Supplementary Geoenvironmental Appraisal

Land at Darton Lane, Barnsley

For Duchy Homes

Report no: 4386/1

Date: August 2022

SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	4386	**Site area/ha**	3.6ha
Client:	Duchy Homes	**NGR:**	SE 319 098
Site:	Darton Lane, Barnsley	**Nearest postcode:**	S75 5AH

The site is located off Darton Lane, Barnsley, approximately 4.5km northwest of Barnsley town centre, and currently comprises three overgrown grassed fields featuring an area of saturated marsh and a gravel track. The site has remained undeveloped throughout its recorded history and has mostly been used for the grazing of horses. A disused mineral railway with an associated embankment formerly ran along the sites southern boundary. A frequently used footpath runs along its former position.

Lithos were commissioned by Duchy Homes to provide a geoenvironmental appraisal of the site, which it is understood is to be redeveloped with 46 two-storey domestic dwellings, associated gardens, POS, adoptable roads and sewers. Lithos' investigation included a review of 3rd party reports, the sites environmental setting, and a ground investigation comprising 12 trial pits, 12 rotary open-hole probeholes and 6 hand-dug pits.

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

Issue	Remarks
Made ground	Shallow made ground present across the site comprising Cohesive Reworked Natural to typical depths of 0.8m. Isolated areas of Colliery Spoil present to 0.6m and >2.8m depth. Made Ground Topsoil present sporadically across the Western and Centre Fields and covers much of the Eastern Field.
Natural ground	Topsoil (typically 300mm thickness) over firm to stiff Cohesive Residual Soils (average depth of 1.8m to base) over Granular Residual Soils over Coal Measures bedrock (average depth encountered of 2.4m).
Contamination	Made Ground Topsoil contains exceedances of Arsenic and contains frequent undesirable objects. Colliery Spoil contains exceedances of Lead and Arsenic. The Dunsil and Barnsley Coal seam are both combustible. Clean cover of varying depths is required over Made Ground Topsoil & Colliery Spoil. The cover above the Dunsil & Barnsley Coal seams where underlying rear gardens or areas of POS needs to be maintained at a minimum of 1m.
Mining & quarrying	Underground shallow mineworkings were encountered in the Barnsley Coal in the far west; the maximum thickness of affected ground was 7.4m, with a cover ratio always less than 11 times seam base. Underground shallow mineworkings were encountered in the Barnsley Coal by 3rd party in the far east; cover ratio also less than 11 times seam base. Possible outcrop workings encountered in the Barnsley Coal in the far east. No evidence of underground or outcrop workings encountered in the Dunsil or Gawber Coal.
Slope stability	No visual evidence of slope instability was observed along the embankment slope (disused mineral railway) forming the site's southern boundary. A formal slope stability risk assessment is not anticipated at this stage.
Hazardous gas	The site lies in an area where 3-5% of homes are estimated to be above the action level for Radon, and therefore basic gas protection measures are required. The site may also be at risk from mines gas resulting from shallow mineworkings and the multiple coal seams and faults underlying the site. Consequently, gas monitoring wells have been installed in 7 probeholes and a period of gas monitoring is underway.
Preparatory works	General site clearance of surface materials and vegetation. Topsoil strip and stockpile. Treatment of shallow mineworkings. Excavation of Colliery Spoil and disposal off-site or isolation beneath hardstand or if left in situ; minimum 600mm clean cover in gardens or 300mm in POS.
Foundations	Plots will be founded on traditional strip footings seated in Cohesive Residual Soils (firm to stiff clays) or Granular Residual Soils (clayey gravels). Where deepening is required it is expected that foundations will reach bedrock at approximately 2 to 2.5m. Additional reinforcement may be required for any plots founded over shallow coal workings; even after treatment; and for any plots in proximity to faults present.
Groundwater & excavations	It is considered unlikely that major groundwater flows will be encountered in shallow excavations. Excavations should remain stable in the short term but if left open for any significant period of time may require shoring.

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Job No.	4386	**Site area/ha**	3.6ha
Client:	Duchy Homes	**NGR:**	SE 319 098
Site:	Darton Lane, Barnsley	**Nearest postcode:**	S75 5AH

Issue	Remarks
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. Soakaways will not provide a suitable means of surface water disposal at the site. Consequently, there is likely to be a need for surface water balancing.
Highways	The Cohesive Residual Soils 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:

- Treatment (drilling and grouting) or shallow coal workings within the Barnsley Coal seam in the east.
- Placement of a minimum 600mm clean cover in garden areas/ 300mm in landscaped areas where underlain by Colliery Spoil or Made Ground Topsoil.
- Requirement to maintain at least 1000mm inert cover in rear gardens underlain by the Barnsley or Dunsil coal seams, due to combustion risk.

Some further work is required, most notably:

- Consideration should be given to the installation of groundwater monitoring wells within the surface water attenuation basin to monitor seasonal ground levels.
- Further trial pitting within the Marsh Area to confirm ground conditions and suitability of topsoil for reuse.
- Topsoil strip in the Eastern Field; east of the Barnsley Coal outcrop to identify if bell pits are present
- Consolidation (via drill & grout) of shallow underground mineworkings in the Eastern Field with associated Specification for the Treatment of Shallow Workings.

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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 pages to a minimum, some information (e.g. full copy of the Landmark/Groundsure Report) is not included in the PDF; by request it can be provided on a CD.

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

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

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

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

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

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

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

SUPPLEMENTARY
GEOENVIRONMENTAL APPRAISAL
of land at
DARTON LANE, BARNSLEY

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by Duchy Homes to carry out a supplementary geoenvironmental appraisal of land at Darton Lane, Barnsley.

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

- A review of third party reports
- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- A mining risk assessment in accordance with Coal Authority guidance
- An intrusive ground investigation comprising 12 trial pits, 6 hand dug pits and 12 boreholes
- Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
- A visual slope stability assessment of the disused railway embankment
- A qualitative assessment of contamination risks
- Recommendations for the necessary site preparatory and remediation works

1.1.3 Primary aims of this phase of investigation were to enable Duchy Homes to obtain budget costs for: foundations; gas protection measures; and site preparatory and remediation works and enable refinement of budget abnormals.

1.2 The proposed development

1.2.1 A site layout has been provided by STEN ARCHITECTURE (Drawing reference Draft Layout SK04, dated October 2020) which is reproduced as Drawing 4386/2 in Appendix B to this report.

1.2.2 It is understood that consideration is being given to redevelopment of the site with 46 two-storey domestic dwellings, associated gardens, POS, adoptable roads and sewers.

1.2.3 The proposed development has Outline Planning Permission (ref. 2019/1244). With respect to ground, the planning consent includes a number of Conditions; most notably:

- Condition 7 which requires a survey of the extent, scale and nature of contamination and assessment of the potential risks to human health and environmental receptors.
- Condition 8 which requires a site investigation to be undertaken to confirm ground conditions with regards to possible shallow coal mine workings.

1.2.4 This Report considers pre-construction issues, and therefore can only aid the discharge of Conditions 7 and Condition 8.

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

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 4386/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	4.5km northwest of Barnsley town centre
NGR	SE 319 098
Approximate area	3.6ha (8.9 acres)
Known services	Underground electric & sewer Overhead electric

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on 14th June 2022.

2.2.2 Existing salient features, at the time of the walkover are presented on Drawing 4386/3 in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current Access	Off Darton Road.
Topography	Topographic high point in the centre of the site in the position of the access track, with a gentle slope of c.1 in 10 to the east and to the west. The site also slopes gently southward from the northern boundary. Gently undulating across the Western and Centre field, with hummocks in the Eastern field. Off site - Former railway embankment runs parallel to southern boundary in the west.
Approximate areas	32,300m^2 overgrown grassed field 3,500m^2 marsh area 200m^2 gravel hardstand track
Nature of boundaries	North – Brick wall with sporadic hedge or tree East & South – Post & wire fence with dense vegetation, hedges and trees. West – Post & wire fence with dense vegetation, hedges and trees in the southwest, and wooden fence and brick wall with dense vegetation in the northwest.
Surrounding land uses	North – Darton Lane with residential housing beyond East – Residential housing South – Former railway (dismantled) with associated embankment in the centre to centre west, now featuring a public footpath, with arable farmland beyond. West – Residential housing and Darton Primary School beyond.

2.2.3 A selection of site photographs is included on Drawing 4386/4.

2.2.4 The site is accessed of Darton Lane via a gravel hardstand track which runs north to south through the site, between the Centre and Eastern Fields.

2.2.5 The site is formed of three adjoining fields which are understood to have once been used for the grazing of horses, however during the site walkover no horses were present.

2.2.6 The site can be divided into three areas based upon the Western, Centre and Eastern Fields.

2.2.7 The Centre and Eastern field can be accessed through wooden gates directly from the gravel track. The western field is accessed through an internal gate situated to the north along the fence line separating the Centre and Western field.

2.2.8 The site is generally topographically highest in the position of the gravel track and gently slopes to the east and west. The site also slopes from the northern boundary to the southern boundary with a gradient of c.1 in 10 in the east.

2.2.9 The Western field features long grass and former wooden fences in a state of disrepair in the southwest, presumably used to create separate paddocks for horse grazing.

2.2.10 An area containing reeds, marsh grass and dense vegetation is located between the Centre and Western field (called Marsh Area hereafter), with its own separating fence line. Though ground conditions could not be directly observed; no standing water appeared present although surface conditions appear saturated. This area could not be traversed by foot.

2.2.11 An area of possible seasonal ponding was observed along the southern boundary of the Western field, identifiable by a change in vegetation and circular shape.

2.2.12 The Central and Eastern field features long grass and dense vegetation but remained traversable by foot.

2.2.13 In the southeast corner of the Central field, an overhead electricity pylon is present which diverts underground, running north underneath the gravel track to Darton Lane.

2.2.14 In the Eastern field; the topography is undulating and borderline hummocky in the west and relatively flat in the east.

2.2.15 Along the southern boundary in the eastern field, a circular area of possible seasonal ponding appears distinctly flatter and more level than the surrounding area. Topsoil is exposed along the perimeter of the circular area.

2.2.16 The south, east, west and internal boundaries often contain Hawthorn Hedgerows.

3 ENVIRONMENTAL SETTING

3.1 General

3.1.1 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 the Coal Authority are presented in Appendix E. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 87: Barnsley) 1:10,000 BGS map (Sheet SE30NW) BGS Memoir 87 - Barnsley	Drift soils – Not present. Solid (bedrock) – Coal Measures (Sandstone, mudstone & siltstone), named unit 'Barnsley Rock Sandstone' in far west and east. Shallowest coal seam – Gawber, Dunsil and Barnsley Coal seams outcrop on site, dipping generally to the north-east. See further details in Section 3.3 below. Strata dip – northeast. Faults – Three present on site, situated in the east, centre and west.
Mining	Coal Authority	This majority of the site is located within a Coal Mining Development High Risk Area. Further details in Section 3.3 below.
Quarrying	Historical OS plans	Area c.20m off-site in south-west formerly used for Coal Opencast
Landfills	Environment Agency electronic open data via QGIS	No known landfills within 250m.
Radon	Public Health England	The site lies in an area where 3-5% of homes are estimated to be above the action level. Further details in Section 11.
Hydrogeology	Environment Agency electronic open data via QGIS	Groundwater Source Protection Zone? No. Aquifer; Secondary A Aquifer (Solid).
Hydrology		Nearest watercourse(s) – Unnamed tributary of River Dearne c.15m from sites south boundary flowing to River Dearne c.600m south. River Dearne from Cawthorne Dyke to Lundwood STW Water Body classified as; Ecological – moderate; Chemical - moderate.
Flood risk		The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. In accordance with Chapter 14 of the National Planning Policy Framework, a site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency).

3.2 Slope Stability Assessment

3.2.1 A former mineral railway (now disused) runs along the sites southern boundary which is used as a public footpath. An embankment is present c.1m off-site along the southern boundary in the centre and west, as shown on Drawing 4386/3a.

3.2.2 The embankment slope gradient is typically 1 in 3 and increases in height westwards from c.3m to a maximum of c.8m just south of the Marsh Area.

3.2.3 The following lines of evidence (visual) show there is no discernible previous or present movement on the slope:

- Trees all appear upright and show a steady unbroken rate of growth.
- No visible tension cracks on the crest or face of the embankment.
- Fence posts at the toe of the embankment are all upright and straight.
- No evidence of toe bulging.
- No evidence of hydrophilic (water loving) vegetation.
- No evidence of water seepages.

3.2.4 In light of observable evidence, it is not considered necessary to undertake further slope stability assessment at this time.

3.3 Coal & mining

3.3.1 In July 2011 the Coal Authority (CA) formalised their requirements in relation to planning applications and introduced some new terminology relating to coal mining development areas. This Section (and section 8.7) provides the necessary mining risk assessment required by the proposed planning application.

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

3.3.3 Geological maps and BGS Memoir 87 suggest that three major coal seams and two thin seams underlie the site at shallow depth. These are the:

- Barnsley Coal (between 2.3m to 3.10m thick), outcropping in the east.
- Dunsil Coal (between 0.5 to 0.8m thick), outcropping in west
- Gawber Coal (about 0.7m thick), outcropping in the far west
- A 'thin' seam is shown stratigraphically between the Gawber Coal and Dunsil Coal; and between the Dunsil Coal and Barnsley Coal. If present on site they will both outcrop between the Gawber, Dunsil and Barnsley coals.

3.3.4 Recorded outcrop positions are shown on Drawing 4386/8a and 4386/8b.

3.3.5 It should be noted that seam outcrops plotted on geological maps have been known to be inaccurate by distances in excess of 100m.

3.3.6 A CA mining report states that:

- The site is underlain by multiple past underground workings ranging from 7mbgl in the Barnsley Seam to 302mbgl in the Silkstone Seam.
- The site contains **probable unrecorded shallow workings**.
- The site contains spine roadways at shallow depth.
- There are numerous mine entries located in close proximity to the site, though none are recorded within the site boundary.

- Three coal seams outcrop on site; an unnamed seam (presumably Gawber), Dunsil and Barnsley.
- Faults recorded under and close to the property.
- Numerous opencast mines surround the site **within 500m**.

3.3.7 The BGS Memoir[1] notes that the **Barnsley Coal** is one of the most important seams in this part of the Yorkshire Coalfield, comprising three economically significant constituents; the bottom softs, the hards and the top softs, each differing in quality and therefore resulting applications. Each constituent can vary by locality in its thickness and amount of dirt and clay partings contained. Sometimes clay partings can be so thick as to split the Barnsley seam top softs into two seams; known as the Top and Low Barnsley Beds.

3.3.8 At Darton Colliery, c.170m south, the Barnsley Coal was measured at 2.9m thickness including all dirt and clay partings; of which the bottom softs, the hards and the top softs measured 0.71m, 0.67m and 1.09m respectively, the remaining thickness of 0.53m accounts for clay and dirt partings.

3.3.9 In reality, the Barnsley Coal does not comprise a uniform thickness of homogenous coal and as such it may appear as several distinct coal seams, separated by soft horizons of clay and dirt partings during drilling.

3.3.10 The memoirs note '*old [*opencast] *workings [*of Barnsley Coal] *are conspicuous for some distance, particularly to the south…near Darton Hall (c.250 northwest of site, Barnsley Coal outcropping on a separate fault block)*.

3.3.11 The Dunsil Coal is mentioned within the memoirs[1] to be 'workable in places', although no mention is given to the Darton Locality and nearly all mentions, except for Silkstone, are to the west of the Barnsley. The Dunsil coal appears typically 15m to 24m below the Barnsley Coal and comprises two thin seams of approximately 0.3m and 0.25m, separated by dirt partings.

3.3.12 The BGS Memoirs do not give mention to the Gawber Coal.

3.3.13 Given dip, topography and faulting, the following seams, excluding thin seams, are expected to underlie the site at shallow depth (<30m);

- The Barnsley seam is expected to underlie an area of about 7400m^2 in the far west and 5050m^2 in the far east; a combined total of 12,450m^2.
- The Dunsil Seam is expected to underlie an area of about 17,700m^2 throughout the majority of the site, from the centre west towards the east
- The Gawber Seam is expected to underlie an area of about 26,400m^2 throughout the majority of the site, from the far west to the east.

[1] *British Geological Survey (1989). Geology Of the Country Around Barnsley. Memoir 87. 4th ed. Pg 55 to 59.*

3.4 Mineral safeguarded areas

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

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

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

3.4.4 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.

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

3.4.6 As a consequence of the NPPF, and the presence of coal beneath the site, the Local Authority may require Duchy 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

3.4.7 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 12 rotary probeholes to depths of between 9.0m and 30.0m (see Section 7.0).

3.5 Agriculture

3.5.1 Historical plans mentioned within 3rd party reports show that the site has been occupied by arable farmland. Generally farming is not considered likely to have caused significant ground contamination. However, activities such as slurry spreading, the discharge of chemicals to ground, and unregulated burial are known to have occurred on farmland. Potential contaminants associated with farming activity could include any of the following.

Agricultural activity	Potential contaminant
Slurry pits, manure heaps, septic tanks	Methane, metals, nitrates, oxygen depletion
Sewage farming, slurry spreading	Methane, metals, nitrates, oxygen depletion
Tracks (if built up with crushed demolition rubble etc)	Metals, asbestos, hydrocarbons
Orchards	Metals, pesticides

Agricultural activity	Potential contaminant
Carcase burial	Anthrax & other biohazards
Plant & animal protection	Pesticides & herbicides
Timber processing/treatment	Metals, PAH, chlorinated organics
Soil conditioners	Metals, sulphates, PAH
Field sports	Lead shot
Fuel storage	Hydrocarbons, methane, oxygen depletion
Equipment maintenance	Hydrocarbons, metals
Waste burial, land levelling, backfilling ponds/quarries	Methane, metals, PAH etc
Derelict buildings	Asbestos
Wartime military use	Metals, asbestos, hydrocarbons, explosives
Naturally occurring contaminants	Arsenic, metals
Sheepfolds	Arsenic

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

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

4 PREVIOUS INVESTIGATION FINDINGS

4.1 General

4.1.1 Duchy Homes have provided Lithos with a copy of the following report:

- Land south of Darton Lane, Barnsley: Phase 2 Geo-Environmental Site Investigation (Ref. RPT-004, Job Number SH12190), issued by Wardell Armstrong in November 2019.

4.1.2 Wardell Armstrong have also issued the following desk-based reports which have been submitted to and available to view from Barnsley Planning Portal:

- Phase 1 Geo-Environmental Desk Study (Ref. SH12190-001) dated February 2019.
- Coal Mining Risk Assessment (Ref. SH12190-003) dated February 2019.

4.1.3 The Phase 2 Geo-Environmental report (SH12190-004) presents the findings of an intrusive site investigation, drawing on information obtained from the Phase 1 Desk Study (SH12190-001) which included a review of environmental and historical OS map data obtained from a Landmark report and a CA Consultants Mining Report. The Landmark report has not been appended to the Phase 1 or Phase 2 report and Lithos have been unable to review the data contained.

4.1.4 A site walkover was undertaken as part of the Phase 1 Desk Study Report on the 1st November 2018 and does not appear to have been revisited until site investigation works on October 7th 2019.

4.2 Summary of Wardell Armstrong findings

4.2.1 Wardell Armstrong's ground investigation works comprised:

- 16 Trial pits (TPs 101 to 116) excavated between 1.6m and 3.4m depth.
- 7 Rotary open probeholes (BHs 101 to 107) sunk between 10.0m and 25.0m depth.
- Monitoring wells were installed in 4 boreholes (BHs 101, 104, 105 & 107), with response zones sealed in residual soils, residual soils with coal (Dunsil Coal) and mudstone bedrock.
- Geotechnical classification tests (Atterberg Limits, pH, soluble sulphate etc).
- Chemical laboratory tests (including inorganics, asbestos ID, phenols, Speciated PAH, pH and metals, monoaromatics and Oxygenates, Petroleum Hydrocarbons).
- Gas monitoring; 3 visits between 31/10/19 and 14/10/19, with atmospheric pressures in the range 993mb to 1010mb. No steady positive flows recorded. Sustained negative flow of -0.4l/hr recorded.

4.2.2 Ground conditions encountered by Wardell Armstrong are summarised in the table on page 11 and 12.

4.2.3 Wardell Armstrong chemical results are contained in the contamination summary tables on pages 23 to 30.

4.2.4 Wardell Armstrong geotechnical data is summarised in Section 12: Geotechnical Testing.

4.3 Lithos comments

4.3.1 Ground conditions typically comprise topsoil over weathered coal measures residual soils over Coal Measures bedrock at average 1.6m depth. Made Ground where encountered comprised Granular, Cohesive and Reworked Natural strata types to an average depth of 1.0m, excluding TP102 which featured Colliery Spoil to >2.8m.

4.3.2 25 samples comprising 2 topsoil, 4 Made Ground Topsoil, 5 Reworked Natural, 8 Cohesive Residual Soils, 2 Cohesive Made Ground and 1 Mudstone bedrock were sent for chemical analysis. Results indicated exceedances of the Soil Screening Values of the following determinands:

- TP101, 0.2m, Topsoil: Arsenic (50mg/kg)
- TP116, 0.1m, Topsoil: Arsenic (44 mg/kg) B(a)P (4.5 mg/kg),
- TP116, 0.1m, Topsoil: Benzo(b)fluoranthene (4.4 mg/kg)
- TP116, 0.1m, Topsoil: Dibenzo(ah)anthracene (0.75mg/kg)

4.3.3 Visual and olfactory evidence of petroleum hydrocarbon contamination was identified at the location of TP116, although no exceedances of petroleum hydrocarbons were identified in chemical testing of TP116 taken at 0.1m and 1.0m depth. The presence of 'black stained reinforced timber' was identified at 1.3m depth.

4.3.4 No asbestos was identified in any soil samples.

4.3.5 No topsoil testing in accordance with BS3882 was undertaken.

4.3.6 Gas monitoring was undertaken in 4 boreholes across a 2 week period from 31/10/19 to 14/10/19 with response zones targeting residual soils, residual soils and coal (Dunsil Coal) and mudstone bedrock. Monitoring results did not report any CH_4 and a maximum CO_2 concentration of 5.7% vol and lowest O_2 concentration of 16.0%. No sustained positive flows were identified. The response zone for BH04, which contained the highest concentrations of CO_2 was flooded on two out of three visits.

4.3.7 It is not clear whether a separate Gas Risk Assessment which contains further monitoring visits has been issued.

4.3.8 Groundwater levels taken from monitoring wells vary from 0.79m and 3.33m. Slight seepages were noted from trial pit excavations.

4.3.9 Mention of an opencast highwall in the southwest is given, although it is not clear whether any attempt was made in the Wardell Armstrong investigation to determine its location or characteristics.

4.3.10 The mining investigation found evidence of workings of the Barnsley Seam in the west (15.5m to 17.4m) and east of the site (5.0m to 6.1m)

5 PRELIMINARY CONCEPTUAL SITE MODEL

5.1.1 A preliminary conceptual site model, presented as Drawing 4386/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 4 inclusive of this report.

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

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

5.1.4 3rd party investigation discovered exceedances of Organic and Inorganic compounds in Topsoil and Made Ground Topsoil and subsequently these areas will be sampled further during this investigation.

6 GROUND INVESTIGATION DESIGN

6.1 Anticipated ground conditions & potential issues

6.1.1 Based on the data reviewed in Sections 3 (Environmental Setting) and 4 (Previous Investigation Findings), anticipated ground conditions are expected to comprise:

Anticipated condition	Remarks
Made ground	Granular, Cohesive and Reworked Natural strata types to an average depth of 1.0m. Colliery Spoil to >2.8m (3rd party report) noted in far west.
Natural soils	Topsoil over cohesive and granular residual soils.
Bedrock	Coal Measures bedrock (sandstone, mudstone & siltstone) expected between 2.0m and 5.0m depth. Barnsley Rock Sandstone in far east and west.
Mineworkings	Known mineworkings of Barnsley Seam in East and West of site, at 5.0 – 6.1m and 15.5m to 17.4m respectively.
Groundwater	0.8m to 3.3m noted in 3rd party monitoring wells (shallow groundwater body), seepages encountered in trial pit sidewalls.

6.1.2 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. Agrochemicals associated with farming 2. Made Ground including colliery spoil 3. Underground mineworkings (with faults present)	1. Metals, organics, inorganics 2. Metals, organics, inorganics 3. Migration of hazardous gas

Type of issue	Specific issue	Remarks
Potential off-site contamination sources	1. Made Ground including colliery spoil	1. Migration of hazardous gas
Potential geotechnical hazards	1. Relict buried obstructions 2. Deep MG 3. Steep slopes 4. Soft ground 5. Shallow workings 6. Faults	1. Associated with backfilled shallow workings 2. Settlement, foundations may require deepening 3. Potential of slope failure 4. Settlement, require deepening of foundations 5. Migration of void to surface 6. Require reinforcement of foundations
Other potential constraints	1. Multiple utilities present	1. May require diversion or easements

6.2 Ground investigation design & strategy

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

Exploratory holes	Purpose
TP's 1 to 12	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of shallow soils, including any made ground • Confirm the position of outcropping coal seams • Suitability of the ground for founding structures and highways • Nature, degree and extent of contamination • Proportion of undesirable elements e.g. biodegradable matter, foundations etc
PHs 1 to 12	To check for the presence of voids or broken ground associated with possible unrecorded shallow mine workings and install monitoring wells to monitor for hazardous gas.

6.2.2 Proposed exploratory hole locations were selected in light of 3rd party exploratory hole locations to provide a representative view of the strata beneath the site and to target potential areas of interest identified in Section 3 and 4 above. A nominal 50m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

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

7 FIELDWORK

7.1 Objectives

7.1.1 The original investigation strategy is outlined in Section 6.2 above.

7.2 Scope of works

7.2.1 Fieldwork was supervised by Lithos from 11th July 2022 to 15th July 2022, the 18th July and the 20th July 2022 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 101 to 112	1.9m to 3.5m	Vane tests in cohesive soils
Hand Dug Pits	TS01 to 04 & CS01 to 02	0.1m to 0.4m	To collect additional samples for chemical analysis
Rotary open-hole probeholes	PHs 101 to 112 & PH104A	9.0m to 30.0m	Monitoring wells installed in 7 probeholes

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

7.2.3 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

7.2.4 Exploratory hole locations are shown on Drawing 4386/6a and 4386/6b presented in Appendix B; all positions are based on data from a hand-held GPS (typically +/- 3m accuracy) and have not been surveyed in. Approximate ground level data (mAOD) has been determined from topographical survey data.

8 GROUND CONDITIONS

8.1 General

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

8.2 Made ground

8.2.1 Some of the made ground on site is a heterogeneous mixture of materials and it is unlikely, even with a huge amount of sampling, that it could be accurately characterised. Nonetheless, the made ground can be categorised as one of 3 broad types:

- **Cohesive Reworked Natural:** comprising orange mottled grey, sometimes slightly gravelly, slightly sandy, silty Clay, to depths ranging 0.7m to 0.9m; average 0.7m. Sometimes Cohesive Reworked Natural was underlain by terracotta land drains, but generally did not contain any anthropogenic material with the exception of a rusted metal bar present in TP109 at 0.6m. The spatial distribution of Cohesive Reworked Natural was widespread from the northwest to the east.

- **Colliery Spoil:** comprising gravelly, silty Clay with frequent anthropogenic, sometimes putrescible material. Colliery Spoil was only observed in TP110 to 0.6m depth in an area of flat ground with anecdotal evidence of seasonal ponding water.
- **Made Ground Topsoil:** comprising slightly gravelly, silty sand with rare plastic netting, brick fragments, whole bricks and paper; to between 0.2m and 0.3m depth. Made Ground Topsoil was dominant in the Eastern field, and was located sporadically throughout the Western and Centre fields.

8.2.2 Review of the Lithos trial pit logs suggest made ground thicknesses beneath the site vary between 0.7m and 0.9m; average 0.8m. The thickest made ground (TP106) was encountered in the Eastern Field by Lithos. However, 3rd party reports encountered made ground >2.8m deep in the far west of the site.

8.3 Obstructions

8.3.1 It is apparent from a review of 3rd party reports (see Section 4) that a small outbuilding was present until at least 1970 in the centre of the site. It is possible that relict foundations associated with this structure may remain present in the ground, although its position is unknown to Lithos. No other obstructions were identified during the excavation of trial pits or drilling of rotary probeholes.

8.4 Natural ground

8.4.1 Natural ground was encountered in all exploratory holes, and typically comprised the following strata types:

- **Topsoil:** comprising slightly gravelly, clayey Sand with frequent rootlets was identified across the site to a typical depth of 300mm. The topsoil in TP104 was rootbound from 0.1m.
- **Cohesive Residual Soils (Gravelly Clay):** comprising typically firm to very stiff, slightly gravelly, slightly sandy, silty Clay. Gravel is comprised of subangular fine to medium sized mudstone, sandstone, siltstone and coal lithorelicts. Cohesive Residual Soils extend to an average depth of 1.8m across the site onto Granular Residual Soils or Coal. The maximum observed base of Cohesive Residual Soils was 3.2m in TP110, where the Barnsley Coal was encountered at 1.9m to 2.5m.
- **Granular Residual Soils (Clayey Gravels):** typically comprising clayey Gravel of either mudstone, sandstone or siltstone to an average depth of 2.4m; maximum >3.5 (TP110). Granular Residual Soils were encountered across the site and extend onto Coal Measures bedrock.
- **Coal Measures Bedrock (Sandstone, Siltstone and Mudstone):** comprising a combination of extremely weak to weak Siltstone, extremely weak carbonaceous Mudstone, extremely weak to weak Mudstone and strong Sandstone. Bedrock was encountered from an average depth of 2.4m in trial pits.
- The following coal seams were encountered in trial pits near to outcrop positions (See Drawing 4386/8a and 4386/8b):
    - **Gawber Coal:** encountered in TP104 as extremely weak dull black Coal from 1.4m to 1.9m depth; thickness 0.5m.
    - **Dunsil Coal:** encountered in TP106 as extremely weak, vitreous, black, blocky Coal from 3.2m to 3.7m depth; thickness 0.5m. A Seat Earth was encountered below the Dunsil Coal in TP106 from 3.7m to >3.9m and comprised stiff gravelly, silty Clay.
    - **Barnsley Coal:** encountered in TP110, TP111 & TP112 as extremely weak, black, sometimes dull and ashy, predominantly vitreous and blocky Coal. A weathered horizon of the Barnsley Coal was encountered from 0.6m to 1.1m in TP112 and comprised clayey Gravel of Coal. The thickness of the Barnsley Coal encountered

in trial pits is likely not representative of its maximum natural thickness due to its proximity to surface and as a result of weathering.

Summary of Ground Conditions – Trial Pits

Hole ID	Final depth (m)	Depth to Base of Made Ground	Depth to Base of (m)						Depth to Coal Measures Bedrock (m)	Depth to base of (m) (THICKNESS)			Penetration into bedrock (m)
			Made Ground			Natural Soils							
			Made Ground Topsoil	Reworked Natural	Colliery Spoil	Topsoil	Residual Soils			Gawber Coal	Dunsil Coal/ Thin Coal	Barnsley Coal	
							Cohesive	Granular					
TP101	2.7	-	-	-	-	0.2	1.6	2.2	2.2	-	-	-	0.5
TP102	1.9	-	-	-	-	0.2	1.5	1.7	1.7	-	-	-	0.2
TP103	2.9	0.7	-	0.7	-	0.2	1.3	2.0	2.0	-	-	-	2.9
TP104	2.8	0.7	-	0.7	-	0.2	1.0, 1.4	2.6	2.6	-	1.9 (0.5)	-	0.2
TP105	3.2	0.9	-	0.9	-	0.5	1.7	2.5	2.5	-	-	-	0.7
TP106	3.9	0.9	-	0.9	-	0.3	2.0	2.9	2.9	-	3.7 (0.5)	-	1
TP107	3.5	-	-	-	-	0.4	1.0	1.8	1.8	-	-	-	1.7
TP108	3.4	0.8	0.2	0.8	-	-	2.1	3.0	3.0	-	-	-	0.4
TP109	2.9	0.8	0.3	0.8	-	-	1.2	2.5	2.5	-	-	-	0.4
TP110	3.5	0.6	-	-	0.6	-	1.9, 3.2	>3.5	-	-	-	2.5 (0.6)	-
TP111	3.3	-	-	-	-	0.3	2.3	2.5	2.5	-	-	>3.3	0.8
TP112	2.6	-	-	-	-	0.3	0.6, >2.6	-	-	-	-	2.5 (1.9)	-

Summary of Ground Conditions – Hand Dug Pits

Hole ID	Final depth (m)	Strata Encountered	Samples Taken
TS101	0.2	Brown slightly gravelly silty fine to coarse Sand with frequent rootlets. Gravel is angular fine to medium of mudstone and rare coal. [Topsoil]	1J & 1T 0.1m
TS102	0.2		1J & 1T 0.1m
TS103	0.4	Made Ground: Brown very gravelly silty fine to coarse Sand with rare ceramic, brick, coal, glass and metal. Gravel is angular to subangular fine to medium of mixed lithologies [Made Ground Topsoil]	1J & 1T 0.4m
TS104	0.3		1J & 1T 0.3m
CS101	0.3	Black gravelly silty Clay with frequent whole brick, metal, glass, brick fragments and wood. Gravel is angular to subrounded fine to medium of mixed lithologies. [Colliery Spoil]	1J & 1T 0.3m
CS102	0.3		1J & 1T 0.3m

Summary of Ground Conditions – Probeholes

Hole ID	Final depth (m)	Depth to base of Overburden (m)	Depth to Coal Measures Bedrock (m)	Penetration into bedrock (m)	Depth to base of (m) (THICKNESS)					Workings (m)	Cover Ratio	Remarks
					Gawber Coal	Dunsil Coal	Barnsley Coal	Swallow Wood Coal	Thin Seam			
PH101	29.7	2.7	2.7	27.0	-	13 (0.5)	-	-	6.9 (0.4)	-	-	Monitoring well installed
PH102	30.0	2.0	2.0	28.0	6.6 (0.4)	-	-	-	13.9 (0.3)	-	-	Monitoring well installed
PH103	29.7	1.5	1.5	28.2	-	-	-	-	7.6 (0.2)	-	-	-
PH104	18.4	2.5	2.5	15.9	-	-	-	-	-	**10.9 to 18.3 (7.4)**	4.9	Migrated workings encountered
PH104A	2.0	>2.0	-	-	-	-	-	-	-	-	-	Monitoring well installed
PH105	24.0	1.6	1.6	22.4	-	-	-	-	5 (0.2), 5.7 (0.2), 12.2 (0.3), 20.8 (0.1), 22,0 (0.3)	-	-	-
PH106	22.8	1.6	1.6	21.2	-	-	18.3 (0.2)	-	-	**18.3 to 20.5 (2.2)**	5.9	Hole terminated in solid ground beneath workings.
PH107	21.0	1.0	1.0	20.0	-	-	15.8 (0.8)	-	-	**12.6 to 15.0 (2.4)**	4.4	Monitoring well installed
PH108	30.0	2.0	2.0	28.0	-	28.8 (0.7)	-	-	-	-	-	Monitoring well installed
PH109	9.0	1.4	2.5	7.6	-	-	2.5 (1.1)	-	-	-	-	-
PH110	9.0	2.0	2.0	7.0	-	-	5.3 (3.0)	-	-	-	-	Monitoring well installed
PH111	9.0	1.2	1.2	7.8	-	-	4.4 (3.2)	-	-	-	-	Maximum thickness of Barnsley Seam encountered
PH112	9.0	2.0	2.0	7.0	-	-	-	-	-	-	-	Monitoring well installed

Summary of Wardell Armstrong Ground Conditions – Trial Pits

Hole ID	Final depth (m)	Depth to Base of (m)							Depth to Coal Measures Bedrock (m)	Depth to base of (m) (THICKNESS)					Penetration into bedrock (m)
			Made Ground				Natural Soils								
		Depth to Base of Made Ground	Gran. Made Ground	Coh. Made Ground	Rework Natural	Colliery Spoil	Topsoil	Residual Soils		Gawber Coal	Dunsil Coal	Barnsley Coal	Swallow Wood Coal?	Seat Earth/ Thin seam	
TP101	2.0	-	-	-	-	-	0.3	1.6	1.6	-	-	-	-	-	0.4
TP102	2.8	>2.8	-	-	1.8	>2.8	-	-	-	-	-	-	-	-	-
TP103	2.1	-	-	-	-	-	0.3	1.6	1.6	-	-	-	-	-	0.5
TP104	2.5	-	-	-	-	-	0.3	1.6	1.6	-	-	-	-	-	0.9
TP105	2.8	0.7	-	0.7	-	-	0.3	1.3	1.3	-	-	-	-	-	1.5
TP106	2.6	-	-	-	-	-	0.2	1.4	1.4	-	-	-	-	-	1.2
TP107	1.6	-	-	-	-	-	0.2	1.4	1.4	-	-	-	-	-	0.2
TP108	2.5	-	-	-	-	-	0.3	1.7	1.7	1.1 (0.4)	-	-	-	-	0.8
TP109	2.8	1.7	-	-	1.7	-	0.2	2.3	2.3	-	-	-	-	-	0.5
TP110	2.8	0.5	-	-	0.5	-	0.2	1.8	-	-	-	-	2.5 (0.7)	2.8	-
TP111	2.8	-	-	-	-	-	0.2	1.8	1.8	-	-	-	-	-	1.0
TP112	2.4	-	-	-	-	-	0.2	1.3	1.3	-	-	-	-	-	1.1
TP113	2.8	0.5	-	-	-	-	0.5	1.0, 2.1	2.1	-	-	-	-	1.1 (0.1)	2.8
TP114	2.3	0.8	-	0.8	-	-	0.2	1.6, 2.1	2.1	-	2.0 (0.4)	-	-	-	0.2
TP115	3.4	-	-	-	-	-	0.2	1.6	-	-	-	3.2 (1.6)	-	3.4	-
TP116	3.1	1.8	-	1.8	-	-	0.3	-	-	-	-	3 (1.2)	-	3.1	-

Summary of Wardell Armstrong Ground Conditions – Probeholes

Hole ID	Final depth (m)	Depth to Base of (m)		Depth to Coal Measures Bedrock (m)	Depth range and thickness (**) of:					Workings (m)	Cover Ratio (m)	Penetration into bedrock (m)
		Topsoil	Residual Soils		Gawber Coal	Dunsil Coal	Barnsley Coal	Swallow Wood Coal?	Thin seam			
BH101	20.2	0.4	3.0	3.0	-	-	-	-	-	15.5 to 17.4 (1.9)	7.58	17.2
BH102	25.0	0.3	2.0	2.0	6.8 to 7.2 (0.4)	-	-	21.3 - 21.6 (0.3), 22.0 - 22.5 (0.5)	14.0 - 14.5 (0.5)	-	-	23
BH103	10.0	0.5	3.0	3.0	6.8 - 7.4 (0.6)	-	-	-	-	-	-	7.0
BH104	21.8	0.2	2.6	2.6	-	1.45 - 1.8 (0.35)	-	-	-	-	-	19.2
BH105	10.0	0.3	2.0	2.0	-	-	-	4.4 - 4.7 (0.3), 5.4 - 5.8 (0.4)	-	-	-	8.0
BH106	15.0	0.3	5.0	5.0	10-10.6 (0.6)	-	-	-	-	-	-	10
BH107	24.8	0.3	3.5	3.5	-	-	3.3-5.0 (1.7)	-	-	5.0-6.1	2.36	21.3

8.5 Groundwater

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

8.5.2 Numerous land drains were encountered in trial pits although none contained water.

8.5.3 Groundwater levels recorded in the first monitoring wells are summarised below.

Hole	Response zone (depth range & strata)	Groundwater body	Typical standing water level	
			m bgl	m AoD#
PH102	2.0 – 4.0m (Coal Measures bedrock – Siltstone)	Deep – Coal Measures bedrock	0.5	68.10
PH110	1.0 – 2.0m (Granular Residual Soils)	Shallow - Residual Soils	1.27	74.78

Estimated from topo survey data

8.5.4 The other five monitoring wells were recorded to be dry, to the base of the well at depths of between c. 2m and 4m.

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

8.6 Stability

8.6.1 Stability of excavations within Natural and Made Ground was generally good.

8.7 Mining Investigation

Shallow workings (rotary probeholes)

8.7.1 It is clear from the review of 3rd party reports and from the Coal Authority Consultants Mining Report that the site is likely to be underlain by shallow mineworkings associated with the Barnsley Coal.

8.7.2 The conjectured outcrop of the Gabwer, Dunsil and Barnsley seam is shown on Drawings 4386/8a and 4386/8b in Appendix B to this report.

8.7.3 Consequently, a mining investigation has been undertaken, comprising the drilling of 12 rotary open-hole probeholes. The investigation identified coal and workings (combination of soft and broken ground) as summarised on page 18.

8.7.4 Analysing the data obtained from the 12 Lithos mining investigation probeholes, the Barnsley Seam is present on site it is apparent that in the **Western Field**:

- **Barnsley seam** of coal underlies about 0.84ha of the site in the far west, truncated to the east by faulting.
- The Barnsley seams maximum recorded thickness on site was 3.2m.
- All three of the holes advanced through the Barnsley seam encountered evidence of **workings** in the far west. Additionally, one 3rd party probehole advanced through the Barnsley Seam encountered workings in the far west.
- The thickness of competent (rock) cover above the Barnsley seam in the far west is always less than 11 times seam base.
- The maximum recorded thickness of workings, including collapse migrated workings in the far west is 7.4m.

8.7.5 Additionally, the Barnsley Seam is apparent in the **Eastern Field** where:

- **Barnsley seam** of coal underlies about 0.38 ha in the far east, outcropping on site and dipping typically north-east.
- One of six holes advanced through the Barnsley Seam encountered evidence of **possible outcrop workings** in the **far east**. Additionally, one 3rd party probehole encountered evidence of possible workings in the far east.
- The thickness of competent (rock) cover above the Barnsley Seam in the far east in 3rd party probeholes is always less than 11 times seam base.
- The maximum recorded thickness of underground workings from 3rd party probeholes, in the far east is 1.1m.

8.7.6 The following coal seams were also encountered on site:

- The **Gawber** seam, encountered in one Lithos probehole at 0.4m thick, outcrops in the west and dips to the northeast.
- The **Dunsil** seam was encountered in two probeholes and one trial pit; typically 0.5m thick, outcropping in the centre-west and dipping to the northeast.
- Multiple **Thin** seams were encountered between all major named coal seams; maximum thickness 0.5m, though typically 0.1m to 0.3m in thickness.
- The Swallow Wood seam was possible encountered at depth in PH105, though it is extremely difficult to differentiate between a thin seam and repeating thin leaves of the swallow wood at such depth and has therefore been recorded as Thin seams.
- No evidence of workings was encountered in the Gawber, Dunsil, Thin or Swallow Wood seams across the site by Lithos or 3rd party probeholes.

8.7.7 Linear triangulation has not been undertaken on any coal seam as data points are too close spatially (due to the sites geometry) which increases the potential for error significantly. Furthermore, faulting present on site adds further potential error. In general, the coal seams appear to dip north/northeast at a shallow gradient (c.4-6°).

8.7.8 Gas monitoring wells were installed 7 in probeholes.

8.8 Revised conceptual ground model (ground conditions)

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

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

9 CONTAMINATION (ANALYSIS)

9.1 General

9.1.1 It is understood from 3rd party reports that the site has not been the subject of a past potentially contaminative industrial land use. However, arable farming and horse grazing has been carried out on the site. Sampling of the topsoil has been undertaken 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 6.

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 via the CLEA default conceptual site model (CSM) used for generating SGVs, but amended, where appropriate, to be more specific to redevelopment within the planning process.

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
Made ground Topsoil	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 TOC, Speciated Polycyclic Aromatic Hydrocarbons (PAH), Banded Total Petroleum Hydrocarbons (TPH)
Colliery Spoil	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 TOC, Speciated Polycyclic Aromatic Hydrocarbons (PAH), Banded Total Petroleum Hydrocarbons (TPH)
Cohesive Reworked Natural	4	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 TOC, Speciated Polycyclic Aromatic Hydrocarbons (PAH), Banded Total Petroleum Hydrocarbons (TPH)
Topsoil	10	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Speciated Polycyclic Aromatic Hydrocarbons (PAH)
	4	Clay/sand/silt content and visible contaminants, sharps (glass etc) to check compliance with BS3882:2015
Coal	3	Calorific Value (1 x Barnsley, 1 x Gawber, 1 x Dunsil)

9.3 Soil contamination results

9.3.1 The soil contamination test results are summarised in the tables on pages 24 to 31.

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	Vn	Zn$	CV	Asbestos
				37	5	26	4000	100	200	199	109	434	584	200	2	
Lithos Data																
TP101	0.8	Cohesive Residual Soil	5.8	9.4	0.3	< 0.1	20	25	22	< 0.1	19	< 0.5	31	62	-	N.D.
TP104	0.5	Cohesive Reworked Natural	5.9	9.7	0.3	< 0.1	20	24	23	< 0.1	20	< 0.5	31	65	-	N.D.
TP108	0.5	Cohesive Reworked Natural	6.0	9.9	0.3	< 0.1	20	30	22	< 0.5	21	< 0.5	31	68	-	N.D.
TP109	0.5	Cohesive Reworked Natural	7.1	14	0.9	0.4	21	34	32	< 0.1	23	< 0.5	33	**230**	-	N.D.
TP106	0.6	Cohesive Reworked Natural	6.3	8.2	0.2	< 0.1	17	22	14	< 0.4	9.5	< 0.5	29	48	-	N.D.
TP110	0.2	Colliery Spoil	7.6	27	0.8	1.8	72	**110**	**300**	< 0.3	36	1.6	73	**410**	-	N.D.
TP110	0.4	Colliery Spoil	7.1	**51**	0.9	1.5	78	**140**	**270**	0.3	40	1.3	85	**340**	-	N.D.
CS101	0.3	Colliery Spoil	7.6	24	1.2	1.3	140	**150**	**230**	< 0.3	40	0.9	96	**460**	-	N.D.
CS102	0.3	Colliery Spoil	7.6	30	1.3	1.6	89	**130**	**270**	< 0.3	42	1	86	**440**	-	N.D.
TP104	1.7	Gawber Coal	-	-	-	-	-	-	-	-	-	-	-	-	< 2	-
TP106	3.4	Dunsil Coal	-	-	-	-	-	-	-	-	-	-	-	-	**18**	-
TP110	2.0	Barnsley Coal	-	-	-	-	-	-	-	-	-	-	-	-	**21**	-
Wardell Armstrong Data																
TP101	0.7	Cohesive Residual Soil	5.0	16	0.5	< 0.2	19	24	17	< 0.3	20	< 1.0	23	87	-	N.D.
TP103	0.4	Cohesive Residual Soil	6.5	6.1	0.6	< 0.2	21	28	27	< 0.3	19	< 1.0	20	91	-	N.D.
TP104	1.0	Cohesive Residual Soil	6.0	6.1	0.4	< 0.2	21	30	16	< 0.3	40	< 1.0	18	85	-	N.D.
TP110	0.5	Cohesive Residual Soil	7.4	3.2	0.5	< 0.2	16	20	18	< 0.3	17	< 1.0	22	44	-	N.D.
TP111	1.4	Cohesive Residual Soil	6.1	7.1	0.4	< 0.2	23	24	14	< 0.3	32	1.7	18	81	-	N.D.

