

A photograph of a stream bed with rocks and green algae, overlaid with a semi-transparent green filter. The text "Geoenvironmental Appraisal" is centered in white.

Geoenvironmental Appraisal

Land at Stanton under Bardon For Caddick Land

Report no: 4252/2

Date: August 2023



SUMMARY OF GEOENVIRONMENTAL ISSUES

Job No.	4252	Site area/ha	2.1
Client:	Caddick Land	NGR:	SK 466 099
Site:	Stanton under Bardon	Nearest postcode:	LE67 9TL

The site is located off Main Street, Stanton under Bardon, approximately 13km north west of Leicester city centre, and currently comprises open fields used as paddocks.

Lithos were commissioned by Caddick to provide a geoenvironmental appraisal of the site, which it is understood is to be redeveloped with housing. Lithos' investigation included a review of the site's history and environmental setting, and a ground investigation comprising 13 trial pits with soakaway testing in 4 of the pits, and 6 mini- boreholes.

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

Issue	Remarks
Made ground	Only encountered in the northwest to 0.7m, comprising Granular Surfacing, Cohesive Made Ground, Colliery Spoil and Reworked Natural soils.
Natural ground	Topsoil, typically 250mm thick covers the majority of the site over Oadby Member (Clay). Localised Granular Glaciofluvial Deposits were recorded on the northern boundary and in one hole in the south, likely a localised lens. Cohesive & Granular Alluvium were encountered in the far east along the line of a drainage ditch. Bedrock, comprising Edwalton Member Mudstone was recorded in 5 of the window sample holes from 1.0m depth, typically from >3m depth.
Contamination	No plausible contaminant linkages have been identified. Testing suggests that topsoil is suitable for re-use.
Mining & quarrying	Whilst the site lies within a Coal Authority Low Risk Area, no significant risks have been identified.
Hazardous gas	The site is in an area where between 1% & 3% of homes are estimated to be above the radon action level and as such no protection measures are required. No potential sources of hazardous gas have been identified, and therefore, no special precautions against methane / carbon dioxide gas are required.
Preparatory works	General site clearance, and topsoil strip & stockpile. Provision of 300mm thickness of topsoil in all garden and landscaped areas underlain by made ground.
Foundations	Shallow strip or deepened trench fill footings founded in medium to high strength clay (Oadby Member). The illustrative layout provided shows no development in the far east where Alluvium (low strength clay) was encountered. However, should changes to the layout be made, alternative foundations such as piles may be required for plots underlain by low strength Alluvium.
Groundwater & excavations	Groundwater was noted in the base of SA01 before the soakaway test was started. Groundwater was also recorded in WS1. Shallow excavations should remain stable during the construction phase in the short term although some shoring may be required for any deep excavations in the far east (Alluvium).
Flooding & drainage	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low.
Highways	Based on visual inspection of the shallow natural materials and published guidance, the Oadby Member should provide a CBR value of at least 3%. This value should be verified prior to or during construction.

Developer abnormalities relating to geoenvironmental issues at the site are:

- Likely need for surface water balancing.
- Diversion of overhead electric cables or incorporation into the proposed layout.

CONTENTS

1	INTRODUCTION	1
1.1	THE COMMISSION AND BRIEF	1
1.2	THE PROPOSED DEVELOPMENT	1
1.3	REPORT FORMAT AND LIMITATIONS	1
2	SITE DESCRIPTION.....	2
2.1	GENERAL	2
2.2	SITE FEATURES	2
3	SITE HISTORY	3
4	ENVIRONMENTAL SETTING.....	4
4.1	GENERAL	4
4.2	COAL & MINING	5
4.3	AGRICULTURE	5
5	PRELIMINARY CONCEPTUAL SITE MODEL	6
6	GROUND INVESTIGATION DESIGN.....	6
6.1	ANTICIPATED GROUND CONDITIONS & POTENTIAL ISSUES	6
6.2	GROUND INVESTIGATION DESIGN & STRATEGY	6
7	FIELDWORK	7
7.1	OBJECTIVES	7
7.2	SCOPE OF WORKS	7
8	GROUND CONDITIONS.....	8
8.1	GENERAL	8
8.2	MADE GROUND	8
8.3	NATURAL GROUND	8
8.4	VISUAL & OLFACTORY EVIDENCE OF ORGANIC CONTAMINATION	10
8.5	GROUNDWATER	10
8.6	STABILITY.....	10
8.7	REVISED CONCEPTUAL GROUND MODEL (GROUND CONDITIONS)	10
9	SOAKAWAY TEST RESULTS	11
9.1	UK GUIDANCE	11
9.2	FIELD TESTS.....	11
9.3	DISCUSSION & CONCLUSIONS.....	11
10	CONTAMINATION (ANALYSIS)	12
10.1	GENERAL	12
10.2	TESTING SCHEDULED	12
10.3	SOIL CONTAMINATION RESULTS	12
11	CONTAMINATION (QUALITATIVE RISK ASSESSMENT)	17
11.1	TOPSOIL	17
11.2	MADE GROUND	17
11.3	REVISED CONCEPTUAL GROUND MODEL (CONTAMINATION)	17
11.4	WASTE CLASSIFICATION	18
12	HAZARDOUS GAS	18
12.1	METHANE & CARBON DIOXIDE	18
12.2	RADON.....	18

13	GEOTECHNICAL TESTING	19
13.1	GENERAL	19
13.2	ATTERBERG LIMITS	19
13.3	PARTICLE SIZE DISTRIBUTION	19
13.4	SOLUBLE SULPHATE AND PH.....	20
13.5	UNDRAINED SHEAR STRENGTH TESTING	20
13.6	STANDARD PENETRATION TEST (SPT)	21
14	GEOTECHNICAL ISSUES	22
14.1	CONCEPTUAL SITE MODEL	22
14.2	MINING & QUARRYING	22
14.3	SITE REGRADE AND/OR GROUND IMPROVEMENT	22
14.4	FOUNDATION RECOMMENDATIONS.....	23
14.5	FLOOR SLABS	24
14.6	DESIGNATED CONCRETE MIXES.....	25
14.7	EXCAVATIONS.....	25
14.8	DRAINAGE	26
14.9	HIGHWAYS	26
14.10	EXTERNAL WORKS	27
15	REDEVELOPMENT ISSUES.....	27
15.1	GENERAL	27
15.2	PREPARATORY WORKS.....	27
15.3	GOOD PRACTICE GUIDANCE	28
15.4	NEW UTILITIES.....	28
15.5	HEALTH & SAFETY ISSUES - CONSTRUCTION WORKERS	28
15.6	POTENTIAL DEVELOPMENT CONSTRAINTS.....	28
16	SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.....	29
16.1	GENERAL	29
16.2	MINING.....	29
16.3	HAZARDOUS GAS	29
16.4	CONTAMINATION	30
16.5	FOUNDATIONS	30
16.6	FLOODING	30
16.7	DRAINAGE	30
16.8	HIGHWAYS	30

APPENDICES

Appendix A - General notes

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

Appendix B - Drawings

Drawing	Revision	Title
4252/1	-	Site location plan
4252/2	B	Proposed site layout
4252/3	-	Site features
4252/4	-	Site photographs
4252/5	A	Preliminary conceptual site model
4252/6	A	Exploratory hole locations
4252/7	-	Revised conceptual site model
4252/8	-	Drift Geology from BGS maps

Appendix C - Commission

Appendix D - Historical OS plans[#]

Appendix E - Search responses[#]

From	Date	Content
Landmark	30/09/2021	Environmental search data
Coal Authority	30/09/2021	Mining report

Appendix F & G - Exploratory records

Appendix F	SA01 to SA04 TP01 to TP09
Appendix G	WS01 to WS06

Appendix H - Chemical test results

Appendix I - Geotechnical test results

Appendix J – Soakaway infiltration calculations

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

FOREWORD (GEOENVIRONMENTAL APPRAISAL REPORT)

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

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

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

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

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

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

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

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

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

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

GEOENVIRONMENTAL APPRAISAL
of land at
STANTON UNDER BARDON

1 INTRODUCTION

1.1 The commission and brief

- 1.1.1 Lithos Consulting Limited were commissioned by Caddick Land to carry out a geoenvironmental appraisal of land at Stanton under Bardon.
- 1.1.2 Lithos have previously issued a Preliminary Investigation Report (Ref 4252/1A, dated May 2022). The information contained in Report 4252/1A has been incorporated within this Report, which now supersedes Report 4252/1A.
- 1.1.3 Correspondence regarding Lithos' appointment, including the brief for this investigation, is included in Appendix C. The agreed scope of works included:
- A site walkover and inspection
 - An assessment of the land use history
 - Determination of the site's environmental setting
 - A mining risk assessment in accordance with Coal Authority guidance.
 - An intrusive ground investigation comprising 13 trial pits with soakaways in 4 pits, and 6 mini-boreholes
 - Assessment of the geotechnical properties of the near surface deposits to enable provision of foundation and highway recommendations
 - A qualitative assessment of contamination risks
 - Recommendations for the necessary site preparatory works
- 1.1.4 Primary aims of this investigation were to identify salient geoenvironmental issues affecting the site to support the submission of a planning application, and also to enable the Developer to obtain budget costs for: foundations; gas protection measures; and site preparatory works.

1.2 The proposed development

- 1.2.1 It is understood that consideration is being given to redevelopment of the site with traditional domestic dwellings, associated gardens, POS, adoptable roads and sewers.
- 1.2.2 An illustrative layout has been provided by 'Nineteen47' (Drawing reference n1686-006-E, dated December 2022) which is reproduced as Drawing 4252/2 in Appendix B to this report.

1.3 Report format and limitations

- 1.3.1 All standard definitions, procedures and guidance are contained within Appendix A, which includes background, generic information on:
- Assessment of the site's environmental setting
 - Ground investigation fieldwork
 - Geotechnical testing
 - Contamination testing
 - 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 4252/1 presented in Appendix B to this report. Site details are summarised in the table below.

Detail	Remarks
Location	13 km north west of Leicester city centre
NGR	SK 466 099
Approximate area	2.1 ha (5.2 acres)
Known services	Overhead electric, running across the site from the west to south

2.2 Site features

- 2.2.1 Lithos completed a walkover survey of the site on 28th September 2021.
- 2.2.2 Existing salient features, at the time of the walkover are presented on Drawing 4252/3 in Appendix B to this report and summarised in the table below.

Feature	Remarks
Current access	Off Main Street via private driveway or Thornton Lane via fields to the south.
Topography	The west of the site slopes gently to the south, with the east sloping gently to the southeast. The far east slopes gently down to the southwest.
Approximate areas	30m ² buildings (wooden stables) 100m ² gravel hardstand 21,000m ² grass
Nature of boundaries	North – Wooden fence and mature hedge East – Mature trees and drainage ditch South – Wooden fence West – Mature hedge and trees
Surrounding land uses	North – Open fields to north east with a menage/paddock in the far east. Public house and residential properties to north west. East – Open fields. South – Open fields, housing beyond to the south west West – Road (Main Street) with open fields beyond. Private gardens beyond the road to the north west

- 2.2.3 A selection of site photographs is included on Drawing 4252/4.
- 2.2.4 The site currently comprises open fields used as paddocks accessed via a private driveway on the northern boundary.
- 2.2.5 Horses were noted on site during the walkover. Wooden stables are present at the site entrance and on the northern tip.
- 2.2.6 To the north of the stables the land comprises part of a beer garden associated with an adjacent public house, accessed through the car park of the public house.
- 2.2.7 Wooden fences partition the site into several separate fields/paddocks.

- 2.2.8 An overhead electric line on timber poles enters the site on the western boundary before turning south east to exit on the southern boundary.
- 2.2.9 The west of the site slopes down to the south at around 1 in 15, with the east sloping down at around 1 in 10 to the southeast towards a drainage ditch. East of the ditch (the far east of the site) the land slopes down to the southwest towards the ditch at around 1 in 20.
- 2.2.10 The drainage ditch contains flowing water and runs across the site from north to south. The northern end of the ditch is culverted allowing access to the far east of the site. Trees of up to 15m in height are present along the length of the ditch.
- 2.2.11 Although not noted during the site walkover aerial imagery suggests that a small area of tipping may be present in the north of the site close to the stables at the site entrance with an area of imported crush material present close to the stables in the far north.
- 2.2.12 No significant changes to the site were noted during the recent fieldwork undertaken in July 2023.

3 SITE HISTORY

- 3.1 Site centred extracts from Ordnance Survey (OS) plans dating back to 1850 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
1883	Open fields with public footpath crossing centre of site from north to south	Brick yard located 100m to west. Cliffe Hill Quarry located 1,000m to northeast, north of Cliffe Hill Road
1903	No significant changes	Brick yard no longer shown
1919-1930		Small pond present on northern boundary Allotments present 250m to north. Cliffe Hill Quarry expanded to south of Cliffe Hill Road.
1955		Sewage works present 250m to south
1959-1977		Pond no longer shown
1980-1985		Area of Cliffe Hill Quarry to south of Cliffe Hill Road infilled. Sewage works no longer shown
1989	Footpath no longer shown	No significant changes
1993	No significant changes	Cliffe Hill Quarry disused, Cliffe Hill Road moved to south.

- 3.3 The surrounding area has been extensively quarried for aggregate (Diorite, Granodiorite and Tonalite) with Old Cliffe Hill Quarry around 600m northeast and Cliffe Hill Quarry around 800m to the northwest.
- 3.4 Whilst there have been quarrying operations since the 19th Century at Old Cliffe Hill Quarry, it was in the late 1980s that the construction and commencement of operations at New Cliffe Hill Quarry began.
- 3.5 As of 2018 Old and New Cliffe quarries are linked by a 714m long tunnel, which was completed in 2003. The aim behind the tunnel was to release some 60 million tonnes of previously sterilised high-quality aggregate.
- 3.6 No quarrying is shown at the site on historical or geological plans.

4 ENVIRONMENTAL SETTING

4.1 General

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

Issue	Data reviewed	Summary
Geology	1:50,000 BGS map (Sheet 155) 1:10,000 BGS maps (Sheet SK 41 SE & SK 40 NE)	Drift soils – Glaciofluvial Deposits (Sand and Gravel) on the northern boundary. Alluvium (clay, silt, sand and gravel) in the east adjacent to the line of the drainage ditch. Drift absent across the remainder of the site. Solid (bedrock) – Edwalton Member Mudstone. Igneous intrusions shown to the north and east (Diorite, Granodiorite and Tonalite)
Mining	Coal Authority BGS maps	This site is located within a Coal Mining Development Low Risk Area. However, the site is underlain by a significant thickness of Mudstone (>100m thick) with no coal shown underlying the site at shallow depth.
Quarrying	Historical OS plans	Large operational quarries located approximately 750m to north west and 500m to the north east
Landfills	Envirocheck	No known landfills within 250m
Radon	Public Health England	The site lies in an area where 1-3% of homes are estimated to be above the action level.
Hydrogeology	Environment Agency electronic open data via QGIS	Source Protection Zone? No. Aquifer: Secondary A Aquifer (Drift); Secondary B Aquifer (Solid). Groundwater abstractions? 3 within 1km of the site, all for general farming and domestic purposes.
Hydrology	Envirocheck Report	Nearest watercourse – Un-named ditch present in the east, flowing south. Water quality – The site lies in the catchment for Rothley Brook (tributary of Soar River) and was rated in 2019 ecologically moderate but failed chemically due to transport drainage, poor livestock management, poor nutrient management and urbanisation. Abstractions? None identified.
Flood risk	Environment Agency electronic open data via QGIS	The site lies in Flood Zone 1, where the risk of flooding from rivers or the sea is classified as low. In accordance with Chapter 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. This Section provides the necessary mining risk assessment required by the proposed planning application.
- 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 Geological maps suggest that no coal seams underlie the site at shallow depth.
- 4.2.4 A CA mining report states that:
- No past underground mining recorded.
 - No probable unrecorded shallow workings.
 - No mine entries recorded within 100m of the enquiry boundary.
 - No opencast mines recorded within 500m of the enquiry 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 31 October 1994.
 - No notices have been given, under Section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.
 - The property is not in an area where a notice to withdraw support has been given.
- 4.2.5 The mining reports suggests there are no known shallow workings (i.e. at less than 30m depth). However, it should be noted that it did not become a statutory requirement to maintain and preserve plans of abandoned mines until the Mine (Coal) Regulations Act of 1872 and consequently there may be mineworkings beneath the site for which the Coal Authority have no records.

4.3 Agriculture

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

Agricultural activity	Potential contaminant
Slurry pits, manure heaps, septic tanks	Methane, metals, nitrates, oxygen depletion
Sewage farming, slurry spreading	Methane, metals, nitrates, oxygen depletion
Plant & animal protection	Pesticides & herbicides
Soil conditioners	Metals, sulphates, PAH
Derelict buildings	Asbestos
Naturally occurring contaminants	Arsenic, metals

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

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

5 PRELIMINARY CONCEPTUAL SITE MODEL

- 5.1.1 A preliminary conceptual site model, presented as Drawing 4252/5 in Appendix B, has been prepared after consideration of all the data presented in Sections 2 to 4 inclusive of this report.
- 5.1.2 Potential contaminant linkages are shown on the preliminary conceptual site model.
- 5.1.3 The conceptual model will likely be subject to modification in light of data arising from the proposed intrusive ground investigation; see Section 11.2.1.

6 GROUND INVESTIGATION DESIGN

6.1 Anticipated ground conditions & potential issues

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

Anticipated condition	Remarks
Made ground	A veneer of made ground is expected in the far north associated with construction of the stables and surrounding access.
Natural soils	Veneer of topsoil across the site. Alluvium (clay, silt, sand & gravel) in the far east with Glaciofluvial deposits (sand & gravel) on the northern boundary, Residual soils (gravelly clay / clayey gravel) from the complete weathering of bedrock should be anticipated.
Bedrock	Edwalton Member Mudstone anticipated at relatively shallow depth (<2m).
Groundwater	Possibly shallow in drift; likely deep in bedrock.

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

Type of issue	Specific issue	Remarks
Potential geotechnical hazards	1. Soft /loose ground (Alluvial soils)	1. Possible need for vibro-improvement or piles
Other potential constraints	1. Overhead utilities	1. Diversion or incorporation into the proposed layout

6.2 Ground investigation design & strategy

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

Exploratory holes	Purpose
12 Trial Pits	To determine the general nature of soils underlying the site, including the: - Nature, distribution and thickness of shallow soils, including any made ground - Suitability of the ground for founding structures and highways
Inc. 4 TPs	To determine whether soakaways could be utilised for storm water drainage
3 boreholes	To install monitoring wells in the vicinity of proposed attenuation in order to determine groundwater levels

6.2.2 Proposed exploratory hole locations were selected to provide a representative view of the strata beneath the site and to target potential areas of interest identified in Section 6.1 above. A nominal 45m grid spacing was proposed. Additional exploratory locations might be scheduled by the site engineer in light of the ground conditions actually encountered.

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

7 FIELDWORK

7.1 Objectives

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

7.2 Scope of works

7.2.1 Fieldwork was supervised by Lithos on the 18th & 31st July 2023 and comprised the exploratory holes listed below.

Technique	Exploratory holes	Final depth(s)	Remarks
Trial pitting (machine dug)	SAs 01 to 04 TPs 01 to 09	1.5m to 2.9m	Hand vanes undertaken in cohesive soils
Soakaway tests	Within SAs 01 to 04		
Window sample boreholes	WSs 01 to 06	3m to 4m	SPTs undertaken. Monitoring wells installed in WSs 01 to 03

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

7.2.3 Exploratory hole logs are presented in Appendices F & G to this Report. These logs include details of the:

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

7.2.4 Exploratory hole locations are shown on Drawing 4252/6 presented in Appendix B; exploratory holes were picked-up by a surveyor and co-ordinates/ground levels are included on the logs.

8 GROUND CONDITIONS

8.1 General

- 8.1.1 A complete record of strata encountered beneath the proposed development site is given on the various exploratory hole records, presented in Appendices F & G.
- 8.1.2 Typical ground conditions encountered are described below in Sections 8.2 (made ground) and 8.3 (natural ground), with a summary provided in the table on page 9.

8.2 Made ground

- 8.2.1 The made ground on site is a heterogeneous mixture of materials and it is unlikely, even with a huge amount of sampling, that it could be accurately characterised. Nonetheless, the bulk of the made ground can be categorised as one of 3 broad types:
- **Granular Surfacing:** encountered in TP01 to 0.3m comprising sandy Gravel of limestone and rare brick.
 - **Cohesive Made Ground:** encountered in TP01 below Granular Surfacing to 0.7m comprising sandy, slightly gravelly Clay.
 - **Colliery Spoil & Reworked Natural:** encountered in TP02 to 0.7m comprising grey, slightly sandy, gravelly Clay and red slightly sandy, slightly gravelly Clay. The grey clay includes gravel of coal and mudstone.
- 8.2.2 Made ground was only encountered in two pits in the north west, likely associated with construction of stables and access. Review of the logs shows a maximum thickness of made ground 0.7m.

8.3 Natural ground

- 8.3.1 Natural ground was encountered in all of the exploratory holes, and typically comprised:
- **Topsoil:** encountered across most of the site as gravelly, clayey Sand to a typical depth of 250mm.
 - **Granular Glaciofluvial Deposits:** comprising gravelly, clayey Sand. Encountered in 3 pits (TPs 02, 05 & 07) to a maximum 1.2m depth.
 - **Cohesive Alluvium:** comprising soft, slightly gravelly, sandy Clay. Encountered in the east to a maximum depth of 3.8m.
 - **Granular Alluvium:** comprising very gravelly, clayey, Sand. Encountered in the east to at least 2.5m depth.
 - **Oadby Member:** encountered in the majority of pits comprising firm to stiff, slightly gravelly Clay, with gravel of chalk, chert and mudstone.
 - **Edwalton Member:** encountered in 5 window sample boreholes from a shallow as 1.0m depth but typically from greater than 3.0m depth. Typically comprises stiff, slightly gravelly Clay.
- 8.3.2 Granular Glaciofluvial Deposits were anticipated on the northern boundary (TPs 02 & 05) but were also recorded to 1.0m depth in TP07 located in the south, suggesting a localised lens.
- 8.3.3 The Oadby Member is not recorded beneath the site on geological maps but is recorded immediately north. Trial pits suggest that the Oadby Member extends further south than that shown on geological plans.



Summary of ground conditions

Hole	Final depth (mbgl)	Depth to Base of Made Ground (mbgl)	Depth to Base of (mbgl)								Depth to weathered Edwalton Member bedrock (mbgl)
			Made Ground			Natural Soils					
			Granular Surfacing	Cohesive Made Ground	Colliery Spoil & Reworked Natural	Topsoil	Granular Glaciofluvial Deposits	Cohesive Alluvium	Granular Alluvium	Oadby Member (Clay)	
SA01	2.5	-	-	-	-	0.25	-	> 2.5	1.0	-	-
SA02	2.4	-	-	-	-	0.20	-	-	-	> 2.5	-
SA03	2.4	-	-	-	-	0.20	-	-	-	> 2.5	-
SA04	2.5	-	-	-	-	0.25	-	-	-	> 2.5	-
TP01	2.5	0.7	0.3	0.7	-	-	-	-	-	> 2.5	-
TP02	1.5	0.7	-	-	0.7	-	1.2	-	-	> 1.5	-
TP03	2.4	-	-	-	-	0.20	-	-	-	> 2.4	-
TP04	2.5	-	-	-	-	0.25	-	-	-	> 2.5	-
TP05	2.7	-	-	-	-	0.20	0.5	-	-	> 2.7	-
TP06	2.3	-	-	-	-	0.25	-	-	-	> 2.3	-
TP07	2.9	-	-	-	-	0.25	1.0	-	-	> 2.9	-
TP08	2.5	-	-	-	-	0.25	-	2.1	> 2.5	-	-
TP09	1.6	-	-	-	-	0.20	-	-	-	> 1.6	-
WS1	4.0	-	-	-	-	0.35	-	0.6 & 2.4	0.8	3.5	3.5
WS2	3.0	-	-	-	-	0.2	-	1.0	-	-	1.0
WS3	3.0	-	-	-	-	0.3	-	1.5 & 2.3	1.8	-	2.3
WS4	3.0	-	-	-	-	0.4	-	1.2	0.9	> 3.0	-
WS5	4.0	-	-	-	-	0.3	-	3.3	-	-	3.3
WS6	4.0	-	-	-	-	0.3	-	3.8	-	-	3.8

8.4 Visual & olfactory evidence of organic contamination

- 8.4.1 No visual or olfactory evidence of hydrocarbon contamination was encountered.
- 8.4.2 Samples of topsoil and made ground were scheduled for chemical testing to confirm their suitability for re-use; see Section 10.

8.5 Groundwater

- 8.5.1 Groundwater was recorded within WS1 at 3.4m, rising to 2.5m after 20 minutes. Groundwater was also recorded in the base of SA01 before the soakaway test was started.
- 8.5.2 An attenuation basin is proposed in the far southeast, therefore monitoring wells have been installed at 3 locations around the basin to allow monitoring of groundwater (see Section 14.8).
- 8.5.3 Groundwater levels recorded in the monitoring wells (one visit on 17th August 2023) are summarised below.

Hole	Response zone (depth range & strata)	Groundwater body	Typical standing water level	
			m bgl	m AoD [#]
WS1	1.0 – 4.0m (Alluvium and Oadby Member)	Shallow (drift)	1.64	155.96
WS2	1.0 – 3.0m (weathered Edwalton Member)	Deep (bedrock)	1.30	154.45
WS3	1.0 – 3.0m (Alluvium and weathered Edwalton Member)	Shallow (drift) & deep (bedrock)	1.58	155.37

[#] levelled-in by survey

- 8.5.4 These results will be required by the drainage designer for the design of the proposed attenuation pond. A monitoring programme comprising 7 visits over 12 months has been implemented, and results will be issued shortly after completion of monitoring in August 2024.

8.6 Stability

- 8.6.1 Stability of excavations within made and natural ground was generally good. Some shoring may be required for any deep excavations in the east where Alluvium was encountered.

8.7 Revised conceptual ground model (ground conditions)

- 8.7.1 The Preliminary Conceptual Site Model has been revised in light of data obtained during the ground investigation, most notably with respect to:
- The nature and distribution of made ground, including the presence of significant buried obstructions
 - The strength, nature and depth of underlying natural strata
- 8.7.2 Further refinement of the Conceptual Site Model is presented in Section 11.2, where the results of laboratory testing for contaminants have been considered.

9 SOAKAWAY TEST RESULTS

9.1 UK guidance

- 9.1.1 General notes about soakaways, including their location, design, and Lithos' test methodology are presented in Appendix A.
- 9.1.2 CIRIA C753¹ 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'.
- 9.1.3 BRE Digest 365² "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.

9.2 Field tests

- 9.2.1 Four soakaway tests were carried out in general accordance with BRE Digest 365 "Soakaway Design". The locations of the soakaways are shown on Drawing 4252/6 presented in Appendix B to this report.
- 9.2.2 Infiltration rates for each soakaway test would usually be calculated in accordance with BRE Digest 365. This design takes into account time for the water level to fall from 75% to 25% of its effective depth. The effective depth is the difference between the starting water level and the soakaway pit base depth.
- 9.2.3 However, infiltration rates could not be calculated for any of the 4 tests as they did not attain 25% effective depth after 3 hours.

9.3 Discussion & conclusions

- 9.3.1 Soakaways are generally only considered to provide a satisfactory solution for the disposal of surface water where the vast majority of tests yield reasonable infiltration rates, which is not the case at this site.
- 9.3.2 Consequently, soakaways will not provide a suitable drainage solution; and there will be a need for surface water balancing.
- 9.3.3 Drainage solutions are discussed further in Section 0.

¹ CIRIA C753. *The SuDS Manual* (2015).

² BRE Digest 365. *Soakaway Design* (1991).

10 CONTAMINATION (ANALYSIS)

10.1 General

- 10.1.1 The site has not been the subject of a past potentially contaminative industrial land use. However, historical mapping suggests arable farming may have been carried out on the site. The site currently comprises grassed paddocks for grazing of horses.
- 10.1.2 Sampling of the topsoil has been undertaken to confirm its suitability for re-use.
- 10.1.3 An assessment of potential contaminants associated with the former uses has been undertaken; see Section 5.
- 10.1.4 In the context of risks to human health associated with residential redevelopment, the Tier 1 Soil Screening Values referenced in this report have been derived via the CLEA default conceptual site model (CSM) used for generating SGVs, but amended, where appropriate, to be more specific to redevelopment within the planning process.
- 10.1.5 Where available, Category 4 Screening Levels (C4SL) have also been referenced.
- 10.1.6 Generic Note 04 in Appendix A provides further details with respect to current guidance and the interpretation of analytical data.

10.2 Testing scheduled

- 10.2.1 Based on the above assessment, Lithos submitted a test schedule (summarised in the table below) to a UKAS accredited laboratory.

Type of sample	No. of samples	Determinands
Made ground	3	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID Water soluble sulphate, chloride, nitrate and magnesium TOC, Speciated Polycyclic Aromatic Hydrocarbons (PAH), Banded Total Petroleum Hydrocarbons (TPH)
Topsoil	10	pH, water soluble boron, and total metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc) & Asbestos ID TOC, Speciated Polycyclic Aromatic Hydrocarbons (PAH)
	5	Clay/sand/silt content and visible contaminants, sharps (glass etc) to check compliance with BS3882:2015

10.3 Soil contamination results

- 10.3.1 The soil contamination test results are summarised in the tables on pages 13 & 14.
- 10.3.2 Laboratory test certificates as received from the laboratory are presented in Appendix H to this report.

Summary of degree of soils contamination (inorganics)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg unless otherwise stated. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a residential with gardens end-use.												
			pH	As ∞	B~	Cd ∞	Cr x	Cu♣\$	Pb ∞	Hg*	Ni	Se	Vn	Zn\$	Asbestos
				37	5	26	4000	100	200	199	109	434	584	200	
TP01	0.5	Cohesive Made Ground	6.8	8.6	1.7	0.3	18	26	50	0.1	15	< 0.5	29	89	N.D.
TP02	0.4	Colliery Spoil & Reworked Natural	7.4	12	1.5	0.2	18	41	34	0.1	27	< 0.5	35	100	N.D.
TP01	0.1	Granular Surfacing	11.4	5.9	1.2	0.3	8.1	24	9.5	< 0.05	7.2	< 0.5	28	45	N.D.
SA01	0.1	Topsoil	6.4	7.6	0.6	0.2	15	18	24	< 0.05	13	< 0.5	25	58	N.D.
SA02	0.1	Topsoil	6.1	9.7	1.0	0.3	18	21	30	< 0.05	15	< 0.5	30	69	N.D.
SA03	0.1	Topsoil	6.0	9.9	1.4	0.2	21	23	34	0.1	19	< 0.5	33	75	N.D.
SA04	0.1	Topsoil	5.8	10	1.2	0.3	17	23	42	0.1	15	< 0.5	30	79	N.D.
TP03	0.1	Topsoil	5.9	10	1.1	0.2	18	20	41	0.1	14	< 0.5	32	74	N.D.
TP04	0.1	Topsoil	5.7	10	1.0	0.2	17	20	42	0.1	13	< 0.5	31	73	N.D.
TP05	0.1	Topsoil	6.0	8.7	1.0	0.3	16	21	37	< 0.05	12	< 0.5	27	77	N.D.
TP06	0.1	Topsoil	6.4	8.8	1.4	0.3	16	22	31	0.1	16	< 0.5	27	74	N.D.
TP07	0.1	Topsoil	5.8	8.9	0.6	0.2	15	22	29	0.1	14	< 0.5	25	71	N.D.
TP08	0.1	Topsoil	5.5	12	0.9	0.3	18	28	45	0.1	16	< 0.5	33	89	N.D.

Key		Source of Guidance Trigger Level	
36	Parameter tested for and found to be in excess of Tier 1 concentration	With the exception of those annotated with one of the symbols below (∞, \$, ~), all Soil Screening Values in brackets above have been derived using CLEA v1.06. Values assume contaminants located in a sandy loam, with 6% soil organic matter (SOM).	
179	Parameter tested for and found to be > 5 x Tier 1 concentration		
12	Parameter tested for but not found to be in excess of Tier 1 concentration	∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE\Defra)
-	Parameter not tested for	\$	Ministry of Agriculture, Fisheries & Food. Code of Practice for Agricultural Practice for the Protection of Soil. 1998
♣	Tier 1 Value is pH dependent	~	Engineering judgement (Lithos). Boron is a phytotoxic, although most phytotoxic compounds can pose a risk to human health if sufficient concentrations are present. However, plants represent the most sensitive receptor, and a Tier 1 value which is protective of flora is therefore also protective of human health.
x	Assumes Cr is CrIII. If demonstrated Cr is CrVI screen would be 21mg/kg		
*	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.	N.D.	Not detected, applicable to asbestos I.D. screen only

Summary of degree of soils contamination (organics)

Expl Hole	Depth (m)	Material	Concentrations in mg/kg. Results are quoted to 1 decimal place if <10, and whole numbers if >10. Trigger Level Concentrations are shown in BLUE and assume a residential with gardens (and no cover) end use					
			% TOC	PAH		TPH - C6 to C40		
				B(a)P ∞	Naphthalene	GRO~ C ₆ to C ₁₀	DRO◇ C ₁₀ to C ₂₁	LRO C ₂₁ to C ₄₀
				5	6	22	215	3299
TP01	0.5	Cohesive Made Ground	3.3	< 0.03	< 0.03	< 0.1	< 30	< 20
TP02	0.4	Colliery Spoil & Reworked Natural	4.9	< 0.03	< 0.03	< 0.1	< 30	< 20
TP01	0.1	Granular Surfacing	2.1	0.03	< 0.03	< 0.1	< 30	< 20
SA01	0.1	Topsoil	2.2	< 0.03	< 0.03	-	-	-
SA02	0.1	Topsoil	3.7	< 0.03	< 0.03	-	-	-
SA03	0.1	Topsoil	3.5	< 0.03	< 0.03	-	-	-
SA04	0.1	Topsoil	3.7	< 0.03	< 0.03	-	-	-
TP03	0.1	Topsoil	2.7	< 0.03	< 0.03	-	-	-
TP04	0.1	Topsoil	4.1	< 0.03	< 0.03	-	-	-
TP05	0.1	Topsoil	3.3	< 0.03	< 0.03	-	-	-
TP06	0.1	Topsoil	3.8	< 0.03	< 0.03	-	-	-
TP07	0.1	Topsoil	2.6	< 0.03	< 0.03	-	-	-
TP08	0.1	Topsoil	2.7	< 0.03	< 0.03	-	-	-

Key		Source of Guidance Trigger Level	
0.3	Parameter tested for but not in excess of Tier 1 concentration	All Soil Screening Values in brackets above have been derived using CLEA v1.06. Values assume contaminants located in a sandy loam, with 6% soil organic matter (SOM). Assumes no soil cover , see Generic Notes 04 in Appendix A.	
60	Parameter tested for and in excess of Tier 1 concentration	~	Assumes all GRO is aromatic fraction C7 to C8
-	Contaminant not tested for	◇	Assumes all DRO is aliphatic fraction C10 to C12
		∞	Category 4 Screening Level – SP1010, December 2013 (CL:AIRE\Defra)

Inorganic determinands

- 10.3.3 Of the 13 samples of made ground and topsoil analysed for inorganic parameters, all 13 can be classified as uncontaminated.
- 10.3.4 These samples have been classified by comparison with Tier 1 Soil Screening Values for an end use including domestic gardens and any area where plants are to be grown (the most sensitive of proposed end-uses).
- 10.3.5 Current UK guidance regarding the statistical analysis of soil contamination data obtained during a site investigation is provided by CL:AIRE³, and uses two-way confidence intervals and graphical summaries, to assist assessors when determining whether or not a dataset is adequate to answer the question posed; e.g. "is existing site topsoil suitable for retention & re-use?". To answer such a question, it is necessary to recover and test a large number of samples (a minimum of 10; ideally 20+) in order to undertake meaningful statistical analysis.
- 10.3.6 The difference between the old and new approaches, including how Lithos apply the statistical assessment is detailed in Generic Note 04, included as Appendix A to this report.
- 10.3.7 Lithos can confirm that statistical assessment of the made ground is not appropriate because:
- There are insufficient samples from the made ground to allow representative statistical assessment to be undertaken.
- 10.3.8 Lithos can confirm that statistical assessment of the Topsoil is appropriate because:
- There is a well understood, robust CSM which identifies possible source areas
 - Sampling locations are relatively evenly spread across the site and only random sample data has been included in the assessment
 - Samples are considered by strata type
 - A minimum of 10 samples have been taken
- 10.3.9 Statistical analysis assumes that a given stratum is reasonably homogenous in terms of composition, the distribution of contaminants and the degree of contamination; the CSM indicates that this is a reasonable assumption at this site.
- 10.3.10 The Dot and Box Plots for key compounds (arsenic, lead and benzo(a)pyrene) are presented in Appendix H.
- 10.3.11 Statistical analysis indicates that the true mean for all determinands screened in the Topsoil are not elevated compared with relevant Lithos tier 1 screening values.

