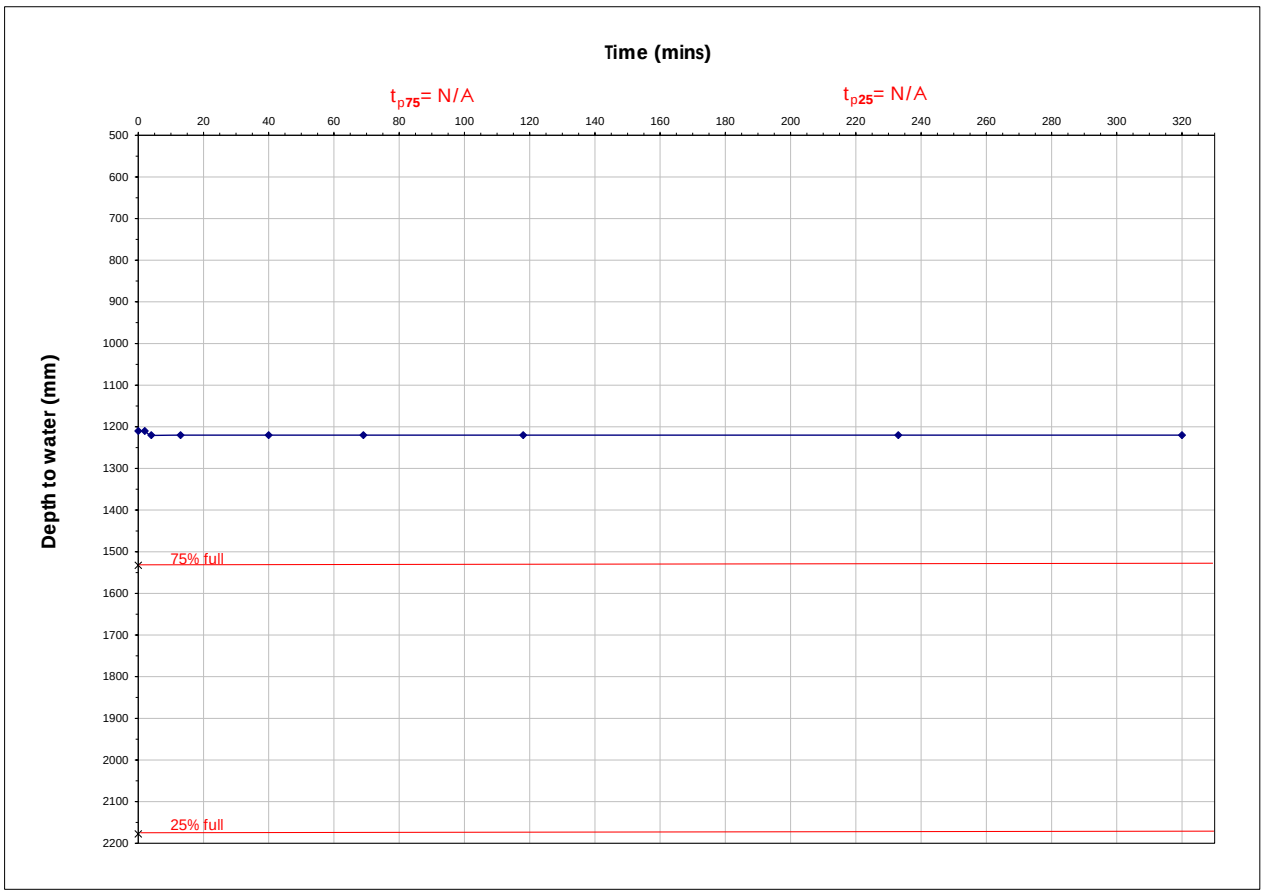
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:06	0	1.21	1210
10:08	2	1.21	1210
10:10	4	1.22	1220
10:19	13	1.22	1220
10:46	40	1.22	1220
11:15	69	1.22	1220
12:04	118	1.22	1220
13:59	233	1.22	1220
15:26	320	1.22	1220

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.70	1700
Width	=	0.60	600
Depth	=	2.50	2500

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2177.5	2.18
0.50	=	1855	1.86
0.75	=	1532.5	1.53

Depth at start of test (mm)	=	1210
Depth at end of test (mm)	=	1220
Base area of pit	=	1.02
a_{p50} - 50% internal surface area inc. base	=	3.987
V_{p75-25} - Volume 75 - 25%	=	0.6579

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:	Crest Nicholson Yorkshire
Engineer	DP
Job Name:	Pit Lane, Wombwell
Job No.:	4721

Date:	**24/07/2023**
Trial Pit No.	**SA03**
Test No.	**1**

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:40	0	1.39	1390
10:42	2	1.39	1390
10:50	10	1.39	1390
11:12	32	1.39	1390
12:07	87	1.33	1330
13:55	195	1.22	1220
15:38	298	1.22	1220

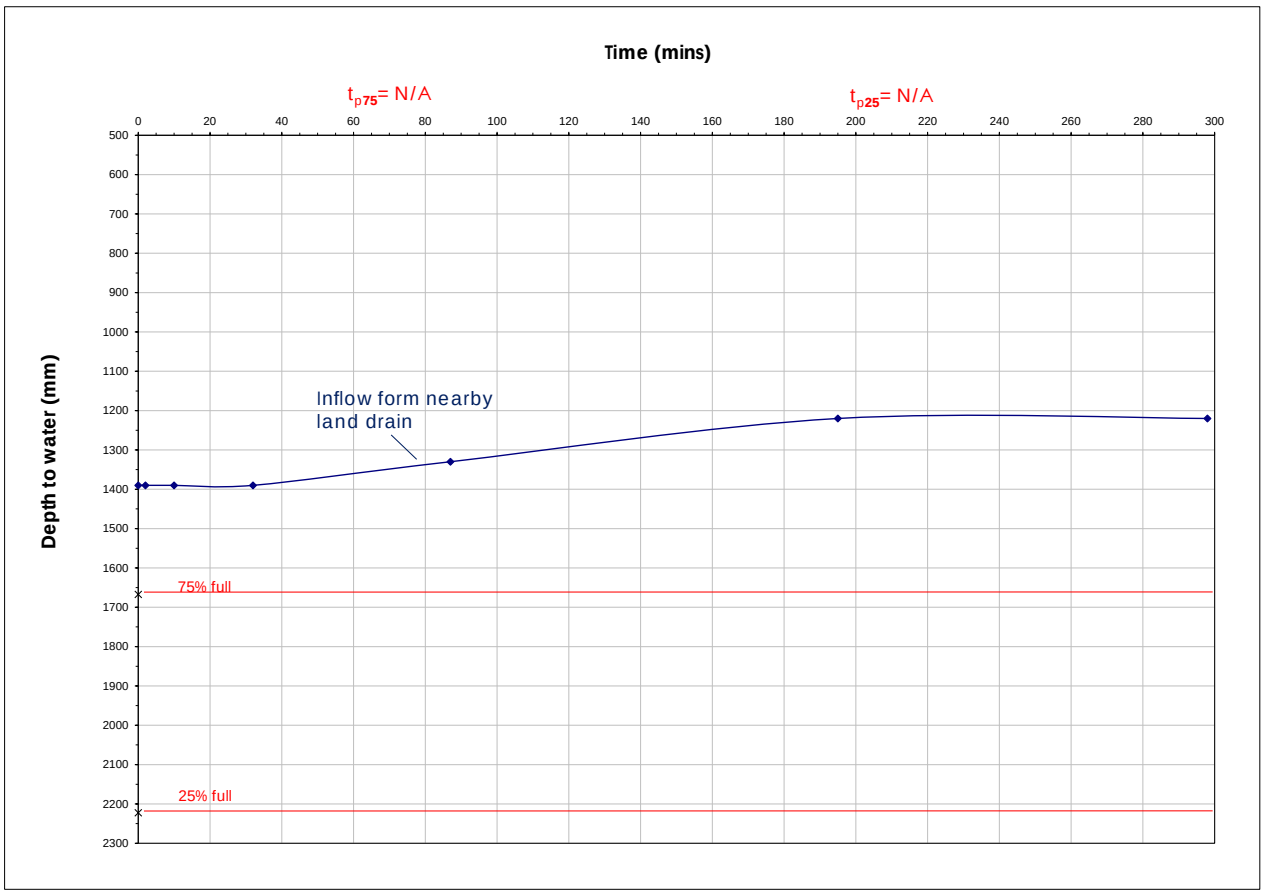
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.60	600
Depth	=	2.50	2500

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2222.5	2.22
0.50	=	1945	1.95
0.75	=	1667.5	1.67

Depth at start of test (mm)	=	1390
Depth at end of test (mm)	=	1390

Base area of pit	=	1.08
a_{p50} - 50% internal surface area inc. base	=	3.744
V_{p75-25} - Volume 75 - 25%	=	0.5994

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:	Crest Nicholson Yorkshire
Engineer	DP
Job Name:	Pit Lane, Wombwell
Job No.:	4721

Date:	**24/07/2023**
Trial Pit No.	**SA04**
Test No.	**1**

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:31	0	0.93	930
11:36	5	0.94	940
11:45	14	0.95	950
11:52	21	0.96	960
12:11	40	0.98	980
13:52	141	1.02	1020
15:49	258	1.02	1020

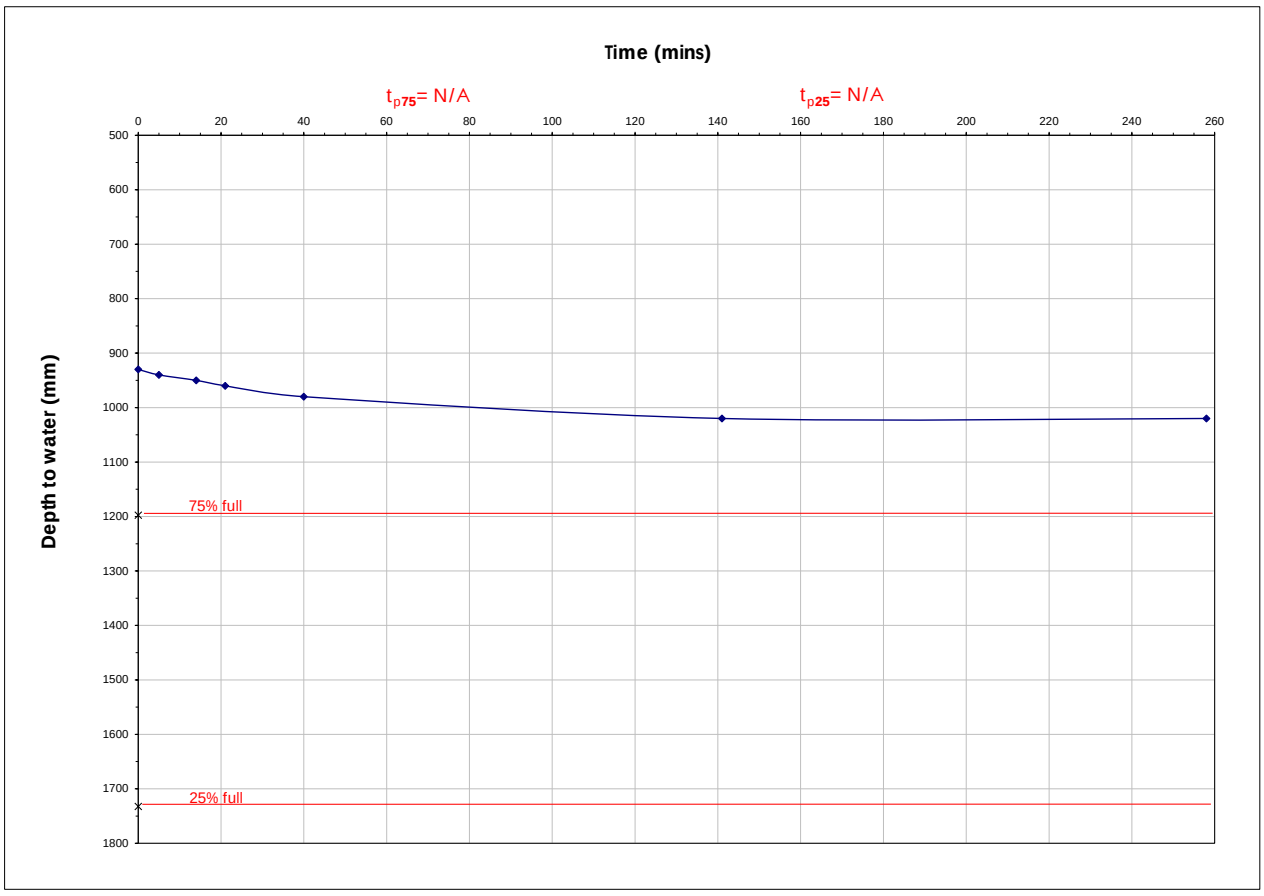
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.60	600
Depth	=	2.00	2000