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens** end-use.												
			pH	As ∞	B~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg*	Ni	Se	Vn	Zn$	CV	Asbestos
				37	5	26	4000	100	200	199	109	434	584	200	2	
TP112	0.1	Cohesive Residual Soil	6.6	12	1.4	< 0.2	26	44	49	< 0.3	22	< 1.0	31	85	-	N.D.
TP102	0.3	Reworked Natural Ground	6.4	1.6	0.5	< 0.2	20	53	24	< 0.3	48	< 1.0	29	94	-	N.D.
TP102	1.3	Reworked Natural Ground	6.7	16	0.3	< 0.2	22	42	30	< 0.3	41	< 1.0	22	76	-	N.D.
Wardell Armstrong Data																
TP109	1.0	Reworked Natural Ground	7.9	7.3	0.4	< 0.2	16	33	19	< 0.3	55	< 1.0	24	57	-	N.D.
TP110	0.2	Reworked Natural Ground	7.6	8.3	0.7	< 0.2	17	23	24	< 0.3	22	< 1.0	24	58	-	N.D.
TP105	0.5	Cohesive Made Ground	6.3	< 1.0	0.8	< 0.2	12	18	16	< 0.3	17	< 1.0	18	50	-	N.D.
TP114	0.5	Cohesive Made Ground	7.7	4.3	0.8	< 0.2	30	40	35	< 0.3	36	< 1.0	26	90	-	N.D.
TP114	1.3	Cohesive Made Ground	7.6	15	0.8	< 0.2	22	29	17	< 0.3	21	< 1.0	26	52	-	N.D.
TP116	1.0	Cohesive Made Ground	6.7	< 1.0	0.8	< 0.2	17	23	15	< 0.3	22	< 1.0	19	61	-	N.D.
TP106	1.5	Coal Measures	6.4	13	0.4	< 0.2	22	32	13	< 0.3	38	< 1.0	20	87	-	N.D.
TP108	0.5	Coal Measures	5.8	17	1.0	< 0.2	19	38	23	< 0.3	35	< 1.0	26	65	-	N.D.

Key		Source of Guidance Trigger Level	
36	Parameter tested for and found to be in excess of Tier 1 concentration	With the exception of those annotated with one of the symbols below (∞, $, ~), all Soil Screening Values in brackets above have been derived using CLEA v1.06. Values assume contaminants located in a sandy loam, with 6% soil organic matter (SOM).	
179	Parameter tested for and found to be > 5 x Tier 1 concentration		
12	Parameter tested for but not found to be in excess of Tier 1 concentration	∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE\Defra)
-	Parameter not tested for	$	Ministry of Agriculture, Fisheries & Food. 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 screen would be 21mg/kg		

Key		Source of Guidance Trigger Level	
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.	N.D.	Not detected, applicable to asbestos I.D. screen only

Summary of degree of soils contamination - Topsoil

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with garden**s end-use.													PAH		Asbestos I.D.
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Vn	Zn $	% TOC	B(a)P ∞	Naphthalene	
				37	5	26	4000	100	200	199	109	434	584	200		5	10	
Lithos Data																		
TS101	0.1	Topsoil	7.3	24	1.9	0.5	23	86	89	<0.2	23	1.2	35	200	9.3	0.1	< 0.1	N.D.
TS102	0.1	Topsoil	6.8	13	2.1	0.3	15	50	48	<0.1	15	0.6	24	88	8.3	< 0.1	< 0.1	N.D.
TS103	0.4	Made Ground Topsoil	7.0	**39**	1.2	0.3	21	90	89	< 0.3	30	0.8	48	100	13.0	< 0.4	< 0.1	N.D.
TS104	0.3	Made Ground Topsoil	7.8	34	1.1	0.3	21	86	96	< 0.3	28	0.8	44	110	9.5	< 0.4	< 0.1	N.D.
TP108	0.1	Made Ground Topsoil	6.3	16	1.6	0.3	19	45	53	< 0.2	19	1.1	33	89	6.4	< 0.1	<0.1	N.D.
TP109	0.1	Made Ground Topsoil	6.0	19	1.4	0.3	22	47	55	< 0.2	22	1.5	38	100	5.6	< 0.8	<0.1	N.D.
TP101	0.1	Topsoil	6.2	16	1.2	0.4	19	47	53	< 0.2	20	1.2	35	96	5.8	<0.2	<0.1	N.D.
TP102	0.1	Topsoil	5.9	16	1.1	0.3	19	39	53	< 0.1	18	0.8	34	87	5.0	< 0.1	<0.1	N.D.
TP103	0.1	Topsoil	5.9	13	1.2	0.3	15	36	45	< 0.1	16	0.5	28	76	5.3	< 0.1	<0.1	N.D.
TP104	0.1	Topsoil	4.8	7	0.7	0.2	11	14	23	< 0.1	12	0.5	20	55	2.9	< 0.1	<0.1	N.D.
TP106	0.1	Topsoil	4.7	12	0.6	0.2	12	28	38	< 0.1	11	<0.1	23	51	4.5	< 0.1	<0.1	N.D.
TP107	0.1	Topsoil	7.1	9.2	0.6	0.2	12	24	37	<0.1	14	0.7	20	56	4.1	< 0.1	<0.1	N.D.
TP111	0.1	Topsoil	6.9	32	1.1	0.2	14	55	76	< 0.2	21	0.6	32	75	12.0	< 0.3	<0.1	N.D.
TP112	0.2	Topsoil	6.8	25	1.3	0.2	13	58	60	< 0.2	21	<0.5	32	70	14.0	< 0.3	<0.1	N.D.

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with garden**s end-use.													PAH		Asbestos I.D.
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Vn	Zn $	% TOC	B(a)P ∞	Naphthalene	
				37	5	26	4000	100	200	199	109	434	584	200		5	10	
Wardell Armstrong Data																		
TP101	0.2	Topsoil	4.0	**50**	1.6	< 0.2	19	25	36	< 0.3	12	< 1.0	30	57	2.9	< 0.1	< 0.1	N.D.
TP106	0.1	Topsoil	6.3	13	2.4	< 0.2	22	29	42	< 0.3	16	< 1.0	25	69	3.8	< 0.1	< 0.1	N.D.
TP105	0.2	Made Ground Topsoil	5.9	7.2	1.0	< 0.2	11	22	34	< 0.3	14	< 1.0	18	58	3.3	0.3	< 0.1	N.D.
TP112	0.7	Made Ground Topsoil	7.8	18	0.6	< 0.2	19	29	15	< 0.3	19	< 1.0	18	44	0.5	< 0.1	< 0.1	N.D.
TP116	0.1	Made Ground Topsoil	6.3	**44**	1.2	< 0.2	21	**130**	94	< 0.3	31	< 1.0	45	100	4.2	4.5	< 0.1	N.D.

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

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

Summary of the leachability testing

Expl Hole	Depth (m)	Material	Concentration in **µg/litre** unless otherwise Shown. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Tier 1 Screening Concentrations are shown in **BLUE**.										
			pH	As ~	B *	Cd ~	Cr ~	Cu ~	Pb ~	Hg ~	Ni ~	Se *	Vn	Zn ~
				50	1000	5	5	5	50	1	50	10	-	30
TP102	0.6	Leachate - Reworked Natural Ground	7.6	< 1.1	< 10	< 0.1	< 5.0	**12**	1.7	< 0.5	0.6	< 4.0	-	3.9
TP105	0.5	Leachate - Cohesive Made Ground	6.9	< 1.1	<10	<0.1	< 5.0	**6.7**	1.0	< 0.5	< 0.3	< 4.0	-	1.6
TP116	0.5	Leachate - Cohesive Residual Soil	7.9	< 1.1	< 10	< 0.1	< 5.0	**10**	3.6	< 0.5	1.4	< 4.0	-	14

Key		**Source of guidance trigger level**	
36	Parameter tested for and found to be in excess of Tier 1 concentration	~	Directive (2000/60/EC) establishing a framework for Community action in the field of water policy (Water Framework Directive)
0.3	Parameter tested for but not found to be in excess of Tier 1 concentration	*	Water Supply (Water Quality) Regulations 1989, as amended in 2000

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. Soil Screening Concentrations are shown in BLUE and assume a **residential with gardens with 600mm cover** end use					
			% TOC	PAH		TPH - C6 to C40		
				B(a)P ∞	Naphthalene	GRO~ C_6 to C_{10}	DRO◊ C_{10} to C_{21}	LRO C_{21} to C_{40}
				25	6	23	218	5000
Lithos Data								
TP104	0.5	Cohesive Reworked Natural	3.7	< 0.1	< 0.1	< 0.1	< 30	< 20
TP108	0.5	Cohesive Reworked Natural	3.5	< 0.1	< 0.1	< 0.1	< 30	< 20
TP109	0.5	Cohesive Reworked Natural	3.7	0.2	< 0.1	< 0.1	< 30	< 20
TP106	0.6	Cohesive Reworked Natural	0.7	< 0.1	< 0.1	< 0.1	< 30	< 20
TP110	0.2	Colliery Spoil	13	0.3	< 0.4	< 0.1	< 167	770
TP110	0.4	Colliery Spoil	16	0.9	< 0.4	< 0.1	**329**	1290
CS101	0.3	Colliery Spoil	11.0	< 0.6	0.1	< 0.1	148	613
CS102	0.3	Colliery Spoil	13.0	0.3	<0.2	< 0.1	116	360
Wardell Armstrong Data								
TP101	0.2	Topsoil	2.9	< 0.1	< 0.1	< 0.1	< 10	< 10
TP106	0.1	Topsoil	3.8	< 0.1	< 0.1	< 0.1	< 10	< 10
TP105	0.2	Made Ground Topsoil	3.3	0.3	< 0.1	< 0.1	12	31
TP112	0.7	Made Ground Topsoil	0.5	< 0.1	< 0.1	< 0.1	< 10	< 10
TP116	0.1	Made Ground Topsoil	4.2	4.5	< 0.1	< 0.1	15	82
TP105	0.5	Cohesive Made Ground	1.2	< 0.1	< 0.1	< 0.1	< 10	< 10
TP114	0.5	Cohesive Made Ground	4.5	0.3	0.3	< 0.1	< 10	< 10
TP114	1.3	Cohesive Made Ground	3.1	< 0.1	< 0.1	< 0.1	133.3	342
TP116	1.0	Cohesive Made Ground	1.1	< 0.1	< 0.1	< 0.1	< 10	< 10
TP101	0.7	Cohesive Residual Soil	0.4	< 0.1	< 0.1	< 0.1	< 10	< 10
TP103	0.4	Cohesive Residual Soil	0.3	< 0.1	< 0.1	< 0.1	< 10	< 10
TP104	1.0	Cohesive Residual Soil	0.2	< 0.1	< 0.1	< 0.1	< 10	< 10
TP110	0.5	Cohesive Residual Soil	1.3	< 0.1	< 0.1	< 0.1	< 10	< 10

Expl Hole	Depth (m)	Material	Concentrations in mg/kg. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Soil Screening Concentrations are shown in **BLUE** and assume a **residential with gardens with 600mm cover** end use					
			% TOC	PAH		TPH - C6 to C40		
				B(a)P ∞	Naphthalene	GRO~ C_6 to C_{10}	DRO◊ C_{10} to C_{21}	LRO C_{21} to C_{40}
				25	6	23	218	5000
TP111	1.4	Cohesive Residual Soil	0.4	< 0.1	< 0.1	< 0.1	< 10	< 10
TP112	0.1	Cohesive Residual Soil	4.6	0.5	< 0.1	< 0.1	< 10	26
TP102	0.3	Reworked Natural Ground	0.2	< 0.1	< 0.1	< 0.1	< 10	< 10
TP102	1.3	Reworked Natural Ground	0.2	< 0.1	< 0.1	< 0.1	< 10	< 10
TP109	1.0	Reworked Natural Ground	1.5	< 0.1	< 0.1	< 0.1	< 10	< 10
TP110	0.2	Reworked Natural Ground	1.9	< 0.1	< 0.1	< 0.1	< 10	< 10
TP106	1.5	Coal Measures	0.2	< 0.1	< 0.1	< 0.1	< 10	< 10
TP108	0.5	Coal Measures	3.7	< 0.1	< 0.1	< 0.1	< 10	< 10

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 The following table contains an outline of the samples analysed for inorganic determinands which could be classified as contaminated:

Ground Type	Number of Samples Analysed	Samples containing exceedance of Tier 1 Screening Value	Inorganic Determinands exceeding Tier 1 Screening Value
Colliery Spoil	4	4	Arsenic, Copper, Lead, Zinc
Cohesive Reworked Natural	4	1	Zinc
Topsoil	12	2	Arsenic
Made Ground Topsoil	7	2	Arsenic, Copper

9.3.4 Of the remaining 7 samples of Cohesive Residual Soil; 4 samples of Reworked Natural Ground; 4 samples of Cohesive Made Ground and 2 samples of Coal Measures strata, all can be classified as uncontaminated.

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

9.3.6 The most common contaminants are Zinc, Copper, Lead and Arsenic.

Phytotoxic Elements

9.3.7 **Zinc** is a phytotoxic metal; phytotoxicity describes the inhibitive and toxic effect high concentrations of some substances can have on plant growth.

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

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

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

9.3.11 On balance, given the context of a residential development and the relatively low concentrations recorded, zinc is not considered significant with regards to its presence in Colliery Spoil and Cohesive Reworked Natural ground.

9.3.12 Similar logic applies to **copper** (human health Tier of 2,400mg/kg), and consequently on balance, the slightly elevated concentrations of copper and zinc are not considered significant with regards to Colliery Spoil and Made Ground Topsoil.

Statistical Assessment

9.3.13 Current UK guidance regarding the statistical analysis of soil contamination data obtained during a site investigation is provided by CL:AIRE[2], and uses two-way confidence intervals and graphical summaries, to assist assessors when determining whether or not a dataset is adequate to answer the question posed; e.g. "is existing site topsoil suitable for retention & re-use?". To answer such a question, it is necessary to recover and test a large number of samples (a minimum of 10; ideally 20+) in order to undertake meaningful statistical analysis.

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

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

9.3.16 Lithos can confirm that statistical assessment of copper in Cohesive Reworked Natural ground; arsenic, zinc, copper and lead in Colliery Spoil; and arsenic and copper in Made Ground Topsoil is not appropriate because there are insufficient samples to allow representative statistical assessment.

9.3.17 Lithos can confirm that statistical assessment of arsenic in Topsoil is appropriate because:

- There is a well understood, robust CSM
- Sampling locations are relatively evenly spread across the site and only random sample data has been included in the assessment
- All targeted data has been removed from the data set and assessed separately
- Samples are considered by strata type
- A sufficient number of samples have been taken from the Topsoil

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

9.3.19 The Dot and Box Plots are presented in Appendix J and the results are summarised below.

Topsoil

Contaminant	Critical concentration	Mean	Upper confidence level (95%)	Lower confidence level (5%)	Range of 'true' mean	Mean lies above critical concentration (Y/N)
Arsenic	37	19.18	26.86	12.35	12.35 to 26.86	N

Notes: All concentrations are in mg/kg

9.3.20 Statistical analysis indicates that the true mean for Arsenic in Topsoil is well below the relevant Lithos tier 1 screening values.

9.3.21 However, the presence of **Arsenic** in Made Ground Topsoil and **Lead** in Colliery Spoil which exceeds the relevant Lithos Tier 1 indicates that some remediation will be required.

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

Calorific value

9.3.22 The calorific value of 3 samples of Coal; taken from the Barnsley, Gawber and Dunsil seams have yielded a CV of 21 MJ/kg, < 2 MJ/kg and 18 MJ/kg respectively. Materials whose CVs exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn.

Asbestos

9.3.23 No asbestos fibres were identified in any of the samples of Topsoil, Made Ground Topsoil, Cohesive Residual Soil, Cohesive Reworked Natural, Colliery Spoil, Reworked Natural Ground, Cohesive Made Ground or Coal Measures bedrock screened.

Leachables

9.3.24 Of the leachability tests conducted on 3 samples; from Reworked Natural Ground, Cohesive Made Ground and Cohesive Residual Soils, all had concentrations of leachable **copper** above the maximum permissible concentrations as defined in the Water Supply (Water Quality) Regulations 1989, as amended in 2000.

9.3.25 The maximum concentration of leachable copper detected was 12 µg/litre (average 9.6 µg/litre). No source of copper contamination has been identified in the Conceptual Site Model and therefore this fraction of leachable copper is likely a natural background concentration contained within natural soils on site.

9.3.26 Furthermore, there is no receptor nor pathway present for which this low concentration of copper can establish a source-pathway-receptor linkage.

Organic determinands

9.3.27 This site is essentially greenfield, however areas of reworked ground and sporadic made ground likely associated with a mining legacy brownfield has yielded elevated concentrations of a number of inorganic determinands. Consequently, for organic compounds, the Tier 1 Soil Screening Values used in this report have been derived with reference to a CSM that assumes a minimum 600mm of clean soil cover will be placed in gardens/landscaped areas (Lithos Scenario B).

9.3.28 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.

9.3.29 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.

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

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Colliery Spoil	13%	No.
Cohesive Made Ground	2.5%	
Cohesive Reworked Natural	2.9%	Yes, but no significant organic contamination was recorded in this soil type. All determinands well below "6%" screening value; most below limit of detection.
Topsoil	3.4%	
Made Ground Topsoil	2.7%	

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Cohesive Residual Soil	1.2%	
Reworked Natural Ground	1.0	
Coal Measures Bedrock	2.0	

Hydrocarbons (TPH & PAH)

9.3.31 Given the possible mining legacy on site and the absence of major visual/olfactory evidence of hydrocarbon contamination, only a simple banded TPH (cf full speciation) was scheduled on 8 samples; 4 samples of colliery spoil and 4 samples of Cohesive Reworked Natural ground.

9.3.32 A simple banded TPH was scheduled as part of 3rd party reporting on 2 samples of Topsoil; 3 samples of Made Ground Topsoil, 4 samples of Cohesive Made Ground; 6 samples of Cohesive Residual Soil, 4 samples of Reworked Natural Ground and 2 samples of Coal Measures bedrock.

9.3.33 One exceedance of DRO (329mg/kg) was encountered in TP110 within Colliery Spoil at 0.4m in the Eastern Field by Lithos.

9.3.34 TPH can be associated with a variety of sources and elevated TPH concentrations do not automatically infer a petroleum product is present; indeed the absence of petroleum products on this site is reflected in the preliminary conceptual model. TPH analysis will detect most hydrocarbons and is not restricted to those detailed within the TPHCWG reports.

9.3.35 Whilst not necessarily associated with a petroleum product, the significance of these hydrocarbons, with respect to health, should still be assessed. Providing no other sources are present on site (solvents, degreasers etc), it can be assumed that the most problematic compounds detected within the banded TPH screen are polycyclic aromatic hydrocarbons (PAHs).

9.3.36 The significance of PAHs can be determined by considering indicator compounds. In most cases, benzo(a)pyrene (B(a)P) is adopted as an indicator (due to the wealth of toxicological data available) and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food.

9.3.37 A C4SL toxicity assessment using the surrogate marker approach can be used to estimate the significance of a mixture of PAHs in soil, using toxicity data for indicator compounds within that mixture. Exposure to the indicator (or surrogate marker) is assumed to represent exposure to all PAHs in that matrix.

9.3.38 The sample profiles here are sufficiently similar to the toxicity study adopted for the C4SL assessment, and B(a)P concentrations are below Lithos' Tier 1 Value. Consequently, the hydrocarbons detected are unlikely to pose any unacceptable risk to end users, and no remediation is required.

9.3.39 Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach. Consequently, naphthalene has been considered individually against Lithos' Tier 1 Value.

9.3.40 Concentrations of B(a)P and naphthalene are below their respective Tier 1 Values, and therefore the DRO hydrocarbons detected in are unlikely to pose any unacceptable risk to end users, and no remediation is required.

9.3.41 Furthermore, Benzo(b)fluoranthene (4.4mg/kg) and Dibenzo(ah)anthracene (0.75mg/kg) identified by 3rd party in Topsoil at 0.1m (TP116) is not considered problematic and B(a)P and naphthalene in the same sample are also below their respective Tier 1 Values.

9.4 Topsoil

BS3882 Topsoil testing

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

9.4.2 The clay/sand/silt content of 4 topsoil samples have been determined to check compliance with BS3882[3] requirements.

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

9.4.4 The results are summarised below:

Parameter	BS3882 Specification	TP102 (0.1m)	TP104 (0.1m)	TP107 (0.1m)	TP111 (0.1m)
Retained on 2mm sieve	< 30%	18	3	13	15
Retained on 20mm sieve	< 10%	0	0	2	3
Retained on 50mm sieve	0%	0	0	0	0
Clay content	5 to 35%	21	**36**	30	27
Silt content	0 to 65%	30	46	37	33
Sand content	0 to 90%	31	15	20	25
Visible contaminants	< 0.5%	0	0	0	0

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

9.4.5 The results indicate that the topsoil complies with the requirements for multipurpose topsoil, with the following exception:

- The clay content of one of the four samples tested slightly exceeded the maximum permissible level (36% *cf* upper threshold of 35%). However, the average clay content from across the four samples is within the specified range.

9.4.6 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 'Silty Clay' class.

10 CONTAMINATION (QUALITATIVE RISK ASSESSMENT & REMEDIATION)

10.1 Topsoil

10.1.1 Topsoil is typically 300mm thick and present across the Western and Centre fields. Testing suggests that Topsoil is chemically suitable for re-use.

10.1.2 Made Ground Topsoil typically 300mm thick is present sporadically in the Western and Centre field and is the dominant topsoil type in the Eastern field. Testing suggests that Made Ground Topsoil **not** chemically suitable for reuse.

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

10.1.3 Furthermore, it was noted that Made Ground Topsoil often contained undesirable foreign object(s) visible to the naked eye such as glass, rope, brick, plastic netting, paper, coal, pottery and whole brick.

10.2 Summary of significant contamination

10.2.1 Colliery Spoil identified in a localised area in the Eastern field to 0.6m depth was found to contain exceedances of Lead and Arsenic.

10.2.2 Made Ground Topsoil was found to contain an exceedance of Arsenic and contains material which would generally be considered undesirable as a near-surface material in garden areas.

10.3 Revised conceptual ground model (contamination)

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

10.3.2 No sampling has been undertaken in the marsh area situated between the Western and Centre Fields.

10.3.3 A revised Conceptual Site Model is presented as Drawing 4386/9 in Appendix B. The Model includes the contaminants described in Section 9.3 above, and potential contaminant linkages (summarised below in Section 10.5) to receptors.

10.4 Environmental setting & end use

10.4.1 As discussed in Section 10.2 above, contamination exists in the soil beneath this site. In order to assess the significance of this contamination, consideration must be given to the site's environmental setting and the proposed end use.

10.4.2 The underlying Coal Measures bedrock is classified as a Secondary A aquifer. The nearest surface watercourse is an unnamed tributary of the River Dearne which flows in a southernly direction, approximately 15m beyond the site's south boundary. Therefore, the site's environmental setting is considered to be **low 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 In terms of a proposed redevelopment of this site, plausible contaminant linkages can be summarised as follows.

Contaminants

10.5.2 Contaminants have been summarised in Section 10.2 above.

Pathways

10.5.3 Potential contaminant pathways include:

- Ingestion
- Dermal contact
- Inhalation of contaminated particulates

Receptors

10.5.4 Potential contaminant receptors include:

- End users of the site (residents)

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

10.6 Potential remediation options

General

Combustibility

10.6.1 The **Barnsley and Dunsil Coal** is considered combustible and, in accordance with current guidance, the following remediation measures should be adopted if it is left on site:

- Garden areas: isolate beneath a minimum **1,000mm** thickness of inert soil, comprising 850mm of "clean" subsoil plus 150mm topsoil.
- Services: utility trenches (especially those carrying potential heat sources e.g. electric cables) should be cut oversize and backfilled with clean, inert material. This applies to any utility trenches that run beneath estate roads or extend under houses. It is strongly recommended that further advice be sought from all statutory service bodies with respect to the ground conditions within which they will lay services.
- Estate roads: no action required (although generally less than 1,000mm thick, the road construction is considered to provide adequate isolation as there will be no heat source). Local Authority Highways approval should be sought.
- Houses: no action required (the floor slab will include insulation and therefore heat transfer into the ground will be negligible). Local Authority Building Control and Warranty Provider approval should be sought.

Inorganic contamination – Colliery Spoil

10.6.2 Colliery Spoil in the Eastern Field has yielded elevated concentrations of arsenic and lead. Therefore, where left in-situ and underlying garden areas (i.e. not beneath hardstanding) a **600mm** thick surface cover of "clean" soil comprising 450mm subsoil and 150mm topsoil is recommended. Where Colliery Spoil underlies landscaped areas a **300mm** thick similar surface cover is required. This cover will break potential contaminant linkages between the contaminated made ground and future end-users.

10.6.3 Colliery Spoil in the Eastern Field is also underlain by the combustible Barnsley Seam which will require a 1000mm inert cover in rear gardens. Therefore, the 1000mm inert cover requirement of the Barnsley Seam will overrule the 600mm requirement of the colliery spoil and should satisfy both cover requirements.

Inorganic contamination – Made Ground Topsoil

10.6.4 Made Ground Topsoil has been found across the Western and Centre fields sporadically and is widespread across the Eastern Field. It has been found to contain exceedances of arsenic and undesirable materials. Therefore, where Made Ground Topsoil is present underlying garden areas a **600mm** thick surface cover of "clean" soil comprising 450mm subsoil and 150mm topsoil is recommended. This cover will break potential contaminant linkages between the contaminated made ground and future end-users.

10.6.5 Alternatively, with the provision of suitable Materials Management Plan, the Made Ground Topsoil from the Eastern Field could be replaced with clean, naturally occurring Topsoil from the Western Field (which is currently destined for use as POS).

10.6.6 The Made Ground Topsoil arising from the Eastern Field being placed into the Western Field would require a 300mm thick surface of "clean" soil.

10.6.7 Duchy Homes should ensure that the 'swapping' of topsoil from the Western Field to the Eastern Field is not restricted by any ecological constraints outlined in their planning permissions.

Marsh Area

10.6.8 Due to the access constraints in the marsh area situated between the Western and Centre Fields, no exploratory holes have been undertaken and therefore it is not possible to determine the composition of soils. Due to presence of Made Ground Topsoil and Colliery Spoil on site containing inorganic exceedances: a worst case scenario of **600mm** thick surface cover of "clean" soil comprising 450mm subsoil and 150mm topsoil is recommended in garden and landscaped areas.

10.6.9 However, if access can be gained during the construction phase, a simple trial-pit investigation in the area with further chemical analysis could negate a clean cover requirement if testing shows topsoil is suitable for re-use.

Summary of Remediation Options

Issue	Remediation Option
Barnsley and Dunsil Coal seam are combustible	1000mm cover required where Barnsley and Dunsil Coal are within 1000mm of finished ground levels in garden areas.
Inorganic contamination (Arsenic and Lead) in Colliery Spoil	If left in-situ: 600mm thick clean cover required where Colliery Spoil is present underlying garden areas or 300mm thick clean cover where underlying POS.
	Excavation and disposal off-site.
	Excavation and re-distribution in Western Field underneath area of POS. 300mm thick clean cover required where Colliery Spoil is placed underneath landscaped areas.
Made Ground Topsoil (Arsenic and undesirable materials) present sporadically across Western and Centre fields, and dominant across Eastern Field.	If left in-situ: 600mm clean cover requirement where Made Ground Topsoil is situated in gardens or 300mm thick clean cover in landscaped areas.
	If Made Ground Topsoil from Eastern field placed into the Western Field (POS) and Clean Naturally occurring Topsoil from Western field placed into Eastern Field: • 300mm cover required above Made Ground Topsoil in Western Field if placed underneath POS. • Material Management Plan required. • Consideration of ecological constraints required
Marshy Area situated between Western and Centre field – no exploratory holes undertaken	At present: Provision of a 600mm thick clean cover requirement in garden and landscaped areas as ground conditions are currently unknown.
	If access can be provided during construction phase: Simple trial-pit investigation in the marshy area with further chemical analysis could negate a clean cover requirement if ground conditions are 'clean'.

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	Arsenic and lead	Yes - Isolation beneath at least 600mm clean soil cover in garden or 300mm clean soil cover in landscaped areas
	Ingestion		
	Dermal contact		
	Inhalation (dust)		
	Infiltration of water supply pipes		No
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 Some excess arisings (topsoil & subsoil) may be generated by excavations for foundations, sewers etc. If these are intended for retention and reuse on the site, they would be classed as clean naturally occurring soils and would not be considered waste, under the Waste Framework Directive.

10.8.2 Off-site disposal of surplus clean naturally occurring soils to landfill is not recommended. In accordance with the CL:AIRE Code of Practice[4] any excess natural soil arisings should be suitable for Direct Transfer to another development site, for use either as clean cover material, or bulk fill, without the need for waste legislation to be applied.

10.8.3 Disposal of the any 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.

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

10.8.5 As there is no WRAP protocol for soils, the characterisation, sampling and classification of soils arising from brownfield sites has been incorporated within the Environment Agency's Technical Guidance WM3[5]. 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] *The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.*
[5] *Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015*

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

10.8.7 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.

10.8.8 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.

10.8.9 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).

10.8.10 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.

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

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

11 HAZARDOUS GAS

11.1 Radon

11.1.1 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.

11.1.2 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.

11.1.3 The Public Health England UK radon map and the 3rd party report indicate that the site is in an area where **more than 3%** of homes are estimated to be above the action level, and **basic** radon protection measures are required in new dwellings.

11.1.4 In accordance with BR211:2015[6], basic radon measures simply comprise a barrier (membrane) laid within the floor construction, which is linked to a damp-proof course (DPC) within the walls of the building. The DPC to cavity walls should be in the form of a cavity tray to prevent radon entering the building through the cavity. Sealing of joints in the barrier and sealing around service penetrations are also required. A 1200-gauge polythene membrane should suffice, and sub-floor ventilation is not essential.

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

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

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

11.2 General

11.2.1 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 made ground (colliery spoil)	Human health	Asphyxiation & explosion	lateral migration, ingress & accumulation	**Low:** colliery spoil tends to be of low permeability
	Buildings	Explosion		
Shallow mineworkings	Human health	Asphyxiation & explosion	Vertical migration, ingress & accumulation	**Moderate**: no significant thickness of low permeability drift or bedrock above workings
	Buildings	Explosion		

11.2.2 Given the above gas monitoring wells have been installed in 7 boreholes across the site. Details of the installations are given on the probehole logs presented in Appendix L to this the report.

11.2.3 The generation potential of the gas source was initially considered to be Low to moderate. Consequently, in accordance with CIRIA Report C665[7], given the proposed residential end use, 9 visits have been scheduled over a 6-month period.

11.3 Scope of works

11.3.1 To date, the wells have been monitored on 1 occasion for groundwater levels and soils-gases, and the results are presented in Appendix L.

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

- Ambient oxygen concentration

[6] *BRE Report BR211, 2007: "Radon: guidance on protective measures for new buildings"*
[7] *CIRIA C665: Assessing risks posed by hazardous ground gases to buildings (2007).*

- 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)

11.4 Monitoring results

11.4.1 The results of the initial monitoring visit 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)
PH101	1.0 – 4.0m (Granular Residual Soil and Coal Measures bedrock)	0.0	1.0	0.6
PH102	2.0 – 4.0m (Coal Measures bedrock – Siltstone)	0.0	1.5	0.0
PH104A	1.0 – 2.0m (Granular Residual Soils)	0.0	0.1	0.0
PH107	1.0 – 3.0m (Coal Measures bedrock – Sandstone)	0.0	0.8	5.0
PH108	1.0 – 3.0m (Granular Residual Soils - Coal Measures bedrock - Siltstone	0.0	0.5	0.0
PH110	1.0 – 2.0m (Granular Residual Soils)	0.0	0.0	0.0
PH112	2.0 to 4.0m (Coal Measures bedrock – Siltstone)	-	-	-

11.5 Discussion (methane & carbon dioxide)

11.5.1 The results of the initial monitoring visit support a Low generation potential of the shallow mineworkings, but further monitoring visits are required to confirm this.

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

11.5.3 A hazardous gas risk assessment incorporating all of the results will be issued on completion of monitoring in October 2022.

12 GEOTECHNICAL TESTING

12.1 General

12.1.1 A total of 16 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 10 samples of cohesive soil have been determined by Lithos; results are summarised below.

Soil type	No. samples tested	Moisture content range % (average)	Range of Plasticity Indices % * (average)	Shrinkability
Cohesive Residual Soil	10	17 - 35 (23)	23 - 38 (31)	Medium

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

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

12.2.2 Furthermore, the plasticity indices of 14 samples of cohesive soil and 2 samples of Cohesive Reworked Natural ground taken by 3rd party are summarised below:

Soil type	No. samples tested	Moisture content range % (average)	Range of Plasticity Indices % * (average)	Shrinkability
Cohesive Residual Soil	14	14 – 34 (22)	14.6 – 36.9 (23.7)	Medium
Cohesive Reworked Natural	2	19 - 34	33 – 41.6	High

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

12.2.4 The two sample of Cohesive Reworked Natural soils which reported high shrinkability were taken from TP102 by the 3rd party, along the western boundary in an area currently being retained as POS, therefore no foundations are expected to be placed in high shrinkability soils.

12.3 Soluble sulphate and pH

12.3.1 In accordance with BRE SD1[8], this site has been classified as brownfield with a mobile groundwater regime.

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

12.3.3 As part of the Lithos ground investigation, the concentrations of sulphate in the aqueous natural soil extracts of 13 samples were determined. In addition, 8 samples of made 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.

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

Lithos			
Soil type	**No. samples tested**	**Lowest pH values**	**Highest soluble sulphate concentration (mg/l)**
Cohesive Residual Soil	9	2.8	290
Granular Residual Soil	2	5.8	86
Coal Measures Strata	2	6.9	16
Cohesive Reworked Natural	4	5.9	38
Colliery Spoil	4	7.1	100

12.3.5 pH values for the majority of soil types, with the exception of Cohesive Residual Soil, were all above 5.5, therefore concentrations of chloride and nitrate are considered insignificant.

12.3.6 Further analysis of the concentrations of water soluble sulphates and lowest pH values taken from the 3rd party ground investigation are shown in the table below:

3rd Party			
Soil type	**No. samples tested**	**Lowest pH values**	**Highest soluble sulphate concentration (mg/l)**
Cohesive Residual Soil	6	5	150
Coal Measures Strata	2	5.8	77
Cohesive Made Ground	3	6.3	25
Reworked Natural Ground	4	6.4	59

12.3.7 The lowest pH value of Cohesive Residual Soils from both data sets was 2.8, however analysis of the remaining 14 samples provide an average pH value of 5.9. Combined with an average soluble sulphate concentration of 94mg/l, it was determined that supplementary analysis of magnesium, chloride and nitrate concentrations was not required.

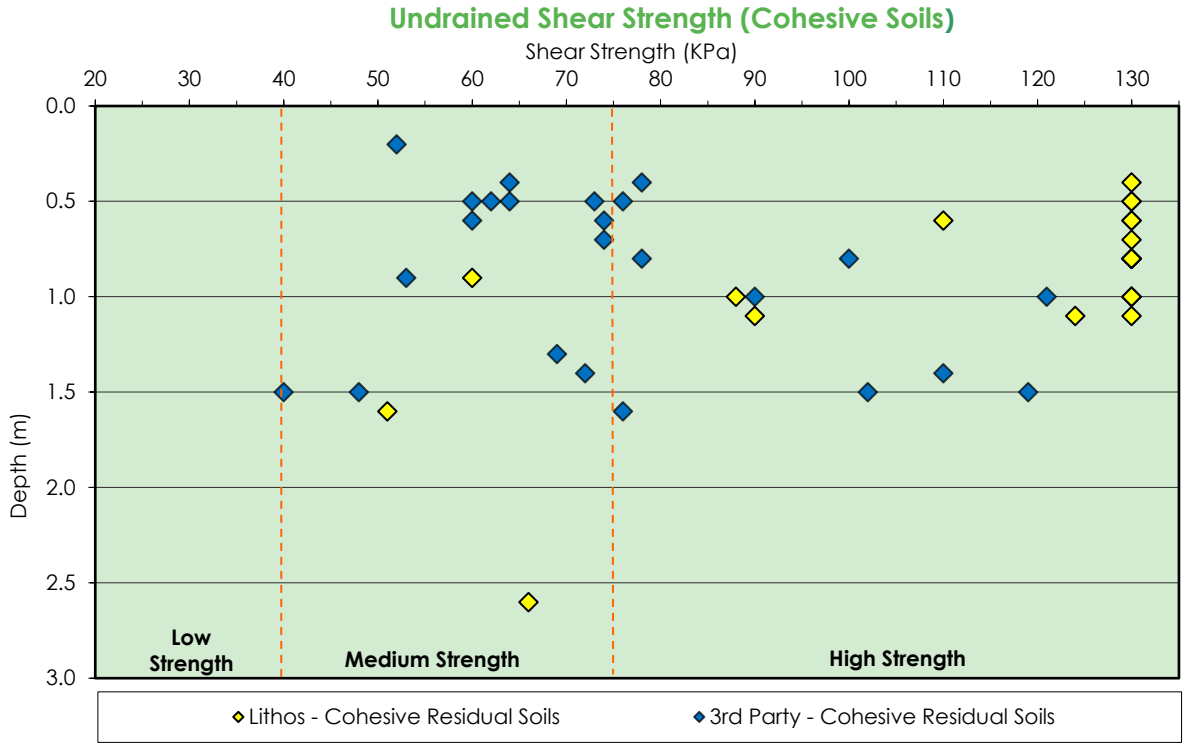
12.3.8 In accordance with Tables C1 and C2 of SD1, sub-surface concrete should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-1**.

Hand shear vane testing

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

12.3.10 The results are summarised within the plot below and illustrate a linear increase in undrained shear strength (Su) with depth within the Cohesive Residual Soils. Below approximately 0.6m depth Su is typically greater than 60kPa.

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



13 GEOTECHNICAL ISSUES

13.1 Conceptual site model

13.1.1 The site contains Topsoil and sporadic Made Ground Topsoil (typically 300mm thick) across the Western and Centre fields whilst the Eastern field contains Made Ground Topsoil (typically 300mm thick).

13.1.2 Underlying Topsoil and Made Ground Topsoil are medium to high strength Cohesive Residual Soils to an average depth of 1.8m, Granular Residual Soils to an average depth of 2.4m, underlain by Coal Measures bedrock.

13.1.3 Made Ground comprising Cohesive Reworked Natural soils to an average depth of 0.8m (maximum 0.9m) are found irregularly in the Western and Central field; becoming regularly encountered in the Eastern Field. Colliery Spoil was encountered to 0.6m in the Eastern field and >2.8m in the Western Field in an isolated area.

13.1.4 Three noteworthy coal seams outcrop on site; the Gawber Coal (Western Field), the Dunsil (Western Field) and the Barnsley Coal (Eastern field. The maximum thickness of the Barnsley Coal encountered was 3.2m. The Dunsil and Gawber Coal are all expected to be <0.5m thickness.

13.1.5 The Dunsil and Barnsley Coal are combustible.

13.1.6 Underground shallow mineworkings associated with the Barnsley coal were encountered in the Western field directly by Lithos and by 3rd party in the Eastern Field.

13.1.7 Three northwest to southeast trending faults are present, one per the Western, Centre and Eastern Fields.

13.2 Mining & quarrying

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

13.2.2 This site is underlain by Coal Measures bedrock from an average of 2.4m depth. The Barnsley Coal underlies the southwest corner of the site and is truncated against a fault in the Western Field. The Gawber and Dunsil Coal outcrop in the Western Field; and the Barnsley Coal outcrops again in the Eastern Field in a separate fault block to that of the Western field.

13.2.3 Former opencast workings of the Barnsley Coal are situated 20m southeast of the site. Numerous mine shafts and adits are situated to the north, east and southeast of the site boundary, but none are reported within the site boundary.

13.2.4 Lithos' mining investigation comprising the drilling of 12 rotary open-hole probeholes; supported by the analysis of the 3rd party mining investigation comprising 7 open-hole probeholes, found evidence of shallow underground mineworkings in the Western and Eastern Fields associated with the Barnsley Coal.

13.2.5 Analysing the data obtained from the 12 Lithos mining investigation probeholes, the Barnsley Seam is present on site it is apparent that in the **Western Field**:

- **Barnsley Coal** underlies about 0.81ha of the site in the far west, truncated to the east by faulting.
- The Barnsley seams maximum recorded thickness on site was 3.2m.

- All three of the holes advanced through the Barnsley seam in the far west encountered evidence of **underground workings**. Additionally, one 3rd party probehole advanced through the Barnsley Seam encountered underground workings in the far west.
- The thickness of competent (rock) cover above the Barnsley seam in the far west is always less than 11 times seam base.
- The depth to the base of the Barnsley Coal/workings in the far west ranged from15.8m to 20.5m.
- The maximum recorded thickness of workings, including collapsed workings in the far west is 7.4m.
- The position of the fault truncating the Barnsley Seam in the far west was found to be c.20m further northeast than the recorded position on geological maps.

13.2.6 Additionally, the Barnsley Seam is apparent in the **Eastern Field** where:

- **Barnsley Coal** underlies about 0.39 ha in the far east, outcropping on site and dipping north-east.
- One trial pit advanced through the Barnsley Seam encountered evidence of **possible outcrop workings**; additionally, one 3rd party probehole encountered evidence of possible **underground shallow workings** in the **far east.**
- The thickness of competent (rock) cover above the Barnsley Seam in the far east in 3rd party probeholes is always less than 11 times seam base.
- The maximum recorded thickness of underground workings from 3rd party probeholes, in the far east is 1.1m.
- The actual position of the Barnsley seam is located c.15m to the east of its recorded position on geological maps.

13.2.7 The following coal seams were also encountered on site:

- The **Gawber** seam, encountered in one Lithos probehole at 0.4m thick, outcrops in the west and dips to the northeast. The quality of the Gawber Coal was generally of poor quality (dull).
- The **Dunsil** seam was encountered in two probeholes and one trial pit; typically 0.5m thick, outcropping in the centre-west and dipping to the northeast. The quality of the Dunsil Coal was generally good (black, vitreous).
- No evidence of workings was encountered in the Gawber, Dunsil, Thin or Swallow Wood seams across the site, by either Lithos or the 3rd party mining investigation.

Outcrop Workings

13.2.8 A possible area of outcrop workings was encountered in the position of possible seasonal ponding in the Eastern Field to 1.9m depth. Colliery Spoil comprising black gravelly clay was identified to 0.6m, underlain by Cohesive Residual Soils to 1.9m depth, beneath which the Barnsley Coal was encountered to 2.5m depth; 0.6m thickness.

13.2.9 TP110 is located c.4.0m from the outcrop position and it is difficult to determine if the low thickness of the Barnsley seam is due to prior extraction or its proximity to the outcrop. Furthermore, the Cohesive Residual Soils overlying the Barnsley Seam could have been reworked.

Shallow mineworkings

13.2.10 CIRIA SP32:1984[9] suggests voids resulting from mineral extraction are unlikely to migrate more than 10 times the seam thickness through competent bedrock. CIRIA C758D[10] notes that the use of this 10 times 'rule-of-thumb', as the design basis for treatment depth, has been observed to be successful over many years for a wide range of mineworkings and overlying rock/soil strata scenarios. However, consideration must always be given to site specifics such as nature of roof strata, strata dip, groundwater, extraction ratio etc.

13.2.11 Mitigation against the risk of subsidence associated with the shallow mineworkings in the East will be required across an area of 0.2ha as a worst case scenario (likely Plots 2 to 7), as shown on Drawing 4386/7B in Appendix B. This will likely involve consolidation by drilling and grouting, although consideration could also be given to coal extraction (see Section 14.7).

13.2.12 Based on the findings of this investigation and the anticipated nature of the workings, it is considered that the necessary consolidation (grouting) would require drilling holes on a 3m grid. A viscous grout composed of appropriate proportions of OPC, PFA, sand or pea gravel would then be injected into the workings via these holes.

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

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

13.2.15 A topsoil strip across an area of 0.35ha should be undertaken in the Eastern Field, as shown on Drawing 4386/11, to ensure no outcrop workings or bell pits associated with the Barnsley Seam are present which may also require consolidation.

13.2.16 Underground shallow mineworkings present in the Western Field are in an area designated as POS (See Drawing 4386/7a). Providing no development takes place above known mineworkings in the western field, consolidation works are not required in these shallow mineworkings.

13.3 Site regrade and/or ground improvement

13.3.1 Made ground comprising Cohesive Reworked Natural soils currently underlies the site sporadically, to an average depth of about 0.8m; maximum of 0.9m. This made ground is not considered a suitable foundation material, however foundations are likely to extend through to natural soils below as the medium shrinkability soils present will require a minimum foundation depth of 900mm.

13.3.2 Made ground comprising Colliery Spoil currently underlies the site in isolated areas in the Western Field and Eastern Field to depths of >2.8m and 0.6m respectively. This made ground is of variable composition and poor strength and is therefore not considered a suitable foundation material. It has also yielded elevated concentrations of a number of inorganic determinands and contains materials (e.g. brick, metal, wood, glass etc), which would generally be considered undesirable as a near-surface material in garden areas.

13.3.3 Cohesive Made Ground currently underlies the site in isolated areas in the Western Field and Eastern Field to depths of 0.8m and 1.8m respectively. This made ground is of variable and poor strength and is therefore not considered a suitable foundation material.

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

13.3.4 No development is planned over Colliery Spoil in the Western Field meaning it can be left in-situ.

13.3.5 Due to the relatively shallow thicknesses of made ground present, turnover of soils is not considered necessary.

13.3.6 Given existing topography (much of the site is sloping, with gradients of up to 1 in 10 in the east), some site regrade is anticipated, with the need for underbuild and retaining walls along the sites northern boundary with Darton Lane.

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

13.3.8 Any digital terrain modelling undertaken, or commissioned, by Duchy Homes should consider implications for the foundation recommendations outlined below.

13.3.9 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.

13.3.10 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 A site layout has been provided by STEN ARCHITECTURE (Drawing reference Draft Layout SK04, dated October 2020) showing 46 two-storey domestic dwellings, associated gardens, POS, adoptable roads and sewers.

13.4.3 All recommendations, including clean cover requirements have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation. Due to the sloping nature of the site, especially in the east where slopes reach 1 in 10, it is assumed levels will change slightly. Any digital terrain modelling undertaken, or commissioned, by Duchy Homes should consider implications for the foundation recommendations outlined below.

13.4.4 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.

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

Strip/trench fill footings

13.4.6 It is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses constructed at the site. Footings will be founded in firm Cohesive Residual Soils or Granular Residual Soils or competent rock.

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

13.4.8 Consolidation of shallow mineworkings is expected in the Eastern Field. Even after consolidation, foundations should be "beefed-up" to accommodate any potential time dependant differential settlement.

13.4.9 Further advice regarding reinforcement should be sought from the appointed Structural Engineer, but in the meantime reference should be made to the table below.

Rock cover above grouted seam	Preferred Foundation
<5 x seam thickness [11]	Raft - designed to span 3m over potential soft spots and cantilever 1.5m at corners. Either stiffened, flat-bottomed rafts a minimum of 300mm thick, on 450mm of compacted Type 1 material, with reinforcement top and bottom. Or, rafts could be of 300mm concrete with a 150mm upstand to allow for wall construction provided that the base of compacted type 1 material lies at a depth of at least 600mm
>5 x seam thickness – 10m	Strip footing OK, but thickened (300mm), and reinforced top and bottom
>10m	Strip footing OK, but needs to be 300mm thick reinforced with one layer of mesh

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

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

13.4.12 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).

13.4.13 In addition to the above, Duchy 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). Duchy Homes should supervise their groundworker to ensure footings are excavated in a controlled and safe manner.

13.4.14 Duchy 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.

Clay/cohesive soils

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

13.4.16 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.

13.4.17 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to c.35% of the site may be affected by trees.

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

13.4.18 A number of immature (likely self-seeded) trees were noted in Eastern Field and the Marsh Area during the site walkover, and these will require removal prior to construction. A number of these trees lie within the footprint of proposed plots. In theory, this could result in foundation depths of >2.5m. However, in accordance with NHBC Standards Chapter 4.2, if the trees are <50% of their mature height at the time of removal, a default distance to the proposed foundation of 2m can be applied to foundation depth calculations. This will likely result in few (if any) foundation depths of >2.5m. This should be confirmed by a detailed tree survey prior to vegetation removal, and removal should take place as soon as possible.

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

13.4.20 However, bedrock is non shrinkable and was encountered from 1.7m depth; average 2.4m. This will result in few (if any) foundation depths of >2.5m.

