LITHOS

Geoenvironmental Appraisal

Land at Northorpe Lane, Mirfield

For Newett Homes

Report no: 3433/2C

Date: March 2022

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	3433	**Site area/ha**	1.4
Client:	Newett Homes	**NGR:**	SE 214 210
Site:	Northorpe Lane, Mirfield	**Nearest postcode:**	WF14 0QJ

The site is located off Northorpe Lane, approximately 3km west of Dewsbury town centre, and currently comprises a residential property with gardens, fishponds and a single grassed field.

Lithos were commissioned by Newett Homes to provide a geoenvironmental appraisal of the site, which is to be redeveloped with 39 no. traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. Lithos' investigation included a review of the site's history and environmental setting, and a ground investigation comprising 10 trial pits (with soakaway testing in 5 pits) and 9 rotary openhole probeholes.

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

Issue	Remarks
Made ground	Made Ground Topsoil (containing anthropogenic fragments) was encountered in 5 pits to an average depth of 0.3m. A veneer of Reworked Natural Ground was encountered in the northeast of site to an average depth of 0.6m. Made Ground is likely to be present (but probably <1m depth) beneath the current residential property, gardens and fishponds although these areas were inaccessible during the investigation.
Natural ground	Topsoil was encountered in 5 pits to an average depth of 0.3m. Natural ground comprises Cohesive Residual Soil (gravelly clays) to an average depth of 1.9m over completely weathered Coal Measures bedrock (clayey gravels) to depths of between 2.5m and 4.0m. Underlying bedrock comprises Coal Measures (successions of mudstone, sandstone and siltstones).
Contamination	No visual or olfactory evidence of hydrocarbon contamination was encountered during the investigation. Topsoil has recorded concentrations of arsenic above the Tier 1 screening value however, bio-accessibility assessment indicates that the bio-accessible fraction of arsenic is below 3% and consequently topsoil is suitable for re-use in garden areas. However, due to the site-specific risk assessment with regard to re-use of topsoil at this site, there will be implications relating to removal of topsoil off-site for disposal or re-use on a different development. Topsoil is not considered chemically suitable for re-use in this manner. A veneer of made ground is likely to be present beneath the current residential property and gardens at this site and further investigation and assessment of this made ground will be required through a post demolition investigation.
Mining & quarrying	The majority of this site is located within a Coal Mining Development Low Risk Area. However, parts of the south of the site and land immediately beyond the northern boundary are located in a High Risk Area. Lithos' mining investigation identified three coal seams beneath this site (all dip to the southeast). They are: • Wheatley Lime Coal – outcrops along the site's western boundary underlying the western margins of the site at very shallow depth (maximum thickness of 0.5m). • Blocking Rider Coal – Encountered beneath the site at between 14.3m and 22.9m (max. thickness of 0.5m). • Blocking Coal – Encountered beneath this site between 21.8m and 28m (max. thickness of 0.6m). The Middleton Eleven Yards seam was not identified in any of the probeholes at this site. No evidence of workings was recorded in the Wheatley Lime and Blocking Rider seams. The Wheatley Lime seam is likely to be too shallow (<2m depth) to have been worked and the Blocking Rider is at a depth and thickness that is unlikely to pose a risk to surface stability. Evidence of workings was recorded in the Blocking Coal seam although the depth and thickness of these workings do not pose a risk to surface stability. There are no known quarries on, or within 50m of the site.
Hazardous gas	A landfill is located 300m to the east of the site and the site is underlain by mineworkings at <30m depth. Furthermore, a geological fault crosses site and intersects the mineworkings. However, there is no plausible migration pathway between gas sources and the site. No special gas measures are required. The Public Health England UK radon map and the Landmark report indicate that the site is in an area where between 1% and 3% of homes are estimated to be above the action level.

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Client:	Newett Homes	**NGR:**	SE 214 210
Site:	Northorpe Lane, Mirfield	**Nearest postcode:**	WF14 0QJ

Issue	Remarks
Preparatory works	• Demolition of the existing buildings, structures and fishponds • Post demolition investigation beneath the existing buildings, structures and fishponds • General site clearance of surface materials and vegetation • Topsoil strip & stockpile • Provision of a maximum of 450mm thickness of topsoil in all garden and landscaped areas
Foundations	The natural ground beneath this site is suitable for the adoption of traditional strip/trenchfill footings across the majority of the site, deepened where necessary due to tree influence. However, alternative foundations (piles) may be required where the earthworks regrade necessary to create development plateaux results areas of deep fill.
Groundwater & excavations	Artesian groundwater was recorded in probeholes in the east of the site and single seepage was recorded in the northeast (TP06). Based on the results of the investigation it is considered unlikely that major groundwater flows will be encountered in shallow excavations. Deep excavations (i.e. excavation >3m) are likely to be required for the proposed pumping station. Care should be taken as deep excavations could encounter artesian groundwater and, if so, groundwater control above and beyond normal site pumping practices will be required. 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 and made ground.
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low although the EA indicate the far east of the site is at risk from surface water flooding. Based on the in-situ soakaway testing and high groundwater levels recorded in the monitoring wells, 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	Cohesive Residual Soil should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

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

- Topography will require significant earthworks regrade.
- Topsoil is not suitable for re-use on other development sites

Some further work is required, most notably:

- A simple post-demolition trial pit investigation (beneath the current residential property, garden and fishponds) will be required in order to remove residual uncertainties with respect to ground, and provide more definitive recommendations with respect to contamination and foundations.

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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 sheets of paper in the hard copy 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.

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.

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.

Lithos reserve the right to amend their conclusions and recommendations in the light of further information that may become available.

GEOENVIRONMENTAL APPRAISAL
of land at
NORTHORPE LANE, MIRFIELD

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Newett Homes to carry out a geoenvironmental appraisal of land at Northorpe Lane, Mirfield.

1.1.2 This document is a revision of the Geoenvironmental Appraisal (Report 3433/2A) issued by Lithos in October 2021; Report 3433/2A is now superseded. The only significant revisions have been made to Drawings 3433/2 & 3433/12 (new layout) and Section 11 (inclusion of gas risk assessment following completion of monitoring).

1.1.3 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 10 trial pits and 9 rotary probeholes
- 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

1.1.4 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 Newett Homes 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 39 no. traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers.

1.2.2 A site layout has been provided by Edward Architecture (Drawing 0899-EA-A-P002 Rev. W, dated 22nd March 2022) which is reproduced as Drawing 3433/2 in Appendix B.

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.

1.3.3 In accordance with the agreed scope of works, the ground investigation reported here is not fully compliant with Eurocode 7 (EC7) and this report does not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. The ground appraisal, parametric assessment and preliminary design guidance presented are intended to assist others as they prepare the design of the proposed works.

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 3433/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	3km west of Dewsbury town centre
NGR	SE 214 210
Approximate area	1.4ha (3.4 acres)
Known services	Private electric, gas, water, sewer & BT associated with house and outbuildings in the north-west

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on 25th March 2021.

2.2.2 The majority of the site comprises a single, open grassed field with intermittent trees and areas of undergrowth in the east and south-west. In the north-west is a residential dwelling with an associated driveway, garden and garage, as well as a series of ponds.

2.2.3 Topography falls from east to west at a gradient of around 1 in 7 in the west, before steadying to around 1 in 13 in the east. Immediately beyond the eastern boundary there is a heavily vegetated embankment (former railway – see Section 3) which has a gradient of around 1 in 1 and is c. 4m in height.

2.2.4 Across the field area of the site, evidence of recent tree felling can be seen, with numerous stumps present.

2.2.5 The residential dwelling (no. 28 Northorpe Lane) is a one to two storey stone-built structure, the front driveway of which is accessed via gates off Northorpe Lane. Another gate to the south of the property allows vehicular access to the wider site via a brick-paved slope.

2.2.6 To the rear of the house is a garden terrace, sitting c. 2.0m taller than the grassed garden further east, resulting in c. 2m high retaining walls running along the east of the garden terrace.

2.2.7 The 'lower' garden consists of a small grassed area with surrounding hardstand (mix of paving, brick & tarmac), a small decorative fishpond, areas of wooden decking and two single-storey outbuildings.

2.2.8 Further east, there is a larger polytunnel, access to which was available during the walkover. The polytunnel houses a number of fish ponds/tanks with associated pumps etc. A large central tank is understood to be c. 7 feet (2.1m) deep, with smaller/shallower tanks either side.

2.2.9 To the east beyond the polytunnel is a small (c. 1.5m high) but steep (1 in 1.5) slope beyond which is a series of open, circular former fishponds (now drained). Each pond is metal-lined, between 3m and 5.5m in diameter and about 1m to 2m deep. The ponds are located on flat 'terraces' becoming lower with the lie of the land to the east.

2.2.10 A gradual ramp made of earth has been created running adjacent to the ponds to the south, gently sloping from east to west, in order to provide access by foot to each pond. Conversations with the landowner suggest this ramp was made up of material dug out from the pond footprints. The ponds have been drained leaving 'hollows' in the ground about 3m wide and 1m deep (see Drawing 3433/3 in Appendix B). The ponds are used by "The Quality Koi Company" to farm Koi fish.

2.2.11 Existing salient features, at the time of the walkover are presented on Drawing 3433/3 in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current access	Off Northorpe Lane via the house's driveway.
Topography	Slopes from east to west at gradients ranging from 1 in 7 to 1 in 13.
Approximate areas	300m^2 buildings 700m^2 hardstand 100m^2 ponds 12,900m^2 grass & undergrowth
Nature of boundaries	North & east – post & wire fencing with some hedgerows South & west – various (rear gardens of adjacent properties) North-west – stone wall & gates (access to property's driveway)
Surrounding land uses	North – open fields East – embankment (former railway) with industrial units & open fields beyond South & west – Housing (Northorpe village) with Mirfield beyond

2.2.12 A selection of site photographs is included on Drawing 3433/4.

3 SITE HISTORY

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

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

Date(s)	Site	Surrounding land
1855	Split into 3 separate fields	Northorpe village immediately north-west Numerous pumps/wells within Northorpe village Balderstone Hall 250m west **Well** shown immediately west Railway line 300m east
1893	**Building** c.160m^2 in the north-west corner Track shown running E-W through sites centre	School shown immediately south Pumps/wells no longer shown Increase in size of Northorpe village
1907	Building and track no longer shown	**Railway** line with embankment immediately east Station 50m south-east Goods yard 100m south
1933	Split into two separate fields	Increase in size of Northorpe village
1955/56	No significant changes	House immediately west Garage shown 60m east, beyond railway
1969-1971	**House** shown in north-west corner in similar position to present day	Houses along Northorpe Lane immediately west Railway labelled as dismantled Goods yard no longer shown
1983	No significant changes	Goods yard now built over
1999 (aerial photo)	Numerous small buildings/sheds in north-west adjacent to house	No significant changes
2013	No significant changes	School now built over with houses
2019 (aerial photo)	**Ponds** in north-west corner	No significant changes

4 ENVIRONMENTAL SETTING

4.1 General

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

Issue	Data reviewed	
Geology	1:50,000 BGS map (Sheet 77) 1:10,000 BGS map (Sheet SE22SW) BGS Technical Report (WA/98/24)	Drift – none shown. Solid – the majority is underlain by Lower Coal Measures strata, with an unnamed Sandstone unit in the north-west. Shallowest coal seam – Wheatley Lime is shown to outcrop on-site in the north-west trending NE-SW. Faults – one runs NW-SE through the site's centre, down-throwing to the south-west.
Mining	Coal Authority BGS maps	This site is located within a Coal Mining Development High Risk Area. Past and present workings – yes within the Blocking Coal at between 6m and 26m depth. Opencast – none shown. Mine entries – nearest (421421-009) 30m north. Further details in Section 4.2 below.
Quarrying	Historical OS plans	None shown within 50m.
Radon	Public Health England	The site lies in an area where 1% to 3% of homes are estimated to be above the action level.
Hydrogeology	Environment Agency Envirocheck Report	Source Protection Zone? No. Aquifer? Secondary A (Solid). Groundwater abstractions? Nearest potable abstraction 650m north-west. Soil leaching potential - Low. Pollution incidents? None at or significant to site.
Hydrology		Nearest watercourse(s) – Nearest feature shown at c. 50m south-east. In the catchment for Spen Beck from source to River Calder 800m east flowing south. Water quality - moderate. Pollution incidents? none at or significant to site. Abstractions? none at or significant to site. Discharge consents? none at or significant to site.
Flood risk		The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low although he EA indicate the far east of the site is at risk from surface water flooding. 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). The site lies within an area where the BGS note there is limited potential for groundwater flooding to occur.

4.1.2 The north-east of the site is shown as lying within an 'Area of Unadopted Green Belt'.

4.2 Coal & mining

4.2.1 The majority of the site lies within a Low Risk Area. However, the west and south lie within a High Risk Area - an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.

4.2.2 Examination of the Coal Authority's (CA) interactive map viewer and comparison with the 1:10,000 BGS plan suggests that the extent of the High Risk Area is dictated by the Wheatley Lime seam, which outcrops in the north-west of the site, and around 250m north-east of the site.

4.2.3 A fault runs through site orientated roughly north-west to south-east, with a throw of c. 30m. However, the geology is broadly the same within each fault block.

4.2.4 Geological maps and BGS Technical Report WA/98/24 suggest that up to 4 coal seams underlie the site at shallow depth. These are the:

- Wheatley Lime Coal (0.7m to 0.8m thick), outcropping in the north-west and off-site to the north-east
- Middleton Eleven Yards Coal (0.3m to 1.1m thick), at approximately 6m depth below the Wheatley Lime
- Blocking Rider Coal (0.2m thick), intermittent at approximately 20m depth below the Wheatley Lime
- Blocking Coal (0.2m to 0.8m thick), at approximately 25m depth below the Wheatley Lime

4.2.5 The approximate outcrop of the Wheatley Lime and the position of the geological fault are shown on Drawing 3433/6. It should be noted that seam outcrops plotted on geological maps have been known to be inaccurate by distances in excess of 100m. However, based on the CA report the outcrop may actually be further west, underlying only 500m^2 in the far north-west.

4.2.6 Dip of strata is not shown on geological maps, but is believed to be around 7^o to the south-east. Land also falls to east at about 6^o.

4.2.7 The BGS Technical Report notes that the Wheatley Lime has been mined to a minor scale within this area; the Middleton Eleven Yards is not known to have been worked in the area; whilst the Blocking Coal has been extensively worked and even open-casted at Canker Dyke Bridge, approximately 600m south.

4.2.8 The other seams mentioned above are likely to underlie the entire site.

4.2.9 In addition, Lithos have undertaken intrusive mining investigations within the local area which found significant evidence of workings within the Blocking seam.

4.2.10 A CA mining report states that:

- Workings are present within two seams beneath the site:
  - Blocking Coal (aka. Silkstone) at between 6m and 26m depth last worked in 1881
  - Black Bed Coal at between 126m and 154m depth last worked in 1885
- There are probable unrecorded shallow workings beneath site
- There are no spine roadways recorded at shallow depth
- No opencast mines within 500m nor any CA managed tips
- The CA has not received a damage claim for the subject property, or any property within 50 metres of the enquiry boundary
- No notices have been given under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence
- Is not within an area where notice to withdraw support has been given
- The Wheatley Lime Seam outcrops on site and is a workable seam
- A mine entry (ref. 421421-009) is present c. 40m north-east of the site.

4.2.11 The mining report not only states that workings are known to exist beneath the site at shallow depth, there is also probable further unrecorded shallow mineworkings.

4.2.12 Abandonment plans are available for workings within the Blocking seam and have been obtained from the Coal Authority. Of the two plans received, only one relates to workings directly beneath the site, whilst the other relates to workings off-site to the north. The abandonment plan showing workings beneath the site is reproduced as Drawing 3433/7 in Appendix B, with workings to the north shown on Drawing 3433/8.

4.2.13 **Plan 1800 – Workings in the Blocking seam from Dark Lane Pit to 1885.** Examination of this plan indicates that workings within the Blocking Coal underlie the entire site.

4.2.14 In addition, a fault line is shown broadly matching the position and orientation of the BGS-mapped fault. However, the fault on the abandonment plan 'thins out' in the north-west before eventually disappearing. It appears this fault had little affect on coal mining within the Blocking seam, suggesting little/no throw.

4.2.15 The plan also shows 'old workings' off-site to the north, which encroach into the far north-west corner. No depths of the workings are given on this abandonment plan, but the thickness of coal worked is shown. The seam is shown as 1ft 8inch thick (0.5m) with an underlying seat earth (unknown thickness).

4.2.16 A mine entry (corresponding with the location of CA ref. 421421-009) is shown c. 40m north of the site.

4.2.17 **Plan M273 – Workings in the Blocking seam from Northorpe Colliery to 1839.** This plan covers land north of the site (presumably relating to the 'old workings' shown on plan 1800 above) with the closest workings at c. 100m distance from the northern boundary.

4.2.18 A mine entry (like CA ref. 421421-029) is shown on this plan c. 80m north-east of the site.

4.2.19 Whilst no information is given beneath the site, the plan does include intermittent 'spot' depths to coal. From these it is possible to work out the approximate dip of the Blocking seam, which is c. 7° to the southeast. Based on this dip, topography and the spot depths shown, the Blocking seam would be anticipated at c. 20m to 30m depth along the northern boundary of the site, becoming deeper further south. This broadly ties in with the depths shown on the stratigraphic column on the BGS plan.

4.2.20 Based on all the information reviewed, there is a significant risk of mineworkings within the Wheatley Lime and Middleton Eleven Yards seams affecting surface stability at this site, and these risks will need assessing further by intrusive investigation.

4.2.21 Given the likely depth and thickness of the Blocking and Blocking Rider seams, they are unlikely to affect surface stability, but it would be prudent to prove their depth as part of the intrusive investigation.

4.2.22 The closest mine entry recorded by the CA is 40m away and will not affect the proposed development. However, given the shallow depths to the Wheatley Lime and Middleton Eleven Yards seams, there is a significant possibility of unrecorded mine entries (including bell pits) being present.

4.3 Mineral safeguarded areas

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

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

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

4.3.4 Paragraph 204 of the National Planning Policy Framework (NPPF) requires Local Authorities, when preparing Local Plans to:

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

4.3.5 NPPF Paragraph 144 notes that when determining planning applications, local planning authorities should give weight to the benefits of the mineral extraction.

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

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

4.3.7 The viability of coal extraction at this site is considered later in this Report (Section 14.7) in light of the findings of Lithos' intrusive mining investigation, which comprised the drilling of 9 rotary probeholes to depths of between 9.0m and 36m (see Section 7.7).

4.4 Landfills

4.4.1 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
Lower Spen Valley	SE 428160 421058 (310m east)	Nature of waste: household, commercial and industrial. Depth of waste: BGS borehole within the landfill indicates deposits extend to 6.8m (could be deeper elsewhere) Licence Issued: 1st April 1996 the southern area of landfill is reinstated as Dewsbury Country Park/farmers fields.	Envirocheck Report

4.4.2 A BGS borehole within the Spen Valley landfill indicates the base of the landfill is underlain by River Terrace deposits (sand and gravels). The development site is likely to be underlain by weathered Coal Measures (gravelly clay/clayey gravel) with Coal Measures bedrock at shallow depth (<3m).

4.4.3 If any hazardous gas is produced by the landfill, they are likely to migrate within the River Terrace deposits themselves (given the landfill is directly underlain by River Terrace deposits).

4.4.4 Given the development site is not underlain by River Terrace deposits, hazardous gas from the Spen Valley landfill is considered unlikely to be migrating beneath the site.

4.4.5 Nonetheless, a programme of gas monitoring will likely be required given the anticipated presence of shallow mineworkings. As such, any residual uncertainties with regards to hazardous gas from Spen Valley landfill should be resolved.

5 GROUND INVESTIGATION DESIGN

5.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	Likely veneer in the north-west associated with the current house and previous building. Possibly present along eastern boundary associated with the railway embankment.
Natural soils	Weathered coal measures (clayey gravel/gravelly clay).
Bedrock	Coal Measures (mudstone, siltstone and sandstone). Coal likely in the north-west at shallow depth (Wheatley Lime outcrop).
Mineworkings	Possible in the Wheatley Lime (north-west) and Middleton Eleven Yards (entire site) at shallow depths.
Groundwater	Possible within bedrock/granular soils especially in the areas of low topography (south-east). Likely at depth within bedrock.

5.1.2 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. Made ground	1. Associated with current & previous buildings in the north-west (inorganics, asbestos)
Potential off-site contamination sources	1. Railway embankment 2. Garage c. 50m east	1. Air-borne contamination from adjacent railway (inorganics, asbestos) 2. Leakage/spillage and migration beneath the site (considered unlikely)
Potential geotechnical hazards	1. Sloping land 2. Shallow workings	1. Gradients of up to 1 in 7 in the west. 2. Possible across the site within underlying coal seams
Other potential constraints	1. Access	1. Currently constrained somewhat by the residential property. Steep gradients in the north-west need consideration for proposed highways.

5.2 Preliminary conceptual site model

5.2.1 A preliminary conceptual site model, presented as Drawing 3433/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 5.1 of this report.

5.2.2 Historical plans show that the site has been occupied by arable farmland which is not considered likely to have caused significant ground contamination. Nonetheless, activities such as slurry spreading, the discharge of chemicals to ground, and unregulated burial have all occurred on farmland. Potential contaminants associated with farming activity might include any of the following:

Agricultural activity	Potential contaminant
Orchards	Metals, pesticides
Field sports	Lead shot
Waste burial, land levelling, backfilling ponds/quarries	Methane, metals, PAH etc
Derelict buildings	Asbestos
Naturally occurring contaminants	Arsenic, metals

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

5.3 Ground investigation design & strategy

5.3.1 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
Ten 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
Five Trial Pits	To determine whether soakaways could be utilised for storm water drainage
9 deep probeholes	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings
6 shallow probeholes	To install monitoring wells across the site in order to monitor for hazardous gas.

5.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site and to target potential areas of interest identified in Section 5.1 above. A nominal 40m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

5.3.3 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.

6 FIELDWORK

6.1 Objectives

6.1.1 The original investigation strategy is outlined in Section 5.3 above.

6.2 Exploratory hole location constraints

6.2.1 No access was available within the vicinity of the residential property, garden and fishponds during the investigation.

6.3 Scope of works

6.3.1 Fieldwork was supervised by Lithos on 14th July 2021 (trial pitting) and 26th to 30th July 2021 (mining probeholes) and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 01 to 10	2.5m to 3.0m	Vane tests in cohesive soils Trial pits terminated within weathered bedrock
Soakaway tests	Within TPs 1 to 5	1m to 2m	-
Rotary open-hole probeholes	PHs 01 to 09	8.5m to 36m	Monitoring wells (PHs 01A to 06A) installed to monitor for gas and groundwater

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

6.3.3 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

6.3.4 Exploratory hole locations are shown on Drawing 3433/9 presented in Appendix B; exploratory holes were picked-up by a surveyor and co-ordinates/ground levels are included on the logs.

7 GROUND CONDITIONS

7.1 General

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

7.1.2 Typical ground conditions encountered at the site are described below in Sections 7.2 (made ground) and 7.4 (natural ground), with a summary provided in the table on page 13.

7.2 Made ground

7.2.1 The made ground at this site comprised the following strata:

- **Made Ground Topsoil** (300mm thickness) encountered in 5 pits sporadically across site comprising brown, slightly sandy Clays, with gravels of mixed lithologies and rare fragments of ceramic and plastic.
- **Reworked Natural Ground** encountered in 2 pits to a depth of 0.5m (TP06) & 0.6m (TP07) comprising soft to firm, greyish brown, sandy Clays, with gravels of sandstone and mudstone and rare organic plant material.

7.2.2 A veneer of made ground is likely to be present beneath the current residential property, gardens and fishponds although no investigation has been undertaken in this area to date.

7.3 Natural ground

7.3.1 Natural ground was encountered in every exploratory hole, and typically comprised:

- **Topsoil** (typically 300mm in thickness) encountered in 5 pits comprising brown, slightly sandy Clays, with gravels of mixed lithologies.
- **Cohesive Residual Soil** encountered in every pit below topsoil to an average depth of 2.2m comprising firm to stiff, orangish brown and greyish brown, slightly sandy Clays, with gravels (lithorelicts) of mudstone.
- **Weathered Coal (Wheatley Lime seam)** encountered in TPs 1 & 2 from about 1m (up to 0.5m thick) comprising black slightly sandy organic CLAY with gravels of angular fine to medium coal. This coal was also encountered in and PHs 6, 8 & 9 from 1.4m to 1.8m (up to 0.3m thick)
- **Weathered Coal Measures (Granular Residual Soil)** encountered in every pit (excluding TP08) below Cohesive Residual Soil comprising yellowish brown and greyish brown, slightly clayey, sandy angular fine to coarse Gravels of mudstone.

7.3.2 **Coal Measures** bedrock was encountered from 2.5m in TP08.

Summary of Ground Conditions

Hole	Final depth (mbgl)	Depth to Base of: (mbgl)							Depth to Coal Measures bedrock (mbgl)
		Made Ground		Natural Ground					
		Made Ground Topsoil	Reworked Natural Ground	Topsoil	Cohesive Residual Soil	Weathered Coal (Wheatley Lime seam)*	Cohesive Residual Soil	Weathered Coal Measures	
TP01	2.8	0.4	-	-	1.1	1.3 (0.2)	2.3	>2.8	>2.8
TP02	2.6	-	-	0.3	0.8	1.3 (0.5)*	2.1	>2.6	>2.6
TP03	2.6	0.4	-	-	2.4	-	-	>2.6	>2.6
TP04	2.6	-	-	0.3	1.9	-	-	>2.6	>2.6
TP05	2.5	-	-	0.3	2.1	-	-	>2.5	>2.5
TP06	2.9	0.3	0.5	-	2.1	-	-	>2.9	>2.9
TP07	3.0	0.2	0.6	-	2.1	-	-	>3.0	>3.0
TP08	2.5	-	-	0.3	2.5	-	-	-	2.5
TP09	2.8	0.3	-	-	1.9	-	-	>2.8	>2.8
TP10	2.7	-	-	0.3	2.4	-	-	>2.7	>2.7

7.4 Stability

7.4.1 Stability of excavations within natural ground was generally good.

7.5 Groundwater

7.5.1 Groundwater seepage during fieldwork was only recorded in TP06 at 0.6m depth. Land drains with water seepages were encountered in 2 pits between 0.3m and 0.8m.

7.5.2 Monitoring wells (PH01A to 06A) have been dipped post fieldwork and groundwater levels recorded are summarised below.

Hole	Response zone (depth range & strata)	Groundwater body	Typical standing water level	
			m bgl	m AoD#
PH01A	2.5m to 5.5m (Coal Measures)	Shallow (bedrock)	3.35	60.80
PH02A	1.0m to 3.0m (Cohesive Residual Soil)		1.06	57.19
PH03A	1.0m to 4.5m (Cohesive Residual Soil & Coal Measures)		+0.30*	56.70
PH04A	0.8m to 2.8m (Cohesive Residual Soil)		+0.20*	58.55
PH05A	0.8m to 2.8m (Cohesive Residual Soil)		0.43	57.37
PH06A	2.0m to 4.3m (Cohesive Residual Soil & Coal Measures)		1.56	59.79

Levelled-in by survey

* Water level above current ground level (artesian groundwater)

7.5.3 Initial dip data indicated a shallow water table, falling with topography from west to east.

7.5.4 However, following further rounds of monitoring it is apparent the groundwater regime is more complicated, with two discrete water bodies:

- shallow perched water, likely associated with surface infiltration recorded in monitoring wells PH01A to 06A.
- deeper **artesian** aquifer encountered during drilling, associated with a discrete sandstone band at between approx. 5 to 12mbgl, with recharge area outcropping to the west, beyond the site boundary.

7.5.5 After an initial dip to record standing water level, the wells were bailed to establish an approximate rate of **recharge**. Findings were:-

Hole	Vol. removed /litres	Water level lowered by /m	From / to m bgl	Water level recovered to /m bgl	After / mins	Recovery rate
PH01A	5	2.29	1.87 to 4.16	3.96	20	Slow
PH02A	2	1.71	0.27 to 1.98	1.21	105	Slow
PH03A	5	3.34	+0.34 to 3.00	Ground level	10	Rapid
PH04A	5	2.07	0.51 to 2.58	2.28	90	Slow
PH05A	5	2.00	0.50 to 2.50	2.13	70	Slow
PH06A	3	1.69	1.36 to 3.05	2.75	55	Slow

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

7.5.6 These results should be of interest to the drainage designer, and groundworker (especially if/where deep excavation is required).

Artesian Groundwater

7.5.7 Groundwater is said to be artesian when its resting level is above ground level. Artesian groundwater is usually encountered when an aquifer is confined (by overlying strata of low permeability).

7.5.8 If ground investigation activities (drilling/excavation) ''puncture'' the low permeable layer, groundwater will flow upwards.

7.5.9 Artesian groundwater was recorded during drilling of PHs 4 & 5 with a resting head level of 2.1m and 1.8m above ground level respectively. On completion of PH3, artesian groundwater was recorded at 0.51m above ground level. Monitoring wells were not installed in the deeper artesian groundwater.

7.5.10 During the drilling of PHs 2, 3, 5 & 6 groundwater initially flowed downwards and could be heard discharging into deeper mineworkings. On completion of drilling, this pathway was sealed with a bentonite plug in each probehole, approximately 1m above the workings.

7.5.11 Subsequent groundwater monitoring has also indicated that the monitoring well in PH3A (drilled to 4.5m) has become artesian, likely due to the pressure of deep groundwater pushing up through the bentonite seal. The recharge to ground level, following bailing, occurred within 10 minutes during groundwater monitoring.

7.5.12 There is a possibility that artesian groundwater in the east forms a natural spring.

7.6 Visual & olfactory evidence of organic contamination

7.6.1 No visual & olfactory evidence of hydrocarbon contamination was encountered during the investigation.

7.6.2 Selected samples of potentially contaminated materials were scheduled for chemical testing to confirm the suitability of existing topsoil for re-use; see Section 9.

7.7 Mining investigation

Shallow workings (rotary probeholes)

7.7.1 It is clear from the desk study that the site is likely to be underlain by mineworkings associated with the Blocking Coal at between 20m and 30m depth.

7.7.2 The conjectured outcrop of the Wheatley Lime Coal is shown on Drawing 3433/6 in Appendix B to this report.

7.7.3 Geological maps indicate that two additional seams are located between the Wheatley Lime and Blocking Coal seams. These are:

- Middleton Eleven Yards Coal at approximately 6m depth below the Wheatley Lime
- Blocking Rider Coal at approximately 20m depth below the Wheatley Lime

7.7.4 Consequently, a mining investigation has been undertaken, comprising the drilling of 9 rotary open-hole probeholes. The investigation identified coal, soft ground, broken ground and voids as summarised on page 18.

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

- The **Wheatley Lime** seam of coal outcrops close to the western boundary of the site and underlies about 0.27 ha of the site in the far west at shallow depth (less than 2m).
- Land appears to fall slightly more steeply than the **Wheatley Lime** seam.

  The line of the outcrop falls between the BGS and CA mapped positions and at a similar trend to the CA mapped position.

  Due to its shallow depth, the **Wheatley Lime** seam was encountered as a weathered black clay rather than solid intact coal.
- The **Middleton Eleven Yards** seam (anticipated to be 6m below the Wheatley Lime) was not clearly identified beneath this site.
- The **Blocking Rider** seam (anticipated to be 20m below the Wheatley Lime) was identified at depths of between 14.3m and 22.9m depth.

  Typical seam thickness of the Blocking Rider seam is 0.2m; maximum recorded was 0.5m.

  None of the probeholes advanced through the Blocking Rider seam encountered evidence of workings.

  The thickness of competent (rock) cover above the Blocking Rider seam is always more than 20 times seam thickness.
- The **Blocking** seam (anticipated to be 25m below the Wheatley Lime) was identified between 21.8m and 28.0m depth and is between 0.5m and 0.6m thick.

  Evidence of **workings** (soft ground/soft push, loss of flush etc.) was recorded in 5 of 7 probeholes.

  Typical seam thickness of the Blocking seam is 0.5m; maximum recorded was 0.6m.

  The thickness of competent (rock) cover above the Blocking seam is always more than 25 times seam thickness.

  Linear triangulation suggests the Blocking seam dip at about 3^0 to the southeast north of the fault and 5.9° to the southeast south of the fault. The fault likely trends northwest to southeast and has an uplift of between 2m between PHs 3 & 4 and thins out towards the northwest.

7.7.6 The **Wheatley Lime** seam was encountered at very shallow depth and is completely weathered and of poor quality (i.e. clay rather than coal). Furthermore, it underlies only a small area (c. 2,700m^2) on the western boundary of site. The seam is likely to be too weathered and in too close proximity to existing properties to be considered worthwhile extracting.

7.7.7 Given the very shallow depth of the seam (<2m) and the fact beneath this site the seam is completely weathered, it is considered unlikely to have been worked beneath this site.

7.7.8 The **Middleton Eleven Yards** seam was anticipated to be 6m below the Wheatley Lime seam. This seam was not identified in any of the probeholes drilled at this site and no evidence of workings (lost flush, soft ground etc.) was recorded. Furthermore, this seam is not known to have been worked in this area according to BGS Technical Report WA/98/24.

7.7.9 Therefore, it is likely that the seam is washed out (i.e. not present) beneath this site and does not pose a risk to surface stability.

7.7.10 The **Blocking Rider** seam was anticipated to be 20m below the Wheatley Lime seam and was encountered as solid coal throughout the 6 probeholes drilled through this seam. Given depth to the seam and limited thickness of this seam, workings (even if present) are unlikely to pose a risk to surface stability.

7.7.11 With respect to the **Blocking** seam, data from the probeholes drilled at this site (thickness of workings, fault pinching out to northwest etc.) corresponds to that shown on the CA abandonment plan (Plan 1800).

7.7.12 The CA Report noted historical working between 6m and 26m below ground level (see Section 4.2 and Appendix E) which contradicts the abandonment plan and site investigation data. Conversations with the CA indicate depths of the seams in the CA report should be used as a guide and that site investigation data should always be given more credence than depths calculated from historical records.

7.7.13 The **Blocking** seam is worked beneath this site. However, given the depth and limited height of workings encountered, there is a more than sufficient thickness of overlying competent rock cover to mitigate potential risks to surface stability.

7.7.14 A further 6 probeholes were taken to shallow depth to enable the installation of gas monitoring wells.

7.8 Revised conceptual ground model (ground conditions)

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

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

7.8.2 Further refinement of the Conceptual Site Model is presented in Sections 10.3, where the results of laboratory testing for contaminants have been considered.

Summary of probeholes

Hole ID	Final Depth (mbgl)	Depth to base of Weathered Wheatley Lime Coal (mbgl)*	Depth to Rock (mbgl)	Blocking Rider Coal		Blocking Coal	
				Depth to Base of Solid Coal (mbgl)	Thickness (m)	Depth to Base of workings/Solid Coal (mbgl)	Thickness (m)
PH01	35.8	-	2.5	20.5	0.2	26.0~	Not known
PH02	24.3	-	4.0	14.7~	Not known	21.8+	0.5
PH03	25.8	-	3.3	14.3~	Not known	21.9+	0.5
PH04	29.7	-	3.5	18.5	0.2	26.0	0.5
PH05	31.0	-	3.5	22.2~	Not known	28.0+	0.5
PH06	29.5	1.8 (0.3)	3.5	22.9	0.5	26.6#	0.6
PH06A	4.3	1.8 (0.3)	3.0	-	-	-	-
PH07	26.5	-	3.0	16.3	0.4	24.6+	0.6
PH08	8.5	1.4 (0.1)	3.0	-	-	-	-
PH09	8.5	1.6 (0.1)	3.0	-	-	-	-

\+ *Evidence of workings recorded (soft ground/soft push, loss of flush etc.)*

\# *Solid coal encountered but flush lost after proving base of the seam.*

~ *Exact depth/thickness not clear from drilling speed/arisings. Recorded depth where first encountered.*

* *Thickness in brackets.*

8 SOAKAWAY TEST RESULTS

8.1 UK Guidance

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

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

8.1.3 Given topography it is considered possible that springs could appear down-gradient.

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

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

8.2 Field tests

8.2.1 Five soakaway tests (TPs 01 to 05) were carried out in general accordance with BRE Digest 365 "Soakaway Design". The locations of the soakaways are shown on Drawing 3433/9 presented in Appendix B to this report with soakaway test sheets presented in Appendix H.

8.2.2 Infiltration rates for each soakaway test are 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.

8.2.3 However, despite running each test for up to 5 hours (drainage rates here (summarised in the table below) were not sufficient to allow calculation of infiltration for any of the tests undertaken.

Soakaway	Stratum	Infiltration rate (m/s)	Remarks
TP01	1.3m to 2.3m (Cohesive Reisdual Soil) 2.3m to 2.8m (Weathered Coal Measures)	Unable to calculate	Still >95% full after 5 hours.
TP02	1.3m to 2.1m (Cohesive Residual Soil) 2.1m to 2.6m (Weathered Coal Measures)		Still >95% full after 4.5 hours.
TP03	1.1m to 2.4m (Cohesive Residual Soil) 2.4m to 2.6m (Weathered Coal Measures)		Still >95% full after 1.5 hour. Complete collapse of trial pit after 2.5 hrs, test abandoned.
TP04	1.2m to 1.9m (Cohesive Residual Soil) 1.9m to 2.6m (Weathered Coal Measures)		Sidewall collapse caused water level to rise after 1 hr
TP05	1.2m to 2.1m (Cohesive Residual Soil) 2.1m to 2.5m (Weathered Coal Measures)		

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

8.3 Discussion & conclusions

8.3.1 The low infiltration rates are likely due to the clayey nature of the shallow soils (cohesive residual soils and weathered mudstone bedrock)

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

8.3.3 Drainage solutions are discussed further in Section 13.8.

9 CONTAMINATION (ANALYSIS)

9.1 General

9.1.1 The site's former usage is considered unlikely to have given rise to any significant ground contamination. Furthermore, no significant made ground was encountered during the ground investigation. However, samples of topsoil have been recovered in order to confirm its suitability for re-use.

9.1.2 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 5.2.

9.1.3 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 using the CLEA model. The default conceptual model has been amended, where appropriate, to be more specific to redevelopment within the planning process.

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

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

9.2 Testing scheduled

9.2.1 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
Reworked Natural Ground	2	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Water soluble sulphate, chloride, nitrate and magnesium Total Organic Carbon (TOC) Speciated Polycyclic Aromatic Hydrocarbons (PAH), Banded Total Petroleum Hydrocarbons (TPH)
Topsoil & Made Ground Topsoil	10 (5 of each)	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Total Organic Carbon (TOC) Speciated Polycyclic Aromatic Hydrocarbons (PAH)
	4 (2 of each)	Clay/sand/silt content and visible contaminants, sharps (glass etc) to check compliance with BS3882:2015

9.3 Soil contamination results

9.3.1 The soil contamination test results are summarised in the tables on pages 22 and 23.

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

Summary of degree of soils contamination (inorganics)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens** end-use.										
			pH	As ∞	B~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg*	Ni	Se	Zn$	Asbestos
				37	5	26	3000	200	200	169	127	350	200	
TP01	0.2	Made Ground Topsoil	6.3	**47**	0.7	0.4	26	60	78	0.2	30	0.7	96	N.D.
TP03	0.2	Made Ground Topsoil	6.1	**66**	0.9	0.4	24	78	110	0.3	23	< 0.5	91	N.D.
TP06	0.1	Made Ground Topsoil	6.3	**56**	0.8	0.4	20	62	150	0.2	26	0.7	110	N.D.
TP07	0.1	Made Ground Topsoil	6.5	**59**	1	0.3	23	73	95	0.4	27	< 0.5	110	N.D.
TP09	0.1	Made Ground Topsoil	6.9	**48**	1	0.3	22	56	69	0.2	23	< 0.5	80	N.D.
TP06	0.4	Reworked Natural Ground	8.7	14	0.5	0.2	17	22	30	0.1	20	< 0.5	82	N.D.
TP07	0.5	Reworked Natural Ground	6.9	**60**	0.7	0.2	21	56	65	0.2	21	< 0.5	70	N.D.
TP02	0.2	Topsoil	5.7	**57**	0.9	0.3	24	64	86	0.2	24	< 0.5	92	N.D.
TP04	0.2	Topsoil	5.9	**51**	1.1	0.3	22	53	84	0.2	22	< 0.5	82	N.D.
TP05	0.2	Topsoil	6.6	**45**	0.8	0.4	30	53	85	0.2	22	0.6	99	N.D.
TP08	0.1	Topsoil	5.4	**54**	0.5	0.2	23	69	91	0.3	29	< 0.5	110	N.D.
TP10	0.1	Topsoil	6.4	**67**	1.1	0.4	28	110	110	0.4	28	< 0.5	110	N.D.

Key		Source of guidance trigger level	
36	Parameter tested for and found to be in excess of Tier 1 value.	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.	
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.	∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
	Parameter not tested for.	$	MAFF. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
♣	Tier 1 Value is pH dependent.	~	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.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI Tier 1 would be 21mg/kg.		
ND	No fibres detected (asbestos screen)		
		*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.

Summary of degree of soils contamination (organics)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens (and no cover)** end use					
			% TOC	PAH		TPH - C6 to C40		
				B(a)P ∞	Naphthalene	GRO~ C_6 to C_{10}	DRO◊ C_{10} to C_{21}	LRO C_{21} to C_{40}
				5	8	30	151	1000
TP01	0.2	Made Ground Topsoil	6.3	< 0.1	< 0.1	-	-	-
TP03	0.2	Made Ground Topsoil	10.0	< 0.1	< 0.1	-	-	-
TP06	0.1	Made Ground Topsoil	11.0	< 0.1	< 0.1	-	-	-
TP07	0.1	Made Ground Topsoil	8.7	< 0.1	< 0.1	-	-	-
TP09	0.1	Made Ground Topsoil	6.0	< 0.1	< 0.1	-	-	-
TP06	0.4	Reworked Natural Ground	1.5	< 0.1	< 0.1	< 0.1	< 10	< 10
TP07	0.5	Reworked Natural Ground	5.9	< 0.1	< 0.1	< 0.1	< 10	< 10
TP02	0.2	Topsoil	8.4	< 0.1	< 0.1	-	-	-
TP04	0.2	Topsoil	6.5	< 0.1	< 0.1	-	-	-
TP05	0.2	Topsoil	6.2	< 0.1	< 0.1	-	-	-
TP08	0.1	Topsoil	5.7	0.1	< 0.1	-	-	-
TP10	0.1	Topsoil	7.4	0.1	< 0.1	-	-	-

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

Inorganic determinands

9.3.3 Of the 10 samples of made ground topsoil and topsoil (5 of each) analysed for inorganic parameters, all 10 could be classified as contaminated

9.3.4 Of the 2 samples of Reworked Natural Ground analysed for inorganic parameters, one can be classified as uncontaminated, and one can be classified as contaminated.

9.3.5 These samples have been classified by comparison with Tier 1 Soil Screening Values for a residential end use with domestic gardens (the most sensitive of proposed end-uses).

9.3.6 **Arsenic** in excess of the Tier 1 screening value (37mg/kg) was recorded in 11 of the 12 soil samples.

Bio-accessibility assessment

9.3.7 The 3 samples of topsoil with the highest concentration of arsenic (TPs 3, 7 & 10, were submitted for bio-accessible testing of arsenic to determine the bio-accessible fraction.

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

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

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

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

Laboratory results

Sample & depth	Total As (mg/kg)	Gastric bio-accessibility (% As)	Gastro Intestinal bio-accessibility (% As)
TP03, 0.2m	49	1.4	1.5
TP07, 0.1m	54	1.2	1.2
TP10, 0.1m	51	1.3	1.3

9.3.12 The 3 samples returned a maximum bio-accessible fraction of arsenic at 1.5%. A conservative estimate of a maximum bio-accessible fraction of arsenic at 3% was input into the CLEA model and a site-specific screening value of 359mg/kg for arsenic generated.

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

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

Asbestos

9.3.15 No asbestos fibres were identified in any of the 12 samples screened.

Organic determinands

9.3.16 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).

9.3.17 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.

9.3.18 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.

9.3.19 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?
Made Ground Topsoil & Topsoil	>5%	No
Reworked Natural Ground	3.7%	

Hydrocarbons (TPH & PAH)

9.3.20 Given the veneer of reworked natural ground encountered and absence of visual/olfactory evidence of any hydrocarbon contamination, only a simple banded TPH (cf full speciation) was initially scheduled on 2 samples.

9.3.21 Assessment of TPH would normally be undertaken in accordance with a 3-step approach, (outlined in Generic Note 04 in Appendix A) on fully speciated TPH results. However, although only banded TPH analysis has been scheduled here, none of the fractions exceed their respective Tier 1 criteria, even if it is conservatively assumed all of each fraction is either aliphatic or aromatic.

9.3.22 Consequently, no significant petroleum hydrocarbon concentrations have been identified, and there is no risk to human health from these hydrocarbons.

Polycyclic Aromatic Hydrocarbons (PAH)

9.3.23 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.

9.3.24 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).

