



Report
Title:

Geo-Environmental Site Investigation

Project
Name:

Land at Arlesey Road, Ickleford



Report
Reference:

BRD4359-OR2-A

Date:

February 2024

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REPORT CONTROL SHEET

REPORT TITLE	GEO-ENVIRONMENTAL SITE INVESTIGATION
PROJECT	LAND AT ARLESEY ROAD, ICKLEFORD
CLIENT	PETER DAVID HOMES

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
BRD4359-OR2-A	First Issue	26/02/2024	R Davies & A Leon	B Devonshire

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Geotechnical and Environmental Services

- Ground Investigation
- Japanese Knotweed Removal
- Soil, Water and Gas Testing
- Contamination Assessment
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Geo-Environmental Site Investigation
Land at Arlesey Road, Ickleford
BRD4359-OR2-A Ickleford SI

REPORT LAYOUT

This report is divided into the following four sections: Summary Report, Technical Report, Supporting Information and Appendices.

SUMMARY REPORT

This expanded executive summary provides the main findings of the work undertaken in brief non-technical language. This section provides an overview of the key outcomes for the benefit of non-specialists and concludes with the main recommendations. This section should only be relied upon in the context of the whole report and the Technical Report should be referred to with respect to any design decisions.

TECHNICAL REPORT

The main report section is intended to provide the technical detail of the investigation and is intended to provide the level of information required by current guidance documents and practice. The Technical Report is written in a language that, in part, assumes knowledge of subject matter so that it can be written in as concise a form as possible. Its intended audience is peers, regulators and other professionals in related disciplines.

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SUPPORTING INFORMATION

This section of the report provides background details of a generic nature together with specific technical approaches adopted by BRD and details of the guidance documents that are commonly referenced in the report. The section also includes explanations of technical terms to assist non-specialist readers in understanding the Technical Report. It should be noted that not all the information within this section is necessarily applicable to this specific report.

APPENDICES

The final section of the report presents the factual data collected and employed as part of the investigation.

APPENDIX 1 SITE PLANS

Site Location Plan	Ref. BRD4359-OP2-A
Revised Conceptual Site Model	Ref. BRD4359-OP5-A
Proposed Development Layout	Ref. 'Site Layout Proposed - Ickleford', Mark Bell Architects Ltd, project No. AA139, drawing ref. 1-0-01, revision D, dated 10/11/2023.
Exploratory Hole Location Plan	Ref. BRD4359-OD1-A
Preliminary Foundation Zoning Plan	Ref. BRD4359-OP6-A

APPENDIX 2 EXPLORATORY HOLE & MONITORING RECORDS

Logs of boreholes.	Ref. WS01-WS05
Rising head permeability test.	2 x A4 pages
Groundwater monitoring records.	1 x A4 pages

APPENDIX 3 LABORATORY TEST RESULTS

DETS reports 23-15493.1 and 23-15656.1	18 x A4 pages
SPT report 43952_1	11 x A4 pages



SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT SITE CONDITION	The site currently comprises two grass paddocks with some disused portable hen houses present in the north west of the site.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as a residential housing estate comprising 8No. detached and semi-detached houses with associated private gardens, driveways and garages built around an estate road linking up to Duncots Close to the south west of the site.
HISTORICAL SUMMARY	The earliest available Ordnance Survey map from 1881 shows the site as an orchard. The 1922 map shows a small possible barn to present on the western site boundary, which is no longer present by the 1978 map. The aerial photograph from 1999 shows the site as a paddock with some trees present in the north surrounded by further trees. The 2016 map shows the site to have been split into two smaller paddocks and it remains this way to the present day.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits within a buried sediment filled glacial channel comprising Glaciofluvial Deposits overlying a mixture of the following: The Lowestoft Formation, Oadby Member and Glaciolacustrine Deposits. Alluvium and River Terrace Deposits are also shown within close proximity to the site. The shallowest bedrock unit is shown to be West Melbury Marly Chalk Formation.
ACTUAL GROUND CONDITIONS	The investigation has proved a thin cover of Topsoil or Made Ground Topsoil was overlying Alluvium. Glaciofluvial Deposits were encountered underlying the Alluvium, which in turn were underlain by the Lowestoft Formation in the centre and west of the site. The West Melbury Marly Chalk Formation was encountered underlying the Glaciofluvial Deposits in the east of the site and the Lowestoft Formation in most of the rest of the site.
HYDROGEOLOGY	The superficial Glaciofluvial Deposits and the Glaciolacustrine Deposits are designated Secondary A aquifers. The superficial Lowestoft Formation and the Oadby Member are designated Secondary Undifferentiated Aquifers. The underlying West Melbury Marly Chalk Formation bedrock geology is designated a Principal Aquifer. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest surface water feature to the site is the pond and the ditch bounding the site to the south east and east. The closest river to the site is the River Hiz located approximately 80m to the east of the site. The site is not in an area indicated to be at risk of flooding.
PREVIOUS GROUND REPORTS	BRD is not aware of any previous ground investigations having been conducted at the site. However, BRD has undertaken geo-environmental desk study research and this has been reported separately.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. Groundwater Control: <u>Western half of the site:</u> Limited groundwater control in the form of pumping from sumps is likely to be required. <u>Eastern half of the site:</u> Specialist groundwater control, such as well pointing, will likely be required at this site. It is unlikely that requirements of the Party Wall Act will apply to the development.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	<u>All on-site soils except Lowestoft Formation below 2.5m depth:</u> Design Sulphate Class of DS-2 and Aggressive Chemical Environment for Concrete class of AC-2 applies. <u>Lowestoft Formation below 2.5m depth:</u> Design Sulphate Class of DS-4 and Aggressive Chemical Environment for Concrete class of AC-3s applies.
SOAKAWAYS	Site is not suitable for surface water disposal to soakaways or other forms of infiltration device.
PAVEMENT DESIGN	A preliminary design California Bearing Ratio (CBR) of less than 2% has been recommended.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	<u>Eastern section of the site:</u> shallow strip footings bearing upon the gravelly soils of the Glaciofluvial Deposits, but subject to groundwater level. Piled foundations may be required due to shallow groundwater levels. <u>Central and Western section of the site:</u> shallow strip or deeper trench fill footings bearing upon Glaciofluvial Deposits and/or the Lowestoft Formation.
VOLUME CHANGE POTENTIAL	<u>Glaciofluvial Deposits:</u> Non shrinkable soils. <u>Lowestoft Formation:</u> Medium i.e. moderate swelling or shrinking with moisture content changes.
ESTIMATED FOUNDATION DEPTHS	<u>Eastern section of the site:</u> Foundations depth required to found into gravelly soils of the Glaciofluvial Deposits, about 0.80m to 1.00m depth. If required, pile lengths to be determined by specialist piling contractor. <u>Central and Western section of the site:</u> Foundations below the Alluvium at 1.00m to 1.30m depth but deeper to about 2.20m depth due to the tree influence.
HEAVE PROTECTION	Will not be required.

SUMMARY REPORT - CONTAMINATION ISSUES

SUBJECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No unacceptable contamination in respect of human health have been identified by this investigation.
LANDFILL GAS	No plausible sources of landfill gas have been identified.
RADON GAS	Radon gas protection measures are not required.
RISKS TO THE WATER ENVIRONMENT	No unacceptable contamination risks to water resources have been identified by this investigation.
RISKS TO BUILDING MATERIALS AND SERVICES	No unacceptable contamination risks to building materials and services have been identified by this investigation.
REMEDIATION	No remedial works are considered necessary to facilitate the development at this stage.
ASBESTOS	No asbestos has been detected in the soil samples tested. No suspected asbestos containing materials has been observed in the soils inspected.
WASTE SOIL DISPOSAL	It is considered that the topsoil present at the site is unlikely to constitute 'inert waste' due to its high organic matter content. It is considered that the natural sub-soils disposed of from the site would be classified as 'non-hazardous waste' and would be characterised for disposal to landfill as 'inert waste'.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS

Groundwater levels at the time of construction will have a critical impact on the ease of which Plots 6 and 7 (maybe Plot 5 too) foundations are constructed. It is therefore recommended that groundwater monitoring is undertaken to assess the variation in the water table with seasonal or short term weather effects. Construction of the footings for Plots 6 and 7 (maybe Plot 5 too) should be avoided in sustained wet periods and the winter months when groundwater can be expected to be at its shallowest.

If groundwater level proves problematic to foundation construction and/or the certainty of a piled foundation is preferred then in order to confirm deeper ground conditions for pile design further ground investigation comprising deep cable percussive borehole is recommended. It is suggested that 1No. borehole is drilled to a depth of 20m. Monitoring wells should be included in the borehole and at least one post work monitoring visit should be undertaken to record groundwater levels. Insitu Standard Penetration Tests should be conducted during forwarding of the borehole and collected soil samples submitted for appropriate geotechnical laboratory testing.

Due to the uncertain ground conditions in the area of Plot 5 further ground investigation along the east and western façades of Plot 5 in the form of trial pitting should be considered in order to determine foundation type and depth.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Peter David Homes Limited trading as Peter David Homes.
SITE	Land situated at Arlesey Road in the village of Ickleford, Hertfordshire.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned directly by the Client.
REPORT CONTEXT	It is understood that the Client intends to purchase the site and develop it for residential housing.
REPORT TYPE	Geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment).
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Geo-Environmental Desk Study - Land at Arlesey Road, Ickleford', BRD Environmental Ltd, report ref. BRD4359-OR1-A, dated December 2023. The purpose of the report is to present the findings of a ground investigation, and to present both geotechnical and contamination assessments of the ground conditions revealed.

1.2. SCOPE OF WORKS

The agreed scope of works was:

- Procure basic set of utility service records (electricity, gas, water, sewers, BT) cover the site and immediate surroundings, if not already held by the Client.
- Mobilisation to site and production of health and safety documentation.
- Undertake a Cable Avoidance Tool (CAT) scan at each exploratory point location.
- One day of windowless sampling using a percussive drilling rig to provide approximately 5No. boreholes to a nominal depth of 3m-5m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals. Installation of a 5m depth combined gas and groundwater monitoring well (nominal 50mm diameter) into 4No. boreholes. Installations will be finished with a flush fitting metal stopcock cover.
- All exploratory points will be logged and sampled in general accordance with BS5930:2015 by supervising Geo-Environmental Consultant.
- In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.
- Determination of the accurate location and level of exploratory points by topographical GPS unit.
- Geo-Environmental Technician to undertake a return groundwater monitoring visit to determine resting groundwater levels and to collect water samples for geotechnical analysis. A falling head permeability test or simple soakage test (as appropriate the ground conditions)

will also be undertaken within one of the monitoring wells to determine likely soil permeability or infiltration rates within deeper strata, as required.

- Chemical testing of soil samples with the budget based on the following testing schedule:
 - 5No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
 - 5No. Inorganics Suite - water soluble sulphate, pH, organic matter.
 - 5No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
 - 2No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
 - 2No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
 - 1No. Semi-Volatile Organic Compounds (SVOC) suite.
 - 2No. Asbestos quantification.
- Geotechnical testing as appropriate to the nature of the ground conditions encountered, but the budget is based on the following testing schedule:
 - 4No. Moisture content.
 - 4No. Plasticity indices.
 - 2No. Particle size distribution by wet sieve and follow on hydrometer.
 - 5No. pH and water soluble sulphate analysis - soil.
 - 5No. Total sulphate and sulphur analysis - soil.
 - 2No. pH and sulphate analysis - water.
- Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records, monitoring and test results. Interpretative reporting to include a summary of information from desk study research, a Generic Quantitative Contamination Risk Assessment (GQRA), waste classification and a Geotechnical Assessment providing comments on pavement design, concrete classification, soakaway feasibility, foundation design recommendations.

1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. In the case of Japanese Knotweed, BRD can undertake separate surveys for this plant undertaken by a Property Care Association qualified surveyor.

The report does not consider whether sensitive ecology or archaeology is present as these require consideration by professionals specialising in these matters. It should be recognised that the collection of desk study information may not be exhaustive and that other information pertinent to the site may be available.

The recommendations, interpretations and conclusions of this report are based solely on the ground conditions found at the exploratory holes. Due to the variability in the nature of ground, conditions between exploratory holes can only be interpreted and not defined. The description of the site and the ground conditions is accurate only for the dates of the field works. In particular, groundwater levels can vary due to seasonal and other effects.

The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning

regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

At the time of writing, detailed information on the proposed structure, such as detailed layout, loadings and serviceability limits, was not available. Accordingly, where geotechnical design advice is provided it is on the prescriptive basis allowed for by Eurocode 7: employing conventional and conservative design rules. The scope of this investigation excludes a formal slope stability study and any observations made regarding slopes are for information only.

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	Land to rear of No. 34, Arlesey Road, Ickleford, Hitchin, Hertfordshire, SG5 3UU.
NATIONAL GRID REFERENCE	518370E, 231510N.

2.2. SITE DESCRIPTION

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site currently comprises two grass paddocks with some disused portable hen houses present in the north west of the site. The site is approximately 0.4 hectares in size and roughly rectangular in shape. The site is currently accessed via a five-bar wooden gate from the garden of No. 34 to the west of the site. There are no buildings on the site. The northern and eastern site boundaries are marked by an approximately 1.3m high dilapidated wooden post and rail fence. The western site boundary is marked by an approximately 1.3m high wooden post and rail fence in the north and by an approximately 1.8m high closed board wooden fence in the south. The southern site boundary is marked by a mixture of an approximately 1.8m high closed board wooden fence and the wall of an adjoining domestic garage. The site slopes gently from a high point in the west at 51.2m Above Ordnance Datum (AOD) to a low point in the north east at 49.4m AOD. A pond bounds the site to the south east and a connected ditch bounds the site to the east. The site is almost entirely surfaced in grass with a small area in the west surfaced in overgrown brambles. There are 3No. apple trees present in the north of the site. Mature mixed deciduous hedgerows bound the site to the north and east. There are also several mature and young trees present on the site boundaries with species including but not limited to poplar, ash and willow. There is a small area in the west of the site which is overgrown with brambles. A tree stump and the remains of a felled tree are also present in the north west of the site. There are some disused wooden portable hen houses present in the north west of the site. There are several small overgrown compost and horse manure heaps present in the west of the site. The water in the pond and connected ditch bounding the site to the east and south east did not appear to be flowing and displayed no evidence of any contamination. Some surface soils were visible where moles had recently been present and the soils appeared to natural clay topsoil with no evidence of any contamination present.

SUBJECT	COMMENTS
SURROUNDING LAND USE	The site is bounded to the north by another larger paddock. A large meadow bounds the site to the east with the River Hiz and a dismantled railway line beyond. The site is bounded to the south and west by a residential housing estate, No. 34 Arlesey Road with associated private garden, driveway and stables with Arlesey Road beyond also bounds the site to the west.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as a residential housing estate comprising 8No. detached and semi-detached houses with associated private gardens, driveways and garages built around an estate road linking up to Duncots Close to the south west of the site.
HISTORICAL SUMMARY	From the previous desk study report, the following summary of the site's history is presented. The earliest available Ordnance Survey map from 1881 shows the site as an orchard. The 1922 map shows a small possible barn to present on the western site boundary, which is no longer present by the 1978 map. The aerial photograph from 1999 shows the site as a paddock with some trees present in the north surrounded by further trees. The 2016 map shows the site to have been split into two smaller paddocks and it remains this way to the present day.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits within a buried sediment filled glacial channel comprising Glaciofluvial Deposits overlying a mixture of the following: The Lowestoft Formation, Oadby Member and Glaciolacustrine Deposits. Alluvium and River Terrace Deposits related to the rivers surrounding the site are also shown within close proximity to the site. The shallowest bedrock unit is shown to be West Melbury Marly Chalk Formation.
RADON	Radon protection measures are not required.
HYDROGEOLOGY	The superficial Glaciofluvial Deposits and the Glaciolacustrine Deposits are designated Secondary A aquifers. The superficial Lowestoft Formation and the Oadby Member are designated Secondary Undifferentiated Aquifers. The underlying West Melbury Marly Chalk Formation bedrock geology is designated a Principal Aquifer. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest surface water feature to the site is the pond and the ditch bounding the site to the south east and east. The closest river to the site is the River Hiz located approximately 80m to the east of the site. The site is not in an area indicated to be at risk of flooding.

2.3. PREVIOUS INVESTIGATIONS

BRD is unaware of any previous ground investigations having been conducted at the site. However, the site has been the subject of geo-environmental desk study research by BRD and this has been reported separately in 'Phase 1 Geo-Environmental Desk Study - Land at Arlessey Road, Ickleford', BRD Environmental Ltd, report ref. BRD4359-OR1-A, dated December 2023. This current report should be read in conjunction with the previous desk study report.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	Windowless sample boreholes were selected as monitoring installations were required and because in-situ density tests were required in the coarse soils. Groundwater monitoring was selected in order to record the resting groundwater levels at the site.	
DATES OF SITE WORKS	The main field works were undertaken on 18 th December 2023. Monitoring visit was undertaken on 20 th December 2023.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	None.	
EXPLORATORY HOLE SPACING	Approximately 25-40m grid.	
LAYOUT RATIONALE	SOURCE / FEATURE	EXPLORATORY HOLE
CONTAMINATION SOURCES TARGETED	Off-site former builder's yard.	WS04.
	General site coverage.	WS01-WS05.
GROUND FEATURES TARGETED		
CONTAMINATION SAMPLING PLAN	Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface samples as these represent the soils most likely to be available to future site users. The analysis is more biased towards the Made Ground samples as this stratum represents the soils most likely to be contaminated.	
ANALYSIS PLAN	Given the site's history as an orchard and paddocks, and based on the potential contaminants identified within the Hazard Identification section of the Phase 1 contamination assessment, BRD has scheduled a suite of typically occurring contaminants and a suite of contaminants in order to specify the proposed water supply pipes for the site.	

3.2. BRD FIELDWORK

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS01 to WS05.
DEPTH RANGE	5.45m.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	Borehole WS05 was backfilled with arisings only. Boreholes WS01 to WS04 had monitoring wells installed. These comprised 50mm nominal diameter standpipes fitted with a gas tap finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel.

MONITORING	
TYPE	Groundwater monitoring.
DATES	20 th December 2023.
GROUNDWATER SAMPLING METHOD	Samples were retrieved using a sampling bailer dedicated to each well.

3.3. LABORATORY TESTING

GEOTECHNICAL TESTING	
The soil samples for geotechnical testing were forwarded to the laboratory of Soil Property Testing Ltd with pH and sulphate analysis undertaken at the laboratory of DETS Ltd. The geotechnical testing suite is detailed below. The UKAS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
TEST	NUMBER OF SAMPLES TESTED
Moisture content	6
Liquid and plastic limits	6
Particle size distribution by wet sieve and hydrometer	1
pH and Water soluble Sulphate	6
Total Sulphur and Sulphate	6

SOIL CHEMICAL TESTING	
The soil samples for contamination testing were forwarded to the laboratory of DETS Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
SOIL TESTS	NUMBER OF SAMPLES TESTED
Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc	5
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	5
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	2
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) plus Methyl Tert Butyl Ether (MTBE)	2
Fibrous Material Screen (for Asbestos)	2
Semi-Volatile Organic Compounds (SVOCs)	1
Waste Acceptance Criteria (WAC) testing	1

GROUNDWATER CHEMICAL TESTING	
The water samples for chemical geotechnical testing were forwarded to the laboratory of DETS Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
WATER TESTS	NUMBER OF SAMPLES TESTED
pH	2
Sulphate	2

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions encountered differed slightly from the published geology maps. A thin cover of Topsoil or Made Ground Topsoil was present overlying Alluvium to depths of between 0.80m below ground level (m bgl) and 1.30m bgl. Glaciofluvial Deposits were encountered underlying the Alluvium to depths of between 1.50m bgl and 3.00m bgl, which in turn were underlain by the Lowestoft Formation in the centre and west of the site to depths of between 2.00m bgl and in excess of 5.45m bgl.

The bedrock identified as the West Melbury Marly Chalk Formation was encountered underlying the Glaciofluvial Deposits in the east of the site and the Lowestoft Formation in most of the rest of the site.

Details of the various stratigraphic units are given in the following sections.

4.2. TOPSOIL AND MADE GROUND TOPSOIL

Topsoil and Made Ground Topsoil were encountered across the site to depths of between 0.30m bgl and 0.60m bgl. The Topsoil was typically described as moist, dark brown, very silty, clay with many rootlets and occasional flint gravel. The Made Ground Topsoil was typically described as dark brown, slightly gravelly, very silty, clay with many rootlets, rare brick fragments, flint and quartzite gravel.

4.3. SUPERFICIAL DEPOSITS

4.3.1. Alluvium

The Alluvium was encountered across the whole of the site underlying the Topsoil and Made Ground Topsoil to depths of between 0.80m bgl and 1.30m bgl.

The deposits were characteristic by the organic content and dark brown colour and were recorded as slightly gravelly, very clayey silt or silt clay with occasional rootlets and gravel of flint, occasional chalk and rare sandstone.

4.3.2. Glaciofluvial Deposits

Glaciofluvial Deposits were encountered across the whole of the site underlying the Alluvium to depths of between 1.50m bgl and 3.00m bgl. This stratum was typically recorded comprising gravel beds described as orange brown, some beige, slightly silty, slightly clayey to clayey, sandy to very sandy gravel which in turn were intercalated by clay/silt sand beds of about 0.5m thickness recorded as follows:

- Stiff, light beige to light grey, gravelly clayey silt with gravel of flint, chalk and rare sandstone.
- Medium dense, light orange brown with some beige and cream, slightly silty, slightly sandy, very clayey gravel of flint, chalk and rare other lithologies.
- Loose, light brown, medium sand with occasional flint gravel.