Asbestos

- 10.3.12 No visual evidence of asbestos-containing materials (ACMs), such as broken fragments of asbestos-cement sheeting, was noted during the excavation of trial pits.
- 10.3.13 No asbestos fibres were identified in any of the 13 samples screened.

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

Organic determinands

- 10.3.14 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 will be placed in gardens/landscaped areas (Lithos Scenario A).
- 10.3.15 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.
- 10.3.16 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.
- 10.3.17 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?
Granular Surfacing	2%	Yes, but no significant organic contamination was recorded in this soil type. All determinands well below "6%" screening value; most below limit of detection.
Cohesive Made Ground	3%	No
Colliery Spoil & Reworked Natural	5%	
Topsoil	3%	

Hydrocarbons (TPH)

- 10.3.18 Given the absence of visual/olfactory evidence of any hydrocarbon contamination, only a simple banded TPH (cf full speciation) was scheduled on 3 samples.
- 10.3.19 Assessment of TPH associated with a fuel/oil source would normally be undertaken in accordance with a 3-step approach, (outlined in Generic Note 04 in Appendix A) on fully speciated TPH results. However, although only banded TPH analysis has been scheduled here, none of the fractions exceed their respective Tier 1 criteria, even if it is conservatively assumed all of each fraction is either aliphatic or aromatic.
- 10.3.20 Consequently, no significant petroleum hydrocarbon concentrations have been identified, and there is no risk to human health from these hydrocarbons.

Polycyclic Aromatic Hydrocarbons (PAH)

- 10.3.21 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.
- 10.3.22 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).
- 10.3.23 Speciated analysis has confirmed the absence of significant concentrations of both benzo(a)pyrene and naphthalene in the soils beneath this site.

BS3882 Topsoil testing

- 10.3.24 The presence of visible contaminants, sharps (glass etc) was assessed by the Engineer in the field (inspection of initial trial pit arisings); none were identified. BS3882 considers visual contaminants to comprise 'undesirable potentially injurious foreign object(s) visible to the naked eye'.
- 10.3.25 The clay/sand/silt content of 5 topsoil samples have been determined to check compliance with BS3882⁴ requirements.
- 10.3.26 It should be noted that this is a reduced suite of analysis, and no N-P-K etc. testing has been undertaken. The results are summarised below:

Parameter	BS3882 Specification	SA01	SA02	SA03	SA04	TP06
Retained on 2mm sieve	< 30%	4	16	2	6	6
Retained on 20mm sieve	< 10%	0	2	0	4	2
Retained on 50mm sieve	0%	0	0	0	0	0
Clay content	5 to 35%	21	19	20	22	16
Silt content	0 to 65%	28	35	38	34	28
Sand content	0 to 90%	51	46	42	44	56

- 10.3.27 The above results suggest that the topsoil at this site complies to the standards set out in BS3882. In terms of textural classification, the topsoil falls into the 'sandy clay loam', 'clay loam' and 'sandy loam' classes.

11 CONTAMINATION (QUALITATIVE RISK ASSESSMENT)

11.1 Topsoil

- 11.1.1 Topsoil, typically 250mm thick, covers the majority of the site. Testing suggests this material is chemically suitable for re-use.
- 11.1.2 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth.

11.2 Made ground

- 11.2.1 Although essentially 'clean', the made ground contains materials (e.g. coal, brick etc), which would generally be considered undesirable as a near-surface material in garden areas.
- 11.2.2 Any residual made ground beneath garden areas should be blinded with 300mm clean topsoil.

11.3 Revised conceptual ground model (contamination)

- 11.3.1 No plausible contaminant linkages have been identified.

⁴ BS3882:2015. Specification for topsoil. Published by BSI Standards Limited.

11.4 Waste classification

- 11.4.1 Some excess arisings (topsoil & subsoil) may be generated by excavations for foundations, sewers etc. If these are intended for retention and reuse on the site, they would be classed as clean naturally occurring soils and would not be considered waste, under the Waste Framework Directive.
- 11.4.2 Off-site disposal of surplus clean naturally occurring soils to landfill is not recommended. In accordance with the CL:AIRE Code of Practice⁵ any excess natural soil arisings should be suitable for Direct Transfer to another development site, for use either as clean cover material, or bulk fill, without the need for waste legislation to be applied.

12 HAZARDOUS GAS

12.1 Methane & carbon dioxide

- 12.1.1 The site is not believed to be affected by sources of hazardous gas generation as it is:
- Not located within 250m of a known former or current landfill site or backfilled feature (e.g. quarry, pond, canal etc)
 - Neither underlain by shallow mineworkings nor located in an area considered susceptible to mines gas emissions
 - Not underlain by a significant thickness of made ground
 - Not underlain by peat or shallow chalk deposits

12.2 Radon

- 12.2.1 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.
- 12.2.2 At present Approved Document C advocates basic measures for the probability banding 3% to 10% (full measures if >10%). However, the UK Health Security Agency (HSA) would like to see all new build include basic measures.
- 12.2.3 In December 2022, the British Geological Survey (BGS), deployed a revised dataset which increased accuracy and also the number of properties falling within radon affected areas. This revised dataset is now referenced by maps on the HSA website.
- 12.2.4 The HSA website indicates that the site is in an area where **between 1% and 3%** of homes are estimated to be above the action level.
- 12.2.5 Consequently, radon protection measures are not required. However, in light of HSA advice, the Developer should consider providing all new dwellings with basic radon protection measures.

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

13 GEOTECHNICAL TESTING

13.1 General

13.1.1 A total of 25 samples of natural soil were delivered to a suitably accredited laboratory with a schedule of geotechnical testing drawn up by Lithos.

13.1.2 The geotechnical laboratory test results are presented in Appendix I to this report.

13.2 Atterberg limits

13.2.1 The plasticity indices of 12 samples of cohesive soil have been determined; results are summarised below.

Soil type	No. samples tested	Moisture content range % (average)	Range of Plasticity Indices % * (average)	Shrinkability
Cohesive Alluvium	4	12-30 (22)	11-23 (14)	Low
Oadby Member	8	16-21 (18)	13-31 (22)	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.

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

13.3 Particle size distribution

13.3.1 The grading of 5 samples (Alluvium, Granular Glaciofluvial Deposits and Oadby Member) have been determined by wet sieving and the results are summarised in the table below:

Sample & depth	Field description	% passing 37.5mm sieve	% passing 20mm sieve	% passing 2mm sieve	% fines	Material description (based on grading & plasticity)
SA01, 2.4m	Gravelly, very sandy CLAY	100	98	88	47	Slightly gravelly, sandy CLAY
TP08, 0.8m	Slightly gravelly, very sandy CLAY	91	85	78	45	Slightly sandy, slightly gravelly CLAY
SA01, 0.7m	Slightly clayey SAND	88	77	56	17	Very gravelly, clayey SAND
TP07, 0.7m	Very gravelly, slightly clayey SAND	88	72	50	12	Very gravelly, clayey SAND
SA04, 0.6m	Slightly gravelly, sandy CLAY	100	100	89	54	Slightly gravelly, sandy CLAY

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

13.3.3 The Clay soils (Cohesive Alluvium and Oadby Member) encountered on this site can therefore be regarded as shrinkable whilst the Granular Alluvium and Granular Glaciofluvial are non-shrinkable.

13.4 Soluble sulphate and pH

- 13.4.1 In accordance with BRE SD1⁶, this site has been classified as greenfield with a mobile groundwater regime.
- 13.4.2 It is envisaged foundations will extend to depths of about 1m through made ground and natural strata and samples taken from this depth range have been submitted for pH and water-soluble sulphate (2:1 soil/water extract).
- 13.4.3 The concentrations of sulphate in the aqueous natural soil extracts of 12 samples were determined. In addition, 3 samples of made ground were tested as part of the contamination suite. The pH value of each sample has also been determined.
- 13.4.4 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 Made Ground	1	6.8	35
Colliery Spoil & Reworked Natural	1	7.4	36
Granular Surfacing	1	11.4	150
Cohesive Alluvium	3	7.2	12
Granular Alluvium	2	6.8	97
Granular Glaciofluvial Deposits	1	7.2	<10
Oadby Member	6	7.1	26

- 13.4.5 pH values were all above 5.5, therefore concentrations of chloride and nitrate are considered insignificant.
- 13.4.6 In accordance with Table C1 of SD1, sub-surface concrete should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-1**.

13.5 Undrained shear strength testing

Hand shear vane and testing

- 13.5.1 Hand shear vane testing was undertaken within trial pits in-situ to around 1m depth and from larger blocks of excavated clay below that depth.
- 13.5.2 The results are summarised within the plot on page 21, together with results from in-situ SPT testing (see Section 13.6). Below approximately 0.5m depth S_u within the Oadby Member (Clay) is typically greater than 60kPa. A lower S_u , typically between 28kPa & 55kPa was recorded in the Cohesive Alluvium in the east.

⁶ BRE Special Digest 1 (2005) – Concrete in aggressive ground.

13.6 Standard penetration test (SPT)

13.6.1 The undrained shear strength of cohesive soils was also established by carrying out Standard Penetration Tests (SPTs) during the drilling of the mini boreholes.

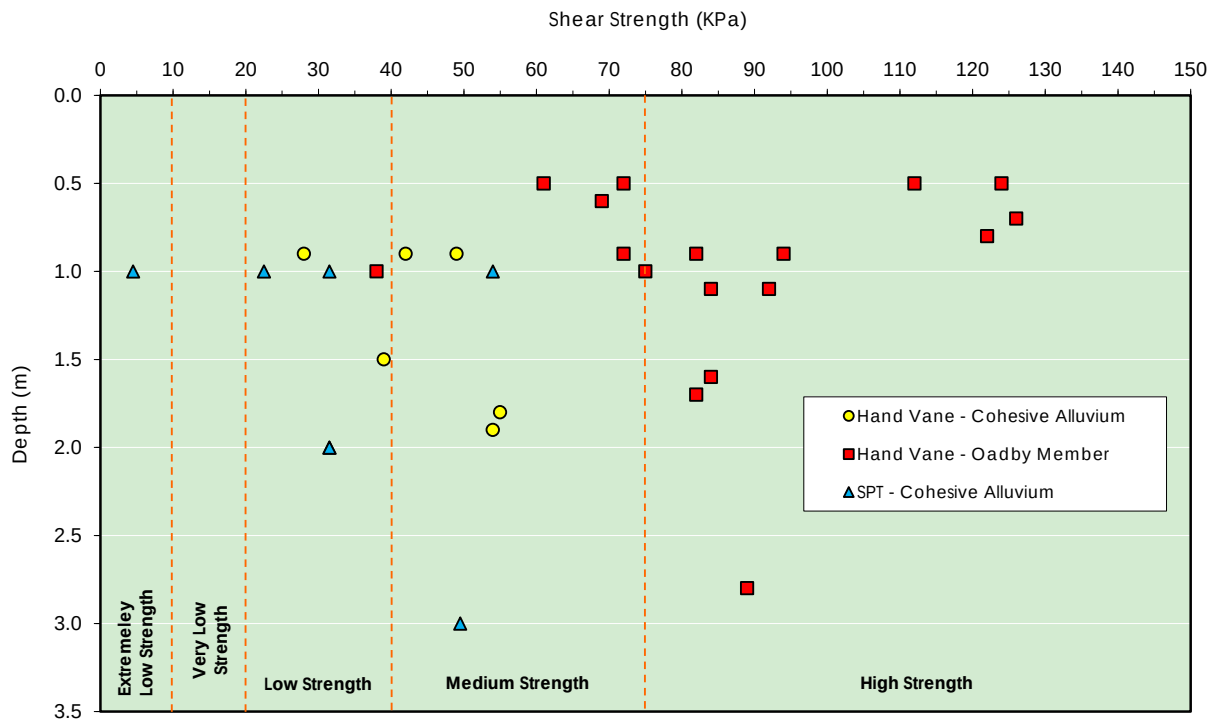
13.6.2 The SPT results are summarised in the table and plot below:

Stratum	Range of SPT 'N' values (avg)	Estimated strength	Remarks
Cohesive Alluvium	5 to 54 (32)	Extremely Low to Medium	Extremely low results possibly due to drilling disturbance

13.6.3 The reported blow counts suggest undrained shear strengths ranging from extremely low to medium which is broadly similar to the results obtained during hand vane testing

13.6.4 Densities of granular soils were not recorded as no significant thicknesses of granular strata were encountered during drilling.

Undrained Shear Strength (Cohesive Soils)



14 GEOTECHNICAL ISSUES

14.1 Conceptual site model

- 14.1.1 Made ground was only encountered in the far northwest, to 0.7m depth, and comprised Granular Surfacing, Cohesive Made Ground and Colliery Spoil & Reworked Natural.
- 14.1.2 Natural ground predominantly comprised Topsoil over Oadby Member (Clay).
- 14.1.3 Localised Granular Glaciofluvial Deposits were recorded on the northern boundary and in one hole in the south, likely a localised lens. Cohesive & Granular Alluvium were encountered in the far east along the line of a drainage ditch.
- 14.1.4 The current layout shows no development in the far east where Alluvium was encountered.
- 14.1.5 Bedrock comprises Edwalton Member (Mudstone), which was encountered in the east from 1.0m depth, typically from greater than 3m depth.

14.2 Mining & quarrying

- 14.2.1 This site is underlain by Edwalton Member Mudstone bedrock and the shallowest coal seam lies at least 100m below the surface. Whilst the site lies within a Coal Authority Low Risk area, no significant risks have been identified, and an intrusive mining investigation will not be required.
- 14.2.2 There are no known quarries on, or within 50m of the site.

14.3 Site regrade and/or ground improvement

- 14.3.1 Made ground, likely associated with construction of stables and access, currently underlies a localised area in the far northwest, to a maximum depth of 0.7m. This made ground is of variable and poor strength and is therefore not considered a suitable foundation material.
- 14.3.2 Although essentially 'clean', the made ground contains materials (e.g. coal, brick etc), which would generally be considered undesirable as a near-surface material in garden areas.
- 14.3.3 Any residual made ground beneath garden areas should be blinded with 300mm clean topsoil.
- 14.3.4 Given the topography of the land in the far east where the site slopes down towards the drainage ditch, some site regrade may be required.
- 14.3.5 Any digital terrain modelling undertaken, or commissioned, by the Developer should consider implications for the foundation recommendations outlined below.
- 14.3.6 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.
- 14.3.7 Wherever possible, Lithos recommend that excavated soils are retained on site. However, if this is not possible the comments in Section 11.4 should apply.

14.4 Foundation recommendations

General

- 14.4.1 It is understood that consideration is being given to redevelopment of the site with traditional domestic dwellings, associated gardens, POS, adoptable roads and sewers. An illustrative layout has been provided by 'Nineteen47'.
- 14.4.2 Foundation recommendations assume that development will be two or three storey construction and that line loads will not exceed 90kN/m run. If this is not the case significant alteration to these recommendations will be required.
- 14.4.3 We have assumed that final development levels will not differ significantly from ground levels existing at the time of investigation. Any digital terrain modelling undertaken, or commissioned, by the Developer should consider implications for the foundation recommendations outlined below.
- 14.4.4 Made ground is not considered a suitable foundation material and foundations should therefore be taken through these materials into underlying natural strata of adequate bearing capacity.
- 14.4.5 Sub-surface concrete in contact with the made and natural ground should be Design Sulphate Class **DS-1**, with the site allocated an ACEC Classification of **AC-1**.
- 14.4.6 At this stage, 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 and these are discussed below.

Strip/trench fill footings

- 14.4.7 Footings will be founded in medium to high strength clay (Oadby Member). This solution is viable where the plots are founded beyond areas of low strength Alluvium (far east).
- 14.4.8 Reinforcement, as a precaution against differential settlement, is recommended only where foundation excavations encounter significant lateral and vertical variations in strata. One layer of B385 mesh placed 75mm above the base of the footing is likely to provide suitable reinforcement, but further advice should be sought from the Structural Engineer.
- 14.4.9 Foundations will be required to be placed below a line drawn up at 45° from the base of any service or similar excavation.
- 14.4.10 Deepened foundations should be stepped in accordance with NHBC Standards, Chapter 4.3.
- 14.4.11 In order to minimise softening and swelling of cohesive soils or loosening of granular soils, it is recommended that footings are cast as soon as formation level is reached (or alternatively formation could be blinded using concrete with as low a water:cement ratio as possible).
- 14.4.12 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

- 14.4.13 Atterberg tests suggest that natural cohesive soils at the site are of medium shrinkability. A minimum founding depth of 900mm (not accounting for any existing or proposed vegetation) is therefore required for all soils on the site where strip footings are proposed.
- 14.4.14 In accordance with NHBC Standards, founding depths in cohesive soils should be taken from original or finished ground level, whichever is the lower, to the underside of the footing.
- 14.4.15 Foundations should be deepened near trees in accordance with NHBC Standards Chapter 4.2. It is estimated that up to 5% of the site may be affected by trees.
- 14.4.16 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.
- 14.4.17 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).
- 14.4.18 A safe bearing capacity of at least 170kPa, allowing a maximum foundation line load of 90kN/m run, can be assumed if the following are true
- A foundation length of 8m
 - A foundation breadth of 0.6m
 - A foundation thickness of 225mm
 - A foundation depth of 0.9m depth
 - An undrained shear strength of 60kPa for the medium strength clay (typical minimum recorded on site for the Oadby Member)
- 14.4.19 Assuming the foundation geometry detailed above, minimal settlements would be anticipated. This is considered likely to be acceptable.
- 14.4.20 Only an illustrative layout has been provided at this stage which shows no development in the far east where Alluvium (low strength clay) was encountered. However, should changes to the layout be made, alternative foundations such as piles may be required for plots underlain by low strength Alluvium.

14.5 Floor slabs

- 14.5.1 Suspended floor slabs should be utilised where the depth of made ground or engineered stone exceeds 600mm in accordance with NHBC Standards Chapter 5.1 (to negate potential settlement problems).
- 14.5.2 According to the current layout, it is considered unlikely that the depth of made ground beneath any plots will exceed 600mm thickness.
- 14.5.3 Where shallow foundations are within the influence of existing or proposed trees (and are underlain by shrinkable soils), NHBC require a suspended floor slab, with sub-floor void. The floor slab is most commonly a precast block and beam construction, but alternatively could comprise a suspended timber floor, or a slab cast on a suitable compressible void former. Ground-bearing and cast in-situ suspended slabs (other than those cast on a void former) are not acceptable where foundations are within the influence of trees.

- 14.5.4 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.
- 14.5.5 Beyond the influence of existing or proposed trees, it is considered that the natural ground is generally suitable for the use of ground bearing floors. However, ground bearing slabs should not be cast on topsoil. Where plots are elevated for design reasons, the depth of engineered stone below a ground bearing slab should not exceed 600mm, in accordance with NHBC guidance.
- 14.5.6 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.
- 14.5.7 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.

14.6 Designated concrete mixes

- 14.6.1 Designated mixes are considered in BRE SD1⁷ and BS 8500⁸. 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.
- 14.6.2 Consequently, the Developer should seek advice from their appointed Structural Engineer.

14.7 Excavations

- 14.7.1 Based on the results of the investigation it is considered unlikely that major groundwater flows will be encountered in shallow excavations.
- 14.7.2 However, if encountered, groundwater should be controlled in accordance with CIRIA Report R113⁹.
- 14.7.3 Excavations should remain stable in the short term but if left open for any significant period of time may require shoring, most notably in the Alluvium.

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

⁸ BS 8500-1&2:2015+A2:2019. Concrete. Complementary British Standard to BS EN 206. Method of specifying and guidance for the specifier (1) & Specification for constituent materials and concrete (2).

⁹ CIRIA Report R113 (1986) - Control of Groundwater for Temporary Works.

14.8 Drainage

- 14.8.1 Based on the results of in-situ testing, soakaways will not provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SuDS), and there may be a need for surface water balancing.
- 14.8.2 Alternative SuDS options (see CIRIA C753¹⁰ for further details) include:
- Swales – linear grassed features in which surface water can be stored or conveyed.
 - Basins - a ground depression designed to store surface water that is normally dry, except during and immediately following a rainfall event. There are two types:
 - o Infiltration – basin designed to store runoff and infiltrate it gradually into the ground.
 - o Detention – an outlet restricts flows, so that the basin fills and provides attenuation.
 - Ponds – designed to have permanent pool of water, but with capacity to provide temporary storage-controlled discharge.
- 14.8.3 With respect to detention basins, which should normally be dry, water table levels should be taken from borehole monitoring wells over 4 consecutive seasons, for at least 3 points in the basin area. The detention basin should be designed to ensure that there is a minimum of 1m of unsaturated soil between the maximum groundwater level and the lowest part of the structure.
- 14.8.4 It is Lithos' understanding that ground does not have to be free-draining (i.e. sands/gravels), but where clay is present the basin needs to be designed to prevent waterlogging - because this renders maintenance (grass cutting) difficult. It would be prudent to seek confirmation of this from Severn Trent Water and/or the appointed drainage designer.
- 14.8.5 Appropriate design usually comprises a fall across the short axis (to centre of basin), and then along the long axis (possibly inclusive of a pipe in gravel trench) to the outfall.
- 14.8.6 The guide also discusses required access to flow control chambers, large diameter (i.e. >900mm) surface water storage pipes, and surface water storage tanks.
- 14.8.7 The proposed layout currently includes an attenuation pond in the southeast.
- 14.8.8 It is recommended that the developer contact Severn Trent Water with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

14.9 Highways

- 14.9.1 This site is greenfield, however the routes, formation level and total length, of proposed estate roads are not known. Consequently, in-situ CBR values have not been obtained.
- 14.9.2 The natural soils present at shallow depth (anticipated formation) are predominantly cohesive. Based on visual inspection of the natural materials and the recorded plasticity indices at the site, published guidance¹¹ and tables¹² indicate that the Oadby Member (Clay) would be expected to provide a CBR value of at least 3%. This value should be verified prior to or during construction.

¹⁰ CIRIA C753 (2015) – The SuDS Manual.

¹¹ CD225 Design for new pavement foundations Revision 1 (Design Manual for Roads and Bridges)

¹² The Structural Design of Bituminous Road, TRRL Laboratory Report 1132 (Table C1, page 36)

- 14.9.3 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.

14.10 External works

- 14.10.1 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.

15 REDEVELOPMENT ISSUES

15.1 General

- 15.1.1 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.
- 15.1.2 Even after an appropriate preliminary investigation and ground investigation, with exploratory holes on a closely spaced grid (say trial pits at 30m centres), a geoenvironmental appraisal is typically based on inspection of the ground underlying less than 0.5% of the total site area (and much less at depths in excess of about 3.5m). Consequently, there is always a possibility that unanticipated ground conditions will be encountered during the construction phase.
- 15.1.3 If unexpected ground is encountered during the construction phase, the Contractor should immediately seek further advice from the Engineer.

15.2 Preparatory works

- 15.2.1 Given the absence of any significant contamination, a remediation strategy is not considered necessary. Nonetheless, some preparatory works will be required, most notably:
- General site clearance of surface materials and vegetation
 - Topsoil strip & stockpile
 - Provision of 300mm thickness of topsoil in all garden and landscaped areas underlain by residual made ground
- 15.2.2 It should be ensured that the groundworker understands the need for good materials management. Most notably the importance of not mixing different materials within a given stockpile; i.e. there should be separate stockpiles of: topsoil; made ground; excess clean, natural soil arisings; general construction waste etc.

15.3 Good practice guidance

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

- CIRIA C741¹³
- EA Pollution Prevention Guidelines¹⁴:
 - o PPG6 - Working at construction and demolition sites
 - o PPG2 - Above ground oil storage tank
 - o PPG7 – The safe operation of refuelling facilities
 - o PPG21 – Incident Response Planning

15.3.2 Site preparatory works associated with this project are likely to involve the re-use of both natural and made ground soils on site. Therefore, the Contractor should prepare a Materials Management Plan (MMP) in accordance with the CL:AIRE Code of Practice (v2, March 2011)¹⁵.

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

15.4 New utilities

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

15.4.2 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.

15.4.3 Consequently, the use of 'standard' polyethylene water supply pipes should be acceptable, although the Developer should consult Severn Trent Water at the earliest opportunity to confirm this.

15.5 Health & safety issues - construction workers

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

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

15.6 Potential development constraints

15.6.1 Some site regrade may be required in the east where ground slopes down to an unnamed drain.

¹³ CIRIA C741 (2015) - Environmental Good Practice on Site

¹⁴ Whilst this has formally been withdrawn it can still be accessed via the EA archives and provides useful information on managing risks.

¹⁵ The Definition of Waste: Development Industry Code of Practice. CL:AIRE, 2011.

- 15.6.2 Some deterioration of the surface is likely to be caused by trafficking, especially after topsoil has been stripped and during/after periods of significant rainfall. Consequently, it would be prudent to consider placement of a minimum 200mm thickness of suitable granular fill (i.e. a "blanket" of 6F2) along the line of proposed highways and any temporary haul roads to protect formation during the construction phase.
- 15.6.3 The overhead electric lines present a potential development constraint unless they can be relocated or incorporated into the proposed layout. Additional enquiries are required to ascertain the feasibility of diversionary works or the particular easement required if they remain in-situ.
- 15.6.4 An unnamed drain flows along the site's eastern boundary. Therefore it is recommended that a silt and surface water management plan be developed prior to construction activities commencing.

16 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

16.1 General

- 16.1.1 The site is located off Main Street, Stanton under Bardon, approximately 13km northwest of Leicester city centre, and currently comprises open fields used as paddocks.
- 16.1.2 It is understood that consideration is being given to redevelopment of the site with traditional domestic dwellings, associated gardens, POS, adoptable roads and sewers. An illustrative layout has been provided.
- 16.1.3 Made ground was only encountered in the far northwest, to 0.7m depth, and comprised Granular Surfacing, Cohesive Made Ground and Colliery Spoil & Reworked Natural.
- 16.1.4 Natural ground predominantly comprised Topsoil over Oadby Member (Clay).
- 16.1.5 Localised Granular Glaciofluvial Deposits were recorded on the northern boundary and in one hole in the south, likely a localised lens. Cohesive & Granular Alluvium were encountered in the far east along the line of a drainage ditch.
- 16.1.6 The current layout shows no development in the far east where Alluvium was encountered.
- 16.1.7 Bedrock, comprising Edwalton Member Mudstone was recorded in 5 of the window sample holes from 1.0m depth, typically from >3m depth.

16.2 Mining

- 16.2.1 This site is underlain at depth by Edwalton Member Mudstone bedrock, and the shallowest coal seams lies at least 100m below the surface. Whilst the site lies within a Coal Authority Low Risk area, no significant risks have been identified, and an intrusive mining investigation will not be required.

16.3 Hazardous gas

- 16.3.1 The site is in an area where between 1% & 3% of homes are estimated to be above the radon action level. Radon protection is not required, but the Developer might consider providing new dwellings with basic measures in light of UK Health Security Agency advice.
- 16.3.2 There are no known or suspected areas of landfilling within 250m, and the site is not in area considered susceptible to mines gas, nor is it underlain by shallow mineworkings. As such, no special precautions against methane / carbon dioxide gas are required.

16.4 Contamination

- 16.4.1 No plausible contaminant linkages have been identified. However, although essentially 'clean', the made ground contains materials (e.g. coal, brick etc), which would generally be considered undesirable as a near-surface material in garden areas. Consequently, any residual made ground beneath garden areas should be blinded with 300mm clean topsoil.
- 16.4.2 Topsoil, typically 250mm thick underlies the entire site. Testing suggests this material is chemically suitable for re-use.
- 16.4.3 Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth. However, the full suite of testing in accordance with BS3882 Specification for Topsoil has not been undertaken to date.

16.5 Foundations

- 16.5.1 At this stage, it is considered that shallow strip or deepened trench fill footings will be the most suitable foundation solution for two or three storey houses constructed at the site. Footings will be founded in medium to high strength Clay (Oadby Member).
- 16.5.2 The illustrative layout provided shows no development in the far east where Alluvium (low strength clay) was encountered. However, should changes to the layout be made, alternative foundations such as piles may be required for plots underlain by low strength Alluvium.

16.6 Flooding

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

16.7 Drainage

- 16.7.1 Due to very slow infiltration rates, soakaways will not provide a suitable drainage solution for surface water run-off at the site. Consequently, it will be necessary to consider alternative sustainable drainage systems (SuDS), and there may be a need for surface water balancing.
- 16.7.2 The proposed layout currently includes an attenuation pond in the southeast.

16.8 Highways

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

Appendix A
General Notes

General

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

Geology, mining & quarrying

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

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

Landfills

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

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

Radon

Radon is a colourless, odourless gas, which is radioactive. It is formed in strata that contain uranium and radium (most notably granite), and can move through 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 BR211¹, 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 2010². 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 2007³. The level of protection needed is site-specific and can be determined by reference to this mapping on the Public Health England website, which indicates the highest radon potential within each 1km grid square. Each 1km grid square is classified on the basis of the percentage of existing homes within that grid square estimated to have radon concentrations above the Action Level. There are 6 'bands': <1%; 1 to 3%; 3 to 5%; 5 to 10%; 10 to 30%; and >30%.

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

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

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

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

Hydrogeology

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

- Groundwater quality
- Recorded pollution incidents
- Licensed groundwater abstractions

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

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

The maps display the following aquifer designations:

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

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

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

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

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

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

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

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

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

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

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

Hydrology

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

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

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

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

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

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

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

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

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

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

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

COMAH & explosive sites

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

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

Preliminary conceptual site model

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

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

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

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

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

General

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

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

Exploratory hole locations

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

Investigation techniques

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

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

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

In-situ testing

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

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

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

Sampling

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

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

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

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

At present, neither ISO/IEC 17025 nor MCERTS specify sample pre-treatment with respect to stone removal. Unsurprisingly therefore UKAS accredited testing laboratories do not adopt the same approach to stones¹ – some crush and test the “as received” soil, whilst others sieve out stones and analyse only the residual soil (the sieve size used varies depending on the laboratory).

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

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

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

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

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

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

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

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

Groundwater

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

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

Description of strata

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

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

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:

$$I_p = I_p * (\% < 425\mu\text{m} / 100)$$

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 SO₄ 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:

- For stiff soils the effective overburden pressure*
- For firm soils "somewhat less" than the effective overburden pressure
- For soft soils "appreciably less" than the effective overburden pressure, usually 25 kPa or less
- 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 ϕ') 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 ϕ') 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 (SO₄), 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 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 C₆ to C₁₀). Also referred to as PRO – Petroleum Range Organics
- DRO – Diesel Range Organics (typically C₁₀ to C₂₈)
- LRO – Lubricating Oil Range Organics (typically C₂₈ to C₄₀)
- MRO – Mineral Oil Range Organics (typically C₁₈ to C₄₄)

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 C₅-C₄₀, whereas others define TPH as C₁₀-C₃₀.

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

Gasoline contains light aliphatic hydrocarbons (especially within the C₄ to C₅ range) that are volatile. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present. Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

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

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

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

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

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

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

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

Methods of analysis (organic compounds)

TPH by GC-FID is an analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C₁₀ to C₄₀ (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 C₆ to C₈, aromatic C₁₀ to C₁₂ etc.

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

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

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

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

Current UK guidance

The UK approach to contaminated land is set out in Land Contamination Risk Management (2020). The approach is based upon risk assessment, where risk is defined as the combination of the probability of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

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

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

Soil screening values used by Lithos

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

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

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

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

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

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

The CLEA conceptual site model assumes a source located in a sandy loam, with 6% soil organic matter (SOM) - equivalent to 3.5% total organic carbon (TOC). However, many organic contaminants are more mobile when the SOM is lower, and consequently comparison of soil results with revised, lower screening values may be required. Other CLEA default characteristics adopted by Lithos are:

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

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

- A - Residential with gardens, but no cover (or only up to 300mm)
- B - Residential with gardens and 600mm 'clean' cover
- C - Residential apartments with landscaping (i.e. no home grown produce)
- D - Commercial/industrial with landscaping
- E - Importation of soil cover

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

Scenario	Land use	Pathways	Justification
A	Residential with garden, but no cover (or only up to 300mm)	• Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	Minimal cover – insufficient to break any pathways therefore all exposure pathways are relevant.
B	Residential with garden minimum 600mm cover	• Inhalation of indoor vapours • Inhalation of outdoor vapours	The 600mm cover removes the risk from all pathways other than inhalation.
C	Residential apartments with landscaped areas and minimum 300mm cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. However consumption of home grown produce not included as unlikely to be grown in landscaped areas. Where vegetables are to be grown site specific QRA may be required.

04 - Contamination analysis & interpretation (including WAC)

Generic notes – geoenvironmental investigations



Scenario	Land use	Pathways	Justification
D	Commercial/ industrial with landscaped areas no cover	- Direct ingestion of soil - Dermal contact - Inhalation of indoor vapours and dust - Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumed the commercial development consists of offices to provide a conservative assessment.
E	Importation of soil for cover in garden and landscaped areas	- Direct ingestion of soil - Dermal contact - Consumption of vegetables & soil attached to vegetables - Inhalation of outdoor vapours and dust	Material used as cover to break existing pathways therefore all direct and indirect pathways relevant; however cover is not placed below plots therefore indoor inhalation is not relevant.