13.4.21 In the marsh area situated between the Western and Centre Fields, it is possible that whatever feature is producing saturated surface conditions has also softened the underlying cohesive soils. As no exploratory holes have been undertaken in this area, it should be assumed that some deepening of excavations to a suitably competent founding stratum is required.

13.4.22 However, bedrock will not be affected by softening and therefore no foundation depth is likely to exceed >2.5m in this area.

13.4.23 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.

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

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

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

- A foundation length of 8m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.9m depth
- An undrained shear strength of 60kPa for the firm clay (typical minimum recorded on site)

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

Granular soils (completely weathered bedrock)

13.4.28 The weathered in-situ Coal Measures bedrock (gravels of mudstone, siltstone and sandstone) is assumed to have a relative density of at least medium dense (in accordance with BS5930).

13.4.29 A safe bearing capacity of at least 175kPa, 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 1.5m depth
- An angle of shearing resistance of ϕ=34 for the granular deposits

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

13.4.31 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).

13.4.32 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.

13.4.33 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).

Coal Measures Bedrock

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

13.4.35 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.

13.4.36 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

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

13.4.38 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.

13.4.39 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

13.4.40 Drawing 4386/2 shows the approximate line of the three faults superimposed on the proposed housing layout; the faults cross the Western Field, the Centre Field and the Eastern Field.

13.4.41 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.

13.4.42 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.

13.4.43 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 12, plots 20 to 26 and plots 45 to 46.

13.4.44 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.

13.5 Floor slabs

13.5.1 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.

13.5.2 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.

13.5.3 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.

13.5.4 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.

13.5.5 In the 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.

13.5.6 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 October 2022.

13.6 Designated concrete mixes

13.6.1 Designated mixes are considered in BRE SD1[12] and BS 8500[13]. 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, Duchy 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. In the Marsh Area, ground conditions are unknown but appear visibly saturated and groundwater flows could be present in shallow excavations.

13.7.2 Groundwater should be controlled in accordance with CIRIA Report R113[14].

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

13.7.4 Coal Measures Bedrock was encountered in ten Lithos trial pits and twelve 3rd party trial pits across the site from between 1.3m and 3.0m depth; average 2.0m. Based on the trial pit logs, excavation greater than 2.0m is likely to prove difficult. 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.

13.8 Drainage

13.8.1 A surface water attenuation basin is shown on the site layout (See Drawing 4386/2), measuring 0.06ha in the west of the proposed development.

13.8.2 Based on observations made during the investigation, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SuDS), and there may be a need for surface water balancing.

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

[13] *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).*

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

13.8.3 Whilst the site may not lend itself to the adoption of discrete soakaways, ground may have the capacity to absorb surface water run-off, and systems which spread infiltration over a wider area (e.g. an infiltration basin, swales and/or pervious paving) may provide the best solution.

13.8.4 Alternative SuDS options (see CIRIA C753[15] for further details) include:

- Swales – linear grassed features in which surface water can be stored or conveyed. Where suitable, swales can be designed to allow infiltration.
- Basins - a ground depression designed to store surface water that is normally dry, except during and immediately following a rainfall event. There are two types:
  - Infiltration – basin designed to store runoff and infiltrate it gradually into the ground.
  - Detention – an outlet restricts flows, so that the basin fills and provides attenuation.
- Ponds – designed to have permanent pool of water, but with capacity to provide temporary storage-controlled discharge.

13.8.5 Yorkshire Water have published a guide[16] for developers and designers outlining their design requirements for surface water attenuation assets.

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

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

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

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

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

13.8.11 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.

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

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

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 guidance[17] and tables[18] indicate that the Cohesive Residual Soils would be expected to provide a CBR value of at least 3%. These values 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.

13.10 External works

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

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

14 REDEVELOPMENT ISSUES

14.1 General

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

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 unexpected 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:

- General site clearance of surface materials and vegetation

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

- Topsoil strip with to check for the presence of bell pits or outcrop workings in the Eastern Field. Made Ground Topsoil and Topsoil should be isolated into separate stockpiles.
- Consolidation (drill & grout) of shallow mineworkings.
- Provision of 600mm thickness of topsoil in all garden and landscaped areas where Colliery Spoil is left in-situ in the Eastern Field. Alternatively, excavation of the area of Colliery Spoil in the Eastern Field with redistribution underneath POS with 300mm clean cover.
- Provision of 600mm thickness of topsoil in all garden and landscaped areas where Made Ground Topsoil is left in-situ in the Eastern Field. If Made Ground Topsoil from the Eastern Field is placed into the POS area in the Western Field, 300mm thickness of clean cover is required above.
- Provision of 600mm thickness of topsoil in all garden areas, and 300mm cover in landscape areas in the Marsh Area, unless further testing of Topsoil is undertaken.
- Provision of or maintain 1000mm inert cover over the Dunsil Coal and Barnsley Coal where it is within <1000mm of finished ground level in plot gardens.

14.2.2 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.

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 The groundworker should appreciate the need for good materials management. Most notably the importance of not mixing different materials within a given stockpile; i.e. there should be separate stockpiles of: Topsoil; Made Ground Topsoil; Colliery Spoil, Cohesive Made Ground; 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. See also comments in Section 10.8 regarding asbestos.

14.3.4 Made ground arisings could be:

- Redistributed beneath concrete oversite, or areas of hardstanding, where they would be satisfactorily isolated from end users;
- Isolated beneath a 600mm thick cover layer in garden areas or 300mm thick cover layer in landscaped areas
- Exported from site to a suitably licensed landfill facility

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

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[19]
- EA Pollution Prevention Guidelines[20]:

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

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

- 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. Therefore, the Contractor should prepare a Materials Management Plan (MMP) in accordance with the CL:AIRE Code of Practice (v2, March 2011) [21].

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.

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 This site is essentially greenfield with only isolated areas of made ground associated with its possible coal mining legacy has resulted in some minor organic and inorganic contamination

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

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

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 Duchy Homes should consult Yorkshire Water at the earliest opportunity to confirm this.

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

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

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 personal protective equipment. See also comments in Section 12.9 regarding asbestos.

14.7 Coal extraction

14.7.1 The Barnsley Coal (c. 3.2m thick) does underlie the far East of the site; typically at depths from 1.2m at outcrop to around 5.0m in the north-east corner; and in the Far West at depths of between 12.0m and 15.0m where it has been heavily worked.

14.7.2 The Gawber, Dunsil and thin seams are typically <0.5m thick and outcrop within the site.

14.7.3 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.

14.7.4 Significant extraction has already occurred in the far West in the Barnsley Coal, reducing the potential yield from further extraction prior to redevelopment. The area of the site underlain by the Barnsley coal in the East is relatively small and also contains possible workings, reducing the potential yield further.

14.7.5 The Gawber, Dunsil and thin seams appeared to be of poor quality coal and were of relatively small thickness.

14.7.6 Consequently, it is considered **unlikely** that prior extraction of coal from this site would be economically viable.

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 In theory, the rear gardens underlain by the Barnsley Coal account for about 0.11ha in the Eastern Field and the Dunsil Coal underlies 0.04ha in the Marsh Area/Centre Field at shallow depth of <2.0m; combined accounting for <5% of the total site area. However, given seam dip and topography it seems unlikely that coal will be present at depths <1000mm across the majority of the site, at **current** site levels.

14.8.3 Drawing 4386/10A and 4386/10B shows which rear gardens of plots where combustible coal seams could be within 1000mm of existing ground levels.

14.8.4 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.

14.8.5 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 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.

14.9.2 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).

14.9.3 The depth and line of the combined sewer and surface water sewer across the site will have a significant impact on the plot layout at the site and it is understood that they will not be re-routed.

14.9.4 It is almost certain that Yorkshire Water will have restrictions with respect to development in the vicinity of the sewers; an easement will probably be required.

15 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

15.1 General

15.1.1 The site comprises of three grassed fields, the Western Field, Centre Field and Eastern Field, situated south of Darton Lane, Barnsley with a total area of 3.6ha. Situated between the Western and Centre fields is an area of marsh which appears saturated at surface. A gravel track runs off Darton Lane from the north and dissects the site between the Centre and Eastern Fields.

15.1.2 It is understood that consideration is being given to redevelopment of the site with 46 two-storey domestic dwellings, associated gardens, POS, adoptable roads and sewers.

15.1.3 The site contains Topsoil and sporadic Made Ground Topsoil (typically 300mm thick) across the Western and Centre fields whilst the Eastern field contains Made Ground Topsoil (typically 300mm thick).

15.1.4 Underlying Topsoil and Made Ground Topsoil are medium to high strength Cohesive Residual Soils to an average depth of 1.8m, Granular Residual Soils to an average depth of 2.4m, underlain by Coal Measures bedrock.

15.1.5 Made Ground comprising Cohesive Reworked Natural soils to an average depth of 0.8m (maximum 0.9m) are found irregularly in the Western and Central field; becoming regularly encountered in the Eastern Field. Colliery Spoil was encountered to 0.6m in the Eastern field and >2.8m in the Western Field in an isolated area.

15.1.6 Three northwest to southeast trending faults are present, one in the Western, Centre and Eastern Fields.

15.2 Mining

15.2.1 The majority of the site is located within a Coal Mining Development High Risk Area.

15.2.2 Three noteworthy coal seams outcrop on site; the Gawber Coal (Western Field), the Dunsil (Western Field, combustible) and the Barnsley Coal (Eastern field, combustible). The maximum thickness of the Barnsley Coal encountered was 3.2m. The Dunsil and Gawber Coal are all expected to be <0.5m thickness.

15.2.3 Underground shallow mineworkings associated with the Barnsley coal were encountered in the Western field directly by Lithos and by 3rd party in the Eastern Field. A possible area of outcrop workings was encountered in the Eastern Field to 1.9m depth.

15.3 Hazardous gas

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

15.3.2 The site is underlain by shallow mineworkings and several coal seams and is therefore susceptible to mines gas. Monitoring wells have been installed to facilitate a gas risk assessment.

15.4 Contamination & remediation

15.4.1 Colliery Spoil identified in a localised area in the Eastern field to 0.6m depth was found to contain exceedances of Lead and Arsenic.

15.4.2 Made Ground Topsoil was found to contain an exceedance of Arsenic and contains material which would generally be considered undesirable as a near-surface material in garden areas.

15.4.3 The Dunsil and Barnsley seam are combustible and will require 1000mm of inert cover where they are situated within1000mm of ground level in rear gardens.

15.4.4 Colliery Spoil and Made Ground Topsoil left in situ will require a 600mm clean cover if present within rear gardens, or 300mm cover if redistributed in areas of POS.

15.5 Foundations

15.5.1 It is considered that shallow strips 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 medium to high strength Cohesive Residual Soils.

15.5.2 Where foundations require deepening due to the impact of tree influence or through made ground, foundations may be seated in Granular Residual Soils of weathered Coal Measures.

15.5.3 Additional reinforcement of foundations is required within 25m of faults and may still be required for any plots founded over shallow coal workings (even after treatment).

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.

15.7 Drainage

15.7.1 Based on observations made during the investigation and the results of initial monitoring data, soakaways are very unlikely to provide a suitable drainage solution for surface water run-off at the site. Consequently, 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, Cohesive Residual Soils should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

15.9 Further works

15.9.1 The surface water attenuation basin shown in the southwest of the proposed site layout may require the installation of groundwater monitoring boreholes to establish water table levels over 4 consecutive seasons, for at least 3 points in the basin area.

15.9.2 Further trial pitting within the Marsh Area will allow the recovery of topsoil samples to ensure its suitability for re-use and enable the collection of geotechnical data of Cohesive Residual Soils which may have become softened at depth.

15.9.3 Topsoil strip to the east of the Barnsley Seam outcrop in the Eastern Field to determine whether outcrop workings or bell pits are present.

15.9.4 Consolidation (via drill & grout) of shallow underground mineworkings in the Eastern Field with associated Specification for the Treatment of Shallow Workings.

15.9.5 Gas monitoring is ongoing and a Gas Risk Assessment will be issued in October 2022.

Appendix A

General Notes

01 - Environmental setting
Generic notes – geoenvironmental Investigations

General

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

Geology, mining & quarrying

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

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

Landfills

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

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

Radon

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

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

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

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

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

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

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

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

Hydrogeology

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

- Groundwater quality
- Recorded pollution incidents
- Licensed groundwater abstractions

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

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

The maps display the following aquifer designations:

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

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

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

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

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

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

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

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

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

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

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

Hydrology

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

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

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

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

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

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

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

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

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

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

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

COMAH & explosive sites

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

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

Preliminary conceptual site model

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

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

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

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

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

02 - Ground investigation fieldwork
Generic notes – geoenvironmental investigations

General

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

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

Exploratory hole locations

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

Investigation techniques

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

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

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

In-situ testing

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

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

Shear strength test results (hand vane readings) reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

Typically Lithos collect at least three soil samples from each exploratory hole, although in practice a greater number are often taken. The collection of a sufficient number of samples provides a sound basis upon which to schedule laboratory analysis, ensuring:

- A sufficient number of samples from each (common) site material are tested
- Horizontal and vertical coverage of the site is adequate, thereby providing a robust data set for use in the conceptual ground model
- Any localised, significant, but non-pervasive conditions are considered

Made ground and natural soils encountered in the field during a ground investigation often contain a significant proportion of coarse grained material (e.g. brick etc). Soil samples obtained during most investigations are often only truly representative of the in-situ soil mass where there is an absence of particles coarser than medium gravel; i.e the entire soil mass would pass a 20mm sieve.

Representative bulk samples of the **soil mass** are retrieved from coarse soils for specific geotechnical tests (most notably grading and compaction); this typically requires the collection of at least 10kg of soil, and occasionally >50kg. However, in the context of assessing land contamination, it is generally accepted that samples should be representative of the **soil matrix** of the stratum from which they are taken. Consequently, truly representative samples of coarse soils for subsequent contaminant analysis are not obtained - only the finer fraction is placed in sample containers. Coarse constituents not sampled would typically comprise any 'particles' with an average diameter greater than about 20mm (i.e. coarse gravel, cobble and boulder).

At present, neither ISO/IEC 17025 nor MCERTS specify sample pre-treatment with respect to stone removal. Unsurprisingly therefore UKAS accredited testing laboratories do not adopt the same approach to stones[1] – some crush and test the "as received" soil, whilst others sieve out stones and analyse only the residual soil (the sieve size used varies depending on the laboratory).

In essence, samples taken from coarser soils for contaminant analysis are "screened" by the geoenvironmental engineer in the field, and often sieved again by the laboratory during sample preparation. Geoenvironmental engineers do not typically re-calculate soil mass contaminant concentrations by taking account of the unsampled coarse fraction. Likewise, laboratories that remove stones typically report contaminant concentrations based on the dry weight of soil passing the sieve. In the context of land contamination and human health risk assessment, this is considered reasonable, because it is the soil matrix which is of greatest concern. Stones are unlikely to:

- Provide a significant source for plant uptake (consumption of vegetables)
- Remain on vegetables after washing (consumption of vegetables)
- Be eaten (accidentally by an adult, or deliberately by a child)
- Be whipped-up by the wind for dust generation (inhalation)
- Stick to the skin for any length of time (dermal contact)
- Yield toxic vapour (inhalation)

Consequently, Lithos instruct labs to remove all stones >10mm, and to report the results as dry-weight based on the mass of matrix tested. However, the laboratory are given site-specific instruction where coarse stones are coated in say oil, or impregnated with mobile contaminants such as diesel. Where the stones are predominantly natural, or inert (e.g. brick, concrete etc), removal will clearly result in higher reported concentrations, than if the stones were crushed and added to the matrix.

Where the stones include a significant proportion of contaminant-rich material (e.g. slag, fragments of galvanised metal etc) an argument could be made for crushing and analysing. However, provided the stones are stable (i.e. unlikely to disintegrate or degrade) they should not pose a significant risk to human health for the reasons stated above.

Sometimes it is necessary to obtain samples that are not representative of the wider soil matrix, for example when investigating localised, significant, but non-pervasive conditions. Any such unrepresentative samples are annotated with the suffix '*' (eg 2D*, or 4G*). Lithos' site engineer describes both the unrepresentative sample, and the soil mass from which it was been taken.

Sample Containers (for contaminant analysis). Samples of soil for contaminant testing are placed into appropriate containers (see below). Soil samples for organic analysis are stored in cool boxes, at a temperature of approximately 4ºC, until delivery to the selected laboratory.

Anticipated testing	Container(s)
Asbestos identification	1000ml plastic tub
pH & metals	1000ml plastic tub or 250ml glass jars
non-volatile organics	250ml glass jars
Speciated TPH	250ml & 50ml glass jars
VOCs (incl. naphthalene and\or GRO)	50ml glass jar

Sample Containers (for geotechnical analysis). The majority of samples are only scheduled for PI and sulphate testing, for which 500g of sample is required (a full 0.5-litre plastic tub). However, bulk bags are taken where scheduling of compaction or grading tests is proposed.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork. Long-term monitoring of standpipes or piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

It should be borne in mind that the rapid excavation rates used during a ground investigation may not allow the establishment of equilibrium water levels. Water levels are likely to fluctuate with season/rainfall and could be substantially higher at wetter times of the year than those found during this investigation.

Description of strata

Soils encountered during a Lithos investigation are described (logged) in general accordance with BS 5930:2015. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text. The materials encountered in the trial pits are logged, samples taken, and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

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

03 – Geotechnical laboratory testing
Generic notes – geoenvironmental investigations

General

Soil samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Lithos. All tests are carried out in accordance with BS 1377:1990. The following laboratory testing is routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

Where soft, cohesive soils are encountered, one-dimensional consolidation tests are scheduled in order to assess settlement characteristics, and unconsolidated undrained triaxial compression tests to assess shear strength.

The additional tests are typically only scheduled where significant earthworks regrade is anticipated:

- Grading
- Compaction tests
- Particle density

Test results are presented as received in an Appendix to the Geoenvironmental Report.

Atterberg limits & moisture content

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each "type" of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth. Lithos typically only consider a soil to be shrinkable if the proportion finer than 63µm is >35%. PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003), which advocates the use of modified Plasticity Index (I'p), defined as:

I'p = Ip * (%< 425µm/100)

i.e. if PI is 30%, but the soil contains 80% < 425µm, then: I'p = 30 * 80/100 = 24%.

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs. Lithos apply engineering judgment where PI results are spread over a range of classifications. Consideration is given to:

- The average values for each particular soil type (ie differentiate between residual soil and alluvium)
- The number of results in each class and
- The actual values

Unless the judgment strongly indicates otherwise, Lithos typically adopts a conservative approach and recommends assumption of the higher classification.

Soluble sulphate and pH

Sulphates in soil and groundwater are the chemical agents most likely to attack sub-surface concrete, resulting in expansion and softening of the concrete to a mush. Another common cause of concrete deterioration is groundwater acidity.

The rate of chemical attack depends on the concentration of aggressive ions and their replenishment at the reaction surface. The rate of replenishment is related to the presence and mobility of groundwater.

Lithos refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2005). SD 1 provides definitions of:

- The nature of the site (greenfield, brownfield or pyritic)
- The groundwater regime (static, mobile or highly mobile)
- The design sulphate class (DS class) and
- The aggressive chemical environment for concrete (ACEC class)

Lithos reports clearly state each of the above for the site being considered.

The concentrations of sulphate in aqueous soil/fill extracts are determined in the laboratory using the gravimetric method. The results are expressed in terms of SO_4 for direct comparison with BS 5328:1997. The pH value of each sample was determined by the electrometric method.

SD1 also discusses determination of "representative" sulphate concentration from a number of tests. Essentially if <10 samples of a given soil-type have been tested, the highest measured sulphate concentration should be taken. If >10 samples have been tested, the mean of the highest 20% of the sulphate test results can be taken. With respect to groundwater, the highest sulphate concentration should always be taken.

With respect to pH (soil & groundwater) the value used is the lowest value if <10 samples have been tested and the mean of the lowest 20% if >10 samples have been tested.

Oedometer (Consolidation) tests

Oedometer tests measure a soil's consolidation properties, and are performed by applying different loads to a soil sample and measuring the deformation response. Typically the sample is subject to 5 incremental pressures (4 loading & 1 unloading), and the convention is for each subsequent pressure to be double the previous pressure. BS1377 suggests the **initial** pressure should be:

a) For stiff soils the effective overburden pressure*
b) For firm soils "somewhat less" than the effective overburden pressure
c) For soft soils "appreciably less" than the effective overburden pressure, usually 25 kPa or less
d) For very soft soils very low, typically 5 kPa or 10 kPa

* Effective **overburden pressure** (kNm^{-2}) = depth (m) x soil bulk unit weight (kNm^{-3})

Results from these tests are used to predict how a soil in the field will deform in response to a change in effective stress.

Triaxial tests

This test measures the mechanical properties of a soil by placing the sample between two parallel platens which apply stress in one (usually vertical) direction, with fluid used to apply a confining pressure in the perpendicular directions. During the test, the surrounding fluid is pressurized, and then stress on the platens is increased until the material in the cylinder fails.

From triaxial test data, it is possible to extract fundamental material parameters, including its angle of shearing resistance, apparent cohesion, and dilatancy angle. These parameters are then used in computer models to predict how the material will behave in a larger-scale engineering application.

Quick (single stage, Unconsolidated, Undrained tests) are most appropriate for foundation design. This is because load is applied relatively quickly, and shear strength of the clay will be lowest initially; after the applied load causes some consolidation of the ground (after drainage results in dissipation of short-term excess pore water pressure), the in-situ clays will become progressively stronger and hence the factor of safety will increase. Confining pressure is specified as equivalent to overburden pressure (kNm^{-2}).

Foundations on granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Unconsolidated Undrained triaxial tests are most appropriate for assessment of the stability of fill slopes on clays. Similar to foundations, the application of load gradually increases the strength of the clays and hence the critical case is the short term undrained condition.

Consolidated Undrained (or sometimes **Consolidated Drained**) triaxial tests are most appropriate for assessment of the stability of cut slopes in clays. This is because unloading of the ground leads to short term reduction in pore pressures that approximately balance the unloading, hence the soil strength is largely unchanged. Over time the reduced pore pressures suck water in, which leads in to the progressive increase in pore pressure and loss of strength. The fully drained state is critical, which must be modelled using effective strength parameters and a reasonable estimate of the long term water table conditions.

Slopes formed in granular soils would use effective shear strength parameters (c' and phi') to assess safe bearing capacity, as the soil would fully drain quickly. These effective shear strength parameters could be determined from Consolidated Undrained (or sometimes the more expensive Consolidated Drained) triaxial tests, but often correlations to the SPT are used.

Determination of analytical suite

An assessment of potential contaminants associated with the former usages of the site is undertaken with reference to CLR 8 "Potential contaminants for the assessment of land" and the relevant DETR Industry Profile(s).

Common contaminants

Common **Inorganic** Contaminants include:

- Metals, most notably cadmium, copper, chromium, mercury, lead, nickel, and zinc
- Semi-metals, most notably arsenic, selenium, and (water soluble) boron
- Non-metals, most notably sulphur
- Inorganic anions, most notably cyanides (free & complex), sulphates, sulphides, and nitrates

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction. Complex cyanide is "bound" in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to UV digestion for determination of both free and total CN.

Thiocyanate (SCN) is a different species combined with sulphur.

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO_4), sulphides etc.

There are 2 forms of chromium (Cr), chromium VI and chromium III. Chromium VI is the more toxic of these. In soils, total chromium is determined by a strong aqua regia acid digestion. Chromium VI is an empirical method based on a water extract test.

Common **Organic** Contaminants include hydrocarbons, phenols, and polychlorinated biphenyls.

Petroleum is a mixture of hydrocarbons produced from the distillation of crude oil, and includes aliphatics (alkanes, alkenes and cycloalkanes), aromatics (benzene and derivatives) and hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen. Petroleum hydrocarbons can be grouped based on the carbon number range:

- GRO – Gasoline Range Organics (typically C_6 to C_{10}). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C_{10} to C_{28})
- LRO - Lubricating Oil Range Organics (typically C_{28} to C_{40})
- MRO – Mineral Oil Range Organics (typically C_{18} to C_{44})

However, it should be borne in mind that the terms "GRO" and "DRO" analysis are purely descriptive terms, the exact definition of which varies. Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from C_5-C_{40}, whereas others define TPH as C_{10}-C_{30}.

The composition of a TPH plume migrating through the ground can vary significantly; this is primarily dictated by the nature of the source (e.g. petrol, diesel, engine oil etc). Furthermore, different hydrocarbons are affected differently by weathering processes, and this can result in further variation in the chemical composition of the TPH.

Gasoline contains light aliphatic hydrocarbons (especially within the C_4 to C_5 range) that are volatile. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present. Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar nitrogen, sulphur and oxygen-containing compounds (NSO) compounds are also present. Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

Polycyclic Aromatic Hydrocarbons (PAHs) have two or more 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 Land Contamination Risk Management (2020). 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 & 10) outlining the UK approach to the assessment of risk to human health from land contamination. In 2008 CLR 7, 9 & 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, Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

In December 2013 Defra published the results of research project SP1010 – Development of Category 4 Screening Levels (C4SLs) for Assessment of Land Affected by Contamination. The objective of this project was to provide technical guidance in support of Defra's revised Statutory Guidance for Part 2A of the Environmental Protection Act 1990 (Part 2A). The revised Statutory Guidance, published in April 2012, introduced a new four-category system for classifying land under Part 2A, where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low. Project SP1010 aimed to deliver:

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

The methodology for deriving both the previous Soil Guideline Values and the 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).

Part 2A Statutory Guidance was developed on the basis that C4SLs could be used under the planning regime. 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.

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, many organic contaminants are more mobile when the SOM is lower, and consequently comparison of soil results with revised, lower screening values may 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 five 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.

Scenario	Land use	Pathways	Justification
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 foundation; 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.

Lithos have derived Tier 1 values for a number of inorganic and organic determinands in the context of the five Scenarios A to E. The Tier 1 values are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part 2A of the Environment Protection Act 1990;
- End uses such as allotments, sports fields, children's playgrounds, care homes, hospitals etc; or
- Groundwater and surface water

Inorganic Tier 1 values for scenarios A to E

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			4,000		4,000	28,767	4,000	Assumes Cr is CrIII
Pb	450	200	200		314	2,330	200	C4SL adopted
Ni	130		109		123	892	109	Assessment of health risk only
Se	350		434		596	13,018	434	
Hg	170		199		244	3,603	199	Assumes in an inorganic compound
Vn			584		586	4,994	584	
B			5		5	5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu			100		100	100	100	
Zn			200		200	200	200	

Organic Tier 1 values for scenarios A to E

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	0.7	<1^	<1^	63	<1	<1 based on professional judgement and lower than calculated value.
Toluene	610		836	2,048	1,912	5,000	<1	Scenario D based on professional judgement and lower than calculated value.
Ethyl Benzene	350		379	592	566	5,000	<10	
Xylenes	240		535	590	585	5,000	<10	Scenario E based on professional judgement and lower than calculated value.
Phenol	420		1,434	3,360	2,264	5,000	<10	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo(a)pyrene		5	5	25	5	76	5	C4SL adopted. Scenario B 5 times scenario A
Naphthalene			6	6	6	619	<10	Scenario E based on professional judgement and lower than calculated value
Gasoline Range Organics			22	23	23	2178	626	See 3-step assessment of TPH below ^Based on professional judgement and lower than calculated value
Diesel Range Organics			215	218	215	^5,000	1,429	
Lubricating Range Org			3,299	5,000	3,829	^5,000	3,299	

* *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]

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.

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

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

The equation used to assess cumulative effects in step 3 is shown below.

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

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

Statistical Assessment

Current UK guidance is provided by CL:AIRE[2], and uses two-way confidence intervals and graphical summaries, to assist assessors when determining whether or not a dataset is adequate to answer the question posed; e.g. "is existing site topsoil suitable for retention & re-use?". To answer such a question, it is necessary to recover and test a large number of samples (a minimum of 10; ideally 20+) in order to undertake meaningful statistical analysis.

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

The CL:AIRE (2020) guidance replaces the withdrawn "Guidance on Comparing Soil Contamination Data with a Critical Concentration" (2008).

The old approach to statistical analysis was based on a definitive yes/no answer which required limited consideration of the dataset and Conceptual Site Model. It was widely accepted that this did not allow sites or risk to be adequately assessed. The updated approach requires a comprehensive understanding of the datasets within the context of the Conceptual Site Model.

Current guidance requires that:

- A robust CSM is in place which identifies source areas, averaging areas and averaging zones
- Sampling locations are relatively evenly spread across the site and were selected using simple or stratified random sampling with no targeting being undertaken
- The field data and CSM do not suggest the presence of a hotspot of contamination which should be treated as a separate zone
- The samples are all taken from a similar same depth and within the same material type across the zone being assessed
- A minimum of 10 samples have been taken. It should be appreciated that confidence in a dataset increases as the number of samples obtained and tested from a zone increases.

The statistical analysis assumes a homogenous distribution of strata and contamination and therefore the dataset will be normally distributed (symmetric, log symmetric or fat tailed).

A normally distributed dataset is assessed using a number of statistical tools to generate a Dot and Box Plot which includes summary statistics and confidence intervals. The review of statistical data enables the assessor to make a decision, with an associated level of confidence, where the true mean of the sample population lies in relation to the critical concentration.

It is essential when using statistics to assess sample data that all decisions relate back to the conceptual site model. Statistics cannot indicate if contamination on a site is likely to present a risk to the end user, this is the role of the 'competent person' i.e. Lithos.

However, broadly speaking the following applies:

- Mean and UCL below the critical concentration – no further assessment required.
- Mean below the critical concentration, but UCL above – consider the CSM and likely sources.
- Mean and UCL above the critical concentration – further assessment required, remediation likely depending on the CSM.
- LCL, Mean & UCL above the critical concentration – further assessment required, remediation likely.

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

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 Sewage Sludge in Agriculture: Code of Practice 2018 for copper and zinc (at pH 5.5 to 6.0). The CLEA derived Tier 1 value 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 always site specific and compare leachate or groundwater concentrations with the appropriate water quality standard based on the CSM and consideration of relevant water quality impacts and assessments.

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**. 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 Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration, 2020 (see above) 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. Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration, 2020 provides some guidance on averaging areas noting that they are the area within which a receptor may be exposed to contamination but leaving the site assessor to determine the appropriate averaging area for their site.

Lithos consider 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; i.e. 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, i.e. 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.

Other relevant UK guidance includes:

- BS8485:2015+A1:2019 – Code of Practice for the characterisation & remediation from ground gas in affected developments.
- BS8576:2013 Guidance on investigations for ground gas – permanent gases and volatile organic compounds
- 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
- Wilson, Card & Haines (CIEH, 208) The Local Authority Guide to Ground Gas
- CL:AIRE Research Bulletin RB17 (November 2012) A Pragmatic Approach to Ground Gas Risk Assessment
- CL:AIRE Research Bulletin RB13 (February 2011) The Utility of Continuous Monitoring in Detection & Prediction of 'Worst-Case' Ground Gas Concentration
- BRE\Environment Agency Report BR 414 (2001) – "Protective Measures for housing on gas-contaminated land".
- YALPAG (December 2016) - Verification Requirements for Gas Protection Systems - Technical Guidance for Developers, Landowners and Consultants.
- Environment Agency Report LFTGN 03 - Guidance on the management of landfill gas, June 2014

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.*

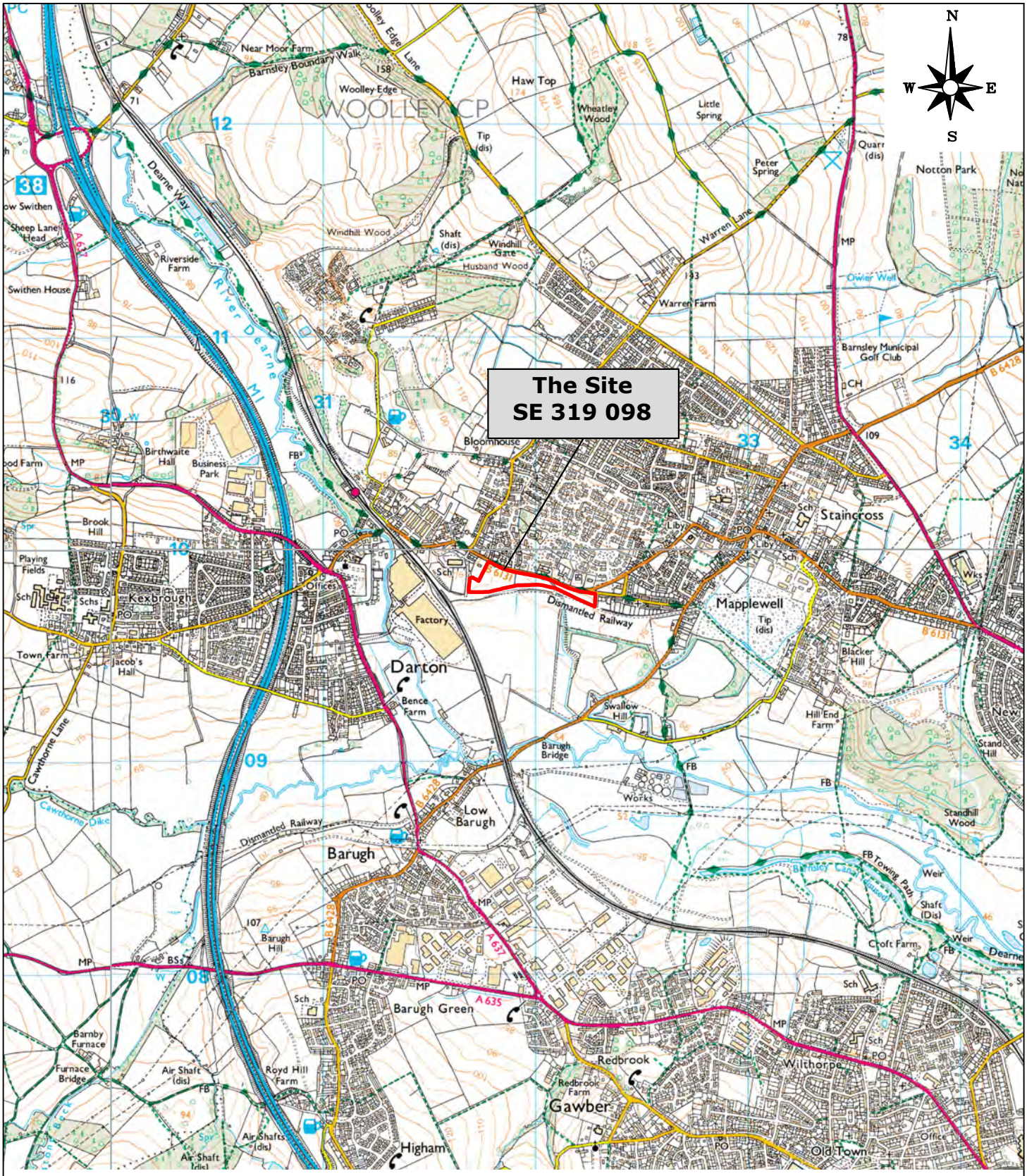
iii *Wilson SA and Card GB (February 1999). Reliability and Risk in Gas Protection Design. Ground Engineering.*

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.*

Appendix B

Drawings



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DRAWING TITLE	SITE LOCATION PLAN
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CHECKED	AG
DATE	10 06 22
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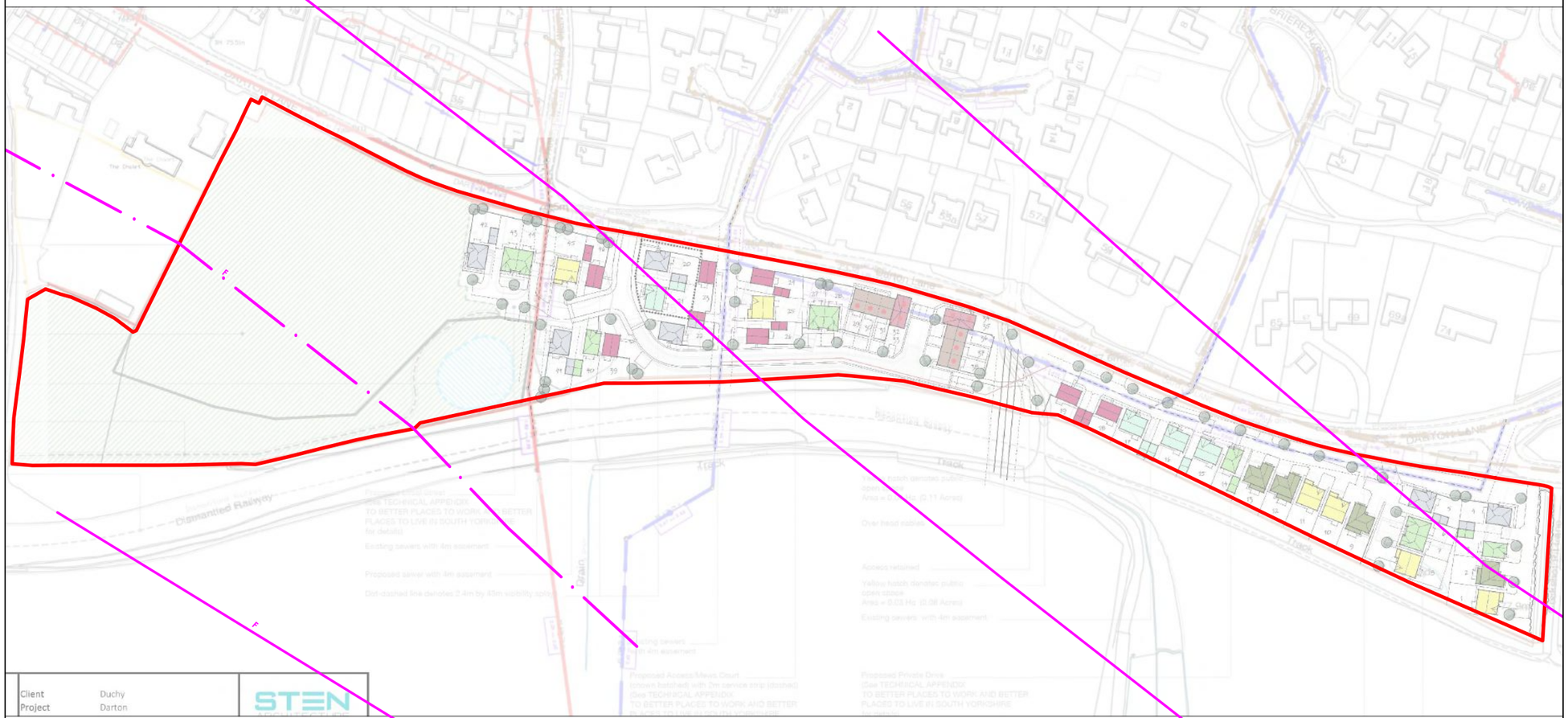

NOTES

F — ACTUAL FAULT

F — RECORDED FAULT

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM DUCHY HOMES DRAWING REFERENCE SK04, DATED OCTOBER 2020

REV.	DESCRIPTION	DATE

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DUCHY HOMES

JOB TITLE

DARTON LANE, BARNSLEY

DRAWING TITLE

PROPOSED SITE LAYOUT

DRAWN	DATE	STATUS
AT	10 06 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
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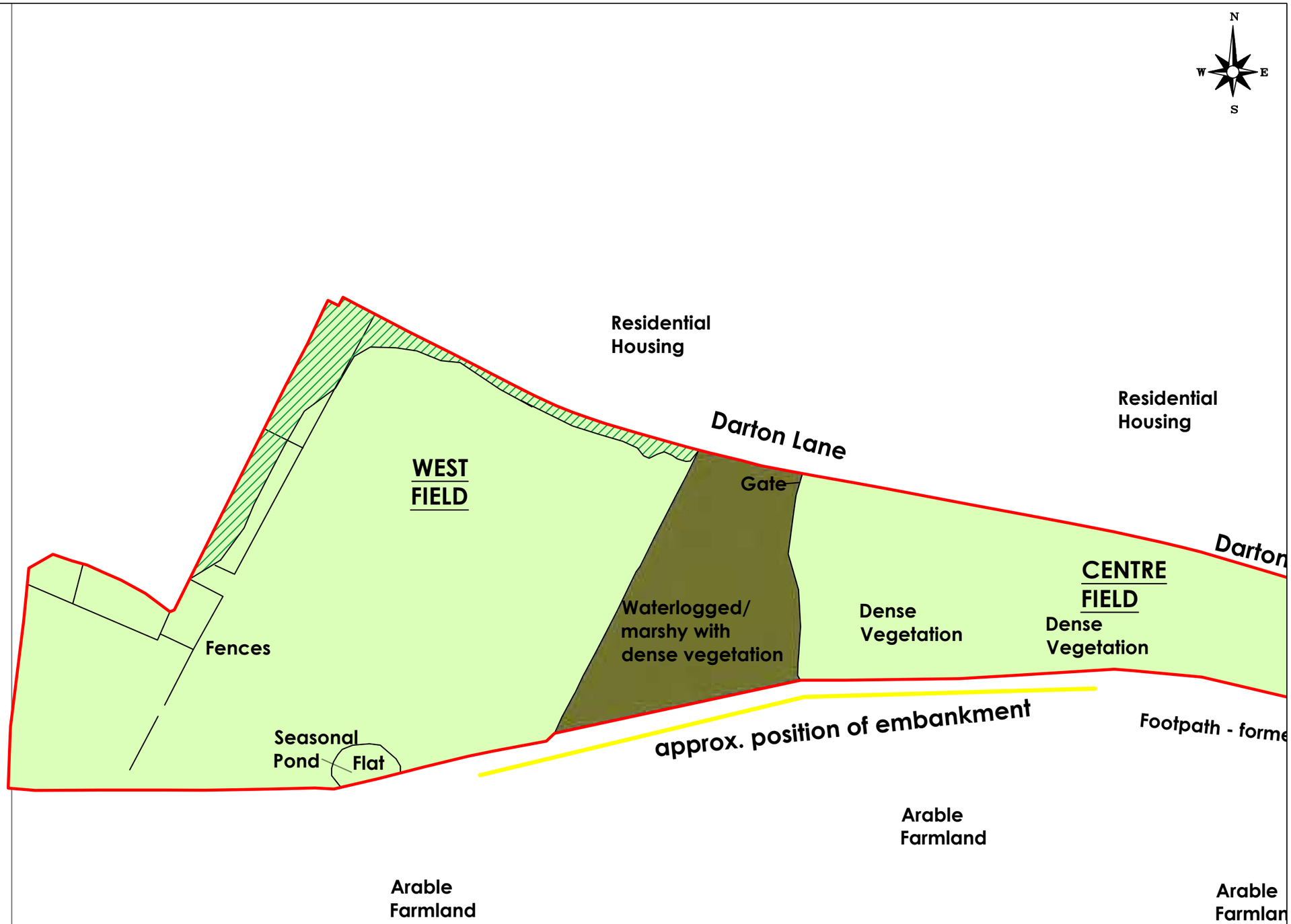

NOTES

- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- MARSH & V.DENSE VEGETATION
- V. DENSE VEGETATION
- APPROXIMATE POSITION OF RAILWAY EMBANKMENT
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

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JOB TITLE

DARTON LANE, BARNSLEY

DRAWING TITLE

SITE FEATURES (WEST)

DRAWN	DATE	STATUS
AT	28 07 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
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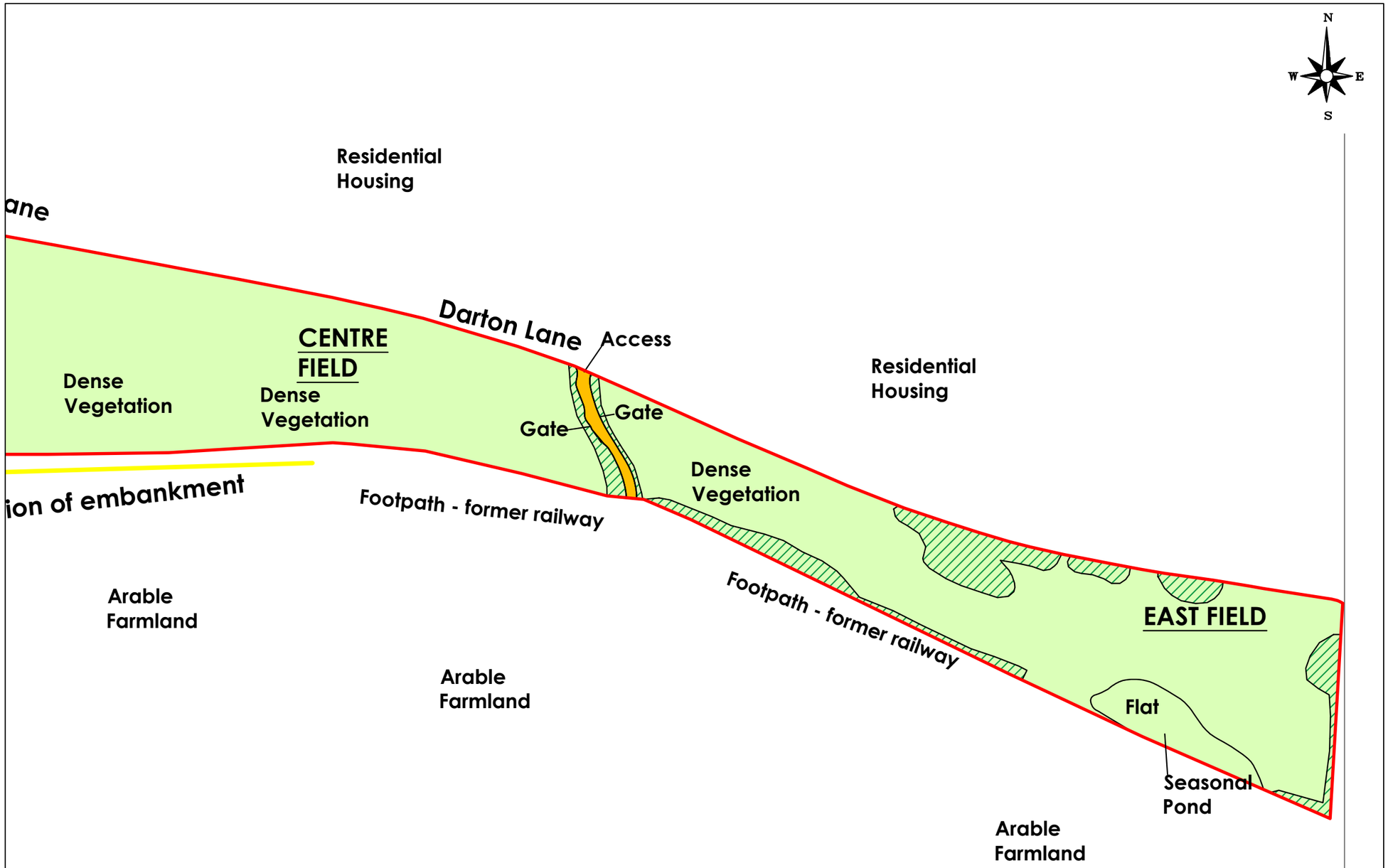

NOTES

- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- MARSH & V.DENSE VEGETATION
- V. DENSE VEGETATION
- APPROXIMATE POSITION OF RAILWAY EMBANKMENT
- APPROXIMATE SITE BOUNDARY

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JOB TITLE

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BARNSLEY

DRAWING TITLE

SITE FEATURES - EAST

DRAWN	DATE	STATUS
AT	28 07 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	28 07 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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NOTES

- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- MARSH & V.DENSE VEGETATION
- V. DENSE VEGETATION
- APPROXIMATE SITE BOUNDARY
- LOCATION & ORIENTATION OF PHOTOGRAPH