4.3.3. Lowestoft Formation

The Lowestoft Formation was encountered in the centre and west of the site (boreholes WS01, WS04 and WS05) underlying the Glaciofluvial Deposits to depths of between 2.00m bgl and in excess of 5.45m bgl. The Lowestoft Formation was typically described as either stiff, grey brown mottled orange brown, gravelly silty clay with gravel of flint, chalk and rare other lithologies or stiff, grey, slightly silty, gravelly clay with gravel of chalk and rare other lithologies.

4.4. **BEDROCK**

4.4.1. West Melbury Marly Chalk Formation

The West Melbury Marly Chalk Formation was encountered across most of the site in all boreholes except WS04 (south western site section). It was encountered underlying the Glaciofluvial Deposits in the east of the site and the Lowestoft Formation in most of the rest of the site and was proven to a maximum depth of 5.45m bgl.

In boreholes WS01 and WS05, the West Melbury Marly Chalk Formation was initially encountered as a structureless Chalk to about 3.7m depth, and recovered as stiff, cream with dark orange brown weathering, slightly clayey, slightly gravelly silt (CIRIA Grade Dm). Beneath, structured Chalk was recorded and recovered as very weak to weak, light grey, slightly clayey, silty gravel (CIRIA Grade A-C Undifferentiated). Structured Chalk was recorded below the Glaciofluvial Deposits in borehole WS02.

4.5. **GEOTECHNICAL COMMENTS**

The ground conditions varied throughout the site with the variable thicknesses of the gravelly soils of the Glaciofluvial Deposits. Whilst the thicker deposits of granular soils were more prevalent at about the eastern half of the site, towards the centre and west the granular beds were less consistent. It should be noted that any changes in ground conditions over short distances will have an effect on the foundation design.

4.6. **CONTAMINATION OBSERVATIONS**

No visual or olfactory evidence of contamination was noted during the forwarding of exploratory holes.

4.7. **GROUNDWATER BEHAVIOUR**

During the progressing of exploratory holes, the following general observations of groundwater behaviour were made.

Groundwater was encountered in boreholes WS02 and WS03, located in the east of the site, within the Glaciofluvial Deposits at a depth of 1.00m bgl.

Additionally, groundwater was also encountered in the West Melbury Marly Chalk Formation in borehole WS01, located in the north west of the site, at a depth of 3.40m bgl.

4.8. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
20/12/23	From 0.05m to 4.35m bgl.	Groundwater was recorded in all 4No. installed boreholes with the shallowest groundwater recorded in the east of the site in boreholes WS02 and WS03 and the deepest groundwater recorded in borehole WS04 in the south west of the site. Boreholes WS01, WS02 and WS03 all recorded shallow groundwater at depths of between 0.05m bgl and 1.16m bgl. The monitoring visit followed a period of relatively wet weather.

5. GEOTECHNICAL PROPERTIES

5.1. COARSE SOIL PARAMETERS

5.1.1. Variable Head Permeability

The records of the variable head permeability tests are presented in the Appendices that includes the calculation of the permeability. The results are presented in the table below:

BOREHOLE	PERMEABILITY	STRATUM TESTED
WS01	1.89×10^{-6} m/s	Structureless Chalk: stiff, cream with dark orange brown weathering, slightly clayey, slightly gravelly silt (CIRIA Grade Dm).
WS03	4.40×10^{-6} m/s	Glaciofluvial Deposits: Medium dense, orange brown, slightly clayey in parts, sandy to very sandy GRAVEL of fine to coarse, angular to sub-rounded flint and rare chalk.

5.1.2. Standard Penetration Tests (SPTs)

The Glaciofluvial Deposits were typically recorded as coarse soil type comprising sand and gravel and SPTs carried in these deposits recorded N-values ranging between 9 and 23, averaging 17, which is indicative of medium dense deposits.

The lowest value $N = 9$, was recorded in borehole WS02 at 1m depth in sand deposits and in the presence of the groundwater. It is considered that the groundwater has reduced the relative density of these soils.

5.1.3. Particle Size Distribution (PSD)

The grading curve of the one sample of Glaciofluvial Deposits subject to PSD determination revealed the soil to be a well graded, slightly clayey, silty sandy gravel, comprising a 44% in gravel content, a 40% in sand content and a 16% in fines content of which only 4% is of clay fraction.

5.2. FINE SOIL PARAMETERS

5.2.1. Index Property Testing

SOIL TYPE	Alluvium.
PLASTICITY INDEX (PI)	Oversize particles present.
MODIFIED PI	8% (One sample: Non-shrinkable soil type).
NHBC CLASS	Non shrinkable soil type.

SOIL TYPE	Glaciofluvial Deposits.
PLASTICITY INDEX (PI)	Oversize particles present.
MODIFIED PI	9% (One sample: Non-shrinkable soil type).
NHBC CLASS	Non shrinkable soil type.

SOIL TYPE	Lowestoft Formation.
PLASTICITY INDEX (PI)	Oversize particles present.
MODIFIED PI	19% (One sample: Low volume change potential). 22% (One sample: Medium volume change potential).
COMMENT	Average modified PI = 20% indicative of medium volume change potential soil type.
NHBC CLASS	Medium volume change potential.

SOIL TYPE	West Melbury Marly Chalk (CIRIA Grade Dm).
PLASTICITY INDEX (PI)	16% and 17% (Two samples: Low volume change potential).
MODIFIED PI	Not applicable - no oversize particles.
NHBC CLASS	Low volume change potential.

5.2.2. Undrained Shear Strength

This section discusses all of the laboratory and in-situ tests that produce either direct or indirect measures of undrained shear strength.

5.2.2.1. *Hand Penetrometer*

SOIL TYPE	Alluvium.
DISCUSSION OF CORRECTED RESULTS	Average penetrometer readings range between 0.25kg/cm ² to 2.25kg/cm ² and have been corrected by a factor of 2. The recorded undrained shear strength was in the range of 6kPa to 55kPa, averaging 39kPa, which is indicative of low strength soil type.

SOIL TYPE	Glaciofluvial Deposits (clay beds).
DISCUSSION OF CORRECTED RESULTS	An average penetrometer reading of 2.3kg/cm ² has been corrected by a factor of 2. The recorded undrained shear strength was of 57kPa which is indicative of medium strength soil type.

SOIL TYPE	Lowestoft Formation.
DISCUSSION OF CORRECTED RESULTS	Average penetrometer readings range between 1.5kg/cm ² to 4.25kg/cm ² and have been corrected by a factor of 2. The recorded undrained shear strength was in the range of 38kPa and 104kPa, averaging 64kPa which is indicative of medium strength soil type.

SOIL TYPE	West Melbury Marly Chalk
DISCUSSION OF CORRECTED RESULTS	Average penetrometer readings range between 2.0kg/cm² to >5.00kg/cm² and have been corrected by a factor of 2. The recorded undrained shear strength was in the range of 50kPa and >123kPa, averaging 84kPa which is indicative of high strength soil type.

5.2.2.2. *Standard Penetration Test Correlations*

A total of 21 No. Standard Penetration Tests (SPTs) were undertaken in the clay soils recorded across the site at intervals of 1m.

Due to the limited thickness of the Alluvium deposits recorded across the site, only one SPT was recorded in these soils, in borehole WS05 at 1m depth, with an N-value of 7, indicating firm soils.

Likewise, the Glaciofluvial Deposits were typically recorded as a coarse material and then only one SPT was recorded in clay soils, in borehole WS01 at 1m depth, with an N-value of 17, indicating very stiff soils. Although, the sand and gravel content of these soils has might increase the recorded N-value.

SPTs carried out in the Lowestoft Formation recorded N-values ranging from 10 to 23, being indicative of stiff to very stiff soils and typically values increase with depth.

The West Melbury Marly Chalk Formation tested from depths below 2m, was recorded with N-values ranging between 10 and 45 which are indicative of stiff to hard soils type/very weak rock. The highest value was recorded in borehole WS02 at 4m depth.

The SPT N-values have been corrected to N_{60} -values, and then correlated to an equivalent undrained shear strength (c_u) using the approach by Stroud (1985) based upon a relationship of $c_u = a \times N_{60}$. The “a” factor was of 5.5 for all the soils except the Lowestoft Formation which has a value of 4.5 was selected. Values selected based on the average plasticity index recorded from these soils.

A hammer efficiency value of $E_r=91\%$ was implemented based on the annual calibration certificate provided by the sub-contractor.

For the Alluvium, an equivalent undrained shear strength value of 58kPa, indicating medium strength, has been inferred and for the clay Glaciofluvial Deposits a value of 142kPa, indicative high strength soil type.

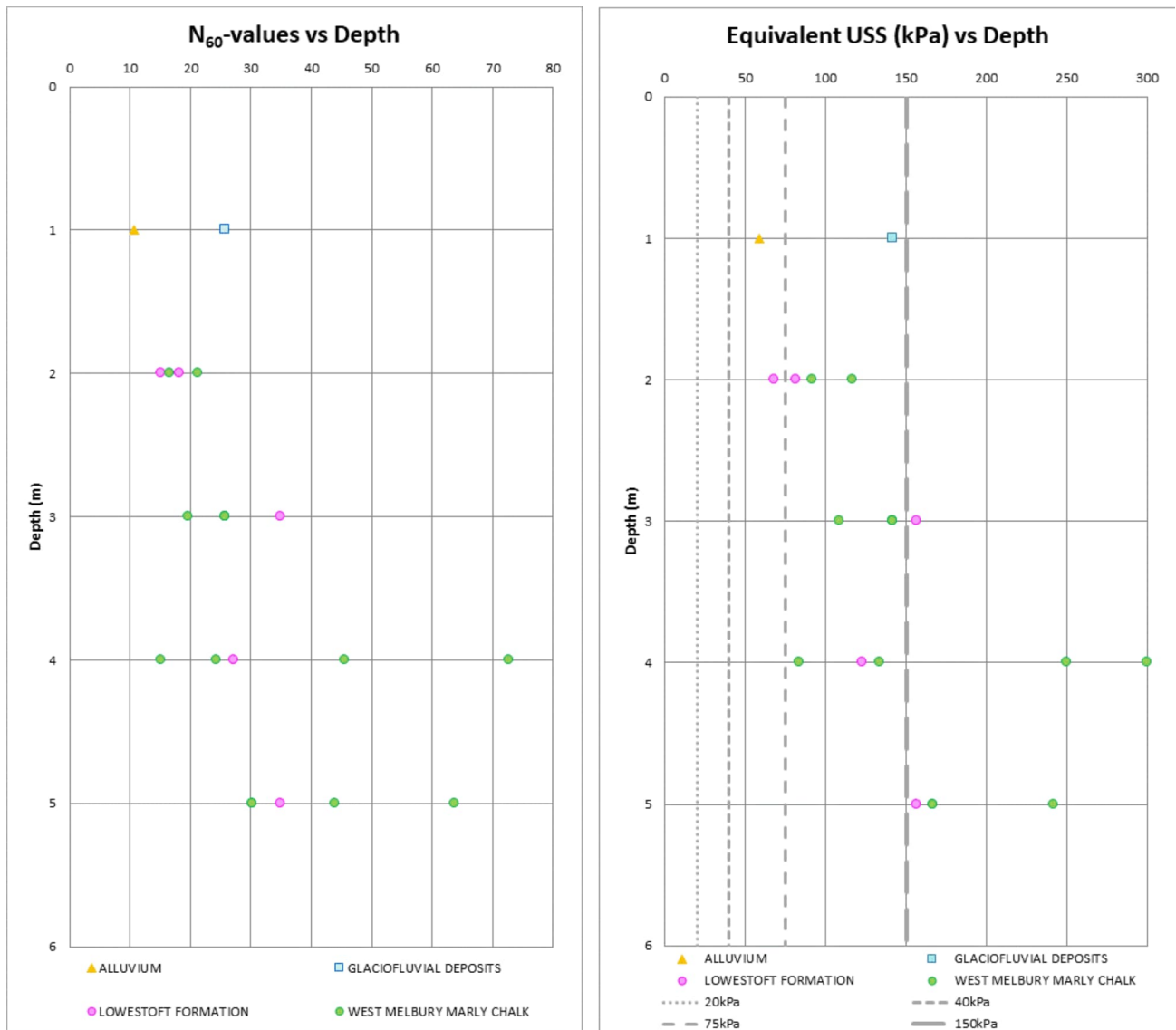
The Lowestoft Formation at 2m depth was recorded with equivalent undrained shear strength values of 68kPa and 82kPa, indicating medium to high strength. Below, between 3m and 5m depth recorded in borehole WS04, equivalent undrained shear strength values of 123kPa and 157kPa were inferred indicating high to very high strength soil type.

The West Melbury Marly Chalk Formation, typically tested below 2m depth, has been recorded with equivalent undrained shear strength values ranging between 92kPa and 117kPa, indicating high strength.

At 3m depth, equivalent undrained shear strength values ranging between 108kPa and 142kPa, indicating high strength have been recorded.

Between 4m and 5m depth, equivalent undrained shear strength values ranging between 83kPa and 400kPa, indicating high to very high strength soil / weak rock have been recorded.

The following charts show the distribution with depth of the N_{60} -values considered in every borehole together with the derived equivalent undrained shear strength values. . Equivalent USS value for $N = 48$ has been limited to USS= 300kPa for a visual representation.



5.3. SULPHATE AND pH

	ALL ON-SITE SOILS EXCEPT LOWESTOFT FORMATION BELOW 2.5m DEPTH			
	Sulphate		pH	
Characteristic Value	879 mg/l		7.0 units	
Justification	Highest groundwater result.		Lowest groundwater result.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	10	<10 - 124 mg/l	10	7.6 - 8.4 units
Groundwater	2	94 - 879 mg/l	2	7.0 - 7.1 units
Total Potential Sulphate	5	Not applicable as pyrite unlikely in the samples tested.		

	LOWESTOFT FORMATION BELOW 2.5m DEPTH			
	Sulphate		pH	
Characteristic Value	1.95%		7.9 units	
Justification	Based on Total Potential Sulphate.		Lowest measured value.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	1	1,860 mg/l	1	7.9 units
Groundwater	-	N/A	-	N/A
Total Potential Sulphate	1	1.95% The sample tested was proved potentially pyritic.		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of about 8No. low rise two to three storey residential properties across the entire site. The proposed development layout plan is included in Appendix 1. From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1.

Should the nature of the development be changed then the results of this investigation would need to be reviewed and reassessed.

6.2. EXCAVATIONS

STABILITY	The site has a cover of superficial deposits of the Glaciofluvial Deposits typically recorded as gravelly soils with associated groundwater level predominantly at about the eastern half of the site. The Glaciofluvial Deposits in the western half of the site are more clayey material with a different behaviour. Therefore, for the eastern half of the site, it is considered that shallow excavations (1m or less) should remain stable in the short term (a few hours at most). However, due to its moist condition, the Glaciofluvial Deposits was noted to be prone to spalling. For the western half of the site, in the absence of gravelly soils of the Glaciofluvial Deposits, it is anticipated that narrow trench excavations will remain relatively stable and open for short periods, but minor spalling of side walls could still occur. On the basis of the above, any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored to provide safe working conditions. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present. Arisings and movement of construction plant should be kept away from open excavations as the loadings from mounded soils and vibrations from plant movement could induce spalling and collapse of excavation walls. Deeper excavations or any excavations open for longer periods within the gravel units of the Glaciofluvial Deposits would be expected to undergo more pronounced collapse, which would be exacerbated when encountering groundwater inflows. Excavations below the water table at this site are likely to result in excavation difficulties due to 'running sands' and appropriate groundwater control will therefore be required to increase stability.
EQUIPMENT	It should be possible to progress excavations with conventional equipment.
GROUNDWATER CONTROL	For the eastern half of the site, it is considered that construction without adequate groundwater control will be problematical and that pumping from sumps alone may not be sufficient. Consultation with groundwater control contractors is recommended as specialist measures such as 'well pointing' may be required. Any groundwater control system should be designed and

	operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement. For the western half of the site, it is anticipated that groundwater control in the form of pumping from sumps formed in the base of excavations will be required. Any groundwater control system should be designed and operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement. Groundwater levels at the time of construction will have a critical impact on the ease of which the structure can be built. It is therefore recommended that deep excavations are planned for the late summer or early autumn when seasonally groundwater will be at its lowest. It is therefore recommended that groundwater monitoring is undertaken to assess the variation in the water table with seasonal or short term weather effects.
PARTY WALL ISSUES	As there are no nearby third party structures, the Party Wall Act is unlikely to apply to the development.

6.3. SLOPE STABILITY

The site is relatively flat and no significant changes in level as part of the development are anticipated. It is therefore considered that slope stability is unlikely to be a significant concern at this site.

6.4. SUB-SURFACE CONCRETE

ALL ON-SITE SOILS EXCEPT LOWESTOFT FORMATION BELOW 2.5m DEPTH	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-2
GROUNDWATER REGIME	Mobile.
ACEC CLASS	AC-2

LOWESTOFT FORMATION BELOW 2.5M DEPTH	
SITE / SOIL CATEGORY	Natural ground containing pyrite.
DESIGN SULPHATE CLASS	DS-4
GROUNDWATER REGIME	Static.
ACEC CLASS	AC-3s
COMMENTS	Concrete in pyritic ground that is initially low in soluble sulphate does not have to be designed to withstand a high potential sulphate class unless ground disturbance is such that pyrite may be oxidised. This may prompt a change in construction e.g. employing piled foundations instead of trench fill footings. The restriction to DS-4 has been applied.

6.5. SOAKAWAYS

Ground conditions across the eastern half of the site comprised granular soils of the Glaciofluvial Deposits which although permeable had an associated shallow groundwater level. The western half of the site had low permeability clay-rich soils through most of the different strata recorded.

Although no BRE365 soakage tests were undertaken during this investigation, it is apparent that the shallow groundwater will have a significant impact on the ability to adopt soakaway drainage as part of the proposed development. It should be noted that the Environment Agency (EA) will object to the use of infiltration devices that lead to the direct input to groundwater and seek that in excess of a 1m thick unsaturated zone is present between the base of the infiltration device and the seasonal high maximum groundwater level. Clearly such an unsaturated zone is not achievable on this site.

It is considered that the site is unsuitable for conventional soakaways and a positive drainage solution to a local sewer or surface water course should be pursued.

6.6. PAVEMENT CONSTRUCTION

From consideration of the observed ground conditions and the plasticity of the clay, it is recommended that a preliminary design California Bearing Ratio (CBR) of less than 2% is assumed. The cohesive deposits will be prone to rapid degradation during wet weather working and this should be avoided where possible.

All unsuitable soils, such as topsoil or desiccated soils, should be removed from beneath proposed paved areas. The exposed sub-grade formation should then be proof rolled to reveal any excessively soft or compressible zones and any such features identified also removed by excavation. Where unsuitable materials are removed, the resultant voids should be filled in layers with appropriately compacted suitable granular fill. To reduce the loss of granular construction materials into the sub-grade, consideration should be given to utilising a geotextile starter layer across the formation level.

6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS

6.7.1. Introduction

The whole site comprises a cover of Alluvium deposits which due to its variable strength and nature should be avoid as founding level. These deposits have been proved to depths ranging from 0.8m to 1.3m depth bgl.

Underneath, Glaciofluvial Deposits have been recorded with a more gravel content and associated shallow groundwater level towards the eastern section of the site. The Glaciofluvial Deposits were more clayey towards the central and western section of the site or gravelly without the ground water level in the south western section. Then, the till deposits of the Lowestoft Formation have been recorded underlain by the Chalk bedrock (not proven in south west corner due to thickness of the till).

The different soil type existing across the site have been recorded with variable volume change potential under the NHBC Standards that coupled with the trees recorded along the site boundaries will have an impact on the foundation design for each plot.

The foundation discussion below is divided into the various soil types encountered at foundation depths and the Plots location, together with general comments that are applicable to all the foundations. A Preliminary Foundation Zoning Plan is provided in Appendix 1 which will aid understanding of the foundation advice given below.

6.7.2. Floor Slabs

In consideration of the near surface clay soils, fully suspended floor slabs designed and constructed in accordance with NHBC Standards are recommended at this development.

With reference to Section 2.2, the floor construction will not have to incorporate radon gas protection measures.

6.7.3. Plots 6 & 7 - Footings on the gravelly soils of the Glaciofluvial Deposits

Approximately the eastern section of the site and below the Alluvium, gravelly soils of the Glaciofluvial Deposits have been recorded to 3.7m depth on top of Chalk. Plots 6 and 7 will be located in this area. Shallow strip footings might be suitable for both plots, but shallow groundwater has been recorded within the gravel. Therefore, the feasibility of shallow footings will be dependent on the groundwater levels at the time of construction.

Foundations should be taken through made ground/topsoil and Alluvium to bear upon the gravelly soils of the Glaciofluvial Deposits.

The Glaciofluvial Deposits have been proved as a non-shrinkable soil type, therefore trees located along the site boundaries should not be considered for foundation depths. The minimum foundation depth required is that necessary to found below the Alluvium into the gravelly soils.

A presumed bearing value of 100kN/m² is considered appropriate for foundations up to 1m wide bearing upon the gravelly soils of the Glaciofluvial Deposits. As the ground conditions may be variable, light steel mesh reinforcement of the footings would be prudent. Immediate and long term settlement should be within tolerable limits and take place largely during the construction period.

Excavations encountering groundwater will become unstable and this will complicate the construction of the footings. The ease of construction will be dependent upon actual groundwater levels present at the time of construction. As a consequence of this, it is recommended that construction of the footings for Plots 6 and 7 is avoided in sustained wet periods and the winter months when groundwater can expected to be at its shallowest.

If problems are encountered with groundwater induced collapse, then a 'dig and pour' approach may be required or in extreme cases adopting a piled solution. It is an inherent risk of 'dig and pour' that spoil disposal and concrete volumes could increase and professional supervision is also required. To minimise instability the length of trench open at any one time can be reduced by adopting a two part solution. The first is a lower mass pour trench fill is constructed using a semi-dry concrete that can be progressed segmentally around the plot. A thin reinforced strip footing can then be constructed upon the mass fill element once it has set.