9.3.25 Speciated analysis has confirmed the absence of significant concentrations of both.

9.4 Topsoil grading

9.4.1 The clay/sand/silt content and visible contaminants, sharps (glass etc) of 4 topsoil samples have been determined to check compliance with BS3882[3] requirements. BS3882 considers visual contaminants to comprise 'undesirable potentially injurious foreign object(s) visible to the naked eye'.

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

9.4.3 The results are summarised below:

Parameter	BS3882 Specification	TP01, 0.1m	TP02, 0.1m	TP03, 0.1m	TP04, 0.1m
Retained on 2mm sieve	< 30%	7	9	10	16
Retained on 20mm sieve	< 10%	0	0	0	0
Retained on 50mm sieve	0%	0	0	0	0
Clay content	5 to 35%	29	25	23	24
Silt content	0 to 65%	45	46	40	40
Sand content	0 to 90%	26	29	37	36
Visible contaminants	< 0.5%	<0.5	< 0.5	< 0.5	<0.5

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

9.4.4 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.

10 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

10.1 Topsoil

10.1.1 Topsoil (and made ground topsoil), typically 300mm thick is present across most of the site. Testing suggests this material has concentrations of arsenic above the Tier 1 screening value for residential with garden end-use.

10.1.2 Further laboratory testing (bio-accessibility testing) and risk assessment has been undertaken and is discussed in Section 9.3 above. Bio-accessibility concentrations indicate that the bio-accessible fraction of arsenic at this site is below 3% and consequently the topsoil at this site is suitable for re-use in gardens.

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

10.2 Summary of significant contamination

10.2.1 No contamination has been identified to date however, a veneer of made ground is likely to underlie the residential property, gardens and fishponds which is anticipated to be less than 1m thick.

10.2.2 This made ground is likely to contain materials (e.g. brick, concrete, tarmac etc), which would generally be considered undesirable as a near-surface material in garden areas.

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

10.2.3 Given the constraints discussed in Section 6.2 (existing buildings across the majority of the site), a simple post-demolition trial pit investigation will be required before definitive recommendations are provided. However, at this stage it is considered unlikely that anything more than placement of soil cover in garden areas (where made ground remains) will be required.

10.3 Revised conceptual ground model (contamination)

10.3.1 Based on existing site data no plausible contaminant linkages have been identified.

10.3.2 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.

10.3.3 A revised Conceptual Site Model is presented as Drawing 3433/10 in Appendix B.

10.4 Environmental setting & end use

10.4.1 It is apparent from Section 10.2 above, that no contamination has been identified to date in the soils beneath this site. However, a supplementary post-demolition investigation will be required.

10.4.2 The underlying Coal Measures bedrock is classified as a Secondary A aquifer. The nearest surface watercourse is Spen Beck, which flows in a south direction, approximately 800m beyond the site's east boundary. Therefore, the site's environmental setting is considered to be **moderate sensitivity**.

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

10.4.4 Transient risks to construction workers can be addressed by the adoption of appropriate health and safety measures, see Section 14.6.

10.5 Contaminant linkages

10.5.1 Based on the existing information, in terms of the proposed redevelopment of this site, no plausible contaminant linkages exist on the site.

10.5.2 The conceptual site model will be revised based on the outcome of the supplementary post-demolition investigation.

Contaminants

10.5.3 Contaminants have been summarised in Section 10.2 above.

Pathways

10.5.4 Potential contaminant pathways include:

- Ingestion
- Dermal contact
- Inhalation of contaminated particulates

Receptors

10.5.5 Potential contaminant receptors include:

- End users of the site (residents)

10.5.6 Further post demolition site investigation is required, therefore at present plausible pathways may exist between the soil contaminants summarised in Section 10.2 above and potential receptors (i.e. end users). Consequently, some remediation may be required; either treatment/removal of the contaminant, or "breakage" of the pathway.

10.6 Potential remediation options

General

10.6.1 Given the constraints discussed in Section 6.2 (existing buildings across the majority of the site), a simple post-demolition trial pit investigation will be required before definitive recommendations are provided. However, at this stage it is considered unlikely that anything more than placement of soil cover in garden areas would be required.

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

10.7 Summary of potential contaminant linkages & mitigation

10.7.1 In terms of the proposed redevelopment plausible contaminant linkages, and feasible remediation options, can be summarised as follows:

Receptors	Pathways	Contaminants	Plausible contaminant linkage? (and remediation options where required)
Human health (Future residents) ◊	Consumption of contaminated vegetables	None identified to date however a veneer of made ground is present beneath the current residential property	Post demolition investigation required before plausible contaminant linkages can be assessed (possible requirement for cover depending on further investigation)
	Ingestion		
	Dermal contact		
	Inhalation (dust and/or vapours)		
Buildings	Migration & accumulation of explosive gas	Methane Carbon dioxide	To be assessed on completion of monitoring and gas risk assessment

◊ transient risks to construction workers will be addressed by the adoption of appropriate health and safety measures in accordance with the Health and Safety at Work Act 1974 and regulations made under the Act including for example the COSHH Regulations.

10.8 Waste classification

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

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

10.8.3 As there is no WRAP protocol for soils, the characterisation, sampling and classification of soils arising from brownfield sites has been incorporated within the Environment Agency's Technical Guidance WM3[4]. 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.

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

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

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

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

10.8.7 Soil treatment facilities (STFs) provide an alternative to landfill. STFs are regulated by the Environment Agency and allow soils to be treated and screened (effectively recycled to be used at other sites). Export to an STF does not require WAC testing and suitability of various soil types will be dependent on material waste codes, which may be allocated after consideration of the data in Section 9 but will often need supplementing with further testing after soils have been stockpiled (see also advice in Section 14.3).

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

10.8.9 Excess topsoil is likely to be classified as waste due to the concentrations of Arsenic recorded in topsoil.

10.8.10 Some excess arisings (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.

10.8.11 Off-site disposal of surplus clean naturally occurring soils to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[5] 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 for use, without the need for waste legislation to be applied.

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

11 HAZARDOUS GAS

11.1 General

11.1.1 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
Off-site landfill (310m east)	Human health	Asphyxiation & explosion	Lateral migration, ingress & accumulation	**Very Low**: Significant distance from landfill and landfill located over highly permeable River Terrace Deposits
	Buildings	Explosion		
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Moderate**: no significant thickness of low permeable drift or bedrock above workings Geological fault also present through site
	Buildings	Explosion		

11.1.2 The landfill it is located 310m to the east of the site. The topography falls from the site to the east, towards the landfill, indicating that in the event that gas is generated in the landfill, it is unlikely to migrate upgradient towards the development site.

11.1.3 The risk from the landfill is considered to be very low and this has been discounted as a viable source. However, the development site is underlain by mine workings and therefore consideration of ground gas is required. Monitoring wells have been installed in 6 shallow boreholes across the site. Shallow gas monitoring piezometers were also installed at two locations (PHs 3A & 4A) due to the presence of artesian groundwater.

11.1.4 Details of the installations are given on the probehole logs presented in Appendix G to this the report. In accordance with CIRIA Report C665[6], given the proposed residential end use and gas source, 9 visits have been scheduled over a 6-month period, between August 2021 and March 2022 and the results are presented in Appendix L.

11.2 Scope of works

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

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

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

11.3 Monitoring results

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

Well	Response zone	Range of methane concentrations (% v/v)	Range of carbon dioxide concentrations (% v/v)	Range of steady flow rates (litre/hour)
PH01A	2.5m to 5.5m (Coal Measures)	N.D	0.4 – 3.5	0.3 – 18.0
PH02A	1.0m to 3.0m (Cohesive Residual Soil)	N.D	1.1 – 7.0	0.1 – 15.6
PH03A	1.0m to 4.5m (Cohesive Residual Soil & Coal Measures)	Not recorded – well and piezometer flooded		
PH04A	0.8m to 2.8m (Cohesive Residual Soil)	N.D	0.3	N.D
PH05A	0.8m to 2.8m (Cohesive Residual Soil)	N.D	0.1 – **8.0**	0.1 – 3.3
PH06A	2.0m to 4.3m (Cohesive Residual Soil & Coal Measures)	N.D	0.7 – **7.1**	0.3 – 23.0

11.3.2 Plots of atmospheric pressure versus time, with the monitoring visits indicated, are appended

11.4 Discussion

11.4.1 The response zones within the monitoring wells were often flooded. Bailing of wells was undertaken but the recharge rate was rapid. Where response zones initially remained clear following bailing, gas monitoring was completed, and the results summarised above. It is thought that shallow gas wells are being flooded by deeper confined groundwater breaching bentonite seals in adjacent probeholes advanced to identify mine workings.

11.4.2 Review of monitoring data obtained confirmed no methane was recorded. Carbon dioxide concentrations in excess of 5% were marginal and depleted oxygen was only recorded on one occasion. Carbon dioxide and oxygen concentrations are considered to be the result of microbial activity, taking place in both the shallow surface soils and to a lesser extent the groundwater, as opposed to hazardous gas migration.

11.4.3 Periods of elevated ground gas flow is most likely due to groundwater movement pre and post bailing, as trapped air is initially released from the monitoring well (peak flow) and then slowly forced into the well from surrounding soil pores by groundwater recharge (steady rates).

11.4.4 The most significant potential source of ground gas at the site is from mine workings identified at depths in excess of 20mbgl. Available evidence indicates that the workings were abandoned in the late 1800s. The discharge of confined groundwater into the mine workings during the investigation indicates the workings are not likely to be flooded.

11.4.5 Whilst the source of gas is viable, the proposed development would only be at risk if there were a viable migration pathway.

11.4.6 A confined aquifer was encountered within a Sandstone band at between 5m and 12m depth. Low permeable mudstone and siltstone was recorded above and below this Sandstone band. The low permeability strata and confined aquifer between the gas source and the surface, effectively break the pathway allowing gas migration from mine workings.

11.4.7 A geological fault is also mapped through the centre of the site approx. north east to south west. Faults can provide migration pathways for deep mines gases. However, the presence of shallow confined groundwater would also restrict this pathway. If broken ground is present around the fault line, the shallow confined aquifer is likely to migrate down the fault, rather than allow gas to migrate upwards.

11.4.8 Based on the above lines of evidence, whilst the mine workings do represent a plausible source of gas, there is no viable pathway by which gas can migrate to the surface of the site and impact the proposed residential properties. A detailed risk assessment is not deemed necessary, and no formal gas protection measures are required.

11.5 Radon

11.5.1 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.

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

11.5.3 The Public Health England UK radon map and the Landmark report indicate that the site is in an area where **between 1% and 3%** of homes are estimated to be above the action level.

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

12 GEOTECHNICAL TESTING

12.1 General

12.1.1 A total of 18 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

12.1.2 The geotechnical laboratory test results are presented in Appendix K to this report.

12.2 Atterberg limits

12.2.1 The plasticity indices of 12 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	10	14 to 46 (25)	17 to 36 (25)	Medium
Weathered Coal Measures	2	11 to 13 (12)	12 to 16 (14)	Low

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

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

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

12.3 Soluble sulphate and pH

12.3.1 In accordance with BRE SD1[7], this site has been classified as greenfield with a mobile groundwater regime.

12.3.2 It is envisaged foundations will extend to depths of about 1m through reworked natural ground and natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).

12.3.3 The concentrations of sulphate in the aqueous natural soil extracts of 12 samples were determined. In addition, 2 samples of reworked natural ground were tested as part of the contamination suite. The pH value of each sample has also been determined.

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

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Reworked Natural Ground	2	6.2	58
Cohesive Residual Soil	3	6.4	35
Weathered Coal Measures	9	6.9	32

12.3.5 pH values were all above 5.5, therefore concentrations of chloride and nitrate are considered insignificant.

12.3.6 In accordance with Tables C1 and C2 of SD1, sub-surface concrete should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-1**.

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

12.4 Particle size distribution

12.4.1 The grading of 4 samples of Cohesive Residual Soil has been determined by wet sieving and the results are summarised in the table below:

Sample & depth	Field description	% passing 37.5mm sieve	% passing 20mm sieve	% passing 2mm sieve	% fines	Material description (based on grading & plasticity)
TP01, 0.6m	Slightly sandy slightly gravelly CLAY	100	100	93	72	Slightly sandy slightly gravelly CLAY
TP02, 0.7m	Slightly sandy slightly gravelly CLAY	100	100	98	84	Slightly sandy slight gravelly CLAY
TP03, 0.8m	Slightly sandy slightly gravelly CLAY	100	100	100	82	Slight sandy CLAY
TP04, 0.8m	Slightly sandy slightly gravelly CLAY	100	100	100	87	Slight sandy CLAY

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

12.4.3 Fines (silt and clay) were found to comprise between 72% and 87% (average 81%) of the material sampled.

12.5 Compaction tests

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

12.5.2 In accordance with BS5930[8] engineered fill is defined as material which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.

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

12.5.4 Laboratory compaction testing was scheduled on 4 samples of Cohesive Residual Soil (using a 4.5kg rammer) to determine their suitability for re-engineering.

12.5.5 Laboratory compaction tests are only appropriate if:

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

12.5.6 It is apparent from the gradings tabulated in Section 12.5, that the samples scheduled for compaction tests are suitable (i.e. at least 70% of the material is finer than 20mm).

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

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

Sample location & depth	Material description	Gs (Mg/m^3)	MDD (Mg/m^3)	OMC (%)	Allowable mc range for 95% MDD & <5% air voids	Typical in-situ moisture content (%)
TP01, 0.6m	Slightly sandy slightly gravelly CLAY	2.40	1.34	30	30 to 35	25
TP02, 0.7m	Slightly sandy slight gravelly CLAY	2.65	1.85	14	14 to 18.5	
TP03, 0.8m	Slight sandy CLAY	2.67	1.87	14	13.5 to 18	
TP04, 0.8m	Slight sandy CLAY	2.74	1.85	15	15 to 20	

12.5.8 The results indicate that the material encountered in TP01 at 0.6m depth has different geotechnical properties to the other 3 samples tested most notably the in-situ moisture content is significantly higher (39% cf. 18% to 26%) and the particle density and MDD are also significantly lower.

12.5.9 The in-situ moisture content of the Cohesive Residual Soil is typically slightly too wet to achieve 95% MDD. Therefore the Cohesive Residual Soils are likely to require some drying out before they can be utilised for engineered fill.

12.5.10 Drying out of these soils will require careful management on site. They should be placed in sealed stockpiles during periods of wet weather, or while the site is unattended. During periods of favourable weather (ideally warm & windy) the soils should be spread in thin layers over as wide an area as possible and aerated by turning with an excavator. Alternatively, consideration could be given to lime stabilisation

12.5.11 Acceptability of the Cohesive Residual Soils for use in the proposed controlled earthworks will need detailed appraisal by the Earthworks Designer in light of the required performance characteristics.

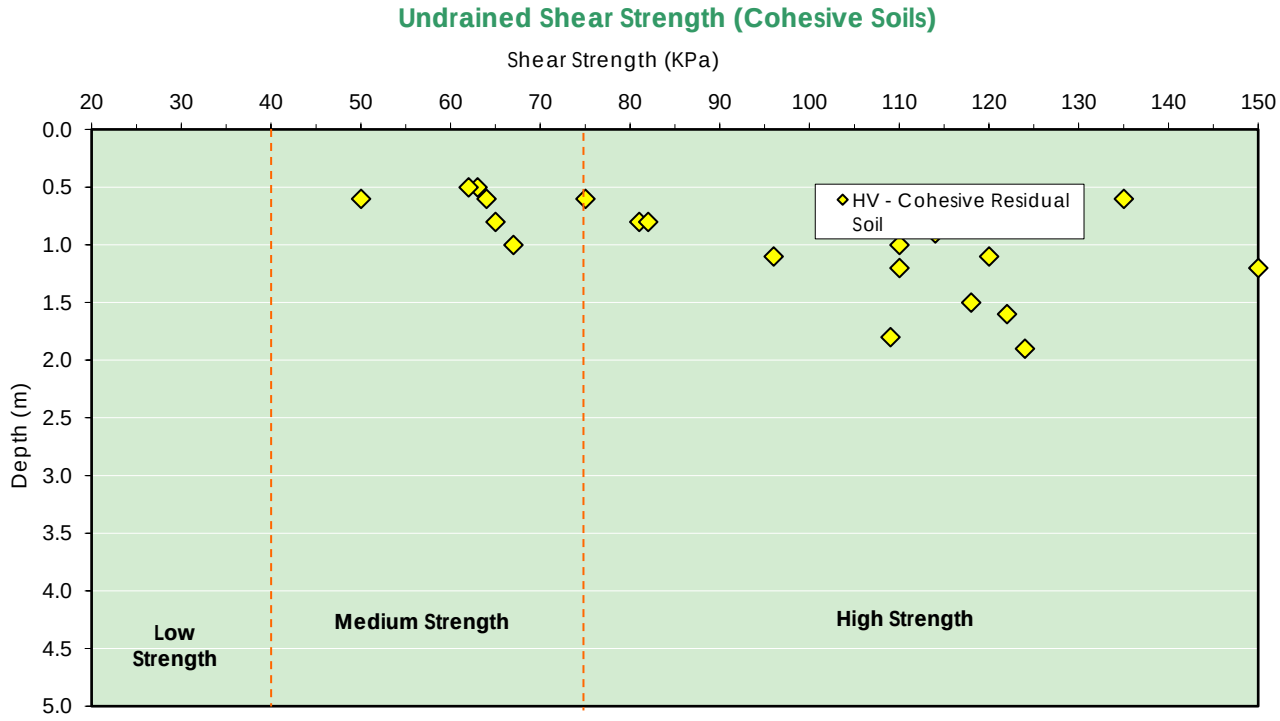
12.6 Undrained shear strength testing

Hand shear vane testing

12.6.1 Hand shear vane testing was undertaken within trial pits in-situ to around 1.2m depth and from larger blocks of excavated clay below that depth.

12.6.2 The results are summarised within the plot below and illustrate a linear increase in undrained shear strength (Su) with depth within the Cohesive Residual Soil. Below approximately 1m depth Su is typically greater than 65kPa.

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



13 GEOTECHNICAL ISSUES

13.1 Conceptual site model

13.1.1 A veneer (0.3m thick) of Reworked Natural ground was recorded in the northeast of the site.

13.1.2 Completely weathered Coal (black clay) was recorded in exploratory holes along the western boundary of the site at between 1m and 1.8m depth.

13.1.3 Natural ground comprises Cohesive Residual Soil (gravelly clays) to an average depth of 1.9m, over completely weathered Coal Measures bedrock (clayey gravels) to depths of between 2.5m and 4.0m.

13.1.4 Underlying bedrock comprises Coal Measures (successions of mudstone, sandstone and siltstones). Artesian groundwater was encountered between 6m and 12m in 3 probeholes in the east of the site (lowest lying area).

13.2 Mining & quarrying

13.2.1 The majority of this site is located within a Coal Mining Development Low Risk Area. However, parts of the south of the site and immediately beyond the northern boundary are located in a High Risk Area.

13.2.2 Lithos' mining investigation identified three coal seams beneath this site (all dip to the southeast). They are:

- Wheatley Lime Coal – outcrops along the site's western boundary and only underlies the western margins of site at very shallow depth (maximum thickness of 0.5m).
- Blocking Rider Coal – Encountered beneath the site at between 14.3m and 22.9m (max. thickness of 0.5m).
- Blocking Coal – Encountered beneath this site between 21.8m and 28m (max. thickness of 0.6m).

13.2.3 No evidence of workings was recorded in the Wheatley Lime and Blocking Rider seams. The Wheatley Lime seam is likely to be too shallow (<2m depth) to be worked and the Blocking Rider is at a depth and thickness that even if worked is unlikely to pose a risk to surface stability.

13.2.4 Evidence of workings was recorded in the Blocking seam although the depth and thickness of these workings do not pose a risk to surface stability.

13.2.5 There are no known quarries on, or within 50m of the site.

13.3 Site regrade and/or ground improvement

13.3.1 Made ground is anticipated to underlie the footprint of the current property and gardens although it is expected to extend to limited depths (<1m). Any made ground encountered is likely to be variable and poor strength and is therefore not considered a suitable foundation material. It will also likely contain materials (e.g. brick, concrete, clinker, coal, etc), which would generally be considered undesirable as a near-surface material in garden areas.

13.3.2 Given existing topography (much of the site is sloping, with gradients of up to 1 in 7 in the east), some site regrade is anticipated, with the need for underbuild and retaining walls.

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

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

13.3.5 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.

13.3.6 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 10.8 should apply.

13.4 Foundation recommendations

General

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

13.4.2 Further investigation should be commissioned if any apartment blocks with higher line loads (say >120kN/m run) are proposed. Such investigation would include cable percussion boreholes and geotechnical analysis (triaxial and oedometer testing) of recovered, undisturbed samples.

13.4.3 Final development levels are expected to differ significantly in places from original ground levels due to the earthworks regrade necessary to create development plateaux. Consequently some refinement of the advice below may be required once detailed design has been completed. Any digital terrain modelling undertaken, or commissioned, by Newett Homes should consider implications for the foundation recommendations outlined below.

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

13.4.5 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.

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

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

Strip/trench fill footings

13.4.8 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for the majority of two or three storey houses constructed at the site. Footings will be founded in firm clay or competent rock. This solution is viable where the thickness of engineered fill placed is less than about 2.5m thick, and natural firm clay or competent rock is the founding material.

13.4.9 Reinforcement, as a precaution against differential settlement would be prudent given the presence of mineworkings (albeit at a depth that should not pose a risk to surface stability). 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.

13.4.10 Where existing buildings are to be demolished, all concrete slabs and service ducts will require breaking out prior to re-development. However, relict foundations could probably be left in-situ and an allowance made for local breaking out, or (probably better) chased-out and removed during the necessary site preparatory works; see Section 13.3.

13.4.11 Foundations of plots placed over relict foundations should be taken to greater depth than the relict foundations and into natural ground of adequate bearing capacity.

13.4.12 Foundations will be required to be placed below a line drawn up at 45° from the base of any service or similar excavation.

13.4.13 Deepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.

13.4.14 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).

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

13.4.16 Newett Homes 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 (clay)

13.4.17 Clay classification tests suggest that natural cohesive soils at the site should be regarded as being of medium shrinkability. A minimum founding depth of 900mm is therefore recommended for all soils on the site where strip footings are proposed.

13.4.18 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.

13.4.19 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 75% of the site may be affected by trees.

13.4.20 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.

13.4.21 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).

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

13.4.23 A safe bearing capacity of around 150kPa, 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 undrained shear strength of 65kPa for the firm clay (typical minimum recorded on site)

13.4.24 Assuming the foundation geometry detailed above, settlements of less than 25mm 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 soils (weathered Coal Measures)

13.4.25 The weathered in-situ sandstone (clayey gravel and cobbles) is assumed to have a relative density of at least medium dense (in accordance with BS5930).

13.4.26 A safe bearing capacity of around 150kPa, 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

13.4.27 Assuming the foundation geometry detailed above, settlements of less than 25mm would be anticipated. This is considered likely to be acceptable. However, further advice should be sought from the Structural Engineer responsible for foundation design.

13.4.28 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).

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

13.4.30 It should be noted that founding at shallow depth (450mm), whilst desirable from an excavation stability viewpoint, may not provide sufficient bearing capacity due to the lesser depth of (resisting) overburden. Consequently, a minimum founding depth of 750mm is recommended. 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

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

13.4.32 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.

13.4.33 Bedrock at the site 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

13.4.34 Some excavations for foundations in the western part of the site may come into contact with coal (see Drawing 3433/12). Care should be taken not to unnecessarily overdeepen foundations, in order to minimise the chance of encountering coal.

13.4.35 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.

13.4.36 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).

Geological fault

13.4.37 Drawing 3433/12 shows the approximate line of the fault superimposed on the proposed housing layout; the fault crosses the north-east corner site.

13.4.38 It should be noted that the line of a fault on a geological map is often very approximate, and it may be inaccurate by 10m or more. Furthermore, the presence of a fault is usually 'masked' by overlying drift or residual soils; they can only be seen where long trenches are excavated into bedrock.

13.4.39 At this site, no movement associated with past, present or future mining is anticipated, therefore building can take place over the fault, without the need to search for the fault, and without the need to adopt special precautions in the footings of those plots suspected to lie in the vicinity of the fault.

13.4.40 However, NHBC like to see reinforcement of footings with one layer of B385 mesh placed 75mm above the base of the footing. Given the uncertainty regarding the precise line of the fault, it would be prudent to reinforce the footings of all plots within 25m of its assumed line; i.e. Plots 1 to 3, 21, 23 to 27 & 29 to 39 (based on the current layout – Rev. W).

13.4.41 Further advice should be sought if a significant weak zone is encountered (e.g. ground comprising loose, broken or soft 'gouge' material) during the excavation of footings. If associated with a fault, the weak zone is likely to form a fairly continuous "linear belt", rather than a localised "pocket", and be anything from a few centimetres to a few metres in width.

Piled foundations

13.4.42 Piled foundations may be an option for dwellings constructed in areas where levels are being raised significantly.

13.4.43 The following general comments relating to piling are provided for guidance, and further advice should be sought from a specialist-piling contractor. Piles are likely to be end bearing in bedrock, therefore in accordance with BS 8004[9] and EC7[10], piling contractors may require further boreholes extended a minimum 5m into competent bedrock using rotary coring techniques.

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

13.4.45 Piled foundations should extend into the underlying bedrock. The safe working load that may be supported on a pile is dependent on the pile diameter, its founding depth and the method of installation.

13.4.46 Probeholes indicate that competent Coal Measures bedrock lies at depths of between 2.5m and 4.0m, below current ground levels.

13.4.47 As piles would be founded in bedrock, they will be essentially end bearing, although there may also be some shaft adhesion in the Residual Soils.

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

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

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

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

[9] *BS 8004 (2015) - Code of practice for foundations.*

[10] *BS EN 1997-1:2007. Eurocode 7: Geotechnical design – Part 2: Ground investigation & testing*

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

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

13.4.53 The number of plots affected by piling will depend on layout proposals and the difference between finished floor levels and current ground levels.

Summary of foundation recommendations

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

Foundation solution(s)	Remarks (influencing factors)
Strips/trenchfill from 0.9m depth	Medium shrinkability clays Overdeepened where necessary due to tree influence
Piles	Where layout proposals require significant raising of ground levels

13.4.55 Lithos could prepare a detailed Foundation Schedule if provided with: an External Works Drawing (with proposed FFLs & infrastructure details); a topographic survey; a tree survey; data from a 'tighter' grid of pits (due to the variable ground conditions encountered).

13.4.56 The foundation solutions outlined in the above table assume that ground levels will not change significantly from those existing at present. If this is not to be the case, further advice should be sought from Lithos.

13.5 Floor slabs

13.5.1 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).

13.5.2 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.

13.5.3 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.

13.5.4 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. 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.

13.5.5 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.

13.5.6 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.

13.5.7 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.

13.5.8 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 November 2021.

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

13.6 Designated concrete mixes

13.6.1 Designated mixes are considered in BRE SD1[11] and BS 8500[12]. 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.

13.6.2 Consequently, Newett Homes should seek advice from their appointed Structural Engineer.

13.7 Excavations

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

13.7.2 Artesian groundwater was encountered across the east of the site between 5m and 12m depth in bedrock. Care should be taken as deep excavations (i.e >3m) could encounter artesian groundwater and, if so, groundwater control above and beyond normal site pumping practices will be required.

13.7.3 Groundwater should be controlled in accordance with CIRIA Report R113[13].

13.7.4 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 and made ground.

13.7.5 Bedrock was encountered in several exploratory holes. Based on the exploratory hole logs, excavation greater than 3.5m is likely to prove difficult across the entire 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.

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

[12] *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).*

[13] *CIRIA Report R113 (1986) - Control of Groundwater for Temporary Works.*

13.8 Drainage

13.8.1 Based on the soakaway testing results, 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.

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

13.8.3 Alternative SUDS options (see CIRIA C753[14] for further details) include:

- Pervious Pavements – provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate into subsurface storage, with subsequent infiltration or controlled discharge. Pavement could be porous (water able to infiltrate across entire surface material; e.g. reinforced grass), or permeable (water infiltrates via joints between concrete blocks).

13.8.4 Yorkshire Water have published a guide[15] for developers and designers outlining their design requirements for surface water attenuation assets.

13.8.5 Land drains were encountered within the site investigation trial pits. Provision of surface drainage infrastructure will negate the need for field drainage. However, field drainage encountered during construction of the infrastructure works, should where practicable and where the layout allows, be maintained.

13.8.6 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.

13.9 Highways

13.9.1 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 tables[16] indicate that the Cohesive Residual Soil would be expected to provide a CBR value of at least 3%. This value should be verified prior to or during construction.

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

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

13.9.4 The made ground present beneath this site is highly likely to be variable in terms of both composition, and strength/density.

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[14] *CIRIA C753 (2015) – The SuDS Manual.*

[15] *Design Requirements for Surface Water Attenuation Assets, February 2017.*

[16] *Interim Advice Note 73/06 Revision 1 (2009), Chapter 5. Characterisation of Materials Design Guidance for Road Pavement Foundations - Draft HD25*

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

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

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

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

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

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

13.10 External works

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

14 REDEVELOPMENT ISSUES

14.1 General

14.1.1 This report has presented options with respect to foundation solutions, 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.

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

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

14.2 Remediation strategy

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

- Demolition of the existing buildings, structures and fishponds
- Post demolition investigation beneath the current property, structures and fishponds.
- General site clearance of surface materials and vegetation
- Topsoil strip & stockpile
- Provision of 300mm thickness of topsoil in all garden and landscaped areas

14.2.2 Immediately prior to demolition of the residential property on Northorpe Lane, current legislation (as outlined in HSG 264) requires a pre-demolition (formerly Type 3) asbestos survey to be undertaken. The Contractor should request a copy of the survey report from Newett Homes.

14.2.3 It is strongly recommended that the demolition contractor should chase-out all significant buried structures, and survey-in the resultant excavations before making them safe by backfilling.

14.2.4 No areas of gross 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. Further advice should also be sought if deep foundations etc associated with the current buildings are encountered during the preparatory works; such obstructions might necessitate revised foundation design.

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

14.3 Control of excavation arisings

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

14.3.2 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; grubbed-up demolition arisings; tarmac; excess clean, natural soil arisings; general construction waste etc.

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

14.3.4 Made ground arisings could be:

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

14.4 Good practice guidance

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

- CIRIA C741[17]
- EA Pollution Prevention Guidelines[18]:
  - PPG6 - Working at construction and demolition sites
  - PPG2 - Above ground oil storage tank
  - PPG7 – The safe operation of refuelling facilities.
  - PPG21 – Incident Response Planning

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

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

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

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

14.5 New utilities

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

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

14.5.3 Water Companies have a statutory duty to supply wholesome water, which could be compromised by the selection of an inappropriate pipe material. For example, compounds such as petroleum hydrocarbons and solvents can permeate commonly used plastics pipes, and/or corrosive chemicals can reduce the service life of metallic pipes. Guidance has been developed for the selection of pipes in brownfield sites and is contained in a UKWIR Report[19].

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

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

14.5.6 However, given the site's history and the relatively consistent ground conditions reported, the use of 'standard' polyethylene water supply pipes should be acceptable, although Newett Homes should consult Yorkshire Water at the earliest opportunity to confirm this.

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

14.6 Health & safety issues - construction workers

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

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

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

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

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

14.7 Coal extraction

14.7.1 Three seams of Coal underlie the site:

- Wheatley Lime Coal – outcrops along the site's western boundary and only underlies the western margins of site at very shallow depth (maximum thickness of 0.5m).
- Blocking Rider Coal – Encountered beneath the site at between 14.3m and 22.9m (max. thickness of 0.5m).
- Blocking Coal – Encountered beneath this site between 21.8m and 28m (max. thickness of 0.6m).

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

14.7.3 As discussed in Section 7.7, old mineworkings exist beneath this site in the Blocking seam, with solid coal only encountered in 3 (43%) of the probeholes located within areas underlain by the Blocking seam.

14.7.4 This suggests that significant extraction has already occurred, reducing the potential yield from further extraction prior to redevelopment. However, the average thickness of coal is around 0.5m, at depths of between 21.8m and 28m (between 29 and 40 times overburden thickness)

14.7.5 Extraction is generally considered possible where the overburden above a seam is less than 12 times the seam's thickness. Consequently, it is considered unlikely that prior extraction of coal from this site would be economically viable.

14.7.6 No workings were encountered in the Wheatley Lime and Blocking Rider seams. However, the Wheatley lime seam is very shallow and completely weathered and therefore likely to be poor quality. Furthermore, the Blocking Rider is of limited thickness and at depths of 14.3m and 22.9m (between 21 and 38 times overburden thickness)

14.8 Shallow coal in garden areas

14.8.1 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.

14.8.2 However, given seam dip and topography it seems likely that coal will only be present at such shallow depth beneath less than 20% of the area.

14.8.3 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.

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

14.9 Potential development constraints

14.9.1 Topography will require significant regrade earthworks across the majority of the site.

14.9.2 Deep excavations (i.e. >3m) could encounter artesian groundwater and, if so, groundwater control above and beyond normal site pumping practices will be required.

14.9.3 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.

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

15 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

15.1 General

15.1.1 The site is located off Northorpe Lane, Mirfield approximately 3km west of Dewsbury town centre and comprises a single residential property with rear gardens, fishponds and a grassed field. Land slopes steeply (up to 1 in 7) to the southeast in the west of the site.

15.1.2 It is understood that consideration is being given to redevelopment of the site with 39 no. traditional two storey domestic dwellings, associated gardens, POS and adoptable roads and sewers.

15.1.3 A veneer (0.3m thick) of Reworked Natural Ground was recorded in the northeast of the site and completely weathered Coal (black clay) was recorded along the western boundary of the site.

15.1.4 Natural ground comprises Cohesive Residual Soil (gravelly clays) to an average depth of 1.9m, over completely weathered Coal Measures bedrock (clayey gravels) to depths of between 2.5m and 4.0m. Underlying bedrock comprises Coal Measures (successions of mudstone, sandstone and siltstones).

15.1.5 Artesian groundwater was encountered within bedrock from between 6m and 12m in 3 in the east of the site (lowest lying area).

15.2 Mining

15.2.1 Parts of this site are located within a Coal Mining Development High Risk Area.

15.2.2 The Wheatley Lime seam (0.5m thick) was identified between 1m and 2m depth on the western boundary of site and was weathered to a black clay. The Blocking Rider seam was identified (0.5m thick) between 14.3m and 22.9m depth and no evidence of mineworkings were identified.

15.2.3 The Middleton Eleven Yards seam was not identified beneath this site.

15.2.4 Lithos' mining investigation found mineworkings (0.6m thick) between 21m and 28m depth in the Blocking seam. The depth and thickness of these workings do not pose a risk to surface stability.

15.3 Hazardous gas

15.3.1 The site is in an area where between 1% and 3% of homes are estimated to be above the radon action level. Radon protection is not essential, but the Developer might consider providing new dwellings with basic measures in light of Public Health England advice.

15.3.2 Based on the conceptual site model developed following intrusive investigation, no plausible pathways are present between potential ground gas sources and the site.

15.4 Contamination & remediation

15.4.1 Topsoil has recorded concentrations of arsenic above the Tier 1 screening value however, bio-accessibility assessment indicates that the bio-accessible fraction of arsenic is below 3% and consequently topsoil is suitable for re-use in garden areas.

15.4.2 However, due to the site-specific risk assessment with regard to re-use of topsoil at this site, there will be implications relating to removal of topsoil off-site for disposal or re-use on a different development. Topsoil is not considered chemically suitable for re-use in this manner.

15.4.3 A veneer of made ground is likely to be present beneath the current residential property and gardens at this site and further investigation and assessment of this made ground is required through a post demolition investigation.

15.5 Foundations

15.5.1 The natural ground beneath this site is suitable for the adoption of traditional strip/trenchfill footings across the majority of the site deepened where necessary due to tree influence.

15.5.2 However, alternative foundations (likely piles) may be required where ground levels are being raised significantly due to the earthworks regrade necessary to create development plateaux.

15.5.3 Some refinement of the above advice may be necessary once detailed design has been completed.

15.6 Flooding

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

15.6.2 Artesian groundwater has been recorded. Care should be taken to avoid damage to the low permeability confining layer. Some evidence of groundwater flooding has been noted in the east and an assessment of groundwater flooding may be required.

15.7 Drainage

15.7.1 Based on the in-situ soakaway testing and high groundwater levels recorded in the monitoring wells, 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.

15.8 Highways

15.8.1 Based on visual inspection of the shallow natural materials and published guidance, the Cohesive Residual Soil should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

15.8.2 Some minor made ground might be present beneath the current residential property and consultation with the adopting authority, regarding the specification of the highways, is strongly recommended.

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

15.9 Further works

15.9.1 Given the constraints discussed in Section 6.2 (existing buildings across the majority of the site) a simple post-demolition trial pit investigation will be required in order to remove residual uncertainties with respect to ground and provide more definitive recommendations with respect to contamination and foundations.

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.
- Cable percussive (Shell & Auger) boreholes, typically using 150mm diameter tools and casing.
- 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).
- 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.

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).

[1] *Mark Perrin. Stoned – Sample Preparation for Soils Analysis. Ground Engineering, April 2007.*

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 4°C, until delivery to the selected laboratory.

Anticipated testing	Container(s)
Asbestos identification	500ml plastic tub
pH & metals, and non-volatile organics	500ml glass jar
Speciated TPH	500ml & 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.

Key to exploratory hole logs

Keys to logs are presented in the Appendix containing the logs. There are two Keys – Symbols & Legends and Terms & Definitions.

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 provide technical guidance in support of Defra's revised Statutory Guidance for Part 2A of the Environmental Protection Act 1990 (Part 2A). The revised Statutory Guidance, published in April 2012, introduced a new four-category system for classifying land under Part 2A where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low. Project SP1010 aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- Demonstration of the methodology, via derivation of C4SLs for 6 substances – arsenic, cadmium, chromium IV, lead, benzene & benzo(a)pyrene.

The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology. Development of C4SLs has been achieved by modifying the toxicological and\or exposure parameters used within CLEA (while maintaining current exposure parameters).

The Part 2A Statutory Guidance was developed on the basis that C4SLs could be used under the planning regime. However, policy responsibility for the National Planning Policy Framework falls to the Department for Communities and Local Government. Defra anticipate that, where they exist, C4SLs will be used as generic screening criteria, and Lithos consider C4SLs to be suitable for use as Tier 1 Screening Values. Lithos have discussed this matter with both NHBC and YALPAG (collection of Yorkshire & Lincolnshire local authorities) and received confirmation that they are satisfied with this approach.

With respect to **inorganic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Inorganic contaminant	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
As	32	37	37	Use (A) in SI Report for initial "screen". If >5 x A, then consider increase of cover to 1,000mm	40	640	37	C4SL adopted
Cd	10	26	26		149	410	26	C4SL adopted
Cr			3,000		3,000	30,000	3,000	Assumes Cr is CrIII
Pb	450	200	200		310	2,330	200	C4SL adopted
Ni	130		127		127	1,700	127	Assessment of health risk only
Se	350		350		595	13,000	434	
Hg	170		169		238	3,640	199	Assumes in an inorganic compound
B			5		5	5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu			80-200		80-200	80-200	80-200	
Zn			200		200	200	200	

With respect to **organic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
Benzene	0.33	0.87	0.9	0.9	3.3	98	N/A	C4SL adopted
Toluene	610		600	3,000	2,700	5,000	N/A	Calculated value over 10,000
Ethyl Benzene	350		350	932	843	5,000	N/A	
Xylenes	240		246	327	321	5,000	N/A	
Phenol	420		412	2,400	519	5,000	N/A	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo(a)pyrene		5	5	25	5.3	76	5	C4SL adopted. Where source is not a coal tar
Naphthalene			8	9	9	1,000	12	
Gasoline Range Organics			30	34	34	5,000	45	See 3-step assessment of TPH below
Diesel Range Organics			151	156	154	5,000	219	
Lubricating Range Org			1,000	5,000	2,000	5,000	1,000	

* *For a residential end use*

The significance of PAHs can be determined by considering indicator compounds. In most cases benzo(a)pyrene (BaP) is adopted as an indicator due to the amount of toxicological data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. A surrogate marker approach can be used to estimate the toxicity of a mixture of PAHs in soil using toxicity data for individual indicator compounds within that mixture. Exposure to the surrogate marker is assumed to represent exposure to all PAHs in that matrix. The surrogate marker approach relies on a number of assumptions:

- Surrogate marker (bap) must be present in all soil samples
- Profile of the different pah relative to bap should be similar in all samples
- PAH profile in the soil samples should be similar to that used in the pivotal toxicity study[1]

[1] SP1010 Appendix E, Provisional C4SIs for benzo(a)pyrene as a surrogate marker for PAHs, CL:AIRE 2013

To assess the PAH profile in a soil sample, the ratio of the seven genotoxic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene), relative to BaP, should be calculated. The ratio relative to BaP should lie within an order of magnitude above and below the mean ratio to BaP.

Naphthalene should also be considered separately against its generic screen. Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than most other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach.

Similarly, **TPH** cannot be assessed as a single "total" value, and reference has been made to the Environment Agency's document P5-080/TR3, "The UK approach for evaluating human health risks from petroleum hydrocarbons in soils". This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down "TPH" into representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the bandings.

The significance of speciated TPH results can be assessed by following the 3 steps outlined in the tables below.

Step	Result	Action
1. Consider indicator compounds: Are BTEX, naphthalene, benzo(a)pyrene above their respective Tier 1 values?	Yes	Remediation or dQRA required
	No	Proceed to Step 2
2. Consider individual TPH fractions: are they above respective screening values?	Yes	Remediation or dQRA required
	No	Proceed to Step 3
3. Assess Cumulative effects: Is the calculated Hazard Index for each source >1	Yes	Remediation or dQRA required
	No	TPH compounds pose no significant risk

Step 1 - Assessing indicator compounds

TPH fraction Indicator compound	End use specific screening value (mg/kg)			
	A: Residential no cover	B: Residential with 600mm cover	C: Residential no gardens	D: Commercial\ industrial
Benzene	0.9	0.9	3.3	98
Toluene	600	3,000	2,700	5,000
Ethyl Benzene	350	932	843	5,000
Xylenes	246	327	321	5,000
Naphthalene	8	9	9	1,000
Benzo(a)pyrene	5	25	5.3	76

Step 2 - Assessing individual TPH fractions

TPH fraction		End use specific screening value (mg/kg)			
		A: Residential no cover	B: Residential with 600mm cover	C: Residential with no gardens	D: Commercial/ industrial
Aliphatic 5-6	GRO	41	41	42	5,000^ per fraction
Aliphatic 6-8	GRO	125	125	125	
Aliphatic 8-10	GRO	31	31	32	
Aliphatic 10-12	DRO	151	156	154	
Aliphatic 12-16	DRO	500^	500^	500^	
Aliphatic 16-21	DRO	1,000^	5,000#	1,000^	
Aliphatic 21-35	LRO	1,000^	5,000#	1,000^	
Aromatic 5-7	GRO	100	123	122	
Aromatic 7-8	GRO	30	34	34	
Aromatic 8-10	GRO	47	50	50	
Aromatic 10-12	DRO	215	287	266	
Aromatic 12-16	DRO	689	1,000*	1,000*	
Aromatic 16-21	DRO	1,000^	5,000#	1,000^	
Aromatic 21-35	LRO	1,000^	5,000#	1,000^	

* Calculated Screening Value exceeded soil saturation limit and could indicate free product, therefore calculated soil saturation limit adopted as a target

^ Calculated Screening Value close to soil saturation limit, screening value selected by Lithos considering visual and olfactory impacts.

Five times the screening value for Scenario A.

Step 3 - Assessing Cumulative Effects

$$HI = \sum_{F_i=1}^{16} HQ\ F_i = \frac{Measured\ concentration\ F_i\ (mg\,kg^{-1})}{SGV\ F_i\ (mg\,kg^{-1})}$$

where HI = Hazard Index
HQ = Hazard Quotient
F_i = Fraction $_i$
SGV = Soil Guideline Value

Other screening values used by Lithos

Tier 1 risk assessment of **hazardous gas** is undertaken through reference to the following documents (and further information is presented in Generic Note No. 5 – Hazardous Gas):

- Approved Document C, Building Regulations 2000
- Boyle & Witherington (2007) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2015 – Code of Practice for the characterisation & remediation from ground gas in affected developments

With respect to the assessment of potential **phytotoxic effects** of contaminants, Lithos refer to "The Soil Code" (MAFF, 1998) for copper and zinc. The CLEA SGV is adopted for nickel due to its human health effects.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, 'Concrete in aggressive ground', 2005.

With respect to the interpretation of the **calorific values**, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that: "*In general … it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn*".

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate or groundwater concentrations with the appropriate water quality standard. Tier 1 Screening Values have been discussed with the Environment Agency, and typically those in **bold** below are adopted.

