LITHOS

Land at Bradley Villa Farm, Huddersfield

For PS & SP Kershaw

Report no: 3319/1

Date: March 2019

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SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	3319	**Site area/ha**	11.8 Ha (29 Acres)
Client:	PS & SP Kershaw	**NGR:**	SE 151 205
Site:	Bradley Villa Farm, Huddersfield	**Nearest postcode:**	HD2 2JY

The site is located off Bradley Road, approximately 2km south of Brighouse town centre, and currently comprises four parcels of land used to run the Villa Farm Business. Three parcels of grassland are used for the grazing of cattle, while the fourth parcel of land is an area of concrete hardstand and several farm buildings housing a coffee shop, farm shop, hens, cattle and storage.

Lithos were commissioned by SP & PS Kershaw to provide a geoenvironmental appraisal of the site, as redevelopment with housing is being considered beyond the farmyard area. Lithos' investigation included a review of the site's history and environmental setting, and a ground investigation comprising 41 trial pits within the fields only (no investigation was undertaken within the farmyard).

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

Issue	Remarks
Made ground	None encountered.
Natural ground	Topsoil over Cohesive Residual Soils with Granular Residual Soils encountered below in the majority of exploratory holes. Coal Measures bedrock (sandstone, mudstone and siltstone) was encountered from an average depth of 1.8m (notably shallower in the northwest and south-east).
Contamination	None encountered. Topsoil is chemically suitable for reuse.
Mining & quarrying	This site is located within a Coal Mining Development Low Risk Area. The Better Bed coal seam is estimated to underlie the site at between 20m and 30m, with a maximum thickness of 0.7m. At such depth, any workings should not pose a significant risk to surface stability.
Hazardous gas	No radon measures required. Green\CS2 protective measures (i.e. including sub-floor ventilation) are recommended due to the very low risk of hazardous gas from mineworkings at depth. Alternatively, gas monitoring could be undertaken.
Preparatory works	Topsoil strip and stockpile.
Foundations	All plots will be founded on traditional strip foundations at minimum depth of 0.9m within Cohesive Residual Soils (over-deepened within the zone of influence of trees), reduced to 0.6m depth where Granular Residual Soils are encountered.
Groundwater & excavations	Groundwater seepages were encountered within 6 pits between 1.2m and 2.4m in the southwest. Trenches for foundations and utilities are likely to remain stable in the short term. Excavations below 2.0m depth are likely to prove difficult across the majority of site due to the presence of shallow bedrock (notably shallower in the northwest and south-east).
Flooding & drainage	The site is located in Flood Zone 1. Soakaways are highly 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 solutions (SUDS), and there may be a need for surface water balancing.
Highways	Based on visual inspection of the shallow natural materials and published guidance, the natural soils should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

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

Appendix B - Drawings

Drawing	Revision	Title
3319/1	-	Site location plan
3319/3	-	Site features
3319/3a	-	Site features (Area B)
3319/4	-	Site photographs
3319/5	-	Preliminary conceptual site model
3319/6	-	Exploratory hole locations
3319/7	-	Revised conceptual site model
3319/8	-	Site geology

Appendix C - Commission

Appendix D - Historical OS plans#

Appendix E - Search responses#

From	Date	Content
Landmark	January 19	Environmental search data
Coal Authority	January 19	Mining report & response from planning advice

Appendix F - Exploratory records

Appendix F	TP01 to TP41

Appendix G - Soakaway test results

Appendix H - Chemical test results

Appendix I - Geotechnical test results

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

FOREWORD (geoenvironmental appraisal report)

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

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

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

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

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

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

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

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

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

This report assumes that ground levels will not change significantly from those existing at present and that houses will be of two storey construction. If this is not to be the case, then some modification to this report may be required.

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

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

GEOENVIRONMENTAL APPRAISAL
of land at
BRADLEY VILLA FARM, HUDDERSFIELD

1 INTRODUCTION

1.1 The commission and brief

1.1.1 Lithos Consulting Limited were commissioned by SP & PS Kershaw via Savills to carry out a geoenvironmental appraisal of land at Bradley Villa Farm, Huddersfield.

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

- A site walkover and inspection
- An assessment of the land use history
- Determination of the site's environmental setting
- An intrusive ground investigation comprising 35 trial pits
- Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
- A qualitative assessment of contamination risks
- Recommendations for the necessary site preparatory works

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

1.2 The proposed development

1.2.1 For the purposes of this report, the site has been split into two main areas as summarised in the table below and on Drawing 3119/3 in Appendix B:

Site Area	Land use	Area (ha)	Location
A	Arable farmland	10.15	Centre, north and east
B	Bradley Villa Farm Buildings	1.65	Southwest

1.2.2 At this stage, it understood that proposed development will be confined to Area A. Sections 1 to 5 of this report (i.e. the "desk study") relate to both Areas; whilst the remainder of the report (Section 6 onwards) focus on the proposed development in Area A only.

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

1.3 Report format and limitations

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

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

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

2 SITE DESCRIPTION

2.1 General

2.1.1 The site's location is shown on Drawing 3319/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	2km south of Brighouse town centre
NGR	SE 151 205
Approximate area	11.8ha (29 acres)
Known services	Underground electric and water

2.2 Site features

2.2.1 Lithos completed a walkover survey of the site on 13th February 2019.

2.2.2 Existing salient features, at the time of the walkover are presented on Drawings 3319/3 and 3319/3A in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current Access	Off Bradley Road
Topography	Area A – gently undulating, with a 'dome' shaped topography in the east. Slopes in the north-east reach up to c. 1 in 7 gradient, with slopes up to 1 in 4 present in the south-west associated with a 'hollow'. Area B – relatively flat
Approximate areas	5,500m^2 buildings 11,000m^2 concrete hardstand 101,500 m^2 grass
Nature of boundaries	North – hedgerows and wooden posts with wire fencing East – hedgerows and wooden posts & wire fencing with Shepherds Thorn Lane beyond South – Garden fences of adjacent housing West – Post & rail fencing with access track beyond
Surrounding land uses	North – Open fields East – Shepherds Thorn Lane with Bradley Park Golf Club and Driving Range beyond South – Bradley Road (housing) with college beyond West – A641 road with open fields (north-west) and housing (south-west) beyond

2.2.3 Access is via one of 3 roads at 3 points (suitable for wheeled traffic) around the site boundary:

- Bradford Road (A641) runs 10m west of the western boundary, oriented north to south. Access is via a double metal 5 bar gate which is reached via a rough track surfaced with granular hardstand.
- Bradley Road (A6107) runs along the southern boundary, oriented east to west. Access is between two stone buildings, with the Villa Farm Shop and Café sign adjacent.
- Shepherds Thorn Lane runs along the eastern boundary, oriented north to south. Access is via a metal 5 bar gate on the western side of the road. Further north there is an entrance to the adjacent Bradley Park Golf Club and Driving Range.

2.3 Site Description

Area A

2.3.1 Area A comprises arable farmland used for the grazing of cattle associated with Villa Farm. Sparsely distributed trees, hedgerows and wooden posts & wire fencing divide the site into 3 separate fields.

2.3.2 Topography undulates and domes in the centre-east. The ground slopes away from the top of the dome with a 1 in 20 slope to the southeast and up to 1 in 7 in the north-east. In the south eastern corner, a smooth hollow is present within a slope of around 1 in 4 on its western edge. Anecdotal evidence suggests the hollow is a recent feature.

2.3.3 A blue water pipe protrudes from the ground on the eastern boundary of the most western field. Discussion with the land owner suggests this pipe runs west to the entrance off Bradford Road. It also runs south towards the farmyard, parallel to a known existing electricity utility. A Plastic black pipe (probably water) was also found to run along the northern boundary of site at the base of the hedgerow.

2.3.4 Towards the south-western corner there is a large manure heap and the land becomes slightly waterlogged.

2.3.5 Area B is a farmyard comprising multiple buildings associated with the 'Villa Farm' business.

2.3.6 The largest building in the far north is a large green, corrugated metal warehouse, housing hens for the 'Villa Farm Eggs' business. Multiple vents can be seen on the side of the building, along with 3 silos (two large; one small).

2.3.7 To the south are two further corrugated metal-clad warehouse buildings which are used for egg storage; and three barns of breeze-block and timber construction which house cattle in winter.

2.3.8 A conveyor belt runs between the egg storage warehouse and the large hen house in the north. A smaller hen storage warehouse is present on the western boundary.

2.3.9 Buildings in the south of Area B include the Villa Farm Shop, Café and residential buildings (including a garage). The open area of tarmac here is used for customer parking.

2.3.10 Areas of concrete hardstand occupy the north-west of Area B, where multiple railway sleepers, large piping (c.60cm in diameter), corrugated metal, corrugated (suspected asbestos-containing) sheeting and wooden pallets are kept. From here the site is around 2m below the level of Area A; exposed rock can be seen suggesting some minor 'cut' has been undertaken to create a level development platform for the newest warehouse in the far north.

2.3.11 In the north-east of Area B are multiple beehives, two skips, tyres and other scrap material. There is also a large pile of dark grey rubble, possibly containing tarmac and asphalt. Further south there is an area storing multiple trailers, logs, tyres, metal and plastic barrels and plastic pipe.

2.3.12 In the southeast corner there are 3 large areas of concrete with concrete panels up the side used to make & store silage for the cows.

2.3.13 Access into the warehouses/barns along the western boundary of Area B was not available.

2.3.14 A selection of site photographs is included on Drawing 3319/4.

2.4 Site operations

Area A

2.4.1 Operations across Area A appear to be limited to livestock grazing, although all livestock were in barns within Area B at the time of walkover.

Area B

2.4.2 Typically, operations across Area B are associated with the welfare of the cows and hens and the farming of milk and eggs.

2.4.3 Grain for the hens is stored on site in multiple Silos. Silage for the cows was evidenced by multiple silage heaps across this area of site.

2.4.4 At the time of the walkover, multiple tractors, trailers and other machinery were in use/stored in Area B.

3 SITE HISTORY

3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1854 have been examined. Some of these plans are presented in Appendix D to this report.

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

Date	Site	Surrounding land
1854	Open fields with **Bradley Villa** in southwest corner	Open fields. Shepherd Thorn 60 northwest of site.
1930	No significant changes	Housing built east of site off Bradley Road
1938		Housing built along western boundary of site off Huddersfield Road
1948		Housing built south of site off Bradley Road
1958	**Additional buildings** constructed within Bradley Villa	No significant changes
1959	Trough shown in western field and within Bradley Villa buildings	Bradley Bar Roundabout built
1971	**Additional buildings** constructed within Bradley Villa	No significant changes
1973	No significant changes	Construction of the **M62** motorway c. 300m north-west.
1977	No significant changes	All Saints Catholic College built to 60m south beyond Bradley Road
1982	'Bradley Villa Farm' shown in south-west with **additional buildings.**	No significant changes
1988	No significant changes	Bradley Park Golf Course Club House built 350m east of site.
2019	**Additional large building** to the north of farmyard	

4 ENVIRONMENTAL SETTING

4.1 General

4.1.1 Notes describing how the site's environmental setting has been assessed are included in Appendix A to this report. Extracts from the response received from Landmark, and the response from the Coal Authority are presented in Appendix E. These responses are summarised below, together with the findings of our own "desk study" investigation.

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 77) 1:10,000 BGS map (Sheet SE 12 SE & SE 12 SW) BGS Memoir/Technical Report	Drift – none. Solid – Pennine Lower Coal Measures with Sandstone in the west and Mudstone, Siltstone and Sandstone in the centre. Thick Stone (Sandstone) present in the east. Shallowest coal seam – Better Bed Coal likely at c. 20m depth in north of site, see further details in Section 4.2 below. Strata dip – 3° east. Faults – one fault running parallel to eastern boundary, dipping east.
Mining	Coal Authority	This site is located within a Coal Mining Development Low Risk Area. However, immediately north is a Coal Mining Development High Risk Area. Past and present workings - none. Opencast - none. Mine entries – none within 100m. Further details in Section 4.2 below.
Quarrying	Historical OS plans	Area of 'made ground' shown on the BGS plan in the south-east; recorded as former 'sand pit'.
Landfills	Envirocheck Report	No known landfills within 250m.
Radon	Public Health England	The site lies in an area where less than 1% of homes are estimated to be above the action level. Therefore no radon measures are required.
Hydrogeology	Environment Agency	Groundwater Source Protection Zone? No. Aquifer: Secondary A Aquifer (Solid). Groundwater abstractions? Nearest is 62m northeast, Kirklees Active Leisure for golf course spray irrigation. Soil leaching potential - Low. Pollution incidents? None within 1km.
Hydrology	Environment Agency Envirocheck Report	Nearest watercourse(s) – Tributary of Bradley Park Dike 150m northeast feeding River Colne. Water quality -moderate. Pollution incidents? Nearest is 757m southwest, foul sewer into freshwater stream/river Abstractions? None within 1km. Discharge consents? Nearest is 656m east, Yorkshire Water storm tank.
Flood risk	Environment Agency	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 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).

4.2 Coal & mining

4.2.1 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.

4.2.2 This site is located within a Coal Mining Development Low Risk Area - within the defined coalfield, but no known defined risks have been recorded by the Coal Authority; there may still be unrecorded issues.

4.2.3 A CA mining report states that:

- *There is no past mining recorded*
- *There are no probable unrecorded shallow workings and no spine roadways recorded at shallow depth*
- *There are no mine entries recorded within 100m of the site boundary*
- *There are no outcrops recorded and no faults, fissures or breaklines recorded.*
- *There are no opencast mines or Coal Authority managed tips within 500m of the site boundary.*
- *The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50m of the enquiry boundary, since 31st October 1994.*
- *There are no recorded incidences of mine gas within 500m of the boundary*
- *The property is not in an area where a notice to withdraw support has been given.*

4.2.4 The mining reports suggests there is no past mining recorded. However, it should be noted that it did not become a statutory requirement to maintain and preserve plans of abandoned mines until the Mine (Coal) Regulations Act of 1872 and consequently there may be mineworkings beneath the site for which the Coal Authority have no records.

4.2.5 The 1:10,000 BGS plans suggest that the Better Bed Coal seam outcrops between 160m and 200m north-west of the site, with an associated Coal Mining Development High Risk Area extending to around 60m north of the site at its closest point. The Better Bed coal seam and site Geology are shown on Drawing 3319/8.

4.2.6 Strata are shown on the BGS plan as dipping at 3° to the east.

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

4.2.8 Based on surrounding topography and the position of the Better Bed outcrop, this seam will underlie the entire site. It has a maximum recorded thickness of 0.7m. Review of the Geological Memoir *Geology of the Country around Huddersfield and Halifax -Sheet 77* suggests that there is no mining of any fireclay/seatearth associated with this seam.

4.2.9 In order to ascertain the likely depth of the Better Bed beneath the site (most notably in areas of lower topography and/or areas closer to the outcrop), strike lines for this seam have been interpolated. This was done using the position of its outcrop across the surrounding area (within the same fault block) and comparing it with topographic contours. This exercise has yielded the following:

- The seam dips at c. 2.2° east
- It is shallowest in the west, c. 145mAOD, reaching c. 125mAOD on the eastern boundary
- It is around 19m depth at its shallowest point
- It is around 30m depth at its deepest point

4.2.10 CIRIA ('Construction over abandoned mine workings', 1989) suggest a thickness of solid rock through which a void can migrate as 7h to 10h above the roof of the workings, where h is the height of the workings (generally assumed to be similar to the seam thickness). The lower end of this range (7h) is generally only applicable where the overlying strata are predominantly thickly bedded sandstones.

4.2.11 The succession here is likely to comprise mudstones and sandstones, therefore it is considered appropriate to use a figure of 10 h for void migration calculations (7m for the Better Bed).

4.2.12 Based on the above and the likely depth of the Better Bed, there should be sufficient competent cover in place above any workings within the Better Bed coal seam so as to not pose a significant risk of subsidence at surface.

4.2.13 In addition to the above, Lithos have liaised with the CA's Planning Advice team regarding coal risks on this site. Their response is included within Appendix E, but in summary the CA are satisfied with their extent of the High Risk Area associated with the Better Bed seam (i.e. it does not extend beneath the site).

4.2.14 Given the findings of the CA report, liaison with the CA and Lithos' mining risk assessment, any workings within the Better Bed coal should not pose a significant risk of subsidence at surface.

4.2.15 Beneath the Better Bed, there are no other coal seams within influencing distance of the site.

5 GROUND INVESTIGATION DESIGN

5.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	Likely veneer of made ground around villa farm buildings (Area B); none anticipated in area under investigation (Area A).
Natural soils	Topsoil with residual soils below (clay/sand/gravel).
Bedrock	Pennine Lower Coal Measures with Sandstone in the west and Mudstone, Siltstone and Sandstone in the centre. Thick Stone (Sandstone) present in the east likely at shallow depths (<3m).
Mineworkings	None anticipated within at least 20m depth.
Groundwater	Likely at depth within bedrock.

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

Type of issue	Specific issue	Remarks
Potential on-site contamination sources	1. Made ground (Area B) 2. Farming related activities	1. Villa Farm buildings 2. Soil conditioners, inorganics, organics (see below)
Potential off-site contamination sources	None of significance	
Potential geotechnical hazards	1. Former sand pit	1. Deep made ground
Other potential constraints	1. Underground Northern Powergrid & water utility 2. Shallow bedrock	1. Likely to require easement during planning and construction stages 2. Difficulty in excavating

5.2 Preliminary conceptual site model

5.2.1 A preliminary conceptual site model, presented as Drawing 3319/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 5.1 inclusive of this report.

5.2.2 Historical plans show that the site has been occupied by arable farmland which is not considered likely to have caused significant ground contamination. Nonetheless, activities such as slurry spreading, the discharge of chemicals to ground, and unregulated burial have all occurred on farmland. Potential pollutants associated with farming activity might 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
Plant & animal protection	Pesticides & herbicides
Soil conditioners	Metals, sulphates, PAH
Equipment maintenance	Hydrocarbons, metals
Derelict buildings	Asbestos
Naturally occurring contaminants	Arsenic, metals

5.3 Ground investigation design & strategy

5.3.1 The preliminary conceptual site model was used as a basis for design of an appropriate ground investigation, the scope of which is summarised below. It is currently understood that development will only take place in Area A, therefore Area B will not be investigated.

Exploratory holes	Purpose
TPs 1 to 35	To determine the general nature of soils underlying the site, including the: • Nature, distribution and thickness of shallow soils, including any made ground • Suitability of the ground for founding structures and highways
Incl. 5 TPs	To determine whether soakaways could be utilised for storm water drainage

5.3.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site. 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.

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

6 FIELDWORK

6.1 Objectives

6.1.1 The original investigation strategy is outlined in Section 5.3 above. From this Section onwards, this report focusses on Area A only.

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

Exploratory holes	Purpose
TPs 36 to 41	To enable better delineation of the depth and lateral extent of Granular Residual Soils associated with the changes in geology across Area A.

6.2 Scope of works

6.2.1 Fieldwork within Area A was supervised by Lithos between 12th and 14th February 2019 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	TPs 1 to 41	0.5m to 3.1m	Vane tests in cohesive soils
Soakaway tests	Within TPs 30 to 35	1.8m to 2.6m	Breaker used in shallow bedrock

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

6.2.3 Exploratory hole logs are presented in Appendix F 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

6.2.4 Exploratory hole locations are shown on Drawing 3319/6 presented in Appendix B; hole positions are based on data from a hand-held GPS (typically +/- 3m accuracy) and have not been surveyed in.

7 GROUND CONDITIONS

7.1 General

7.1.1 A complete record of strata encountered beneath the proposed development site is given on the trial pit logs, presented in Appendix F.

7.1.2 No made ground was encountered within any of the exploratory holes, including within the suspected 'sand pit' as shown on BGS plans in the south-east.

7.2 Natural ground

7.2.1 Natural ground typically comprised:

- **Topsoil:** Dark grey slightly sandy slightly gravelly CLAY. Encountered across the site to a typical depth of 300mm.
- **Cohesive Residual Soil**: Firm (locally stiff) light orange and grey mottled slightly sandy, slightly gravelly CLAY. Encountered immediately below topsoil in most trial pits to depths of between 0.6m and 1.9m.
- **Granular Residual Soil**: Slightly clayey sands and gravel/cobble. Typically encountered below Cohesive Residual soils to depths between 0.5m and 3.0m
- **Bedrock** was encountered at the base of each trial pit at depths of between 0.5m and 3.1m (average 1.8m). In TP30, a breaker was used to excavate the bedrock in order to undertake a soakaway test.

7.2.2 Cohesive residual soils were locally absent in the far south-east, central north and far west. In these locations, Granular Residual soil was encountered directly beneath the topsoil, with bedrock at shallower depths than elsewhere on site (between 0.5m and 1.4m).

7.3 Visual & olfactory evidence of organic contamination

7.3.1 No visual or olfactory evidence of organic contamination was encountered during the investigation.

7.4 Groundwater

7.4.1 Groundwater seepages were encountered in 6 exploratory holes (TPs 02, 03, 04, 07, 09 & 35) between depths of 1.2m and 2.4m. These holes are all located to the southeast.

7.5 Stability

7.5.1 Stability of excavations was generally good.

7.6 Revised conceptual ground model (ground conditions)

7.6.1 The preliminary conceptual site has been revised in light of the ground conditions encountered, most notably with respect to the absence of any significant made ground associated with the suspected former 'sand pit' in the south-east.

7.6.2 Further refinement of the Conceptual Site Model is presented in Section 10.2, where the results of laboratory testing for contaminants have been considered.

Summary of Ground Conditions

Hole ID	Final Depth (mbgl)	Depth to Base (mbgl)				Depth to Rockhead (mbgl)	Remarks
		Topsoil	Granular Residual Soil	Cohesive Residual Soil	Granular Residual Soil		
TP01	2.1	0.3	1.9	2.1	-	2.1	-
TP02	1.6	0.3	-	1.6	-	1.6	Water seepage at 1.2m
TP03	2.3	0.3	-	2.3	-	2.3	Water seepage at 2.1m
TP04	2.1	0.3	-	1.7	2.1	2.1	Water seepage at 2.1m
TP05	1.8	0.3	-	1.8	-	1.8	-
TP06	3.0	0.3	-	2.4	3.0	3.0	-
TP07	1.5	0.3	-	1.5	-	1.5	Water seepage at 1.5m
TP08	3.1	0.3	-	1.8	3.1	3.1	-
TP09	2.5	0.3	-	0.8	2.5	2.5	Water seepage at 2.4m
TP10	3.0	0.4	-	1.4	3.0	3.0	-
TP11	2.0	0.4	-	2.0	-	2.0	-
TP12	2.5	0.4	-	1.9	2.5	2.5	-
TP13	1.5	0.4	-	1.0	1.5	1.5	-
TP14	1.2	0.4	-	0.9	1.2	1.2	-
TP15	0.5	0.3	0.5	-	-	0.5	-
TP16	1.3	0.4	-	-	1.3	1.3	-
TP17	1.2	0.4	-	-	1.2	1.2	-
TP18	1.5	0.4	0.6	1.5	-	1.5	-
TP19	1.0	0.4	1.0	-	-	1.0	-
TP20	1.4	0.4	1.1	-	1.4	1.4	-
TP21	1.2	0.4	-	-	1.2	1.2	-
TP22	2.2	0.4	-	1.6	2.2	2.2	-
TP23	1.6	0.3	-	1.4	1.6	1.6	-
TP24	1.9	0.4	-	1.2	1.9	1.9	-
TP25	1.2	0.3	-	0.6	1.2	1.2	-
TP26	2.2	0.3	-	1.1	2.2	2.2	-
TP27	1.6	0.3	-	1.2	1.6	1.6	-
TP28	1.5	0.4	-	1.2	1.5	1.5	-
TP29	2.4	0.3	-	1.2	2.4	2.4	-
TP30	1.8	0.3	0.9	-	-	0.9	Breaker used from 0.9m
TP31	2.4	0.4	-	0.9	2.4	2.4	-
TP32	2.6	0.3	-	2.3	2.6	2.6	-
TP33	2.5	0.4	-	2.0	2.5	2.5	-
TP34	2.6	0.3	-	2.3	2.6	2.6	-
TP35	2.5	0.4	-	1.4	2.5	2.5	Water seepage at 2.2m
TP36	1.6	0.4	-	1.5	1.6	1.6	-
TP37	1.6	0.4	-	1.0	1.6	1.6	-
TP38	1.2	0.4	1.2	-	-	1.2	-
TP39	1.2	0.4	-	1.2	-	1.2	-
TP40	1.1	0.3	1.1	-	-	1.1	-
TP41	1.2	0.3	0.8	1.2	-	1.2	-

8 SOAKAWAY TEST RESULTS

8.1 UK Guidance

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

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

8.1.3 CIRIA C753:2015[1] recommends that soakaways should not be constructed 'in ground where the water table reaches a level within 1m below the base of the soakaway at any time of the year'.

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

8.2 Field tests

8.2.1 Soakaway tests were carried out in general accordance with BRE Digest 365[2] "Soakaway Design". The locations of the soakaways are shown on Drawing 3319/6 presented in Appendix B to this report.

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

8.2.3 Where the water level did not fall to 25% effective depth within 2 hours, the test was not considered suitable for calculation of an infiltration rate; this was the case for unsuccessful tests in all trial pits, except TP30 test 1.

8.2.4 Relatively slow drainage meant that only one filling cycle was possible in all trial pits except TP30 where a second filling cycle was undertaken.

8.2.5 Calculated infiltration rates for each successful test are summarised in the table below, and copies of the associated calculations are presented in Appendix G to this report.

Soakaway	Stratum	Infiltration rate (m/s)	Remarks
TP30 (Test 1)	Granular Residual Soil (0.3-0.9), and sandstone (0.9m-1.8m)	2.16×10^{-5}	
TP30 (Test 2)		-	Still c. 75% full after 1hr 30 min
TP31	Cohesive Residual Soil (0.4m to 0.9m), and Granular Residual Soil (0.9m to 2.4m)	-	Still c. 75% full after 5 hrs Water level rose by 40mm
TP32	Cohesive Residual Soil (0.3m to 2.3m), and Granular Residual Soil (2.3m to 2.6m)	-	Still c. 75% full after 2hrs 30min
TP33	Cohesive Residual Soil (0.4m to 2.0m), and Granular Residual Soil (2.0m to 2.5m)	-	Still c. 75% full after 4 hrs
TP34	Cohesive Residual Soil (0.3m to 1.9m), and Granular Residual Soil (1.9m to 2.6m)	-	Still c. 75% full after 3 hrs
TP35	Cohesive Residual Soil (0.4m to 1.4m), and Granular Residual Soil (1.4m to 2.5m)	-	Still c. 75% full after 3 hrs Water level rose by 120mm

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

8.3 Discussion & conclusions

8.3.1 Soakaways are generally only considered likely to provide a suitable drainage solution for the discharge of surface water run-off where vast majority of tests yield reasonable infiltration rates, which is not the case at this site. Consequently, soakaways are unlikely to provide a suitable drainage solution for the discharge of surface water run-off at the site; therefore there may be a need for surface water balancing.

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

8.3.3 Drainage solutions are discussed further in Section 13.8.

9 CONTAMINATION (ANALYSIS)

9.1 General

9.1.1 Former usage in Area A is considered unlikely to have given rise to any significant contamination. Furthermore, no made ground was encountered during the ground investigation. However, samples of topsoil have been recovered in order to confirm its suitability for reuse.