Alternatively, a piled foundation solution for Plots 6 and 7 could be pursued.

6.7.4. Plots 1 to 4 & Plot 8 - Footings on Lowestoft Formation

Plots 1 to 4 and Plot 8 will be located in the centre and western site areas. The ground conditions have proved variable Glaciofluvial Deposits underlain by the Lowestoft Formation from depths between 1.5m and 2.2m bgl.

The Lowestoft Formation has been shown a medium volume change potential under the NHBC Standards and boundary high water demand trees such as Poplar or Hawthorn have been recorded. Therefore, following the NHBC Standards recommendations foundations depths will consider the plasticity of the Lowestoft Formation.

Therefore, outside of the zones of influence of the trees and hedges it is considered that shallow footings may be adopted for the proposed Plots 1 to 4 and Plot 8 emplaced within the underlying Glaciofluvial Deposits underlain and/or the Lowestoft Formation. However, within the zones of influence of the trees deepened trench fill foundations are considered appropriate.

Foundations should be taken through made ground/topsoil and Alluvium to bear upon the Glaciofluvial Deposits and/or the Lowestoft Formation. It is likely that both strata will be present at formation level, and therefore it is recommended that nominal steel mesh reinforcement is included within the footing to reduce the effects of differential settlement across the varying strata and distribute stresses more evenly. Alternatively, the footings could be over deepened so that they bear entirely within the Lowestoft Formation and thereby eliminating the potential for differential settlement.

A presumed bearing value of 100kN/m² is considered appropriate for foundations up to 1m wide bearing upon the Glaciofluvial Deposits and/or clay soils of the Lowestoft Formation. Immediate and long term settlement should be within tolerable limits and take place over several years.

The Lowestoft Formation clay has been shown to have a medium volume change potential when assessed against NHBC standards and therefore the minimum foundation depth required is 0.90m, but 1.25m where required to allow for restricted new tree planting. Under the NHBC Standards, foundation depths have to be increased if they are within the influence zone of felled trees, existing trees or proposed tree planting. It should be noted that where trees are in groups the resulting competition for resources can lead to deeper root systems than allowed for in the NHBC Standards.

A cursory analysis has been conducted based on the provided tree survey and foundation depths between about 1.8m to 2.2m have been recorded for Plots 1 to 4 and Plot 8 due to the tree influence. The Lowestoft Formation will be recorded at those depths.

In any event, foundations should be taken below any roots encountered in foundation trench excavation. Where the required foundation depth varies around a structure, this can be accommodated by forming steps in the foundation as per NHBC Standards.

Where foundation depths exceed 1.50m in clay soils and are within the zone of influence of existing or felled trees or where foundations cut through tree roots, a compressible void former will be required against the internal faces of new foundations in order to accommodate potential

long term soil heave. Such precautions against heave should be designed and constructed in accordance with NHBC Standards.

There may still be problems with groundwater in parts of these plots and so the 'dig and pour' approach outlined above may also be appropriate in such circumstances.

6.7.5. Plot 5

Ground conditions in this plot are considered uncertain as it is located in a transition zone between the deep gravelly soils of the Glaciofluvial Deposits and the presence of the Lowestoft Formation. Additionally, high water demand trees such as a Poplar is recorded in the northern site boundary which might interfere in foundation depths if the Lowestoft Formation is confirmed beneath this plot. The presence of the clay soils of the Lowestoft Formation will require foundation depths of about 1.9m depth due to the tree influence. However, if deep gravelly soils are recorded then foundation recommendations provided for Plots 6 and 7 should be considered.

Therefore, further ground investigation is recommended along the east and western façade of Plot 5 in order to prove ground conditions which are essential to determine foundation type and depth.

6.7.6. General Footing Recommendations

The excavator must be set up with care and operated correctly to ensure trench walls are vertical and base horizontal as any slight inclination will result in eccentric loading on such deep trench fill footings.

A number of trees and hedges are located across the site. It will be necessary to remove all unwanted trees, stumps and root structures prior to commencing with the development. Any resultant void should be backfilled accordingly with respect to the preferred foundation design.

During construction, any soft spots found at foundation formation level should be excavated and replaced with lean mix concrete. Foundation excavations should be kept dry and left open for the minimum amount of time possible. Where foundations cannot be completed immediately, a blinding layer of concrete should be placed.

6.7.7. Piling

If groundwater levels and/or trench collapse proves problematic a piled foundation solution may be required for Plots 6 and 7 and possibly Plot 5.

Deeper ground conditions will need to be confirmed for a pile design and then a deep ground investigation comprising deep cable percussive borehole is recommended.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

Groundwater levels at the time of construction will have a critical impact on the ease of which Plots 6 and 7 (maybe Plot 5 too) foundations are constructed. It is therefore recommended that groundwater monitoring is undertaken to assess the variation in the water table with seasonal or short term weather effects. Construction of the footings for Plots 6 and 7 (maybe Plot 5 too) should be avoided in sustained wet periods and the winter months when groundwater can be expected to be at its shallowest.

If groundwater level proves problematic to foundation construction and/or the certainty of a piled foundation is preferred then in order to confirm deeper ground conditions for pile design further ground investigation comprising deep cable percussive borehole is recommended. It is suggested that 1No. borehole is drilled to a depth of 20m. Monitoring wells should be included in the borehole and at least one post work monitoring visit should be undertaken to record groundwater levels. Insitu Standard Penetration Tests should be conducted during forwarding of the borehole and collected soil samples submitted for appropriate geotechnical laboratory testing.

Due to the uncertain ground conditions in the area of Plot 5 further ground investigation along the east and western façades of Plot 5 in the form of trial pitting should be considered in order to determine foundation type and depth.

7. RISK ESTIMATION - SOILS

7.1. HUMAN HEALTH

The Generic Assessment Criteria (GAC) employed below are for residential land use as this is appropriate to the proposed form of development.

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/kg	5	10	37	0
Cadmium	mg/kg	5	0.3	22	0
Chromium (total)	mg/kg	5	9	910	0
Chromium (hexavalent)	mg/kg	5	<2	21	0
Copper	mg/kg	5	25	2,400	0
Lead	mg/kg	5	80	200	0
Mercury	mg/kg	5	<1	11	0
Nickel	mg/kg	5	11	180	0
Selenium	mg/kg	5	<2	250	0
Zinc	mg/kg	5	106	3,700	0
pH	Units	11	8.4	<5-10>	0
Naphthalene	mg/kg	5	<0.1	2.3	0
Acenaphthylene	mg/kg	5	<0.1	170	0
Acenaphthene	mg/kg	5	<0.1	210	0
Fluorene	mg/kg	5	<0.1	170	0
Phenanthrene	mg/kg	5	0.17	95	0
Anthracene	mg/kg	5	<0.1	2,400	0
Fluoranthene	mg/kg	5	0.49	280	0
Pyrene	mg/kg	5	0.47	620	0
Benzo(a)anthracene	mg/kg	5	0.29	7.2	0
Chrysene	mg/kg	5	0.29	15	0
Benzo(b)fluoranthene	mg/kg	5	0.30	2.6	0
Benzo(k)fluoranthene	mg/kg	5	0.12	77	0
Benzo(a)pyrene	mg/kg	5	0.26	2.2	0
Indeno(1,2,3-cd)pyrene	mg/kg	5	0.15	27	0
Dibenzo(a,h)anthracene	mg/kg	5	<0.1	0.24	0
Benzo(ghi)perylene	mg/kg	5	0.14	320	0
TPH Aliphatic C5-C6	mg/kg	2	<0.01	42	0
TPH Aliphatic C6-C8	mg/kg	2	<0.05	100	0
TPH Aliphatic C8-C10	mg/kg	2	<2	27	0
TPH Aliphatic C10-C12	mg/kg	2	<2	130	0
TPH Aliphatic C12-C16	mg/kg	2	<3	1,100	0
TPH Aliphatic C16-C35	mg/kg	2	<10	65,000	0
TPH Aliphatic C35-C44	mg/kg	2	<10	65,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C5-C7	mg/kg	2	<0.01	70	0
TPH Aromatic C7-C8	mg/kg	2	<0.05	130	0
TPH Aromatic C8-C10	mg/kg	2	<2	34	0
TPH Aromatic C10-C12	mg/kg	2	<2	74	0
TPH Aromatic C12-C16	mg/kg	2	<2	140	0
TPH Aromatic C16-C21	mg/kg	2	<3	260	0
TPH Aromatic C21-C35	mg/kg	2	<10	1,100	0
TPH Aromatic C35-C44	mg/kg	2	<10	1,100	0
Benzene	mg/kg	2	<0.002	0.87	0
Toluene	mg/kg	2	<0.005	130	0
Ethylbenzene	mg/kg	2	<0.002	47	0
Xylene (total of all types)	mg/kg	2	<0.004	56	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	2	<0.005	49	0
Semi-Volatile Organic Compounds (SVOCs)	mg/kg	1	None Detected	LOD*	0
Asbestos	Presence	2	>0.001	Fibres Present	0
Notes: *Limit of detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.					

None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

7.2. WATER ENVIRONMENT

It is not appropriate to consider human health assessment criteria for human health in relation to the risk to the water environment, but currently there are no generic soil assessment criteria in respect of the water environment. In the absence of any groundwater sampling data, the soil results are assessed on the basis of professional judgement.

The contaminant concentrations recorded in the soils at the site are not considered to be at such levels that they would present any significant risk to the underlying water environment.

7.3. BUILDING MATERIALS

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
pH	units	11	7.6	<5.5	0
Sulphate (w/s)	mg/l	11	1860	500	1
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	1	None Detected	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	2	None Detected	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	2	None Detected	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	2	None Detected	0.1	0
Phenols	mg/kg	1	None Detected	2	0
Cresols and chlorinated phenols	mg/kg	1	None Detected	2	0
Naphthalene	mg/kg	5	>0.1	0.5	0
Benzo(a)pyrene	mg/kg	5	0.26	0.5	0

RESULTS EXCEEDING BUILDING MATERIALS ASSESSMENT CRITERIA

WATER SOLUBLE SULPHATE

Concentrations of water soluble sulphate are such that they could detrimentally impact sub-surface concrete. The impact on concrete mix design is a geotechnical issue that is considered separately and so no further comment is made on these results within this contamination assessment.

8. RISK EVALUATION

8.1. REVISED CONCEPTUAL MODEL

The revised conceptual site model plan is presented in the Appendices.

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	No significant contamination has been recorded at the site. As such all of the potential pollutant linkages identified at the start of the ground investigation have been proven to be invalid.
LIMITATIONS AND UNCERTAINTIES	All of the potential contamination sources have been targeted by the exploratory holes and therefore it is considered that a sufficient number of exploratory points have been completed for contamination assessment purposes.

8.2. UPDATED CONTAMINATION RISK ASSESSMENT

The pollutant linkages identified in the revised conceptual site model will now be evaluated as to their severity:

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Off-site former builder's yard - Petroleum hydrocarbons (diesel). Asbestos containing materials (e.g. cement asbestos building products).	Ingestion Inhalation	Residents	Negligible Risk
	Consumption of home grown produce		
	Inhalation of fibres		
	Direct Contact	Water Supply Pipes	Negligible Risk

The contamination risks that are presented to the various receptor groups are discussed further in the following sections:

RISK TO HUMAN HEALTH
No significant risks identified.
RISK TO WATER ENVIRONMENT
No significant risks identified.

RISK TO BUILDING MATERIALS AND SERVICES

No significant risks identified.

8.3. RISK MANAGEMENT

8.3.1. Introduction

No significant contamination risks have been identified and as such the site can be considered suitable for its proposed use.

It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory.

8.3.2. Further Contamination Assessment

It is considered that no further ground investigation is required for contamination assessment purposes.

8.3.3. Outline Remediation Strategy

Due to the absence of contamination risks, no remediation is considered necessary.

8.4. WASTE SOIL DISPOSAL

Topsoil should be viewed as a resource rather than a waste. As the topsoil is suitable for residential garden use in terms contamination, the topsoil at the site should be stripped and the surplus reused on other developments. It should be noted that topsoil, even if uncontaminated, is unlikely to constitute 'inert waste' due to its high organic matter content.

It is considered that the natural sub-soils disposed of from the site would be classified as 'non-hazardous waste' and would be characterised for disposal to landfill as 'inert waste'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. Waste Acceptance Criteria (WAC) testing of the soils will also be required where the soil is to be disposed of at a landfill permitted to accept inert waste. Such WAC testing has been completed and the results are in the Appendices which confirm the soil tested complies with the inert waste limits. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'.

9. HEALTH AND SAFETY FILE INFORMATION

9.1. INTRODUCTION

The aim of the following sections is to present pertinent Health and Safety information that has arisen from the current investigation/survey works discussed in this report. The aim is to identify health and safety controls that may be necessary during any subsequent maintenance, refurbishment, demolition or construction works. The information is not exhaustive and stems only from the aspects identified within the scope of the works undertaken by BRD.

Where BRD has been appointed as a Principal Contractor, then this information shall form the Health and Safety Files as required by the Construction Design and Management (CDM) Regulations 2015.

Reports are always forwarded to the Client and they shall be responsible for ensuring this safety information is disseminated to those who need it.

The works undertaken by BRD are detailed in the previous sections of this report.

9.2. HAZARDS

During the course of the BRD works the following noteworthy safety hazards have been identified:

9.2.1. Contamination

Although no contamination has been identified, as with any construction site, if any anomalous material is encountered during the redevelopment then expert environmental advice should be sought.

9.2.2. Other Issues

During the BRD works the following safety hazards were identified:

- There is open water hazards on the eastern site boundary and to the south east of the site where the off-site pond and connected ditch are present.

9.3. HAZARDOUS MATERIALS

BRD did not construct anything with hazardous materials.

Any soils to be imported to the site, in particular topsoil, should be tested to confirm their suitability in the development.

9.4. UTILITY SERVICES

No previously unidentified utility services were encountered during the BRD works.

The utility services plans held by the Client should be referred to.

The utility service companies should be contacted for records of their own equipment.

REPORT SPECIFIC REFERENCES

- ‘Phase 1 Geo-Environmental Desk Study - Land at Arlesey Road, Ickleford’, BRD Environmental Ltd, report ref. BRD4359-OR1-A, dated December 2023.
- British Geological Survey sheet 221 “Hitchin” Solid and Drift edition (1:50,000) published 1995.

SUPPORTING INFORMATION

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Consultant in general accordance with 'Code of practice for site investigations' BS5930:2015, British Standards Institution, 2015. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

Where stated on the logs of inspection pits, trial pits or boreholes (where insitu testing has not been undertaken), the relative density of coarse (sand and gravel) soils is tentative only. Such assessments of density are on the basis of visual inspection only taking into consideration such factors as drilling rates, stability of pit side walls, appearance and behaviour under excavation.

Where Chalk strata is encountered it is logged and graded in general accordance with CIRIA guidance 'C574 - Engineering in Chalk'. It should be recognised that where percussive drilling methods are employed, the structure of the Chalk is destroyed and therefore the grading stated on such logs is either tentative or absent where it is not possible to assess the grade.

Hand Dug Inspection Pits

Hand tools are used to forward shallow inspection pits as a cost effective method of describing and sampling near surface soils. The technique is also used where exposure of existing footings is required. The depth reached by such techniques is a function of the nature of the ground and generally does not exceed 1.5m

Trial Pits

Mechanically excavated trial pits allow detailed inspection of near surface ground due to the large volume of soil exposed. A wheeled backhoe loader is the usual machine for digging trial pits that are typically 3 to 4.5m deep, 0.5m wide and 3m long.

Windowless Sampling Boreholes

This type of borehole is formed by a small tracked dynamic percussion drilling rig with samples retrieved in thin plastic liners within the narrow diameter steel sampling tubes. Borehole depths of up to 5m are typical, but in exceptional circumstances up to 15m depth can be achieved. This is the smallest type of rig that is capable of undertaking Standard Penetration Tests (SPTs).

Hand Held Window Sampling

Hand held window sampling is a useful method of drilling narrow diameter boreholes particularly where access is difficult. Hand held mechanical percussive hammers are used to drive the sampling tube into the ground. The soil samples are collected within the hollow metal sampling tubes and inspected via the open window along one side. Window sampling boreholes can be forwarded to depths of 3m to 6m depending upon ground conditions.

Cable Percussive Boreholes

This form of drilling involves repetitive dropping of a tube into the soil under its own weight from a tripod support. The sample is obtained from the clay cutter head in fine soils or a bailer for wet granular soils. As the borehole progresses SPTs can be undertaken and relatively undisturbed samples can be obtained. Typically these boreholes are 15 to 25m deep, but depths of double that can be achieved in soils, but only thin weak rock layers can be penetrated.



Rotary Boreholes

Where competent rock is required to be drilled then rotary drilling techniques are required. The drilling rigs can vary in size from small tracked units to larger units mounted on four wheel drive trucks. Rotary open hole drilling techniques break the rock into small fragments and so recovery of any samples is limited. In contrast, rotary coring retrieves excellent samples. Some rigs also allow windowless sampling to be undertaken through soil layers. There are no practical limits to the depths that this drilling method can achieve.

Dynamic Probing

Dynamic probing comprises a sectional rod with a sacrificial cone at the base of slightly larger diameter than the rod. The rod is driven into the ground by a constant mass falling through a set distance. The number of blows required to forward the rod per 100mm is then recorded and presented in a graph of N_{10} values. The standard applicable to dynamic probing is "BS EN ISO 22476-2:2005 Incorporating corrigendum no. 1, Geotechnical investigation and testing – Field testing – Part 2: Dynamic probing" BSi, February 2007.

Static Cone Penetration Tests

Cone Penetration Tests (CPT) consist of pushing a conical 60° cone into the ground at a constant rate and recording the force required to do this. Sensors in the cone record other information and this data can be correlated to a number of different geotechnical parameters.

Dynamic Penetrometer

The Transport Research Laboratory Dynamic Cone Penetrometer (TRL DCP) uses an 8 kg hammer dropping through a height of 575mm to drive a 60° cone of 20mm maximum diameter into the ground. The depth driven either per blow or per several blows is recorded. The strength of each of the soil layer encountered is then calculated by converting the penetration rate (mm per blow) into an approximate California Bearing Ratio (CBR) value employing the correlation proposed by TRL.

Gas Monitoring

Gas monitoring is undertaken with a portable gas monitor for oxygen, Methane, Carbon Dioxide, Hydrogen Sulphide and Carbon Monoxide together with recording of atmospheric pressure and any flow rate.

Vapour Monitoring

Headspace tests and monitoring for Volatile Organic Compounds (VOC) or Semi Volatile Organic Compounds (SVOC) is undertaken using a Photo Ionisation Detector (PID). The MiniRAE models used have a 10.6 eV lamp calibrated for isobutylene. The PID is useful tool to indicate the presence of a wide range of volatile compounds, but only provides semi-quantitative data as different compounds provide a different response and thus the reading is not a true reflection of the actual concentration present.

Low PID readings can be recorded in natural uncontaminated organic soils or even as a result of atmospheric pollution. It is generally accepted by consultants and regulators that recorded values in excess 50 parts per million (ppm) represents the presence of organic compound pollutants and in excess of 100 ppm such contamination may be significant.

The headspace test procedure involves the collection of a sample of suspected contaminated soils and placing within a sample bag. A tight seal to the bag is formed with a similar volume of air trapped to that of the soil and the sample is left for fifteen minutes to allow volatilisation of any contaminants. The bag is then pierced by, and sealed around, the sample probe of the PID and a reading taken.

Borehole well monitoring is undertaken by connecting the PID directly to the gas tap on the monitoring well installation.

Groundwater Level Monitoring

Groundwater levels are recorded with an electronic dip meter that has a detector end that is lowered into the borehole well. An audible signal is made when water is reached and the depth recorded from the graduated tape used to lower the detector. Where there is potential for a separate Light Non Aqueous Phase Liquid (LNAPL) to be present floating on the groundwater an oil/water interface meter is used in preference to a conventional dip meter so that any such floating product can be detected.

Geotechnical Sampling

BRD schedule a range of geotechnical testing as appropriate to the identified ground conditions, available budget and the proposed development. Different types of soil samples are obtained as appropriate to the ground conditions and planned testing.

SAMPLE TYPE	SYMBOL USED ON LOGS	DESCRIPTION
<i>Disturbed</i>	<i>D</i>	<i>Small disturbed soil samples of about 1 to 2 kg are collected in plastic bags.</i>
<i>Bulk</i>	<i>B</i>	<i>Large disturbed bulk samples up to about 20 to 30 kg are collected in plastic bags</i>
<i>Undisturbed</i>	<i>U</i>	<i>‘Undisturbed’ samples generally collected in plastic or metal tubes within cable percussive boreholes of 100mm diameter for samples of fine soils of firm to stiff consistency. Can also be representative of samples taken by cutting plastic sample liners from windowless sampling drilling methods. It is recognised that such samples do not generally meet Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common in United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.</i>
<i>Undisturbed</i>	<i>UT</i>	<i>A thin walled steel sampler developed by Archway Engineering called a UT100 in an attempt to gain better quality samples of soft to firm fine soils when using cable percussive drilling methods.</i>

Contamination Sampling

BRD schedule contamination testing as appropriate to the ground conditions, available budget, potential contaminants and the proposed development. Samples are collected in single use laboratory supplied containers.

Soil samples are retrieved in plastic containers and/or amber glass jars with a lined plastic cap. Contamination samples are indicated by a 'J' on exploratory hole logs.

Water samples are collected in plastic bottles and/or amber glass jars with a lined plastic cap then placed in cool boxes together with freezer packs. Water samples are indicated by a 'W' on exploratory hole records, but generally such samples are not tested as testing from dedicated monitoring wells is preferred for sample quality reasons.