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JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL ☐
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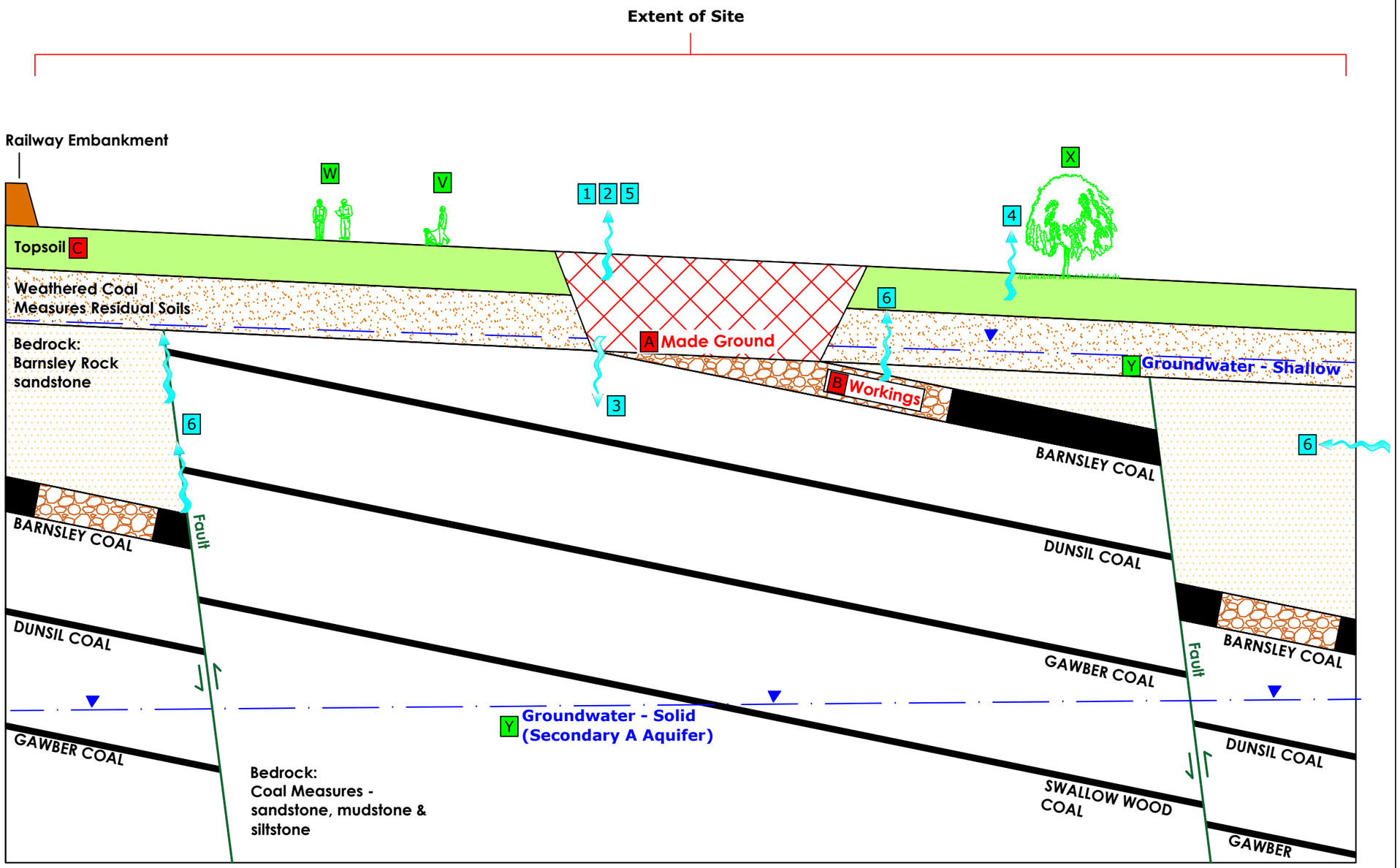

SOURCES	PATHWAYS	RECEPTORS
A MADE GROUND (INORGANICS & ORGANICS)	1 DERMAL CONTACT	V END USERS (RESIDENTS)
B COAL & WORKINGS	2 INGESTION/INHALATION	W SITE WORKERS
C TOPSOIL (ORGANICS & INORGANICS)	3 LEACHING OF CONTAMINANTS	X VEGETATION
	4 UPTAKE BY PLANTS	Y GROUNDWATER
	5 VOLATILISATION	
	6 MIGRATION OF GAS	

NOTES

REV.	DESCRIPTION	DATE

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CLIENT: DUCHY HOMES

JOB TITLE: DARTON LANE, BARNSLEY

DRAWING TITLE: PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
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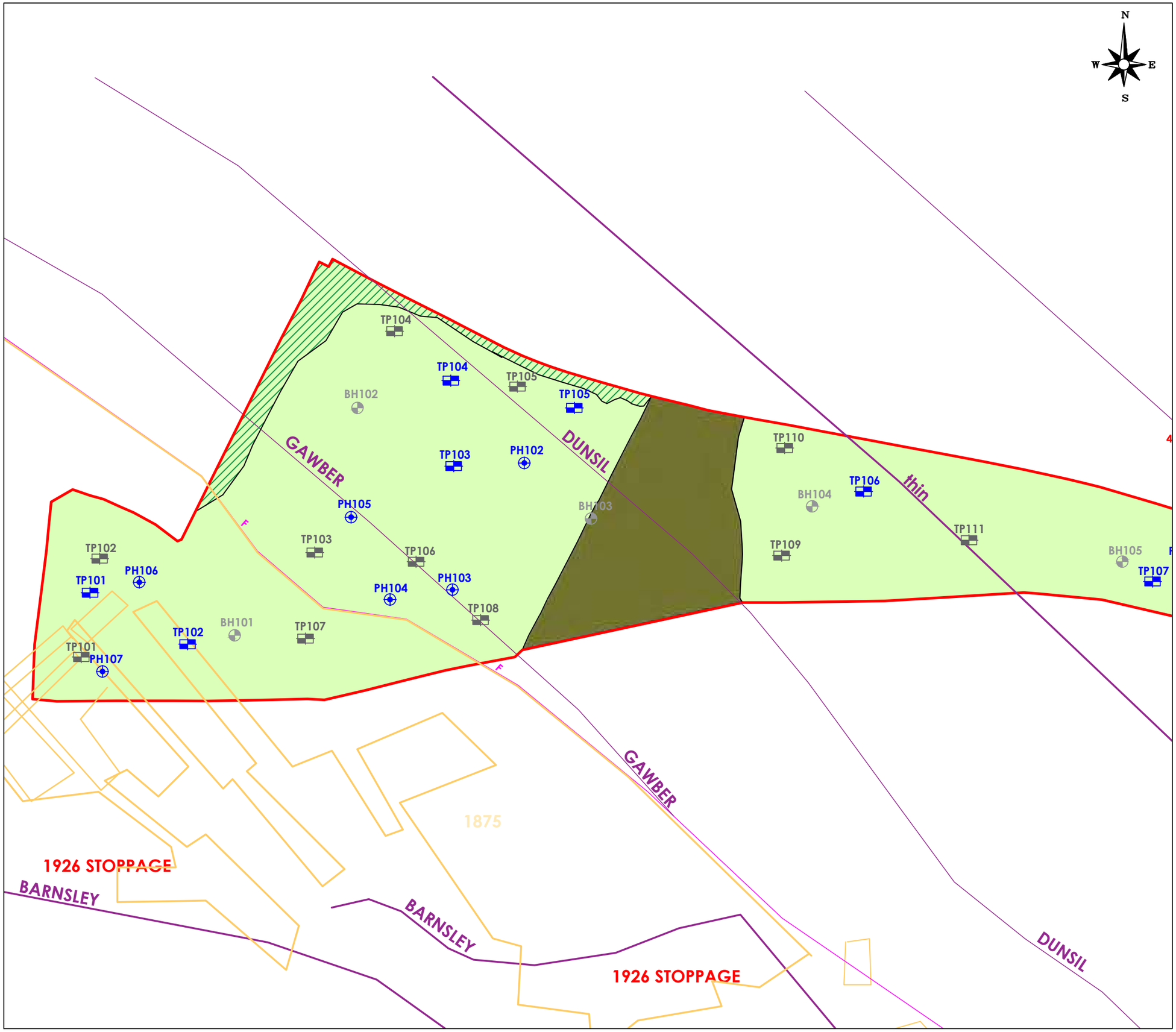

NOTES

- LITHOS TRIAL PIT LOCATION
- LITHOS PROBEHOLE LOCATION
- WA TRIAL PIT LOCATION
- WA PROBEHOLE LOCATION
- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- MARSH & V.DENSE VEGETATION
- V. DENSE VEGETATION
- AREA OF COLLIERY SPOIL - REPRODUCED FROM GEOLOGY MAP SE 30 NW
- AREA OF KNOWN OPENCAST WORKINGS - REPRODUCED FROM CA ABANDONMENT PLAN REFERENCE NE.158, DATED 5TH APRIL 1955.
- AREA OF KNOWN UNDERGROUND WORKINGS - REPRODUCED FROM CA ABANDONMENT PLAN REFERENCE NE.863/2, DATED 9TH JULY 1980.
- RECORDED COAL SEAM
- F RECORDED FAULT
- APPROXIMATE POSITION OF RAILWAY EMBANKMENT
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

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JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS-
WEST

DRAWN	DATE	STATUS
AT	25 07 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
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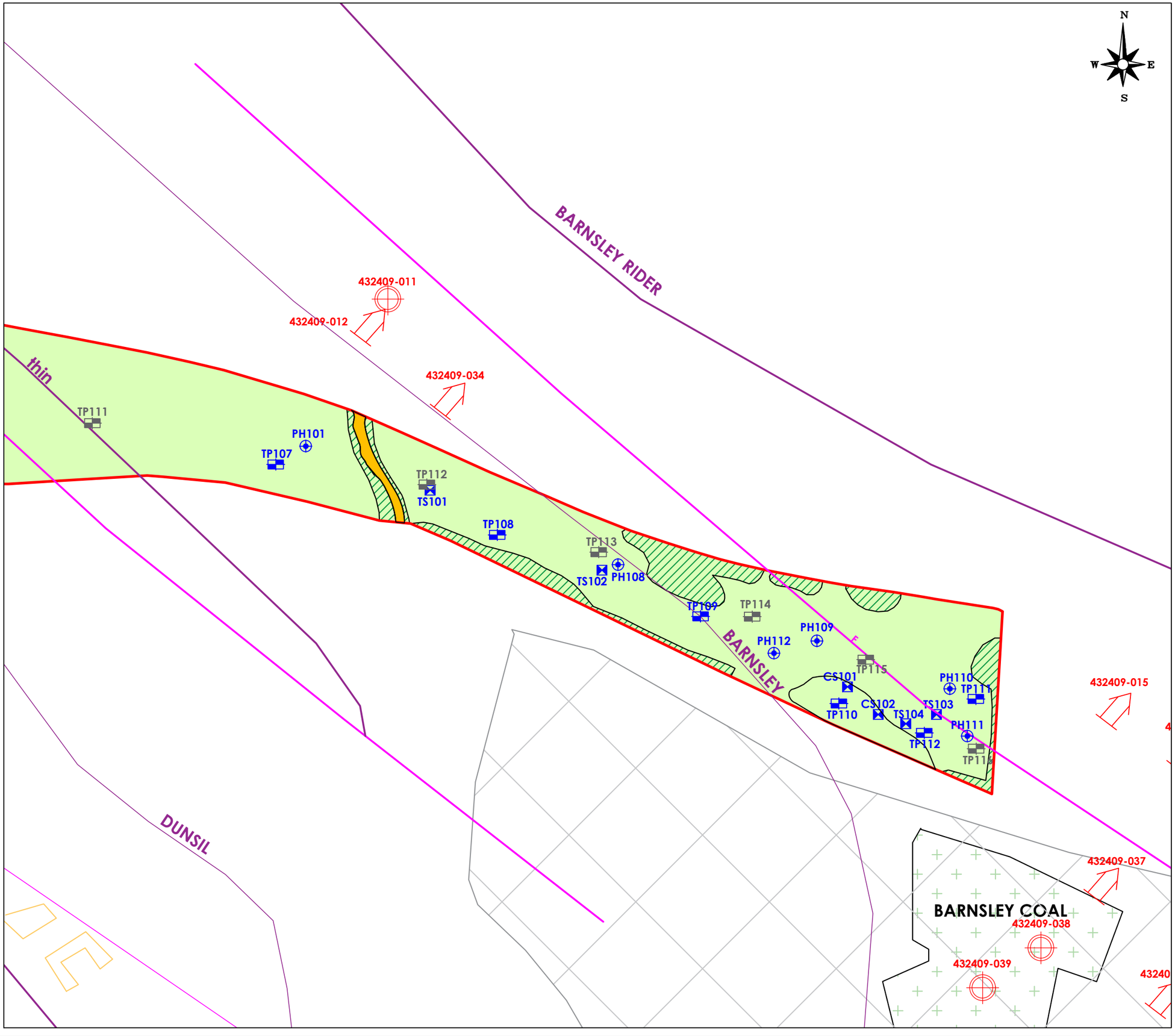

NOTES

- LITHOS TRIAL PIT LOCATION
- LITHOS PROBEHOLE LOCATION
- WA TRIAL PIT LOCATION
- WA PROBEHOLE LOCATION
- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- POSSIBLE OUTCROP WORKINGS
- V. DENSE VEGETATION
- AREA OF COLLIERY SPOIL - REPRODUCED FROM GEOLOGY MAP SE 30 NW
- AREA OF KNOWN OPENCAST WORKINGS - REPRODUCED FROM CA ABANDONMENT PLAN REFERENCE NE.158, DATED 5TH APRIL 1955.
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- F RECORDED FAULT
- APPROXIMATE POSITION OF RAILWAY EMBANKMENT
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE, BARNSLEY

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS - EAST

DRAWN	DATE	STATUS
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CHECKED	DATE	FOR APPROVAL ☐
AG	25 07 22	DRAFT ☐
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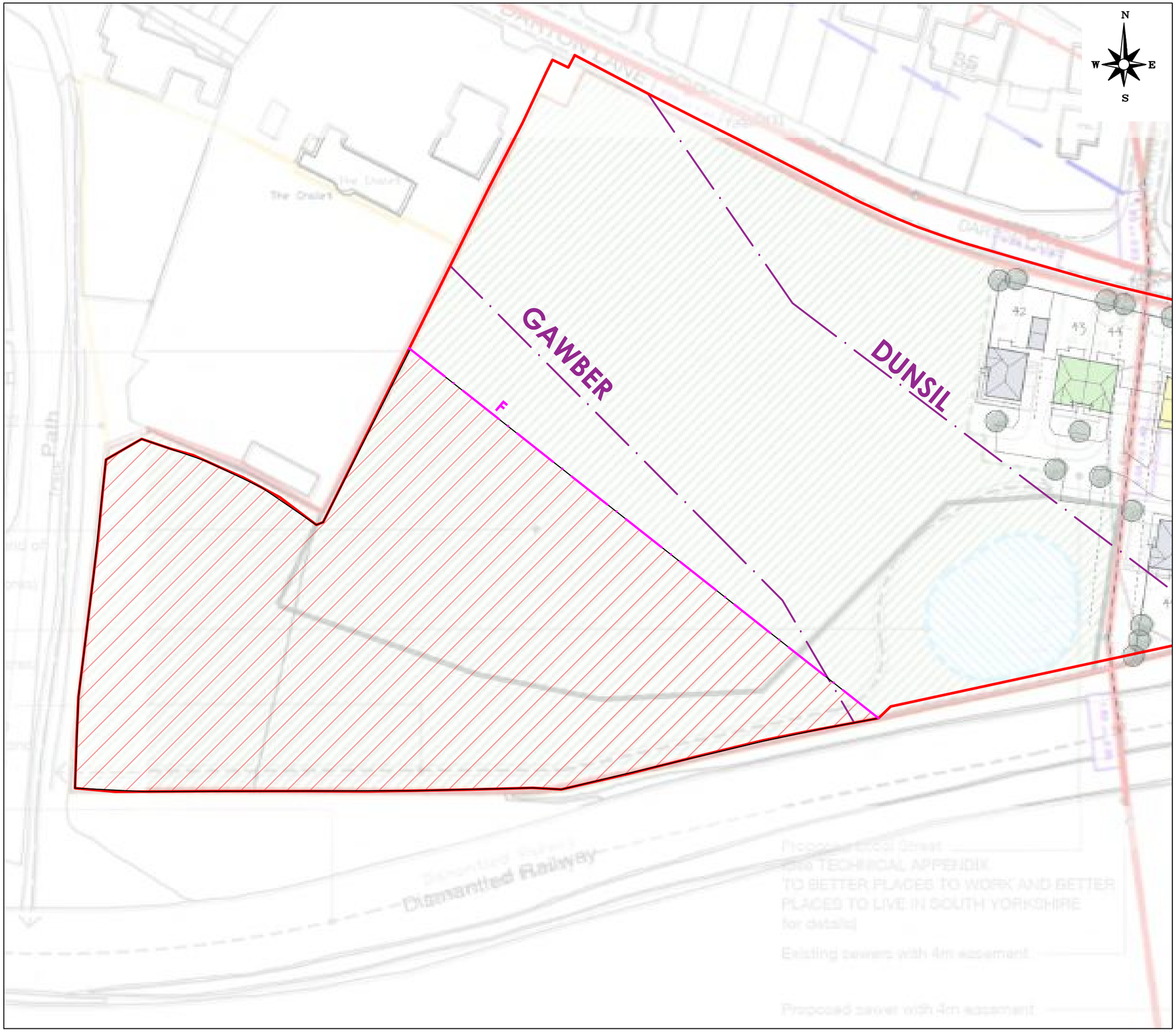


NOTES

- ACTUAL COAL SEAM
- F ACTUAL FAULT
- APPROXIMATE DRILL & GROUT AREA REQUIRED - IF DEVELOPED
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

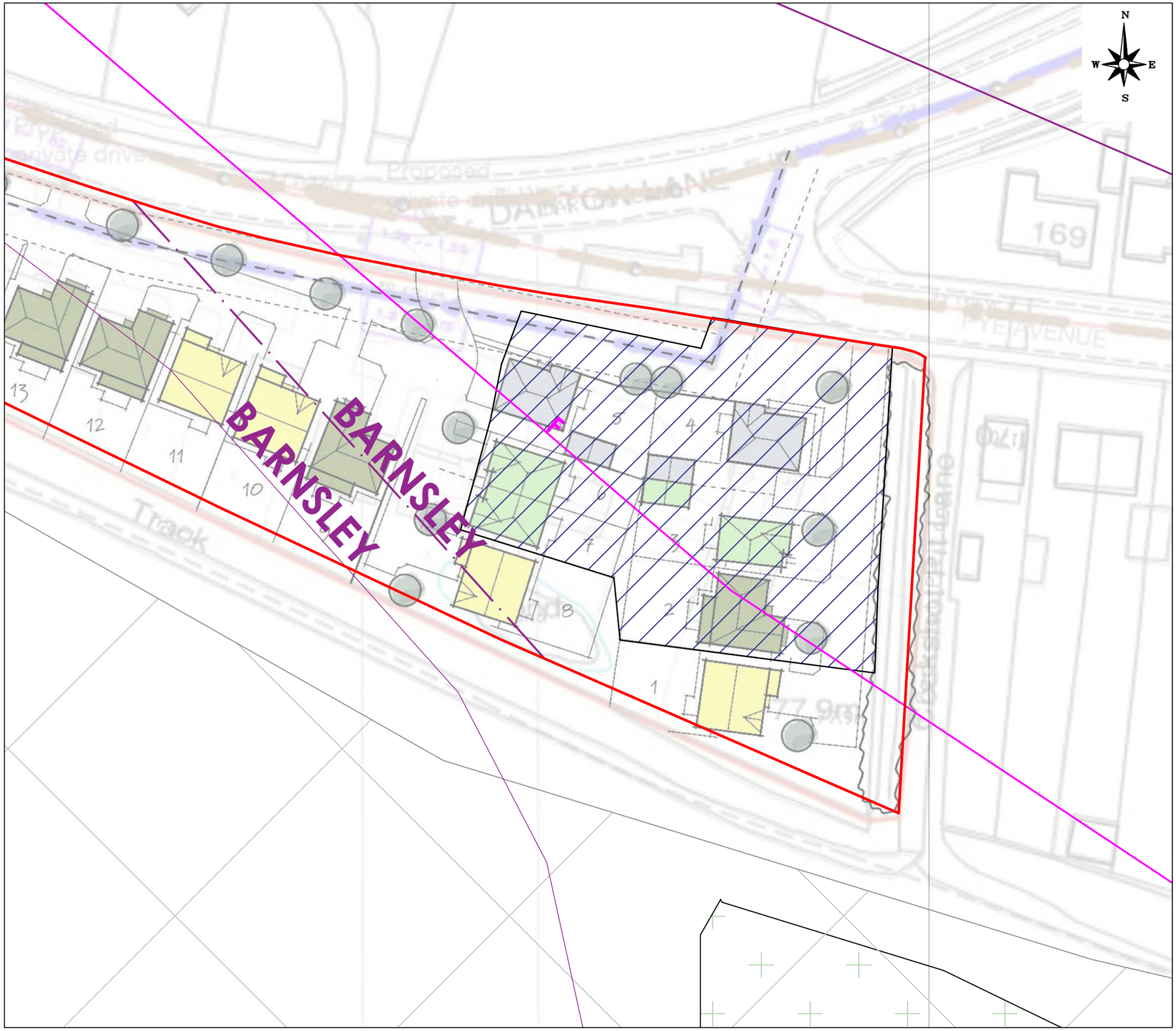
DARTON LANE,
BARNSLEY

DRAWING TITLE

DRILL & GROUT AREA - WEST

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:750	A3	4386/7a	



NOTES

- ACTUAL COAL SEAM
- RECORDED COAL SEAM
- F FAULT
- APPROXIMATE DRILL & GROUT AREA REQUIRED
- APPROXIMATE SITE BOUNDARY

REPRODUCED FROM DUCHY HOMES DRAWING REFERENCE SK04, DATED OCTOBER 2020

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

DRILL & GROUT AREA - EAST

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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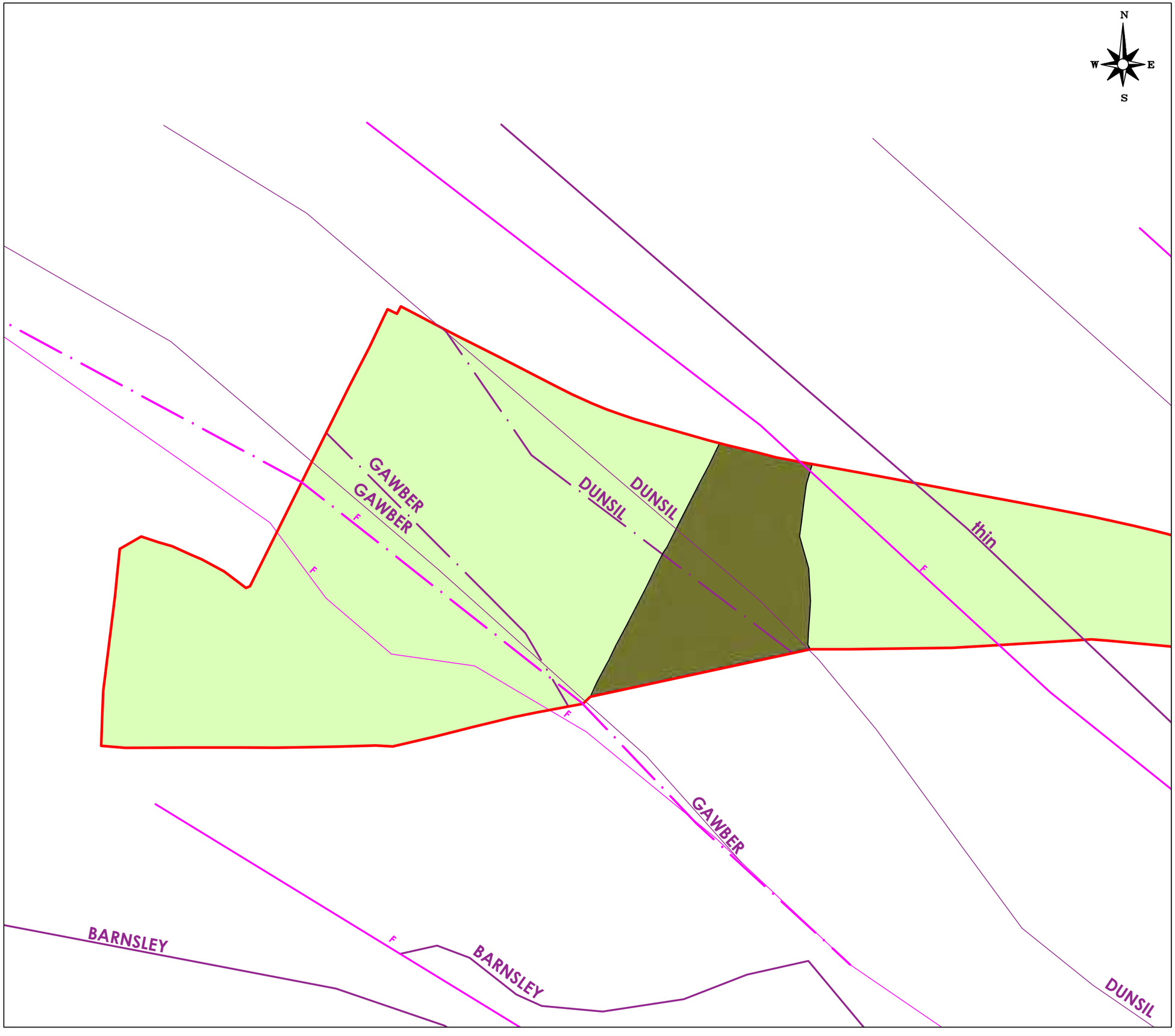

NOTES

- ACTUAL COAL SEAM
- RECORDED COAL SEAM
- ACTUAL FAULT
- RECORDED FAULT
- APPROXIMATE SITE BOUNDARY
- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- MARSH & V.DENSE VEGETATION

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

GEOLOGY(WEST)

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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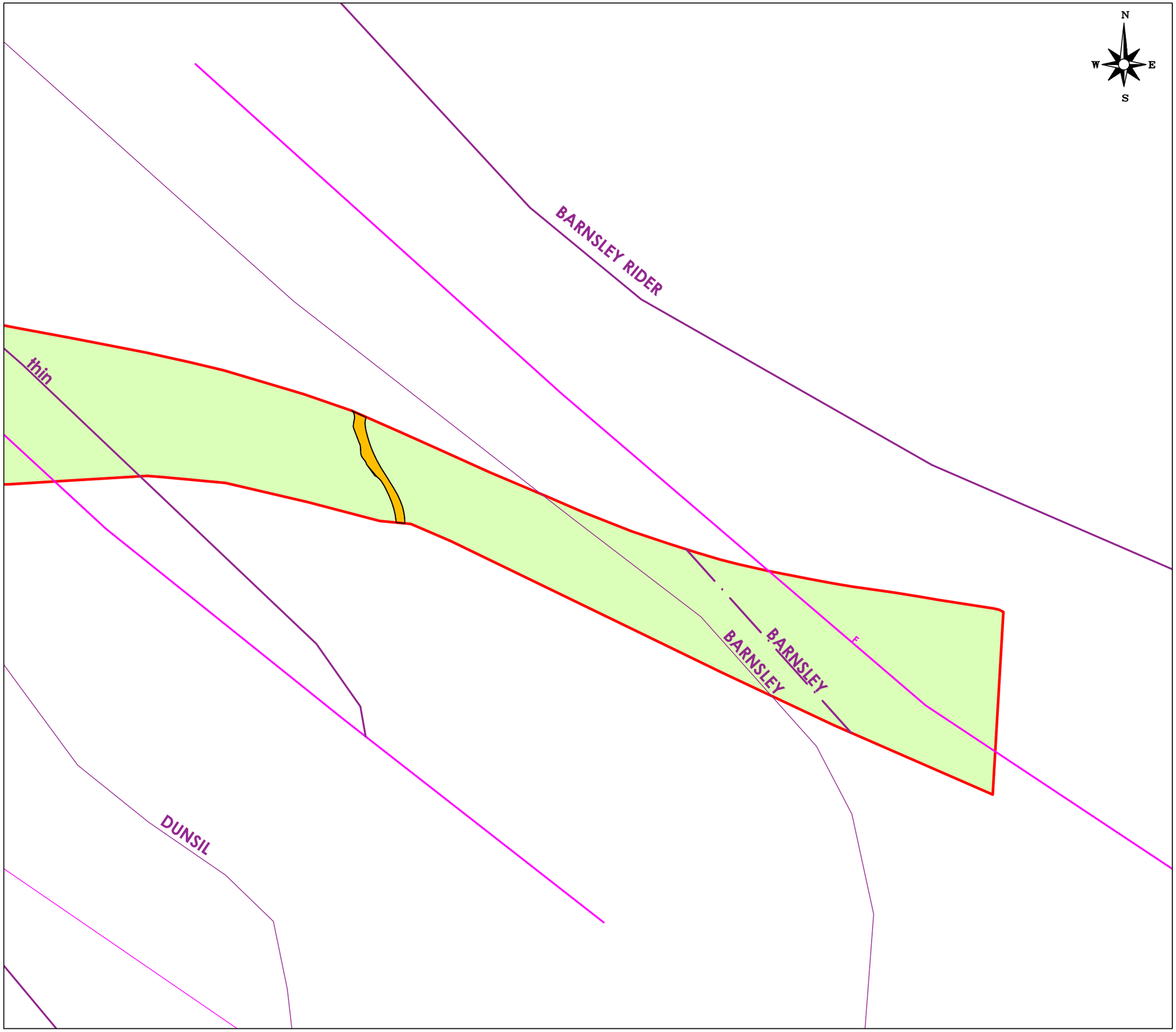

NOTES

- ACTUAL COAL SEAM
- RECORDED COAL SEAM
- ACTUAL FAULT
- RECORDED FAULT
- APPROXIMATE SITE BOUNDARY
- GRASS & OVERGROWN AREAS
- GRAVEL HARDCORE SURFACING
- MARSH & V.DENSE VEGETATION

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

GEOLOGY(EAST)

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
		FOR APPROVAL ☐
CHECKED	DATE	DRAFT ☐
AG	11 08 22	FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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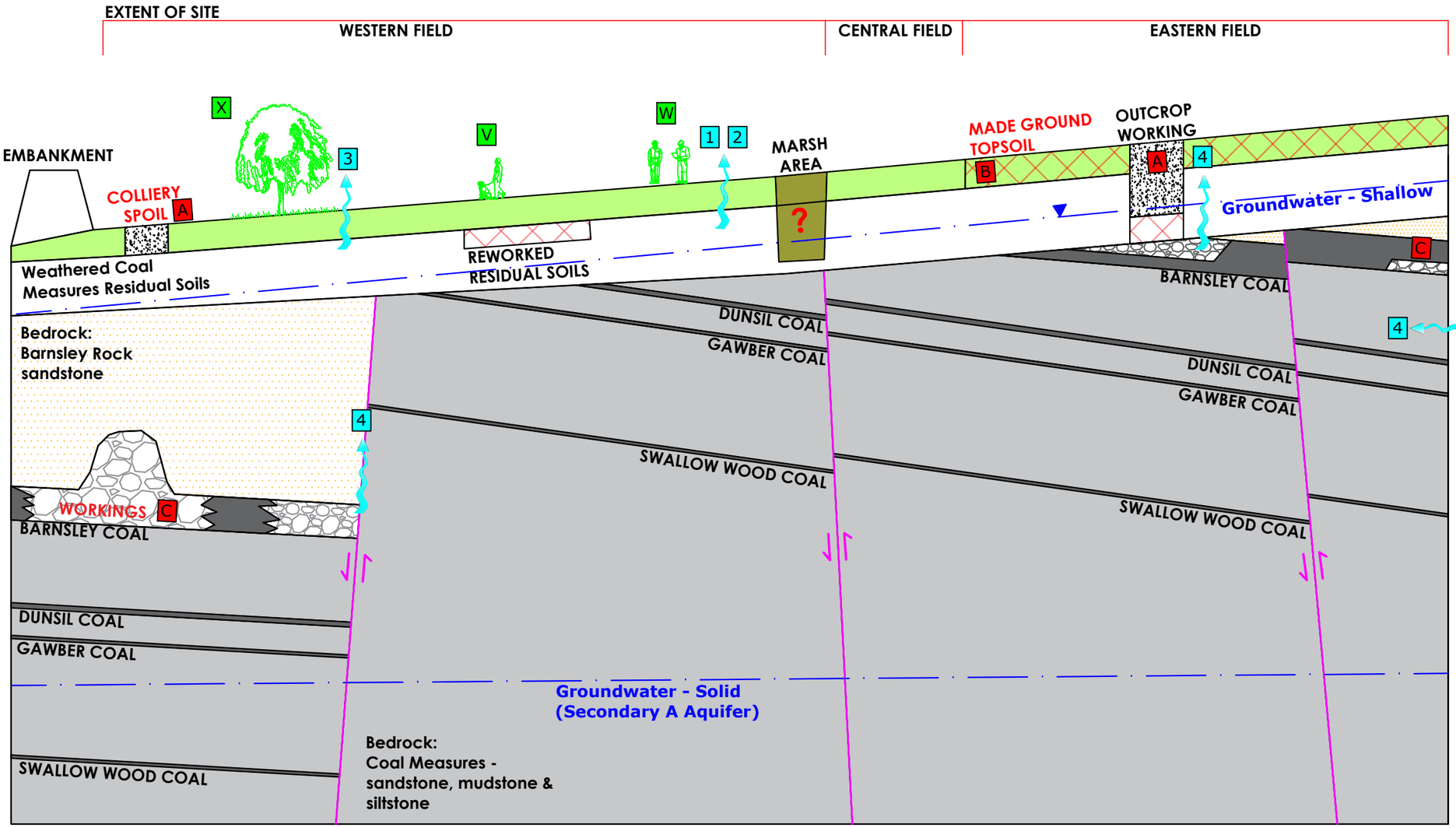

SOURCES	PATHWAYS	RECEPTORS
A COLLIERY SPOIL (INORGANICS)	1 DERMAL CONTACT	V END USERS (RESIDENTS)
B MADE GROUND TOPSOIL (INORGANICS)	2 INGESTION/INHALATION	W SITE WORKERS
C WORKINGS/COAL (GAS)	3 UPTAKE BY PLANTS	X VEGETATION
	4 MIGRATION OF GAS	

NOTES

REV.	DESCRIPTION	DATE

LITHOS CONSULTING
info@lithos.co.uk
www.lithos.co.uk
Tel 01937 545330

CLIENT: DUCHY HOMES

JOB TITLE: DARTON LANE, BARNSLEY

DRAWING TITLE: REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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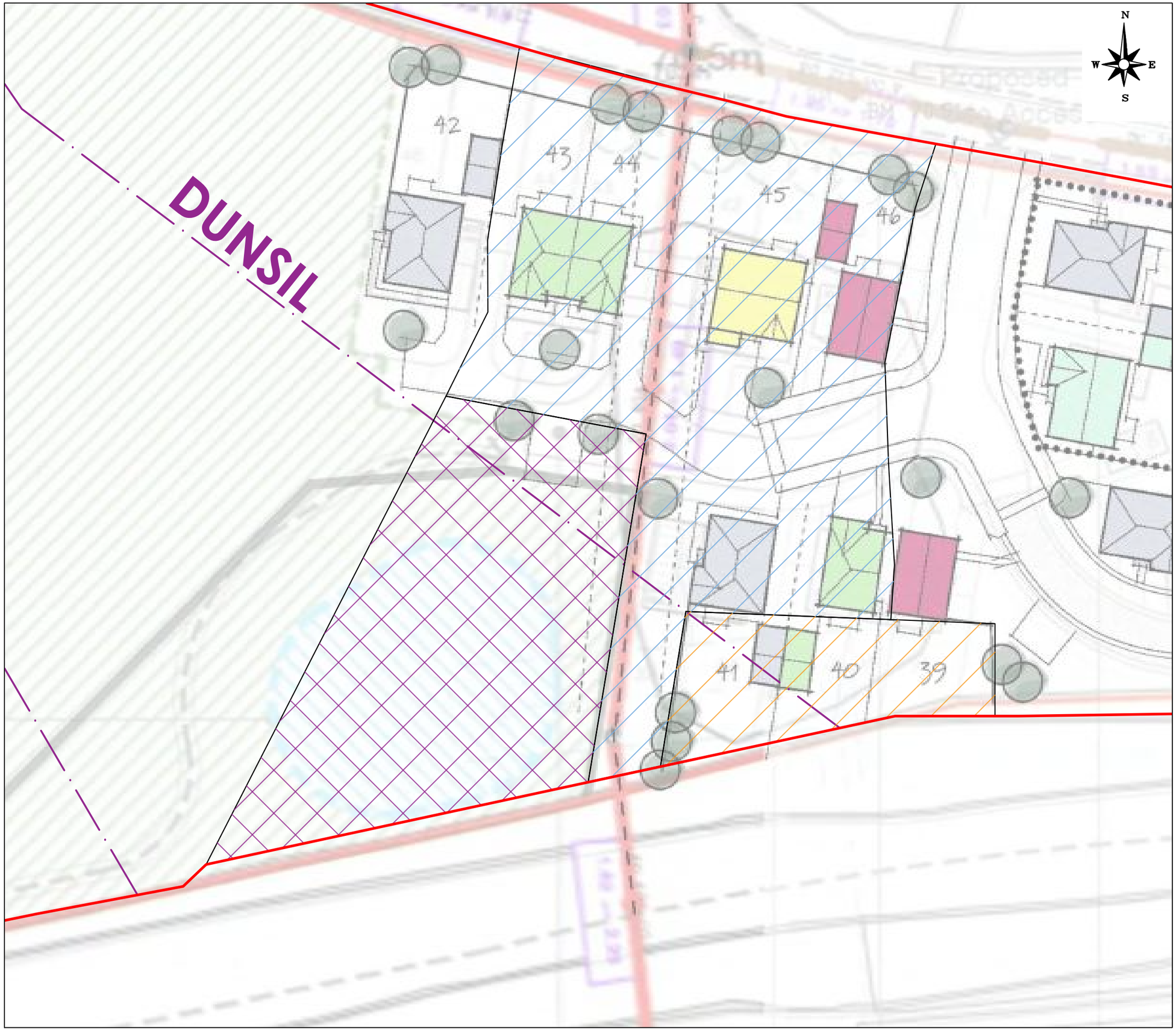

NOTES

- ACTUAL COAL SEAM
- 1000mm COVER NEEDS TO BE MAINTAINED - COMBUSTIBLE SEAM
- 600mm COVER REQUIRED (GARDENS) - NO DATA
- 300mm COVER REQUIRED (POS) - NO DATA
- APPROXIMATE SITE BOUNDARY

REPRODUCED FROM DUCHY HOMES DRAWING REFERENCE SK04, DATED OCTOBER 2020

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE, BARNSLEY

DRAWING TITLE

COVER REQUIRED (WEST)

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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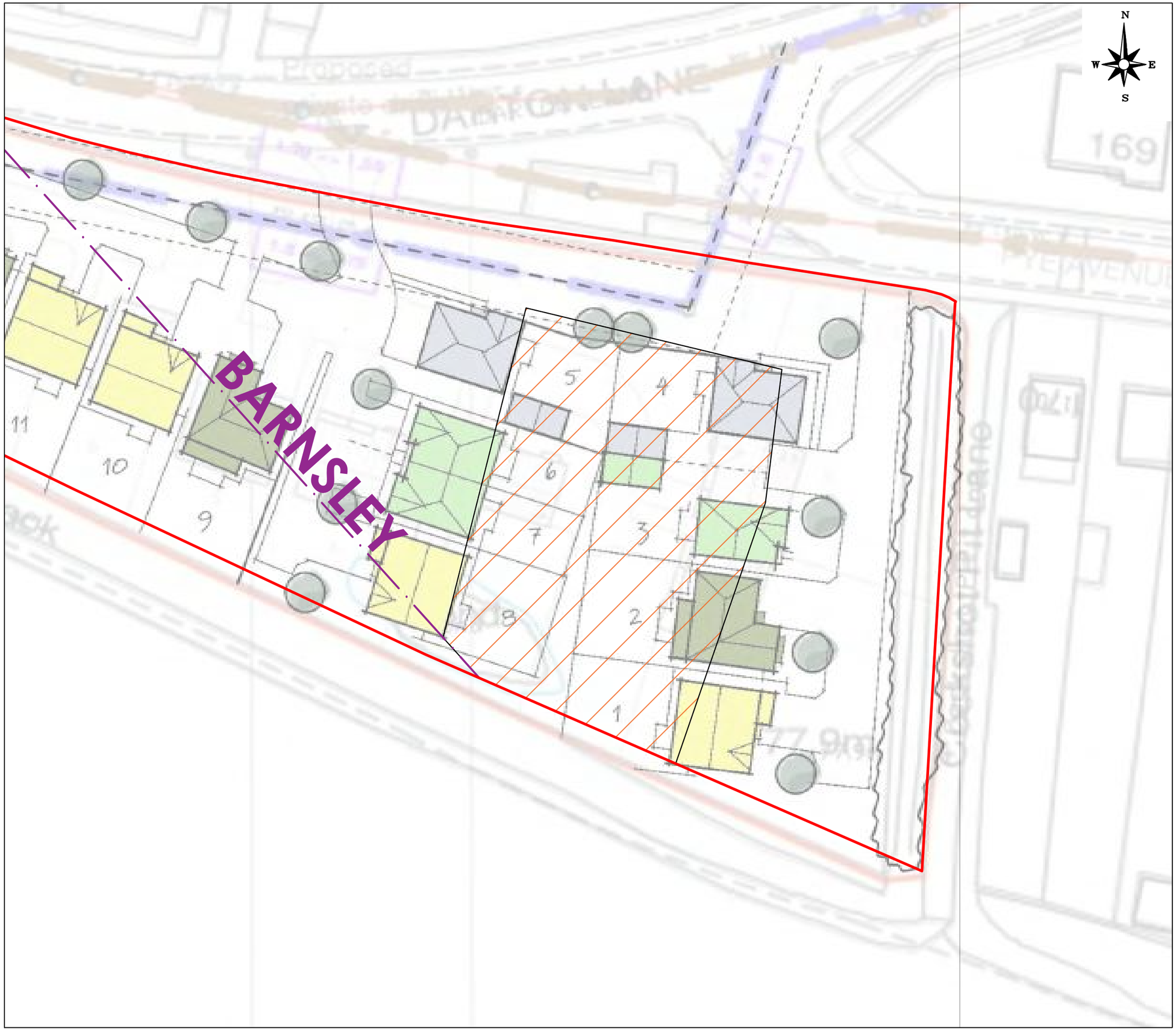

NOTES

- ACTUAL COAL SEAM
- 1000mm COVER NEEDS TO BE MAINTAINED-COMBUSTIBLE SEAM
- APPROXIMATE SITE BOUNDARY

REPRODUCED FROM DUCHY HOMES DRAWING REFERENCE SK04, DATED OCTOBER 2020

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

info@lithos.co.uk
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Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

COVER REQUIRED(EAST)

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1250	A3	4386/10b	

NOTES

ACTUAL COAL SEAM

TOPSOIL STRIP REQUIRED

APPROXIMATE SITE BOUNDARY

REPRODUCED FROM DUCHY HOMES DRAWING REFERENCE SK04, DATED OCTOBER 2020

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

DUCHY HOMES

JOB TITLE

DARTON LANE,
BARNSLEY

DRAWING TITLE

TOPSOIL STRIP REQUIRED

DRAWN	DATE	STATUS
AT	11 08 22	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	11 08 22	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:400	A3	4386/11	

Appendix C

Commission

003/4386/REG

5th May 2022

Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330
www.lithos.co.uk

Mr L Foxon
Duchy Homes Ltd
4100 Park Approach
Thorpe Park Business Park
Leeds
LS15 8GB

Dear Lee

Darton Lane, Barnsley

Further to your recent invitation, please find attached our proposal for undertaking supplementary site investigation on the above land. We understand that proposed development will include traditional 2 storey domestic dwellings with associated gardens, POS and adoptable roads and sewers; a sketch layout showing 46 units has been provided.

Brief review of the Wardell Armstrong report supplied (Ref. SH12190-Rpt-04, dated Nov. '19) and our own research suggests the site:

- Consists of a single parcel of land (c. 3.6 hectares) comprising open fields, used as grazing land for horses.
- Appears to have remained undeveloped throughout its history;
- Is not located within 250m of a known landfill site;
- Is not within a groundwater source protection zone;
- Is in an area where the risk of encountering UXO is considered low; and
- Is directly underlain by completely weathered bedrock (firm/stiff gravelly clay), with bedrock (mudstone & sandstone) typically from <2m depth.
- The Barnsley, Dunsil, Gawber coal seams outcrop on site.
- Is located within Coal Mining Development High & Low Risk Areas.

We will need a Promap or topo survey in CAD format, to provide a base plan for technical drawings etc. If you do not have one, we could obtain at cost plus £***.

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, LCRM etc). Our Report may not be fully compliant with Eurocode 7 (EC7) and will not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. Our ground appraisal is intended to assist others as they proceed with design of the proposed development.

This proposal allows for the following works:

Desk study: We will complete a more detailed review of the WA reports, and obtain a Consultant's mining report and abandonment plans.

We will also visit site to undertake a walkover survey. The walkover will include consideration of the need for a formal **slope stability** assessment (embankment to a disused mineral railway that forms the southern boundary).

Fieldwork: We have allowed for the drilling of about 10 rotary probeholes to check for the presence of mineworkings. All probeholes will be supervised and logged by an experienced geoenvironmental engineer.

The site is underlain by the Barnsley, Dunsil, Gawber coal seams, and therefore we have allowed for the drilling of 10 **rotary probeholes** to check whether old mineworkings are present and pose a significant risk to surface stability of the site.

If a potential risk is perceived to exist, further probeholes may be required to delineate the extent of workings in order to obtain fixed price quotations for the necessary consolidation works. Furthermore, we have assumed that it will be possible to advance the 10 probeholes within 4 days but there is a chance that it may take longer in which case we will inform you before leaving site, and seek your further instruction. Each day of additional drilling would cost £*** (inclusive of supervision) provided it were instructed whilst the drilling rig was still on site.

It will be necessary to submit an application (with the associated fee) to the Coal Authority (CA) for 'Permission to enter CA mining interests'; and we have allowed for this. You should note that the CA have updated the application process and as of 4th October 2021, developers (clients) must submit a signed copy of the **CA's T&Cs** (copy enclosed) before the CA will commence work on permit issue which can take up to 4 weeks. Lithos can perform the role of Agent.

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

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

At this stage, we have assumed that overnight security will not be required, but this will be reviewed following a site visit. If required, security would be an E\O of £*** per night. We have allowed for overnight security (guard) for plant outside normal working hours (nights & weekends).

We have also provided costs for a day's trial pitting should you think this worthwhile.

Exploratory holes will be positioned a hand-held GPS (typically +/- 3m accuracy); if required we could arrange for a **surveyor** to pick-up exploratory holes (and provide co-ordinates/ground levels) for an E\O cost of £***.

At this stage, it seems likely that further gas monitoring will be required and we have allowed for the installation of wells in 8 probeholes and monitoring for hazardous **gas** (and any shallow groundwater).

The generation potential of this gas source is considered likely to be Low. Therefore, in accordance with CIRIA Report C665, we have initially allowed for 9 visits over a 6-month period. A hazardous gas risk assessment will be issued on completion of monitoring.

We strongly recommend that groundwater / gas wells be decommissioned after monitoring has been completed. Decommissioning involves removal of the metal covers, unscrewing the upper 1m to 2 m of pipework and filling the void / remaining well with bentonite.

Decommissioning of monitoring wells removes prevents gas migration into sub-floor voids. Subject to your instruction, we will decommission accessible wells after the last monitoring visit for an E\O price of £***. We will contact you to seek instruction following issue of our gas risk assessment.

Testing: If the trial pitting is considered worthwhile, this will comprise routine **geotechnical** soils analysis, including 10 moisture content & Atterberg limits, and 10 pH & water-soluble sulphate.