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

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

9.1.4 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
Topsoil	12	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Speciated Polycyclic Aromatic Hydrocarbons (PAH) Total Organic Carbon (TOC)
	2	PAAH Pesticides

9.3 Soil contamination results

9.3.1 The soil contamination test results are summarised in the tables on page 15.

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

Summary of degree of soils contamination

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a **residential with gardens** end-use.												
			pH	As ∞	B ~	Cd ∞	Cr x	Cu♣$	Pb ∞	Hg *	Ni	Se	Zn $	PAH		Asbestos I.D.
														B(a)P ∞	Naphthalene	
				37	5	26	3000	200	200	169	127	350	200	5	8	
TP01	0.20	Topsoil	6.4	21	< 0.4	0.5	37	39	82	0.4	20	0.4	100	0.2	< 0.1	N.D.
TP05	0.20	Topsoil	6.2	18	< 0.4	0.5	44	36	75	0.4	20	0.4	110	0.4	< 0.1	N.D.
TP08	0.20	Topsoil	6.4	13	< 0.4	0.4	35	30	64	0.3	17	0.3	80	0.4	< 0.1	N.D.
TP13	0.20	Topsoil	7.0	13	< 0.4	0.4	29	29	66	0.2	17	0.3	90	0.8	0.3	N.D.
TP24	0.20	Topsoil	7.4	14	< 0.4	0.4	22	31	79	0.2	19	0.3	100	1.2	1.0	N.D.
TP27	0.20	Topsoil	7.2	15	< 0.4	0.4	22	33	82	0.2	18	0.3	93	1.6	0.9	N.D.
TP30	0.20	Topsoil	6.4	11	0.6	0.3	17	22	58	0.2	15	0.3	74	1.9	0.6	N.D.
TP31	0.30	Topsoil	6.5	18	0.8	0.5	30	41	94	0.6	19	0.4	100	1.9	0.6	N.D.
TP32	0.10	Topsoil	6.6	14	0.7	0.4	24	30	110	0.3	19	0.4	100	0.7	0.2	N.D.
TP33	0.30	Topsoil	7.3	14	< 0.4	0.4	25	28	68	0.2	17	0.4	89	1.4	1.6	N.D.
TP34	0.20	Topsoil	6.5	15	< 0.4	0.7	35	31	68	0.3	15	0.4	82	0.6	0.2	N.D.
TP35	0.20	Topsoil	6.5	10	< 0.4	0.5	36	25	62	0.3	15	0.3	82	0.2	< 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 v1.06.	
∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE/Defra).
$	MAFF. Code of Practice for Agricultural Practice for the Protection of Soil, 1998.
~	Engineering judgement (Lithos). Boron is a phytotoxic, although most phytotoxic compounds can pose a risk to human health if sufficient concentrations are present. However, plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.

Inorganic determinands

9.3.3 Of the 12 samples of ground analysed for inorganic parameters, all can be classified as uncontaminated.

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

Asbestos

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

Organic determinands

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

9.3.7 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.

9.3.8 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.

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

Fill type	Typical TOC (%)	Comparison of soil results with revised screening value necessary?
Topsoil	>5%	No

Polycyclic Aromatic Hydrocarbons (PAH)

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

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

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

Pesticides

9.3.13 Both of the topsoil samples scheduled for pesticide analysis (PAAH pesticides) yielded results for the various determinands below the laboratory limit of detection (0.02mg/kg).

10 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

10.1 Topsoil

10.1.1 Topsoil, typically 300mm thick underlies the entire site. Testing suggests this material is chemically suitable for re-use.

10.1.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth. However, no testing in accordance with BS3882:2015 Specification for Topsoil (N-P-K, clay content etc) has been undertaken to date.

10.2 Revised conceptual ground model (contamination)

10.2.1 No plausible contaminant linkages have been identified within Area A.

10.2.2 Possible contamination within Area B should be assessed through an exploratory site investigation if this area of site is to be developed, however, it is currently understood this is not be the case.

10.3 Waste classification

10.3.1 Some excess arisings may be generated by excavations for foundations, sewers etc.

10.3.2 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[3]. Classification of soils as inert, non-hazardous or hazardous in accordance with WM3 is quite a complex process. However, all soil arisings generated by excavations at this site are likely to be classified inert.

10.3.3 Off-site disposal 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 for use, without the need for waste legislation to be applied.

[3] Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015
[4] The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

11 HAZARDOUS GAS

11.1 Methane & carbon dioxide

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

Source	Receptors	Hazard	Pathway	Initial Risk
Mineworkings at depth	Human Health	Asphyxiation & explosion	Lateral migration, ingress & accumulation	**Very Low:** mineworkings likely to be at depth (>20m) if present.
	Buildings	Explosion		

11.1.2 Whilst risks associated with hazardous gas are considered very low, they cannot be entirely discounted. Consequently, it would be prudent to install protection measures to comply with Green\CS2 requirements **or** install 12 monitoring wells and undertake gas monitoring (6 visits over 3 months).

11.1.3 Assuming Green\CS2 measures are adopted, and subject to agreement of NHBC and the local authority, they would comprise:

Traffic light classificn and "score" req'd by BS8485#	Floor slab (BS8485 "score")	Protective measures	
		Sub-floor ventilation (BS8485 "score")	Membrane Type (BS8485 "score")
Green & **CS2** (Wilson & Card) **2.5***	*Select one from:* i. Block & Beam – **(0)**. ii. Reinforced ground bearing slab – **(0.5)**. iii. Reinforced, cast in-situ suspended slab (with minimal and suitably sealed service penetrations & joints) – **(1.5)**. iv. Reinforced ground bearing raft (with limited service penetrations cast into slab). Note: the venting area through any downstand beam should be 3 times greater than that provided by the side ventilation (air bricks) – **(1.5)**.	*Select one from:* Passive sub-floor ventilation; venting layer could be: i. A min. 150mm clear void **(2.5)**, or ii. A proprietary void former providing an equivalent clear void depth of 60mm; see Section B7 in BS8485:2015 **(2.5)**, or iii. Min. 300mm thick blanket of min. 20mm single size gravel **(1.0)**. Min. ventilation = 1,500 mm^2/m run of external wall (via air bricks on each of 2 opposite sides), with 100mm pipes at 1.75m centres or honeycombing of any sub-floor sleeper walls.	Waterproof DPM (2000 gauge polyethylene). Lapped & sealed in accordance with BR 414. **(0)**

Footnotes:

- *#Scores are broadly based on those outlined in BS8485:2015 (for Characteristic Situations 2 & 3, and Building Type A).*
- *Modified from BS8485:2015 by Lithos. Monitoring data has also been reviewed using Wilson & Card methodology and found to be Characteristic Situation 2; consequently a lapped/sealed membrane & ventilation are recommended.*
- *∞In accordance with CIRIA C735, a Verification Plan should be prepared which outlines the activities (inspection and testing), the relevant personnel, and the type of records to be collected. Gas membranes need to be visually inspected to establish possible damage.*
- *Note NHBC guidance only requires membranes to be certified on Amber 2 sites. However, BS8485 is considered to 'outrank' NHBC guidance, and it would be prudent to comply with this Standard and CIRIA C735. Furthermore, (YALPAG) local authorities have issued guidance requiring a detailed verification method statement in advance of the construction phase. This should address how gas measures will be installed and what verification information will be provided to demonstrate that installation has been carried out in accordance with the appropriate guidance.*
- *A combination of two or more of the three types of protection measures (slab, ventilation & membrane) should be used to achieve the BS8485 score.*
- *The membrane should always be lapped and sealed in accordance with BRE\Environment Agency Report BR 414 (2001) – "Protective Measures for housing on gas-contaminated land". The membrane should be continuous across internal walls & the cavity, and there should be a cavity tray in external walls.*
- *In all cases there should be minimum penetration of floor slab by **services**; any penetrations should be suitably sealed.*
- *Integral **garages** with occupied rooms above, or direct access through a doorway from the garage to the house, should be provided with the same protective measures as the rest of the dwelling. Buildings with basement car parks (with ventilation in accordance with Building Regulations) may not require gas resistant membranes.*

11.1.4 BRE\Environment Agency Report BR 414 (2001) – "*Protective Measures for housing on gas-contaminated land*" provides a practical guide to good practice for the detailing and construction of passive soil gas protection measures for new residential development. Of particular relevance are a list of 'Watchpoints', which offer practical information for installation and buildability.

11.1.5 Gas monitoring would be required to ascertain whether or not ground-bearing floors (i.e. with no sub-floor ventilation), are able to be used.

11.2 Radon

11.2.1 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.

11.2.2 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.

11.2.3 Information from Landmark suggests that radon protection measures are not required. This is confirmed by the Public Health England UK radon map which indicates that the site lies in an area where less than 1% of homes are estimated to be above the action level.

11.2.4 As such, no special precautions against radon are required on this site.

12 GEOTECHNICAL TESTING

12.1 General

12.1.1 A total of 31 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 I to this report.

12.2 Atterberg limits

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

Soil type	No. samples tested	Moisture content range (average)	Range of Plasticity Indices* (average)	Shrinkability
Cohesive Residual Soil	15	18-33 (25)	16-35 (30)	Medium

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

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

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

12.3 Particle size distribution

12.3.1 The grading of 3 samples of Cohesive Residual Soil has been determined by wet sieving and the results are summarised in the table below:

Sample & depth	Field description	Modified PI	% passing 37.5mm sieve	% passing 20mm sieve	% passing 2mm sieve	% fines	Material description (based on grading & plasticity)
TP39, 0.7m*	Clayey, slightly gravelly SAND.	19	100	95	73	54	Slightly gravelly, slightly sandy CLAY.
TP40, 0.7m*	Clayey, slightly gravelly SAND.	16	100	96	60	42	Gravelly, slightly sandy CLAY.
TP41, 0.6m*	Clayey, slightly gravelly SAND.	27	100	99	79	60	Slightly gravelly, slightly sandy CLAY.

**log description (see Appendix F) changed based on lab result*

12.3.2 Fines (silt and clay) were found to comprise between 42% and 60% (average 52%) of the material sampled. NHBC Chapter 4.2 considers shrinkable soils to be those containing more than 35% fines and having a Modified Plasticity Index greater than 10%. The clayey sand above should therefore be regarded as shrinkable.

12.4 Soluble sulphate and pH

12.4.1 In accordance with BRE Special Digest 1:2005, this site has been classified as greenfield with a mobile groundwater regime.

12.4.2 It is envisaged foundations will extend to depths of about 0.6m natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).

12.4.3 The concentrations of sulphate in the aqueous natural soil extracts of 17 samples were determined. The pH value of each sample has also been determined.

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

Soil type	No. samples tested	Lowest pH values	Highest soluble sulphate concentration (mg/l)
Cohesive Residual Soil	12	5.7	40
Granular Residual Soil	5	6.3	320

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

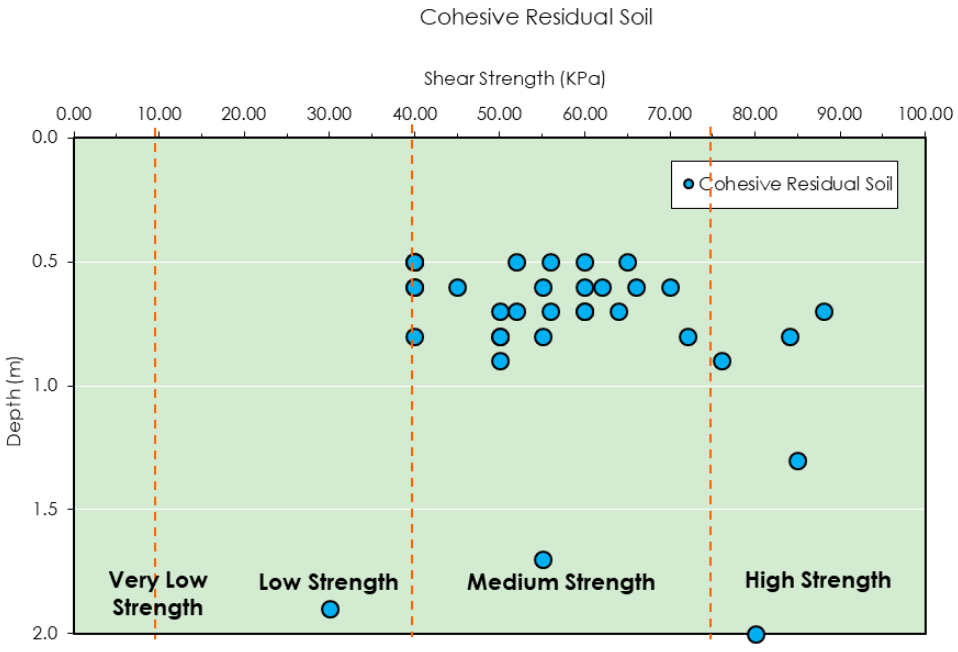
12.4.6 In accordance with Tables C1 and C2 of SD1, sub-surface concrete should be Design Sulphate Class DS-1, with the site allocated an ACEC Classification of AC-1.

12.5 Undrained shear strength testing

Hand shear vane testing

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

12.5.2 The results are summarised within the plot below and show the majority of results to lie between 50kPa and 70kPa (medium strength). It should be noted that hand vane testing was often not possible due to the sand, gravel and cobble content of the cohesive soils.



13 GEOTECHNICAL ISSUES

13.1 Conceptual site model

13.1.1 Ground conditions typically comprise topsoil (around 0.3m thick), over firm light orange slightly sandy, slightly gravelly, Clay (Cohesive Residual Soils), with clayey sands/gravel/cobble below (Granular Residual Soils)

13.1.2 Bedrock was encountered in all trial pits across site at an average depth of 1.8m, but typically shallower in the south-east and north-west (between 0.5m and 1.2m).

13.1.3 Groundwater seepages were encountered in TPs 02, 03, 04, 07, 09 & 35 between depths of 1.2m and 2.4m.

13.1.4 The topography of the site is gently undulating with a dome in the centre, this will likely require some regrading to create level development platforms.

13.2 Mining & quarrying

13.2.1 This site is located within a Coal Mining Development Low Risk Area.

13.2.2 Lithos' mining risk assessment (see Section 4.2) found that the shallowest seam beneath the site is the Better Bed, with a maximum thickness of 0.7m and at a minimum depth of c. 19m. At such depth, any workings within this seam should not pose a significant risk to surface stability.

13.2.3 Beneath the Better Bed, there are no coal seams within influencing distance beneath the site.

13.2.4 An former 'sand pit' is shown in the south-east on the BGS plan. However, no evidence of this feature was encountered during Lithos' site investigation.

13.3 Site regrade

13.3.1 Given existing topography (much of the site is sloping, with gradients of up to 1 in 4 in the south-east), some site earthworks regrade is anticipated, with the need for underbuild and retaining walls.

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

13.3.3 Any digital terrain modelling undertaken or commissioned by the developer should consider implications for the foundation recommendations outlined below.

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

13.3.5 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 10.3 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 We have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation.

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

Strip/trench fill footings

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

13.4.5 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.

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

13.4.7 Overdeepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.4.

13.4.8 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).

13.4.9 The developer 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

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

13.4.11 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.

13.4.12 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 15% of the site may be affected by trees.

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

13.4.14 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.

13.4.15 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.

13.4.16 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 very few foundations being deeper than 2.5m.

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

- A foundation length of 10m
- A foundation breadth of 0.6m
- A foundation thickness of 225mm
- A foundation depth of 0.9m
- An undrained shear strength of 50kPa for the firm clay (typical minimum recorded on site)

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

Granular Soils

13.4.19 Granular soils were encountered at founding depth in the north-west and south-east. In addition, these soils may be encountered where foundations require over-deepening due to tree influence.

13.4.20 The granular soils are assumed to have a relative density of at least medium dense (in accordance with BS5930:2015).

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

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

13.4.22 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.

13.4.23 In accordance with NHBC Standards, a minimum founding depth of 450mm is required in the granular soil (due to potential frost susceptibility). 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).

13.4.24 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.

13.4.25 It should be noted that founding at shallow depth (450mm), whilst desirable from an excavation stability viewpoint, may not provide sufficient bearing capacity due to the lesser depth of (resisting) overburden. Consequently, a minimum founding depth of 600mm is recommended.

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

13.4.27 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).

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

Bedrock

13.4.29 Bedrock was encountered at an average of 1.8m (notably shallower in the north-west and south-east) therefore it will be encountered in foundation excavations and possibly where deepening due to trees is required.

13.4.30 Where encountered, foundations need not be deepened any further and need only penetrate the bedrock by the foundation thickness.

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

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

Geological fault

13.4.33 Drawing 3319/8 shows the approximate line of the fault crossing the east of the site.

13.4.34 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.

13.4.35 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.

13.4.36 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.

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

13.5.4 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.

13.5.5 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.

13.5.6 Floor slab design should also take into the account the comments in Section 11 (Hazardous Gas).

13.6 Designated concrete mixes

13.6.1 Designated mixes are considered in BRE Special Digest SD1 and BS 8500 -1:2015+A1:2016. 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, the developer should seek advice from their appointed Structural Engineer.

13.7 Excavations

13.7.1 Groundwater should be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".

13.7.2 Based on the results of the investigation it is considered unlikely that major groundwater flows will be encountered in shallow excavations. However, steady seepages were encountered in a number of trial pits dug in the southeast corner of site. It may be prudent to allow for some groundwater control over and abo normal site pumping practices may be required for any excavations in excess of 1m deep.

13.7.3 Excavations should remain stable in the short term.

13.7.4 Bedrock was encountered in the majority of exploratory holes across the site. Based on the exploratory hole logs, excavation greater than 2.0m is likely to prove difficult across the site. It would therefore be prudent to allow for excavation of hard rock in any deep excavations such as those that may be required for drainage etc.

13.8 Drainage

13.8.1 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.

13.8.2 Alternative SUDS options (see CIRIA C753:2015 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.
- Pervious Pavements – provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate into subsurface storage, with subsequent infiltration or controlled discharge. Pavement could be porous (water able to infiltrate across entire surface material; e.g. reinforced grass), or permeable (water infiltrates via joints between concrete blocks).
- Ponds – designed to have permanent pool of water, but with capacity to provide temporary storage-controlled discharge.

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

13.9 Highways

13.9.1 The natural soils present at shallow depth (anticipated formation) are predominantly cohesive. Based on visual inspection of the natural materials and the recorded plasticity indices at the site, published tables[5] indicate that the natural soils would be expected to provide a CBR value of at least 3%. This value should be verified prior to or during construction.

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

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

13.10 External works

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

14 REDEVELOPMENT ISSUES

14.1 General

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

14.1.2 If unanticipated ground is encountered during the site preparatory works, the Contractor should immediately seek further advice from the Engineer.

14.2 Good practice guidance

14.2.1 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 C502 'Environmental Good Practice on Site'
- EA Pollution Prevention Guidelines[6]:
  - PPG6 - Working at construction and demolition sites
  - PPG2 - Above ground oil storage tank
  - PPG7 – The safe operation of refuelling facilities.
  - PPG21 – Incident Response Planning

14.3 New utilities

14.3.1 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.

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

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

14.4 Health & safety issues - construction workers

14.4.1 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.

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

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

14.5 Potential development constraints

14.5.1 The underground electric and water utilities in the northwest corner of site present a potential development constraint unless they can be relocated. Additional enquiries are required to ascertain the feasibility of such diversionary works and the particular easement required by each service undertaker if they remain in-situ.

15 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

15.1 General

15.1.1 The site is located off Bradley Road, approximately 2km south of Brighouse town centre, and currently comprises four parcels of land associated with Villa Farm. The majority of the site is used for the cattle grazing, whilst the south-west is occupied by a farmyard including warehouses, barns, residential buildings, a coffee shop, a farm shop, and storage.

15.1.2 It is understood that consideration is being given to redevelopment of the site with traditional 2 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. At this stage, development is understood to be restricted to the farmland in the north & east; no development is currently proposed within the farmyard.

15.1.3 No investigation has been undertaken within the farmyard. Ground conditions beneath the fields comprise topsoil, overlying Cohesive Residual Soils across the majority of site with granular Residual Soils grading into Bedrock at depths of between 0.5m and 3.1m. Cohesive Residual Soils were not encountered in the far north-west or far south-east corners.

15.2 Mining & quarrying

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

15.2.2 Lithos' mining risk assessment found that the shallowest seam beneath the site is the Better Bed, with a maximum thickness of 0.7m and at a minimum depth of c.19m. At such depth, any workings within this seam should not pose a significant risk to surface stability.

15.2.3 Beneath the Better Bed, there are no coal seams within influencing distance beneath the site.

15.2.4 A former 'sand pit' is shown in the south-east on the BGS plan however no evidence of this feature was encountered during Lithos' site investigation.

15.3 Hazardous gas

15.3.1 The site is in an area where less than 1% of homes are estimated to be above the radon action level.

15.3.2 At this stage, risks associated with hazardous gas appear very low, but cannot be entirely discounted.

15.3.3 It is recommended that the developer either opts for Green\CS2 protective measures in all dwellings (including sub-floor ventilation), or commissions gas monitoring in order to finalise floor slab design. This strategy should be agreed with the warranty provider and the local authority.

15.4 Contamination & remediation

15.4.1 No significant contamination has been identified.

15.4.2 Topsoil is considered chemically suitable for re-use.

15.5 Foundations

15.5.1 All plots will be founded on traditional strip/trench-fill foundations, founding within Residual soils at a minimum of 0.9m depth (where soils are cohesive) and 600mm (where soils are granular), over-deepened where necessary due to tree influence.

15.5.2 Where hard bedrock is encountered at very shallow depth (<0.6m), footings need only penetrate the bedrock by the foundation thickness.

15.6 Flooding

15.6.1 The EA indicate that the site is not located within an indicative floodplain.

15.7 Drainage

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

15.8 Highways

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

Appendix A

General Notes

01 - Environmental setting
Generic notes – geoenvironmental Investigations

General

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

Geology, mining & quarrying

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

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

Landfills

Lithos obtain data from Landmark or Groundsure, 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 and Target Levels should also be applied to non-domestic buildings with public occupancy exceeding 2,000 hours per year and to all schools.

Hydrogeology

Lithos obtain information from the Environment Agency (EA), 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

Lithos obtain information from the Environment Agency and Landmark or Groundsure with respect to:

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

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

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

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

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

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

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

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

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

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

COMAH & explosive sites

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

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

Preliminary conceptual site model

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

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

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

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

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

02 - Ground investigation fieldwork
Generic notes – geoenvironmental investigations

General

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

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

Exploratory hole locations

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

Investigation techniques

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

- Machine excavated trial pits, usually equipped with a backactor and a 0.6m wide bucket.
- Cable percussive (Shell & Auger) boreholes, typically using 150mm diameter tools and casing.
- Window or windowless sampling boreholes (dynamic sampling). Constraints associated with existing buildings, operations and underground service runs can render some sites partly or wholly inaccessible to a mechanical excavator. In such circumstances, window sampling is often the most appropriate technique. A window sampling drilling rig can be manoeuvred in areas of restricted access and results in minimal disturbance of the ground (a 150mm diameter tarmac/concrete core can be lifted and put to one side). However, it should be noted that window sampling allows only a limited inspection of the ground (especially made ground with a significant proportion of coarse material).
- Rotary percussive open-hole probeholes are typically drilled using a tri-cone rock roller or polycrystalline diamond compact (PDC) bit with air as the flushing medium. Probeholes are generally lined through made ground with temporary steel casing to prevent hole collapse.

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

In-situ testing

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

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

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

Sampling

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

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

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

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

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

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

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

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

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

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

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

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

Anticipated testing	Container(s)
Asbestos identification	500ml plastic tub
pH & metals, and non-volatile organics	500ml glass jar
Speciated TPH	500ml & 50ml glass jars
VOCs (incl. naphthalene and\or GRO)	50ml glass jar

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

Groundwater

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

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

Description of strata

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

Key to exploratory hole logs

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

03 – Geotechnical laboratory testing
Generic notes – geoenvironmental investigations

General

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

- Atterberg limits & moisture contents
- Soluble sulphate & pH

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

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

- Grading
- Compaction tests
- Particle density

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

Atterberg limits & moisture content

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

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

I'p = Ip * (%< 425µm/100)

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

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

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

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

Soluble sulphate and pH

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

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

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

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

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

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

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

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

Oedometer (Consolidation) tests

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

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

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

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

Triaxial tests

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

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

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

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

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

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

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

Determination of analytical suite

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

Common contaminants

Common **Inorganic** Contaminants include:

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

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

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

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

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

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

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

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

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

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

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

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

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

Polycyclic Aromatic Hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic. PAH compounds are present in both petrol and diesel, although in significantly lower concentrations than in coal tars. Certain PAH compounds are carcinogenic (benzo(a)pyrene) and\or mobile in the environment (naphthalene).

Volatile Organic Compounds (VOCs) are organic chemicals, and most are liquids that readily evaporate on exposure to air. Examples include benzene, toluene, xylene, chloroform etc. Semi-Volatile Organic Compounds (sVOCs) include phenol and benzo(a)pyrene, and have relatively low boiling points. Both groups of chemicals are readily absorbed through skin and some, such as benzene, are believed to be linked to tumour growth.

Phenols are compounds that have a hydroxyl group (-OH) attached to an aromatic ring (ie include a benzene ring and an –OH group). Most are colourless solids. A solution of phenol in water is known as carbolic acid, and is a powerful antiseptic. However, phenol vapour is toxic, and skin contact can result in burns.

Polychlorinated Biphenyls (PCBs) were used in pre-1974 transformers as dielectric fluids. PCB's are of increasing toxicity relative to the degree of chlorination. Acute symptoms of PCB poisoning are irritation of the respiratory tract leading to coughing and shortness of breath. Nausea, vomiting and abdominal pain are caused by ingestion of PCB's.

Dioxins and furans (polychlorinated dibenzodioxins and polychlorinated dibenzofurans) are some of the most toxic chemicals known; in the environment, they tend to bio-accumulate in the food chain. Dioxin is a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD.

Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxin in the environment comes from waste-burning incinerators and also from backyard burn-barrels. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process and with the production of Polyvinyl Chloride (PVC) plastics and with the production of certain chlorinated chemicals (like many pesticides).

Methods of analysis (organic compounds)

TPH by GC-FID is an analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C_{10} to C_{40} (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a broad, 'banded' breakdown of the TPH results into gasoline range organics (GRO), diesel range organics (DRO) and heavier lubricating oil range organics (LRO), or fully speciated results with the reporting of hydrocarbon concentrations in 14 specific carbon bandings based upon behavioural characteristics, e.g. aliphatic C_6 to C_8, aromatic C_{10} to C_{12} etc.

Speciated VOC (by GC-MS) analysis quantifies the concentrations of 30 USA-EPA priority compounds. These include chlorinated alkanes and alkenes (in the molecular weight range chloroethane to tetrachloroethane); trimethylbenzenes; dichlorobenzenes; and the 4 BTEX compounds (benzene, ethyl-benzene, toluene & xylene).

Speciated sVOC by (GC-MS) analysis quantifies the concentrations of a variety of organic compounds, including the 16 USA-EPA priority PAHs, phenols, 7 USA EPA priority PCB congeners, herbicides & pesticides.

Note: PAHs are hydrocarbons and consequently (where present) will be picked-up when scheduling TPH by GC-FID.

Note: Risk assessment models require physiochemical properties (solubilities, toxicities etc) of compounds in order to model their behaviour in the environment. These physiochemical properties cannot be derived from a single "TPH", "GRO" or "DRO" value. However, the carbon banded fractions can be used in risk assessment models.

Current UK guidance

The UK approach to contaminated land is set out in Contaminated Land Report No. 11 (2004) "Model Procedures for the Management of Land Contamination". The approach is based upon risk assessment, where risk is defined as the combination of the probability of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

In the context of land contamination, there are three essential elements to any risk: (1) a contaminant source; (2) a receptor (eg controlled water or people); and (3) a pathway linking (1) and (2). Risk can only exist where all three elements combine to create a pollutant linkage. Risk assessment requires the formulation of a conceptual model which supports the identification and assessment of pollutant linkages.

Lithos adopt a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate UK guidance levels, Lithos risk-derived screening values, or remedial targets. It should be noted that exceedance of Tier 1 does not necessarily mean that remedial action will be required.

Soil screening values used by Lithos

In March 2002 DEFRA and the Environment Agency published a series of technical papers (R&D Publications CLR 7, 8, 9 and 10) outlining the UK approach to the assessment of risk to human health from land contamination. In 2008 CLR 7, 9 and 10 and all corresponding SGV and Tox reports were withdrawn and superseded by new guidance including:

- Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software Handbook (Version 1.071), Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

The approach set out in these documents represents current scientific knowledge and thinking; and includes the Contaminated Land Exposure Model (CLEAv1.06). The Environment Agency are in the process of using this updated approach to regenerate a selection of Soil Guideline Values (SGVs).

CLEA SGVs were derived for standard land use scenarios predominantly in the context of Part IIA, using a conceptual site model (CSM) defined in SR3. Lithos have incorporated amendments to the CSM used to derive SGVs, that more accurately reflect redevelopment within the planning regime; consequently, Lithos have not adopted any published SGV as a screening value.