Samples retrieved from the exploratory holes are dispatched to the laboratory by overnight courier. Where samples cannot be transported directly from site they are temporarily stored in the BRD dedicated sample storage facility which includes refrigeration where necessary. The individual accreditation of the test methods is detailed in the laboratory test report.

GEOTECHNICAL ASSESSMENT

Under Eurocode 7 (EC7) the following risk ranking is applied to geotechnical projects:

GEOTECHNICAL CATEGORY	DESCRIPTION
1	<i>Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk. For example, straightforward ground conditions, local experience, no excavation below the water table unless this will be straight forward.</i>
2	<i>Conventional types of structures and foundations. No difficult soil or loading conditions. Quantitative geotechnical data and laboratory testing. Routine procedures for field and laboratory testing. Conventional structures and no exceptional geotechnical risk. For example, spread, raft and piled foundations, retaining walls, bridge piers and abutments, embankments, ground anchors, tunnels and excavations.</i>
3	<i>Those structures not in Categories 1 and 2 such as very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions. Structures in highly seismic areas. Structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.</i>

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The tests are undertaken in general accordance with 'Digest DG 365: Soakaway design' BRE, Revised 2016. The test pits are usually gravel filled for safety with a slotted vertical pipe through which water observations are made. Water is generally supplied by a tanker to allow fast filling of the pits with water. Compliant tests are filled and allowed to drain near empty three times.

Standard Penetration Tests

The standard penetration test (SPT) determines the resistance of soils at the base of a borehole to the dynamic penetration of a split barrel sampler and the recovering of disturbed samples for identification purposes. In gravelly soils and some soft rocks a solid cone is used in preference to the sampler.

The basis of the test consists in driving a sampler by dropping a hammer of 63.5 kg mass on from a height of 760 mm. The number of blows (N value) necessary to achieve a penetration of the sampler of 300 mm is recorded. The test is described in 'Geotechnical investigation and testing – Field testing – Part 3: Standard penetration test - BS EN ISO 22476-3:2005 Incorporating corrigendum no. 1', BSi, 2007.

The uncorrected N values of the SPT tests are recorded upon the borehole logs together with a record of blows for each 75mm test portion including the seating blows. Where the full test depth cannot be achieved due to refusal on hard stratum, the number of blows and the distance achieved is recorded and the N value given as >50. The abbreviation SPT(c) is used upon the logs indicates that the test was performed with a solid cone rather than a split spoon sampler.

It is necessary to apply a correction to the N values to account for the effects of energy delivery using the equation: $N_{60} = \frac{E_r}{60} N$ where E_r is the energy ratio of the specific test equipment.

In the case of tests in sand, for the effects of overburden and rod length the equation is modified to $N_{60} = \frac{E_r}{60} \times \lambda \times C_N \times N$ where λ is the correction factor for energy losses due to the rod length and C_N is the correction factor for vertical stress due to overburden of the soil.

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 mg/l. Laboratory results expressed as SO_3 g/l and are multiplied by a factor of 1200 to express the results as SO_4 mg/l.

Index Property Tests

In accordance with National House Building Council (NHBC) Standards Chapter 4.2 - Building near trees, the laboratory plasticity indexes are assessed against their volume change potential. The Modified Plasticity Index is defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 425µm. Whilst the NHBC Standards were developed for residential buildings, the advice is equally applicable to a large number of other types of low rise structures.

Hand Shear Vane

The undrained shear strength of the fine (i.e. clay) soils at the site can be established using hand shear vane apparatus. Usually three readings are taken at every depth tested and the uncorrected results recorded on the exploratory point log. Shear vane readings from depths below 1.2m depth in trial pits are from tests performed on excavated soil. In accordance with Eurocode 7 – Geotechnical design – Part 2: Ground investigation and testing EN 1997-2:2007 the results should be corrected. BRD employ only simple correction methods as the more complex correction methodologies imply undue accuracy to a test that has distinct disadvantages and limitations.

Pocket Penetrometers

The Pocket Penetrometer is a lightweight instrument for use by field personnel to check visual classification of soils. It is a simple test and there is inherent uncertainty related to the small volume of soil being tested and so the results should be used with appropriate caution. Pocket penetrometers are calibrated in terms of unconfined compressive strength and once converted to undrained shear strength (divide by two) the results are further reduced by a factor of 1.5 - 2.0 as the device tends to overestimate strengths.

<i>Instrument Reading (uncompressive strength in kg/cm²)</i>	<i>Indicative Undrained Shear Strength (kN/m²)</i>	<i>Indicative Consistency</i>	<i>Indicative strength</i>
1.0	25 - 33	Soft	Low
1.5	38 - 50	Soft to firm	Low to medium
2.0	50 - 67	Firm	Medium
2.5	63 - 83	Firm to stiff	Medium to high
3.5	88 - 116	Stiff	High
4.5	113 - 150	Stiff to very stiff	High to very high

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.

The three main drivers for contamination assessment and remediation are:

- Voluntary action.*
- Development as part of the planning regime.*
- Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.*

Pollutant Linkages

For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.

Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:

- The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- Migration of pollutants from adjacent land.*
- Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.*

Conceptual Site Model

The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.

It is important that the conceptual site model is updated with new information as the various investigation, risk assessment and remediation works are completed.

Technical Guidance

The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:

- 'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175:2011+A2:2017', The British Standards Institution 2017.
- Land Contamination Risk Management, Environment Agency, 2021.
- 'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.

Risk Assessment Methodology

In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:

PHASE	DESCRIPTION	RISK ASSESSMENT STAGE
PHASE 1	Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.	Hazard Identification and Assessment A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.
PHASE 2	This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.	Risk Estimation A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions. Risk Evaluation A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.
PHASE 3	The appraisal and selection of remediation techniques, their implementation and verification.	Risk Management The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.

Risk Classification

The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:

- The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].
- The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].

There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:

		SEVERITY OF CONSEQUENCE			
		SEVERE	MEDIUM	MILD	MINOR
PROBABILITY	HIGH LIKELIHOOD	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	LIKELY	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	LOW LIKELIHOOD	Moderate Risk	Moderate/Low Risk	Low Risk	Negligible Risk
	UNLIKELY	Moderate/Low Risk	Low Risk	Negligible Risk	Negligible Risk

These risk classifications are defined as follows:

- **Very High Risk** - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.
- **High Risk** - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.
- **Moderate Risk** - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.
- **Low Risk** - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.
- **Negligible Risk** - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

The Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) had previously issued revised guidance following the consultation about the DEFRA publication “Assessing risks from land contamination - a proportionate approach. Soil Guideline Values: the Way Forward”. This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model (version 1.06) and a few of the previously published Soil Guideline Values (SGVs) were revised.

The main legislative driver for dealing with historical land affected by contamination is Part 2A of the Environmental Protection Act 1990. Revised Statutory Guidance to support Part 2A was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health,¹ 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. The impact assessment for the new Statutory Guidance stated “The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land”. The C4SLs are still derived using the CLEA model, but adopt a slightly different approach to toxicological assessment and exposure modelling.

In March 2014, the outcome of “SP1010 - Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report” (CL:AIRE) was published. Due to slightly ambiguous wording within this report, Lord de Mauley, Parliamentary Under Secretary, DEFRA wrote to all local authorities on 3 September 2014 to confirm that the published C4SLs were final and that they can be used in risk assessment undertaken under the planning regime.

Whilst there are proposals for the industry to develop C4SLs for other contaminants, these have yet to produce any new values. BRD do not believe that C4SLs could be developed by a single organisation with sufficient confidence. BRD has therefore employed other, more conservative guidance based on the CLEA model (detailed below) within this assessment for compounds where C4SLs are not available. However, it should be noted that the results of this investigation may need to be reinterpreted as new C4SLs become available.

Due to the limited number of published C4SL values at this time, the Chartered Institute of Environmental health (CIEH) and Land Quality Management Ltd (LQM) have produced Generic Assessment Criteria (GAC) known as Suitable for Use Levels (S4ULs), for use in contaminated land human health risk assessment. These S4ULs (2014) have been derived for a large number of substances using the current CLEA model and are therefore consistent with current guidance. They also incorporate the revised exposure parameters as adopted by the C4SL programme, but have not adopted the revised toxicological approach adopted by the C4SLs and so remain a more conservative assessment criteria. The substances for which SGVs were previously published have also been revised as new S4ULs in light of the new exposure parameters proposed by the C4SL programme, and therefore effectively replace the existing SGVs.

In addition, in December 2009, other GAC for less common substances were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.

In summary, C4SLs have been used where these are available. For those substances where C4SLs have yet to be issued, then the S4ULs have been adopted or in some cases, the EIC/AGS/CLAIRE GAC. All of the previously produced SGVs have now either been withdrawn, or superseded by the respective C4SLs or S4ULs.

The only exception to this approach is the PAH compound benzo(a)pyrene (BaP) where a C4SL guideline value has been produced, whereas BRD has adopted the S4UL value. The C4SL for BaP relates to its use as a surrogate marker compound representing all of the genotoxic PAH compounds as a mixture, rather than this individual compound. BRD has therefore adopted the compound specific S4UL value as the initial screening value, for consistency with the other PAH compounds before then employing the C4SL is necessary.

It should be noted that unless otherwise stated, all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1% where applicable (i.e. organic contaminants).

Human Health - Soil Generic Assessment Criteria

The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. Where applicable, the results have also been assessed with reference to the required statistical tests presented within CLAIRE document "Guidance on comparing soil contamination data with a critical concentration".

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total) ⁵	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	
Dibenzo(a,h)anthracene	0.24	0.31	3.5	S4UL
Benzo(ghi)perylene	320	360	3,900	
TPH Aliphatic C5-C6	42	42	3,200	
TPH Aliphatic C6-C8	100	100	7,800	
TPH Aliphatic C8-C10	27	27	2,000	
TPH Aliphatic C10-C12	130	130	9,700	
TPH Aliphatic C12-C16	1,100	1,100	59,000	
TPH Aliphatic C16-C35	65,000	65,000	1,600,000	
TPH Aliphatic C35-C44	65,000	65,000	1,600,000	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
TPH Aromatic C5-C7	70	370	26,000	
TPH Aromatic C7-C8	130	860	56,000	
TPH Aromatic C8-C10	34	47	3,500	
TPH Aromatic C10-C12	74	250	16,000	
TPH Aromatic C12-C16	140	1,800	36,000	
TPH Aromatic C16-C21	260	1,900	28,000	
TPH Aromatic C21-C35	1,100	1,900	28,000	
TPH Aromatic C35-C44	1,100	1,900	28,000	
Benzene	0.87	3.3	98	C4SL
Toluene	130	880	56,000	S4UL
Ethylbenzene	47	83	5,700	
Xylene [^]	56	79	5,900	EIC / AGS / CL: AIRE GAC
MTBE	49	73	7,900	

Notes:

* The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.

[^] The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.

[§] S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

Water Environment - Soil Generic Assessment Criteria

There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment and therefore risk estimation is on the basis of the professional judgement and experience of BRD to employ values that are a reasonable concentration above which concern for water resources is valid.

The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). BRD employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.

In respect of Total Petroleum Hydrocarbons, BRD employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:

- In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.
- BRD is aware of regional Environment Agency groundwater and contaminated land teams historically employing 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.
- The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.

Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.

Building Materials and Services - Soil Generic Assessment Criteria

Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.

The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.

The UKWIR guidance is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, BRD have adopted the approach of summing only those compounds detected above their respective limits of detection.

In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
pH	<5.5	BRE Special Digest 1:2005
Sulphate (w/s)	500 mg/l	BRE Special Digest 1:2005
Sum of any VOC above detection limits	0.5 mg/kg	Relevant compounds adapted from UKWIR Table 3.1
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	2 mg/kg	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	10 mg/kg	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	500 mg/kg	
Sum of BTEX + MTBE above detection limits	0.1 mg/kg	
Phenols	2 mg/kg	
Cresols and chlorinated phenols	2 mg/kg	
Naphthalene	0.5 mg/kg	
Benzo(a)pyrene	0.5 mg/kg	

RISK ESTIMATION - GROUNDWATER

The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values (GAC) that are protective of groundwater resources.

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS) (accessed July 2018: <http://evidence.environment-agency.gov.uk/ChemicalStandards/report.aspx?cid=17>), the Water Supply (Water Quality) Regulations 2016 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table below. The 'Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies'. CL:AIRE, 2017 has also been used as reference source for the values.

ANALYSIS	GENERIC ASSESSMENT CRITERIA (GAC)	SOURCE
Arsenic	50 µg/l	DW1 & EQS
Cadmium	5 µg/l	EQS
Chromium (total)	50 µg/l	DW2 & EQS
Copper	50 µg/l	DW1
Nickel	20 µg/l	EQS
Lead	50 µg/l	DW1
Mercury	1 µg/l	WSR
Selenium	10 µg/l	WSR
Zinc	5 mg/l	DW2
Cyanide	50 µg/l	WSR
pH	6 to 9 units	EQS
Benzene	10 µg/l	EQS
Toluene	74 µg/l	EQS
Ethylbenzene	300 µg/l	WHO guideline
Xylene	30 µg/l	EQS
Methyl tert-butyl ether (MTBE)	15 µg/l	Taste and odour threshold.
Naphthalene	2 µg/l	EQS
Benzo(a)pyrene	0.0017 µg/l	EQS - Less than Limit of Detection (LOD)
Total PAH	0.2 µg/l	DW1
TPH Aliphatic C5-C6	15,000 µg/l	World Health Organization (WHO) guide values for TPHCWG fractions in drinking water
TPH Aliphatic C6-C8	15,000 µg/l	
TPH Aliphatic C8-C10	300 µg/l	
TPH Aliphatic C10-C12	300 µg/l	
TPH Aliphatic C12-C16	300 µg/l	
TPH Aromatic C5-C7	10 µg/l	
TPH Aromatic C7-C8	700 µg/l	
TPH Aromatic C8-C10	300 µg/l	
TPH Aromatic C10-C12	90 µg/l	
TPH Aromatic C12-C16	90 µg/l	
TPH Aromatic C16-C21	90 µg/l	
TPH Aromatic C21-C35	90 µg/l	

There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.

RISK ESTIMATION - GROUND GAS

Introduction

A variety of potentially hazardous gases occur naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.

Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.

Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.

Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every building contains radon, some buildings built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2015 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new buildings, extensions or refurbishments.

Basis of Gas Assessment

In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:

- The source of the gas.*
- The generation potential of the gas.*
- The location of the source and the geological setting.*
- Boreholes flow rate and estimated surface emission rate.*
- The nature of the proposed development.*
- Confidence in the knowledge of the gas regime.*

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007 and 'BS8485:2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' BSi 2015.



Gas Screening Value

The methods within CIRIA C665 and BS8485 both use the gas concentrations together with the borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

$$\text{Gas Screening Value (l / hr)} = \text{borehole flow rate (l/hr)} \times \text{gas concentration (fraction)}$$

The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.

Characteristic Gas Situation

The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.

Characteristic situation	Hazard potential	Gas Screening Value (CH ₄ or CO ₂ l/hr)	Additional factors
CS1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.
CS2	Low risk	0.07 to <0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.
CS3	Moderate risk	0.7 to <3.5	-
CS4	Moderate to high risk	3.5 to <15	-
CS5	High risk	15 to <70	-
CS6	Very high risk	>70	-

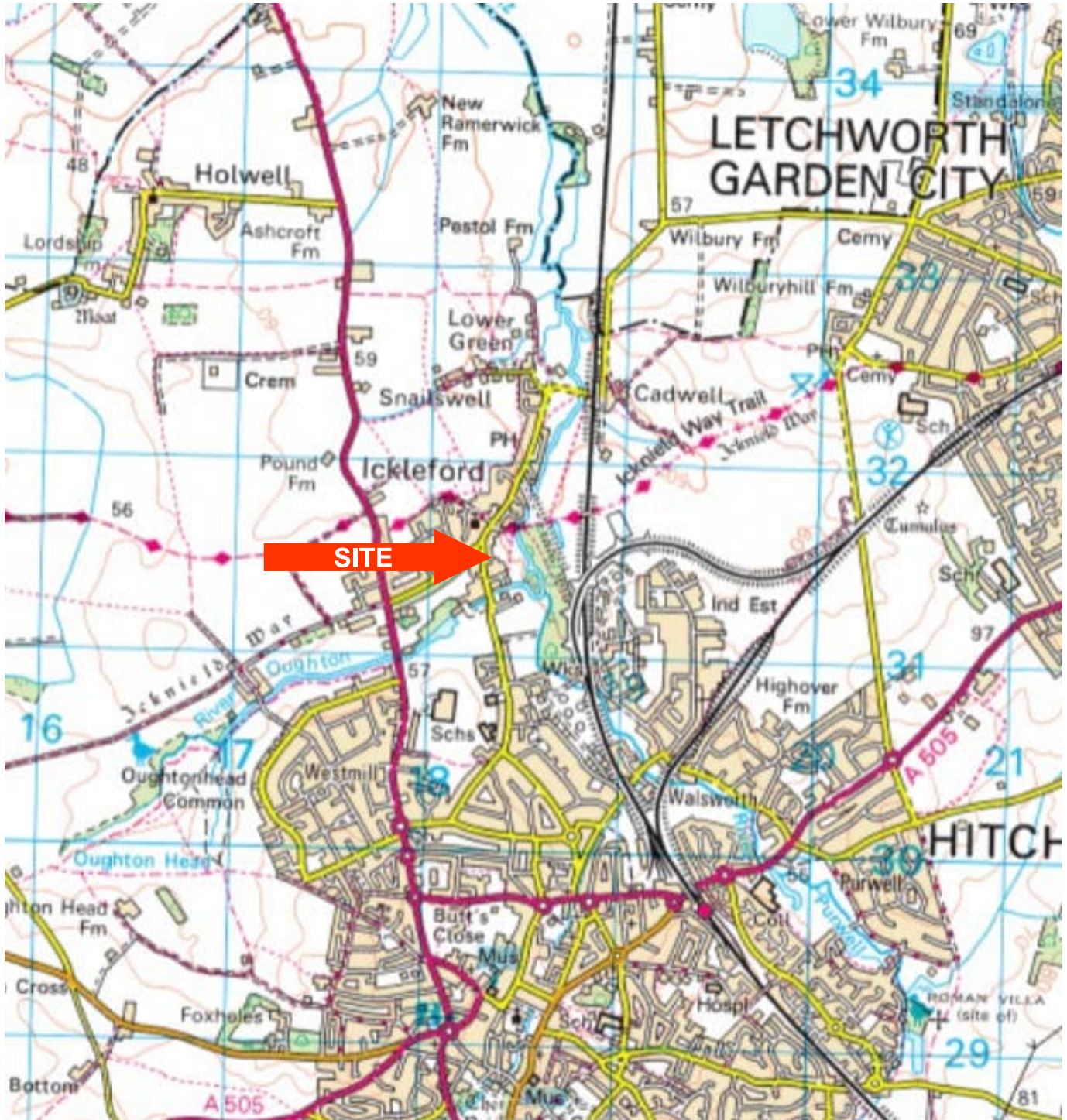
Low rise housing with gardens - NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m², suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1 > to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5 > to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

APPENDIX 1

Site Location Plan



Not to scale.