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

At this stage, we have no reason to expect wide areas of the site to be underlain by significant thicknesses of made ground. Consequently, we have only allowed for **contaminant** testing of up to 12 made ground samples, plus a further 10 samples of topsoil to confirm its suitability for re-use. The test suite will include heavy metals, speciated PAH, and banded TPH (with supplementary speciation as/where appropriate).

Within in our proposal we have allowed for the screening (ID) of 22 samples for asbestos. In the event that positive IDs are reported, it is likely that we will need to schedule further analysis (asbestos quantification), in order to determine the significance of the results. Asbestos quantification is currently a relatively expensive test and consequently we have not allowed for it at this stage. We will inform you immediately after receipt of results if we consider asbestos quantification is required.

Visible contaminants, sharps and the clay/sand/silt content of 4 topsoil samples will be determined to check compliance with BS3882 requirements.

Reporting & timescales: In order to provide you with sufficient information to enable assessment of abnormal costs at the earliest opportunity we will issue a concise overview report within 3 days of fieldwork completion.

On completion of the desk study, fieldwork and laboratory testing a comprehensive, factual and interpretative report will be issued. This will contain exploratory hole logs, laboratory test results, copies of all relevant correspondence and drawings of the site. The report will include qualitative risk assessment with respect to both controlled waters and human health. The report will also include consideration of foundation types.

At the time of writing, fieldwork could be commenced within 4 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion. This report will comment on issues associated with hazardous gas, but the gas risk assessment will not be issued until monitoring is completed.

This report will include a **mining risk assessment** in accordance with Coal Authority guidance.

A copy of the final report will be issued to the relevant regulatory authorities on receipt of written instruction from yourselves.

Invoicing: The attached proposal provides a breakdown of the costs associated with this project. This breakdown is for information only and the proposal can be regarded as a lump sum price of **£*** ** plus VAT (mining & gas investigation only), or **£*** ** plus VAT (if pitting & soils analysis is also instructed). Variation will only occur in the event that a given item is not undertaken or that substantial additional works are recommended, in which case we will inform you immediately, provide costs for the required works, and seek your prior consent. Revision of the costings provided may be required if works are not instructed within 6 months of the date this proposal was issued.

Our proposal allows for submission of the report to the Local Authority and NHBC, and for submission of a single piece of subsequent correspondence with each regulator to address any queries they may have. Any further meetings, correspondence etc, would be chargeable.

We will submit invoices for this project on completion of each Item(s) instructed.

Please note if following instruction of the works outlined in this proposal, it is necessary to subsequently **postpone or cancel**, this should be done at least 3 working days before Lithos are due to commence intrusive investigation on site. We reserve the right to charge a cancellation fee in the event of later

notification to cover plant / drill rig costs and abortive consultancy time. The cancellation fee will not exceed £*** plus VAT.

Health, safety & welfare: The works outlined above will be carried out in accordance with Lithos' task- and site- specific Risk Assessments and Method Statements.

Details of welfare will be included within the Method Statements. However, this investigation is expected to last for at least 3 working days and therefore this proposal includes for provision of a Welfare Unit, with the benefit of full canteen facilities, hot water with full size sink, toilet and drying room.

Utility plans are required in order to protect operatives from the hazards associated with striking buried services and avoid potentially substantial disruption\repair costs. We will make every effort not to damage any services (including review of utility plans and use of a CAT detector). However, Lithos cannot accept liability for damage to any underground services that are not accurately marked on plans made available to us prior to commencement of our field investigation, or have not been accurately marked on the ground by a responsible third party (e.g. utility company, site owner).

Most developers have copies of the necessary utility plans (including electricity, gas, water, drainage & telecom), and it would be appreciated if you could forward these prior to the proposed fieldworks. However, if you do not have the necessary plans, Lithos will obtain them direct from each of the utility companies.

Under the **CDM** Regulations 2015, Lithos must be provided with pre-construction information already in your possession, or information that can reasonably be obtained through sensible enquiry. This information must be relevant to the project, have an appropriate level of detail, and be proportionate to the nature of the risks.

If no other designers or contractors have been appointed, Lithos could perform the role of Principal Contractor but only for the duration of the site investigation outlined in this proposal. If you require us to perform the role of Principal Contractor, please make this clear in your instruction. It should be noted that we are not suitably qualified to perform this role where other designers or contractors are also appointed.

It is anticipated that the site investigation outlined in this proposal will be undertaken several months before any construction is commenced on site. Consequently, our works can be considered in isolation and, given the anticipated number of person days on site, this site investigation is not notifiable to the HSE.

Terms & conditions: This work will be undertaken in accordance with our Standard Terms and Conditions, a copy of which are enclosed.

It is hoped the above is sufficient for your present needs. However, should you require any further information, please contact the undersigned.

Yours sincerely

Mark Perrin
Director
for and on behalf of
LITHOS CONSULTING LIMITED

From: Lee Foxon <lee.foxon@duchyhomes.co.uk>
Sent: 30 May 2022 10:05
To: Reg <Reg@lithos.co.uk>
Cc: Ben Mansell <ben.mansell@duchyhomes.co.uk>; Steve Graham <steve.graham@duchyhomes.co.uk>; Craig Knowles <craig.knowles@duchyhomes.co.uk>
Subject: RE: 4386, Darton Lane, Darton

Hi Reg,
As discussed this morning please accept this email as confirmation to book in the rig (mining investigation) please also undertake the additional gas monitoring.
Could you please issue RAMS too Reg.
Ben can you please issue PO to Reg.
Many thanks.

Lee Foxon | Head of Technical
07949 648167

From: Reg <Reg@lithos.co.uk>
Sent: 06 May 2022 16:15
To: Lee Foxon <lee.foxon@duchyhomes.co.uk>
Subject: 4386, Darton Lane, Darton

Afternoon Lee

I think you said that Duchy would obtain reliance on the WA Reports so I've not allowed for a new Envirocheck. It's not clear whether WA completed sufficient gas monitoring; their Report refers to 3 preliminary monitoring visits (4 wells) over a 3-week period. I've also provided E\O costs for a further days' TPs (with soils testing) if you think this is required.
So, the SI quote attached (£***) allows for a mining investigation (4 days' drilling) & gas monitoring/risk assessment.
We would expect to be on site within 4 weeks of instruction, with a summary of initial findings issued within 2 to 3 days of fieldwork completion. Our final SI Report should be available within 8 weeks of instruction (although a quicker turnaround might be possible).

Any queries, please call.
Regards

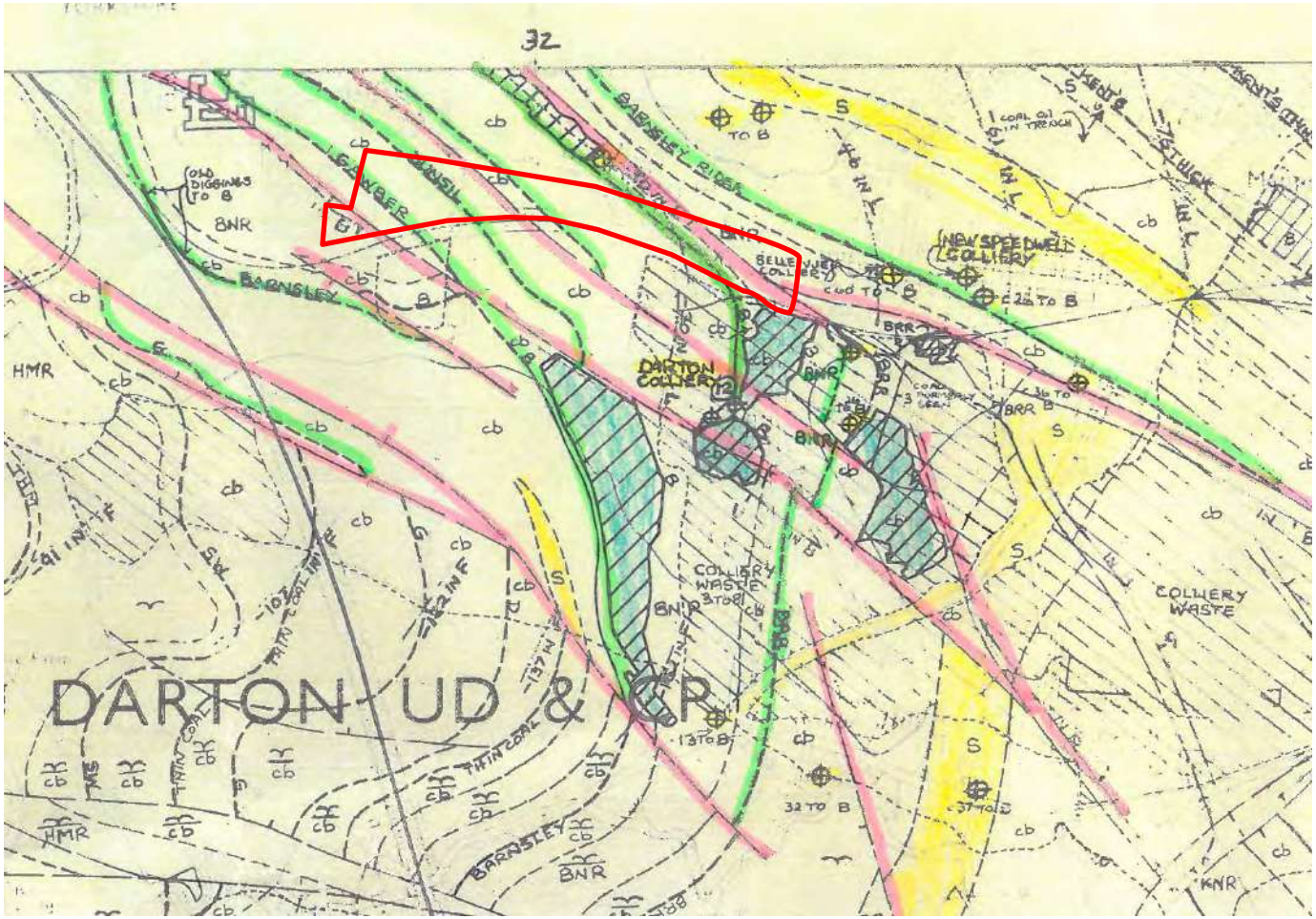
Mark Perrin
Director
Lithos Consulting Ltd
M 07703 396 635
DD 01937 545 331

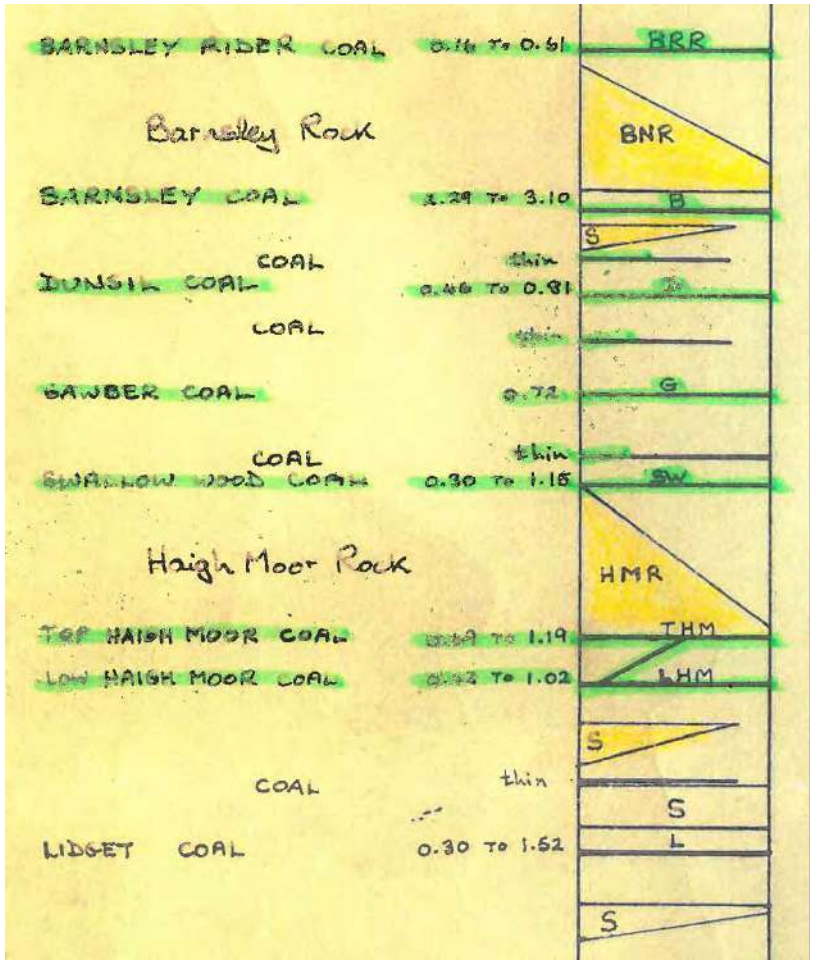
LITHOS CONSULTING
www.lithos.co.uk

Appendix D

Geological Map

ANNOTATED GEOLOGY SHEET SE30NW AND STRATIGRAPHIC COLUMN





Red line indicates indicative site boundary

Appendix E

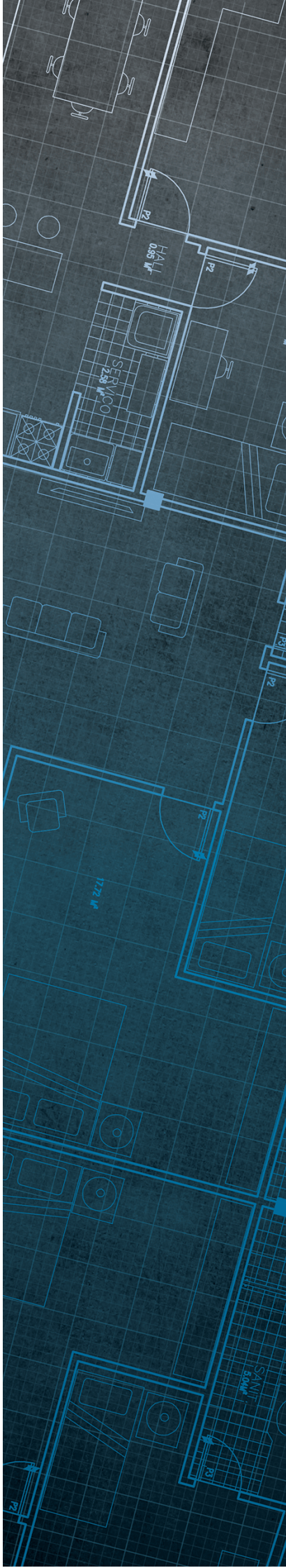
Search Responses & other Correspondence

The Coal Authority

Consultants

Coal Mining Report

Darton Lane
Barnsley
S75 5AH



Date of enquiry:	**13 June 2022**
Date enquiry received:	**13 June 2022**
Issue date:	**13 June 2022**
Our reference:	**71008661156001**
Your reference:	

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

Enquiry address

Darton Lane
Barnsley
S75 5AH

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	BARNSLEY	Coal	609R	7	Beneath Property	4.1	North-East	237	1887
unnamed	BARNSLEY	Coal	6OAR	10	Beneath Property	4.1	North-East	237	1875
DARTON	TOP HAIGH MOOR	Coal	640W	69	Beneath Property	3.6	South-West	94	1943
NORTH GANBER	TOP HAIGH MOOR	Coal	640X	76	South-East	3.6	East	94	1949
WOOLLEY	LOW HAIGH MOOR	Coal	164P	77	Beneath Property	3.6	East	7	1935
DARTON	LIDGETT	Coal	6OAT	91	Beneath Property	5.3	North-East	66	1926
DARTON	LIDGETT	Coal	64P9	104	Beneath Property	3.7	East	72	1921
WOOLLEY	FENTON	Coal	R84	186	Beneath Property	4.4	North-East	209	1985
WOOLLEY	FENTON	Coal	649T	191	Beneath Property	5.0	North-East	209	1985
WOOLLEY	FENTON	Coal	64PS	194	Beneath Property	4.9	East	175	1965
WOOLLEY	FENTON	Coal	64PU	202	South-West	5.3	South-East	195	1984
WOOLLEY	MIDDLETON MAIN	Coal	6OAW	231	North	6.4	East	52	1952
unnamed	MIDDLETON MAIN	Coal	6J5P	232	North-East	4.7	East	57	1952
unnamed	MIDDLETON MAIN	Coal	6Y05	240	North	5.0	North-East	126	1952
WOOLLEY	WHEATLEY LIME	Coal	64PD	254	Beneath Property	5.7	North-East	71	1960
WOOLLEY	WHEATLEY LIME	Coal	6OAY	256	Beneath Property	4.5	North-East	58	1960
unnamed	WHEATLEY LIME	Coal	6Y34	267	North	6.8	North-East	69	1959
WOOLLEY/REDBROOK	SILKSTONE	Coal	X05	302	Beneath Property	4.0	North-East	115	1980

Probable unrecorded shallow workings

Yes.

Spine roadways at shallow depth

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

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Adit	431409-002	431600 409821		Coal	
Adit	431409-003	431604 409790		Coal	
Shaft	432409-008	432305 409642		Coal	
Shaft	432409-011	432081 409884		Coal	
Adit	432409-012	432074 409874		Coal	
Adit	432409-015	432317 409749		Coal	
Adit	432409-016	432340 409734		Coal	
Adit	432409-019	432333 409655		Coal	
Adit	432409-034	432100 409850		Coal	
Adit	432409-037	432313 409692		Coal	
Shaft	432409-038	432299 409678	has probably been totally removed by opencast mining operations at some time in the past.	Coal	
Shaft	432409-039	432280 409665	has probably been totally removed by opencast mining operations at some time in the past.	Coal	

Abandoned mine plan catalogue numbers

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

NE158	7081	M175
17603	NE1034	SCC20
16345	5692	NE816

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
BARNSLEY	Coal	Yes	Within	N/A	320
DUNSIL	Coal	Yes	Within	N/A	137
UNNAMED	Coal	Yes	Within	N/A	304

Geological faults, fissures and breaklines

Please refer to the 'Summary of findings' map (on separate sheet) for details of any geological faults, fissures or breaklines either within or intersecting the enquiry boundary.

Faults under or close to the property recorded.

Opencast mines

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

Coal Authority managed tips

None recorded within 500 metres of the enquiry boundary.

Section 2 – Investigative or remedial activity

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

Site investigations

Distance to site investigation (m)	Direction
24.6	North

See Section 4 for further information.

Remediated sites

None recorded within 50 metres of the enquiry boundary.

Coal mining subsidence

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

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

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

Mine gas

None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes

None recorded within 500 metres of the enquiry boundary.

Section 3 – Licensing and future mining activity

Future underground mining
None recorded.

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

Court orders
None recorded.

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

Withdrawal of support notices
The property is in an area where notices to withdraw support were given in 1945, 1946, 1979 and 1980.

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.

Site investigations

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

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

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

Section 5 – Data definitions

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

Past underground coal mining

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

Probable unrecorded shallow workings

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

Spine roadways at shallow depth

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

Mine entries

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

Abandoned mine plan catalogue numbers

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

Outcrops

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

Geological faults, fissures and breaklines

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

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

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

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

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

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

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

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

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

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.

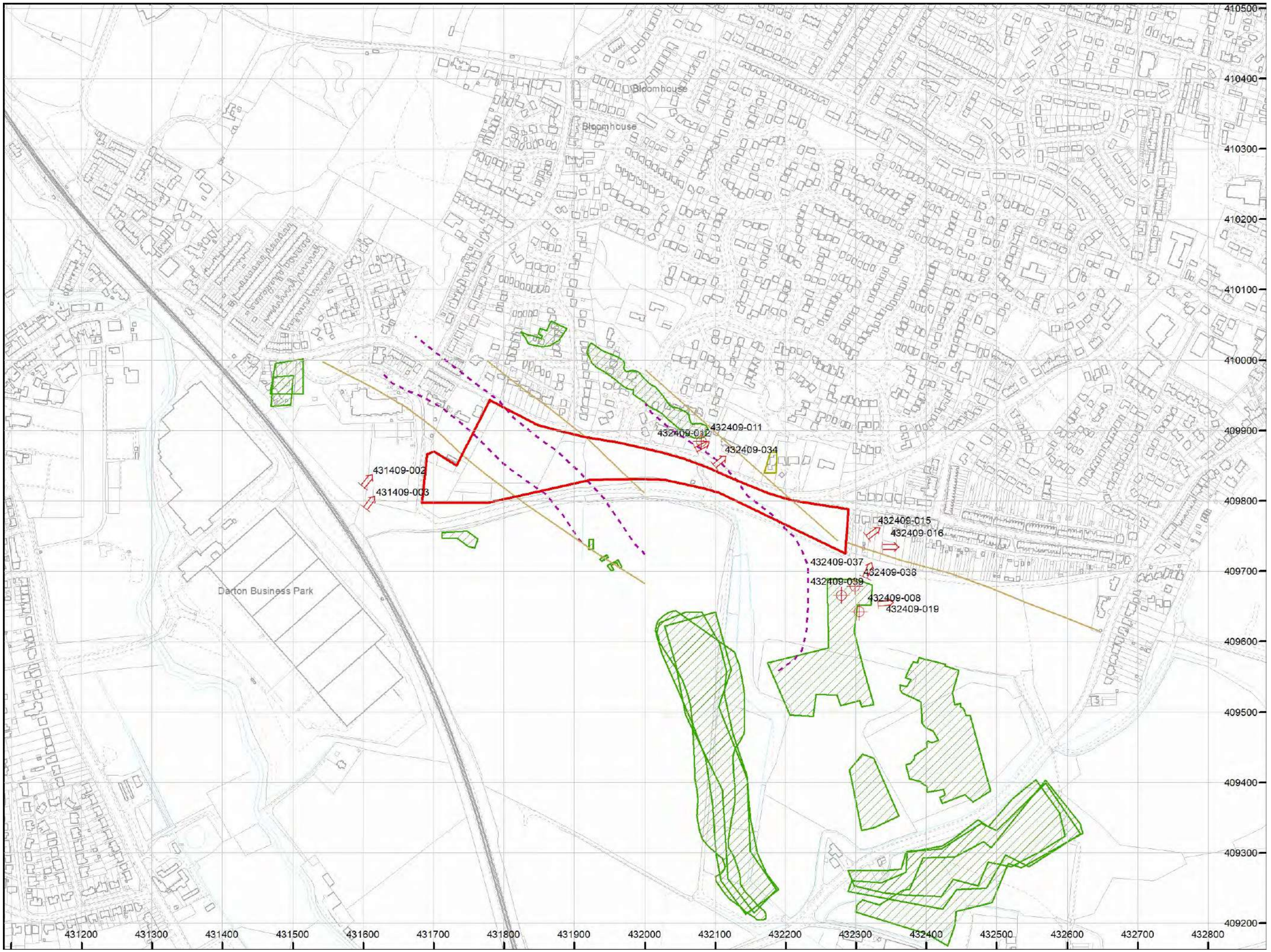
The Coal Authority

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
- Disused adit
- Outcrop (Conjectured)
- Geological faults
- Unlicensed opencast site
- Site investigations



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

NE 863/2

OLD BARTON & EST
361211(C)
LICENSED OPENCAST COAL SITE
SOUTH YORKS. M.C.C.
SCALE 1/2500
PLAN SE 31 04 3209 3304 (1961)
NATIONAL GRID REF. SE 327093

NATIONAL COAL BOARD
OPENCAST EXECUTIVE
No 5 CENTRAL (EAST) REGION
NOTTINGHAM

DRAFT Conformity Plan

DRAWING No. OE/10577(1)

NE 863/2

Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP101
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431703.00 - 409831.00 Level: 71.30	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 2.70	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	71.10		Dark brown slightly gravelly clayey sandy SILT with rare plastic and frequent rootlets. Gravel is angular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
	0.50	J&T	HVP=130				Stiff orange mottled grey slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mixed lithologies. (COHESIVE RESIDUAL SOIL)
	0.80	D					
				1.60	69.70		Grey clayey angular to subangular fine to medium GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.20	69.10		Extremely weak grey SILTSTONE. Recovered as slightly clayey angular fine to medium GRAVEL. (COAL MEASURES)
	2.50	D		2.70	68.60		End of pit at 2.70 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP102
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431735.00 - 409815.00 Level: 69.55	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 1.90	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10 0.10	B J&T					Dark brown gravelly very silty very clayey fine to coarse SAND with frequent rootlets. Gravel is angular to subrounded fine to medium of mixed lithologies. (TOPSOIL)
				0.30	69.25		*From 0.0m to 0.3m; topsoil description altered to reflect particle size distribution classification.*
			HVP=130				Very stiff orange mottled grey slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL)
	0.70	D					
			HVP=130				
			HVP=130				
				1.50	68.05		Grey clayey angular to subangular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
	1.60	D					
				1.70	67.85		Strong thinly laminated grey medium grained SANDSTONE. Recovered as angular tabular fine to coarse gravel with a low cobble content. (COAL MEASURES)
				1.90	67.65		*At 1.9m, unable to excavate further.*
							End of pit at 1.90 m

1
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4
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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP103
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431822.00 - 409872.00 Level: 69.75	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6 Depth 2.90	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T		0.20	69.55		Brown silty fine to coarse SAND with frequent rootlets and rare gravel of angular to subangular fine to medium of mixed lithologies. (TOPSOIL)
			HVP=130				MADE GROUND: Orange mottled grey silty CLAY with rare angular fine gravel of mudstone and sandstone. (COHESIVE REWORKED NATURAL)
			HVP=130	0.70	69.05		Very stiff orange mottled grey silty CLAY with rare angular fine gravel of mudstone and sandstone. (COHESIVE RESIDUAL SOIL)
	1.00	D					*At 0.7m, land drain (dry) encountered running north to south.*
			HVP=130	1.30	68.45		Orange and grey clayey angular to subangular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
							At 1.4m, horizon of rounded fine to coarse gravel of ironstone encountered.
	1.90	D		2.00	67.75		Weak brownish grey SILTSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
							At 2.9m, difficult to excavate further.
				2.90	66.85		End of pit at 2.90 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP104
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431821.00 - 409900.00 Level: 70.40	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 2.80	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10 0.10	B J&T		0.20	70.20		Dark brown sandy very clayey SILT with frequent rootlets. (TOPSOIL) *From 0.0m to 0.2m; topsoil description altered to reflect particle size distribution classification.*
	0.50	J&T					MADE GROUND: Very stiff orange mottled grey slightly sandy silty CLAY. (COHESIVE REWORKED NATURAL) *At 0.1m, topsoil is becoming rootbound.*
	0.80	D	HVP=130	0.70	69.70		Very stiff orange mottled grey silty CLAY. (COHESIVE RESIDUAL SOIL) *At 0.7m, terracotta land drain (dry) encountered running north to south.*
	1.10	D	HVP=90	1.00	69.40		Firm greyish black gravelly silty CLAY. Gravel is angular tabular fine to medium of coal and carbonaceous mudstone. (COHESIVE RESIDUAL SOIL)
	1.70	D		1.40	69.00		Extremely weak dull black COAL. Recovered as angular tabular fine to coarse gravel. (GAWBER COAL) *At 1.5m, gravel is wet.*
				1.90	68.50		Grey and brown clayey angular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.60	67.80		Extremely weak grey SILTSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
				2.80	67.60		End of pit at 2.80 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP105
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431861.00 - 409891.00 Level: 69.30	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 3.20	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.50	68.80		Dark brown silty fine to coarse SAND with common rootlets. (TOPSOIL)
	0.70	D					MADE GROUND: Very stiff orange mottled grey slightly gravelly slightly sandy CLAY. Gravel is angular fine to medium of mudstone, coal and sandstone. (COHESIVE REWORKED NATURAL)
	1.00	D	HVP=88	0.90	68.40		Stiff orange mottled grey slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone, sandstone and coal. (COHESIVE RESIDUAL SOIL)
				1.70	67.60		Brownish grey angular tabular fine to coarse GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
	2.70	D		2.50	66.80		Weak grey SILTSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
				3.20	66.10		End of pit at 3.20 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP106
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431955.00 - 409864.00 Level: 69.75	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 3.90	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30	69.45		Dark brown silty fine to coarse SAND with frequent rootlets. (TOPSOIL)
	0.60	J&T	HVP=110				MADE GROUND: Stiff locally very stiff orange mottled grey slightly sandy silty CLAY. (COHESIVE REWORKED NATURAL) *At 0.6m, cobble of rounded sandstone.*
	1.00	D		0.90	68.85		Stiff orange mottled grey slightly gravelly sandy silty CLAY. Gravel is angular fine to medium of sandstone and mudstone. (COHESIVE RESIDUAL SOIL) *At 1.5m, clay is grey and gravelly of angular fine to medium mudstone.*
	2.10	D		2.00	67.75		Grey clayey angular tabular fine to coarse GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.90	66.85		Extremely weak carbonaceous MUDSTONE. Recovered as angular tabular fine to medium gravel. (COAL MEASURES)
	3.40	D		3.20	66.55		Extremely weak black vitreous blocky COAL with orange staining and clay infill in fractures. Recovered as angular fine to coarse gravel. (DUNSIL COAL)
				3.70	66.05		Stiff grey gravelly silty CLAY. Gravel is angular tabular fine to medium of mudstone. (SEAT EARTH)
				3.90	65.85		End of pit at 3.90 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP107
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432049.00 - 409835.00 Level: 72.80	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 3.50	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Brown slightly sandy slightly clayey SILT with rare angular to subrounded fine to medium gravel of mixed lithologies. (TOPSOIL)
				0.40	72.40		*From 0.0m to 0.3m; topsoil description altered to reflect particle size distribution classification.*
			HVP=130				Very stiff orange mottled grey slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone and sandstone. (COHESIVE RESIDUAL SOIL)
	0.80	D	HVP=130				
				1.00	71.80		Orange and grey clayey angular to subangular fine to medium GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				1.80	71.00		Weak grey MUDSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
	1.90	D					*From 2.7m to 2.8m, band of ironstone nodules.*
							At 3.4m, becoming difficult to excavate.
				3.50	69.30		End of pit at 3.50 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP108
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432121.00 - 409812.00 Level: 74.10	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 x 0.6 Depth 3.40	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.20	73.90		MADE GROUND: Dark brown slightly gravelly silty fine to coarse SAND with frequent rootlets and rare plastic netting and brick fragment. Gravel is angular to subrounded fine to coarse of mixed lithologies. (MADE GROUND TOPSOIL)
	0.50	J&T		0.80	73.30		MADE GROUND: Very stiff multicoloured gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone, sandstone and coal. (COHESIVE REWORKED NATURAL)
	1.00	D	HVP=130				Firm orange mottled grey gravelly slightly sandy silty CLAY. Gravel is angular to subangular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL) *At 0.8m, terracotta land drain (dry) running north to south.*
	2.80	D		2.10	72.00		Grey clayey angular to subangular fine to medium GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				3.00	71.10		Extremely weak brownish grey SILTSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
				3.40	70.70		End of pit at 3.40 m

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Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP109
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432190.00 - 409772.00 Level: 73.55	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6 Depth 2.90	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					MADE GROUND: Brown gravelly silty fine to coarse SAND with frequent whole brick and paper. Gravel is angular to subangular fine to medium of mudstone, sandstone and coal. (MADE GROUND TOPSOIL)
				0.30	73.25		MADE GROUND: Firm orangish grey slightly gravelly slightly sandy CLAY. Gravel is angular to subangular fine to medium of mudstone, coal and sandstone. (COHESIVE REWORKED NATURAL)
	0.50	J&T					*At 0.6m, rusted metal bar encountered.*
			HVP=130	0.80	72.75		Stiff orange mottled grey slightly gravelly slightly sandy CLAY. Gravel is angular to subangular of mudstone. (COHESIVE RESIDUAL SOIL)
	0.90	D					
			HVP=124	1.20	72.35		Orange mottled grey angular to subangular fine to medium GRAVEL of mudstone. (GRANULAR RESIDUAL SOIL)
				2.50	71.05		Extremely weak brownish grey MUDSTONE. Recovered as angular tabular fine to coarse gravel. (COAL MEASURES)
				2.90	70.65		End of pit at 2.90 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP110
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432233.00 - 409757.00 Level: 73.50	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6 Depth 3.50	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J,K&T					MADE GROUND: Black gravelly silty CLAY with frequent whole brick, metal, glass, brick fragments and wood. Gravel is angular to subrounded fine to medium of mixed lithologies. (COLLIERY SPOIL)
	0.40	J,K&T					
				0.60	72.90		Firm greyish brown slightly gravelly silty CLAY. Gravel is angular fine of mudstone. (COHESIVE RESIDUAL SOIL)
	1.00	D	HVP=60				
			HVP=51				
				1.90	71.60		Extremely weak black vitreous blocky COAL. Recovered as angular fine to coarse gravel. (BARNSLEY COAL)
	2.00	D					
				2.50	71.00		Firm orange mottled grey silty CLAY. (COHESIVE RESIDUAL SOIL)
	2.60	D	HVP=66				
				3.20	70.30		Brownish orange silty angular tabular fine to medium GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
	3.40	D					
				3.50	70.00		End of pit at 3.50 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP111**

Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432277.00 - 409759.00 Level: 76.55	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6, Depth 3.30	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10 0.10	B J&T					Brown slightly gravelly slightly sandy slightly clayey SILT with frequent rootlets. Gravel is subangular fine to medium of mudstone and sandstone. (TOPSOIL)
				0.30	76.25		*From 0.0m to 0.3m; topsoil description altered to reflect particle size distribution classification.*
			HVP=130				Stiff orange mottled grey slightly gravelly slightly sandy silty CLAY. Gravel is angular tabular fine to medium of mudstone. (COHESIVE RESIDUAL SOIL)
	0.70	D					
			HVP=130				
			HVP=130				
							At 1.8m, thin horizon of black gravelly clay. Gravel is angular fine to medium of carbonaceous mudstone
							From 2.0m, clay is gravelly of mudstone.
				2.30	74.25		
	2.40	D					Grey slightly clayey angular tabular fine to medium GRAVEL of siltstone. (GRANULAR RESIDUAL SOIL)
				2.50	74.05		Weak grey SILTSTONE. Recovered as angular to subangular fine to medium gravel. (COAL MEASURES)
				3.20	73.35		
				3.30	73.25		Extremely weak black vitreous blocky COAL. Recovered as angular fine to coarse gravel. (BARNSLEY COAL)
							At 3.3m, difficult to excavate further.
							End of pit at 3.30 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP112
Sheet 1 of 1

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432261.00 - 409748.00 Level: 74.25	Date 11/07/2022
Location: Darton Lane, Barnsley		Dimensions (m): 2.5 × 0.6 Depth 2.60	Scale 1:25
Client: Duchy Homes			Logged AT

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30	73.95		MADE GROUND: Brown gravelly silty fine to coarse SAND with frequent rootlets and ceramic. (TOPSOIL)
				0.60	73.65		Stiff brownish grey gravelly slightly sandy CLAY. Gravel is angular fine to medium of mixed lithologies including mudstone and sandstone. (COHESIVE RESIDUAL SOIL)
				1.10	73.15		Black clayey angular fine to medium GRAVEL of coal. (GRANULAR RESIDUAL SOIL)
	1.30	D					Extremely weak black dull ashy COAL. Recovered as clayey angular fine to medium gravel. (BARNSLEY COAL)
							At 2.0m, coal is vitreous and blocky.
				2.50	71.75		
	2.60	D		2.60	71.65		Firm yellow and grey silty CLAY. (COHESIVE RESIDUAL SOIL)
							End of pit at 2.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

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

AGS

Appendix G

Probehole Logs

LITHOS CONSULTING

Borehole Log

Borehole No.
PH101
Sheet 1 of 3

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432057.00 - 409839.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 73.80	Scale 1:50
Client: Duchy Homes		Dates: 12/07/2022 - 12/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					2.70	71.10		Orangish brown SILTSTONE (COAL MEASURES)
					5.00	68.80		Black Carbonaceous MUDSTONE (COAL MEASURES)
					6.50	67.30		Black Coal (THIN COAL)
					6.90	66.90		Whitish grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost temporarily at 25.8, quickly returning to almost full flush shortly after. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

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Borehole Log

Borehole No.
PH101
Sheet 2 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432057.00 - 409839.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	73.80	Scale 1:50
Client:	Duchy Homes		Dates:	12/07/2022 - 12/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					12.50	61.30		Black COAL (DUNSIL COAL)
					13.00	60.80		Whitish grey MUDSTONE (COAL MEASURES)
					16.80	57.00		Carbonaceous MUDSTONE (COAL MEASURES)
					18.00	55.80		Dark grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

11 12 13 14 15 16 17 18 19 20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost temporarily at 25.8, quickly returning to almost full flush shortly after. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH101
Sheet 3 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432057.00 - 409839.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	73.80	Scale 1:50
Client:	Duchy Homes		Dates:	12/07/2022 - 12/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					24.50	49.30		Whiteish grey MUDSTONE (COAL MEASURES)
								At 25.8m; spontaneous full loss of flush, quickly returning to paretial flush once rods pulled up slightly. Solid Ground maintained throughout flush loss. Some water being continuously lost to ground (approximatley maintaining 95% flush).
					29.70	44.10		End of borehole at 29.70 m

21 22 23 24 25 26 27 28 29 30

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost temporarily at 25.8, quickly returning to almost full flush shortly after. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH102
Sheet 1 of 3

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431843.00 - 409872.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 68.60	Scale 1:50
Client: Duchy Homes		Dates: 13/07/2022 - 13/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					2.00	66.60		Brown SILTSTONE (COAL MEASURES)
					4.80	63.80		Grey MUDSTONE (COAL MEASURES)
					6.20	62.40		Black vitreous COAL (GAWBER COAL)
					6.60	62.00		Grey MUDSTONE (COAL MEASURES)
								At 9.8m; temporary loss of flush for 60 seconds, returning to
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost temporarily at 9.8m, quickly returning to full flush shortly after. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

Borehole No. **PH102**

Sheet 2 of 3

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431843.00 - 409872.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 68.60	Scale 1:50
Client: Duchy Homes		Dates: 13/07/2022 - 13/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								full flush. Solid ground encountered during temporary flush loss.
					13.60	55.00		Black COAL (THIN COAL)
					13.90	54.70		Grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

11 12 13 14 15 16 17 18 19 20

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost temporarily at 9.8m, quickly returning to full flush shortly after. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH102
Sheet 3 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431843.00 - 409872.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	68.60	Scale 1:50
Client:	Duchy Homes		Dates:	13/07/2022 - 13/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					22.00	46.60		Black carbonaceous MUDSTONE (COAL MEASURES)
					22.70	45.90		Grey MUDSTONE (COAL MEASURES)
					23.20	45.40		Black carbonaceous MUDSTONE (COAL MEASURES)
					23.60	45.00		Grey MUDSTONE (COAL MEASURES)
					30.00	38.60		End of borehole at 30.00 m

21 22 23 24 25 26 27 28 29 30

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Flush returns were lost temporarily at 9.8m, quickly returning to full flush shortly after. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

Borehole No. **PH103**

Sheet 1 of 3

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431819.00 - 409830.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 68.45	Scale 1:50
Client: Duchy Homes		Dates: 13/07/2022 - 13/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					1.50	66.95		Brown SILTSTONE (COAL MEASURES)
					5.10	63.35		Grey MUDSTONE (COAL MEASURES)
					7.40	61.05		Black COAL (THIN COAL)
					7.60	60.85		Grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Partial reduction of flush returns at 25.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

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Borehole Log

Borehole No.
PH103
Sheet 2 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431819.00 - 409830.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	68.45	Scale 1:50
Client:	Duchy Homes		Dates:	13/07/2022 - 13/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				

11
12
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18
19
20

Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Partial reduction of flush returns at 25.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

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Borehole Log

Borehole No.
PH103
Sheet 3 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431819.00 - 409830.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	68.45	Scale 1:50
Client:	Duchy Homes		Dates:	13/07/2022 - 13/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								At 25.0m; partial loss (approx 25% loss) of flush returns. Smooth steady drilling noted.
					29.70	38.75		End of borehole at 29.70 m

21 22 23 24 25 26 27 28 29 30

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Partial reduction of flush returns at 25.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

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Borehole Log

Borehole No.
PH104
Sheet 1 of 2

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431799.00 - 409827.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 69.20	Scale 1:50
Client: Duchy Homes		Dates: 14/07/2022 - 14/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					2.50	66.70		Brown SILTSTONE (COAL MEASURES)
					5.20	64.00		Grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at 10.9m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

Borehole No. **PH104** Sheet 2 of 2

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431799.00 - 409827.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	69.20	Scale 1:50
Client:	Duchy Homes		Dates:	14/07/2022 - 14/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					10.90	58.30		Migrated WORKINGS (WORKINGS - BARNSLEY COAL) *At 10.9m; drilling speed increased. Rods able to 'push' through ground without drilling. Full loss of flush returns.*
					15.10	54.10		SOFT GROUND (WORKINGS - BARNSLEY COAL) *At 15.1m; drilling speed decreased, still extremely fast. Cannot 'soft push' drill rods through ground. Drill bit has become blocked and water level in tank not lowering.* *At 17.6m; drilling speed increased. Rods able to 'soft push' through ground.*
					18.30 18.40	50.90 50.80		Solid Ground (COAL MEASURES) *At 18.3m, two unsuccessful attemps undertaken to clear blockage in drill bit caused by soft ground encountered in workings.* *At 18.4m; drilling terminated as drill bit continuously blocking whilst passing through workings. Solid ground encountered with slow smooth drilling at 18.3m.* End of borehole at 18.40 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at 10.9m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

Borehole Log

Borehole No. **PH104A**

Sheet 1 of 1

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431799.00 - 409827.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	69.20	Scale 1:50
Client:	Duchy Homes		Dates:	14/07/2022 - 14/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
						69.20		Overburden - Residual Soils (OVERBURDEN)
					2.00	67.20		End of borehole at 2.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Co-ordinates from hand held GPS, hole not surveyed in. 4. Approximate ground level (mAOD) taken from topographical survey.

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Borehole Log

Borehole No.
PH105
Sheet 1 of 3

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431786.00 - 409854.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 70.90	Scale 1:50
Client: Duchy Homes		Dates: 14/07/2022 - 14/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					1.60	69.30		Brown SILTSTONE (COAL MEASURES)
					4.00	66.90		Grey MUDSTONE (COAL MEASURES)
					4.80	66.10		Black COAL (THIN COAL)
					5.00	65.90		Grey MUDSTONE (COAL MEASURES)
					5.50	65.40		Black COAL (THIN COAL)
					5.70	65.20		Grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

Borehole No. **PH105**

Sheet 2 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431786.00 - 409854.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	70.90	Scale 1:50
Client:	Duchy Homes		Dates:	14/07/2022 - 14/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					11.90	59.00		Black COAL (THIN COAL)
					12.20	58.70		Grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

11 12 13 14 15 16 17 18 19 20

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

Borehole Log

Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431786.00 - 409854.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 70.90	Scale 1:50
Client: Duchy Homes		Dates: 14/07/2022 - 14/07/2022	Logged By AT

Borehole No. **PH105** Sheet 3 of 3

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					20.70	50.20		Black COAL (THIN COAL)
					20.80	50.10		Grey MUDSTONE (COAL MEASURES)
					21.70	49.20		Black COAL (THIN COAL)
					22.00	48.90		Grey MUDSTONE (COAL MEASURES)
					24.00	46.90		End of borehole at 24.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

Borehole Log

Borehole No. **PH106**

Sheet 1 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431717.00 - 409833.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	71.15	Scale 1:50
Client:	Duchy Homes		Dates:	15/07/2022 - 15/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					1.00	70.15		Overbuden - Possible weathered coal or colliery spoil (OVERBURDEN)
					1.60	69.55		Brown SILTSTONE (COAL MEASURES)
					6.50	64.65		Grey MUDSTONE and brown SILTSTONE (COAL MEASURES)
								At 7.0m; bright orange clay included in arisings.
					8.10	63.05		Grey MUDSTONE (COAL MEASURES)
								From 9.0m; slight loss (approx. 5%) of flush returns during drilling.
								Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at 18.3m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

Borehole Log

LITHOS CONSULTING			Borehole No. **PH106** Sheet 2 of 3
Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431717.00 - 409833.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 71.15	Scale 1:50
Client: Duchy Homes		Dates: 15/07/2022 - 15/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					18.10	53.05		Black COAL (BARNSLEY COAL)
					18.30	52.85		SOFT GROUND (WORKINGS - BARNSLEY COAL) *At 18.3m; full loss of flush returns.*
								Continued on next sheet

11 12 13 14 15 16 17 18 19 20

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at 18.3m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

			Borehole No. **PH106** Sheet 3 of 3
Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 431717.00 - 409833.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 71.15	Scale 1:50
Client: Duchy Homes		Dates: 15/07/2022 - 15/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					20.50	50.65		HARD GROUND (COAL MEASURES) *At 20.5m; solid ground encountered incidicated by decreased drill speed, smooth and steady.*
					22.80	48.35		*At 22.8m; drilling terminated due to emptying of water from tank due to loss of flush - sufficient solid ground beneath workings.* End of borehole at 22.80 m

21 22 23 24 25 26 27 28 29 30

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at 18.3m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH107
Sheet 1 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431705.00 - 409804.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	69.41	Scale 1:50
Client:	Duchy Homes		Dates:	15/07/2022 - 15/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					1.00	68.41		Orangish brown SANDSTONE (COAL MEASURES)
					4.00	65.41		Grey MUDSTONE (COAL MEASURES)
								At 4.4m; loss of flush returns - still in solid ground. Casing taken to 4.5m - full flush returned.
								Continued on next sheet

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Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at from 12.6m to 15.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

Borehole No. **PH107**

Sheet 2 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431705.00 - 409804.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	69.41	Scale 1:50
Client:	Duchy Homes		Dates:	15/07/2022 - 15/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					12.60	56.81		Broken GROUND (WORKINGS - BARNSLEY COAL) *At 12.6m; full loss of flush returns. Drilling noted to be of increased speed and not steady, although hole still required drilling rather than 'soft push'.* *At 13.8m; drilling speed reduced - although noticeably faster than drilling mudstone.*
					15.00	54.41		Black COAL (BARNSLEY COAL) *At 15.0m; flush returned and black coal flush arisings.*
					15.80	53.61		Grey MUDSTONE (COAL MEASURES) *At 16.8m; drilling stopped to fill water tanks. Upon resuming, hole has become blocked from 15.0m likely due to soft ground from workings. Intermittant flush returns as a result.*

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at from 12.6m to 15.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

Borehole Log

Borehole No. **PH107**

Sheet 3 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	431705.00 - 409804.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	69.41	Scale 1:50
Client:	Duchy Homes		Dates:	15/07/2022 - 15/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					21.00	48.41		End of borehole at 21.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Full loss of flush returns at from 12.6m to 15.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

LITHOS CONSULTING

Borehole Log

Borehole No.
PH108
Sheet 1 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432159.00 - 409800.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	74.45	Scale 1:50
Client:	Duchy Homes		Dates:	18/07/2022 - 18/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					2.00	72.45		Brown SILTSTONE (COAL MEASURES)
					3.00	71.45		Grey MUDSTONE (COAL MEASURES)
								At 6.9m; a possible thin coal seam.
								Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Partial loss of flush returns at from 28.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH108
Sheet 2 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432159.00 - 409800.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	74.45	Scale 1:50
Client:	Duchy Homes		Dates:	18/07/2022 - 18/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					16.60	57.85		Carbonaceous MUDSTONE (COAL MEASURES)
					18.50	55.95		Grey MUDSTONE (COAL MEASURES)
								Continued on next sheet

11 12 13 14 15 16 17 18 19 20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Partial loss of flush returns at from 28.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Borehole Log

Borehole No. **PH108**

Sheet 3 of 3

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432159.00 - 409800.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	74.45	Scale 1:50
Client:	Duchy Homes		Dates:	18/07/2022 - 18/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					22.00	52.45		Black carbonaceous MUDSTONE (COAL MEASURES)
					22.20	52.25		Grey MUDSTONE (COAL MEASURES)
					28.10	46.35		*At 28.0m; partial loss of flush returns (approx 50%).* Black COAL (DUNSIL COAL)
					28.80	45.65		Grey MUDSTONE (COAL MEASURES)
					30.00	44.45		End of borehole at 30.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Partial loss of flush returns at from 28.0m. 4. Co-ordinates from hand held GPS, hole not surveyed in on completion. 5. Approximate ground level (mAOD) taken from topographical survey.