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1732.5	1.73
0.50	=	1465	1.47
0.75	=	1197.5	1.20

Depth at start of test (mm)	=	930
Depth at end of test (mm)	=	1020

Base area of pit	=	1.08
a_{p50} - 50% internal surface area inc. base	=	3.648
V_{p75-25} - Volume 75 - 25%	=	0.5778

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 I

Chemical Results

Certificate of Analysis

Certificate Number 23-18602 *Issued:* 14-Aug-23

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 23-18602

Client Reference 4721

Order No PO21049

Contract Title PIT LANE, WOMBWELL

Description 24 Soil samples.

Date Received 04-Aug-23

Date Started 04-Aug-23

Date Completed 14-Aug-23

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 23-18602
Client Ref 4721
Contract Title PIT LANE, WOMBWELL

				Lab No	2213856	2213857	2213858	2213859	2213860	2213861
				.Sample ID	TP01	TP02	TP03	TP06	TP07	TP10
				Depth	0.10	0.10	0.10	0.10	0.10	0.10
				Other ID						
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	24/07/2023	24/07/2023	24/07/2023	24/07/2023	25/07/2023	25/07/2023
				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	< 1.0	< 1.0	< 1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	22	22	28	25	24	22
Metals										
Arsenic	DETSC 2301#	0.2	mg/kg	35	26	20	21	37	32
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg	1.0	0.8	0.8	1.3	1.0	0.7
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.3	0.2	0.3	0.4	0.3
Chromium	DETSC 2301#	0.15	mg/kg	20	16	28	25	27	27
Chromium III	DETSC 2301*	0.15	mg/kg	20	16	28	25	27	27
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	56	42	34	40	51	390
Lead	DETSC 2301#	0.3	mg/kg	73	55	50	59	1100	67
Mercury	DETSC 2325#	0.05	mg/kg	0.17	0.14	0.09	0.12	0.40	0.17
Nickel	DETSC 2301#	1	mg/kg	20	16	23	21	32	27
Selenium	DETSC 2301#	0.5	mg/kg	0.6	0.5	1.9	2.3	2.2	1.4
Vanadium	DETSC 2301#	0.8	mg/kg	42	31	46	48	49	49
Zinc	DETSC 2301#	1	mg/kg	100	82	95	86	110	110
Inorganics										
pH	DETSC 2008#		pH	6.7	6.7	6.7	6.4	6.8	6.6
Total Organic Carbon	DETSC 2084#	0.5	%	8.0	7.5	5.3	6.7	9.2	9.2
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l						
Sulphur as S, Total	DETSC 2320	0.01	%						
Sulphate as SO4, Total	DETSC 2321#	0.01	%						
PAHs										
Naphthalene	DETSC 3303#	0.03	mg/kg	0.06	0.11	< 0.03	0.03	0.05	0.04
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	0.20	0.23	0.07	0.10	0.12	0.16
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.27	0.27	0.08	0.12	0.15	0.22
Pyrene	DETSC 3303#	0.03	mg/kg	0.23	0.23	0.07	0.10	0.12	0.19
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.06	0.06	< 0.03	< 0.03	0.03	0.05
Chrysene	DETSC 3303	0.03	mg/kg	0.11	0.10	0.04	0.05	0.06	0.09
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.06	0.09	< 0.03	< 0.03	< 0.03	0.05
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.07	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.03	< 0.03	< 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	< 0.03
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	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	1.0	1.2	0.21	0.37	0.51	0.81

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil Samples

Our Ref 23-18602
Client Ref 4721
Contract Title PIT LANE, WOMBWELL

			Lab No	2213862	2213863	2213864	2213865	2213866	2213867
			.Sample ID	TP11	TP13	TP18	TP20	TP22	TP24
			Depth	0.10	0.10	0.10	0.10	0.10	0.10
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	25/07/2023	25/07/2023	25/07/2023	25/07/2023	25/07/2023	26/07/2023
			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	< 1.0	< 1.0	< 1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	24	24	26	27	25	19
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	36	22	17	19	11	13
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg	0.9	0.9	1.0	0.7	0.8	0.7
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.2	0.3	0.3	0.3	0.2
Chromium	DETSC 2301#	0.15	mg/kg	26	25	21	26	27	21
Chromium III	DETSC 2301*	0.15	mg/kg	26	25	21	26	27	21
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	56	39	41	36	32	24
Lead	DETSC 2301#	0.3	mg/kg	68	42	46	52	54	35
Mercury	DETSC 2325#	0.05	mg/kg	0.16	0.09	0.10	0.09	0.09	0.07
Nickel	DETSC 2301#	1	mg/kg	28	23	24	22	22	22
Selenium	DETSC 2301#	0.5	mg/kg	1.8	1.5	1.1	1.8	1.5	0.9
Vanadium	DETSC 2301#	0.8	mg/kg	48	40	37	44	44	32
Zinc	DETSC 2301#	1	mg/kg	110	140	81	85	100	90
Inorganics									
pH	DETSC 2008#		pH	6.7	6.8	6.6	6.9	6.8	6.6
Total Organic Carbon	DETSC 2084#	0.5	%	11	8.9	5.3	5.3	3.6	3.3
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l						
Sulphur as S, Total	DETSC 2320	0.01	%						
Sulphate as SO4, Total	DETSC 2321#	0.01	%						
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	0.03	< 0.03	0.08	< 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	0.04	< 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	0.09	0.04	0.29	0.08	0.10	0.06
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.11	0.05	0.27	0.10	0.15	0.11
Pyrene	DETSC 3303#	0.03	mg/kg	0.09	0.04	0.22	0.08	0.12	0.09
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.05	< 0.03	0.03	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	0.05	< 0.03	0.09	0.05	0.06	0.05
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.03	< 0.03	< 0.03	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 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	< 0.03
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	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	0.35	0.13	1.0	0.31	0.43	0.31

Summary of Chemical Analysis
Soil Samples

Our Ref 23-18602
Client Ref 4721
Contract Title PIT LANE, WOMBWELL

	Lab No	2213868	2213869	2213870	2213871	2213872	2213873
	.Sample ID	TP27	TP29	TP30	TP10	SA04	TP14
	Depth	0.10	0.10	0.10	0.50	0.70	1.40
	Other ID						
	Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Sampling Date	26/07/2023	26/07/2023	26/07/2023	25/07/2023	24/07/2023	25/07/2023
	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	< 1.0			
Moisture Content	DETSC 1004	0.1	%	24	21	24			
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	10	16	13			
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg	0.8	0.9	0.8			
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.3	0.2			
Chromium	DETSC 2301#	0.15	mg/kg	24	27	23			
Chromium III	DETSC 2301*	0.15	mg/kg	24	27	23			
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0			
Copper	DETSC 2301#	0.2	mg/kg	28	30	25			
Lead	DETSC 2301#	0.3	mg/kg	39	46	42			
Mercury	DETSC 2325#	0.05	mg/kg	0.06	0.08	0.07			
Nickel	DETSC 2301#	1	mg/kg	20	24	22			
Selenium	DETSC 2301#	0.5	mg/kg	0.8	1.5	0.9			
Vanadium	DETSC 2301#	0.8	mg/kg	34	38	32			
Zinc	DETSC 2301#	1	mg/kg	96	90	83			
Inorganics									
pH	DETSC 2008#		pH	6.9	7.1	6.6	7.1	7.1	7.1
Total Organic Carbon	DETSC 2084#	0.5	%	3.5	3.3	3.3			
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l				28	12	14
Sulphur as S, Total	DETSC 2320	0.01	%				0.03	< 0.01	
Sulphate as SO4, Total	DETSC 2321#	0.01	%				0.07	0.02	
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.12	0.06	0.04			
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.19	0.13	0.06			
Pyrene	DETSC 3303#	0.03	mg/kg	0.15	0.11	0.05			
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.04	0.03	< 0.03			
Chrysene	DETSC 3303	0.03	mg/kg	0.08	0.07	0.03			
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.04	0.04	< 0.03			
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 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			
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03			
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	0.59	0.38	0.15			

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil Samples

Our Ref 23-18602
Client Ref 4721
Contract Title PIT LANE, WOMBWELL

	Lab No	2213874	2213875	2213876	2213877	2213878	2213879
	.Sample ID	TP32	TP29	TP33	TP11	TP16	TP17
	Depth	1.40	1.60	1.90	0.70	2.20	2.50
	Other ID						
	Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Sampling Date	26/07/2023	26/07/2023	26/07/2023	25/07/2023	25/07/2023	25/07/2023
	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						
Moisture Content	DETSC 1004	0.1	%						
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg						
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg						
Cadmium	DETSC 2301#	0.1	mg/kg						
Chromium	DETSC 2301#	0.15	mg/kg						
Chromium III	DETSC 2301*	0.15	mg/kg						
Chromium, Hexavalent	DETSC 2204*	1	mg/kg						
Copper	DETSC 2301#	0.2	mg/kg						
Lead	DETSC 2301#	0.3	mg/kg						
Mercury	DETSC 2325#	0.05	mg/kg						
Nickel	DETSC 2301#	1	mg/kg						
Selenium	DETSC 2301#	0.5	mg/kg						
Vanadium	DETSC 2301#	0.8	mg/kg						
Zinc	DETSC 2301#	1	mg/kg						
Inorganics									
pH	DETSC 2008#		pH	5.0	5.3	6.8	4.7	5.1	6.1
Total Organic Carbon	DETSC 2084#	0.5	%						
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l	12	23	23	31	21	16
Sulphur as S, Total	DETSC 2320	0.01	%	0.01			0.10	0.08	0.01
Sulphate as SO4, Total	DETSC 2321#	0.01	%	0.03			0.09	0.03	0.03
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg						
Acenaphthylene	DETSC 3303#	0.03	mg/kg						
Acenaphthene	DETSC 3303#	0.03	mg/kg						
Fluorene	DETSC 3303	0.03	mg/kg						
Phenanthrene	DETSC 3303#	0.03	mg/kg						
Anthracene	DETSC 3303	0.03	mg/kg						
Fluoranthene	DETSC 3303#	0.03	mg/kg						
Pyrene	DETSC 3303#	0.03	mg/kg						
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg						
Chrysene	DETSC 3303	0.03	mg/kg						
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg						
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg						
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg						
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg						
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg						
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg						
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg						