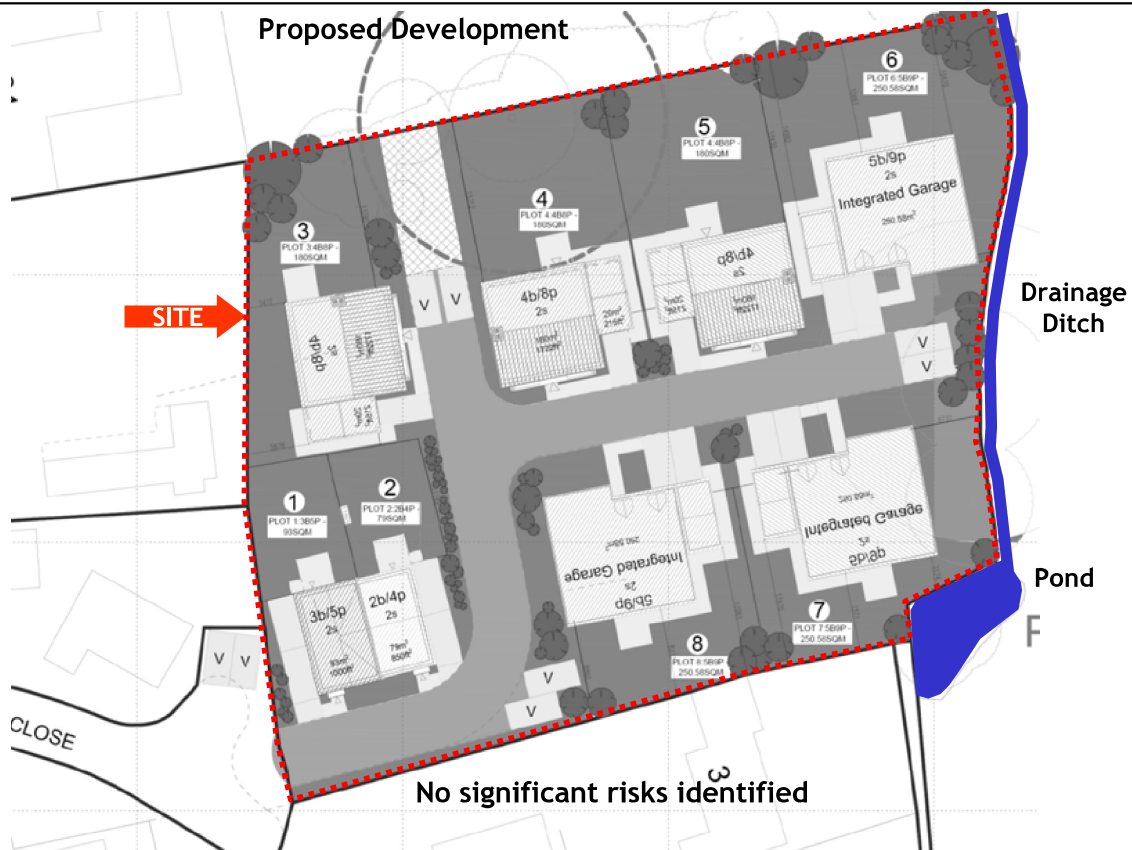
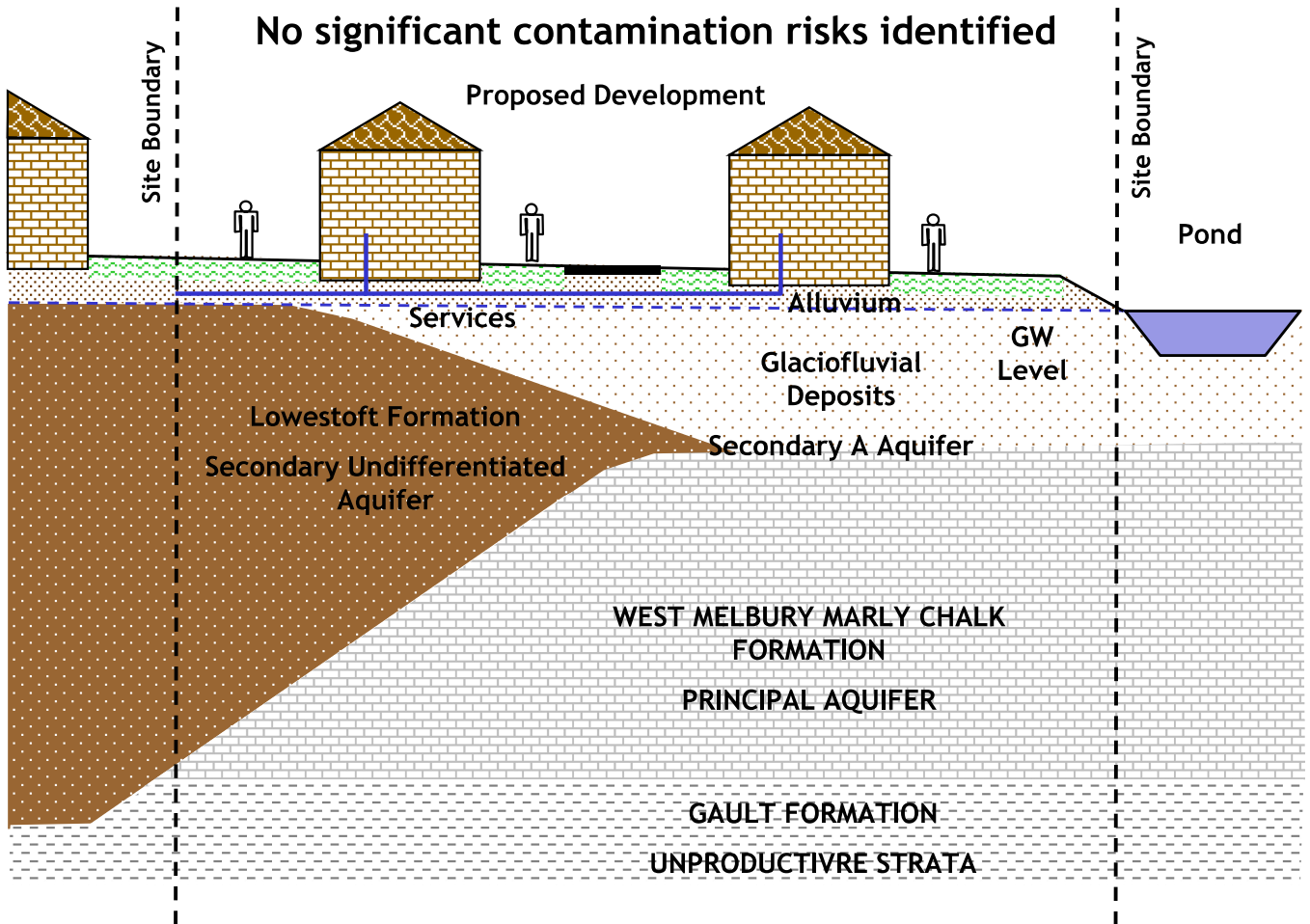
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Project Title: Land at Arlesey Road, Ickleford
Client: Peter David Homes
BRD Reference: BRD4359-OP2-A
Date Issued: December 2023



01295 272244
info@brduk.com

Revised Conceptual Model



Project Title: Land at Arlesey Road, Ickleford
 Client: Peter David Homes
 BRD Reference: BRD4359-OP5-A
 Date Issued: January 2024



Notes:

NOTES

- The connector is responsible for checking dimensions, dimensions and references. Any discrepancy will be verified with the Architect before proceeding with the work.
 - Where an item is covered by drawings to different scales the larger scale drawing is to be worked to.
 - Do not scale drawing. Fixed dimensions to be worked to in all cases.
- The structural civil engineering and architectural information shown on this drawing is purely for coordination purposes only and in no way does it take on any responsibility or liability for errors. It is stated information relating to these items has been taken from drawings and design information.
- Do not copy to 1:4 or in part without the expressed consent of MEA Ltd.

CDM Regulations 2015

ALL current drawings and specifications for the project must be read in conjunction with the Designer's Hazard and Environmental Assessment Record.

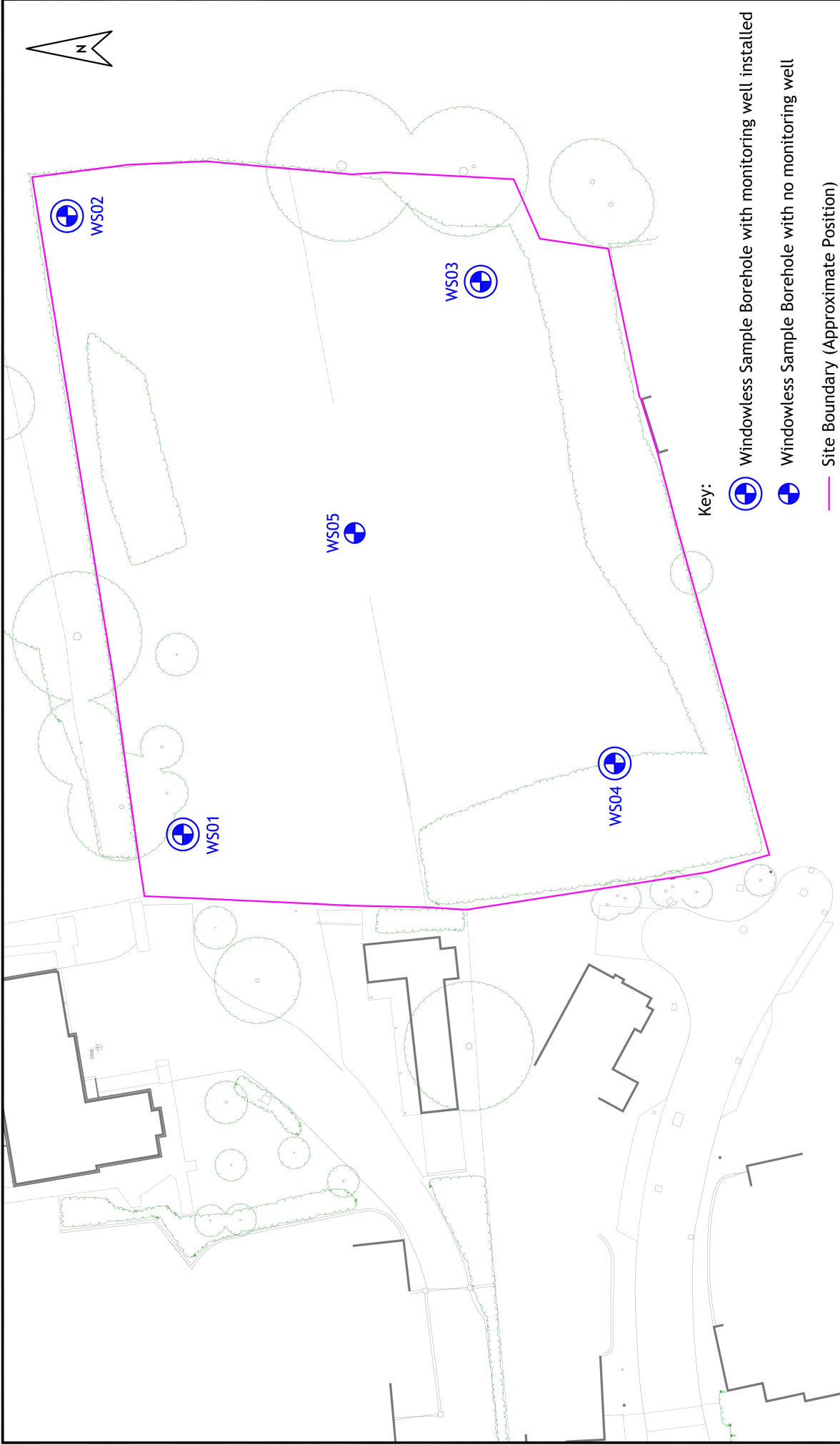


Site Plan
Scale 1:200

284°	98.5P	488P	589P	GIA (m2)	GIA (m2)-SUM	UNITS
SEMI	SEMI	DETACHED	DETACHED			
1	1			79	79	
				93	93	
				180	540	
		3				
			3		250.58	751.74
TOTALS						
					1449.74	8
					19755.57	SQFT

TITLE NUMBER
- HD430757

[illegible]



Notes:
All BRD exploratory points located using topographical grade GPS.

Drawing reproduced from Chinery Land Surveys, 'Topographical Survey - Land Rear of Arlesey Road, Ickleford', drawing ref: CLS23126001, Revision 0, dated: 25/09/2023.

Project title		LAND AT ARLESEY ROAD, ICKLEFORD			
Client		PETER DAVID HOMES			
Scale	1:500	Original drg. size/ colour		Date	
		A4 / C		08/01/2024	
Drawn	RD	Checked	RD	Approved	
				BD	

Drawing title		EXPLORATORY POINT PLAN	
Drawing Number		BRD4359-OD1	
Rev		A	



- Key:
- Windowless Sample Borehole with monitoring well installed
 - Windowless Sample Borehole with no monitoring well
 - Site Boundary (Approximate Position)

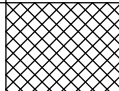
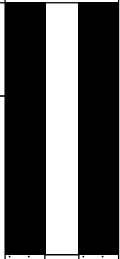
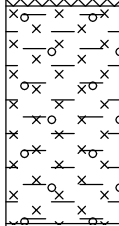
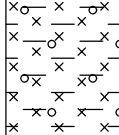
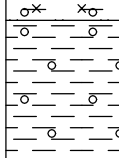
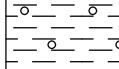
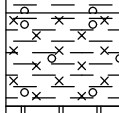
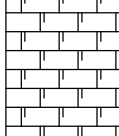
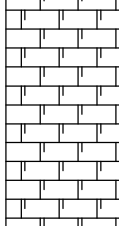
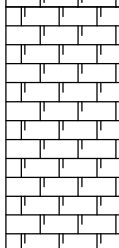
Preliminary Foundation Zoning Plan



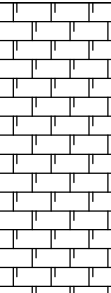
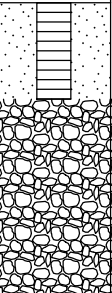
Project Title: Arlessey Road, Ickleford
Client: Peter David Homes
BRD Reference: BRD4359-OP6-A
Date Issued: February 2024

APPENDIX 2

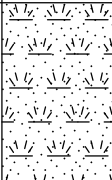
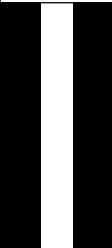
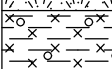
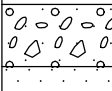
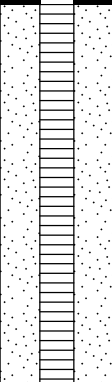
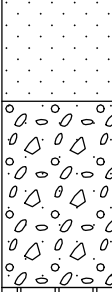
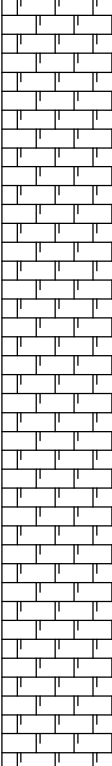
PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS01		
						Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			MADE GROUND: Grass over dark brown, slightly gravelly, very silty clay topsoil with many rootlets and rare brick fragments. Gravel of fine to coarse, angular to subrounded flint and rare quartzite.	0.30 (50.71)		MG	
0.70 0.70 0.80	PEN J2 D1	2.5/2.25/1.75 kg/cm²		Stiff, friable, organic, dark brown, slightly gravelly, very clayey SILT with occasional rootlets. Gravel of fine to coarse, angular to subrounded flint and occasional chalk.			ALLUVIUM	
1.00 1.10	SPT D2	17 N		Stiff, beige to light grey, gravelly, clayey SILT. Gravel of fine, angular to rounded flint, chalk and rare sandstone. 1.00 m: SPT: 3,2/3,4,4,6 1.30 m: Becoming sandy then very sandy.	1.00 (50.01)		GLACIOFLUVIAL DEPOSITS	
1.50 1.60	B1 PEN	1.75/3.0/2.25 kg/cm²		Stiff, light orange brown with some beige and cream, slightly silty, slightly sandy, very gravelly CLAY/ very clayey GRAVEL of fine to coarse, angular to subrounded flint, chalk and rare other lithologies.	1.50 (49.51)			
2.00	SPT(C)	10 N		2.00 m: SPT(C): 2,2/3,2,3,2	2.0			
2.30 2.30	PEN D3	1.75/1.5/2.0 kg/cm²		Stiff, grey brown mottled orange brown, gravelly, silty CLAY. Gravel of fine to medium, rounded to subangular chalk, flint and rare other lithologies.	2.20 (48.81)		LF	
2.60 2.70	PEN D4	3.5/3.75/3.5 kg/cm²		Structureless CHALK: Recovered as stiff, cream with dark orange brown weathering, slightly clayey, slightly gravelly silt. Gravel of fine to medium, angular chalk (CIRIA Grade Dm).	2.50 (48.51)		WEST MELBURY MARLY CHALK FORMATION	
3.00	SPT(C)	17 N		3.00 m: SPT(C): 2,2/3,3,5,6	3.0			
3.80 3.90 4.00	D5 PEN SPT	2.25/2.5/2.5 kg/cm² 10 N		CHALK: Recovered as very weak to weak, light grey, slightly clayey, silty gravel of calcareous mudstone (CIRIA Grade A-C undifferentiated). 4.00 m: SPT: 1,2/2,2,3,3	3.70 (47.31) 4.0			
					4.50			
General Remarks: Borehole terminated at 5.45m bgl. Monitoring well installed to 4.80m bgl.					Surface Elevation Level: 51.014 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

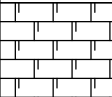
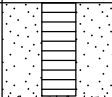
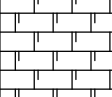
PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS01		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.70	PEN	2.5/2.75/2.5 kg/cm²		Continued from 3.70m: CHALK: Recovered as very weak to weak, light grey, slightly clayey, silty gravel of calcareous mudstone (CIRIA Grade A-C undifferentiated).			WMMCF	
4.90	D6				5.0			
5.00	SPT	20 N		5.00 m: SPT: 3,3/4,5,5,6	5.45 (45.56)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Borehole terminated at 5.45m bgl. Monitoring well installed to 4.80m bgl.					Surface Elevation Level: 51.014 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS02		
						Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Grass over moist, dark brown, very silty clay with many rootlets and occasional flint gravel.			TOPSOIL	
0.70 0.70	PEN J2	0.25/0.25/0.5 kg/cm²		Soft, moist, organic, dark brown, slightly gravelly, silty CLAY with occasional rootlets. Gravel of fine to medium, subangular to subrounded flint.	0.60 (48.80) 0.80 (48.60)		AL	
0.90 1.00 1.00	D1 SPT B1	9 N		Orange brown, very sandy GRAVEL of fine to coarse, angular to subrounded flint and occasional chalk. Loose, light brown, medium SAND with occasional flint gravel. 1.00 m: SPT: 0,0/2,2,2,3 1.00 - 2.00 m: Approximately 80% recovery.	1.0 1.00 (48.40)		GLACIOFLUVIAL DEPOSITS	
1.50	B2			Orange brown and off-white, sandy GRAVEL of fine to coarse, angular to subrounded flint and chalk.	1.40 (48.00)			
2.00	SPT	11 N		CHALK: Recovered as very weak to weak, light grey, slightly clayey, silty gravel of calcareous mudstone (CIRIA Grade A-C undifferentiated). 2.00 m: SPT: 1,2/1,3,3,4	2.0 2.00 (47.40)			
2.70 2.80	D2 PEN	2.0/2.0/2.25 kg/cm²						
3.00	SPT	17 N		3.00 m: SPT: 2,2/3,4,4,6	3.0			
3.70 3.80	PEN D3	2.25/2.5/3.0 kg/cm²						
4.00	SPT	48 N		4.00 m: SPT: 6,6/8,14,13,13	4.0			
					4.50			
General Remarks: Borehole terminated at 5.45m bgl. Borehole cased to 3.00m. Monitoring well installed to 4.80m bgl.					Surface Elevation Level: 49.397 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

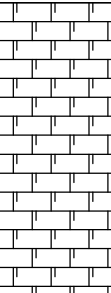
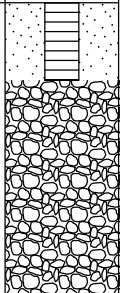
Client: Peter David Homes			Borehole No. WS02					
Project Title: Land at Arlesey Road, Ickleford								
Project No: BRD4359			Sheet 2 of 2					
Logged By: R Davies								
Date Commenced: 18/12/2024								
Date Completed: 18/12/2024								
Method Used: Windowless Percussive Sampling Rig								
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.70	PEN	4.5/4.5/>5.0		Continued from 2.00m: CHALK: Recovered as very weak to weak, light grey, slightly clayey, silty gravel of calcareous mudstone (CIRIA Grade A-C undifferentiated).	5.0		WM	
4.80	D4	kg/cm²						
5.00	SPT	29 N		5.00 m: SPT: 5,6/6,7,8,8	5.45 (43.95)		WM	
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Borehole terminated at 5.45m bgl. Borehole cased to 3.00m. Monitoring well installed to 4.80m bgl.					Surface Elevation Level: 49.397 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

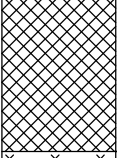
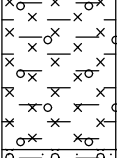
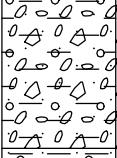
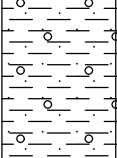
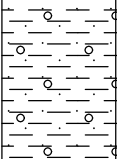
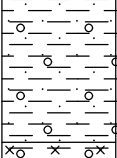
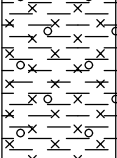
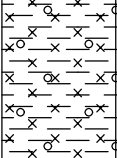
Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS03		
						Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Grass over moist, dark brown, very silty clay with many rootlets and occasional flint gravel.		TOPSOIL		
				Firm, organic, dark brown, very silty CLAY with occasional rootlets and occasional flint gravel.				ALLUVIUM
0.70	PEN J2	1.5/1.25/1 kg/cm²		0.70 m: Becoming moist.				
0.70	D1							
0.80								
1.00	SPT(C)	14 N		0.90 m: Rare chalk gravel.				
				Medium dense, orange brown, slightly clayey in parts, sandy to very sandy GRAVEL of fine to coarse, angular to subrounded flint and rare chalk.		GLACIOFLUVIAL DEPOSITS		
1.40	B1			1.00 m: SPT(C): 3,3/4,3,4,3				
2.00	SPT(C)	22 N		2.00 m: SPT(C): 3,2/3,6,7,6 2.00 - 3.00 m: Approximately 50% recovery due to groundwater.				
2.60	D2			Stiff, grey mottled orange brown, silty, gravelly CLAY. Gravel of fine to medium, angular to subrounded flint and chalk.				
				Orange brown, slightly clayey in parts, sandy to very sandy GRAVEL of fine to coarse, angular to subrounded flint and rare chalk.				
3.00	SPT(C)	17 N		CHALK: Recovered as very weak to weak, light grey, slightly clayey, silty gravel of calcareous mudstone (CIRIA Grade A-C undifferentiated).		WEST MELBURY MARLY CHALK FM		
				3.00 m: SPT(C): 2,2/3,4,5,5				
3.80	PEN D3	>5.0x3 kg/cm²						
3.90								
4.00	SPT(C)	30 N		4.00 m: SPT(C): 4,5/6,6,8,10				
					4.50			

General Remarks: Borehole terminated at 5.45m bgl. Borehole cased to 4.00m. Monitoring well installed to 4.75m bgl.	Surface Elevation Level: 50.068 mAOD	 Telephone: 01295 272244 Email: info@brduk.com
	All dimensions in metres Log Scale 1:25	

PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS03		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.70	PEN	3.5/3.5/>5.0		Continued from 3.00m: CHALK: Recovered as very weak to weak, light grey, slightly clayey, silty gravel of calcareous mudstone (CIRIA Grade A-C undifferentiated). 5.00 m: SPT: 7,7/8,10,11,13	5.0 5.45 (44.62) 6.0 7.0 8.0 9.0		WMMCF	
4.80	D4	kg/cm²						
5.00	SPT	42 N						
General Remarks: Borehole terminated at 5.45m bgl. Borehole cased to 4.00m. Monitoring well installed to 4.75m bgl.				Surface Elevation Level: 50.068 mAOD		 Telephone: 01295 272244 Email: info@brduk.com		
				All dimensions in metres Log Scale 1:25				

PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS04		
						Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			MADE GROUND: Grass over dark brown, slightly gravelly, very silty clay topsoil with many rootlets and rare brick fragments. Gravel of fine to coarse, angular to subrounded flint and rare quartzite.			MG	
0.70	J2			Stiff, organic, friable, dark brown, slightly gravelly, very clayey SILT. Gravel of fine to coarse, subangular to subrounded flint and rare sandstone.	0.50 (50.69)		ALLUVIUM	
0.80	PEN	2.25x3						
0.90	D1	kg/cm²						
1.00	SPT(C)	23 N		Medium dense, orange brown with occasional cream, slightly clayey, sandy GRAVEL of fine to coarse, subangular to subrounded flint and chalk.	1.0 1.00 (50.19)		GFD	
1.00	B1			1.00 m: SPT(C): 6,8/9,6,4,4				
1.70	PEN	1.25/1.5/1.5		Firm to stiff, grey brown mottled orange brown, slightly gravelly, slightly silty CLAY. Gravel of fine to coarse, subangular to rounded chalk, flint and rare other lithologies.	1.50 (49.69)		LOWESTOFT FORMATION	
1.80	D2	kg/cm²		1.80 m: Becoming gravelly.				
2.00	SPT	12 N		2.00 m: SPT: 1,2/2,3,3,4 2.00 m: Becoming stiff.	2.0			
2.90	D3							
3.00	SPT	23 N		Stiff, grey, slightly silty, gravelly CLAY. Gravel of fine to coarse, subangular to rounded chalk and rare other lithologies.	3.0 3.00 (48.19)			
3.70	D4			3.00 m: SPT: 6,7/6,5,7,5				
3.80	PEN	2.75/2.75/3.0						
4.00	SPT	18 N		4.00 m: SPT: 4,4/3,4,5,6	4.0			
					4.50			
General Remarks: Borehole terminated at 5.45m bgl. Monitoring well installed to 4.80m bgl.					Surface Elevation Level: 51.187 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

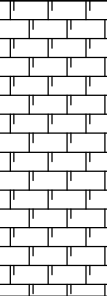
PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS04 Sheet 2 of 2																
Samples & Tests <table><tr><th>Depth</th><th>Type & No</th><th>Value</th></tr><tr><td>4.70</td><td>PEN</td><td>3.5/4.25/4.5</td></tr><tr><td>4.80</td><td>D5</td><td>kg/cm²</td></tr><tr><td>5.00</td><td>SPT</td><td>23 N</td></tr></table>			Depth	Type & No	Value	4.70	PEN	3.5/4.25/4.5	4.80	D5	kg/cm²	5.00	SPT	23 N	Water	Description of Strata Continued from 3.00m: Stiff, grey. slightly silty, gravelly CLAY. Gravel of fine to coarse, subangular to rounded chalk and rare other lithologies. 5.00 m: SPT: 3,3/5,5,6,7	Depth / (Level) 5.0 5.45 (45.74) 6.0 7.0 8.0 9.0	Legend LOWESTOFT FM	Geology	Installation /Backfill
Depth	Type & No	Value																		
4.70	PEN	3.5/4.25/4.5																		
4.80	D5	kg/cm²																		
5.00	SPT	23 N																		
General Remarks: Borehole terminated at 5.45m bgl. Monitoring well installed to 4.80m bgl.				Surface Elevation Level: 51.187 mAOD All dimensions in metres Log Scale 1:25		 Telephone: 01295 272244 Email: info@brduk.com														

PROBEHOLE RECORD

Client: Peter David Homes Project Title: Land at Arlesey Road, Ickleford Project No: BRD4359 Logged By: R Davies Date Commenced: 18/12/2024 Date Completed: 18/12/2024 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS05		
						Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			MADE GROUND: Grass over dark brown, slightly gravelly, very silty clay topsoil with many rootlets and rare brick fragments. Gravel of fine to coarse, angular to subrounded flint and rare quartzite.			MADE GROUND	
0.70	PEN	2.0/1.75/2.0		Stiff, friable, organic, dark brown, slightly gravelly, very clayey SILT with occasional rootlets. Gravel of fine to coarse, angular to subrounded flint and occasional chalk.	0.60 (50.00)		ALLUVIUM	
0.70	J2	kg/cm²						
0.80	D1							
1.00	SPT	7 N		0.90 m: Becoming moist. 1.00 m: SPT: 1,1/1,2,2,2	1.0			
1.40	D2			Stiff, beige to light grey, gravelly, clayey SILT. Gravel of fine, angular to rounded flint, chalk and rare sandstone.	1.30 (49.30)		GFD	
1.70	PEN	2.0x3		Stiff, orange brown mottled grey brown, slightly sandy, gravelly, silty CLAY with occasional pockets or thin beds of gravelly sand. Gravel of fine to coarse, subangular to rounded flint and chalk.	1.60 (49.00)		LF	
1.80	D3	kg/cm²						
2.00	SPT	14 N		Structureless CHALK: Recovered as stiff, light grey, slightly clayey, silt. (CIRIA Grade Dm). 2.00 m: SPT: 2,2/3,3,4,4	2.0 2.00 (48.60)		WEST MELBURY MARLY CHALK FORMATION	
2.70	D4							
2.80	PEN	3.0/4.0/4.5						
3.00	SPT	13 N		3.00 m: SPT: 2,2/2,3,4,4	3.0			
3.70	PEN	3.5/4.0/3.75		3.50 m: Some evidence of possible structure visible.				
3.80	D5	kg/cm²						
4.00	SPT	16 N		4.00 m: SPT: 2,2/3,3,5,5	4.0			
					4.50			
General Remarks: Borehole terminated at 5.45m bgl. No monitoring well installed.					Surface Elevation Level: 50.598 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Peter David Homes				Borehole No.				
Project Title: Land at Arlesey Road, Ickleford				WS05				
Project No: BRD4359								
Logged By: R Davies				Sheet 2 of 2				
Date Commenced: 18/12/2024								
Date Completed: 18/12/2024								
Method Used: Windowless Percussive Sampling Rig								
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.80	PEN 4	75/4.5/>5.0		Continued from 2.00m: Structureless CHALK: Recovered as stiff, light grey, slightly clayey, silt. (CIRIA Grade Dm). 5.00 m: SPT: 2,3/4,4,6,6	5.0		WMM/CF	
4.90	D6	kg/cm²						
5.00	SPT	20 N						
					5.45 (45.15)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Borehole terminated at 5.45m bgl. No monitoring well installed.				Surface Elevation Level: 50.598 mAOD		 Telephone: 01295 272244 Email: info@brduk.com		
				All dimensions in metres Log Scale 1:25				

IN-SITU PERMEABILITY TEST

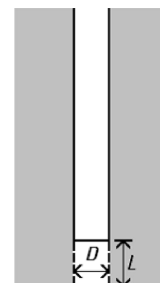
BS5930:1999+A2:2010 - Rising Head



Project No: BRD4359
Project: Land at Arlesey Road, Ickleford
Client: Peter David Homes

Test Details

Borehole Number WS01
Test Number 1
Depth of response zone below G [a] 5.01 m
Depth of resting water level [b] 1.16 m
Height of casing above GL [c] 0.00 m
Depth of casing below GL [d] 0.81 m
Length of response zone [L] 4.20 m
Diameter of response zone [D] 0.05 m
Intake Factor [F] 5.15



Well point or hole extended in uniform soil

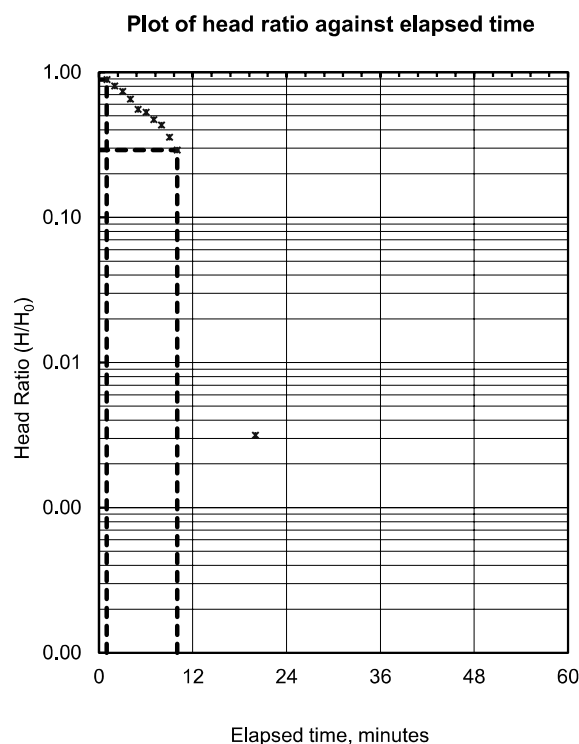
Supervising Engineer Rob Davies
Date of test 20/12/2023

Description of Soil at test level

Structureless Chalk: stiff, cream with dark orange brown weathering, slightly clayey, slightly gravelly silt (CIRIA Grade Dm).

Test Record

Elapsed Time	Depth to Water	Head of water	H/H ₀
min	m	m	
0	4.32	-3.16	1.00
1	3.97	-2.81	0.89
2	3.70	-2.54	0.80
3	3.49	-2.33	0.74
4	3.22	-2.06	0.65
5	2.91	-1.75	0.55
6	2.84	-1.68	0.53
7	2.65	-1.49	0.47
8	2.53	-1.37	0.43
9	2.29	-1.13	0.36
10	2.08	-0.92	0.29
20	1.17	-0.01	0.00
28	1.13	0.03	-0.01
41	1.10	0.06	-0.02
			-0.02
			-0.02
			-0.02
			-0.02
			-0.02
			-0.02
			-0.02
			-0.02



Calculation and Result

$$k = \frac{A}{F(t_2 - t_1) \cdot \log_e(H_1/H_2)} \quad \text{General Approach}$$

Cross-sectional area A = 0.0020 m²
Time between H1 and H2 = 9 minutes
Permeability k = 0.79 x 10⁻⁶ m/s

Remarks

IN-SITU PERMEABILITY TEST

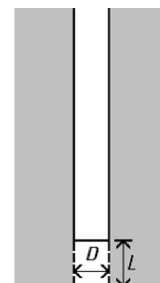
BS5930:1999+A2:2010 - Rising Head



Project No: BRD4359
Project: Land at Arlesey Road, Ickleford
Client: Peter David Homes

Test Details

Borehole Number WS03
Test Number 1
Depth of response zone below G [a] 4.71 m
Depth of resting water level [b] 0.54 m
Height of casing above GL [c] 0.00 m
Depth of casing below GL [d] 0.75 m
Length of response zone [L] 3.96 m
Diameter of response zone [D] 0.05 m
Intake Factor [F] 4.91



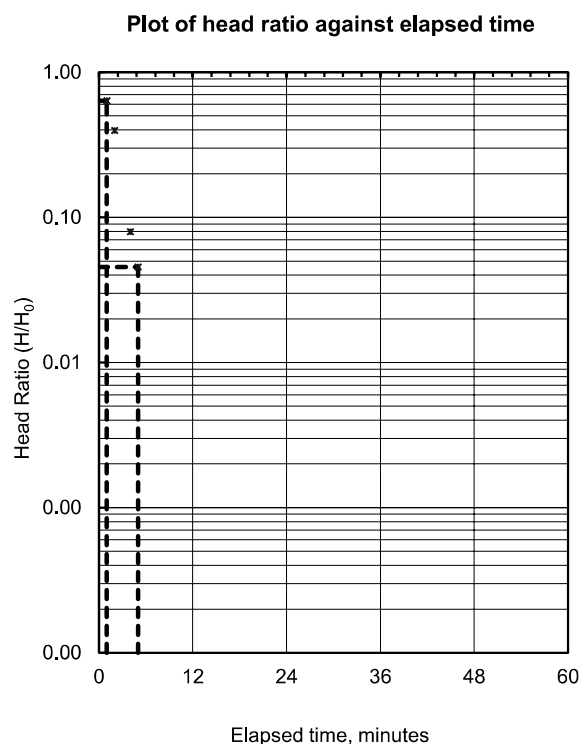
Well point or hole extended in uniform soil

Supervising Engineer Rob Davies
Date of test 20/12/2023

Description of Soil at test level Medium dense, orange brown, slightly clayey in parts, sandy to very sandy GRAVEL of fine to coarse, angular to sub-rounded flint and rare chalk.

Test Record

Elapsed Time	Depth to Water	Head of water	H/H ₀
min	m	m	
0	1.42	-0.88	1.00
1	1.10	-0.56	0.64
2	0.89	-0.35	0.40
4	0.61	-0.07	0.08
5	0.58	-0.04	0.05
6	0.54	0.00	0.00
7	0.52	0.02	-0.02
8	0.50	0.04	-0.05
9	0.48	0.06	-0.07
10	0.47	0.07	-0.08
13	0.46	0.08	-0.09
28	0.43	0.11	-0.13
			-0.13
			-0.13
			-0.13
			-0.13
			-0.13
			-0.13
			-0.13
			-0.13
			-0.13
			-0.13



Calculation and Result

$$k = \frac{A}{F(t_2 - t_1) \cdot \log_e(H_1/H_2)} \quad \text{General Approach}$$

Cross-sectional area A = 0.0020 m²
Time between H1 and H2 = 4 minutes
Permeability k = 4.40 x 10⁻⁶ m/s

Remarks



Groundwater Monitoring Record

Project: Land at Arlesey Road, Ickleford Client: Peter David Homes Project No: BRD4359										
Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Description	Comments
WS01	20/12/2023	RD	5.01	-	1.16	1.13	-	-	-	Resting groundwater level above top of standpipe.
WS02	20/12/2023	RD	4.47	-	0.05	-0.09	26.0	0.13	Light brown, silty sediment load with no odours or sheen.	
WS03	20/12/2023	RD	4.71	-	0.54	0.41	-	-	-	
WS04	20/12/2023	RD	4.93	-	4.35	4.23	0.0	4.71	Light brown, silty sediment load with no odours or sheen.	

APPENDIX 3



Rob Davies
BRD Environmental Ltd
Hawthorne Villa
1 Old Parr Road
Banbury
Oxfordshire
OX16 5HT

Derwentside Environmental Testing Services Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 23-15493

Site Reference: Land at Arlesev Road, Ickleford

Project / Job Ref: BRD4359

Order No: None Supplied

Sample Receipt Date: 20/12/2023

Sample Scheduled Date: 20/12/2023

Report Issue Number: 1

Reporting Date: 03/01/2024

Authorised by:



Steve Knight
Customer Support Manager

Dates of laboratory activities for each tested analyte are available upon request.

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.

For Topsoil and WAC analysis the expanded uncertainty measurement should be considered while evaluating results against compliance values.



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Soil Analysis Certificate						
DETS Report No: 23-15493	Date Sampled	18/12/23	18/12/23	18/12/23	18/12/23	18/12/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS01	WS02	WS02	WS03	WS04
Project / Job Ref: BRD4359	Additional Refs	J1	J1	J2	J1	J1
Order No: None Supplied	Depth (m)	0.10	0.20	0.70	0.20	0.10
Reporting Date: 03/01/2024	DETS Sample No	691532	691533	691534	691535	691536

Determinand	Unit	RL	Accreditation					
Asbestos Quantification ^(S)	%	< 0.001	ISO17025	< 0.001				< 0.001
pH	pH Units	N/a	MCERTS	8.0	7.9		8.0	7.7
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS					
Total Sulphate as SO ₄	%	< 0.02	MCERTS					
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	< 10	13		< 10	< 10
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	< 0.01	0.01		< 0.01	< 0.01
Total Sulphur	%	< 0.02	NONE					
Organic Matter (SOM)	%	< 0.1	MCERTS	5.2	6.9		5.5	7.5
Arsenic (As)	mg/kg	< 2	MCERTS	10	10		10	9
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2		< 0.2	0.3
Chromium (Cr)	mg/kg	< 2	MCERTS	8	9		9	9
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2		< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	20	24		25	25
Lead (Pb)	mg/kg	< 3	MCERTS	62	54		39	80
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1		< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	11	11		11	11
Selenium (Se)	mg/kg	< 2	MCERTS	< 2	< 2		< 2	< 2
Zinc (Zn)	mg/kg	< 3	MCERTS	56	46		46	106

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion

Subcontracted analysis (S)

(n) Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation



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Soil Analysis Certificate						
DETS Report No: 23-15493	Date Sampled	18/12/23	18/12/23	18/12/23	18/12/23	18/12/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS04	WS05	WS05	WS02	WS04
Project / Job Ref: BRD4359	Additional Refs	J2	D1	D3	D2	D3
Order No: None Supplied	Depth (m)	0.70	0.80	1.80	2.70	2.90
Reporting Date: 03/01/2024	DETS Sample No	691537	691538	691539	691540	691541

Determinand	Unit	RL	Accreditation					
Asbestos Quantification ^(S)	%	< 0.001	ISO17025					
pH	pH Units	N/a	MCERTS	8.1	8.4	7.7	7.6	7.9
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS		732	369	508	6754
Total Sulphate as SO ₄	%	< 0.02	MCERTS		0.07	0.04	0.05	0.68
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	16	< 10	10	20	1860
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02	< 0.01	0.01	0.02	1.86
Total Sulphur	%	< 0.02	NONE		0.03	< 0.02	< 0.02	0.65
Organic Matter (SOM)	%	< 0.1	MCERTS	3.6				
Arsenic (As)	mg/kg	< 2	MCERTS	5				
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2				
Chromium (Cr)	mg/kg	< 2	MCERTS	5				
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2				
Copper (Cu)	mg/kg	< 4	MCERTS	17				
Lead (Pb)	mg/kg	< 3	MCERTS	20				
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1				
Nickel (Ni)	mg/kg	< 3	MCERTS	10				
Selenium (Se)	mg/kg	< 2	MCERTS	< 2				
Zinc (Zn)	mg/kg	< 3	MCERTS	29				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 23-15493	Date Sampled	18/12/23	18/12/23			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS01	WS02			
Project / Job Ref: BRD4359	Additional Refs	B1	B1			
Order No: None Supplied	Depth (m)	1.50	1.00			
Reporting Date: 03/01/2024	DETS Sample No	691542	691543			

Determinand	Unit	RL	Accreditation	(n)			
Asbestos Quantification ^(S)	%	< 0.001	ISO17025				
pH	pH Units	N/a	MCERTS	8.2	8.3		
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS	581	281		
Total Sulphate as SO ₄	%	< 0.02	MCERTS	0.06	0.03		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	124	29		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.12	0.03		
Total Sulphur	%	< 0.02	NONE	0.02	< 0.02		
Organic Matter (SOM)	%	< 0.1	MCERTS				
Arsenic (As)	mg/kg	< 2	MCERTS				
Cadmium (Cd)	mg/kg	< 0.2	MCERTS				
Chromium (Cr)	mg/kg	< 2	MCERTS				
Chromium (hexavalent)	mg/kg	< 2	NONE				
Copper (Cu)	mg/kg	< 4	MCERTS				
Lead (Pb)	mg/kg	< 3	MCERTS				
Mercury (Hg)	mg/kg	< 1	MCERTS				
Nickel (Ni)	mg/kg	< 3	MCERTS				
Selenium (Se)	mg/kg	< 2	MCERTS				
Zinc (Zn)	mg/kg	< 3	MCERTS				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 23-15493	Date Sampled	18/12/23	18/12/23	18/12/23	18/12/23	18/12/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS01	WS02	WS03	WS04	WS04
Project / Job Ref: BRD4359	Additional Refs	J1	J1	J1	J1	J2
Order No: None Supplied	Depth (m)	0.10	0.20	0.20	0.10	0.70
Reporting Date: 03/01/2024	DETS Sample No	691532	691533	691535	691536	691537

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.17	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	0.28	< 0.1	0.13	0.49	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	0.26	< 0.1	< 0.1	0.47	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.16	< 0.1	< 0.1	0.29	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	0.16	< 0.1	< 0.1	0.29	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.18	< 0.1	< 0.1	0.30	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.12	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.16	< 0.1	< 0.1	0.26	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.15	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.14	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	2.7	< 1.6



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Soil Analysis Certificate - TPH LQM Banded

DETS Report No: 23-15493	Date Sampled	18/12/23	18/12/23			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS03	WS04			
Project / Job Ref: BRD4359	Additional Refs	J1	J2			
Order No: None Supplied	Depth (m)	0.20	0.70			
Reporting Date: 03/01/2024	DETS Sample No	691535	691537			

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6 : HS_1D_MS_AL	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aliphatic >C6 - C8 : HS_1D_MS_AL	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aliphatic >C8 - C10 : EH_CU_1D_AL	mg/kg	< 2	MCERTS	< 2	< 2			
Aliphatic >C10 - C12 : EH_CU_1D_AL	mg/kg	< 2	MCERTS	< 2	< 2			
Aliphatic >C12 - C16 : EH_CU_1D_AL	mg/kg	< 3	MCERTS	< 3	< 3			
Aliphatic >C16 - C35 : EH_CU_1D_AL	mg/kg	< 10	MCERTS	< 10	< 10			
Aliphatic >C35 - C44 : EH_CU_1D_AL	mg/kg	< 10	NONE	< 10	< 10			
Aliphatic (C5 - C44) : HS_1D_MS+EH_CU_1D_AL	mg/kg	< 30	NONE	< 30	< 30			
Aromatic >C5 - C7 : HS_1D_MS_AR	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aromatic >C7 - C8 : HS_1D_MS_AR	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aromatic >C8 - C10 : EH_CU_1D_AR	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C10 - C12 : EH_CU_1D_AR	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C12 - C16 : EH_CU_1D_AR	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C16 - C21 : EH_CU_1D_AR	mg/kg	< 3	MCERTS	< 3	< 3			
Aromatic >C21 - C35 : EH_CU_1D_AR	mg/kg	< 10	MCERTS	< 10	< 10			
Aromatic >C35 - C44 : EH_CU_1D_AR	mg/kg	< 10	NONE	< 10	< 10			
Aromatic (>C5 - C44) : HS_1D_MS+EH_CU_1D_AR	mg/kg	< 30	NONE	< 30	< 30			
Total >C5 - C44 : HS_1D_MS+EH_CU_1D_Tot al	mg/kg	< 60	NONE	< 60	< 60			