Analyte	Source of Tier 1 Screening Value (µg/l)			
	Surface water (Abstraction for drinking) 1996	Water Supply Regulations 2000	Water Framework Directive	EA Advice
Arsenic	50	10	**50**	
Selenium	10	**10**		
Cadmium	5	5	**1.5**	
Chromium	50	50	**32**	
Copper	50	2,000	**28**	
Lead	50	10	**7.2**	
Nickel		20	**20**	
Zinc	3,000		**125**	
Boron		**1,000**		
Mercury	1	1	**0.07**	
Petroleum Hydrocarbons				**10**
1,1,1-Trichloroethane			**100**	
1,1 Dichloroethane				**100**
1,2-Dichloroethane		3	**10**	
1,1-Dichloroethene				**100**
Benzene		1	**10**	
Ethylbenzene				**10**
Tetrachloroethene		10	**10**	
Toluene			**50**	
Trichloroethene		10	**10**	
Vinyl Chloride		**0.5**		
Trichloromethane			**2.5**	
Xylenes			**30**	
Chloroethane				**100**

Waste classification & WAC

In the context of waste soils generated by remediation and\or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated 'natural' soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds)
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds)

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

Landfill operators require Waste Acceptance Criteria (WAC) laboratory data, if soil waste is classified as **hazardous**, and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Lithos typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated, for example where redevelopment proposals include basement construction etc. If off-site disposal of soils classified as hazardous waste during redevelopment is anticipated, then WAC analysis should be scheduled at an early stage in the remediation programme. However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous, and these contaminants can often be dealt with by alternative technologies (e.g. by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (e.g. WAC) is required.

Possible action in event of Tier 1 exceedance

Should any of the Tier 1 criteria detailed above be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

1. Undertake further statistical analysis following the approach set out in "*Guidance on Comparing Soil Contamination Data* with *a Critical Concentration - CL:AIRE and CIEH, May 2008*" in order to determine whether contaminant concentrations of inorganic contaminants within soil\fill actually present a risk (only applicable to assessing the risk to human health).
2. Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.
3. Based on a qualitative risk assessment, advocate an appropriate level of remediation to "break" the pollutant linkage - for example the removal of the contaminated materials or the provision of a clean cover.

Prior to undertaking any statistical analysis the issue of the **averaging area** requires further consideration. The CL:AIRE\CIEH document still refers to CLR 7, which suggests averaging area should reflect receptor behaviour and therefore might be a single garden, or an open area used by the local community as a play area. This approach to averaging areas is considered applicable within the context of Part IIA of the Environmental Protection Act (EPA) 1990, in terms of an existing residential development.

However, Lithos consider the concept of a single garden as an averaging area to be inappropriate with respect to brownfield redevelopment, which is regulated by the planning regime. In this context, contamination across the entire site needs to be characterised by reference to the Conceptual Site Model. Consequently, Lithos gather and analyse sample results by fill type, and\or by former use in a given sub-area of the site, before undertaking statistical analysis; ie the averaging area is associated with the extent of a particular fill type, or an area affected by spillage\leakage.

In terms of brownfield redevelopment, this is considered a more appropriate methodology which provides a more representative sample population for statistical analysis. As such the entire site is considered in terms of the proposed end use, be this residential with, or without gardens.

Analysis by soil\fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil\fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass, ie contamination would normally be more pervasive and significant in granular soils than cohesive soils

05 – Hazardous gas
Generic notes – geoenvironmental investigations

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency). In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 01 – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark Information Group, the Environment Agency and the Local Authority and the British Geological Survey. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Where landfilling has occurred within 250m of the site boundary, the Local Planning Authority may request a landfill gas investigation in accordance with the Town and Country Planning General Development Order, 1988.

Sources

Potential sources of hazardous gas include:

- Landfill sites
- Made ground, especially where significant depths are present
- Shallow mineworkings associated with coal extraction
- Geological strata, including peat, organic silts, coal and limestone (reaction with acidic waters), granite (radon)
- Groundwater can sometimes act as a "carrier" for hazardous gas
- Leakages from pipelines or storage tanks
- Sewers, septic tanks and cess pits

Generation

Wherever biodegradable material is deposited, landfill gas (principally a mixture of methane and carbon dioxide) is likely to be generated by microbial activity. Carbon dioxide is an asphyxiant and toxic; methane is flammable and a mixture containing between 5% and 15% methane by volume in air is explosive. Landfill gas in the ground is unlikely in itself to pose a significant risk, though it may damage vegetation. However, infiltration of landfill gas into confined spaces (e.g. cellars, services, etc) may give rise to considerable risk.

There is no typical figure for the length of time that landfill gas will be evolved, but at many sites significant gas generation continues for at least 15 years after the last deposit of waste.

Migration

Gas migration from a landfill site may occur in several ways. It may migrate through adjacent strata; the distance of migration being dependent on the pressure gradients, volume of gas and permeability of the strata. Where there are faults, cavities and fissures within the strata, gas may move considerable distances. Other migration pathways for gas include man-made features such as mine shafts, roadways and underground services.

Gas migration is influenced by a number of climatic factors, such as atmospheric pressure variations, water table level variations and the influence of a covering of snow or ice over the surface of the site and surrounding area.

Gas monitoring procedure

Lithos adopt a standard gas monitoring procedure, in accordance with CIRIA guidance. This procedure involves the measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration
- Gas emission rate
- Methane, oxygen and carbon dioxide concentrations using an infra-red gas analyser
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism. Where samples of gas are required for laboratory analysis, Gresham Tubes or multi-layer Tedlar / ALTEF sampling bags are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Current guidance

CIRIA Report 151 (1995)[i] identified that there was inadequate guidance on trigger concentrations for ground gases. CIRIA concluded that the most important aspect of a gas regime below or adjacent to a site was the surface emission rate, i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. CIRIA Report C665 (2007)[ii] advocates two methodologies for characterising sites:

A – All developments except low rise housing. The advocated methodology is that proposed by Wilson & Card, 1999[iii]

B – Low rise housing. An alternative (traffic light) methodology, derived by Boyle and Witherington, 2006[iv] for NHBC

Both methodologies refer to Gas Screening Values (GSV); previously referred to as limiting borehole gas volume flow.

A – All developments except low rise housing

(Wilson & Card, 1999)[v] revised Table 28 of CIRIA 149[v] in terms of borehole gas volume flow rate (now GSV) in order to achieve a more consistent design of protection measures. This was done to reflect the importance of recognising the gas surface emission rate. Wilson & Card then developed a method for classifying gassing sites (Table 1 below), which took into account the combined gas concentration and GSV.

Characteristic Situation	Gas Screening Value, CH_4 or CO_2 (l/hr)	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% v/v and carbon dioxide not to exceed 5% v/v	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70 litre/hr otherwise increase to Characteristic Situation 3	Natural soil, high peat/organic content
3	<3.5		Old landfill, inert waste, mineworkings flooded.
4	<15	Quantitative Risk Assessment required to evaluate scope of protection measures.	Mineworkings – susceptible to flooding, completed landfill, inert waste
5	<70		Mineworkings unflooded, inactive
6	>70		Recent landfill site

Notes: *Borehole flow rate = volume of gas (regardless of composition) which is escaping from well (l/hr). Gas Screening Value (litre/hour) = gas concentration (%) / 100 x borehole flow rate (l/hr). To facilitate design implementation, the limiting values for both methane and carbon dioxide are identical.*

B – Low rise housing.

NHBC have developed a characterisation system similar to that of Wilson & Card above, but specific to low-rise housing development (Boyle and Witherington) (Table 8.7). This approach compares measured gas emission rates with generic "Traffic Lights". The Traffic Lights include "Typical Maximum Concentrations" for initial screening, and risk-based Gas Screening Values (GSVs) for consideration of situations where the Typical Maximum Concentrations are exceeded. Calculations are carried out for both methane and carbon dioxide and the worst case adopted in order to establish the appropriate protection measures.

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light Classification	Methane [1]		Carbon Dioxide [1]	
	Typical Maximum Concentration [5] (%v/v)	Gas Screening Value [2,4,6] (l/hr)	Typical Maximum Concentration [5] (%v/v)	Gas Screening Value [2,3,4,6] (l/hr)
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.13
Red				

Notes:

1. The worst gas-regime identified at the site, either methane or carbon dioxide, recorded from monitoring in the worst temporal conditions, will be the decider for which Traffic Light and GSV is allocated.
2. Generic GSVs are based on guidance contained within "The Building Regulations: Approved Document C" (2004) and assume a sub-floor void of 150 mm thickness.
3. A leak of gas from the sub-floor void into a small room (e.g. downstairs toilet with soil pipe potentially passing into sub-floor void) of dimensions 1.50m × 1.50m × 2.50m, with a total room volume of 5.63m^3 has been considered.
4. The GSV, in litres per hour, is as defined in Wilson and Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.
5. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgment will be required, based on a thorough understanding of the gas regime identified at the site where monitoring in the worst temporal conditions has occurred.
6. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

---

i *Harries CR, Witherington PJ and McEntee JM (1995). Interpreting measurements of gas in the ground. CIRIA Report 151*

ii *CIRIA (2007) – Assessing risks posed by hazardous ground gases to buildings.*

iii *Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.*

iv *Boyle & Witherington (2006) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights". Report Ref. 10627-R01-(02), for NHBC*

v *Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.*

06 - Soakaways
Generic notes – geoenvironmental investigations

Background

Soakaways have been the traditional way to dispose of stormwater from buildings and paved areas remote from a public sewer or watercourse. In recent years, soakaways have been used within urban, fully-sewered areas to limit the impact on discharge of new upstream building works, and to avoid costs of sewer up-grading outside a development.

Soakaways are increasingly seen as a more widely applicable option alongside other means of stormwater control and disposal. Soakaways must store the immediate stormwater run-off and allow for its efficient infiltration into the adjacent soil. They must discharge their stored water sufficiently quickly to provide the necessary capacity to receive run-off from a subsequent storm. The time taken for discharge depends upon the soakaway shape and size, and the surrounding soil's infiltration characteristics. Soakaways can be constructed in many different forms and from a range of materials.

BRE Digest 365, DG365: 1991 describes design and construction procedures, explains how to calculate rainfall design values and soil infiltration rates, and gives design examples. Further advice is provided in **NHBC** Standards Chapter 5.3 (Section 9 & Appendix F), **Building Regulations** Section 3 of Approved Document H (Drainage & Waste Disposal), and Chapter 13 of **CIRIA's** SUDS Manual (C753:2015).

Soakaways should generally be built on land lower than or sloping away from buildings and be sited **at least 5m** from the foundations of a building.

BRE365 states that '**Groundwater should not rise to the level of the base of the soakaway** during annual variations in the water table' this is further reinforced in Chapter 13 of CIRIA C753:2015 which states that: "*A minimum distance of 1m between the base of the infiltration system and the maximum likely groundwater level should always be adopted. This is to minimise the risk of groundwater rising into the infiltration component and reducing the available storage volume, to protect the functionality of the infiltration process by ensuring a sufficient depth of unsaturated material and to protect the groundwater from any contamination in the run-off*". There may be a requirement to install groundwater monitoring wells at a site in order to monitor seasonal variations in groundwater level at least over a wet winter period.

Soakaways should **not be sited on sloping sites**, an assessment should also be made to ensure that infiltrating water will not cause a rise in groundwater levels, waterlogging of downhill areas or springs, and that slopes are not made unstable.

Made ground (and ground within 5m of deep fill) is not generally regarded as suitable for soakaways, due to the potential for inundation settlement and the leaching of contaminants.

Chalk: CIRIA C574:2002 notes that concentrated ingress of water into the chalk can initiate dissolution, particularly in low-density chalk. For this reason, soakaways should be sited well away from foundations for structures, roads or railways:-

- in areas where dissolution features are known to be prevalent, soakaways should be avoided but, if unavoidable, should be sited at least 20m away from foundations etc
- where the chalk is of low density (weak), or where density is not known, soakaways should be sited at least 10m away from foundations
- where the chalk is of medium density, or higher (moderately weak), soakaways should be sited at least 5m away from foundations

Test methodology

Lithos undertake soakaway tests in general accordance with BRE Digest 365 "Soakaway Design". The BRE Digest recommends that each soakaway pit is filled and allowed to drain three times to near empty; the three fillings to be on the same or consecutive days. However, each test can take over 2 hours to complete. Consequently, at site investigation / feasibility stage, testing is usually undertaken in a 'broad sweep', relatively widely spaced; often only 1 or 2 fills. The drainage designer reviews SI data and if soakaways look feasible, commences design with the incorporation of soakaways. Prior to finalising design, the Drainage Engineer will usually recommend further soakaway testing: (a) within 25m of proposed chamber locations; and (b) to include 3 fills.

Whilst in theory 3 fills is fine, in practice it is often not straightforward. Where drainage rates are quick (draining < 1 hour), allowing 3 fills per pit within a day, even larger water bowsers (say 2,300 gallon/10,000 litre) will run out of water after testing in two pits. Re-filling can take 2 to 3 hours depending on available water supplies etc. So, it is typically only possible to do fully compliant BRE 365 testing in 4 pits a day.

Where infiltration is moderate (a fill drains in say 2 to 4 hours), soakaways may be considered feasible, but it will not usually be possible to complete 3 fills in a day. Therefore, it becomes necessary to leave pits open overnight (usually with a consequent need for herras fencing, site security etc, or the use of stone backfill).

Infiltration rates

Infiltration rates for each soakaway test are calculated (where possible) in accordance with BRE Digest 365. This design takes into account the time of emptying the soakaway pit between 25% and 75% of its effective depth. The effective depth is calculated from the starting water level to the soakaway pit base. Where the water level did not fall to 25% effective depth, the data was interpolated in order to obtain a representative infiltration rate.

Soakaway design

Soakaway design should be carried out by a suitably qualified and experienced Drainage Engineer, in accordance with BRE Digest 365 using the infiltration rates calculated from soakaway testing during a ground investigation.

It is generally assumed that soakaways become impracticable on residential developments when:

- A chamber type design requires a square pit with side length in excess of 1.8m, or an effective depth greater than 1.5m.
- A trench type design requires a length greater than about 10m, or an effective depth greater than 1.5m.

Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

- Standing groundwater level
- Depth to base of permeable strata
- Cost of excavation

Soakaway percolation in some rock types is predominately via the vertical joints within the rock mass. The relatively small-scale soakaway test pits may not intercept such joints and this can result in variable test results. However, it is likely that the larger surface area of a completed soakaway within the development will intercept such joints.

The drainage designer submits designs for approval to:

- The Lead Local Flood Authority (LLFA), usually part of the Local Authority (e.g. NYCC). The LLFA are a consultee to the planning authority. They review the full technical design to ensure that proposals (both plots & highways) are satisfactory. The LLFA may also set standards for soakaway design (NYCC have, and these now require 3 fills and soakaway testing within 25m of proposed chamber locations).
- Local Authority Highways Dept. The Highways Authority adopt highways drainage, so review drainage design (via approval of a Section 38 submission). They also visit site to inspect construction.
- Building warranty provider (e.g. NHBC, Premier etc), if soakaways are proposed for roof & driveway waters.

Appendix B

Drawings

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CLIENT	NEWETT HOMES
JOB TITLE	NORTHORPE LANE, MIRFIELD
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	LEW
DATE	22 03 21
CHECKED	REG
DATE	22 03 21
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
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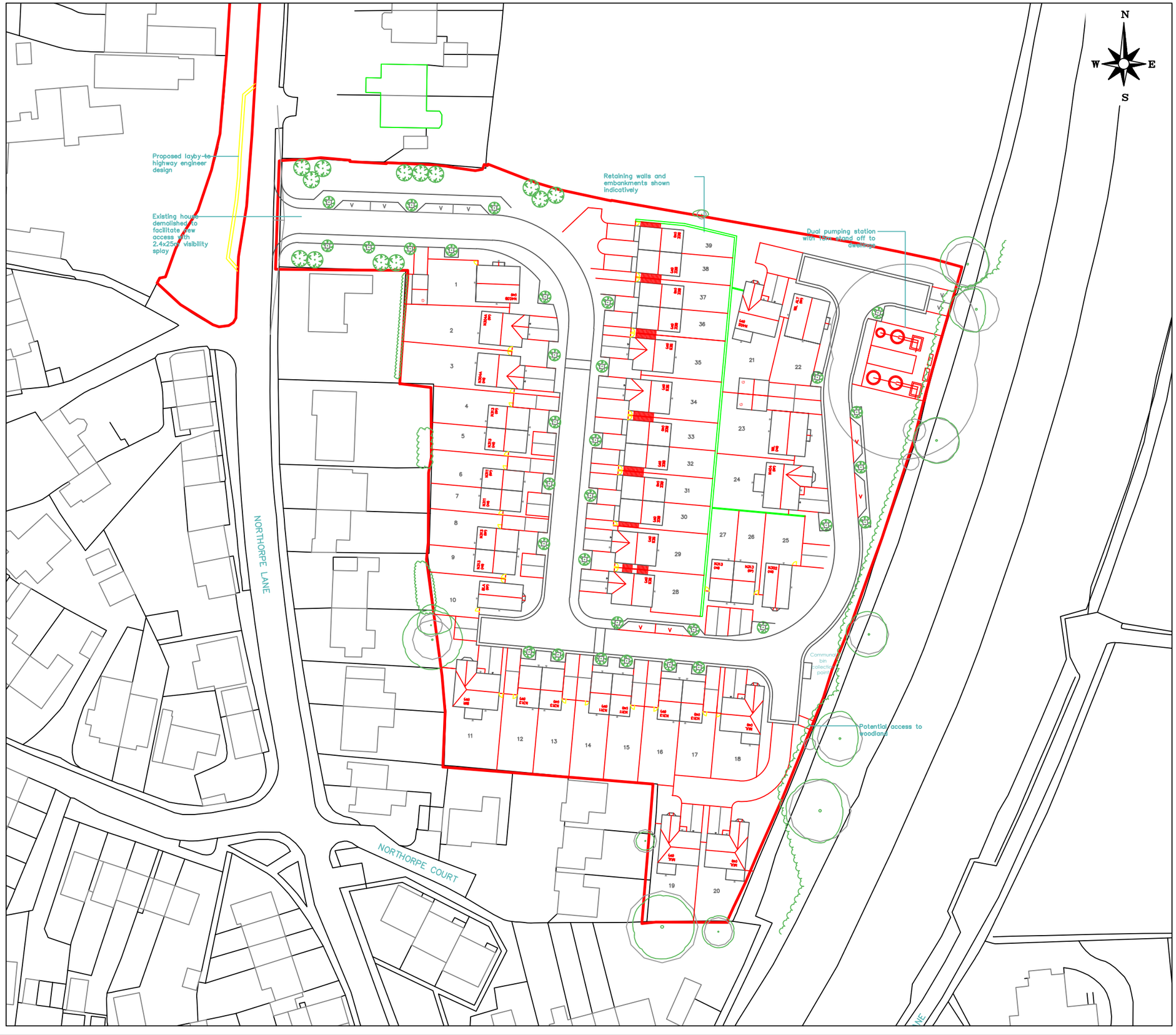
REVISION	



NOTES

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM EDWARD ARCHITECTURE DRAWING REFERENCE 0899-EA-A-P002 REV. W, DATED 22nd MARCH 2022

REV.	DESCRIPTION	DATE
D	UPDATED LAYOUT	28 03 2022

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CLIENT

NEWETT HOMES

JOB TITLE

NORTHORPE LANE, MIRFIELD

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
LEW	22 03 21	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	22 03 21	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
NTS	A3	3433/2	D

NOTES

- OVERGROWN AREAS
- GRASS
- BUILDING
- HARDSTAND (mix of block paving, tarmac & concrete)
- PONDS
- APPROXIMATE SITE BOUNDARY
- PROPOSED PROBEHOLE LOCATION

REV.	DESCRIPTION	DATE

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NEWETT HOMES

JOB TITLE

NORTHORPE LANE, MIRFIELD

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
LEW	30/07/2019	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	30/07/2019	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1,500	A3	3433/3	

NOTES

- OVERGROWN AREAS
- GRASS
- BUILDING
- HARDSTAND (mix of block paving, tarmac & concrete)
- PONDS
- APPROXIMATE SITE BOUNDARY
- LOCATION & ORIENTATION OF PHOTOGRAPH

REV.	DESCRIPTION	DATE

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JOB TITLE

NORTHORPE LANE, MIRFIELD

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
LEW	22 03 21	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	22 03 21	DRAFT ☐
		FINAL ☑

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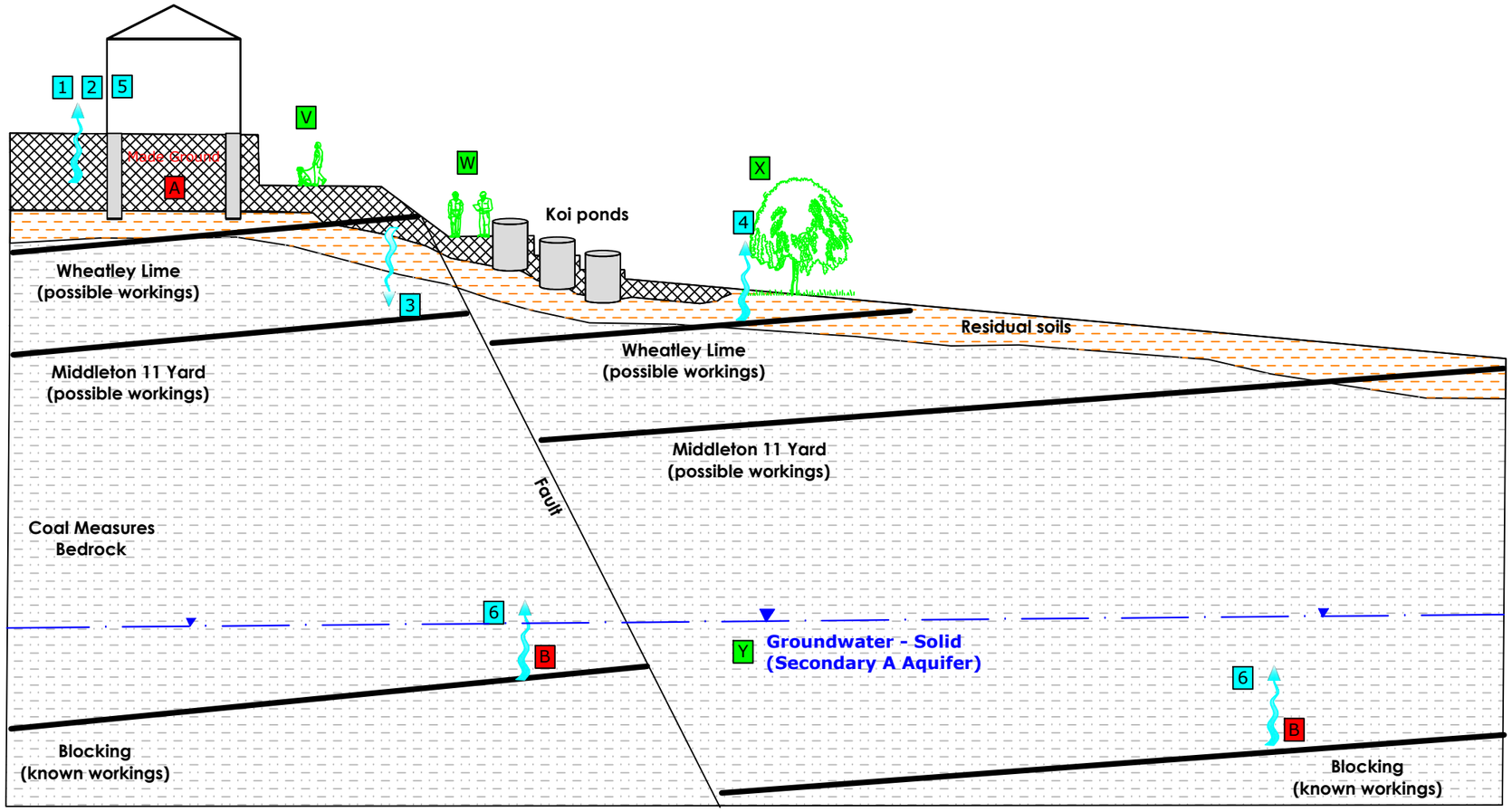

SOURCES	
A	MADE GROUND (INORGANICS & ORGANICS)
B	MINEWORKINGS (HAZARDOUS GAS)

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	GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

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NORTHORPE
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DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
LEW	22 03 21	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	22 03 21	DRAFT ☐
		FINAL ☑

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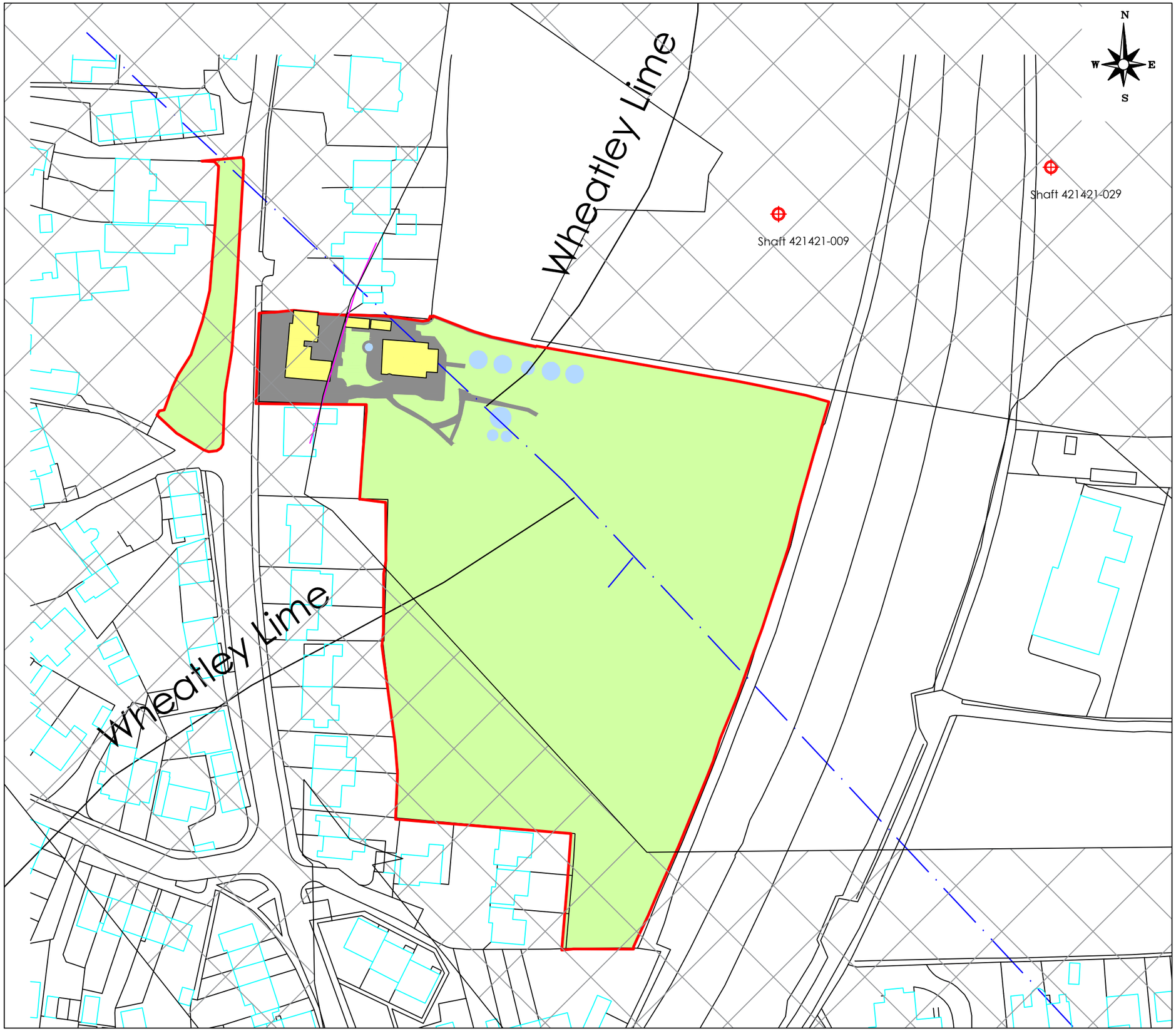

NOTES

- APPROXIMATE SITE BOUNDARY
- APPROXIMATE LINE OF FAULT
- APPROXIMATE COAL SEAM OUTCROP (BGS)
- APPROXIMATE COAL SEAM OUTCROP (CA)
- COAL AUTHORITY MINING DEVELOPMEN HIGH RISK AREA

REV.	DESCRIPTION	DATE
A	UPDATED WITH ADDITIONAL AREA OF LAND, COAL AUTHORITY MINING DEVELOPMENT HIGH RISK AREA ADDED	29 04 21

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JOB TITLE

NORTHORPE
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DRAWING TITLE

GEOLOGICAL FEATURES

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL ☐
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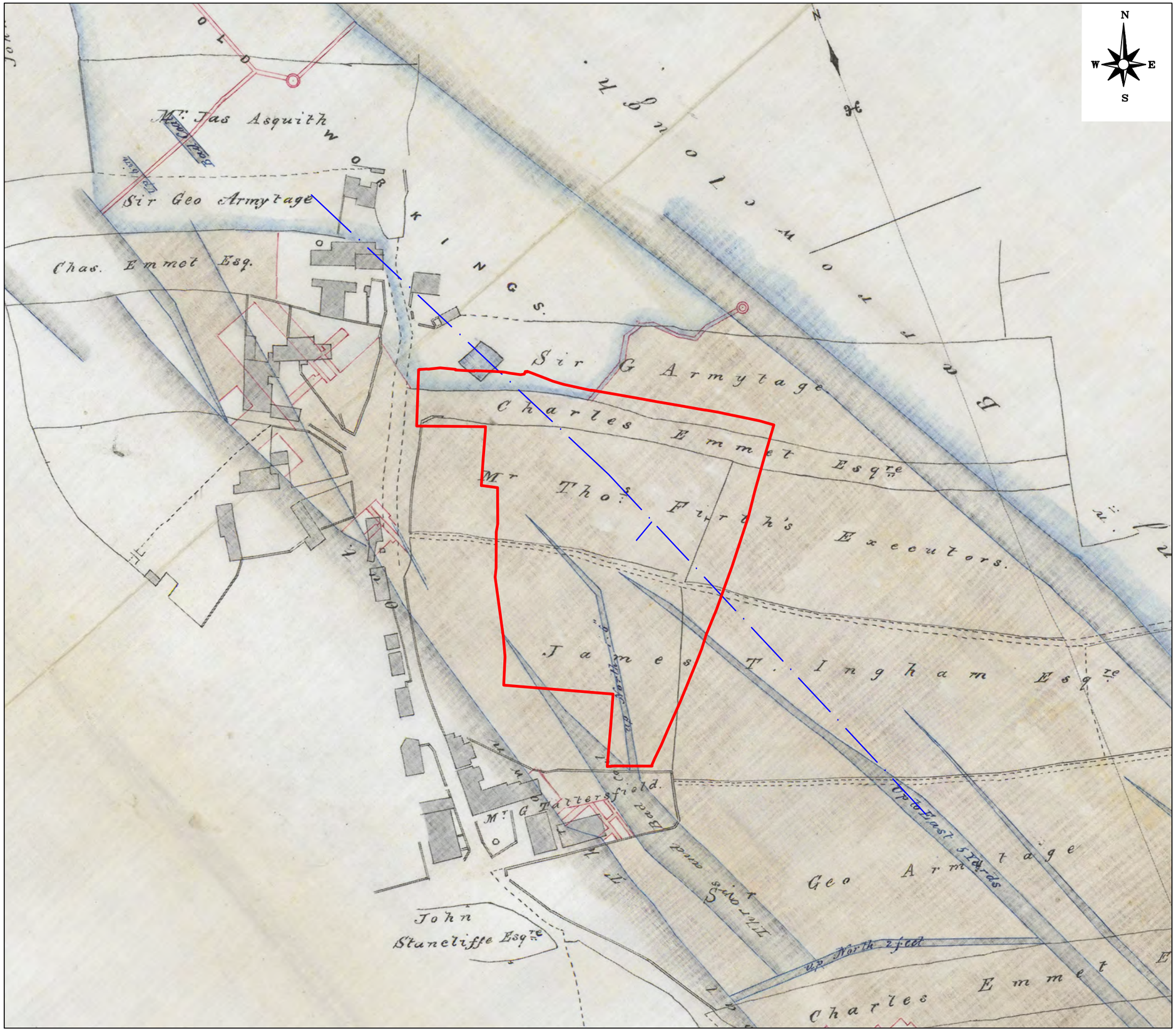

NOTES

APPROXIMATE SITE BOUNDARY

APPROXIMATE LINE OF FAULT

REV.	DESCRIPTION	DATE

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CLIENT

NEWETT HOMES

JOB TITLE

NORTHORPE
LANE, MIRFIELD

DRAWING TITLE

ABANDONMENT PLAN - BLOCKING SEAM

DRAWN	DATE	STATUS
LEW	22 03 21	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	22 03 21	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
NTS	A3	3433/7	

NOTES

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

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JOB TITLE

NORTHORPE
LANE, MIRFIELD

DRAWING TITLE

ABANDONMENT PLAN - BLOCKING SEAM (off-site)

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL ☐
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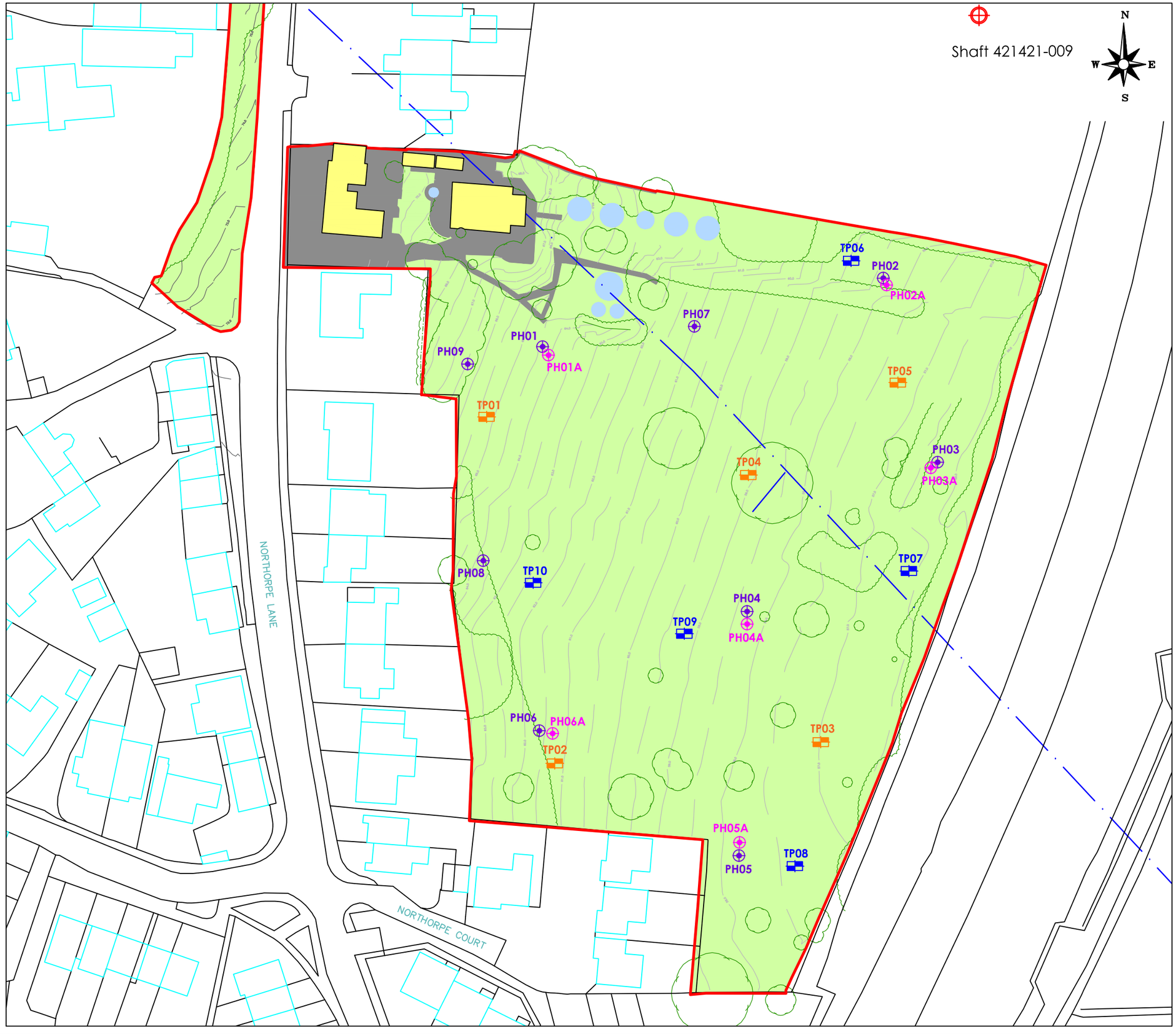


NOTES

- TRIAL PIT LOCATION
- SOAKAWAY PIT LOCATION
- PROBEHOLE LOCATION
- MONITORING WELL LOCATION
- APPROXIMATE SITE BOUNDARY
- APPROXIMATE LINE OF FAULT

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

NEWETT HOMES

JOB TITLE

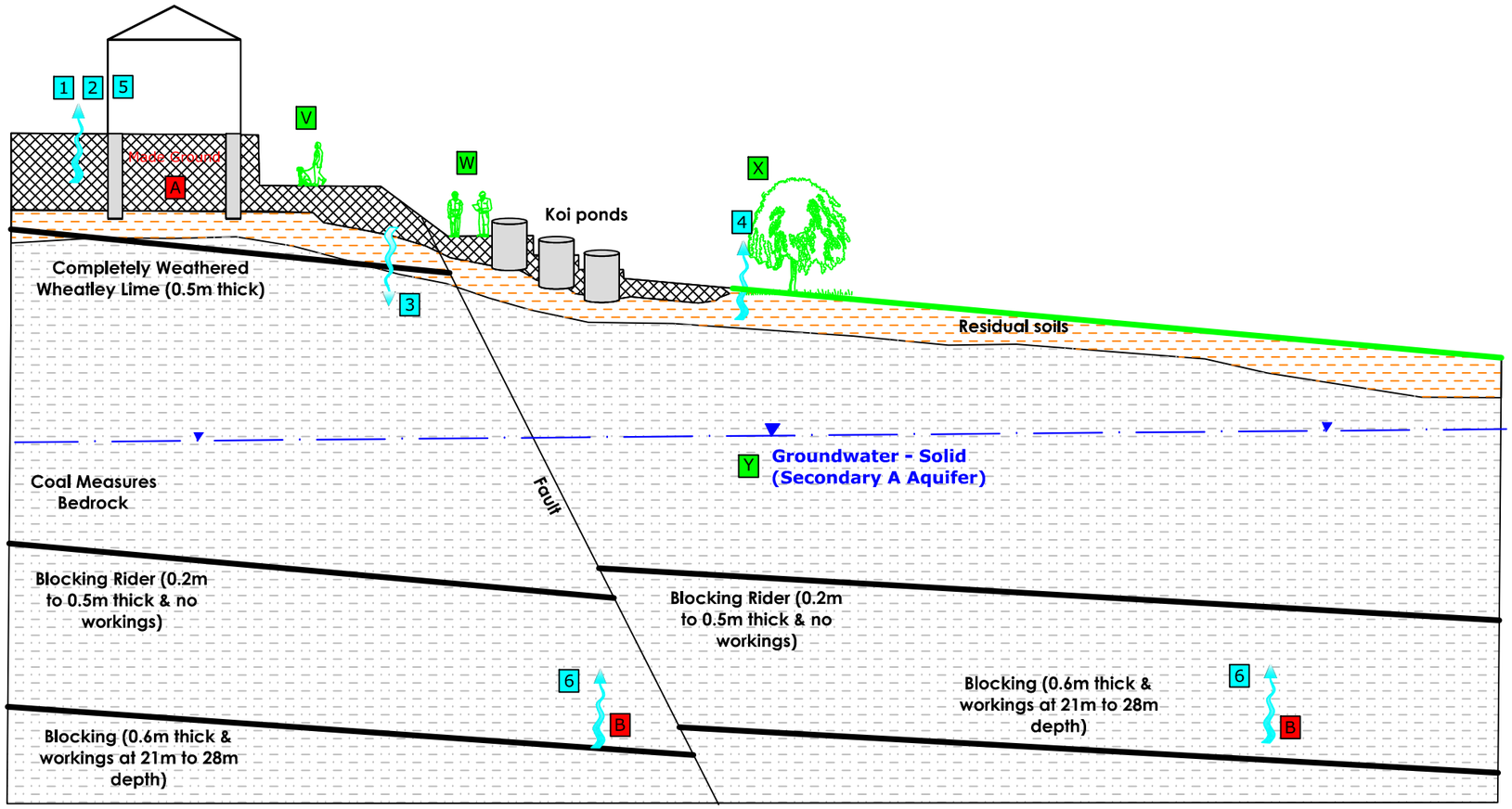
NORTHORPE LANE, MIRFIELD

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
LEW	13/08/21	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	13/08/21	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:750	A3	3433/9	



SOURCES	
A	MADE GROUND (INORGANICS & ORGANICS)
B	MINEWORKINGS (GAS)

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	GROUNDWATER

NOTES

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

NEWETT HOMES

JOB TITLE

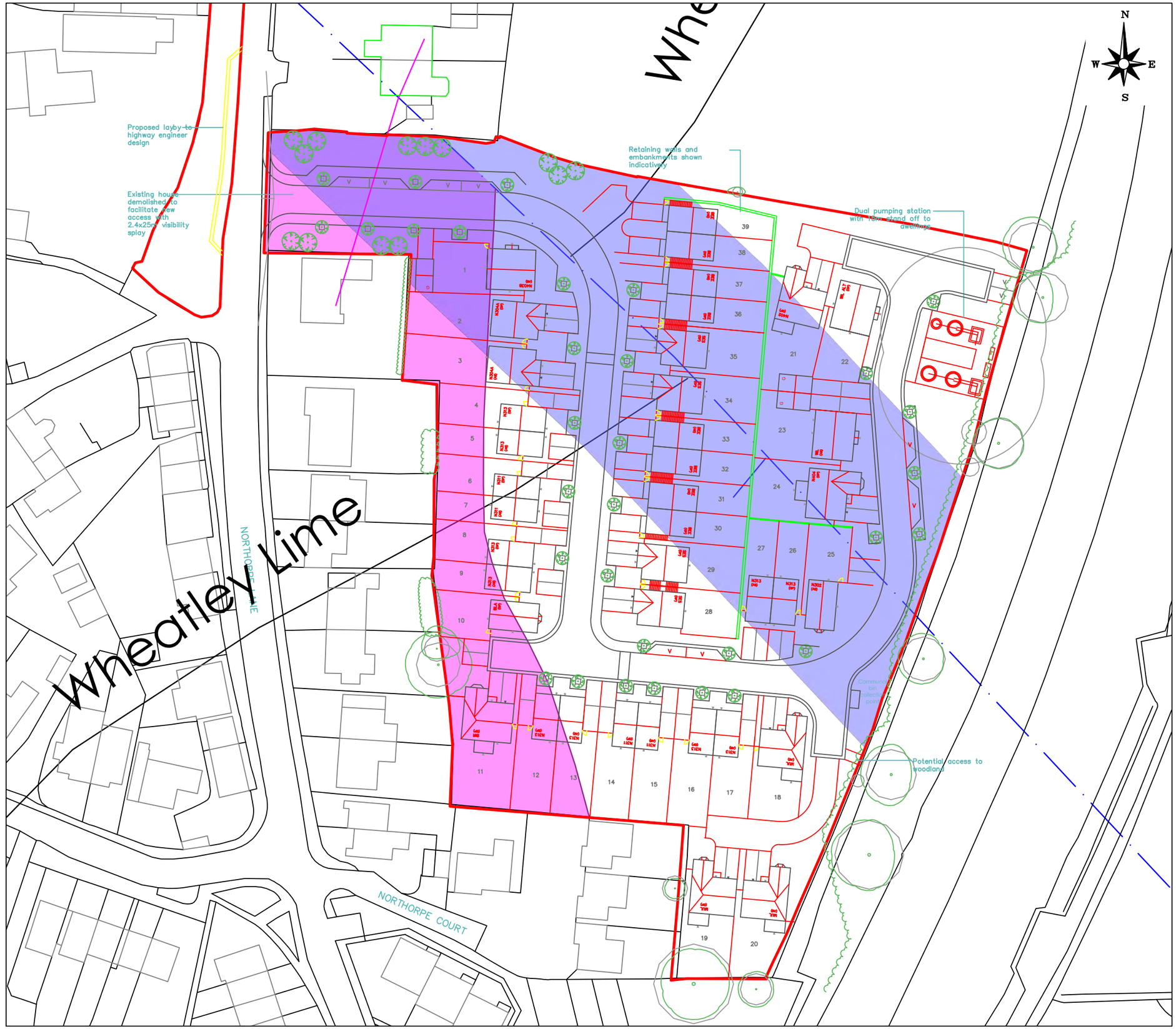
NORTHORPE
LANE, MIRFIELD

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
LEW	03/09/2021	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	03/09/2021	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	3433/10	



NOTES

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM EDWARD ARCHITECTURE DRAWING REFERENCE 0899-EA-A-P002 REV. W, DATED 22nd MARCH 2022

APPROXIMATE LINE OF FAULT

25M OFFSET OF APPROXIMATE LINE OF FAULT

APPROXIMATE COAL SEAM OUTCROP (BGS)

APPROXIMATE COAL SEAM OUTCROP (CA)

APPROXIMATE COAL SEAM OUTCROP (OBSERVED)

AREA UNDERLAIN BY WHEATLEY LIME SE AT SHALLOW DEPTH

REV.	DESCRIPTION	DATE
C	UPDATED LAYOUT	28 03 2022

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

NEWETT HOMES

JOB TITLE

NORTHORPE LANE, MIRFIELD

DRAWING TITLE

PROPOSED SITE LAYOUT & GEOLOGICAL FEATURES

DRAWN	DATE	STATUS
LEW	13/08/2021	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
REG	13/08/2021	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:750	A3	3433/2	A

Appendix C

Commission

26th February 2021

LITHOS CONSULTING

Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330

www.lithos.co.uk

Northorpe Lane, Mirfield

Further to your recent invitation, please find attached our proposal for undertaking a site investigation on the above land. We understand that your proposed development will include traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; although no layout is available yet.