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Asbestos Analysis
Soil Samples

Our Ref 23-18602
Client Ref 4721
Contract Title PIT LANE, WOMBWELL

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
2213856	TP01 0.10	SOIL	NAD	none	Barry Kelly
2213857	TP02 0.10	SOIL	NAD	none	Barry Kelly
2213858	TP03 0.10	SOIL	NAD	none	Barry Kelly
2213859	TP06 0.10	SOIL	NAD	none	Barry Kelly
2213860	TP07 0.10	SOIL	NAD	none	Barry Kelly
2213861	TP10 0.10	SOIL	NAD	none	Barry Kelly
2213862	TP11 0.10	SOIL	NAD	none	Barry Kelly
2213863	TP13 0.10	SOIL	NAD	none	Barry Kelly
2213864	TP18 0.10	SOIL	NAD	none	Barry Kelly
2213865	TP20 0.10	SOIL	NAD	none	Barry Kelly
2213866	TP22 0.10	SOIL	NAD	none	Barry Kelly
2213867	TP24 0.10	SOIL	NAD	none	Barry Kelly
2213868	TP27 0.10	SOIL	NAD	none	Barry Kelly
2213869	TP29 0.10	SOIL	NAD	none	Barry Kelly
2213870	TP30 0.10	SOIL	NAD	none	Barry Kelly

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 23-18602
Client Ref 4721
Contract PIT LANE, WOMBWELL

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2213856	TP01 0.10 SOIL	24/07/23	GJ 250ml	pH + Conductivity (7 days)	
2213857	TP02 0.10 SOIL	24/07/23	GJ 250ml, PT 1L x2	pH + Conductivity (7 days)	
2213858	TP03 0.10 SOIL	24/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213859	TP06 0.10 SOIL	24/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213860	TP07 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213861	TP10 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213862	TP11 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213863	TP13 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213864	TP18 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213865	TP20 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213866	TP22 0.10 SOIL	25/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213867	TP24 0.10 SOIL	26/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213868	TP27 0.10 SOIL	26/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213869	TP29 0.10 SOIL	26/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213870	TP30 0.10 SOIL	26/07/23	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2213871	TP10 0.50 SOIL	25/07/23	PT 1L	Total Sulphur ICP (7 days), pH + Conductivity (7 days)	
2213872	SA04 0.70 SOIL	24/07/23	PT 1L	Total Sulphur ICP (7 days), pH + Conductivity (7 days)	
2213873	TP14 1.40 SOIL	25/07/23	PT 1L	pH + Conductivity (7 days)	
2213874	TP32 1.40 SOIL	26/07/23	PT 1L	Total Sulphur ICP (7 days), pH + Conductivity (7 days)	
2213875	TP29 1.60 SOIL	26/07/23	PT 1L	pH + Conductivity (7 days)	
2213876	TP33 1.90 SOIL	26/07/23	PT 1L	pH + Conductivity (7 days)	
2213877	TP11 0.70 SOIL	25/07/23	PT 1L	Total Sulphur ICP (7 days), pH + Conductivity (7 days)	
2213878	TP16 2.20 SOIL	25/07/23	PT 1L	Total Sulphur ICP (7 days), pH + Conductivity (7 days)	
2213879	TP17 2.50 SOIL	25/07/23	PT 1L	Total Sulphur ICP (7 days), pH + Conductivity (7 days)	

Key: G-Glass J-Jar 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

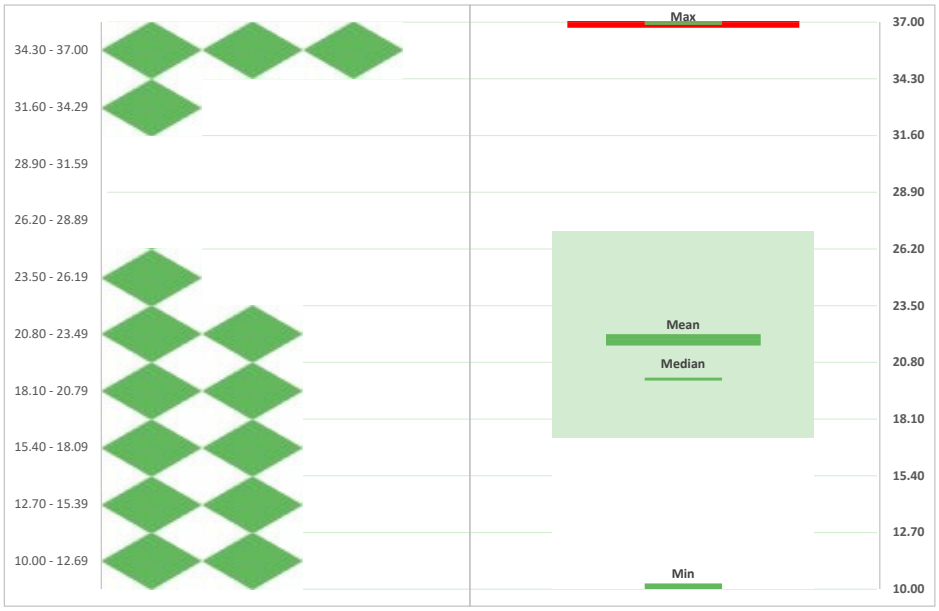
End of Report

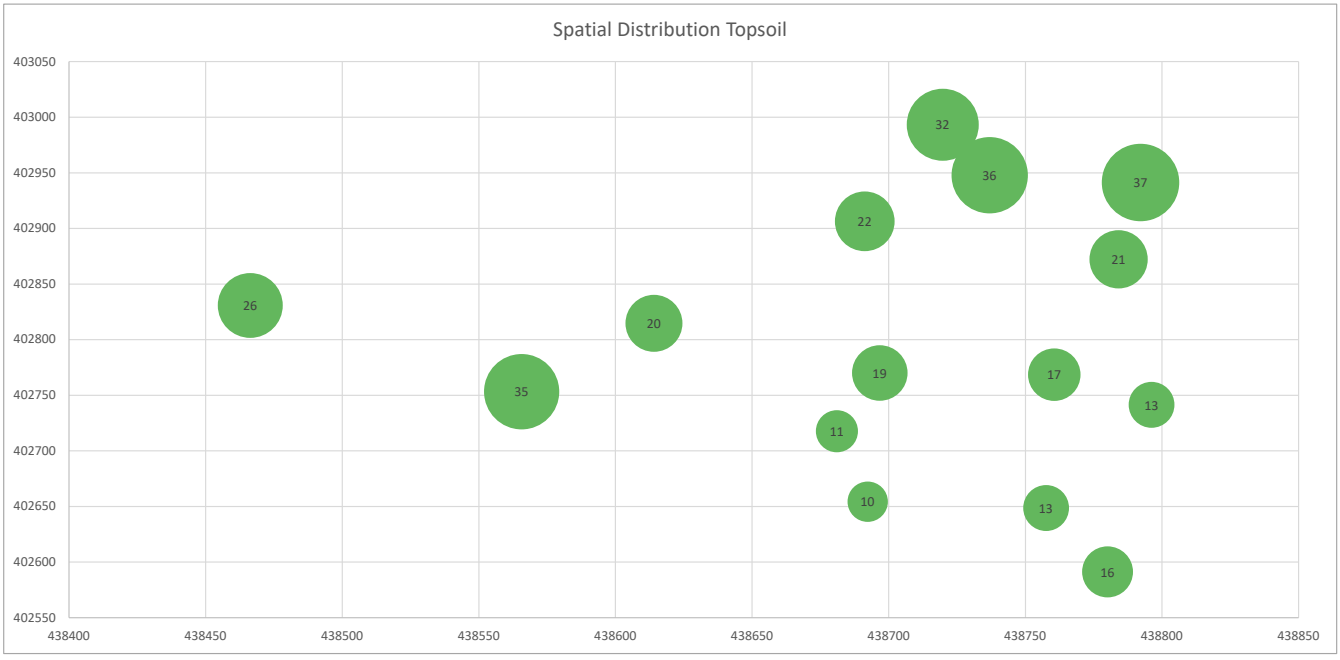
Pit Lane, Wombwell

Job No: 4721
Engineer: ASw
Date: 19 09 23

Topsoil: Dataset for As - Dot & Box Plots and Summary Statistics

Determinant	As
Critical concentration	37.00
No. samples	15.00
Max	37.00
Mean	21.87
Min	10.00
Median	20.00
Standard Deviation	9.29
Standard Error	2.40
T value	2.14
Upper Confidence Level (95%)	27.01
Upper Confidence Level (80%)	25.09
Lower Confidence Level (5%)	17.17
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