The CLEA conceptual site model assumes a source located in a sandy loam, with 6% soil organic matter (SOM) - equivalent to 3.5% total organic carbon (TOC). However, where the average TOC value for a particular soil type is significantly lower than the 3.5%, evaluation of Lithos Screening Values should be undertaken and a site specific risk assessment will usually be required. Other CLEA default characteristics adopted by Lithos are:

Sandy Loam characteristics (source)	Default values adopted
Total porosity (fraction)	0.53
Water filled porosity (fraction)	0.33
Air filled porosity (fraction)	0.2

Lithos have derived Screening Values for four different CSMs (scenarios); these are:

A - Residential with gardens, but no cover (or only up to 300mm)

B - Residential with gardens and 600mm 'clean' cover

C - Residential apartments with landscaping (i.e. no home grown produce)

D - Commercial/industrial with landscaping

E – Importation of soil cover

The **exposure** pathways considered for each scenario are detailed in the table below.

Scenario	Land use	Pathways	Justification
A	Residential with garden, but no cover (or only up to 300mm)	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	Minimal cover – insufficient to break any pathways therefore all exposure pathways are relevant.
B	Residential with garden minimum 600mm cover	• Inhalation of indoor vapours • Inhalation of outdoor vapours	The 600mm cover removes the risk from all pathways other than inhalation.
C	Residential apartments with landscaped areas and minimum 300mm cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. However consumption of home grown produce not included as unlikely to be grown in landscaped areas. Where vegetables are to be grown site specific QRA may be required.
D	Commercial/ industrial with landscaped areas no cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumed the commercial development consists of offices to provide a conservative assessment.
E	Importation of soil for cover in garden and landscaped areas	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of outdoor vapours and dust	Material used as cover to break existing pathways therefore all direct and indirect pathways relevant; however cover is **not** placed below plots therefore indoor inhalation is not relevant.

Lithos have assumed the source of contamination is directly below the building foundations; i.e. a depth to source of 0.15m as opposed to the CLEA default of 0.65m. This assumption provides for a more conservative approach than the UK default. This adjustment has been included to account for sites where made ground is re-engineered to enable new buildings to be established on raft foundations. In such situations contamination may lie directly beneath the foundation.

The Soil Screening Values referred to in this document are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part IIA of the Environment Protection Act 1990;
- End uses such as allotments, sports fields, children's playgrounds, care homes, hospitals etc; and
- Controlled waters.

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

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

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

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

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

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

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

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

* *For a residential end use*

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

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

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

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

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

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

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

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

Step 1 - Assessing indicator compounds

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

Step 2 - Assessing individual TPH fractions

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

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

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

Five times the screening value for Scenario A.

Step 3 - Assessing Cumulative Effects

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

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

Other screening values used by Lithos

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

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

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

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

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

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

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

Waste classification & WAC

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

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

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

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

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

Possible action in event of Tier 1 exceedance

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

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

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

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

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

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

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

06 - Soakaways
Generic notes – geoenvironmental investigations

Background

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

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

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

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

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

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

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

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

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

Test methodology

Lithos undertake soakaway tests in general accordance with BRE Digest 365 "Soakaway Design". The BRE Digest recommends that each soakaway pit is filled and allowed to drain three times to near empty; the three fillings to be on the same or consecutive days. However, each test can take over 2 hours to complete and therefore pits are often only filled and allowed to drain on one occasion, due to the time constraints imposed on the investigation

Three filling\drainage cycles are more important where drainage is primarily via fissures, most notably within a rock mass. Initial drainage within the rock mass may be high, as the fissures fill with water, giving the impression (if only one cycle is undertaken) that soakaways would be a suitable drainage solution. If infiltration through the matrix of the rock is low, then drainage from the test pit becomes slow as the fissures become saturated.

For non-fissile, granular soils infiltration is via the matrix, and consequently one filling\drainage cycle is generally considered sufficient. Soakaway pits are typically excavated to a depth of about 2.5m using a mechanical excavator equipped with a 0.3m wide bucket. The soakaway test pits are rapidly filled with water to the top of the test section. The fall in water level is then monitored at regular intervals.

Infiltration rates

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

Soakaway design

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

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

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

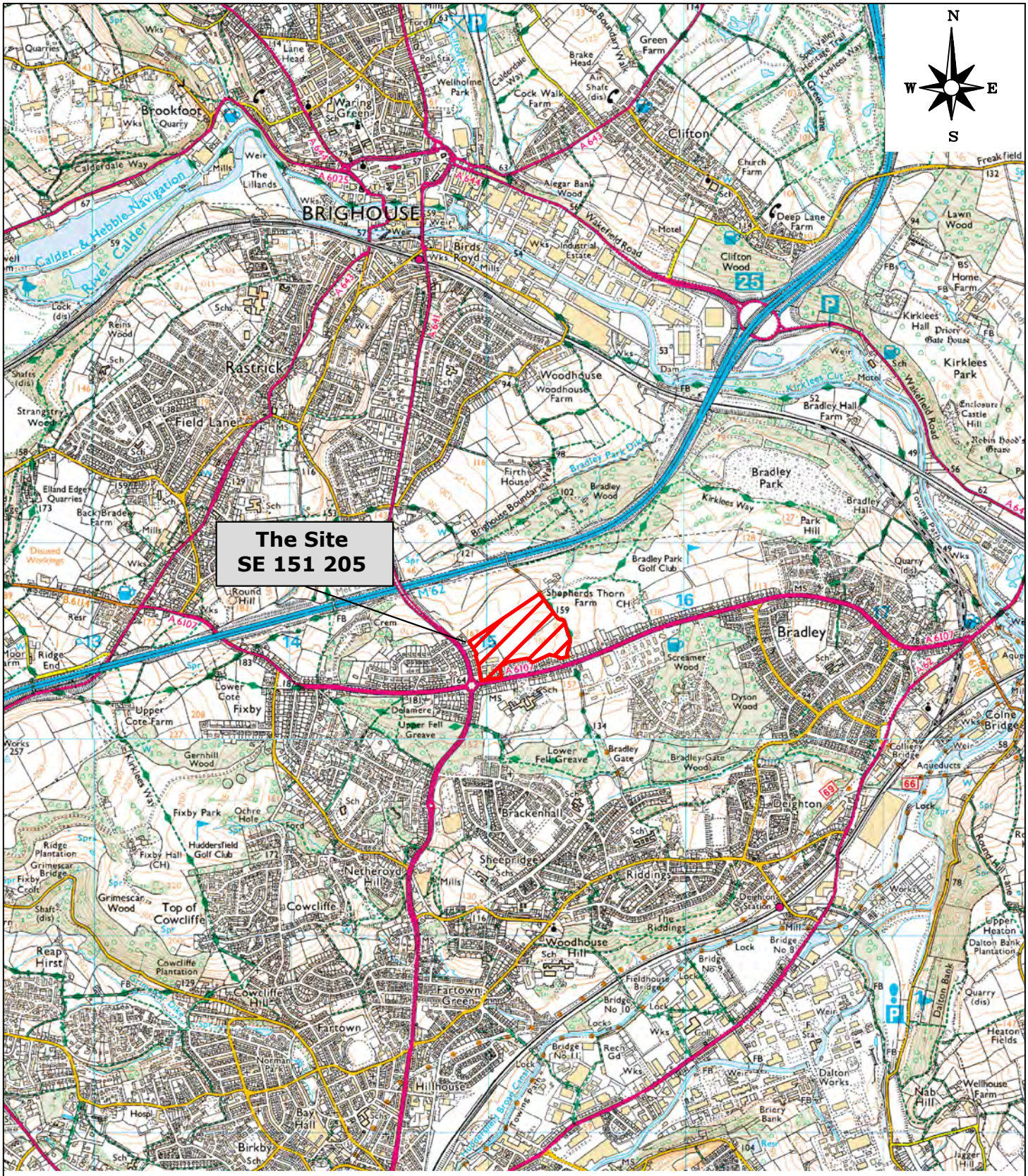
Increasing the soakaway effective depth might offer a solution, but consideration should be given to:

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

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

Appendix B

Drawings



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CLIENT	PS & SP KERSHAW
JOB TITLE	VILLA FARM, BRADLEY
DRAWING TITLE	SITE LOCATION PLAN
DRAWN	CC
DATE	21/02/19
CHECKED	MJT
DATE	21/02/19
STATUS	FOR COMMENT ☐ DRAFT ☐ FOR APPROVAL ☐ FINAL ☑
SCALE	1:25,000
SHEET	A4
DRAWING NO.	3319/1
REVISION	

NOTES

- GRASS & OVERGROWN AREAS
- BUILDING
- TARMAC HARDSTAND
- TREES
- MANURE HEAP
- SILOS
- HISTORICAL SAND PIT (FROM BGS)
- APPROXIMATE SITE BOUNDARY
- LINE OF ELECTRICITY UTILITY

REV.	DESCRIPTION	DATE

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JOB TITLE

VILLA FARM, BRADLEY

DRAWING TITLE

SITE FEATURES

DRAWN	DATE	STATUS
CC	21/02/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	21/02/19	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
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Beehives
Silos
skips
Manure heap
Piles of timber, corrugated metal etc.
warehouse (hens)
Silos
Possible asphalt heap
Egg conveyor belt
Cattle shed
Cattle sheds
Egg box storage
warehouse (hens)
Trailers, barrels, machinery etc.
Silage heap
Silage heap
Silage heap
Storage
Cattle sheds
Silage heap
Polytunnel
Car park
Car park
Residential building
disabled toilet
Bradley Villa Farm Shop
Bradley Villa Farm cafe
Garage

N
W E
S

NOTES

- GRASS & OVERGROWN AREAS
- BUILDING
- TARMAC HARDSTAND
- TREES
- MANURE HEAP
- SILOS
- APPROXIMATE SITE BOUNDARY
- LINE OF ELECTRICITY UTILITY

REV.	DESCRIPTION	DATE

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JOB TITLE

VILLA FARM, BRADLEY

DRAWING TITLE

SITE FEATURES (AREA B)

DRAWN	DATE	STATUS
CC	21/02/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	21/02/19	DRAFT ☐
		FINAL ☑

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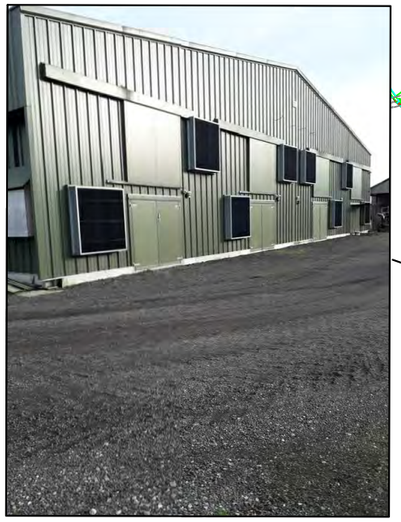

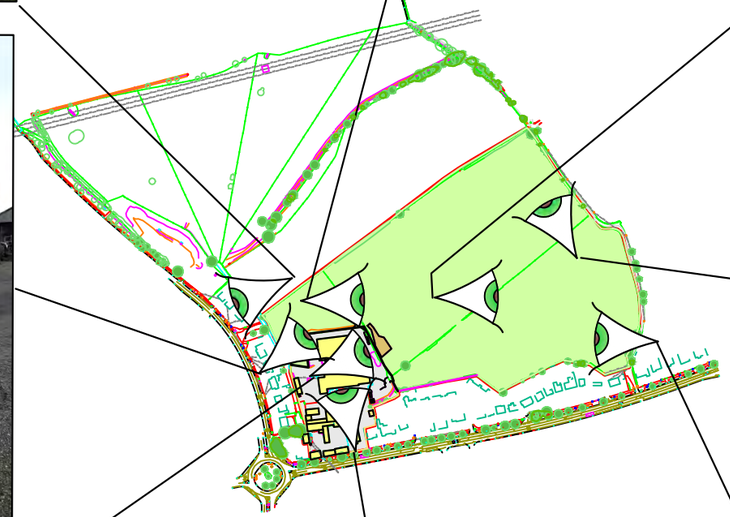

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NOTES

- GRASS & OVERGROWN AREAS
- BUILDING
- GRAVEL OR HARDCORE SURFACING
- APPROXIMATE SITE BOUNDARY
- LOCATION & ORIENTATION OF PHOTOGRAPH
- LINE OF ELECTRICITY UTILITY

REV.	DESCRIPTION	DATE

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JOB TITLE

VILLA FARM,
BRADLEY

DRAWING TITLE

SITE PHOTOGRAPHS

DRAWN	DATE	STATUS
CC	19/02/19	FOR COMMENT ☐
		FOR APPROVAL ☐
CHECKED	DATE	DRAFT ☐
MJT	19/02/19	FINAL ☑

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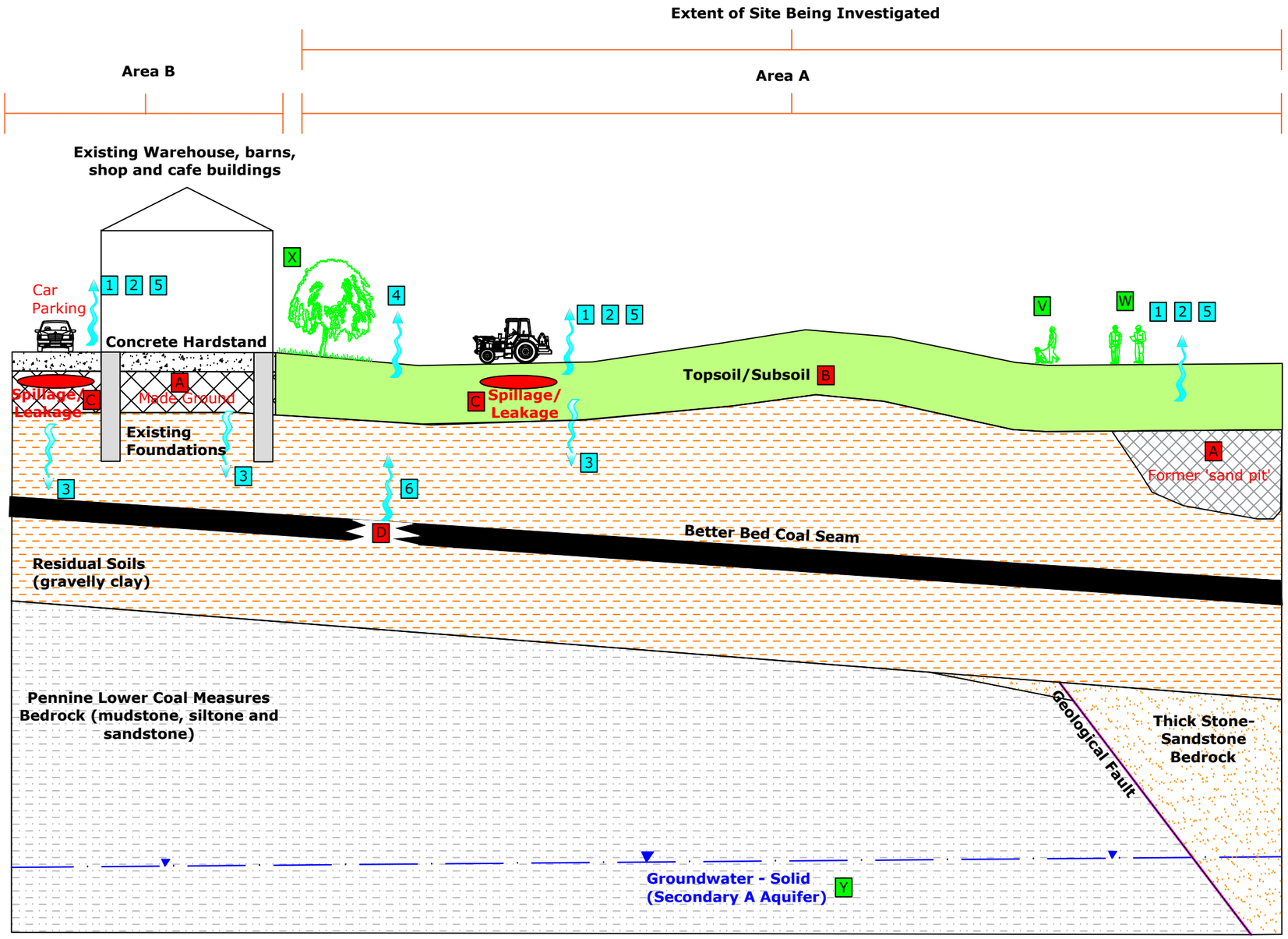

SOURCES	PATHWAYS	RECEPTORS
A MADE GROUND (INORGANICS AND ORGANICS)	1 DERMAL CONTACT	V END USERS (RESIDENTS)
B TOPSOIL (INORGANICS)	2 INGESTION/INHALATION	W SITE WORKERS
C LEAKAGE/SPILLAGE (ORGANICS)	3 LEACHING OF CONTAMINANTS	X VEGETATION
D POSSIBLE MINE WORKINGS (HAZARDOUS GAS)	4 UPTAKE BY PLANTS	Y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

NOTES

REV.	DESCRIPTION	DATE

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JOB TITLE

VILLA FARM, BRADLEY

DRAWING TITLE

PRELIMINARY CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
CC	21/02/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	21/02/19	DRAFT ☐
		FINAL ☑

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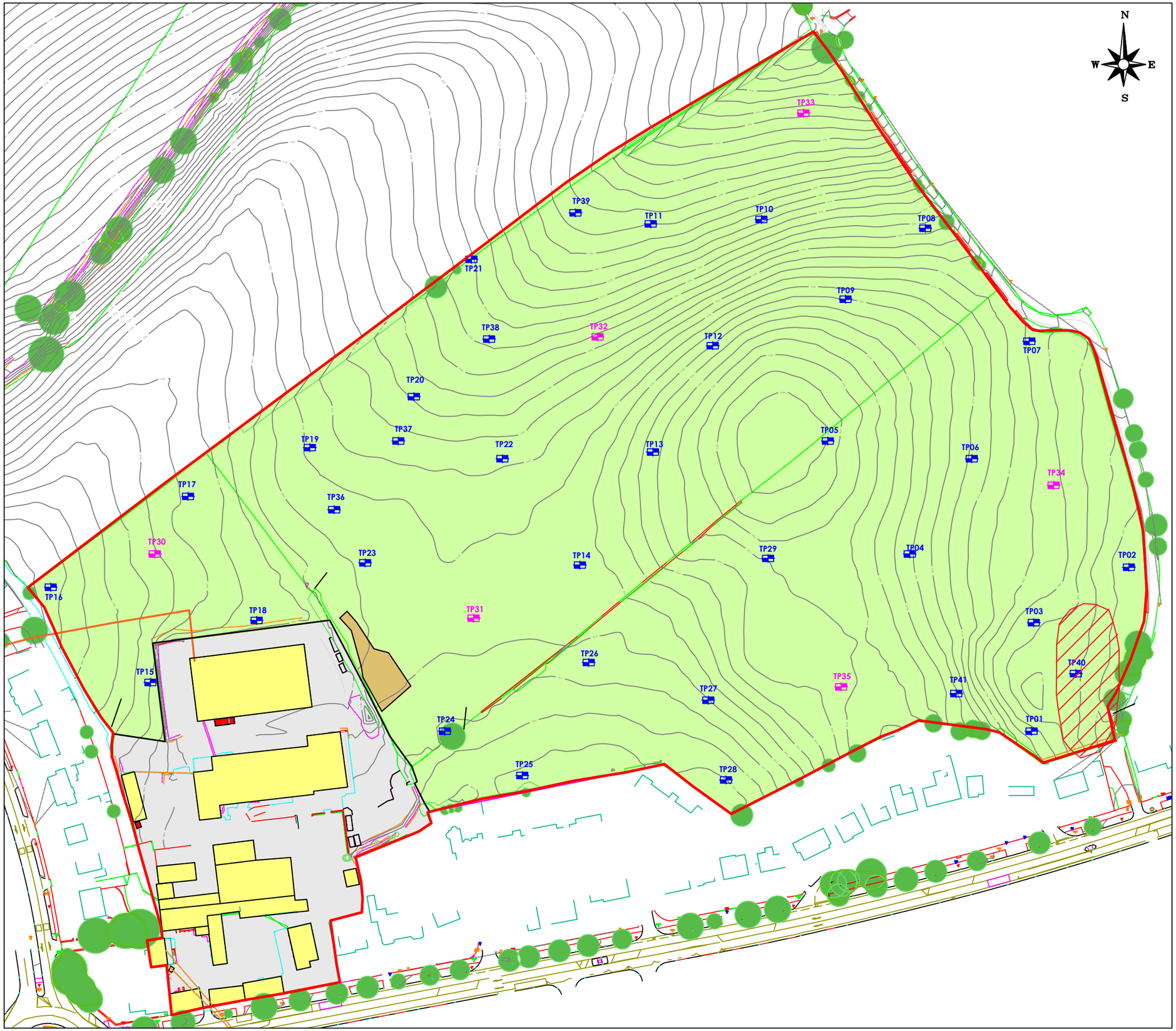


NOTES

- PROPOSED TRIAL PIT LOCATION
- PROPOSED SOAKAWAY LOCATION
- GRASS & OVERGROWN AREAS
- BUILDING
- GRAVEL OR HARDCORE SURFACING
- LINE OF ELECTRICITY UTILITY

NOTE THAT UTILITY LOCATIONS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION PURPOSES, NOR SHOULD IT BE ASSUMED THAT ALL UTILITIES BENEATH THE SITE ARE SHOWN ON THIS PLAN. THERE MAY BE UTILITIES UNKNOWN TO LITHOS. THIS DRAWING IS NOT AN ALTERNATIVE TO VISUAL INSPECTION, USE OF A CAT DETECTION TOOL AND CAREFUL EXCAVATION.

- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

PS & SP
KERSHAW

JOB TITLE

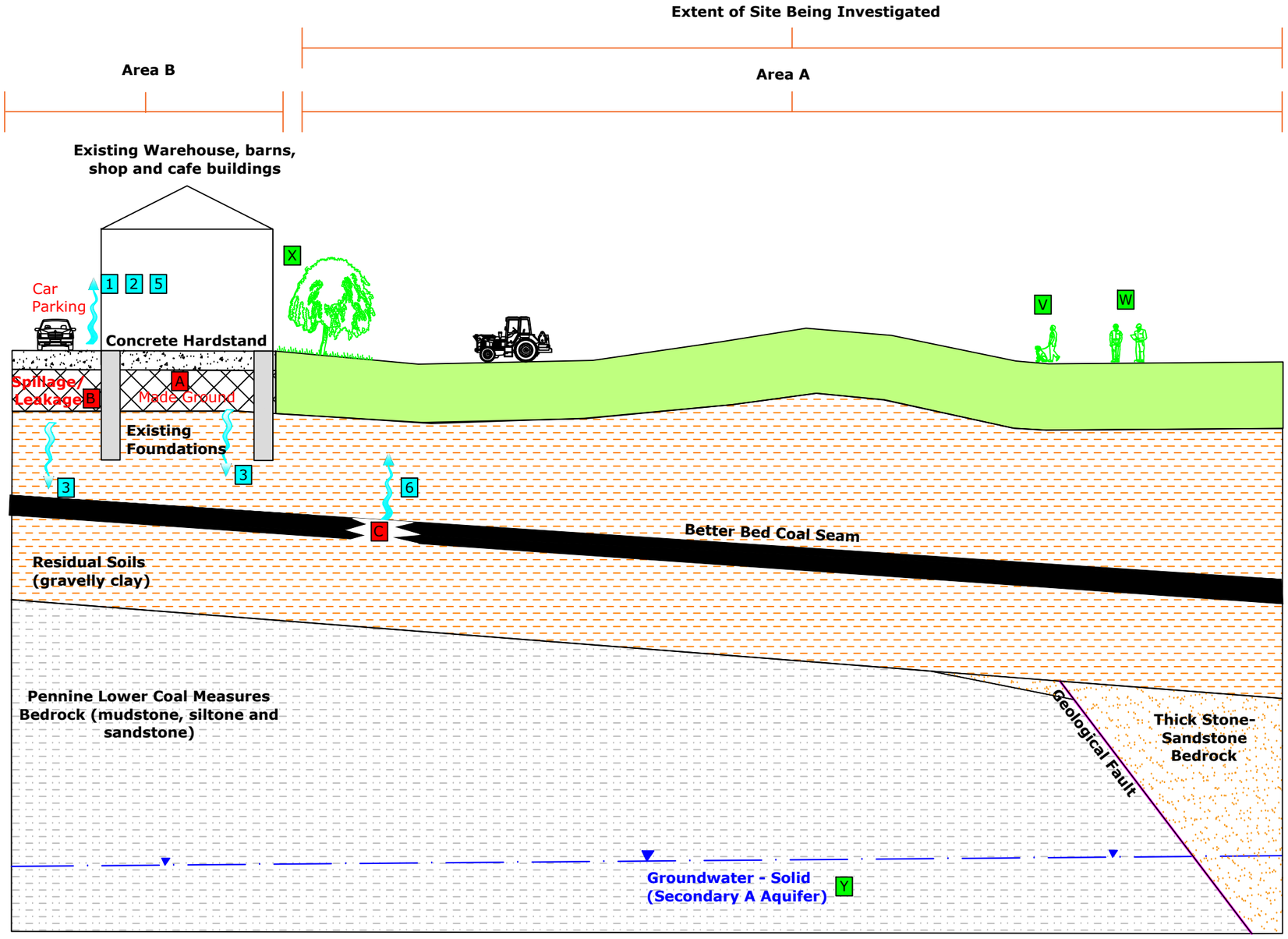
VILLA FARM,
BRADLEY

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	DATE	STATUS
CC	19/02/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	19/02/19	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1500	A3	3319/6	



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

NOTES

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

PS & SP KERSHAW

JOB TITLE

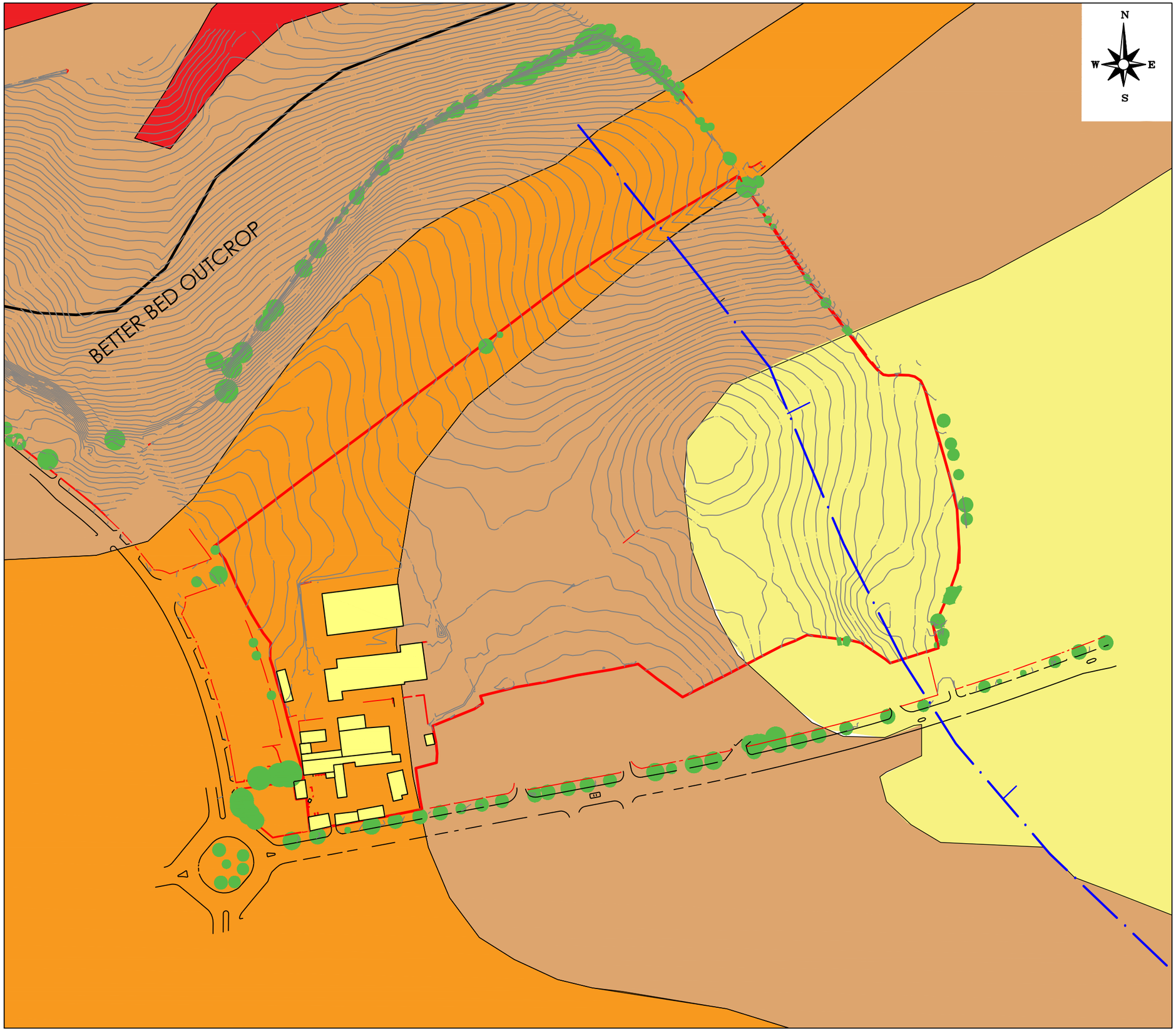
VILLA FARM, BRADLEY

DRAWING TITLE

REVISED CONCEPTUAL SITE MODEL

DRAWN	DATE	STATUS
CC	06/03/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	06/03/19	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	3319/7	



NOTES

- LOWER COAL MEASURES
- GRENOSIDE SANDSTONE
- THICK STONE
- SANDSTONE (LOWER COAL MEASURES)
- GEOLOGICAL FAULT
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

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

Tel 01937 545330

CLIENT

PS & SP
KERSHAW

JOB TITLE

VILLA FARM,
BRADLEY

DRAWING TITLE

SITE GEOLOGY

DRAWN	DATE	STATUS
CC	25/02/19	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
MJT	25/02/19	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:3000	A3	3319/8	

Appendix C

Commission

003/3319/MJT

11th January 2019

Registered in England 07068066

Parkhill
Wetherby
West Yorkshire
LS22 5DZ

T 01937 545 330
www.lithos.co.uk

Mr S Douglas
Savills
Ground Floor
City Point
29 King Street
Leeds
LS1 2HL

Dear Simon

Bradley Villa Farm

Further to your recent enquiry, please find attached our proposal for undertaking an exploratory site investigation on the above land. We understand that the land is being marketed with the benefit of an outline planning consent for the construction of new residential dwellings.