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 23-15493	Date Sampled	18/12/23	18/12/23			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS03	WS04			
Project / Job Ref: BRD4359	Additional Refs	J1	J2			
Order No: None Supplied	Depth (m)	0.20	0.70			
Reporting Date: 03/01/2024	DETS Sample No	691535	691537			

Determinand	Unit	RL	Accreditation				
Benzene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2	< 2		
Toluene : HS_1D_MS	ug/kg	< 5	MCERTS	< 5	< 5		
Ethylbenzene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2	< 2		
p & m-xylene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2	< 2		
o-xylene : HS_1D_MS	ug/kg	< 2	MCERTS	< 2	< 2		
MTBE : HS_1D_MS	ug/kg	< 5	MCERTS	< 5	< 5		



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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)						
DETS Report No: 23-15493	Date Sampled	18/12/23				
BRD Environmental Ltd	Time Sampled	None Supplied				
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS04				
Project / Job Ref: BRD4359	Additional Refs	J2				
Order No: None Supplied	Depth (m)	0.70				
Reporting Date: 03/01/2024	DETS Sample No	691537				

Determinand	Unit	RL	Accreditation				
Phenol	mg/kg	< 0.1	NONE	< 0.1			
1,2,4-Trichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1			
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1			
Nitrobenzene	mg/kg	< 0.1	MCERTS	< 0.1			
0-Cresol	mg/kg	< 0.1	NONE	< 0.1			
bis(2-chloroethoxy)methane	mg/kg	< 0.1	MCERTS	< 0.1			
bis(2-chloroethyl)ether	mg/kg	< 0.1	MCERTS	< 0.1			
2,4-Dichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1			
2-Chlorophenol	mg/kg	< 0.1	ISO17025	< 0.1			
1,3-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1			
1,4-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1			
1,2-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1			
2,4-Dimethylphenol	mg/kg	< 0.15	ISO17025	< 0.15			
Isophorone	mg/kg	< 0.1	NONE	< 0.1			
Hexachloroethane	mg/kg	< 0.1	MCERTS	< 0.1			
p-Cresol	mg/kg	< 0.15	MCERTS	< 0.15			
2,4,6-Trichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1			
2,4,5-Trichlorophenol	mg/kg	< 0.15	MCERTS	< 0.15			
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1			
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1			
2-Methylnaphthalene	mg/kg	< 0.1	MCERTS	< 0.1			
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1			
Hexachlorobutadiene	mg/kg	< 0.1	ISO17025	< 0.1			
2,6-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1			
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1			
2-Chloronaphthalene	mg/kg	< 0.1	MCERTS	< 0.1			
4-Chloroaniline	mg/kg	< 0.15	NONE	< 0.15			
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1			
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1			
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1			
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1			
4-Bromophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1			
Hexachlorobenzene	mg/kg	< 0.1	MCERTS	< 0.1			
2,4-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1			
Diethyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1			
Dibenzofuran	mg/kg	< 0.1	MCERTS	< 0.1			
Azobenzene	mg/kg	< 0.1	NONE	< 0.1			
Dibutyl phthalate	mg/kg	< 0.1	ISO17025	< 0.1			
Carbazole	mg/kg	< 0.1	ISO17025	< 0.1			
bis(2-ethylhexyl)phthalate	mg/kg	< 0.15	ISO17025	< 0.15			
Benzyl butyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1			
Di-n-octyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1			



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Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3																																							
DETS Report No: 23-15493		Date Sampled	18/12/23		<table border="1"> <thead> <tr> <th colspan="3">Landfill Waste Acceptance Criteria Limits</th> </tr> <tr> <th>Inert Waste Landfill</th> <th>Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill</th> <th>Hazardous Waste Landfill</th> </tr> </thead> <tbody> <tr> <td>3%</td> <td>5%</td> <td>6%</td> </tr> <tr> <td>--</td> <td>--</td> <td>10%</td> </tr> <tr> <td>6</td> <td>--</td> <td>--</td> </tr> <tr> <td>1</td> <td>--</td> <td>--</td> </tr> <tr> <td>500</td> <td>--</td> <td>--</td> </tr> <tr> <td>100</td> <td>--</td> <td>--</td> </tr> <tr> <td>--</td> <td>>6</td> <td>--</td> </tr> <tr> <td>--</td> <td>To be evaluated</td> <td>To be evaluated</td> </tr> </tbody> </table>					Landfill Waste Acceptance Criteria Limits			Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill	3%	5%	6%	--	--	10%	6	--	--	1	--	--	500	--	--	100	--	--	--	>6	--	--	To be evaluated	To be evaluated
Landfill Waste Acceptance Criteria Limits																																							
Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill																																					
3%	5%	6%																																					
--	--	10%																																					
6	--	--																																					
1	--	--																																					
500	--	--																																					
100	--	--																																					
--	>6	--																																					
--	To be evaluated	To be evaluated																																					
BRD Environmental Ltd		Time Sampled	None Supplied																																				
Site Reference: Land at Arlesey Road, Ickleford		TP / BH No	WS02																																				
Project / Job Ref: BRD4359		Additional Refs	J2																																				
Order No: None Supplied		Depth (m)	0.70																																				
Reporting Date: 03/01/2024		DETS Sample No	691534																																				
Determinand	Unit	MDL																																					
TOC ^{MU}	%	< 0.1	2.2																																				
Loss on Ignition ^{MU}	%	< 0.01	6.80																																				
BTEX ^{MU}	mg/kg	< 0.05	< 0.05																																				
Sum of PCBs	mg/kg	< 0.1	< 0.1																																				
Mineral Oil ^{MU}	mg/kg	< 10	< 10																																				
Total PAH ^{MU}	mg/kg	< 1.7	< 1.7																																				
pH ^{MU}	pH Units	N/a	8.0																																				
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	3.8																																				
Eluate Analysis			2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)																																
Arsenic ^U		0.0010	0.0014		0.026	0.5	2	25																															
Barium ^U		0.0367	0.0255		0.467	20	100	300																															
Cadmium ^U		< 0.0002	< 0.0002		< 0.002	0.04	1	5																															
Chromium ^U		< 0.0002	< 0.0002		0.003	0.5	10	70																															
Copper ^U		0.0035	0.0053		0.096	2	50	100																															
Mercury ^U		< 0.00004	< 0.00004		< 0.0004	0.01	0.2	2																															
Molybdenum ^U		0.0037	0.0014		0.027	0.5	10	30																															
Nickel ^U		0.0032	0.0019		0.0345	0.4	10	40																															
Lead ^U		< 0.0002	< 0.0002		0.003	0.5	10	50																															
Antimony ^U		< 0.0002	< 0.0002		< 0.002	0.06	0.7	5																															
Selenium ^U		0.0077	0.0023		0.0434	0.1	0.5	7																															
Zinc ^U		0.005	0.013		0.23	4	50	200																															
Chloride ^U		5	2		43	800	15000	25000																															
Fluoride ^U		0.6	< 0.5		< 1	10	150	500																															
Sulphate ^U		22	5		100	1000	20000	50000																															
TDS		112	67		1234	4000	60000	100000																															
Phenol Index ^U		< 0.01	< 0.01		< 0.5	1	-	-																															
DOC ^U		11.1	14.4		259	500	800	1000																															
Leach Test Information																																							
Sample Mass (kg)		0.12																																					
Dry Matter (%)		75.5																																					
Moisture (%)		32.4																																					
Stage 1																																							
Volume Eluate L2 (litres)		0.15																																					
Filtered Eluate VE1 (litres)		0.04																																					

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
 Stated limits are for guidance only and DETS Ltd cannot be held responsible for any discrepancies with current legislation
 M Denotes MCERTS accredited test
 U Denotes ISO17025 accredited test



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Tel : 01622 850410



Soil Analysis Certificate - Sample Descriptions

DETS Report No: 23-15493	
BRD Environmental Ltd	
Site Reference: Land at Arlesey Road, Ickleford	
Project / Job Ref: BRD4359	
Order No: None Supplied	
Reporting Date: 03/01/2024	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
691532	WS01	J1	0.10	18.3	Brown sandy clay with stones
691533	WS02	J1	0.20	26.5	Brown sandy clay with stones
691534	WS02	J2	0.70	24	Brown clay
691535	WS03	J1	0.20	20.3	Brown sandy clay with vegetation
691536	WS04	J1	0.10	19.7	Brown loamy sand with stones and vegetation
691537	WS04	J2	0.70	18.5	Brown sandy clay
691538	WS05	D1	0.80	25.6	Grey sandy clay
691539	WS05	D3	1.80	12.5	Orange sandy clay with stones
691540	WS02	D2	2.70	15.2	Grey clay
691541	WS04	D3	2.90	9.1	Brown sandy clay with stones and chalk
691542	WS01	B1	1.50	6	Light brown sandy clay with stones and chalk
691543	WS02	B1	1.00	7.3	Brown sandy gravel with stones and chalk

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{I/S}

Unsuitable Sample ^{U/S}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 23-15493

BRD Environmental Ltd

Site Reference: Land at Arlesey Road, Ickleford

Project / Job Ref: BRD4359

Order No: None Supplied

Reporting Date: 03/01/2024

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphénylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	Fraction Organic Carbon (FOC)	Determination of TOC by combustion analyser.	E027
Soil	D	Organic Matter (SOM)	Determination of TOC by combustion analyser.	E027
Soil	D	TOC (Total Organic Carbon)	Determination of TOC by combustion analyser.	E027
Soil	AR	Exchangeable Ammonium	Determination of ammonium by discrete analyser.	E029
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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Water Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 23-15493

BRD Environmental Ltd

Site Reference: Land at Arlesey Road, Ickleford

Project / Job Ref: BRD4359

Order No: None Supplied

Reporting Date: 03/01/2024

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	F	Ammoniacal Nitrogen	Determination of ammoniacal nitrogen by discrete analyser.	E126
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazine followed by	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR dete	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethane	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered



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List of HWOL Acronyms and Operators	
DETS Report No: 23-15493	
BRD Environmental Ltd	
Site Reference: Land at Arlesey Road, Ickleford	
Project / Job Ref: BRD4359	
Order No: None Supplied	
Reporting Date: 03/01/2024	

Acronym	Description
HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
2D	GC-GC - Double coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative eg. EH+HS_Total or EH_CU+HS_Total

Det - Acronym
Benzene - HS_1D_MS
Ethylbenzene - HS_1D_MS
MTBE - HS_1D_MS
Mineral Oil (C10 - C40) (BS EN 12457-3) - EH_CU_1D_AL
TPH CWG - Aromatic >C16 - C21 - EH_CU_1D_AR
TPH LQM - Aliphatic >C10 - C12 - EH_CU_1D_AL
TPH LQM - Aliphatic >C12 - C16 - EH_CU_1D_AL
TPH LQM - Aliphatic >C16 - C35 - EH_CU_1D_AL
TPH LQM - Aliphatic >C35 - C44 - EH_CU_1D_AL
TPH LQM - Aliphatic >C5 - C44 - HS_1D_MS+EH_CU_1D_AL
TPH LQM - Aliphatic >C5 - C6 - HS_1D_MS_AL
TPH LQM - Aliphatic >C6 - C8 - HS_1D_MS_AL
TPH LQM - Aliphatic >C8 - C10 - EH_CU_1D_AL
TPH LQM - Aromatic >C10 - C12 - EH_CU_1D_AR
TPH LQM - Aromatic >C12 - C16 - EH_CU_1D_AR
TPH LQM - Aromatic >C21 - C35 - EH_CU_1D_AR
TPH LQM - Aromatic >C35 - C44 - EH_CU_1D_AR
TPH LQM - Aromatic >C5 - C44 - HS_1D_MS+EH_CU_1D_AR
TPH LQM - Aromatic >C5 - C7 - HS_1D_MS_AR
TPH LQM - Aromatic >C7 - C8 - HS_1D_MS_AR
TPH LQM - Aromatic >C8 - C10 - EH_CU_1D_AR
TPH LQM - Total >C5 - C44 - HS_1D_MS+EH_CU_1D_Total
Toluene - HS_1D_MS
Total BTEX (BS EN 12457-3) - HS_1D_MS_Total
m & p-xylene - HS_1D_MS
o-Xylene - HS_1D_MS

Parameter	Matrix Type	Suite Reference	Expanded Uncertainty Measurement	Unit
TOC	Soil	BS EN 12457	10.4	%
Loss on Ignition	Soil	BS EN 12457	16.9	%
BTEX	Soil	BS EN 12457	14.0	%
Sum of PCBs	Soil	BS EN 12457	21.1	%
Mineral Oil	Soil	BS EN 12457	9.0	%
Total PAH	Soil	BS EN 12457	17.9	%
pH	Soil	BS EN 12457	0.282	Units
Acid Neutralisation Capacity	Soil	BS EN 12457	18.0	%
Arsenic	Leachate	BS EN 12457	19.5	%
Barium	Leachate	BS EN 12457	12.2	%
Cadmium	Leachate	BS EN 12457	17.2	%
Chromium	Leachate	BS EN 12457	20.7	%
Copper	Leachate	BS EN 12457	14.1	%
Mercury	Leachate	BS EN 12457	16.7	%
Molybdenum	Leachate	BS EN 12457	13.3	%
Nickel	Leachate	BS EN 12457	14.0	%
Lead	Leachate	BS EN 12457	12.1	%
Antimony	Leachate	BS EN 12457	16.1	%
Selenium	Leachate	BS EN 12457	15.5	%
Zinc	Leachate	BS EN 12457	14.0	%
Chloride	Leachate	BS EN 12457	15.7	%
Fluoride	Leachate	BS EN 12457	19.1	%
Sulphate	Leachate	BS EN 12457	27.6	%
TDS	Leachate	BS EN 12457	10.0	%
Phenol Index	Leachate	BS EN 12457	12.9	%
DOC	Leachate	BS EN 12457	20.4	%
Clay Content	Soil	BS 3882: 2015	15.0	%
Silt Content	Soil	BS 3882: 2015	14.0	%
Sand Content	Soil	BS 3882: 2015	13.0	%
Loss on Ignition	Soil	BS 3882: 2015	16.9	%
pH	Soil	BS 3882: 2015	0.282	Units
Carbonate	Soil	BS 3882: 2015	12.0	%
Total Nitrogen	Soil	BS 3882: 2015	12.0	%
Phosphorus (Extractable)	Soil	BS 3882: 2015	24.0	%
Potassium (Extractable)	Soil	BS 3882: 2015	20.0	%
Magnesium (Extractable)	Soil	BS 3882: 2015	26.0	%
Zinc	Soil	BS 3882: 2015	19.8	%
Copper	Soil	BS 3882: 2015	23.2	%
Nickel	Soil	BS 3882: 2015	32.6	%
Available Sodium	Soil	BS 3882: 2015	23.0	%
Available Calcium	Soil	BS 3882: 2015	23.0	%
Electrical Conductivity	Soil	BS 3882: 2015	10.0	%



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DETS Report No: 23-15656

Site Reference: Land at Arlesev Road, Ickleford

Project / Job Ref: BRD4359

Order No: None Supplied

Sample Receipt Date: 27/12/2023

Sample Scheduled Date: 27/12/2023

Report Issue Number: 1

Reporting Date: 05/01/2024

Authorised by:



Steve Knight
Customer Support Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Water Analysis Certificate						
DETS Report No: 23-15656	Date Sampled	20/12/23	20/12/23			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Land at Arlesey Road, Ickleford	TP / BH No	WS02	WS03			
Project / Job Ref: BRD4359	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.05	4.35			
Reporting Date: 05/01/2024	DETS Sample No	692359	692360			

Determinand	Unit	RL	Accreditation			
pH	pH Units	N/a	ISO17025	7.1	7.0	
Sulphate as SO ₄	mg/l	< 1	ISO17025	94	879	

Subcontracted analysis ^(S)

Insufficient sample ^{I/S}

Unsuitable Sample ^{U/S}



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Water Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 23-15656

BRD Environmental Ltd

Site Reference: Land at Arlesey Road, Ickleford

Project / Job Ref: BRD4359

Order No: None Supplied

Reporting Date: 05/01/2024

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	F	Ammoniacal Nitrogen	Determination of ammoniacal nitrogen by discrete analyser.	E126
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazine followed by	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR dete	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethane	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



List of HWOL Acronyms and Operators

Acronym	Description
HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
2D	GC-GC - Double coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative eg. EH+HS_Total or EH_CU+HS_Total

Det - Acronym



TEST REPORT
ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 11/01/2024



Contract	Arlesey Road, Ickleford		
Serial No.	43952_1		
Client:			
BRD Environmental Ltd BRD Environmental Ltd Hawthorne Villa 1 Old Parr Road Banbury Oxfordshire OX16 5HT		Soil Property Testing Ltd 15, 16, 18 Halcyon Court, St Margaret's Way, Stukeley Meadows, Huntingdon, Cambridgeshire, PE29 6DG Tel: 01480 455579 Email: enquiries@soilpropertytesting.com Website: www.soilpropertytesting.com	
Samples Submitted By: BRD Environmental Ltd		Approved Signatories:	
Samples Labelled: Arlesey Road, Ickleford		☒ J.C. Garner B.Eng (Hons) FGS Technical Director & Quality Manager ☐ W. Johnstone Materials Lab Manager 	
Date Received: 20/12/2023		Samples Tested Between: 20/12/2023 and 11/01/2024	
Remarks: For the attention of Rob Davies Your Reference No: BRD4359			
Notes:			
1 All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary.			
2 Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.			
3 Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory.			
4 This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.			
5 The results within this report only relate to the items tested or sampled.			



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Contract			Arlesey Road, Ickleford																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Bore Hole No.	Type	Sample Ref.	Top Depth	Water Content (BS EN) Liquid/Plastic Limits Wet Sieve Preparation Particle Size Distribution (BS1377)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												



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Contract	Arlesey Road, Ickleford
Serial No.	43952_1

SUMMARY OF WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole /Pit No.	Depth (m)	Type	Ref.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquid-ity Index	Sample Preparation				Description	Class
									Method	Ret'd 0.425mm (%)	Corr'd W/C <0.425mm	Curing Time (hrs)		
WS01	1.10	D	2	15.1	25	14	11	0.10	Wet Sieved	18 (M)	18.4*	24	Firm light olive brown slightly gravelly slightly sandy silty CLAY with rare recently active roots. Gravel is fine to medium angular to sub rounded chert and chalk.	CL
WS01	2.30	D	3	20.7	38	15	23	0.25	Wet Sieved	5 (M)	21.8*	24	Soft olive slightly gravelly slightly sandy silty CLAY with occasional orange staining. Gravel is fine to medium angular to sub rounded chert and chalk.	CI
WS01	2.70	D	4	22.0	35	18	17	0.24	From Natural	0 (A)		26	Pale yellow and light grey marly CHALK with occasional orange staining and rare decayed roots.	CL/CI
WS04	0.90	D	1	28.6	37	27	10	0.16	Wet Sieved	22 (M)	36.6*	24	Dark brownish grey slightly gravelly slightly sandy CLAY/SILT with occasional shell debris. Gravel is fine to medium angular to sub rounded chert and chalk.	MI
WS04	1.80	D	2	23.2	36	17	19	0.33	From Natural	<1% (A)		26	Soft mottled grey and orange silty CLAY with rare fine chalk gravel and rare decayed roots.	CI
WS05	2.70	D	4	16.7	32	16	16	0.04	From Natural	0 (A)		26	Mottled pale olive and light grey marly CHALK with rare decayed roots.	CL

Method Of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2:1990:4.2
Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2:1990:3.2, 4.4, 5.3, 5.4
Type of Sample Key: U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments: *Corrected water content assume material greater than 0.425mm is non-porous. See BS1377: Part 2: 1990 Clause 3 Note 1.
Table Notation: Ret'd 0.425mm: (A) = Assumed, (M) = Measured