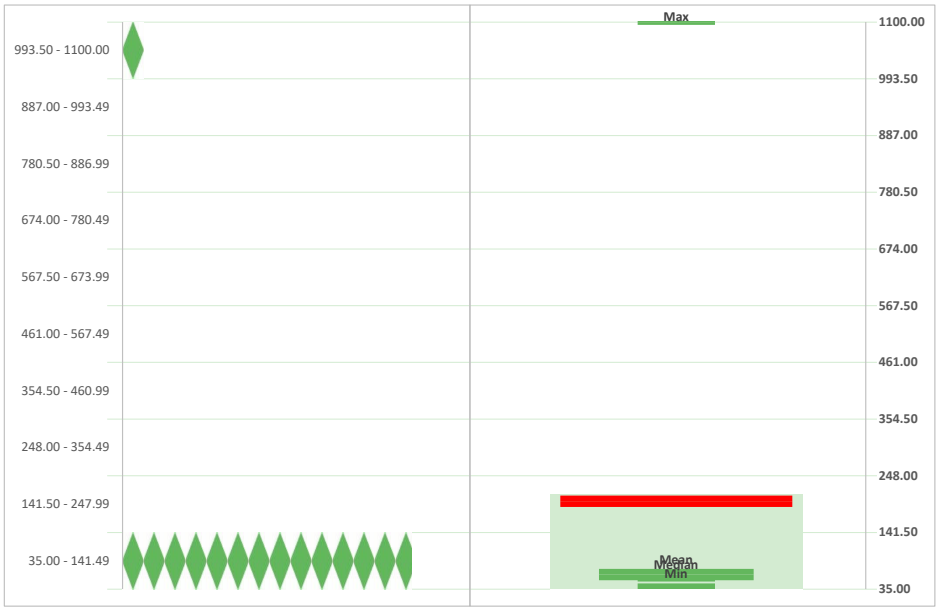
Pit Lane, Wombwell

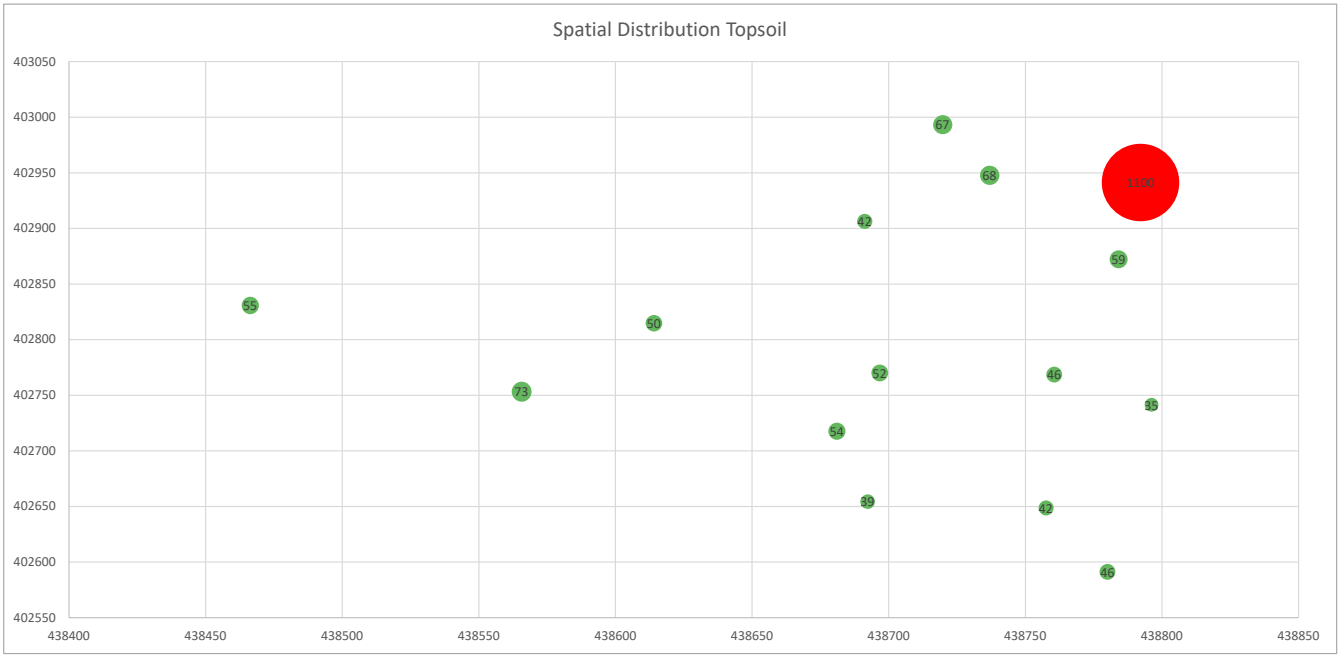
Job No: 4721
Engineer: ASw
Date: 19 09 23

Topsoil: Dataset for Pb - Dot & Box Plots and Summary Statistics

Determinant	Pb
Critical concentration	200.00
No. samples	15.00
Max	1,100.00
Mean	62.41
Min	35.00
Median	52.00
Standard Deviation	270.82
Standard Error	69.93
T value	2.14
Upper Confidence Level (95%)	212.39
Upper Confidence Level (80%)	156.46
Lower Confidence Level (5%)	(74.64)
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

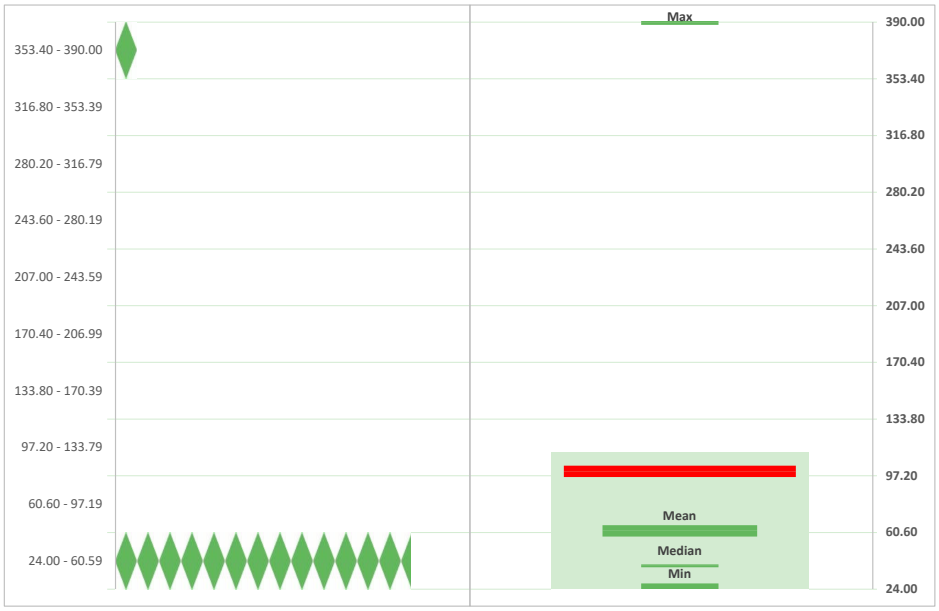
Pit Lane, Wombwell

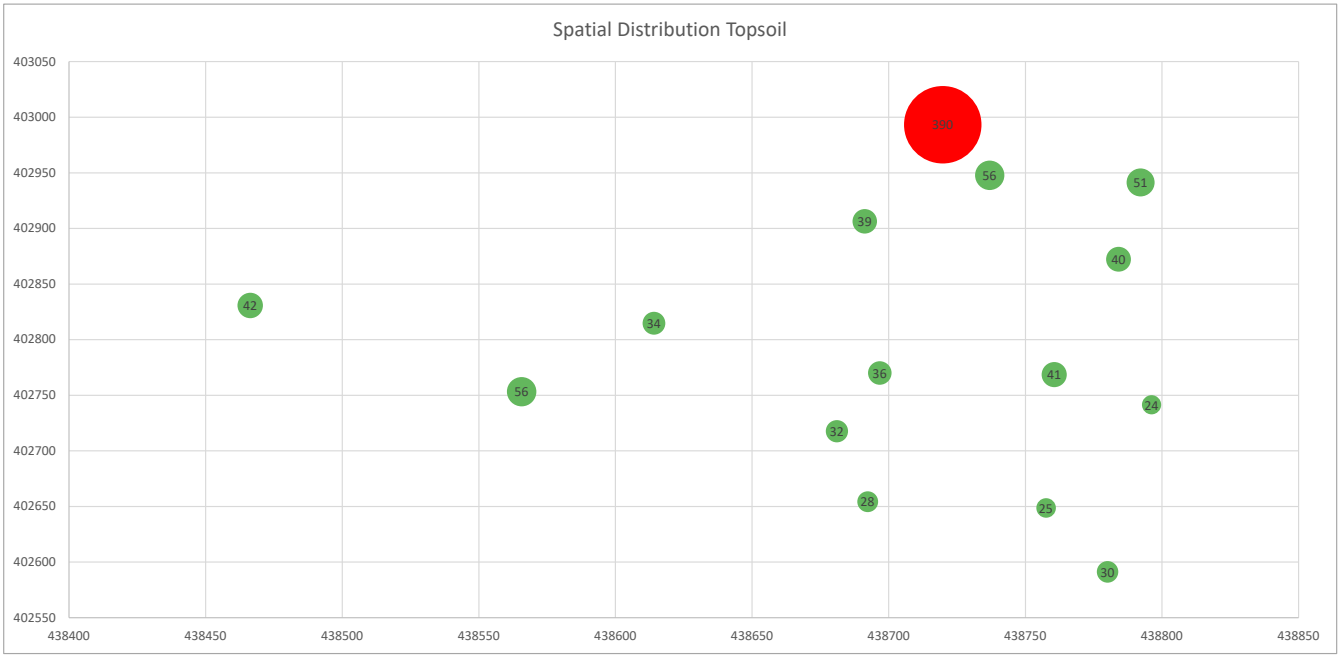
Job No: 4721
Engineer: ASw
Date: 19 09 23

Topsoil: Dataset for Cu - Dot & Box Plots and Summary Statistics

Determinant	Cu
Critical concentration	100.00
No. samples	15.00
Max	390.00
Mean	61.60
Min	24.00
Median	39.00
Standard Deviation	91.41
Standard Error	23.60
T value	2.14
Upper Confidence Level (95%)	112.22
Upper Confidence Level (80%)	93.35
Lower Confidence Level (5%)	15.34
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

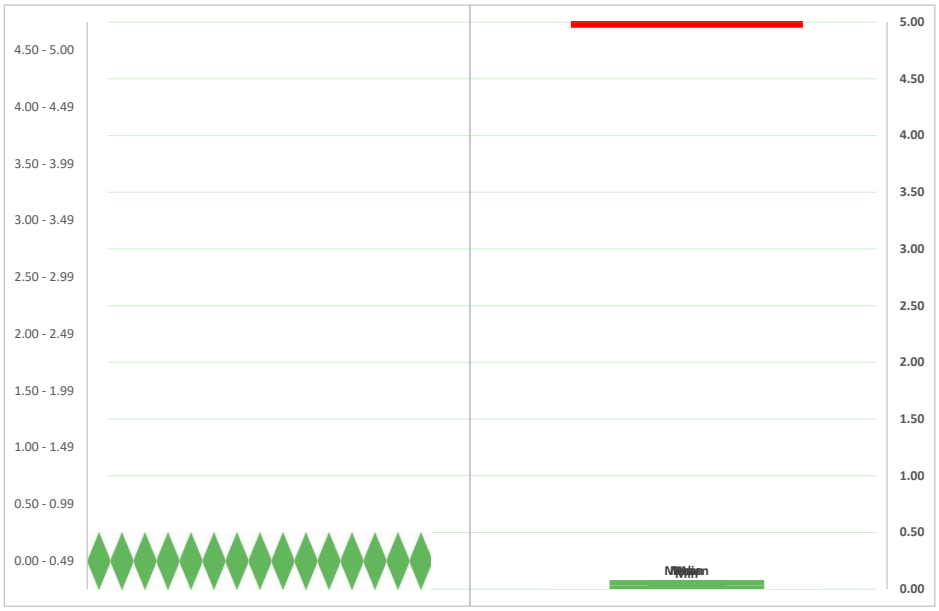
Pit Lane, Wombwell

Job No: 4721
Engineer: ASw
Date: 19 09 23

Topsoil: Dataset for B(a)P - Dot & Box Plots and Summary Statistics

Determinant	B(a)P
Critical concentration	5.00
No. samples	15.00
Max	0.03
Mean	0.03
Min	0.03
Median	0.03
Standard Deviation	0.00
Standard Error	0.00
T value	2.14
Upper Confidence Level (95%)	0.03
Upper Confidence Level (80%)	0.03
Lower Confidence Level (5%)	0.03
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 J

Contaminated land assessment for selection of water supply pipes

Contaminated Land Assessment Form

Introduction

In January 2011, UK Water Industry Research (UKWIR) published “Guidance for the selection of Water Supply Pipes to be used in Brownfield Sites” (UKWIR 2010 Ref 10/WM/03/21). The aim of this publication is to ensure that the correct materials are selected for Water Pipes to be used below ground in Brownfield Sites. It supersedes the Water Regulations Advisory Scheme (WRAS) Information and Guidance Note 9-04-03 “Laying Pipes in Contaminated Land” which has now been withdrawn.

The UKWIR guidance is for use by Water Companies, Self Lay Organisations, Developers and Consultants during the planning, designing and construction of water mains and/or services in Brownfield Sites. The guidance defines a Brownfield Site as “Land or premises that have not previously been used or developed. They may also be vacant or derelict. However, they are not necessarily contaminated.” UKWIR state the guidance does not apply to Greenfield Sites, however YW reserve the right to apply relevant sections of the publication to Greenfield Sites that may potentially be contaminated.