Lithos have assumed the source of contamination is directly below the building foundation; i.e. a depth to source of 0.15m as opposed to the CLEA default of 0.65m. This assumption provides for a more conservative approach than the UK default.

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

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

Inorganic Tier 1 values for scenarios A to E

Inorganic contaminant	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
As	32	37	37	Use (A) in SI Report for initial "screen" If >5 x A, then consider increase of cover to 1,000mm	40	640	37	C4SL adopted
Cd	10	26	26		149	410	26	C4SL adopted
Cr			4,000		4,000	28,767	4,000	Assumes Cr is CrIII
Pb	450	200	200		314	2,330	200	C4SL adopted
Ni	130		109		123	892	109	Assessment of health risk only
Se	350		434		596	13,018	434	
Hg	170		199		244	3,603	199	Assumes in an inorganic compound
Vn			584		586	4,994	584	
B			5		5	5	5	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Cu			100		100	100	100	
Zn			200		200	200	200	

Organic Tier 1 values for scenarios A to E

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
Benzene	0.33	0.87	0.7	<1 [^]	<1 [^]	63	<1	<1 based on professional judgement and lower than calculated value.
Toluene	610		836	2,048	1,912	5,000	<1	Scenario D based on professional judgement and lower than calculated value.
Ethyl Benzene	350		379	592	566	5,000	<10	Scenario E based on professional judgement and lower than calculated value.
Xylenes	240		535	590	585	5,000	<10	Scenario E based on professional judgement and lower than calculated value.
Phenol	420		1,434	3,360	2,264	5,000	<10	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo[a]pyrene		5	5	25	5	76	5	C4SL adopted. Scenario B 5 times scenario A
Naphthalene			6	6	6	619	<10	Scenario E based on professional judgement and lower than calculated value
Gasoline Range Organics			22	23	23	2178	626	See 3-step assessment of TPH below
Diesel Range Organics			215	218	215	^5,000	1,429	^Based on professional judgement and lower than calculated value
Lubricating Range Org			3,299	5,000	3,829	^5,000	3,299	

* For a residential end use

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

- Surrogate marker (BaP) must be present in all soil samples
- Profile of the different PAH relative to BaP should be similar in all samples
- PAH profile in the soil samples should be similar to that used in the pivotal toxicity study¹

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

¹ SP1010 Appendix E, Provisional C4SLs for benzo[a]pyrene as a surrogate marker for PAHs, CL:AIRE 2013

Naphthalene should also be considered separately against its generic screen. Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than most other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach. Similarly, **TPH** cannot be assessed as a single "total" value, and reference has been made to the Environment Agency's document P5-080/TR3, "The UK approach for evaluating human health risks from petroleum hydrocarbons in soils". This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down "TPH" into representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the bandings.

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

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

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

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

where

HI	=	Hazard Index
HQ	=	Hazard Quotient
F _i	=	Fraction _i
SGV	=	Soil Guideline Value

Statistical Assessment

Current UK guidance is provided by CL:AIRE², and uses two-way confidence intervals and graphical summaries, to assist assessors when determining whether or not a dataset is adequate to answer the question posed; e.g. "is existing site topsoil suitable for retention & re-use?". To answer such a question, it is necessary to recover and test a large number of samples (a minimum of 10; ideally 20+) in order to undertake meaningful statistical analysis.

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

The CL:AIRE (2020) guidance replaces the withdrawn "Guidance on Comparing Soil Contamination Data with a Critical Concentration" (2008). The old approach to statistical analysis was based on a definitive yes/no answer which required limited consideration of the dataset and Conceptual Site Model. It was widely accepted that this did not allow sites or risk to be adequately assessed. The updated approach requires a comprehensive understanding of the datasets within the context of the Conceptual Site Model.

Current guidance requires that:

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

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

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

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

However, broadly speaking the following applies:

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

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

Other screening values used by Lithos

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

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

With respect to the assessment of potential **phytotoxic effects** of contaminants, Lithos refer to The Sewage Sludge in Agriculture: Code of Practice 2018 for copper and zinc (at pH 5.5 to 6.0). The CLEA derived Tier 1 value is adopted for nickel due to its human health effects.

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

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

Tier 1 **groundwater risk assessments** are always site specific and compare leachate or groundwater concentrations with the appropriate water quality standard based on the CSM and consideration of relevant water quality impacts and assessments.

Waste classification & WAC

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

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

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

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

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

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

Possible action in event of Tier 1 exceedance

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

1. Undertake further statistical analysis following the approach set out in Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration, 2020 (see above) in order to determine whether contaminant concentrations of inorganic contaminants within soil/fill actually present a risk (only applicable to assessing the risk to human health).
2. Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.
3. Based on a qualitative risk assessment, advocate an appropriate level of remediation to “break” the pollutant linkage - for example the removal of the contaminated materials or the provision of a clean cover.

Prior to undertaking any statistical analysis the issue of the **averaging area** requires further consideration. Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration, 2020 provides some guidance on averaging areas noting that they are the area within which a receptor may be exposed to contamination but leaving the site assessor to determine the appropriate averaging area for their site.

Lithos consider the entire site needs to be characterised by reference to the Conceptual Site Model. Consequently, Lithos gather and analyse sample results by fill type, and/or by former use in a given sub-area of the site, before undertaking statistical analysis; i.e. the averaging area is associated with the extent of a particular fill type, or an area affected by spillage/leakage.

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

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

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

Background

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

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

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

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

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

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

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

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

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

Test methodology

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

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

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

Infiltration rates

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

Soakaway design

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

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

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

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

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

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

The drainage designer submits designs for approval to:

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

Appendix B

Drawings



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CLIENT

CADDICK LAND

JOB TITLE

STANTON UNDER
BARDON

DRAWING TITLE

SITE LOCATION
PLAN

DRAWN WN

DATE 4 10 2021

CHECKED ASw

DATE 11 10 2021

STATUS

FOR COMMENT ☐

DRAFT ☐

FOR APPROVAL ☐

FINAL ☒

SCALE

1:25,000

SHEET

A4

DRAWING NO.

4252/1

REVISION



NOTES		
— APPROXIMATE SITE BOUNDARY		
REPRODUCED FROM NINETEEN47 DRAWING REFERENCE n1686-006 REV E, DATED 12 th DECEMBER 2022		
B	LAYOUT UPDATED	11 07 23
A	LAYOUT UPDATED	11 05 22
REV.	DESCRIPTION	DATE



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CLIENT		
CADDICK LAND		
JOB TITLE		
STANTON UNDER BARDON		
DRAWING TITLE		
PROPOSED SITE LAYOUT		
DRAWN	WN	DATE 04 10 2021
CHECKED	ASw	DATE 11 10 2021
		STATUS
		FOR COMMENT ☐
		FOR APPROVAL ☐
		DRAFT ☐
		FINAL ☒
SCALE	1:1000	SHEET A3
DRAWING NO.	4252/2	REVISION B



NOTES

- GRASS
- OVERGROWN
- BUILDINGS
- HARDSTAND
- OVERHEAD ELECTRIC UTILITY
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

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CLIENT

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JOB TITLE

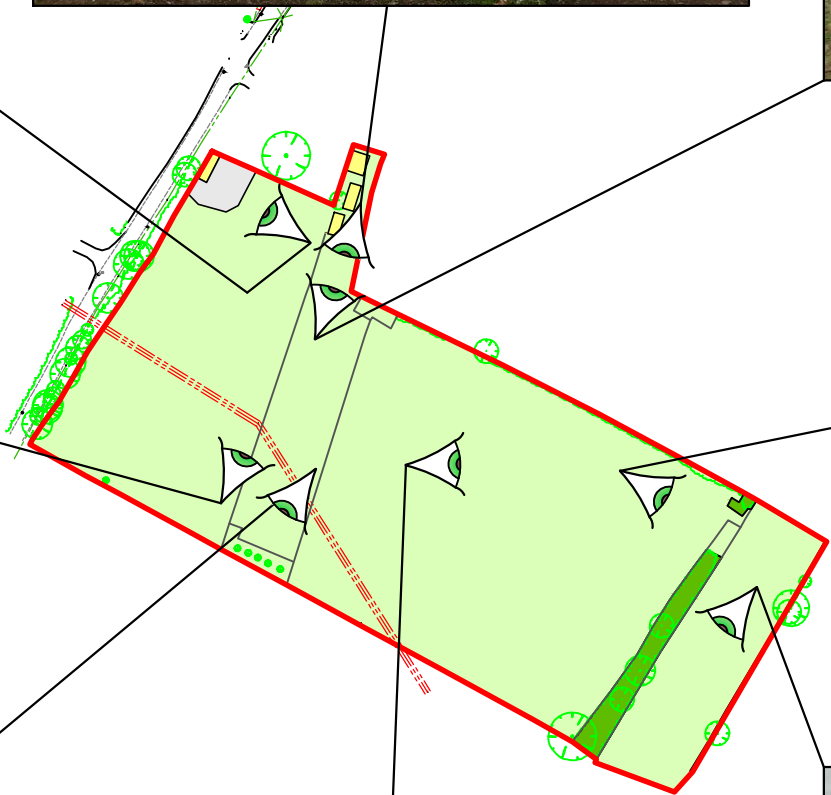
STANTON UNDER BARDON

DRAWING TITLE

SITE FEATURES

DRAWN	WN	DATE	04 10 2021	STATUS	FOR COMMENT	☐
CHECKED	ASw	DATE	11 10 2021	FOR APPROVAL	DRAFT	☐
					FINAL	☒

SCALE	1:1000	SHEET	A3	DRAWING NO.	4252/3	REVISION	
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NOTES		
	GRASS	
	OVERGROWN	
	BUILDINGS	
	HARDSTAND	
	APPROXIMATE SITE BOUNDARY	
	LOCATION & ORIENTATION OF PHOTOGRAPH	
REV.	DESCRIPTION	DATE



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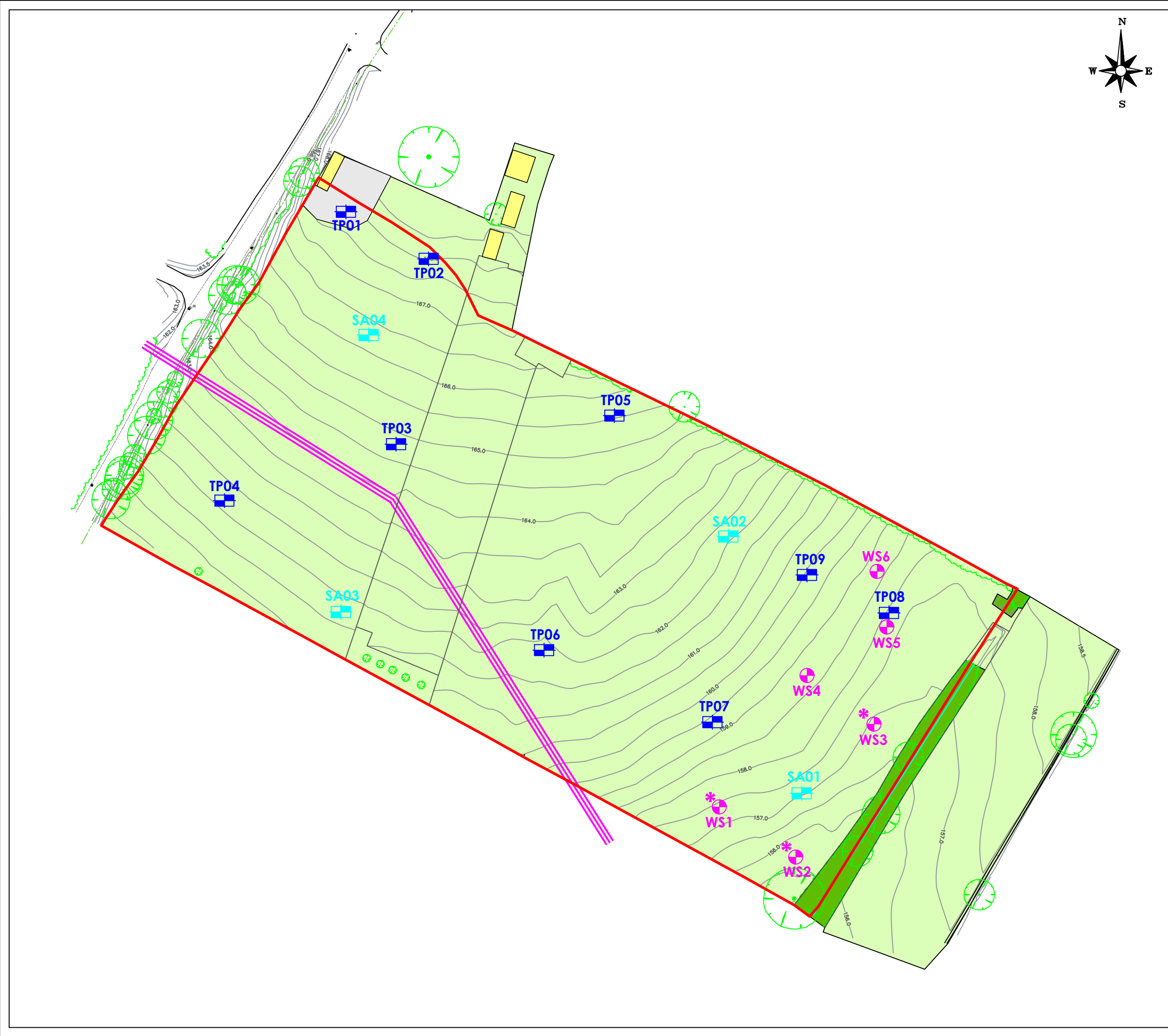
CLIENT
CADDICK LAND

JOB TITLE
STANTON UNDER BARDON

DRAWING TITLE
SITE PHOTOGRAPHS

DRAWN	WN	DATE	15 10 2021	STATUS	FOR COMMENT	☐
CHECKED	ASw	DATE	18 10 2021		FOR APPROVAL	☐
					DRAFT	☐
					FINAL	☒

SCALE	SHEET	DRAWING NO.	REVISION
NOT TO SCALE	A3	4252/4	



- NOTES
- TRIAL PIT LOCATION
 - SOAKAWAY LOCATION
 - WINDOW SAMPLE LOCATION WITH GW WELL
 - WINDOW SAMPLE LOCATION
 - APPROXIMATE SITE BOUNDARY

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

A	ADDED WS LOCATIONS AND SURVEYOR DATA	01/08/23
REV.	DESCRIPTION	DATE



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JOB TITLE

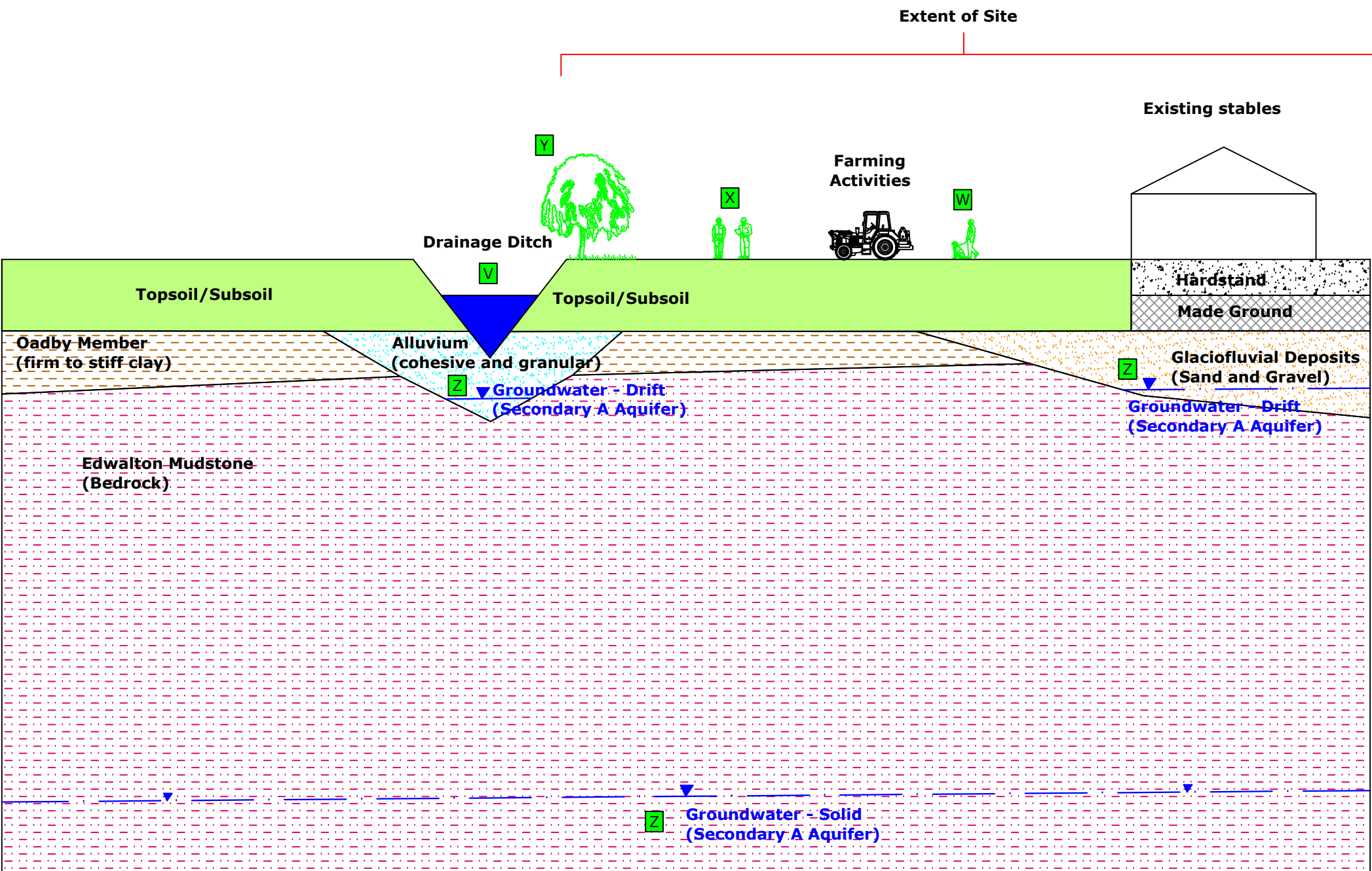
STANTON UNDER
BARDON

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	CR	DATE	19/07/23	STATUS	FOR COMMENT ☐
CHECKED	ASw	DATE	19/07/23	FOR APPROVAL ☐	DRAFT ☐
				FINAL	☒

SCALE	1:1000	SHEET	A3	DRAWING NO.	4252/6	REVISION	A
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SOURCES
NO CONTAMINATION ENCOUNTERED

PATHWAYS
NO PLAUSIBLE PATHWAYS

RECEPTORS
V SURFACE WATERS
W END USERS (RESIDENTS)
X SITE WORKERS
Y VEGETATION
Z GROUNDWATER

NOTES		
REV.	DESCRIPTION	DATE



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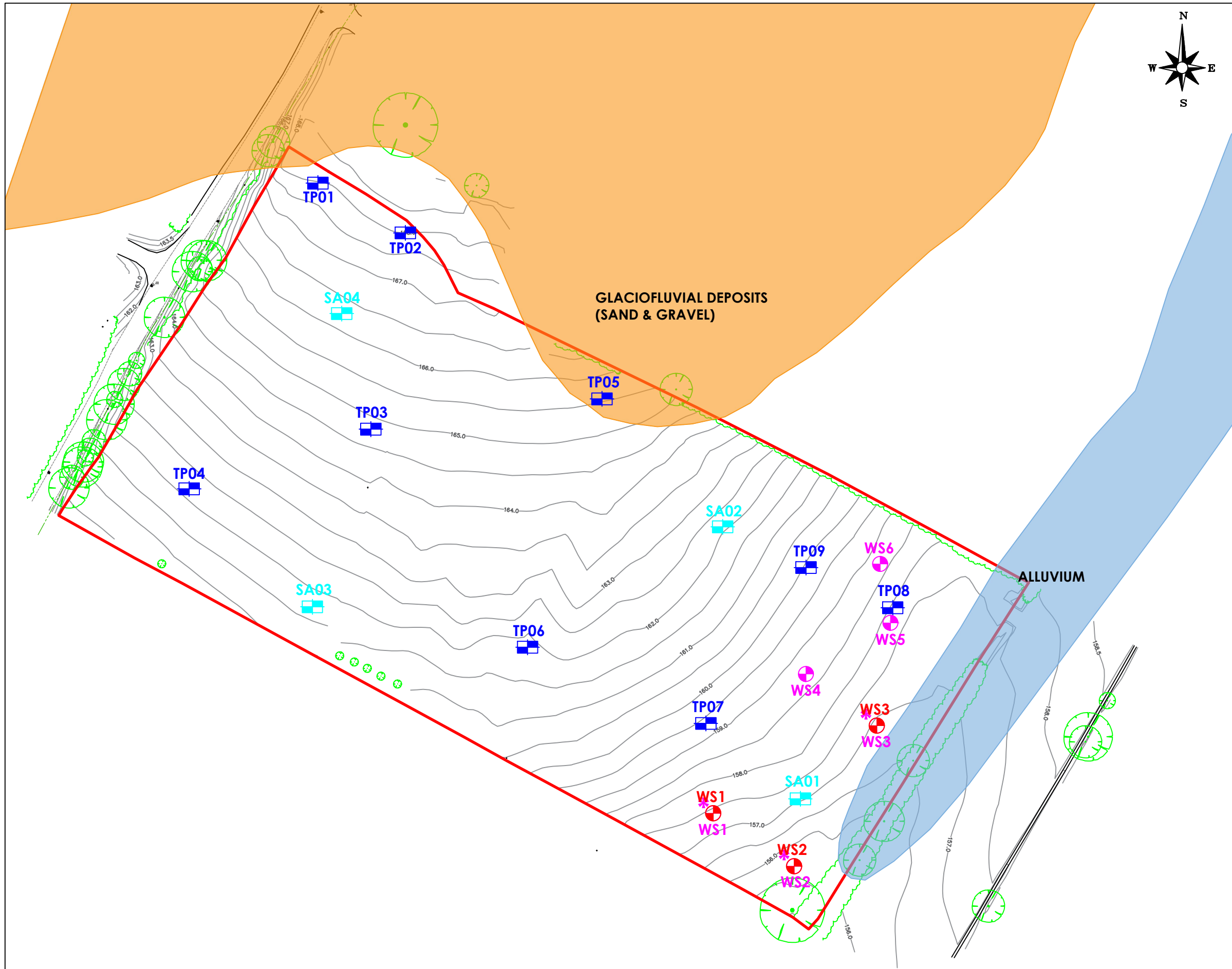
CLIENT
CADDICK LAND

JOB TITLE
STANTON UNDER BARDON

DRAWING TITLE
REVISED CONCEPTUAL SITE MODEL

DRAWN	CR	DATE	11/08/23	STATUS	FOR COMMENT ☐
CHECKED	ASw	DATE	11/08/23	FOR APPROVAL ☐	DRAFT ☐
				FINAL	☒

SCALE	Not to scale	SHEET	A3	DRAWING NO.	4252/7	REVISION	
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NOTES

- ALLUVIUM
- GLACIOFLUVIAL DEPOSITS (SAND & GRAVEL)
- WHOLE SITE UNDERLAIN BY EDWALTON MEMBER MUDSTONE BEDROCK
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE



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CLIENT

CADDICK LAND

JOB TITLE

STANTON UNDER BARDON

DRAWING TITLE

DRIFT GEOLOGY FROM BGS MAPS

DRAWN	CR	DATE	11/08/23	STATUS	FOR COMMENT ☐
CHECKED	ASw	DATE	11/08/23	FOR APPROVAL ☐	DRAFT ☐
				FINAL	☒

SCALE	1:1000	SHEET	A3	DRAWING NO.	4252/8	REVISION	
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Appendix C

Commission

008/4252/LEW

15th June 2023

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Bull Street
Birmingham
B4 6EQ



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LS22 5DZ

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www.lithos.co.uk

Dear David

Stanton under Bardon

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

As you know we have already issued a Desk Study report (Ref. 4252/1A, dated May 2022), key findings of which were the site:

- Appears to have remained undeveloped throughout its history;
- Is underlain by Glaciofluvial Deposits (sand and gravel) in the north and Alluvium (clay, silt, sand and gravel) in the east with shallow mudstone bedrock elsewhere;
- Is not located within 250m of a known landfill site;
- Is not within a groundwater source protection zone;
- Is in an area where the risk of encountering UXO is considered low; and
- Is located within a Coal Mining Development Low Risk Area (however, at this stage an intrusive mining investigation is considered unlikely to be required).

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

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

This proposal allows for the following works:

Desk study: The previously issued Desk Study report (Ref. 4252/1A, dated May 2022) will be incorporated into our final geoenvironmental appraisal.



Fieldwork: We have allowed for a day's trial pitting and the drilling of 3 boreholes in the vicinity of a proposed surface water attenuation basin. All trial pits and boreholes will be supervised and logged by an experienced geoenvironmental engineer.

Trial pitting will enable us to determine the:

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

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

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

If the pitting encounters significant thicknesses of made ground or very soft/loose deposits (the latter is considered possible), boreholes may be required to obtain geotechnical data from greater depth. We will advise you of any need for boreholes within 2 days of completion of the pitting.

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

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

It is understood a surface water attenuation basin is proposed in the east and therefore boreholes will be required to determine groundwater levels in this area. Typically, water table levels are required from borehole monitoring wells over 4 consecutive seasons, for at least 3 points in the basin area.

At this stage, the nature of underlying soils is not known and therefore the drilling method should be determined following the trial pitting. If the weathered mudstone is stiff clay or gravel, cable percussion boreholes (Item C) are likely to be required to enable casing off during drilling. However, if the shallow soils are 'softer' it may be possible to use a dynamic sampling rig (Item D). At this stage, it would be prudent to assume cable percussion boreholes are required.

Boreholes will allow the installation of groundwater wells (50mm ID, HDPE pipework with bentonite seals and a gravel filter pack). Well headworks will comprise a 100mm diameter steel security helmet which will extend about 150mm above ground level (if required, the position of each helmet could be "marked" with a 1.5m high fence post to reduce the likelihood of damage by farm machinery).

On completion of the works we will dip the monitoring wells on at least 7 occasions; monthly for 3 months, and then bi-monthly for a further 8 months.

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

Decommissioning of monitoring wells removes the potential for groundwater pollution caused by accidental spillages during the construction phase. Subject to your instruction, we will decommission

accessible wells after the last monitoring visit for an E\O price of £***. We will contact you to seek instruction following issue of our groundwater dip results.

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

At this stage, we have assumed that overnight security will not be required, but this will be reviewed following a site visit. If required, security would be an E\O of £*** per night.

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

This site is greenfield and therefore highly unlikely to be underlain by significant thicknesses of made ground. Furthermore, we are not aware of any other sources of hazardous **gas** (shallow mine workings, landfill sites etc) within influencing distance of the site. Consequently, at this stage, we have not allowed for undertaking a hazardous gas risk assessment but we will review the need for this in light of desk study data and the ground conditions actually encountered.

Testing: This will comprise routine **geotechnical** soils analysis, including 12 moisture content & Atterberg limits, and 12 pH & water-soluble sulphate and 5 gradings.

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

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

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.

Visible contaminants, sharps and the clay/sand/silt content of 5 topsoil samples will be determined to check compliance with BS3882 requirements.

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

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

At the time of writing, fieldwork could be commenced within 2 weeks of receipt of your written instruction to proceed. Our comprehensive geoenvironmental appraisal report will be issued within 4 weeks of fieldwork completion.

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

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

Invoicing: The attached proposal provides a breakdown of the costs associated with this project. This breakdown is for information only and the proposal can be regarded as a lump sum price of either:

- £*** plus VAT (including cable percussion boreholes), or
- £*** plus VAT (including dynamic sample boreholes).

Variation will only occur in the event that a given item is not undertaken or that substantial additional works are recommended, in which case we will inform you immediately, provide costs for the required works, and seek your prior consent. Revision of the costings provided may be required if works are not instructed within **3 months** of the date this proposal was issued.

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

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

Please note if following instruction of the works outlined in this proposal, it is necessary to subsequently **postpone or cancel**, this should be done at least 3 working days before Lithos are due to commence intrusive investigation on site. We reserve the right to charge a cancellation fee in the event of later notification to cover plant / drill rig costs and abortive consultancy time. The cancellation fee will not exceed £*** plus VAT.

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

Details of welfare will be included within the Method Statements. However, this investigation is expected to 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).

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

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

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

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

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

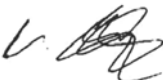
- If deep infrastructure (e.g. a wet well) is proposed, **boreholes** to provide further information regarding soil and groundwater conditions to inform groundworks design for the required enabling works.
- **Cable percussion boreholes**, in order to carry out SPTs at approximate 1m intervals to allow assessment of the in-situ density of granular soils and confirm either that they are strong enough to support shallow footings or provide data for Vibro contractors. Boreholes would also allow the installation of groundwater wells. The ability to use temporary steel casing to line the borehole during drilling, enables the recovery of more reliable geotechnical data.
- If the initial **soakaway** tests yield satisfactory results, it may be necessary to:
 - o Undertake further testing in order to obtain approvals from the LLFA etc: (a) within 25m of proposed chamber locations; and (b) to include 3 fills.
 - o Install groundwater monitoring wells to depths of around 5m in at least 3 boreholes. Given the anticipated depth to bedrock, these boreholes might need to be advanced by rotary probing.
 - o The wells should then be monitored on at least 7 occasions; monthly for 3 months, and then bi-monthly for a further 8 months.

Terms & conditions: Caddick and Lithos have an agreed Appointment document, and this work will be undertaken in accordance with that. However, if the Appointment term expires or remains unsigned, works 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 Caddick'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 Caddick. In the event that both Caddick 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 Caddick 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



Lewis Whiteley
Senior Engineer

**for and on behalf of
LITHOS CONSULTING LIMITED**

1 DEFINITIONS AND INTERPRETATION

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

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

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

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

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

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

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

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

- 1.2 Words importing the singular only shall also include the plural and vice versa, where the context requires.
- 1.3 Words importing persons or parties shall include firms, corporations and any organisation having legal capacity and vice versa, where the context requires; and words importing a particular gender include all genders.
- 1.4 The sub-headings to the clauses of these Terms are for convenience only and shall not affect the construction of the Agreement.
- 1.5 A reference to legislation includes that legislation as from time to time amended, re-enacted or substituted and any Orders in Council, orders, rules, regulations, schemes, warrants, by-laws, directives or codes of practice issued under any such legislation.
- 1.6 In the event of conflict between the documents forming part of the Agreement, the Proposal shall prevail, followed by the Terms.

2 APPOINTMENT

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

3 OUR OBLIGATIONS

- 3.1 We shall perform the Services using the reasonable standard of skill and care normally exercised by qualified members of our profession, performing similar services under similar conditions.
- 3.2 We shall use all reasonable endeavours to perform the Services in accordance with relevant environmental and safety legislation.

4 YOUR OBLIGATIONS

- 4.1 Throughout the period of this Agreement you shall afford to us, or procure for our benefit, access to any site where access is required for the performance of the Services.
- 4.2 You accept responsibility for ensuring that we are notified in writing of all special site and/or plant conditions, including without prejudice to the generality of the foregoing, the existence and precise location of all underground services, cables, pipes, drains or underground buildings, constructions or any hazards, which you shall clearly mark on the ground or identify on accurate location plans supplied to us prior to the commencement of the Services. You shall also inform us in writing of any relevant operating procedures including any site safe operating procedures and any other regulations relevant to the carrying out of the Services. You shall indemnify us against all costs, losses, claims, demands and expenses arising as a result of any non-disclosure in this respect, including but not limited to indemnification against any action brought by the owner of the land or otherwise.
- 4.3 If you discover any conflict, defect or other fault in the information or designs provided by us pursuant to the Agreement, you will advise us in writing of such defect, conflict or other fault and we shall have the right to rectify the same or where necessary, to design the solution for rectification of any works carried out by others pursuant to the conflicting, defective or in any other way faulty information or designs.

5 COPYRIGHT

- 5.1 The copyright in all Intellectual Property prepared by or on behalf of us in connection with the Project for delivery to you shall remain vested in us.
- 5.2 You shall have a non-exclusive licence to copy and use such Intellectual Property for purposes directly related to the Project. Such licence shall enable you to copy and use the Intellectual Property but solely for your own purposes in connection with the Project and such use shall not include any licence to reproduce any conceptual designs or professional opinions contained therein nor shall it include any licence to amend any drawing, design or other Intellectual Property produced by us.
- 5.3 Should you wish to use such Intellectual Property in connection with any other works or for any other purpose not directly related to the Project or wish to pass any Intellectual Property to any third party, you must obtain our prior written consent. The giving of such consent shall be at our absolute discretion and shall be upon such terms as we may require. We shall not be liable to you for the use by any person of such Intellectual Property for any purpose other than that for which the same were prepared by or on our behalf.
- 5.4 Ownership of any proposals submitted to you that are not subsequently confirmed as part of the Services to be provided for you remain with us and such proposals must not be used as the basis for any future work undertaken by you or a third party and no liability can be accepted howsoever arising from such proposals.
- 5.5 In the event of you being in default of payment of any fees or other amounts due, we may suspend further use of the licence on giving no less than 2 calendar days' notice of the intention to do so. Use of the licence may be resumed on receipt of the outstanding amounts.

6 CONFIDENTIALITY

- 6.1 Neither you nor we shall at any time disclose to any person any confidential information concerning the business, affairs, customers, clients or suppliers of the other party or of any member of the group of companies to which the other party belongs, except as permitted by clauses 6.2 and 6.4.
- 6.2 Each party may disclose the other party's confidential information:
- (a) to its employees, officers, representatives, contractors, sub-contractors or advisers who need to know such information for the purposes of exercising the party's rights or carrying out its obligations under or in connection with this Agreement. Each party shall ensure that its employees, officers, representatives, contractors, sub-contractors or advisers to whom it discloses the other party's confidential information comply with this paragraph 6; and
- (b) as may be required by law, to a court of competent jurisdiction or any governmental or regulatory authority.
- 6.3 Neither you nor we shall use any other party's confidential information for any purpose other than to exercise our rights or perform our respective obligations under or in connection with this Agreement.
- 6.4 Subject to the above and our privacy policy which can be found on www.lithos.co.uk, we shall be permitted to use information related to the Services we provide in connection with the Project for the purposes of marketing its services and in proposals for work of a similar type.
- 7 ASSIGNMENT**
- 7.1 You may assign the benefit of this Agreement on two occasions with our prior written consent (not to be unreasonably withheld) and any additional assignments shall be with our prior consent.
- 7.2 We may at any time assign, mortgage, charge, subcontract, delegate, declare a trust over or deal in any other manner with any or all of our rights and obligations under this Agreement.

8 INSURANCE

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

9 PAYMENT

- 9.1 Invoices for services rendered will be submitted for payment in accordance with the Proposal.
- 9.2 You shall pay you any VAT properly chargeable on the Services and any amount expressed as payable to us under this Agreement is exclusive of VAT unless stated otherwise.
- 9.3 The due date for payment is the date of the invoice and the final date for payment is 28 days from the date of the invoice.
- 9.4 If you dispute the amount included for payment in an invoice then you must serve a written notice on us no later than 14 calendar days before the final date for payment. If no notice is given within the required timeframe the amount due shall be the amount stated in the invoice.
- 9.5 If you fail to pay any monies in accordance with the foregoing payment provisions, we shall be entitled to charge interest on any monies owed to us, such interest to be at a rate of 4% above the base rate of a clearing bank from time to time calculated from the final date for payment to the date of actual payment on a compound basis. The parties acknowledge that our liability under this clause 10.5 is a substantial remedy for the purposes of section 9(1) of the Late Payment of Commercial Debts (Interest) Act 1998.

10 LIMITATIONS ON LIABILITY

- 10.1 Unless otherwise agreed in writing, our total liability under or in connection with this Agreement whether in contract, tort, negligence, breach of statutory duty or otherwise (other than in respect of personal injury or death) shall be limited to and shall not exceed the lesser of either the level of insurance cover referred to within clause 8.1 above, or 20 times the total value of invoices issued to you for the Services.
- 10.2 No action or proceedings under or in respect of the Agreement whether in contract, tort, negligence, under statute or otherwise shall be commenced against us after the expiry of a period of six years from the date of the completion (or termination) of the Services under this Agreement.
- 10.3 Whilst we usually scan for potential exploratory locations with a Cable Avoidance Tool, we shall not be liable for any damage to underground services, cables, pipes, drains or underground buildings, constructions and the like which were either not marked on site or for which accurate plans were not provided.
- 10.4 We shall not be liable for the cost of rectifying any defect, conflict or other fault in the information or designs provided by us or for the cost of designing a solution for and rectifying any subsequent works carried out by others pursuant to the conflicting, defective or in any other way faulty information or designs, unless we have been advised in writing of the same by you and have been given the opportunity to rectify the same or where necessary, to design the solution for rectification of any subsequent works carried out by others pursuant to the same.

11 DELAY

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

12 TERMINATION

- 12.1 The Agreement may be terminated by either of us in the event of the other making a composition or arrangement with its creditors, becoming bankrupt, or being a company, making a proposal for a voluntary arrangement for a composition of debts, or has a provisional liquidator appointed, or has a winding-up order made, or passes a resolution for voluntary winding-up (except for the purposes of a bona fide scheme of amalgamation or reconstruction), or has an administrator or an administrative receiver appointed to the whole or any part of its assets. Notice of termination must be given to the party which is insolvent by the other party.
- 12.2 If for any reason our Services are suspended for a period in excess of three calendar months then we shall be entitled to terminate our appointment under this Agreement in respect of the Services by no less than seven days written notice to you.
- 12.3 If you fail to pay in full any sum due under the terms of this Agreement by the final date for payment for that sum and no effective pay less notice is issued, we may serve written notice to you demanding payment within 14 days of such notice. If you fail to comply with such notice, we shall be entitled to terminate our employment under this Agreement forthwith.
- 12.4 Any termination of our appointment howsoever caused shall be without prejudice to our rights to require payment for all Services performed up to the date of such termination including but not limited to payment of a fair and reasonable proportion of any figure identified in the Proposal or otherwise for fees in respect of a particular service which Lithos has started, but not completed.

13 THIRD PARTY RIGHTS

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

14 COLLATERAL WARRANTIES & LETTERS OF RELIANCE

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

15 NOTICES

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

16 ENTIRE AGREEMENT

- 16.1 The Agreement constitutes the complete and entire agreement between us with respect to the Services and supersedes any prior oral and/or written warranties, terms, conditions, communications and representations, whether express or implied and any claim against us in respect of the Services can only be made in contract under the provisions of this Agreement and not otherwise under the law or tort or otherwise.
- 16.2 No amendments, modifications or variation of this Agreement shall be valid unless made in writing and agreed to by us; such agreement must be recorded in writing by at least one of us.
- 16.3 We shall not be bound by any standard or printed terms or conditions furnished by you in any of your documents unless we specifically state in writing separately from such documents that we intend such terms and conditions to apply.

17 DISPUTES, JURISDICTION AND GOVERNING LAW

- 17.1 This Agreement shall be governed by and construed in accordance with English law and we irrevocably and unconditionally submit to the jurisdiction of the English Courts.
- 17.2 Where the Housing Grants, Construction and Regeneration Act 1996 applies, any dispute between us may be referred to adjudication in accordance with the Scheme for Construction Contracts Regulations 1998 or any amendment or modification thereof being in force at the time of the dispute, as applicable to England, Wales, Scotland and Northern Ireland.

Chris Ryan

From: David Baker-Brook <David.Baker-Brook@caddickgroup.co.uk>
Sent: 05 July 2023 11:39
To: Lewis Whiteley
Subject: RE: 4252: Stanton under Bardon - Phase 2

Hi Lewis

I met with the landowners yesterday and they are happy to please proceed with the work as outlined.

The trial pit location adjacent to the shed isn't an issue, but I would appreciate if we could follow the process outlined below, only progressing in the off-site location as strictly necessary – the owners have recently laid a new driveway in the area (see attached) so avoiding unnecessary disturbance would be preferable.

If you could please provide dates to progress the work, I will confirm with the landowner.

Thanks

David

From: Lewis Whiteley <Lewis.Whiteley@lithos.co.uk>
Sent: Monday, July 3, 2023 12:09 PM
To: David Baker-Brook <David.Baker-Brook@caddickgroup.co.uk>
Subject: Fwd: 4252: Stanton under Bardon - Phase 2

Hi David

I sent the below email last week about working in the roadway, unfortunately it won't be possible.

I am out on site today but feel free to give me a ring.

Kind regards

Lewis Whiteley
Lithos Consulting
07951 702 083

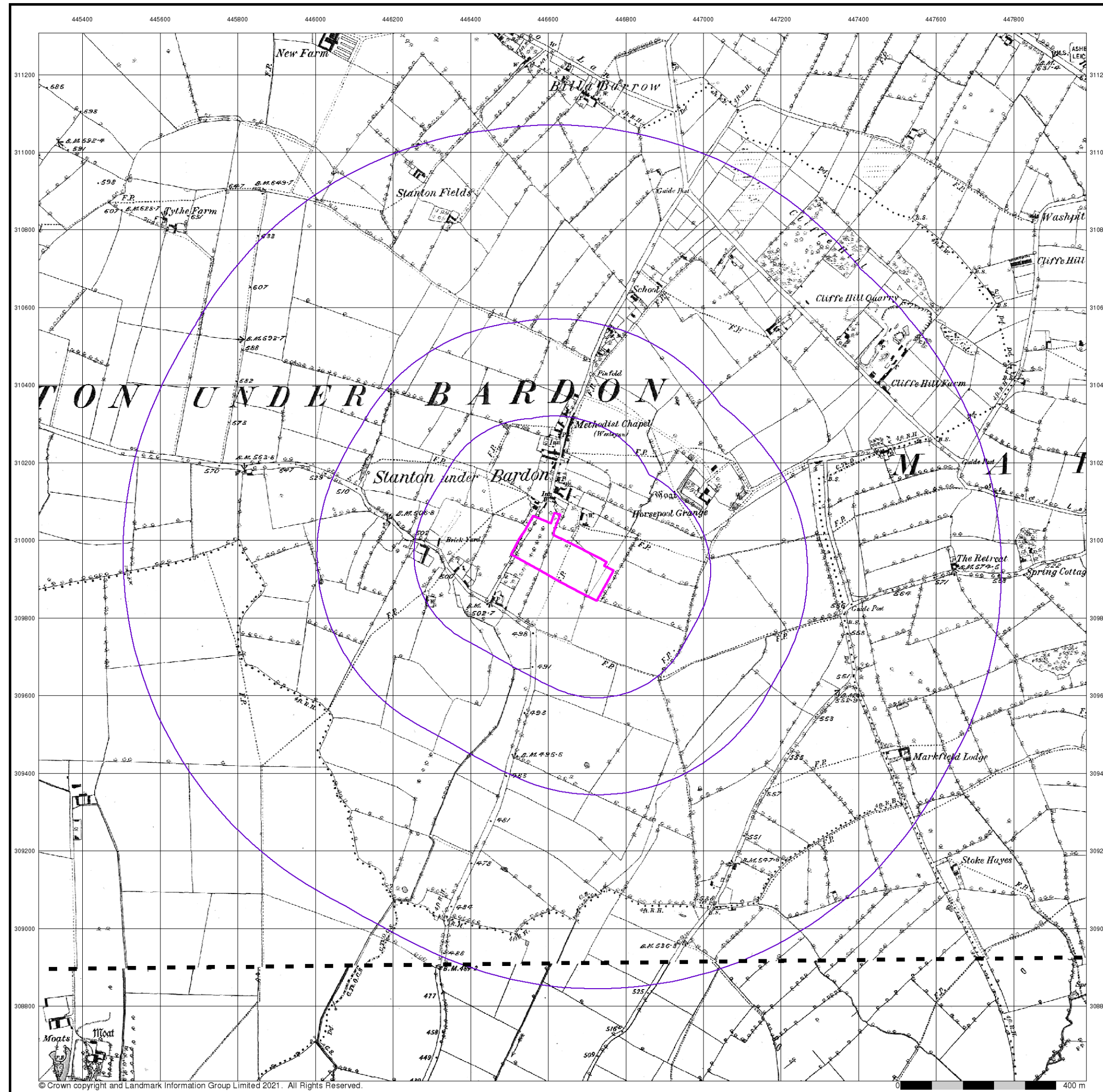
From: Lewis Whiteley <Lewis.Whiteley@lithos.co.uk>
Sent: Tuesday, 27 June 2023, 07:55
To: David Baker-Brook <David.Baker-Brook@caddickgroup.co.uk>
Cc: Alan Swales <Alan.Swales@lithos.co.uk>
Subject: RE: 4252: Stanton under Bardon - Phase 2

Hi David

Unfortunately we won't be able to work in the roadside as access looks very tight and we don't have the necessary tickets to work in highways.

Appendix D

Historical OS Plans



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Leicestershire

Published 1884 - 1885

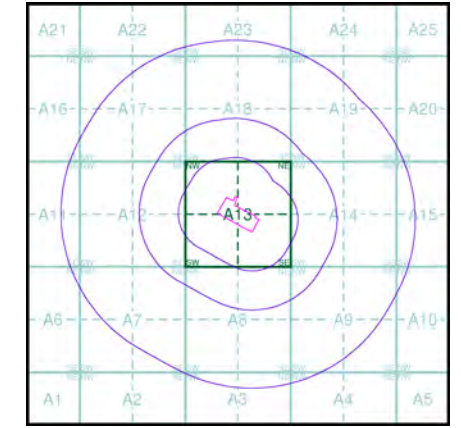
Source map scale - 1:10,560

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)

024SW
1884
1:10,560
030NW
1885
1:10,560

Historical Map - Slice A



Order Details

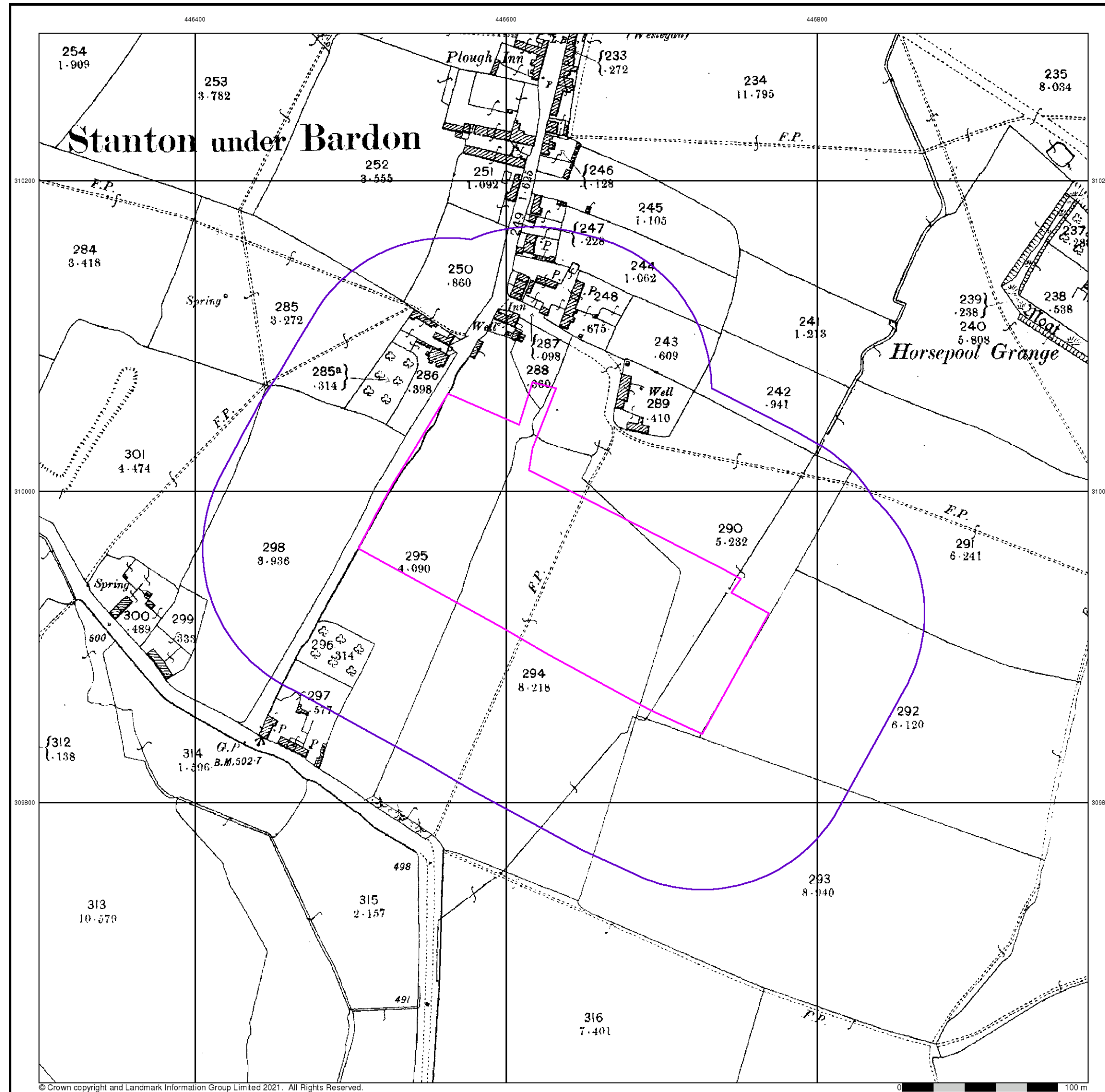
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Customer Ref:	PO18114/JW/4252
National Grid Reference:	446640, 309960
Slice:	A
Site Area (Ha):	2.65
Search Buffer (m):	1000

Site Details

Stanton under Bardon, LE67 9TL



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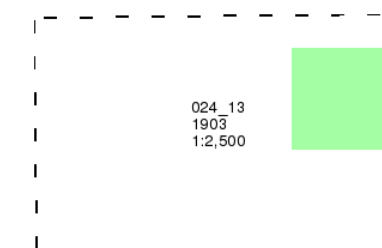
Leicestershire

Published 1903

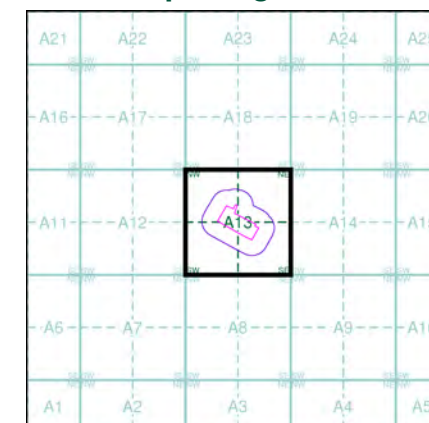
Source map scale - 1:2,500

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

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

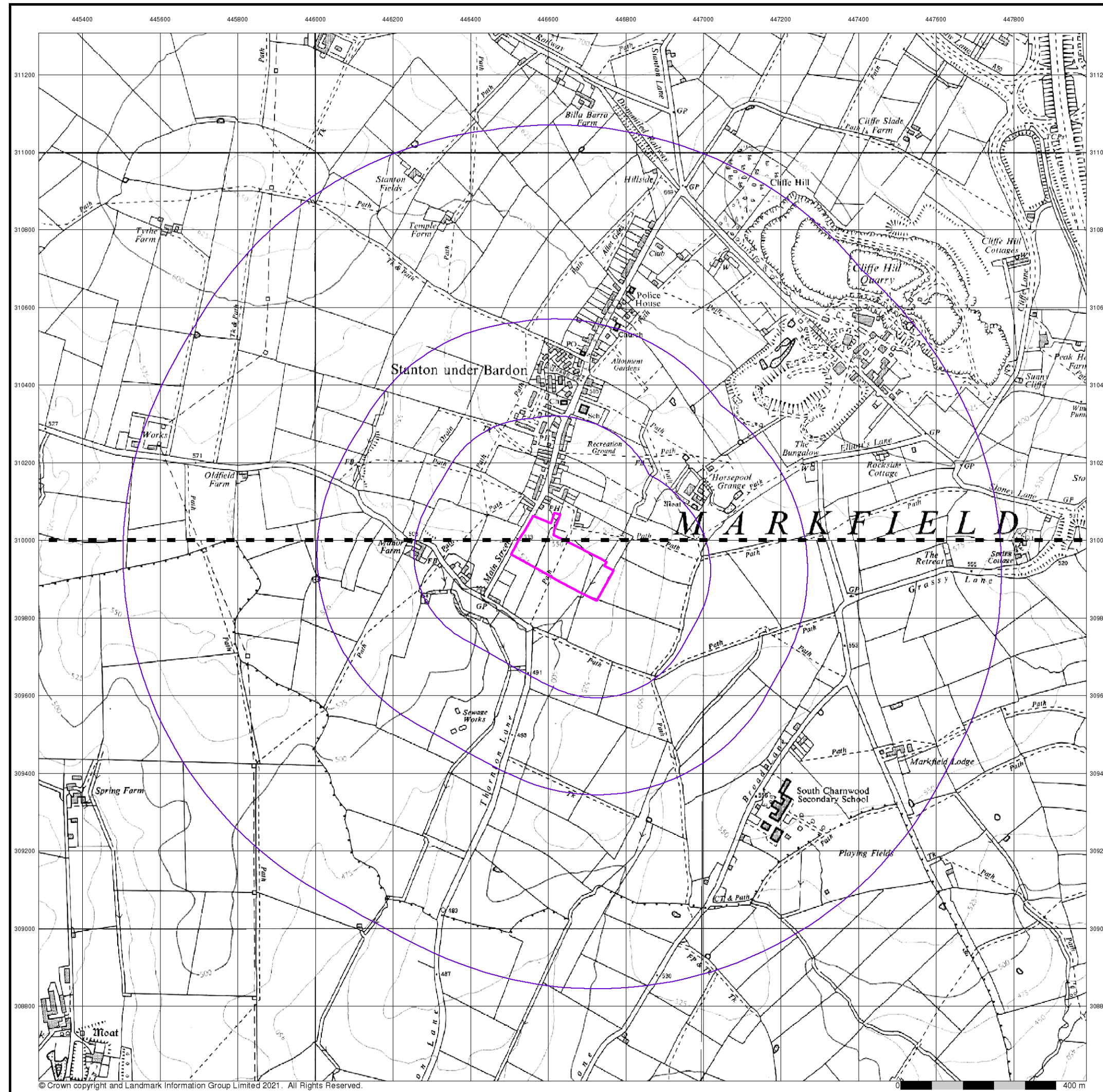
Order Number: 285657532_1_1
Customer Ref: PO18114/JW/4252
National Grid Reference: 446640, 309960
Slice: A
Site Area (Ha): 2.65
Search Buffer (m): 100

Site Details

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Ordnance Survey Plan

Published 1968

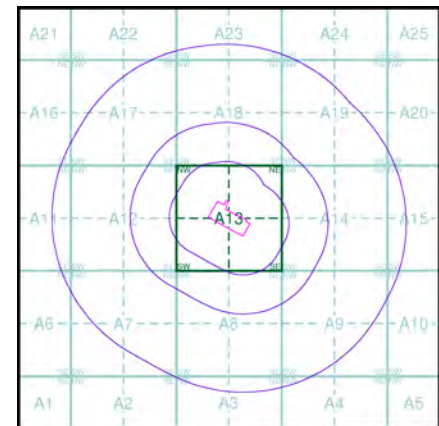
Source map scale - 1:10,000

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

Map Name(s) and Date(s)

SK41SE	1968
1:10,560	
SK40NE	1968
1:10,560	

Historical Map - Slice A



Order Details

Order Number: 285657532_1_1
Customer Ref: PO18114/JW/4252
National Grid Reference: 446640, 309960
Slice: A
Site Area (Ha): 2.65
Search Buffer (m): 1000

Site Details

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Additional SIMs

Published 1989 - 1993

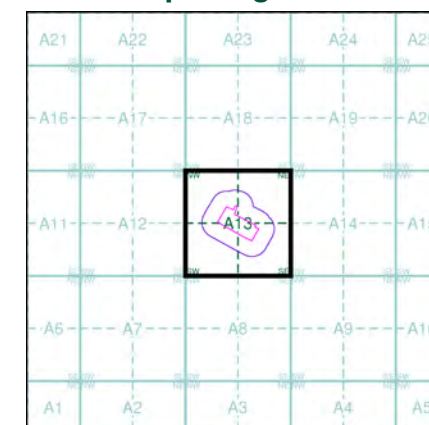
Source map scale - 1:2,500

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SK4610	1993	1:2,500
SK4609	1989	1:2,500

Historical Map - Segment A13



Order Details

Order Number: 285657532_1_1
Customer Ref: PO18114/JW/4252
National Grid Reference: 446640, 309960
Slice: A
Site Area (Ha): 2.65
Search Buffer (m): 100

Site Details

Site Details

Stanton under Bardon, LE67 9TL

Landmark
INFORMATION GROUP

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

Appendix E

Search Responses & other Correspondence



Envirocheck[®] Report:

Datasheet

Order Details:

Order Number:

285657532_1_1

Customer Reference:

PO18114/JW/4252

National Grid Reference:

446640, 309960

Slice:

A

Site Area (Ha):

2.65

Search Buffer (m):

1000

Site Details:

Stanton under Bardon

LE67 9TL

Client Details:

Mr M Perrin

Lithos Consulting Ltd

Parkhill

Walton Road

Wetherby

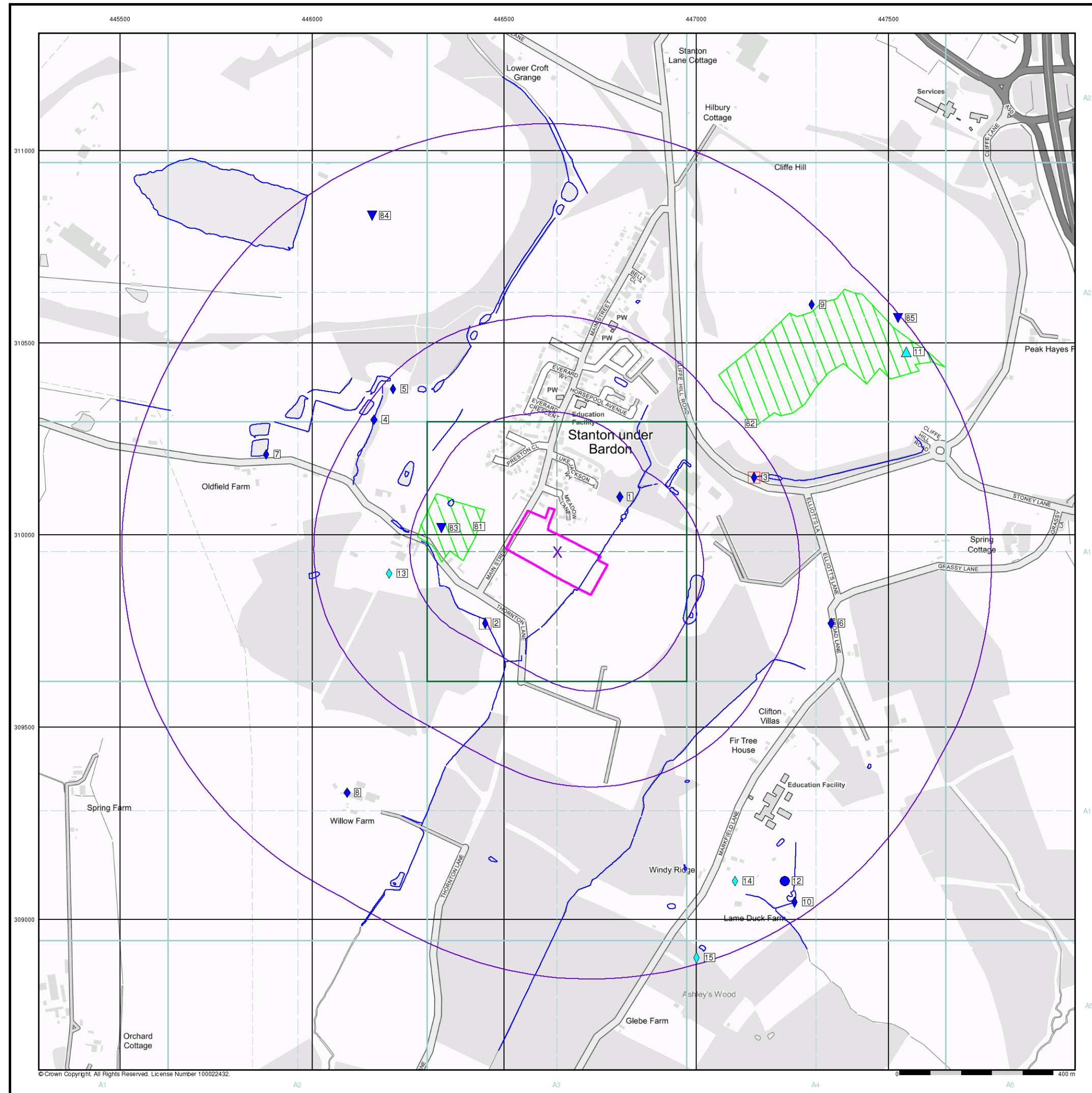
LS22 5DZ

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes	Yes	Yes	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 2		4	4	5
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 5				1
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 5	Yes			
Pollution Incidents to Controlled Waters	pg 5				1
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality					
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register					
Water Abstractions	pg 6			1	2 (*1)
Water Industry Act Referrals					
Groundwater Vulnerability Map	pg 7	Yes	n/a	n/a	n/a
Groundwater Vulnerability - Soluble Rock Risk			n/a	n/a	n/a
Groundwater Vulnerability - Local Information			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 8	Yes	n/a	n/a	n/a
Superficial Aquifer Designations	pg 8	Yes	n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
OS Water Network Lines	pg 8	3	9	18	35

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites					
Historical Landfill Sites					
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)					
Local Authority Landfill Coverage	pg 16	2	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 16		1		1
Potentially Infilled Land (Water)					
Registered Landfill Sites					
Registered Waste Transfer Sites					
Registered Waste Treatment or Disposal Sites					
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					

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 17	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 17	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 18		1		2
BGS Urban Soil Chemistry					
BGS Urban Soil Chemistry Averages					
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 19	Yes	n/a	n/a	n/a
Mining Instability			n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 19	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 19	Yes	Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 19	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 19	Yes	Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 20	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 21			14	3
Fuel Station Entries					
Points of Interest - Commercial Services	pg 22			7	
Points of Interest - Education and Health					
Points of Interest - Manufacturing and Production	pg 23			2	1
Points of Interest - Public Infrastructure	pg 23		1	1	2
Points of Interest - Recreational and Environmental	pg 23		1		
Gas Pipelines					
Underground Electrical Cables					

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland					
Areas of Adopted Green Belt					
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 24	1			
Ramsar Sites					
Sites of Special Scientific Interest	pg 24				1
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					

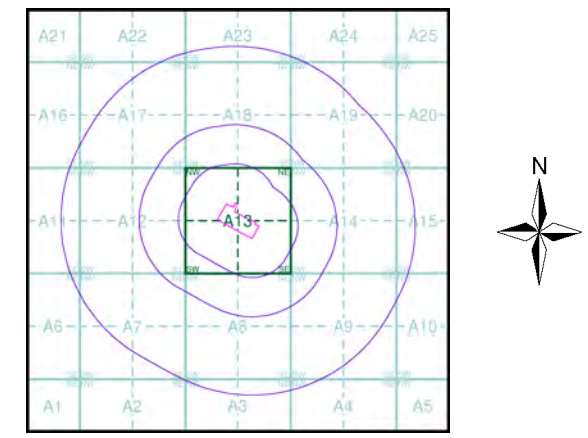


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- General**
- Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point
 - Map ID
 - Several of Type at Location
- Agency and Hydrological**
- Contaminated Land Register Entry or Notice (Location)
 - Contaminated Land Register Entry or Notice
 - Discharge Consent
 - Enforcement or Prohibition Notice
 - Integrated Pollution Control
 - Integrated Pollution Prevention Control
 - Local Authority Integrated Pollution Prevention and Control
 - Local Authority Pollution Prevention and Control
 - Local Authority Pollution Prevention and Control Enforcement
 - Pollution Incident to Controlled Waters
 - Prosecution Relating to Authorised Processes
 - Prosecution Relating to Controlled Waters
 - Registered Radioactive Substance
 - River Network or Water Feature
 - River Quality Sampling Point
 - Substantiated Pollution Incident Register
 - Water Abstraction
 - Water Industry Act Referral
- Hazardous Substances**
- COMAH Site
 - Explosive Site
 - NIHHS Site
 - Planning Hazardous Substance Consent
 - Planning Hazardous Substance Enforcement
 - 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)
 - Potentially Infilled Land (Water)
 - Registered Landfill Site (Location)
 - Registered Landfill Site (Point Buffered to 100m)
 - Registered Landfill Site (Point Buffered to 250m)
 - Registered Waste Transfer Site (Location)
 - Registered Waste Transfer Site
 - Registered Waste Treatment or Disposal Site (Location)
 - Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Slice A



Order Details

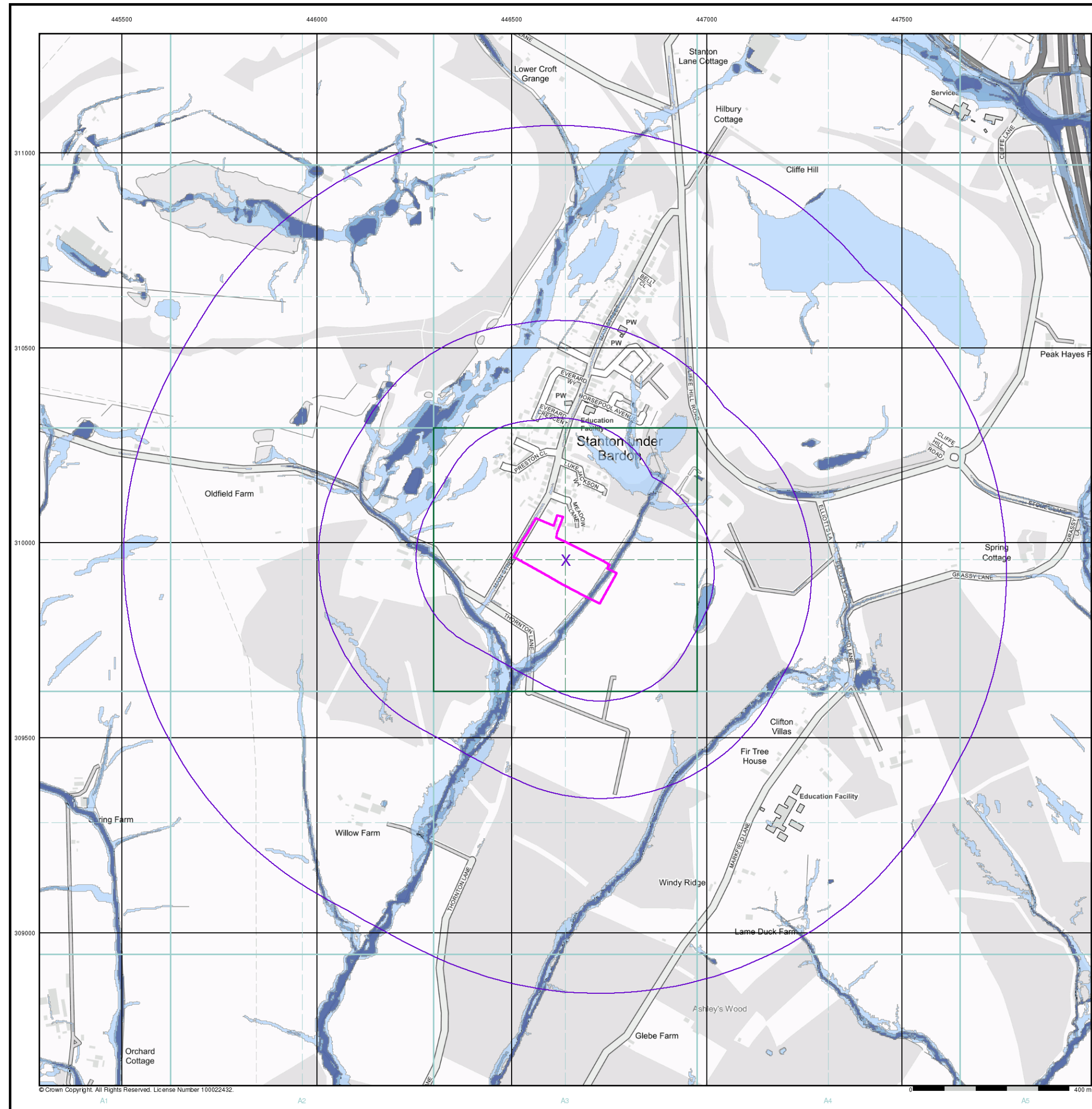
Order Number: 285657532_1_1
 Customer Ref: PO18114/JW/4252
 National Grid Reference: 446640, 309960
 Slice: A
 Site Area (Ha): 2.65
 Search Buffer (m): 1000

Site Details

Stanton under Bardon, LE67 9TL

Landmark
 INFORMATION GROUP

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General

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

Risk of Flooding from Surface Water

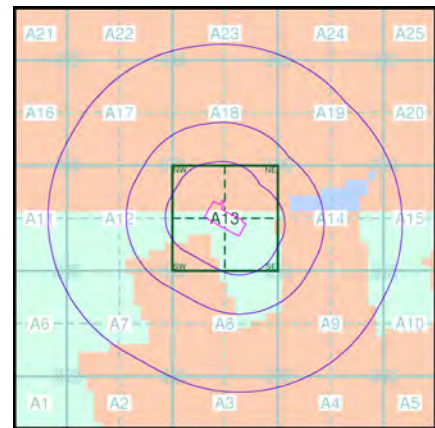
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

EAN/RW Suitability Map - Slice A



Order Details

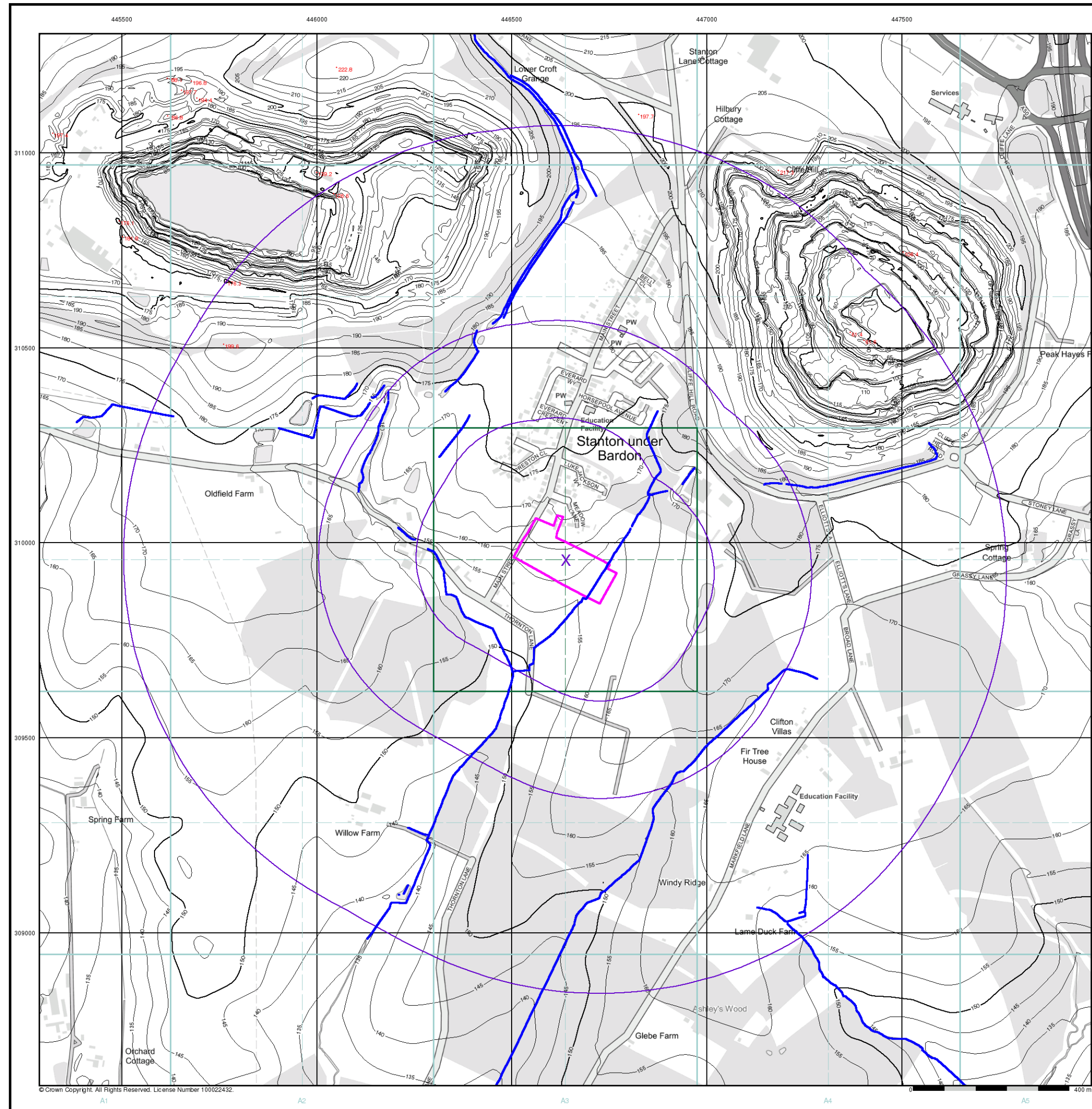
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Customer Ref: PO18114/JW/4252
National Grid Reference: 446640, 309960
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Site Area (Ha): 2.65
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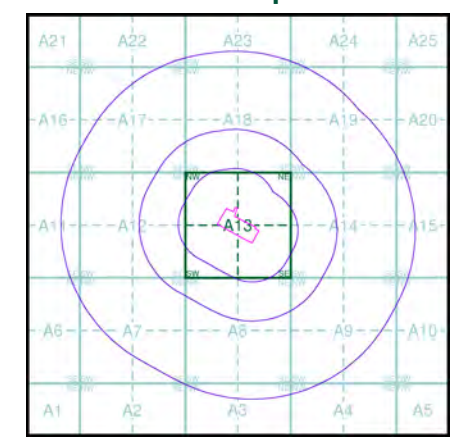


- General**
- Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point

- OS Water Network Data**
- | | |
|--------------|-------------------------|
| Canal | Drain |
| Reservoir | Other |
| Foreshore | Lake |
| Marsh | Transfer |
| Tidal River | Lock Or Flight Of Locks |
| Inland River | Sea |

- Contours (height in meters)**
- Standard Contour: 105, 100, 95
- Master Contour: 105, 100, 95
- Spot Height: 167.3
- MLW: Mean Low Water
- MHW: Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number: 285657532_1_1

Customer Ref: PO18114/JW/4252

National Grid Reference: 446640, 309960

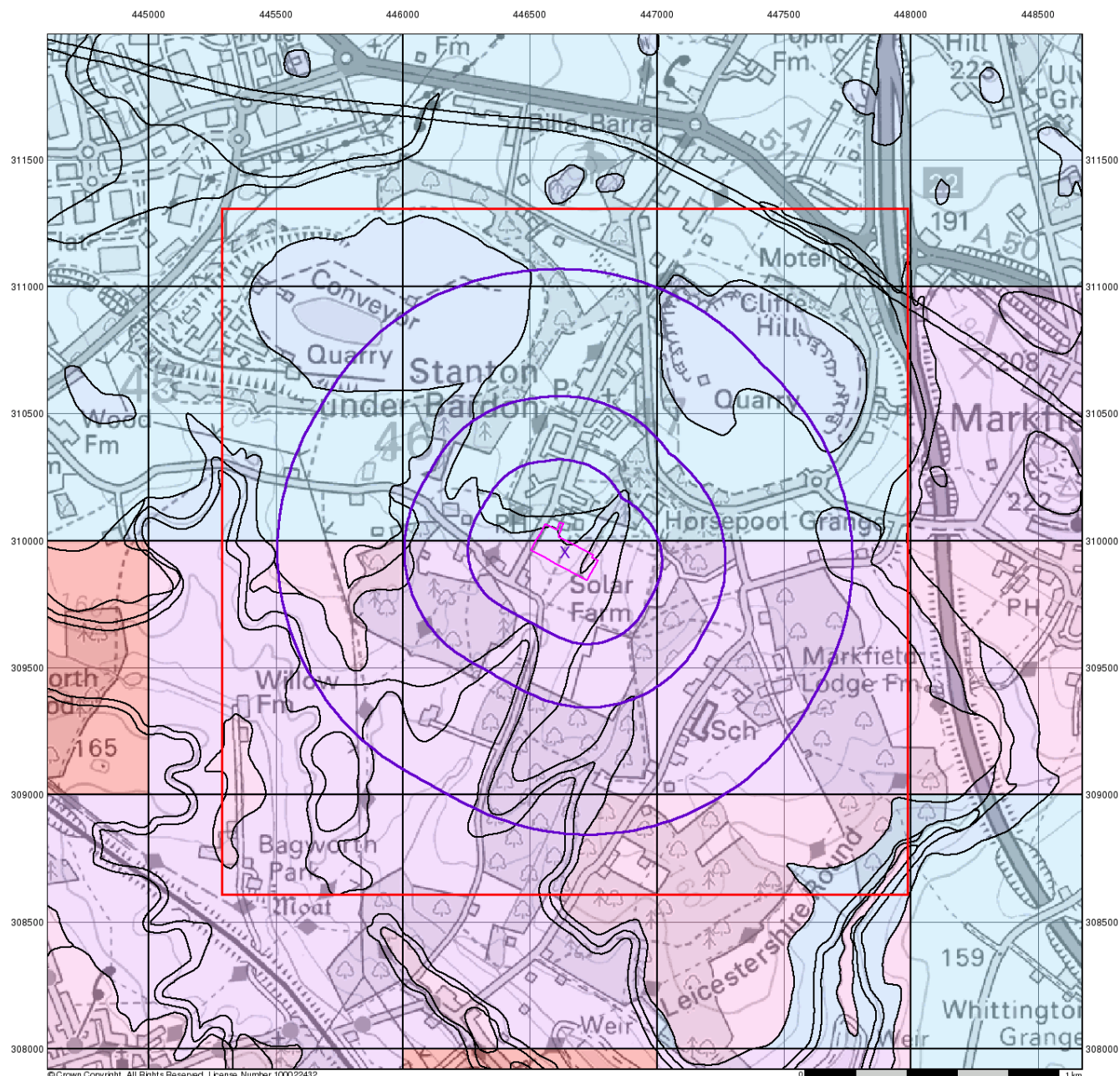
Slice: A

Site Area (Ha): 2.65

Search Buffer (m): 1000

Site Details

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Groundwater Vulnerability

General

- ✱ Specified Site
- Specified Buffer(s)
- ✕ Bearing Reference Point
- Slice
- 8 Map ID

Agency and Hydrological

Bedrock Aquifers

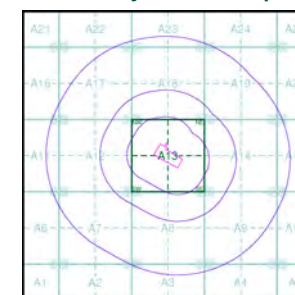
- High Vulnerability, Principal Aquifer
- High Vulnerability, Secondary Aquifer
- Medium Vulnerability, Principal Aquifer
- Medium Vulnerability, Secondary Aquifer
- Low Vulnerability, Principal Aquifer
- Low Vulnerability, Secondary Aquifer

Superficial Aquifers

- High Vulnerability, Principal Aquifer
- High Vulnerability, Secondary Aquifer
- Medium Vulnerability, Principal Aquifer
- Medium Vulnerability, Secondary Aquifer
- Low Vulnerability, Principal Aquifer
- Low Vulnerability, Secondary Aquifer

- Unproductive Aquifer
- ⋯ Soluble Rock

Site Sensitivity Context Map - Slice A



Order Details

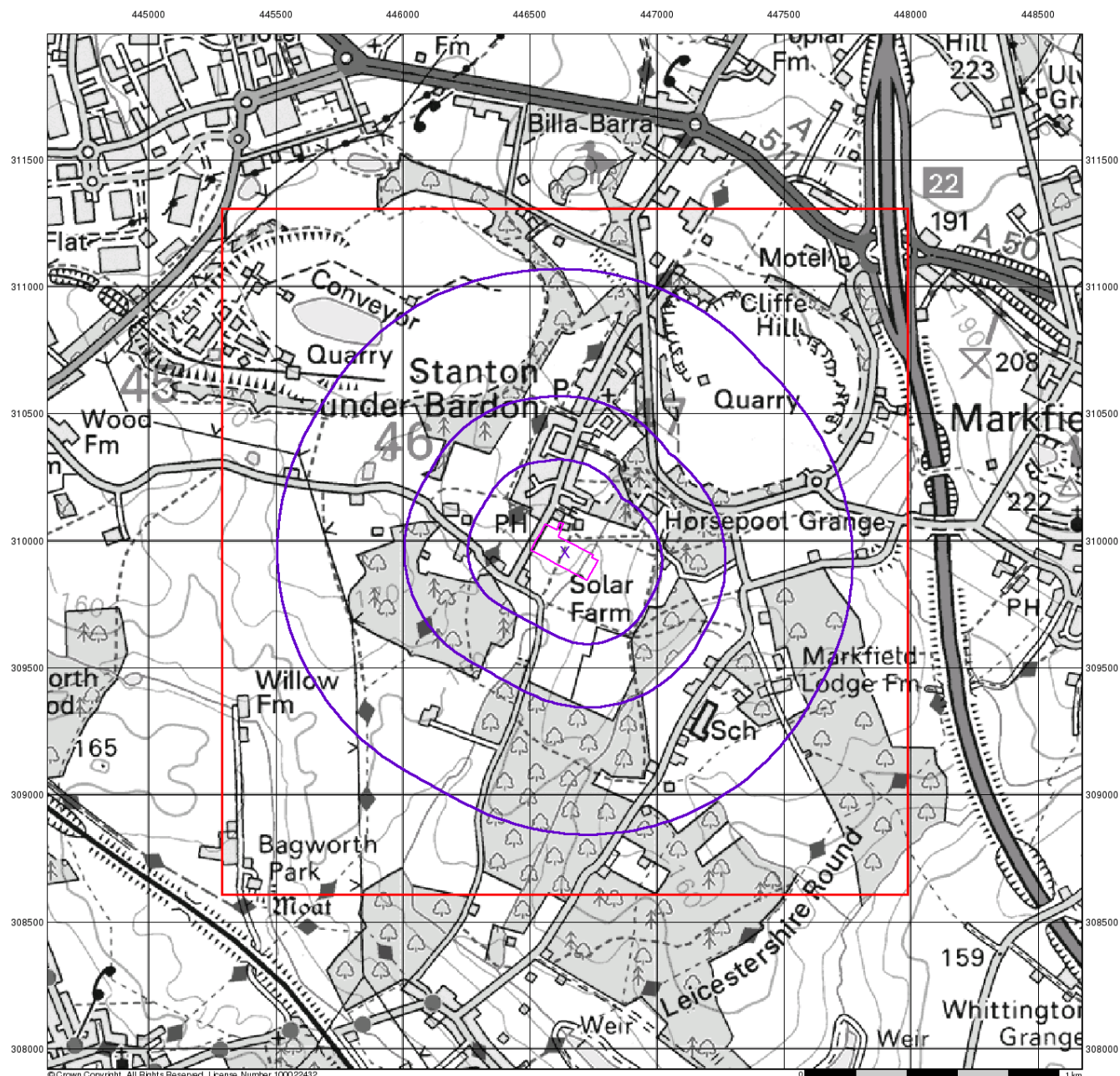
Order Number: 285657532_1_1
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 National Grid Reference: 446640, 309960
 Slice: A
 Site Area (Ha): 2.65
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Source Protection Zones

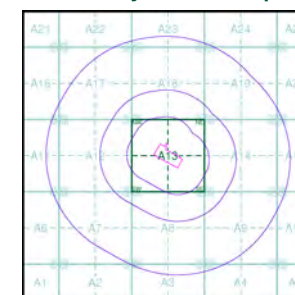
General

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

Agency and Hydrological

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

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 285657532_1_1
 Customer Ref: PO18114/JW/4252
 National Grid Reference: 446640, 309960
 Slice: A
 Site Area (Ha): 2.65
 Search Buffer (m): 1000

Site Details

Stanton under Bardon, LE67 9TL

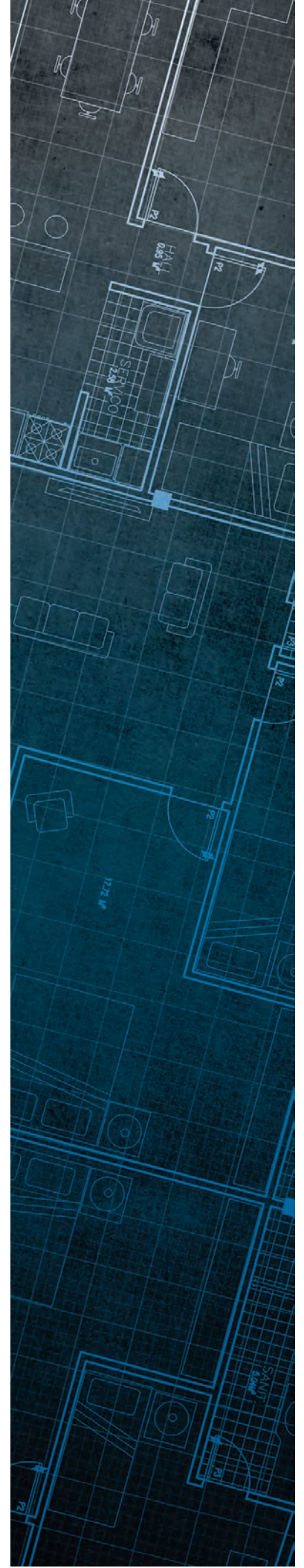


Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk

Consultants Coal Mining Report

Stanton Under Bardon
LE67 9TL

Date of enquiry:	30 September 2021
Date enquiry received:	30 September 2021
Issue date:	30 September 2021
Our reference:	51002677014001
Your reference:	PO18115/JW/4252



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

Stanton Under Bardon
LE67 9TL

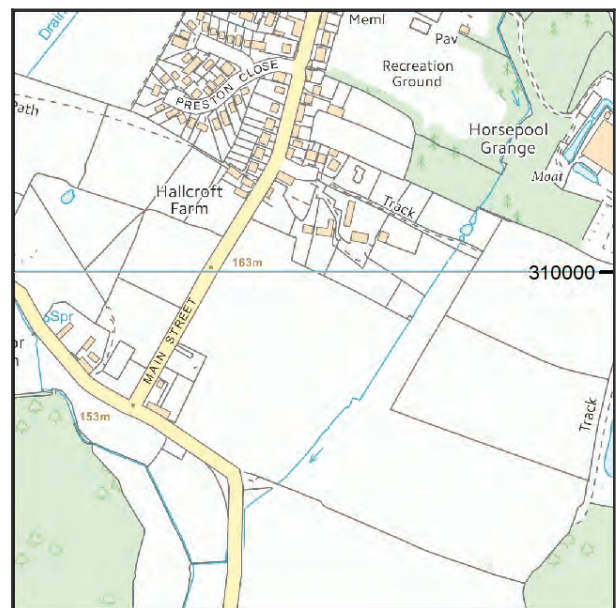
How to contact us

0345 762 6848 (UK)
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200 Lichfield Lane
Mansfield
Nottinghamshire
NG18 4RG

www.groundstability.com

 @coalauthority
 /company/the-coal-authority
 /thecoalauthority
 /thecoalauthority



Approximate position of property



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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

None available.

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

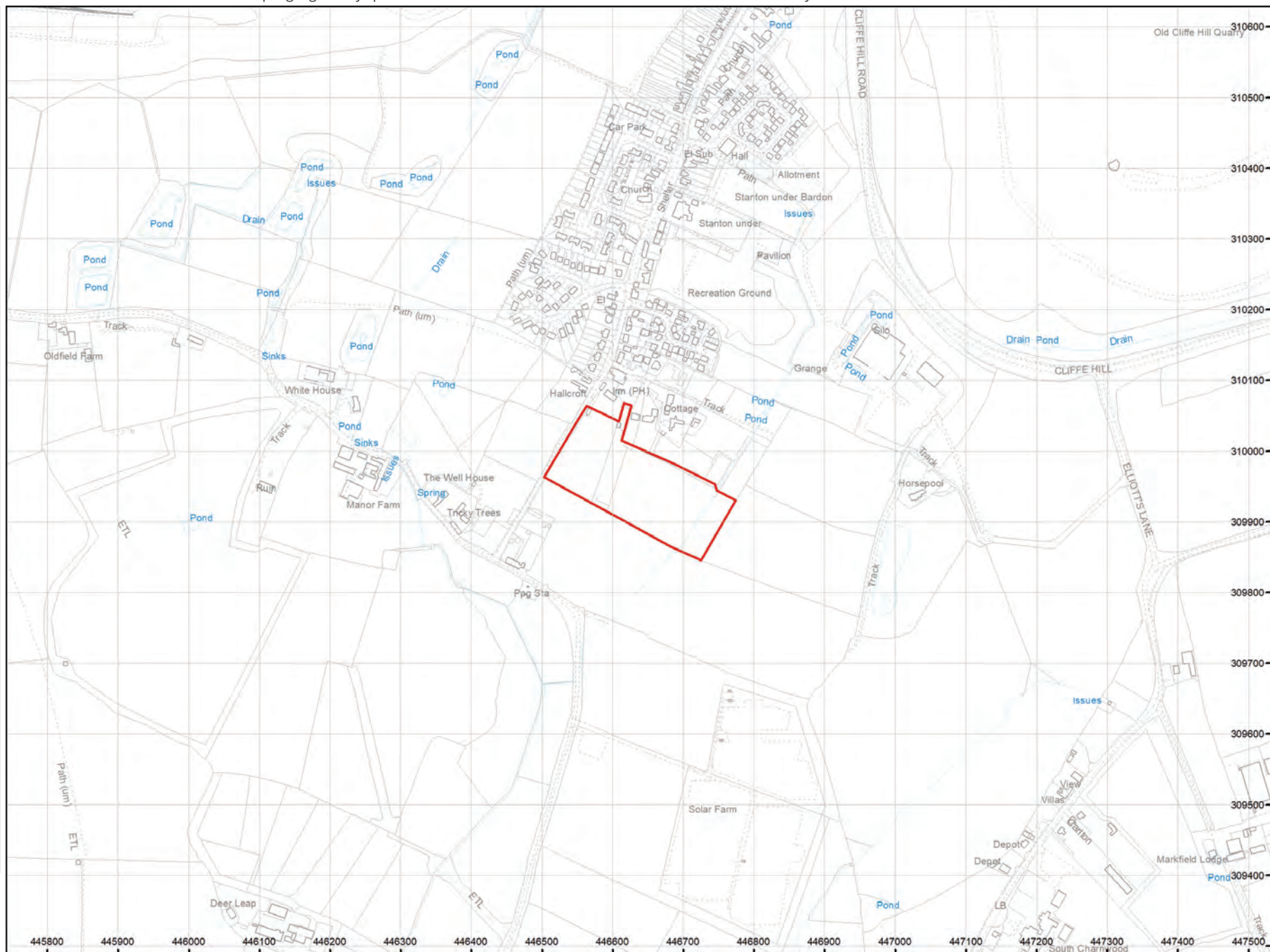
Relevant notices which may affect the property and any subsequent notice of retained interests in coal and coal mines, acceptance or rejection notices and whether any compensation has been paid to a claimant.

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



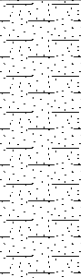
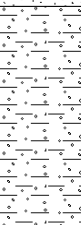
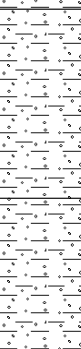
How to contact us

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

Appendix F

Trial Pit Logs

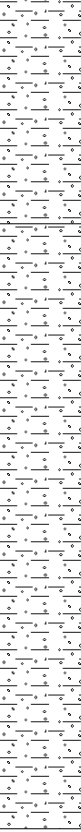
				Trial Pit Log			TrialPit No SA01 Sheet 1 of 1	
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446689.84 - 309892.10 Level: 157.20		Date 18/07/2023
Location: Markfield						Dimensions (m): 1.90 		Scale 1:20
Client: Caddick Land						Depth 2.50		Logged CR

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HSV=84kPa	0.25	156.95		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is rounded fine to coarse of mixed lithologies. (TOPSOIL)	1	
	0.20	B							
	0.60	D							
	0.60	HSV							
	0.70	B	HSV=55kPa	1.00	156.20		Orangish-brown slightly clayey SAND interbedded with firm to stiff slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to medium of mixed lithologies. (GRANULAR ALLUVIUM)		
	1.30	D							
	1.60	HSV							
	1.80	HSV							
	2.10	D&B	HSV=55kPa	2.10	155.10		Soft grey and orangish-brown mottled slightly gravelly sandy CLAY with low cobble content. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)		2
	2.40	D&B							
2.50	D&B								
			2.50	154.70		Firm red with yellowish-brown and grey slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM) <i>At 1.9m, becomes red with orangish-brown and grey mottling.</i> Soft reddish-brown with yellowish-brown and grey slightly gravelly very sandy CLAY with frequent lenses of clayey sand. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM) <i>Pit terminated at 2.5m for soakaway testing. Water in base before test started.</i> End of Pit at 2.50m	3		
								4	

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

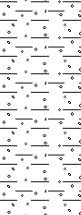
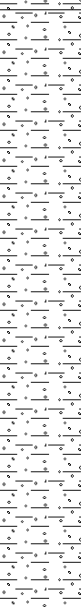
Stability: 1. The sides of the trial pit remained stable during excavation.



				Trial Pit Log			TrialPit No SA02 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446670.59 - 309959.48 Level: 162.25		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.70 		Scale 1:20	
Client: Caddick Land						Depth 2.40		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T		0.20	162.05		Brown gravelly clayey SAND with occasional pockets of sandy clay and occasional rootlets. Gravel is subangular to rounded fine to coarse of mixed lithologies. (TOPSOIL)		
	0.20	B					Firm to stiff orangish-brown slightly sandy slightly gravelly CLAY with occasional thin lenses of sand. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (OADBY MEMBER)		
	0.50	HSV	HSV=112kPa	0.80	161.45				
	0.90 0.90	D HSV	HSV=72kPa				Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to medium of mudstone and chalk. (OADBY MEMBER)		
				2.40	159.85		End of Pit at 2.40m		
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.									



				Trial Pit Log			TrialPit No SA03 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446568.90 - 309939.67 Level: 161.95		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80		Scale 1:20	
Client: Caddick Land						Depth 2.40		Logged CR	

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T						
	0.20	B		0.20	161.75		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL)	
	0.50	D						
	0.50	HSV	HSV=61kPa				Firm orangish-brown and brown slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (OADBY MEMBER)	
				0.80	161.15		Stiff red with light grey mottling slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of mudstone, chalk and chert. (OADBY MEMBER)	1
	1.00	HSV	HSV=38kPa					
	1.50	D						
	1.70	HSV	HSV=82kPa					
								2
							From 2.0m, very stiff.	
				2.40	159.55			
							End of Pit at 2.40m	
								3
								4

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

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



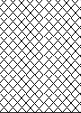
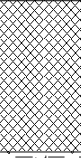
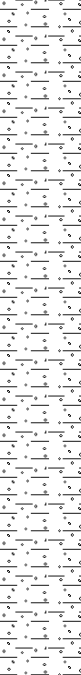
				Trial Pit Log			TrialPit No SA04 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446576.18 - 310012.32 Level: 166.25		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.75 0.60		Scale 1:20	
Client: Caddick Land						Depth 2.50		Logged CR	

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T					Brown very clayey SAND with occasional rootlets. (TOPSOIL)	
	0.20	B		0.25	166.00		Firm orangish-brown and greyish-brown sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (OADBY MEMBER)	
	0.60	D&B						
	0.60	HSV	HSV=69kPa	0.80	165.45		Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to medium of mudstone, chalk and chert. (OADBY MEMBER)	1
	1.00	HSV	HSV=75kPa				At 1.0m, 2 limestone boulders c. 60-70cm.	
	1.20	D						2
				2.50	163.75		End of Pit at 2.50m	3
								4

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

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

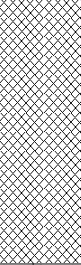
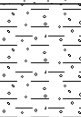


				Trial Pit Log			TrialPit No TP01 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446570.25 - 310044.65 Level: 168.00		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80 0.60		Scale 1:20	
Client: Caddick Land						Depth 2.50		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J,K&T	HSV=84kPa	0.30	167.70		MADE GROUND: Yellowish-brown and grey sandy angular to subangular fine to coarse GRAVEL of limestone and rare brick. (GRANULAR SURFACING)		
	0.50	J,K&T		0.70	167.30		MADE GROUND: Dark brownish-grey slightly sandy slightly gravelly CLAY. Gravel is subangular fine to medium of quartz. (COHESIVE MADE GROUND)		
	0.90	D			Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to coarse of mudstone, limestone and chalk. (OADBY MEMBER)				
	1.10	HSV			At 2.0m, becomes very stiff, red and greyish-brown with light grey mottling.				
	End of Pit at 2.50m								
				2.50	165.50				

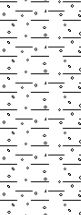
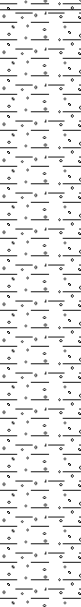
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.

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



				Trial Pit Log			TrialPit No TP02 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446591.94 - 310032.31 Level: 168.40		Date 18/07/2023	
Location: Markfield						Dimensions (m): 0.60 1.80		Scale 1:20	
Client: Caddick Land						Depth 1.50		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.40	J,K&T		0.70	167.70		MADE GROUND: Grey slightly sandy gravelly CLAY. Gravel is angular fine to coarse of coal and mudstone intermixed with Red slightly sandy slightly gravelly CLAY. Gravel is red clay is subangular to subrounded fine to medium of mudstone and chalk. (COLLIERY SPOIL & REWORKED NATURAL)		
				1.20	167.20		Reddish-brown very clayey SAND. (GRANULAR GLACIOFLUVIAL DEPOSITS)		
				1.50	166.90		Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to coarse of mudstone, chalk and chert. (OADBY MEMBER)		
	End of Pit at 1.50m								
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in. Stability: 1. The sides of the trial pit remained stable during excavation. 									

				Trial Pit Log			TrialPit No TP03 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446583.40 - 309983.69 Level: 164.95		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80 		Scale 1:20	
Client: Caddick Land						Depth 2.40		Logged CR	

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.20	164.75		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subangular to rounded fine to medium of mixed lithologies. (TOPSOIL)	
	0.50	HSV	HSV=124kPa				Firm orangish-brown and reddish-brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (OADBY MEMBER)	
	0.60	D						
	0.90	HSV	HSV=82kPa	0.80	164.15		Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to medium of chalk, mudstone and quartz. (OADBY MEMBER)	1
								2
							At 2.2m, becomes greyish-brown.	
				2.40	162.55		End of Pit at 2.40m	3
								4

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

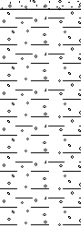
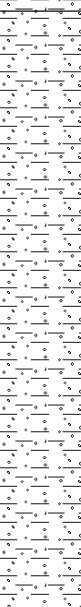
Stability: 1. The sides of the trial pit remained stable during excavation.



				Trial Pit Log			TrialPit No TP04 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446538.36 - 309968.89 Level: 162.30		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80 		Scale 1:20	
Client: Caddick Land						Depth 2.50		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HSV=126kPa	0.25	162.05		Brown slightly gravelly slightly clayey SAND with occasional rootlets. Gravel is angular to subangular of mixed lithologies. (TOPSOIL)		
							Stiff yellowish-brown and orangish-brown slightly sandy slightly gravelly CLAY. Gravel is subangular fine to coarse of mixed lithologies. (OADBY MEMBER)		
	0.70	HSV					Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse of quartz, chalk and chert. (OADBY MEMBER)		
	0.80	D							
									
	2.30	D		2.50	159.80				
	End of Pit at 2.50m								
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.									
Stability: 1. The sides of the trial pit remained stable during excavation.									



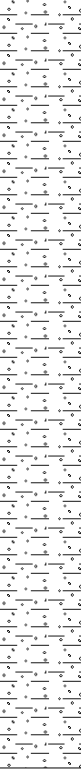
				Trial Pit Log			TrialPit No TP05 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446640.68 - 309991.20 Level: 165.90		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80		Scale 1:20	
Client: Caddick Land						Depth 2.70		Logged CR	

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.20	165.70		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL)	
				0.50	165.40		Orangish-brown gravelly clayey SAND. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (GRANULAR GLACIOFLUVIAL DEPOSITS)	
	0.90	HSV	HSV=94kPa				Stiff orangish-brown and red slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (OADBY MEMBER)	1
	1.00	D		1.10	164.80		Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of chalk, mudstone and quartz. (OADBY MEMBER)	
	1.60	HSV	HSV=84kPa					2
				2.70	163.20		End of Pit at 2.70m	3
								4

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

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

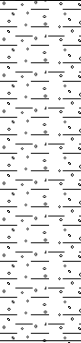
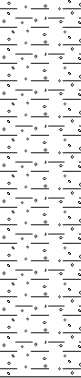


				Trial Pit Log			TrialPit No TP06 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446622.23 - 309929.66 Level: 162.00		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80 		Scale 1:20	
Client: Caddick Land						Depth 2.30		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T		0.25	161.75		Brown slightly gravelly very clayey SAND with occasional rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL)		
	0.20	B							
	0.50	HSV	HSV=72kPa	2.30	159.70		Stiff red with light grey mottling slightly gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse of limestone, chalk and mudstone. (OADBY MEMBER) <i>At 0.7m, becomes reddish-brown and light grey mottled.</i>		
	0.80	HSV	HSV=122kPa						
	1.40	D							
							End of Pit at 2.30m		

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.

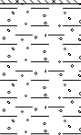
Stability: 1. The sides of the trial pit remained stable during excavation.



				Trial Pit Log			TrialPit No TP07 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446666.41 - 309910.78 Level: 159.70		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80 0.60		Scale 1:20	
Client: Caddick Land						Depth 2.90		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
	0.10	J&T	HSV=92kPa	0.25	159.45		Brown slightly gravelly slightly clayey SAND with occasional rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL)		
	0.70	D&B		1.00	158.70		Orangish-brown very gravelly slightly clayey SAND. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (GRANULAR GLACIOFLUVIAL DEPOSITS)		
	1.10	HSV		1.90	157.80		Stiff orangish-brown, brown and light grey mottled slightly sandy slightly gravelly CLAY with low cobble content. Gravel is subrounded fine to coarse of mixed lithologies. (OADBY MEMBER)		
	2.70	D		2.90	156.80		Stiff red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to coarse of limestone, mudstone and chalk. (OADBY MEMBER)		
							End of Pit at 2.90m		
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.									
Stability: 1. The sides of the trial pit remained stable during excavation.									



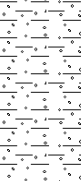
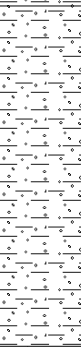
				Trial Pit Log			TrialPit No TP08 Sheet 1 of 1	
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446712.74 - 309939.44 Level: 157.85		Date 18/07/2023
Location: Markfield						Dimensions (m): 1.80 		Scale 1:20
Client: Caddick Land						Depth 2.50		Logged CR

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J&T		0.25	157.60		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (TOPSOIL)	
				0.60	157.25		Firm to stiff orange and greyish-brown mottled slightly sandy slightly gravelly CLAY. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)	
	0.80	D&B					Soft greyish-brown and orange mottled slightly gravelly very sandy CLAY. Gravel is subangular to rounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)	
	0.90	HSV	HSV=49kPa					1
	1.50	D		1.40	156.45		Soft grey silty CLAY. (COHESIVE ALLUVIUM)	
	1.50	HSV	HSV=39kPa					
	1.70			1.70	156.15		Firm red with light grey mottling slightly gravelly CLAY. Gravel is subangular fine to medium of limestone and mudstone. (COHESIVE ALLUVIUM)	
	1.90	HSV	HSV=54kPa					2
	2.10			2.10	155.75		Blue-grey very gravelly clayey SAND with low cobble content and rare decomposing wood. Gravel is angular fine to coarse of sandstone. (GRANULAR ALLUVIUM)	
	2.30	D						
				2.50	155.35		End of Pit at 2.50m	3
								4

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

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



				Trial Pit Log			TrialPit No TP09 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446691.23 - 309949.40 Level: 160.05		Date 18/07/2023	
Location: Markfield						Dimensions (m): 1.80 		Scale 1:20	
Client: Caddick Land						Depth 1.60		Logged CR	
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
				0.20	159.85		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subrounded to rounded fine to medium of mixed lithologies. (TOPSOIL)		
				0.70	159.35		Stiff orangish-brown slightly sandy slightly gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse of chalk, mudstone and quartz. (OADBY MEMBER)		
				1.60	158.45		Stiff red and greyish-brown with light grey mottling slightly gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse of chalk, mudstone and quartz. (OADBY MEMBER)		
							End of Pit at 1.60m		
Remarks: 1. Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during excavation. 3. Backfilled with materials arising upon completion. 4. Co-ordinates from hand held GPS, hole not surveyed in.									
Stability: 1. The sides of the trial pit remained stable during excavation.									



Appendix G

Borehole Logs



Borehole Log

Borehole No.

WS1

Sheet 1 of 1

Project Name: Stanton under Bardon

Project No. 4252

Co-ords: 446668E - 309889N

Hole Type WS

Location: Markfield

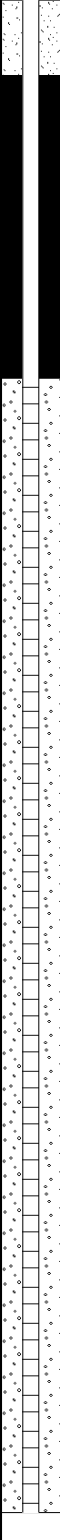
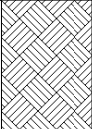
Level: 157.60 m AOD

Scale 1:20

Client: Caddick Land

Dates: 31/07/2023

Logged By CR

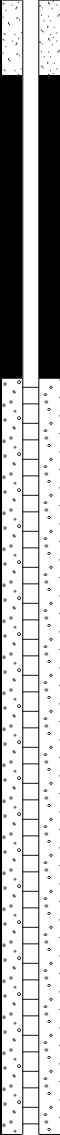
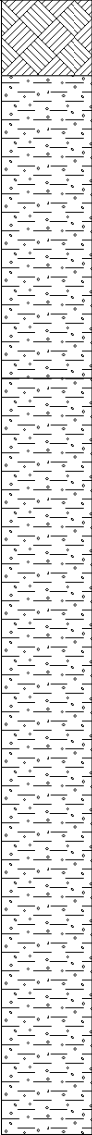
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					157.60		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subangular to subrounded fine to medium of mixed lithologies. (TOPSOIL)		
					0.35	157.25		Firm orangish-brown slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)	
					0.60	157.00		Orangish-brown gravelly slightly clayey SAND. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (GRANULAR ALLUVIUM)	
	0.90	HSV	HSV =42		0.80	156.80		Firm orangish-brown slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)	1
	1.00	S	N=12 (2,3/3,3,3,3)					At 1.0m, becomes locally soft, sandy to very sandy.	
								At 1.4m, becomes reddish-brown.	
	2.00	S	N=7 (1,1/1,2,2,2)					At 2.2m, rare wood and root fragments.	2
					2.40	155.20		Firm to stiff red slightly sandy slightly gravelly CLAY. Gravel is subangular fine to coarse of mudstone, chalk and limestone. (OADBY MEMBER)	
					2.80	HSV	HSV =89		
					3.00	S	N=41 (2,5/15,13,7,6)		3
					3.50	154.10		At 3.4m, 0.1m lense of sandy gravel of siltstone. Groundwater encountered. Stiff to very stiff light grey sandy CLAY. (WEATHERED EDWALTON MEMBER)	
								At 3.9m, becomes red and grey.	
					4.00			End of Borehole at 4.00m	4

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 3.4m and rose to 2.5m after 20 minutes. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.



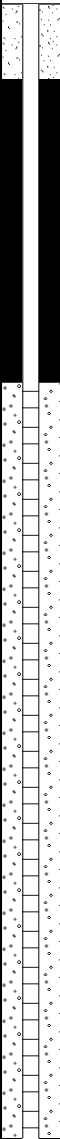
				Borehole Log				Borehole No. WS2 Sheet 1 of 1	
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446688E - 309875N		Hole Type WS	
Location: Markfield				Level: 155.75 m AOD		Scale 1:20			
Client: Caddick Land				Dates: 31/07/2023		Logged By CR			

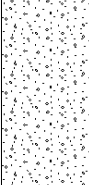
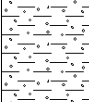
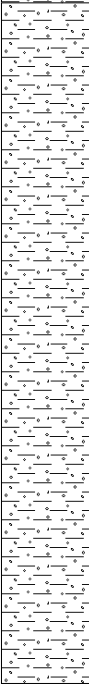
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					155.75		Brown slightly gravelly sandy CLAY with occasional rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL)		
				0.20	155.55		Firm orangish-brown and greyish-brown mottled slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (COHESIVE ALLUVIUM)		
	1.00	S	N=8 (2,2/2,2,2,2)	1.00	154.75		<u>0.1m lense of slightly gravelly slightly clayey sand.</u> Firm becoming stiff red with light grey mottling slightly gravelly CLAY. Gravel is angular to subangular fine to medium of mudstone. (WEATHERED EDWALTON MEMBER)	1	
								<u>Between 2.3m and 2.7m, firm.</u> <u>At 2.8m, becomes red and light grey mottled, silty.</u>	2
		2.80			3.00		End of Borehole at 3.00m	3	
								4	

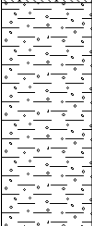
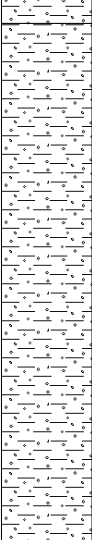
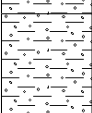
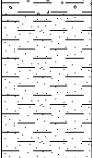
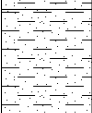
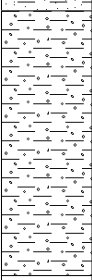
Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

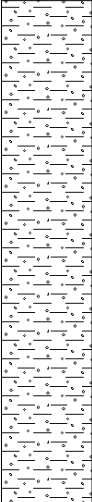
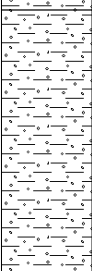
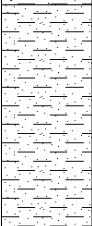
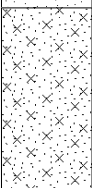


				Borehole Log				Borehole No. WS3 Sheet 1 of 1		
Project Name: Stanton under Bardon				Project No. 4252		Co-ords: 446709E - 309910N		Hole Type WS		
Location: Markfield				Level: 156.95 m AOD		Scale 1:20				
Client: Caddick Land				Dates: 31/07/2023		Logged By CR				
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.25	156.95		Brown clayey SAND with occasional rootlets. (TOPSOIL)	1	
						156.70		Firm orangish-brown and greyish-brown mottled slightly sandy locally sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)		
						156.15		Soft greyish-brown with orange mottling slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)		
		0.90	HSV	HSV =28	0.80	156.15		Soft greyish-brown with orange mottling slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)	1	
		1.00	S	N=7 (0,0/1,1,2,3)				Mixed orange gravelly SAND and red slightly sandy CLAY. Gravel is angular to subrounded fine to coarse of mixed lithologies. (GRANULAR ALLUVIUM)		
						155.45		Firm to stiff red and light grey mottled slightly sandy locally sandy CLAY. (COHESIVE ALLUVIUM)		
						1.50	155.45		Soft light grey very sandy CLAY with rare subrounded gravel. (COHESIVE ALLUVIUM)	2
						1.80	155.15		Firm red slightly sandy slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone and limestone. (WEATHERED EDWALTON MEMBER)	
		2.00	S	N=7 (2,1/1,2,2,2)	2.00	154.95		Firm red slightly sandy slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone and limestone. (WEATHERED EDWALTON MEMBER)		
						2.30	154.65		Firm red slightly sandy slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone and limestone. (WEATHERED EDWALTON MEMBER)	3
					3.00	154.65		Firm red slightly sandy slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium of mudstone and limestone. (WEATHERED EDWALTON MEMBER)		
							End of Borehole at 3.00m			
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.										

					Borehole Log				Borehole No. WS4 Sheet 1 of 1	
Project Name: Stanton under Bardon					Project No. 4252		Co-ords: 446691E - 309923N		Hole Type WS	
Location: Markfield							Level: 158.65 m AOD		Scale 1:20	
Client: Caddick Land							Dates: 31/07/2023		Logged By CR	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
						158.65		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subangular fine to medium of mixed lithologies. (TOPSOIL)	1	
					0.40	158.25		Orangish-brown gravelly clayey SAND. Gravel is subrounded to rounded fine to medium of mixed lithologies. (GRANULAR ALLUVIUM)		
		0.90			0.90	157.75		Firm red slightly sandy to sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (COHESIVE ALLUVIUM)		
		1.00	S	N=7 (2,1/2,2,1,2)	1.20	157.45		Firm becoming stiff red slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (OADBY MEMBER)		
					3.00			End of Borehole at 3.00m	3	
									4	
Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.										

					Borehole Log				Borehole No. WS5 Sheet 1 of 1		
Project Name: Stanton under Bardon					Project No. 4252		Co-ords: 446712E - 309936N		Hole Type WS		
Location: Markfield							Level: 157.90 m AOD		Scale 1:20		
Client: Caddick Land							Dates: 31/07/2023		Logged By CR		
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
						157.90		Brown and orangish-brown slightly gravelly clayey SAND with occasional rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL)	1		
					0.25	157.65		Firm orangish-brown and greyish-brown mottled slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)			
		0.90 1.00	S	N=1 (0,0/0,0,0,1)	0.90	157.00		Soft greyish-brown and orangish-brown slightly sandy to sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)			
					2.00	S	N=7 (1,0/1,0,1,5)			2	
					2.30	155.60		Firm red with light grey mottling slightly sandy slightly gravelly CLAY. Gravel is subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)	3		
					2.60	155.30		Soft grey sandy CLAY mixed with clayey SAND. (COHESIVE ALLUVIUM)			
					3.00	154.90		Firm light grey sandy CLAY. (COHESIVE ALLUVIUM)			
					3.30	154.60		Firm to stiff red slightly gravelly CLAY. Gravel is angular to subangular fine to medium of mudstone. (WEATHERED EDWALTON MEMBER)			
					4.00			End of Borehole at 4.00m			4
		Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.									

					Borehole Log			Borehole No. WS6 Sheet 1 of 1	
Project Name: Stanton under Bardon					Project No. 4252		Co-ords: 446710E - 309950N		Hole Type WS
Location: Markfield					Level: 158.70 m AOD		Scale 1:20		Logged By CR
Client: Caddick Land					Dates: 31/07/2023				

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.25	158.70		Brown slightly gravelly clayey SAND with occasional rootlets. Gravel is angular to subangular fine to medium of mixed lithologies. (TOPSOIL)	1	
						158.45		Firm orangish-brown and greyish-brown mottled slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mixed lithologies. (COHESIVE ALLUVIUM)		
		0.90								
		1.00	S	N=5 (1,1/1,1,1,2)						
					1.60	157.10		Firm to stiff red with grey and orangish-brown mottling slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of mixed lithologies. (COHESIVE ALLUVIUM)	2	
					2.30	156.40		Stiff red with light grey mottling slightly sandy CLAY. (COHESIVE ALLUVIUM)		
							<u>At 2.7m, becomes firm.</u>			
					2.90	155.80		Soft grey sandy CLAY. (COHESIVE ALLUVIUM)	3	
					3.10	155.60		Firm red slightly sandy CLAY. (COHESIVE ALLUVIUM)		
					3.30	155.40		Grey and light grey slightly clayey SAND interbedded with soft sandy CLAY. (COHESIVE ALLUVIUM)		
			3.80	154.90		Stiff red and light grey mottled silty CLAY. (WEATHERED EDWALTON MEMBER)				
			4.00				End of Borehole at 4.00m	4		

Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.



Appendix H
Chemical Results



Certificate of Analysis

Certificate Number 23-17471

Issued: 08-Aug-23

Client Lithos Consulting Ltd
Parkhill
Walton Rd
Wetherby
LS22 5DZ

Our Reference 23-17471

Client Reference 4252

Order No PO20966

Contract Title Stanton under Bardon

Description 13 Soil samples.

Date Received 21-Jul-23

Date Started 21-Jul-23

Date Completed 08-Aug-23

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read "K. Bridgewood".

Kirk Bridgewood
General Manager



2139

Summary of Chemical Analysis

Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	2206861	2206862	2206863	2206864	2206865	2206866
Sample ID	TP01	TP02	TP01	SA01	SA02	SA03
Depth	0.50	0.40	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0	9.0	23	< 1.0	8.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	24	14	6.5	17	19	21
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	8.6	12	5.9	7.6	9.7	9.9
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg	1.7	1.5	1.2	0.6	1.0	1.4
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.2	0.3	0.2	0.3	0.2
Chromium	DETSC 2301#	0.15	mg/kg	18	18	8.1	15	18	21
Chromium III	DETSC 2301*	0.15	mg/kg	18	18	8.1	15	18	21
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	26	41	24	18	21	23
Lead	DETSC 2301#	0.3	mg/kg	50	34	9.5	24	30	34
Magnesium Aqueous Extract (2:1)	DETSC 2076*	10	mg/l	< 10	< 10	< 10			
Mercury	DETSC 2325#	0.05	mg/kg	0.14	0.10	< 0.05	< 0.05	< 0.05	0.06
Nickel	DETSC 2301#	1	mg/kg	15	27	7.2	13	15	19
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Vanadium	DETSC 2301#	0.8	mg/kg	29	35	28	25	30	33
Zinc	DETSC 2301#	1	mg/kg	89	100	45	58	69	75
Inorganics									
pH	DETSC 2008#		pH	6.8	7.4	11.4	6.4	6.1	6.0
Total Organic Carbon	DETSC 2084#	0.5	%	3.3	4.9	2.1	2.2	3.7	3.5
Chloride Aqueous Extract (2:1)	DETSC 2055	1	mg/l	4.8	2.1	25			
Nitrate Aqueous Extract as NO3 (2:1)	DETSC 2055	1	mg/l	5.1	13	18			
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l	35	36	150			
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	< 0.1	< 0.1	< 0.1			
EPH (C10-C12)	DETSC 3311	10	mg/kg	< 10	< 10	< 10			
EPH (C12-C16)	DETSC 3311	10	mg/kg	< 10	< 10	< 10			
EPH (C16-C21)	DETSC 3311	10	mg/kg	< 10	< 10	< 10			
EPH (C21-C35)	DETSC 3311	10	mg/kg	< 10	< 10	< 10			
EPH (C35-C40)	DETSC 3311	10	mg/kg	< 10	< 10	< 10			
EPH (C10-C40)	DETSC 3311#	10	mg/kg	< 10	< 10	< 10			
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.04	< 0.03	< 0.03	< 0.03	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.04	0.09	0.04	< 0.03	< 0.03	0.05
Pyrene	DETSC 3303#	0.03	mg/kg	0.04	0.08	0.03	< 0.03	< 0.03	0.04
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	0.04	0.03	< 0.03	< 0.03	< 0.03

Summary of Chemical Analysis

Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	2206861	2206862	2206863	2206864	2206865	2206866
Sample ID	TP01	TP02	TP01	SA01	SA02	SA03
Depth	0.50	0.40	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.04	0.04	< 0.03	< 0.03	0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10	0.28	0.15	< 0.10	< 0.10	< 0.10

Summary of Chemical Analysis

Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	2206867	2206868	2206869	2206870	2206871	2206872
Sample ID	SA04	TP03	TP04	TP05	TP06	TP07
Depth	0.10	0.10	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Preparation									
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Moisture Content	DETSC 1004	0.1	%	24	21	21	21	25	15
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	10	10	10	8.7	8.8	8.9
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg	1.2	1.1	1.0	1.0	1.4	0.6
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.2	0.2	0.3	0.3	0.2
Chromium	DETSC 2301#	0.15	mg/kg	17	18	17	16	16	15
Chromium III	DETSC 2301*	0.15	mg/kg	17	18	17	16	16	15
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	23	20	20	21	22	22
Lead	DETSC 2301#	0.3	mg/kg	42	41	42	37	31	29
Magnesium Aqueous Extract (2:1)	DETSC 2076*	10	mg/l						
Mercury	DETSC 2325#	0.05	mg/kg	0.07	0.07	0.06	< 0.05	0.05	0.06
Nickel	DETSC 2301#	1	mg/kg	15	14	13	12	16	14
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Vanadium	DETSC 2301#	0.8	mg/kg	30	32	31	27	27	25
Zinc	DETSC 2301#	1	mg/kg	79	74	73	77	74	71
Inorganics									
pH	DETSC 2008#		pH	5.8	5.9	5.7	6.0	6.4	5.8
Total Organic Carbon	DETSC 2084#	0.5	%	3.7	2.7	4.1	3.3	3.8	2.6
Chloride Aqueous Extract (2:1)	DETSC 2055	1	mg/l						
Nitrate Aqueous Extract as NO3 (2:1)	DETSC 2055	1	mg/l						
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l						
Petroleum Hydrocarbons									
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg						
EPH (C10-C12)	DETSC 3311	10	mg/kg						
EPH (C12-C16)	DETSC 3311	10	mg/kg						
EPH (C16-C21)	DETSC 3311	10	mg/kg						
EPH (C21-C35)	DETSC 3311	10	mg/kg						
EPH (C35-C40)	DETSC 3311	10	mg/kg						
EPH (C10-C40)	DETSC 3311#	10	mg/kg						
PAHs									
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.04	0.03	0.06	0.05	< 0.03	< 0.03
Pyrene	DETSC 3303#	0.03	mg/kg	0.04	0.03	0.05	0.04	< 0.03	< 0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

Summary of Chemical Analysis

Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	2206867	2206868	2206869	2206870	2206871	2206872
Sample ID	SA04	TP03	TP04	TP05	TP06	TP07
Depth	0.10	0.10	0.10	0.10	0.10	0.10
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023	18/07/2023
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10	< 0.10	0.11	< 0.10	< 0.10	< 0.10

Summary of Chemical Analysis

Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	2206873
Sample ID	TP08
Depth	0.10
Other ID	
Sample Type	SOIL
Sampling Date	18/07/2023
Sampling Time	n/s

Test	Method	LOD	Units	
Preparation				
Stones >10mm	DETSC 1003*	1	% m/m	< 1.0
Moisture Content	DETSC 1004	0.1	%	20
Metals				
Arsenic	DETSC 2301#	0.2	mg/kg	12
Boron, Water Soluble (2.5:1)	DETSC 2311#	0.2	mg/kg	0.9
Cadmium	DETSC 2301#	0.1	mg/kg	0.3
Chromium	DETSC 2301#	0.15	mg/kg	18
Chromium III	DETSC 2301*	0.15	mg/kg	18
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	28
Lead	DETSC 2301#	0.3	mg/kg	45
Magnesium Aqueous Extract (2:1)	DETSC 2076*	10	mg/l	
Mercury	DETSC 2325#	0.05	mg/kg	0.14
Nickel	DETSC 2301#	1	mg/kg	16
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5
Vanadium	DETSC 2301#	0.8	mg/kg	33
Zinc	DETSC 2301#	1	mg/kg	89
Inorganics				
pH	DETSC 2008#		pH	5.5
Total Organic Carbon	DETSC 2084#	0.5	%	2.7
Chloride Aqueous Extract (2:1)	DETSC 2055	1	mg/l	
Nitrate Aqueous Extract as NO3 (2:1)	DETSC 2055	1	mg/l	
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l	
Petroleum Hydrocarbons				
EPH (C6-C10)	DETSC 3321*	0.1	mg/kg	
EPH (C10-C12)	DETSC 3311	10	mg/kg	
EPH (C12-C16)	DETSC 3311	10	mg/kg	
EPH (C16-C21)	DETSC 3311	10	mg/kg	
EPH (C21-C35)	DETSC 3311	10	mg/kg	
EPH (C35-C40)	DETSC 3311	10	mg/kg	
EPH (C10-C40)	DETSC 3311#	10	mg/kg	
PAHs				
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	0.04
Pyrene	DETSC 3303#	0.03	mg/kg	0.03
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03

Summary of Chemical Analysis

Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	2206873
Sample ID	TP08
Depth	0.10
Other ID	
Sample Type	SOIL
Sampling Date	18/07/2023
Sampling Time	n/s

Test	Method	LOD	Units	
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03
PAH - USEPA 16, Total	DETSC 3303	0.1	mg/kg	< 0.10

Summary of Asbestos Analysis Soil Samples

Our Ref 23-17471

Client Ref 4252

Contract Title Stanton under Bardon

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
2206861	TP01 0.50	SOIL	NAD	none	Vicky Convery
2206862	TP02 0.40	SOIL	NAD	none	Vicky Convery
2206863	TP01 0.10	SOIL	NAD	none	Vicky Convery
2206864	SA01 0.10	SOIL	NAD	none	Vicky Convery
2206865	SA02 0.10	SOIL	NAD	none	Vicky Convery
2206866	SA03 0.10	SOIL	NAD	none	Vicky Convery
2206867	SA04 0.10	SOIL	NAD	none	Vicky Convery
2206868	TP03 0.10	SOIL	NAD	none	Vicky Convery
2206869	TP04 0.10	SOIL	NAD	none	Vicky Convery
2206870	TP05 0.10	SOIL	NAD	none	Vicky Convery
2206871	TP06 0.10	SOIL	NAD	none	Vicky Convery
2206872	TP07 0.10	SOIL	NAD	none	Vicky Convery
2206873	TP08 0.10	SOIL	NAD	none	Vicky Convery

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 23-17471
 Client Ref 4252
 Contract Stanton under Bardon

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Hold time exceeded for tests	Inappropriate container for tests
2206861	TP01 0.50 SOIL	18/07/23	GJ 250ml, GJ 60ml, PT 1L		
2206862	TP02 0.40 SOIL	18/07/23	GJ 250ml, GJ 60ml, PT 1L		
2206863	TP01 0.10 SOIL	18/07/23	GJ 250ml, GJ 60ml, PT 1L		
2206864	SA01 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206865	SA02 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206866	SA03 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206867	SA04 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206868	TP03 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206869	TP04 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206870	TP05 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206871	TP06 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206872	TP07 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		
2206873	TP08 0.10 SOIL	18/07/23	GJ 250ml, PT 1L		

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

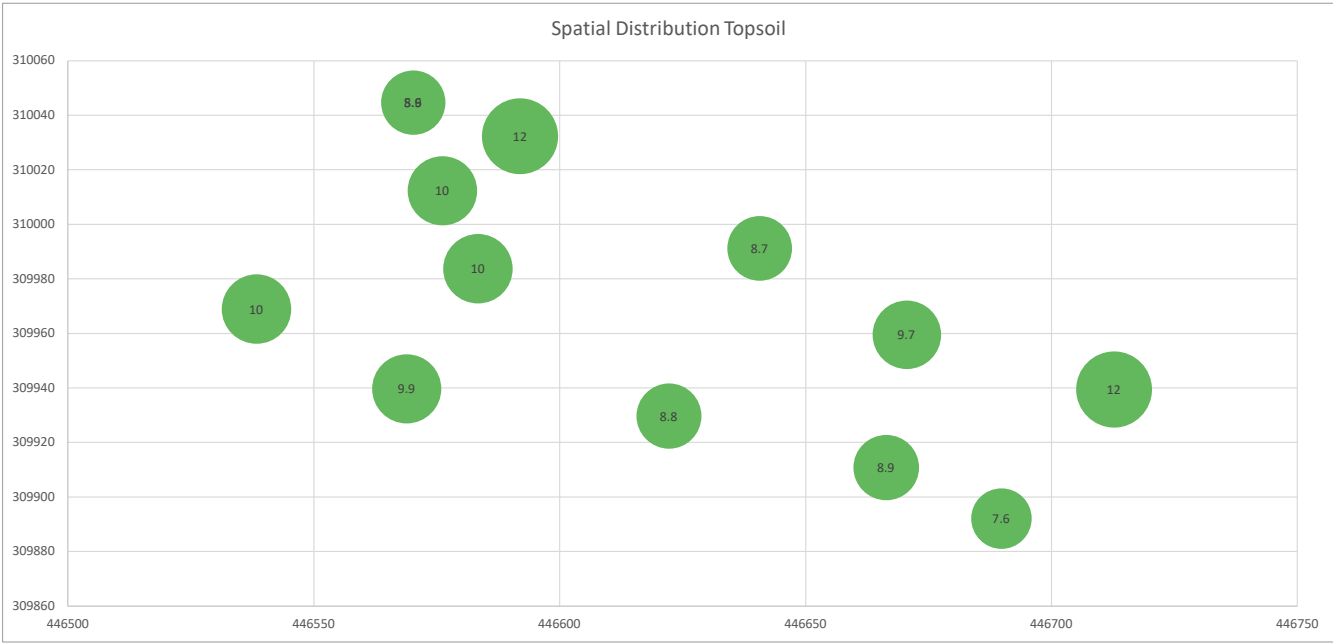
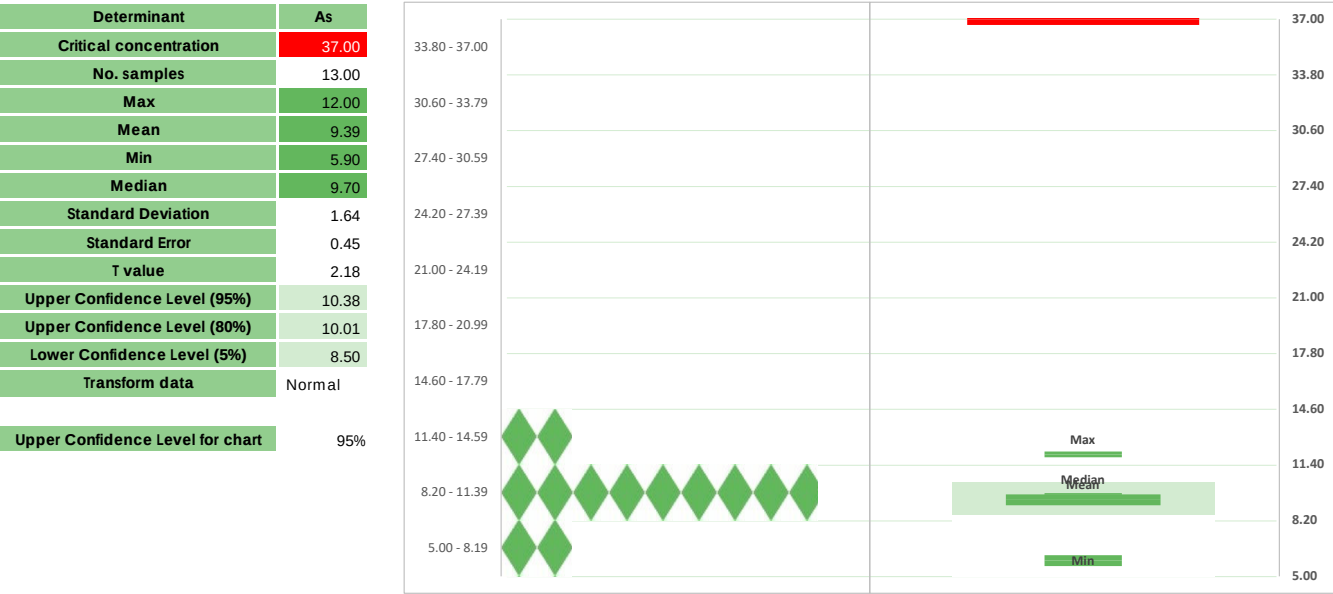
End of Report

Stanton Under Bardon

Job No: 4252
Engineer: ASw
Date: 23 August 2023



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



Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamination

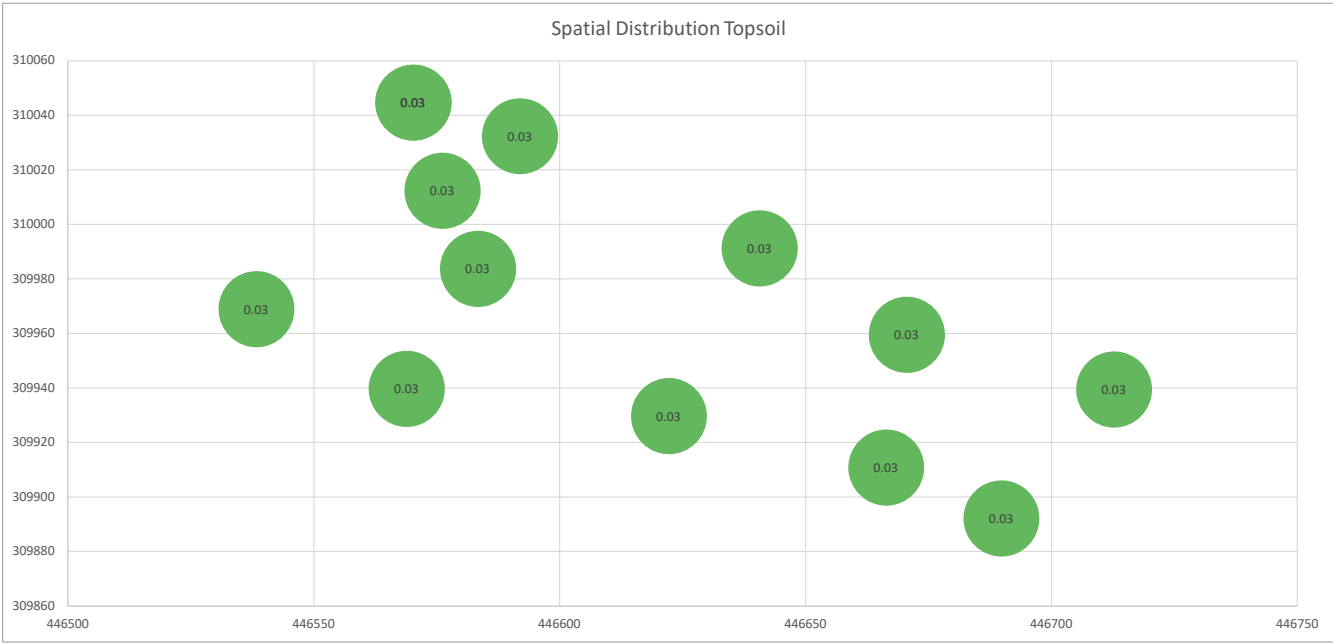
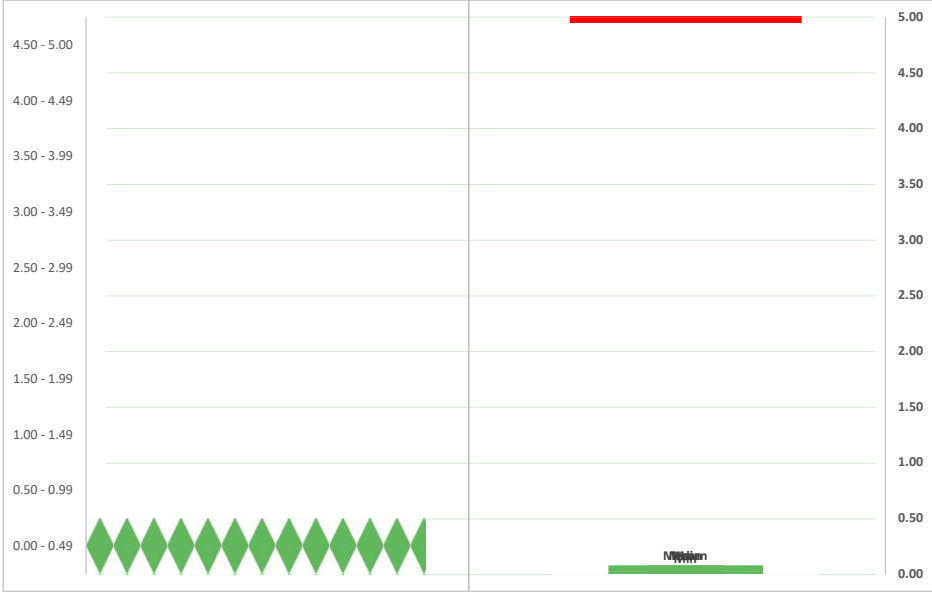
Stanton Under Bardon

Job No: 4252
Engineer: ASw
Date: 23 August 2023



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

Determinant	B(a)P
Critical concentration	5.00
No. samples	13.00
Max	0.03
Mean	0.03
Min	0.03
Median	0.03
Standard Deviation	0.00
Standard Error	0.00
T value	2.18
Upper Confidence Level (95%)	0.03
Upper Confidence Level (80%)	0.03
Lower Confidence Level (5%)	0.03
Transform data	Normal
Upper Confidence Level for chart	95%



Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamination

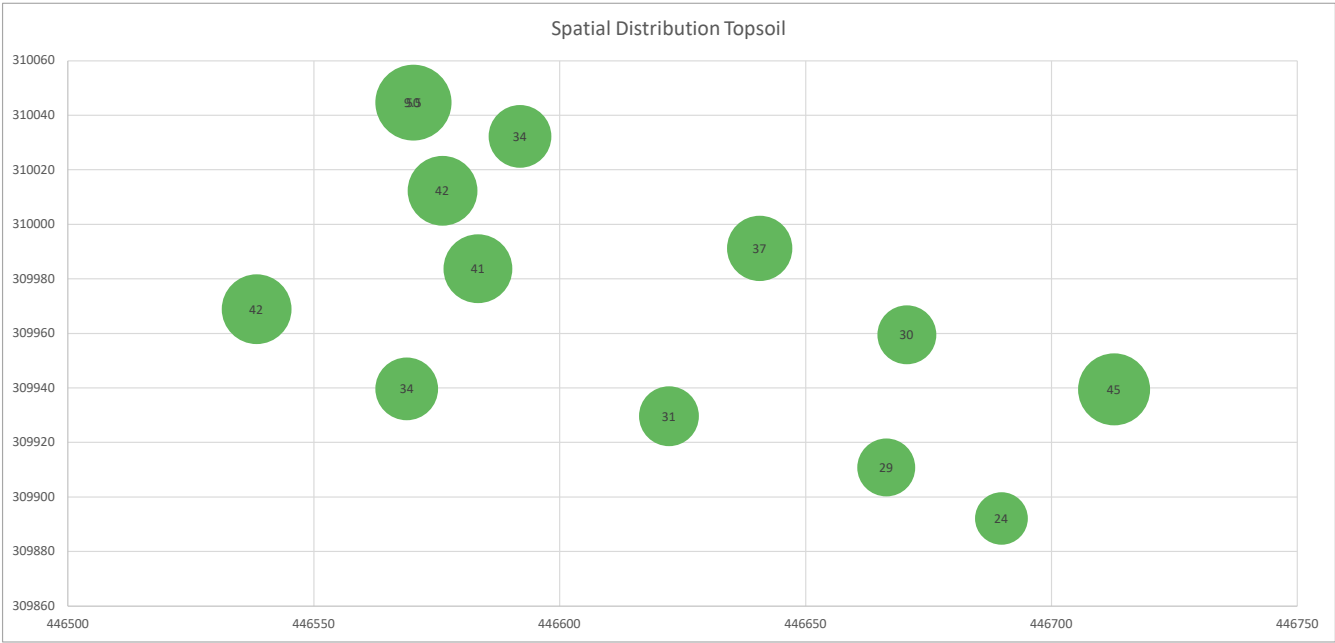
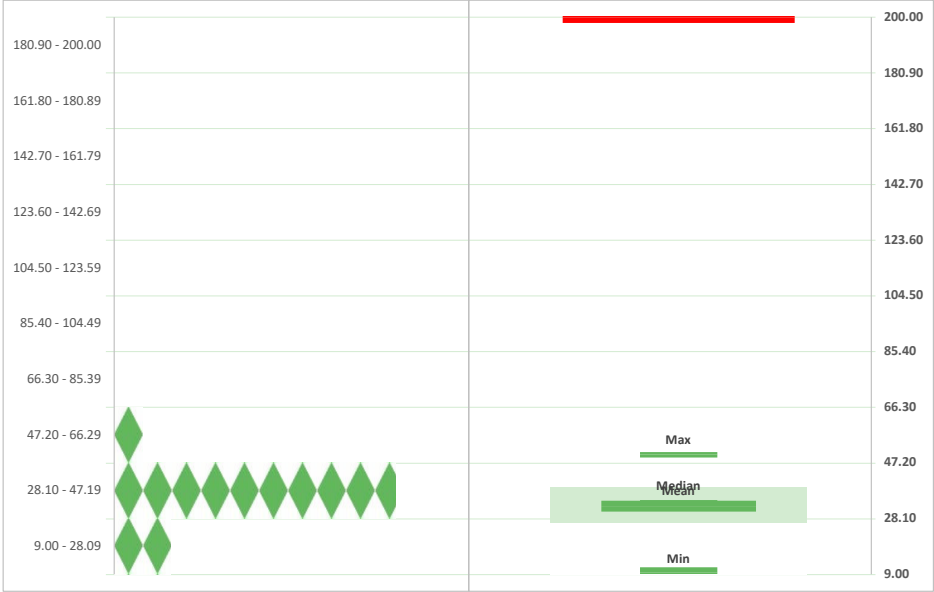
Stanton Under Bardon

Job No: 4252
Engineer: ASw
Date: 23 August 2023



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

Determinant	Pb
Critical concentration	200.00
No. samples	13.00
Max	50.00
Mean	32.37
Min	9.50
Median	34.00
Standard Deviation	10.45
Standard Error	2.90
T value	2.18
Upper Confidence Level (95%)	38.68
Upper Confidence Level (80%)	36.30
Lower Confidence Level (5%)	26.69
Transform data	Normal
Upper Confidence Level for chart	95%



Spatial distribution can show sampling clusters based on ground type it **does not** identify areas of contamination

Appendix I
Geotechnical Test Results



LABORATORY REPORT



Contract Number: PSL23/6098

Report Date: 14 August 2023

Client's Reference: 4252

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

For the attention of: Chris Ryan

Project Name: Stanton under Bardon

Date Received: 26/7/2023

Date Commenced: 26/7/2023

Date Completed: 09/08/2023

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

R Berriman
(Quality Manager)

S Royle
(Laboratory Manager)

L Knight
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Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
SA01	5	D	1.30		Brown slightly gravelly very sandy CLAY.
SA01	6	D&B	2.40		Brown gravelly very sandy CLAY.
TP08	2	D&B	0.80		Brown very gravelly very sandy CLAY.
TP08	3	D	1.50		Brown slightly gravelly sandy CLAY.
SA01	4	B	0.70		Brown very sandy clayey SAND & GRAVEL.
TP07	2	D&B	0.70		Brown very sandy clayey GRAVEL.
SA03	3	D	0.50		Brown slightly gravelly sandy CLAY.
SA04	3	D&B	0.60		Brown gravelly very sandy CLAY.
TP01	3	D	0.90		Brown slightly gravelly sandy CLAY.
TP04	2	D	0.80		Brown slightly gravelly sandy CLAY.
TP04	3	D	2.30		Brown slightly gravelly sandy CLAY.
TP05	2	D	1.00		Brown slightly gravelly sandy CLAY.
TP06	3	D	1.40		Brown slightly gravelly sandy CLAY.
TP07	3	D	2.70		Brown slightly gravelly sandy CLAY.
SA02	2	B	0.20		Brown TOPSOIL.
SA03	2	B	0.20		Brown TOPSOIL.
SA01	2	B	0.20		Brown TOPSOIL.
SA04	2	B	0.20		Brown TOPSOIL.
TP06	2	B	0.20		Brown TOPSOIL.



Stanton under Bardon

Contract No:

PSL23/6098

Client Ref:

4252

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
SA01	5	D	1.30		16			25	14	11	97	Low Plasticity CL
SA01	6	D&B	2.40		12.0			30	15	15	72	Low Plasticity CL
TP08	2	D&B	0.80		28			34	17	17	78	Low Plasticity CL
TP08	3	D	1.50		30			45	22	23	98	Intermediate Plasticity CI
SA03	3	D	0.50		17			39	19	20	96	Intermediate Plasticity CI
SA04	3	D&B	0.60		19			32	16	16	81	Low Plasticity CL
TP01	3	D	0.90		21			48	23	25	94	Intermediate Plasticity CI
TP04	2	D	0.80		20			50	23	27	96	High Plasticity CH
TP04	3	D	2.30		16			41	21	20	98	Intermediate Plasticity CI
TP05	2	D	1.00		21			57	25	32	96	High Plasticity CH
TP06	3	D	1.40		17			44	22	22	94	Intermediate Plasticity CI
TP07	3	D	2.70		16			46	22	24	95	Intermediate Plasticity CI

SYMBOLS : NP : Non Plastic

* : Liquid Limit and Plastic Limit Wet Sieved.



Stanton under Bardon

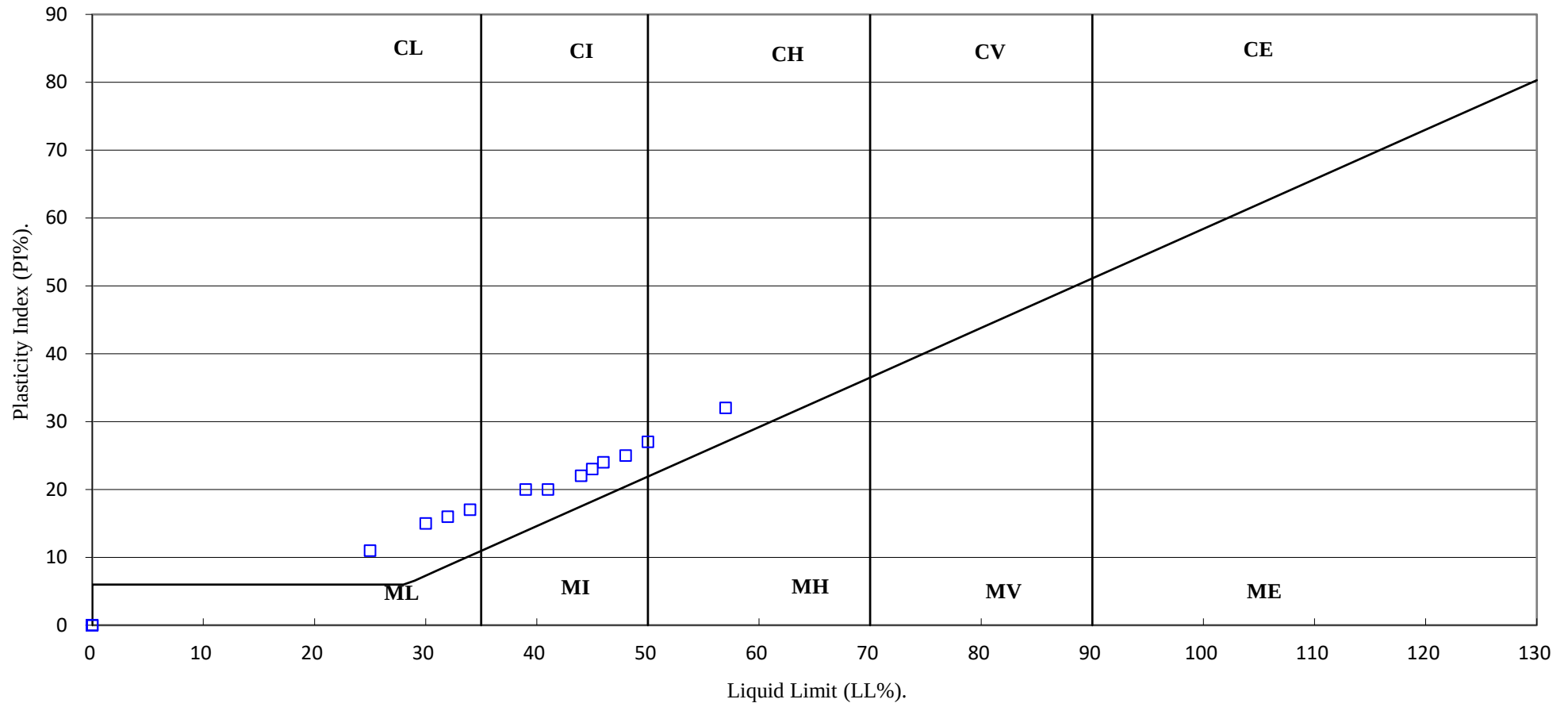
Contract No:

PSL23/6098

Client Ref:

4252

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



Stanton under Bardon

Contract No:

PSL23/6098

Client Ref:

4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

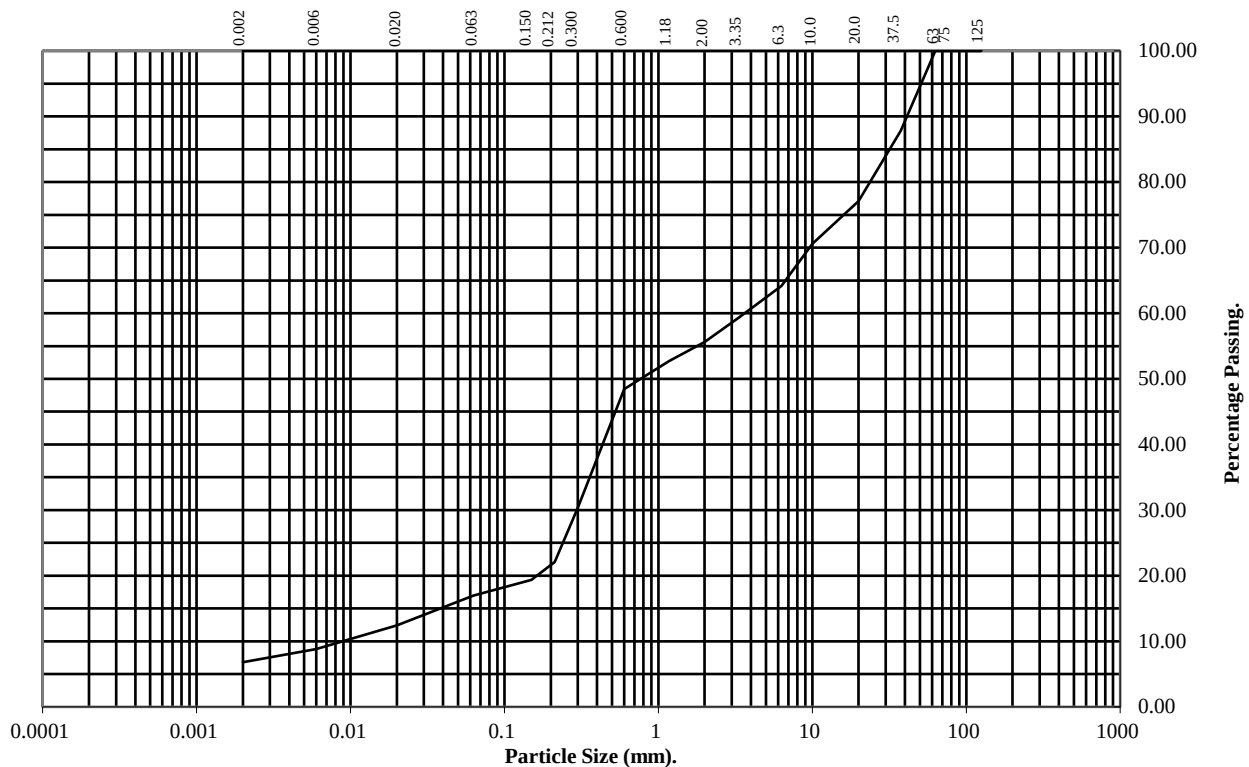
Hole Number: SA01

Top Depth (m): 0.70

Sample Number: 4

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	88
20	77
10	71
6.3	64
3.35	59
2	56
1.18	53
0.6	48
0.3	30
0.212	22
0.15	19
0.063	17

Particle Diameter	Percentage Passing
0.02	12
0.006	9
0.002	7

Soil Fraction	Total Percentage
Cobbles	0
Gravel	44
Sand	39
Silt	10
Clay	7

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

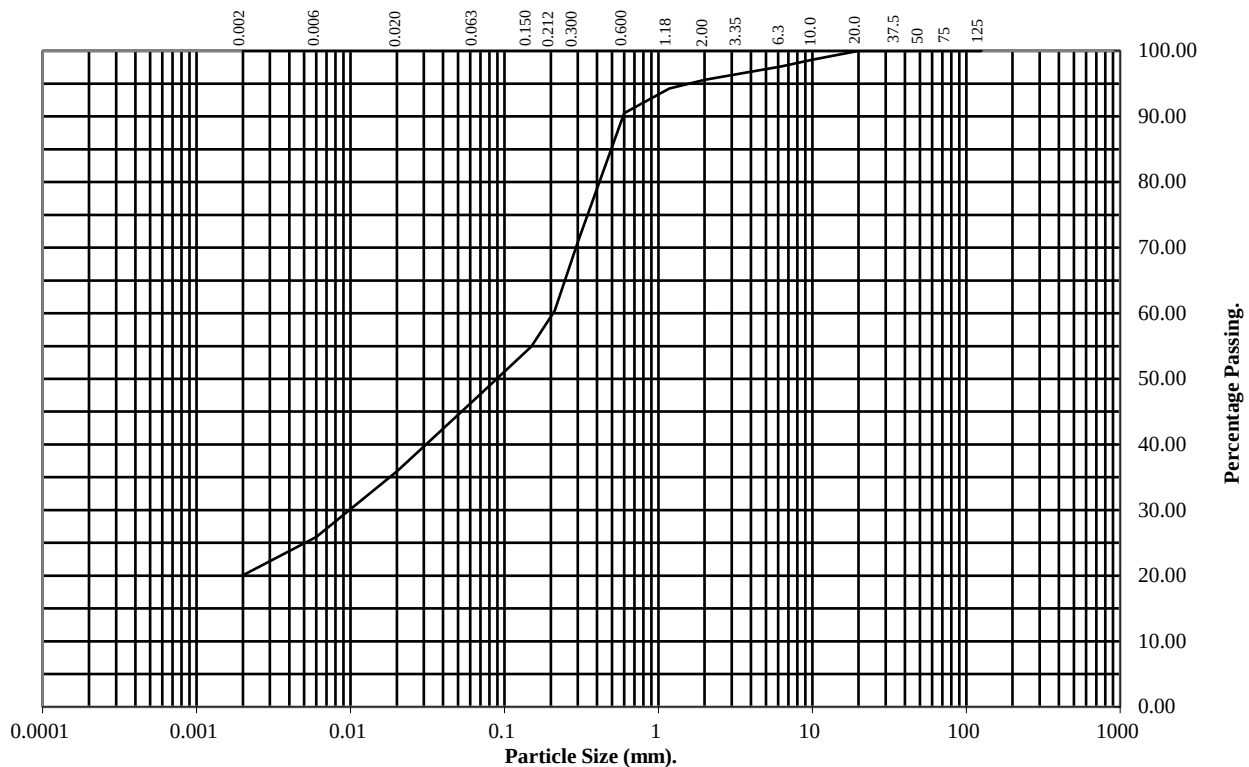
Hole Number: SA01

Top Depth (m): 0.20

Sample Number: 2

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	99
6.3	98
3.35	97
2	96
1.18	94
0.6	90
0.3	71
0.212	60
0.15	55
0.063	47

Particle Diameter	Percentage Passing
0.02	36
0.006	26
0.002	20

Soil Fraction	Total Percentage
Cobbles	0
Gravel	4
Sand	49
Silt	27
Clay	20

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

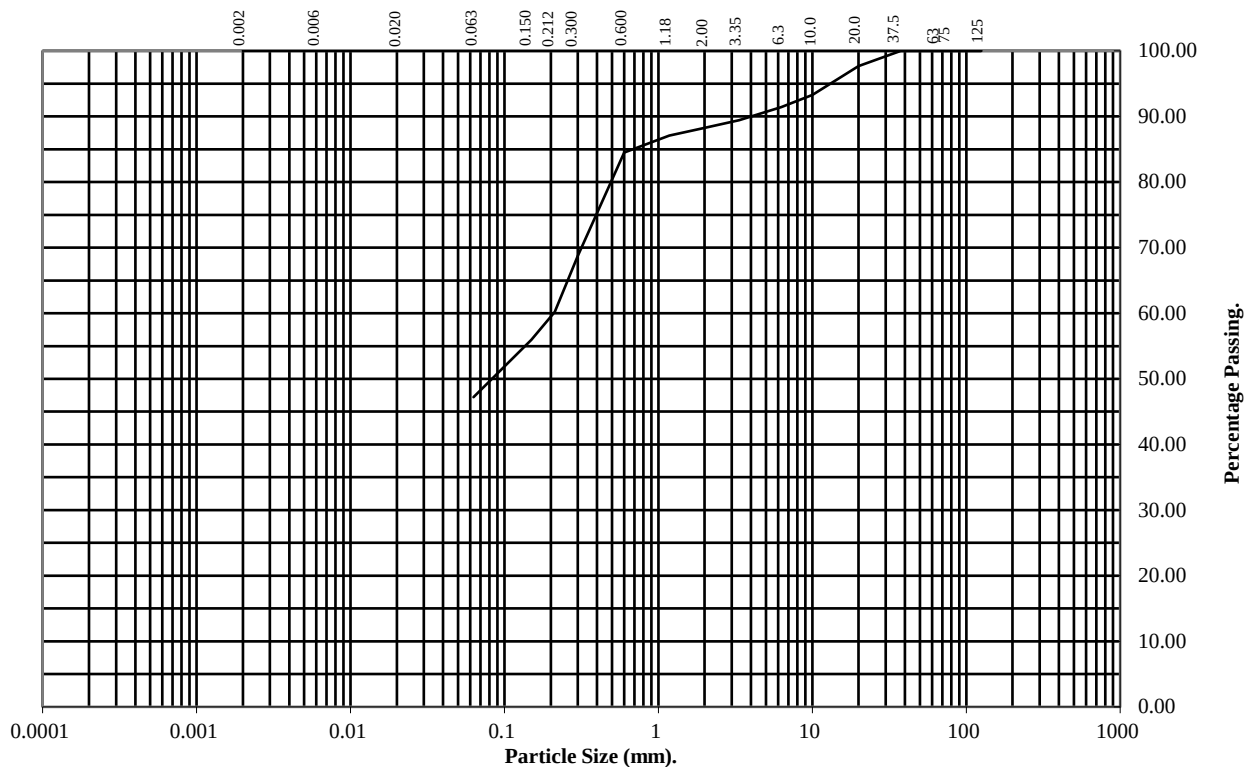
Hole Number: SA01

Top Depth (m): 2.40

Sample Number: 6

Base Depth(m):

Sample Type: D&B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	98
10	93
6.3	91
3.35	89
2	88
1.18	87
0.6	85
0.3	69
0.212	60
0.15	56
0.063	47

Soil Fraction	Total Percentage
Cobbles	0
Gravel	12
Sand	41
Silt/Clay	47

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

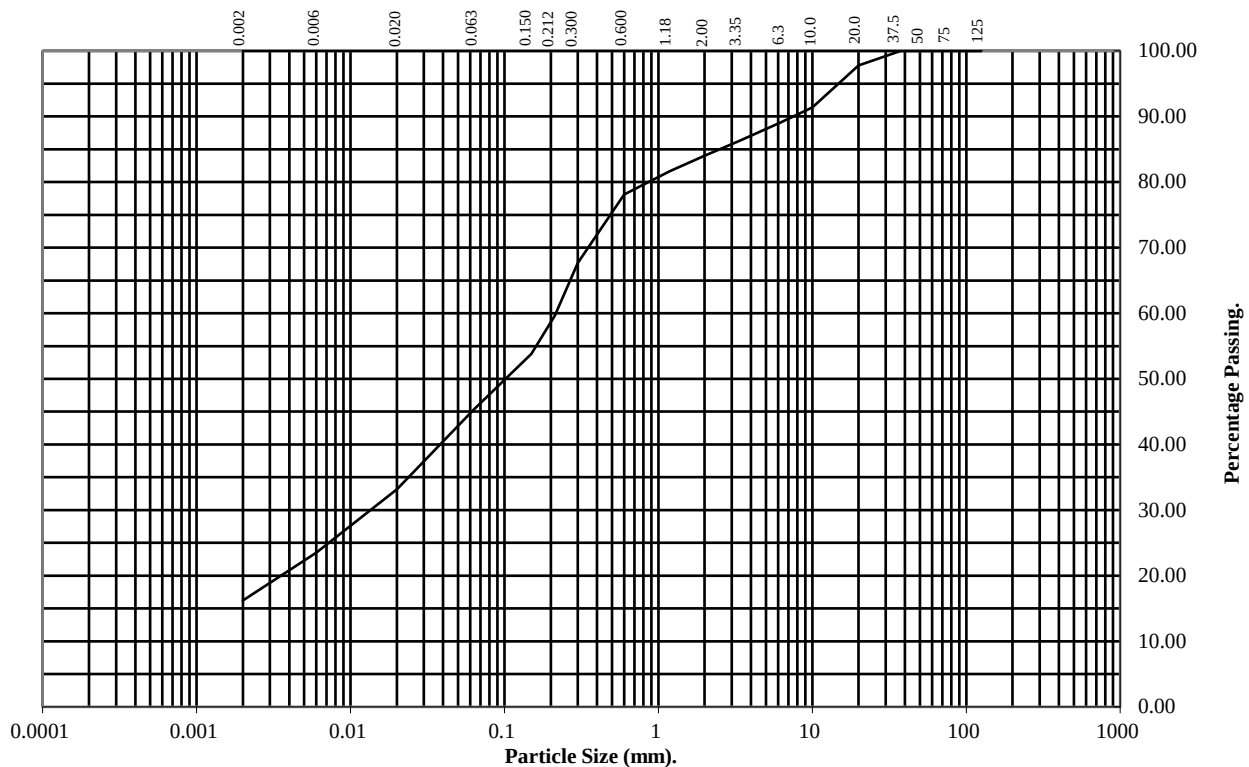
Hole Number: SA02

Top Depth (m): 0.20

Sample Number: 2

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	98
10	91
6.3	89
3.35	86
2	84
1.18	82
0.6	78
0.3	68
0.212	60
0.15	54
0.063	45

Particle Diameter	Percentage Passing
0.02	33
0.006	23
0.002	16

Soil Fraction	Total Percentage
Cobbles	0
Gravel	16
Sand	39
Silt	29
Clay	16

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

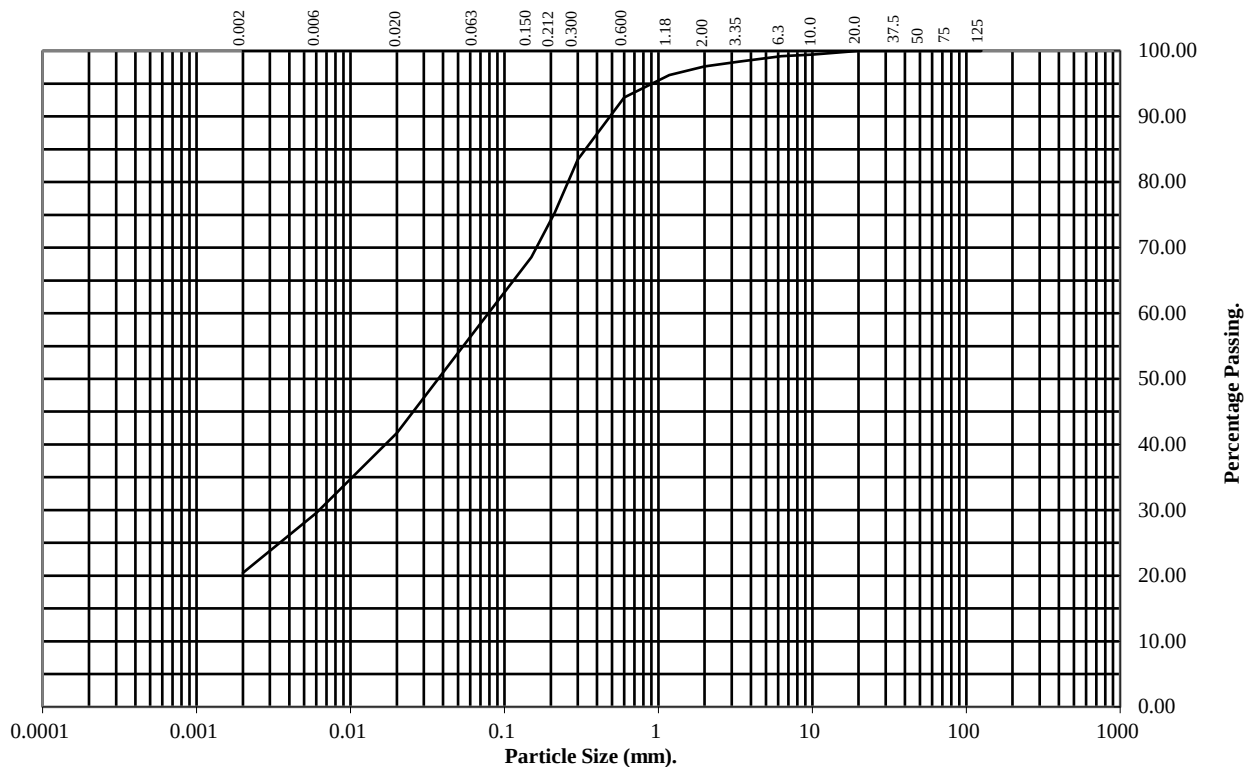
Hole Number: SA03

Top Depth (m): 0.20

Sample Number: 2

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	100
10	99
6.3	99
3.35	98
2	98
1.18	96
0.6	93
0.3	83
0.212	75
0.15	69
0.063	57

Particle Diameter	Percentage Passing
0.02	42
0.006	30
0.002	20

Soil Fraction	Total Percentage
Cobbles	0
Gravel	2
Sand	41
Silt	37
Clay	20

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

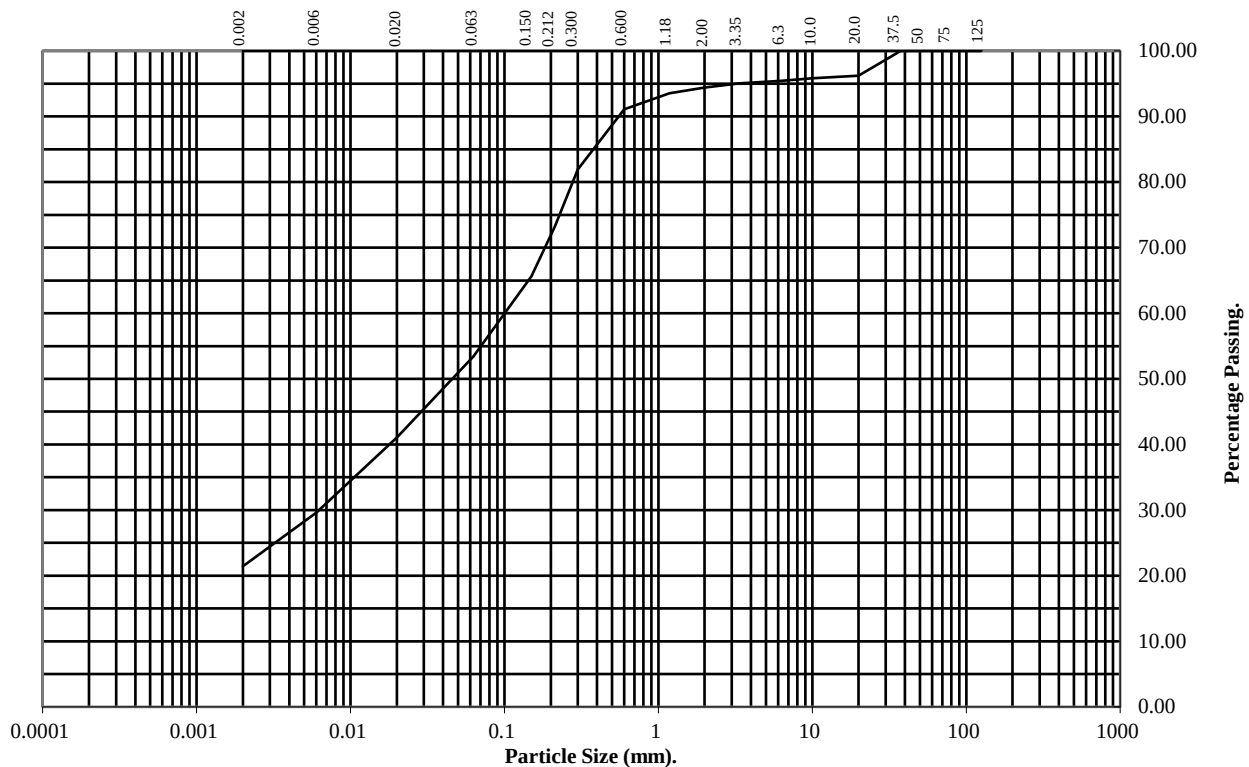
Hole Number: SA04

Top Depth (m): 0.20

Sample Number: 2

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	96
10	96
6.3	95
3.35	95
2	94
1.18	94
0.6	91
0.3	82
0.212	73
0.15	66
0.063	53

Particle Diameter	Percentage Passing
0.02	41
0.006	30
0.002	21

Soil Fraction	Total Percentage
Cobbles	0
Gravel	6
Sand	41
Silt	32
Clay	21

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

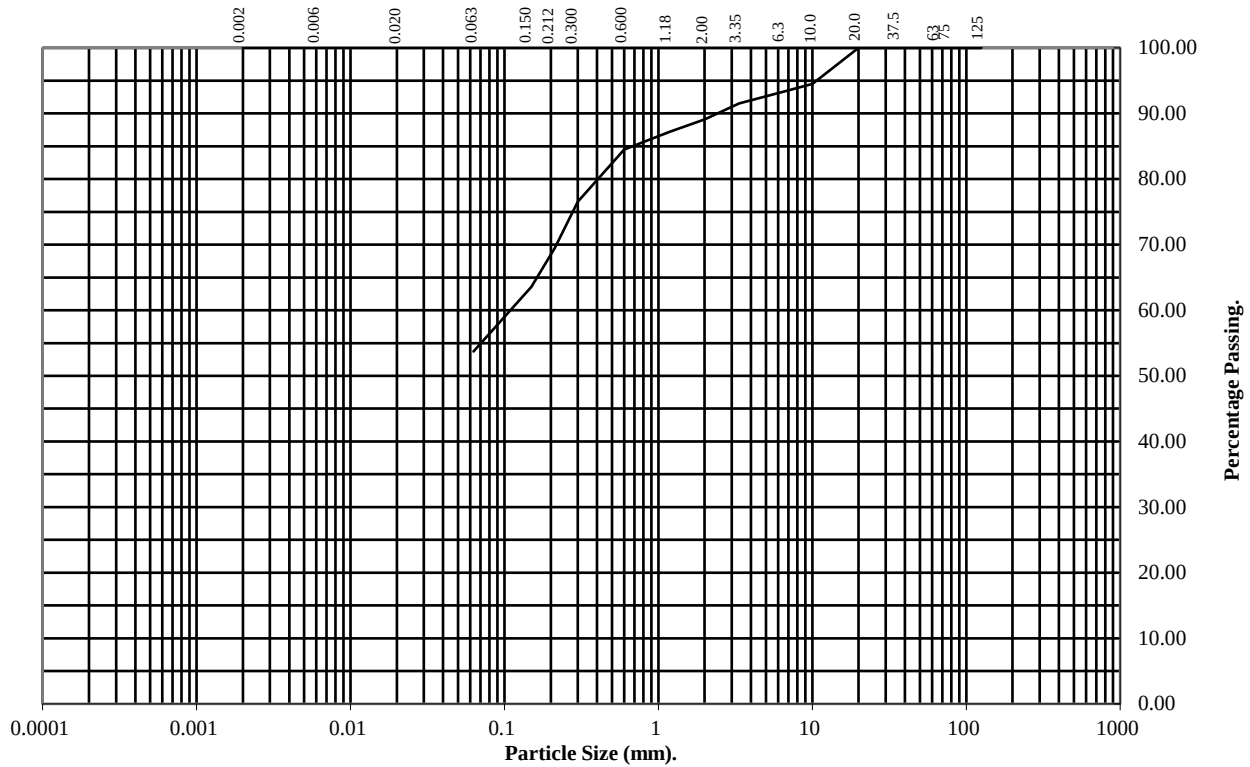
Hole Number: SA04

Top Depth (m): 0.60

Sample Number: 3

Base Depth(m):

Sample Type: D&B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	95
6.3	93
3.35	92
2	89
1.18	87
0.6	85
0.3	77
0.212	69
0.15	64
0.063	54

Soil Fraction	Total Percentage
Cobbles	0
Gravel	11
Sand	35
Silt/Clay	54

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:

PSL23/6098

Client Ref:

4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

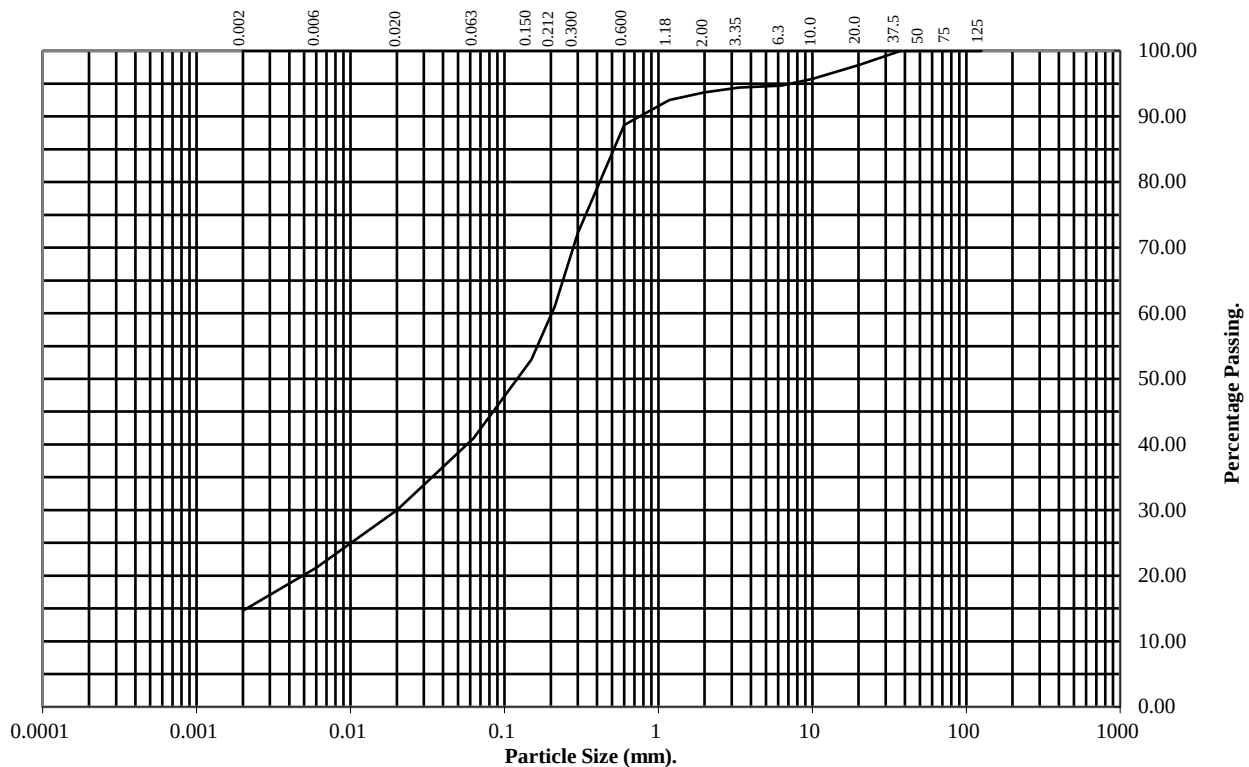
Hole Number: TP06

Top Depth (m): 0.20

Sample Number: 2

Base Depth(m):

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
50	100
37.5	100
20	98
10	96
6.3	95
3.35	94
2	94
1.18	92
0.6	89
0.3	72
0.212	61
0.15	53
0.063	41

Particle Diameter	Percentage Passing
0.02	30
0.006	21
0.002	15

Soil Fraction	Total Percentage
Cobbles	0
Gravel	6
Sand	53
Silt	26
Clay	15

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

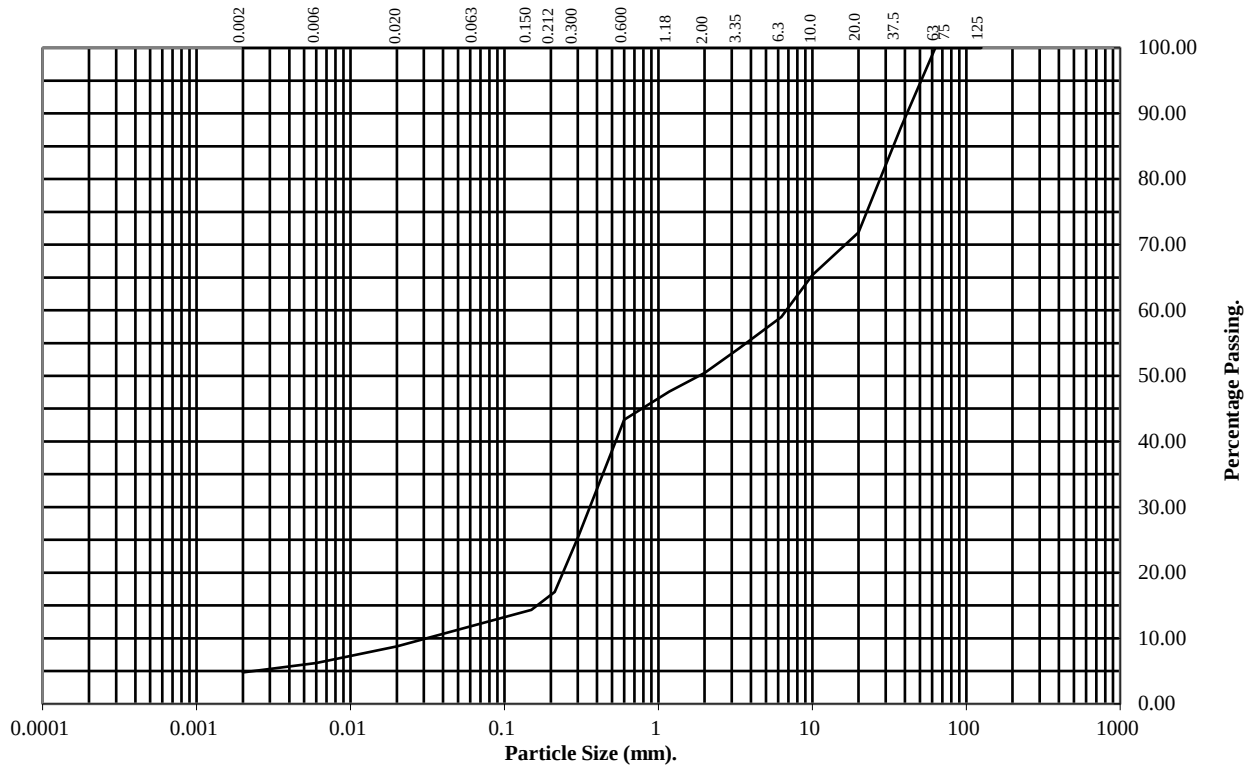
Hole Number: TP07

Top Depth (m): 0.70

Sample Number: 2

Base Depth(m):

Sample Type: D&B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	88
20	72
10	65
6.3	59
3.35	54
2	50
1.18	48
0.6	43
0.3	25
0.212	17
0.15	14
0.063	12

Particle Diameter	Percentage Passing
0.02	9
0.006	6
0.002	5

Soil Fraction	Total Percentage
Cobbles	0
Gravel	50
Sand	38
Silt	7
Clay	5

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

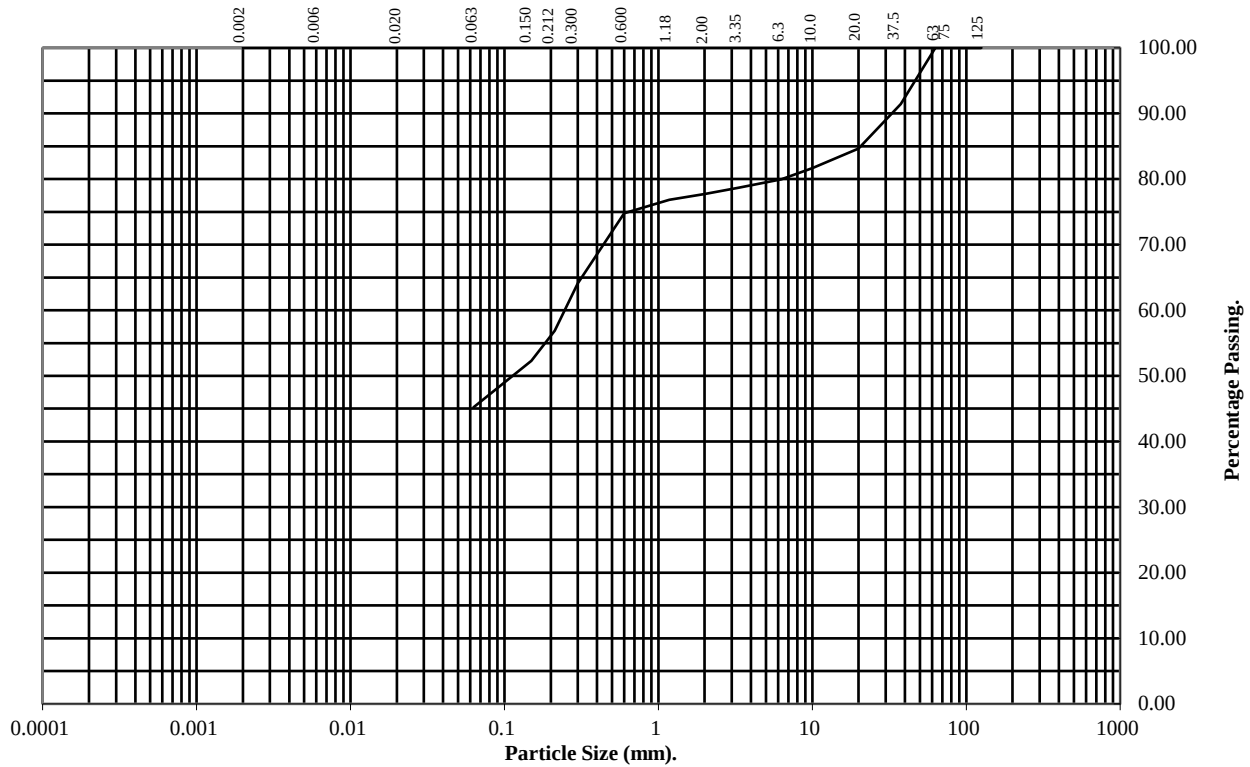
Hole Number: TP08

Top Depth (m): 0.80

Sample Number: 2

Base Depth(m):

Sample Type: D&B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	91
20	85
10	82
6.3	80
3.35	79
2	78
1.18	77
0.6	75
0.3	64
0.212	57
0.15	52
0.063	45

Soil Fraction	Total Percentage
Cobbles	0
Gravel	22
Sand	33
Silt/Clay	45

Remarks:

See Summary of Soil Descriptions



Stanton under Bardon

Contract No:
PSL23/6098
Client Ref:
4252



4161



7 - 11 Harding Street
Leicester
LE1 4DH

Professional Soils Laboratory

5/7 Hexthorpe Road

Hexthorpe

Doncaster

DN4 0AR

Analytical Test Report: L23/04151/PSL - 23-36139Your Project Reference: **PSL23/6098 Stanton Under Bardon**

Your Order Number: PSL23/6098

Samples Received / Instructed: 07/08/2023 / 07/08/2023

Report Issue Number: 1

Sample Tested: 07/08 to 14/08/2023

Samples Analysed: 12 soil samples

Report issued: 14/08/2023

Signed

James Gane

Analytical Services Manager

CTS Group

Notes:**General**

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

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

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

Moisture Content is reported as a percentage of the dry mass of soil, this calculation is in accordance with BS1377, Part 2, 1990, Clause 3.2

Where specification limits are included these are for guidance only. Where a measured value has been highlighted this is not implying acceptance or failure and certainty of measurement values have not been taken into account.**Uncertainty of measurement values are available on request.**

Samples were supplied by customer, results apply to the samples as received.

Deviating Samples

On receipt samples are compared against our sample holding and handling protocols, where any deviations have been noted these are reported on our deviating sample page (if present)

Accreditation Key

UKAS = UKAS Accreditation, MCERTS = MCERTS Accreditation, u = Unaccredited

MCERTS Accreditation only covers the SAND, CLAY and LOAM matrices

Date of Issue: 26.07.23

Issued by: J. Gane

Issue No: 4

Rev No: 2



L23/04151/PSL - 23-36139

Project Reference - PSL23/6098 Stanton Under Bardon

Analytical Test Results - Soil

Lab Reference			308296	308297	308298	308299	308300	308301	308302
Client Sample ID			-	-	-	-	-	-	-
Client Sample Location			SA01	TP08	TP08	TP08	SA01	TP07	SA03
Client Sample Type			D	D	D	D	D	D	D
Client Sample Number			-	-	-	-	-	-	-
Depth - Top (m)			2.40	0.80	1.50	2.30	0.60	0.70	0.50
Depth - Bottom (m)			2.40	0.80	1.50	2.30	0.60	0.70	0.50
Date of Sampling			-	-	-	-	-	-	-
Time of Sampling			-	-	-	-	-	-	-
Sample Matrix			Clay	Clay	Clay	Sand	Other	Sand	Clay
Determinant	Units	Accreditation							
pH	pH Units	MCERTS	8.4	7.6	7.2	6.8	7.2	7.2	7.1
Sulphate (Water soluble as SO ₄)	(mg/l)	u	< 10	< 10	12	97	< 10	< 10	11

L23/04151/PSL - 23-36139

Project Reference - PSL23/6098 Stanton Under Bardon

Analytical Test Results - Soil

Lab Reference		308303	308304	308305	308306	308307
Client Sample ID		-	-	-	-	-
Client Sample Location		TP01	TP04	TP05	TP06	TP07
Client Sample Type		D	D	D	D	D
Client Sample Number		-	-	-	-	-
Depth - Top (m)		0.90	0.80	1.00	1.40	2.70
Depth - Bottom (m)		0.90	0.80	1.00	1.40	2.70
Date of Sampling		-	-	-	-	-
Time of Sampling		-	-	-	-	-
Sample Matrix		Clay	Clay	Clay	Clay	Clay
Determinant	Units Accreditation					
pH	pH Units MCERTS	7.7	7.8	7.6	8.6	8.8
Sulphate (Water soluble as SO ₄)	(mg/l) u	26	< 10	< 10	19	< 10



4161



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Leicester
LE1 4DH

L23/04151/PSL - 23-36139

Project Reference - PSL23/6098 Stanton Under Bardon

Sample Descriptions

Lab Reference	Client Sample ID	Client Sample Location	Client Sample Type	Client Sample Number	Description	Moisture Content (%)	Stone Content (%)	Passing 2mm test sieve (%)
308296	-	SA01	D	-	Reddish brown gravelly sandy clay	-	-	39
308297	-	TP08	D	-	Greyish brown gravelly sandy clay	-	-	65
308298	-	TP08	D	-	Greyish brown sandy clay	-	-	68
308299	-	TP08	D	-	Greyish brown clayey sand	-	-	82
308300	-	SA01	D	-	Brown slightly clayey silt	-	-	63
308301	-	TP07	D	-	Brown gravelly silty sand	-	-	36
308302	-	SA03	D	-	Mottled brown black silty clay with occasional slag	-	-	36
308303	-	TP01	D	-	Greyish reddish brown silty clay	-	-	46
308304	-	TP04	D	-	Brown slightly gravelly silty clay with rare rootlets	-	-	44
308305	-	TP05	D	-	Reddish brown slightly gravelly silty clay	-	-	41
308306	-	TP06	D	-	Mottled grey brown gravelly silty clay	-	-	50
308307	-	TP07	D	-	Reddish brown gravelly silty clay	-	-	46



4161



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Leicester
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L23/04151/PSL - 23-36139

Project Reference - PSL23/6098 Stanton Under Bardon

Sample Comments

Lab Reference	Client Sample ID	Client Sample Location	Client Sample Type	Client Sample Number	Comments
308296	-	SA01	D	-	
308297	-	TP08	D	-	
308298	-	TP08	D	-	
308299	-	TP08	D	-	
308300	-	SA01	D	-	
308301	-	TP07	D	-	
308302	-	SA03	D	-	
308303	-	TP01	D	-	
308304	-	TP04	D	-	
308305	-	TP05	D	-	
308306	-	TP06	D	-	
308307	-	TP07	D	-	



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Leicester
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L23/04151/PSL - 23-36139

Project Reference - PSL23/6098 Stanton Under Bardon

Analysis Methodologies

Test Code	Test Name / Reference	Sample condition for analysis	Sample Preparation	Test Details
ANIONSS	MS - CL - Anions by Aquakem (2:1Extract)	Oven dried	Passing 2mm test sieve	Determination of Anions (inc Sulphate, chloride etc.) in soils by Aquakem. Analysis is based on a 2:1 water to soil extraction ratio
PHS	MS - CL - pH in Soils	As received	Passing 10mm test sieve	Determination of pH in soils using a pH probe (using a 1:3 soil to water extraction)
SAMPLEPREP	MS - CL - Sample Preparation	-	-	Preparation of samples (including determination of moisture content) to allow for subsequent analysis



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L23/04151/PSL - 23-36139

Project Reference - PSL23/6098 Stanton Under Bardon

Sample Deviations

Deviations are listed below against each sample and associated test method, where deviation(s) are noted it means data may not be representative of the sample at the time of sampling and it is possible that results provided may be compromised.

Observations on receipt

A - No date of sampling provided

C - Received in inappropriate container

H - Contains headspace

T - Temperature on receipt exceeds storage temperature

R - Date of sampling to receipt insufficient to allow analysis to be completed without deviation, Please note this is only a deviation if 'X' is also recorded against the sample

Observations whilst in laboratory

X - Exceeds sampling to extraction or analysis timescales

Lab Reference	Client Sample ID	Client Sample Location	Client Sample Type	Client Sample Number	Test	Deviations
308296	-	SA01	D	-		A
308297	-	TP08	D	-		A
308298	-	TP08	D	-		A
308299	-	TP08	D	-		A
308300	-	SA01	D	-		A
308301	-	TP07	D	-		A
308302	-	SA03	D	-		A
308303	-	TP01	D	-		A
308304	-	TP04	D	-		A
308305	-	TP05	D	-		A
308306	-	TP06	D	-		A
308307	-	TP07	D	-		A

Appendix J

Soakaway Infiltration Calculations

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991



Client:	Caddick Land
Engineer	L Whiteley
Job Name:	Stanton under Bardon
Job No.:	4252

Date:	18/07/2023
Trial Pit No.	SA01
Test No.	1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:23	0	1.43	1430
10:24	1	1.44	1440
10:25	2	1.44	1440
10:26	3	1.45	1450
10:27	4	1.45	1450
10:28	5	1.46	1460
10:35	12	1.46	1460
10:56	33	1.46	1460
11:22	59	1.46	1460
12:12	109	1.46	1460
13:02	159	1.46	1460
13:37	194	1.46	1460

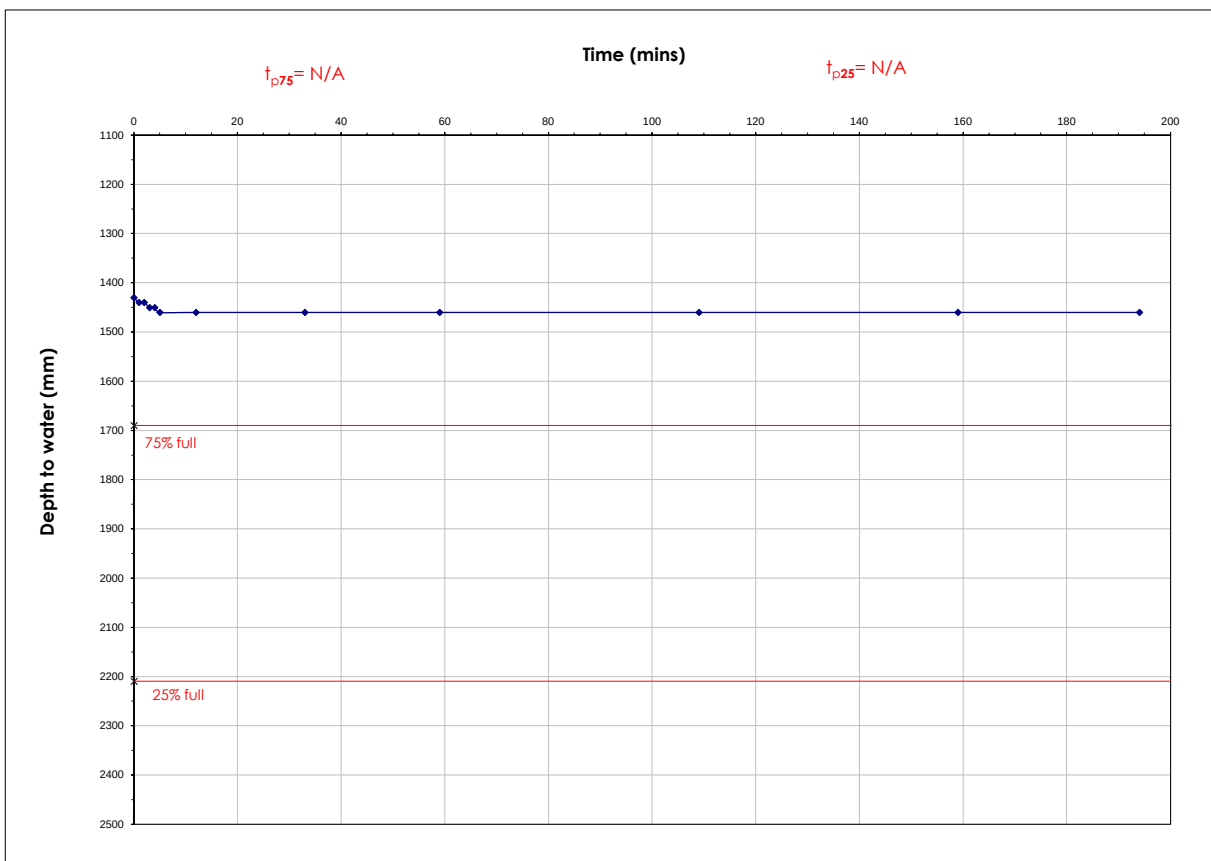
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	1.90	1900
Width	=	0.60	600
Depth	=	2.47	2470

Effective Depth (% full)		(mm)	(m)
0.25	=	2210	2.21
0.50	=	1950	1.95
0.75	=	1690	1.69

Depth at start of test (mm)	=	1430
Depth at end of test (mm)	=	1460

Base area of pit	=	1.14
C_{p50} - 50% internal surface area inc. base	=	3.74
V_{p75-25} - Volume 75 - 25%	=	0.5928

Read from the graph:		
t_{p75} (min)	=	N/A
t_{p25} (min)	=	N/A



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

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991



Client:	Caddick Land
Engineer	L Whiteley
Job Name:	Stanton under Bardon
Job No.:	4252

Date:	18/07/2023
Trial Pit No.	SA02
Test No.	1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:14	0	1.50	1500
10:15	1	1.50	1500
10:16	2	1.50	1500
10:17	3	1.50	1500
10:18	4	1.50	1500
10:19	5	1.50	1500
10:29	15	1.50	1500
10:54	40	1.50	1500
11:20	66	1.50	1500
12:10	116	1.50	1500
12:59	165	1.50	1500
13:30	196	1.50	1500

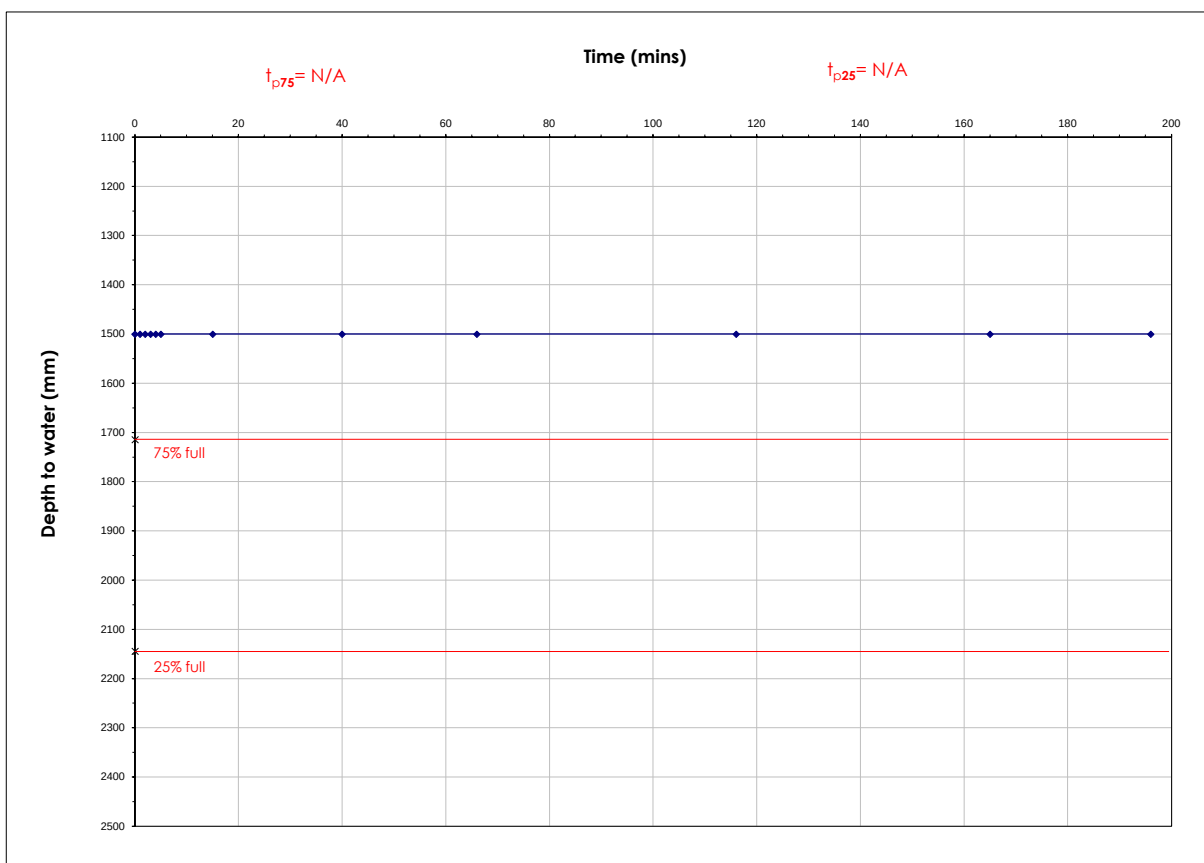
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	1.70	1700
Width	=	0.60	600
Depth	=	2.36	2360

Effective Depth (% full)		(mm)	(m)
0.25	=	2145	2.15
0.50	=	1930	1.93
0.75	=	1715	1.72

Depth at start of test (mm)	=	1500
Depth at end of test (mm)	=	1500

Base area of pit	=	1.02
C_{p50} - 50% internal surface area inc. base	=	2.998
V_{p75-25} - Volume 75 - 25%	=	0.4386

Read from the graph:		
t_{p75} (min)	=	N/A
t_{p25} (min)	=	N/A



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

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991



Client:	Caddick Land
Engineer	L Whiteley
Job Name:	Stanton under Bardon
Job No.:	4252

Date:	18/07/2023
Trial Pit No.	SA03
Test No.	1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
10:45	0	1.31	1310
10:46	1	1.31	1310
10:47	2	1.31	1310
10:48	3	1.32	1320
10:49	4	1.32	1320
10:50	5	1.32	1320
11:01	16	1.32	1320
11:16	31	1.32	1320
11:45	60	1.32	1320
12:05	80	1.32	1320
12:56	131	1.32	1320
13:50	185	1.32	1320

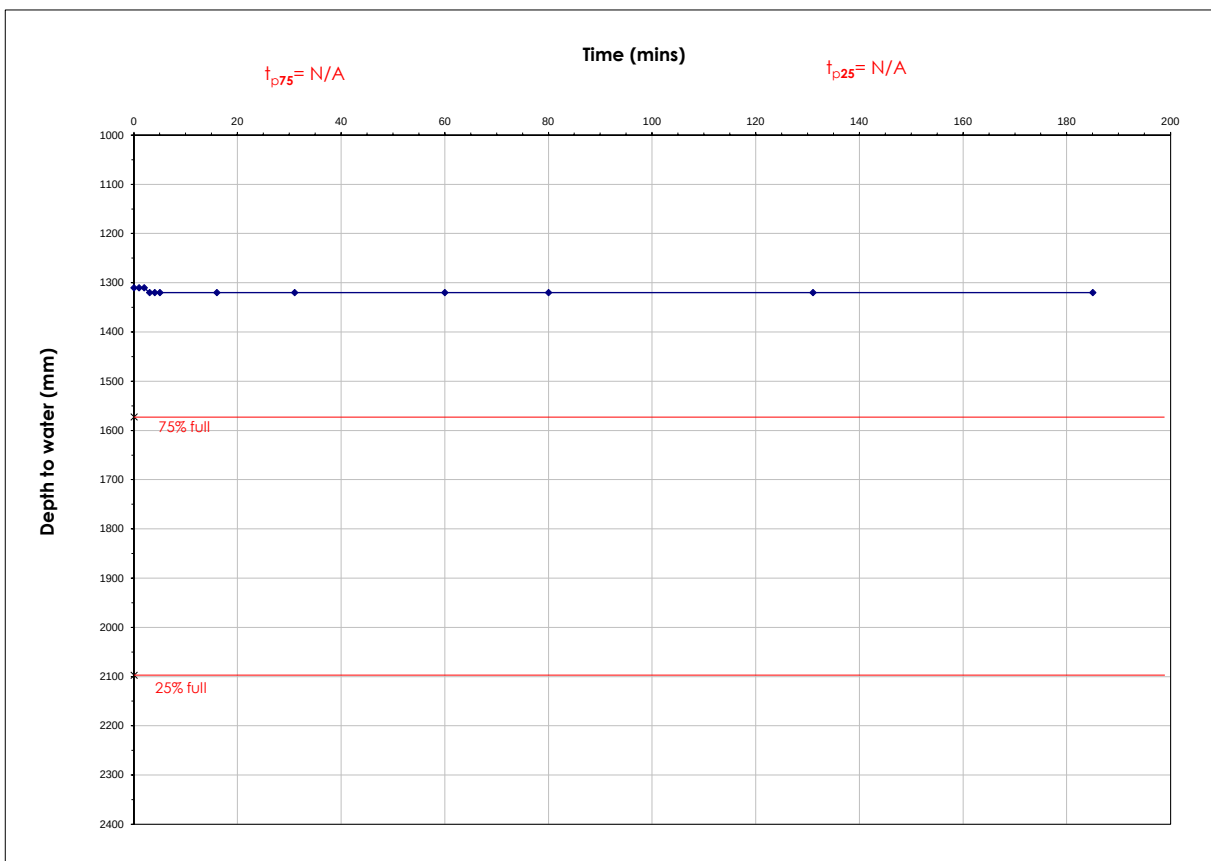
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	1.80	1800
Width	=	0.60	600
Depth	=	2.36	2360

Effective Depth (% full)		(mm)	(m)
0.25	=	2097.5	2.10
0.50	=	1835	1.84
0.75	=	1572.5	1.57

Depth at start of test (mm)	=	1310
Depth at end of test (mm)	=	1320

Base area of pit	=	1.08
C_{p50} - 50% internal surface area inc. base	=	3.6
V_{p75-25} - Volume 75 - 25%	=	0.567

Read from the graph:		
t_{p75} (min)	=	N/A
t_{p25} (min)	=	N/A



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

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991



Client:	Caddick Land
Engineer	L Whiteley
Job Name:	Stanton under Bardon
Job No.:	4252

Date:	18/07/2023
Trial Pit No.	SA04
Test No.	1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
11:07	0	1.50	1500
11:08	1	1.50	1500
11:09	2	1.50	1500
11:10	3	1.50	1500
11:11	4	1.50	1500
11:12	5	1.50	1500
11:18	11	1.50	1500
11:30	23	1.50	1500
12:07	60	1.50	1500
12:54	107	1.50	1500
14:07	180	1.50	1500

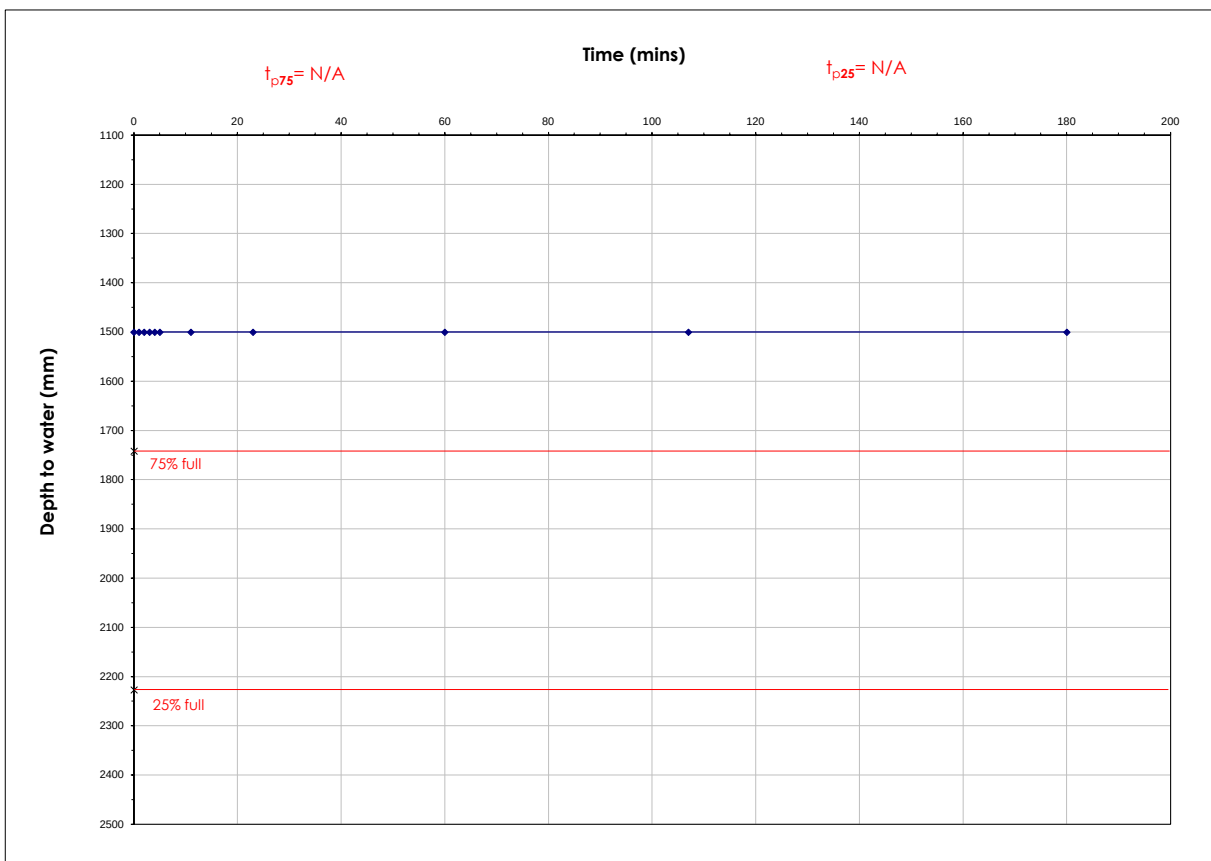
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	1.75	1750
Width	=	0.65	650
Depth	=	2.47	2470

Effective Depth (% full)		(mm)	(m)
0.25	=	2227.5	2.23
0.50	=	1985	1.99
0.75	=	1742.5	1.74

Depth at start of test (mm)	=	1500
Depth at end of test (mm)	=	1500

Base area of pit	=	1.1375
C_{p50} - 50% internal surface area inc. base	=	3.4655
V_{p75-25} - Volume 75 - 25%	=	0.5516875

Read from the graph:		
t_{p75} (min)	=	N/A
t_{p25} (min)	=	N/A



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