Review of the information supplied suggests that the site consists of a single parcel of land of approximately 1.4 hectares off Northorpe Lane. Review of Google Maps suggests the majority of the site is occupied by a grassed field, with an existing house and gardens in the far northwest.

Brief review of internet data and Lithos knowledge of the area suggests the site:

- Appears to have remained undeveloped throughout its history, with a former railway line running along the eastern boundary;
- 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 Lower Coal Measures with the Wheatley Lime coal seam outcropping in the northwest. This site is located within a Coal Mining Development High Risk Area.

The scope of works outlined in this letter should enable us to assess abnormal development issues, associated with ground. However, the nature of site investigation is such that it is not always possible to foresee all the potential issues. Consequently, it is sometimes necessary to recommend additional work, but where this occurs we will inform you immediately, provide costs, and seek your further instruction. We have visited site and reviewed available internet data and our geological maps in order to minimise the likelihood of further work.

Ground investigation is generally best undertaken post-demolition; access constraints associated with existing buildings, and underground service runs, can prevent thorough inspection of the ground via extensive trial pitting/trenching. Consequently, some uncertainties may remain in the vicinity of the existing house and a supplementary, post-demolition ground investigation may be required by the relevant regulatory authorities. Nonetheless, useful data can be obtained at this time and we will certainly aim to resolve as much uncertainty relating to ground as possible, in order to enable you to make an unconditional offer for the site.

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.

Given the site's location within a Coal Mining High Risk Area, a Consultant's mining report will be obtained. Review of the CA's interactive viewer suggests abandonment plans should be available for known shallow mineworkings beneath the site and we will obtain copies of these plans.

We will also visit site to undertake a walkover survey.

Fieldwork: We have allowed for a day's trial pitting and the drilling of 12 rotary probeholes to check for the presence of mineworkings. All trial pits and boreholes will be supervised and logged by an experienced geoenvironmental engineer.

This proposal has been put together without a recent site visit. If ground conditions are found to be significantly wet/boggy at the time of the investigation, it may be necessary to hire additional resources (bog mats, tracked excavators, tractors, stone etc) in order for works to continue. We will discuss the requirement for any such items and associated costs with you prior to ordering.

Trial pitting will enable us to determine the:

- Nature of any made ground, including:
  - visual/olfactory evidence of potential contamination and the proportion of undesirable elements e.g. biodegradable matter, relict foundations etc
  - the proportion of "oversize", boulder-sized material
- Nature, distribution and thickness of shallow soils
- Suitability of the ground for founding structures and highways

Given nature of the land and the time of year we have allowed for pits to be dug using a tracked 360° excavator.

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.

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 5 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.

This investigation should yield sufficient data to enable a foundation zoning plan, and possibly a detailed Foundation Schedule. However, if ground conditions are found to be more variable than anticipated, a 'tighter' grid of pits will be necessary prior to preparation of a detailed Foundation Schedule. This proposal does not allow for the preparation of a detailed Foundation Schedule, but we will provide a quote on completion of the site investigation if requested.

The site is underlain by a number of shallow coal seams, and therefore we have allowed for the drilling of 12 **rotary probeholes** to check for the presence of mineworkings. This drilling should be sufficient to determine whether old mineworkings are present and pose a significant risk to surface stability of the site. However, 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.

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. Given the proximity of surrounding housing (within 50m of much of the general site area), and in accordance with CA requirements we have had to assume that the probeholes will need to be advanced using water as the flushing medium (as reinforced by recent CA guidance on managing the risk of hazardous gas). Our drilling sub-contractor will need to locate the wash outs close to the site, and procure a standpipe and licence from Yorkshire Water.

With reference to the control, management and disposal of surplus water and flush arising from the works, (and in order to avoid additional costs associated with the provision of a telehandler to transfer a weir tank between boreholes, and the provision of a pump to transfer surplus water from the weir tank to an approved disposal point), we have made provision for a sand bag bund at the foot of the drilling mast, at each borehole to contain the majority of the drill cuttings. However, we have assumed that potentially discoloured surplus water will be allowed to flow and settle into the field.

We have also assumed that it will be possible to park plant overnight close to the existing house, where it will be more secure. At this stage, we have assumed that overnight security will not be required, but this will be reviewed following a site visit. If required, security would be an E\O of £ per night. We have allowed for overnight security (guard) for plant outside normal working hours (nights & weekends).

We have allowed for all exploratory holes to be picked-up by a **surveyor** (co-ordinates/ground levels will be included on the logs).

Given the likely presence of shallow mineworkings, we have allowed for the installation of wells in 8 holes 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.

Testing: This will comprise routine **geotechnical** soils analysis, including 12 moisture content & Atterberg limits, and 12 pH & water-soluble sulphate and 4 gradings. Given the sloping nature of the site we will also schedule 4 compaction tests on samples of natural ground to assess suitability for use in any earthworks.

This site is greenfield and therefore we could obtain in-situ CBR values from plate tests on site. However, at this stage routes, formation level and total length, of proposed estate roads are unknown. Consequently, 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 (9 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH. Visible contaminants, sharps and the clay/sand/silt content of 4 topsoil samples will be determined to check compliance with BS3882 requirements.

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 9 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.

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. Due to the presence of shallow coal the Local Authority may consider the site to lie within a Mineral Safeguarding Area. As a consequence of this and the NPPF, the Local Authority may require you to consider the opportunity to recover (extract) the coal. Our report will include an assessment of the feasibility of coal extraction.

A completed copy of the **YW** Contaminated Land Assessment Form will be included in an Appendix to our Report.

Given previous usage of this land, a **Remediation Statement** may be required by the Local Authority to support discharge of planning Conditions. If required, we will provide a separate Remediation Statement for an E\O fee of c. £ .

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.

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 at the milestones defined below:

- 1st milestone invoice (Items A, to E) within 5 days of fieldwork completion, with exploratory hole logs and an interim letter report outlining our initial findings
- 2nd milestone invoice (Items F to H) on issue of the final SI report
- 3rd and final invoice (Item I) after completion of the gas monitoring/issue of the supplementary letter report

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 4 working days and therefore this proposal includes for provision of a chemical toilet.

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.

It is highly likely that the site is underlain by many "private" services and drains etc which will not be shown on statutory utility plans. Consequently, it would be appreciated if copies of plans showing these services could be made available to our field engineer, and\or someone with site knowledge could advise us with respect to safe locations for our exploratory holes.

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 either 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.

Further work: In addition to the investigation outlined above, the following further works may ultimately be required:

- Further pitting and rotary drilling in the vicinity of the existing house post-demolition

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

Mark Perrin
Director
for and on behalf of
LITHOS CONSULTING LIMITED

Terms and Conditions for the Appointment of Lithos Consulting Limited

V007.20

1 DEFINITIONS AND INTERPRETATION

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

"Agreement" shall mean these Terms (entitled "Terms and Conditions for the Appointment of Lithos Consulting"), the Proposal, any document recording the Client's unequivocal acceptance of the Proposal and any other documents or parts of other documents expressly referred to in any of the foregoing:

"Client" shall mean the party for whom the Services are being provided by Lithos;

"Documents" shall mean 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 Lithos, and whether in paper form or stored electronically or on disk, or otherwise;

"Lithos" shall mean Lithos Consulting Limited whose registered office is at Parkhill, Walton Road, Wetherby, West Yorkshire, LS22 5DZ.

"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;

"Parties" shall mean the Client and Lithos

"Project" shall mean the project described in the Proposal and any enquiry from the Client on which Lithos has based its Proposal;

"Proposal" means the offer document prepared by Lithos 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 Lithos pursuant to the Agreement and as set out in the Proposal and shall include any additions or amendments thereto made in accordance with these Terms;

"Terms" means these terms entitled "Lithos Consulting Terms of Appointment".

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 The Client agrees to engage Lithos and Lithos agrees to provide the Services in accordance with the provisions of the Agreement.

3 OBLIGATIONS OF LITHOS

3.1 Lithos shall perform the Services using the reasonable standard of skill and care normally exercised by similar professional Environmental firms in performing similar services under similar conditions.

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

4 OBLIGATIONS OF THE CLIENT

4.1 Throughout the period of this Agreement the Client shall afford to Lithos or procure the affording to Lithos of access to any site where access is required for the performance of the Services.

4.2 The Client accepts responsibility for ensuring that Lithos is 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 known or suspected by the Client, which the Client shall clearly mark on the ground or identify on accurate location plans supplied to Lithos prior to the commencement of the Services. The Client shall also inform Lithos 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. The Client shall indemnify Lithos against all costs, 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 the Client discovers any conflict, defect or other fault in the information or designs provided by Lithos pursuant to the Agreement, he will advise Lithos in writing of such defect, conflict or other fault and Lithos 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 INTELLECTUAL PROPERTY

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

5.2 The Client shall have a non-exclusive licence to copy and use such Intellectual Property for purposes directly related to the Project. Such licence shall enable the Client to copy and use the Intellectual Property but solely for its 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 Lithos.

5.3 Should the Client 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, it must obtain the prior written consent of Lithos. The giving of such consent shall be at the discretion of Lithos and shall be upon such terms as may be required by Lithos. Lithos shall not be liable 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 behalf of Lithos.

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

5.5 In the event of the Client being in default of payment of any fees or other amounts due, Lithos may suspend further use of the licence on giving 2 days' notice of the intention to do so. Use of the licence may be resumed on receipt of the outstanding amounts.

6 TITLE

6.1 Lithos shall transfer only such title or rights in respect of the Documents as it has, and if any part is purchased from a third party Lithos shall transfer only such title or rights as that party had and has transferred to Lithos.

6.2 Title in the Documents shall remain with and shall not pass to the Client until the amount due under the invoice(s) (including interest and costs) has been paid in full.

6.3 Until title passes, the Client shall hold the Documents as bailee for Lithos and shall store or mark them so that they can at all times be identified as the property of Lithos.

6.4 At any time before title passes (save and except where payment is not due), but only after prior consultation with the Client, Lithos may without any liability to the Client repossess and use or sell all or any of part of the Documents and by doing so terminate the right of the Client to use, sell or otherwise deal in the Documents.

6.5 Lithos may maintain an action for the price of the Documents notwithstanding that title in them has not passed to the Client.

7 CONFIDENTIALITY AND DATA PROTECTION

7.1 Lithos undertakes not to divulge or disclose to any third party without the written consent of the Client information which is designated confidential by the Client or which can reasonably be considered to be confidential and arises during the performance of the Services unless required to do so by law or necessary in the proper performance of its duties in relation to the Project, or in order to make full frank and proper disclosure to its insurers or intended insurers, or to obtain legal or accounting advice.

7.2 Subject to the above and Lithos' Privacy Policy which can be found on www.lithos.co.uk, Lithos shall be permitted to use information related to the Services it provides in connection with the Project for the purposes of marketing its services and in proposals for work of a similar type.

8 THIRD PARTIES

8.1 The Agreement or any part thereof or any benefit or interest thereunder may not be assigned by the Client without the prior written consent of Lithos. The giving of such consent shall be at the discretion of Lithos and Lithos will only agree to an assignment on its terms and in return for payment of a fee by the Client to Lithos to cover Lithos' legal and other costs associated with any assignment.

8.2 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.

8.3 Lithos will consider and may consent to any request from the Client for Lithos to enter a collateral warranty with a third party with regard to the Services provided under the Agreement. The giving of such consent shall be at the discretion of Lithos and Lithos will only enter a collateral warranty on its terms and in return for payment of a fee by the Client to Lithos to cover Lithos' legal and other costs associated with any collateral warranty.

9 INSURANCE

9.1 Lithos warrants to the Client that there is in force a policy of Professional Indemnity insurance covering its 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) in the aggregate cover. This policy is annually renewable and whilst renewal is not automatic, Lithos agrees to use reasonable endeavours to maintain such insurance at all times until six years from the date of the completion (or termination) of the Services under the Agreement, provided such insurance is available at commercially reasonable rates having regard, inter alia, to premiums required and policy terms obtainable.

9.2 If for any period such insurance is not available at commercially reasonable rates, Lithos shall forthwith inform the Client 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 Lithos to obtain.

10 LIMITATIONS ON LIABILITY

10.1 Unless otherwise agreed in writing, Lithos' liability under or in connection with the 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 9.1 above, or 20 times the total value of invoices issued to the Client for consultancy work instructed under the Agreement.

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 Lithos after the expiry of a period of six years from the date of the completion (or termination) of the Services under the Agreement.

10.3 Whilst Lithos will scan all potential exploratory locations with a Cable Avoidance Tool, Lithos 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 Lithos shall not be liable for the cost of rectifying any defect, conflict or other fault in the information or designs provided by Lithos 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 Lithos has been advised in writing of the same by the Client and has 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 PAYMENT

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

11.2 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.

11.3 If the Client disputes the amount included for payment in an invoice a written notice must be served on Lithos by the Client not later than 14 days before the final date for payment. If no notice is given the amount due shall be the amount stated in the invoice.

11.4 In the event of failure on the part of the Client to pay any monies in accordance with the foregoing payment provisions, Lithos will be entitled to charge interest on any monies owed to it by the Client, such interest to be at a rate of 8% 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.

12 DELAY

12.1 Lithos will comply with any timescale agreed for completion of the Services unless delayed or prevented by circumstances beyond its reasonable control and in the event of any such circumstances arising Lithos undertakes to complete the Services within a reasonable period, but will not be liable to the Client for any delay as a result.

13 TERMINATION

13.1 The Agreement may be terminated by either party 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.

13.2 If for any reason the performance of the Services by Lithos is suspended for a period in excess of three calendar months then Lithos shall be entitled to terminate its appointment in respect of the Services by seven days written notice to the Client.

13.3 If the Client shall fail to pay in full any sum due under the terms of the Agreement by the final date for payment for that sum and no effective notice of intention to withhold payment has been issued, Lithos may serve written notice on the Client demanding payment within 14 days of such notice. If the Client shall fail to comply with such notice, Lithos shall be entitled to terminate its employment under the Agreement forthwith.

13.4 Any termination of the appointment of Lithos howsoever caused shall be without prejudice to the right of Lithos 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.

14 NOTICES

14.1 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 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 the address of Lithos set out above or to the registered address of the Client.

14.2 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 first class post.

15 ENTIRE AGREEMENT

15.1 The Agreement constitutes the complete and entire agreement between the Client and Lithos 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 Lithos in respect of the Services can only be made in contract under the provisions of the Agreement and not otherwise under the law or tort or otherwise.

15.2 No amendments, modifications or variation of the Agreement shall be valid unless made in writing and agreed to by both the Client and Lithos; such agreement must be recorded in writing by at least one of the Parties.

15.3 Lithos will not be bound by any standard or printed terms or conditions furnished by the Client in any of its documents unless Lithos specifically states in writing separately from such documents that it intends such terms and conditions to apply.

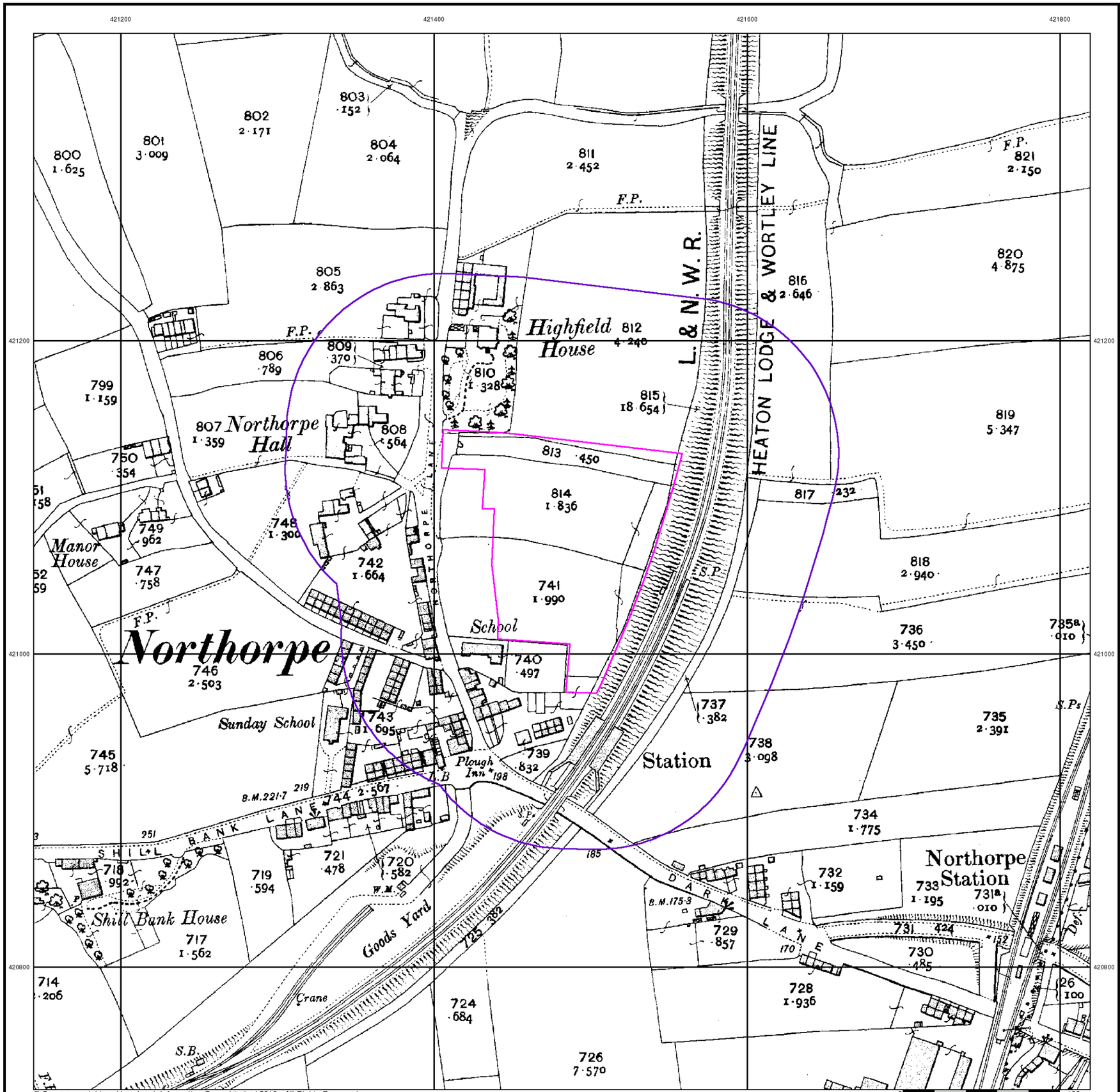
16 DISPUTES AND GOVERNING LAW

16.1 The Agreement shall be governed by and construed in accordance with English law and the Parties irrevocably and unconditionally submit to the jurisdiction of the English Courts.

16.2 Where the Housing Grants, Construction and Regeneration Act 1996 applies, any dispute between the Parties 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.

Appendix D

Historical OS Plans



LITHOS CONSULTING

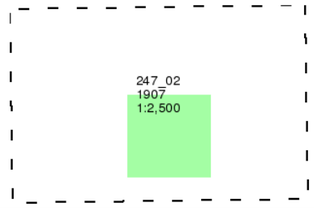
Yorkshire

Published 1907

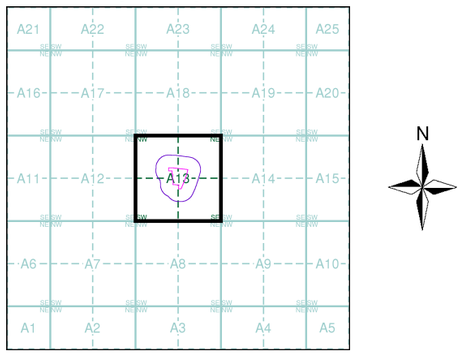
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



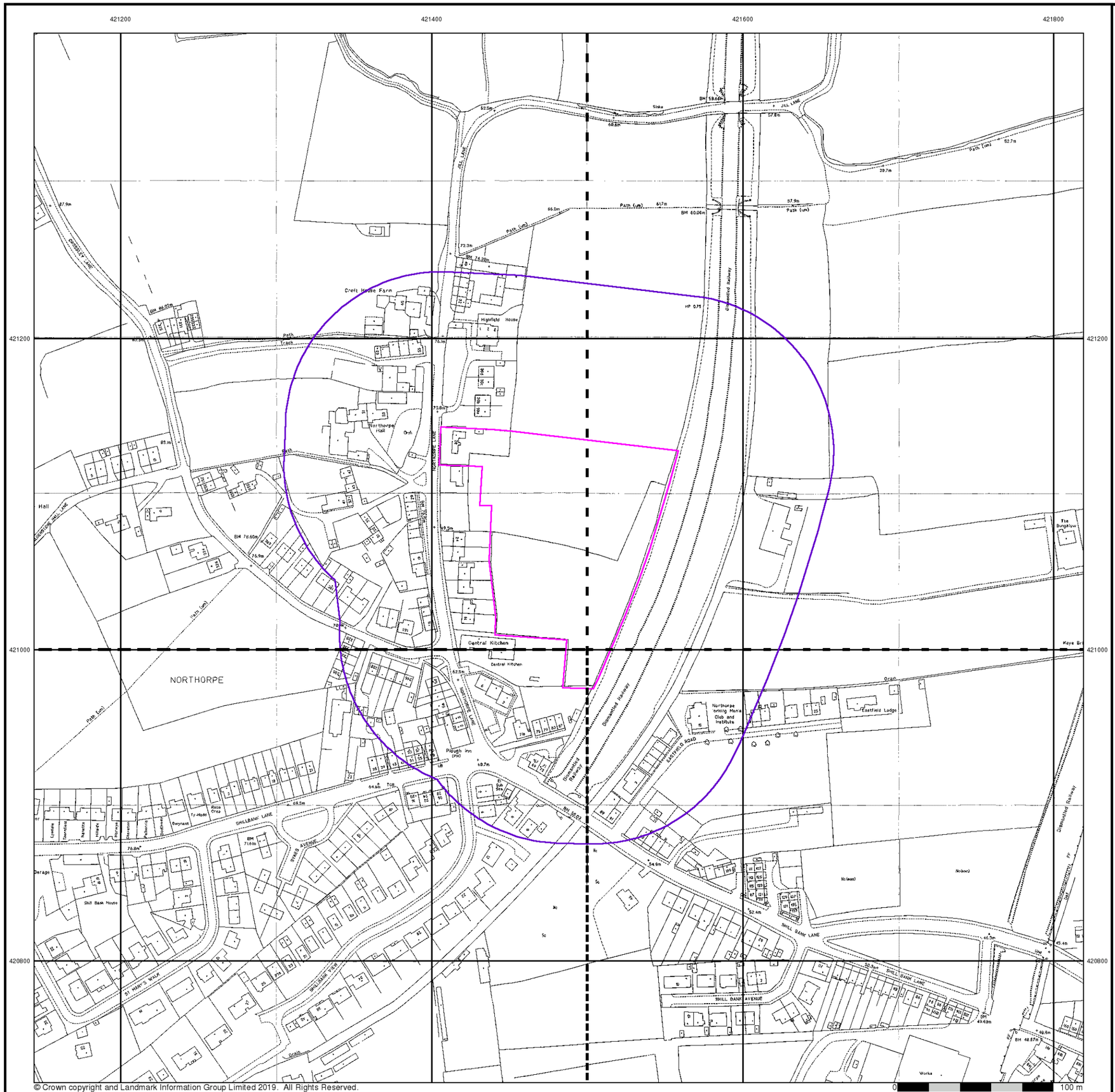
Order Details

Order Number:	210715698_1_1
Customer Ref:	3433
National Grid Reference:	421480, 421070
Slice:	A
Site Area (Ha):	1.49
Search Buffer (m):	100

Site Details

1, Northorpe Lane, MIRFIELD, WF14 0QQ

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



LITHOS CONSULTING

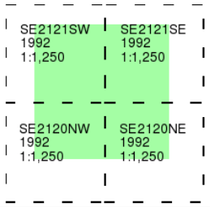
Large-Scale National Grid Data

Published 1992

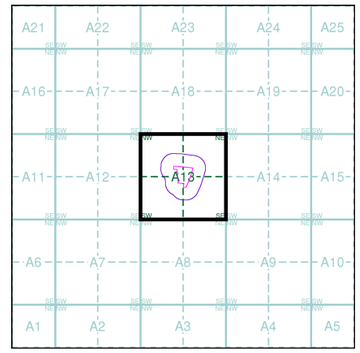
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



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

Appendix E

Search Responses

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
210715698_1_1

Customer Reference:
3433

National Grid Reference:
421480, 421070

Slice:
A

Site Area (Ha):
1.49

Search Buffer (m):
1000

Site Details:

1, Northorpe Lane
MIRFIELD
WF14 0QQ

Client Details:

Mr M Thompson
Lithos Consulting Ltd
Parkhill
Walton Road
Wetherby
LS22 5DZ

LITHOS CONSULTING

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 1				7
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 3				1
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 3		Yes		
Pollution Incidents to Controlled Waters	pg 3			2	8
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality	pg 5				1
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register	pg 5				2
Water Abstractions	pg 5			1	2 (*34)
Water Industry Act Referrals					
Groundwater Vulnerability Map	pg 15	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 15	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
OS Water Network Lines	pg 15		6	9	25

LITHOS CONSULTING

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 21			1	2
Historical Landfill Sites	pg 21			2	5
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)	pg 22			2	
Licensed Waste Management Facilities (Locations)	pg 23				1
Local Authority Landfill Coverage	pg 23	1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 23			2	10
Potentially Infilled Land (Water)	pg 24				1
Registered Landfill Sites	pg 24				7
Registered Waste Transfer Sites	pg 28				3
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					

LITHOS CONSULTING

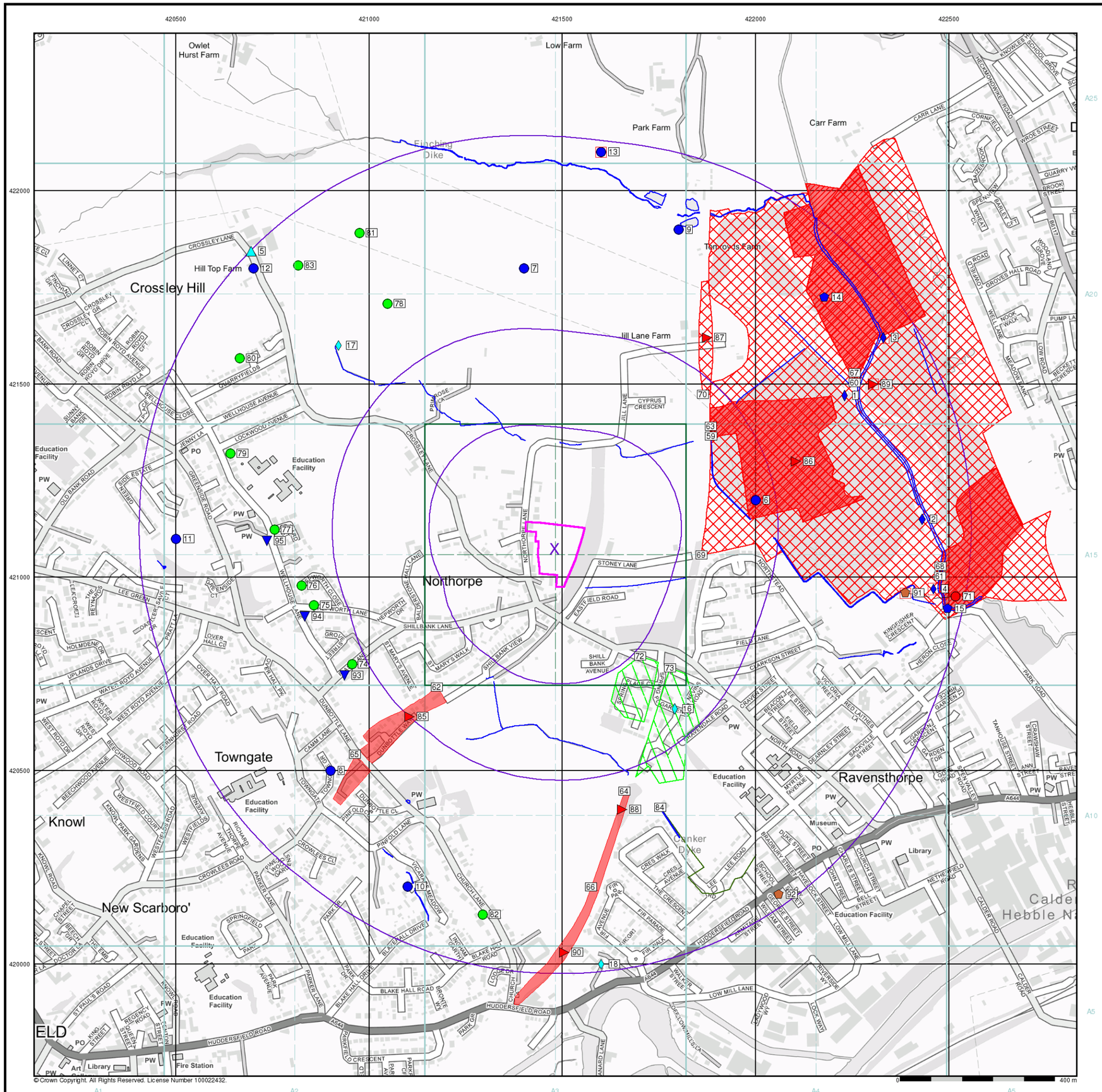
Summary

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 30	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 30	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 38				3
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 38	Yes	n/a	n/a	n/a
Mining Instability	pg 38	Yes	n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 38	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards				n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 38	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 39		Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 39	Yes		n/a	n/a
Radon Potential - Radon Affected Areas	pg 39	Yes	n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 40		2	6	33
Fuel Station Entries					
Points of Interest - Commercial Services	pg 43		2		11
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 44			4	6
Points of Interest - Public Infrastructure	pg 45		1		7
Points of Interest - Recreational and Environmental	pg 46				7
Gas Pipelines					
Underground Electrical Cables					

LITHOS CONSULTING

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland					
Areas of Adopted Green Belt	pg 47	1			
Areas of Unadopted Green Belt	pg 47	1			
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 47	1			
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					



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

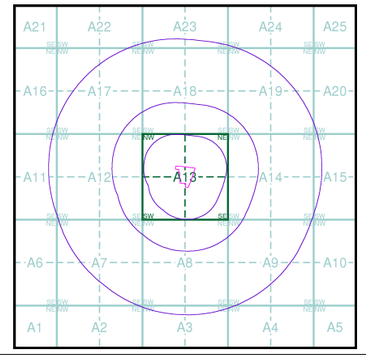
Geological

- 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



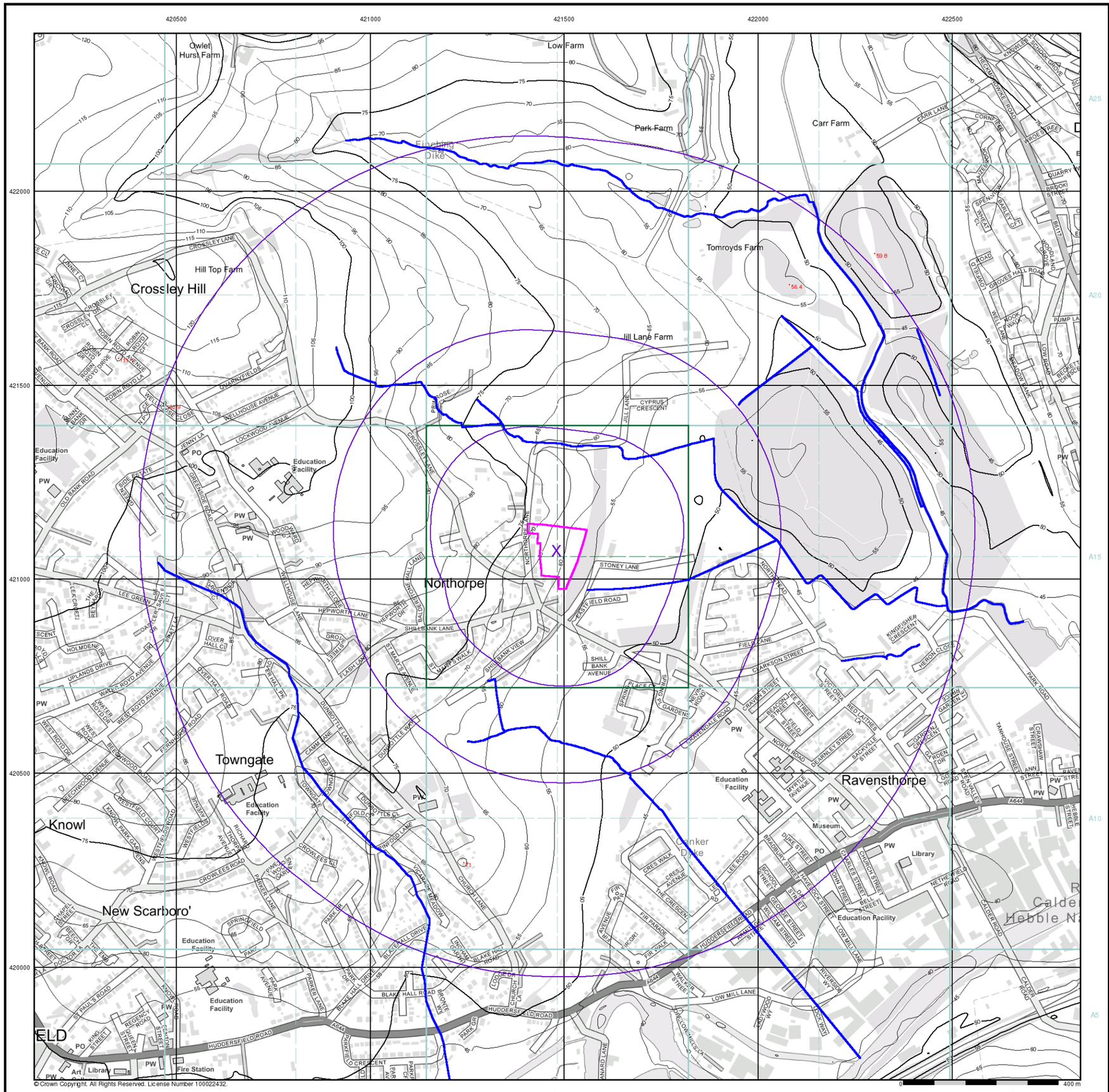
Order Details

Order Number:	210715698_1_1
Customer Ref:	3433
National Grid Reference:	421480, 421070
Slice:	A
Site Area (Ha):	1.49
Search Buffer (m):	1000

Site Details

1, Northorpe Lane, MIRFIELD, WF14 0QQ

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

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)

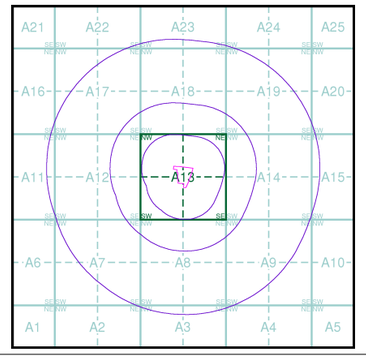
Standard Contour 105 100 95

Master Contour

Spot Height 167.3

- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



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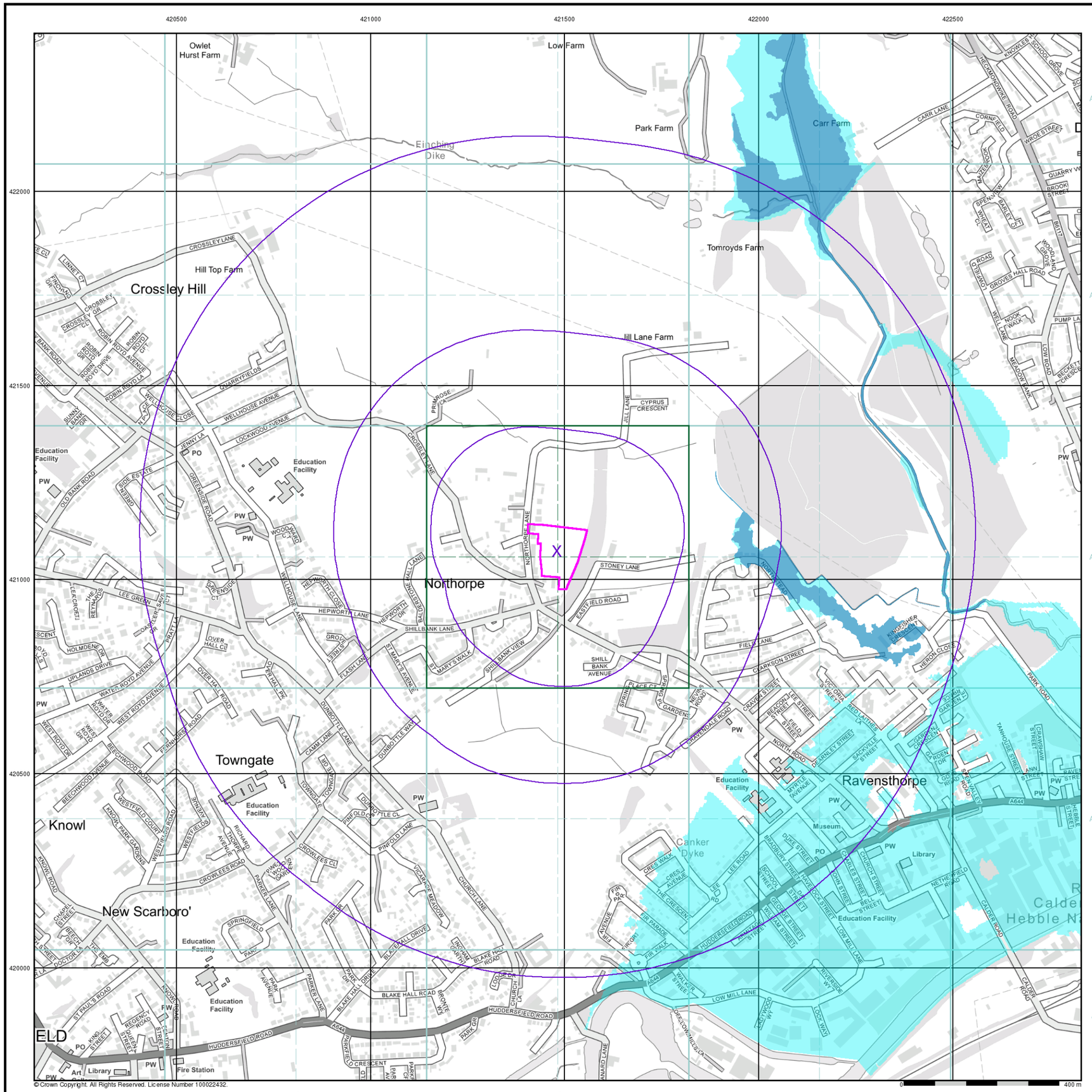


LITHOS CONSULTING

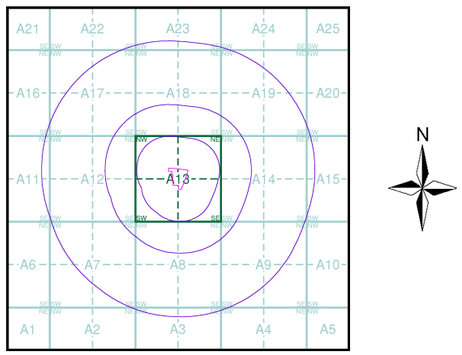
General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



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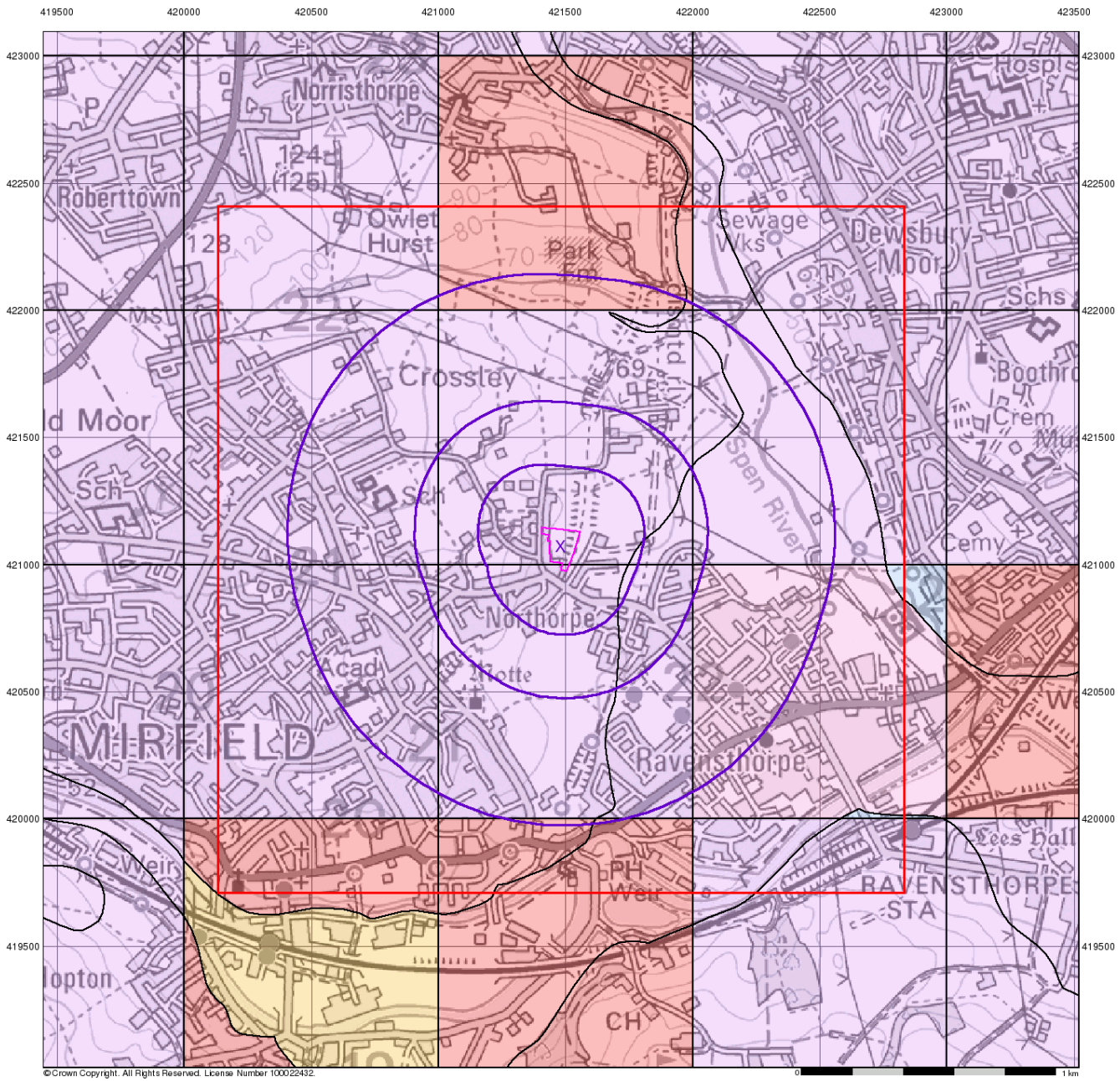


LITHOS CONSULTING

Groundwater Vulnerability

General

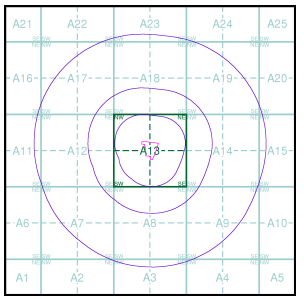
Specified Site | Specified Buffer(s) | Bearing Reference Point
Slice | Map ID

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



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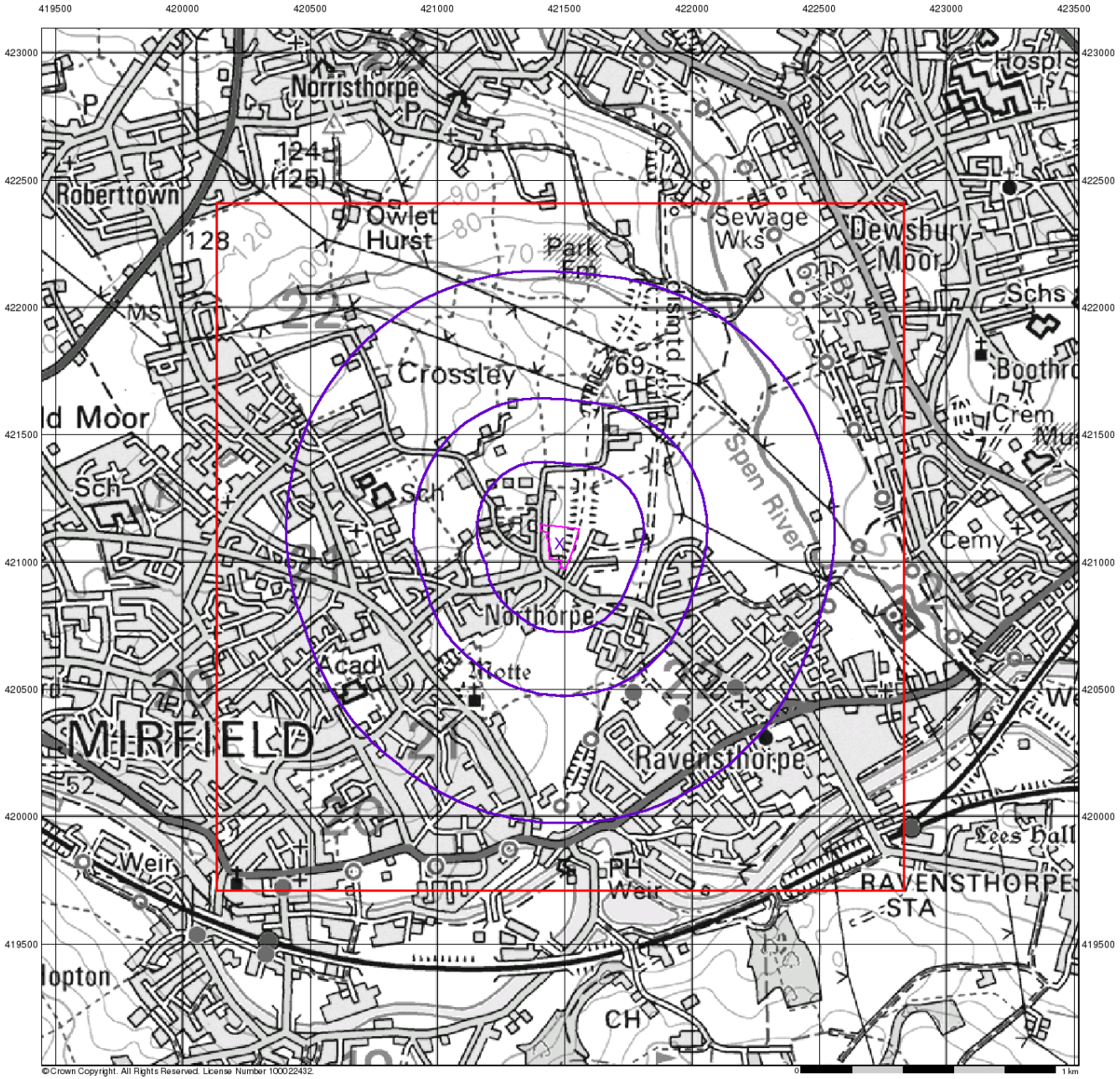


LITHOS CONSULTING

Source Protection Zones

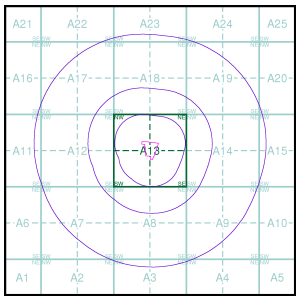
General

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

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A



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Search Buffer (m):	1000

Site Details

1, Northorpe Lane, MIRFIELD, WF14 0QQ

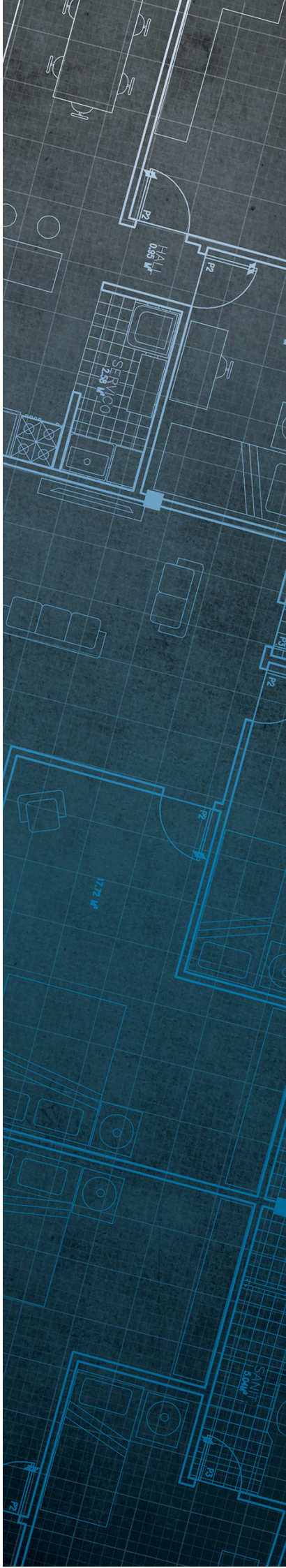
The Coal Authority

Consultants

Coal Mining Report

Northorpe Lane
Mirfield
WF14 0QQ

Date of enquiry:	**15 July 2019**
Date enquiry received:	**15 July 2019**
Issue date:	**15 July 2019**
Our reference:	**51002155712001**
Your reference:	**PO14820/JW/3433**



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

Northorpe Lane
Mirfield
WF14 0QQ

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	SILKSTONE	Coal	62WI	6	Beneath Property	5.5	South-East	51	1870
unnamed	SILKSTONE	Coal	62WE	11	Beneath Property	2.0	South-East	51	1875
unnamed	SILKSTONE	Coal	6HBF	26	Beneath Property	4.6	South	51	1881
unnamed	BLACK BED	Coal	62WR	126	Beneath Property	1.1	South-East	76	1885
unnamed	BLACK BED	Coal	6HBN	153	Beneath Property	2.7	East	76	1885
unnamed	BLACK BED	Coal	62WQ	154	Beneath Property	2.4	South-East	76	1879

Probable unrecorded shallow workings

Yes.