Borehole Log

LITHOS CONSULTING			Borehole No. **PH109** Sheet 1 of 1
Project Name: Darton Lane, Barnsley	Project No. 4386	Co-ords: 432224.00 - 409776.00	Hole Type PH
Location: Darton Lane, Barnsley		Level: 74.45	Scale 1:50
Client: Duchy Homes		Dates: 18/07/2022 - 20/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
								Overburden - Residual Soils (OVERBURDEN)
					1.40	73.05		*From 1.2m to 1.4m; weathered Barnsley Coal encountered underneath cohesive residual soils.*
								Black vitreous COAL (BARNSLEY COAL)
					2.50	71.95		Grey MUDSTONE (COAL MEASURES)
					9.00	65.45		End of borehole at 9.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH110
Sheet 1 of 1

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432267.00 - 409760.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	76.05	Scale 1:50
Client:	Duchy Homes		Dates:	20/07/2022 - 20/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					2.00	74.05		Brownish SILTSTONE (COAL MEASURES)
					2.30	73.75		Black vitreous COAL (BARNSLEY COAL)
					5.30	70.75		Grey MUDSTONE (COAL MEASURES)
					9.00	67.05		End of borehole at 9.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH111
Sheet 1 of 1

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432263.00 - 409740.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	75.30	Scale 1:50
Client:	Duchy Homes		Dates:	21/07/2022 - 21/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					1.20	74.10		Black COAL (BARNSLEY COAL)
					4.40	70.90		Grey MUDSTONE (COAL MEASURES)
					9.00	66.30		End of borehole at 9.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

LITHOS CONSULTING

Borehole Log

Borehole No.
PH112
Sheet 1 of 1

Project Name:	Darton Lane, Barnsley	Project No. 4386	Co-ords:	432210.00 - 409772.00	Hole Type PH
Location:	Darton Lane, Barnsley		Level:	74.50	Scale 1:50
Client:	Duchy Homes		Dates:	21/07/2022 - 21/07/2022	Logged By AT

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Overburden - Residual Soils (OVERBURDEN)
					2.00	72.50		Brown SILTSTONE (COAL MEASURES)
					6.20	68.30		Grey MUDSTONE (COAL MEASURES)
					9.00	65.50		End of borehole at 9.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. No loss of flush returns during drilling. 4. Co-ordinates from hand held GPS, hole not surveyed in. 5. Approximate ground level (mAOD) taken from topographical survey.

AGS

Appendix H

Contaminated land assessment for selection of water supply pipes

Contaminated Land Assessment Form

Introduction

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

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

Contamination Risk Assessment

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

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

Testing Requirements

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

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

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

Sufficiency of Testing

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

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

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

Health & Safety Assessment

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

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

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

Contaminants highlighted green tested for with results below the Trigger Values above.

Contaminants highlighted red tested for with results above the Trigger Values above. Arsenic Resulted in exceedances of 44mg/kg and 51mg/kg.

Contaminants in **black** not tested for as no potential source identified on the Conceptual Site Model.

1. Your Details

Company Name	Contact Name
Lithos Consulting Ltd	A Taylor

Site Address	Contact Number
Darton Lane, Barnsley	01937 545 330

2. The Previous Use of the Site

Please indicate below the previous uses of the site being developed

Predominantly greenfield site has remained undeveloped throughout its recorded history used primarily for the grazing of horses. Possible outcrop coal mining has been undertaken in the far east of the site.

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	Not tested	10
4	Mineral Oils C_{21}-C_{40}	mg/kg	Not tested	500
5	Corrosive (Conductivity, Redox & pH)		Not tested	
	Conductivity	µS/cm	Not tested	
	Redox	Volt	Not tested	
	pH	pH		
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 tested1	Any presence

No sources of the above potential contaminants identified on the Conceptual Site Model therefore no testing has been undertaken.

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 infrastructure design have been completed.

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 4386/6a and 4386/6b show the locations 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.

Colliery Spoil will be redistributed underneath areas of hardstand or underneath areas of POS (requiring 300mm clean cover), or if left in-situ beneath gardens a 600mm clean cover will be required. Made Ground Topsoil will require a 600m clean cover if left beneath gardens.

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
AT	12/08/22

Your Name & Title (PLEASE PRINT	Role in organisation
A TAYLOR	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 I

Chemical Results

Certificate of Analysis

Certificate Number	22-13858	*Issued:*	29-Jul-22

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference	22-13858
Client Reference	4386
Order No	PO19411
Contract Title	Darton Lane, Barnsley
Description	17 Soil samples.
Date Received	20-Jul-22
Date Started	20-Jul-22
Date Completed	29-Jul-22
Test Procedures	Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

2139

Summary of Chemical Analysis
Soil Samples

Our Ref 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

			Lab No	2035230	2035231	2035232	2035233	2035234	2035235
			.Sample ID	TP101	TP104	TP108	TP109	TP106	TP110
			Depth	0.80	0.50	0.50	0.50	0.60	0.20
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	18	16	14	14	15	28
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	9.4	9.7	9.9	14	8.2	27
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.3	0.3	0.3	0.9	0.2	0.8
Cadmium	DETSC 2301#	0.1	mg/kg	< 0.1	< 0.1	< 0.1	0.4	< 0.1	1.8
Chromium	DETSC 2301#	0.15	mg/kg	20	20	20	21	17	72
Chromium III	DETSC 2301*	0.15	mg/kg	20	20	20	21	17	72
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	25	24	30	34	22	110
Lead	DETSC 2301#	0.3	mg/kg	22	23	22	32	14	300
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l		< 10	< 10	< 10	< 10	< 10
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05	< 0.05	0.46	0.05	0.33	0.25
Nickel	DETSC 2301#	1	mg/kg	19	20	21	23	9.5	36
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.6
Vanadium	DETSC 2301#	0.8	mg/kg	31	31	31	33	29	73
Zinc	DETSC 2301#	1	mg/kg	62	65	68	230	48	410
Inorganics									
pH	DETSC 2008#		pH	5.8	5.9	6.0	7.1	6.3	7.6
Total Organic Carbon	DETSC 2084#	0.5	%		3.7	3.5	3.7	0.7	13
Chloride Aqueous Extract	DETSC 2055	1	mg/l		2.1	2.3	4.4	3.0	36
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l		< 1.0	< 1.0	1.1	< 1.0	3.9
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	31	38	24	17	22	100
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
EPH (C10-C12)	DETSC 3311	10	mg/kg		< 10	< 10	< 10	< 10	< 10
EPH (C12-C16)	DETSC 3311	10	mg/kg		< 10	< 10	< 10	< 10	37
EPH (C16-C21)	DETSC 3311	10	mg/kg		< 10	< 10	< 10	< 10	120
EPH (C21-C35)	DETSC 3311	10	mg/kg		< 10	< 10	< 10	< 10	660
EPH (C35-C40)	DETSC 3311	10	mg/kg		< 10	< 10	< 10	< 10	110
EPH (C10-C40)	DETSC 3311#	10	mg/kg		< 10	< 10	< 10	< 10	940
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	0.31
Acenaphthylene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	0.14
Fluorene	DETSC 3303	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	0.16
Phenanthrene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.26	< 0.03	1.7
Anthracene	DETSC 3303	0.03	mg/kg		< 0.03	< 0.03	0.05	< 0.03	0.27
Fluoranthene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.56	< 0.03	1.6
Pyrene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.48	< 0.03	1.1
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.19	< 0.03	0.36

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 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

			Lab No	2035230	2035231	2035232	2035233	2035234	2035235
			.Sample ID	TP101	TP104	TP108	TP109	TP106	TP110
			Depth	0.80	0.50	0.50	0.50	0.60	0.20
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Chrysene	DETSC 3303	0.03	mg/kg		< 0.03	< 0.03	0.26	< 0.03	0.59
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.28	< 0.03	0.49
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.13	< 0.03	0.24
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.19	< 0.03	0.34
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.13	< 0.03	0.18
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	< 0.03	< 0.03	0.04
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg		< 0.03	< 0.03	0.14	< 0.03	0.21
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg		< 0.10	< 0.10	< 2.30	< 0.10	7.7

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 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

	Lab No	2035236	2035237	2035238	2035239	2035240	2035241
	.Sample ID	TP110	TP108	TP109	TP101	TP102	TP103
	Depth	0.40	0.10	0.10	0.10	0.10	0.10
	Other ID						
	Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Sampling Date	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022
	Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Preparation							
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0	< 1.0	< 1.0	< 1.0	1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	34	15	15	16	14	13
Metals							
Arsenic	DETSC 2301#	0.2	mg/kg	51	16	19	16	16	13
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.9	1.6	1.4	1.2	1.1	1.2
Cadmium	DETSC 2301#	0.1	mg/kg	1.5	0.3	0.3	0.4	0.3	0.3
Chromium	DETSC 2301#	0.15	mg/kg	78	19	22	19	19	15
Chromium III	DETSC 2301*	0.15	mg/kg	78	19	22	19	19	15
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	140	45	47	47	39	36
Lead	DETSC 2301#	0.3	mg/kg	270	53	55	53	53	45
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l	< 10	< 10	< 10			
Mercury	DETSC 2325#	0.05	mg/kg	0.30	0.11	0.12	0.11	0.09	0.08
Nickel	DETSC 2301#	1	mg/kg	40	19	22	20	18	16
Selenium	DETSC 2301#	0.5	mg/kg	1.3	1.1	1.5	1.2	0.8	0.5
Vanadium	DETSC 2301#	0.8	mg/kg	85	33	38	35	34	28
Zinc	DETSC 2301#	1	mg/kg	340	89	100	96	87	76
Inorganics							
pH	DETSC 2008#		pH	7.1	6.3	6.0	6.2	5.9	5.9
Total Organic Carbon	DETSC 2084#	0.5	%	16	6.4	5.6	5.8	5.0	5.3
Chloride Aqueous Extract	DETSC 2055	1	mg/l	< 5.00	3.5	3.3			
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l	3.8	2.4	< 1.0			
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	37	18	20			
Petroleum Hydrocarbons							
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	< 0.1	< 0.1	< 0.1			
EPH (C10-C12)	DETSC 3311	10	mg/kg	11	< 10	< 10			
EPH (C12-C16)	DETSC 3311	10	mg/kg	58	< 10	< 10			
EPH (C16-C21)	DETSC 3311	10	mg/kg	260	< 10	< 10			
EPH (C21-C35)	DETSC 3311	10	mg/kg	1100	< 10	< 10			
EPH (C35-C40)	DETSC 3311	10	mg/kg	190	< 10	< 10			
EPH (C10-C40)	DETSC 3311#	10	mg/kg	1700	< 10	< 10			
PAHs							
Naphthalene	DETSC 3303#	0.03	mg/kg	0.31	< 0.03	0.07	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	0.04	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	0.23	< 0.03	0.06	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	0.22	< 0.03	0.06	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	3.1	0.08	0.71	0.32	0.04	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	0.59	< 0.03	0.13	0.05	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	3.8	0.13	1.4	0.59	0.06	0.03
Pyrene	DETSC 3303#	0.03	mg/kg	3.3	0.11	1.2	0.49	0.06	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.89	0.04	0.54	0.16	< 0.03	< 0.03

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 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

			Lab No	2035236	2035237	2035238	2035239	2035240	2035241
			.Sample ID	TP110	TP108	TP109	TP101	TP102	TP103
			Depth	0.40	0.10	0.10	0.10	0.10	0.10
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Chrysene	DETSC 3303	0.03	mg/kg	1.4	0.08	0.71	0.24	0.04	< 0.03
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	1.2	0.06	0.93	0.21	0.03	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	0.56	< 0.03	0.45	0.09	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.90	< 0.03	0.78	0.15	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	0.42	< 0.03	0.44	0.05	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	0.10	< 0.03	0.09	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	0.45	< 0.03	0.48	0.05	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	17	< 0.38	8.0	< 2.01	< 0.17	< 0.10

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Summary of Chemical Analysis
Soil Samples

Our Ref 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

			Lab No	2035242	2035243	2035244	2035245	2035246
			.Sample ID	TP104	TP106	TP107	TP111	TP112
			Depth	0.10	0.10	0.10	0.10	0.20
			Other ID					
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**					
Preparation								
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0	< 1.0	3.0	< 1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	12	11	12	14	12
Metals								
Arsenic	DETSC 2301#	0.2	mg/kg	7.0	12	9.2	32	25
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.7	0.6	0.6	1.1	1.3
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	0.2	0.2	0.2	0.2
Chromium	DETSC 2301#	0.15	mg/kg	11	12	12	14	13
Chromium III	DETSC 2301*	0.15	mg/kg	11	12	12	14	13
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	14	28	24	55	58
Lead	DETSC 2301#	0.3	mg/kg	23	38	37	76	60
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l					
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05	0.07	< 0.05	0.19	0.15
Nickel	DETSC 2301#	1	mg/kg	12	11	14	21	21
Selenium	DETSC 2301#	0.5	mg/kg	0.5	< 0.5	0.7	0.6	< 0.5
Vanadium	DETSC 2301#	0.8	mg/kg	20	23	20	32	32
Zinc	DETSC 2301#	1	mg/kg	55	51	56	75	70
Inorganics								
pH	DETSC 2008#		pH	4.8	4.7	7.1	6.9	6.8
Total Organic Carbon	DETSC 2084#	0.5	%	2.9	4.5	4.1	12	14
Chloride Aqueous Extract	DETSC 2055	1	mg/l					
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l					
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l					
Petroleum Hydrocarbons								
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg					
EPH (C10-C12)	DETSC 3311	10	mg/kg					
EPH (C12-C16)	DETSC 3311	10	mg/kg					
EPH (C16-C21)	DETSC 3311	10	mg/kg					
EPH (C21-C35)	DETSC 3311	10	mg/kg					
EPH (C35-C40)	DETSC 3311	10	mg/kg					
EPH (C10-C40)	DETSC 3311#	10	mg/kg					
PAHs								
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.08	0.19	0.08	0.09	0.08
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.17	0.34	0.13	0.33	0.28
Pyrene	DETSC 3303#	0.03	mg/kg	0.15	0.28	0.10	0.34	0.28
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.06	0.10	0.03	0.18	0.17

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 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

			Lab No	2035242	2035243	2035244	2035245	2035246
			.Sample ID	TP104	TP106	TP107	TP111	TP112
			Depth	0.10	0.10	0.10	0.10	0.20
			Other ID					
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	11/07/2022	11/07/2022	11/07/2022	11/07/2022	11/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**					
Chrysene	DETSC 3303	0.03	mg/kg	0.09	0.18	0.06	0.28	0.27
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.08	0.14	0.05	0.34	0.36
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	0.04	0.06	< 0.03	0.16	0.15
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.05	0.10	0.03	0.27	0.24
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.04	< 0.03	0.14	0.14
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	0.03	0.04
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	0.04	< 0.03	0.12	0.13
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.64	< 1.31	< 0.38	< 1.95	< 1.87

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 22-13858
Client Ref 4386
Contract Title Darton Lane, Barnsley

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
2035231	TP104 0.50	SOIL	NAD	none	Josh Best
2035232	TP108 0.50	SOIL	NAD	none	Josh Best
2035233	TP109 0.50	SOIL	NAD	none	Josh Best
2035234	TP106 0.60	SOIL	NAD	none	Josh Best
2035235	TP110 0.20	SOIL	NAD	none	Josh Best
2035236	TP110 0.40	SOIL	NAD	none	Josh Best
2035237	TP108 0.10	SOIL	NAD	none	Josh Best
2035238	TP109 0.10	SOIL	NAD	none	Josh Best
2035239	TP101 0.10	SOIL	NAD	none	Josh Best
2035240	TP102 0.10	SOIL	NAD	none	Josh Best
2035241	TP103 0.10	SOIL	NAD	none	Josh Best
2035242	TP104 0.10	SOIL	NAD	none	Josh Best
2035243	TP106 0.10	SOIL	NAD	none	Josh Best
2035244	TP107 0.10	SOIL	NAD	none	Josh Best
2035245	TP111 0.10	SOIL	NAD	none	Josh Best
2035246	TP112 0.20	SOIL	NAD	none	Josh Best

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 22-13858
Client Ref 4386
Contract Darton Lane, Barnsley

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2035230	TP101 0.80 SOIL	11/07/22	PT 1L	pH + Conductivity (7 days)	
2035231	TP104 0.50 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035232	TP108 0.50 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035233	TP109 0.50 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035234	TP106 0.60 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035235	TP110 0.20 SOIL	11/07/22	GJ 250ml, GJ 60ml, PT 1L	pH + Conductivity (7 days)	
2035236	TP110 0.40 SOIL	11/07/22	GJ 250ml, GJ 60ml, PT 1L	pH + Conductivity (7 days)	
2035237	TP108 0.10 SOIL	11/07/22	GJ 250ml	pH + Conductivity (7 days)	
2035238	TP109 0.10 SOIL	11/07/22	GJ 250ml, PT 1L x2	pH + Conductivity (7 days)	
2035239	TP101 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035240	TP102 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035241	TP103 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035242	TP104 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035243	TP106 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035244	TP107 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035245	TP111 0.10 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	
2035246	TP112 0.20 SOIL	11/07/22	GJ 250ml, PT 1L	pH + Conductivity (7 days)	

Key: P-Plastic T-Tub G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

Certificate of Analysis

Certificate Number	22-14104	*Issued:*	29-Jul-22

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference	22-14104
Client Reference	4386
Order No	419435/003/4386
Contract Title	Daton Lane, Barnsley
Description	6 Soil samples.
Date Received	22-Jul-22
Date Started	22-Jul-22
Date Completed	29-Jul-22
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

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Summary of Chemical Analysis
Soil Samples

Our Ref 22-14104
Client Ref 4386
Contract Title Daton Lane, Barnsley

			Lab No	2036488	2036489	2036490	2036491	2036492	2036493
			.Sample ID	TS101	TS102	TS103	TS104	CS101	CS102
			Depth	0.10	0.10	0.40	0.30	0.30	0.30
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	20/07/2022	20/07/2022	20/07/2022	20/07/2022	20/07/2022	20/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	18	18	15	17	28	34
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	24	13	39	34	24	30
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	1.9	2.1	1.2	1.1	1.2	1.3
Cadmium	DETSC 2301#	0.1	mg/kg	0.5	0.3	0.3	0.3	1.3	1.6
Chromium	DETSC 2301#	0.15	mg/kg	23	15	21	21	140	89
Chromium III	DETSC 2301*	0.15	mg/kg	23	15	21	21	140	89
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	86	50	90	86	150	130
Lead	DETSC 2301#	0.3	mg/kg	89	48	89	96	230	270
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l			< 10	< 10	< 10	< 10
Mercury	DETSC 2325#	0.05	mg/kg	0.15	0.06	0.22	0.26	0.23	0.27
Nickel	DETSC 2301#	1	mg/kg	23	15	30	28	40	42
Selenium	DETSC 2301#	0.5	mg/kg	1.2	0.6	0.8	0.8	0.9	1.0
Vanadium	DETSC 2301#	0.8	mg/kg	35	24	48	44	96	86
Zinc	DETSC 2301#	1	mg/kg	200	88	100	110	460	440
Inorganics									
pH	DETSC 2008#		pH	7.3	6.8	7.0	7.8	7.6	7.6
Total Organic Carbon	DETSC 2084#	0.5	%	9.3	8.3	13	9.5	11	13
Chloride Aqueous Extract	DETSC 2055	1	mg/l			6.3	3.8	52	100
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l			2.0	2.4	5.1	6.7
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l			42	21	32	37
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg			< 0.1	< 0.1	< 0.1	< 0.1
EPH (C10-C12)	DETSC 3311	10	mg/kg			< 10	< 10	11	< 10
EPH (C12-C16)	DETSC 3311	10	mg/kg			< 10	< 10	37	33
EPH (C16-C21)	DETSC 3311	10	mg/kg			< 10	< 10	100	83
EPH (C21-C35)	DETSC 3311	10	mg/kg			< 10	< 10	540	320
EPH (C35-C40)	DETSC 3311	10	mg/kg			< 10	< 10	73	40
EPH (C10-C40)	DETSC 3311#	10	mg/kg			< 10	< 10	760	490
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	0.10	0.11
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.05	< 0.03	< 0.03	0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	0.06	0.09
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	0.07	0.11
Phenanthrene	DETSC 3303#	0.03	mg/kg	0.25	0.20	0.11	0.07	0.89	1.1
Anthracene	DETSC 3303	0.03	mg/kg	0.05	0.04	0.04	< 0.03	0.17	0.21
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.47	0.42	0.30	0.32	1.4	1.4
Pyrene	DETSC 3303#	0.03	mg/kg	0.40	0.35	0.30	0.32	1.2	1.0
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	0.17	0.15	0.27	0.25	0.55	0.41

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 22-14104
Client Ref 4386
Contract Title Daton Lane, Barnsley

			Lab No	2036488	2036489	2036490	2036491	2036492	2036493
			.Sample ID	TS101	TS102	TS103	TS104	CS101	CS102
			Depth	0.10	0.10	0.40	0.30	0.30	0.30
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	20/07/2022	20/07/2022	20/07/2022	20/07/2022	20/07/2022	20/07/2022
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Chrysene	DETSC 3303	0.03	mg/kg	0.24	0.20	0.30	0.26	0.75	0.56
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	0.22	0.20	0.53	0.40	1.4	0.54
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	0.08	0.06	0.22	0.18	1.3	0.21
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	0.10	0.09	0.34	0.28	0.58	0.30
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	0.06	0.05	0.17	0.11	0.42	0.20
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.05	< 0.03	0.07	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	0.07	0.06	0.20	0.13	0.50	0.24
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 1.75	< 1.47	< 2.42	< 1.94	9.5	6.5

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 22-14104
Client Ref 4386
Contract Title Daton Lane, Barnsley

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
2036488	TS101 0.10	SOIL	NAD	none	Josh Best
2036489	TS102 0.10	SOIL	NAD	none	Josh Best
2036490	TS103 0.40	SOIL	NAD	none	Josh Best
2036491	TS104 0.30	SOIL	NAD	none	Josh Best
2036492	CS101 0.30	SOIL	NAD	none	Josh Best
2036493	CS102 0.30	SOIL	NAD	none	Josh Best

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 22-14104
Client Ref 4386
Contract Daton Lane, Barnsley

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2036488	TS101 0.10 SOIL	20/07/22	GJ 250ml, PT 1L		
2036489	TS102 0.10 SOIL	20/07/22	GJ 250ml, PT 1L		
2036490	TS103 0.40 SOIL	20/07/22	GJ 250ml, PT 1L		
2036491	TS104 0.30 SOIL	20/07/22	GJ 250ml, PT 1L		
2036492	CS101 0.30 SOIL	20/07/22	GJ 250ml, PT 1L		
2036493	CS102 0.30 SOIL	20/07/22	GJ 250ml, PT 1L		

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

Appendix J

Dot and Box Plots

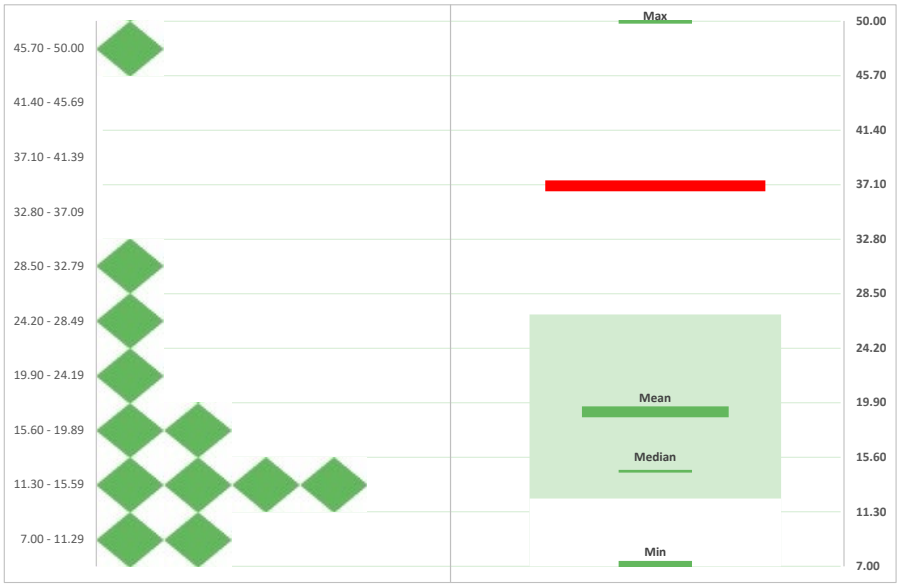
Darton Lane, Barnsley

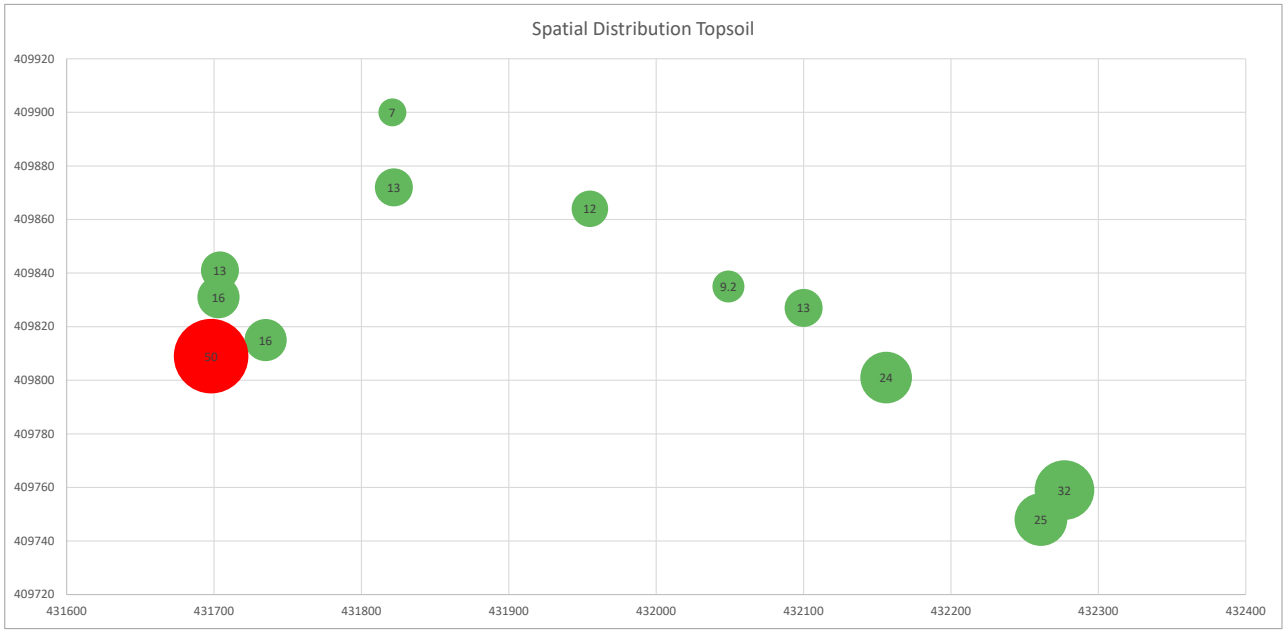
Job No: 4386
Engineer: AT
Date: 05 08 22

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

Determinant	As
Critical concentration	37.00
No. samples	12.00
Max	50.00
Mean	19.18
Min	7.00
Median	14.50
Standard Deviation	12.08
Standard Error	3.49
T value	2.20
Upper Confidence Level (95%)	26.86
Upper Confidence Level (80%)	23.94
Lower Confidence Level (5%)	12.35
Transform data	Normal

Upper Confidence Level for chart	95%





Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamintion

Appendix K

Geotechnical Test Results

LABORATORY REPORT

4043

Contract Number: PSL22/4824

Report Date: 29 July 2022

Client's Reference: 4386

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

For the attention of: Ashley Taylor

Contract Title: Darton Lane, Barnsley

Date Received: 20/7/2022
Date Commenced: 20/7/2022
Date Completed: 29/7/2022

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. 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 other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins (Director)
R Berriman (Quality Manager)
S Royle (Laboratory Manager)
L Knight (Senior Technician)
S Eyre (Senior Technician)
T Watkins (Senior Technician)

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Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: awatkins@prosoils.co.uk
rberriman@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP102	1	B	0.10		Brown TOPSOIL
TP104	1	B	0.10		Brown TOPSOIL
TP111	1	B	0.10		Brown TOPSOIL
TP107	1	B	0.10		Brown TOPSOIL
TP102	2	D	0.70		Brown mottled grey slightly sandy CLAY.
TP105	2	D	1.00		Brown mottled grey slightly sandy CLAY.
TP107	2	D	0.80		Brown mottled grey slightly sandy CLAY.
TP111	2	D	0.70		Brown mottled grey slightly sandy CLAY.
TP104	3	D	0.80		Brown mottled grey slightly sandy CLAY.
TP108	3	D	1.00		Brown mottled grey sandy CLAY.
TP109	3	D	0.90		Brown slightly sandy CLAY.
TP110	3	D	1.00		Brown slightly sandy CLAY.
TP112	3	D	2.60		Brown mottled grey sandy CLAY.
TP110	5	D	2.60		Brown mottled grey slightly 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
TP102	2	D	0.70		17			50	24	26	100	High Plasticity CH
TP105	2	D	1.00		27			58	26	32	100	High Plasticity CH
TP107	2	D	0.80		20			60	26	34	100	High Plasticity CH
TP111	2	D	0.70		22			59	26	33	100	High Plasticity CH
TP104	3	D	0.80		21			56	25	31	100	High Plasticity CH
TP108	3	D	1.00		19			48	23	25	100	Intermediate Plasticity CI
TP109	3	D	0.90		27			55	25	30	100	High Plasticity CH
TP110	3	D	1.00		35			61	27	34	100	High Plasticity CH
TP112	3	D	2.60		17			44	21	23	100	Intermediate Plasticity CI
TP110	5	D	2.60		28			65	27	38	100	High Plasticity CH

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

UKAS TESTING 4043

PSL Professional Soils Laboratory

Darton Lane, Barnsley

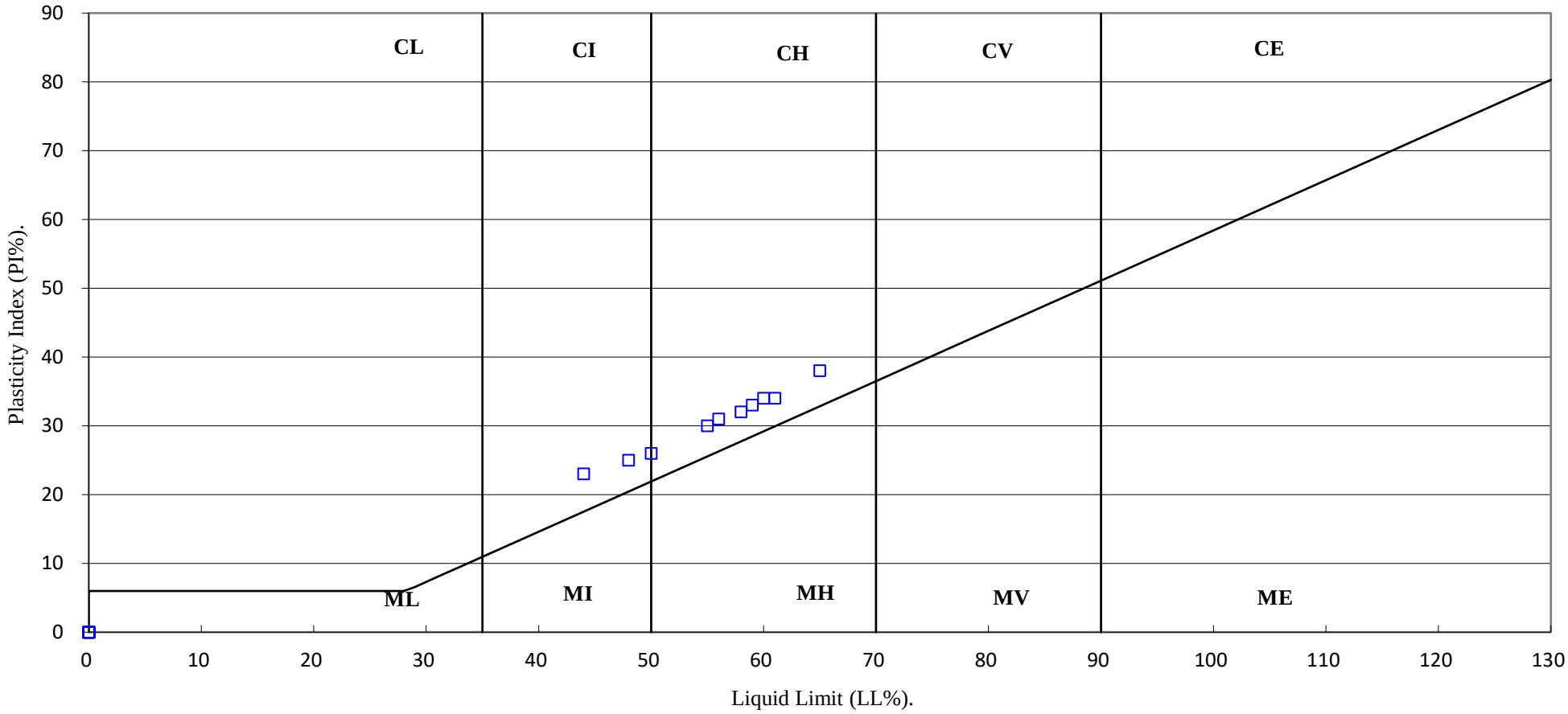
Contract No:

PSL22/4824

Client Ref:

4386

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Darton Lane, Barnsley**	**Contract No:** PSL22/4824 **Client Ref:** 4386

PARTICLE SIZE DISTRIBUTION TEST

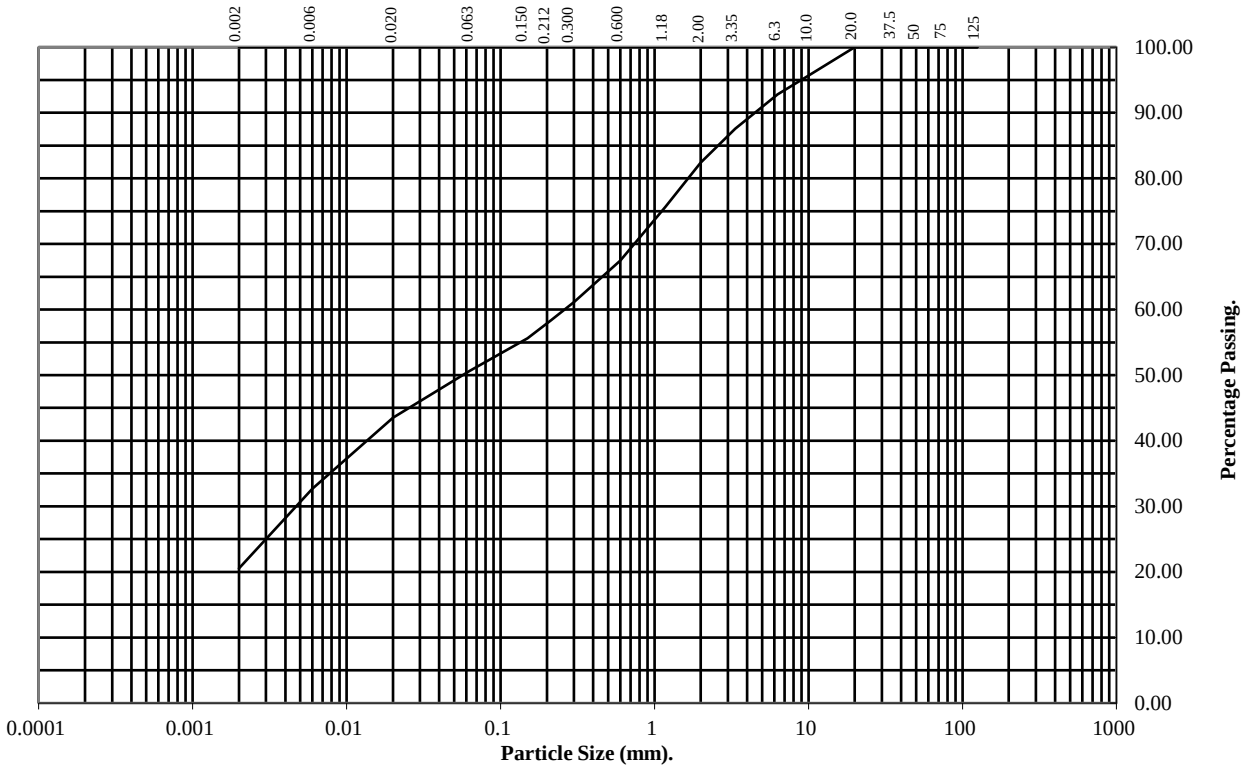
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP102** **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	96
6.3	93
3.35	88
2	82
1.18	76
0.6	67
0.3	61
0.212	58
0.15	56
0.063	51

Particle Diameter	Percentage Passing
0.02	44
0.006	33
0.002	21

Soil Fraction	Total Percentage
Cobbles	0
Gravel	18
Sand	31
Silt	30
Clay	21

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

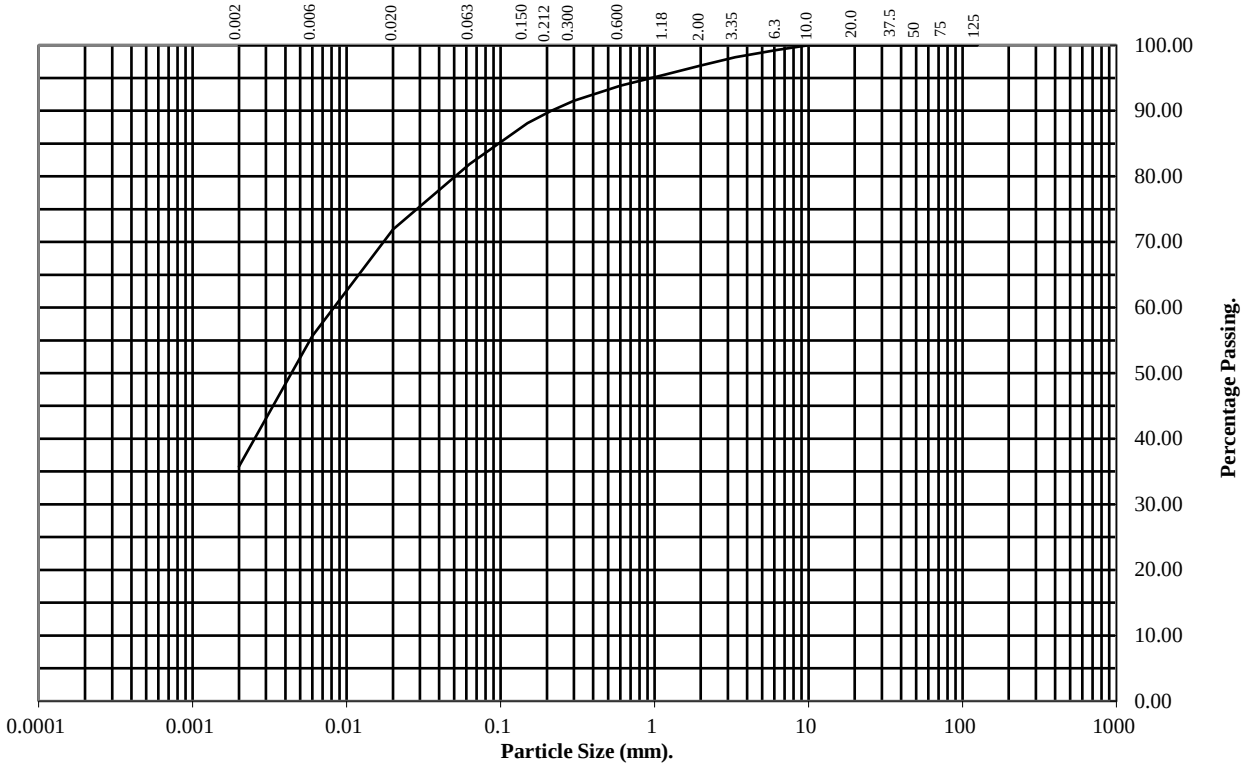
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP104** **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	99
3.35	98
2	97
1.18	96
0.6	94
0.3	92
0.212	90
0.15	88
0.063	82

Particle Diameter	Percentage Passing
0.02	72
0.006	56
0.002	36

Soil Fraction	Total Percentage
Cobbles	0
Gravel	3
Sand	15
Silt	46
Clay	36

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

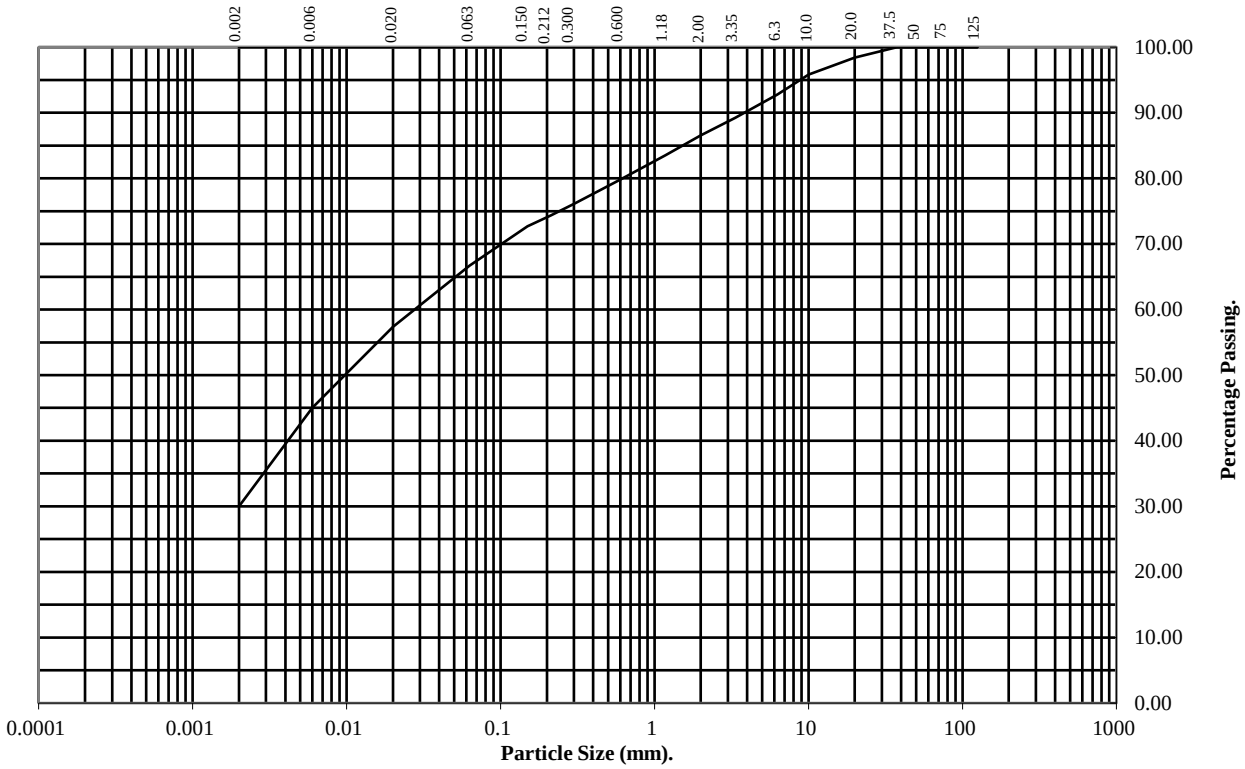
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP107** **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	98
10	96
6.3	93
3.35	89
2	87
1.18	84
0.6	80
0.3	76
0.212	74
0.15	73
0.063	67

Particle Diameter	Percentage Passing
0.02	57
0.006	45
0.002	30

Soil Fraction	Total Percentage
Cobbles	0
Gravel	13
Sand	20
Silt	37
Clay	30

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

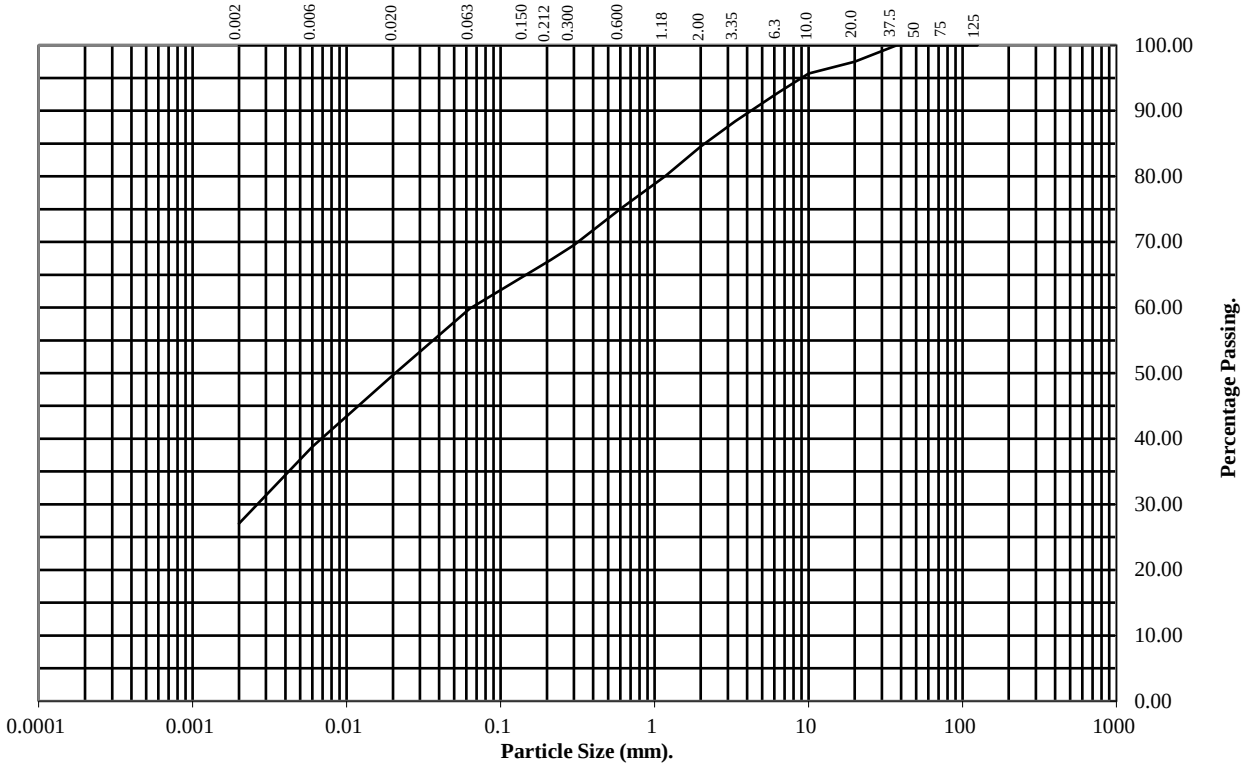
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **TP111** **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	97
10	96
6.3	93
3.35	88
2	85
1.18	80
0.6	75
0.3	70
0.212	67
0.15	65
0.063	60

Particle Diameter	Percentage Passing
0.02	50
0.006	39
0.002	27

Soil Fraction	Total Percentage
Cobbles	0
Gravel	15
Sand	25
Silt	33
Clay	27

Remarks:

See Summary of Soil Descriptions

2531

ANALYTICAL TEST REPORT

Contract no: 111968

Contract name: Darton Lane, Barnsley

Client reference: PSL22/4824

Clients name: Professional Soils Laboratory

Clients address: 5/7 Hexthorpe Road
Doncaster
DN4 0AR

Samples received: 27 July 2022

Analysis started: 27 July 2022

Analysis completed: 04 August 2022

Report issued: 09 August 2022

This is a supplementary report to report number 111968 issued 04 August 2022.