We understand that your Client is funding this investigation, and we confirm that our Report can be assigned to the successful bidder on their instruction. We will require details of the clients (including their invoicing address) or, or prior to, instruction.

Review of the information supplied suggests that the site consists of a single parcel of land of approximately 12.2 hectares off Bradley Road comprising farm buildings (barns, sheds, coffee shop) covering c.2ha in the south-west, and open grassland covering c.10.2ha to the north & east.

It is understood that, at this stage, intrusive investigation will be limited to the grassland and no investigation will be undertaken within the farmyard area.

Lithos have previously undertaken a desk study for the adjacent Bradley Park Golf Course which included this site. Key points from our available data are:

- The site is greenfield (with the exception of Bradley Villa Farm in the south-west)
- No drift deposits are present, ground conditions are likely to comprise topsoil over weathered coal measures bedrock
- There are no landfills within 250m
- The site is not within a groundwater source protection zone

This site is located within a Coal Mining Development Low Risk Area (within the defined coalfield, but no known defined risks have been recorded by the Coal Authority; there may still be unrecorded issues), therefore a Consultant's mining report will be obtained. Land immediately beyond the northern boundary lies within a High Risk Area (an area with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc), and the shallowest coal seam beneath the site is likely to be the Better Bed coal at around 5m to 10m depth along the northern boundary.

Given the above, we will carefully review all available coal authority information (including the consultants mining report) at desk study stage. At this stage, it is considered likely that rotary probing along the northern boundary will be required to confirm the presence, depth and thickness of the Better Bed seam beneath the site, in order to determine whether it poses any significant risk to surface stability. A rate is given for this on the appended cost breakdown (Item D). Alternatively, this could be done at a later stage by a prospective buyer.

Our site investigation will be undertaken in accordance with UK good practice (as outlined in BS5930, BS10175, CLR11 etc). Our Report may not be fully compliant with Eurocode 7 (EC7) and will not purport to be a Ground Investigation Report, nor a Geotechnical Design Report as defined by EC7. Our ground appraisal is intended to assist others as they proceed with design of the proposed development.

This proposal allows for the following works:

Desk study: Environmental search data and historical maps (obtained from Landmark or Groundsure), will be reviewed in order to determine whether past land uses have had any effect on the proposed development. In addition, published geological plans of the area will be examined.

We will also visit site to undertake a walkover survey.

Fieldwork: We have allowed for 3 day's trial pitting, all supervised and logged by an experienced geoenvironmental engineer.

Soakaway testing will also be carried out in at least 6 pits in order to assess suitability of the ground for house and highway surface water drainage. Given the size of the site, if the initial soakaway tests yield satisfactory results, further soakaway tests to provide a tighter grid will likely be required, but this would be best carried out by a prospective developer at a later stage.

In line with current UK guidance, (most notably BRE365 and CIRIA C697:2007) soakaways should not be advocated where the seasonally high groundwater table lies within 1m of the soakaway base. Consequently, if the initial soakaway tests yield satisfactory results, it will be necessary to install groundwater monitoring wells to depths of around 5m in at least 6 boreholes. Given the anticipated depth to bedrock, these boreholes might need to be advanced by rotary probing. The wells should then be monitored on at least 6 occasions over about a year. Again, this would be better carried out by a prospective developer at a later stage.

Representative soil samples of natural and man-made ground, including any contaminated samples, will be taken during the works. In-situ shear strengths of any cohesive soils encountered will be determined by the use of a hand-held shear vane.

The mechanical excavator will be equipped with a breaker to enable excavation where necessary in bedrock (for soakaway tests).

We will make every effort to compact arisings and 'sweep' them over each pit. However, you should be aware that on completion of the investigation, "graves" of spoil (each about 3m long by 1m wide) unsuitable for trafficking, will be left up to 400mm proud at each trial pit location. At this stage, no allowance has been made for any further reinstatement such as removal of excess arisings, replacement of turf.

If the pitting encounters significant thicknesses of made ground or very soft/loose deposits neither considered likely), boreholes may be required to obtain geotechnical data from greater depth. We will advise you of any need for boreholes within 2 days of completion of the pitting.

If mineworkings are found to underlie the site (as/when the rotary probing is carried out), gas monitoring would need to be carried out. This would cost an additional £ , but could be commissioned by a prospective developer at a later stage

This proposal has been put together without a visit to the site and it has been assumed that access is available for a JCB-type excavator along with a tractor towed water bowser. If surface conditions are found to be very boggy, it may be necessary to use a tracked 360º excavator; this would add about £ to the cost.

Testing: This will comprise routine geotechnical soils analysis, including 12 moisture content & Atterberg limits, and 15 pH & water-soluble sulphate.

This site is greenfield and therefore we could obtain in-situ CBR values from plate tests on site. However, at this stage routes, formation level and total length, of proposed estate roads are unknown. Consequently, we will simply estimate CBR values from strata descriptions and classification test results.

The site is understood to be essentially Greenfield, and therefore testing of potentially contaminated samples should only be required if made ground is encountered in the exploratory holes. However, we have allowed for analysis of topsoil (12 samples) to confirm its suitability for re-use. The test suite will include heavy metals and speciated PAH; 2 samples will also be analysed for pesticides.

Within in our proposal we have allowed for the screening (ID) of 12 samples for asbestos. In the event that positive IDs are reported, it is likely that we will need to schedule further analysis (asbestos quantification), in order to determine the significance of the results. Asbestos quantification is currently a relatively expensive test and consequently we have not allowed for it at this stage. We will inform you immediately after receipt of results if we consider asbestos quantification is required.

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

On completion of the desk study, fieldwork and laboratory testing a comprehensive bound, factual and interpretative report will be issued. This will contain detailed engineering records, 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.

Fieldwork could be commenced within 3 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion.

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 **£** (excludes rotary open hole drilling). Variation will only occur in the event that a given item is not undertaken or that substantial additional works are recommended, in which case we will inform you immediately, provide costs for the required works, and seek your prior consent.

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

We will submit our invoices on completion of each of the items instructed, however we may require partial payment prior to carrying out the fieldwork.

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

Details of welfare will be included within the Method Statements, however, this investigation is expected to be completed within 3 working days and therefore it is not considered reasonably practicable to provide formal welfare facilities, and our proposal makes no allowance for so doing.

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

If you have copies of the necessary utility plans (including electricity, gas, water, drainage & telecom), 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.

Further work: Given the anticipated relatively simple nature of this site from a ground perspective, significant additional SI work is not anticipated. However, the following items may potentially need undertaking by future developers:

- Installation of shallow (c. 3m) wells, with subsequent groundwater monitoring & letter report – c. £
- Additional soakaway testing (if initial tests are successful) – c. £ per day

In addition to the above, it is likely that rotary openhole drilling to investigate mineworkings will be required along the northern boundary (to be confirmed on receipt of Coal Authority information). This would cost £ (Item D) but could be carried out at a later stage by a prospective buyer. If the initial drilling confirmed shallow coal within influencing distance of the site, additional drilling would be required to determine extent and risks associated with mineworkings to the remainder of the site, at which stage revised costs would be quoted.

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

At the time of writing, we understand that our report is solely for you client's benefit. However, it is anticipated that eventually a third party (the Developer) will wish to rely on our report. We confirm that we will assign, free of charge, the benefit of our Report(s) to the Developer on receipt of an instruction from your client. In the event that both your client and the Developer require reliance, or if more than one Developer requires reliance, a warranty will be required. We confirm that we will consent to a request from your client to enter a collateral warranty, provided it is our approved standard form, and subject to payment of a fee to cover our legal and incidental costs. We will require approval from our insurers if more than one beneficiary requires a warranty, or if the proposed warranty is not Lithos' approved standard form.

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

Yours sincerely

Matt Thompson
Associate Director
for and on behalf of
LITHOS CONSULTING LIMITED

Terms and Conditions for the Appointment of Lithos Consulting Limited

V006.18

1 DEFINITIONS AND INTERPRETATION

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

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

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

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

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

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

"Parties" shall mean the Client and Lithos

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

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

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

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

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

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

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

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

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

2 APPOINTMENT

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

3 OBLIGATIONS OF LITHOS

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

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

4 OBLIGATIONS OF THE CLIENT

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

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

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

5 INTELLECTUAL PROPERTY

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

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

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

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

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

6 TITLE

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

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

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

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

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

7 CONFIDENTIALITY AND DATA PROTECTION

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

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

8 THIRD PARTIES

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

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

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

9 INSURANCE

9.1 Lithos warrants to the Client that there is in force a policy of Professional Indemnity insurance covering its liabilities for negligence under this Agreement, with a limit of indemnity of £5,000,000 (FIVE MILLION POUNDS) any one claim, save for pollution and contamination claims and asbestos claims both of which carry £2,000,000 (TWO MILLION) in the aggregate cover. This policy is annually renewable and whilst renewal is not automatic, Lithos agrees to use reasonable endeavours to maintain such insurance at all times until six years from the date of the completion (or termination) of the Services under the Agreement, provided such insurance is available at commercially reasonable rates having regard, inter alia, to premiums required and policy terms obtainable.

9.2 If for any period such insurance is not available at commercially reasonable rates, Lithos shall forthwith inform the Client and shall obtain in respect of such period such reduced level of Professional Indemnity insurance as is available and as would be fair and reasonable in the circumstances for Lithos to obtain.

10 LIMITATIONS ON LIABILITY

10.1 Unless otherwise agreed in writing, Lithos' liability under or in connection with the Agreement whether in contract, tort, negligence, breach of statutory duty or otherwise (other than in respect of personal injury or death) shall be limited to and shall not exceed the lesser of either five million pounds in the aggregate (unless it is a pollution, contamination or asbestos claim in which case it is two million pounds in the aggregate) or 10 times the total value of invoices issued to the Client for consultancy work instructed under the Agreement.

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

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

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

11 PAYMENT

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

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

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

11.4 In the event of failure on the part of the Client to pay any monies in accordance with the foregoing payment provisions, Lithos will be entitled to charge interest on any monies owed to it by the Client, such interest to be at a rate of 8% above the base rate of a clearing bank from time to time calculated from the final date for payment to the date of actual payment on a compound basis.

12 DELAY

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

13 TERMINATION

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

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

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

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

14 NOTICES

14.1 Any notice provided for in the Agreement shall be in writing and shall be deemed to be properly given if delivered by hand or sent by first class post to the address of the relevant party as may have been notified by each party to the other or, in the absence of notification, to the address of Lithos set out above or to the registered address of the Client.

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

15 ENTIRE AGREEMENT

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

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

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

16 DISPUTES AND GOVERNING LAW

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

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

Charlotte Copley

Subject: FW: Bradley Villa Farm, Bradley, Huddersfield

From: Simon Douglas <SDouglas@savills.com>
Sent: 18 January 2019 16:31
To: Matt Thompson <Matt.thompson@lithos.co.uk>
Subject: Bradley Villa Farm, Bradley, Huddersfield

Dear Matt

Please accept this email as confirmation that Sue Kershaw would like to instruct Lithos to undertake the ground investigation as set out in your quotation dated 11th January 2019. Please exclude the Rotary Open Hole drilling which makes a total of £ .

All the best

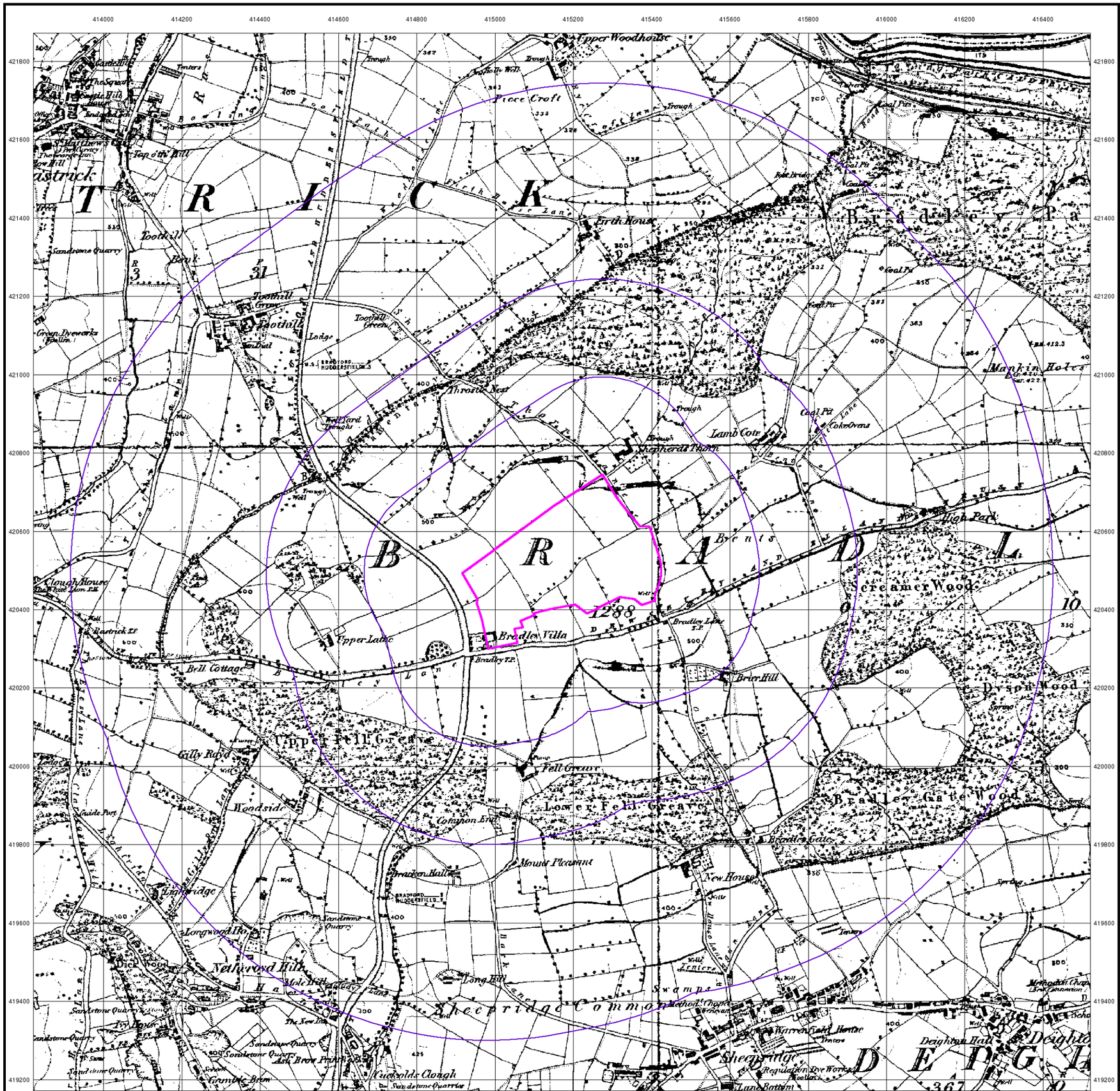
Simon

Simon Douglas BSc(Hons) MRICS DipArb MCIArb
Director
Development

Savills, Ground Floor, City Point, 29 King Street, Leeds LS1 2HL
Tel :+44 (0) 113 220 1253
Mobile :+44 (0) 7870 999 482
Email :sdouglas@savills.com
Website :www.savills.co.uk

Appendix D

Historical OS Plans



LITHOS CONSULTING

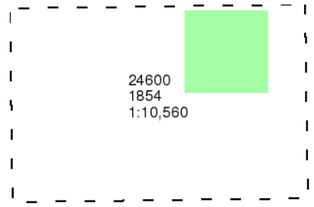
Yorkshire

Published 1854

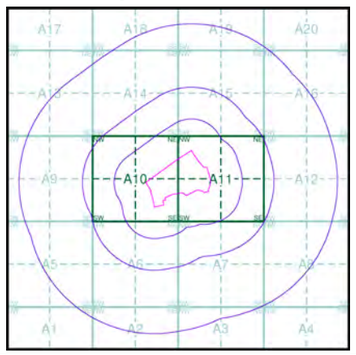
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



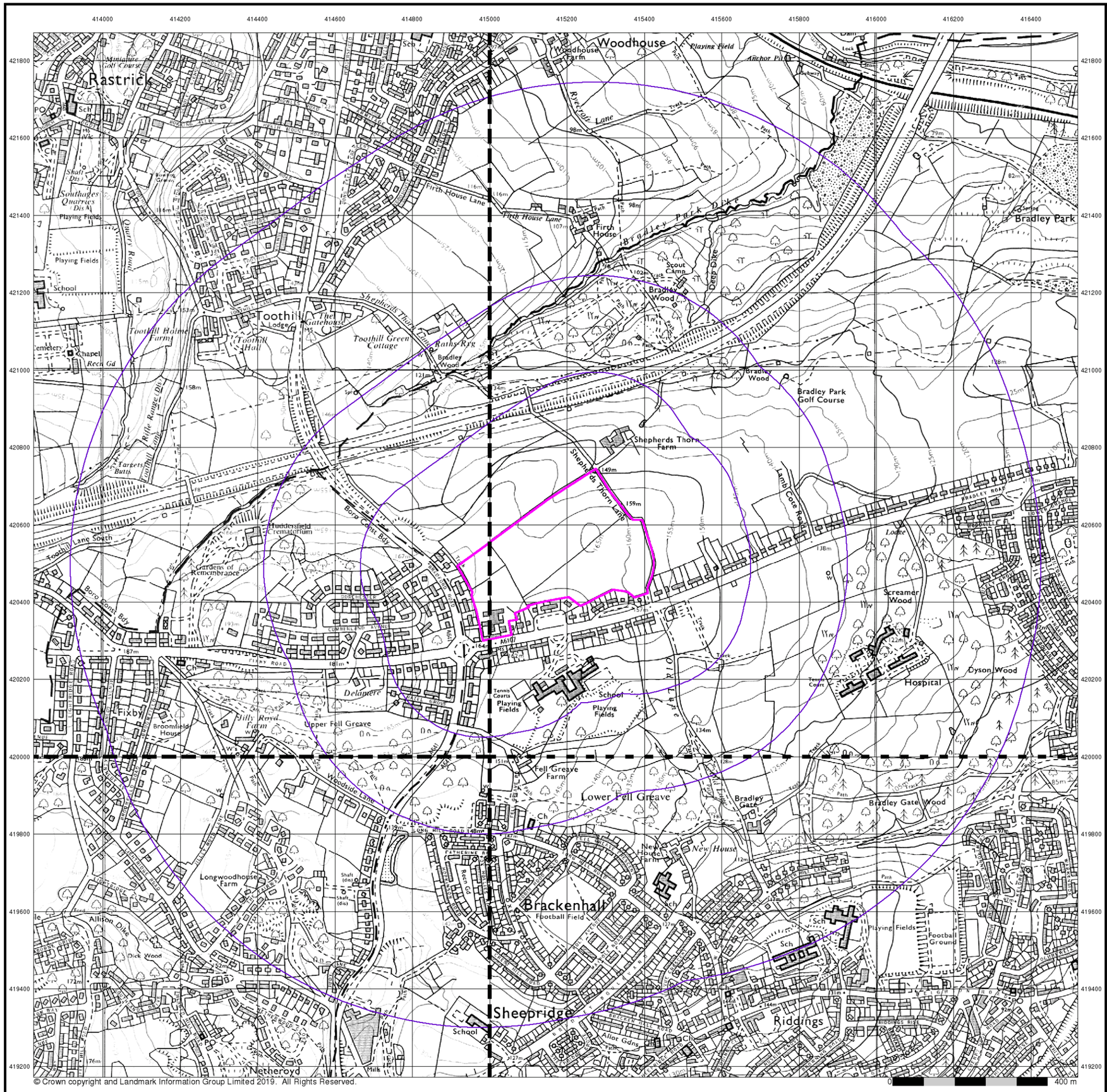
Order Details

Order Number:	192531415_1_1
Customer Ref:	PO14098/JW/3319
National Grid Reference:	415180, 420500
Slice:	A
Site Area (Ha):	11.85
Search Buffer (m):	1000

Site Details

13, Torcote Crescent, HUDDERSFIELD, HD2 2JU

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



LITHOS CONSULTING

Ordnance Survey Plan

Published 1976 - 1978

Source map scale - 1:10,000

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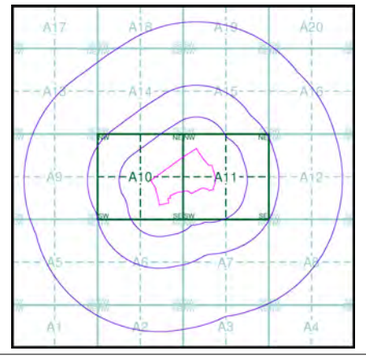
Map Name(s) and Date(s)

SE12SW 1978 1:10,000	SE12SE 1977 1:10,000
SE11NW 1978 1:10,000	SE11NE 1976 1:10,000

Historical Map - Slice A



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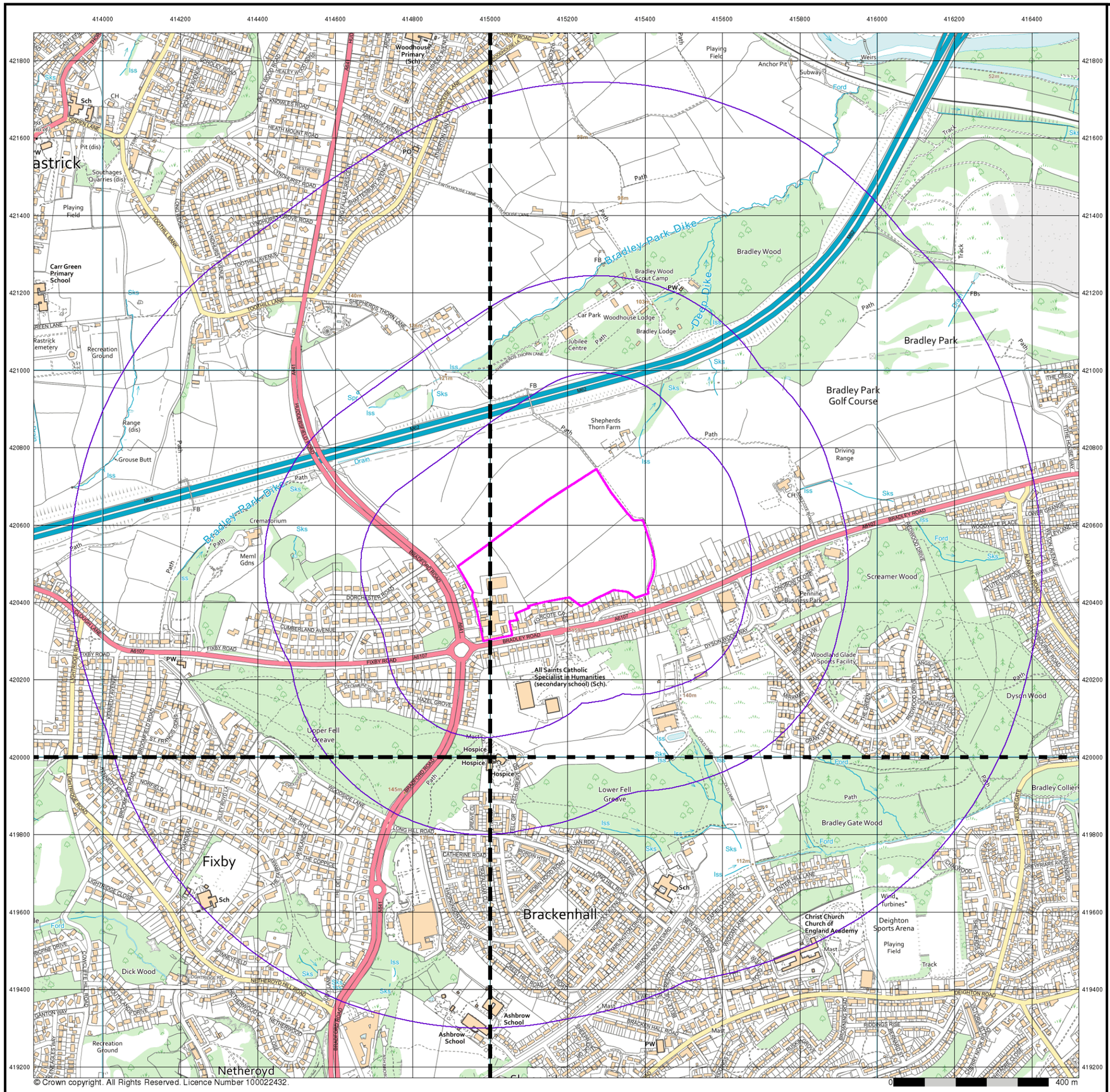


0 400 m

LITHOS CONSULTING

VectorMap Local

Published 2019

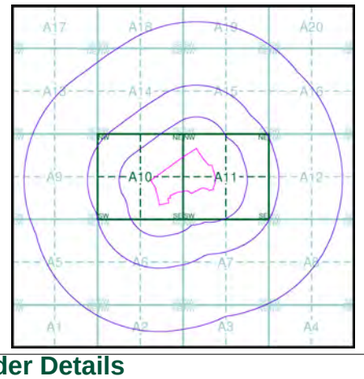
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities),1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)

SE12SW 2019 Variable	SE12SE 2019 Variable
SE11NW 2019 Variable	SE11NE 2019 Variable

Historical Map - Slice A



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Search Buffer (m):	1000

Site Details

13, Torcote Crescent, HUDDERSFIELD, HD2 2JU

Landmark INFORMATION GROUP

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Web: www.envirocheck.co.uk

Appendix E

Search Responses & other Correspondence

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
192531415_1_1

Customer Reference:
PO14098/JW/3319

National Grid Reference:
415180, 420500

Slice:
A

Site Area (Ha):
11.85

Search Buffer (m):
1000

Site Details:

13, Torcote Crescent
HUDDERSFIELD
HD2 2JU

Client Details:

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

LITHOS CONSULTING

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes	Yes	Yes	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 3				11
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 6				3
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 6		Yes		
Pollution Incidents to Controlled Waters	pg 7				5
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality					
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register	pg 7			1	
Water Abstractions	pg 8		4		(*23)
Water Industry Act Referrals					
Groundwater Vulnerability	pg 14	Yes	n/a	n/a	n/a
Drift Deposits			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 14	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
OS Water Network Lines	pg 15		3	34	38