Contamination Risk Assessment

Please complete the form below to allow us to assess the risk of contamination of the drinking water supply from chemicals within the soil. Yorkshire Water now lays all its water mains and service pipes in plastic. Many organic compounds (i.e. Phenols, Fuels and other hydrocarbons) can either permeate through the walls of plastic pipes into the water supply or dissolve and weaken the pipe causing water leaks.

As a minimum a desk top study (Preliminary Risk Assessment) shall be provided to YW that sets out whether the land through which the Water Pipes are to be laid may be affected by contamination. For those sites where land contamination may be present, appropriate testing shall be undertaken on existing ground materials and remediated materials. The testing requirements are as described below:

Testing Requirements

The tests that are required on all sites where the potential for contamination has been established through the desk top study and where water pipes are proposed to be laid must be undertaken by bodies with accreditation from UKAS (United Kingdom Accreditation Service) and where possible MCERTS (Environment Agency’s Monitoring Certification Service).

The tests on soil/water samples shall be those to detect and report on the levels of the following contaminant groups and chemical characteristics: **VOC’s, SVOC’s, Mineral Oil compounds C10-C40, Conductivity, pH** and **Redox potential** (as stipulated in the UKWIR guidance Appendix G).
If the previous function of the site involved the use, storage, manufacture or disposal of any of the following elements, appropriate testing for these substances will be required:

Ethers, Nitrobenzene, Ketones, Aldehydes and Amines. Please note UKWIR guidance states the presence of Amines on any site precludes the use of Polyethylene pipework.

Sufficiency of Testing

Samples taken must be representative of the soil conditions in which the Water Pipes are proposed to be laid (normally Water Pipes are laid at a depth between 0.7m and 1.3m below finished ground level). As a result samples must be taken at least 500mm below the base of the proposed pipe where the proposed location is known. If the proposed location is unknown then samples must be taken at intervals between the surface level and 1.5m from below finished ground level as a minimum. Where appropriate groundwater sampling and groundwater monitoring will also be necessary (see UKWIR guidance).

Further guidance on representative sampling is contained within BS10175:2011 “Code of practice for the Investigation of Potentially Contaminated Sites”.

The table in section 3 lists the contaminants and their respective levels which can permeate or damage plastic water pipes with consequent risk to the water supply. Where soil analysis results indicate levels of these contaminants above the maximum allowable concentration shown, then Yorkshire Water will determine that all mains and service pipes are laid in suitable materials resistant to the risks posed by those contaminants. Where sites have been used for any of the activities listed in Section 2 all mains and services shall be laid in suitable permeation resistant pipe systems due to the high risk of these contaminants being present.

Health & Safety Assessment

The UKWIR guidance does not cover Health & Safety considerations as part of any operational activities undertaken on Brownfield Sites. In order to maintain the safety of our staff, service partners and customers YW will also assess the site based on the EA CLEA (Contaminated Land Exposure Assessment) guidelines.

In order to comply with Yorkshire Water’s Health & safety requirements please review the following information relating to trigger values for Health & Safety considerations when laying Water Pipes in contaminated Land.

	Contaminant	Mg/Kg		Contaminant	Mg/Kg
Inorganic	Arsenic	32	Organic	Benzene	0.33
	Nickel	130		Toulene	610
	Mercury	170		Ethylbenzene	350
	Selenium	35		Xylene	230
	Cadmium	10		Phenol	420

None of the above inorganic thresholds exceeded in any of the samples tested with the exception of 4 samples of Topsoil which recorded concentrations of arsenic between 32 and 37mg/kg/

No source of organic contamination noted during the desk study & site investigation therefore none of samples recovered from the site have been tested for the above organic contaminants (only a reduced organic contamination suite – Speciated PAH).

1. Your Details

Company Name	Contact Name
Lithos Consulting	D Platford

Site Address	Contact Number
Pit Lane, Wombwell	01937 545330

2. The Previous Use of the Site

Please indicate below the previous uses of the site being developed

Site is greenfield (agricultural) with no former development. Currently comprises several cropped fields.

Please indicate if the site (or part of it) has previously been used for any of the following activities:

no	Chemicals Manufacture	no	Paint or Ink Manufacture
no	Explosives / Ordnance Manufacture	no	Railway Land / Railway Engineering
no	Fuel Filling Stations / Storage	no	Scrap metals
no	Metal Finishing / Treating	no	Shipbuilding & Repair
no	Mechanical Engineering Works	no	Vehicle Repair Garages
no	Oil & Gas Refineries / Storage	no	Vehicle Manufacturing

3. Contaminants

Please complete the table below with the highest concentrations in mg/kg of each or any of the contaminants listed. The information should be extracted from your soil reports already undertaken, if any of the contaminants were not tested for, this should be declared on the form along with the reasons for this. If you have any difficulty interpreting the results of your soil sample analyses and transposing them into the table, then you should consult the body who undertook the sampling and reporting. If there are more than 3 sample locations with associated test results please copy the table for each location and label each with the sample reference and its location on a site plan.

Laboratory Name:		Date	Concentration	
Group No.	Parameter group	Unit	Depth (m)	Detection Limit
1	Extended VOC suite (with TIC)	mg/kg	-	0.5
1a	BTEX & MTBE	mg/kg	-	0.1
2	Extended SVOC suite (with TIC)	mg/kg	-	2
2e	Phenols	mg/kg	-	2
2f	Cresols and chlorinated phenols	mg/kg	-	2
3	Mineral Oils C_{11}-C_{20}	mg/kg	-	10
4	Mineral Oils C_{21}-C_{40}	mg/kg	-	500
5	Corrosive (Conductivity, Redox & pH)		-	
	Conductivity	µS/cm	-	
	Redox	Volt	-	
	pH	pH	6.4 – 7.1 (average 6.7)	
2a	Ethers	mg/kg	-	0.5
2b	Nitrobenzene	mg/kg	-	0.5
2c	Ketones	mg/kg	-	0.5
2d	Aldehydes	mg/kg	-	0.5
6	Amines	mg/kg	-	Any presence

At the time of investigation, the proposed route(s), and total length, of pipeline were unknown. Consequently, to date laboratory testing of soil samples in line with UKWIR guidance was not undertaken.

However, given the site's history and the relatively consistent ground conditions reported, the use of 'standard' polyethylene water supply pipes should be acceptable.

DO NOT include a copy of your soil report with your application, if you do not complete the table above your application will be returned to you.

Please include a site plan highlighting the locations of the above sample points.

Please find appended to this document.

4. Remediation of the site

Please indicate below any remediation work that will be undertaken on the site to remove / mitigate the effect of any contaminants identified in the soil report. Please include the nature and depth of any remediation work.

Site is greenfield, however elevated concentrations of lead were encountered in one sample of Topsoil. As such, some remediation (excavation and disposal off site or isolation beneath clean cover in gardens) is anticipated.

5. Can I use plastic pipe if I undertake remediation works?

Yes, as long as the remediation work either removes the contaminated soil or reduces the level of contaminants below trigger levels. Moving contaminated material so that it is under roads and footpaths is not acceptable as this is the likely location of the water mains.

As water mains are lad to a depth of 0.9m to the top of the pipe, any contaminated soil to a depth of 1.3m must be removed. We will require post remediation sampling results confirming contamination has fallen below the trigger levels prior to releasing any works to our Service Partners.

If contamination is found all water mains and services on the site must be laid in a suitable barrier pipe. Yorkshire Water will not change the agreed mains material after the agreement has been signed by all parties. So please ensure your remediation proposals are made clear at this stage.

6. Declaration

I hereby confirm that the information provided in this form is true and I understand that should the site conditions change from those indicated in this report that I may incur additional costs.

Your Signature	Date
Dan Platford	26th September 2023

Your Name & Title (PLEASE PRINT	Role in organisation
DAN PLATFORD	Graduate Engineer

Please return this completed form with your application to Developer Services, Yorkshire Water Services Ltd, PO Box 52, Bradford BD3 7YD

References

BS10175:2011 “Investigation of Potentially Contaminated Sites Code of Practice

UK Water Industry Research (UKWIR) “ Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites” (Ref 10/WM/03/21)

Appendix K

Geotechnical Test Results

LABORATORY REPORT

Contract Number: PSL23/6509

Report Date: 24 August 2023

Client's Reference: 4721

Client Name: Lithos Consulting
Parkhill
Walton Road
Wetherby
North Yorkshire
LS22 5DZ

For the attention of: Lewis Whiteley

Project Name: Pit Lane, Wombwell

Date Received: 4/8/2023
Date Commenced: 4/8/2023
Date Completed: 24/08/2023

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)
M Fennell (Senior Technician)

5 – 7 Hexthorpe Road,
Hexthorpe,
Doncaster,
DN4 0AR
Tel: 01302 768098
Email: rberriman@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
TP24	2	B	0.15		Brown TOPSOIL.
TP01	2	B	0.20		Brown TOPSOIL.
TP06	2	B	0.20		Brown TOPSOIL.
TP10	2	B	0.20		Brown TOPSOIL.
TP20	2	B	0.20		Brown TOPSOIL.
TP13	2	D	0.60		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP01	3	D	0.70		Brown mottled grey slightly sandy CLAY.
TP08	1	D	0.70		Brown mottled grey slightly sandy CLAY.
TP25	1	D	0.70		Brown mottled grey slightly sandy CLAY.
TP31	1	D	0.80		Brown mottled grey slightly sandy CLAY.
SA01	1	D	0.90		Brown mottled grey slightly sandy CLAY.
TP03	2	D	0.90		Brown mottled grey slightly sandy CLAY.
TP06	3	D	1.00		Brown mottled grey slightly sandy CLAY.
TP22	2	D	1.00		Brown mottled grey slightly sandy CLAY.
TP29	2	D	1.00		Brown mottled grey slightly sandy CLAY.
TP12	1	D	1.10		Brown mottled grey slightly sandy CLAY.
TP17	2	D	1.40		Brown sandy CLAY.
TP20	4	D	1.50		Brown mottled grey slightly sandy CLAY.
TP30	3	D	1.50		Brown mottled grey slightly sandy CLAY.

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP05	3	D	1.80		Brown sandy CLAY.

UKAS TESTING 4043

PSL PROFESSIONAL SOILS LABORATORY A PHOENIX GROUP COMPANY

Pit Lane, Wombwell

Contract No:

PSL23/6509

Client Ref:

4721

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
TP13	2	D	0.60		22			55	25	30	91	High Plasticity CH
TP01	3	D	0.70		34			64	28	36	100	High Plasticity CH
TP08	1	D	0.70		23			59	26	33	100	High Plasticity CH
TP25	1	D	0.70		24			58	25	33	100	High Plasticity CH
TP31	1	D	0.80		13			51	24	27	100	High Plasticity CH
SA01	1	D	0.90		24			61	27	34	100	High Plasticity CH
TP03	2	D	0.90		21			58	26	32	100	High Plasticity CH
TP06	3	D	1.00		22			63	27	36	100	High Plasticity CH
TP22	2	D	1.00		20			62	27	35	100	High Plasticity CH
TP29	2	D	1.00		24			60	26	34	100	High Plasticity CH
TP12	1	D	1.10		20			52	24	28	100	High Plasticity CH
TP17	2	D	1.40		19			40	20	20	100	Intermediate Plasticity CI
TP20	4	D	1.50		17			55	25	30	100	High Plasticity CH
TP30	3	D	1.50		16			50	23	27	100	High Plasticity CH
TP05	3	D	1.80		20			36	17	19	100	Intermediate Plasticity CI

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL PROFESSIONAL SOILS LABORATORY A PREMIER GROUP COMPANY

Pit Lane, Wombwell

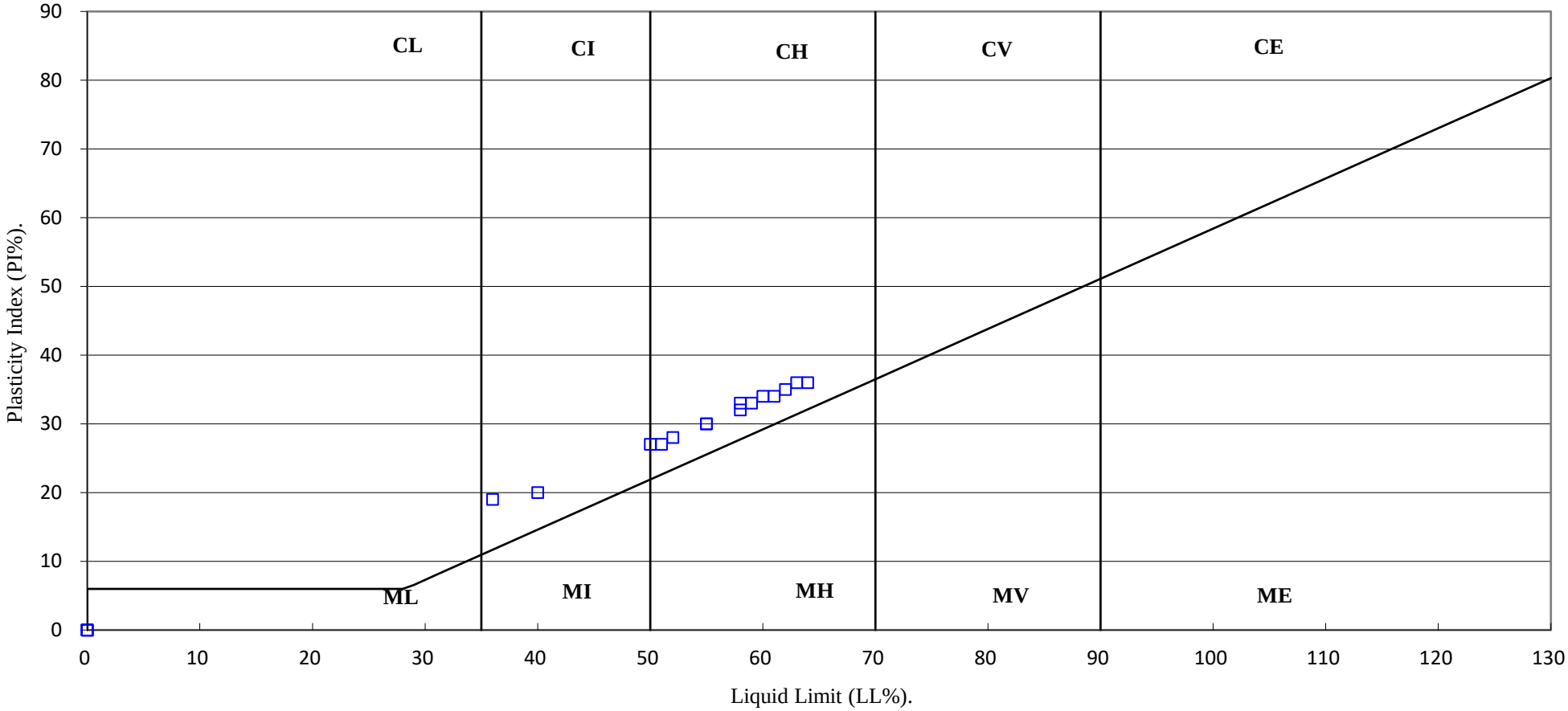
Contract No:

PSL23/6509

Client Ref:

4721

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL PROFESSIONAL SOILS LABORATORY A PREMIER GROUP COMPANY	**Pit Lane, Wombwell**

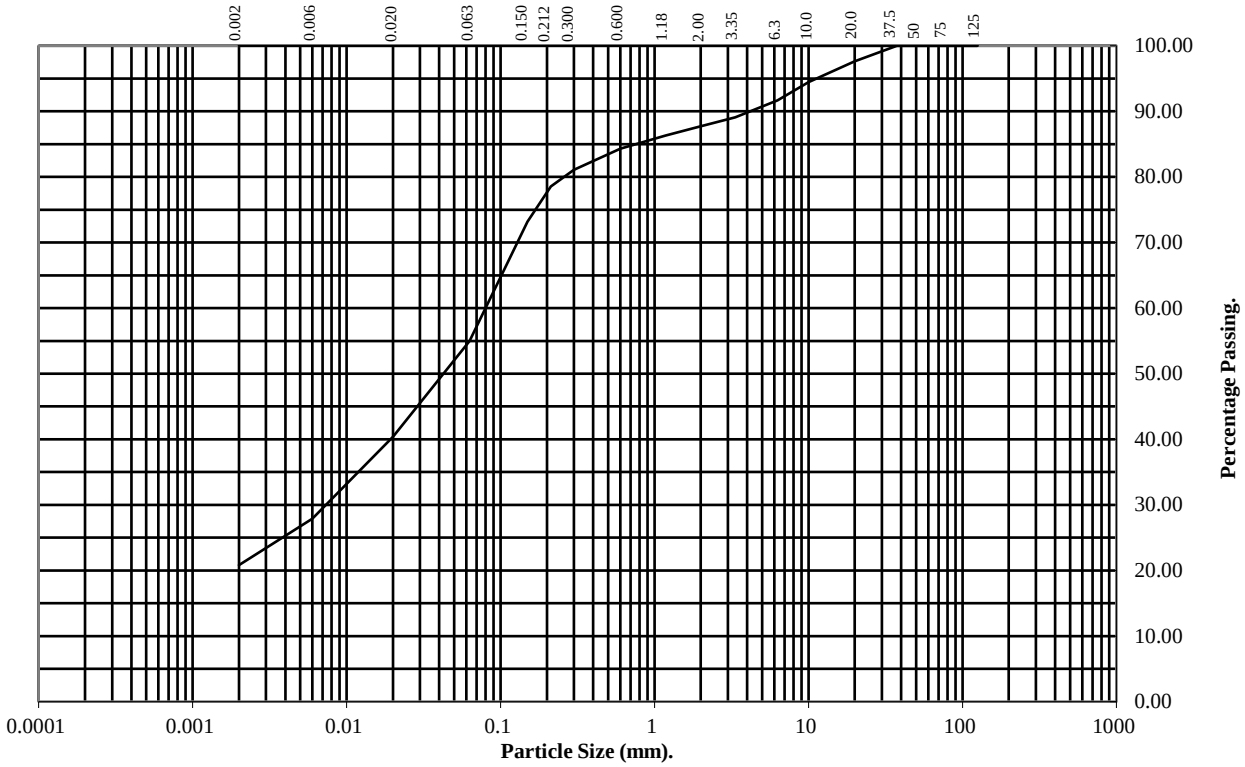
Contract No:
PSL23/6509
Client Ref:
4721

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP01**	**Top Depth (m):**	**0.20**
Sample Number:	**2**	**Base Depth(m):**	
Sample Type:	**B**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	98
10	94
6.3	92
3.35	89
2	88
1.18	86
0.6	84
0.3	81
0.212	79
0.15	73
0.063	55

Particle Diameter	Percentage Passing
0.02	40
0.006	28
0.002	21

Soil Fraction	Total Percentage
Cobbles	0
Gravel	12
Sand	33
Silt	34
Clay	21

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043 / PSL PROFESSIONAL SOILS LABORATORY	**Pit Lane, Wombwell**	**Contract No:** PSL23/6509 / **Client Ref:** 4721

PARTICLE SIZE DISTRIBUTION TEST

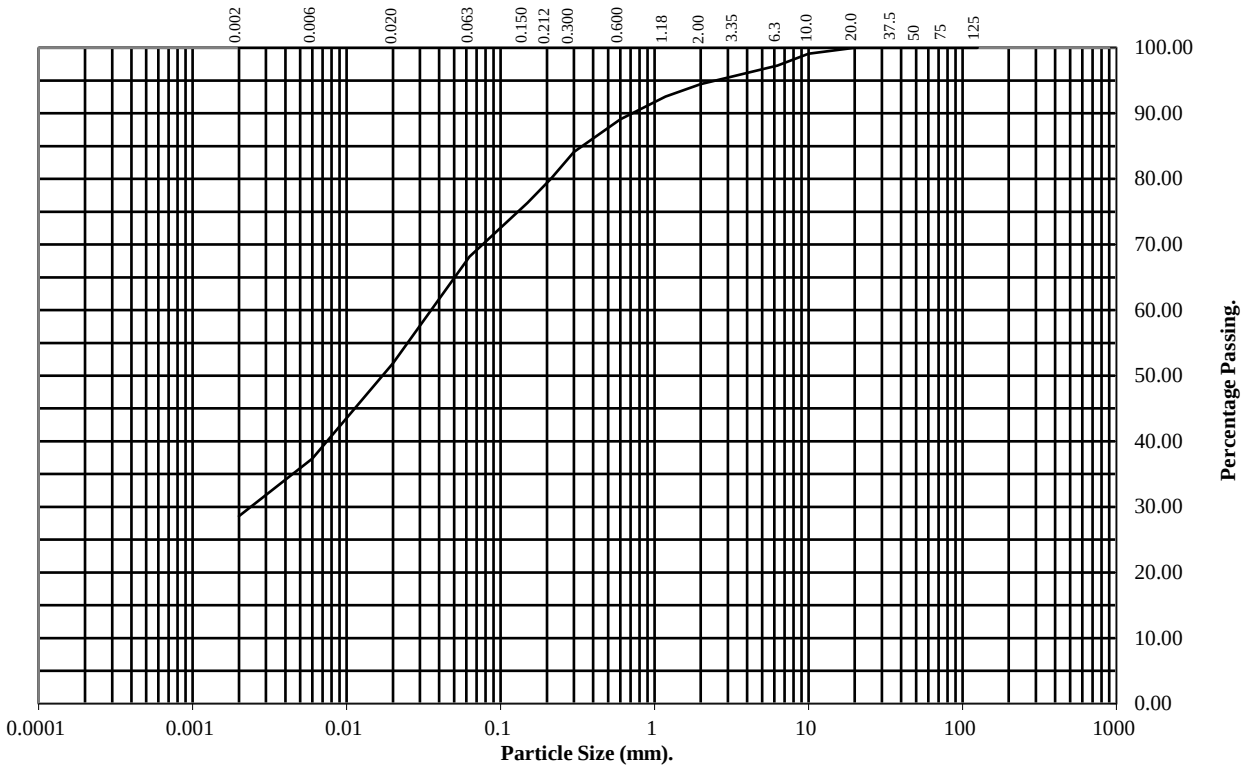
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP06** **Top Depth (m):** **0.20**

Sample Number: **2** **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	96
2	94
1.18	93
0.6	89
0.3	84
0.212	80
0.15	76
0.063	68

Particle Diameter	Percentage Passing
0.02	52
0.006	37
0.002	29

Soil Fraction	Total Percentage
Cobbles	0
Gravel	6
Sand	26
Silt	39
Clay	29

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043	PSL PROFESSIONAL SOILS LABORATORY	**Pit Lane, Wombwell**

Contract No:
PSL23/6509
Client Ref:
4721

PARTICLE SIZE DISTRIBUTION TEST

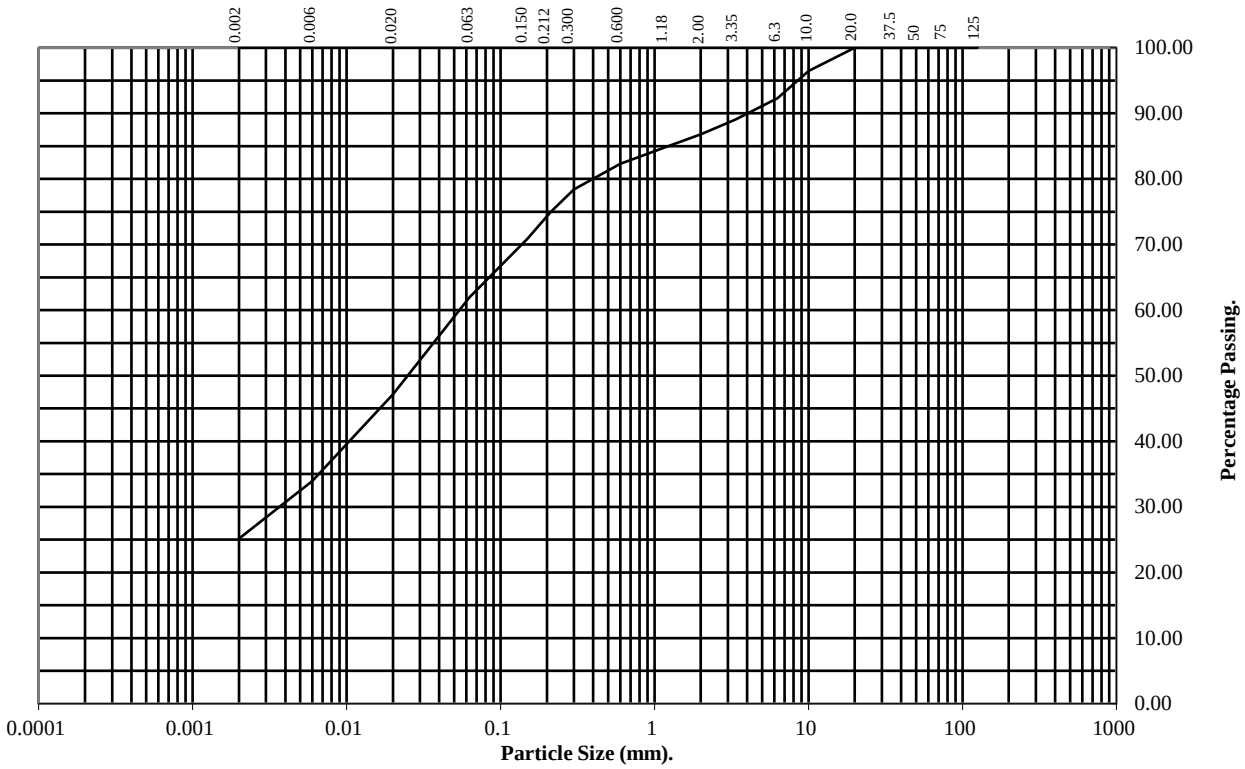
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP10** **Top Depth (m):** **0.20**

Sample Number: **2** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	96
6.3	92
3.35	89
2	87
1.18	85
0.6	82
0.3	78
0.212	75
0.15	71
0.063	62

Particle Diameter	Percentage Passing
0.02	47
0.006	34
0.002	25

Soil Fraction	Total Percentage
Cobbles	0
Gravel	13
Sand	25
Silt	37
Clay	25

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043	PSL PROFESSIONAL SOILS LABORATORY	**Pit Lane, Wombwell**

Contract No:
PSL23/6509
Client Ref:
4721

PARTICLE SIZE DISTRIBUTION TEST

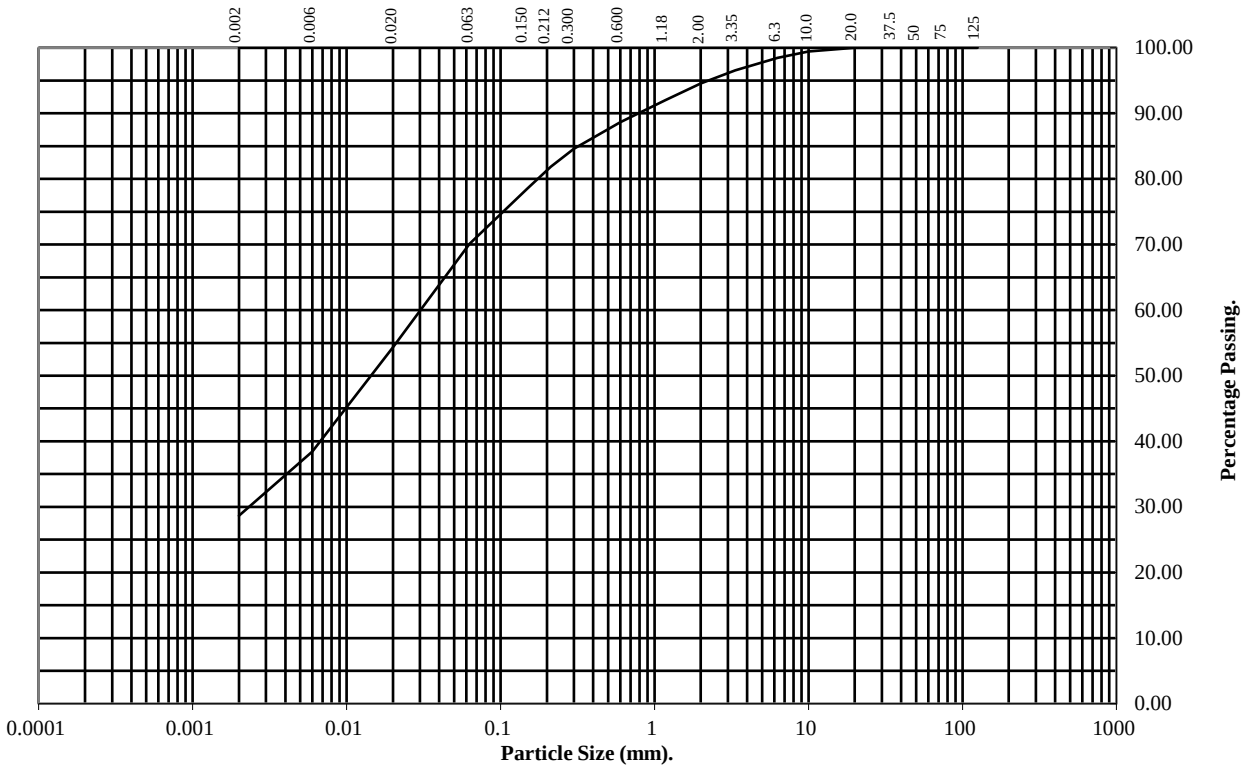
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP20** **Top Depth (m):** **0.20**

Sample Number: **2** **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	95
1.18	92
0.6	89
0.3	85
0.212	82
0.15	79
0.063	70

Particle Diameter	Percentage Passing
0.02	54
0.006	38
0.002	29

Soil Fraction	Total Percentage
Cobbles	0
Gravel	5
Sand	25
Silt	41
Clay	29

Remarks:
See Summary of Soil Descriptions

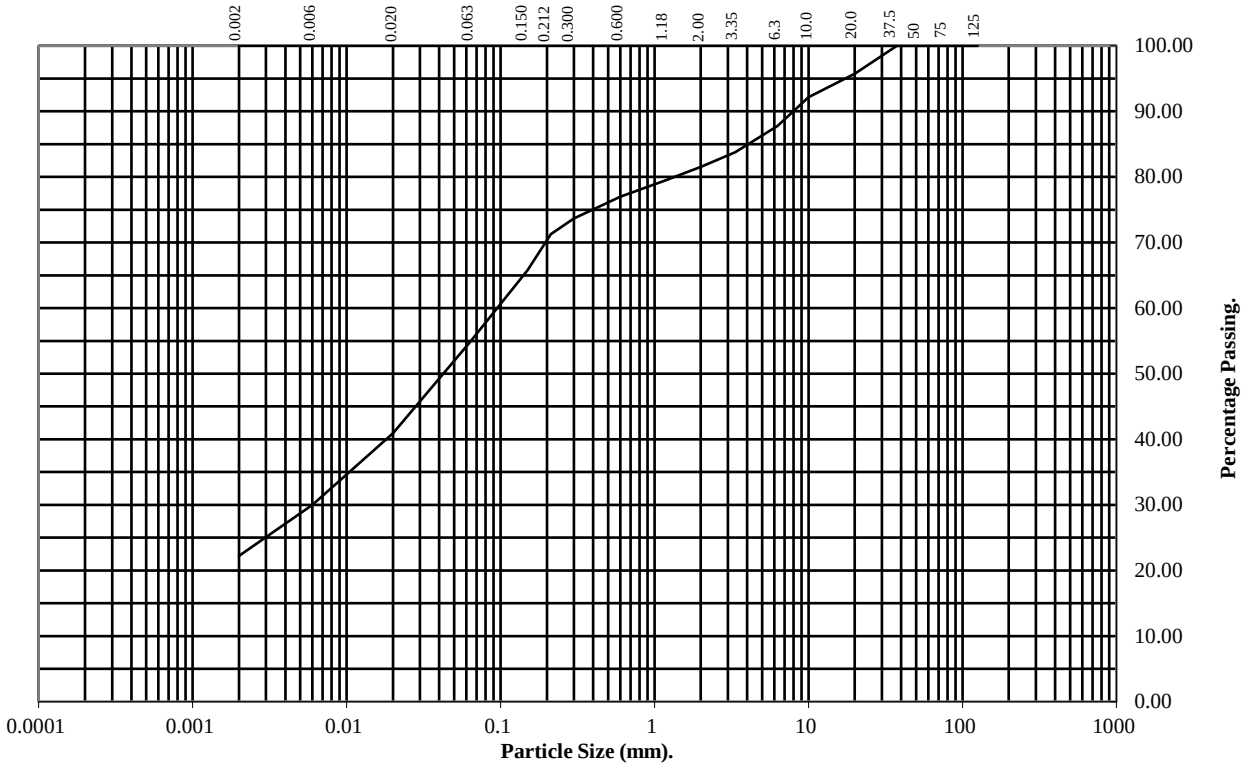
UKAS TESTING 4043 / PSL PROFESSIONAL SOILS LABORATORY	**Pit Lane, Wombwell**	**Contract No:** PSL23/6509 **Client Ref:** 4721

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP24**	**Top Depth (m):**	**0.15**
Sample Number:	**2**	**Base Depth(m):**	
Sample Type:	**B**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	96
10	92
6.3	88
3.35	84
2	82
1.18	79
0.6	77
0.3	74
0.212	71
0.15	66
0.063	55

Particle Diameter	Percentage Passing
0.02	41
0.006	30
0.002	22

Soil Fraction	Total Percentage
Cobbles	0
Gravel	18
Sand	27
Silt	33
Clay	22

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043 / PSL PROFESSIONAL SOILS LABORATORY	**Pit Lane, Wombwell**	**Contract No:** PSL23/6509 / **Client Ref:** 4721

7 - 11 Harding Street
Leicester
LE1 4DH

Professional Soils Laboratory
5/7 Hexthorpe Road
Hexthorpe
Doncaster
DN4 0AR

Analytical Test Report: L23/04477/PSL - 23-36485

Your Project Reference:	**PSL23/6509 Pit Lane Wombwell**		
Your Order Number:	PSL	Samples Received / Instructed:	16/08/2023 / 16/08/2023
Report Issue Number:	1	Sample Tested:	16/08 to 23/08/2023
Samples Analysed:	13 soil samples	Report issued:	23/08/2023

Signed

James Gane
Analytical Services Manager
CTS Group

Notes:

General

Please refer to Methodologies page for details pertaining to the analytical methods undertaken.

Samples will be retained for 14 days after issue of this report unless otherwise requested.

Moisture Content was determined in accordance with CTS method statement MS - CL - Sample Prep, oven dried at <30˚C.

Moisture Content is reported as a percentage of the dry mass of soil, this calculation is in accordance with BS1377, Part 2, 1990, Clause 3.2

Where specification limits are included these are for guidance only. Where a measured value has been highlighted this is not implying acceptance or failure and certainty of measurement values have not been taken into account.

Uncertainty of measurement values are available on request.

Samples were taken by CTS

Deviating Samples

On receipt samples are compared against our sample holding and handling protocols, where any deviations have been noted these are reported on our deviating sample page (if present)

Accreditation Key

UKAS = UKAS Accreditation, MCERTS = MCERTS Accreditation, u = Unaccredited

MCERTS Accreditation only covers the SAND, CLAY and LOAM matrices

Date of Issue: 26.07.23

Issued by: J. Gane

Issue No: 4

Rev No: 2

CTS Group
7 - 11 Harding Street
Leicester
LE1 4DH

L23/04477/PSL - 23-36485

Project Reference - PSL23/6509 Pit Lane Wombwell

Analytical Test Results - Soil

Lab Reference			310279	310280	310281	310282	310283	310284	310285
Client Sample ID			-	-	-	-	-	-	-
Client Sample Location			TP13	TP01	TP08	TP25	SA01	TP03	TP06
Client Sample Type			D	D	D	D	D	D	D
Client Sample Number			2	3	1	1	1	2	3
Depth - Top (m)			0.60	0.70	0.70	0.70	0.90	0.90	1.00
Depth - Bottom (m)			0.60	0.70	0.70	0.70	0.90	0.90	1.00
Date of Sampling			-	-	-	-	-	-	-
Time of Sampling			-	-	-	-	-	-	-
Sample Matrix			Clay	Clay	Clay	Clay	Clay	Clay	Clay
Determinant	**Units**	**Accreditation**							
pH	pH Units	MCERTS	8.2	8.2	7.8	6.0	6.4	5.2	5.1
Sulphate (Water soluble as SO_4)	(mg/l)	u	16	21	63	81	47	100	74
Acid Soluble Sulphate	(%)	u	-	-	0.02	-	-	0.08	0.02
Total Sulphur	(%)	UKAS	-	-	0.01	-	-	0.03	0.01

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L23/04477/PSL - 23-36485

Project Reference - PSL23/6509 Pit Lane Wombwell

Analytical Test Results - Soil

Lab Reference			310286	310287	310288	310289	310290	310291
Client Sample ID			-	-	-	-	-	-
Client Sample Location			TP22	TP29	TP17	TP20	TP30	TP05
Client Sample Type			D	D	D	D	D	D
Client Sample Number			2	2	2	4	3	3
Depth - Top (m)			1.00	1.00	1.40	1.50	1.50	1.80
Depth - Bottom (m)			1.00	1.00	1.40	1.50	1.50	1.80
Date of Sampling			-	-	-	-	-	-
Time of Sampling			-	-	-	-	-	-
Sample Matrix			Clay	Clay	Clay	Clay	Clay	Clay
Determinant	**Units**	**Accreditation**						
pH	pH Units	MCERTS	5.2	5.2	5.8	5.8	5.2	5.7
Sulphate (Water soluble as SO_4)	(mg/l)	u	57	59	43	45	100	19
Acid Soluble Sulphate	(%)	u	-	0.03	0.08	-	0.04	-
Total Sulphur	(%)	UKAS	-	0.02	0.03	-	0.02	-

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L23/04477/PSL - 23-36485

Project Reference - PSL23/6509 Pit Lane Wombwell

Sample Descriptions

Lab Reference	Client Sample ID	Client Sample Location	Client Sample Type	Client Sample Number	Description	Moisture Content (%)	Stone Content (%)	Passing 2mm test sieve (%)
310279	-	TP13	D	2	Orangish light brown slightly gravelly silty clay	-	-	100
310280	-	TP01	D	3	Orangish brown slightly gravelly silty clay	-	-	100
310281	-	TP08	D	1	Orangish light brown slightly gravelly silty clay	-	-	100
310282	-	TP25	D	1	Orangish greyish brown slightly gravelly silty clay	-	-	100
310283	-	SA01	D	1	Orangish greyish brown slightly gravelly silty clay	-	-	100
310284	-	TP03	D	2	Orangish greyish brown slightly gravelly silty clay with rare rootlets	-	-	100
310285	-	TP06	D	3	Orangish grey slightly gravelly silty clay	-	-	100
310286	-	TP22	D	2	Greyish orange slightly gravelly silty clay	-	-	100
310287	-	TP29	D	2	Greyish orangish brown slightly gravelly silty clay	-	-	100
310288	-	TP17	D	2	Greyish brown slightly gravelly silty clay	-	-	100
310289	-	TP20	D	4	Greyish brown slightly gravelly silty clay	-	-	100
310290	-	TP30	D	3	Orangish greyish brown slightly gravelly silty clay	-	-	100
310291	-	TP05	D	3	Orangish dark brown slightly gravelly silty clay	-	-	100

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L23/04477/PSL - 23-36485

Project Reference - PSL23/6509 Pit Lane Wombwell

Sample Comments

Lab Reference	Client Sample ID	Client Sample Location	Client Sample Type	Client Sample Number	Comments
310279	-	TP13	D	2	
310280	-	TP01	D	3	
310281	-	TP08	D	1	
310282	-	TP25	D	1	
310283	-	SA01	D	1	
310284	-	TP03	D	2	
310285	-	TP06	D	3	
310286	-	TP22	D	2	
310287	-	TP29	D	2	
310288	-	TP17	D	2	
310289	-	TP20	D	4	
310290	-	TP30	D	3	
310291	-	TP05	D	3	

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L23/04477/PSL - 23-36485

Project Reference - PSL23/6509 Pit Lane Wombwell

Analysis Methodologies

Test Code	Test Name / Reference	Sample condition for analysis	Sample Preperation	Test Details
ANIONSS	MS - CL - Anions by Aquakem (2:1Extract)	Oven dried	Passing 2mm test sieve	Determination of Anions (inc Sulphate, chloride etc.) in soils by Aquakem. Analysis is based on a 2:1 water to soil extraction ratio
PHS	MS - CL - pH in Soils	As received	Passing 10mm test sieve	Determination of pH in soils using a pH probe (using a 1:3 soil to water extraction)
ASSO4S	MS - CL - Acid Soluble Sulphate	Oven Dried	Passing 2mm test sieve	Determination of total sulphate in soils by acid extraction followed by ICP analysis
SAMPLEPREP	MS - CL - Sample Preparation	-	-	Preparation of samples (including determination of moisture content) to allow for subsequent analysis
1377TS-ELT	BS1377 Total Sulphur Content by HTC	Oven dried	BS1377 : Part 1 : 2016	Total Sulphur Content testing of Soil in accordance with BS 1377 : Part 3 : 2018 + A1 : 2021 Clause 7.10 (using Eltra CS-800 Analyser)

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L23/04477/PSL - 23-36485

Project Reference - PSL23/6509 Pit Lane Wombwell

Sample Deviations

Deviations are listed below against each sample and associated test method, where deviation(s) are noted it means data may not be representative of the sample at the time of sampling and it is possible that results provided may be compromised.

Observations on receipt

A - No date of sampling provided
C - Received in inappropriate container
H - Contains headspace
T - Temperature on receipt exceeds storage temperature
R - Date of sampling to receipt insufficient to allow analysis to be completed without deviation, Please note this is only a deviation if 'X' is also recorded against the sample

Observations whist in laboratory

X - Exceeds sampling to extraction or analysis timescales

Lab Reference	Client Sample ID	Client Sample Location	Client Sample Type	Client Sample Number	Test	Deviations
310279	-	TP13	D	2		A
310280	-	TP01	D	3		A
310281	-	TP08	D	1		A
310282	-	TP25	D	1		A
310283	-	SA01	D	1		A
310284	-	TP03	D	2		A
310285	-	TP06	D	3		A
310286	-	TP22	D	2		A
310287	-	TP29	D	2		A
310288	-	TP17	D	2		A
310289	-	TP20	D	4		A
310290	-	TP30	D	3		A
310291	-	TP05	D	3		A

Appendix L
Gas Monitoring Results

Visit 1

Job Title:	Job No:
Pit Lane, Wombwell	***
Client:	Sheet :
Crest Nicholson Yorkshire	9 of 1

Date:	Arrival Time:	Depart Time:	Operator:
12/09/2023	13:00	14:15	Erin Waddilove

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.7

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	
PH101	3.56	ND	0.2	ND	0.2	20.5	ND	ND	30.0	4.08	
PH102	2.52	ND	2.2	ND	2.2	15.0	ND	ND	30.0	4.11	
PH103	ND	ND	4.3	ND	4.3	13.6	0.1	ND	40.0	3.60	
PH104	1.33	ND	0.9	ND	0.9	17.5	-3.0	ND	60.0	4.15	
PH105	0.84	ND	1.7	ND	1.7	18.6	-0.3	ND	50.0	4.32	
PH106	ND	ND	0.3	ND	0.3	20.5	-1.0	ND	60.0	4.30	
PH107	4.14	ND	0.5	ND	0.5	20.0	ND	ND	30.0	4.34	
PH108	ND	ND	0.9	ND	0.9	19.4	ND	ND	30.0	4.32	
PH109	ND	ND	ND	ND	ND	20.8	-7.0	ND	60.0	4.34	
PH110	ND	ND	4.9	ND	4.9	13.6	-0.3	ND	60.0	3.89	
PH111	ND	ND	0.9	ND	0.9	18.6	ND	ND	30.0	4.15	
PH112	2.50	ND	2.6	ND	2.6	17.6	9.6	ND	120.0	4.25	
PH113	3.46	ND	5.3	ND	5.3	6.6	ND	ND	30.0	4.27	
PH114	0.88	ND	2.5	ND	2.5	15.1	ND	ND	30.0	4.16	

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 (Stocksbridge Station)						
	Temp (°C):	13 to 14		Barometric Pressure Trend:			Rising			
Time:	13:00	13:40	14:15	01:02	11:01	13:02	13:47	14:17	16:17	
Pressure (mb):	1007	1005	1004	1013	1015	1016	1016	1016	1017	

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Weather Conditions:	Heavy rain, heavy cloud
Surface Ground Conditions:	Wet

Remarks:

Stocksbridge station located 10 miles south west from the site (Pit Lane Wombwell).