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

Reporting Team Lead

Chemtech Environmental Limited

SOILS

Lab number			111968-1	111968-2	111968-3	111968-4	111968-5	111968-6
Sample id			TP101	TP102	TP102	TP104	TP104	TP105
Depth (m)			0.80	0.70	1.60	0.80	1.70	2.70
Sample Type			D	D	D	D	D	D
Date sampled			-	-	-	-	-	-
Test	**Method**	**Units**						
pH	CE004 [U]	units	6.3	5.4	5.8	6.9	-	6.9
Sulphate (2:1 water soluble)	CE061 [U]	mg/l SO_4	290	164	86	68	-	16
Subcontracted analysis								
Calorific value	$	MJ/kg	-	-	-	-	<2	-

Chemtech Environmental Limited

SOILS

Lab number			111968-7	111968-8	111968-9	111968-10	111968-11	111968-12
Sample id			TP106	TP106	TP106	TP107	TP108	TP110
Depth (m)			1.00	2.10	3.40	1.90	1.00	1.00
Sample Type			D	D	D	D	D	D
Date sampled			-	-	-	-	-	-
Test	**Method**	**Units**						
pH	CE004 [U]	units	5.8	6.6	-	7.1	4.7	5.8
Sulphate (2:1 water soluble)	CE061 [U]	mg/l SO_4	56	29	-	16	32	164
Subcontracted analysis								
Calorific value	$	MJ/kg	-	-	18	-	-	-

Chemtech Environmental Limited

SOILS

Lab number			111968-13	111968-14	111968-15
Sample id			TP110	TP110	TP112
Depth (m)			2.00	2.60	2.60
Sample Type			D	D	D
Date sampled			-	-	-
Test	**Method**	**Units**			
pH	CE004 U	units	-	5.0	5.2
Sulphate (2:1 water soluble)	CE061 U	mg/l SO_4	-	63	27
Subcontracted analysis					
Calorific value	$	MJ/kg	21	-	-

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	U	10	mg/l SO_4
$	Calorific value	Details on Request	Dry		2	MJ/kg

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)
111968-1	TP101	0.80	N	
111968-2	TP102	0.70	N	
111968-3	TP102	1.60	N	
111968-4	TP104	0.80	N	
111968-6	TP105	2.70	N	
111968-7	TP106	1.00	N	
111968-8	TP106	2.10	N	
111968-10	TP107	1.90	N	
111968-11	TP108	1.00	N	
111968-12	TP110	1.00	N	
111968-14	TP110	2.60	N	
111968-15	TP112	2.60	N	

Chemtech Environmental Limited

ADDITIONAL INFORMATION

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 4 weeks from initial receipt unless otherwise instructed.

For soils and solids, all results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.

Analytical results are inclusive of stones, where applicable.

Chemtech Environmental Limited

TEST REPORT REVISIONS

The table below identifies ammendments that have been made to this test report for each revision.

Test Report Reference	Details of amendments to test report	Issue Date
11968	Original report issued	04 August 2022
11968(1)	Sample ID's amended for 111968-10 and 111968-15	09 August 2022

Appendix L
Gas Monitoring Results

Visit 1											
Job Title:										**Job No:**	
Darton Lane, Barnsley										**4386**	
Client:										**Sheet :**	
Duchy Homes										1 of 1	
Date:	**Arrival Time:**		**Depart Time:**		**Operator:**						
04/08/2022	15:30		17:05		Cameron Daniel						

Gas Monitoring Results:

Ambient Concentration (% Volume):	**CH_4:**	ND	**CO_2:**	ND	**O_2:**	21.0

Monitoring Point	**Groundwater level**	**Concentrations**					**Gas Flow Rates**			**Bottom of well**	**Remarks**
		Initial / Highest		**Steady concentrations**		**Lowest concn**	**Initial / Maximum**	**Steady**	**Time to fall from highest to steady**		
		CH_4	**CO_2**	**CH_4**	**CO_2**	**O_2**					
	(m) bgl	**% v/v**	**(%)**	**% v/v**	**(%)**	**(%)**	**litre/hr**	**litre/hr**	**secs**	**m**	
PH101	ND	ND	1.0	ND	1.0	19.6	1.9	0.6	90.0	3.96	Flow fluctuating 0.3 to 0.6.
PH102	0.50	ND	1.5	ND	1.5	19.6	ND	ND	ND	3.91	
PH104A	ND	ND	0.1	ND	0.1	20.8	ND	ND	ND	2.05	
PH107	ND	ND	0.8	ND	0.8	19.4	0.1	ND	5.0	2.92	
PH108	ND	ND	0.5	ND	0.5	20.7	ND	ND	ND	3.00	
PH110	1.27	ND	ND	ND	ND	21.1	ND	ND	ND	2.22	
PH112	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Could not remove unfasten bolt on first visit - will attempt on 2nd visit.

Equipment Used:	**Next Calibration Date**
Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	08/03/2023

Key	
ND	None Detected
NR	Not Recorded
1.0	Recorded value does not breach trigger levels
5.0	Recorded value breaches trigger level 1
10.0	Recorded value breaches trigger level 2

	Site Data:			**Weather Station Data (Brettas Park Station)**							**CH_4**	**CO_2**	**O_2**
	Temp (°C):	18 to 19		**Barometric Pressure Trend:**			Rising						
Time:	15:46	16:18	17:01	01:02	12:59	15:45	16:18	17:00	18:59	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	1007	1007	1007	1015	1018	1019	1019	1019	1020	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:		Light cloud/ Moderate breeze										
	Surface Ground Conditions:		Dry										

Remarks:	

Appendix M
3rd Party Chemical Results

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Analytical Report Number : 19-65354

Project / Site name:	Darto Lane	**Samples received on:**	09/10/2019
Your job number:	J2092	**Samples instructed on:**	11/10/2019
Your order number:		**Analysis completed by:**	22/10/2019
Report Issue Number:	1	**Report issued on:**	22/10/2019
Samples Analysed:	11 soil samples		

Signed:

Dr Claire Stone
Quality Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 19-65354

Project / Site name: Darto Lane

Lab Sample Number				1327830	1327831	1327832	1327833	1327834
Sample Reference				TP101	TP101	TP102	TP102	TP103
Sample Number				ES01	ES03	ES02	ES04	ES02
Depth (m)				0.20	0.70	0.30	1.30	0.40
Date Sampled				07/10/2019	07/10/2019	07/10/2019	07/10/2019	08/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	21	12	24	14	19
Total mass of sample received	kg	0.001	NONE	0.45	0.57	0.50	0.55	0.55
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	4.0	5.0	6.4	6.7	6.5
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	3300	1000	150	120	270
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	100	73	59	51	35
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.050	0.037	0.030	0.026	0.018
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	49.9	36.6	29.5	25.5	17.5
Sulphide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Organic Matter	%	0.1	MCERTS	4.9	0.7	0.4	0.4	0.5
Total Organic Carbon (TOC)	%	0.1	MCERTS	2.9	0.4	0.2	0.2	0.3
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	50	16	1.6	16	6.1
Boron (water soluble)	mg/kg	0.2	MCERTS	1.6	0.5	0.5	0.3	0.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	19	19	20	22	21
Copper (aqua regia extractable)	mg/kg	1	MCERTS	25	24	53	42	28
Lead (aqua regia extractable)	mg/kg	1	MCERTS	36	17	24	30	27
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	12	20	48	41	19
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	30	23	29	22	20
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	57	87	94	76	91

Analytical Report Number: 19-65354

Project / Site name: Darto Lane

Lab Sample Number				1327830	1327831	1327832	1327833	1327834
Sample Reference				TP101	TP101	TP102	TP102	TP103
Sample Number				ES01	ES03	ES02	ES04	ES02
Depth (m)				0.20	0.70	0.30	1.30	0.40
Date Sampled				07/10/2019	07/10/2019	07/10/2019	07/10/2019	08/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10

Analytical Report Number: 19-65354

Project / Site name: Darto Lane

Lab Sample Number				1327835	1327836	1327837	1327838	1327839
Sample Reference				TP104	TP105	TP105	TP106	TP106
Sample Number				ES02	ES01	ES02	ES01	ES04
Depth (m)				1.00	0.20	0.50	0.10	1.50
Date Sampled				08/10/2019	08/10/2019	08/10/2009	08/10/2019	08/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	13	20	12	24	11
Total mass of sample received	kg	0.001	NONE	0.52	0.47	0.59	0.50	0.52
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	6.0	5.9	6.3	6.3	6.4
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	380	870	290	1000	220
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	150	23	25	41	61
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.073	0.012	0.012	0.020	0.030
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	72.7	11.5	12.4	20.3	30.3
Sulphide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Organic Matter	%	0.1	MCERTS	0.3	5.7	2.0	6.5	0.3
Total Organic Carbon (TOC)	%	0.1	MCERTS	0.2	3.3	1.2	3.8	0.2
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	0.32	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.74	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.64	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.43	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.46	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.46	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.21	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.33	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	3.59	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.1	7.2	< 1.0	13	13
Boron (water soluble)	mg/kg	0.2	MCERTS	0.4	1.0	0.8	2.4	0.4
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	11	12	22	22
Copper (aqua regia extractable)	mg/kg	1	MCERTS	30	22	18	29	32
Lead (aqua regia extractable)	mg/kg	1	MCERTS	16	34	16	42	13
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	40	14	17	16	38
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	18	18	18	25	20
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	85	58	50	69	87

Analytical Report Number: 19-65354

Project / Site name: Darto Lane

Lab Sample Number				1327835	1327836	1327837	1327838	1327839
Sample Reference				TP104	TP105	TP105	TP106	TP106
Sample Number				ES02	ES01	ES02	ES01	ES04
Depth (m)				1.00	0.20	0.50	0.10	1.50
Date Sampled				08/10/2019	08/10/2019	08/10/2009	08/10/2019	08/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	12	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	31	< 10	< 10	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	46	< 10	< 10	< 10

Analytical Report Number: 19-65354

Project / Site name: Darto Lane

Lab Sample Number				1327840				
Sample Reference				TP108				
Sample Number				ES02				
Depth (m)				0.50				
Date Sampled				08/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	18				
Total mass of sample received	kg	0.001	NONE	0.50				
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	5.8				
Total Cyanide	mg/kg	1	MCERTS	< 1				
Free Cyanide	mg/kg	1	MCERTS	< 1				
Total Sulphate as SO_4	mg/kg	50	MCERTS	580				
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	77				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.039				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	38.5				
Sulphide	mg/kg	1	MCERTS	< 1.0				
Organic Matter	%	0.1	MCERTS	6.4				
Total Organic Carbon (TOC)	%	0.1	MCERTS	3.7				
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0				
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05				
Fluorene	mg/kg	0.05	MCERTS	< 0.05				
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05				
Anthracene	mg/kg	0.05	MCERTS	< 0.05				
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Pyrene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Chrysene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05				
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80				
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	17				
Boron (water soluble)	mg/kg	0.2	MCERTS	1.0				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2				
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	19				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	38				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	23				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	35				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	26				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	65				

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Project / Site name: Darto Lane

Lab Sample Number				1327840				
Sample Reference				TP108				
Sample Number				ES02				
Depth (m)				0.50				
Date Sampled				08/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0				
Toluene	µg/kg	1	MCERTS	< 1.0				
Ethylbenzene	µg/kg	1	MCERTS	< 1.0				
p & m-xylene	µg/kg	1	MCERTS	< 1.0				
o-xylene	µg/kg	1	MCERTS	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0				
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0				
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0				
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10				
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0				
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10				
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10				
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10				

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Project / Site name: Darto Lane

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1327830	TP101	ES01	0.20	Light brown sandy clay with vegetation.
1327831	TP101	ES03	0.70	Light brown sandy clay with vegetation.
1327832	TP102	ES02	0.30	Light brown clay and sand.
1327833	TP102	ES04	1.30	Grey sandy clay.
1327834	TP103	ES02	0.40	Brown clay and loam.
1327835	TP104	ES02	1.00	Brown clay and loam with vegetation.
1327836	TP105	ES01	0.20	Brown loam and clay with vegetation.
1327837	TP105	ES02	0.50	Brown loam and clay with vegetation.
1327838	TP106	ES01	0.10	Brown clay and loam with vegetation.
1327839	TP106	ES04	1.50	Brown clay and loam.
1327840	TP108	ES02	0.50	Brown clay and loam with vegetation.

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Project / Site name: Darto Lane

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS

Analytical Report Number : 19-65354

Project / Site name: Darto Lane

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
TP105	ES02	S	19-65354	1327837	c	Free cyanide in soil	L080-PL	c
TP105	ES02	S	19-65354	1327837	c	Hexavalent chromium in soil	L080-PL	c
TP105	ES02	S	19-65354	1327837	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
TP105	ES02	S	19-65354	1327837	c	Monohydric phenols in soil	L080-PL	c
TP105	ES02	S	19-65354	1327837	c	Organic matter (Automated) in soil	L009-PL	c
TP105	ES02	S	19-65354	1327837	c	Speciated EPA-16 PAHs in soil	L064-PL	c
TP105	ES02	S	19-65354	1327837	c	Sulphide in soil	L010-PL	c
TP105	ES02	S	19-65354	1327837	c	TPHCWG (Soil)	L088/76-PL	c
TP105	ES02	S	19-65354	1327837	c	Total cyanide in soil	L080-PL	c
TP105	ES02	S	19-65354	1327837	c	Total organic carbon (Automated) in soil	L009-PL	c
TP105	ES02	S	19-65354	1327837	c	pH in soil (automated)	L099-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

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Analytical Report Number : 19-66231

Project / Site name:	Darton Lane	**Samples received on:**	11/10/2019
Your job number:	2092	**Samples instructed on:**	15/10/2019
Your order number:		**Analysis completed by:**	23/10/2019
Report Issue Number:	1	**Report issued on:**	23/10/2019
Samples Analysed:	2 leachate samples - 11 soil samples		

Signed: Karoline Marek

Karolina Marek
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 19-66231

Project / Site name: Darton Lane

Lab Sample Number				1332387	1332388	1332389	1332390	1332391
Sample Reference				TP109	TP110	TP110	TP110	TP111
Sample Number				ES04	ES01	ES02	ES05	ES04
Depth (m)				1.00	0.20	0.50	0.10	1.40
Date Sampled				09/10/2019	09/10/2019	09/10/2019	10/10/2019	09/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	-	< 0.1
Moisture Content	%	N/A	NONE	13	14	17	-	15
Total mass of sample received	kg	0.001	NONE	0.53	1.1	1.2	-	0.50
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.9	7.6	7.4	-	6.1
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	-	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	-	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	180	420	310	-	300
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	24	45	46	-	96
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.012	0.023	0.023	-	0.048
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	12.2	22.5	22.9	-	48.0
Sulphide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
Organic Matter	%	0.1	MCERTS	2.5	3.3	2.2	-	0.7
Total Organic Carbon (TOC)	%	0.1	MCERTS	1.5	1.9	1.3	-	0.4
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	-	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	-	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	7.3	8.3	3.2	-	7.1
Boron (water soluble)	mg/kg	0.2	MCERTS	0.4	0.7	0.5	-	0.4
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	-	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	-	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	16	17	16	-	23
Copper (aqua regia extractable)	mg/kg	1	MCERTS	33	23	20	-	24
Lead (aqua regia extractable)	mg/kg	1	MCERTS	19	24	18	-	14
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	55	22	17	-	32
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	1.7
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	24	24	22	-	18
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	57	58	44	-	81

Analytical Report Number: 19-66231

Project / Site name: Darton Lane

Lab Sample Number				1332387	1332388	1332389	1332390	1332391
Sample Reference				TP109	TP110	TP110	TP110	TP111
Sample Number				ES04	ES01	ES02	ES05	ES04
Depth (m)				1.00	0.20	0.50	0.10	1.40
Date Sampled				09/10/2019	09/10/2019	09/10/2019	10/10/2019	09/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	-	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	-	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	-	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	-	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	-	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	-	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	-	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	-	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	-	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	-	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	-	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	-	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	< 10	< 10	-	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	< 10	< 10	-	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	-	< 10

Analytical Report Number: 19-66231

Project / Site name: Darton Lane

Lab Sample Number				1332392	1332393	1332394	1332395	1332396
Sample Reference				TP101	TP105	TP106	TP12	TP12
Sample Number				ES06	ES07	ES06	ES01	ES02
Depth (m)				0.10	0.10	0.10	0.10	0.70
Date Sampled				10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	-	-	-	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	-	-	-	24	9.4
Total mass of sample received	kg	0.001	NONE	-	-	-	2.0	0.55
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	-	-	6.6	7.8
Total Cyanide	mg/kg	1	MCERTS	-	-	-	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	-	-	-	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	-	-	-	830	220
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	-	-	58	45
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	-	-	0.029	0.023
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	-	-	29.0	22.6
Sulphide	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Organic Matter	%	0.1	MCERTS	-	-	-	7.9	0.9
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	-	4.6	0.5
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	-	-	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	0.55	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	-	-	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	0.98	< 0.05
Pyrene	mg/kg	0.05	MCERTS	-	-	-	0.89	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	0.52	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	-	-	0.66	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	0.67	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	0.32	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	0.52	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	0.25	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	0.28	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	-	-	5.64	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	12	18
Boron (water soluble)	mg/kg	0.2	MCERTS	-	-	-	1.4	0.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	-	-	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	-	-	-	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	26	19
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	44	29
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	49	15
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	-	-	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	22	19
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	31	18
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	85	44

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Lab Sample Number				1332392	1332393	1332394	1332395	1332396
Sample Reference				TP101	TP105	TP106	TP12	TP12
Sample Number				ES06	ES07	ES06	ES01	ES02
Depth (m)				0.10	0.10	0.10	0.10	0.70
Date Sampled				10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	< 10	< 10

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	3.4	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	26	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	39	< 10

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Lab Sample Number				1332397				
Sample Reference				TP14				
Sample Number				ES02				
Depth (m)				0.50				
Date Sampled				10/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	32				
Total mass of sample received	kg	0.001	NONE	2.0				
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.7				
Total Cyanide	mg/kg	1	MCERTS	< 1				
Free Cyanide	mg/kg	1	MCERTS	< 1				
Total Sulphate as SO_4	mg/kg	50	MCERTS	350				
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	30				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.015				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	15.1				
Sulphide	mg/kg	1	MCERTS	< 1.0				
Organic Matter	%	0.1	MCERTS	7.8				
Total Organic Carbon (TOC)	%	0.1	MCERTS	4.5				
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0				
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.25				
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05				
Fluorene	mg/kg	0.05	MCERTS	< 0.05				
Phenanthrene	mg/kg	0.05	MCERTS	0.47				
Anthracene	mg/kg	0.05	MCERTS	< 0.05				
Fluoranthene	mg/kg	0.05	MCERTS	0.56				
Pyrene	mg/kg	0.05	MCERTS	0.51				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.39				
Chrysene	mg/kg	0.05	MCERTS	0.37				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.46				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.27				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.32				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.22				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.28				
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	4.10				
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	4.3				
Boron (water soluble)	mg/kg	0.2	MCERTS	0.8				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2				
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	30				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	40				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	35				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	36				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	26				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	90				

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Lab Sample Number				1332397				
Sample Reference				TP14				
Sample Number				ES02				
Depth (m)				0.50				
Date Sampled				10/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0				
Toluene	µg/kg	1	MCERTS	< 1.0				
Ethylbenzene	µg/kg	1	MCERTS	< 1.0				
p & m-xylene	µg/kg	1	MCERTS	< 1.0				
o-xylene	µg/kg	1	MCERTS	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0				

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0				
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0				
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0				
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10				

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0				
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10				
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10				
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10				

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Lab Sample Number				1332398	1332399			
Sample Reference				TP102	TP105			
Sample Number				ES07	ES06			
Depth (m)				0.60	0.50			
Date Sampled				07/10/2019	08/10/2019			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.6	6.9			
Total Cyanide	µg/l	10	ISO 17025	< 10	< 10			
Free Cyanide	µg/l	10	ISO 17025	< 10	< 10			
Thiocyanate as SCN	µg/l	200	ISO 17025	< 200	< 200			
Sulphate as SO_4	mg/l	0.1	ISO 17025	1.6	0.9			
Sulphide	µg/l	5	NONE	< 5.0	< 5.0			
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	4.36	3.06			
Alkalinity	mgCaCO3/l	3	ISO 17025	< 3.0	30			
Total Phenols								
Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10	< 10			
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01			
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01	< 0.01			
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01	< 0.01			
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01	< 0.01			
Total PAH								
Total EPA-16 PAHs	µg/l	0.2	NONE	< 0.2	< 0.2			
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	1.1	ISO 17025	< 1.1	< 1.1			
Boron (dissolved)	µg/l	10	ISO 17025	< 10	< 10			
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08	< 0.08			
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0			
Chromium (dissolved)	µg/l	0.4	ISO 17025	3.1	< 0.4			
Copper (dissolved)	µg/l	0.7	ISO 17025	12	6.7			
Lead (dissolved)	µg/l	1	ISO 17025	1.7	1.0			
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5	< 0.5			
Nickel (dissolved)	µg/l	0.3	ISO 17025	0.6	< 0.3			
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0	< 4.0			
Zinc (dissolved)	µg/l	0.4	ISO 17025	3.9	1.6			
Calcium (dissolved)	mg/l	0.012	ISO 17025	5.5	1.1			

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Lab Sample Number				1332398	1332399			
Sample Reference				TP102	TP105			
Sample Number				ES07	ES06			
Depth (m)				0.60	0.50			
Date Sampled				07/10/2019	08/10/2019			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0			
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0			
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0			
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0			
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0			
MTBE (Methyl Tertiary Butyl Ether)	µg/l	10	NONE	< 10	< 10			
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0			
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0			
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0			
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0			
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0			
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0			
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10			
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10			

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* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1332387	TP109	ES04	1.00	Brown clay and sand with gravel.
1332388	TP110	ES01	0.20	Brown loam and clay with gravel.
1332389	TP110	ES02	0.50	Brown clay and sand.
1332390	TP110	ES05	0.10	-
1332391	TP111	ES04	1.40	Light brown clay.
1332392	TP101	ES06	0.10	-
1332393	TP105	ES07	0.10	-
1332394	TP106	ES06	0.10	-
1332395	TP12	ES01	0.10	Brown loam and clay with gravel and vegetation.
1332396	TP12	ES02	0.70	Light brown clay and sand.
1332397	TP14	ES02	0.50	Brown clay and sand with vegetation.

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Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Alkalinity in Leachate	Determination of Alkalinity by discreet analyser (colorimetry).	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron in leachate	Determination of boron in leachate. Sample acidified and followed by ICP-OES.	In-house method based on MEWAM	L039-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Dissolved Organic Carbon in leachate	Determination of dissolved organic carbon in leachate by the measurement on a non-dispersive infrared analyser of carbon dioxide released by acidification.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L023-PL	W	NONE
Free cyanide in leachate	Determination of free cyanide by distillation followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in leachate	Determination of hexavalent chromium in leachate by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols in leachate	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE

Analytical Report Number : 19-66231

Project / Site name: Darton Lane

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	ISO 17025
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Sulphide in leachate	Determination of sulphide in leachate by ion selective electrode.	In-house method	L010-PL	W	NONE
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Thiocyanate in leachate	Determination of thiocyanate in water by discreet analyser (colorimetry).	In house method based on SMWW 4500-CN-M.	L082-PL	W	ISO 17025
Total cyanide in leachate	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
TPHCWG (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
TP110	ES01	S	19-66231	1332388	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
TP110	ES01	S	19-66231	1332388	b	TPHCWG (Soil)	L088/76-PL	b
TP110	ES02	S	19-66231	1332389	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
TP110	ES02	S	19-66231	1332389	b	TPHCWG (Soil)	L088/76-PL	b

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

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Analytical Report Number : 19-66315

Project / Site name:	Darton	**Samples received on:**	15/10/2019
Your job number:	2092	**Samples instructed on:**	16/10/2019
Your order number:		**Analysis completed by:**	24/10/2019
Report Issue Number:	1	**Report issued on:**	24/10/2019
Samples Analysed:	1 leachate sample - 2 soil samples		

Signed:

Zina Abdul Razzak
Senior Quality Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 19-66315

Project / Site name: Darton

Lab Sample Number				1332766	1332767			
Sample Reference				TP116	TP116			
Sample Number				ES01	ES03			
Depth (m)				0.10	1.00			
Date Sampled				11/10/2019	11/10/2019			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1			
Moisture Content	%	N/A	NONE	24	18			
Total mass of sample received	kg	0.001	NONE	1.9	2.0			
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected			
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	6.3	6.7			
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1			
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1			
Total Sulphate as SO_4	mg/kg	50	MCERTS	820	170			
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	33	34			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.017	0.017			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	16.6	17.0			
Sulphide	mg/kg	1	MCERTS	< 1.0	< 1.0			
Organic Matter	%	0.1	MCERTS	7.2	1.9			
Total Organic Carbon (TOC)	%	0.1	MCERTS	4.2	1.1			
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0			
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Phenanthrene	mg/kg	0.05	MCERTS	0.34	< 0.05			
Anthracene	mg/kg	0.05	MCERTS	0.15	< 0.05			
Fluoranthene	mg/kg	0.05	MCERTS	3.9	< 0.05			
Pyrene	mg/kg	0.05	MCERTS	3.9	< 0.05			
Benzo(a)anthracene	mg/kg	0.05	MCERTS	3.3	< 0.05			
Chrysene	mg/kg	0.05	MCERTS	2.7	< 0.05			
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	4.4	< 0.05			
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	2.7	< 0.05			
Benzo(a)pyrene	mg/kg	0.05	MCERTS	4.5	< 0.05			
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	2.5	< 0.05			
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.75	< 0.05			
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	2.6	< 0.05			
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	31.6	< 0.80			
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	44	< 1.0			
Boron (water soluble)	mg/kg	0.2	MCERTS	1.2	0.8			
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0			
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	17			
Copper (aqua regia extractable)	mg/kg	1	MCERTS	130	23			
Lead (aqua regia extractable)	mg/kg	1	MCERTS	94	15			
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	31	22			
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0			
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	45	19			
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	100	61			

Analytical Report Number: 19-66315

Project / Site name: Darton

Lab Sample Number				1332766	1332767			
Sample Reference				TP116	TP116			
Sample Number				ES01	ES03			
Depth (m)				0.10	1.00			
Date Sampled				11/10/2019	11/10/2019			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0			
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0			
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0			
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0			
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0			
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0			
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10			
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0			
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0			
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	15	< 10			
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	82	< 10			
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	97	< 10			

Analytical Report Number: 19-66315

Project / Site name: Darton

Lab Sample Number				1332768				
Sample Reference				TP116				
Sample Number				ES02				
Depth (m)				0.50				
Date Sampled				11/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.9				
Total Cyanide	µg/l	10	ISO 17025	< 10				
Free Cyanide	µg/l	10	ISO 17025	< 10				
Thiocyanate as SCN	µg/l	200	ISO 17025	< 200				
Sulphate as SO_4	mg/l	0.1	ISO 17025	1.2				
Sulphide	µg/l	5	NONE	< 5.0				
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE	4.77				
Alkalinity	mgCaCO3/l	3	ISO 17025	63				
Total Phenols								
Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10				
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01				
Fluorene	µg/l	0.01	ISO 17025	< 0.01				
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01				
Anthracene	µg/l	0.01	ISO 17025	< 0.01				
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Pyrene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Chrysene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01				
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01				
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01				
Total PAH								
Total EPA-16 PAHs	µg/l	0.2	NONE	< 0.2				
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	1.1	ISO 17025	< 1.1				
Boron (dissolved)	µg/l	10	ISO 17025	< 10				
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08				
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0				
Chromium (dissolved)	µg/l	0.4	ISO 17025	2.0				
Copper (dissolved)	µg/l	0.7	ISO 17025	10				
Lead (dissolved)	µg/l	1	ISO 17025	3.6				
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5				
Nickel (dissolved)	µg/l	0.3	ISO 17025	1.4				
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0				
Zinc (dissolved)	µg/l	0.4	ISO 17025	14				
Calcium (dissolved)	mg/l	0.012	ISO 17025	21				

Analytical Report Number: 19-66315

Project / Site name: Darton

Lab Sample Number				1332768				
Sample Reference				TP116				
Sample Number				ES02				
Depth (m)				0.50				
Date Sampled				11/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/l	1	ISO 17025	< 1.0				
Toluene	µg/l	1	ISO 17025	< 1.0				
Ethylbenzene	µg/l	1	ISO 17025	< 1.0				
p & m-xylene	µg/l	1	ISO 17025	< 1.0				
o-xylene	µg/l	1	ISO 17025	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/l	10	NONE	< 10				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10				

Analytical Report Number : 19-66315

Project / Site name: Darton

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1332766	TP116	ES01	0.10	Brown loam and clay with gravel and vegetation.
1332767	TP116	ES03	1.00	Light brown clay.

Analytical Report Number : 19-66315

Project / Site name: Darton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Alkalinity in Leachate	Determination of Alkalinity by discreet analyser (colorimetry).	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron in leachate	Determination of boron in leachate. Sample acidified and followed by ICP-OES.	In-house method based on MEWAM	L039-PL	W	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Dissolved Organic Carbon in leachate	Determination of dissolved organic carbon in leachate by the measurement on a non-dispersive infrared analyser of carbon dioxide released by acidification.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L023-PL	W	NONE
Free cyanide in leachate	Determination of free cyanide by distillation followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in leachate	Determination of hexavalent chromium in leachate by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols in leachate	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
NRA Leachate Prep	10:1 extract with de-ionised water shaken for 24 hours then filtered.	In-house method based on National Rivers Authority	L020-PL	W	NONE

Analytical Report Number : 19-66315

Project / Site name: Darton

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	ISO 17025
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate in leachates	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Sulphide in leachate	Determination of sulphide in leachate by ion selective electrode.	In-house method	L010-PL	W	NONE
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Thiocyanate in leachate	Determination of thiocyanate in water by discreet analyser (colorimetry).	In house method based on SMWW 4500-CN-M.	L082-PL	W	ISO 17025
Total cyanide in leachate	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
TPHCWG (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 19-66790

Project / Site name:	Darton Lane	**Samples received on:**	11/10/2019
Your job number:	J2092	**Samples instructed on:**	18/10/2019
Your order number:		**Analysis completed by:**	28/10/2019
Report Issue Number:	1	**Report issued on:**	28/10/2019
Samples Analysed:	1 soil sample		

Signed:

Zina Abdul Razzak
Senior Quality Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 19-66790

Project / Site name: Darton Lane

Lab Sample Number				1335409				
Sample Reference				TP114				
Sample Number				ES3				
Depth (m)				1.30				
Date Sampled				10/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	14				
Total mass of sample received	kg	0.001	NONE	2.0				
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.6				
Total Cyanide	mg/kg	1	MCERTS	< 1				
Free Cyanide	mg/kg	1	MCERTS	< 1				
Total Sulphate as SO_4	mg/kg	50	MCERTS	170				
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	32				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.016				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	16.1				
Sulphide	mg/kg	1	MCERTS	< 1.0				
Organic Matter	%	0.1	MCERTS	5.3				
Total Organic Carbon (TOC)	%	0.1	MCERTS	3.1				
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0				
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05				
Fluorene	mg/kg	0.05	MCERTS	< 0.05				
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05				
Anthracene	mg/kg	0.05	MCERTS	< 0.05				
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Pyrene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Chrysene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05				
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80				

Analytical Report Number: 19-66790

Project / Site name: Darton Lane

Lab Sample Number				1335409				
Sample Reference				TP114				
Sample Number				ES3				
Depth (m)				1.30				
Date Sampled				10/10/2019				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	15				
Boron (water soluble)	mg/kg	0.2	MCERTS	0.8				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2				
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	22				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	29				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	17				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	21				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	26				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	52				
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0				
Toluene	µg/kg	1	MCERTS	< 1.0				
Ethylbenzene	µg/kg	1	MCERTS	< 1.0				
p & m-xylene	µg/kg	1	MCERTS	< 1.0				
o-xylene	µg/kg	1	MCERTS	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	2.9				
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	7.4				
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	26				
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	82				
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	120				
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	13				
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	84				
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	260				
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	360				

Analytical Report Number : 19-66790

Project / Site name: Darton Lane

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1335409	TP114	ES3	1.30	Grey clay.

The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 19-66790

Project / Site name: Darton Lane

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS

Analytical Report Number : 19-66790

Project / Site name: Darton Lane

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
TP114	ES3	S	19-66790	1335409	c	Free cyanide in soil	L080-PL	c
TP114	ES3	S	19-66790	1335409	c	Total cyanide in soil	L080-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Appendix N
3rd Party
Geotechnical Results

LABORATORY REPORT

4043

Contract Number: PSL19/6224

Report Date: 31 October 2019

Client's Reference: J2092

Client Name: Geotron
Unit E201B
Warmco Industry Park Estate
Manchester Road
Mosseley
OL5 9AY

For the attention of: Jamie Taylor

Contract Title: Darton

Date Received: 16/10/2019
Date Commenced: 16/10/2019
Date Completed: 30/10/2019

Notes: Opinions and Interpretations are outside the UKAS Accreditation

Checked and Approved Signatories:

R Gunson (Director)
A Watkins (Director)
R Berriman (Quality Manager)

S Royle (Laboratory Manager)
S Eyre (Senior Technician)
L Knight (Senior Technician)

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awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP101	2	B	0.60		Brown mottled grey very gravelly sandy very silty CLAY.
TP102	3	B	0.60		Brown mottled grey slightly sandy CLAY.
TP102	5	B	1.30		Brown mottled grey CLAY.
TP103	3	B	0.60		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP103	5	B	1.60		Brown mottled grey slightly gravelly sandy CLAY.
TP104	3	B	1.00		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP104	5	B	2.00		Grey gravelly slightly sandy CLAY.
TP108	3	B	0.50		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP108	5	B	1.50		Brown mottled grey gravelly slightly sandy CLAY.
TP109	5	B	1.80		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP111	3	B	0.50		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP112	3	B	0.70		Brown mottled grey slightly sandy CLAY.
TP113	5	B	2.00		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP115	3	B	0.60		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP115	4	B	1.00		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP115	6	B	1.50		Brown mottled grey slightly gravelly 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
TP101	2	B	0.60		18			54	26	28	52	High plasticity CH.
TP102	3	B	0.60		34		2.66	72	30	42	99	Very high plasticity CV.
TP102	5	B	1.30		19			60	27	33	100	High plasticity CH.
TP103	3	B	0.60		23			45	23	22	97	Intermediate plasticity CI.
TP103	5	B	1.60		18			43	23	20	96	Intermediate plasticity CI.
TP104	3	B	1.00		22		2.65	45	23	22	90	Intermediate plasticity CI.
TP104	5	B	2.00		18			51	25	26	89	High plasticity CH.
TP108	3	B	0.50		24			55	26	29	96	High plasticity CH.
TP108	5	B	1.50		17		2.61	51	25	26	87	High plasticity CH.
TP109	5	B	1.80		21			45	23	22	92	Intermediate plasticity CI.
TP111	3	B	0.50		33		2.59	66	28	38	97	High plasticity CH.
TP112	3	B	0.70				2.65					
TP113	5	B	2.00		14			48	24	24	87	Intermediate plasticity CI.
TP115	3	B	0.60		22			52	24	28	97	High plasticity CH.
TP115	4	B	1.00		21			51	24	27	99	High plasticity CH.
TP115	6	B	1.50		23			55	27	28	99	High plasticity CH.

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

UKAS TESTING 4043

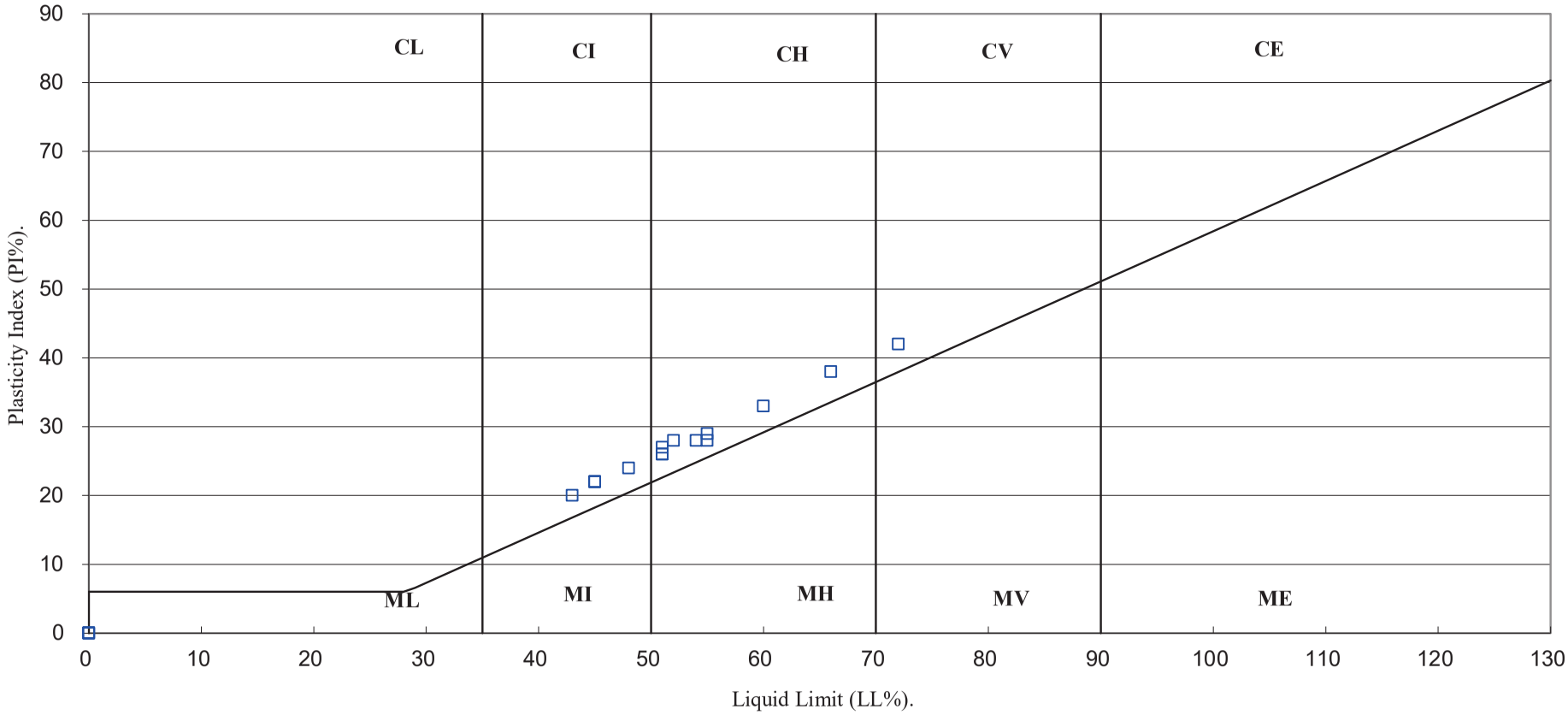
PSL Professional Soils Laboratory

Darton

Contract No: PSL19/6224

Client Ref: J2092

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



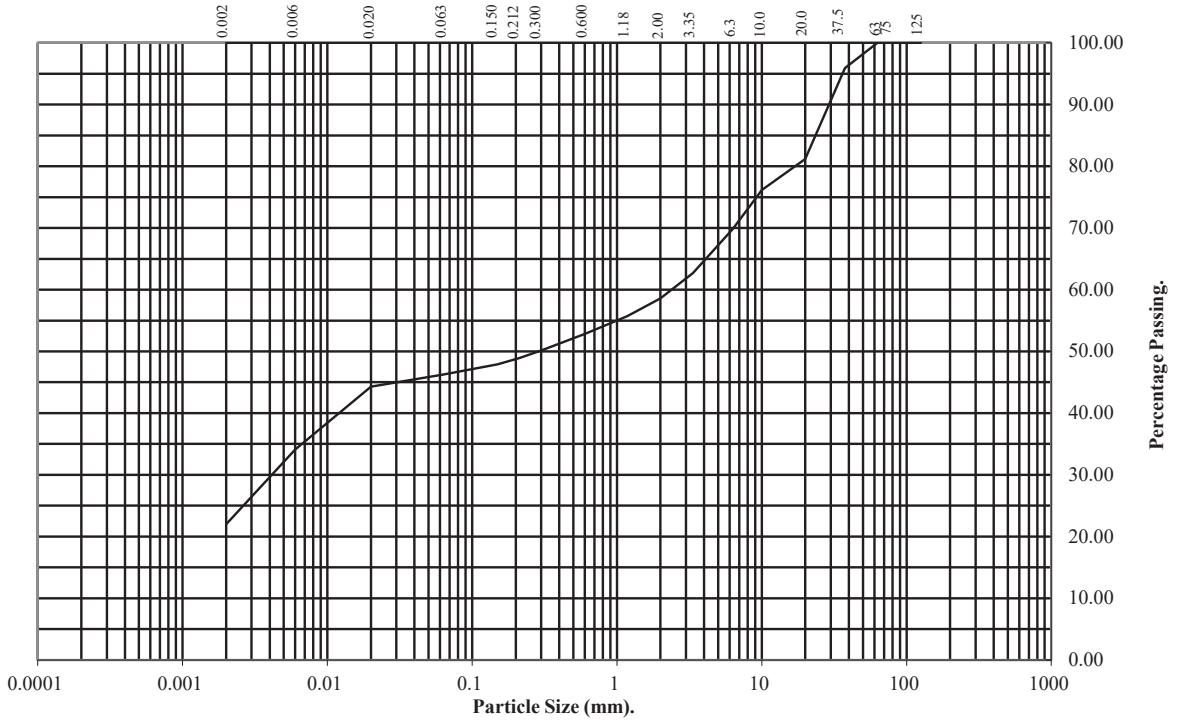
UKAS TESTING 4043	PSL Professional Soils Laboratory	Darton	Contract No: PSL19/6224
			Client Ref: J2092

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP101**	**Top Depth (m):**	**0.60**
Sample Number:	**2**	**Base Depth(m):**	
Sample Type:	**B**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	96
20	81
10	76
6.3	70
3.35	63
2	59
1.18	56
0.6	53
0.3	50
0.212	49
0.15	48
0.063	46

Particle Diameter	Percentage Passing
0.02	44
0.006	34
0.002	22

Soil Fraction	Total Percentage
Cobbles	0
Gravel	41
Sand	13
Silt	24
Clay	22

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

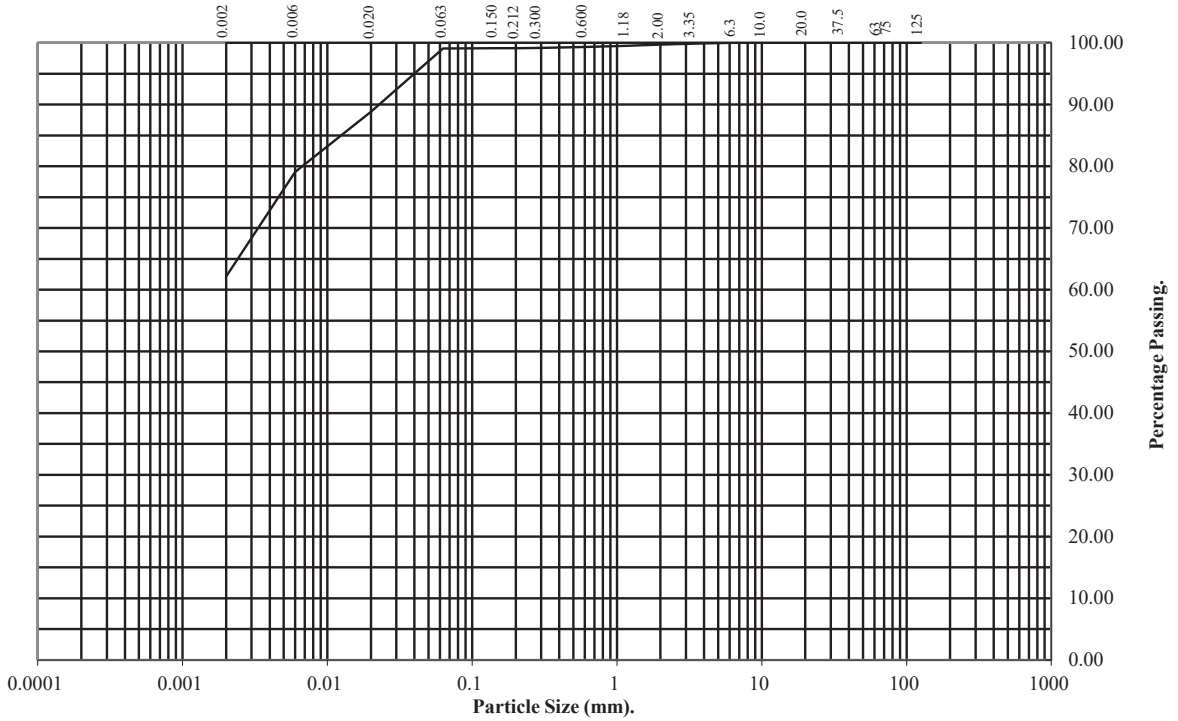
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: TP102 **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	100
6.3	100
3.35	100
2	100
1.18	100
0.6	99
0.3	99
0.212	99
0.15	99
0.063	99

Particle Diameter	Percentage Passing
0.02	89
0.006	79
0.002	62

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	1
Silt	37
Clay	62

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

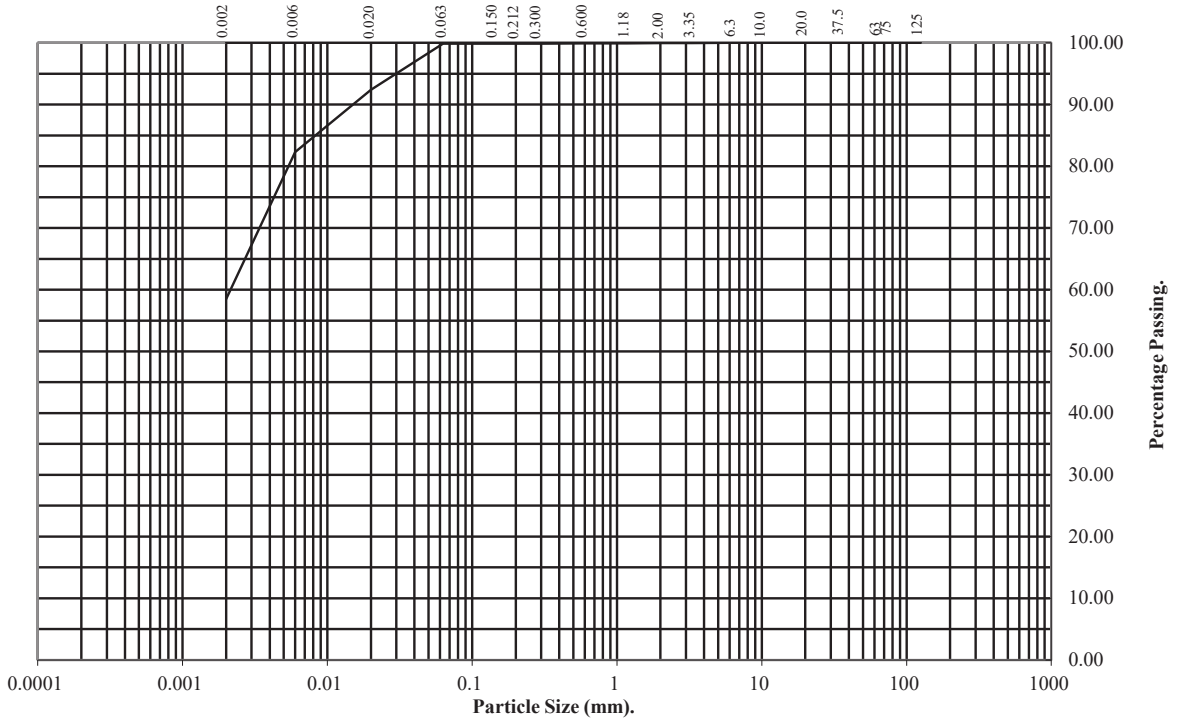
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: TP102 **Top Depth (m):** 1.30