Summary

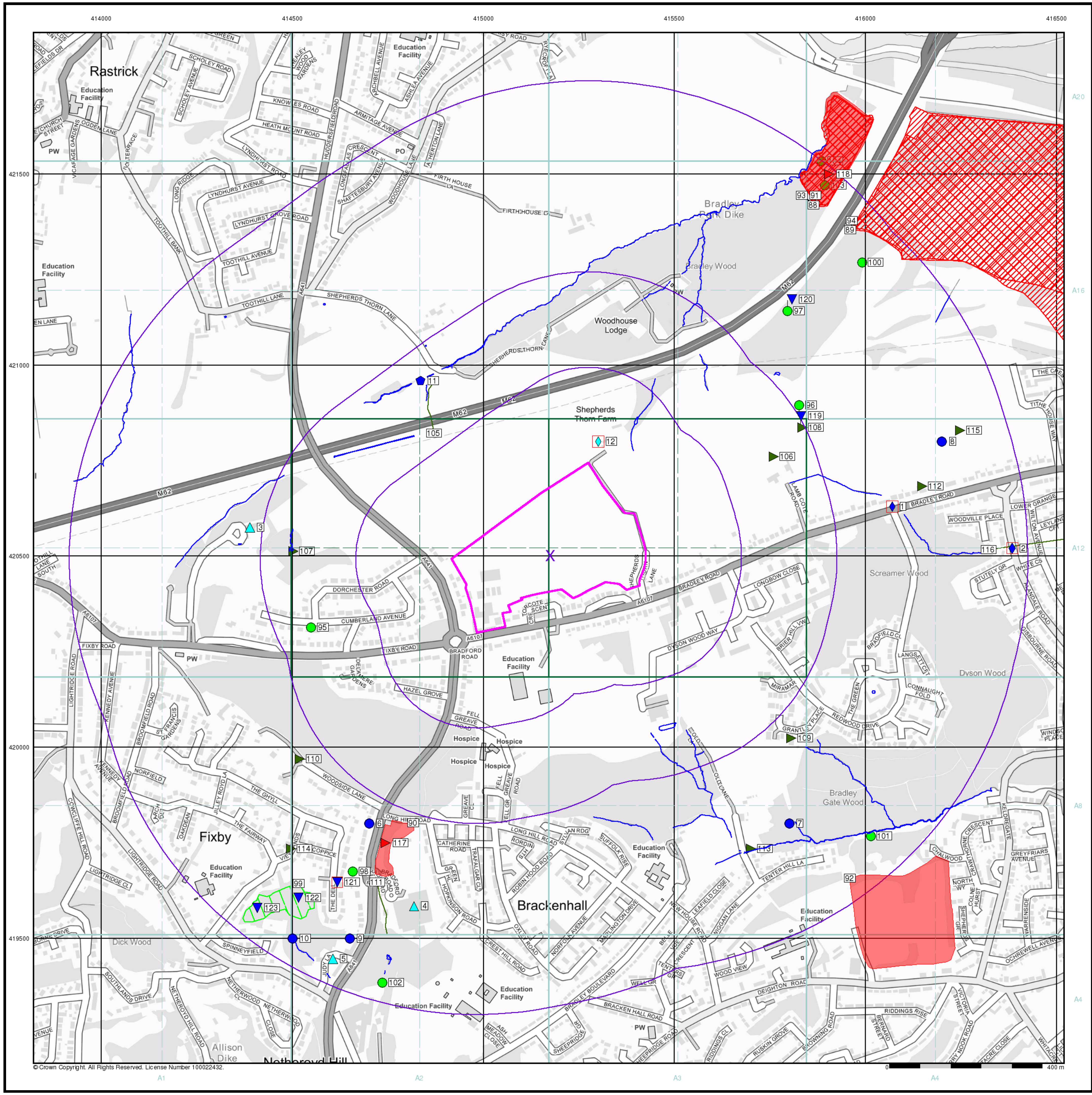
Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites	pg 24				2
Historical Landfill Sites	pg 24				3
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)	pg 24				2
Licensed Waste Management Facilities (Locations)					
Local Authority Landfill Coverage		1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 25			1	9
Potentially Infilled Land (Water)	pg 25			3	9
Registered Landfill Sites	pg 26				2
Registered Waste Transfer Sites					
Registered Waste Treatment or Disposal Sites					
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Geological					
BGS 1:625,000 Solid Geology	pg 28	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 28	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 35				6
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 36	Yes	n/a	n/a	n/a
Mining Instability	pg 36	Yes	n/a	n/a	n/a
Man-Made Mining Cavities	pg 36				1
Natural Cavities					
Non Coal Mining Areas of Great Britain	pg 36		Yes	n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 36	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 36		Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 36	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 37		Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 37	Yes	Yes	n/a	n/a
Radon Potential - Radon Affected Areas			n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 38		3	13	11
Fuel Station Entries	pg 40				1
Points of Interest - Commercial Services	pg 40			1	5
Points of Interest - Education and Health	pg 41			1	
Points of Interest - Manufacturing and Production	pg 41	1		1	
Points of Interest - Public Infrastructure	pg 41				9
Points of Interest - Recreational and Environmental	pg 42				4
Gas Pipelines					
Underground Electrical Cables					

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland	pg 43		1	3	
Areas of Adopted Green Belt	pg 43	1		1	
Areas of Unadopted Green Belt	pg 43	1			
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones					
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					



LITHOS CONSULTING

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID
- Several of Type at Location

Agency and Hydrological

- Contaminated Land Register Entry or Notice (Location)
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Local Authority Integrated Pollution Prevention and Control
- Local Authority Pollution Prevention and Control
- Local Authority Pollution Prevention and Control Enforcement
- Pollution Incident to Controlled Waters
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Registered Radioactive Substance
- River Network or Water Feature
- River Quality Sampling Point
- Substantiated Pollution Incident Register
- Water Abstraction
- Water Industry Act Referral

Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

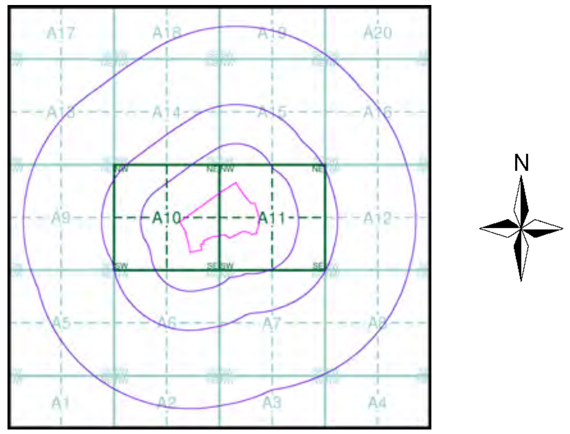
Geological

- BGS Recorded Mineral Site

Waste

- BGS Recorded Landfill Site (Location)
- BGS Recorded Landfill Site
- EA Historic Landfill (Buffered Point)
- EA Historic Landfill (Polygon)
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facility (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Local Authority Recorded Landfill Site (Location)
- Local Authority Recorded Landfill Site
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Non-water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Potentially Infilled Land (Water)
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Slice A



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Site Details

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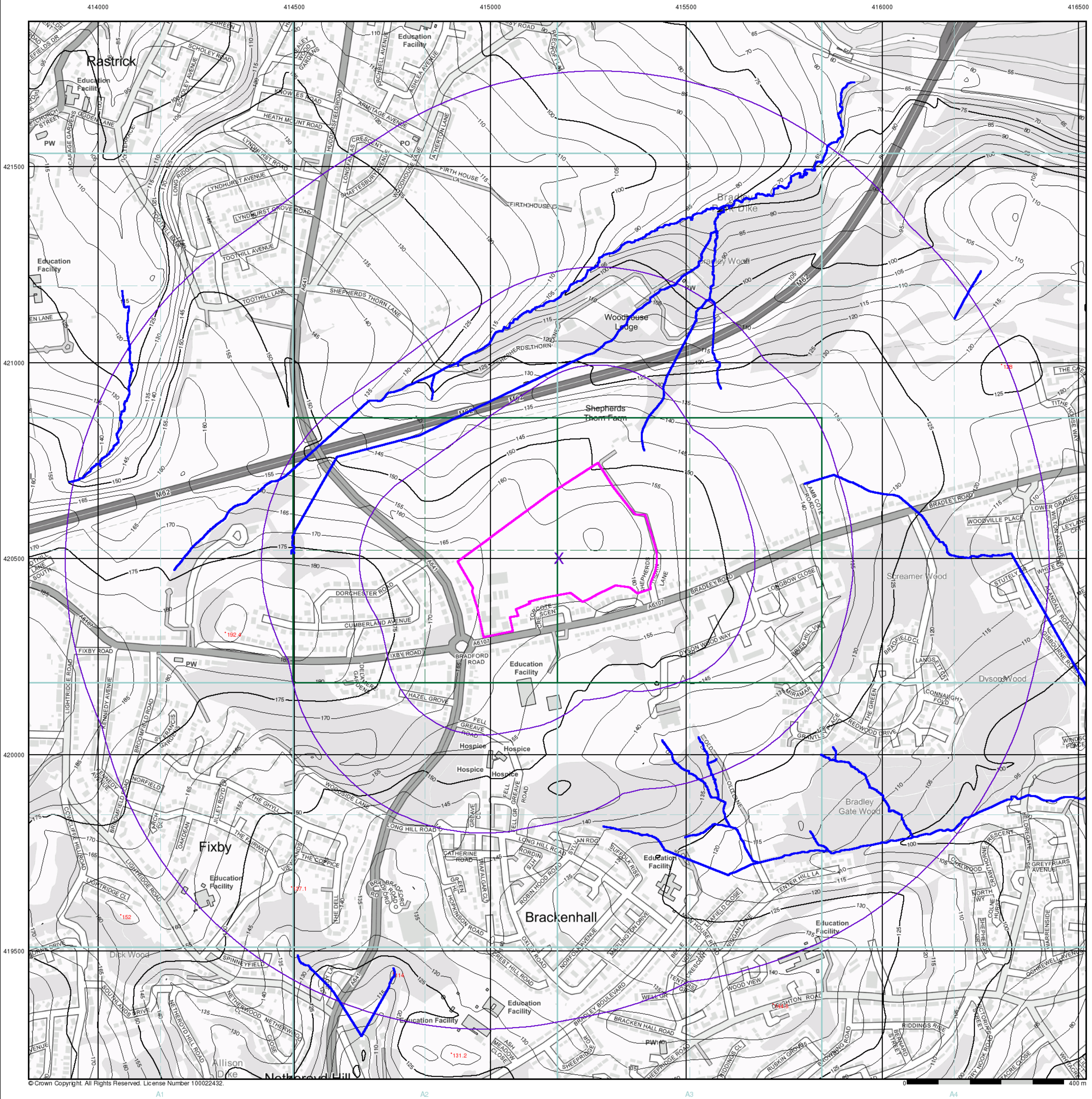


LITHOS CONSULTING

General

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

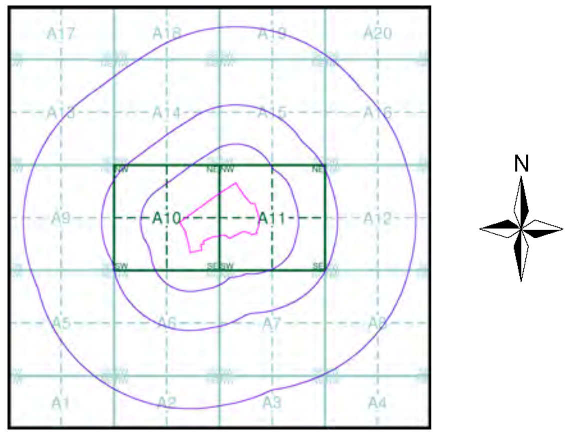
OS Water Network Data

- Canal
- Reservoir
- Foreshore
- Marsh
- Tidal River
- Inland River
- Drain
- Other
- Lake
- Transfer
- Lock Or Flight Of Locks
- Sea

Contours (height in meters)

- Standard Contour
- Master Contour
- Spot Height 167.3
- Mean Low Water
- Mean High Water

OS Water Network Map - Slice A



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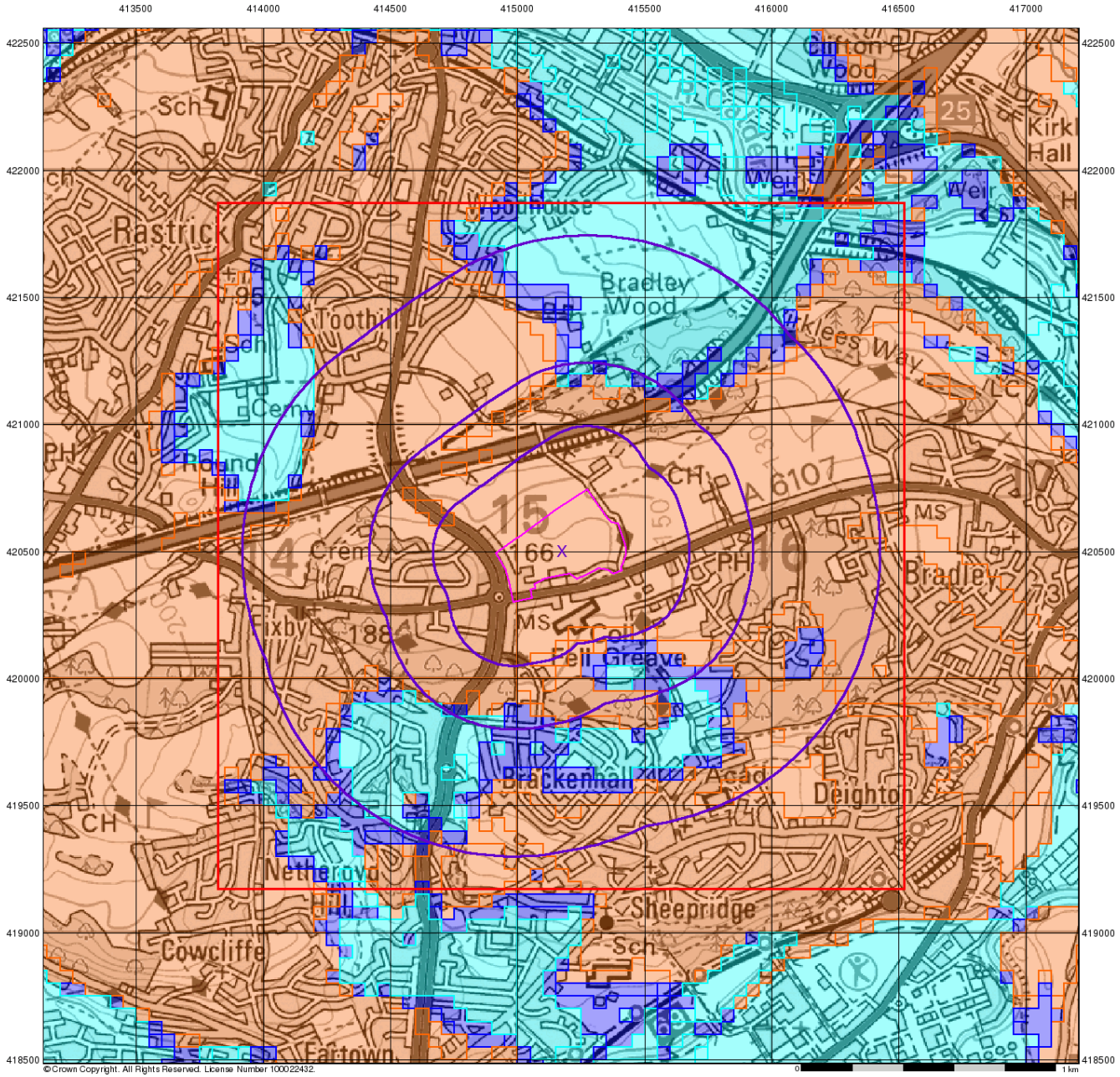

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BGS Flood GFS Data

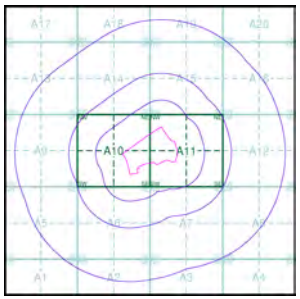
General

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

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



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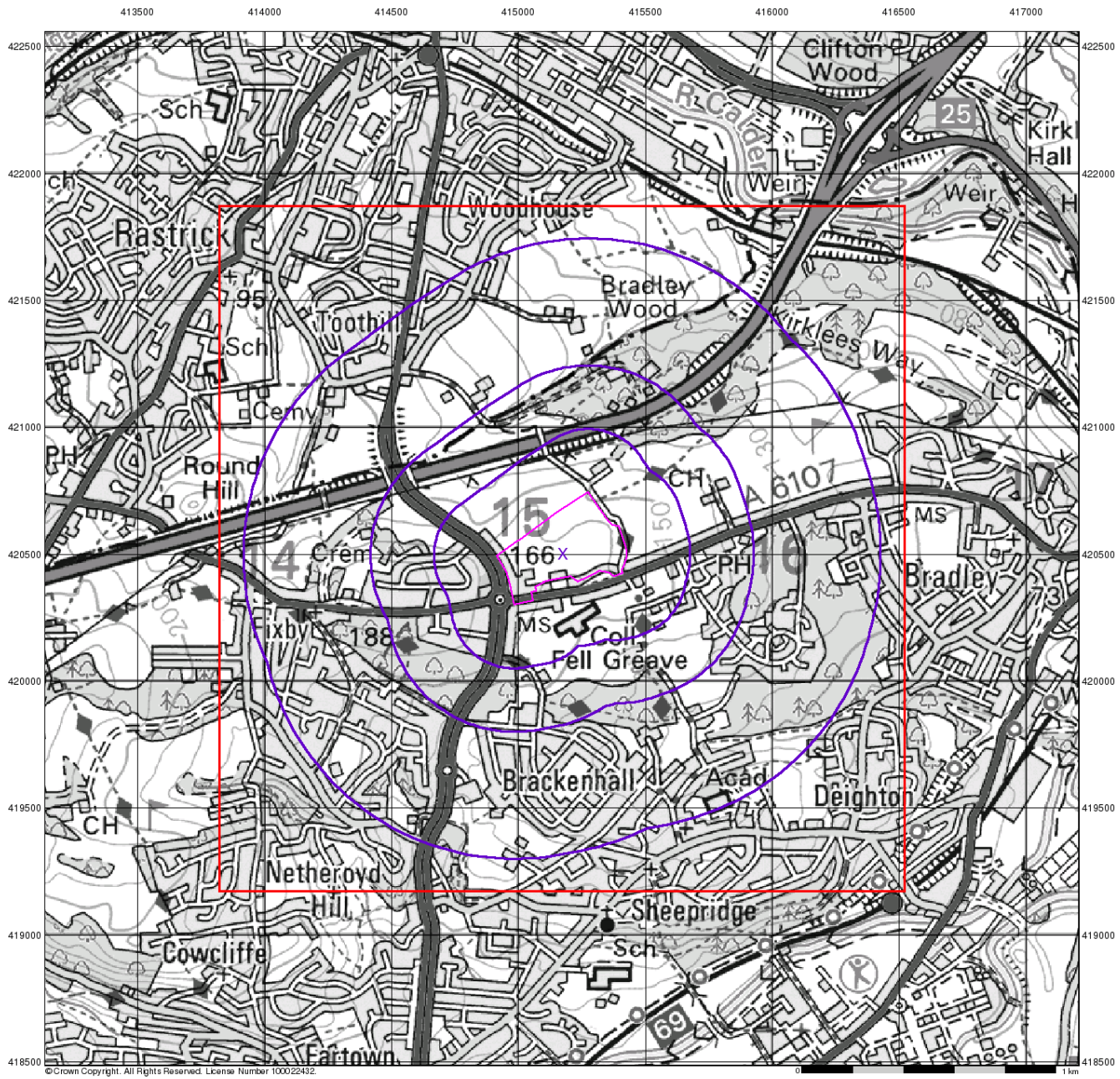


LITHOS CONSULTING

Source Protection Zones

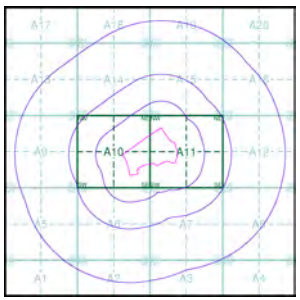
General

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

Agency and Hydrological

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

Site Sensitivity Context Map - Slice A



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Search Buffer (m):	1000

Site Details

13, Torcote Crescent, HUDDERSFIELD, HD2 2JU

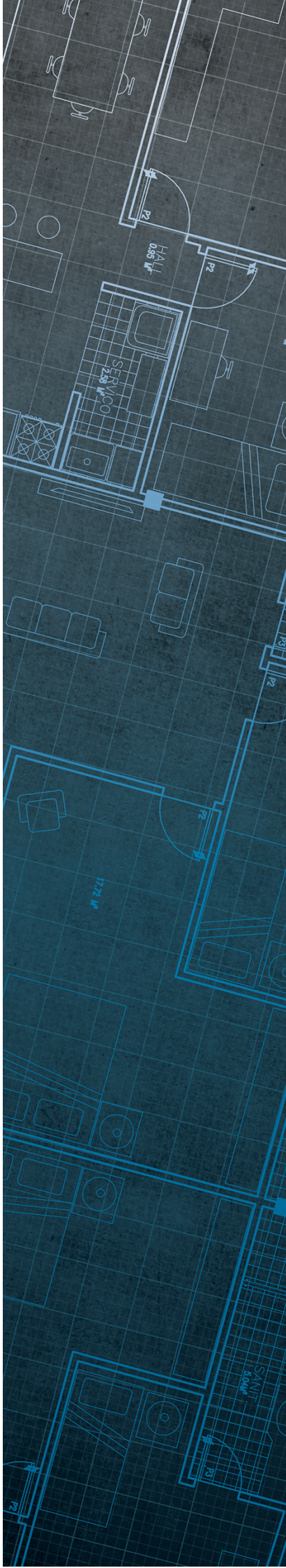
The Coal Authority

Consultants

Coal Mining Report

Bradley Villa Farm
Huddersfield
HD2 2JY

Date of enquiry:	**30 January 2019**
Date enquiry received:	**30 January 2019**
Issue date:	**30 January 2019**
Our reference:	**51002003374001**
Your reference:	**PO14102/JW/3319**



Consultants

Coal Mining Report

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

Client name

LITHOS CONSULTING LTD

Enquiry address

Bradley Villa Farm
Huddersfield
HD2 2JY

Approximate position of property

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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
No past mining recorded.

Probable unrecorded shallow workings
None.

Spine roadways at shallow depth
No spine roadway recorded at shallow depth.

Mine entries
None recorded within 100 metres of the enquiry boundary.

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

1167	FGB272	1801
7712	4299	FGB274
11052	PO0	6698

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

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

Outcrops
No outcrops recorded.

Geological faults, fissures and breaklines
No faults, fissures or breaklines recorded.

Opencast mines
None recorded within 500 metres of the enquiry boundary.

Coal Authority managed tips
None recorded within 500 metres of the enquiry boundary.

Section 2 – Investigative or remedial activity

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

Site investigations
None recorded within 50 metres of the enquiry boundary.

Remediated sites
None recorded within 50 metres of the enquiry boundary.

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

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

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

Mine gas
None recorded within 500 metres of the enquiry boundary.

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

Section 3 – Licensing and future mining activity

Future underground mining
None recorded.

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

Court orders
None recorded.

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

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

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

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

Section 4 – Further information

Based on the responses in this report, no further information has been highlighted.

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

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

From:	Steve Meredith
To:	Charlotte Copley
Cc:	Matt Thompson; James Smith; Philip Smith
Subject:	FW: [External] FW: Planning and technical advice
Date:	14 March 2019 16:16:00
Attachments:	image002.jpg image004.jpg image001.png

Good afternoon,

RE: Bradley Villa Farm, Huddersfield, HD2 2JY

Thank you for your enquiry on the email below. After chatting briefly to you while you were on site and then at length with Matt I thought it best to cover what was said in an email.

I can confirm that the Coal Authority are happy with the extent of our Development High Risk Area. The Better Bed coal seam outcrops to the north of your site and while we generally give a 50m buffer on the dipside of an outcrop, I notice that in this case it is extended a further 70m by an area of probable shallow workings. This brings it to within 60m of the north western corner of your site.

However, as discussed on the phone with Matt, our datasets are inherited from British Coal and it is impractical for us to check and validate everything. If you feel that there is a chance that there is shallow coal beneath your site then we would advise you to investigate this possibility to the best of your professional abilities.

I hope this information is of some use to you.

Many thanks,

Steve

Steve Meredith
Mining Information Manager
T : (01623) 637 317
W : **www.gov.uk/coalauthority**

From: Planning Advice
Sent: 26 February 2019 08:28
To: Steve Meredith
Subject: FW: [External] FW: Planning and technical advice

Morning Steve

Hope you're well.

I understand that Huddersfield is in your neck of the woods, so I'm hoping you'll be able to help

Charlotte Copley at Lithos.

She's emailed the Planning and Technical Advice inbox (chargeable service), however, her enquiry relates entirely to matters regarding the reasoning behind the extent of the Development High / Low Risk Areas relative to her study site. As such, the enquiry relates to our data and Planning and Permitting would not have anything of use to feed back at this stage of the development proposals.

Are you/MI able to provide Charlotte with some comments re how we defined the DHRA and DLRAs? If this represents a chargeable service, please let her know.

Thanks
James

From: Charlotte Copley [mailto:Charlotte.Copley@lithos.co.uk]
Sent: 22 February 2019 12:14
To: Planning Advice
Subject: [External] FW: Planning and technical advice

Apologies for a second email, however, I just noticed a typo- the coal outcrops 200m north of site, not 20m.

Many thanks,
Charlotte

Charlotte Copley
Graduate Engineer
Lithos Consulting Ltd
M 07507 503 333
DD 01937 545 359

www.lithos.co.uk

From: Charlotte Copley
Sent: 22 February 2019 12:09
To: 'planningadvice@coal.gov.uk' <planningadvice@coal.gov.uk>
Cc: Matt Thompson <Matt.thompson@lithos.co.uk>
Subject: Planning and technical advice

Good Afternoon,

Please could I request a pre-application advice service.

We are a geoenvironmental consultancy providing advice on proposed housing developments and currently have a site 'Villa Farm, Bradley'. The site lies within a Coal Mining Development Low Risk Area, however, a Coal Authority Development High Risk Area lies just beyond the northern and eastern boundary of site.

The High Risk Area to the north contains the Better Bed Coal Seam and has associated probable shallow workings. The High risk area to the east does not contain any probable shallow workings.

From looking at BGS maps the Better Bed Coal seam outcrops around 20m north of the site , with rocks younging to the south. Using the GVS we have estimated that the Better Bed Coal seam will be around 5-10m depth below the north of the site.

Due to the coal appearing to be very shallow in the north of site, is there a reason why the site (particularly the north) is a Low Risk area/ is unlikely to have been mined underneath the site if the coal is likely to be at a shallow depth, and why the area to the east is also classed as high risk even though there are no probable shallow workings?

The postcode for the site is HD2 2JT.

Please find attached and OS Map with the site and CA/BGS data overlain and the Coal Authority Report. If any terms and conditions need to be signed, please don't hesitate to contact me.

Before starting on this, please could you give me the cost of the work?