Spine roadways at shallow depth

No spine roadway recorded at shallow depth.

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Shaft	421421-009	421545 421171		Coal	
Shaft	421421-029	421655 421158		Coal	

Abandoned mine plan catalogue numbers

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

M278	1800	GCR56
10527	M273	M277
GCR51	GCR154	FGB431

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
WHEATLEY LIME	Coal	Yes	Within	N/A	195

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
None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes
None recorded within 500 metres of the enquiry boundary.

Section 3 – Licensing and future mining activity

Future underground mining
None recorded.

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

Court orders
None recorded.

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

Withdrawal of support notices
The property is not in an area where a notice to withdraw support has been given.

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

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

Section 4 – Further information

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

Development advice

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

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

Section 5 – Data definitions

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

Past underground coal mining

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

Probable unrecorded shallow workings

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

Spine roadways at shallow depth

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

Mine entries

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

Abandoned mine plan catalogue numbers

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

Outcrops

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

Geological faults, fissures and breaklines

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

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

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

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

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

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

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

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

Mine gas
Reports of alleged mine gas emissions received by the Coal Authority, either within or within 500 metres of the enquiry boundary that subsequently required investigation and action by the Coal Authority to mitigate the effects of the mine gas emission.

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

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

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

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

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

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

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

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

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

The Coal Authority

Summary of findings

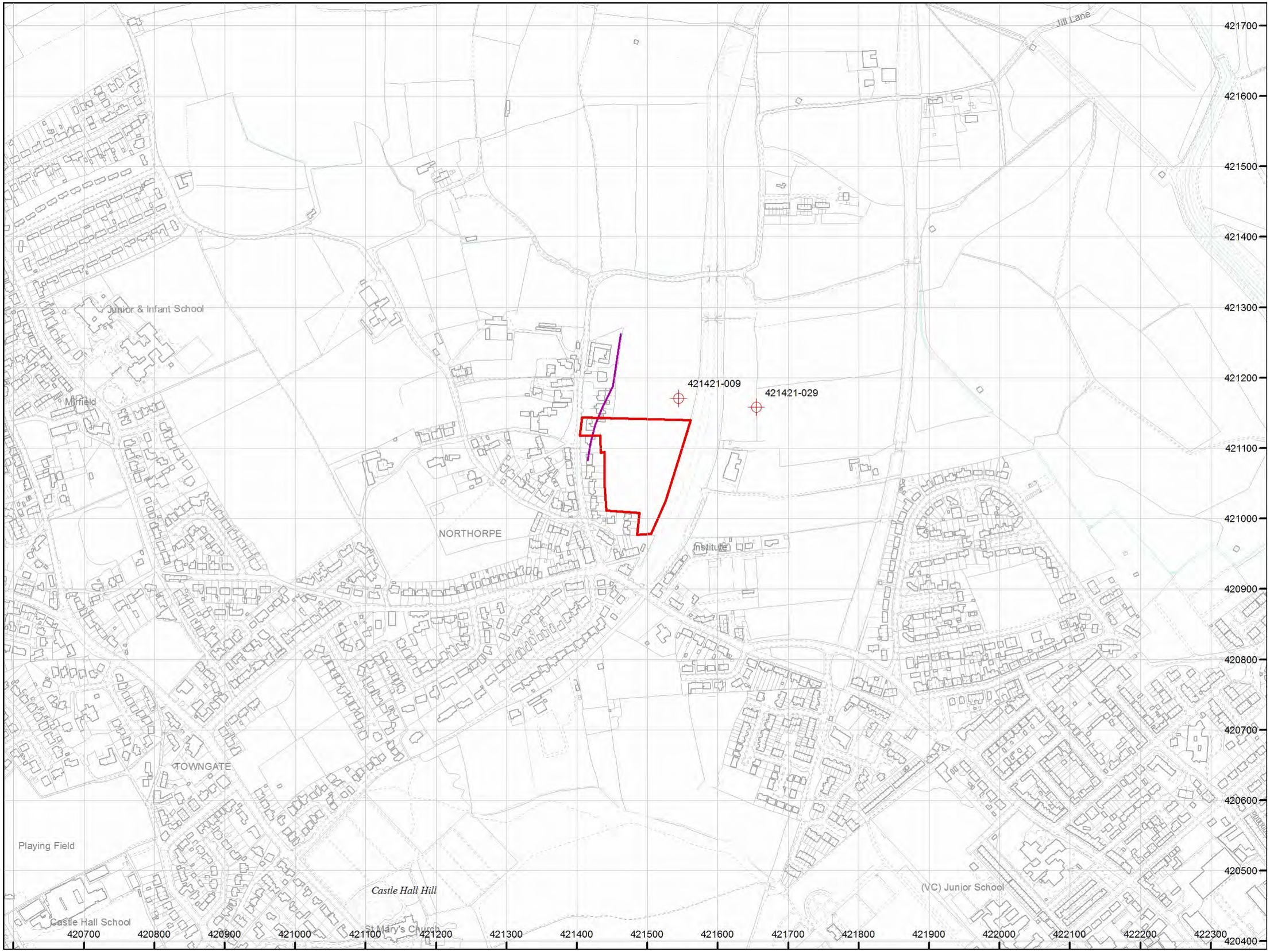
The map highlights any specific surface or subsurface features within or near to the boundary of the site.

Key

Approximate position of the enquiry boundary shown

Disused mine shaft

Outcrop (Proven)



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

Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP01
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No.: 3433	Co-ords: 421445.10 - 421089.16
			Level: 65.20
			Date: 14/07/2021
Location:	Mirfield	Dimensions (m):	Scale: 1:25
Client:	Newett Homes	Depth: 2.80	Logged: CR

Dimensions (m): 2.00 × 0.50

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					MADE GROUND: Brown slightly sandy slightly gravelly silty CLAY with rare ceramic fragments (up to 50mm) and occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (MADE GROUND TOPSOIL)
	0.20	J&T					
				0.35	64.85		Soft greyish-brown with orange mottling sandy CLAY. (COHESIVE RESIDUAL SOIL)
				0.50	64.70		Firm to stiff orange and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.60	B					
	0.60	HSV	HSV=75kPa				
	0.80	D					
				1.10	64.10		Firm black slightly sandy gravelly organic CLAY. Gravel is angular fine to coarse of coal. (WEATHERED WHEATLEY LIME COAL)
				1.30	63.90		Stiff yellowish-brown and grey gravelly CLAY. Gravel is angular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	1.80	D					
				2.30	62.90		Yellowish-brown slightly clayey sandy angular fine to coarse GRAVEL of mudstone. (WEATHERED COAL MEASURES)
				2.80	62.40		End of Pit at 2.80m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP02
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421458.45 - 421021.35	Date 14/07/2021
Location: Mirfield		Level: 61.20	Scale 1:25
Client: Newett Homes		Dimensions (m): 1.90 x 0.55, Depth 2.60	Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.20	J&T		0.30	60.90		
	0.50	D					Firm orange and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.50	HSV	HSV=63kPa				
	0.70	B		0.80	60.40		
	0.90	D					Black slightly sandy gravelly organic CLAY. Gravel is angular fine to medium of coal. (WEATHERED WHEATLEY LIME COAL)
				1.30	59.90		
	1.50	HSV	HSV=118kPa				Stiff yellowish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
							From 1.7m to 1.8m, lense of clayey gravel.
				2.10	59.10		Yellowish-brown slightly clayey slightly sandy angular fine to coarse GRAVEL of weak mudstone. (WEATHERED COAL MEASURES)
				2.60	58.60		End of Pit at 2.60m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP03
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421510.52 - 421025.51 Level: 56.90	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.10 x 0.60 Depth 2.60	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					MADE GROUND: Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is angular to subrounded fine to medium of mixed lithologies. (MADE GROUND TOPSOIL)
	0.20	J&T					*At 0.3m, brick land drain in north-south orientation.*
				0.40	56.50		Soft brown with greyish-brown mottling slightly gravelly sandy CLAY. Gravel is subangular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
	0.50	D					
				0.70	56.20		Firm becoming stiff orange and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.80	B					
	0.80	HSV	HSV=81kPa				
	1.20	HSV	HSV=110kPa				
	1.30	D					
				1.60	55.30		Stiff light orangish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
				2.40	54.50		Light greyish-brown slightly clayey slightly sandy angular fine to coarse GRAVEL of mudstone. (WEATHERED COAL MEASURES)
				2.60	54.30		End of Pit at 2.60m

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. Co-ordinates from hand held GPS, hole not surveyed in.

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: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421496.35 - 421077.79 Level: 59.00	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.10 x 0.55 Depth 2.60	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					Greyish-brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.20	J&T		0.30	58.70		Firm becoming stiff orangish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
▼							*At 0.5m, slight groundwater seepage.*
	0.60	D					
	0.70	HSV	HSV=105kPa				
	0.80	B					
	1.10	HSV	HSV=120kPa				*At 1.4m, becomes sandy.*
				1.90	57.10		Greyish-brown slightly clayey slightly sandy angular to subangular fine to coarse GRAVEL of weak mudstone. (WEATHERED COAL MEASURES)
	2.10	D					
				2.60	56.40		End of Pit at 2.60m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 0.5m. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP05
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421525.61 - 421095.87 Level: 57.15	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.00 x 0.55 Depth 2.50	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	B					Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is angular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.20	J&T		0.30	56.85		Stiff orangish-brown and light grey mottled slightly sandy gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.60	HSV	HSV=135kPa				
	0.90	D					
	1.20	HSV	HSV=150kPa				
							At 1.6m, becomes very gravelly.
	1.70	D					
				2.10	55.05		Orangish-brown and greyish-brown slightly sandy slightly clayey angular fine to coarse GRAVEL of weak mudstone. (WEATHERED COAL MEASURES)
				2.50	54.65		End of Pit at 2.50m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP06
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421516.45 - 421119.70 Level: 58.90	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.00 x 0.60 Depth 2.90	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					MADE GROUND: Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (MADE GROUND TOPSOIL)
				0.30	58.60		
	0.40	J&T					MADE GROUND: Soft to firm greyish-brown slightly gravelly sandy CLAY. Gravel is subangular to rounded fine to medium of sandstone and mudstone. (REWORKED NATURAL GROUND)
				0.50	58.40		
	0.60	D					Firm becoming stiff orangish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.80	HSV	HSV=82kPa				
				2.10	56.80		Greyish-brown and orangish-brown slightly clayey slightly sandy angular fine to coarse GRAVEL of mudstone. (WEATHERED COAL MEASURES)
	2.30	D					
				2.90	56.00		End of Pit at 2.90m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP07
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421527.77 - 421059.02 Level: 56.55	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.00 × 0.60 Depth 3.00	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	56.35		MADE GROUND: Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (MADE GROUND TOPSOIL)
	0.50	J&T		0.60	55.95		MADE GROUND: Soft greyish-brown and light greyish-brown slightly gravelly sandy CLAY with rare organic material (up to 20mm). Gravel is angular to subangular fine to coarse of mudstone. (REWORKED NATURAL GROUND)
	0.80	HSV	HSV=65kPa				Stiff orangish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	1.10	HSV	HSV=96kPa				
	1.20	D					
	1.60	HSV	HSV=122kPa				*At 1.8m, becomes gravelly.*
				2.10	54.45		Greyish-brown slightly clayey sandy angular fine to coarse GRAVEL of mudstone. (WEATHERED COAL MEASURES)
	2.90	D					
				3.00	53.55		End of Pit at 3.00m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP08
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421505.46 - 421001.24 Level: 57.40	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.00 x 0.60 Depth 2.50	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.25	57.15		Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.50	D					Firm greyish-brown slightly gravelly sandy CLAY. Gravel is angular to subangular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
	0.60	HSV	HSV=64kPa				
	1.00	HSV	HSV=67kPa	0.70	56.70		Firm becoming stiff orangish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL) *At 0.8m, brick land drain in east-west orientation with water seepage from pipe in western sidewall.*
	1.90	D		1.70	55.70		Stiff light greyish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
	1.90	HSV	HSV=124kPa				
				2.50	54.90		*Trial pit terminated at 2.5m due to excavator scraping on bedrock.* End of Pit at 2.50m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP09
Sheet 1 of 1

Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421483.81 - 421046.74 Level: 59.20	Date 14/07/2021
Location: Mirfield		Dimensions (m): 2.00 x 0.60 Depth 2.80	Scale 1:25
Client: Newett Homes			Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					MADE GROUND: Brown slightly sandy slightly gravelly silty CLAY with rare plastic (up to 60mm). Gravel is angular to subrounded fine to medium of mixed lithologies. (MADE GROUND TOPSOIL)
				0.30	58.90		Firm greyish-brown with orange mottling slightly sandy slightly gravelly CLAY with low cobble content. Gravel is angular to subangular fine to coarse of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
	0.50 0.50	D HSV	HSV=62kPa				
				0.80	58.40		Stiff orange and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.90 0.90	D HSV	HSV=114kPa				*At 1.4m, 0.1m lense of clayey gravel.*
				1.90	57.30		Greyish-brown and brown slightly clayey sandy angular fine to coarse GRAVEL of mudstone. (WEATHERED COAL MEASURES)
							At 2.5m, becomes grey and orangish-brown slightly sandy with low cobble content.
				2.80	56.40		End of Pit at 2.80m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

LITHOS CONSULTING

Trial Pit Log

TrialPit No: TP10
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421454.21 - 421056.69 Level: 62.35	Date 14/07/2021
Location:	Mirfield	Dimensions (m): 2.00 × 0.60		Scale 1:25
Client:	Newett Homes	Depth 2.70		Logged CR

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.25	62.10		Brown slightly sandy slightly gravelly silty CLAY with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
				0.50	61.85		Soft greyish-brown slightly gravelly sandy CLAY. Gravel is angular to subangular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
	0.60	HSV	HSV=50kPa				Firm orangish-brown and light grey mottled slightly sandy slightly gravelly locally gravelly CLAY. Gravel is angular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	0.80	D					
	1.00	HSV	HSV=110kPa				
				1.40	60.95		Stiff light greyish-brown and light grey mottled slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone. (COHESIVE RESIDUAL SOIL)
	1.80	D					
	1.80	HSV	HSV=109kPa				
				2.40	59.95		Greyish-brown and light grey slightly clayey slightly sandy angular fine to coarse GRAVEL of mudstone. (WEATHERED COAL MEASURES)
				2.70	59.65		End of Pit at 2.70m

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. Co-ordinates from hand held GPS, hole not surveyed in.

Stability: 1. The sides of the trial pit remained stable during excavation.

AGS

Appendix G

Probehole Logs

Borehole Log

Borehole No. **PH01**

Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421456.06 - 421102.89	Hole Type PH
Location:	Mirfield		Level:	64.40	Scale 1:100
Client:	Newett Homes		Dates:	26/07/2021 - 26/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown sandy CLAY. (TOPSOIL)
					0.80	63.60		Light brown slightly gravelly CLAY. (COHESIVE RESIDUAL SOIL)
					2.50	61.90		Light grey MUDSTONE. (COAL MEASURES)
					13.00	51.40		Light 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 due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole surveyed to be surveyed in (level and co-ordinates) at a later date.

Borehole Log

LITHOS CONSULTING			Borehole No. **PH01** Sheet 2 of 2
Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421456.06 - 421102.89	Hole Type PH
Location: Mirfield		Level: 64.40	Scale 1:100
Client: Newett Homes		Dates: 26/07/2021 - 26/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					20.30	44.10		
					20.50	43.90		Dark grey MUDSTONE. (BLOCKING RIDER COAL)
								Grey MUDSTONE. (COAL MEASURES)
					26.00	38.40		Grey MUDSTONE with dark grey MUDSTONE traces. (COAL MEASURES)
								From 26.00m, Blocking Bed Coal seam lies between 26 and 29m. Exact depth not clear from speed of drilling and arisings.
					29.00	35.40		Grey MUDSTONE (COAL MEASURES)
					35.80	28.60		End of borehole at 35.80 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole surveyed to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No.
PH01A
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421457.21 - 421101.24	Hole Type PH
Location:	Mirfield		Level:	64.15	Scale 1:100
Client:	Newett Homes		Dates:	26/07/2021 - 26/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.80	63.35		Brown sandy CLAY. (TOPSOIL)
					2.50	61.65		Light brown slightly gravelly CLAY. (COHESIVE RESIDUAL SOIL)
					5.50	58.65		Light grey MUDSTONE. (COAL MEASURES)
								End of borehole at 5.50 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH02
Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421522.76 - 421116.32	Hole Type PH
Location:	Mirfield		Level:	58.35	Scale 1:100
Client:	Newett Homes		Dates:	26/07/2021 - 26/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	57.85		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.00	55.35		Greyish brown SANDSTONE. (COAL MEASURES)
					4.00	54.35		Grey MUDSTONE. (COAL MEASURES)
	▼							*At 6.0m, groundwater inflow.*
					14.70	43.65		Grey MUDSTONE with dark grey MUDSTONE traces. (COAL MEASURES)
					15.40	42.95		*From 14.70m, Blocking Rider Coal seam lies between 14.7m and 15.4m. Exact depth not clear from speed of drilling and arisings.*
								Grey MUDSTONE. (COAL MEASURES)

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from 6.0m. 3. Flush returns (100%) were lost from 21.3m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

Borehole Log

LITHOS CONSULTING			Borehole No. **PH02** Sheet 2 of 2
Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421522.76 - 421116.32	Hole Type PH
Location: Mirfield		Level: 58.35	Scale 1:100
Client: Newett Homes		Dates: 26/07/2021 - 26/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					21.30	37.05		SOFT GROUND. (Lost flush returns) (BLOCKING BED COAL)
					21.80	36.55		SOLID DRILLING. (No flush returns) (COAL MEASURES)
					24.30	34.05		End of borehole at 24.30 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from 6.0m. 3. Flush returns (100%) were lost from 21.3m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH02A
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421523.41 - 421114.97	Hole Type PH
Location:	Mirfield		Level:	58.25	Scale 1:100
Client:	Newett Homes		Dates:	26/07/2021 - 26/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	57.75		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.00	55.25		End of borehole at 3.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No. **PH03**

Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421533.39 - 421080.28	Hole Type PH
Location:	Mirfield		Level:	56.35	Scale 1:100
Client:	Newett Homes		Dates:	27/07/2021 - 27/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	55.85		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.30	53.05		Greyish brown MUDSTONE. (COAL MEASURES)
					5.00	51.35		Grey MUDSTONE. (COAL MEASURES)
	▼							*At 12.0m, groundwater inflow.*
					14.30	42.05		Grey MUDSTONE with dark grey MUDSTONE traces. (COAL MEASURES)
					15.00	41.35		*From 14.30m, Blocking Rider Coal seam lies between 14.3m and 15.0m. Exact depth not clear from speed of drilling and arisings.*
								Grey MUDSTONE. (COAL MEASURES)

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from between 12m and 15m. 3. Flush returns (50%) were lost 21.4m and (100%) from 24m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH03
Sheet 2 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421533.39 - 421080.28	Hole Type PH
Location:	Mirfield		Level:	56.35	Scale 1:100
Client:	Newett Homes		Dates:	27/07/2021 - 27/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					21.40	34.95		Black COAL. (Soft push) (BLOCKING BED COAL)
					21.90	34.45		Grey MUDSTONE. (50% flush returns) (COAL MEASURES)
					24.00	32.35		SOLID DRILLING. (No flush returns) (COAL MEASURES) *At 24m, complete loss of flush.*
					25.80	30.55		End of borehole at 25.80 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from between 12m and 15m. 3. Flush returns (50%) were lost 21.4m and (100%) from 24m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH03A
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421532.06 - 421079.18	Hole Type PH
Location:	Mirfield		Level: 56.40	Scale 1:100
Client:	Newett Homes		Dates: 27/07/2021 - 27/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	55.90		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.30	53.10		Greyish brown MUDSTONE. (COAL MEASURES)
					4.50	51.90		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 due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No.
PH04
Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421496.09 - 421051.08	Hole Type PH
Location:	Mirfield		Level:	58.35	Scale 1:100
Client:	Newett Homes		Dates:	27/07/2021 - 27/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	57.85		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.50	54.85		Greyish brown MUDSTONE. (COAL MEASURES)
					6.00	52.35		Grey MUDSTONE. (COAL MEASURES)
	▼							*At 12.0m, Artesian groundwater recorded (resting water level 2.1m above current ground level).*
					18.30	40.05		Dark grey MUDSTONE. (BLOCKING RIDER COAL)
					18.50	39.85		Grey MUDSTONE. (COAL MEASURES)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Artesian groundwater inflow was apparent from 12m. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

Borehole Log

Borehole No. **PH04**

Sheet 2 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421496.09 - 421051.08	Hole Type PH
Location:	Mirfield		Level:	58.35	Scale 1:100
Client:	Newett Homes		Dates:	27/07/2021 - 27/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					25.50	32.85		Dark grey MUDSTONE. (BLOCKING BED COAL)
					26.00	32.35		Grey MUDSTONE. (COAL MEASURES)
					29.70	28.65		End of borehole at 29.70 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Artesian groundwater inflow was apparent from 12m. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

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Borehole Log

Borehole No.
PH04A
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421496.11 - 421048.61	Hole Type PH
Location:	Mirfield		Level:	58.35	Scale 1:100
Client:	Newett Homes		Dates:	28/07/2021 - 28/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	57.85		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					2.80	55.55		End of borehole at 2.80 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No.
PH05
Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421494.51 - 421003.30	Hole Type PH
Location:	Mirfield		Level:	57.75	Scale 1:100
Client:	Newett Homes		Dates:	28/07/2021 - 28/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	57.25		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.50	54.25		Greyish brown MUDSTONE. (COAL MEASURES)
					5.00	52.75		Grey MUDSTONE (COAL MEASURES)
	▼							*At 5.8m, Artesian groundwater (resting water level 1.7m above current ground level)*

Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Artesian groundwater inflow was apparent from 5.8m. 3. Flush returns (100%) were lost from 28.0m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No.
PH05
Sheet 2 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421494.51 - 421003.30	Hole Type PH
Location:	Mirfield		Level:	57.75	Scale 1:100
Client:	Newett Homes		Dates:	28/07/2021 - 28/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					22.20	35.55		Grey MUDSTONE with dark grey MUDSTONE traces. (COAL MEASURES) *From 22.2m, Blocking Rider Coal seam lies between 22.2m and 27.5m. Exact depth not clear from speed of drilling and arisings.*
					27.50	30.25		SOFT GROUND. (Lost flush returns) (BLOCKING BED COAL)
					28.00	29.75		SOLID DRILLING. (No flush returns) (COAL MEASURES)
					31.00	26.75		End of borehole at 31.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Artesian groundwater inflow was apparent from 5.8m. 3. Flush returns (100%) were lost from 28.0m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No.
PH05A
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421494.61 - 421005.88	Hole Type PH
Location:	Mirfield		Level: 57.80	Scale 1:100
Client:	Newett Homes		Dates: 28/07/2021 - 28/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	57.30		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					2.80	55.00		End of borehole at 2.80 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

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Borehole Log

Borehole No. **PH06**

Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421455.43 - 421027.74	Hole Type PH
Location:	Mirfield		Level:	61.60	Scale 1:100
Client:	Newett Homes		Dates:	29/07/2021 - 29/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	61.10		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					1.50	60.10		
					1.80	59.80		Black organic CLAY. (WEATHERED WHEATLEY LIME COAL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.50	58.10		Light brown and greyish brown MUDSTONE. (COAL MEASURES)
					5.00	56.60		Grey MUDSTONE. (COAL MEASURES)
	▼							*At 12.6m, groundwater inflow.*
								Between 18.5m and 19.8m, faster drilling.

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from 12.6m. 3. Flush returns (100%) were lost from 28.5m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

Borehole Log

Borehole No. **PH06**

Sheet 2 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421455.43 - 421027.74	Hole Type PH
Location:	Mirfield		Level:	61.60	Scale 1:100
Client:	Newett Homes		Dates:	29/07/2021 - 29/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					22.40	39.20		Dark grey MUDSTONE/Black COAL. (BLOCKING RIDER COAL)
					22.90	38.70		Grey MUDSTONE. (COAL MEASURES)
					26.00	35.60		Dark grey MUDSTONE/Black COAL. (BLOCKING BED COAL)
					26.60	35.00		Grey MUDSTONE. (COAL MEASURES)
					28.50	33.10		SOLID DRILLING. (No flush returns) (COAL MEASURES)
								At 28.5m, flush returns lost.
					29.50	32.10		End of borehole at 29.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from 12.6m. 3. Flush returns (100%) were lost from 28.5m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH06A
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421458.03 - 421027.21	Hole Type PH
Location:	Mirfield		Level: 61.35	Scale 1:100
Client:	Newett Homes		Dates: 28/07/2021 - 28/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	60.85		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					1.50	59.85		
					1.80	59.55		Black organic CLAY. (WEATHERED WHEATLEY LIME COAL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.00	58.35		Greyish brown MUDSTONE. (COAL MEASURES)
					4.30	57.05		End of borehole at 4.30 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No. **PH07**

Sheet 1 of 2

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421485.78 - 421106.86	Hole Type PH
Location:	Mirfield		Level:	61.00	Scale 1:100
Client:	Newett Homes		Dates:	30/07/2021 - 30/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	60.50		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.00	58.00		Greyish brown MUDSTONE. (COAL MEASURES)
					6.50	54.50		Grey MUDSTONE. (COAL MEASURES)
					9.00	52.00		Grey SANDSTONE. (COAL MEASURES)
	▼				12.00	49.00		Grey MUDSTONE. (COAL MEASURES)
					15.90	45.10		Dark grey MUDSTONE/Black COAL. (BLOCKING RIDER COAL)
					16.30	44.70		Grey MUDSTONE. (COAL MEASURES)

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from between 9m and 12m. 3. Flush returns (100%) were lost 24m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

AGS

Borehole Log

Borehole No. **PH07** Sheet 2 of 2			
Project Name: Northorpe Lane, Mirfield	Project No. 3433	Co-ords: 421485.78 - 421106.86	Hole Type PH
Location: Mirfield		Level: 61.00	Scale 1:100
Client: Newett Homes		Dates: 30/07/2021 - 30/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					24.00	37.00		SOFT GROUND. (Lost flush returns) (BLOCKING BED COAL)
					24.60	36.40		SOLID DRILLING. (No flush returns) (COAL MEASURES)
					26.50	34.50		End of borehole at 26.50 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater inflow was apparent from between 9m and 12m. 3. Flush returns (100%) were lost 24m during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole to be surveyed in (level and co-ordinates) at a later date.

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Borehole Log

Borehole No.
PH08
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421444.44 - 421061.03	Hole Type PH
Location:	Mirfield		Level:	63.85	Scale 1:100
Client:	Newett Homes		Dates:	30/07/2021 - 30/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	63.35		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					1.30	62.55		
					1.40	62.45		Black organic CLAY. (WEATHERED WHEATLEY LIME COAL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.00	60.85		Light brown MUDSTONE. (COAL MEASURES)
					5.00	58.85		Light grey MUDSTONE. (COAL MEASURES)
					8.50	55.35		End of borehole at 8.50 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole surveyed to be surveyed in (level and co-ordinates) at a later date.

AGS

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Borehole Log

Borehole No.
PH09
Sheet 1 of 1

Project Name:	Northorpe Lane, Mirfield	Project No. 3433	Co-ords:	421441.40 - 421099.51	Hole Type PH
Location:	Mirfield		Level:	66.40	Scale 1:100
Client:	Newett Homes		Dates:	30/07/2021 - 30/07/2021	Logged By JBr

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	65.90		Brown sandy CLAY. (TOPSOIL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					1.50	64.90		
					1.60	64.80		Black organic CLAY. (WEATHERED WHEATLEY LIME COAL)
								Light brown CLAY. (COHESIVE RESIDUAL SOIL)
					3.00	63.40		Greyish brown MUDSTONE. (COAL MEASURES)
					6.00	60.40		Grey MUDSTONE. (COAL MEASURES)
					8.50	57.90		End of borehole at 8.50 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling due to waterflush medium. 3. Full flush returns throughout drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. Exploratory hole surveyed to be surveyed in (level and co-ordinates) at a later date.

AGS

Appendix H

Soakaway Calculation Sheets

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	Newett Homes
Engineer	DW
Job Name:	Northorpe Lane, Mirfield
Job No.:	3433

Date:	**14/07/2021**
Trial Pit No.	**TP01**
Test No.	**1**

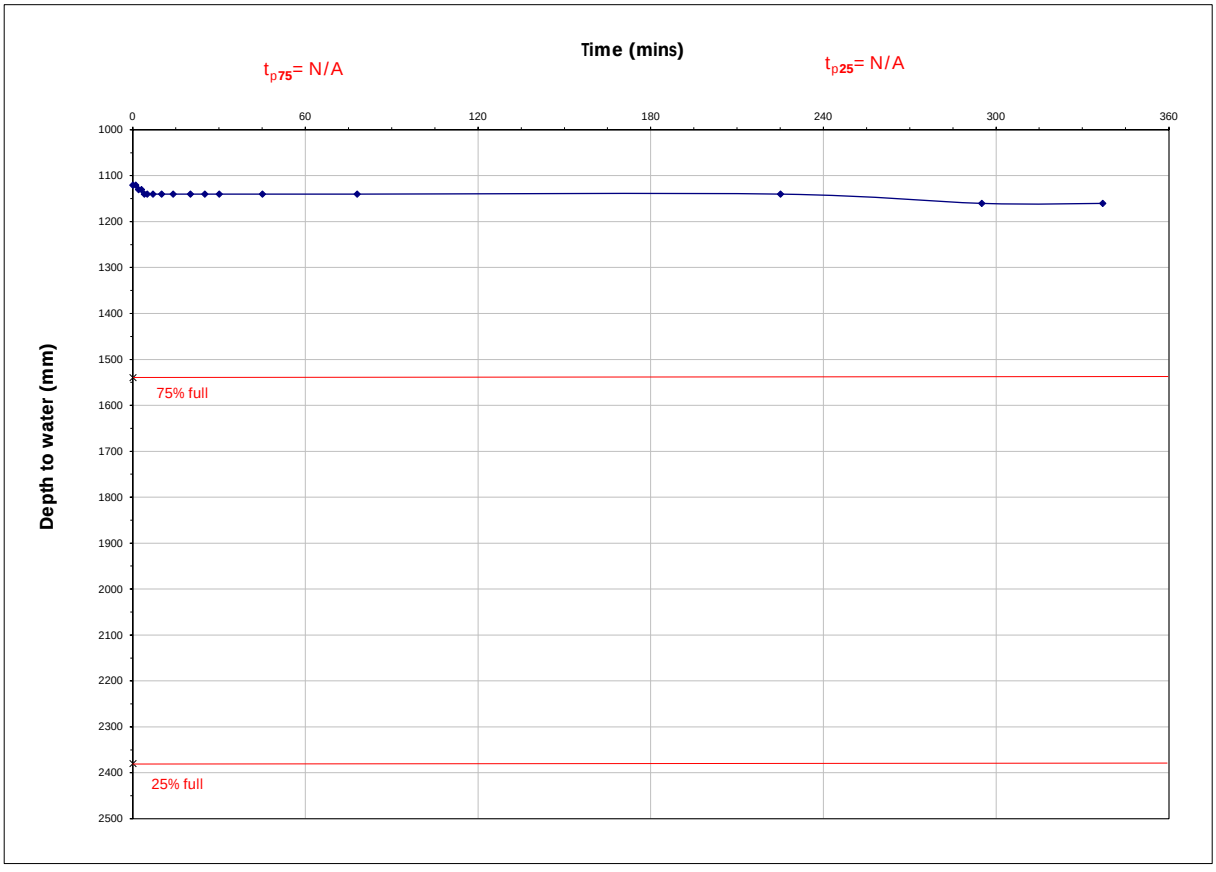
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
09:15	0	1.12	1120
09:16	1	1.12	1120
09:17	2	1.13	1130
09:18	3	1.13	1130
09:19	4	1.14	1140
09:20	5	1.14	1140
09:22	7	1.14	1140
09:25	10	1.14	1140
09:29	14	1.14	1140
09:35	20	1.14	1140
09:40	25	1.14	1140
09:45	30	1.14	1140
10:00	45	1.14	1140
10:33	78	1.14	1140
13:00	225	1.14	1140
14:10	295	1.16	1160
14:52	337	1.16	1160

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.00	2000
Width	=	0.50	500
Depth	=	2.80	2800

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2380	2.38
0.50	=	1960	1.96
0.75	=	1540	1.54

Depth at start of test (mm)	=	1120
Depth at end of test (mm)	=	1160
Base area of pit	=	1.00
a_{p50} - 50% internal surface area inc. base	=	5.20
V_{p75-25} - Volume 75 - 25%	=	0.84

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:	Newett Homes
Engineer	DW
Job Name:	Northorpe Lane, Mirfield
Job No.:	3433

Date:	**14/07/2021**
Trial Pit No.	**TP02**
Test No.	**1**

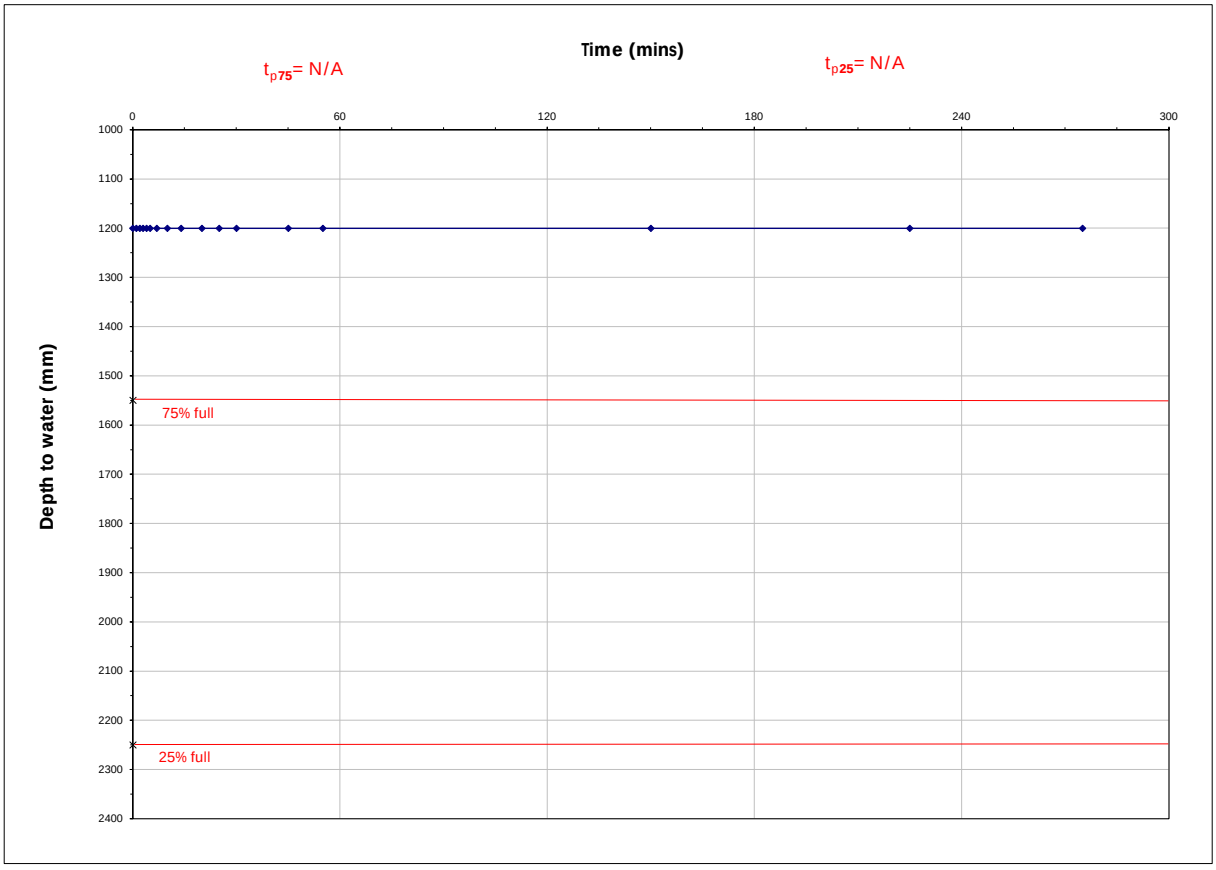
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:15	0	1.20	1200
10:16	1	1.20	1200
10:17	2	1.20	1200
10:18	3	1.20	1200
10:19	4	1.20	1200
10:20	5	1.20	1200
10:22	7	1.20	1200
10:25	10	1.20	1200
10:29	14	1.20	1200
10:35	20	1.20	1200
10:40	25	1.20	1200
10:45	30	1.20	1200
11:00	45	1.20	1200
11:10	55	1.20	1200
12:45	150	1.20	1200
14:00	225	1.20	1200
14:50	275	1.20	1200

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.90	1900
Width	=	0.55	550
Depth	=	2.60	2600

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2250	2.25
0.50	=	1900	1.90
0.75	=	1550	1.55

Depth at start of test (mm)	=	1200
Depth at end of test (mm)	=	1200
Base area of pit	=	1.05
a_{p50} - 50% internal surface area inc. base	=	4.48
V_{p75-25} - Volume 75 - 25%	=	0.73

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:	Newett Homes
Engineer	DW
Job Name:	Northorpe Lane, Mirfield
Job No.:	3433

Date:	**14/07/2021**
Trial Pit No.	**TP03**
Test No.	**1**

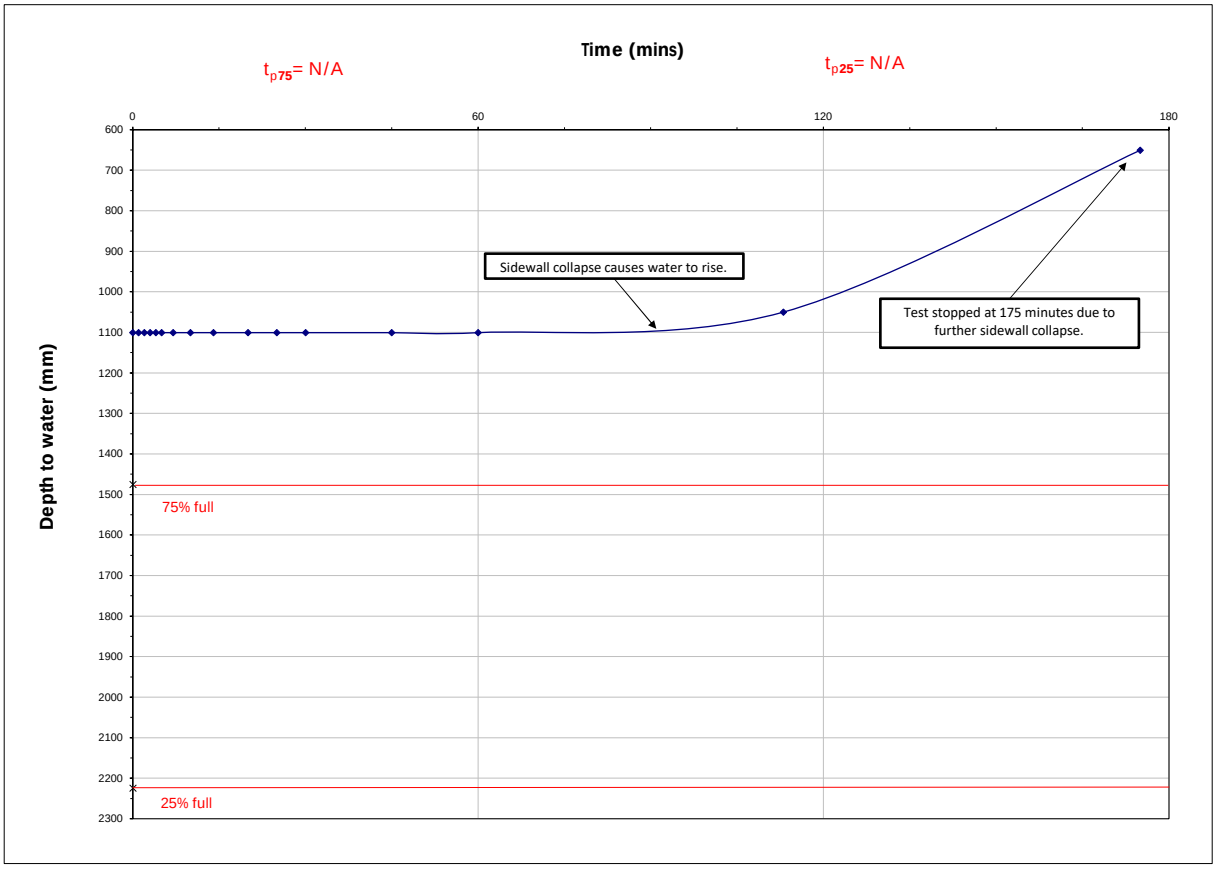
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:55	0	1.10	1100
10:56	1	1.10	1100
10:57	2	1.10	1100
10:58	3	1.10	1100
10:59	4	1.10	1100
11:00	5	1.10	1100
11:02	7	1.10	1100
11:05	10	1.10	1100
11:09	14	1.10	1100
11:15	20	1.10	1100
11:20	25	1.10	1100
11:25	30	1.10	1100
11:40	45	1.10	1100
11:55	60	1.10	1100
12:48	113	1.05	1050
13:50	175	0.65	650

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.10	2100
Width	=	0.60	600
Depth	=	2.60	2600

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2225	2.23
0.50	=	1850	1.85
0.75	=	1475	1.48

Depth at start of test (mm)	=	1100
Depth at end of test (mm)	=	650
Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	5.31
V_{p75-25} - Volume 75 - 25%	=	0.95

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:	Newett Homes
Engineer	DW
Job Name:	Northorpe Lane, Mirfield
Job No.:	3433

Date:	**14/07/2021**
Trial Pit No.	**TP04**
Test No.	**1**

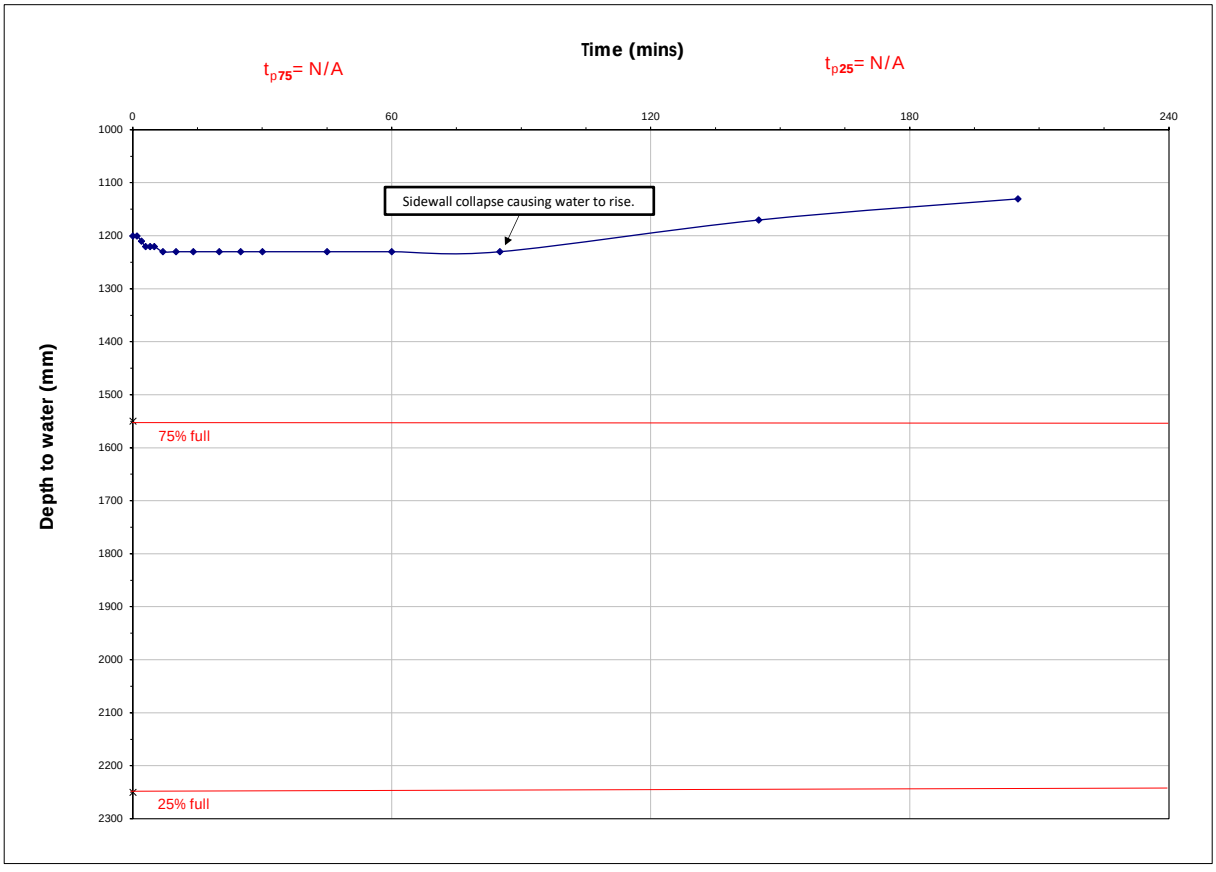
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:20	0	1.20	1200
11:21	1	1.20	1200
11:22	2	1.21	1210
11:23	3	1.22	1220
11:24	4	1.22	1220
11:25	5	1.22	1220
11:27	7	1.23	1230
11:30	10	1.23	1230
11:34	14	1.23	1230
11:40	20	1.23	1230
11:45	25	1.23	1230
11:50	30	1.23	1230
12:05	45	1.23	1230
12:20	60	1.23	1230
12:45	85	1.23	1230
13:45	145	1.17	1170
14:45	205	1.13	1130

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.10	2100
Width	=	0.55	550
Depth	=	2.60	2600

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2250	2.25
0.50	=	1900	1.90
0.75	=	1550	1.55

Depth at start of test (mm)	=	1200
Depth at end of test (mm)	=	1130
Base area of pit	=	1.16
a_{p50} - 50% internal surface area inc. base	=	4.87
V_{p75-25} - Volume 75 - 25%	=	0.81

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:	Newett Homes
Engineer	DW
Job Name:	Northorpe Lane, Mirfield
Job No.:	3433

Date:	**14/07/2021**
Trial Pit No.	**TP05**
Test No.	**1**

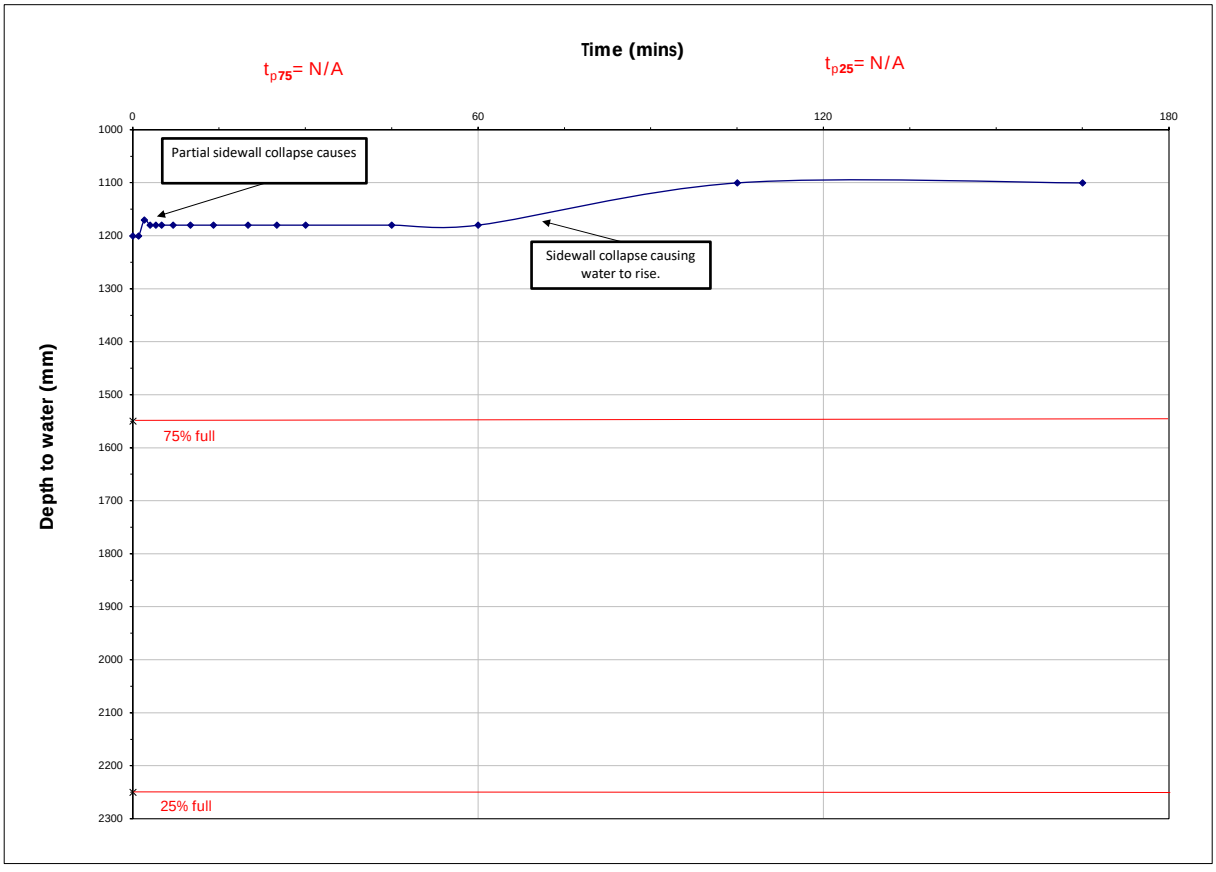
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
12:00	0	1.20	1200
12:01	1	1.20	1200
12:02	2	1.17	1170
12:03	3	1.18	1180
12:04	4	1.18	1180
12:05	5	1.18	1180
12:07	7	1.18	1180
12:10	10	1.18	1180
12:14	14	1.18	1180
12:20	20	1.18	1180
12:25	25	1.18	1180
12:30	30	1.18	1180
12:45	45	1.18	1180
13:00	60	1.18	1180
13:45	105	1.10	1100
14:45	165	1.10	1100

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	2.10	2100
Width	=	0.55	550
Depth	=	2.60	2600

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2250	2.25
0.50	=	1900	1.90
0.75	=	1550	1.55

Depth at start of test (mm)	=	1200
Depth at end of test (mm)	=	1100
Base area of pit	=	1.16
a_{p50} - 50% internal surface area inc. base	=	4.87
V_{p75-25} - Volume 75 - 25%	=	0.81

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 Test Results

Certificate of Analysis

Certificate Number 21-15079 *Issued:* 27-Jul-21

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 21-15079

Client Reference 3433

Order No PO17831

Contract Title Northorpe Lane, Mirfield

Description 12 Soil samples.

Date Received 19-Jul-21

Date Started 19-Jul-21

Date Completed 27-Jul-21

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

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 21-15079
Client Ref 3433
Contract Title Northorpe Lane, Mirfield

			Lab No	1878122	1878123	1878124	1878125	1878126	1878127
			.Sample ID	TP01	TP03	TP06	TP07	TP09	TP06
			Depth	0.20	0.20	0.10	0.10	0.10	0.40
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021
			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	5.0	5.0	5.0	5.0	5.0	5.0
Moisture Content	DETSC 1004	0.1	%	23	30	27	34	22	20
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	47	66	56	59	48	14
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.7	0.9	0.8	1.0	1.0	0.5
Cadmium	DETSC 2301#	0.1	mg/kg	0.4	0.4	0.4	0.3	0.3	0.2
Chromium	DETSC 2301#	0.15	mg/kg	26	24	20	23	22	17
Chromium III	DETSC 2301*	0.15	mg/kg	26	24	20	23	22	17
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	60	78	62	73	56	22
Lead	DETSC 2301#	0.3	mg/kg	78	110	150	95	69	30
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l						< 10
Mercury	DETSC 2325#	0.05	mg/kg	0.21	0.34	0.23	0.36	0.21	0.05
Nickel	DETSC 2301#	1	mg/kg	30	23	26	27	23	20
Selenium	DETSC 2301#	0.5	mg/kg	0.7	< 0.5	0.7	< 0.5	< 0.5	< 0.5
Vanadium	DETSC 2301#	0.8	mg/kg	43	47	43	44	43	29
Zinc	DETSC 2301#	1	mg/kg	96	91	110	110	80	82
Inorganics									
pH	DETSC 2008#		pH	6.3	6.1	6.3	6.5	6.9	8.7
Total Organic Carbon	DETSC 2084#	0.5	%	6.3	10	11	8.7	6.0	1.5
Chloride Aqueous Extract	DETSC 2055	1	mg/l						6.2
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l						3.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l						32
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg						< 0.1
EPH (C10-C12)	DETSC 3311	10	mg/kg						< 10
EPH (C12-C16)	DETSC 3311	10	mg/kg						< 10
EPH (C16-C21)	DETSC 3311	10	mg/kg						< 10
EPH (C21-C35)	DETSC 3311	10	mg/kg						< 10
EPH (C35-C40)	DETSC 3311	10	mg/kg						< 10
EPH (C10-C40)	DETSC 3311#	10	mg/kg						< 10

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 21-15079
Client Ref 3433
Contract Title Northorpe Lane, Mirfield

			Lab No	1878122	1878123	1878124	1878125	1878126	1878127
			.Sample ID	TP01	TP03	TP06	TP07	TP09	TP06
			Depth	0.20	0.20	0.10	0.10	0.10	0.40
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.04	0.06	0.05	0.13	0.07	< 0.03
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	0.07	0.14	0.12	0.22	0.20	< 0.03
Pyrene	DETSC 3303#	0.03	mg/kg	0.06	0.11	0.10	0.19	0.17	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.03	0.04	< 0.03	0.04	0.06	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	0.05	0.04	0.07	0.08	< 0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	0.04	0.04	0.06	< 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	0.17	0.39	0.27	0.61	0.64	< 0.10

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 21-15079
Client Ref 3433
Contract Title Northorpe Lane, Mirfield

			Lab No	1878128	1878129	1878130	1878131	1878132	1878133
			.Sample ID	TP07	TP02	TP04	TP05	TP08	TP10
			Depth	0.50	0.20	0.20	0.20	0.10	0.10
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021
			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	5.0	5.0	5.0	5.0	5.0	5.0
Moisture Content	DETSC 1004	0.1	%	22	26	33	33	24	29
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	60	57	51	45	54	67
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.7	0.9	1.1	0.8	0.5	1.1
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	0.3	0.3	0.4	0.2	0.4
Chromium	DETSC 2301#	0.15	mg/kg	21	24	22	30	23	28
Chromium III	DETSC 2301*	0.15	mg/kg	21	24	22	30	23	28
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	64	53	53	69	110
Lead	DETSC 2301#	0.3	mg/kg	65	86	84	85	91	110
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l	< 10					
Mercury	DETSC 2325#	0.05	mg/kg	0.19	0.22	0.15	0.22	0.26	0.36
Nickel	DETSC 2301#	1	mg/kg	21	24	22	22	29	28
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	0.6	< 0.5	< 0.5
Vanadium	DETSC 2301#	0.8	mg/kg	40	42	40	42	40	48
Zinc	DETSC 2301#	1	mg/kg	70	92	82	99	110	110
Inorganics									
pH	DETSC 2008#		pH	6.9	5.7	5.9	6.6	5.4	6.4
Total Organic Carbon	DETSC 2084#	0.5	%	5.9	8.4	6.5	6.2	5.7	7.4
Chloride Aqueous Extract	DETSC 2055	1	mg/l	8.0					
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l	4.7					
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	23					
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	< 0.1					
EPH (C10-C12)	DETSC 3311	10	mg/kg	< 10					
EPH (C12-C16)	DETSC 3311	10	mg/kg	< 10					
EPH (C16-C21)	DETSC 3311	10	mg/kg	< 10					
EPH (C21-C35)	DETSC 3311	10	mg/kg	< 10					
EPH (C35-C40)	DETSC 3311	10	mg/kg	< 10					
EPH (C10-C40)	DETSC 3311#	10	mg/kg	< 10					

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 21-15079
Client Ref 3433
Contract Title Northorpe Lane, Mirfield

			Lab No	1878128	1878129	1878130	1878131	1878132	1878133
			.Sample ID	TP07	TP02	TP04	TP05	TP08	TP10
			Depth	0.50	0.20	0.20	0.20	0.10	0.10
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.19	0.06	0.04	0.21	0.14
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	0.22	0.16
Fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.47	0.14	0.09	0.40	0.27
Pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.38	0.11	0.07	0.38	0.25
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	0.10	0.04	0.03	0.17	0.17
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	0.13	0.04	< 0.03	0.16	0.10
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.09	0.04	< 0.03	0.19	0.11
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	0.03	< 0.03	0.04	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.05	< 0.03	< 0.03	0.12	0.07
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	< 0.03	< 0.03	0.04	< 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	0.04	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10	1.4	0.31	0.16	2.0	1.3

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 21-15079
Client Ref 3433
Contract Title Northorpe Lane, Mirfield

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1878122	TP01 0.20	SOIL	NAD	none	Jordan Farley
1878123	TP03 0.20	SOIL	NAD	none	Jordan Farley
1878124	TP06 0.10	SOIL	NAD	none	Jordan Farley
1878125	TP07 0.10	SOIL	NAD	none	Jordan Farley
1878126	TP09 0.10	SOIL	NAD	none	Jordan Farley
1878127	TP06 0.40	SOIL	NAD	none	Jordan Farley
1878128	TP07 0.50	SOIL	NAD	none	Jordan Farley
1878129	TP02 0.20	SOIL	NAD	none	Jordan Farley
1878130	TP04 0.20	SOIL	NAD	none	Jordan Farley
1878131	TP05 0.20	SOIL	NAD	none	Jordan Farley
1878132	TP08 0.10	SOIL	NAD	none	Jordan Farley
1878133	TP10 0.10	SOIL	NAD	none	Jordan Farley

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 21-15079
Client Ref 3433
Contract Northorpe Lane, Mirfield

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1878122	TP01 0.20 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878123	TP03 0.20 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878124	TP06 0.10 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878125	TP07 0.10 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878126	TP09 0.10 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878127	TP06 0.40 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878128	TP07 0.50 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878129	TP02 0.20 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878130	TP04 0.20 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878131	TP05 0.20 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878132	TP08 0.10 SOIL	14/07/21	GJ 250ml, PT 500ml		
1878133	TP10 0.10 SOIL	14/07/21	GJ 250ml, PT 500ml		

Key: G-Glass P-Plastic J-Jar 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

Certificate of Analysis

Certificate Number 21-16473 *Issued:* 26-Aug-21

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 21-16473

Client Reference 3433

Order No PO17831

Contract Title Northorpe Lane, Mirfield

Description 3 Soil samples.

Date Received 19-Jul-21

Date Started 05-Aug-21

Date Completed 26-Aug-21

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

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 21-16473
Client Ref 3433
Contract Title Northorpe Lane, Mirfield

			Lab No	1885981	1885982	1885983
			.Sample ID	TP03	TP07	TP10
			Depth	0.20	0.10	0.10
			Other ID			
			Sample Type	SOIL	SOIL	SOIL
			Sampling Date	14/07/2021	14/07/2021	14/07/2021
			Sampling Time	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**			
Metals						
Arsenic Gastric % Bioaccessible (% of Total As)	DETSC 2400*	0	%	1.4	1.2	1.3
Arsenic Gastric mg/kg Bioaccessible	DETSC 2400*	0.5	mg/kg	0.7	0.6	0.6
Arsenic Gastro Intestinal % Bioaccessible (% of Total As)	DETSC 2400*	0	%	1.5	1.2	1.3
Arsenic Gastro Intestinal mg/kg Bioaccessible	DETSC 2400*	0.5	mg/kg	0.7	0.7	0.6
Arsenic	DETSC 2301#	0.2	mg/kg	49	54	51

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

Information in Support of the Analytical Results

Our Ref 21-16473
Client Ref 3433
Contract Northorpe Lane, Mirfield

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1885981	TP03 0.20 SOIL	14/07/21	PT 1L (1kg)		
1885982	TP07 0.10 SOIL	14/07/21	PT 1L (1kg)		
1885983	TP10 0.10 SOIL	14/07/21	PT 1L (1kg)		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Appendix 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 (highest conc recorded on site)	Arsenic	32 (67)	Organic	Benzene	0.33 (not tested)
	Nickel	130 (30)		Toulene	610 (not tested)
	Mercury	170 (0.4)		Ethylbenzene	350 (not tested)
	Selenium	35 (0.7)		Xylene	230 (not tested)
	Cadmium	10 (0.4)		Phenol	420 (not tested)

1. Your Details

Company Name	Contact Name
Lithos Consulting Ltd	James Brown

Site Address	Contact Number
Land at 28 Northorpe Lane Mirfield WF14 0QQ	01937 545 330

2. The Previous Use of the Site

Please indicate below the previous uses of the site being developed

The site is currently a single residential dwelling, gardens, fishponds and grassed fields. No other known previous uses throughout history.

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	Not tested	0.5
1a	BTEX & MTBE	mg/kg	Not tested	0.1
2	Extended SVOC suite (with TIC)	mg/kg	Not tested	2
2e	Phenols	mg/kg	Not tested	2
2f	Cresols and chlorinated phenols	mg/kg	Not tested	2
3	Mineral Oils C_{11}-C_{20}	mg/kg	< 0.1	10
4	Mineral Oils C_{21}-C_{40}	mg/kg	< 10	500
5	Corrosive (Conductivity, Redox & pH)			
	Conductivity	µS/cm	Not tested	
	Redox	Volt	Not tested	
	pH	pH	6.2 to 8.7	
2a	Ethers	mg/kg	Not tested	0.5
2b	Nitrobenzene	mg/kg	Not tested	0.5
2c	Ketones	mg/kg	Not tested	0.5
2d	Aldehydes	mg/kg	Not tested	0.5
6	Amines	mg/kg	Not tested	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. Sampling within 15m of proposed water supply pipes could be undertaken, once

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.
Drawing 3433/9 shows the location of exploratory holes.

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.

Demolition of residential dwelling, gardens and fishponds and regarde of site levels to create development platforms.

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
	26th August 2021

Your Name & Title (PLEASE PRINT	Role in organisation
JAMES BROWN	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

4043

Contract Number: PSL21/5788

Report Date: 09 August 2021

Client's Reference: 3433

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

For the attention of: James Brown

Contract Title: Northorpe Lane, Mirfield

Date Received: 19/7/2021
Date Commenced: 19/7/2021
Date Completed: 9/8/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

Checked and Approved Signatories:

A Watkins (Director)	R Berriman (Quality Manager)	S Royle (Laboratory Manager)
L Knight (Assistant Laboratory Manager)	S Eyre (Senior Technician)	T Watkins (Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: 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
TP01	1	B	0.10		Brown TOPSOIL.
TP01	3	B	0.60		Brown SUBSOIL.
TP02	1	B	0.10		Brown TOPSOIL.
TP02	4	B	0.70		Brown slightly gravelly sandy CLAY.
TP02	5	D	0.90		Dark grey slightly gravelly slightly sandy CLAY.
TP03	1	B	0.10		Brown TOPSOIL.
TP03	4	B	0.80		Brown sandy CLAY.
TP03	5	D	1.30		Brown mottled grey slightly gravelly sandy CLAY.
TP04	1	B	0.10		Brown TOPSOIL.
TP04	3	D	0.60		Brown mottled grey slightly gravelly sandy CLAY.
TP04	4	B	0.80		Brown mottled grey sandy CLAY.
TP04	5	D	2.10		Brown mottled grey slightly gravelly very sandy CLAY.
TP05	4	D	1.70		Brown mottled grey slightly gravelly sandy CLAY.
TP06	3	D	0.60		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP07	3	D	1.20		Brown mottled grey slightly gravelly sandy CLAY.
TP07	4	D	2.90		Brown gravelly very sandy CLAY.
TP08	3	D	1.90		Brown mottled grey sandy CLAY.
TP09	2	D	0.50		Brown slightly gravelly sandy CLAY.
TP10	2	D	0.80		Brown mottled grey slightly gravelly sandy CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP01	3	B	0.60		39			71	32	39	86	Very High Plasticity CV
TP02	5	D	0.90		46			69	31	38	94	High Plasticity CH
TP03	5	D	1.30		24			51	23	28	97	High Plasticity CH
TP04	3	D	0.60		18			44	21	23	95	Intermediate Plasticity CI
TP04	5	D	2.10		13			35	17	18	91	Intermediate Plasticity CI
TP05	4	D	1.70		14			38	18	20	93	Intermediate Plasticity CI
TP06	3	D	0.60		24			56	25	31	98	High Plasticity CH
TP07	3	D	1.20		21			42	20	22	99	Intermediate Plasticity CI
TP07	4	D	2.90		11			33	17	16	73	Low Plasticity CL
TP08	3	D	1.90		17			45	22	23	100	Intermediate Plasticity CI
TP09	2	D	0.50		25			49	24	25	94	Intermediate Plasticity CI
TP10	2	D	0.80		24			40	22	18	97	Intermediate Plasticity CI

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

UKAS TESTING 4043

PSL Professional Soils Laboratory

Northorpe Lane, Mirfield

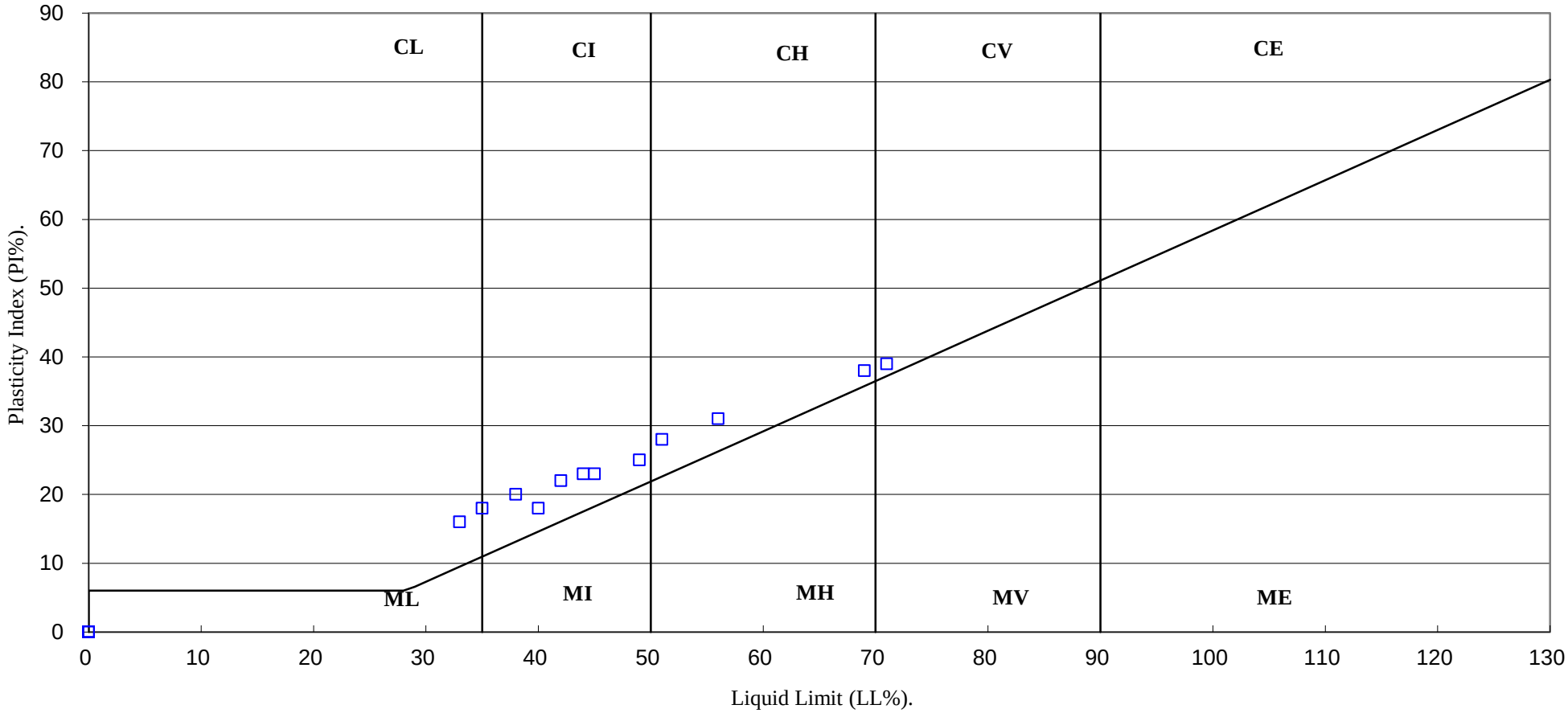
Contract No:

PSL21/5788

Client Ref:

3433

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	Northorpe Lane, Mirfield	**Contract No:** PSL21/5788 **Client Ref:** 3433

PARTICLE SIZE DISTRIBUTION TEST

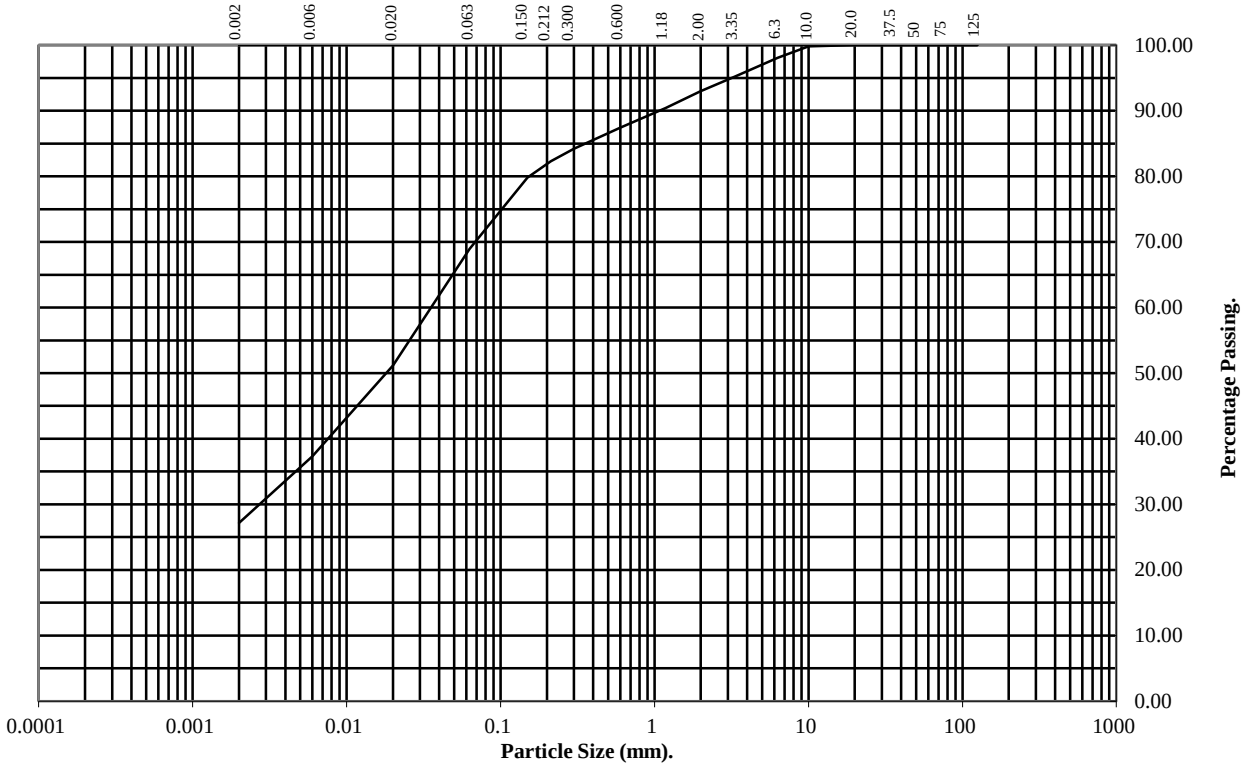
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP01** **Top Depth (m):** **0.10**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	100
6.3	98
3.35	95
2	93
1.18	90
0.6	87
0.3	84
0.212	82
0.15	80
0.063	69

Particle Diameter	Percentage Passing
0.02	51
0.006	37
0.002	27

Soil Fraction	Total Percentage
Cobbles	0
Gravel	7
Sand	24
Silt	42
Clay	27

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

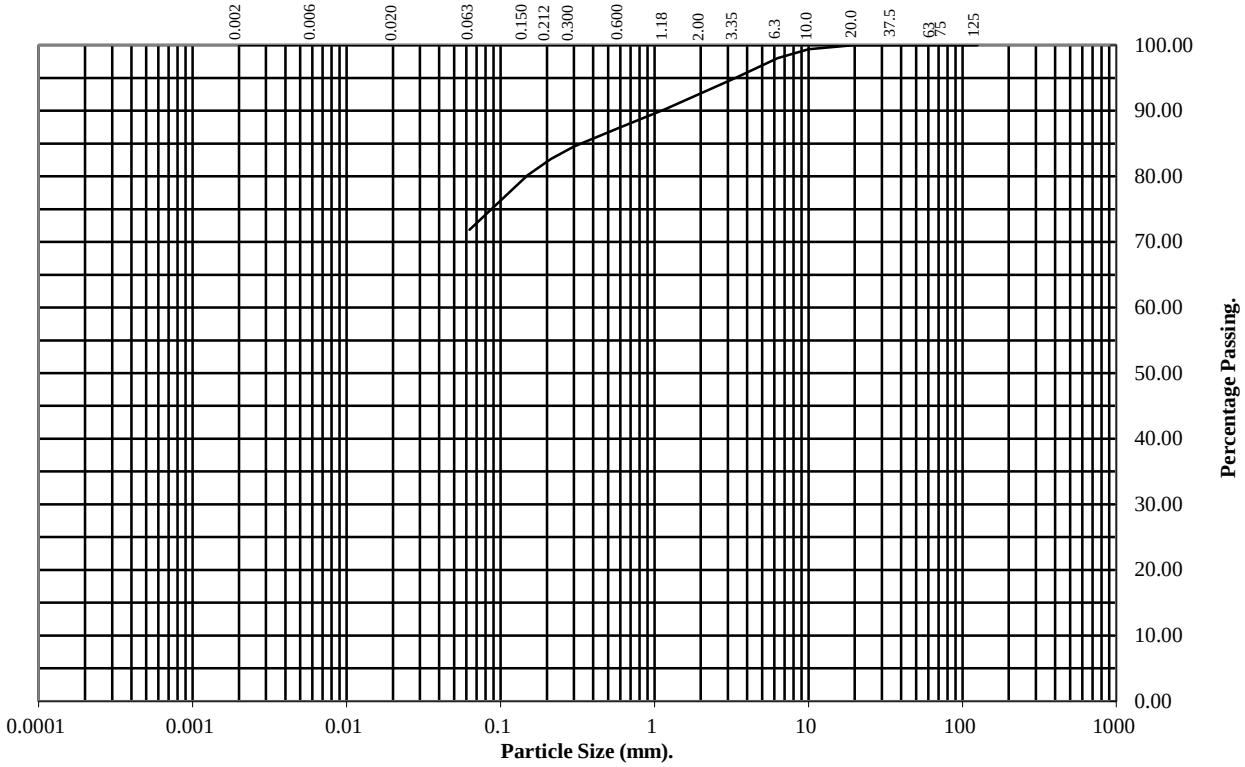
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP01** **Top Depth (m):** **0.60**

Sample Number: **3** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	99
6.3	98
3.35	95
2	93
1.18	90
0.6	87
0.3	85
0.212	83
0.15	80
0.063	72

Soil Fraction	Total Percentage
Cobbles	0
Gravel	7
Sand	21
Silt/Clay	72

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

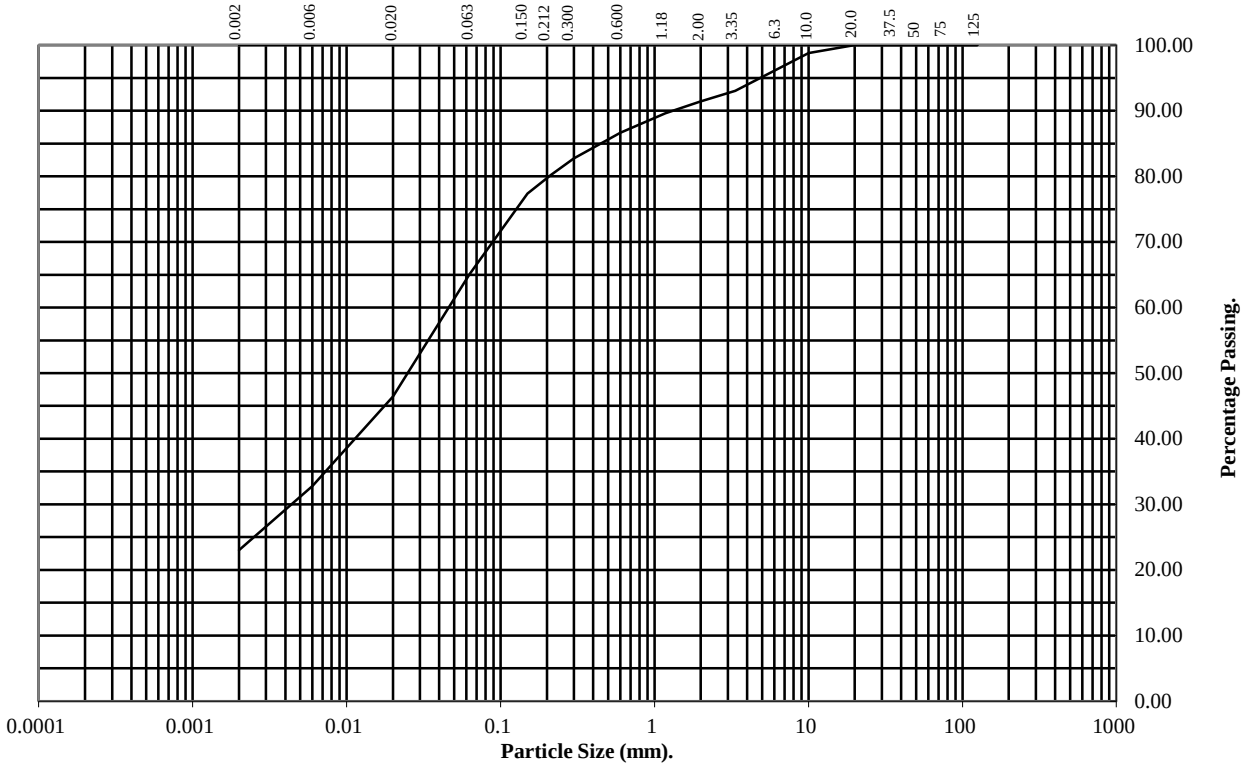
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP02** **Top Depth (m):** **0.10**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	99
6.3	96
3.35	93
2	91
1.18	90
0.6	87
0.3	83
0.212	80
0.15	77
0.063	65

Particle Diameter	Percentage Passing
0.02	46
0.006	33
0.002	23

Soil Fraction	Total Percentage
Cobbles	0
Gravel	9
Sand	26
Silt	42
Clay	23

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

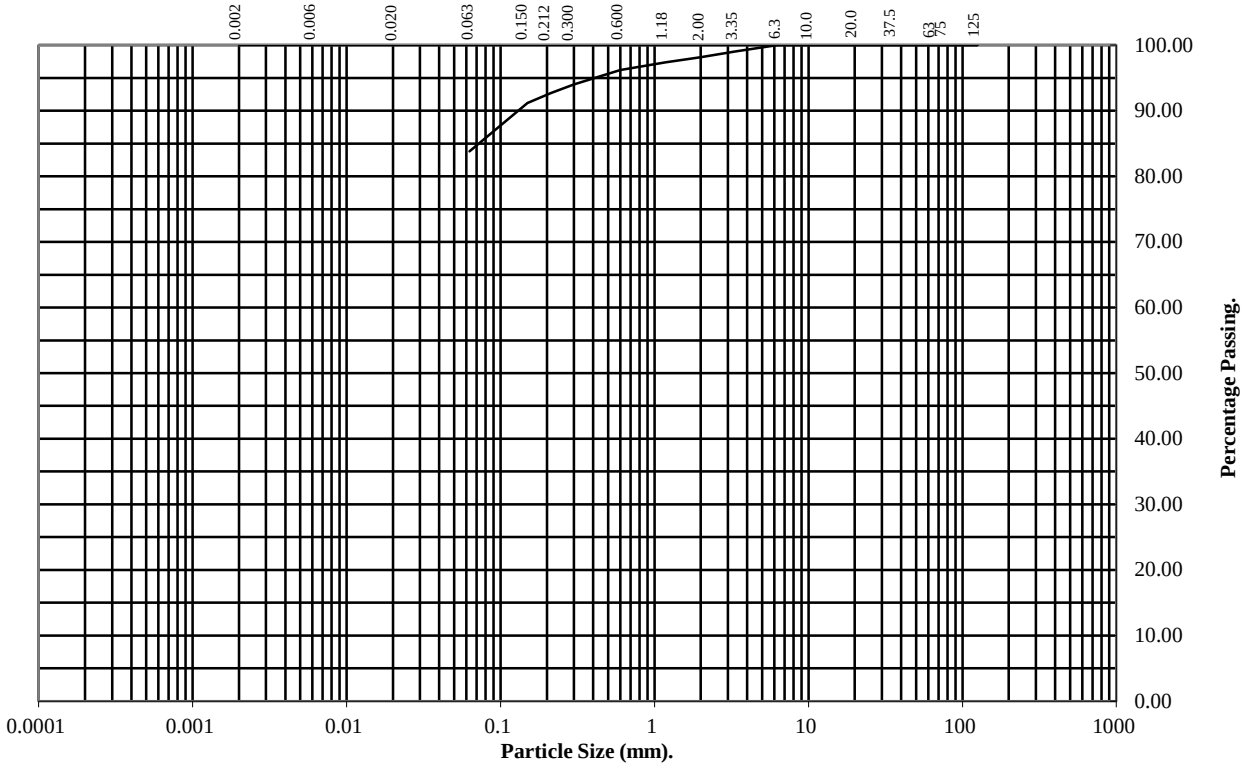
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP02** **Top Depth (m):** **0.70**

Sample Number: **4** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	99
2	98
1.18	97
0.6	96
0.3	94
0.212	93
0.15	91
0.063	84

Soil Fraction	Total Percentage
Cobbles	0
Gravel	2
Sand	14
Silt/Clay	84

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

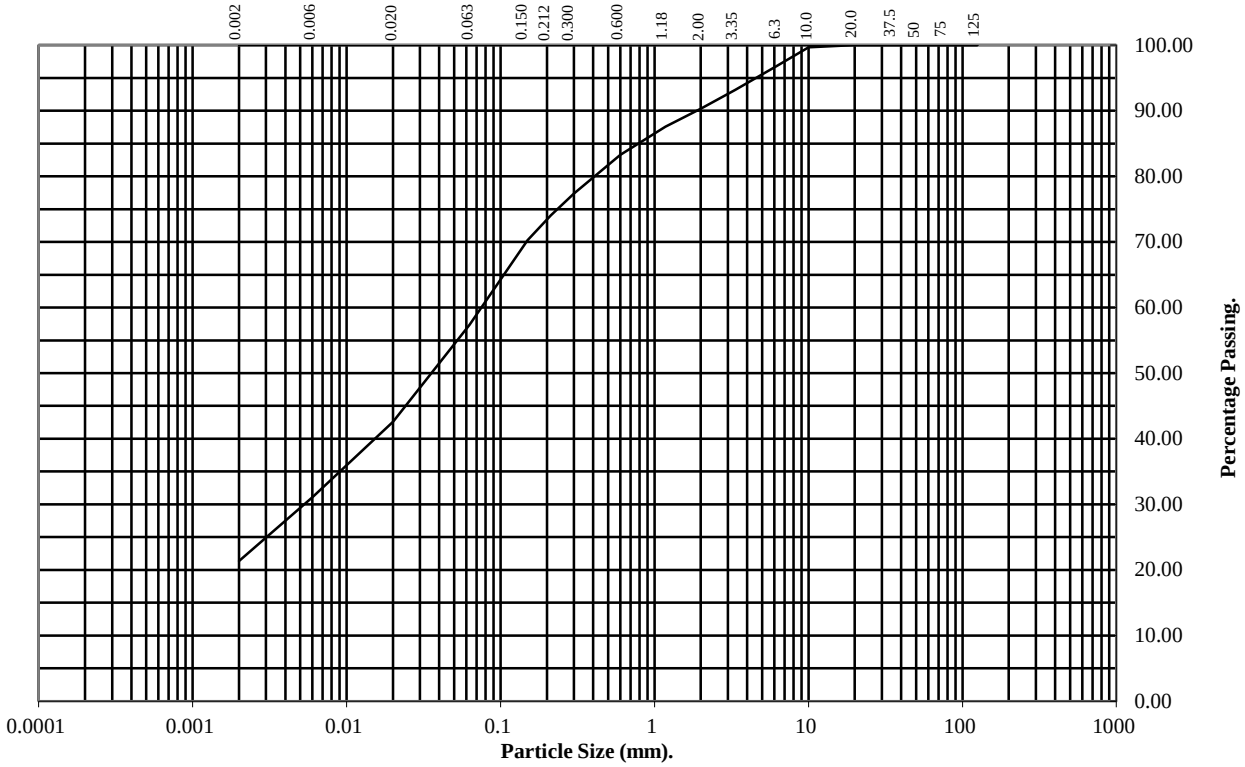
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP03** **Top Depth (m):** **0.10**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	100
6.3	97
3.35	93
2	90
1.18	88
0.6	83
0.3	77
0.212	74
0.15	70
0.063	57

Particle Diameter	Percentage Passing
0.02	43
0.006	31
0.002	21

Soil Fraction	Total Percentage
Cobbles	0
Gravel	10
Sand	33
Silt	36
Clay	21

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

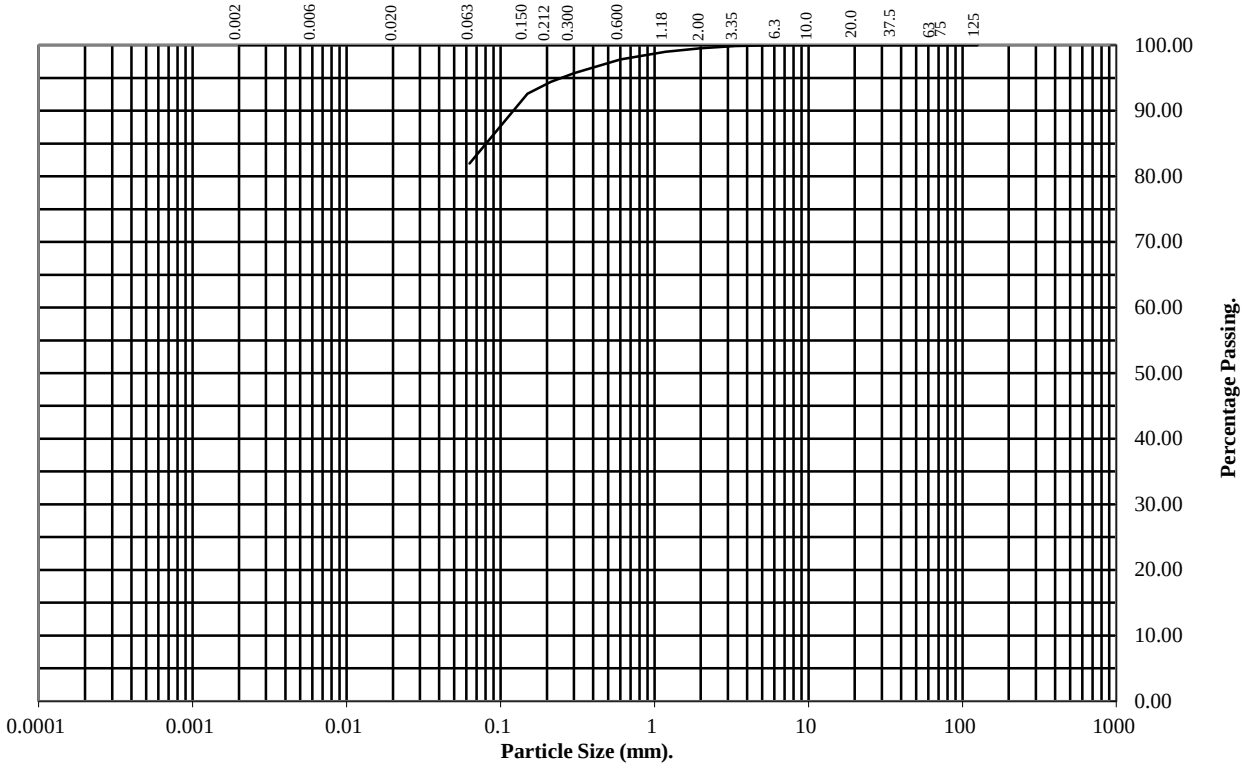
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP03** **Top Depth (m):** **0.80**

Sample Number: **4** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	99
0.6	98
0.3	96
0.212	94
0.15	93
0.063	82

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	18
Silt/Clay	82

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

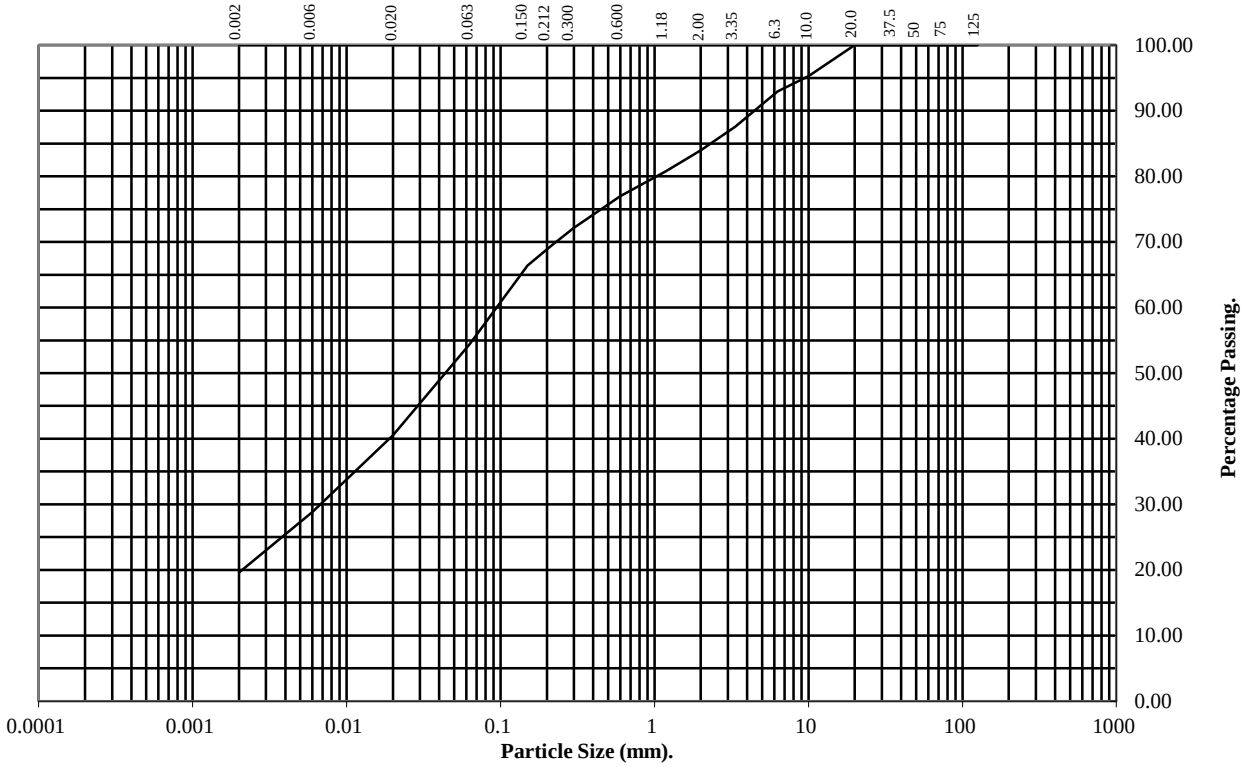
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP04** **Top Depth (m):** **0.10**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	95
6.3	93
3.35	88
2	84
1.18	81
0.6	77
0.3	72
0.212	69
0.15	66
0.063	54

Particle Diameter	Percentage Passing
0.02	41
0.006	29
0.002	20

Soil Fraction	Total Percentage
Cobbles	0
Gravel	16
Sand	30
Silt	34
Clay	20

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

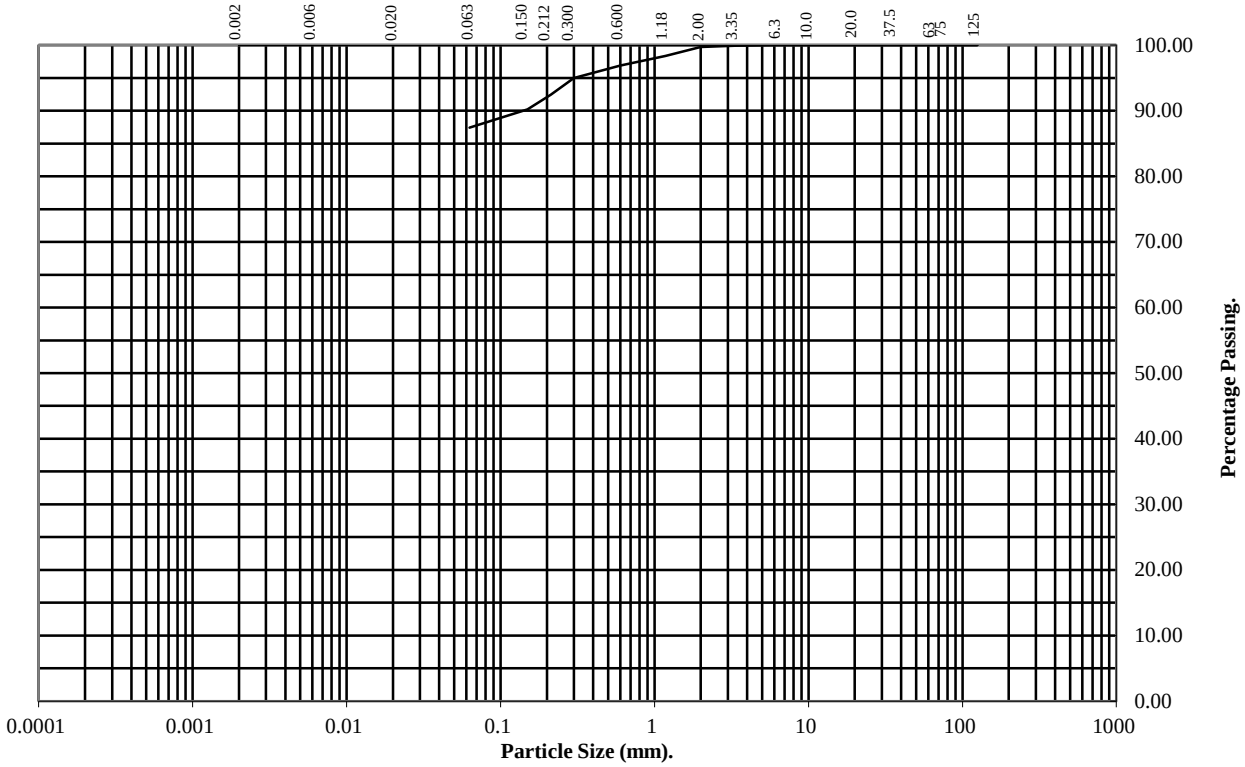
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP04** **Top Depth (m):** **0.80**

Sample Number: **4** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	98
0.6	97
0.3	95
0.212	92
0.15	90
0.063	87

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	13
Silt/Clay	87

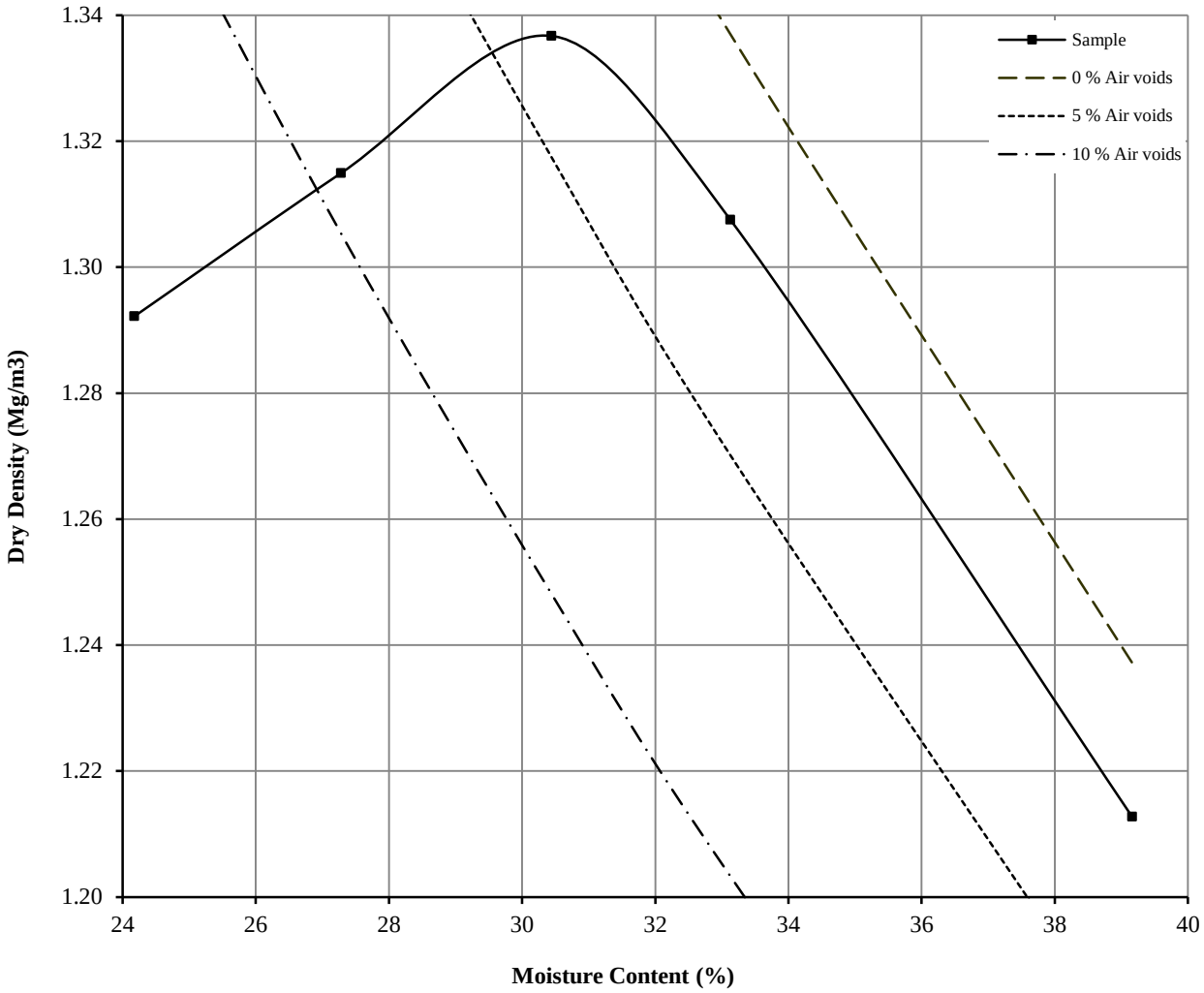
Remarks:

See Summary of Soil Descriptions

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.5 : 1990

Hole Number:	**TP01**	**Top Depth (m) :**	**0.60**
Sample Number:	**3**	**Base Depth (m) :**	
Sample Type:	**B**		

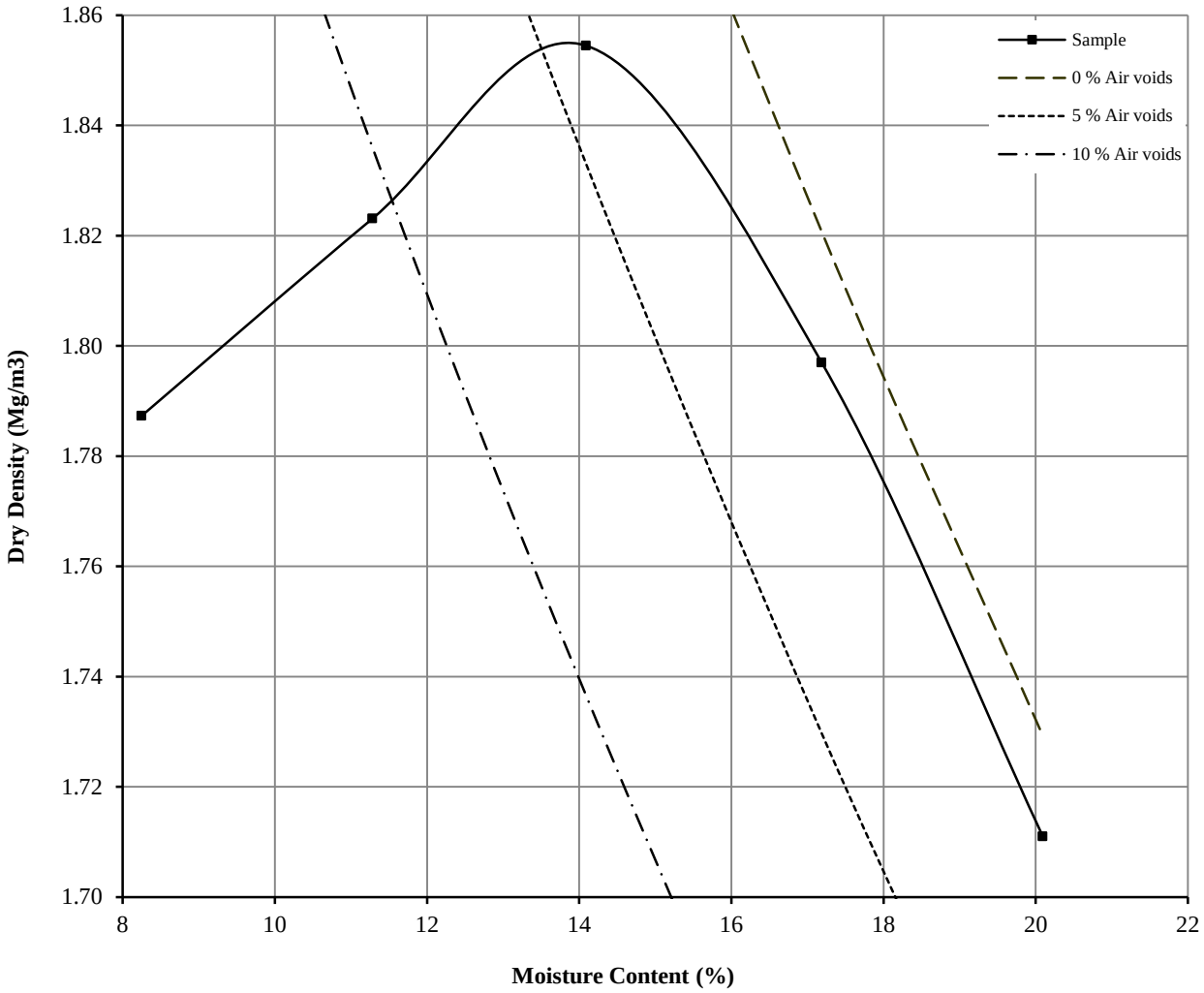


Initial Moisture Content:		39	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.40	Assumed	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.34	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		30			
Remarks See summary of soil descriptions					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.5 : 1990

Hole Number:	**TP02**	**Top Depth (m) :**	**0.70**
Sample Number:	**4**	**Base Depth (m) :**	
Sample Type:	**B**		

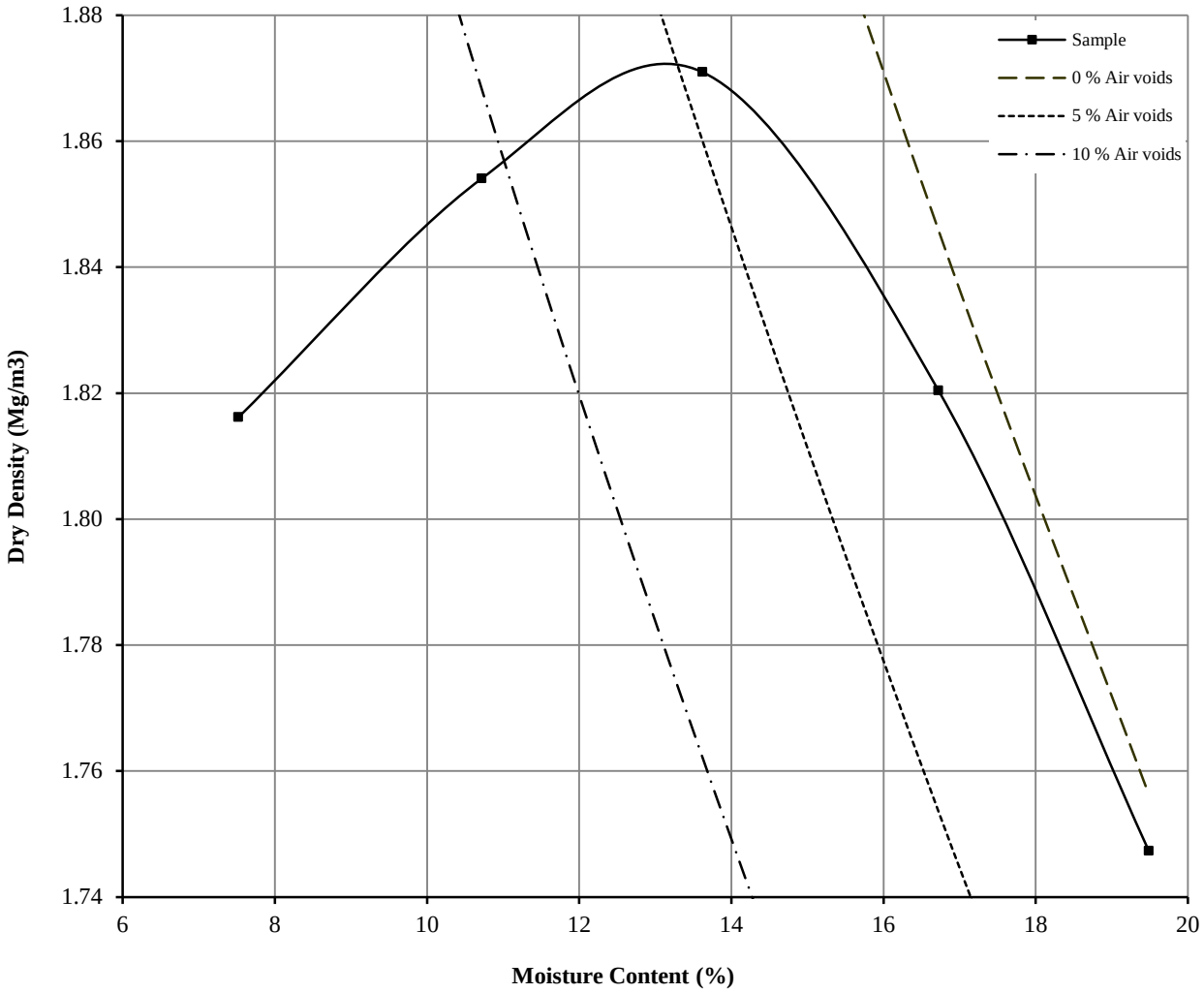


Initial Moisture Content:		26	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.65	Assumed	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.85	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		14			
Remarks See summary of soil descriptions					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.5 : 1990

Hole Number:	**TP03**	**Top Depth (m) :**	**0.80**
Sample Number:	**4**	**Base Depth (m) :**	
Sample Type:	**B**		

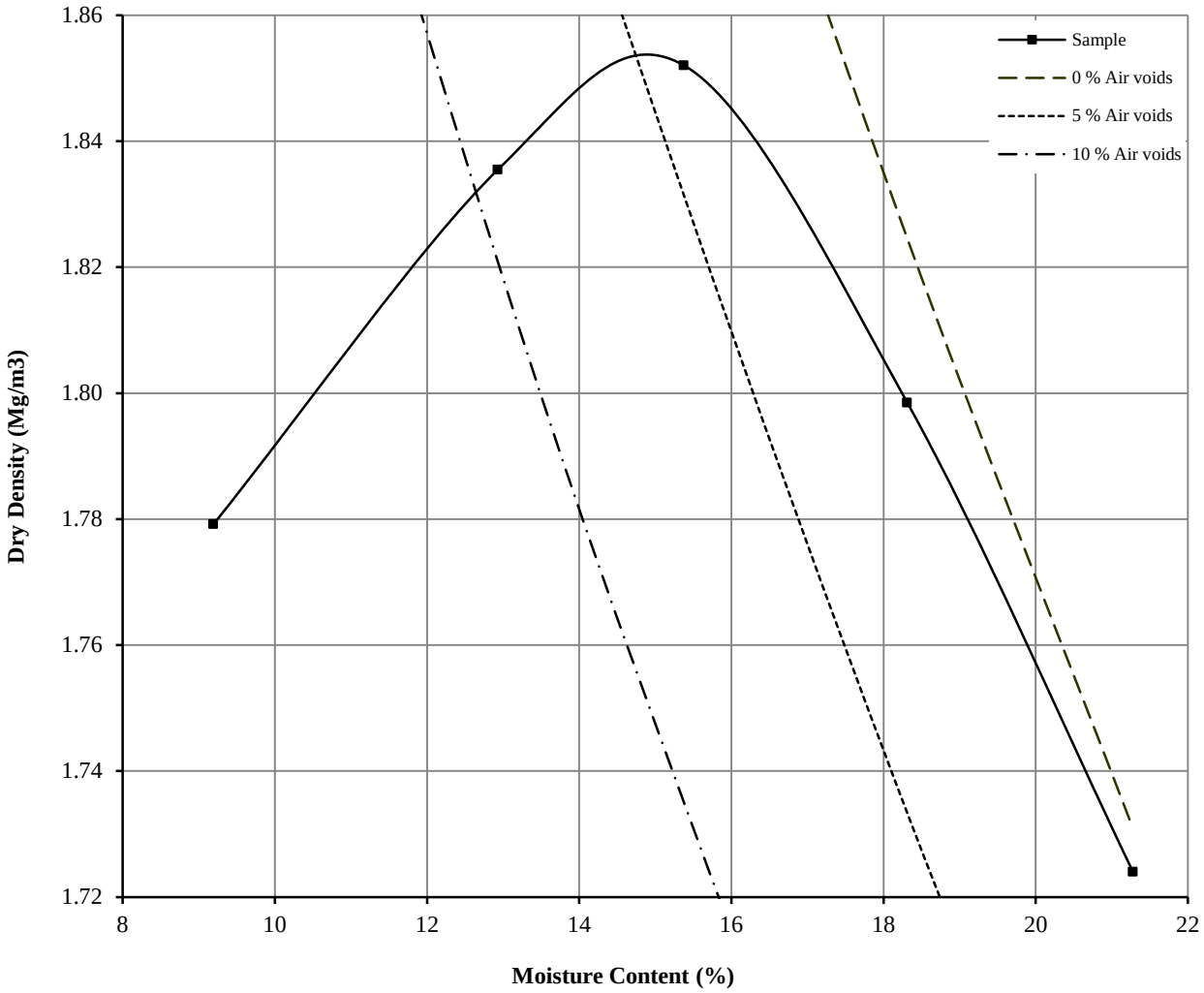


Initial Moisture Content:		26	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.67	Assumed	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.87	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		14			
Remarks See summary of soil descriptions					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.5 : 1990

Hole Number:	**TP04**	**Top Depth (m) :**	**0.80**
Sample Number:	**4**	**Base Depth (m) :**	
Sample Type:	**B**		



Initial Moisture Content:		18	Method of Compaction:	4.5kg	Separate Samples
Particle Density (Mg/m3):	2.74	Assumed	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.85	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		15			
Remarks See summary of soil descriptions					

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ANALYTICAL TEST REPORT

Contract no:	98690
Contract name:	Northorpe Lane, Mirfield
Client reference:	PSL21/5788
Clients name:	Professional Soils Laboratory
Clients address:	5/7 Hexthorpe Road Doncaster DN4 0AR
Samples received:	22 July 2021
Analysis started:	22 July 2021
Analysis completed:	29 July 2021
Report issued:	29 July 2021

Notes:

Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key:

U UKAS accredited test
M MCERTS & UKAS accredited test
$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing

Approved by:

Rachael Burton
Customer Support Squad Leader

Chemtech Environmental Limited

SOILS

Lab number			98690-1	98690-2	98690-3	98690-4	98690-5	98690-6
Sample id			TP01	TP02	TP03	TP04	TP04	TP05
Depth (m)			0.60	0.90	1.30	0.60	2.10	1.70
Date sampled			14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021
Test	Method	Units						
pH	CE004 [U]	units	6.3	6.2	6.7	6.4	6.7	6.3
Sulphate (2:1 water soluble)	CE061	mg/l SO_4	26	18	40	47	10	33

Chemtech Environmental Limited

SOILS

Lab number			98690-7	98690-8	98690-9	98690-10	98690-11	98690-12
Sample id			TP06	TP07	TP07	TP08	TP09	TP10
Depth (m)			2.30	1.20	2.90	1.90	0.50	0.80
Date sampled			14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021	14/07/2021
Test	Method	Units						
pH	CE004 [U]	units	6.4	7.0	6.4	6.8	6.9	7.6
Sulphate (2:1 water soluble)	CE061	mg/l SO_4	35	20	19	23	58	35

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE004	pH	Based on BS 1377, pH Meter	As received	U	-	units
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry		10	mg/l SO_4

Chemtech Environmental Limited

DEVIATING SAMPLE INFORMATION

Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
98690-1	TP01	0.60	N	
98690-2	TP02	0.90	N	
98690-3	TP03	1.30	N	
98690-4	TP04	0.60	N	
98690-5	TP04	2.10	N	
98690-6	TP05	1.70	N	
98690-7	TP06	2.30	N	
98690-8	TP07	1.20	N	
98690-9	TP07	2.90	N	
98690-10	TP08	1.90	N	
98690-11	TP09	0.50	N	
98690-12	TP10	0.80	N	

Appendix L

Gas Monitoring Results

Job Title:	Job No:
Northorpe Lane, Mirfield	3433
Client:	Sheet :
Newett Homes	1 of 18

Date:	Arrival Time:	Depart Time:	Operator:
25/08/2021	09:30	11:20	L Latta

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	0.0	CO_2:	0.0	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	
PH01A	3.35	ND	1.5	ND	1.5	19.8	13.4	ND	5.0	5.53	
PH02A	1.06	ND	2.8	ND	2.8	19.1	119.8	ND	ND	2.52	Flow monitoring stopped due to water within monitor tube
PH03A	-0.30	NR	NR	NR	NR	NR	NR	NR	NR	4.55	Water above ground level
PH04A	-0.20	NR	NR	NR	NR	NR	NR	NR	NR	2.65	Water above ground level
PH05A	0.43	ND	1.9	ND	1.9	19.5	ND	ND	ND	2.65	
PH06A	1.56	ND	1.1	ND	0.8	20.3	ND	ND	ND	4.03	
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Liversedge Station)					
Temp (°C):	15		Barometric Pressure Trend:			Falling		
Time:	09:30	10:25	11:20	06:00	09:00	12:00	15:00	18:00	21:00
Pressure (mb):	1019	1020	1017	1017	1017	1017	1015	1014	1013
Weather Conditions:	Overcast & light breeze								
Surface Ground Conditions:	Damp								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				2 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
25/08/2021	09:30	11:20	L Latta	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	0.0	CO_2:	0.0	O_2:	20.7

Monitoring Point	Groundwater level	Concentrations: Initial / Highest CH_4	Initial / Highest CO_2	Steady concentrations CH_4	Steady concentrations CO_2	Lowest concn O_2	Gas Flow Rates: Initial / Maximum	Steady	Time to fall from highest to steady	Bottom of well	Remarks
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	-	-	-	-	-	-	-	-	-	-	
PH02A	-	-	-	-	-	-	-	-	-	-	
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	1.94	ND	0.3	ND	0.3	20.7	ND	ND	ND	2.65	Bailed 9 litres to 2.24mbgl.
PH05A	1.90	ND	0.3	ND	0.3	20.6	ND	ND	ND	2.66	Bailed 6 litres to 2.13mbgl.
PH06A	3.06	ND	0.7	ND	0.7	20.4	ND	ND	ND	4.02	Bailed 8 litres to 3.52mbgl.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:

Gas Data GFM436 Infrared Gas Analyser
Geotechnical Instruments Dipmeter

Next Calibration Date

26/02/2022

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 (Liversedge Station)					
Temp (°C):	15		Barometric Pressure Trend:			Falling		
Time:	09:30	10:25	11:20	06:00	09:00	12:00	15:00	18:00	21:00
Pressure (mb):	1019	1020	1017	1017	1017	1017	1015	1014	1013
Weather Conditions:	Overcast & light breeze								
Surface Ground Conditions:	Damp								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				3 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
28/09/2021	11:11	13:05	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.6

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	3.82	ND	3.5	ND	3.5	17.2	-30.0	ND	50.0	5.55	
PH02A	1.01	ND	**5.8**	ND	**5.8**	**15.3**	113.9	0.1	2.0	2.49	Flow fluctuating from ND to 0.1.
PH03A	-0.12	NR	NR	NR	NR	NR	NR	NR	NR	4.54	Groundwater above ground level.
PH04A	-0.19	NR	NR	NR	NR	NR	NR	NR	NR	2.67	Groundwater above ground level.
PH05A	0.71	ND	4.5	ND	4.5	17.1	105.4	ND	40.0	2.70	Bailed 11:37 - 11:43 to 2.59 m (8 L).
PH06A	1.96	ND	1.0	ND	1.0	19.6	6.3	ND	1.0	4.03	Briefly removed bung before monitring gas as water around casing. Bailed 11:54 - 12:00 to 3.75 m (8 L).
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)							CH_4	CO_2	O_2
	Temp (°C):	15 to 17		Barometric Pressure Trend:			Falling						
Time:	11:11	12:48	13:05	00:04	05:59	11:09	12:49	13:04	17:59	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1003	1002	1000	1002	1002	1001	1000	1000	997	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Overcast/ Moderate Breeze										
	Surface Ground Conditions:		Damp										

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				4 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
28/09/2021	11:11	13:05	Cameron Daniel	

LITHOS CONSULTING

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.6

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	-	-	-	-	-	-	-	-	-	-	
PH02A	-	-	-	-	-	-	-	-	-	-	
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	2.23	ND	0.3	ND	0.3	20.6	ND	ND	ND	2.67	Bailed 11:37 - 11:43 to 2.59 m (8 L). Remonitored 12:41.
PH06A	3.26	ND	0.7	ND	0.7	20.3	119.4	1.5	360.0	4.03	Bailed 11:54 - 12:00 to 3.75 m (8 L). Remonitored 12:48. Flow fluctuating.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)						
	Temp (°C):	15 to 17		Barometric Pressure Trend:		Falling			
Time:	11:11	12:48	13:05	00:04	05:59	11:09	12:49	13:04	17:59
Pressure (mb):	1003	1002	1000	1002	1002	1001	1000	1000	997
	Weather Conditions:	Overcast/ Moderate Breeze							
	Surface Ground Conditions:	Damp							

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				5 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
14/10/2021	08:20	10:25	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.8

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	3.28	ND	3.3	ND	3.3	16.2	120.3	0.3	420.0	5.48	
PH02A	0.87	ND	**6.4**	ND	**6.4**	**14.4**	119.6	0.9	480.0	2.50	Occassional flow fluctuations around 0.9. Bailed 09:06-09:09 to 2.29 m (6 L). Remonitored 09:52.
PH03A	-0.20	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH04A	-0.21	NR	NR	NR	NR	NR	NR	NR	NR	2.65	
PH05A	0.71	ND	**6.0**	ND	**6.0**	16.5	120.4	0.6	240.0	2.68	Occassional flow fluctuations around 0.6. Bailed 09:21-09:25 to 2.38 m (7 L). Remonitored 10:09.
PH06A	2.60	ND	**5.5**	ND	**5.5**	16.8	120.7	18.0	600.0	4.05	Flow fluctuating 14 to 18.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)					
Temp (°C):	12 to 13		Barometric Pressure Trend:			Falling		
Time:	08:37	10:10	10:23	00:04	08:39	10:09	10:24	14:59	19:59
Pressure (mb):	1012	1012	1011	1014	1011	1010	1009	1007	1006
Weather Conditions:	Overcast/ Strong breeze								
Surface Ground Conditions:	Damp								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				6 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
14/10/2021	08:20	10:25	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.8

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	-	-	-	-	-	-	-	-	-	-	
PH02A	1.24	ND	1.7	ND	1.7	19.4	120.6	2.5	540.0	2.54	Bailed 09:06-09:09 to 2.29 m (6 L). Remonitored 09:52. Flow still slowly falling.
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	1.98	ND	0.3	ND	0.3	20.5	0.6	0.6	120.0	2.69	Bailed 09:21-09:25 to 2.38 m (7 L). Remonitored 10:09.
PH06A	-	-	-	-	-	-	-	-	-	-	
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)							CH_4	CO_2	O_2
	Temp (°C):	12 to 13		Barometric Pressure Trend:			Falling					
Time:	08:37	10:10	10:23	00:04	08:39	10:09	10:24	14:59	19:59	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1012	1012	1011	1014	1011	1010	1009	1007	1006	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Overcast/ Strong breeze									
	Surface Ground Conditions:		Damp									

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				7 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
02/11/2021	09:00	10:50	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.4

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	2.95	ND	3.3	ND	3.3	**14.6**	121.5	1.5	120.0	5.54	
PH02A	1.12	NR	NR	NR	NR	NR	NR	NR	NR	2.56	Initially removed bung as water around well. Remonitored approx 30 minutes later.
PH03A	-0.22	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH04A	-0.20	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH05A	0.71	ND	**6.9**	ND	**6.9**	16.9	119.5	1.6	180.0	2.71	Bailed 09:36 - 09:39 to 2.52 m (8 L). Remonitored 10:19.
PH06A	1.29	ND	2.2	ND	2.2	19.0	ND	ND	ND	4.04	Bailed 09:46 - 09:52 to 3.68 m (12 L). Remonitored 10:24.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:

Gas Data GFM436 Infrared Gas Analyser
Geotechnical Instruments Dipmeter

Next Calibration Date

26/02/2022

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 (Littletown - ILIVER67 Station)							CH_4	CO_2	O_2
	Temp (°C):	4 to 8		Barometric Pressure Trend:			Gradually Rising						
Time:	09:10	10:08	10:46	00:04	05:59	09:09	10:09	10:44	15:59	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	988	988	988	984	984	985	985	985	986	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Cloudy Patches/ Still										
	Surface Ground Conditions:		Damp - Wet										

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				8 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
02/11/2021	09:00	10:50	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.4

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	-	-	-	-	-	-	-	-	-	-	
PH02A	1.01	ND	4.7	ND	4.7	17.2	121.7	7.8	180.0	2.54	Initially removed bung as water around well. Remonitored approx 30 minutes later. Flow decreasing slowly.
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	2.17	ND	0.4	ND	0.4	20.3	18.8	1.6	60.0	2.69	Bailed 09:36 - 09:39 to 2.52 m (8 L). Remonitored 10:19.
PH06A	2.98	ND	0.8	ND	0.8	20.1	77.1	5.4	180.0	4.06	Bailed 09:46 - 09:52 to 3.68 m (12 L). Remonitored 10:24.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)							CH_4	CO_2	O_2
	Temp (°C):	4 to 8		Barometric Pressure Trend:			Gradually Rising						
Time:	09:10	10:08	10:46	00:04	05:59	09:09	10:09	10:44	15:59	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	988	988	988	984	984	985	985	985	986	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Cloudy Patches/ Still										
	Surface Ground Conditions:		Damp - Wet										

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				9 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
23/11/2021	07:55	10:25	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.6

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	2.48	ND	2.9	ND	2.9	**15.3**	119.8	ND	60.0	5.53	Bailed 08:30 - 08:34 to 5.42 m (12 L). Remonitored 09:35.
PH02A	0.46	ND	**6.7**	ND	**6.7**	**14.0**	119.4	3.4	600.0	2.55	Bung briefly removed before mon. Flow decreasing slowly. Bailed 08:55 - 08:57 to 2.25 m (6 L). Remonitored 09:47.
PH03A	-0.18	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH04A	-0.21	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH05A	0.45	ND	**8.0**	ND	**8.0**	**15.6**	62.6	ND	20.0	2.71	Bailed 09:12 - 09:14 to 2.34 m (7 L). Remonitored 09:58.
PH06A	1.04	ND	**7.1**	ND	**7.1**	17.0	-0.2	ND	10.0	4.06	Bailed 09:24 - 09:30 to 3.67 m (13 L). Remonitored 10:03.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)					
Temp (°C):	8		Barometric Pressure Trend:			Steady then Falling		
Time:	08:13	09:34	10:20	00:04	05:59	08:14	09:34	10:19	15:59
Pressure (mb):	1023	1023	1023	1022	1021	1021	1022	1022	1019

Weather Conditions:	Cloudy with Sunny Spells/ Gentle Breeze
Surface Ground Conditions:	Wet

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				10 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
23/11/2021	07:55	10:25	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.6

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	4.56	ND	0.5	ND	0.5	19.8	120.0	1.9	300.0	5.55	Bailed 08:30 - 08:34 to 5.42 m (12 L). Remonitored 09:35. Flow fluctuating 1.7 to 1.9.
PH02A	1.19	ND	1.1	ND	1.1	19.6	120.1	10.7	300.0	2.57	Bailed 08:55 - 08:57 to 2.25 m (6 L). Remonitored 09:47. Flow decreasoing slowly.
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	1.98	ND	0.4	ND	0.4	20.2	ND	ND	ND	2.70	Bailed 09:12 - 09:14 to 2.34 m (7 L). Remonitored 09:58.
PH06A	2.66	ND	1.8	ND	1.8	19.5	95.6	6.7	300.0	4.07	Bailed 09:24 - 09:30 to 3.67 m (13 L). Remonitored 10:03. Flow decreasing slowly.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)					
Temp (°C):	8		Barometric Pressure Trend:			Steady then Falling		
Time:	08:13	09:34	10:20	00:04	05:59	08:14	09:34	10:19	15:59
Pressure (mb):	1023	1023	1023	1022	1021	1021	1022	1022	1019
Weather Conditions:	Cloudy with Sunny Spells/ Gentle Breeze								
Surface Ground Conditions:	Wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				11 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
13/12/2021	09:20	12:40	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.5

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	2.17	ND	1.7	ND	1.7	18.7	122.8	2.8	600.0	5.50	Bailed 10:39 - 10:45 to 5.29 m (12 L). Remonitored 11:41.
PH02A	0.78	ND	**6.3**	ND	**6.3**	**15.4**	105.0	9.3	600.0	2.54	Bung briefly removed before monitoring. Bailed 11:03 - 11:03 to 2.34 m (7 L). Remonitored 11:56.
PH03A	-0.23	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH04A	-0.22	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH05A	0.32	ND	**6.4**	ND	**6.4**	16.5	1.0	ND	20.0	2.72	Bailed 11:19 - 11:22 to 2.49 m (8 L). Remonitored 12:06.
PH06A	0.56	ND	**5.1**	ND	2.2	**10.5**	0.3	0.3	30.0	4.05	Flow fluctuating ND to 0.3. Bailed 11:30 - 11:33 to 3.55 m (12 L). Remonitored 12:15.
PZ01	0.19	ND	0.5	ND	0.5	19.6	-0.9	-0.9	30.0	1.16	Installed 10:10 (4 rods). Monitored 11:51. Flow fluctuating -0.9 to -0.7.
PZ02	ND	ND	0.3	ND	0.3	20.4	ND	ND	ND	0.84	Installed 10:18 (3 rods). Monitored 12:12.

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)					
Temp (°C):	9		Barometric Pressure Trend:			Rising		
Time:	09:40	11:40	12:32	00:04	05:59	09:39	11:39	12:34	17:59
Pressure (mb):	1012	1012	1009	1002	1006	1008	1009	1009	1010
Weather Conditions:	Overcast/ Still								
Surface Ground Conditions:	Wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				12 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
13/12/2021	09:20	12:40	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.5

Monitoring Point	Groundwater level	Concentrations: Initial / Highest CH_4	Initial / Highest CO_2	Steady concentrations CH_4	Steady concentrations CO_2	Lowest concn O_2	Gas Flow Rates: Initial / Maximum	Steady	Time to fall from highest to steady	Bottom of well	Remarks
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	3.57	ND	0.5	ND	0.5	20.3	122.0	6.3	300.0	5.54	Bailed 10:39 - 10:45 to 5.29 m (12 L). Remonitored 11:41. Flow fluctuating 6.1 to 6.5.
PH02A	1.18	ND	2.0	ND	2.0	19.1	122.4	15.6	300.0	2.51	Bailed 11:03 - 11:03 to 2.34 m (7 L). Remonitored 11:56. Flow falling slowly.
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	2.01	ND	0.2	ND	0.2	20.4	2.2	2.0	120.0	2.71	Bailed 11:19 - 11:22 to 2.49 m (8 L). Remonitored 12:06. Flow fluctuating 1.7 to 2.0.
PH06A	1.69	ND	2.8	ND	2.8	18.9	85.4	6.9	300.0	4.08	Bailed 11:30 - 11:33 to 3.55 m (12 L). Remonitored 12:15. Flow falling slowly.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILIVER67 Station)					
Temp (°C):	9		Barometric Pressure Trend:			Rising		
Time:	09:40	11:40	12:32	00:04	05:59	09:39	11:39	12:34	17:59
Pressure (mb):	1012	1012	1009	1002	1006	1008	1009	1009	1010
Weather Conditions:	Overcast/ Still								
Surface Ground Conditions:	Wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				13 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
06/01/2022	09:20	12:00	Cameron Daniel	

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Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.3

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	2.22	ND	2.2	ND	2.2	18.4	123.6	3.6	360.0	5.55	Bailed 10:00 - 10:05 to 5.31 m (12 L). Remonitored 11:11.
PH02A	0.19	ND	**6.9**	ND	**6.9**	**13.6**	123.0	4.8	600.0	2.53	Flow still falling slowly. Bailed 10:29 - 10:31 to 2.30 m (8 L). Remonitored 11:23.
PH03A	-0.05	NR	NR	NR	NR	NR	NR	NR	NR	NR	
PH04A	-0.22	NR	NR	NR	NR	NR	NR	NR	NR	2.99	
PH05A	0.36	ND	**7.3**	ND	**7.3**	**15.3**	14.7	ND	20.0	2.72	Bailed 10:44 - 10:48 to 2.39 m (9 L). Remonitored 11:33.
PH06A	0.38	ND	**5.2**	ND	**5.2**	17.2	ND	ND	ND	4.06	Bailed 11:03 - 11:07 to 3.42 m (12 L). Remonitored 11:40.
PZ01	0.05	NR	NR	NR	NR	NR	ND	ND	ND	1.16	
PZ02	0.22	ND	ND	ND	ND	ND	ND	ND	ND	0.85	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILVER67 Station)					
Temp (°C):	0 to 3		Barometric Pressure Trend:			Falling		
Time:	09:46	10:58	11:52	00:04	05:59	09:44	10:59	11:54	17:59
Pressure (mb):	1003	1002	1000	1008	1005	1002	1001	1000	992
Weather Conditions:	Light cloud and light rain showers/ Gentle breeze								
Surface Ground Conditions:	Frosty - wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				14 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
06/01/2022	09:20	12:00	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.3

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	3.46	ND	0.7	ND	0.7	19.6	123.7	9.0	300.0	5.53	Bailed 10:00 - 10:05 to 5.31 m (12 L). Remonitored 11:11. Flow still falling slowly.
PH02A	0.22	ND	2.5	ND	2.5	17.9	47.7	6.7	300.0	2.54	Bailed 10:29 - 10:31 to 2.30 m (8 L). Remonitored 11:23. Flow still falling slowly.
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	1.87	ND	0.5	ND	0.5	19.9	3.6	0.6	120.0	2.71	Bailed 10:44 - 10:48 to 2.39 m (9 L). Remonitored 11:33.
PH06A	2.39	ND	1.2	ND	1.2	19.5	123.8	19.9	360.0	4.08	Bailed 11:03 - 11:07 to 3.42 m (12 L). Remonitored 11:40. Flow still falling slowly.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Littletown - ILVER67 Station)					
Temp (°C):	0 to 3		Barometric Pressure Trend:			Falling		
Time:	09:46	10:58	11:52	00:04	05:59	09:44	10:59	11:54	17:59
Pressure (mb):	1003	1002	1000	1008	1005	1002	1001	1000	992
Weather Conditions:	Light cloud and light rain showers/ Gentle breeze								
Surface Ground Conditions:	Frosty - wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				15 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
11/02/2022	07:55	10:15	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.6

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	2.28	ND	2.5	ND	2.5	18.3	124.7	1.3	480.0	5.53	Bailed 08:27 - 08:31 to 5.31 m (12 L). Remonitored 09:37.
PH02A	-0.08	ND	**7.0**	ND	**7.0**	**6.7**	-23.0	-0.1	45.0	2.59	Water entering tubes. Bailed 08:44 - 08:47 to 2.29 m (8 L). Remonitored 09:47.
PH03A	0.36	NR	NR	NR	NR	NR	NR	NR	NR	4.49	
PH04A	-0.23	NR	NR	NR	NR	NR	NR	NR	NR	2.66	
PH05A	0.34	ND	**7.2**	ND	**7.2**	**13.4**	-10.0	-0.1	30.0	2.71	Bailed 09:10- 09:14 to 2.53 m (8 L). Remonitored 09:50.
PH06A	0.60	ND	**5.4**	ND	2.0	17.8	ND	ND	ND	4.01	Oxygen rose to 19.2 %. Bailed 09:28 - 09:32 to 3.53m (12 L). Remonitored 09:55.
PZ01	0.00	NR	NR	NR	NR	NR	NR	NR	NR	1.16	
PZ02	0.23	ND	0.1	ND	0.1	20.0	0.1	ND	10.0	0.85	

Equipment Used:

Gas Data GFM436 Infrared Gas Analyser
Geotechnical Instruments Dipmeter

Next Calibration Date

26/02/2022

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 (Lower Hopton - IMIRF13 Station)					
Temp (°C):	-2 to 1		Barometric Pressure Trend:			Rising		
Time:	08:12	09:36	10:01	12:03	05:58	08:13	09:38	10:03	11:58
Pressure (mb):	1020	1021	1021	1025	1029	1030	1031	1031	1030
Weather Conditions:	Clear sky/ Still								
Surface Ground Conditions:	Frosty - wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				16 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
11/02/2022	07:55	10:15	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.6

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	3.51	ND	0.6	ND	0.6	19.8	125.4	8.8	300.0	5.52	Bailed 08:27 - 08:31 to 5.31 m (12 L). Remonitored 09:37.Flow still falling gradually.
PH02A	0.99	NR	NR	NR	NR	NR	NR	NR	NR	NR	Bailed 08:44 - 08:47 to 2.29 m (8 L). Remonitored 09:47.
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	2.08	ND	0.4	ND	0.4	20.1	1.3	0.7	30.0	NR	Bailed 09:10- 09:14 to 2.53 m (8 L). Remonitored 09:50.
PH06A	2.21	ND	1.9	ND	1.9	18.9	188.6	13.9	300.0	4.05	Bailed 09:28 - 09:32 to 3.53m (12 L). Remonitored 09:55. Flow still falling gradually.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Lower Hopton - IMIRF13 Station)					
	Temp (°C):	-2 to 1		Barometric Pressure Trend:			Rising		
Time:	08:12	09:36	10:01	12:03	05:58	08:13	09:38	10:03	11:58
Pressure (mb):	1020	1021	1021	1025	1029	1030	1031	1031	1030
	Weather Conditions:	Clear sky/ Still							
	Surface Ground Conditions:	Frosty - wet							

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				17 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
01/03/2022	08:10	10:20	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.9

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	2.20	ND	0.8	ND	0.8	20.9	120.0	ND	240.0	5.50	Bailed 08:48 - 08:57 to 5.35 m (13 L). Remonitored 09:40.
PH02A	-0.31	NR	NR	NR	NR	NR	NR	NR	NR	2.58	
PH03A	0.21	NR	NR	NR	NR	NR	NR	NR	NR	4.52	
PH04A	-0.23	NR	NR	NR	NR	NR	NR	NR	NR	2.66	
PH05A	0.27	ND	1.3	ND	0.5	19.9	1.9	ND	15.0	2.71	Bailed 09:18 - 09:21 to 2.53 m (9 L). Remonitored 09:51.
PH06A	0.41	ND	3.2	ND	0.9	18.9	1.9	ND	15.0	4.05	Bailed 09:32 - 09:37 to 3.56 m (13 L). Remonitored 09:57.
PZ01	0.00	NR	NR	NR	NR	NR	NR	NR	NR	1.16	
PZ02	0.16	NR	NR	NR	NR	NR	NR	NR	NR	0.85	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

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 (Lower Hopton - IMIRF13 Station)					
Temp (°C):	0		Barometric Pressure Trend:			Rising		
Time:	08:37	09:30	10:15	00:01	06:01	08:36	09:31	10:17	12:56
Pressure (mb):	1020	1020	1020	1025	1027	1028	1028	1028	1030
Weather Conditions:	Light cloud/ Still								
Surface Ground Conditions:	Wet								

	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Job Title:				Job No:
Northorpe Lane, Mirfield				3433
Client:				Sheet :
Newett Homes				18 of 18
Date:	Arrival Time:	Depart Time:	Operator:	
01/03/2022	08:10	10:20	Cameron Daniel	

Gas Monitoring Results:

Ambient Concentration (% Volume):	CH_4:	ND	CO_2:	ND	O_2:	20.9

Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH_4	CO_2	CH_4	CO_2	O_2					
	(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr	secs	m	
PH01A	3.43	ND	0.4	ND	0.4	20.3	120.0	18.0	240.0	5.46	Bailed 08:48 - 08:57 to 5.35 m (13 L). Remonitored 09:40. Flow fluctuating 13.5 to 18.0.
PH02A	-	-	-	-	-	-	-	-	-	-	
PH03A	-	-	-	-	-	-	-	-	-	-	
PH04A	-	-	-	-	-	-	-	-	-	-	
PH05A	2.05	ND	0.1	ND	0.1	20.5	8.8	3.3	90.0	2.71	Bailed 09:18 - 09:21 to 2.53 m (9 L). Remonitored 09:51. Flow fluctuating 3.1 to 3.3.
PH06A	2.25	ND	1.6	ND	1.6	19.4	120.0	23.0	300.0	4.06	Bailed 09:32 - 09:37 to 3.56 m (13 L). Remonitored 09:57. Flow slowly falling.
PZ01	-	-	-	-	-	-	-	-	-	-	
PZ02	-	-	-	-	-	-	-	-	-	-	

Equipment Used:	Next Calibration Date
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	26/02/2022

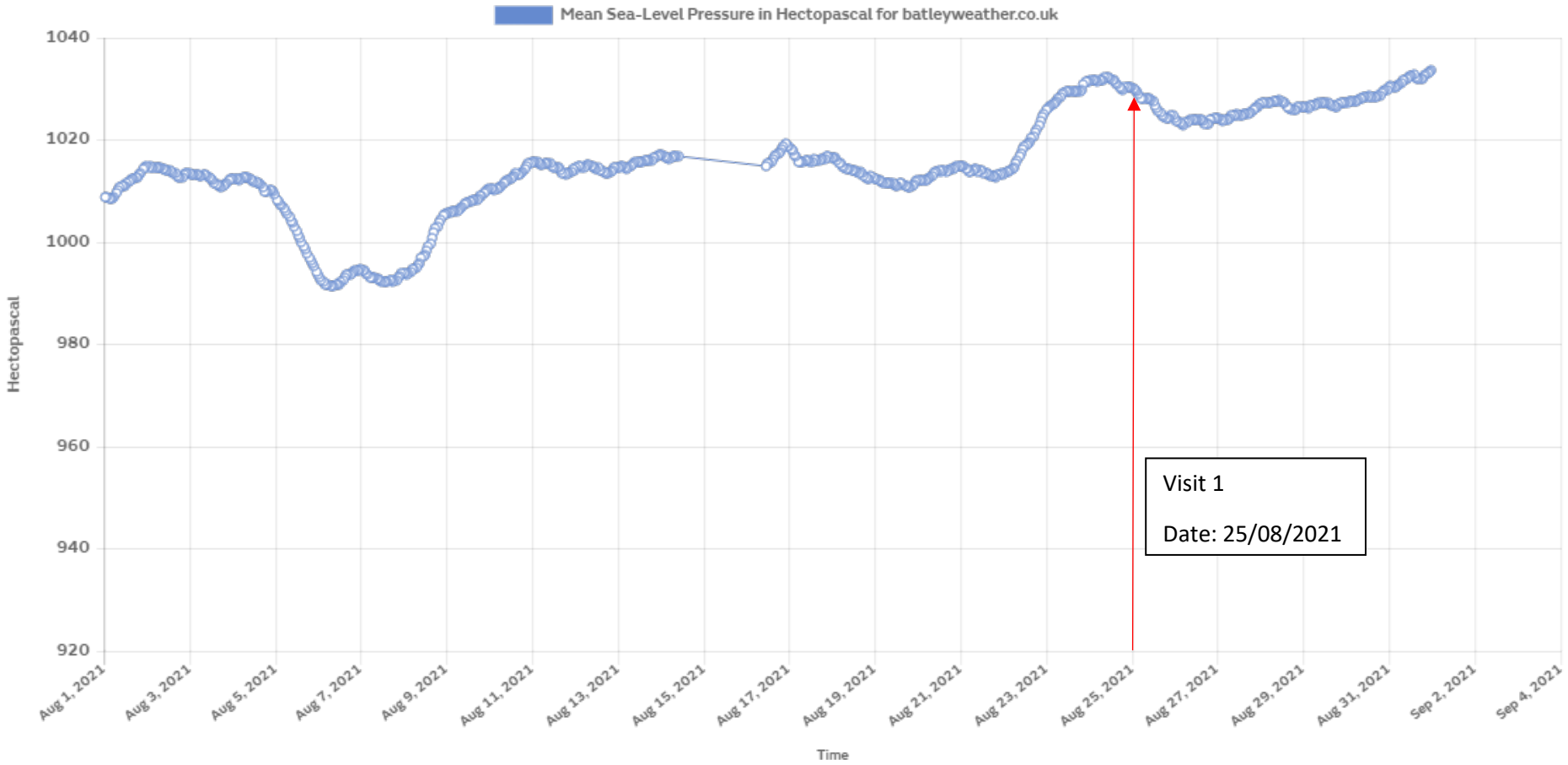
Key	
ND	None Detected
NR	Not Recorded
1.0	Recorded value does not breach trigger levels
5.0	Recorded value breaches trigger level 1
10.0	Recorded value breaches trigger level 2

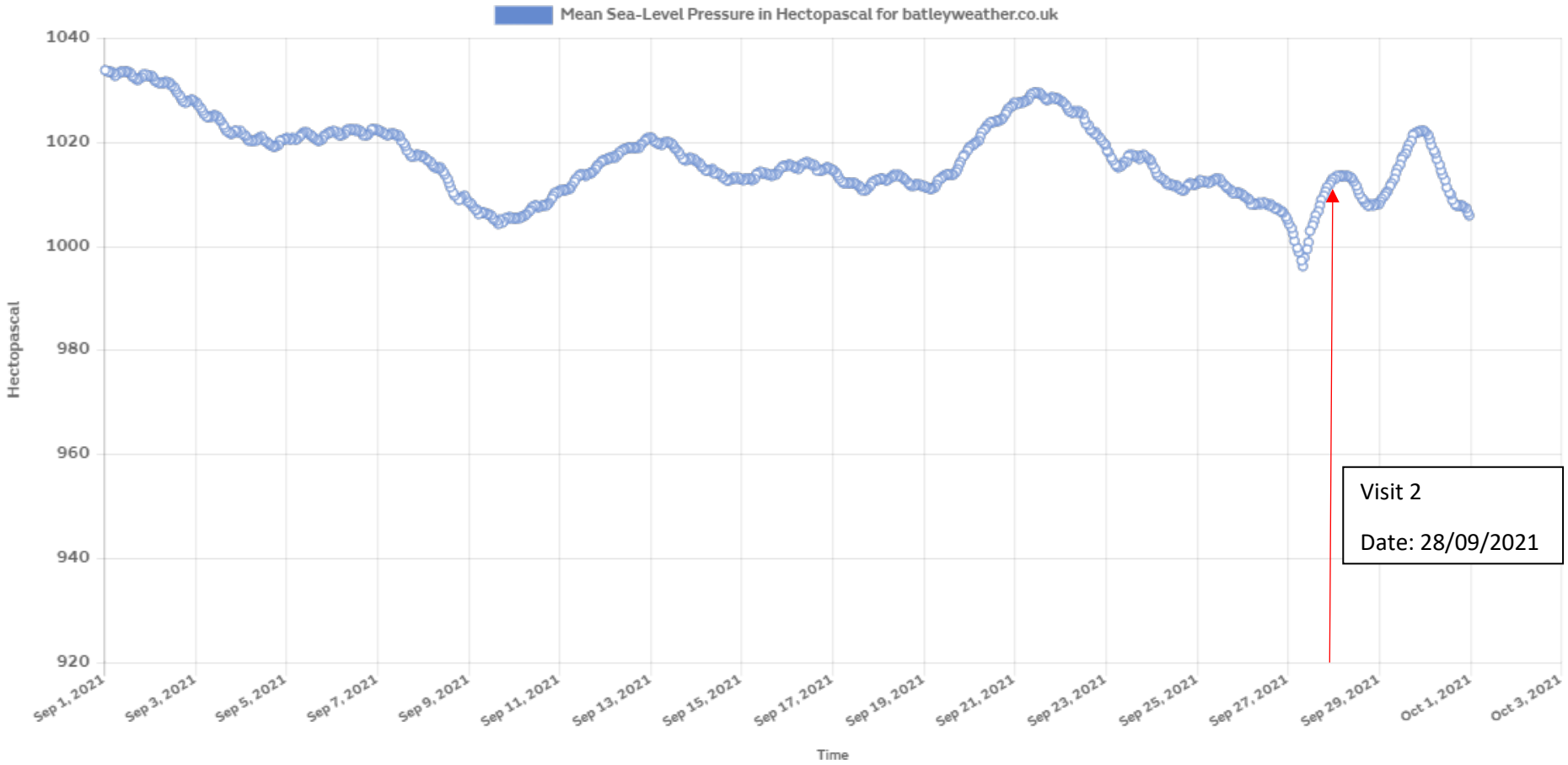
	Site Data:			Weather Station Data (Lower Hopton - IMIRF13 Station)					
	Temp (°C):	0		Barometric Pressure Trend:			Rising		
Time:	08:37	09:30	10:15	00:01	06:01	08:36	09:31	10:17	12:56
Pressure (mb):	1020	1020	1020	1025	1027	1028	1028	1028	1030
	Weather Conditions:	Light cloud/ Still							
	Surface Ground Conditions:	Wet							

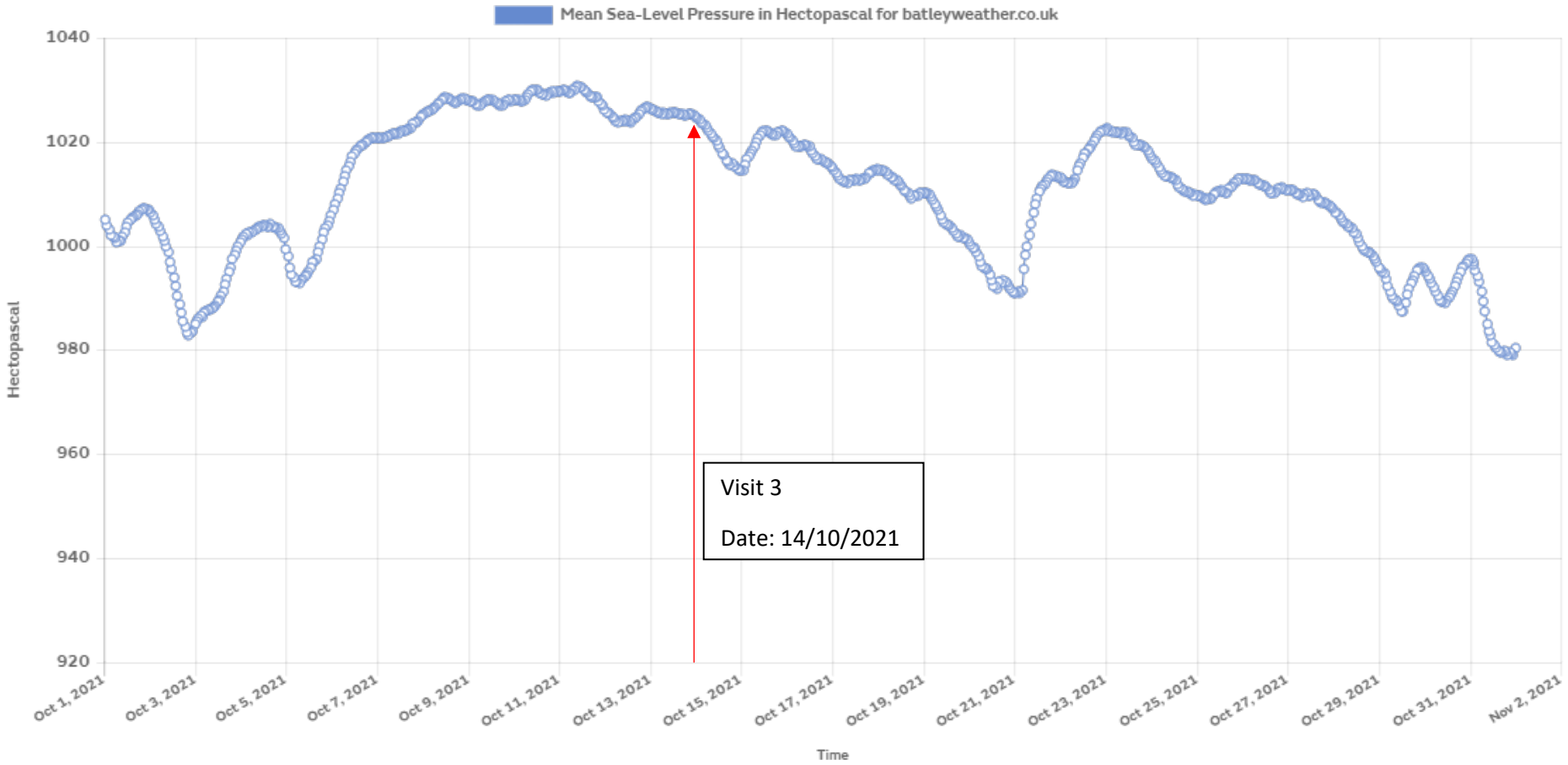
	CH_4	CO_2	O_2
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

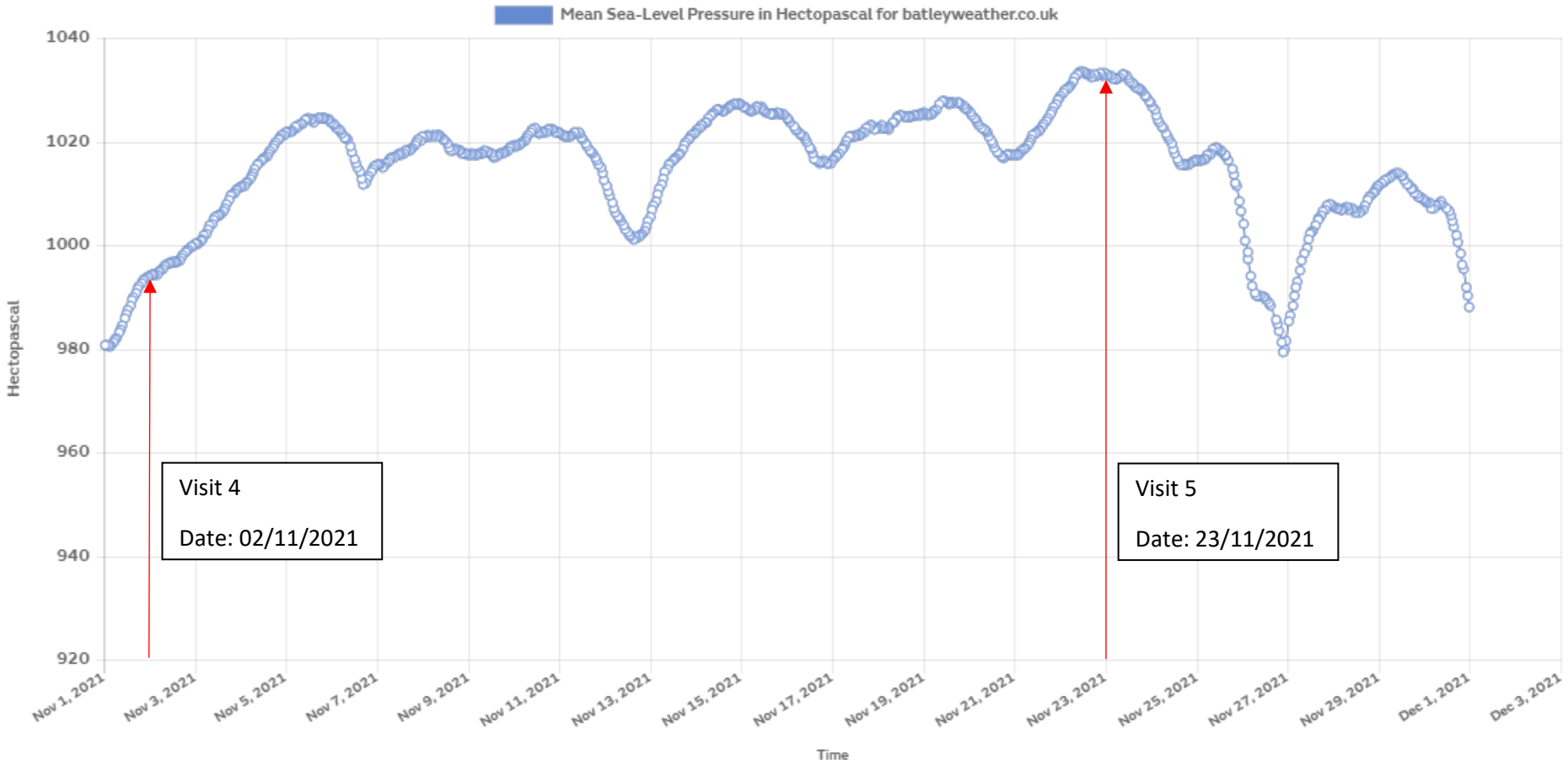
Remarks:

Atmospheric Pressure Graphs


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
Hectopascal
1040
1020
1000
980
960
940
920
Aug 1, 2021
Aug 3, 2021
Aug 5, 2021
Aug 7, 2021
Aug 9, 2021
Aug 11, 2021
Aug 13, 2021
Aug 15, 2021
Aug 17, 2021
Aug 19, 2021
Aug 21, 2021
Aug 23, 2021
Aug 25, 2021
Aug 27, 2021
Aug 29, 2021
Aug 31, 2021
Sep 2, 2021
Sep 4, 2021
Time
Visit 1
Date: 25/08/2021


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
1040
1020
1000
980
960
940
920
Hectopascal
Sep 1, 2021
Sep 3, 2021
Sep 5, 2021
Sep 7, 2021
Sep 9, 2021
Sep 11, 2021
Sep 13, 2021
Sep 15, 2021
Sep 17, 2021
Sep 19, 2021
Sep 21, 2021
Sep 23, 2021
Sep 25, 2021
Sep 27, 2021
Sep 29, 2021
Oct 1, 2021
Oct 3, 2021
Time
Visit 2
Date: 28/09/2021


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
1040
1020
1000
980
960
940
920
Hectopascal
Visit 3
Date: 14/10/2021
Oct 1, 2021
Oct 3, 2021
Oct 5, 2021
Oct 7, 2021
Oct 9, 2021
Oct 11, 2021
Oct 13, 2021
Oct 15, 2021
Oct 17, 2021
Oct 19, 2021
Oct 21, 2021
Oct 23, 2021
Oct 25, 2021
Oct 27, 2021
Oct 29, 2021
Oct 31, 2021
Nov 2, 2021
Time


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
Hectopascal
1040
1020
1000
980
960
940
920
Visit 4
Date: 02/11/2021
Visit 5
Date: 23/11/2021
Nov 1, 2021
Nov 3, 2021
Nov 5, 2021
Nov 7, 2021
Nov 9, 2021
Nov 11, 2021
Nov 13, 2021
Nov 15, 2021
Nov 17, 2021
Nov 19, 2021
Nov 21, 2021
Nov 23, 2021
Nov 25, 2021
Nov 27, 2021
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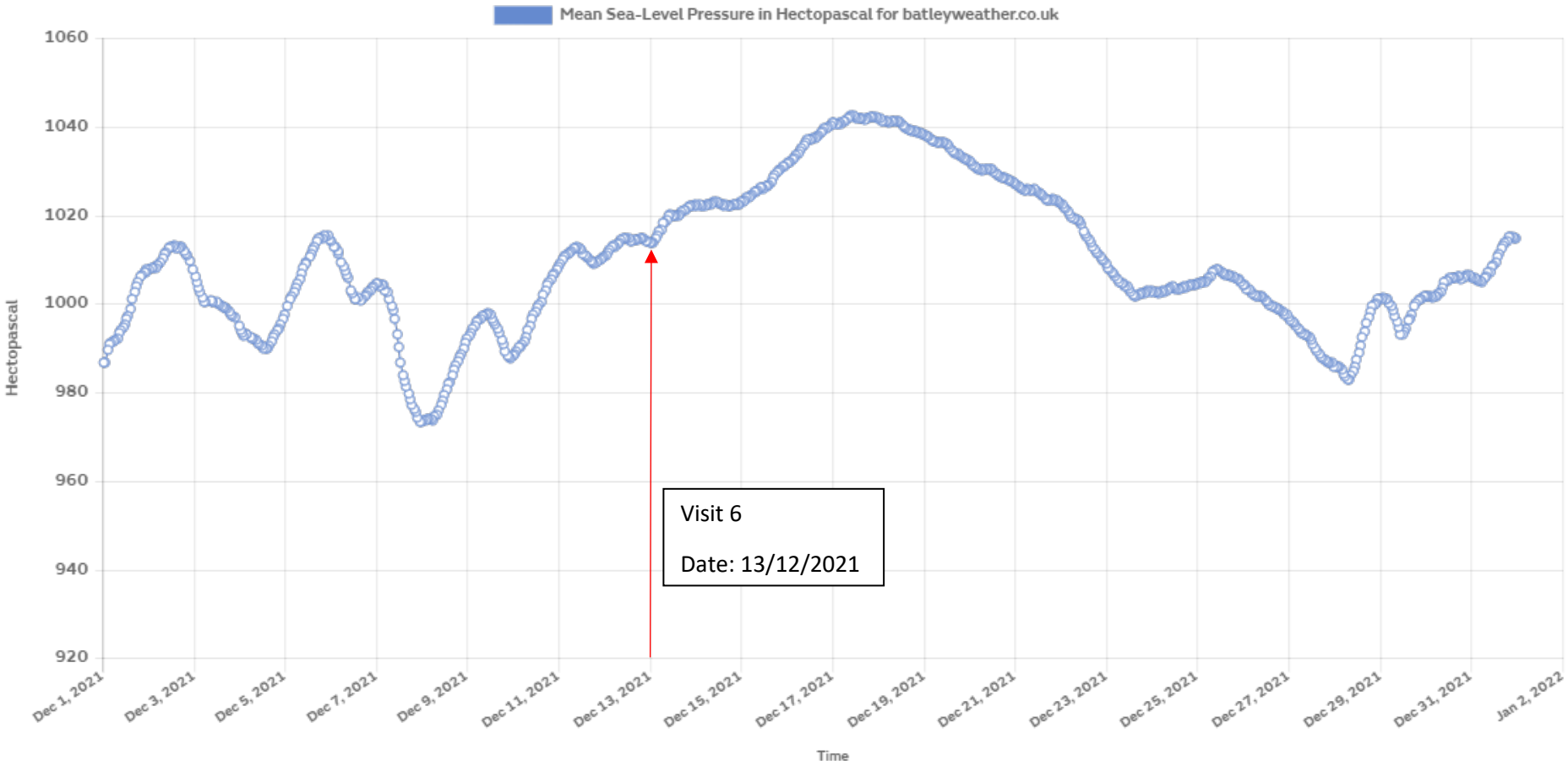
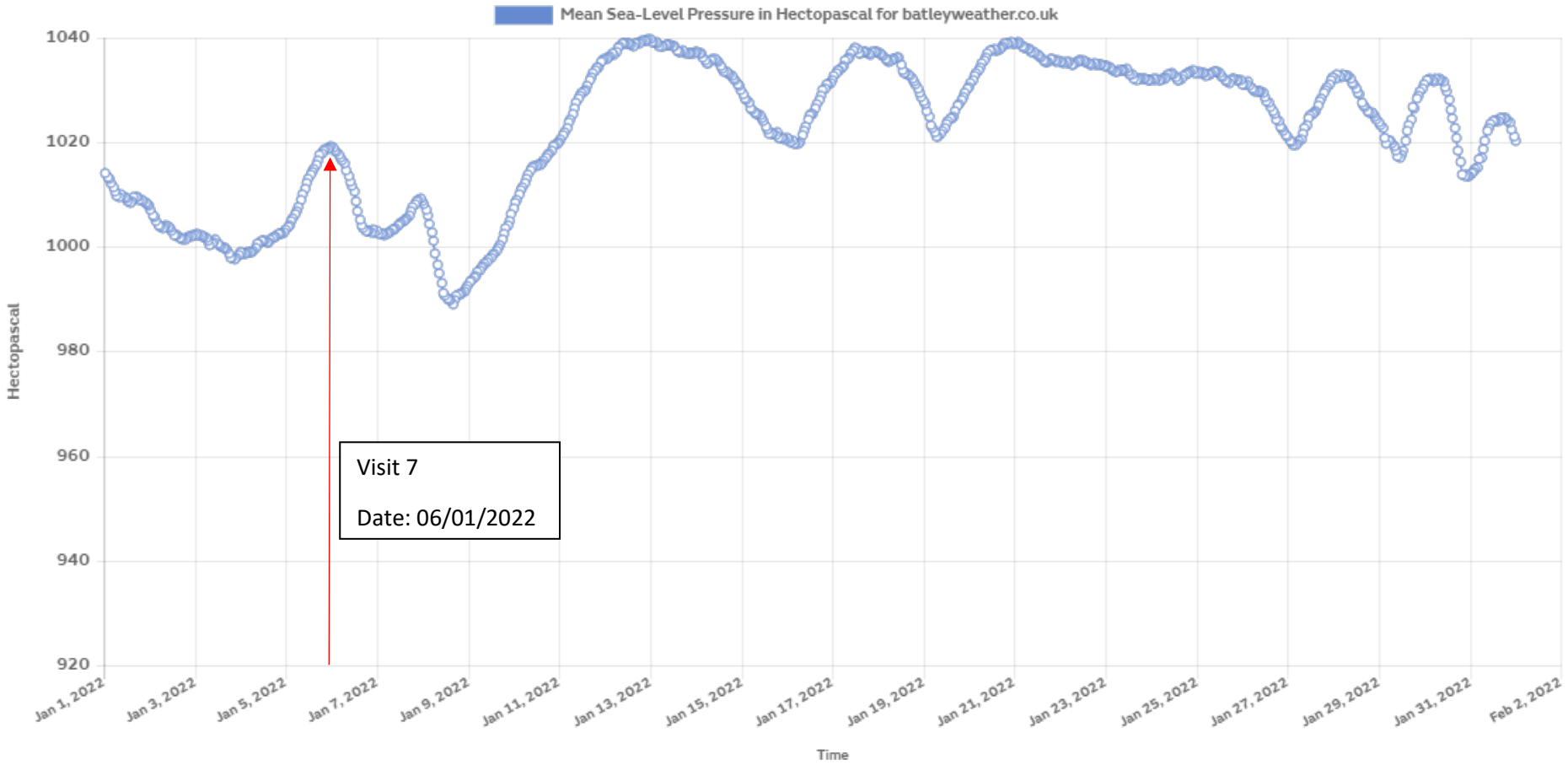
Dec 1, 2021
Dec 3, 2021
Time


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
1060
1040
1020
1000
980
960
940
920
Hectopascal
Visit 6
Date: 13/12/2021
Dec 1, 2021
Dec 3, 2021
Dec 5, 2021
Dec 7, 2021
Dec 9, 2021
Dec 11, 2021
Dec 13, 2021
Dec 15, 2021
Dec 17, 2021
Dec 19, 2021
Dec 21, 2021
Dec 23, 2021
Dec 25, 2021
Dec 27, 2021
Dec 29, 2021
Dec 31, 2021
Jan 2, 2022
Time


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
Hectopascal
1040
1020
1000
980
960
940
920
Visit 7
Date: 06/01/2022
Jan 1, 2022
Jan 3, 2022
Jan 5, 2022
Jan 7, 2022
Jan 9, 2022
Jan 11, 2022
Jan 13, 2022
Jan 15, 2022
Jan 17, 2022
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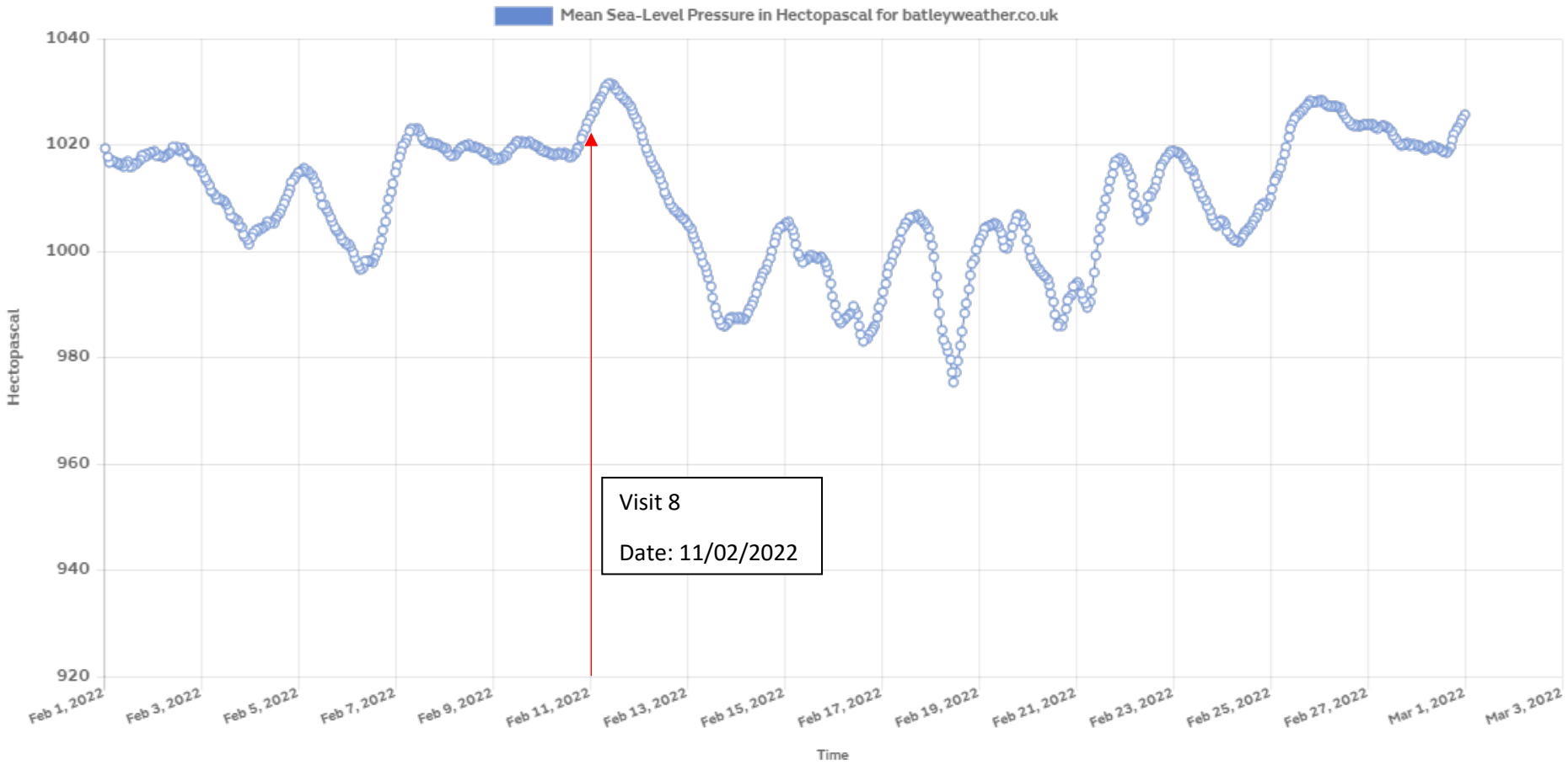
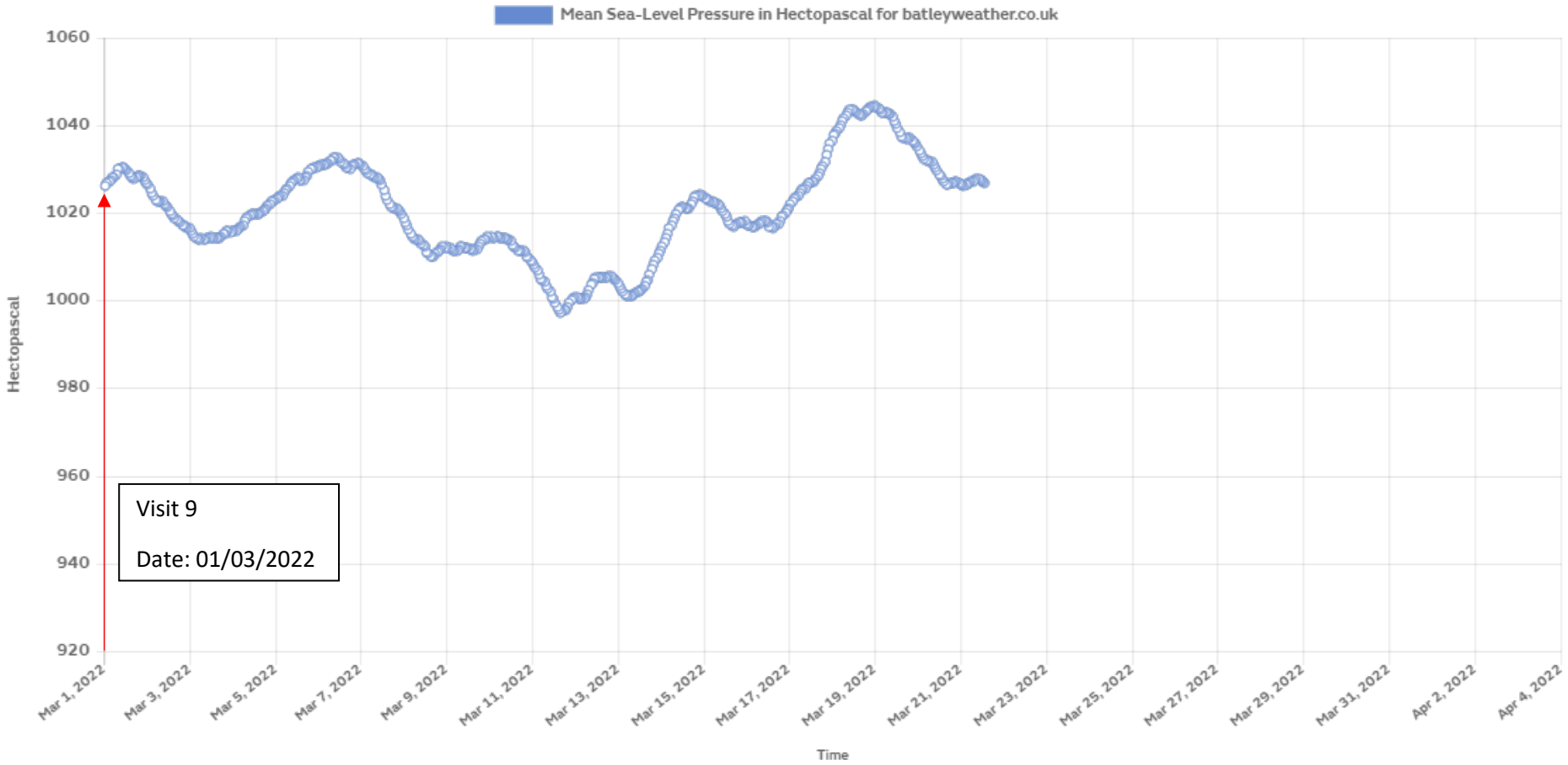
Feb 2, 2022
Time


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
1040
1020
1000
980
960
940
920
Hectopascal
Visit 8
Date: 11/02/2022
Feb 1, 2022
Feb 3, 2022
Feb 5, 2022
Feb 7, 2022
Feb 9, 2022
Feb 11, 2022
Feb 13, 2022
Feb 15, 2022
Feb 17, 2022
Feb 19, 2022
Feb 21, 2022
Feb 23, 2022
Feb 25, 2022
Feb 27, 2022
Mar 1, 2022
Mar 3, 2022
Time


Mean Sea-Level Pressure in Hectopascal for batleyweather.co.uk
1060
1040
1020
1000
980
960
940
920
Hectopascal
Visit 9
Date: 01/03/2022
Mar 1, 2022
Mar 3, 2022
Mar 5, 2022
Mar 7, 2022
Mar 9, 2022
Mar 11, 2022
Mar 13, 2022
Mar 15, 2022
Mar 17, 2022
Mar 19, 2022
Mar 21, 2022
Mar 23, 2022
Mar 25, 2022
Mar 27, 2022
Mar 29, 2022
Mar 31, 2022
Apr 2, 2022
Apr 4, 2022
Time