Sample Number: 5 **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	100
0.6	100
0.3	100
0.212	100
0.15	100
0.063	100

Particle Diameter	Percentage Passing
0.02	92
0.006	82
0.002	58

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	0
Silt	42
Clay	58

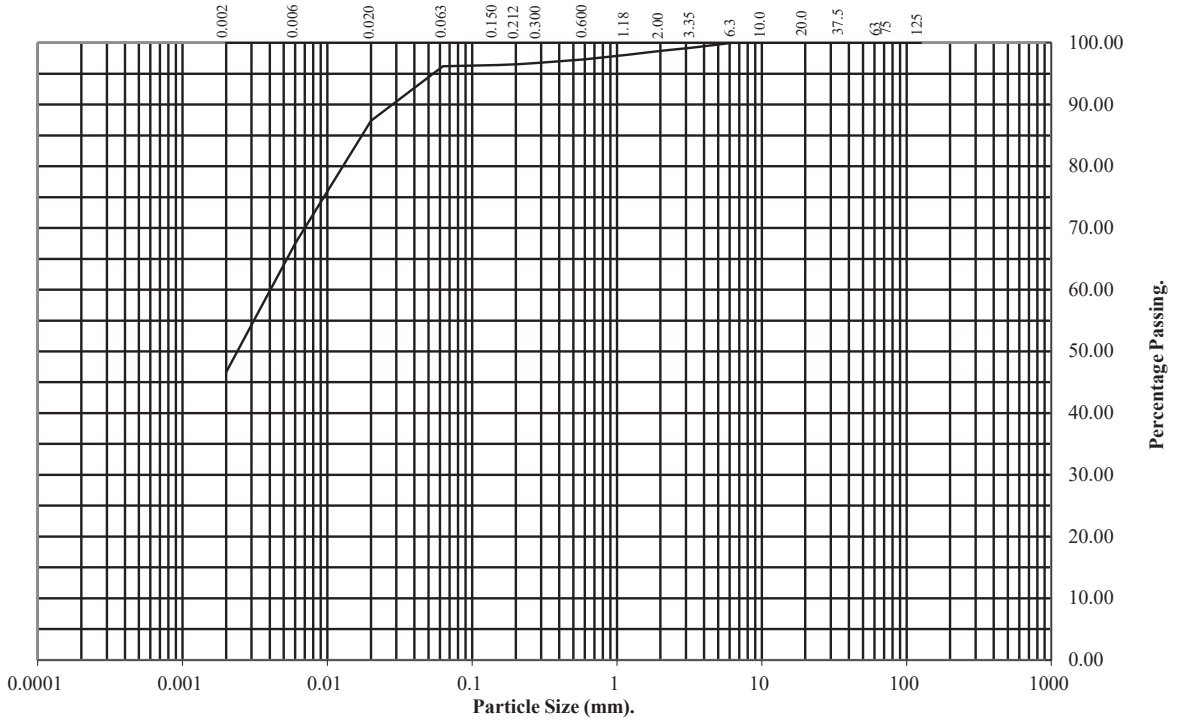
Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP103**	**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	100
6.3	100
3.35	99
2	99
1.18	98
0.6	97
0.3	97
0.212	97
0.15	96
0.063	96

Particle Diameter	Percentage Passing
0.02	87
0.006	67
0.002	47

Soil Fraction	Total Percentage
Cobbles	0
Gravel	1
Sand	3
Silt	49
Clay	47

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043

PSL Professional Soils Laboratory

Darton

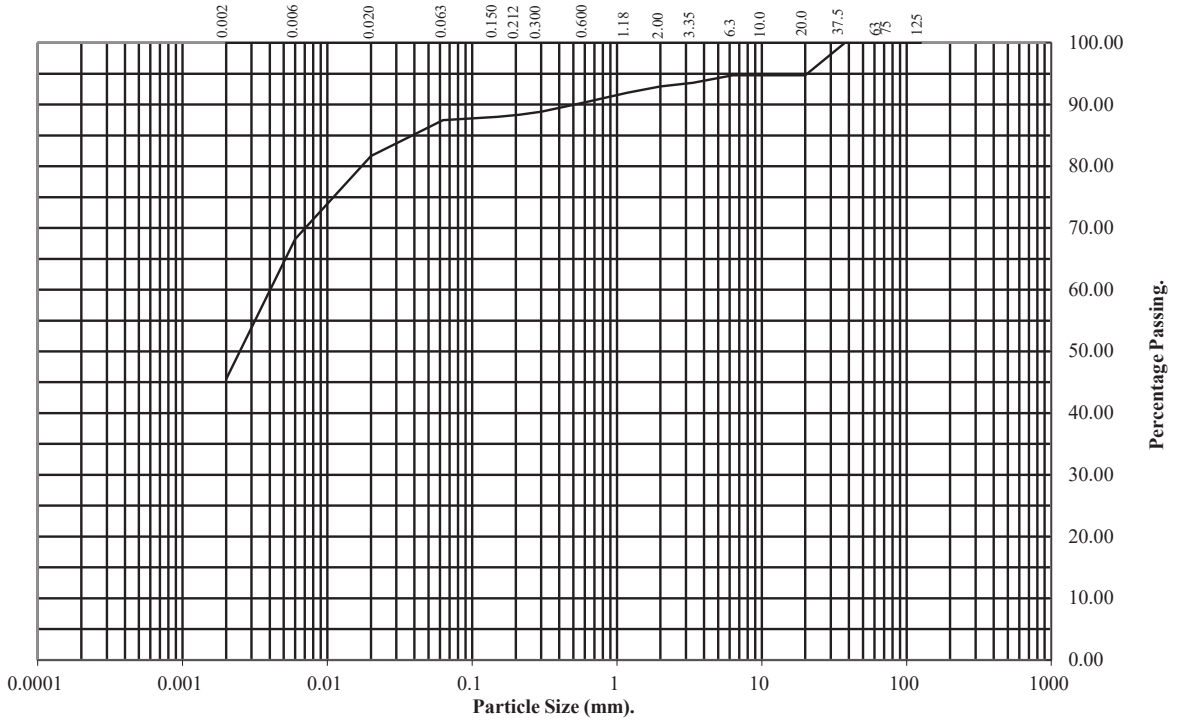
Contract No:
PSL19/6224
Client Ref:
J2092

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP104**	**Top Depth (m):**	**1.00**
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	95
10	95
6.3	95
3.35	94
2	93
1.18	92
0.6	90
0.3	89
0.212	88
0.15	88
0.063	87

Particle Diameter	Percentage Passing
0.02	82
0.006	68
0.002	46

Soil Fraction	Total Percentage
Cobbles	0
Gravel	7
Sand	6
Silt	41
Clay	46

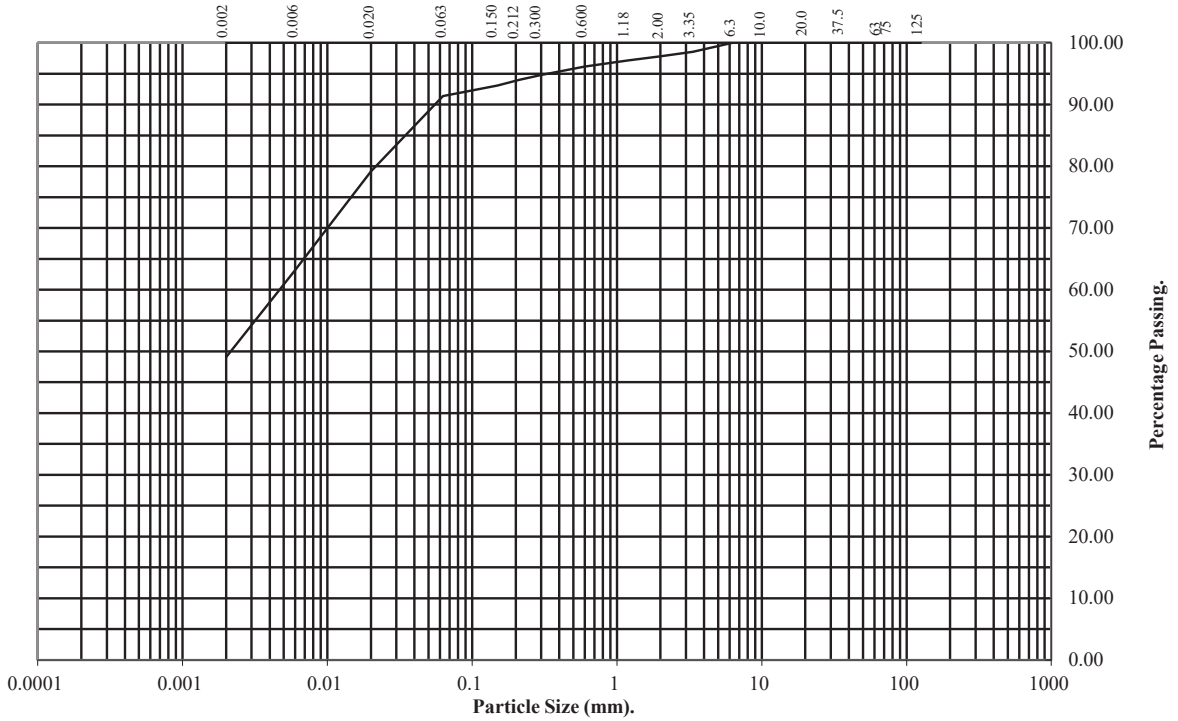
Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP108**	**Top Depth (m):**	**0.50**
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	100
6.3	100
3.35	99
2	98
1.18	97
0.6	96
0.3	95
0.212	94
0.15	93
0.063	91

Particle Diameter	Percentage Passing
0.02	79
0.006	63
0.002	49

Soil Fraction	Total Percentage
Cobbles	0
Gravel	2
Sand	7
Silt	42
Clay	49

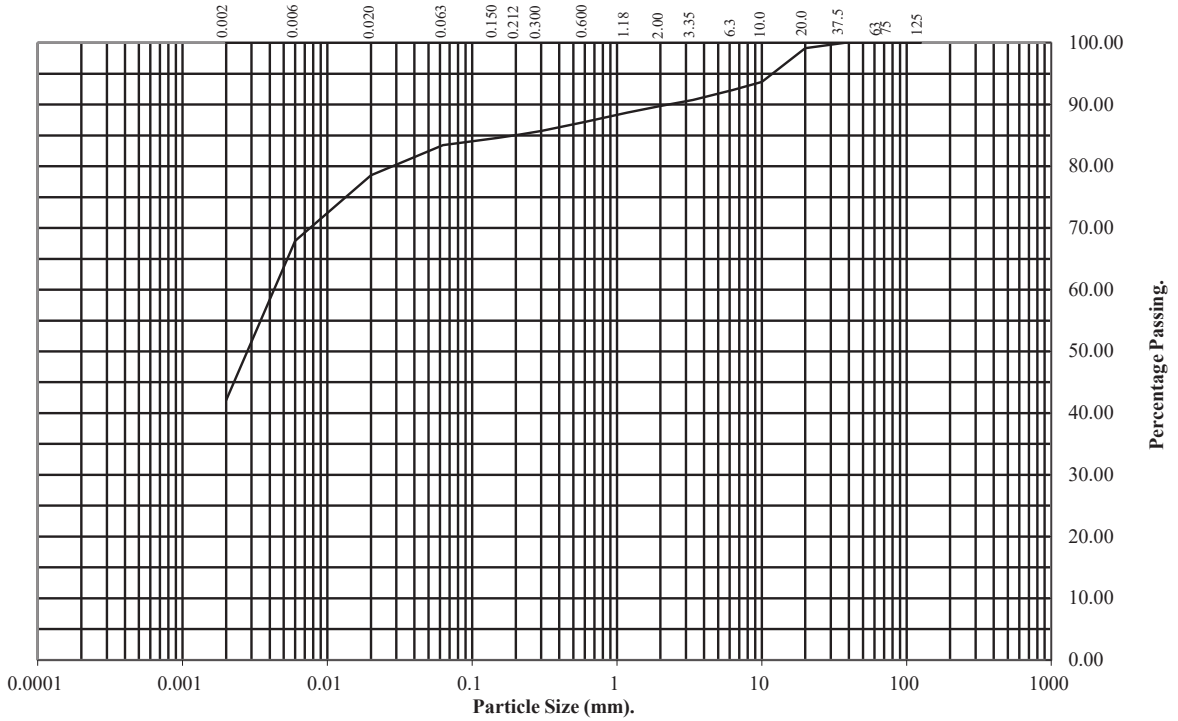
Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP108**	**Top Depth (m):**	**1.50**
Sample Number:	**5**	**Base Depth(m):**	
Sample Type:	**B**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	99
10	94
6.3	92
3.35	91
2	90
1.18	89
0.6	87
0.3	86
0.212	85
0.15	85
0.063	83

Particle Diameter	Percentage Passing
0.02	79
0.006	68
0.002	42

Soil Fraction	Total Percentage
Cobbles	0
Gravel	10
Sand	7
Silt	41
Clay	42

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043

PSL Professional Soils Laboratory

Darton

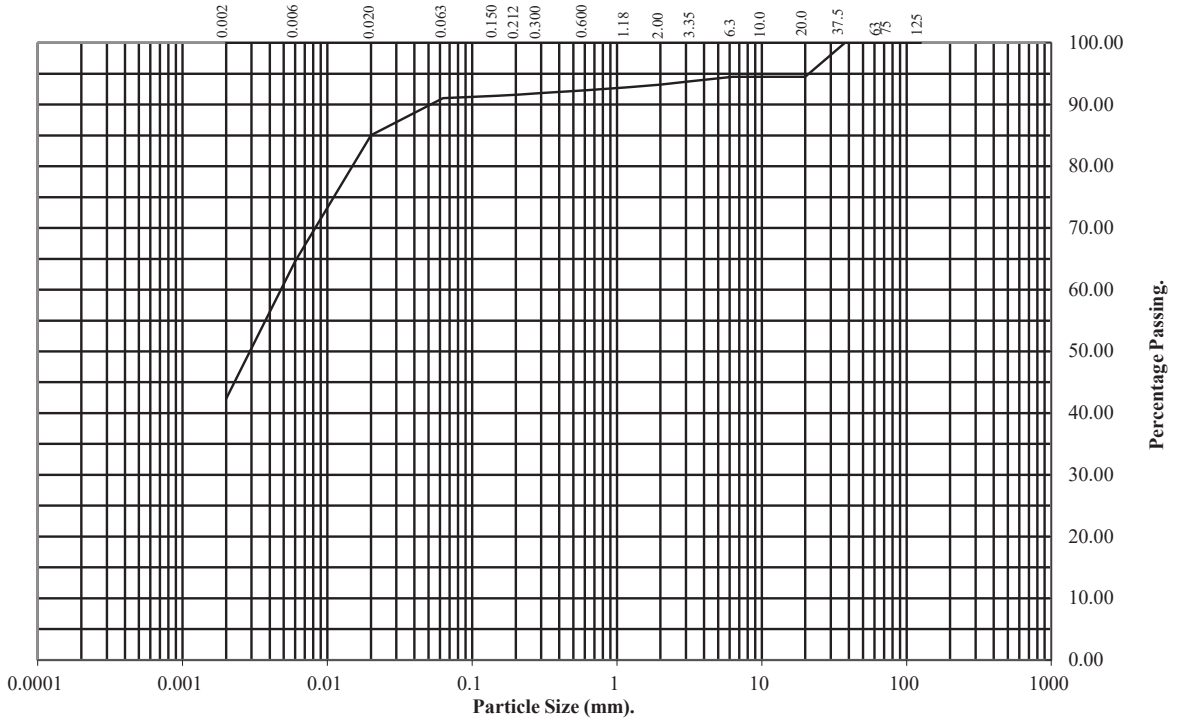
Contract No:
PSL19/6224
Client Ref:
J2092

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP109**	**Top Depth (m):**	**1.80**
Sample Number:	**5**	**Base Depth(m):**	
Sample Type:	**B**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	95
10	95
6.3	95
3.35	94
2	93
1.18	93
0.6	92
0.3	92
0.212	92
0.15	91
0.063	91

Particle Diameter	Percentage Passing
0.02	85
0.006	65
0.002	42

Soil Fraction	Total Percentage
Cobbles	0
Gravel	7
Sand	2
Silt	49
Clay	42

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043

PSL Professional Soils Laboratory

Darton

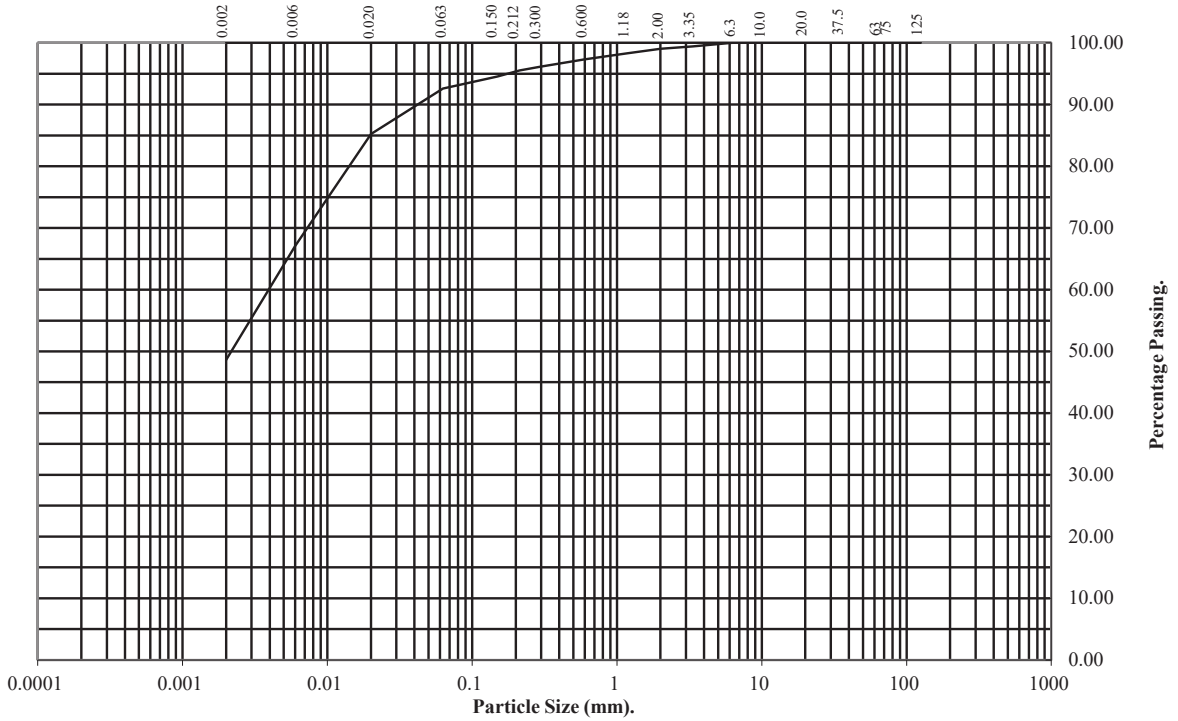
Contract No:
PSL19/6224
Client Ref:
J2092

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP111**	**Top Depth (m):**	**0.50**
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	100
6.3	100
3.35	99
2	99
1.18	98
0.6	97
0.3	96
0.212	96
0.15	95
0.063	93

Particle Diameter	Percentage Passing
0.02	85
0.006	67
0.002	49

Soil Fraction	Total Percentage
Cobbles	0
Gravel	1
Sand	6
Silt	44
Clay	49

Remarks:
See Summary of Soil Descriptions

UKAS TESTING 4043

PSL Professional Soils Laboratory

Darton

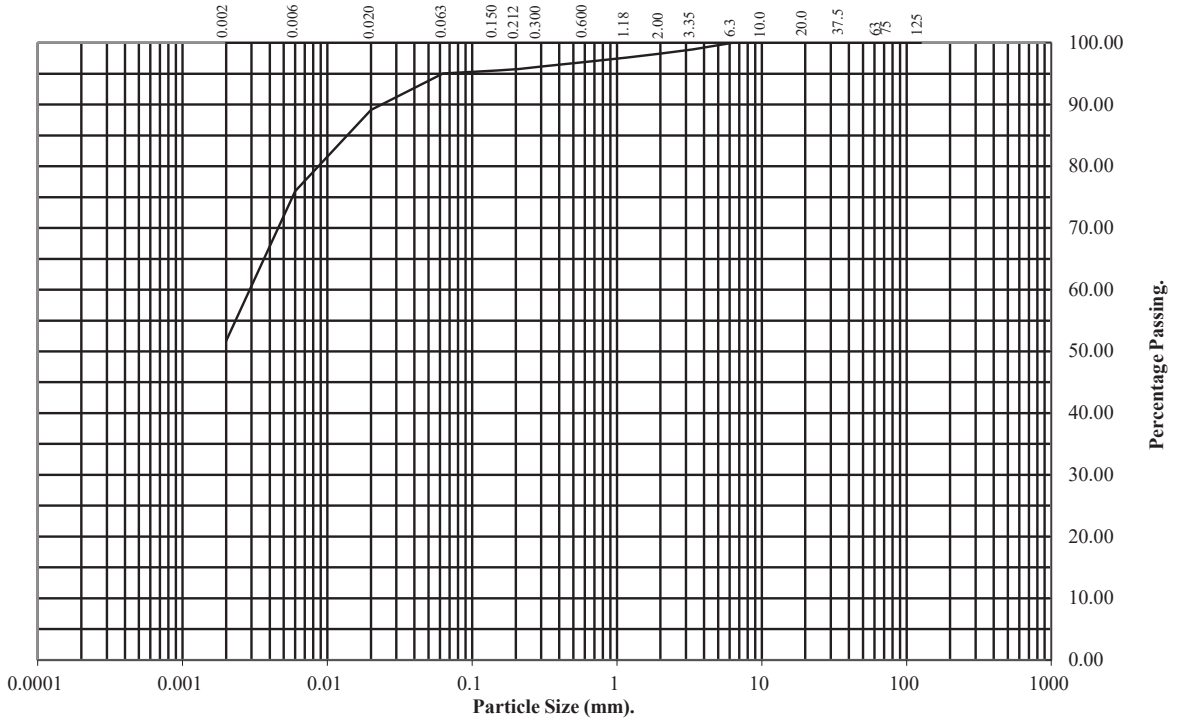
Contract No:
PSL19/6224
Client Ref:
J2092

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP115**	**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	100
6.3	100
3.35	99
2	98
1.18	98
0.6	97
0.3	96
0.212	96
0.15	96
0.063	95

Particle Diameter	Percentage Passing
0.02	89
0.006	76
0.002	52

Soil Fraction	Total Percentage
Cobbles	0
Gravel	2
Sand	3
Silt	43
Clay	52

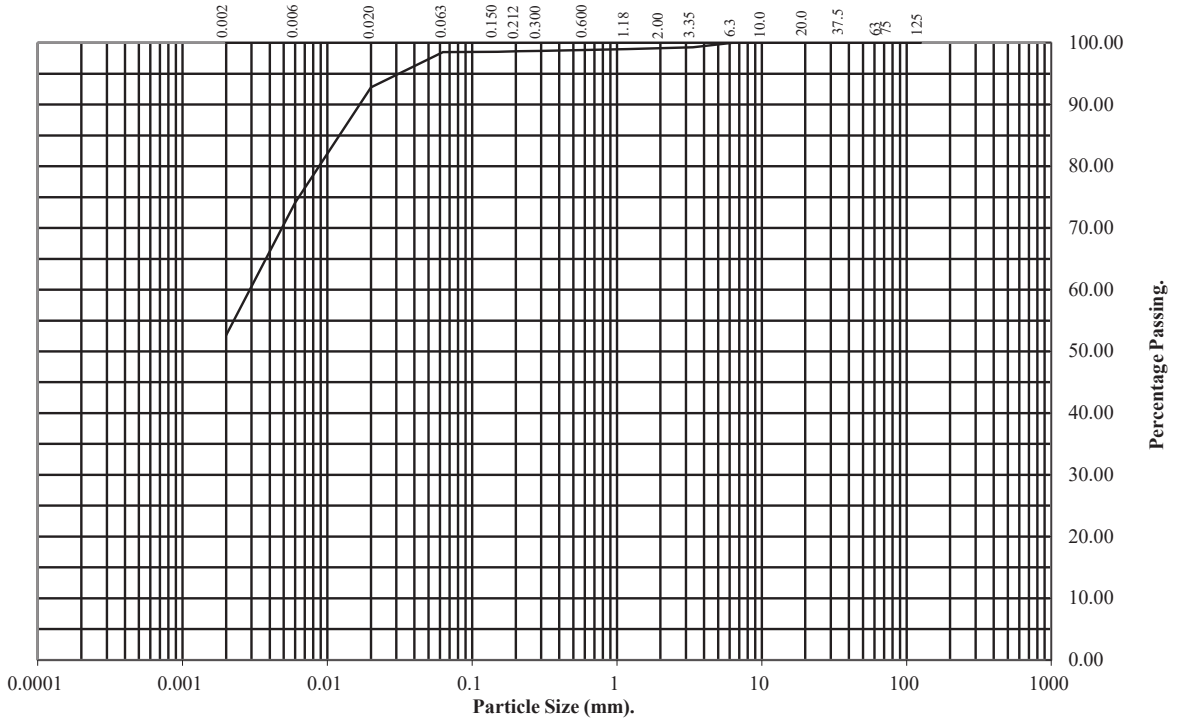
Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number:	**TP115**	**Top Depth (m):**	**1.00**
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	99
1.18	99
0.6	99
0.3	99
0.212	99
0.15	99
0.063	98

Particle Diameter	Percentage Passing
0.02	93
0.006	74
0.002	53

Soil Fraction	Total Percentage
Cobbles	0
Gravel	1
Sand	1
Silt	45
Clay	53

Remarks:
See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

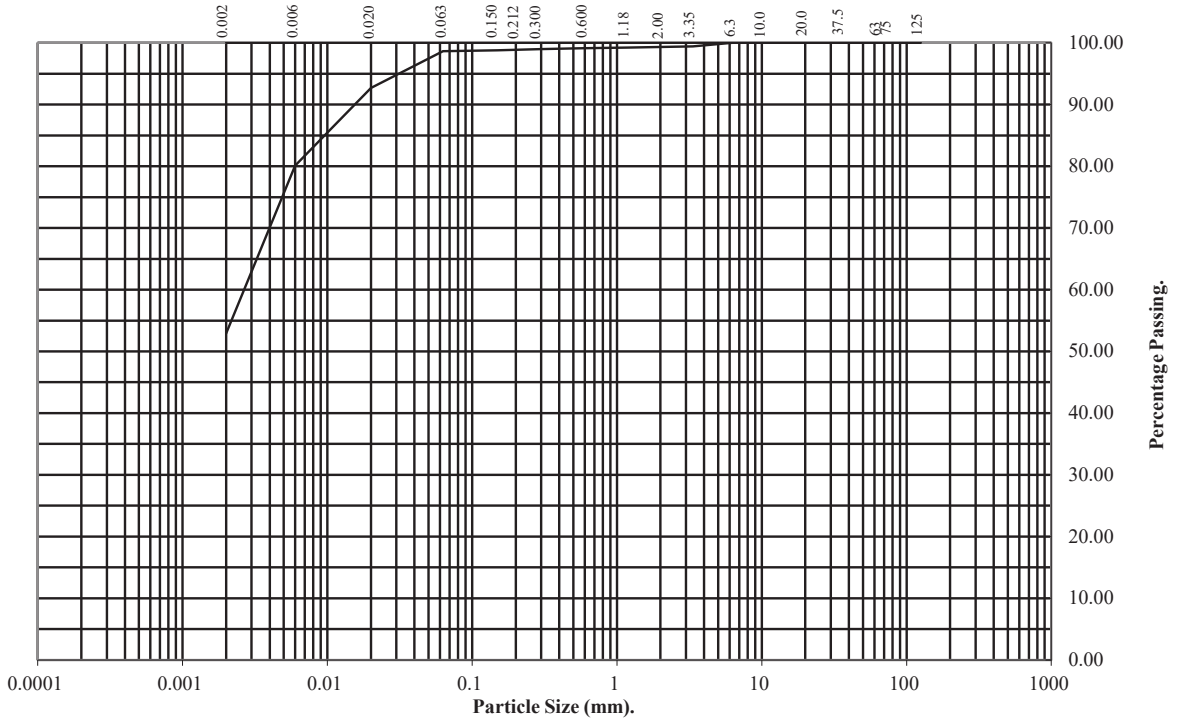
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: TP115 **Top Depth (m):** 1.50

Sample Number: 6 **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	99
1.18	99
0.6	99
0.3	99
0.212	99
0.15	99
0.063	99

Particle Diameter	Percentage Passing
0.02	93
0.006	80
0.002	53

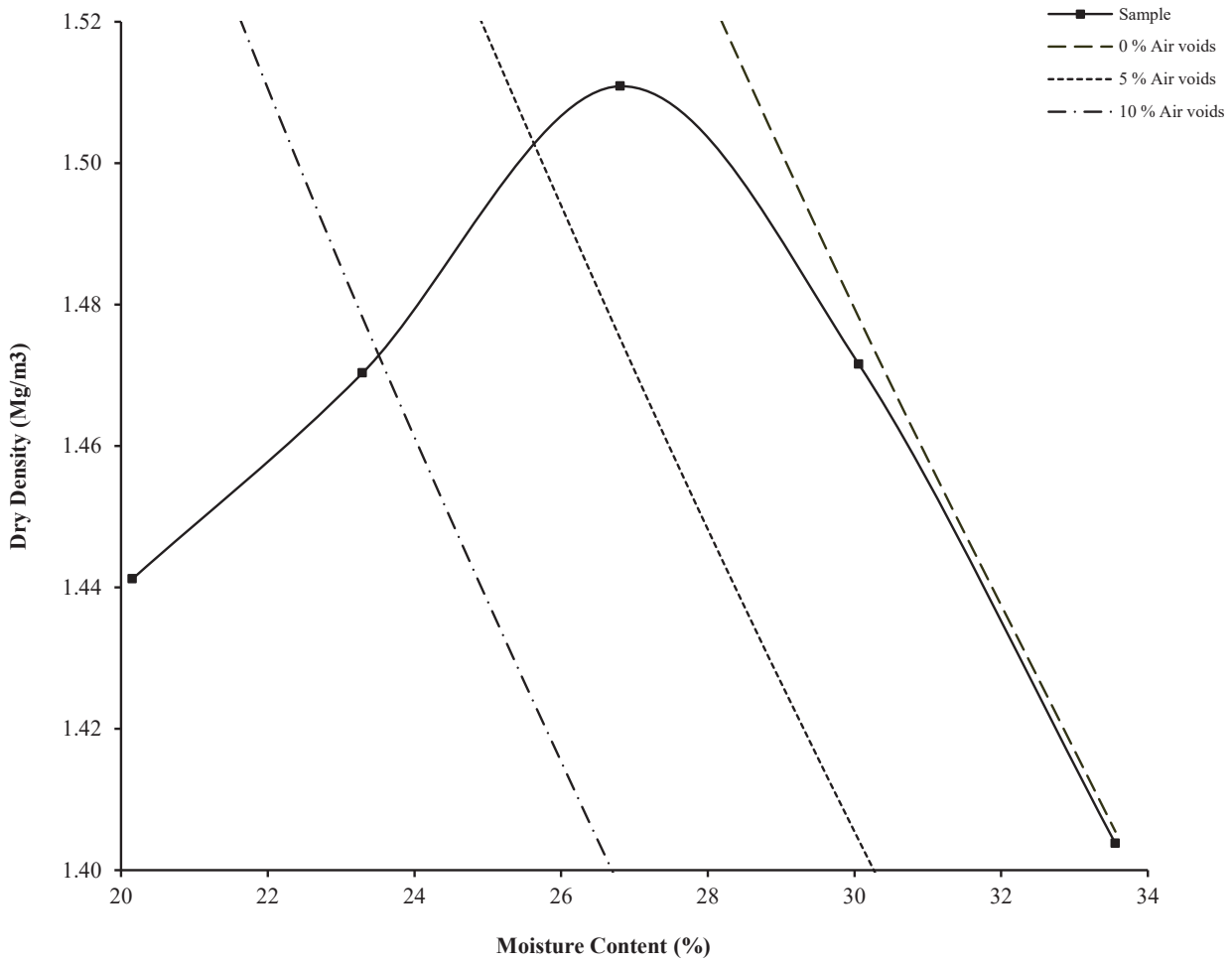
Soil Fraction	Total Percentage
Cobbles	0
Gravel	1
Sand	0
Silt	46
Clay	53

Remarks:
See Summary of Soil Descriptions

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number:	**TP102**	**Top Depth (m) :**	**0.60**
Sample Number:	**3**	**Base Depth (m) :**	
Sample Type:	**B**		

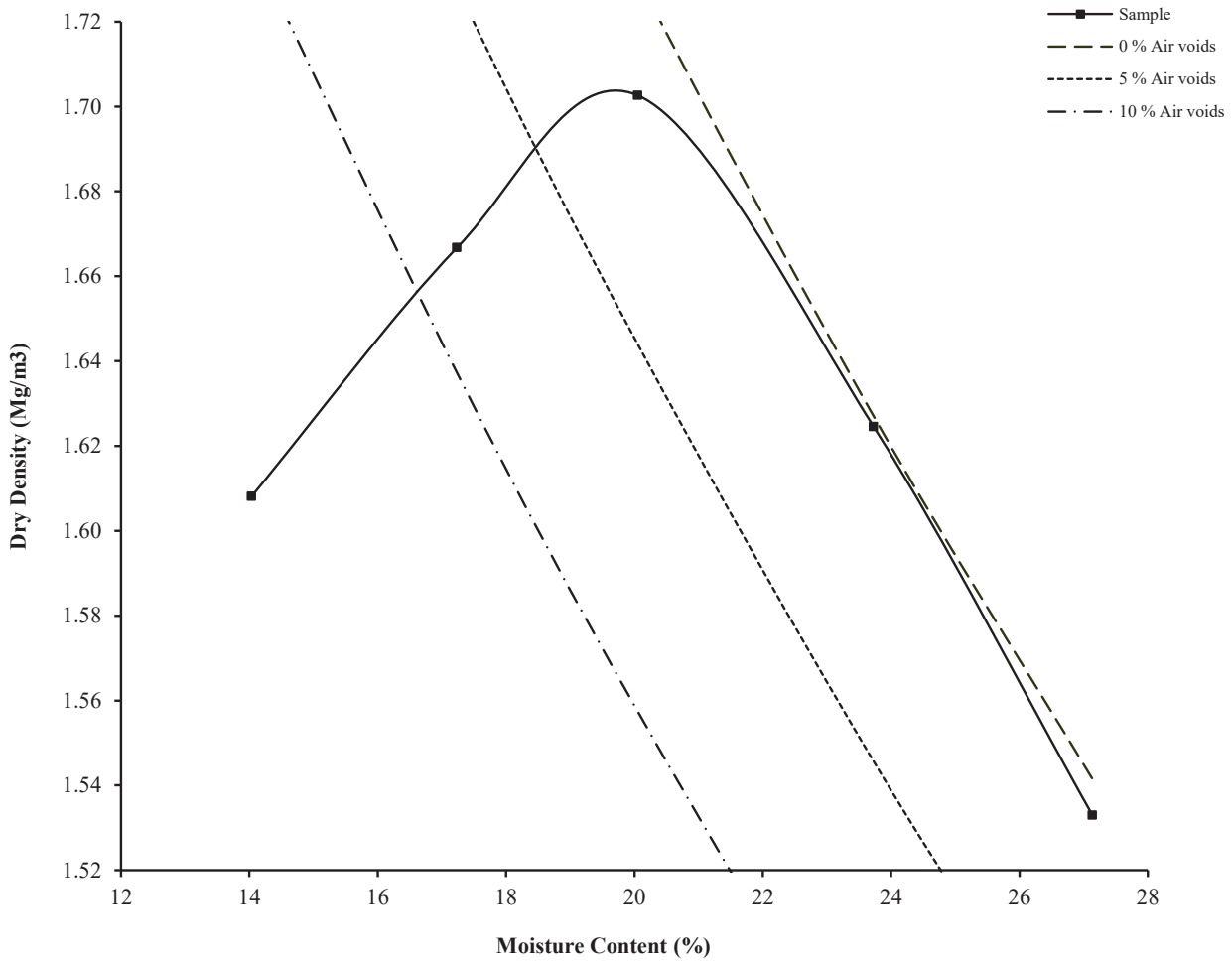


Initial Moisture Content:		34	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m3):	2.66	Measured	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.51	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		27			
Remarks See summary of soil descriptions.					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number:	**TP104**	**Top Depth (m) :**	**1.00**
Sample Number:	**3**	**Base Depth (m) :**	
Sample Type:	**B**		

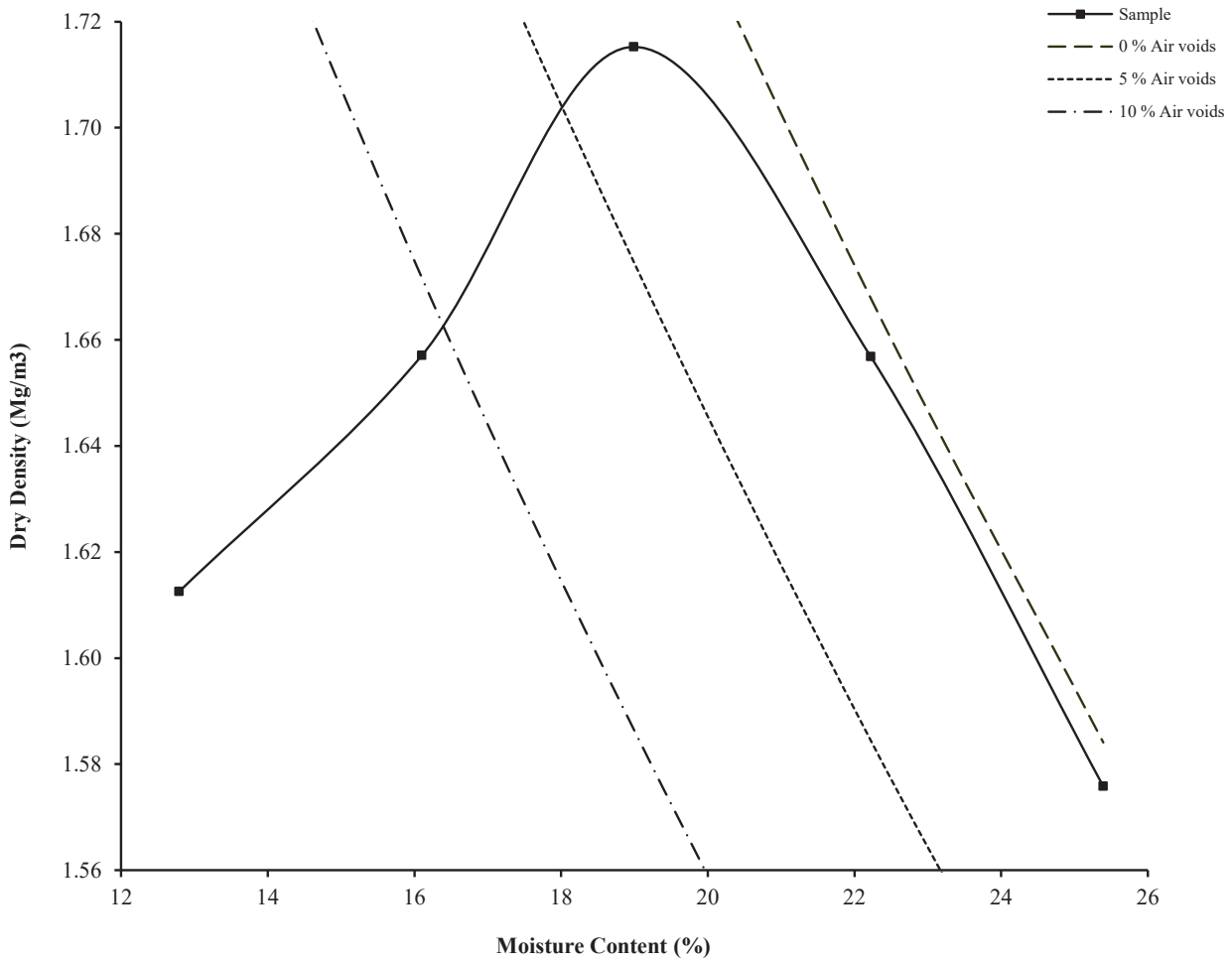


Initial Moisture Content:		20	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m3):	2.65	Measured	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.70	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		20			
Remarks See summary of soil descriptions.					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number:	**TP112**	**Top Depth (m) :**	**0.70**
Sample Number:	**3**	**Base Depth (m) :**	
Sample Type:	**B**		

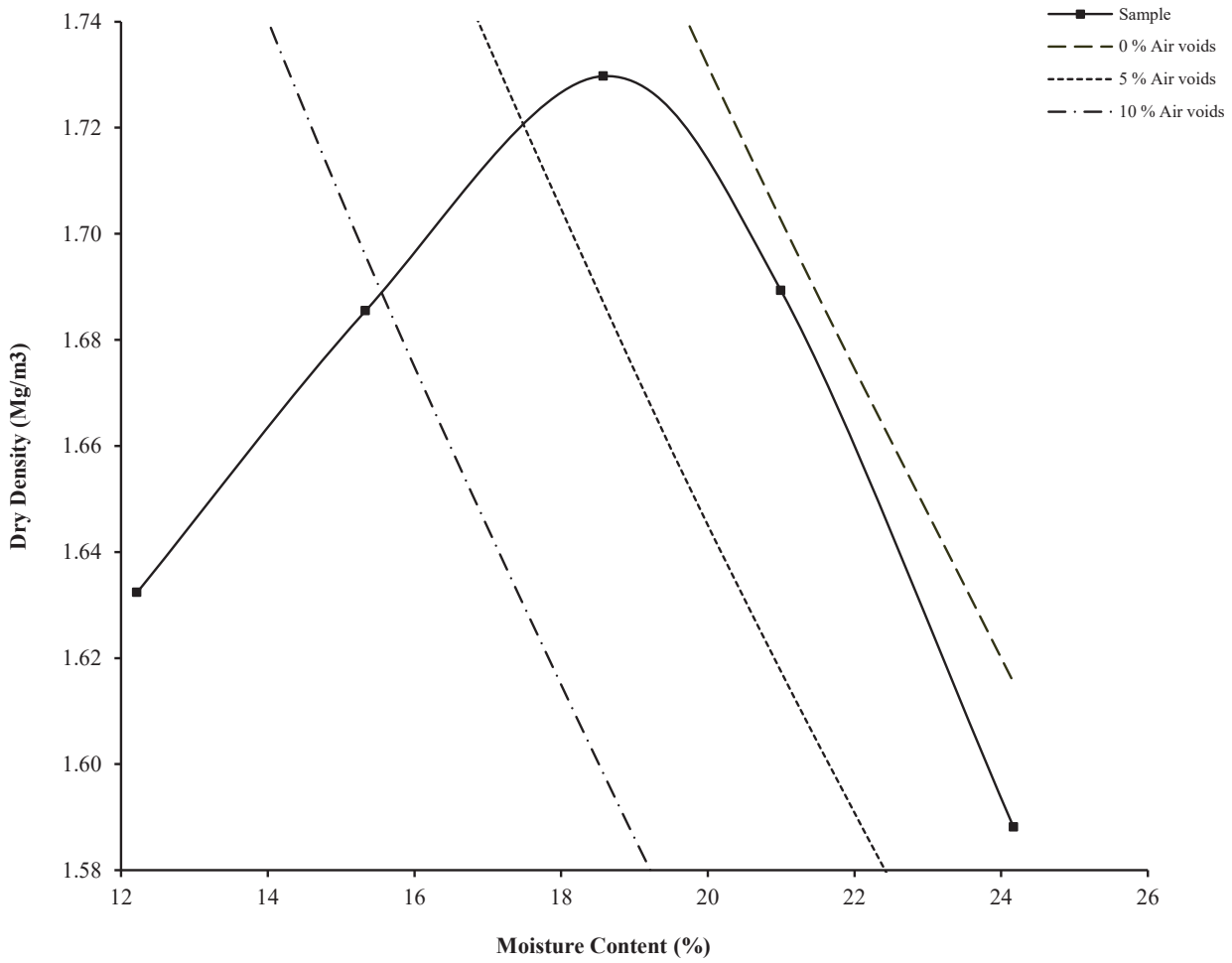


Initial Moisture Content:		22	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m3):	2.65	Measured	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.72	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		19			
Remarks See summary of soil descriptions.					

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP

BS 1377 : Part 4 : Clause 3.3 : 1990

Hole Number:	**TP115**	**Top Depth (m) :**	**1.00**
Sample Number:	**4**	**Base Depth (m) :**	
Sample Type:	**B**		



Initial Moisture Content:		21	Method of Compaction:	2.5kg	Separate Samples
Particle Density (Mg/m3):	2.65	Measured	Material Retained on 37.5 mm Test Sieve (%):		0
Maximum Dry Density (Mg/m3):		1.73	Material Retained on 20.0 mm Test Sieve (%):		0
Optimum Moisture Content (%):		19			
Remarks See summary of soil descriptions.					

Certificate of Analysis

Certificate Number 19-21394

01-Nov-19

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 19-21394

Client Reference PSL19/6224

Order No (not supplied)

Contract Title Darton

Description 12 Soil samples.

Date Received 23-Oct-19

Date Started 23-Oct-19

Date Completed 01-Nov-19

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 19-21394
Client Ref PSL19/6224
Contract Title Darton

			Lab No	1586711	1586712	1586713	1586714	1586715	1586716	1586717	1586718	1586719	1586720	1586721	1586722
			Sample ID	TP102	TP102	TP103	TP105	TP105	TP106	TP108	TP111	TP111	TP112	TP115	TP115
			Depth	0.60	1.30	1.60	0.50	1.70	0.50	2.50	0.50	1.40	0.70	0.60	1.50
			Other ID	3	5	5	3	5	3	6	3	5	3	3	6
			Sample Type	B	B	B	B	B	B	B	B	B	B	B	B
			Sampling Date	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**												
Metals															
Magnesium Aqueous Extract	DETSC 2076*	10	mg/l	< 10	10	< 10	< 10	< 10		< 10	< 10		< 10		< 10
Inorganics															
pH	DETSC 2008#		pH	7.8	7.8	6.2	7.2	6.6		7.0	7.6		7.4		5.1
Organic matter	DETSC 2002#	0.1	%						0.6			0.6		0.5	
Chloride Aqueous Extract	DETSC 2055	1	mg/l	15	22	7.0	5.2	3.4		2.9	11		29		5.9
Nitrate Aqueous Extract as NO3	DETSC 2055	1	mg/l	1.5	1.3	< 1.0	1.8	1.0		< 1.0	2.7		1.5		1.5
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	19	25	35	20	10		16	14		21		23
Sulphur as S, Total	DETSC 2320	0.01	%	0.01	< 0.01	0.01	0.01	< 0.01		0.01	< 0.01		< 0.01		< 0.01
Sulphate as SO4, Total	DETSC 2321#	0.01	%	0.01	0.01	0.03	0.02	< 0.01		0.02	0.02		0.01		0.02

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 19-21394
Client Ref PSL19/6224
Contract Darton

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1586711	TP102 0.60 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586712	TP102 1.30 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586713	TP103 1.60 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586714	TP105 0.50 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586715	TP105 1.70 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586716	TP106 0.50 SOIL		PT 1L	Sample date not supplied, Organic Matter (Manual) (28 days)	
1586717	TP108 2.50 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586718	TP111 0.50 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586719	TP111 1.40 SOIL		PT 1L	Sample date not supplied, Organic Matter (Manual) (28 days)	
1586720	TP112 0.70 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	
1586721	TP115 0.60 SOIL		PT 1L	Sample date not supplied, Organic Matter (Manual) (28 days)	
1586722	TP115 1.50 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), Total Sulphur ICP (365 days), Total Sulphate ICP (730 days), Metals ICP Prep (365 days), pH + Conductivity (7 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Information in Support of the Analytical Results

Our Ref 19-21394
Client Ref PSL19/6224
Contract Darton

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