I look forward to hearing from your response,

Kind Regards,
Charlotte

Charlotte Copley
Graduate Engineer
Lithos Consulting Ltd

Parkhill
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M 07507 503 333
DD 01937 543 359

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Appendix F

Trial Pit Logs

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP01
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415371.00 - 420427.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.5 × 0.7, Depth 2.10	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to medium angular to subangular of sandstone. (TOPSOIL)
	0.60	D		1.20			Light orange clayey slightly gravelly SAND. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (GRANULAR RESIDUAL SOIL)
				1.90			Light orange slightly clayey SAND and GRAVEL with low cobble content. Gravel is fine to coarse angular to subangular of sandstone. Cobbles are tabular and up to 15cm in size. (GRANULAR RESIDUAL SOIL)
	2.00	D	HVP=80	2.10			Firm light orange and grey mottled gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL) *At 2.1m bedrock encountered, unable to excavate further.* End of pit at 2.10 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP02
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415415.00 - 420501.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.4 × 0.7 Depth 1.60	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to medium angular to subangular of sandstone. (TOPSOIL)
							Firm light orange sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
▼	0.90	D	HVP=50				*At 1.2m, groundwater seepage.*
							At 1.5m, sandstone boulder c.30cm in size excavated.
				1.60			*At 1.6m bedrock encountered, unable to excavate further.* End of pit at 1.60 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 1.2m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP03**

Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415372.00 - 420476.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.6 × 0.7 Depth 2.30	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to coarse subangular to subrounded of sandstone. (TOPSOIL)
	0.60 0.70	B D	HVP=55				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY with low cobble content. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. Cobbles are angular of sandstone. (COHESIVE RESIDUAL SOIL) *Higher cobble content with depth.*
			HVP=30	2.10			Firm with localised softer patches light orange gravelly CLAY with medium cobble content. Gravel is fine to coarse angular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL) *At 2.2m, groundwater seepage.* *At 2.3m bedrock encountered, unable to excavate further.*
▼				2.30			End of pit at 2.30 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 2.3m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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

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Trial Pit Log

Trialpit No **TP04**

Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415316.00 - 420507.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.3 × 0.7, Depth 2.10	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40			Dark grey organic rich slightly clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (TOPSOIL)
	0.50	D	HVP=40				Firm light orange and grey mottled sandy slightly gravelly CLAY with low cobble content. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				1.70			Light orangish grey clayey SAND and GRAVEL. Gravel is fine to coarse angular to subangular of thily laminated fine grained sandstone. Laminations are c.1cm in thick. (GRANULAR RESIDUAL SOIL)
▼				2.00 2.10			Weak light orangish grey, angular COBBLES of thinly laminated sandstone. (GRANULAR RESIDUAL SOIL) *At 2.1m, groundwater seepage.* *At 2.1m bedrock encountered, unable to excavate further.* End of pit at 2.10 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 2.1m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP05
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415279.00 - 420558.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.5 × 0.7 Depth 1.80	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly gravelly SAND with occassional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.50	D	HVP=40	0.70			Firm light orange and grey mottled gravelly CLAY with high cobble content. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
			HVP=50				Firm light orange and grey mottled slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
							From 1.5m, clay becomes dry and is recovered as a fine to coarse, sub angular to sub rounded gravel.
				1.80			*At 1.8m bedrock encountered, unable to excavate further.*
							End of pit at 1.80 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP06
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415344.00 - 420550.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.3 × 0.7, Depth 3.00	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Dark grey organic rich clayey SAND with occassional rootlets. (TOPSOIL)
				0.30			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
			HVP=55				
				1.50			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
							Clay recovered as a fine to coarse, angular to sub angular GRAVEL.
				2.40			Light greyish brown fine to coarse angular to subangular GRAVEL and COBBLES of thinly laminated fine grained sandstone. Laminations are c.1m in thick. (GRANULAR RESIDUAL SOIL)
							At 3.0m bedrock encountered, unable to excavate further.
				3.00			End of pit at 3.00 m

1 2 3 4 5

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

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

AGS

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Trial Pit Log

Trialpit No **TP07**

Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415370.00 - 420603.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.2 × 0.7 Depth 1.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly sandy slightly gravelly CLAY with occassional rootlets. Gravel is fine to coarse subangular to subrounded of sandstone. (TOPSOIL)
	0.60	D	HVP=40				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
▼				1.50			*At 1.5m, groundwater seepage.* *At 1.5m bedrock encountered, unable to excavate further.* End of pit at 1.50 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 1.5m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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

AGS

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Trial Pit Log

Trialpit No
TP08
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415323.00 - 420654.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.5 × 0.7 Depth 3.10	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	J&T		0.30			Dark grey organic rich clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to medium subangular to subrounded of sandstone. (TOPSOIL)
	0.60	D	HVP=70				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
							From 1.4m, clay is recovered as a fine to coarse, angular to sub angular gravel.
				1.80			Light greyish orange slightly clayey fine to coarse, angular GRAVEL and COBBLES of thinly laminated sandstone, siltstone and occassional siderite nodules. Laminations are c.1cm in size. (GRANULAR RESIDUAL SOIL)
							At 3.1m bedrock encountered, unable to excavate further.
				3.10			End of pit at 3.10 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP09**

Sheet 1 of 1

Project Name:	Villa Farm, Bradley	Project No. 3319	Co-ords: 415287.00 - 420622.00 Level:
Location:	Huddersfield	Dimensions (m): 2.3 × 0.7	Scale 1:25
Client:	PS & SP Kershaw	Depth 2.50	Logged CC

Date 12/02/2019

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.30			Dark grey organic rich clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
			HVP=60	0.80			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
▼	0.90	B					Light grey fine to coarse angular GRAVEL of thinly laminated sandstone with low cobble and boulder content. Sandstone laminations are c.1cm thick. Cobbles and boulders are tabular up to 30cm in size of thinly laminated sandstone. (GRANULAR RESIDUAL SOIL) *Relict horizontal bedding structure seen.*
				2.50			*At 2.4m, groundwater seepage.* *At 2.5m bedrock encountered, unable to excavate further.* End of pit at 2.50 m

1 2 3 4 5

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 2.4m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP10
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415249.00 - 420658.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.8 × 0.7 Depth 3.00	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark grey organic rich slightly clayey slightly gravelly SAND with occassional rootlets. Gravel is fine to medium angular to subangular of sandstone. (TOPSOIL)
				0.40			
			HVP=40				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY with low cobble content. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	0.60	D					
				1.40			Light grey clayey fine to coarse angular to subrounded GRAVEL of sandstone and siderite. (GRANULAR RESIDUAL SOIL)
							At 3.0m bedrock encountered, unable to excavate further.
				3.00			End of pit at 3.00 m

1 2 3 4 5

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP11
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415199.00 - 420656.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 3 × 0.7, Depth 2.00	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40			Dark grey organic rich slightly sandy slightly gravelly CLAY with occassional rootlets. Gravel is fine to medium subangular to subrounded of sandstone. (TOPSOIL)
	0.60	D	HVP=45				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				2.00			*At 2.0m bedrock encountered, unable to excavate further.* End of pit at 2.00 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP12
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415227.00 - 420601.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 1.8 × 0.7, Depth 2.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40			Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.70	D	HVP=60				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse, angular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL) *At 0.6m, boulder c.45cm in size recovered.*
			HVP=85				*From 1.2m, clay recovered as gravel and cobbles with occasional boulder up to 50cm in size.*
				1.90			Light grey slightly clayey fine to coarse angular to subangular GRAVEL of thinly laminated sandstone and siderite nodule fragments. (GRANULAR RESIDUAL SOIL)
				2.50			*At 2.5m bedrock encountered, unable to excavate further.* End of pit at 2.50 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.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP13
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415200.00 - 420553.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 1.8 × 0.7, Depth 1.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	J&T					Dark grey organic rich light sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone and agricultural lime with occasional rootlets. (TOPSOIL)
	0.50	D	HVP=65	0.40			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				1.00			Light grey slightly clayey sandy fine to coarse angular GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				1.50			*At 1.5m bedrock encountered, unable to excavate further.* End of pit at 1.50 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP14
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415167.00 - 420502.00 Level:	Date 12/02/2019
Location: Huddersfield		Dimensions (m): 2.4 × 0.7 Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	J&T		0.40			Dark grey organic rich slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of sandstone and agricultural lime. (TOPSOIL)
	0.60	D	HVP=40	0.90			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				1.20			Light grey fine to coarse, angular GRAVEL and COBBLES of thinly laminated sandstone. Laminations are c.1cm in size. (GRANULAR RESIDUAL SOIL) *At 1.2m bedrock encountered, unable to excavate further.* End of pit at 1.20 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP15
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 414973.00 - 420449.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 1.8 × 0.7 Depth 0.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly gravelly slightly clayey SAND. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.40	D		0.50			Light orangish brown slightly clayey SAND and GRAVEL with a low cobble content. Gravel is fine to coarse angular to subangular of sandstone. (GRANULAR RESIDUAL SOIL) *At 0.5m bedrock encountered, unable to excavate further.* End of pit at 0.50 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.

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

AGS

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Trial Pit Log

Trialpit No
TP16
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 414928.00 - 420492.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2 × 0.7 Depth 1.30	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40			Dark grey organic rich slightly clayey slightly gravelly SAND. Gravel is fine to medium angular to subangular of sandstone. (TOPSOIL)
	0.90	D		1.30			Light orangish brown slightly clayey sandy fine to coarse, angular GRAVEL and COBBLES of thinly laminated sandstone. Laminations are c.1cm thick. (GRANULAR RESIDUAL SOIL) *Relict horizontal bedding structure seen, becoming harder to excavate with depth.* *At 1.3m bedrock encountered, unable to excavate further.* End of pit at 1.30 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.

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

AGS

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Trial Pit Log

Trialpit No
TP17
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 414990.00 - 420533.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.3 × 0.7 Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.40			Dark grey organic rich slightly clayey slightly gravelly SAND. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	1.00	D		1.20			Light orangish brown sandy slightly clayey, fine to coarse angular GRAVEL and COBBLES of thinly laminated sandstone. Laminations are c.1cm in size. (GRANULAR RESIDUAL SOIL) *Relict horizontal bedding structure seen, becoming harder to excavate with depth.* *At 1.2m bedrock encountered, unable to excavate further.* End of pit at 1.20 m

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

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

AGS

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Trial Pit Log

Trialpit No **TP18**

Sheet 1 of 1

Project Name:	Villa Farm, Bradley	Project No. 3319	Co-ords: 415021.00 - 420477.00 Level:	Date 13/02/2019
Location:	Huddersfield	Dimensions (m): Depth 1.50	2.6 × 0.7	Scale 1:25
Client:	PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.40			Dark grey organic rich slightly clayey slightly gravelly SAND. Gravel is fine to coarse subangular to subrounded of mixed lithologies including quartz and sandstone. (TOPSOIL)
	0.50	D	HVP=88	0.60			Light orangish grey clayey sandy, fine to coarse, angular to subangular GRAVEL and COBBLES of sandstone. (GRANULAR RESIDUAL SOIL)
							Stiff light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone. (COHESIVE RESIDUAL SOIL)
	1.20	D					*Becoming more gravelly with cobbles at depth.*
				1.50			*At 1.5m, bedrock encountered, unable to excavate further.* End of pit at 1.50 m

1 2 3 4 5

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

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

AGS

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Trial Pit Log

Trialpit No **TP19**

Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415045.00 - 420555.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.4 × 0.7 Depth 1.00	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.90	D		1.00			Light orange clayey SAND and GRAVEL with a low cobble content. Gravel is fine to coarse angular to thinly laminated sandstone. Laminations are c.1cm sized tabular cobbles. (GRANULAR RESIDUAL SOIL)
							At 1.0m bedrock encountered, unable to excavate further.
							End of pit at 1.00 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP20
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415092.00 - 420578.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2 × 0.7, Depth 1.40	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.40			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.80	D		1.10			Light orangish grey clayey SAND and GRAVEL. Gravel is fine to coarse angular to subangular of sandstone. (GRANULAR RESIDUAL SOIL)
				1.40			Light orangish grey tabular COBBLES of sandstone. (GRANULAR RESIDUAL SOIL) *At 1.4m bedrock encountered, unable to excavate further.* End of pit at 1.40 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.

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

AGS

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Trial Pit Log

Trialpit No
TP21
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415118.00 - 420640.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.4 × 0.7 Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T					Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of sandstone. (TOPSOIL)
				0.40			Light greyish brown gravelly tabular COBBLES of thinly laminated sandstone. Gravel is fine to coarse angular of thinly laminated sandstone. Laminations are c.1cm thick. (WEATHERED PENNINE LOWER COAL MEASURES-SANDSTONE)
							Relict horizontal bedding structure seen, becoming harder to excavate with depth.
				1.20			*At 1.2m bedrock encountered, unable to excavate further.*
							End of pit at 1.20 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP22
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415132.00 - 420550.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.1 × 0.7 Depth 2.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.10	J&T					Dark grey organic rich clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to medium subangular to subrounded of sandstone. (TOPSOIL)
				0.40			
	0.60	B	HVP=60				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	0.80	D					
				1.60			Light grey sandy fine to coarse angular GRAVEL of thinly laminated fine grained SANDSTONE and siltstone. Laminations are c.1cm thick. (GRANULAR RESIDUAL SOIL) *Feint relict bedding structure seen.* *Vitreous black coating on surface of gravel.* *At 2.2m bedrock encountered, unable to excavate further.*
				2.20			End of pit at 2.20 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP23
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415070.00 - 420503.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.6 × 0.7 Depth 1.60	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to medium subangular to subrounded of sandstone. (TOPSOIL)
	0.60	D	HVP=66	1.40			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				1.60			Light grey clayey fine to coarse angular GRAVEL of siltstone and thinly laminated sandstone . Laminations are c.1cm in size. (GRANULAR RESIDUAL SOIL) *At 1.6m bedrock encountered, unable to excavate further.* End of pit at 1.60 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP24
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415106.00 - 420427.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.2 × 0.7 Depth 1.90	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T					Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies. (TOPSOIL) *Lots of tree roots present.*
			HVP=60	0.40			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	0.70	D					
				1.20			Light orangish grey sandy fine to coarse angular GRAVEL of weak thinly laminated sandstone. Laminations are c.1cm thick. (GRANULAR RESIDUAL SOIL) *Feint relict horizontal bedding structure seen.* *At 1.9m bedrock encountered, unable to excavate further.*
				1.90			End of pit at 1.90 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.

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

AGS

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Trial Pit Log

Trialpit No
TP25
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415141.00 - 420407.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.3 × 0.7 Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	J&T		0.30			Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse angular to subangular of mixed lithologies. (TOPSOIL)
	0.40	D	HVP=56	0.60			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				1.20			Light grey sandy slightly clayey fine to coarse angular GRAVEL of thinly laminated weak sandstone with a low cobble content. (GRANULAR RESIDUAL SOIL) *Feint relict horizontal bedding structure seen.* *At 1.2m bedrock encountered, unable to excavate further.* End of pit at 1.20 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP26
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415171.00 - 420458.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.1 × 0.7 Depth 2.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies. (TOPSOIL)
	0.60	D	HVP=40	1.10			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				2.20			Light grey slightly sandy slightly clayey fine to coarse angular GRAVEL of weak sandstone and siltstone. (GRANULAR RESIDUAL SOIL) *At 2.2m bedrock encountered, unable to excavate further.* End of pit at 2.20 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.

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

AGS

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Trial Pit Log

Trialpit No
TP27
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415225.00 - 420441.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.2 × 0.7, Depth 1.60	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies. (TOPSOIL)
	0.50	D	HVP=62				Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular rounded sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	1.40	B		1.20			Light grey slightly sandy slightly clayey fine to coarse angular GRAVEL of sandstone and siltstone. (GRANULAR RESIDUAL SOIL)
				1.60			*Feint relict bedding structure seen.* *At 1.6m bedrock encountered, unable to excavate further.* End of pit at 1.60 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP28
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415233.00 - 420405.00 Level:	Date 13/02/2019
Location: Huddersfield		Dimensions (m): 2.3 × 0.7 Depth 1.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.30	J&T		0.40			Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies including sandstone. (TOPSOIL)
	0.50	D	HVP=52	1.20			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse subangular to angular of mixed lithologies including red sandstone. (COHESIVE RESIDUAL SOIL)
				1.50			Light grey slightly sandy slightly clayey fine to coarse angular GRAVEL of sandstone and siltstone. (GRANULAR RESIDUAL SOIL) *At 1.5m bedrock encountered, unable to excavate further.* End of pit at 1.50 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.

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

AGS

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Trial Pit Log

Trialpit No
TP29
Sheet 1 of 1

Project Name:	Villa Farm, Bradley	Project No. 3319	Co-ords: 415252.00 - 420505.00 Level:	Date 13/02/2019
Location:	Huddersfield	Dimensions (m): 2.5 × 0.7, Depth 2.40		Scale 1:25
Client:	PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies. (TOPSOIL)
	0.80	D	HVP=50	1.20			Firm light grey and orange mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	1.60	D		2.40			Light grey slightly sandy slightly clayey fine to coarse angular to subangular GRAVEL of sandstone and siltstone. (GRANULAR RESIDUAL SOIL) *At 2.4m bedrock encountered, unable to excavate further.* End of pit at 2.40 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.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP30
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 414975.00 - 420507.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.1 × 0.7 Depth 1.80	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
				0.90			Light brown sandy GRAVEL and COBBLES of thinly laminated sandstone with a low cobble content. Laminations are c.1cm thick. Cobbles are tabular of sandstone up to 60cm. (GRANULAR RESIDUAL SOIL)
				1.80			Light brown fine grained SANDSTONE recovered as fine to coarse, angular gravel and cobbles. (PENNINE LOWER COAL MEASURES-SANDSTONE) *From 0.9m, breaker used.* End of pit at 1.80 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.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP31
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415119.00 - 420478.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.5 × 0.7 Depth 2.40	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.30	J&T		0.40			Dark grey organic rich clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone and agricultural lime. (TOPSOIL)
	0.70	D	HVP=52	0.90			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	1.20	D					Light grey sandy slightly clayey fine to coarse angular GRAVEL of sandstone and siltstone with a medium cobble content (GRANULAR RESIDUAL SOIL)
				2.40			*At 2.4m bedrock encountered, unable to excavate further.* End of pit at 2.40 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.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No **TP32**

Sheet 1 of 1

Project Name:	Villa Farm, Bradley	Project No. 3319	Co-ords: 415175.00 - 420605.00 Level:
Location:	Huddersfield	Dimensions (m): 2.5 × 0.7, Depth 2.60	Scale 1:25
Client:	PS & SP Kershaw		Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	J&T		0.30			Dark grey organic rich clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.70	D	HVP=64	2.30			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				2.60			Light grey slightly clayey sandy fine to coarse angular GRAVEL and COBBLES of sandstone and siltstone. (GRANULAR RESIDUAL SOIL) *At 2.6m bedrock encountered, unable to excavate further.* End of pit at 2.60 m

1 2 3 4 5

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP33
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415268.00 - 420706.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.3 × 0.7 Depth 2.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.30	J&T		0.40			Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to medium of mixed lithologies. (TOPSOIL)
			HVP=84				Light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	1.20	B					*From 1.2m, clay becomes dry and is recovered as a fine to coarse subangular to subrounded gravel.*
				2.00			Light grey clayey SAND and GRAVEL. Gravel is fine to coarse subangular to subrounded of thinly laminated weak sandstone and siltstone. (GRANULAR RESIDUAL SOIL)
							At 2.5m bedrock encountered, unable to excavate further.
				2.50			End of pit at 2.50 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP34
Sheet 1 of 1

Project Name:	Villa Farm, Bradley	Project No. 3319	Co-ords: 415381.00 - 420538.00 Level:	Date 14/02/2019
Location:	Huddersfield	Dimensions (m): 2.6 × 0.7, Depth 2.60		Scale 1:25
Client:	PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.30			Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies including sandstone. (TOPSOIL)
	0.90	D	HVP=72	1.90			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY with a low cobble content. Gravel is fine to coarse angular to subangular of sandstone lithorelicts. Cobbles are tabular of sandstone. (COHESIVE RESIDUAL SOIL)
				2.60			Light orangish grey fine to coarse subangular to subrounded GRAVEL of thinly laminated sandstone. Laminations are c.1cm thick. (GRANULAR RESIDUAL SOIL)
							At 2.6m bedrock encountered, unable to excavate further.
							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.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP35
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415285.00 - 420447.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.6 × 0.7, Depth 2.50	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	J&T		0.40			Dark grey slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies including sandstone. (TOPSOIL)
	0.90	D	HVP=55	1.40			Firm light orange and grey slightly sandy slightly gravel CLAY. Gravel is fine to medium subangular to angular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
▼				2.50			Light grey slightly clayey sandy fine to coarse angular GRAVEL of sandstone and siltstone with a low cobble content. Cobbles are of tabular sandstone and siltstone. (GRANULAR RESIDUAL SOIL) *At 2.2m groundwater seepage.* *At 2.5m bedrock encountered, unable to excavate further.* End of pit at 2.50 m

Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage at 2.2m during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP36
Sheet 1 of 1

Project Name:	Villa Farm, Bradley	Project No. 3319	Co-ords: 415056.00 - 420527.00 Level:
Location:	Huddersfield	Dimensions (m): 2.3 × 0.7 Depth 1.60	Date 14/02/2019 Scale 1:25
Client:	PS & SP Kershaw		Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse subangular to subrounded of sandstone. (TOPSOIL)
				0.40			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to coarse subangular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
			HVP=50				
				1.50			Light grey slightly clayey fine to coarse angular to subangular GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				1.60			*At 1.6m bedrock encountered, unable to excavate further.* End of pit at 1.60 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP37
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415086.00 - 420558.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.9 × 0.7 Depth 1.60	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.40			Dark grey organic rich clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies. (TOPSOIL)
			HVP=56	1.00			Firm light orange and grey mottled slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to subangular of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
				1.60			Light orangish grey slightly clayey SAND and GRAVEL. Gravel is fine to coarse subangular to subrounded of weak thinly laminated sandstone and siltstone. Laminations are c.1cm thick. (GRANULAR RESIDUAL SOIL) *At 1.6m bedrock encountered, unable to excavate further.* End of pit at 1.60 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP38
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415126.00 - 420604.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.8 × 0.7 Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Dark grey organic rich slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
				0.40			Light orangish grey clayey SAND and GRAVEL. Gravel is fine to coarse subangular to subrounded of sandstone. (GRANULAR RESIDUAL SOIL)
				1.10			Light grey slightly clayey fine to coarse, angular GRAVEL and COBBLES of thinly laminated sandstone and siltstone. Cobbles are tabular of thinly laminated sandstone and siltstone. Laminations are c.1cm thick. (GRANULAR RESIDUAL SOIL)
				1.20			*At 1.2m bedrock encountered, unable to excavate further.*
							End of pit at 1.20 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP39
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415165.00 - 420661.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 3 × 0.7, Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of mixed lithologies including sandstone. (TOPSOIL)
				0.40			Light orangish brown slightly gravelly slightly sandy CLAY. Gravel is fine to coarse subangular to subrounded of sandstone lithorelicts. (COHESIVE RESIDUAL SOIL)
	0.70	B					
				1.20			*At 1.2m bedrock encountered, unable to excavate further.*
							End of pit at 1.20 m

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

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

AGS

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Trial Pit Log

Trialpit No
TP40
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415391.00 - 420453.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.1 × 0.6, Depth 1.10	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse subangular to subrounded of sandstone. (TOPSOIL)
				0.30			Light orangish brown gravelly, slightly sandy CLAY. Gravel is fine to coarse angular to subangular of sandstone. (COHESIVE RESIDUAL SOIL)
	0.70	B					
				1.00			Light orangish brown fine to coarse angular GRAVEL of sandstone. (GRANULAR RESIDUAL SOIL)
				1.10			*At 1.1m bedrock encountered, unable to excavate further.* End of pit at 1.10 m

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

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

AGS

LITHOS CONSULTING

Trial Pit Log

Trialpit No
TP41
Sheet 1 of 1

Project Name: Villa Farm, Bradley	Project No. 3319	Co-ords: 415337.00 - 420444.00 Level:	Date 14/02/2019
Location: Huddersfield		Dimensions (m): 2.5 × 0.7 Depth 1.20	Scale 1:25
Client: PS & SP Kershaw			Logged CC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30			Dark grey organic rich slightly clayey slightly gravelly SAND with occasional rootlets. Gravel is fine to coarse angular to subangular of sandstone. (TOPSOIL)
	0.60	B					Light orangish brown slightly gravelly, slightly sandy CLAY. Gravel is fine to coarse angular to subangular of sandstone. (COHESIVE RESIDUAL SOIL)
			HVP=76	0.80			Stiff light orangish brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subangular of sandstone. (COHESIVE RESIDUAL SOIL)
				1.20			*At 1.2m bedrock encountered, unable to excavate further.* End of pit at 1.20 m

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

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

AGS

Appendix G

Soakaway Test Results

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Engineer	A Taylor
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Date:	**14/02/2019**
Trial Pit No.	**TP30**
Test No.	**1**

Time	Elpsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:37	0	1.02	1020
10:38	1	1.02	1020
10:39	2	1.04	1040
10:40	3	1.06	1060
10:41	4	1.07	1070
10:42	5	1.08	1080
10:47	10	1.12	1120
10:52	15	1.15	1150
11:12	35	1.22	1220
11:35	58	1.30	1300
12:33	116	1.50	1500
13:29	172	1.62	1620

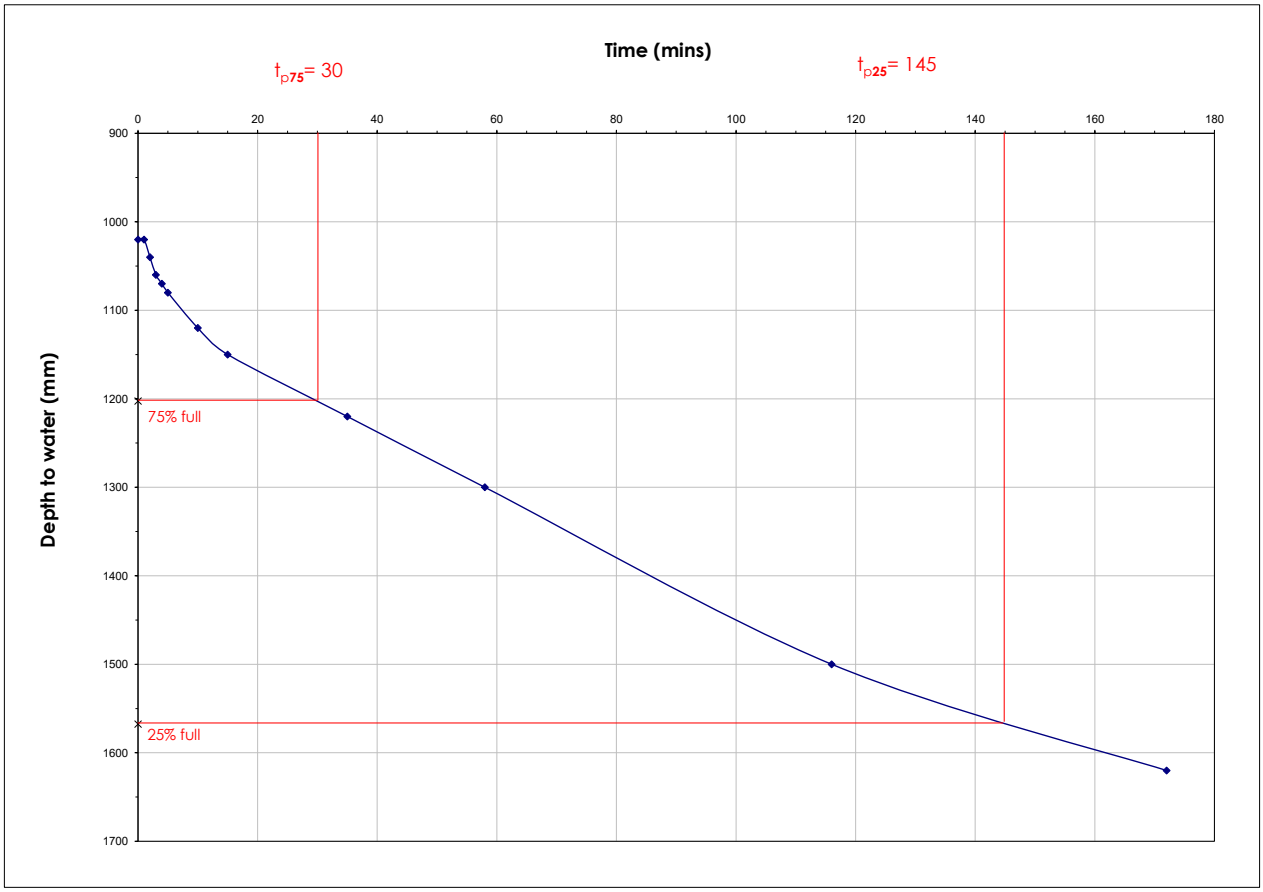
SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.70	700
Depth	=	1.75	1750

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1567.5	1.57
0.50	=	1385	1.39
0.75	=	1202.5	1.20

Depth at start of test (mm)	=	1020
Depth at end of test (mm)	=	1620

Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	3.085
V_{p75-25} - Volume 75 - 25%	=	0.4599

Read from the graph:		
$t_{p\,75}$ (min)	=	30
$t_{p\,25}$ (min)	=	145



Soil infiltration rate, f, (m/s) = 2.16E-05

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Trial Pit No.	**TP30**
Test No.	**2**

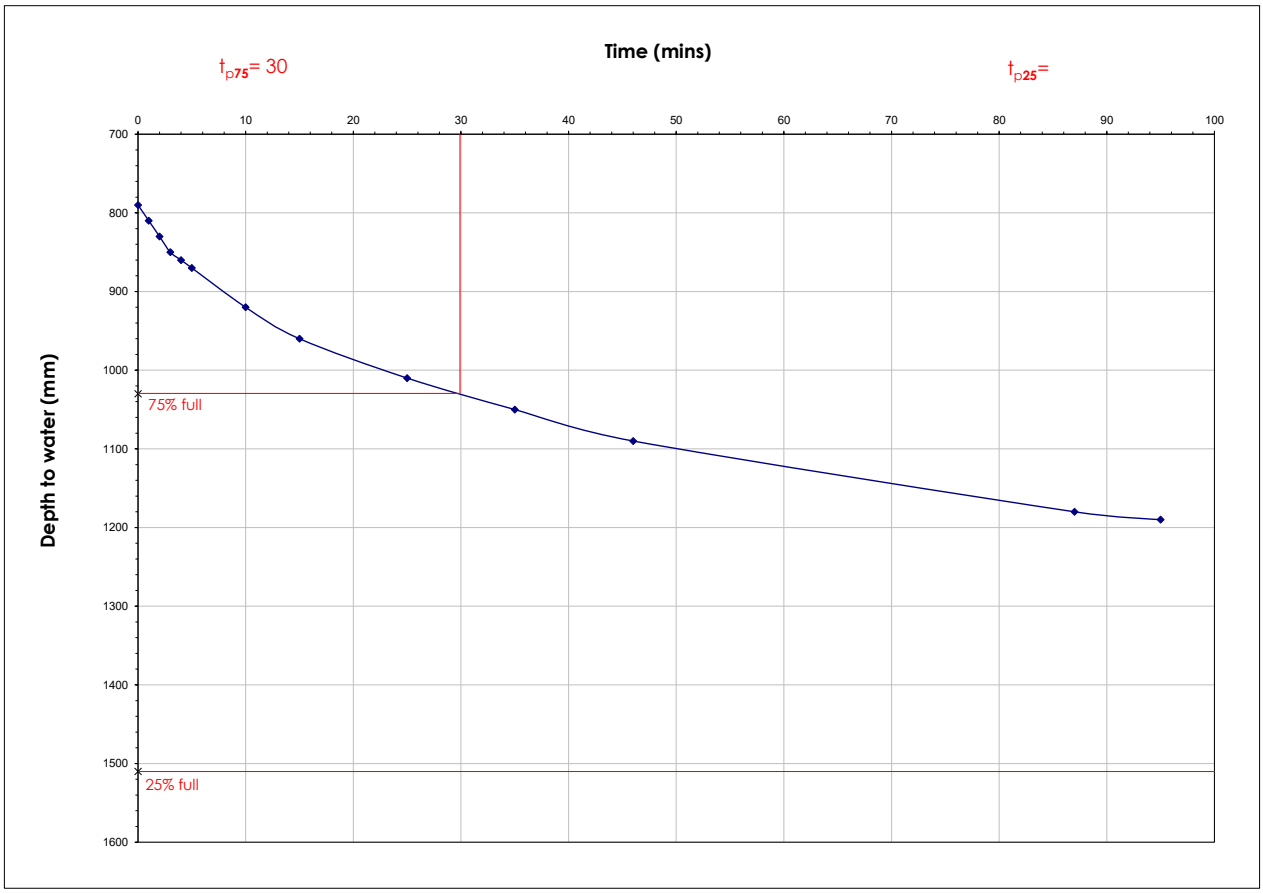
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
14:21	0	0.79	790
14:22	1	0.81	810
14:23	2	0.83	830
14:24	3	0.85	850
14:25	4	0.86	860
14:26	5	0.87	870
14:31	10	0.92	920
14:36	15	0.96	960
14:41	25	1.01	1010
14:46	35	1.05	1050
14:57	46	1.09	1090
15:48	87	1.18	1180
15:56	95	1.19	1190

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.70	700
Depth	=	1.75	1750

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	1510	1.51
0.50	=	1270	1.27
0.75	=	1030	1.03

Depth at start of test (mm)	=	790
Depth at end of test (mm)	=	1190
Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	3.66
V_{p75-25} - Volume 75 - 25%	=	0.6048

Read from the graph:		
$t_{p\,75}$ (min)	=	75.00
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Trial Pit No.	**TP31**
Test No.	**1**

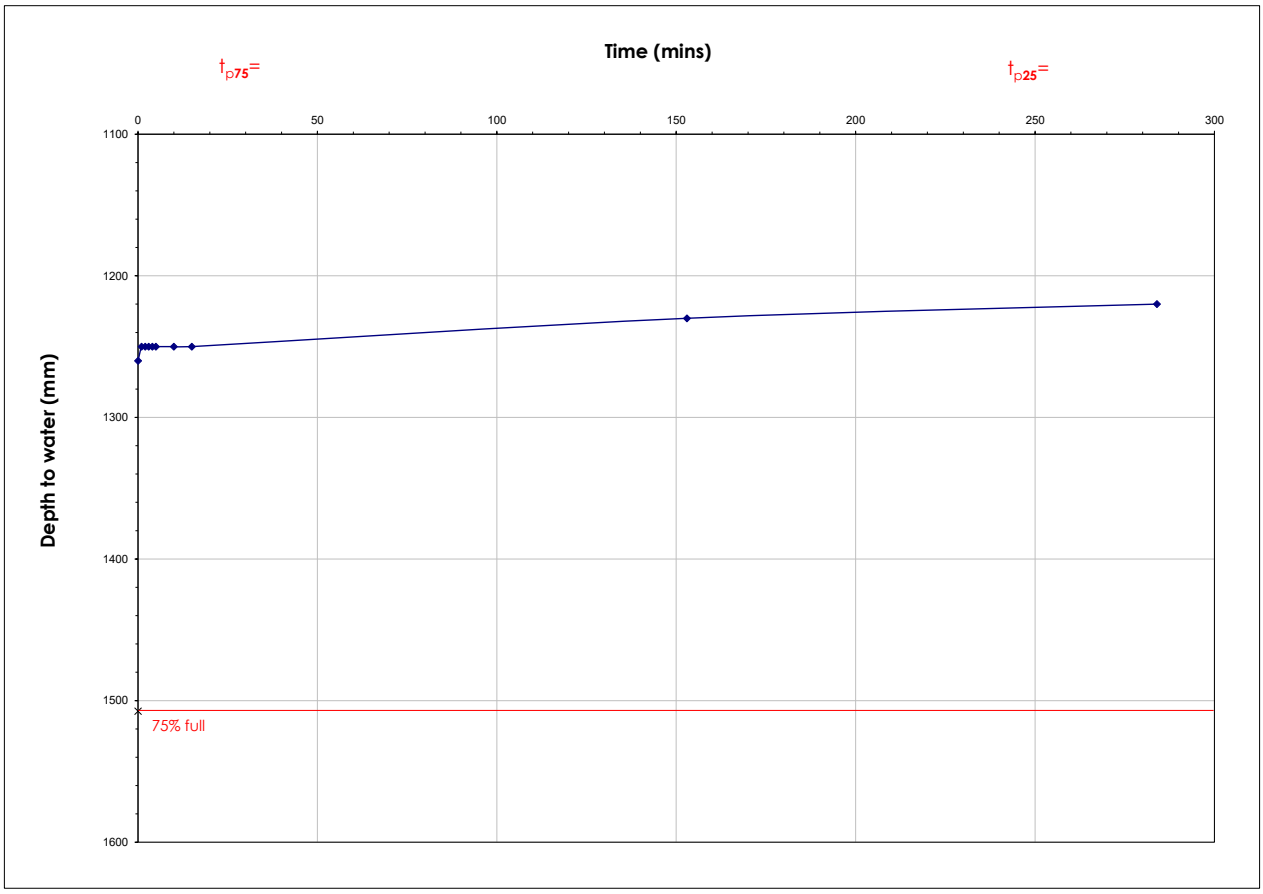
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:59	0	1.26	1260
11:00	1	1.25	1250
11:01	2	1.25	1250
11:02	3	1.25	1250
11:03	4	1.25	1250
11:14	5	1.25	1250
11:09	10	1.25	1250
11:14	15	1.25	1250
13:32	153	1.23	1230
15:43	284	1.22	1220

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.70	700
Depth	=	2.25	2250

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2002.5	2.00
0.50	=	1755	1.76
0.75	=	1507.5	1.51

Depth at start of test (mm)	=	1260
Depth at end of test (mm)	=	1250
Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	3.735
V_{p75-25} - Volume 75 - 25%	=	0.6237

Read from the graph:		
$t_{p\,75}$ (min)	=	
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Trial Pit No.	**TP32**
Test No.	**1**

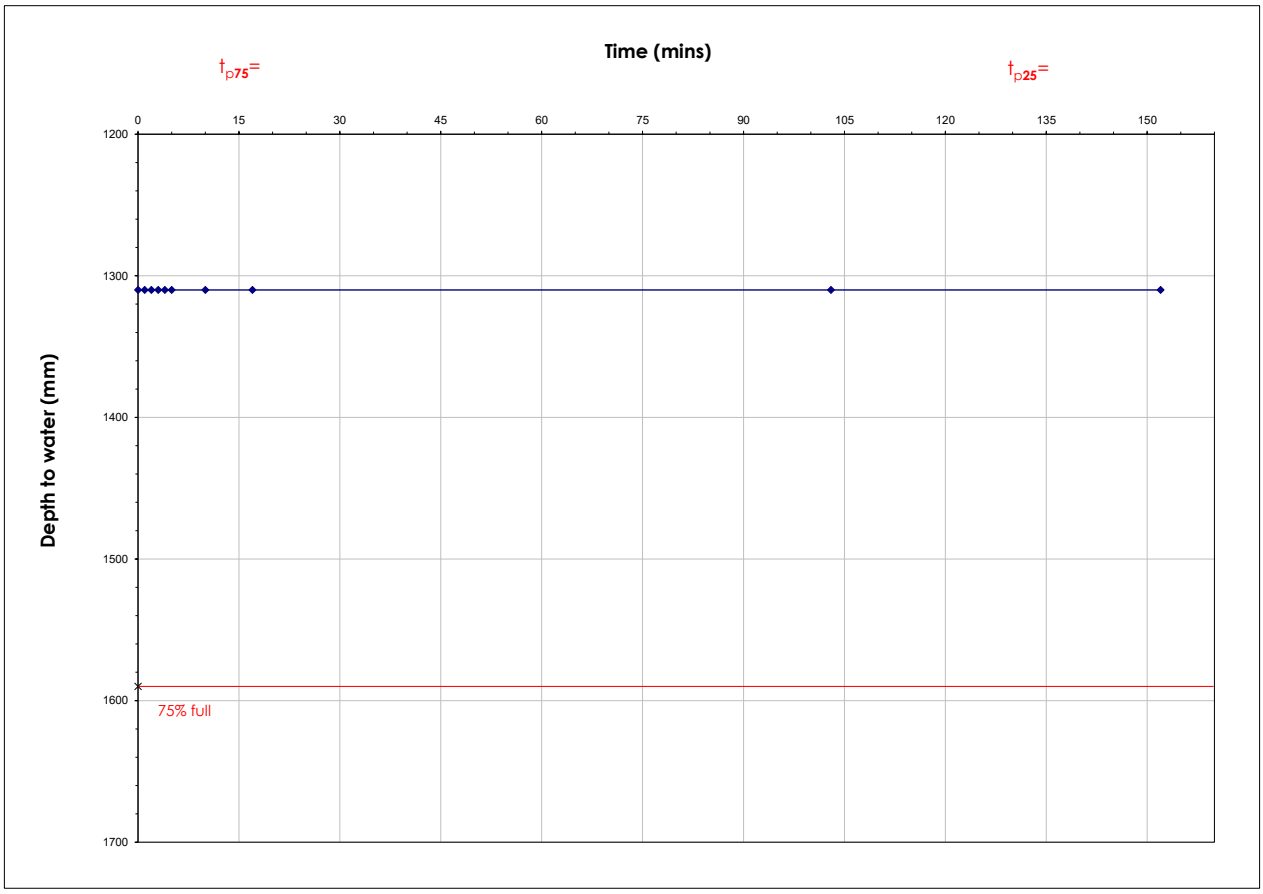
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:22	0	1.31	1310
11:23	1	1.31	1310
11:24	2	1.31	1310
11:25	3	1.31	1310
11:26	4	1.31	1310
11:27	5	1.31	1310
11:32	10	1.31	1310
11:39	17	1.31	1310
13:05	103	1.31	1310
13:53	152	1.31	1310

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.70	700
Depth	=	2.43	2430

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2150	2.15
0.50	=	1870	1.87
0.75	=	1590	1.59

Depth at start of test (mm)	=	1310
Depth at end of test (mm)	=	1310
Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	4.06
V_{p75-25} - Volume 75 - 25%	=	0.7056

Read from the graph:		
$t_{p\,75}$ (min)	=	
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Trial Pit No.	**TP33**
Test No.	**1**

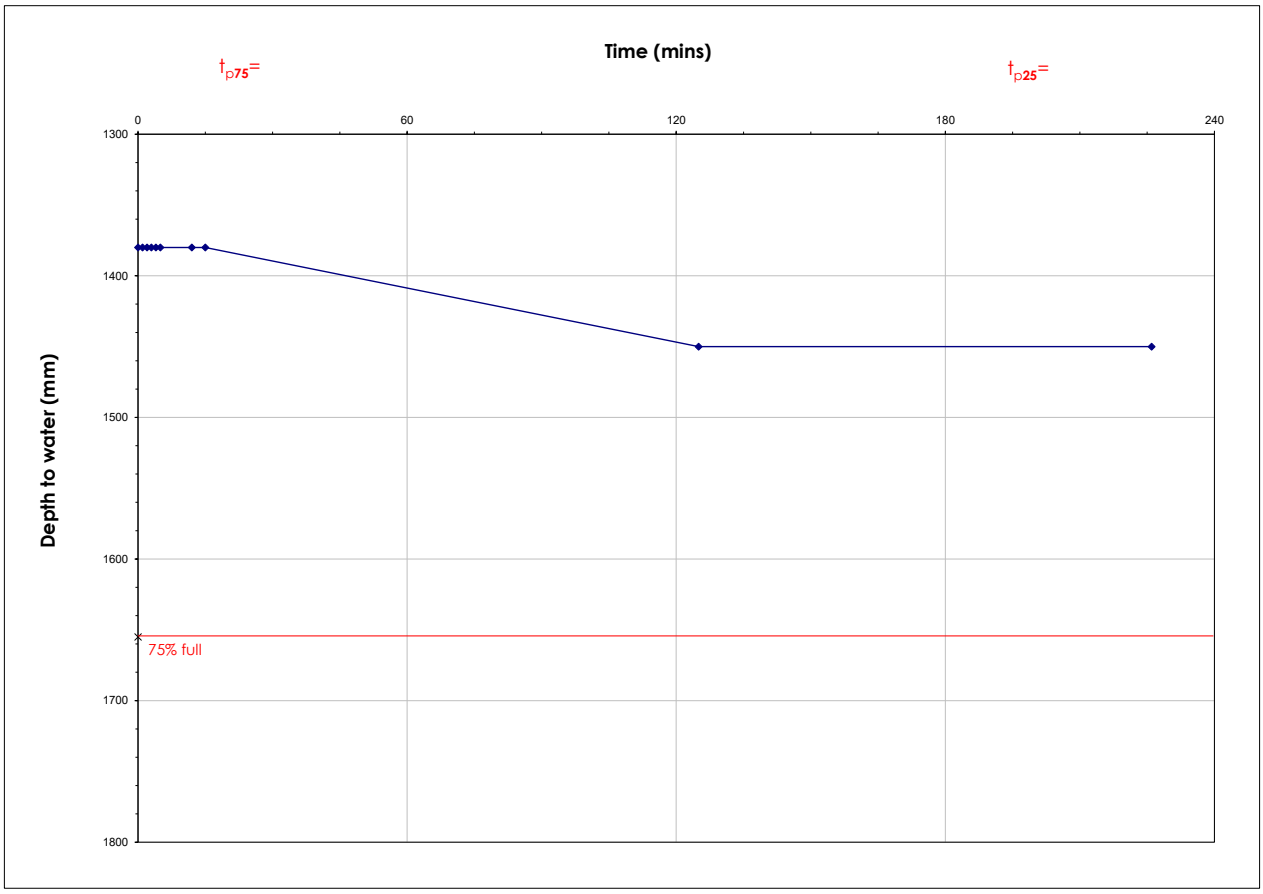
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:46	0	1.38	1380
11:47	1	1.38	1380
11:48	2	1.38	1380
11:49	3	1.38	1380
11:50	4	1.38	1380
11:51	5	1.38	1380
11:58	12	1.38	1380
12:01	15	1.38	1380
13:51	125	1.45	1450
15:32	226	1.45	1450

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.40	1400
Width	=	0.70	700
Depth	=	2.48	2480

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2205	2.21
0.50	=	1930	1.93
0.75	=	1655	1.66

Depth at start of test (mm)	=	1380
Depth at end of test (mm)	=	1450
Base area of pit	=	0.98
a_{p50} - 50% internal surface area inc. base	=	3.29
V_{p75-25} - Volume 75 - 25%	=	0.539

Read from the graph:		
$t_{p\,75}$ (min)	=	
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Trial Pit No.	**TP34**
Test No.	**1**

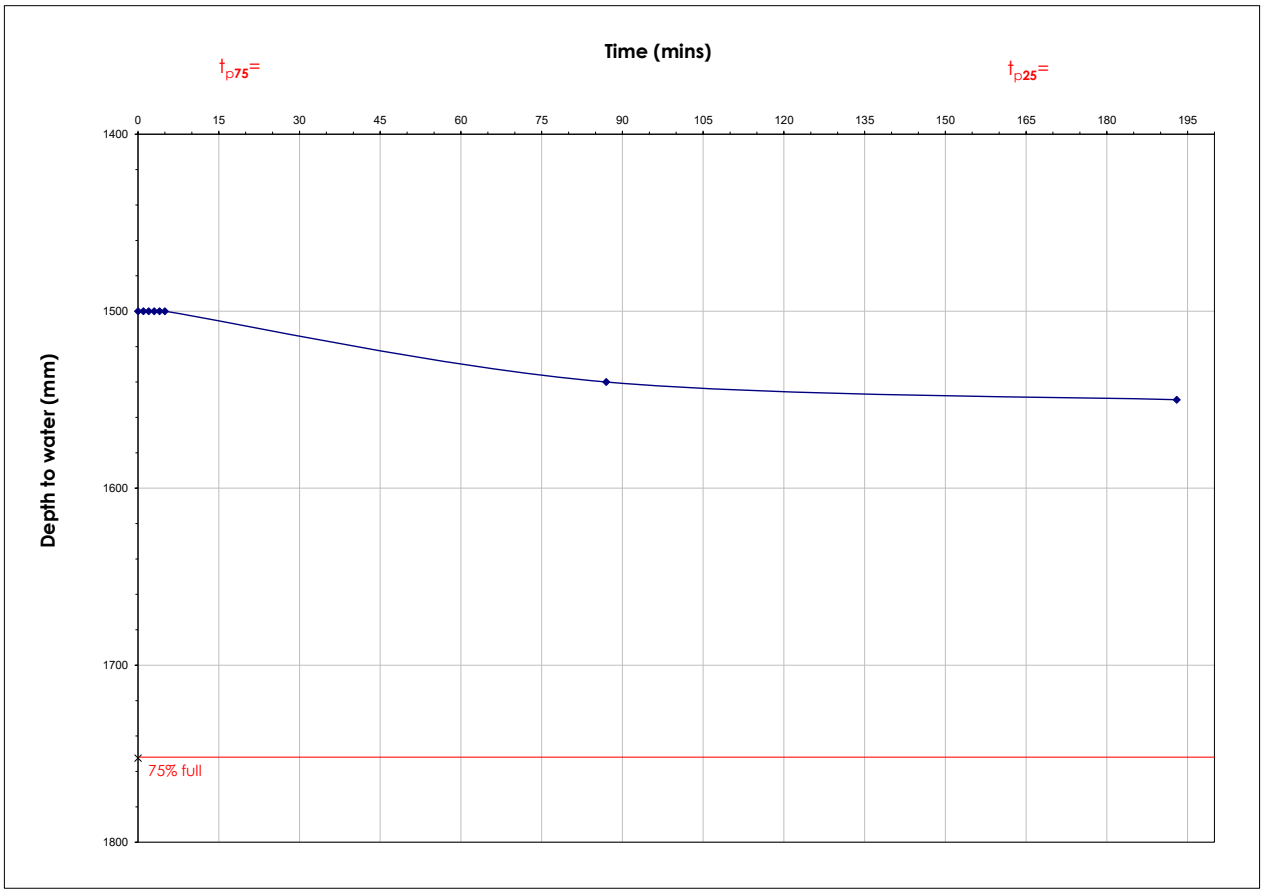
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
12:12	0	1.50	1500
12:13	1	1.50	1500
12:14	2	1.50	1500
12:15	3	1.50	1500
12:16	4	1.50	1500
12:17	5	1.50	1500
13:44	87	1.54	1540
15:25	193	1.55	1550

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.80	1800
Width	=	0.70	700
Depth	=	2.51	2510

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2257.5	2.26
0.50	=	2005	2.01
0.75	=	1752.5	1.75

Depth at start of test (mm)	=	1500
Depth at end of test (mm)	=	1550
Base area of pit	=	1.26
a_{p50} - 50% internal surface area inc. base	=	3.785
$V_{p75\text{-}25}$ - Volume 75 - 25%	=	0.6363

Read from the graph:		
$t_{p\,75}$ (min)	=	
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client:	PS & SP Kershaw
Job Name:	Bradley Villa Farm, Huddersfield
Job No.:	3319

Trial Pit No.	**TP35**
Test No.	**1**

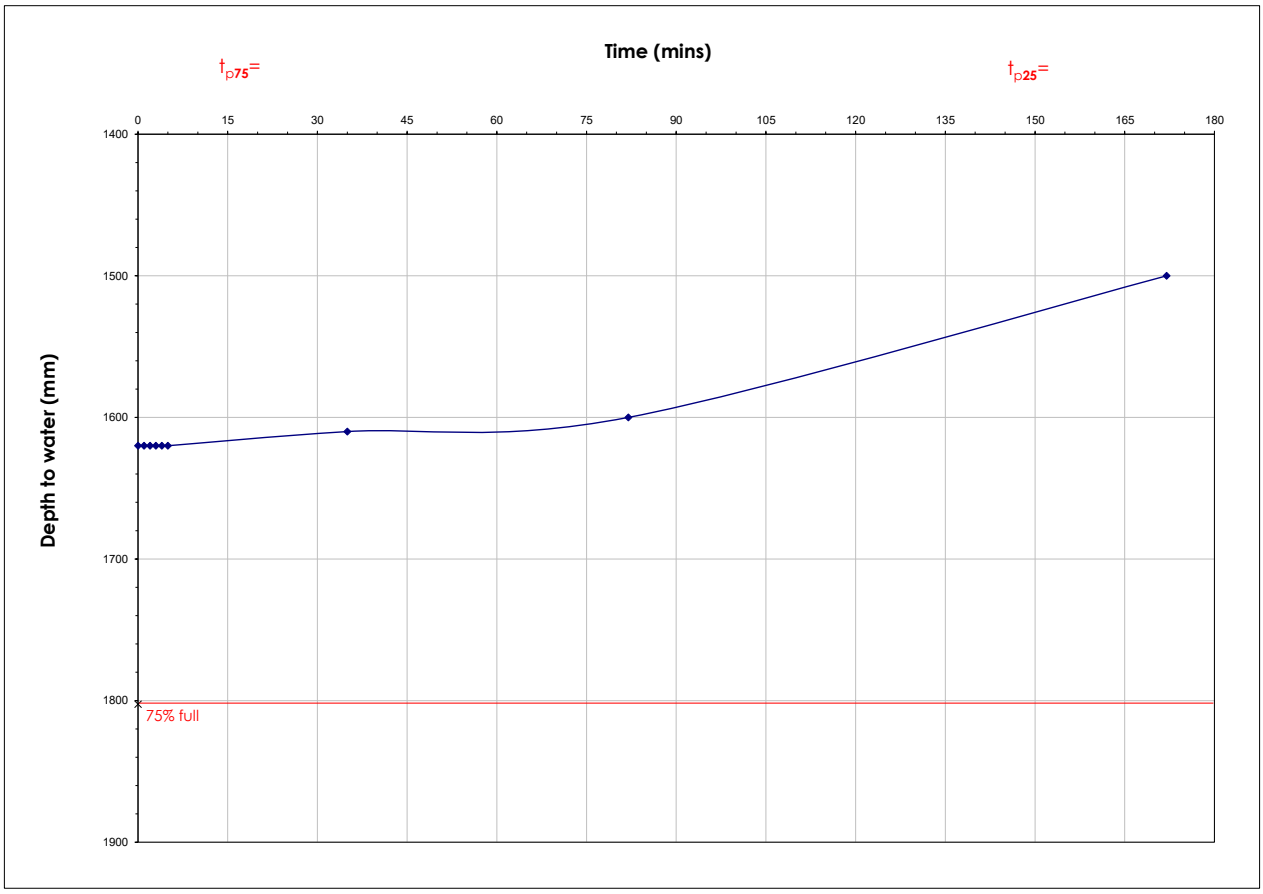
Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
12:25	0	1.62	1620
12:26	1	1.62	1620
12:27	2	1.62	1620
12:28	3	1.62	1620
12:29	4	1.62	1620
12:30	5	1.62	1620
13:00	35	1.61	1610
13:47	82	1.60	1600
15:17	172	1.50	1500

SOAKAWAY TRIAL PIT			
Dimensions		**(m)**	**(mm)**
Length	=	1.90	1900
Width	=	0.70	700
Depth	=	2.35	2350

Effective Depth (% full)		**(mm)**	**(m)**
0.25	=	2167.5	2.17
0.50	=	1985	1.99
0.75	=	1802.5	1.80

Depth at start of test (mm)	=	1620
Depth at end of test (mm)	=	1620
Base area of pit	=	1.33
a_{p50} - 50% internal surface area inc. base	=	3.228
V_{p75-25} - Volume 75 - 25%	=	0.48545

Read from the graph:		
$t_{p\,75}$ (min)	=	
$t_{p\,25}$ (min)	=	



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

Appendix H

Chemical Results

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	19-05926-1
Initial Date of Issue:	05-Mar-2019
Client	Lithos Consulting
Client Address:	Walton Road Wetherby LS22 5DZ
Contact(s):	Charlotte Copley Matthew Thompson
Project	3319 Villa Farm, Bradley

Quotation No.:		**Date Received:**	18-Feb-2019
Order No.:	PO14180/3319/MJT	**Date Instructed:**	21-Feb-2019
No. of Samples:	14		
Turnaround (Wkdays):	5	**Results Due:**	27-Feb-2019
Date Approved:	05-Mar-2019	**Subcon Results Due:**	14-Mar-2019

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3319 Villa Farm, Bradley

Client: Lithos Consulting					**Chemtest Job No.:**	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926
Quotation No.:					**Chemtest Sample ID.:**	776966	776969	776970	776972	776976	776985	776987	776990	776993
Order No.: PO14180/3319/MJT					Client Sample Ref.:	1	1	1	1	1	1	1	1	1
					Sample Location:	TP01	TP04	TP05	TP08	TP13	TP22	TP24	TP27	TP30
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.20	0.30	0.20	0.20	0.20	0.10	0.20	0.20	0.20
					Date Sampled:	12-Feb-2019	12-Feb-2019	12-Feb-2019	12-Feb-2019	12-Feb-2019	13-Feb-2019	13-Feb-2019	13-Feb-2019	14-Feb-2019
					Asbestos Lab:	COVENTRY		COVENTRY	COVENTRY	COVENTRY		COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
ACM Type	U	2192		N/A		-		-	-	-		-	-	-
Asbestos Identification	U	2192	%	0.001		No Asbestos Detected		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A		-		-	-	-		-	-	-
Moisture	N	2030	%	0.020		25		18	24	23		23	26	18
Soil Colour	N	2040		N/A		Brown,		Brown,	Brown,	Brown,		Brown,	Brown,	Brown,
Other Material	N	2040		N/A		Stones,		Stones,	Stones,	Stones,		Stones,	Stones,	Stones,
Soil Texture	N	2040		N/A		Sand,		Sand,	Sand,	Sand,		Sand,	Sand,	Sand,
pH	M	2010		N/A		6.4		6.2	6.4	7.0		7.4	7.2	6.4
Vanadium	U	2450	mg/kg	5.0		34		32	28	33		33	33	28
Total Organic Carbon	M	2625	%	0.20		7.1		6.1	3.3	5.4		14	6.9	3.4
Phenoxy Acid Herbicides (Subcon)	SN		µg/kg	20			<20				<20			
Arsenic	M	2450	mg/kg	1.0		21		18	13	13		14	15	11
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40		< 0.40		< 0.40	< 0.40	< 0.40		< 0.40	< 0.40	0.59
Cadmium	M	2450	mg/kg	0.10		0.47		0.45	0.37	0.38		0.43	0.43	0.30
Chromium	M	2450	mg/kg	1.0		37		44	35	29		22	22	17
Chromium (Trivalent)	N	2490	mg/kg	1.0		37		44	35	29		22	22	17
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50		< 0.50	< 0.50	< 0.50		< 0.50	< 0.50	< 0.50
Copper	M	2450	mg/kg	0.50		39		36	30	29		31	33	22
Lead	M	2450	mg/kg	0.50		82		75	64	66		79	82	58
Mercury	M	2450	mg/kg	0.10		0.37		0.41	0.30	0.21		0.24	0.24	0.15
Nickel	M	2450	mg/kg	0.50		20		20	17	17		19	18	15
Selenium	M	2450	mg/kg	0.20		0.35		0.43	0.33	0.30		0.28	0.34	0.25
Zinc	M	2450	mg/kg	0.50		100		110	80	90		100	93	74
Acenaphthene	M	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	0.39		0.79	0.82	0.59
Acenaphthylene	N	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	0.18		0.27	0.34	0.35
Anthracene	M	2800	mg/kg	0.10		0.33		0.43	0.32	1.1		1.0	1.3	1.5
Benzo[a]anthracene	M	2800	mg/kg	0.10		0.41		0.57	0.54	1.2		1.5	1.9	2.5
Benzo[a]pyrene	M	2800	mg/kg	0.10		0.20		0.38	0.37	0.80		1.2	1.6	1.9
Benzo[b]fluoranthene	M	2800	mg/kg	0.10		0.60		0.90	0.74	1.5		1.9	2.6	2.8
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10		< 0.10		< 0.10	0.21	0.49		0.65	0.99	1.2
Benzo[k]fluoranthene	M	2800	mg/kg	0.10		0.16		0.28	0.16	0.55		0.71	0.97	1.4
Chrysene	M	2800	mg/kg	0.10		0.89		1.1	0.87	1.8		2.3	3.1	3.7
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	< 0.10		< 0.10	< 0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10		2.1		2.6	2.2	4.9		5.3	6.0	7.9
Fluorene	M	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	0.28		0.46	0.59	0.46
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	< 0.10		0.47	0.77	1.1
Naphthalene	M	2800	mg/kg	0.10		< 0.10		< 0.10	< 0.10	0.26		1.0	0.90	0.55

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3319 Villa Farm, Bradley

Client: Lithos Consulting					**Chemtest Job No.:**	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926	19-05926
Quotation No.:					**Chemtest Sample ID.:**	776966	776969	776970	776972	776976	776985	776987	776990	776993
Order No.: PO14180/3319/MJT					Client Sample Ref.:	1	1	1	1	1	1	1	1	1
					Sample Location:	TP01	TP04	TP05	TP08	TP13	TP22	TP24	TP27	TP30
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.20	0.30	0.20	0.20	0.20	0.10	0.20	0.20	0.20
					Date Sampled:	12-Feb-2019	12-Feb-2019	12-Feb-2019	12-Feb-2019	12-Feb-2019	13-Feb-2019	13-Feb-2019	13-Feb-2019	14-Feb-2019
					Asbestos Lab:	COVENTRY		COVENTRY	COVENTRY	COVENTRY		COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Phenanthrene	M	2800	mg/kg	0.10		1.6		1.6	1.3	3.9		4.1	4.9	5.6
Pyrene	M	2800	mg/kg	0.10		2.0		2.5	2.1	4.2		4.4	5.8	7.3
Total Of 16 PAH's	N	2800	mg/kg	2.0		8.3		10	8.8	22		26	33	39

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3319 Villa Farm, Bradley

Client: Lithos Consulting					**Chemtest Job No.:**	19-05926	19-05926	19-05926	19-05926	19-05926
Quotation No.:					**Chemtest Sample ID.:**	776994	776995	776996	776997	776998
Order No.: PO14180/3319/MJT					Client Sample Ref.:	1	1	1	1	1
					Sample Location:	TP31	TP32	TP33	TP34	TP35
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.30	0.10	0.30	0.20	0.20
					Date Sampled:	14-Feb-2019	14-Feb-2019	14-Feb-2019	14-Feb-2019	14-Feb-2019
					Asbestos Lab:	COVENTRY	COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**						
ACM Type	U	2192		N/A		-	-	-	-	-
Asbestos Identification	U	2192	%	0.001		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A		-	-	-	-	-
Moisture	N	2030	%	0.020		21	20	22	19	19
Soil Colour	N	2040		N/A		Brown,	Brown,	Brown,	Brown,	Stones,
Other Material	N	2040		N/A		Stones,	Stones,	Stones,	Stones,	Stones,
Soil Texture	N	2040		N/A		Sand,	Sand,	Sand,	Sand,	Sand,
pH	M	2010		N/A		6.5	6.6	7.3	6.5	6.5
Vanadium	U	2450	mg/kg	5.0		34	32	32	33	35
Total Organic Carbon	M	2625	%	0.20		8.6	15	2.9	4.2	3.6
Phenoxy Acid Herbicides (Subcon)	SN		µg/kg	20						
Arsenic	M	2450	mg/kg	1.0		18	14	14	15	9.9
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40		0.81	0.70	< 0.40	< 0.40	< 0.40
Cadmium	M	2450	mg/kg	0.10		0.47	0.41	0.37	0.73	0.54
Chromium	M	2450	mg/kg	1.0		30	24	25	35	36
Chromium (Trivalent)	N	2490	mg/kg	1.0		30	24	25	35	36
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Copper	M	2450	mg/kg	0.50		41	30	28	31	25
Lead	M	2450	mg/kg	0.50		94	110	68	68	62
Mercury	M	2450	mg/kg	0.10		0.56	0.26	0.23	0.26	0.32
Nickel	M	2450	mg/kg	0.50		19	19	17	15	15
Selenium	M	2450	mg/kg	0.20		0.35	0.38	0.36	0.36	0.27
Zinc	M	2450	mg/kg	0.50		100	100	89	82	82
Acenaphthene	M	2800	mg/kg	0.10		0.48	0.21	0.69	0.20	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10		0.26	< 0.10	0.35	0.10	< 0.10
Anthracene	M	2800	mg/kg	0.10		1.2	0.51	1.4	0.53	0.17
Benzo[a]anthracene	M	2800	mg/kg	0.10		2.2	0.99	2.2	0.85	0.25
Benzo[a]pyrene	M	2800	mg/kg	0.10		1.9	0.73	1.4	0.56	0.17
Benzo[b]fluoranthene	M	2800	mg/kg	0.10		3.0	1.4	2.5	1.1	0.31
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10		1.1	0.36	0.77	0.33	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10		1.0	0.41	1.0	0.46	< 0.10
Chrysene	M	2800	mg/kg	0.10		3.1	1.6	2.9	1.4	0.50
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10		6.7	3.8	6.9	3.3	1.5
Fluorene	M	2800	mg/kg	0.10		0.40	0.13	0.51	0.14	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10		1.0	0.25	0.60	0.22	< 0.10
Naphthalene	M	2800	mg/kg	0.10		0.57	0.16	1.6	0.18	< 0.10

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 3319 Villa Farm, Bradley

Client: Lithos Consulting			**Chemtest Job No.:**		19-05926	19-05926	19-05926	19-05926	19-05926
Quotation No.:			**Chemtest Sample ID.:**		776994	776995	776996	776997	776998
Order No.: PO14180/3319/MJT			Client Sample Ref.:		1	1	1	1	1
			Sample Location:		TP31	TP32	TP33	TP34	TP35
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.30	0.10	0.30	0.20	0.20
			Date Sampled:		14-Feb-2019	14-Feb-2019	14-Feb-2019	14-Feb-2019	14-Feb-2019
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**					
Phenanthrene	M	2800	mg/kg	0.10	4.8	2.4	5.7	1.9	0.86
Pyrene	M	2800	mg/kg	0.10	5.9	3.2	6.3	2.8	1.3
Total Of 16 PAH's	N	2800	mg/kg	2.0	34	16	35	14	5.1

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Appendix I

Geotechnical Test Results

LABORATORY REPORT

4043

Contract Number: PSL19/1211

Report Date: 01 March 2019

Client's Reference: 3319

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

For the attention of: Matt Thompson/Charlotte Copley

Contract Title: Villa Farm, Bradley

Date Received: 20/2/2019
Date Commenced: 20/2/2019
Date Completed: 1/3/2019

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)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP02	2	D	0.90		Brown slightly gravelly slightly sandy CLAY.
TP04	2	D	0.50		Brown slightly gravelly slightly sandy CLAY.
TP10	2	D	0.60		Brown slightly gravelly slightly sandy CLAY.
TP13	2	D	0.50		Brown slightly gravelly slightly sandy CLAY.
TP18	3	D	1.20		Brown very gravelly sandy CLAY.
TP22	2	B	0.60		Brown slightly gravelly slightly sandy CLAY.
TP24	2	D	0.70		Brown slightly gravelly slightly sandy CLAY.
TP28	2	D	0.50		Brown slightly gravelly slightly sandy CLAY.
TP31	2	D	0.70		Brown slightly gravelly slightly sandy CLAY.
TP32	2	D	0.70		Brown slightly gravelly slightly sandy CLAY.
TP34	2	D	0.90		Brown slightly gravelly slightly sandy CLAY.
TP35	2	D	0.90		Brown slightly gravelly slightly sandy CLAY.
TP39	1	B	0.70		Brown very gravelly sandy CLAY.
TP40	1	B	0.70		Brown very gravelly sandy CLAY.
TP41	1	B	0.60		Brown very gravelly sandy CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP02	2	D	0.90		23			63	27	36	98	High plasticity CH.
TP04	2	D	0.50		22			56	25	31	94	High plasticity CH.
TP10	2	D	0.60		29			66	29	37	91	High plasticity CH.
TP13	2	D	0.50		24			53	23	30	91	High plasticity CH.
TP18	3	D	1.20		15			55	24	31	66	High plasticity CH.
TP22	2	B	0.60		32			66	29	37	88	High plasticity CH.
TP24	2	D	0.70		33			64	27	37	88	High plasticity CH.
TP28	2	D	0.50		30			70	30	40	99	High plasticity CH.
TP31	2	D	0.70		31			69	29	40	99	High plasticity CH.
TP32	2	D	0.70		27			56	25	31	99	High plasticity CH.
TP34	2	D	0.90		21			57	25	32	88	High plasticity CH.
TP35	2	D	0.90		30			60	26	34	99	High plasticity CH.
TP39	1	B	0.70		18			57	25	32	60	High plasticity CH.
TP40	1	B	0.70		18			55	23	32	50	High plasticity CH.
TP41	1	B	0.60		23			68	28	40	67	High plasticity CH.

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

UKAS TESTING 4043

PSL Professional Soils Laboratory

Villa Farm, Bradley

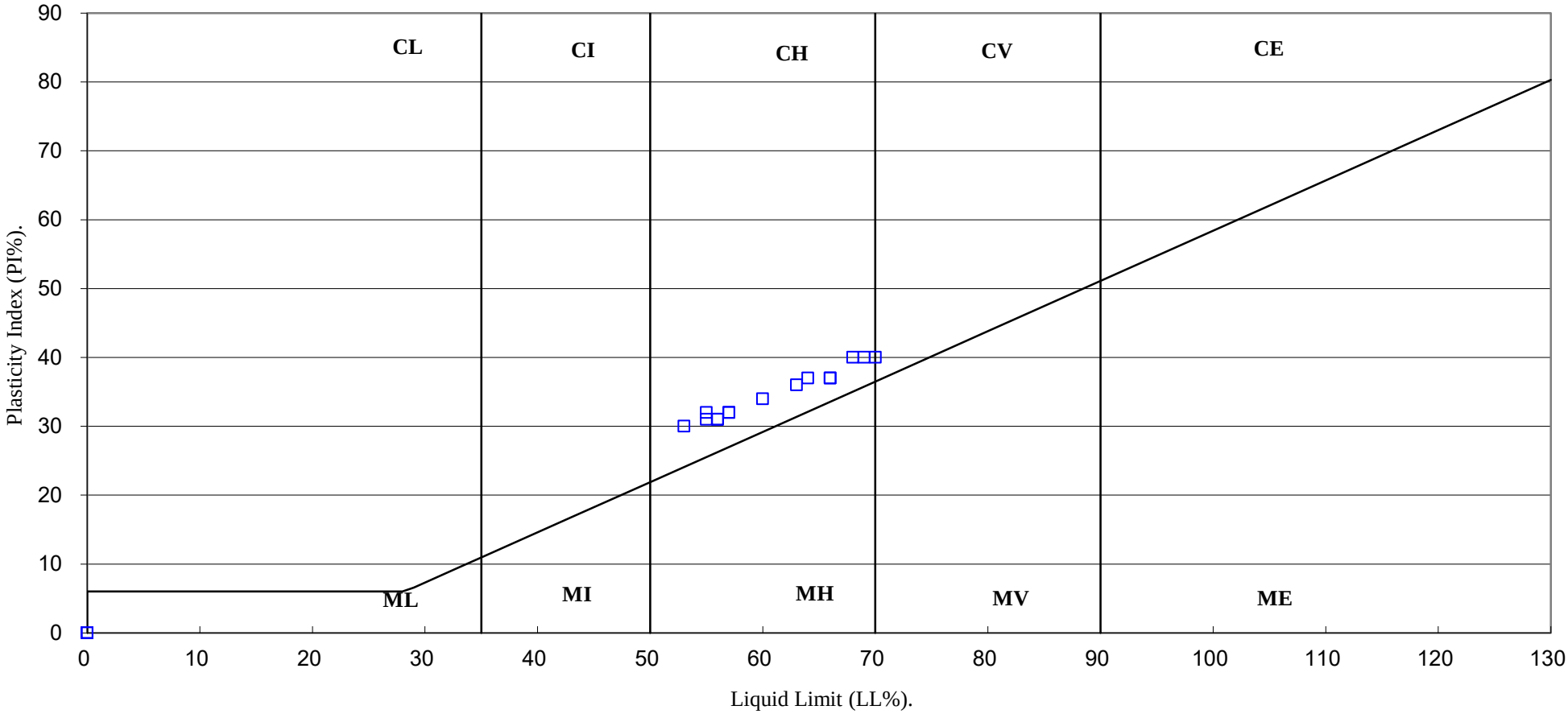
Contract No:

PSL19/1211

Client Ref:

3319

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Villa Farm, Bradley**	**Contract No:**
			PSL19/1211
			Client Ref:
			3319

PARTICLE SIZE DISTRIBUTION TEST

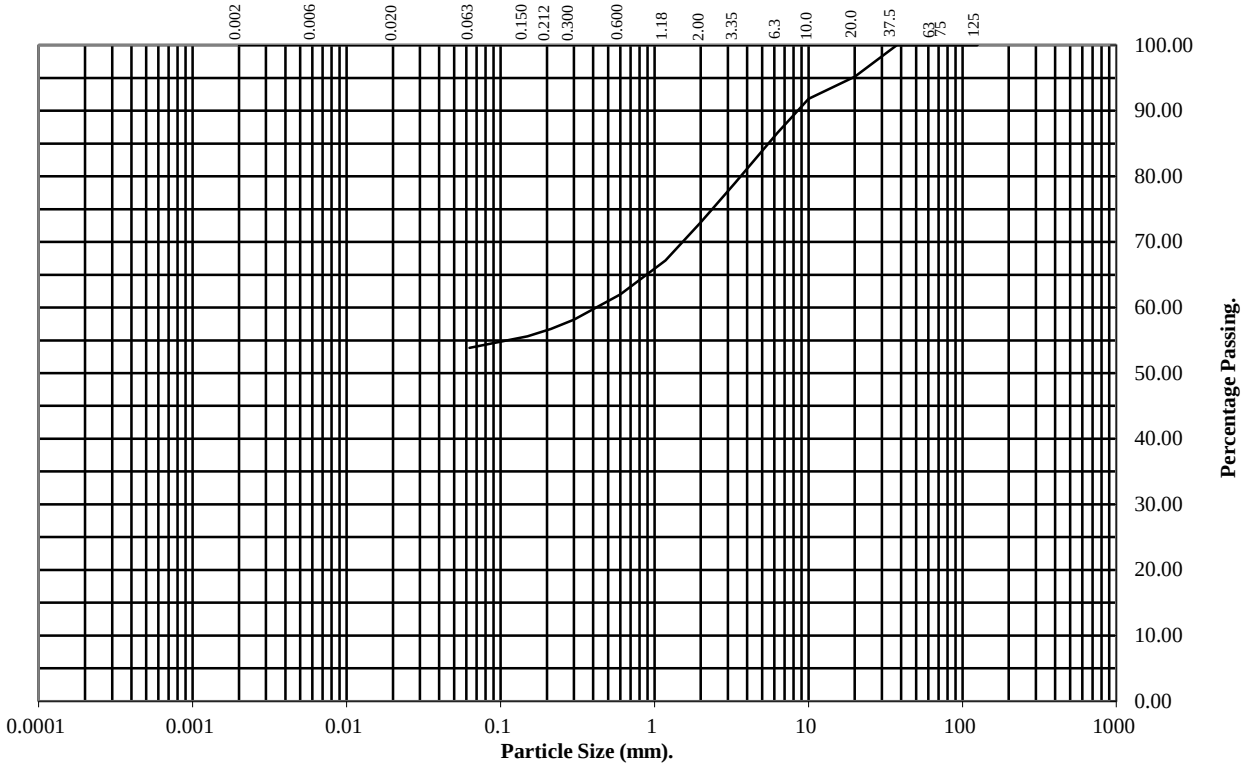
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP39** **Top Depth (m):** **0.70**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	95
10	92
6.3	87
3.35	79
2	73
1.18	67
0.6	62
0.3	58
0.212	57
0.15	56
0.063	54

Soil Fraction	Total Percentage
Cobbles	0
Gravel	27
Sand	19
Silt/Clay	54

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

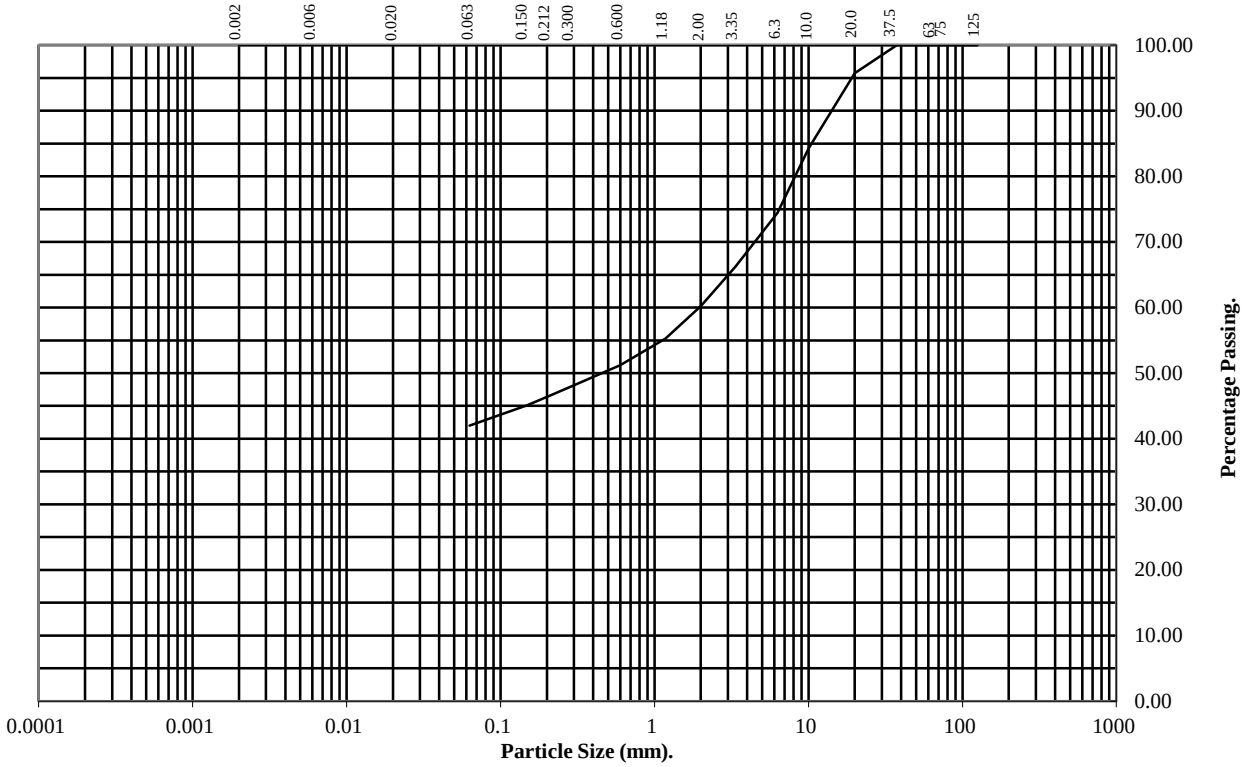
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP40** **Top Depth (m):** **0.70**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	96
10	84
6.3	74
3.35	66
2	60
1.18	55
0.6	51
0.3	48
0.212	47
0.15	45
0.063	42

Soil Fraction	Total Percentage
Cobbles	0
Gravel	40
Sand	18
Silt/Clay	42

Remarks:

See Summary of Soil Descriptions

PARTICLE SIZE DISTRIBUTION TEST

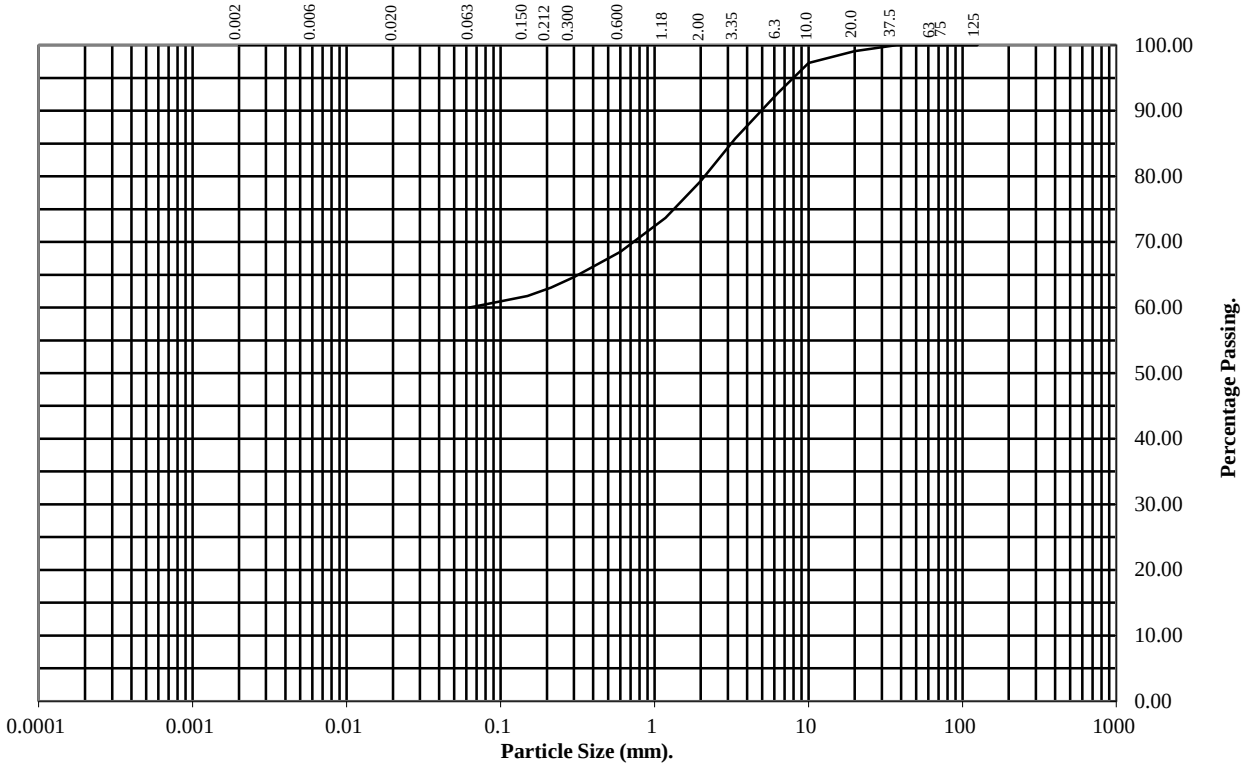
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP41** **Top Depth (m):** **0.60**

Sample Number: **1** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	99
10	97
6.3	93
3.35	86
2	79
1.18	74
0.6	69
0.3	65
0.212	63
0.15	62
0.063	60

Soil Fraction	Total Percentage
Cobbles	0
Gravel	21
Sand	19
Silt/Clay	60

Remarks:

See Summary of Soil Descriptions

Certificate of Analysis

Certificate Number 19-03416

27-Feb-19

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 19-03416

Client Reference PSL19/1211

Order No (not supplied)

Contract Title Villa Farm Bradley

Description 17 Soil samples.

Date Received 22-Feb-19

Date Started 22-Feb-19

Date Completed 27-Feb-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 19-03416
Client Ref PSL19/1211
Contract Title Villa Farm Bradley

			Lab No	1464331	1464332	1464333	1464334	1464335	1464336	1464337	1464338	1464339	1464340	1464341
			Sample ID	TP02	TP04	TP10	TP13	TP18	TP22	TP24	TP28	TP31	TP32	TP34
			Depth	0.90	0.50	0.60	0.50	1.20	0.60	0.70	0.50	0.70	0.70	0.90
			Other ID	2	2	2	2	3	2	2	2	2	2	2
			Sample Type	D	D	D	D	D	B	D	D	D	D	D
			Sampling Date	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**											
Inorganics														
pH	DETSC 2008#			7.0	6.5	6.6	6.4	7.1	7.5	7.5	6.6	7.5	7.5	5.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	68	60	99	320	28	200	79	210	140	140	260

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

Summary of Chemical Analysis
Soil Samples

Our Ref 19-03416
Client Ref PSL19/1211
Contract Title Villa Farm Bradley

			Lab No	1464342	1464343	1464344	1464345	1464346	1464347
			Sample ID	TP35	TP09	TP15	TP20	TP16	TP17
			Depth	0.90	0.90	0.40	0.80	0.90	1.00
			Other ID	2	1	2	2	2	2
			Sample Type	D	B	D	D	D	D
			Sampling Date	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
Test	**Method**	**LOD**	**Units**						
Inorganics									
pH	DETSC 2008#			6.2	6.6	7.1	6.3	7.0	7.1
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	110	25	18	40	32	20

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

Information in Support of the Analytical Results

Our Ref 19-03416
Client Ref PSL19/1211
Contract Villa Farm Bradley

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1464331	TP02 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464332	TP04 0.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464333	TP10 0.60 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464334	TP13 0.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464335	TP18 1.20 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464336	TP22 0.60 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464337	TP24 0.70 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464338	TP28 0.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464339	TP31 0.70 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464340	TP32 0.70 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464341	TP34 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464342	TP35 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464343	TP09 0.90 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464344	TP15 0.40 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464345	TP20 0.80 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464346	TP16 0.90 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1464347	TP17 1.00 SOIL		PT 1L	Sample date not supplied, Anions 2:1 (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 19-03416
Client Ref PSL19/1211
Contract Villa Farm Bradley

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