TEST REPORT

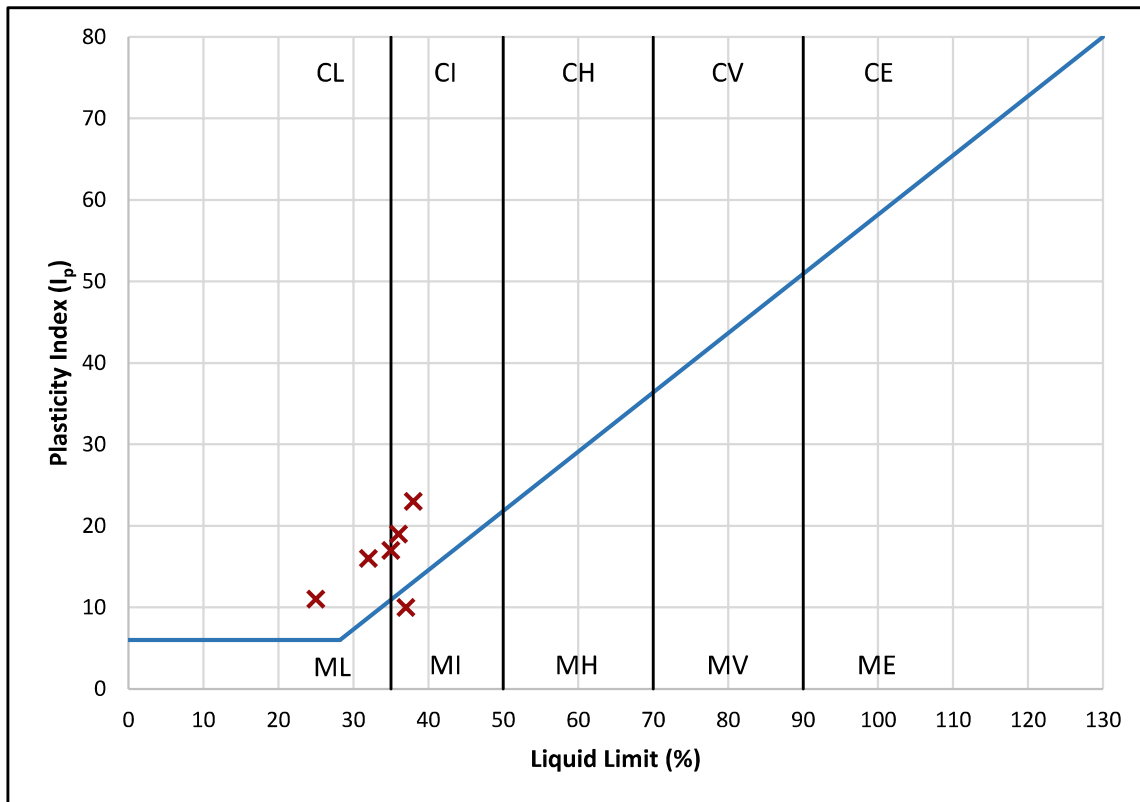
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DATE ISSUED: 11/01/2024



Contract	Arlesey Road, Ickleford
Serial No.	43952_1

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART

Plasticity				
Low	Medium	High	Very High	Extremely High



Plasticity Chart BS5930: 2015: Figure 8

High	NHBC Volume Change Potential
Medium	
Low	

Method of Preparation:	BS 1377: Part 2: 1990: 4.2
Method of Test:	BS1377: Part 2: 3.2, 4.4, 5.3, 5.4
Type of Sample Key:	U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments:	Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index



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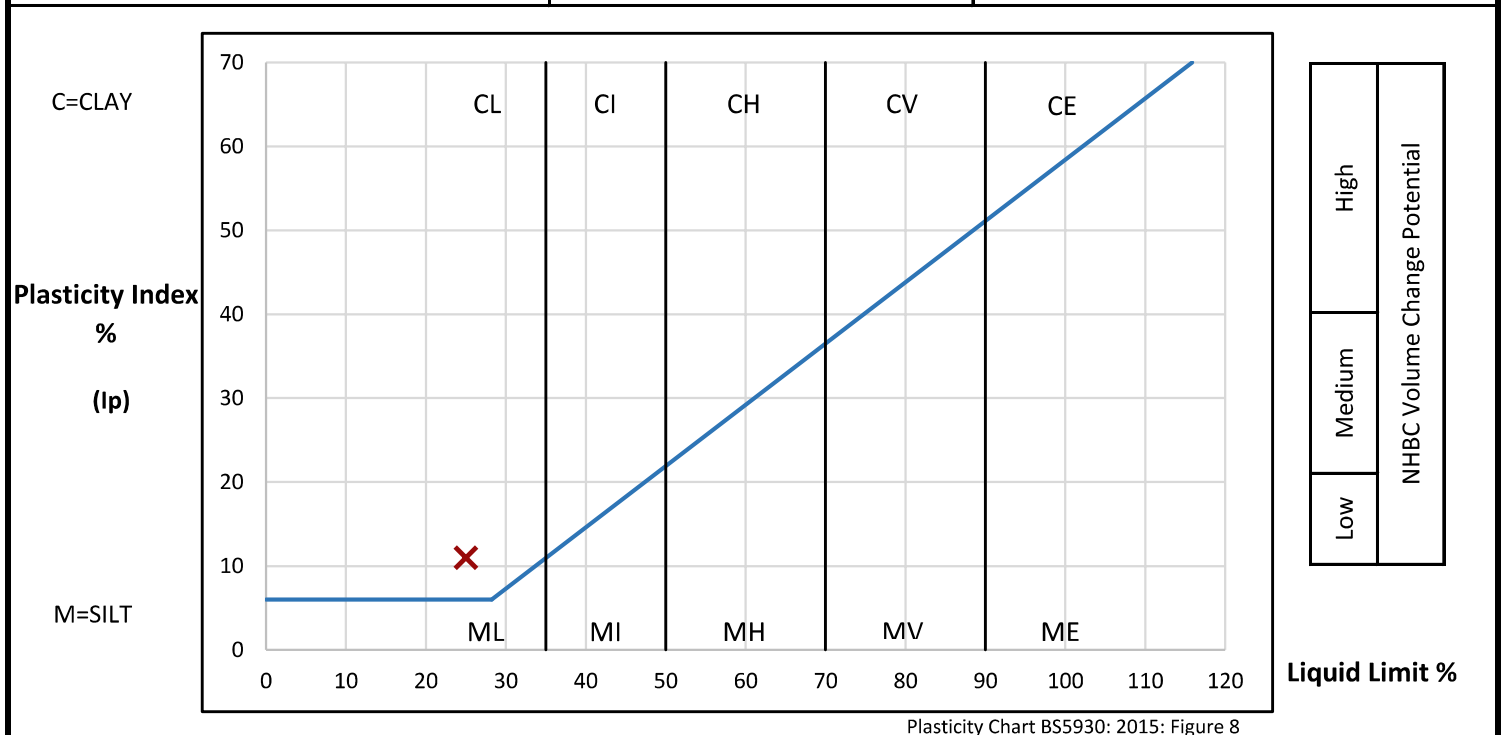


Contract	Arlesey Road, Ickleford
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DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks
		Type	Reference			
WS01	1.10	D	2	15.1	Firm light olive brown slightly gravelly slightly sandy silty CLAY with rare recently active roots. Gravel is fine to medium angular to sub rounded chert and chalk.	

PREPARATION			Liquid Limit	25 %	
Method of preparation		Wet sieved over 0.425mm sieve	Plastic Limit	14 %	
Sample retained 0.425mm sieve	(Measured)	18 %	Plasticity Index	11 %	
Corrected water content for material passing 0.425mm			Liquidity Index	0.10	
Sample retained 2mm sieve	(Measured)	12 %	NHBC Modified (I'p)	9 %	
Curing time	24 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



Method of Preparation:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2
Method of Test:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4
Type of Sample Key:	U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
Comments:	Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)



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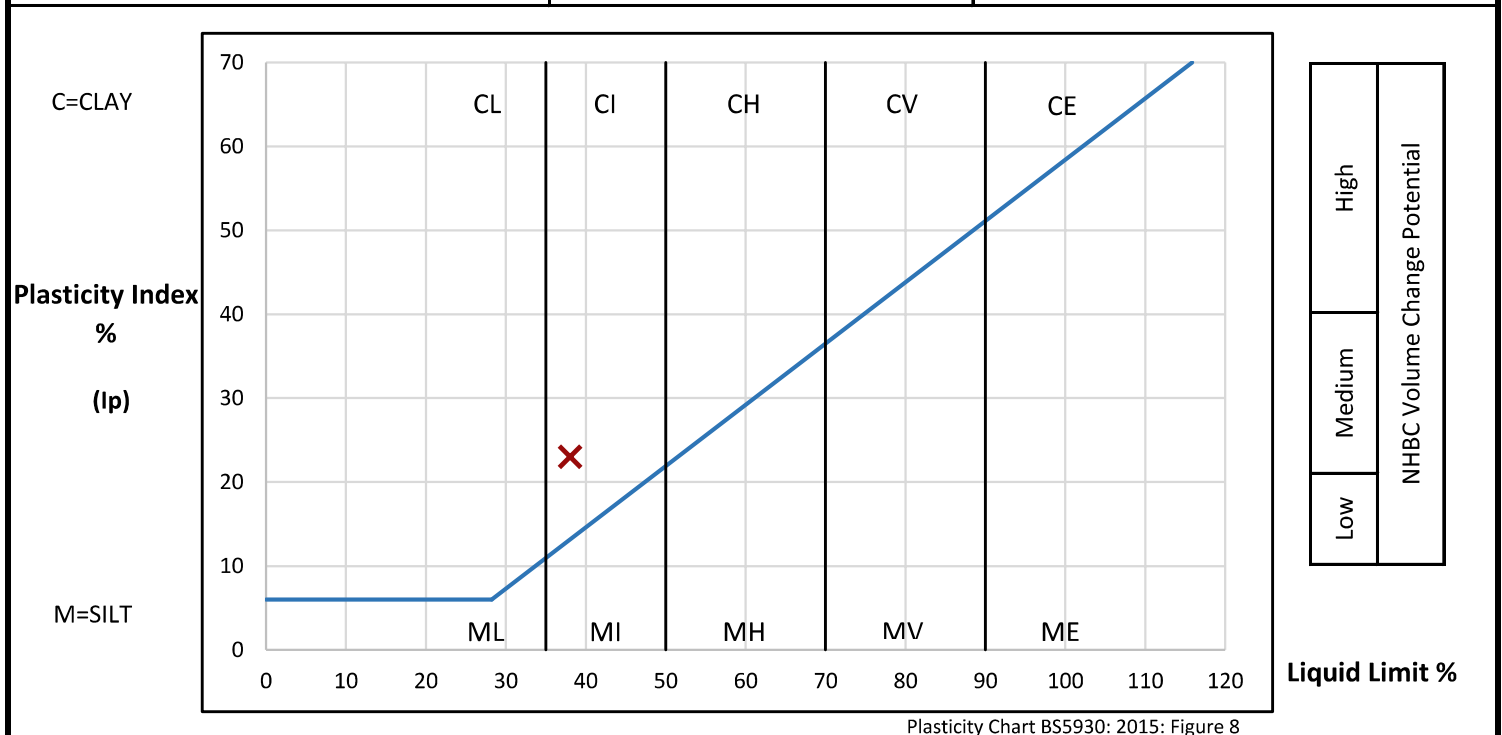


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DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks
		Type	Reference			
WS01	2.30	D	3	20.7	Soft olive slightly gravelly slightly sandy silty CLAY with occasional orange staining. Gravel is fine to medium angular to sub rounded chert and chalk.	

PREPARATION			Liquid Limit	38 %	
Method of preparation		Wet sieved over 0.425mm sieve	Plastic Limit	15 %	
Sample retained 0.425mm sieve	(Measured)	5 %	Plasticity Index	23 %	
Corrected water content for material passing 0.425mm			Liquidity Index	0.25	
Sample retained 2mm sieve	(Measured)	2 %	NHBC Modified (I'p)	22 %	
Curing time	24 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



Method of Preparation:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2
Method of Test:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4
Type of Sample Key:	U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
Comments:	Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)



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Contract	Arlesey Road, Ickleford						
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DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX							
Borehole / Pit No.	Depth m	Sample TypeReference		Water Content (W) %	Description	Remarks	
WS01	2.70	D	4	22.0	Pale yellow and light grey marly CHALK with occasional orange staining and rare decayed roots.		
PREPARATION					Liquid Limit	35 %	
Method of preparation					From natural	Plastic Limit	18 %
Sample retained 0.425mm sieve (Assumed)					0 %	Plasticity Index	17 %
Corrected water content for material passing 0.425mm						Liquidity Index	0.24
Sample retained 2mm sieve (Assumed)					0 %	NHBC Modified (I'p)	n/a
Curing time			26 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY M=SILT Plasticity Index % (Ip) Plasticity Chart BS5930: 2015: Figure 8							

High

Medium

Low

NHBC Volume Change Potential

Liquid Limit %



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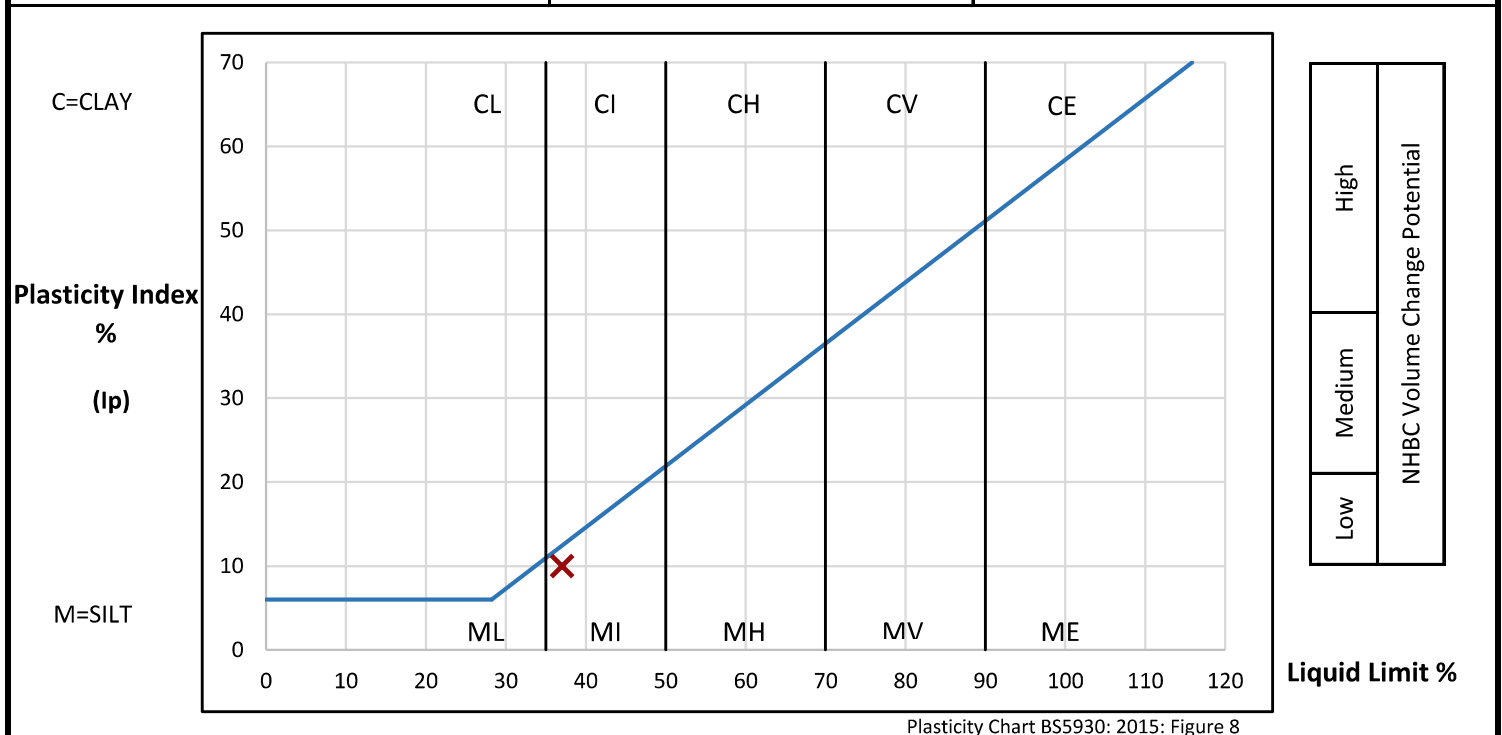


Contract	Arlesey Road, Ickleford
Serial No.	43952_1

DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks
		Type	Reference			
WS04	0.90	D	1	28.6	Dark brownish grey slightly gravelly slightly sandy CLAY/SILT with occasional shell debris. Gravel is fine to medium angular to sub rounded chert and chalk.	

PREPARATION			Liquid Limit	37 %		
Method of preparation			Wet sieved over 0.425mm sieve	Plastic Limit	27 %	
Sample retained 0.425mm sieve		(Measured)	22 %	Plasticity Index	10 %	
Corrected water content for material passing 0.425mm			36.6 %	Liquidity Index	0.16	
Sample retained 2mm sieve			(Measured)	11 %	NHBC Modified (I'p)	8 %
Curing time		24 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



Method of Preparation:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2
Method of Test:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4
Type of Sample Key:	U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
Comments:	Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)



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Contract	Arlesey Road, Ickleford								
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DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX									
Borehole / Pit No.	Depth m	Sample TypeReference		Water Content (W) %	Description	Remarks			
WS04	1.80	D	2	23.2	Soft mottled grey and orange silty CLAY with rare fine chalk gravel and rare decayed roots.				
PREPARATION					Liquid Limit	36 %			
Method of preparation					From natural/gravel picked out by hand	Plastic Limit	17 %		
Sample retained 0.425mm sieve					(Assumed)	0 %	Plasticity Index	19 %	
Corrected water content for material passing 0.425mm							Liquidity Index	0.33	
Sample retained 2mm sieve					(Assumed)	<1 %	NHBC Modified (I'p)	n/a	
Curing time					26 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY M=SILT Plasticity Index % (Ip) 70 60 50 40 30 20 10 0 0102030405060708090100110120 CLCI CHCVCE MLMI MH MV ME Plasticity Chart BS5930: 2015: Figure 8 High Medium Low NHBC Volume Change Potential Liquid Limit %									
Method of Preparation:						BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2			
Method of Test:						BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4			
Type of Sample Key:						U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter			
Comments:									



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DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX							
Borehole / Pit No.	Depth m	Sample TypeReference		Water Content (W) %	Description	Remarks	
WS05	2.70	D	4	16.7	Mottled pale olive and light grey marly CHALK with rare decayed roots.		
PREPARATION					Liquid Limit	32 %	
Method of preparation					From natural	Plastic Limit	16 %
Sample retained 0.425mm sieve (Assumed)					0 %	Plasticity Index	16 %
Corrected water content for material passing 0.425mm						Liquidity Index	0.04
Sample retained 2mm sieve (Assumed)					0 %	NHBC Modified (I'p)	n/a
Curing time			26 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY M=SILT Plasticity Index % (Ip) 70 60 50 40 30 20 10 0 0102030405060708090100110120 CLCI CHCVCE MLMI MH MV ME Plasticity Chart BS5930: 2015: Figure 8 High Medium Low NHBC Volume Change Potential Liquid Limit %							
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2							
Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4							
Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter							
Comments:							



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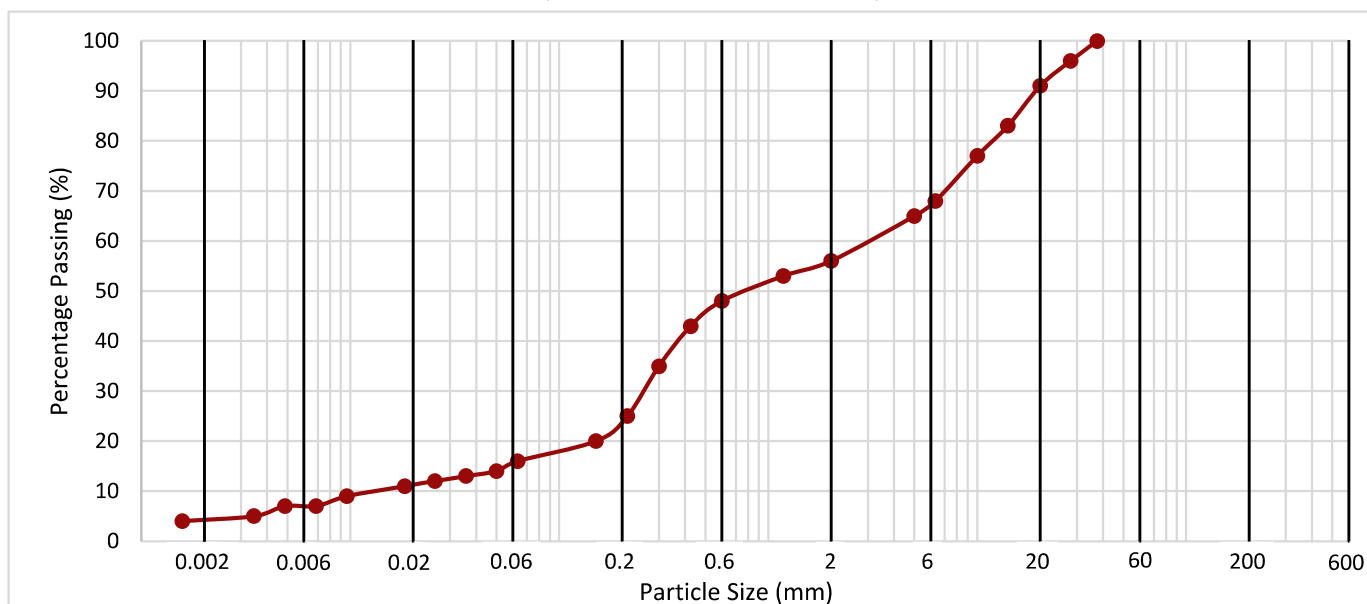


Contract	Arlesey Road, Ickleford
Serial No.	43952_1

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
WS02+WS03	1.40 - 1.50	B	1	Yellowish brown slightly clayey silty SAND with brown, black and white angular to sub rounded chert and rare white and yellowish brown quartzite GRAVEL.	

Method of Test: **Wet Sieve + Hydrometer** Method of Pretreatment: **Not required**



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
	SILT			SAND			GRAVEL				

Hydrometer	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	0.0500	14	12
	0.0357	13	
	0.0254	12	
	0.0182	11	Clay by Dry Mass (%)
	0.0096	9	
	0.0069	7	
	0.0049	7	4
	0.0035	5	
	0.0016	4	

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	56	40
1.18	53	
0.600	48	
0.425	43	
0.300	35	
0.212	25	
0.150	20	
0.063	16	

Fines By Dry Mass (%)	
<0.063mm	16

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		44
125		
90		
63		
50		
37.5	100	
28	96	
20	91	
14	83	
10	77	
6.3	68	
5	65	

Method of Preparation: BS1377: Part 1: 2016: 8.3 & 8.4.5
Method of test: BS1377: Part 2: 1990: 9.2,9.5
Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
Comments: