| | |
|---|---|
| **Document:** | **Site Investigation Report** |
| **Project:** | **Grange Farm, Alconbury** |
| **Reference No:** | **GC25457_SI** |
| **Date:** | **June 2024** |
| **Prepared for:** | **Urban&Civic Alconbury Limited** |

harrisongeotechnical
ENGINEERING



A division of Harrison Group Environmental Limited

**HARRISON GROUP ENVIRONMENTAL LIMITED**

**Document:** **Site Investigation Report**

**Project:** **Grange Farm, Alconbury**

**Reference No:** **GC25457 _SI**

**Date:** **June 2024**

**Prepared For:** **Urban&Civic Alconbury Limited**

## REPORT STATUS

| Revision | Comments | Prepared By | Approved By | Audited By | Issued By |
|---|---|---|---|---|---|
| 0 | First Issue | INITIALS IH<br>DATE 18/06/24 | INITIALS JAu<br>DATE 20/06/24 | INITIALS JAu<br>DATE 24/06/24 | INITIALS IH<br>DATE 24/06/24 |
| | | INITIALS<br>DATE | INITIALS<br>DATE | INITIALS<br>DATE | INITIALS<br>DATE |
| | | INITIALS<br>DATE | INITIALS<br>DATE | INITIALS<br>DATE | INITIALS<br>DATE |
| | | INITIALS<br>DATE | INITIALS<br>DATE | INITIALS<br>DATE | INITIALS<br>DATE |

## CONTENTS

**FOREWORD** IV

**EXECUTIVE SUMMARY** V

**1 TERMS OF REFERENCE & INTRODUCTION** 1
1.1 Introduction 1
1.2 Site Location and Setting 1

**2 SUMMARY OF BACKGROUND INFORMATION** 1
2.1 Geological Record 1

**3 POTENTIAL SOURCES OF CONTAMINATION & CSM** 2

**4 INITIAL GEOTECHNICAL HAZARD IDENTIFICATION** 2

**5 INTRUSIVE INVESTIGATION** 3
5.1 Introduction 3
5.2 Fieldwork, Monitoring and In-Situ Testing Program 3
5.2.1 Service Clearance, Surveying 3
5.2.2 Dynamic Sampling Boreholes 3
5.2.3 Cable Percussive Boreholes 6
5.2.4 Monitoring Wells 6
5.2.5 Machine Excavated Trial Pits 7
5.2.6 Hand Excavated Trial Pits 10
5.2.7 In-Situ Testing To Derive California Bearing Ratio 10
5.2.8 Ground Gas Monitoring 10
5.2.9 Groundwater & Surface Water Monitoring & Sampling 10
5.3 Fieldwork Observations 11
5.3.1 Ground Conditions 11
5.3.2 Groundwater 11
5.3.3 Ground Gas Monitoring 12
5.4 In-Situ Testing 12
5.4.1 Standard Penetration Testing 13
5.4.2 In-Situ Hand Vane Testing 14
5.4.3 In-Situ California Bearing Ratio (CBR) Testing by TRL-DCP Tests 14
5.4.4 In-Situ Plate Bearing Testing 16
5.4.5 In-Situ Light Weight Deflectometer Testing 16
5.5 Geotechnical Laboratory Testing 16
5.6 Chemical Laboratory Testing 17
5.7 Comparison with the Ground Model 18

**6 GEOTECHNICAL ASSESSMENT** 18
6.1 General 18
6.2 Geotechnical Parameters 19
6.3 Foundation Recommendations 19
6.3.1 Traditional Shallow Foundations 19
6.3.2 Piled Foundations 20
6.4 Floor Slabs 21
6.5 Drainage 21
6.6 Pavements 21
6.7 Stability of Excavations 22
6.8 Foundation Concrete (Aggressive Chemical Environment) 22
6.9 Geotechnical Hazard Evaluation 22

**7 CONTAMINATION ASSESSMENT** 23
7.1 General 23
7.2 Soil Assessment 23
7.2.1 Selection of Screening Criteria 23
7.2.2 Soil Screening 24

7.2.3 Topsoil 28
7.2.4 Made Ground 28
7.3 Topsoil Assessment 29
7.4 Water Supply Pipework 30
7.5 Groundwater & Surface Water Assessment 30
7.5.1 Heavy Metals 33
7.5.2 Ammonium, Polycyclic Aromatic Hydrocarbons (PAH), & Total Petroleum Hydrocarbons (TPH) 33
7.5.3 Per- and polyfluoroalkyl substances (PFAS) 33
7.6 Ground Gas Assessment 34
7.7 Waste Disposal 35
7.8 Summary and Discussion 35

**REFERENCES 37**

**LIST OF APPENDICES 38**

# FOREWORD

General Conditions Relating to Site Investigation

This investigation has been devised to generally comply with the relevant principles and requirements of BS10175:2011+A2:2017 'Investigation of potentially contaminated sites - Code of practice', 'Land contamination: technical guidance' collection (Environment Agency, 2022), 'Land contamination risk management' (LCRM, Environment Agency, 2023) and BS EN 1997 (Eurocode 7). The recommendations made and opinions expressed in this report are based on the information obtained from the sources described using a methodology intended to provide reasonable consistency and robustness.

The opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site and of laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between exploratory positions, these are only for guidance and no liability can be accepted for their accuracy.

Boring and sampling procedures are undertaken in accordance with BS5930:2015+A1:2020 'Code of Practice for Ground Investigations'. Likewise, in-situ and laboratory testing comply with BS1377:1990 'Methods of Tests for Soils for Civil Engineering Purposes' and BS22475:2011, unless stated otherwise in the text. Chemical testing has been undertaken by a UKAS accredited laboratory.

The groundwater conditions entered on the boring records are those observed at the time of investigation. The normal rate of boring usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions.

Some items of the investigation have been provided by third parties and whilst Harrison Group have no reason to doubt their accuracy, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report.

This report is produced in accordance with the scope of Harrison Group's appointment and is subject to the terms of appointment. Harrison Group accepts no liability for any use of this document other than by its client, and only for the purposes for which it was designed and produced. No responsibility can be accepted for any consequences of this information being passed to a third party who may act upon its contents and recommendations.

Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the document as a whole. The contents of this document are not to be construed as providing legal, business or tax advice or opinion.

# EXECUTIVE SUMMARY

| | |
|---|---|
| **Location** | The site known as Grange Farm, Alconbury can be identified by National Grid Reference 123456, 123456. |
| **Current Site Use** | The site comprises a farmyard (Grange Farm), two small areas of woodland, and three arable fields. The farmyard is currently utilised for joinery manufacturing (RT Joinery) and is understood to have been used for vehicle maintenance in the past. |
| **Proposed Site Use** | Residential development of up to 1,500 dwellings, a local centre with retail and community facilities, a primary school, and areas of open space, playgrounds/recreation grounds, and landscaping. |
| **Ground Conditions and Geology** | Made ground was encountered in twenty exploratory locations, mostly within the farmyard area, with a few occurrences noted at/near farm tracks within the fields, although generally only present to a shallow depth. Within the farmyard area, made ground was encountered to a greater depth (up to 1.40m) and was noted to include brick, asphalt, concrete, and occasionally glass throughout. Fuel odours were noted in DS107 to DS109, generally from ground level up to a maximum depth of 1.20m<br>Topsoil was encountered throughout the arable fields, generally present to a depth of 0.40m.<br>The underlying natural soils were relatively consistent between positions throughout the site and were thought to comprise entirely of Oadby Member – Diamicton to the maximum depth investigated (20.00m bgl). These soils were generally described as slightly gravelly to gravelly, sandy, CLAY, often with pockets or lenses of orangey/reddish sand or silt, and occasional cobbles or boulders at shallower depths. The material was generally recorded as initially being soft or firm below topsoil, becoming firm by 1.00m depth, and stiff from approximately 2.50m depth, accompanied by a change in colour to grey or dark grey. In addition, rafts of structureless chalk were encountered in seven exploratory positions between 1.40m and 2.50m depth.<br>Groundwater was encountered during the investigation at between 0.06m to 3.46m bgl (35.63m to 44.82m aOD). |
| **Foundations, Floor Slabs** | Traditional strip/pad foundations are considered suitable for this site at a minimum depth of 0.9m bgl assuming an allowable bearing pressure in the region of 100kPa. Consideration should be given to increasing the reinforcement of the foundation to negate any effects of the variability of the composition of some of the deposits. Foundations should be deepened and/or ground improvement methods utilised should unsuitable material be encountered. On-site supervision by qualified personnel is suggested.<br>Piled foundations may be utilised where higher loads are required, or where made ground is present to a depth where shallow foundations are not practical, Preliminary pile capacity calculations have been undertaken and outline pile capacity for a range of pile diameters and penetration depths in order to guide detailed design once further information becomes available.<br>Reinforced ground bearing slabs are likely to be suitable for structures utilising a shallow strip/pad foundation, following the removal of any topsoil/ made ground and replacement with engineered fill. Suspended floor slabs, such as block and beam, incorporated with the piles, will likely represent the most suitable solution where a piled foundation is used. |
| **Concrete Design** | A design sulphate class of DS-1 and an ACEC class of AC-1s is suitable. |
| **Drainage** | Although formal soakaway testing has not been completed at the site, lack of drainage within the soakaway pits (likely infilled with surface water run off) and visible pooling/ponding of rainwater across the site surface appears to indicate that traditional soakaways are unlikely to be a suitable means of surface water management at the site. |
| **Pavements** | A CBR value of 2.0% is recommended for initial design of pavements founded in the natural cohesive deposits encountered below the topsoil/made ground. Options for improvement of the subgrade include excavation and replacing between 500 and 1000mm of the subgrade with granular fill, or mechanical stabilisation (geogrids and/or geotextiles) and soil stabilisation. Consideration will need to be given to frost susceptibility and the variability of this material and the pavement and/or capping layers may need to be thickened. |
| **Ground Gas** | Elevated levels of ground gases were not recorded, as such the site falls within the 'Very low risk' category for carbon dioxide and methane suggesting that special precautions are not necessary for new structures. |
| **Contamination** | Made ground and topsoil within the farmyard area were shown to be impacted with PAH compounds and heavy metals (beryllium & lead). Furthermore, elevated concentrations of PFAS (specifically, PFOS) were shown to be present in a localised area of made ground around DS107 and DS108.<br>Groundwater was also shown to be impacted with elevated concentrations of heavy metals throughout the farmyard area, and ammonium, PAH, TPH, and other combustion products within a relatively localised area in close proximity to DS107.<br>PFOS was detected in groundwater at low or slightly elevated concentrations throughout the arable fields and farmyard, and at high concentrations (circa 2,000ng/l) within the monitoring well in DS73. |

| | |
|---|---|
| | In addition, slightly elevated concentrations of PFOS were detected in the onsite watercourse immediately adjacent to the farmyard; albeit not detected near the eastern site boundary.<br>Should potentially contaminated soils be discovered during construction, the advice of a specialist should be sought before construction continued.<br>Waste disposal of excavated soils should be carried out in accordance with current legislation and the responsibility for suitable disposal rests with the waste producer. The results from this investigation should be provided to groundwork contractors to aid in classification, although most material would appear to be suitable for disposal as inert waste. |
| **Recommendations and Conclusions** | Based on the findings of the current investigation, further assessment and or remedial actions are recommended, with the following suggested scope of work:<br>• Thickness of made ground is variable but is greatest at the central portion of the farmyard area. Given the deleterious nature of the made ground, close proximity to the nearby watercourse, and as it will not be suitable founding material for buildings or structures proposed within the farmyard area, it is recommended that this material be remediated (via excavation or other suitable techniques) during site development.<br>• Resampling, analysis and assessment of groundwater within the farmyard area for the M-BAT suite of contaminants is recommended to further assess the risk these contaminant concentrations may pose.<br>• It is recommended that further investigation be completed to help determine potential sources for the high concentrations of ammonium, PAH, TPH, and other combustion products recorded in groundwater collected from DS107 and determine if this contaminant source is on-going, as this will affect any future assessment and remediation works. Furthermore, additional groundwater and surface water monitoring events are recommended to better delineate the identified groundwater impacts and to assess potential migration towards the onsite watercourse.<br>• Further investigation is recommended to better delineate the extents of PFAS-impacted soils to the west and south of DS107 & DS108. Additional monitoring of existing wells and surface water is recommended to better assess both the nature of the PFAS at the site (which may be transient at the north portion, near DS03), and whether any evidence of contaminant migration towards the onsite watercourse is present.<br>• A detailed quantitative risk assessment (DQRA) is recommended to assess whether the recorded PFAS concentrations pose an unacceptable risk to surface waters or groundwater resources as well as human health at the site. Should remediation or mitigation prove to be viable (with consideration of existing technology, feasibility, cost and timescales), it should be anticipated that a formalised options appraisal, remediation strategy, method statement, and verification plan will be required. The DQRA should also serve to develop site-specific remediation target values for soil and groundwater, where appropriate. |

# SITE INVESTIGATION REPORT
# FOR LAND AT
# GRANGE FARM, ALCONBURY

## 1 TERMS OF REFERENCE & INTRODUCTION

### 1.1 Introduction

The work covered by this report was undertaken on behalf of Urban&Civic Alconbury Limited. The investigation is in accordance with Harrison Group Environmental Limited's (HGE's) quotations (GC25457_Q_IH_Rev2 and GC25457_Q2_IH) dated 30th June 2023 and 21st February 2024, respectively. A formal appointment document was received from Urban&Civic Alconbury Limited on 21st November 2023, and an emailed instruction to proceed received 21st February 2024.

The report was undertaken in order to assess environmental and geotechnical issues at the site prior to development involving the construction of access routes, residential development of up to 1,500 dwellings, a local centre with retail and community facilities, a primary school, and areas of open space, playgrounds/recreation grounds, and landscaping.

This was carried out in accordance with the requirements of LCRM guidance and constitutes a Stage 1, Tier 2 generic quantitative risk assessment, and includes advice on the design of foundations, floor slabs, drainage and pavements. This has been prepared by review of available published documentation in association with an intrusive ground investigation.

### 1.2 Site Location and Setting

The area of investigation comprises an approximately 43ha area of land located east of Great Stuckeley and southeast of Alconbury Airfield in Huntingdonshire. The site is approximately centred on National Grid Reference 523112, 275246.

The area of investigation comprises a farmyard (Grange Farm), two small areas of woodland, and three arable fields, which are accessible via Green End and Owl End roadways, generally running east-west towards Great Stuckeley. The existing site surface is predominantly cultivated topsoil, with the farmyard being a mixture of areas of soft landscaping, gravel, asphalt, and concrete.

The farmyard is currently utilised for joinery manufacturing (RT Joinery) and is understood to have been used for vehicle maintenance in the past. At the eastern edge of the farmyard there is an open section of watercourse that extends eastwards from Grange Farm towards the Great Stukeley Cutting biological Site of Special Scientific Interest (SSSI). The watercourse is understood to pass beneath the Great Stukeley Cutting in a syphon-like culvert (Lodge Farm Culvert – Stukeley Cutting), eventually feeding into a tributary of the Ripton Brook.

The site location and boundary are presented on drawing GC25457_DR001 in Appendix B.

## 2 SUMMARY OF BACKGROUND INFORMATION

The following investigations have been completed at the site by others, and should be read in conjunction with this report:

- 'Alconbury Weald Southern Gateway - Ground Investigation Interpretive Report' by Shadbolt Group, dated October 2018, report ref. 2599 – Alconbury Weald Southern Gateway (V1). Herein, 'Shadbolt Investigation'.
- 'Phase 1 Ground Condition Assessment (Land Stability and Contamination Desk Study)' by Peter Brett Associates LLP (PBA), dated May 2019, report ref. 24213/3545. Herein, 'PBA Assessment'.

A brief summary of relevant information is provided below.

### 2.1 Geological Record

Published geological data for the Great Stukeley district shows the site to be underlain by glacial till of Oadby Member – Diamicton (herein, 'Oadby Member'), overlying and masking the Jurassic aged Oxford

Clay bedrock. Boreholes completed during the Shadbolt Investigation have shown the till to generally comprise an olive grey to dark grey, but weathering yellowish brown, clayey matrix with gravel of chalk, flint, sandstone, quartzite, limestone and ironstone. Locally the till is sandy and can include lenses/layers of sand. This stratum has been proven to extend to depths of more than 8.0m at the site, and to approximately 15.0m in nearby borehole records located to the north.

Depth to groundwater at the site is unknown, and no groundwater seepages were recorded in any of the borehole, trial pits, or during groundwater/ground gas monitoring completed during the previous site investigation by Shadbolt Group.

## 3 POTENTIAL SOURCES OF CONTAMINATION & CSM

The PBA Assessment has identified the following potentially significant sources of contamination at the site:

- Site-wide usage and storage of agro-chemical such as fertilisers, pesticides, herbicides, and growth regulators.
- Potential asbestos-cement containing materials used in the various buildings that form the farmyard area (and small industrial estate), including possible asbestos-cement cladding and roofing to outbuildings (fragments of which may be present in the near surface soils from breakages during the initial erection works or later breakage/replacement).
- Solvents and other chemical products used in the joinery business (the RT Joinery website states that they have an ‘in-house’ spray shop).
- Organic compounds (including motor oils, lubricants, solvents, anti-freeze, detergents), metals their compounds (including lead and chromium), acids/alkalis and other asbestos containing materials (ACM) used in the car maintenance/ workshop trade.

Upon review, the PBA assessment appears to be generally robust and thorough, and the conceptual site model (CSM) presented appears to be suitable for the current investigation. However, we would advise the consideration of the following potential sources of contamination:

- The proximity of the site to the end of the former runway at the airbase (approximately 350m from the northern boundary) presents a risk of encountering soil and groundwater impacted with aqueous film forming foam (AFFF), which may have been used as a means of fire suppression. Of particular concern are per- and polyfluoroalkyl substances (PFAS), which are known to have a high environmental mobility and persistence.
- There is the potential for made ground to be encountered on a local scale within the farmyard area due to historical/current operations, as well as hazardous vapour generation from use of solvents and petroleum hydrocarbons in this area. Therefore, the risk posed by ground gases will also be assessed as part of this investigation, within the farmyard area.

If visually contaminated or malodourous material is encountered during development, or other observations suggest the potential presence of other contaminants, additional analysis may be advised. These are not suggested as part of initial testing, but in some cases, may form part of follow-up analysis, particularly where initial test results indicate greater potential for other contaminants.

## 4 INITIAL GEOTECHNICAL HAZARD IDENTIFICATION

Table 1 below contains an initial assessment of the likely geotechnical hazards that could be present at the site.

| Hazard | Requires Further Consideration? | Comment |
|---|---|---|
| **Sulphate Bearing Soils** | **Yes** | Considered to be a low risk from encountering soils high in sulphate, but chemical testing is recommended. |
| **Uncontrolled Backfill** | **Yes** | No evidence to suggest uncontrolled backfill on-site, however there may be the potential for undocumented backfilled pits within the agricultural fields. In addition, some made ground should be expected within the farmyard area. |

| Hazard | Requires Further Consideration? | Comment |
|---|---|---|
| **Low Permeability Soil** | **Yes** | The site is anticipated to be underlain by primarily cohesive soils (clay) which will have a lower permeability. |
| **Shrink/Swell potential** | **Yes** | The site is anticipated to include cohesive (potentially shrinkable) soils within the superficial deposits. |
| **Variable Deposits** | **Yes** | The site is anticipated to be underlain by Oadby Member, which is an inherently variable formation. |
| **Unexploded Ordnance** | **Yes** | The PBA Assessment indicates UXO mitigation measures are required. |
| **Slope Stability** | No | Considered to be a low risk as shallow gradients present on-site. |

**Table 1 Initial Geotechnical Hazard Identification**

This table has been based on a review of local knowledge, geology and topography; however, it should be revised at any time if additional relevant data was identified.

# 5 INTRUSIVE INVESTIGATION

## 5.1 Introduction

The intrusive investigation was designed to provide a good coverage of the ground conditions across the site but largely concentrating on the parcels proposed for residential, institutional and commercial development. This was undertaken by cable percussive and dynamic continuous sampling (window sampler) boreholes, machine excavated trial pits, in-situ Plate Bearing Tests (PBTs), Lightweight Deflectometer (LWD) testing, Dynamic Cone Penetrometer (TRL-DCP) tests, and ground gas and groundwater monitoring of installations.

During and immediately following completion of the fieldwork, soil samples were transported to Harrison Group's Laboratory in Norwich via in house transportation where, upon arrival, they were logged into our sample management system.

## 5.2 Fieldwork, Monitoring and In-Situ Testing Program

Details of the site investigation methods employed have been presented on the appended data sheet and a brief summary of the fieldwork has been presented below with the exploratory locations indicated on appended drawing GC25457_DR102 included in Appendix A.

### 5.2.1 Service Clearance, Surveying

Exploratory locations were surveyed whilst undertaking a utility clearance survey on 27th to 29th November 2023 to establish co-ordinates and ground levels. The service clearance was conducted by a specialist subcontractor, Midland Survey Limited. In addition to examining plans, utility covers were lifted, and services traced using a variety of electromagnetic means. Where possible, ground probing radar was also utilised and confirmed service locations and alignments marked on the ground.

### 5.2.2 Dynamic Sampling Boreholes

Eighty dynamic sampler boreholes (DS01 to DS80) were drilled between 4th and 21st December 2023 using a dual-purpose tracked rig to depths of up to 4.45m, as summarised in Table 2 below. A further nine dynamic sampler boreholes (DS101 to DS109) were drilled on the 7th and 8th March 2024 to further investigate the potential presence of PFAS in soil and groundwater at the north and south portions of the site. Experienced field technicians undertook the drilling and collected samples within plastic liners, which were examined, described and sub-sampled for subsequent laboratory testing.

Upon completion, the majority of the boreholes were backfilled with spoil/ballast, whilst twenty-eight of the boreholes (DS01 to DS04, DS07, DS09, DS11, DS13, DS21, DS34, DS38, DS50, DS59, DS68, DS69, DS73 to DS76, & DS101 to DS109) were installed with groundwater/ground gas monitoring wells, the details of which are provided in section 5.2.4.

| Borehole ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| DS01 | 523052.59 | 275793.18 | 44.02 | 1.90 | Y | Dense stratum |
| DS02 | 523145.40 | 275725.06 | 44.13 | 2.75 | Y | Dense stratum |
| DS03 | 523259.16 | 275684.97 | 42.18 | 2.43 | Y | Dense stratum |
| DS04 | 523367.80 | 275609.87 | 41.49 | 2.25 | Y | Dense stratum |
| DS05 | 523046.04 | 275649.60 | 44.30 | 3.45 | N | Dense stratum |
| DS06 | 522975.68 | 275650.54 | 44.64 | 2.55 | N | Dense stratum |
| DS07 | 522919.05 | 275631.55 | 44.85 | 2.92 | Y | Dense stratum |
| DS08 | 522880.56 | 275587.40 | 44.88 | 2.80 | N | Dense stratum |
| DS09 | 522824.47 | 275526.58 | 45.01 | 2.93 | Y | Dense stratum |
| DS10 | 522801.77 | 275462.96 | 44.47 | 2.58 | N | Dense stratum |
| DS11 | 522802.51 | 275390.62 | 43.82 | 2.95 | Y | Dense stratum |
| DS12 | 522887.90 | 275359.18 | 42.94 | 3.12 | N | Dense stratum |
| DS13 | 522935.88 | 275395.81 | 43.32 | 1.66 | Y | Dense stratum |
| DS14 | 523015.91 | 275371.59 | 42.71 | 2.41 | N | Dense stratum |
| DS15 | 523019.27 | 275462.53 | 43.54 | 3.25 | N | Dense stratum |
| DS16 | 523044.18 | 275566.23 | 44.07 | 2.80 | N | Dense stratum |
| DS17 | 522959.01 | 275569.00 | 44.59 | 3.00 | N | Dense stratum |
| DS18 | 522886.48 | 275469.05 | 44.17 | 2.40 | N | Dense stratum |
| DS19 | 523110.86 | 275633.43 | 44.05 | 2.23 | N | Dense stratum |
| DS20 | 523135.94 | 275558.95 | 43.71 | 2.85 | N | Dense stratum |
| DS21 | 523109.54 | 275487.63 | 43.23 | 3.42 | Y | Dense stratum |
| DS22 | 523103.15 | 275407.78 | 42.10 | 3.45 | N | Dense stratum |
| DS23 | 523187.89 | 275611.94 | 43.56 | 2.94 | N | Dense stratum |
| DS24 | 523207.75 | 275538.43 | 42.54 | 2.90 | N | Dense stratum |
| DS25 | 523164.89 | 275474.82 | 42.43 | 2.45 | N | Dense stratum |
| DS26 | 523205.78 | 275432.74 | 41.41 | 3.03 | N | Dense stratum |
| DS27 | 523267.02 | 275605.97 | 42.49 | 2.91 | N | Dense stratum |
| DS28 | 523280.31 | 275540.95 | 41.93 | 3.13 | N | Dense stratum |
| DS29 | 523261.54 | 275486.07 | 41.63 | 2.83 | N | Dense stratum |
| DS30 | 523270.13 | 275430.99 | 40.82 | 2.79 | N | Dense stratum |
| DS31 | 523355.61 | 275594.75 | 41.59 | 3.03 | N | Dense stratum |
| DS32 | 523359.88 | 275508.24 | 40.94 | 3.02 | N | Dense stratum |
| DS33 | 523324.87 | 275454.73 | 40.91 | 3.38 | N | Dense stratum |
| DS34 | 523367.99 | 275409.08 | 39.85 | 2.00 | Y | Dense stratum |
| DS35 | 523313.41 | 275385.16 | 39.84 | 1.95 | N | Dense stratum |
| DS36 | 523140.36 | 275302.67 | 40.40 | 2.63 | N | Dense stratum |
| DS37 | 523169.84 | 275262.36 | 39.75 | 2.39 | N | Dense stratum |
| DS38 | 523150.55 | 275229.90 | 39.58 | 2.45 | Y | Dense stratum |
| DS39 | 523156.48 | 275166.42 | 38.72 | 2.44 | N | Dense stratum |
| DS40 | 523206.36 | 275198.30 | 38.76 | 3.11 | N | Dense stratum |
| DS41 | 523238.97 | 275252.85 | 39.01 | 2.85 | N | Dense stratum |

| Borehole ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| DS42 | 523286.67 | 275181.30 | 38.06 | 1.70 | N | Dense stratum |
| DS43 | 523214.93 | 275312.30 | 39.78 | 2.34 | N | Dense stratum |
| DS44 | 523288.38 | 275287.17 | 38.97 | 3.24 | N | Dense stratum |
| DS45 | 523301.95 | 275338.11 | 39.25 | 2.50 | N | Dense stratum |
| DS46 | 523397.76 | 275363.88 | 39.18 | 3.09 | N | Dense stratum |
| DS47 | 523371.62 | 275322.04 | 38.86 | 2.95 | N | Dense stratum |
| DS48 | 523323.82 | 275251.72 | 38.47 | 2.33 | N | Dense stratum |
| DS49 | 523373.37 | 275219.39 | 37.65 | 2.43 | N | Dense stratum |
| DS50 | 523410.79 | 275282.39 | 37.93 | 2.90 | Y | Dense stratum |
| DS51 | 523443.67 | 275241.03 | 37.25 | 2.30 | N | Dense stratum |
| DS52 | 523056.20 | 275320.15 | 41.37 | 3.18 | N | Dense stratum |
| DS53 | 523035.26 | 275242.48 | 40.59 | 2.90 | N | Dense stratum |
| DS54 | 523004.31 | 275165.81 | 39.98 | 2.74 | N | Dense stratum |
| DS55 | 523063.22 | 275126.85 | 39.12 | 3.15 | N | Dense stratum |
| DS56 | 523001.21 | 275090.14 | 39.38 | 4.45 | N | Target depth achieved |
| DS57 | 522991.69 | 275302.12 | 41.57 | 3.15 | N | Dense stratum |
| DS58 | 522896.96 | 275264.52 | 41.89 | 2.41 | N | Dense stratum |
| DS59 | 522955.63 | 275239.90 | 41.29 | 3.45 | Y | Dense stratum |
| DS60 | 522868.88 | 275197.60 | 41.35 | 3.45 | N | Dense stratum |
| DS61 | 522934.72 | 275168.36 | 40.58 | 2.90 | N | Dense stratum |
| DS62 | 522905.70 | 275132.94 | 40.40 | 3.13 | N | Dense stratum |
| DS63 | 522902.98 | 275072.77 | 39.97 | 3.95 | N | Dense stratum |
| DS64 | 522941.77 | 275026.70 | 39.64 | 3.93 | N | Dense stratum |
| DS65 | 522879.53 | 274970.37 | 40.16 | 3.08 | N | Dense stratum |
| DS66 | 522873.49 | 275040.58 | 39.97 | 3.95 | N | Dense stratum |
| DS67 | 522820.93 | 275102.64 | 40.84 | 4.03 | N | Target depth achieved |
| DS68 | 522789.28 | 275049.35 | 40.69 | 3.91 | Y | Dense stratum |
| DS69 | 522934.59 | 274957.03 | 39.88 | 3.43 | Y | Dense stratum |
| DS70 | 522967.21 | 275004.52 | 40.33 | 3.45 | N | Dense stratum |
| DS71 | 522974.78 | 274980.12 | 40.00 | 2.89 | N | Dense stratum |
| DS72 | 523034.32 | 274989.70 | 39.96 | 3.38 | N | Dense stratum |
| DS73 | 523019.23 | 275021.61 | 39.59 | 3.37 | Y | Dense stratum |
| DS74 | 523005.33 | 274954.85 | 39.55 | 2.40 | Y | Dense stratum |
| DS75 | 523020.11 | 274909.31 | 39.30 | 3.89 | Y | Dense stratum |
| DS76 | 523028.21 | 274949.77 | 39.60 | 3.38 | Y | Dense stratum |
| DS77 | 522795.56 | 274964.56 | 40.62 | 4.45 | N | Target depth achieved |
| DS78 | 523096.93 | 275021.63 | 38.86 | 4.15 | N | Target depth achieved |
| DS79 | 523219.88 | 275044.95 | 38.04 | 3.95 | N | Dense stratum |
| DS80 | 523403.79 | 275130.23 | 36.82 | 3.45 | N | Dense stratum |
| DS101 | 523306.20 | 275675.21 | 42.00 | 2.60 | Y | Dense stratum |
| DS102 | 523261.18 | 275615.16 | 42.66 | 2.50 | Y | Dense stratum |

| Borehole ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| DS103 | 523261.08 | 275720.36 | 42.55 | 2.70 | Y | Dense stratum |
| DS104 | 523013.27 | 275049.25 | 39.70 | 2.70 | Y | Dense stratum |
| DS105 | 523043.86 | 275026.11 | 40.13 | 2.80 | Y | Dense stratum |
| DS106 | 522992.94 | 275039.69 | 39.72 | 2.40 | Y | Dense stratum |
| DS107 | 523007.83 | 275013.50 | 39.75 | 2.50 | Y | Dense stratum |
| DS108 | 523041.74 | 275021.74 | 39.75 | 3.00 | Y | Target depth |
| DS109 | 523054.49 | 275013.68 | 39.56 | 3.00 | Y | Target depth |

**Table 2 Summary of Dynamic Sampling Boreholes**

A detailed description of all the strata encountered, in-situ testing undertaken, position and types of samples taken along, with any groundwater observations made at the time of drilling are included on the window sample borehole records presented in Appendix C.

### 5.2.3 Cable Percussive Boreholes

Four cable percussive boreholes were drilled between the 2nd and 3rd January 2023 (CP01 and CP04), and 21st and 22nd May 2024 (CP02 and CP03) to a maximum depth of 20.32m in order to identify, sample and test the sub-soils underlying the site. Upon completion, both of boreholes were installed with groundwater monitoring wells, the details of which are provided in section 5.2.4. A summary of the cable percussive boreholes is presented in Table 3 below.

| Borehole ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| CP01 | 522942.98 | 275063.50 | 39.59 | 20.32 | Y | Target depth |
| CP02 | 522855.63 | 275098.72 | 40.48 | 20.00 | Y | Target depth |
| CP03 | 522822.11 | 275021.05 | 40.46 | 20.00 | Y | Target depth |
| CP04 | 522904.27 | 274997.42 | 39.83 | 20.30 | Y | Target depth |

**Table 3 Summary of Cable Percussive Boreholes**

A detailed description of all the strata encountered, in-situ testing undertaken, position and types of samples taken along, with any groundwater observations made at the time of drilling are included on the cable percussive borehole records presented in Appendix C.

### 5.2.4 Monitoring Wells

Thirty-two dynamic sampling boreholes and four cable percussive boreholes were installed with standpipes for monitoring groundwater and/or ground gas flow rates and concentrations within the soils encountered. Table 4 below provides a summary of the installations.

| Monitoring Point ID | Diameter of Installation (mm) | Response Zone (mbgl) | | Response Zone (maOD) | | Target Strata |
|---|---|---|---|---|---|---|
| | | Top | Base | Top | Base | |
| CP01 | 50 | 1.00 | 5.00 | 38.59 | 34.59 | Oadby Member |
| CP02 | 50 | 1.00 | 5.00 | 39.48 | 35.48 | Oadby Member |
| CP03 | 50 | 1.00 | 5.00 | 39.46 | 35.46 | Oadby Member |
| CP04 | 50 | 1.00 | 5.00 | 38.83 | 34.83 | Oadby Member |
| DS01 | 50 | 0.50 | 1.50 | 43.52 | 42.52 | Oadby Member |
| DS02 | 50 | 0.50 | 2.60 | 43.63 | 41.53 | Oadby Member |
| DS03 | 50 | 0.50 | 2.00 | 41.68 | 40.18 | Oadby Member |

| Monitoring Point ID | Diameter of Installation (mm) | Response Zone (mbgl) | | Response Zone (maOD) | | Target Strata |
|---|---|---|---|---|---|---|
| | | Top | Base | Top | Base | |
| DS04 | 50 | 0.50 | 1.80 | 40.99 | 39.69 | Oadby Member |
| DS07 | 50 | 0.50 | 2.50 | 44.35 | 42.35 | Oadby Member |
| DS09 | 50 | 0.50 | 2.50 | 44.51 | 42.51 | Oadby Member |
| DS11 | 50 | 0.50 | 2.50 | 43.32 | 41.32 | Oadby Member |
| DS13 | 50 | 0.50 | 1.50 | 42.82 | 41.82 | Oadby Member |
| DS21 | 50 | 1.00 | 2.00 | 42.23 | 41.23 | Oadby Member |
| DS34 | 50 | 0.50 | 1.60 | 39.35 | 38.25 | Oadby Member |
| DS38 | 50 | 0.50 | 2.00 | 39.08 | 37.58 | Oadby Member |
| DS50 | 50 | 0.50 | 2.50 | 37.43 | 35.43 | Oadby Member |
| DS59 | 50 | 0.50 | 3.00 | 40.79 | 38.29 | Oadby Member |
| DS68 | 50 | 0.50 | 3.50 | 40.19 | 37.19 | Oadby Member |
| DS69 | 50 | 0.50 | 3.00 | 39.38 | 36.88 | Oadby Member |
| DS73 | 50 | 0.50 | 3.00 | 39.09 | 36.59 | Oadby Member |
| DS74 | 50 | 0.50 | 2.00 | 39.05 | 37.55 | Made Ground & Oadby Member |
| DS75 | 50 | 0.50 | 3.50 | 38.80 | 35.80 | Oadby Member |
| DS76 | 50 | 0.50 | 3.00 | 39.10 | 36.60 | Oadby Member |
| DS101 | 50 | 0.60 | 2.60 | 41.40 | 39.40 | Oadby Member |
| DS102 | 50 | 0.50 | 2.50 | 42.16 | 40.16 | Oadby Member |
| DS103 | 50 | 0.70 | 2.70 | 41.85 | 39.85 | Oadby Member |
| DS104 | 50 | 0.70 | 2.70 | 39.00 | 37.00 | Oadby Member |
| DS105 | 50 | 0.80 | 2.80 | 39.33 | 37.33 | Made Ground |
| DS106 | 50 | 1.00 | 2.40 | 38.72 | 37.32 | Oadby Member |
| DS107 | 50 | 0.80 | 1.70 | 38.95 | 37.95 | Made Ground & Oadby Member |
| DS108 | 50 | 1.00 | 3.00 | 38.75 | 36.75 | Made Ground & Oadby Member |
| DS109 | 50 | 1.00 | 3.00 | 38.56 | 36.56 | Oadby Member |

**Table 4 Summary of Borehole Monitoring Installations**

Detailed descriptions of the installations and their corresponding backfill materials are included on the relevant exploratory hole logs presented in the appendix.

### 5.2.5 Machine Excavated Trial Pits

Sixty-five trial pits (TP01 to TP63, TP65 & TP66) were excavated using a 14 tonne tracked excavator between the 28th November and 13th December 2023 to a maximum depth of 3.20m bgl to investigate the shallow ground conditions and take representative samples for subsequent testing.

A further seventeen trial pits (SA01 to SA16 & SA08A) were excavated and backfilled with monitoring standpipes and clean inert gravel to maintain stability in order to enable soakaway testing. However, soakaway testing was not undertaken due to the vast majority of the pits infilling with water, generally to depths of between ground level and 0.80m bgl. It is unclear whether this water represents true groundwater or surface water run off failing to permeate through the underlying predominantly cohesive soils, although given the high volume of rainfall during the investigation and the findings of the previous investigation, the latter seems most likely.

Table 5 below provides a summary of machine excavated trial pitting.

| Trial Pit ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| SA01 | 523095.67 | 275738.89 | 44.16 | 2.00 | Y | Target depth |
| SA02 | 523108.52 | 275700.18 | 44.10 | 1.50 | Y | Target depth |
| SA03 | 523165.76 | 275680.25 | 43.71 | 2.00 | Y | Target depth |
| SA04 | 523221.63 | 275665.40 | 43.12 | 2.50 | Y | Target depth |
| SA05 | 523275.32 | 275652.73 | 41.91 | 1.75 | Y | Target depth |
| SA06 | 523327.21 | 275647.69 | 42.13 | 1.50 | Y | Target depth |
| SA07 | 523081.35 | 275374.80 | 41.84 | 1.00 | Y | Target depth |
| SA08 | 523141.32 | 275386.59 | 41.30 | 1.00 | N | Land drain encountered |
| SA08A | 523141.32 | 275389.09 | 41.30 | 2.00 | Y | Target depth |
| SA09 | 523184.46 | 275356.29 | 40.59 | 2.00 | Y | Target depth |
| SA10 | 523233.39 | 275386.64 | 40.58 | 0.90 | Y | Target depth |
| SA11 | 523256.91 | 275151.16 | 38.24 | 1.60 | Y | Target depth |
| SA12 | 523356.17 | 275168.01 | 37.56 | 2.00 | Y | Target depth |
| SA13 | 523438.24 | 275185.19 | 37.00 | 1.50 | Y | Target depth |
| SA14 | 523351.50 | 275074.03 | 37.12 | 2.00 | Y | Target depth |
| SA15 | 523445.16 | 275101.21 | 36.99 | 2.50 | Y | Target depth |
| SA16 | 523508.84 | 275125.02 | 36.65 | 1.10 | Y | Target depth |
| TP01 | 523091.65 | 275674.73 | 44.29 | 3.00 | N | Target depth |
| TP02 | 523161.75 | 275643.12 | 43.75 | 3.00 | N | Target depth |
| TP03 | 523029.18 | 275620.97 | 44.31 | 3.00 | N | Target depth |
| TP04 | 523003.81 | 275555.63 | 44.31 | 3.20 | N | Target depth |
| TP05 | 522995.53 | 275602.45 | 44.43 | 3.00 | N | Target depth |
| TP06 | 523030.33 | 275501.18 | 43.98 | 3.00 | N | Target depth |
| TP07 | 522994.16 | 275418.72 | 43.27 | 3.00 | N | Target depth |
| TP08 | 522962.83 | 275507.52 | 44.32 | 3.00 | N | Target depth |
| TP09 | 522890.43 | 275545.94 | 44.81 | 3.00 | N | Target depth |
| TP10 | 522839.07 | 275462.80 | 44.30 | 3.00 | N | Target depth |
| TP11 | 522812.95 | 275421.65 | 44.07 | 3.00 | N | Target depth |
| TP12 | 522937.74 | 275446.52 | 43.91 | 3.00 | N | Target depth |
| TP13 | 522893.33 | 275402.35 | 43.55 | 3.10 | N | Target depth |
| TP14 | 523088.52 | 275593.22 | 44.21 | 3.00 | N | Target depth |
| TP15 | 523107.45 | 275539.28 | 43.72 | 3.00 | N | Target depth |
| TP16 | 523169.33 | 275534.77 | 43.20 | 3.00 | N | Target depth |
| TP17 | 523248.00 | 275573.40 | 42.42 | 3.00 | N | Target depth |
| TP18 | 523309.71 | 275577.20 | 41.96 | 3.00 | N | Target depth |
| TP19 | 523361.95 | 275554.24 | 41.35 | 3.00 | N | Target depth |
| TP20 | 523327.14 | 275511.97 | 41.27 | 3.00 | N | Target depth |
| TP21 | 523147.88 | 275438.32 | 41.88 | 3.00 | N | Target depth |
| TP22 | 523082.83 | 275455.54 | 43.23 | 3.00 | N | Target depth |
| TP23 | 523206.24 | 275491.10 | 42.13 | 3.00 | N | Target depth |
| TP24 | 523241.70 | 275451.13 | 41.58 | 3.00 | N | Target depth |

| Trial Pit ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| TP25 | 523293.61 | 275480.50 | 41.28 | 3.00 | N | Target depth |
| TP26 | 523305.59 | 275417.65 | 40.33 | 3.00 | N | Target depth |
| TP27 | 523358.11 | 275459.92 | 40.65 | 3.00 | N | Target depth |
| TP28 | 523171.56 | 275316.76 | 40.30 | 3.00 | N | Target depth |
| TP29 | 523123.57 | 275263.15 | 39.78 | 3.00 | N | Target depth |
| TP30 | 523201.64 | 275237.44 | 39.15 | 3.00 | N | Target depth |
| TP31 | 523254.37 | 275312.75 | 39.43 | 3.00 | N | Target depth |
| TP32 | 523275.05 | 275254.12 | 38.70 | 3.00 | N | Target depth |
| TP33 | 523169.29 | 275199.06 | 39.05 | 2.90 | N | Target depth |
| TP34 | 523247.17 | 275204.21 | 38.51 | 3.00 | N | Target depth |
| TP35 | 523362.21 | 275351.20 | 39.26 | 3.00 | N | Target depth |
| TP36 | 523326.09 | 275308.45 | 38.87 | 3.00 | N | Target depth |
| TP37 | 523412.64 | 275336.71 | 38.52 | 3.00 | N | Target depth |
| TP38 | 523453.52 | 275279.46 | 37.57 | 3.00 | N | Target depth |
| TP39 | 523374.51 | 275258.50 | 37.97 | 3.00 | N | Target depth |
| TP40 | 523333.77 | 275222.87 | 37.99 | 3.00 | N | Target depth |
| TP41 | 523408.68 | 275209.73 | 37.29 | 3.00 | N | Target depth |
| TP42 | 522822.82 | 275325.17 | 42.94 | 2.70 | N | Target depth |
| TP43 | 522832.93 | 275249.75 | 42.02 | 3.00 | N | Target depth |
| TP44 | 522940.86 | 275333.49 | 42.36 | 3.00 | N | Target depth |
| TP45 | 523075.65 | 275330.24 | 41.42 | 2.90 | N | Target depth |
| TP46 | 522952.27 | 275293.45 | 41.78 | 3.10 | N | Target depth |
| TP47 | 522914.73 | 275235.44 | 41.52 | 3.00 | N | Target depth |
| TP48 | 522868.35 | 275162.57 | 40.97 | 3.00 | N | Target depth |
| TP49 | 522964.71 | 275201.29 | 40.76 | 3.00 | N | Target depth |
| TP50 | 523007.78 | 275217.31 | 40.45 | 3.00 | N | Target depth |
| TP51 | 523061.35 | 275193.50 | 39.70 | 3.00 | N | Target depth |
| TP52 | 523020.83 | 275126.47 | 39.31 | 3.00 | N | Target depth |
| TP53 | 522955.26 | 275127.41 | 40.08 | 2.70 | N | Target depth |
| TP54 | 522901.00 | 275107.67 | 40.17 | 3.00 | N | Target depth |
| TP55 | 522825.46 | 275068.03 | 40.53 | 3.00 | N | Target depth |
| TP56 | 522874.22 | 275006.80 | 40.04 | 3.00 | N | Target depth |
| TP57 | 522967.41 | 275043.54 | 39.40 | 3.00 | N | Target depth |
| TP58 | 522910.83 | 274989.16 | 39.93 | 3.00 | N | Target depth |
| TP59 | 522833.89 | 274986.77 | 40.47 | 3.00 | N | Target depth |
| TP60 | 522838.83 | 274927.16 | 40.50 | 3.00 | N | Target depth |
| TP61 | 522943.10 | 274948.17 | 39.87 | 3.00 | N | Target depth |
| TP62 | 523013.85 | 274894.73 | 39.29 | 0.50 | N | Water ingress made pit unstable |
| TP63 | 523065.80 | 274990.04 | 39.09 | 3.00 | N | Target depth |
| TP65 | 523149.85 | 275060.78 | 38.47 | 3.00 | N | Target depth |

| Trial Pit ID | Easting | Northing | Ground Level (maOD) | Termination Depth (mbgl) | Installed? | Termination Reason |
|---|---|---|---|---|---|---|
| TP66 | 523148.09 | 275143.63 | 38.56 | 3.00 | N | Target depth |

**Table 5 Summary of Trial Pits**

Where ground conditions allowed, hand shear vane testing was conducted on cohesive soils periodically within the trial pits in accordance with BS1377-9:1990 “Methods of test for soils for civil engineering purposes”.

The trial pits not proposed for soakaway testing were backfilled with nominally compacted arisings to ground level on completion. A detailed description of the strata encountered, position and types of samples taken along with any groundwater observations made at the time of excavation are included on trial pit records in Appendix C.

### 5.2.6 Hand Excavated Trial Pits

Twenty-three hand dug trial pits (HDTP101 to HDTP123) were excavated on 6th March 2024 to a maximum depth of 0.50m to investigate the shallow ground conditions and obtain representative samples of topsoil for assessment of contamination concentrations at select locations throughout the site.

A detailed description of the strata encountered, position and types of samples taken along with any groundwater observations made at the time of excavation are included on the trial pit records in Appendix C,

### 5.2.7 In-Situ Testing To Derive California Bearing Ratio

In-situ light weight deflectometer (LWD) testing, plate load testing (PBT), and dynamic cone penetrometer testing (TRL-DCP) was undertaken between the 14th December 2023 and 5th January 2024 throughout the proposed access road alignments in order to derive California Bearing Ratio (CBR) values. PBT and LWD testing were completed on the surface of the natural soils (base of topsoil) with TRL-DCP testing complete from ground level.

The results are presented on the LWD, PBT and TRL-DCP test results sheets in Appendix C.

### 5.2.8 Ground Gas Monitoring

Ground gas monitoring was undertaken on six occasions following completion of the main part of the investigation between the 15th January and 19th February 2024 utilising a Geotechnical Instruments GA5000 infrared gas analyser. Monitoring was undertaken to record the concentrations of gases including methane, carbon dioxide, oxygen and also relative pressure and flow rate.

The results are presented on the in-situ gas monitoring results sheet presented in Appendix D.

### 5.2.9 Groundwater & Surface Water Monitoring & Sampling

Groundwater monitoring was undertaken on eight occasions between 4th January and 12th March 2024 using an electronic dip tape.

Groundwater sampling was initially undertaken on 15th January 2024 from seven selected monitoring wells (DS01 to DS03, DS69, DS73, DS75 & DS76) located at the north of the site and within the farmyard area. Following receipt of the analytical results, which indicated PFAS to be present in several of these samples, additional monitoring wells were installed within the farmyard area.

A second round of groundwater sampling was undertaken on 13th March 2024 at twenty locations (DS01 to DS03, DS09, DS13, DS38, DS59, DS73 to DS76, DS101, DS103, DS104, DS106 to DS109, CP01 and CP04) throughout the site. It should be noted that monitoring wells in DS102 and DS105 were recorded as dry during this event.

All monitoring wells were developed prior to sampling using a dedicated disposable bailer to purge a minimum of three well volumes or until dry. Samples were collected using a disposable bailer, stored in appropriate containers and placed in a cool box with freezer blocks to maintain low temperature during the subsequent transfer to a chemical laboratory for analysis.

In addition, two surface water samples were collected from the onsite watercourse on March 13th 2024, located close to the eastern site boundary (SW1) and farmyard area (SW2).

The results of the in-situ groundwater and surface water monitoring are presented in Appendix D.

## 5.3 Fieldwork Observations

### 5.3.1 Ground Conditions

Soil containing anthropogenic material (made ground) was encountered in twenty exploratory locations, predominantly located within the farmyard area, with a few occurrences noted at/near farm tracks within the fields. Made ground recorded within the arable field generally comprised reworked natural soils with traces of brick and was present from ground level to a maximum depth of 0.40m.

The made ground recorded beneath hardstanding within the farmyard area was recorded to a maximum depth of 1.40m and comprised a mixture of both granular and cohesive soils including anthropogenic material such as brick, asphalt, concrete, and occasionally glass throughout. Hydrocarbon-like odours were noted in DS107 to DS109, generally from ground level up to a maximum depth of 1.20m. In addition, it should be noted that no recovery was possible in borehole DS105 from 0.50m depth within the made ground. This is suspected to be due to the presence of brick or a concrete cobble, traces of which were noted in the overlying made ground and visible at site surface in this area.

Topsoil was recorded in all other positions across the site from ground level, generally extending to a depth of 0.40m bgl (maximum depth of 0.50m bgl). Topsoil generally comprised soft to firm, brown, slightly gravelly CLAY, with gravel being chalk and flint.

The underlying natural soils were relatively consistent between positions throughout the site, and considered to comprise entirely of Oadby Member – Diamicton to the maximum depth investigated (20.00m bgl). These soils were generally described as a yellowish brown, orangish brown to brown, slightly gravelly to gravelly, sandy, CLAY, often with pockets or lenses of orangish brown sand or silt. The material was generally recorded as initially being soft or firm below topsoil, becoming firm by 1.00m depth, and stiff from approximately 2.50m depth, accompanied by a change in colour to grey or dark grey.

Rare cobbles and boulders were recorded from depths of 1.50m bgl. Gravel, cobbles and boulders were predominantly of chalk with some flint and were less commonly composed of siltstone, mudstone, and/or limestone.

Rafts of structureless chalk were encountered in seven exploratory positions (DS12, DS73, DS76, TP03, TP07, TP21 & TP34) between 1.40m and 2.50m depth. These soils were generally described as either slightly gravelly, sandy SILT with low cobble content (Grade Dm), or slightly sandy, slightly silty GRAVEL (Grade Dc). In both instances, gravel was noted as being weak, low density, fine to coarse chalk.

Ground conditions encountered during the investigation are summarised in Table 6 below.

| Depth Encountered [upper boundary] (mbgl) | Thickness [Min-Max] (m) | Elevation Range Encountered [top and base] (m aOD) | Geological Stratum | Notes |
|---|---|---|---|---|
| 0.00 | 0.15 - 0.50 | 45.01 – 36.05 | Topsoil | |
| 0.00 | 0.20 - 1.40 | 44.29 – 37.53 | Made Ground | Only encountered at DS27, DS31, DS38, DS39, DS50, DS70-DS74, DS76, DS104, DS105, DS107 to DS109, TP01, SA07, SA08, SA08A. |
| 0.00 – 1.40 | 0.20 - >19.92 | 44.61 - <19.27 | Oadby Member | Total thickness not proven. |
| 1.40 – 2.50 | 0.20 – >1.40 | 41.54 – <35.71 | Chalk Raft | Only encountered in DS12, DS73, DS76, TP03, TP07, TP21 & TP34. |

**Table 6 Summary of Depth/Thickness of Strata Encountered**

### 5.3.2 Groundwater

Depth to groundwater was recorded to range between 0.06m to 3.46m bgl (35.63m to 44.82m aOD) within the exploratory holes during drilling and subsequent monitoring of the wells installed, as presented in the appended groundwater monitoring sheets. Following review of available background information, groundwater is anticipated to underlie the site at a depth of approximately 1.00m bgl.

A strong fuel or rubber-like odour and black discolouration were observed in the groundwater sample collected from DS107. This was not observed in any of the other monitoring wells sampled and developed at the site.

### 5.3.3 Ground Gas Monitoring

The gas monitoring regime comprised of six rounds carried out over a six week period following completion of the main investigation phase. The monitoring results are presented in Appendix D and are summarised in Table 7 below.

| Monitoring Point ID | Barometric Pressure (mB) | Gas Concentration Ranges | | | | | Max Flow Rate (l/hr) |
|---|---|---|---|---|---|---|---|
| | | $CH_4$ (%) | $CO_2$ (%) | $O_2$ (%) | CO (ppm) | $H_2S$ (ppm) | |
| DS69 | 1002 - 1024 | 0.0-0.1 | 0.6-1.8 | 20.3-21.8 | <1 | <1 | 0.1 |
| DS73 | 1002 - 1024 | 0.0-0.1 | 0.1-1.2 | 19.1-22.7 | <1 | <1 | 0.2 |
| DS74 | 1002 - 1024 | 0.0-0.1 | 0.1-1.1 | 18.1-21.5 | <1 - 2 | <1 | 0.2 |
| DS75 | 1001 - 1024 | 0.0-0.1 | 0.2-1.9 | 20.2-21.7 | <1 | <1 | 0.2 |
| DS76 | 1001 - 1024 | 0.0-0.1 | 0.1-0.4 | 19.8-21.7 | <1 | <1 | 0.2 |

**Table 7 Summary of Ground Gas Concentrations and Flow Rates**

## 5.4 In-Situ Testing

In-situ testing was undertaken for geotechnical purposes and is summarised below in Table 8 with subsequent sections providing details regarding the tests results.

| Test Type and Reference (BS 1377: 1990 unless stated) | Stratum | Number of Results | Results (Range) | Comments / Limitations |
|---|---|---|---|---|
| **Standard Penetration Test** (BS EN ISO 22476-3:2005) | Made Ground | 1 | N = 12<br>$N_{60}$ = 12 | Indicative of medium dense granular soils or firm cohesive soils |
| | Oadby Member | 257 | N = 5 - 50<br>$N_{60}$ = 5 - 56 | Indicative of soft to very stiff cohesive soils.<br>N values display a degree of scatter, with some elevated values (at a shallow depth) likely to be due to encountering gravels and cobbles. |
| | Chalk Raft | 3 | N = 12 - 50<br>$N_{60}$ =12 - 51 | Chalk grade difficult to determine from N values |
| **In-Situ Hand Vane Test** (Part 9, Clause 4.4) | Oadby Member | 75 | 46 - 190kPa<br>Avg.: 95.5kPa | Indicative of moderate strength to very high strength cohesive soils, being high strength on average |
| **In-Situ CBR Test by DCP-TRL Test** (DMRB CD 225) | All Strata | 79 | CBR = 0.53 - 130%<br>(Average CBR = 8.2%)<br>E: 11.7 – 396.7 MPa | CBR to estimated subgrade surface modulus conversion is only valid for CBR values in the range 2 to 12% |
| **Plate Bearing Tests** (Part 9: clause 4.4) | All Strata | 3 | Modulus of Subgrade Reaction 16.2 – 19.8 MPa/m<br>Derived CBR<br>1.2 – 1.7% | 600mm diameter plate. |
| **Light Weight Deflectometer Tests** (DMRB CD 225) | All Strata | 22 | CBR = 0.45 – 1.3%<br>(Average CBR = 0.71%)<br>E: 10.6 – 20.8 MPa | |

**Table 8 Summary of In-Situ Geotechnical Testing**

### 5.4.1 Standard Penetration Testing

The N values reported directly from the blow counts of the equipment in the field (standard penetration tests) are presented on the appended borehole records. These have been converted to standardised $N_{60}$ values by using the following equation provided in BS EN ISO 22476-3:2005+A1:2011.

$$N_{60} = \frac{E_r}{60} N C_N \boldsymbol{\lambda}$$

where:

**N** = N values from field tests.
**$E_r$** = Energy ratio of the hammer (80% for the dynamic sampling rig hammer utilised on this site).
**$C_N$** = Correction factor for the type of consolidation history of the soils.
**$\boldsymbol{\lambda}$** = Correction value for the rod length below the anvil (where in granular soils).

Figure 1 below provides the relationship between $N_{60}$ and depth below ground level.

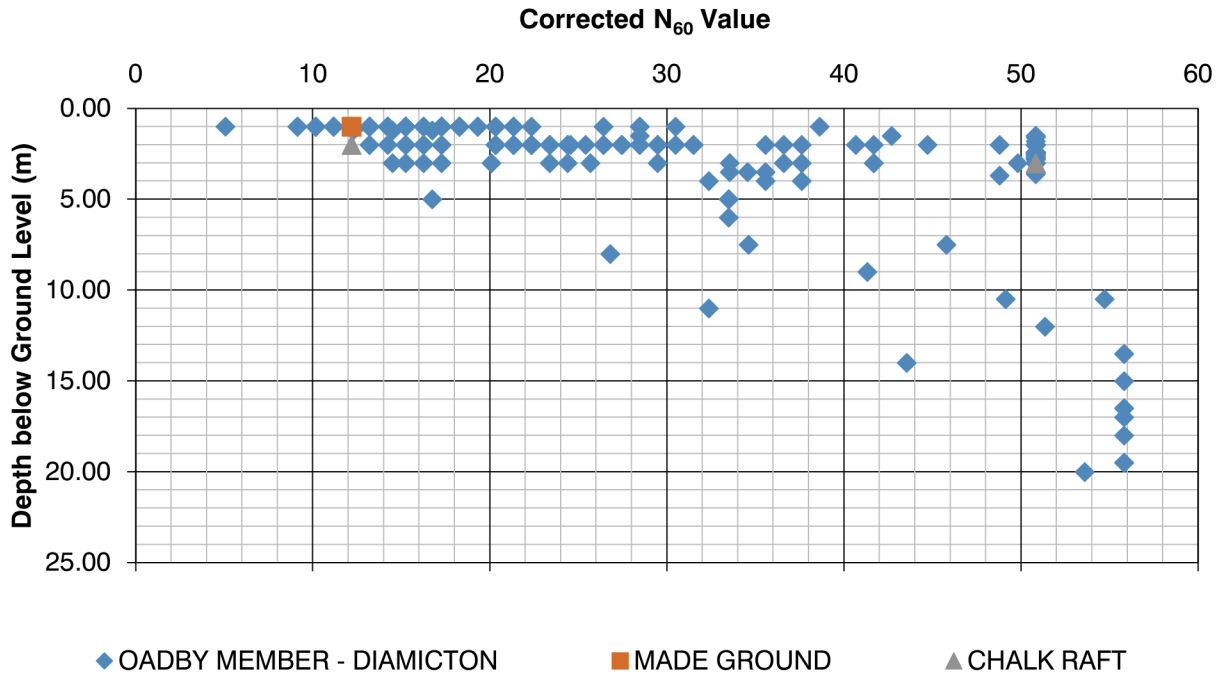



**Figure 1 Corrected $N_{60}$ Values vs. Depth Below Ground Level**

The SPT results, in conjunction with engineer's descriptions and correlation with hand shear vane results can be also used as a guide to estimate the strength of cohesive material. The figure above indicates that the majority of the SPT $N_{60}$ values were above 10; indicating cohesive soils with a moderate or higher resistance, which can be interpreted as a firm or better strength. SPT values display a great deal of scatter at from 1.00m to 3.00m bgl, likely due to encountering gravel and cobbles present within the Diamicton and surface softening as a consequence of the heavy rainfall which occurred during the investigation.

Furthermore, a general positive trend is observed of increasing SPT $N_{60}$ values with depth, with soils in most positions interpreted as having high resistance (stiff or better strength) below 2.00m to 3.00m depth.

Adjustment can also be made to N-values to consider the effect of the overburden pressure in granular material, as described in BS EN ISO 22476-3:2005+A1:2011. This correction has not been applied to the data for this project.

### 5.4.2 In-Situ Hand Vane Testing

In-situ hand shear vane testing can be used as a means of directly measuring undrained shear strength; however, ultimate strength determination should be given using a number of individual determinations by specific means (i.e. triaxial testing, laboratory vane, etc).

Hand shear vanes undertaken in the Oadby Member have determined shear strengths of between 46kPa and 190kPa at depths of between 0.40 – 1.60m bgl. In general, the hand shear vane testing has determined the shallow cohesive soils to be firm to very stiff (moderate to very high strength).

### 5.4.3 In-Situ California Bearing Ratio (CBR) Testing by TRL-DCP Tests

Seventy-nine in-situ TRL-DCP tests were carried out throughout the proposed access roads. The tests were performed from ground level to a maximum depth of 0.92m bgl within the underlying natural material (comprising Topsoil and Oadby Member). The results are presented on the appended TRL-DCP results sheets and indicate an overall CBR value ranging between 0.53 – 130%, and a CBR value ranging between 0.53% and 34% between 0.40m and 0.60m depth (i.e. below the initial layer of topsoil) as presented in Table 9 below.

| Stratum | Position | Test Depth Range (m bgl) | CBR Value at 0.40m bgl | CBR Value at 0.60m bgl |
|---|---|---|---|---|
| Topsoil and Oadby Member | TRL01 | 0.00 - 0.89 | 3.3 | 3.3 |
| | TRL02 | 0.00 - 0.9 | 7.7 | 4.0 |
| | TRL03 | 0.00 - 0.88 | 4.2 | 4.2 |
| | TRL04 | 0.00 - 0.88 | 3.4 | 5.4 |
| | TRL05 | 0.00 - 0.87 | 6.9 | 16.0 |
| | TRL06 | 0.00 - 0.88 | 6.0 | 6.0 |
| | TRL07 | 0.00 - 0.90 | 5.7 | 5.7 |
| | TRL08 | 0.00 - 0.88 | 5.0 | 7.5 |
| | TRL09 | 0.00 - 0.88 | 3.8 | 6.4 |
| | TRL10 | 0.00 - 0.89 | 0.5 | 4.3 |
| | TRL11 | 0.00 - 0.88 | 4.6 | 4.6 |
| | TRL12 | 0.00 - 0.89 | 4.6 | 4.6 |
| | TRL13 | 0.00 - 0.89 | 5.6 | 5.6 |
| | TRL14 | 0.00 - 0.84 | 3.9 | 3.9 |
| | TRL15 | 0.00 - 0.91 | 3.8 | 6.5 |
| | TRL16 | 0.00 - 0.88 | 1.9 | 5.4 |
| | TRL17 | 0.00 - 0.89 | 6.6 | 6.6 |
| | TRL19 | 0.00 - 0.89 | 4.9 | 8.1 |
| | TRL20 | 0.00 - 0.89 | 5.4 | 13.0 |
| | TRL21 | 0.00 - 0.88 | 4.0 | 3.1 |
| | TRL22 | 0.00 - 0.89 | 13 | 6.2 |
| | TRL23 | 0.00 - 0.88 | 3.3 | 6.6 |
| | TRL24 | 0.00 - 0.89 | 5.6 | 5.6 |
| | TRL25 | 0.00 - 0.91 | 4.4 | 4.4 |
| | TRL26 | 0.00 - 0.88 | 4.8 | 6.2 |
| | TRL27 | 0.00 - 0.88 | 6.9 | 6.9 |
| | TRL28 | 0.00 - 0.88 | 6.1 | 6.1 |
| | TRL29 | 0.00 - 0.88 | 5.0 | 5.0 |
| | TRL30 | 0.00 - 0.90 | 4.2 | 6.6 |

| Stratum | Position | Test Depth Range (m bgl) | CBR Value at 0.40m bgl | CBR Value at 0.60m bgl |
|---|---|---|---|---|
| | TRL31 | 0.00 - 0.89 | 5.5 | 5.5 |
| | TRL32 | 0.00 - 0.86 | 4.6 | 4.6 |
| | TRL33 | 0.00 - 0.90 | 5.2 | 5.2 |
| | TRL34 | 0.00 - 0.89 | 3.1 | 4.4 |
| | TRL35 | 0.00 - 0.87 | 6.5 | 6.5 |
| | TRL36 | 0.00 - 0.90 | 8.1 | 7.3 |
| | TRL37 | 0.00 - 0.88 | 8.1 | 8.1 |
| | TRL38 | 0.00 - 0.88 | 4.5 | 8.4 |
| | TRL39 | 0.00 - 0.89 | 4.6 | 10.0 |
| | TRL40 | 0.00 - 0.82 | 3.9 | 2.7 |
| | TRL41 | 0.00 - 0.89 | 5.5 | 6.3 |
| | TRL42 | 0.00 - 0.90 | 4.8 | 4.8 |
| | TRL43 | 0.00 - 0.90 | 3.4 | 5.4 |
| | TRL44 | 0.00 - 0.89 | 4.8 | 14.0 |
| | TRL45 | 0.00 - 0.89 | 11.0 | 7.3 |
| | TRL46 | 0.00 - 0.90 | 4.1 | 4.1 |
| | TRL47 | 0.00 - 0.87 | 3.7 | 14.0 |
| | TRL48 | 0.00 - 0.88 | 4.6 | 4.6 |
| | TRL49 | 0.00 - 0.89 | 5.8 | 5.8 |
| | TRL50 | 0.00 - 0.89 | 4.2 | 7.9 |
| | TRL51 | 0.00 - 0.88 | 6.0 | 6.0 |
| | TRL52 | 0.00 - 0.87 | 7.4 | 16.0 |
| | TRL53 | 0.00 - 0.90 | 4.7 | 6.8 |
| | TRL54 | 0.00 - 0.90 | 8.1 | 7.9 |
| | TRL55 | 0.00 - 0.89 | 4.6 | 9.3 |
| | TRL57 | 0.00 - 0.88 | 3.7 | 9.7 |
| | TRL58 | 0.00 - 0.89 | 5.9 | 5.9 |
| | TRL59 | 0.00 - 0.91 | 2.0 | 6.3 |
| | TRL60 | 0.00 - 0.88 | 10 | 6.8 |
| | TRL61 | 0.00 - 0.88 | 3.4 | 6.7 |
| | TRL62 | 0.00 - 0.87 | 8.6 | 11.0 |
| | TRL63 | 0.00 - 0.90 | 5.0 | 5.0 |
| | TRL64 | 0.00 - 0.89 | 4.0 | 12.0 |
| | TRL65 | 0.00 - 0.89 | 4.3 | 7.0 |
| | TRL66 | 0.00 - 0.88 | 0.53 | 7.5 |
| | TRL67 | 0.00 - 0.88 | 5.9 | 10.0 |
| | TRL68 | 0.00 - 0.90 | 3.1 | 5.8 |
| | TRL69 | 0.00 - 0.90 | 5.1 | 5.1 |
| | TRL70 | 0.00 - 0.92 | 5.6 | 5.6 |
| | TRL71 | 0.00 - 0.89 | 4.3 | 4.3 |
| | TRL72 | 0.00 - 0.88 | 4.9 | 4.9 |

| Stratum | Position | Test Depth Range (m bgl) | CBR Value at 0.40m bgl | CBR Value at 0.60m bgl |
|---|---|---|---|---|
| | TRL73 | 0.00 - 0.86 | 6.4 | 4.1 |
| | TRL74 | 0.00 - 0.89 | 5.7 | 5.7 |
| | TRL75 | 0.00 - 0.89 | 3.3 | 3.3 |
| | TRL76 | 0.00 - 0.9 | 6.2 | 34 |
| | TRL77 | 0.00 - 0.88 | 3.0 | 1.3 |
| | TRL78 | 0.00 - 0.88 | 2.1 | 2.1 |
| | TRL79 | 0.00 - 0.89 | 5.5 | 5.5 |
| | TRL80 | 0.00 - 0.84 | 2.5 | 4.0 |
| | TRL81 | 0.00 - 0.86 | 3.0 | 6.0 |

**Table 9 Summary of the In-Situ DCP-TRL Test Results**

### 5.4.4 In-Situ Plate Bearing Testing

Three in-situ plate bearing tests (PBT01, PBT02 & PBT08) were undertaken within the proposed access roads.

Plate bearing tests were carried out in accordance with BS 1377:Part 9:1990. This method covers the determination of the in-situ vertical deformation and strength characteristics of soil or hardstanding by assessing the force and amount of penetration with time when loading is applied to a rigid plate. The test is used to evaluate the load deformation characteristics of the ground beneath the plate without entailing the effects of sample disturbance. Results may also be used to assess plate modulus of elasticity (EPLT) and the coefficient of sub-grade reaction (Ks), both in accordance with BS EN 1997-2:2007. Estimated CBR vales may also be derived in accordance with the equation provided in Design Manual for Roads and Bridges (DMRB) CD 225, Revision 1 (April 2020).

Testing was undertaken for a maximum of 19 minutes and recorded a maximum deformation of 1.48mm. Corresponding derived CBR values were determined to be between 1.2% and 1.7% at a depth of 0.15m bgl. The values were determined using applied pressures ranging from 27.4kPa and 35.3kPa.

### 5.4.5 In-Situ Light Weight Deflectometer Testing

Due to wet site conditions and shallow excavations infilling with water, twenty-two in-situ LWD tests (LWD03 to LWD07, LWD09 to LWD25) were undertaken along the proposed access roads where it was not possible to complete the proposed PBTs.

Testing was undertaken in accordance with the method described in DMRB document CD225 revision 1, “Design for new pavement foundations” in order to derive CBR values. The test results determined derived average CBR values between 0.35% and 1.1% at test depths of between 0.20m to 0.40m. Ten of these tests were completed at 0.40m depth, which determined an average derived CBR value of 0.74%.

## 5.5 Geotechnical Laboratory Testing

The following laboratory tests have been scheduled by Harrison Geotechnical Engineering and carried out on samples obtained during the ground investigation.

Unless otherwise stated the tests were performed in accordance with BS1377 Methods of Test for Soils for Civil Engineering Purposes. The laboratory test results presented in the appendix and are summarised in Table 10 below.

| Test Type and Reference (BS 1377: 1990 unless stated) | Strata | Depth (m) | Number of Results | Results (Range) | Comments / Limitations |
|---|---|---|---|---|---|
| **Water Content** (BS EN ISO 17892-1:2014) | Oadby Member | 0.40 – 18.95 | 191 | 13 - 33% (Avg. 18.4%) | |
| | Chalk (Raft) | 1.50 – 2.90 | 3 | 16 - 22% | |

| Test Type and Reference (BS 1377: 1990 unless stated) | Strata | Depth (m) | Number of Results | Results (Range) | Comments / Limitations |
|---|---|---|---|---|---|
| **Atterberg Limits** (Part 2) | Oadby Member | 0.40 – 2.45 | 54 | PL 15 - 22%<br>LL 30 - 51%<br>PI 13 - 30%<br>Modified PI 10 - 28% | British Standard classification – Low to High plasticity (CL to CH).<br>NHBC Standards Chapter 4.2 'Building Near Tress' – low and medium volume change potential |
| **Particle Size Distribution - Wet Sieving** (Part 2, clause 9.2) & Sedimentation by pipette (Part 2, clause 9.4) | Oadby Member | 0.50 - 18.45 | 33 | Cobbles 0.0 - 13.4%<br>Gravel 2.0 - 23.1%<br>Sand 4.0 - 49.0%<br>Silt 36.8 - 49.0%<br>Clay 22.6 - 42.0% | Very consistent cohesive material, with the vast majority of samples described as slightly gravelly and/or cobbly, slightly sandy to sandy, silty CLAY. |
| **California Bearing Ratio** (Part 4, clause 7) | Oadby Member | 0.50 – 1.00 | 19 | 1.5 - 4.8% | |
| **Single Stage 38mm UU Triaxial Compression Test** (Part 7, clause 8) | Oadby Member | 2.00 - 19.50 | 15 | 123 - 474 kPa | Representative of stiff (high strength) to hard (extremely high strength) cohesive soils. |
| **Determination of One-Dimensional Consolidation Properties** (Part 5, clause 3) | Oadby Member | 2.00 – 15.65 | 8 | 0.00m – 5.00m depth $m_v$: 0.099 - 0.16$m^2$/MN<br>>5.00m depth $m_v$: 0.14 - 0.062$m^2$/MN | Quoted $m_v$ values are for total in-situ stress plus 100kPa |
| **Determination of Dry Density / Moisture Content Relationship** (Part 4:1990, clause 3.3) | Oadby Member | 1.00 – 2.00 | 8 | Max Dry Density 1.73 - 1.98Mg/$m^3$<br>Optimum Moisture Content 9.60 - 20.00% (Mean 13.5%) | |
| **Particle Density by Gas Jar Method** (Part 2, clause 8.2) | Oadby Member | 1.00 - 1.80 | 4 | 2.69 - 2.73Mg/$m^3$ | |
| **Soil pH – Geochemical Testing** (BRE SD1 2005) | Oadby Member | 0.40 - 6.45 | 37 | 8.1 - 8.8 | - |
| **Water Soluble Sulphate Content 2:1 Aqueous Extract** (BRE SD1 2005) | Oadby Member | 0.40 - 6.45 | 37 | 17 - 140mg/l | - |

**Table 10 Summary of Geotechnical Laboratory Test Results**

## 5.6 Chemical Laboratory Testing

Thirty-five samples of topsoil and near surface made ground (depth ranging 0.05m to 1.10m) were submitted to a UKAS/MCERTS accredited laboratory for a general suite of analytes as detailed in Table 11 below. Eight samples of topsoil were submitted for topsoil testing (as per BS3882:2015), and a further eight samples were submitted for a generic pesticide screen. Five samples of the shallow made ground (depth ranging from 0.10m to 0.50m) were submitted for laboratory analysis of selected volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and tentatively identified compounds (TICs). Thirty-two samples were submitted for a generic suite of per- and polyfluoroalkyl substances (PFAS).

Following the supplementary hand pitting, ten samples of topsoil were submitted for analysis of arsenic, and six samples of topsoil were submitted for analysis of polycyclic aromatic hydrocarbons (PAH).

In addition, four shallow soil samples were submitted for Waste Acceptance Criteria (WAC) analysis to aid in waste classification.

Furthermore, five groundwater samples were submitted for laboratory analysis of for a general suite of analytes (as detailed in Table 11), VOCs, and SVOCs, and twenty-seven groundwater samples were analysed for a generic suite of PFAS.

| Analysis Type | Number of Tests |
|---|---|
| ***Soil*** | |
| **Suite HS1.0:** As, B, Cd, Cr (total & VI), Cu, Ni, Pb, Hg, Se, Zn, V, Be, pH, TOC, TPH CWG, PAH USEPA 16, phenols (total), asbestos screen (with ID where found) | 13 |
| **Suite HSS6:** As, Cd, Cr (total & VI), Cu, Pb, Hg, Ni, Se, Zn, B, pH, TOC, PAH (EPA16), TPH-CWG (inc. BTEX & MTBE), Asbestos Screen (with ID where found) | 22 |
| **BS3882:2015 Suite:** Soil Texture, Stone content, loss on ignition, pH, carbonate, N (total), P, K, Mg, C:N ratio, Electrical conductivity, exchangeable sodium, metals, visual contaminants. | 8 |
| Pesticide Screen | 8 |
| Volatile Organic Compounds (VOCs) | 5 |
| Semi-Volatile Organic Compounds (SVOCs) & Tentatively Identified Compounds (TICs) | 5 |
| Per- and polyfluoroalkyl substances (PFAS) | 32 |
| Arsenic | 10 |
| PAH | 6 |
| **Full Waste Assessment Criteria (WAC):** leachate and total concentrations for inert, stable non-reactive and hazardous material | 4 |
| ***Groundwater*** | |
| **Suite HW1.3:** As, B, Cd, Cr (total and VI), Cu, Pb, Hg, Ni, Se, Zn, pH, PAH (speciated 16), TPHCWG | 5 |
| Volatile Organic Compounds (VOCs) | 5 |
| Semi-Volatile Organic Compounds (SVOCs) | 5 |
| Liquid PFAS Suite by LC-MS | 27 |

**Table 11 Summary of Chemical Laboratory Testing**

### 5.7 Comparison with the Ground Model

The soils encountered during the investigation are in general agreement to that of the ground model and the background research. However, soils considered representative of the Oadby Member appear to extend to greater depths (i.e. >20.00m) than indicated in nearby borehole records. Therefore, the Oxford Clay Formation (bedrock) is not thought to have been encountered at the maximum depths investigated.

The background research did not give any indication as to the potential depth to groundwater at the site, and no groundwater strikes were recorded in the previously completed site investigations by Shadbolt Group. It should be noted that the Shadbolt Investigation is considered limited in terms of groundwater assessment, as it only included installation of one monitoring well and two groundwater monitoring events.

## 6 GEOTECHNICAL ASSESSMENT

### 6.1 General

It is understood that the site is planned to be developed for a variety of uses including residential development of up to 1,500 dwellings, a local centre with retail and community facilities, a primary school, access routes, and areas of open space, playgrounds/recreation grounds, and landscaping (as shown on appended regulatory plan, ref. 00628G_RP08_P3). More specifically, five residential parcels (Parcels A to F) are proposed to largely occupy the central portion of the site, generally separated by a spine road, several community parks, and greenways with attenuation basins. The southwestern corner of the site is

proposed for development with a primary school and small local centre (including retail and community facilities), with allotments at its southwest corner, and a small community greenspace at the south.

The ground conditions were found to comprise topsoil with localised made ground from ground level, generally recorded to 0.40m depth overlying firm, predominantly cohesive Oadby Member, generally becoming stiff from approximately 2.50m depth, and very stiff beyond 5.00m depth.

Potential geotechnical hazards identified at this location include sulphate bearing soils, uncontrolled backfill, low permeability soils, shrink/swell potential, unexploded ordnance and variable natural soils.

It should be noted that the current work has only investigated the site at discrete locations although the development site was given coverage. Ground conditions may vary between areas of investigation.

## 6.2 Geotechnical Parameters

For the proposed development, the primary geotechnical considerations will be the strength and compressibility of the founding soils and following on from this the foundation requirements of the proposed structures. This section of the report presents comments on the ground conditions in relation to design and construction of the geotechnical elements of the proposed structures.

Recommended characteristic values of parameters for geotechnical design as determined from consideration of the results of geotechnical testing carried out on samples of the soils recovered during the ground investigation, and consideration of published data and correlations with index properties, are discussed below and are summarised in the following table.

| Stratum | Bulk Unit Weight, ɣ' (kN/m$^3$)[1] | Undrained Shear Strength, $c_u$ (kPa)[2] | Effective Cohesion, c' (kPa)[3] | Angle of Internal Friction, ø' (degrees)[4] | Elastic Modulus, E' (MPa) | Coefficient of Volume Compressibility, $m_v$ (m$^2$/MN) |
|---|---|---|---|---|---|---|
| **Made Ground** | 18.0 | - | 0 | 33 | 20 | 0.40 |
| **Oadby Member** | 20.0 to 2.5m<br>21.4 at >2.5m | 40 to 2.5m<br>250 to 6m<br>150 6-12m<br>200 >12m | 0 | 24 | 2 to 2.5m<br>20 at >2.5m | 0.15 to 5.00m<br>0.10 below 5.00m |

**Notes**

[1] Bulk unit weight of the encountered soils is based on the visual description of the material and the recommendations of Figure 1 of BS8004:2015 and laboratory test results.

[2] Undrained shear strength is based on the engineers' description of consistency and measured values.

[3] For superficial soils present on site, effective cohesion should be taken to be zero in design analysis.

[4] The effective friction angle of the Oadby Member is based on the measured modified plasticity index of 13 - 30% and the recommendations of Table 2 of BS8004:2015.

**Table 12 Summary of Geotechnical Properties**

## 6.3 Foundation Recommendations

### 6.3.1 Traditional Shallow Foundations

Review of the investigation results indicates that traditional shallow concrete strip/pad foundations will be suitable for the proposed development. The cohesive soils are categorised as having low to medium volume change potential according to the National House Building Council (NHBC), and as such will be susceptible to seasonal changes in moisture content. A medium volume change potential should be assumed for design purposes and in accordance with the NHBC guidelines a minimum foundation depth of 0.90mbgl should be adopted.

Outline assessment has been undertaken for strip foundations in accordance with BS EN 1997-1:2004 +A1:2013 (Eurocode 7), Design Approach 1, Combinations 1 and 2. The assessment has been undertaken using the software package GEO5 2022 Spread Footing (Fine Software). The analysis has been undertaken based on a 0.60m wide concrete strip foundation constructed at a depth of 0.90mbgl. Calculations indicate that a maximum allowable bearing capacity of 150kPa should be adopted for design purposes. The actual settlement of foundations will be dependent upon their size and configuration but would generally not be expected to exceed 25mm at the recommended maximum allowable bearing capacity.

The ground investigation revealed chalk rafts present in localised areas within the Oadby Member – Diamicton, generally between 1.40m to 2.50m depth. Given their anticipated depth and limited size, these rafts are not anticipated to have a significant effect on the proposed foundations; however, it is critical that all excavations are inspected by suitably experienced personnel before construction. Reinforcement is recommended where foundations span variable material/soil types to reduce and limit the effect of differential settlement.

Whilst an initial foundation depth of 0.90m should be adopted, if any soft material (less than 40kPa) or made ground is identified, foundations should be increased in depth to bear upon competent soils. Should unsuitable material be encountered at founding depths, and deepening the foundations is not considered a viable option, alternative foundations options or ground improvement should be considered.

The ground investigation indicates that the founding material will predominantly comprise firm to stiff, slightly gravelly, slightly sandy to sandy, silty clay. Localised areas of made ground were encountered to a maximum depth of 1.40m, mostly within the farmyard area. It is therefore recommended that an initial foundation depth of 0.90m be adopted but localised deepening of foundations is likely to be required.

If it is proposed to plant semi-mature to mature vegetation within the influencing from proposed structures, their foundations may need to be increased below the proposed minimum depth in line with standard design tables. Reference should be made to the National House Building Council Standards (NHBC) Chapter 4.2 “Buildings near trees” for appropriate precautions, which may include deepening of foundations and the provision of compressible materials to foundation sides and beneath floor slabs.

Groundwater may be encountered in shallow excavations and surface water/rainfall may pond in excavations. The strength of the sub-soils will be moisture dependent both on drying and wetting and excavations should not be left open for any longer than required for construction. Superficial soils were noted to soften substantially during rainy events, and it is recommended that wet weather working be avoided as much as possible.

### 6.3.2 Piled Foundations

Should higher loads be required then achievable using shallow foundations or should made ground be present to a depth where shallow foundations are not practical, further assessment has been undertaken to determine the capacity of piled foundations. Preliminary pile capacity calculations have been undertaken in accordance with BS EN 1997-1:2004+A1:2013 (Eurocode 7), Design Approach 1, Combinations 1 and 2. The assessment has been undertaken using the software package GEO5 2022 Pile (Fine Software).

The soil profile has been modelled using boreholes CP01-04, which provides coverage of ground conditions to sufficient depth beneath the site in the area designated for commercial use and for the primary school development. Despite the soft surface ground conditions encountered during completion of the ground investigation, favourable conditions extend to significant depth beneath the site. Ground conditions are proven to be wholly cohesive, with undrained shear strengths ranging from stiff to very stiff below approximately 2.50m bgl.

At this stage we have not been advised on the anticipated foundation loads for larger structures. As such, we have undertaken outline pile capacity for a range of pile diameters and penetration depths in order to guide detailed design once further information becomes available. Given the cohesive nature of subgrade soils underlying the site, it is anticipated that continuous flight auger (CFA) piles are likely to be the most economical solution and this has been used in our calculations in the determination of maximum allowable bearing capacity. However, the use of driven pre-cast concrete or steel pile may also be used providing any nearby structures will not be adversely affected by vibration during their installation.

The axial load capacity of the piles may be determined from the characteristic geotechnical parameters as recommended in Table 13 using the static design procedures and the partial and model factors given in the BS EN 1997-1:2004+A1:2013. In these procedures, the axial capacity of the pile is taken to be the sum of the adhesion on the pile shaft and the end bearing resistance on the pile base. Preliminary pile capacity calculations have been undertaken to determine the axial pile resistance using appropriate partial factors on soil properties, actions and resistances to ensure the adequacy of the pile design.

Preliminary estimates of the axial resistance for the GEO limit state of 300, 450 and 600mm piles have been made using the static design procedures and the partial and model factors given in the BS EN 1997-1 (2004a and 2004b). For piles with a pile head at current ground level, the preliminary estimates are presented in Table 13 below. Note that for the purposes of the analysis it is assumed that the piles will comprise square section pre-cast concrete.

| | Axial Resistance (kN) | | |
|---|---|---|---|
| **Pile Toe Depth (m bgl)** | **300mm** | **450mm** | **600mm** |
| **10m** | 390 | 620 | 870 |
| **15m** | 570 | 910 | 1280 |
| **20m** | 740 | 1170 | 1620 |

**Table 13 Summary of Estimated Axial Pile Resistance**

The preliminary estimates of axial resistance presented above are appropriate for single isolated piles assuming that no bending or horizontal loads are applied to the pile and are given to inform the conceptual design of the proposed structure only.

Design of the piles will need to be carried out by the appointed Geotechnical Designer taking into account the partial factors on soil properties, actions and resistances in accordance with the requirements of BS EN 1997-1 (2004a and 2004b). The actual resistance of a pile will be dependent on the method of installation and technique used; hence the design of the piles should be carried with reference to specialist piling contractors. Pile integrity testing should be carried out to confirm the design and workmanship. In addition, consideration should be given to carrying out pile load tests to verify the pile head settlement at the serviceability limit state such that lower partial limit factors on pile resistance can be adopted.

## 6.4 Floor Slabs

Suspended floor slabs, such as block and beam, are recommended for all areas of the development due to the moderate susceptibility to volume change of the shallow soils underlying the site.

The effect of existing trees/shrubs on the clay sub-soils is unlikely to give rise to issues with clay shrinkage/heave considering the current proposed layout, but it is important that the sub-grade is protected from exposure during construction to limit the potential detrimental effects of wetting or drying of cohesive sub-soils.

## 6.5 Drainage

Although formal soakaway testing has not been completed at the site, lack of drainage within the soakaway pits (likely infilled with surface water run off) and visible pooling/ponding of rainwater across the site surface appears to indicate that traditional soakaways are unlikely to be a suitable means of surface water management at the site.

## 6.6 Pavements

CBR values were assessed using a variety of in-situ techniques including dynamic cone penetrometer (TRL-DCP) testing, plate bearing tests (PBTs), and light weight deflectometer (LWD) tests, as well as laboratory CBR testing of representative samples. A wide range of CBR values was obtained (between 0.53% and 34%) on strata between 0.40m and 0.60m bgl, likely due to the inherent biases amongst the testing techniques as well as the variability in granular content (i.e. presence of gravels and cobbles/boulders) in localised areas of the superficial deposits. Relevant CBR values derived from each of the assessment techniques are summarised in Table 14 below.

| Assessment Technique | Depth (m bgl) | Relevant Values | Recommended CBR Value |
|---|---|---|---|
| **TRL-DCP** | 0.40 | Mean value: 5.01%<br>Characteristic value (EC7 method): 3.00% | 2.5% based on a construction depth between of 0.40m and 0.60m bgl): |
| **PBT** | 0.15 | 1.2 to 1.7% - discounted due to shallow depth and limited number of tests | |
| **LWD** | 0.40 | Mean: 0.74% | |
| **Laboratory CBR** | 0.50 – 1.00 | 5$^{th}$ Percentile: 2.58% | |
| **Cambridgeshire Estate Roads Guidance (Plasticity)** | 0.40 – 1.40 | Plasticity Index 13 - 30%<br>Recommended CBR value: 3% | See Table 2A of the Cambridgeshire Estate Roads Guidance (January 2023) |

**Table 14 Summary of derived CBR values and Recommendations**

Based on the results obtained from in-situ and laboratory testing, an initial design CBR of 2.5% is recommended based on a construction depth of 0.40m to 0.60m below current ground level.

In accordance with Highways England document CD225 'Design for new pavement foundations', the subgrade surface modulus (E) is derived by the following equation:

$$E = 17.6(CBR)^{0.64}$$

Based on a CBR of 2.5%, E would be greater than 30MPa indicating that improvement of the subgrade would generally not be required. However, it should be noted that some areas testing indicate that lower CBR values may be present locally and that limited thickening of the subbase or capping may be required. Options for improvement of the subgrade include excavation and replacing between 500 and 1000mm of the subgrade with granular fill, or mechanical stabilisation (geogrids and/or geotextiles) and soil stabilisation.

Consideration will need to be given to the variability of the likely formation materials and the pavement and/or capping layers may need to be thickened accordingly. Consideration may also have to be given to the effects of frost heave where cohesive soils are encountered unless specific testing indicates otherwise, and a minimum 450mm pavement thickness may therefore need to be adopted in initial design.

### 6.7 Stability of Excavations

The short-term stability of excavations within the cohesive superficial deposits is thought to be generally good. However, due to the nature of the material, wetting could potentially cause softening making excavations less stable; therefore, it would be wise to protect excavations from wet weather . Instability of excavations is likely where they are taken through the pockets of loose natural granular soils or chalk rafts.

Attention is drawn to the provisions of the Management of Health and Safety at Work Regulations (1999), which state that to maintain the required precautions, a competent person must inspect excavation supports or battering at the start of the working shift and at other specified times. No work should take place until the excavation is safe.

### 6.8 Foundation Concrete (Aggressive Chemical Environment)

Chemical laboratory testing of the shallow soils found soluble sulphates in concentrations of up to 0.140g/l or 140mg/l, associated with pH values varying between 8.1 and 8.8. The results indicate that a design sulphate class of DS-1 and an ACEC class of AC-1s should be used for buried concrete in contact with these materials in accordance with BRE Special Digest 1, "Concrete in aggressive ground". The digest described should be consulted prior to scheduling the permanent works as the specification must be applicable to the application.

### 6.9 Geotechnical Hazard Evaluation

Six geotechnical hazards have been carried forward in the assessment and are detailed in Table 15 below. Based on the findings of the intrusive investigation, laboratory testing and monitoring each risk has been evaluated to assess whether a positive risk remains. Where a positive risk is still identified the recommended action(s) have been provided.

| Hazard | Requires further consideration? | Comment |
|---|---|---|
| **Shrink/Swell Potential** | **Yes** | The majority of the cohesive soils found across the site were shown to have low to medium volume change potential. A minimum foundation depth of 0.90m should be adopted. |
| **Low Permeability Soils** | **Yes** | Although formal soakaway testing has not been completed at the site, lack of drainage within the soakaway pits (likely infilled with surface water run off) and visible pooling/ponding of rainwater across the site surface appears to indicate that conventional surface water soakaway design is not feasible. |
| **Unexploded Ordnance** | **Yes** | Suitable awareness training and emergency plans should be given to construction personnel regarding UXO, with site supervision provided where necessary. |
| **Uncontrolled Backfill** | **Yes** | No significant uncontrolled fill and limited made ground has been recorded throughout fields. However, there may be the potential for undocumented backfilled pits within the agricultural fields.<br>In addition, made ground of a limited thickness was proven within the farmyard area. |

| Hazard | Requires further consideration? | Comment |
|---|---|---|
| **Sulphate Bearing Soils** | No | Use a concrete design class DS-1 and an ACEC class of AC-1s for buried concrete. |
| **Variable Deposits** | No | Geology across the site was consistent, and comprised slightly gravelly and/or cobbly, slightly sandy to sandy, silty CLAY. However, foundation excavations should be deepened where necessary and foundations should be suitably reinforced where spanning variable material. |

**Table 15 Geotechnical Hazard Evaluation**

It is considered that the development of the site will not be limited based on the geotechnical findings of the investigation, assuming the recommendations from this report are followed and approved construction methods are adhered to.

# 7 CONTAMINATION ASSESSMENT

## 7.1 General

The risks posed to the potential sensitive receptors associated with the site are assessed at this stage. Specific assessment of the short-term exposure to ground workers was not part of the scope of this investigation. Therefore, with regard to these pollutant links, chemical testing and ground gas data should be made available to inform the ground workers own risk assessment.

The risk to future site users from ground gases is assessed by considering ground gas data recorded from monitoring.

The risks associated with long-term human exposure to soil can be addressed by comparing the laboratory test results with soil generic assessment criteria (GAC) derived using the CLEA model. This specifically applies to dermal exposure and inhalation of contaminated dust but can be used as a preliminary indication to consider the effects on controlled water, drinking water supply pipes, natural flora and fauna and building structures from soil contamination on the site. Screening values have been published for standard land uses, including commercial and residential (with and without gardens) and the CLEA software initially allows for GAC to be amended for site specific exposure scenarios.

The potential for asbestos to be present in soil will also be considered by reviewing laboratory test results in accordance with CAR:SOIL™ (CL:AIRE, 2016) guidance for the application of the Control of Asbestos Regulations (2012) Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials.

## 7.2 Soil Assessment

### 7.2.1 Selection of Screening Criteria

For an initial screening of soil chemical test results with regard to long-term human health risks, the results have been compared to GAC. Land Quality Management Limited and the Chartered Institute for Environmental Health published ‘Suitable 4 Use Levels’ (S4UL) as GAC for a range of substances, for a range of generic land uses. DEFRA published category four screening levels (C4SL) for six contaminants in March 2014 to assist practitioners in assessing land contamination under part IIA of the Environmental Protection Act 1990. These have also been identified as suitable for use within the planning system, although it should be noted that they assume a higher level of acceptable risk than S4UL and earlier published GAC. Rather than universally adopting a higher level of risk, the S4UL are applied initially, with C4SL considered where the maximum concentrations exceed the S4UL.

The proposed end use is for residential housing with gardens. A ‘residential with home-grown produce’ generic land use is adopted as it is considered to be the most conservative land use within the proposed development.

For each land use category, a single value is provided for metals, with three values specified for organic contaminants based on the proportion of soil organic matter (%SOM) or the total organic carbon (%TOC) content of the soil.

There are no S4UL values for PFAS; however, interim C4SL values were recently published by CL:AIRE for perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS)

and perfluorooctane sulfonic acid (PFOS). A hazard index approach should be used to assess whether these chemicals pose an unacceptable risk to identified sensitive receptors and requires that a hazard quotient (ratio of the measured soil concentration to the relevant C4SL) is calculated for each of the four PFAS for each soil sample. The hazard index (HI) for the soil sample is then the sum of the hazard quotients for the four PFAS. The risk is considered acceptable (subject to consideration of uncertainties) provided that the hazard quotient for each individual PFAS and the hazard index do not exceed a value of 1. A hazard quotient or index of greater than 1 (again, subject to consideration of uncertainties) signifies that further assessment or consideration of the risk is required.

A large proportion of the soil sampling analysis has been completed on samples of topsoil, which inherently has a higher proportion of organic matter and organic carbon than made ground and/or underlying natural soils. Specifically, topsoil was shown to have a minimum and mean total organic content (TOC) of 1.60% and 2.63%, respectively (approximately equivalent to 2.75% and 4.52% soluble organic matter (SOM)), while made ground was shown to have a minimum and mean TOC content of 1.00% and 2.26%, respectively (approximately equivalent to 1.72% and 3.88% SOM). Therefore, topsoil results have been screened using a generic SOM value of 2.5%, while made ground and natural subsoils have been screened using the more conservative value of 1% for this assessment.

### 7.2.2 Soil Screening

The soil sampling regime is outlined in Section 5.6. Records of the soil chemical testing have been appended to this report and are summarised in Table 16 and Table 17 below.

| Determinant | Maximum recorded concentration (mg/kg) | LQM/CIEH S4UL 2014 and C4SL* for residential with gardens and 2.5% SOM (mg/kg) | Maximum Exceeds Screening Value? | Samples Exceeding (Fieldwork ID_Sample ID_Depth) |
|---|---|---|---|---|
| **Arsenic** | 55 | 37 / 37* | **Yes** | DS09_ES1_0.20, DS32_ES1_0.20 |
| **Beryllium** | 1.6 | 1.7 | No | |
| **Boron** | 3.6 | 290 | No | |
| **Cadmium** | 1.1 | 11 | No | |
| **Chromium** | 120 | 910 | No | |
| **Chromium - Hexavalent** | < 0.5 | 6 / 21* | No | |
| **Chromium - Trivalent** | 120 | 910 | No | |
| **Copper** | 48 | 2400 | No | |
| **Lead** | 120 | 200* | No | |
| **Mercury** | 0.34 | 1.2 | No | |
| **Nickel** | 84 | 130 | No | |
| **Selenium** | 2.5 | 250 | No | |
| **Vanadium** | 96 | 410 | No | |
| **Zinc** | 230 | 3700 | No | |
| **Acenaphthene** | 2.3 | 510 | No | |
| **Acenaphthylene** | 0.25 | 420 | No | |
| **Anthracene** | 4.7 | 5400 | No | |
| **Benzo(a)anthracene** | 10 | 11 | No | |
| **Benzo(a)pyrene** | 11 | 2.7 / 5* | **Yes** | DS69_ES1_0.20 DS75_ES1_0.20 |
| **Benzo(b)fluoranthene** | 13 | 3.3 | **Yes** | DS69_ES1_0.20 DS75_ES1_0.20 |
| **Benzo(ghi)perylene** | 5.9 | 340 | No | |
| **Benzo(k)fluoranthene** | 5.5 | 93 | No | |

| Determinant | Maximum recorded concentration (mg/kg) | LQM/CIEH S4UL 2014 and C4SL* for residential with gardens and 2.5% SOM (mg/kg) | Maximum Exceeds Screening Value? | Samples Exceeding (Fieldwork ID_Sample ID_Depth) |
|---|---|---|---|---|
| **Chrysene** | 11 | 22 | No | |
| **Di-benzo(a,h)anthracene** | 1.5 | 0.28 | **Yes** | DS69_ES1_0.20 DS75_ES1_0.20, TP60_ES1_0.20 |
| **Fluoranthene** | 23 | 560 | No | |
| **Fluorene** | 2 | 400 | No | |
| **Indeno(1,2,3-cd)Pyrene** | 6.7 | 36 | No | |
| **Naphthalene** | 0.31 | 5.6 | No | |
| **Phenanthrene** | 15 | 220 | No | |
| **Pyrene** | 18 | 1200 | No | |
| **Total Phenols - HPLC** | 0.47 | - | - | |
| **Aliphatic >C5 - C6** | < 0.05 | 78 | No | |
| **Aliphatic >C6 - C8** | | 230 | No | |
| **Aliphatic >C8 - C10** | < 0.05 | 65 | No | |
| **Aliphatic >C10 - C12** | < 2 | 330 | No | |
| **Aliphatic >C12 - C16** | 1.3 | 2400 | No | |
| **Aliphatic >C16 - C21** | < 2 | 92000 | No | |
| **Aliphatic >C21 - C35** | 31 | 92000 | No | |
| **Aliphatic >C35 - C44** | < 1 | 92000 | No | |
| **Aromatic >C5 - C7** | < 0.05 | 140 | No | |
| **Aromatic >C7 - C8** | < 1 | 290 | No | |
| **Aromatic >C8 - C10** | < 0.05 | 83 | No | |
| **Aromatic >C10 - C12** | < 1 | 180 | No | |
| **Aromatic >C12 - C16** | < 1 | 330 | No | |
| **Aromatic >C16 - C21** | 28 | 540 | No | |
| **Aromatic >C21 - C35** | 90 | 1500 | No | |
| **Aromatic >C35 - C44** | < 1 | 1500 | No | |
| **Benzene** | < 0.001 | 0.17 / 0.87* | No | |
| **Ethylbenzene** | < 0.001 | 110 | No | |
| **o-Xylene** | < 0.001 | 140 | No | |
| **p & m-Xylene** | < 0.001 | 130 | No | |
| **Toluene** | < 0.001 | 290 | No | |
| **Pesticide Screen**[1] | <0.2 | - | No | |
| **PFOA (ug/kg)** | 0.2 | 7.6 | No | |
| **PFOS (ug/kg)** | 0.7 | 13 | No | |
| **PFHxS (ug/kg)** | 0.1 | 8.1 | No | |
| **PFNA (ug/kg)** | <1 | 7.3 | No | |
| **PFAS Hazard Quotient** | 0.07 | 1 | No | |
| **Asbestos** | Not detected | - | No | |

Note: [1] – See appended laboratory analytical results for full chemical suite
[2] – Adopted screening value

**Table 16 Contamination Test Result Summary - Topsoil**

| Determinant | Maximum recorded concentration (mg/kg) | LQM/CIEH S4UL 2014 and C4SL* for residential with gardens and 1% SOM (mg/kg) | Maximum Exceeds Screening Value? | Samples Exceeding (Fieldwork ID_Sample ID_Depth) |
|---|---|---|---|---|
| **Arsenic** | 36 | 37 / 37* | No | |
| **Beryllium** | 10 | 1.7 | **Yes** | DS71_ES2_0.20, DS72_ES1_0.10 |
| **Boron** | 3.1 | 290 | No | |
| **Cadmium** | 1.7 | 11 | No | |
| **Chromium** | 110 | 910 | No | |
| **Chromium - Hexavalent** | < 0.5 | 6 / 21* | No | |
| **Chromium - Trivalent** | 110 | 910 | No | |
| **Copper** | 80 | 2400 | No | |
| **Lead** | 870 | 200* | **Yes** | DS72_ES1_0.10, DS76_ES1_0.20 |
| **Mercury** | 0.23 | 1.2 | No | |
| **Nickel** | 120 | 130 | No | |
| **Selenium** | 4 | 250 | No | |
| **Vanadium** | 210 | 410 | No | |
| **Zinc** | 490 | 3700 | No | |
| **Acenaphthene** | < 0.5 | 210 | No | |
| **Acenaphthylene** | < 0.5 | 170 | No | |
| **Anthracene** | 0.66 | 2400 | No | |
| **Benzo(a)anthracene** | 4 | 7.2 | No | |
| **Benzo(a)pyrene** | 5.4 | 2.2 / 5* | **Yes** | DS70_ES2_0.40, DS71_ES2_0.20, DS72_ES1_0.10 |
| **Benzo(b)fluoranthene** | 7.6 | 2.6 | **Yes** | DS70_ES2_0.40, DS71_ES2_0.20, DS72_ES1_0.10 |
| **Benzo(ghi)perylene** | 4.7 | 320 | No | |
| **Benzo(k)fluoranthene** | 2.7 | 77 | No | |
| **Chrysene** | 4.7 | 15 | No | |
| **Di-benzo(a,h)anthracene** | 0.89 | 0.24 | **Yes** | DS71_ES2_0.20, DS72_ES1_0.10 |
| **Fluoranthene** | 7.9 | 280 | No | |
| **Fluorene** | < 0.5 | 170 | No | |
| **Indeno(1,2,3-cd)Pyrene** | 4.1 | 27 | No | |
| **Naphthalene** | < 0.5 | 2.3 | No | |
| **Phenanthrene** | 3.8 | 95 | No | |
| **Pyrene** | 6.6 | 620 | No | |
| **Total Phenols - HPLC** | < 0.1 | - | | |
| **Aliphatic >C5 - C6** | < 0.05 | 42 | No | |
| **Aliphatic >C6 - C8** | < 0.1 | 100 | No | |
| **Aliphatic >C8 - C10** | < 0.05 | 27 | No | |
| **Aliphatic >C10 - C12** | < 2 | 130 | No | |
| **Aliphatic >C12 - C16** | 1.5 | 130 | No | |

| Determinant | Maximum recorded concentration (mg/kg) | LQM/CIEH S4UL 2014 and C4SL* for residential with gardens and 1% SOM (mg/kg) | Maximum Exceeds Screening Value? | Samples Exceeding (Fieldwork ID_Sample ID_Depth) |
|---|---|---|---|---|
| **Aliphatic >C16 - C21** | 4.5 | 65000 | No | |
| **Aliphatic >C21 - C35** | 35 | 65000 | No | |
| **Aliphatic >C35 - C44** | < 1 | 65000 | No | |
| **Aromatic >C5 - C7** | < 0.05 | 70 | No | |
| **Aromatic >C7 - C8** | < 1 | 130 | No | |
| **Aromatic >C8 - C10** | < 0.05 | 34 | No | |
| **Aromatic >C10 - C12** | < 1 | 74 | No | |
| **Aromatic >C12 - C16** | < 1 | 140 | No | |
| **Aromatic >C16 - C21** | 31 | 260 | No | |
| **Aromatic >C21 - C35** | 140 | 1100 | No | |
| **Aromatic >C35 - C44** | < 1 | 1100 | No | |
| **Benzene** | < 0.001 | 0.087 | No | |
| **Ethylbenzene** | < 0.001 | 47 | No | |
| **o-Xylene** | < 0.001 | 60 | No | |
| **p & m-Xylene** | < 0.001 | 56 | No | |
| **Toluene** | < 0.001 | 130 | No | |
| **SVOCs[1] (excluding PAHs)** | <0.5 | - | | |
| **VOCs[1]** | <0.001 to <0.05 | - | | |
| **Pesticide Screen[1]** | <0.2 | - | | |
| **PFOA (µg/kg)** | <1 | 7.6 | No | |
| **PFOS (µg/kg)** | 60.3 | 13 | **Yes** | DS107_ES2_0.20, DS108_ES3_1.00 |
| **PFHxS (µg/kg)** | <1 | 8.1 | No | |
| **PFNA (µg/kg)** | <1 | 7.3 | No | |
| **PFAS Hazard Quotient** | 4.61 | 1 | **Yes** | DS107_ES2_0.20, DS108_ES3_1.00 |
| **Asbestos** | Chrysotile fibres | - | **-** | DS72_ES1_0.10m |
| **Asbestos Quantification** | <0.001% | 0.001% | No | |
| Note: [1] – See appended laboratory analytical results for full chemical suite | | | | |

**Table 17 Contamination Test Result Summary – Made Ground and Subsoils**

The contaminants listed above which do not exceed the screening criteria are not considered to pose a significant risk to the sensitive receptors identified and therefore are not considered further.

A summary of reported soil exceedances is presented in drawing GC25457-DR003A in the appendix. The results of the asbestos analysis indicate that there were asbestos fibres detected in three of the samples tested.

Implications of the contaminants exceeding GAC threshold values are considered in more detail below.

### 7.2.3 Topsoil

#### 7.2.3.1 Heavy Metals

The concentration of arsenic exceeds the GAC in two samples of topsoil (DS09 & DS32) out of thirty-two samples collected. These samples were collected at opposite ends of the site, and no anthropogenic material was noted in the borehole logs.

Using the data available for topsoil, the 95$^{th}$ percentile arsenic concentration is calculated as being 35mg/kg, which is below the screening value of 37mg/kg. Furthermore, topsoil samples collected in close proximity of these exceedances (from HDTP101 to HDTP110) did not reveal elevated concentrations of arsenic. Therefore, these exceedances are considered to be statistical outliers, and are not considered to pose a significant risk to future site users.

#### 7.2.3.2 Polycyclic Aromatic Hydrocarbons (PAH)

PAH compounds are shown to be slightly elevated in three samples of topsoil collected within the farmyard area (DS69), and fields immediately north (TP60) and south (DS75). Further sampling of topsoil in close vicinity to TP60 did not reveal elevated concentrations of PAH, and no evidence of anthropogenic impact was observed. Taking into consideration the ground conditions present and the results of the chemical analysis undertaken, the PAH exceedances recorded in this area are not considered to present a significant risk to the sensitive receptors identified for the proposed development.

DS69 and DS75 are located within or near to the farmyard area, with evidence of vehicle parking observed near DS75 during the site investigation and on recent aerial imagery. Although evidence of contamination or made ground was not noted in the borehole records at these locations, made ground with anthropogenic material was recorded in nearby positions (DS70 to DS74, DS76), and may relate to the reported exceedances. The site is proposed to be developed as a local retail and community centre with a greenspace in this area. As the layout has yet to be confirmed, it is not clear whether features may be present to break the potential source/receptor pathway (e.g. hardstanding) within the impacted areas, and further assessment is recommended. Regardless, topsoil within these areas is unlikely to be suitable for reuse within a residential, public open space, or allotment setting, and should be segregated during development and assessed for potential reuse (potentially in commercial areas) or taken for disposal offsite.

### 7.2.4 Made Ground

#### 7.2.4.1 Asbestos

The results of the asbestos analysis indicate that asbestos fibres were detected within made ground in one location (DS72) only, at a depth of 0.10m bgl. The shallow made ground at this location was observed to contain building debris (brick, concrete, and asphalt); however, no obvious signs of asbestos containing materials (ACM) were observed. It is likely that the detected asbestos fibre relates to degradation or damage of the nearby farm building, observed to contain potential ACM roofing.

Quantification testing has revealed the asbestos to be present as chrysotile fibres of <0.001% by weight. The detected concentration of asbestos fibres is not considered to pose a significant risk to current and future site users and do not warrant further action. However, care should be taken to comprehensively assess for the presence of asbestos at the site, with appropriate asbestos abatement measures implemented during building demolition and redevelopment.

Should areas of made ground containing potential asbestos-containing materials (ACM) be discovered during development, this should be further assessed by a qualified professional.

#### 7.2.4.2 Heavy Metals & Polycyclic Aromatic Hydrocarbons (PAH)

Elevated concentrations of heavy metals (beryllium & lead) and PAH compounds were reported in four shallow samples of made ground collected within the farmyard area from DS70 to DS72 & DS76. Made ground was observed to extend between ground level and 1.40m in these positions, and included horizons of building material, such as brick, asphalt, concrete. Made ground of a similar nature, and extending to similar depths, was also observed in the boreholes completed in DS104, DS105 & DS107 to DS109 located in the north-eastern area of the farmyard.

The reported elevated concentrations of heavy metals and PAH compounds may relate to anthropogenic material present in the made ground at the farmyard; however, it is possible they relate to chemical products used in the joinery business, and/or metals or compounds used in the historical car

maintenance/workshop trade in this area. Given the deleterious nature of the made ground, its proximity to the nearby watercourse, and as it will not be suitable founding subgrade for buildings or structures proposed within the farmyard area, it is recommended that this material be remediated (via excavation or other suitable techniques) during site development.

#### 7.2.4.3 Per- and polyfluoroalkyl substances (PFAS)

When the results of the laboratory analysis are compared against recently available C4UL interim screening levels, concentrations of perfluorooctane sulfonic acid (PFOS) are shown to be elevated in two soil samples collected from DS107 & DS108, at 0.20m and 1.00m depth, respectively. Both samples were collected in made ground, noted to include fragments of brick, ceramic, glass, and pottery, with olfactory evidence of fuel contamination present.

It should be noted that no elevated concentrations of PFAS were detected in soil samples collected from DS01, DS02, DS04, DS07, DS101 to DS106, DS109, HDTP101, HDTP108, HDTP114 & HDTP117 to HDTP123. Further investigation is warranted to better delineate the western and southern extents of the impacted area. However, gross, site-wide contamination does not appear to be present.

DS107 and DS108 are located in close proximity to one another; with DS107 located at the eastern portion of the farmyard, and DS108 located immediately adjacent to the southern end of the onsite watercourse. It is unclear what potential contaminant source may be attributed to the elevated concentrations of PFOS in this area, especially given their location relative to the former RAF runway (approximately 1km to the north), and the low PFAS concentrations recorded throughout the remainder of the site.

Based on this generic quantitative risk assessment, the PFAS-impacted soils are considered to pose a localised but significant risk to the identified sensitive receptors - in particular the onsite watercourse, given its close proximity. Further investigation and a detailed quantitative risk assessment are recommended, as discussed further in section 7.8.

Should indications of additional contamination be discovered during development, this should be further assessed, and appropriate action taken as necessary.

### 7.3 Topsoil Assessment

Eight samples of topsoil collected from positions spread throughout the arable fields were submitted to a UKAS/MCERTS accredited laboratory for analysis in accordance with the British Standard for the specification for topsoil (BS3882:2015).

This topsoil testing was specifically undertaken to assess the soil texture including the proportion of anthropogenic material and sharps present alongside the organic and nutrients content of the soils, to enable an assessment of the suitability for the planned end use.

As stated within BS3882:2015, topsoil shall either be classified as multipurpose topsoil or specific purpose topsoil. It is considered that in this scenario where topsoil is required to support grass growth and limited vegetation that a multipurpose topsoil is what is required rather than topsoil for a specific purpose. The results are summarised in Table 18 below, which shows that two samples failed the criteria set by BS3882:2015 and are not suitable as topsoil for any topsoil purpose in their current state. Six samples passed the specific purpose criteria for low fertility topsoil use.

| Location_Sample ID/ Depth | Multipurpose | Specific Purpose Topsoil | | |
|---|---|---|---|---|
| | | Acidic | Calcareous | Low Fertility |
| SA03_B1 0.20m – 0.30m | Fail | Fail | Fail | Fail |
| SA10_B1 0.25m – 0.33m | Fail | Fail | Fail | Pass |
| TP05_B1 0.20m – 0.30m | Fail | Fail | Fail | Pass |
| TP21_B1 0.20m – 0.30m | Fail | Fail | Fail | Pass |
| TP22_B1 0.30m – 0.45m | Fail | Fail | Fail | Pass |

| Location_Sample ID/ Depth | Multipurpose | Specific Purpose Topsoil | | |
|---|---|---|---|---|
| | | Acidic | Calcareous | Low Fertility |
| TP31_B1 0.20m – 0.30m | Fail | Fail | Fail | Fail |
| TP47_B1 0.20m – 0.30m | Fail | Fail | Fail | Pass |
| TP53_B1 0.25m – 0.35m | Fail | Fail | Fail | Pass |

**Table 18 Classification of Topsoil Samples**

The testing generally defined the topsoil as a silty clay loam, clay loam or clay.

Evaluation of the results demonstrates that samples which failed have elevated pH or extractable phosphorous. Concentrations of phototoxic contaminants were below levels of concern.

It would be recommended that prior to stripping any topsoil the advice of an agronomist/soil scientist be sought regarding improving nutrient concentrations in the topsoil to bring this into a compliant range. Post treatment, further topsoil testing should be undertaken to demonstrate suitability for use in residential gardens and soft landscaping.

### 7.4 Water Supply Pipework

UKWIR has published the 'Guidance for the selection of water supply pipes to be used in brownfield sites (10/WM/03/21)' to advise developers of contaminants in soil which have the potential to leach through drinking water supply pipework and includes a list of threshold concentrations specific to several commonly used types of pipework.

It should be noted that the scope of testing presented in this report is limited to assessing contaminated land based on the previous site use and does not included analysis of all of the parameters specified in the UKWIR guidance. However, based on an initial comparison of contaminants assessed within the scope of this investigation, there are no reported exceedances of the guidance values for any type of pipework under the Pipe Selection Risk Assessment Summary (PSRAS).

It is recommended that this report is provided to the appointed water company to advise on appropriate materials to be used for construction of potable water supplies.

### 7.5 Groundwater & Surface Water Assessment

Based on the surveyed monitoring well elevations and recorded groundwater depths, groundwater at the site is inferred to flow in southeast direction towards the nearby railway cutting and onsite watercourse. It should be noted that groundwater flow direction may be locally influenced in the farmyard area by the presence of underground structures (e.g., building foundations and utility corridors), the influence of which may vary seasonally.

The risk to controlled waters is addressed by comparing the laboratory test data to adopted screening values. Groundwater was encountered during the investigation at between 0.06m to 3.46m bgl (35.63m to 44.82m aOD). The site is situated over a Secondary Aquifer (Undifferentiated) within the superficial soils and unproductive strata within the underlying bedrock. Furthermore, the site is not located within a groundwater source protection zone (SPZ).

Several land drains are noted to flow into the onsite watercourse, which travels eastwards from Grange Farm towards the Great Stukeley Cutting (designated as a SSSI), eventually connecting to Ripton Brook.

At this stage the risk to controlled water is evaluated from groundwater and surface water sampled on completion of the intrusive works. Environment Agency (EA) publication "Groundwater Protection: Principles and Practice (GP3)" describes the method for assessing the risk to controlled waters, which in this case are considered to be the onsite watercourse and groundwater within the superficial deposits (Secondary Aquifer (Undifferentiated)).

Twenty-seven groundwater samples were collected from a total of twenty-one monitoring wells (in DS01 to DS03, DS09, DS13, DS38, DS59, DS69, DS73 to DS76, DS101, DS103, DS104, DS106 to DS109, CP01 and CP04) over two monitoring events on 15th January and 13th March 2024. In addition, two surface water samples were collected from the onsite watercourse.

The results of the groundwater and surface water sample analyses are summarised in Table 19 below, and are compared against the appropriate groundwater screening values, which are described in the appended Groundwater Screening Values Datasheet (collectively referred to as the 'applicable standards'). These include the UK Drinking Water Standards, WHO Drinking Water Quality Guidelines (WHO DWQG), Environmental Quality Standards (EQS) annual averages (EQS-AA) and maximum allowable concentrations (EQS-MAC), and the Society of Brownfield Risk Assessment (SoBRA) $GAC_{gwvap}$.

| Determinant (Hardness band - $mgCaCO_3/l$) | Max. Recorded (µg/l) – Range provided where exceeding | U.K. Drinking Water Standard / [WHO DWQG] (µg/l) | EQS-AA (freshwater)/ [EQS-MAC (freshwater)] (µg/l) | SoBRA - Residential [SoBRA – Commercial] (µg/l) | Sample Exceeding (Borehole ID_Sample ID) |
|---|---|---|---|---|---|
| **Arsenic** | 7.44 | 10 | 50 | - | |
| **Boron** | 340 | 1000 | 2,000 | - | |
| **Cadmium (>200)** | <0.2 | 5 | 0.25 / [1.5] | | |
| **Chromium (total)** | 0.4 | 50 | 4.7 / [32] Cr(III) | - | |
| | | | 3.4 Cr(VI) | - | |
| **Copper** | 6.7 | 2,000 | **1 (bioavailable)** | - | DS69_EW1, DS73_EW1, DS75_EW1, DS76_EW1, DS107_EW2 |
| **Lead** | < 0.2 | 25 | 1.2 (bioavailable) / [14] | - | |
| **Mercury** | < 0.05 | 1 | [0.07] | - | |
| **Nickel** | 4.7 | 20 | **4** / [34] | - | DS73_EW1, DS76_EW1 |
| **Selenium** | 2.5 | 10 | - | - | |
| **Zinc** | 4.9 | - | 10.9 (bioavailable, dissolved plus ambient background) | - | |
| **pH (unit less)** | 7.3 – 7.5 | 6.5 to 9.5 | 6 to 9 | - | |
| **Sulphate (soluble)** | 18,000 | 250,000 | 400,000 | - | |
| **Ammonium as $NH_4$** | 3,400 | **500 (guide value)** | - | - | DS107_EW2 |
| **Total Cyanide** | <10 | 50 | 1 / [5] | - | |
| **Total Phenols** | < 3.5 | - | 7.7 / [46] | - | |
| **Aliphatic >EC5 - EC6** | < 1.0 | [15,000] | - | 1,900 [190,000] | |
| **Aliphatic >EC6 - EC8** | < 1.0 | [15,000] | - | 1,500 [150,000] | |
| **Aliphatic >EC8 - EC10** | < 1.0 | [300] | - | 57 [5,700] | |
| **Aliphatic >EC10 - EC12** | < 10 | [300] | - | 37 [3,600] | |
| **Aliphatic >EC12 - EC16** | < 10 | [300] | - | - | |
| **Aliphatic >EC16 - EC21** | < 10 | - | - | - | |
| **Aliphatic >EC21 - EC35** | < 10 | - | - | - | |
| **Aromatic >EC5 - EC7** | 19 | **[10]** | - | 210,000 [20,000,000] | DS107_EW2 |
| **Aromatic >EC7 - EC8** | 31 | [700] | - | 220,000 [21,000,000] | |
| **Aromatic >EC8 - EC10** | 100 | [300] | - | 1,900 [190,000] | |
| **Aromatic >EC10 - EC12** | 10,000 | **[90]** | - | **6,800** [660,000] | DS107_EW2 |
| **Aromatic >EC12 - EC16** | 20,000 | **[90]** | - | 39,000 [3,700,000] | DS107_EW2 |

| Determinant (Hardness band - $mgCaCO_3/l$) | Max. Recorded ($\mu g/l$) – Range provided where exceeding | U.K. Drinking Water Standard / [WHO DWQG] ($\mu g/l$) | EQS-AA (freshwater)/ [EQS-MAC (freshwater)] ($\mu g/l$) | SoBRA - Residential [SoBRA – Commercial] ($\mu g/l$) | Sample Exceeding (Borehole ID_Sample ID) |
|---|---|---|---|---|---|
| **Aromatic >EC16 - EC21** | 19,000 | **[90]** | - | - | DS107_EW2 |
| **Aromatic >EC21 - EC35** | 12,000 | **[90]** | - | - | DS107_EW2 |
| **Benzene** | 19.5 | **1.0** | **10** | 210 [20,000] | DS107_EW2 |
| **Toluene** | 32.4 | [700] | 50 | 230,000 [21,000,000] | |
| **Ethylbenzene** | 19.8 | [300] | 20 | 10,000 [960,000] | |
| **Xylenes (total)** | 41.1 | [500] | **30** | 9,500[b] [940,000] | DS107_EW2 |
| **Acenaphthene** | 3,300 | - | - | 170,000 [15,000,000] | |
| **Acenaphthylene** | 140 | - | - | 220,000 [20,000,000] | |
| **Anthracene** | 1,400 | - | **0.1** | - | DS107_EW2 |
| **Benzo(a)pyrene** | 80 | **0.01** | **0.05** | - | DS107_EW2 |
| **Benzo(b)fluoranthene** | 98 | **0.1** | **0.03** | - | DS107_EW2 |
| **Benzo(ghi)perylene** | 23 | **0.1** | **0.002** | - | DS107_EW2 |
| **Benzo(k)fluoranthene** | 44 | **0.1** | **0.03** | - | DS107_EW2 |
| **Chrysene** | 170 | - | - | - | |
| **Di-benzo(a,h)anthracene** | 5.2 | - | - | - | |
| **Fluoranthene** | 2,400 | - | **0.1** | - | DS107_EW2 |
| **Fluorene** | 2,000 | - | - | 210,000 [18,000,000] | |
| **Indeno(1,2,3-cd)pyrene** | 21 | **0.1** | **0.002** | - | DS107_EW2 |
| **Naphthalene** | 10,000 | - | **2.4** | 220 [23,000,000] | DS107_EW2 |
| **Phenanthrene** | 4,700 | - | - | - | |
| **Pyrene** | 1,800 | - | - | - | |
| **1,3,5-Trimethylbenzene** | 15.5 | - | - | - | |
| **1,2,4-Trimethylbenzene** | 38.1 | - | - | - | |
| **2,4-Dimethylphenol** | 53 | - | - | - | |
| **Dibenzofuran** | 1900 | - | - | - | |
| **Carbazole** | 450 | - | - | - | |
| **PFOA** | 93.5 | {100ng/l} | - | | |
| **Total PFOS** | **2,000** | **{100ng/l}** | **0.65ng/l** / [36,000ng/l] | | DS02_EW2, DS03_EW1, DS09_EW2, DS13_EW2, DS73_EW1, DS73_EW2 DS74_EW2 DS75_EW1, DS75_EW2, DS76_EW1, DS76_EW2, DS104_EW2, DS106_EW2, DS109_EW2, SW2_EW2 |

**Table 19 Groundwater & Surface Water Test Results Summary**

The contaminants listed above which do not exceed the applicable standards are not considered to pose a risk to the sensitive receptors identified and are therefore not considered further.

A summary of reported groundwater and surface water exceedances is presented in drawing GC25457-DR003B in the appendix.

Implications of the contaminants exceeding the threshold values above are considered in more detail below.

### 7.5.1 Heavy Metals

Environmental quality standards for copper and nickel are contingent on the hardness of the groundwater. Currently these metals have been recorded at concentrations that may exceed the EQS in the right circumstances, but did not exceed the U.K. Drinking Water Standards where existing. The risk is anticipated to be further reduced as the superficial geology is classified a Secondary Aquifer (Undifferentiated) and likely has relatively poor connectivity to the nearby watercourse. However, given the potential sources of metal contamination (associated with the joinery business) and the near proximity of the onsite watercourse to some of the monitoring locations, further assessment is required before an acceptably low risk can be considered.

### 7.5.2 Ammonium, Polycyclic Aromatic Hydrocarbons (PAH), & Total Petroleum Hydrocarbons (TPH)

Elevated concentrations of ammonium were detected in DS107. Although ammonium can be indicative of degradation of organic material, leachate or sewage, it is thought to be more likely related to historical potential spillage of fertiliser in this area of the farmyard.

Very high concentrations of PAH, TPH, and other combustion products (1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 2,4-dimethylphenol, dibenzofuran, and carbazole) were also detected in this sample, with concentrations of TPH (aromatic EC10 - EC12) exceeding the SoBRA generic standards for a residential site. As the site is being used for commercial purposes, with the building in close proximity to the impacted groundwater generally being used for industrial purposes, these concentrations are not considered to warrant immediate action based on current land use. The following potential sources of the elevated TPH, PAH and other combustion products are considered:

- Borehole records for this location (DS107) and two nearby positions (DS70 & DS71) revealed made ground of significant thickness (up to 1.40m); albeit comprising predominantly natural soils with worked in horizons of various building materials. Therefore, it is possible that deleterious fill material (potentially impacted with or including contaminant sources beyond those identified) has been used to make up ground levels in this area.
- A tank was observed in close proximity to DS107, adjacent to the northeast elevation of the main farmyard building. The Desk Study notes the presence of this tank but does not indicate it's use.
- The Desk Study notes vehicle maintenance occurring in this area of the site.

It should be noted that the boreholes in DS70 and DS71 were observed to be dry during all monitoring events. Furthermore, concentrations of TPH, PAH, VOCs and SVOCs were all below the laboratory limit of detection in monitoring wells in the inferred down-gradient direction (DS73), and surrounding area (DS69, DS75 & DS76). Therefore, current findings appear to indicate that the area of impacted groundwater is relatively localised within close proximity to DS107.

Further investigation is recommended to determine the potential source(s) of contamination, better delineate the area of impacted groundwater, and determine if it is migrating towards the onsite watercourse. Remedial action is likely to be required, and further investigation would serve to better assess remedial options and inform costs.

### 7.5.3 Per- and polyfluoroalkyl substances (PFAS)

Over the two groundwater monitoring events completed, PFAS were detected in samples collected from monitoring wells located throughout the site, generally at very low concentrations (i.e. <6.5ng/l), albeit above the stringent EQS of 0.65ng/l. Slightly elevated PFOS concentrations were detected in DS03 (36.3ng/l) near the northern boundary, and DS13 (15ng/l) at the centre of the site. It should be noted that

elevated concentrations of PFOS were detected in DS03 during the first monitoring event only, with concentrations reported below the laboratory limit of detection during the second event.

Although the majority of groundwater samples collected from monitoring wells within the farmyard area had slightly elevated PFOS concentrations (i.e. samples from DS74 to DS76, DS104, DS106 & DS109) highly elevated concentrations were reported in groundwater samples collected from DS73 (1,450ng/l and 2,000ng/l during each monitoring event). It is unclear as to what the potential source of this contamination is; however, it is speculated that it may relate to undocumented waste disposal (possibly military or relating to the farming or joinery business). PFAS are present in a wide variety of products, and there is a possibility that these are buried within the made ground or may have been spilled or dumped in this area.

Slightly elevated concentrations of PFOS were detected in SW2, collected from the onsite watercourse immediately adjacent to the farmyard. However, PFOS concentrations were not detected in the surface water sample collected downstream at SW1, near the eastern site boundary. Although current data do not appear to indicate surface water with elevated PFOS concentrations to be migrating offsite (potentially due to dilution from other drainage catchments), the potential for migration offsite should be considered further.

It should be noted that it was not possible to collect a groundwater sample from DS108 as it was dry during the second monitoring event. Furthermore, the groundwater sample collected from DS107 was not suitable for PFAS analysis due to the high concentrations of TPH and PAH. Both of these locations had high soil concentrations of PFOS and should be considered as impacted areas in any future assessment or remediation program.

Further investigation is recommended with the aim to determine the potential source of PFAS in this area and a detailed quantitative risk assessment should be completed. These are discussed in greater detail in section 7.8.

### 7.6 Ground Gas Assessment

For the purposes of assessing ground gas concentrations, the levels of methane and carbon dioxide recorded will be assessed in line with current guidance.

Requirement C2 of Schedule 1 of the Building Regulations 2004 for England & Wales covers the potential for methane and carbon dioxide ingress into buildings. This publication indicates that a risk-based approach to consideration of ground gas hazard potential should be undertaken.

Further reference is made to BS8485:2015 which provides a mechanism to initially quantify the risk from methane ($CH_4$) and carbon dioxide ($CO_2$) by calculating a maximum gas flow rate or gas screening value (GSV) as part of a conservative semi-quantitative approach. The GSV is calculated by multiplying the highest flow rate with the maximum recorded concentration of each gas. The GSV may be calculated for the whole site or zoned based on the conceptual model and according to the monitoring results from each borehole.

In this case, the GSV has been calculated for the whole site (farmyard area only) because carbon dioxide and methane concentrations were detected at comparable levels in the majority of boreholes, albeit not necessarily during each monitoring event

Confidence can be gained in the data from the fact that monitoring was completed during varying atmospheric pressures, and over a suitably long period.

Table 20 summarises the pertinent ground gas concentrations and flow readings taken during the investigation and presents the GSVs for methane and carbon dioxide.

| Max Reported (%) | | | | | Flow (l/h) | | GSV $CH_4$ (l/h) | CS $CH_4$ | GSV $CO_2$ (l/h) | CS $CO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $CH_4$ | $CO_2$ | $O_2$ (min) | $H_2S$ (ppm) | CO (ppm) | Min | Max | | | | |
| 0.1 | 1.9 | 18.1 | <1 | 2 | <0.1 | 0.2 | 0.0002 | CS1 | 0.0038 | CS1 |

**Table 20 Ground Gas Assessment Summary**

Based on the GSVs for $CO_2$ and $CH_4$ and in accordance with BS8485:2015, the site falls into characteristic situation (CS) CS1, representing a very low hazard potential. The maximum carbon monoxide and hydrogen sulphide concentrations have been recorded at 2ppm and <1ppm, and as such do not give cause for concern.

Therefore, no specific ground gas protection measures are recommended.

If further confidence in the data is required, additional ground gas monitoring may be undertaken, and/or a detailed risk assessment completed.

### 7.7 Waste Disposal

All waste related activities must be undertaken in accordance with The Waste (England and Wales) Regulations (2011) and The Landfill (England and Wales) Regulations (2002). Any proposed disposal or reuse of materials must be in accordance with the Waste (England and Wales) Regulations 2011 (as amended). According to the regulations waste soil and construction waste must be classified and assessed prior to disposal. The process is described in the Environment Agency Technical Guidance WM3 (2021), with the following steps identified:

Steps to *classify* the waste:

i. Check if the waste needs to be classified (is it a waste).
ii. Identify the code or codes that may apply to the waste, as classified in the List of Waste (LoW).
iii. Identify the assessment needed to select the correct code.

Steps to *assess* the waste:

iv. Determine the chemical composition of the waste.
v. Identify if the substances in the waste are 'hazardous substances' or 'persistent organic pollutants'.
vi. Assess the hazardous properties of the waste.
vii. Assign the classification code and describe the classification code.

Once classified, the waste can be removed to the appropriately licensed facilities with some waste requiring pre-treatments prior to disposal. The results contained in this report should be submitted to allow suitable classification for waste disposal purposes by the contractor.

At the request of the client specific Waste Acceptance Criteria (WAC) testing has been undertaken on a total of four samples representative of material (two samples of topsoil, and two samples of made ground) which may be excavated as part of construction and sought to be removed from the site. The results of this testing indicate the topsoil may generally be classified as inert, while the made ground (within the farmyard area) may generally be classified as hazardous due to elevated concentrations of total petroleum hydrocarbons and/or total organic carbon.

If soils are planned to be removed from the site, waste classification should be reviewed, completed and is the responsibility of the contractor generating/holding the waste soil. The waste classification should be determined in accordance with Environment Agency's Technical Guidance (WM3, 2018) and it may be appropriate to do so in conjunction with the intended landfill to receive it. If excavated soils are planned to be retained and reused on site after it may be appropriate to complete a materials management plan (MMP) according to CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice (DoW CoP), in order to appropriately reuse material without contravening the waste regulations.

### 7.8 Summary and Discussion

Based on the laboratory analytical results received, topsoil throughout the arable fields is generally considered to be suitable for reuse at the proposed development following improvement of nutrient concentrations where the specific purpose warrants.

Made ground and topsoil within the farmyard area was shown to be impacted with PAH compounds and heavy metals (beryllium & lead), with made ground containing building material, such as brick, asphalt, concrete. Furthermore, elevated concentrations of PFAS (specifically, PFOS) were shown to be present in a localised area around DS107 and DS108.

Made ground is of variable thickness (see drawing GC25457-DR004) but is thickest at the central portion of the farmyard area (i.e. in the vicinity of DS70, DS71, DS74, DS107 & DS108), extending to a maximum recorded depth of 1.40m. Given the deleterious nature of the made ground, its proximity to the nearby watercourse, and as it will not be a suitable subgrade to support foundations for buildings or structures proposed within the farmyard area, it is recommended that this material be remediated (via excavation or other suitable techniques) during site development.

Concentrations of heavy metals (copper and nickel) in groundwater were shown to be elevated in monitoring wells throughout the farmyard area. These may relate to the anthropogenic material noted in made ground; however, as environmental quality standards are contingent on the hardness of the groundwater, resampling, analysis and assessment for the M-BAT suite of contaminants is recommended to further assess the risk these contaminant concentrations may pose.

Groundwater appears to be impacted with very high concentrations of ammonium, PAH, TPH, and other combustion products within a relatively localised area in proximity to DS107. It is recommended that the current tenants are contacted to help determine whether current or past site operations (e.g. use of nearby storage tank, past spill incidents, historical above or underground storage tanks, waste management practices, etc) may have contributed to this contamination and to determine if this contaminant source is on-going, as this will affect any future assessment and remediation works. Furthermore, additional groundwater and surface water monitoring events are recommended to better delineate the identified groundwater impacts and to assess potential migration towards the onsite watercourse.

PFOS was detected in groundwater at low or slightly elevated concentrations (i.e. <6.5ng/l or <36.5ng/l, respectively) throughout the arable fields and farmyard, and at high concentrations (circa 2,000ng/l) within the monitoring well in DS73. In addition, slightly elevated concentrations of PFOS were detected in the onsite watercourse immediately adjacent to the farmyard. The source of these elevated contaminant concentrations is unclear, though may relate to undocumented waste disposal (possibly military or relating to the farming or joinery business).

Further investigation is recommended to better delineate the extents of PFAS-impacted soils to the west and south of DS107 & DS108. Additional monitoring of existing wells and surface water is recommended to better assess both the nature of the PFAS at the site (which may be transient at the north portion, near DS03), and whether any evidence of contaminant migration towards the onsite watercourse is present.

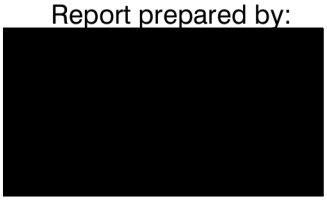
It is recommended that the findings of the current and proposed investigations be used to inform a detailed quantitative risk assessment (DQRA) to assess whether the recorded PFAS concentrations pose an unacceptable risk to surface waters or groundwater resources as well as human health at the site. Should remediation or mitigation prove to be viable (with consideration of existing technology, feasibility, cost and timescales), it should be anticipated that a formalised options appraisal, remediation strategy, method statement, and verification plan will be required. The DQRA should also serve to develop site-specific remediation target values for soil and groundwater, where appropriate.

The basic requirement for development standards in the UK is that land should be ‘suitable for use’ or ‘fit for purpose’. It is important to consider the limited nature of the sampling for this investigation, and the possibility of higher concentrations of contaminants and differing ground conditions existing between sample positions. However, providing the recommendations are adhered to, we believe that the site can be suitable for the intended use.

We recommend that this report is submitted to Regulators as part of the planning process.

Harrison Group Environmental Limited would be pleased to offer further assistance with the recommended works if requested, and if the client or regulators have any comments or questions, we would be glad to discuss them.

Report prepared by:



**Iain Hall BSc (Hons) MEnvSc FGS**
Senior Geoenvironmental Engineer

Report checked by:



**Jamie Austin BSc (Hons) MSc FGS CGeol**
Principal Geotechnical Engineer

## REFERENCES

BS1377:1990, Methods of Test for Soils for Civil Engineering Purposes.

BS5930:2015+A1:2020, Code of Practice for Ground Investigations.

BS8485:2015+A1:2019, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

BS10175:2011+A2:2017, Investigation of Potentially Contaminated Sites.

BS EN 1997-1:2004 +A1:2013, Eurocode 7: Geotechnical Design - Part 1: General Rules.

BS EN 1997-2:2007, Eurocode 7: Geotechnical Design - Part 2: Ground Investigation and Testing.

BS EN ISO 14688-2:2018 Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification.

BS EN ISO 22475-1:2021, 22475-2:2011 & 22475-3:2011 Geotechnical investigation and testing. Sampling methods and groundwater measurements.

BS EN ISO 22476 Geotechnical investigation and testing. Field testing… (various).

BS EN ISO 17892-1:2014, Geotechnical investigation and testing. Laboratory testing of soil… (various).

Building Research Establishment, 2005. Special Digest 1:2005, Concrete in Aggressive Ground.

Building Research Establishment, 2016. Digest DG 365:2016, Soakaway design.

CIRIA Report C665D, 2007, Assessing risks posed by hazardous ground gases to buildings.

CL:AIRE, 2016. CAR-SOIL™ – Control of Asbestos Regulations 2012, Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance.

Department for Environment, Food & Rural Affairs, 2015, 'The Water Framework Directive (Standards and Classification) Directions (England and Wales)'.

Environment Agency, 2006. Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination'.

Environment Agency, 'Updated technical background to the CLEA model', Science Report: SC050021/SR3.

Environment Agency, 2021. 'Land contamination risk management (LCRM)'.

Environment Agency, SEPA and NRW; Technical Guidance WM3, 2021, 'Waste Classification - Guidance on the classification and assessment of waste (1st Edition v1.2.GB)'.

Highways England, 2020, CD225 - Design for new pavement foundations, Version 1.

Land Quality Management Ltd, 2015, The LQM/CIEH Suitable 4 Use Levels (S4ULs) for Human Health Risk Assessment.

National House Building Council (NHBC) Standards, Part 4.2. NHBC Standards 2022 - House-Building Standards NHBC Standards 2022 (nhbc-standards.co.uk).

Society of Brownfield Risk Assessment (SoBRA), 2017, Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater. Version 1.0.

The Waste (England and Wales) Regulations 2011 – as amended.

The Landfill (England and Wales) Regulations 2002 – as amended.

UK Water Industry Research (UKWIR), 2010, Guidance for the selections of water supply pipes to be used in brownfield sites, 10/WM/03/21.

World Health Organization (WHO), 2008, Petroleum products in drinking-water, Background document for development of WHO Guidelines for Drinking Water Quality, WHO/SDE/WSH/05.08/123.

# LIST OF APPENDICES

**APPENDIX A Drawings**

Site Location Plan GC25457-DR001

Fieldwork Location Plan GC25457-DR102

Summary of Soil Exceedances GC25457-DR103A

Summary of Groundwater & Surface Water Exceedances GC25457-DR103B

Summary of Geology Within Farmyard Area GC25457-DR104

Regulatory Plan (client provided) 00628G_RP08_P3

**Appendix B Datasheets**

Datasheet: Site Investigation Methods

Datasheet: General Risk Assessment Methodology

**Appendix C Fieldwork Records/Data**

Cable Percussive Borehole Records CP01-04

Cable Percussive SPT Calibration Certificate

Dynamic Continuous Sample Borehole Records DS01-80 & DS101-109

Dynamic Continuous Sampler SPT Calibration Certificate

Trial Pit Records TP01-63, TP65, TP66, & SA01-16

Hand Dug Trial Pit Records HDTP101-123

Soakaway Test Results SA01-16

In-Situ Plate Bearing Tests Results PBT01, PBT02 & PBT08

In-Situ Dynamic Cone Penetration Tests Results TRL01-17, 19-55 & 57-81

In-Situ Light Weight Deflectometer Tests Results LWD03-07 & LWD09-25

**Appendix D Monitoring Results**

Gas Monitoring Results 6 Weekly Rounds

Groundwater Monitoring Results 8 Rounds

**Appendix E Laboratory Test Data**

Geotechnical Laboratory Test Results HTS Reports GC25457-01 to -04

Chemical Laboratory Analysis Results

Eurofins Reports: 23-40697, 23-40699, 23-40743, 23-41106, 23-41108, 23-41111, 23-41114, 23-41116, 23-41492, 23-41494, 23-41496, 23-41497, 23-42050, 23-42051, 23-42457, 23-42464, 23-42466, 23-42466, 24-00630, 24-01291, 24-01293, 23-39843, 23-40000, 23-40263, 23-40406, 23-40701, 23-41111, 23-41114, 23-39836

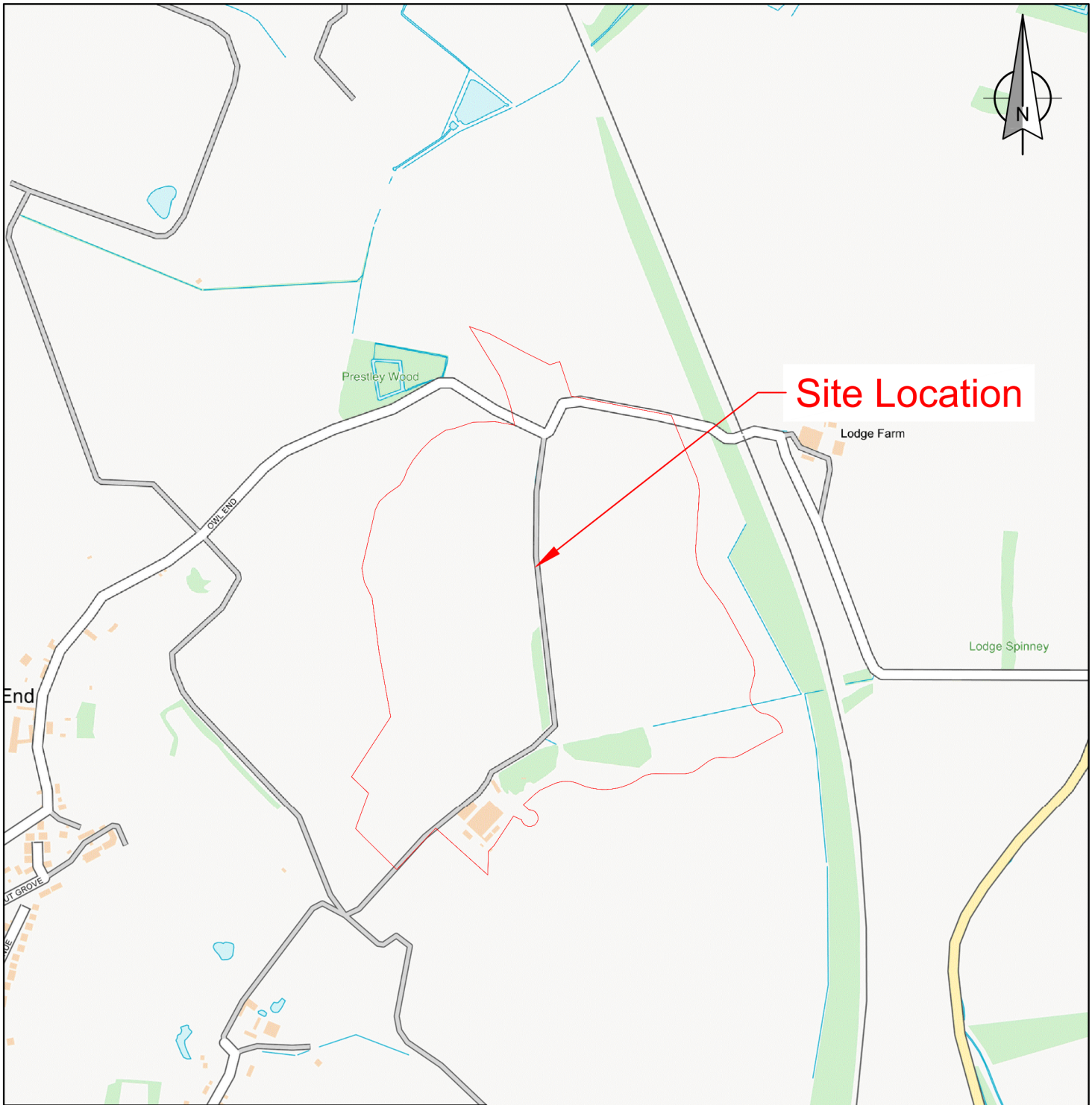
i2 Analytical Reports: 24-78715-1, 24-008041-2, 24-009853-3

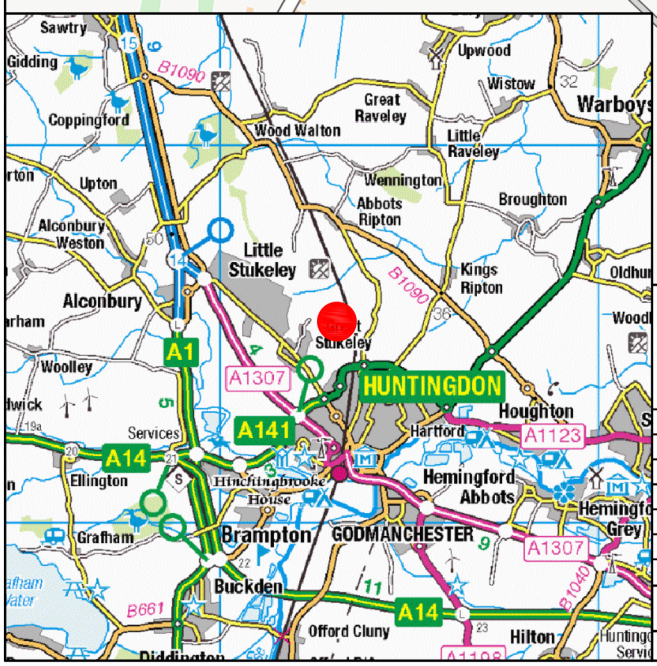
ALS Reports: 717780, 724023, 731578

# APPENDIX A
# DRAWINGS

FM-Hh-D-0001

F:\Jobs 25000\25400\GC25457 Grange Farm, Alconbury Weald\Drawings\CAD files\GC25457 - DR001.dwg




Urban&Civic plc

| | |
|---|---|
| Client : Urban & Civic Alconbury Ltd | |
| Project : Grange Farm, Alconbury Weald | |
| Job No : GC25457 | Date : March 2024 |
| Drawing No : GC25457 - DR001 | |
| Scale : 1:10000 @ A4 | |
| Drawn by : RW | Checked by : IH |
| Eastings : 523100 | Northings : 275350 |

Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office © Crown Copyright Harrison Group Environmental Ltd., Kimberley Street, Norwich, NR2 2RJ. AL100021199

THIS DRAWING IS THE PROPERTY OF HARRISON GROUP LIMITED AND NO REPRODUCTION MAY BE MADE IN WHOLE OR IN PART WITHOUT PERMISSION

harrisongroup ENVIRONMENTAL

Norwich: 01603 613111
Cambridge: 01223 781585
London: 020 7537 9233
Laboratory: 01603 416333

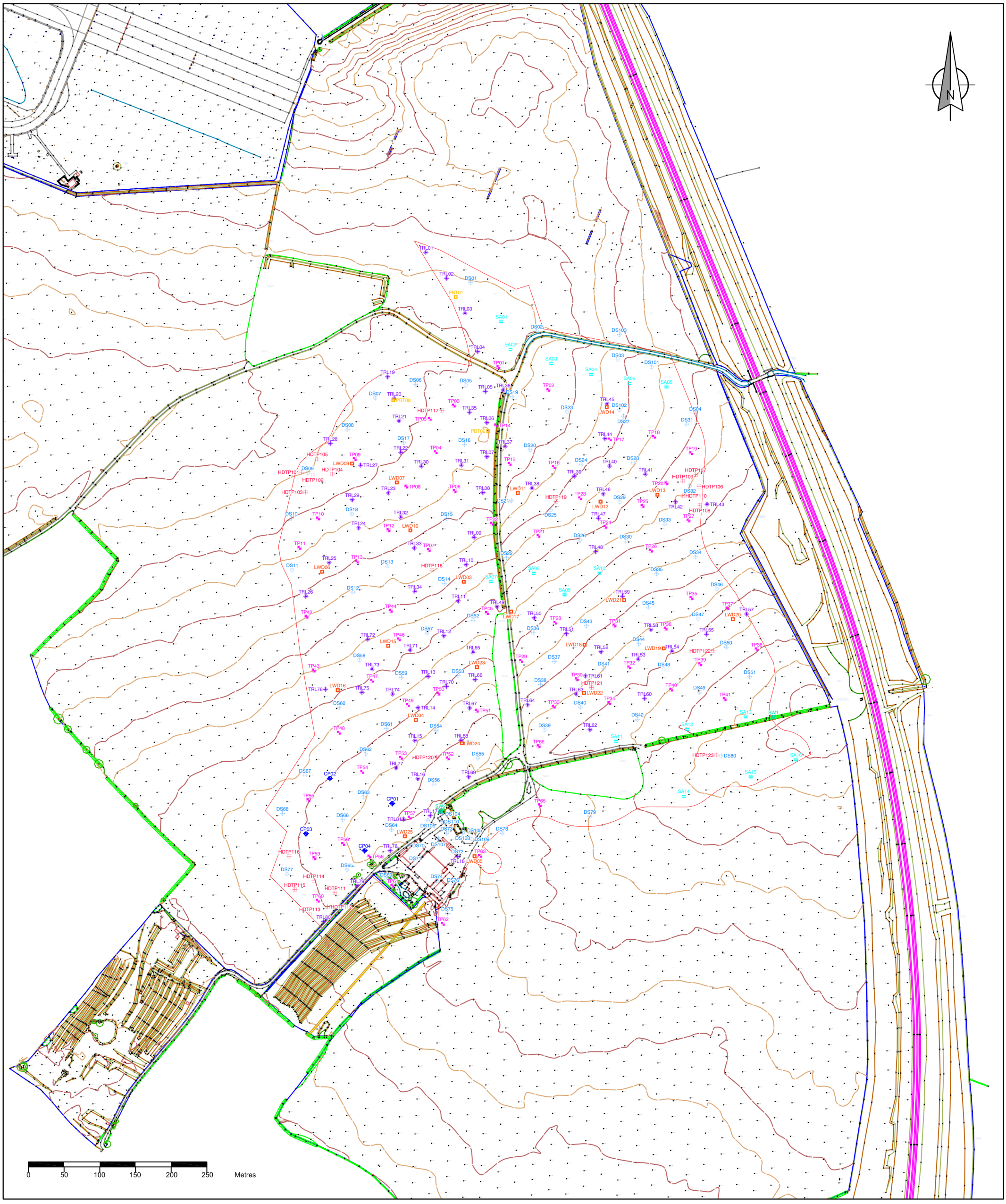
Email: info@harrisongroupuk.com
Website: www.harrisongroupuk.com

ISOQAR REGISTERED alcumus.com
UKAS MANAGEMENT SYSTEMS 0026
UKAS TESTING 4031

Certificate Number 5933
ISO 9001, ISO 14001

FM-Hn-D-0005

F:\Jobs 25000\25400\GC25457 Grange Farm, Alconbury Weald\Drawings\CAD files\GC25457 – DR102.dwg




| | |
|---|---|
| Client : | Urban & Civic Alconbury Ltd |
| Project : | Grange Farm, Alconbury Weald |
| Job No : GC25457 | Date : March 2024 |
| Drawing Title : | Fieldwork Location Plan |
| Drawing No : | GC25457 - DR102 |
| Scale : | 1:5000 @ A3 |
| Drawn by : RW | Checked by : IH |
| Eastings : 523100 | Northings : 275350 |

Revision history

| Rev | Date | Revision Data |
|---|---|---|
| .01 | 02/04/2024 | Topographic survey, site boundary and LWD locations added |
| | | |
| | | |
| | | |

Key :

| | |
|---|---|
| Site Boundary | |
| DS01 | Dynamic Sampling Borehole |
| CP01 | Cable Percussive Borehole |
| TP01 | Machine Excavated Trial Pit |
| TP02 | Machine Excavated Trial Pit with Soakaway Test |
| PLT01 | Plate Loading Test |
| LWD03 | Lightweight Deflectometer Test |
| DCP01 | Dynamic Cone Penetrometer |
| HDTP101 | Hand Dug Trial Pit |
| SW1 | Surface Water Sample |

Notes :


harrisongroup ENVIRONMENTAL

Norwich: 01603 613111 London: 020 7537 9233
Cambridge: 01223 781585 Laboratory: 01603 416333

Email: info@harrisongroupuk.com
Website: www.harrisongroupuk.com


ISOQAR REGISTERED firmus.com

UKAS MANAGEMENT SYSTEMS 0026

UKAS TESTING 4031

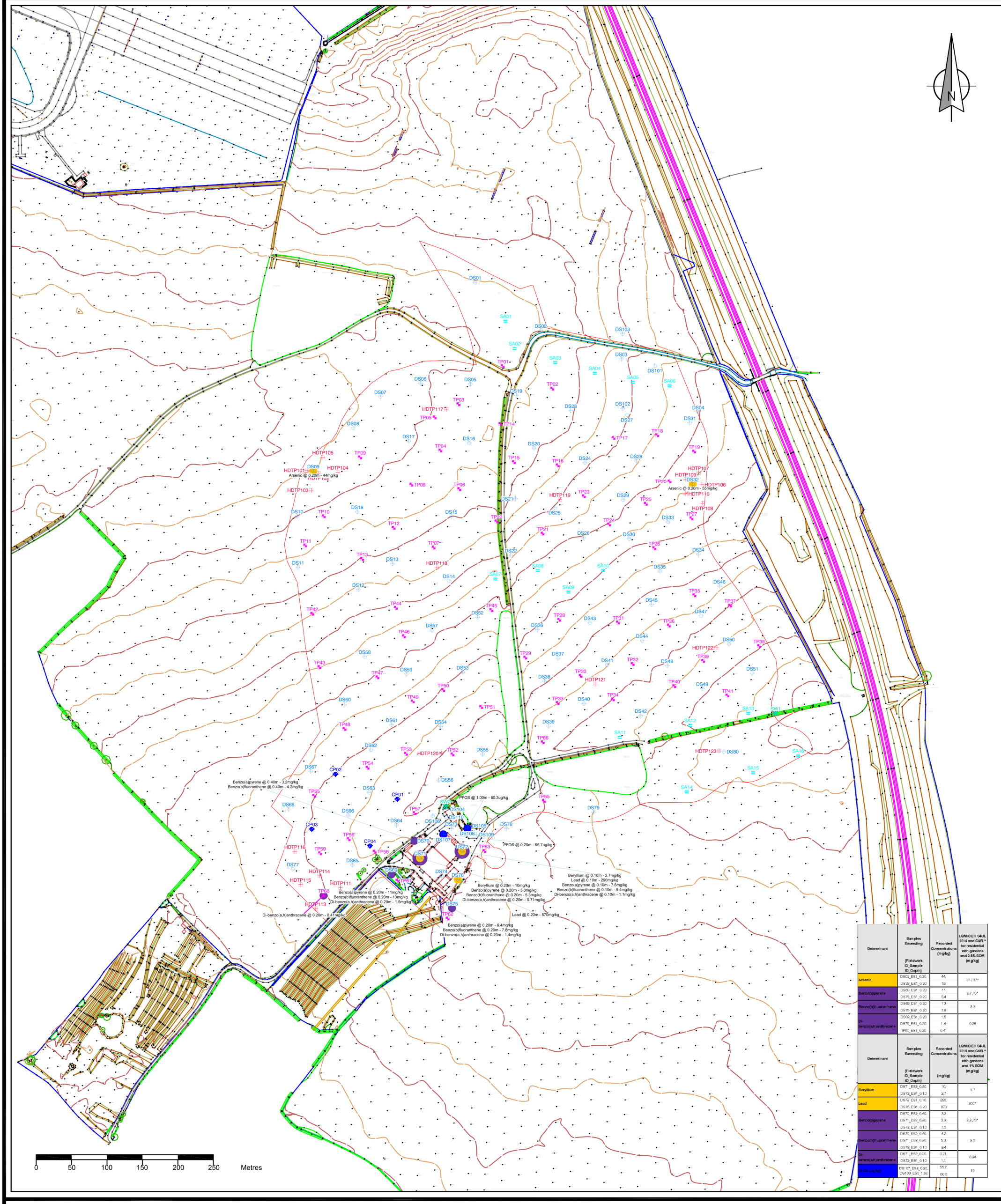
Certificate Number 5933
ISO 9001, ISO 14001


Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office © Crown Copyright Harrison Group Environmental Ltd., Kimberley Street, Norwich, NR2 2RJ. AL100021199

THIS DRAWING IS THE PROPERTY OF HARRISON GROUP LIMITED AND NO REPRODUCTION MAY BE MADE IN WHOLE OR IN PART WITHOUT PERMISSION

FM-Hn-D-0005

F:\Jobs 25000\25400\GC25457 Grange Farm, Alconbury Weald\Drawings\CAD files\GC25457 – DR103.dwg




| Determinant | Samples Exceeding (Fieldwork ID_Sample ID_Depth) | Recorded Concentrations (mg/kg) | LQM/CIEH S4UL 2014 and C4SL* for residential with gardens and 2.5% SOM (mg/kg) |
|---|---|---|---|
| Arsenic | DS03_ES1_0.20, DS32_ES1_0.20 | 44, 55 | 37 / 37* |
| Benzo(a)pyrene | DS03_ES1_0.20, DS75_ES1_0.20 | 11, 5.4 | 2.7 / 5* |
| Benzo(b)fluoranthene | DS03_ES1_0.20, DS75_ES1_0.20 | 13, 7.8 | 3.3 |
| Di-benzo(a,h)anthracene | DS03_ES1_0.20, DS75_ES1_0.20, TP63_ES1_0.20 | 1.5, 1.4, 0.41 | 0.28 |

| Determinant | Samples Exceeding (Fieldwork ID_Sample ID_Depth) | Recorded Concentrations (mg/kg) | LQM/CIEH S4UL 2014 and C4SL* for residential with gardens and 1% SOM (mg/kg) |
|---|---|---|---|
| Beryllium | DS71_ES2_0.20, DS72_ES1_0.10 | 10, 2.7 | 1.7 |
| Lead | DS72_ES1_0.10, DS75_ES1_0.20 | 290, 870 | 200* |
| Benzo(a)pyrene | DS70_ES2_0.40, DS71_ES2_0.20, DS72_ES1_0.10 | 3.2, 3.8, 7.6 | 2.2 / 5* |
| Benzo(b)fluoranthene | DS70_ES2_0.40, DS71_ES2_0.20, DS72_ES1_0.10 | 4.2, 5.3, 9.4 | 2.5 |
| Di-benzo(a,h)anthracene | DS71_ES2_0.20, DS72_ES1_0.10 | 0.71, 1.1 | 0.24 |
| PFOS (ug/kg) | DS107_ES2_0.20, DS109_ES3_1.00 | 55.7, 60.3 | 13 |

Urban&Civic plc

| | |
|---|---|
| Client : Urban & Civic Alconbury Ltd | |
| Project : Grange Farm, Alconbury Weald | |
| Job No : GC25457 | Date : June 2024 |
| Drawing Title : Fieldwork Location Plan with Summary of Soil Exceedances | |
| Drawing No : GC25457 - DR103A | |
| Scale : 1:5000 @ A3 | |
| Drawn by : RW | Checked by : IH |
| Eastings : 523100 | Northings : 275350 |

Revision history

| Rev | Date | Revision Data |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

Key :

- Site Boundary
- CP01 — Cable Percussive Borehole
- DS01 — Dynamic Sampling Borehole
- TP01 — Machine Excavated Trial Pit
- TP02 — Machine Excavated Trial Pit with Soakaway Test
- HDTP101 — Hand Dug Trial Pit
- Metal Exceedances in Soil
- TPH / PAH Exceedances in Soil
- PFOS Exceedances in Soil

Notes :


harrisongroup ENVIRONMENTAL

Norwich: 01603 613111 London: 020 7537 9233
Cambridge: 01223 781585 Laboratory: 01603 416333
Email: info@harrisongroupuk.com
Website: www.harrisongroupuk.com


ISOQAR REGISTERED accumus.com — UKAS MANAGEMENT SYSTEMS 0026 — UKAS TESTING 4031

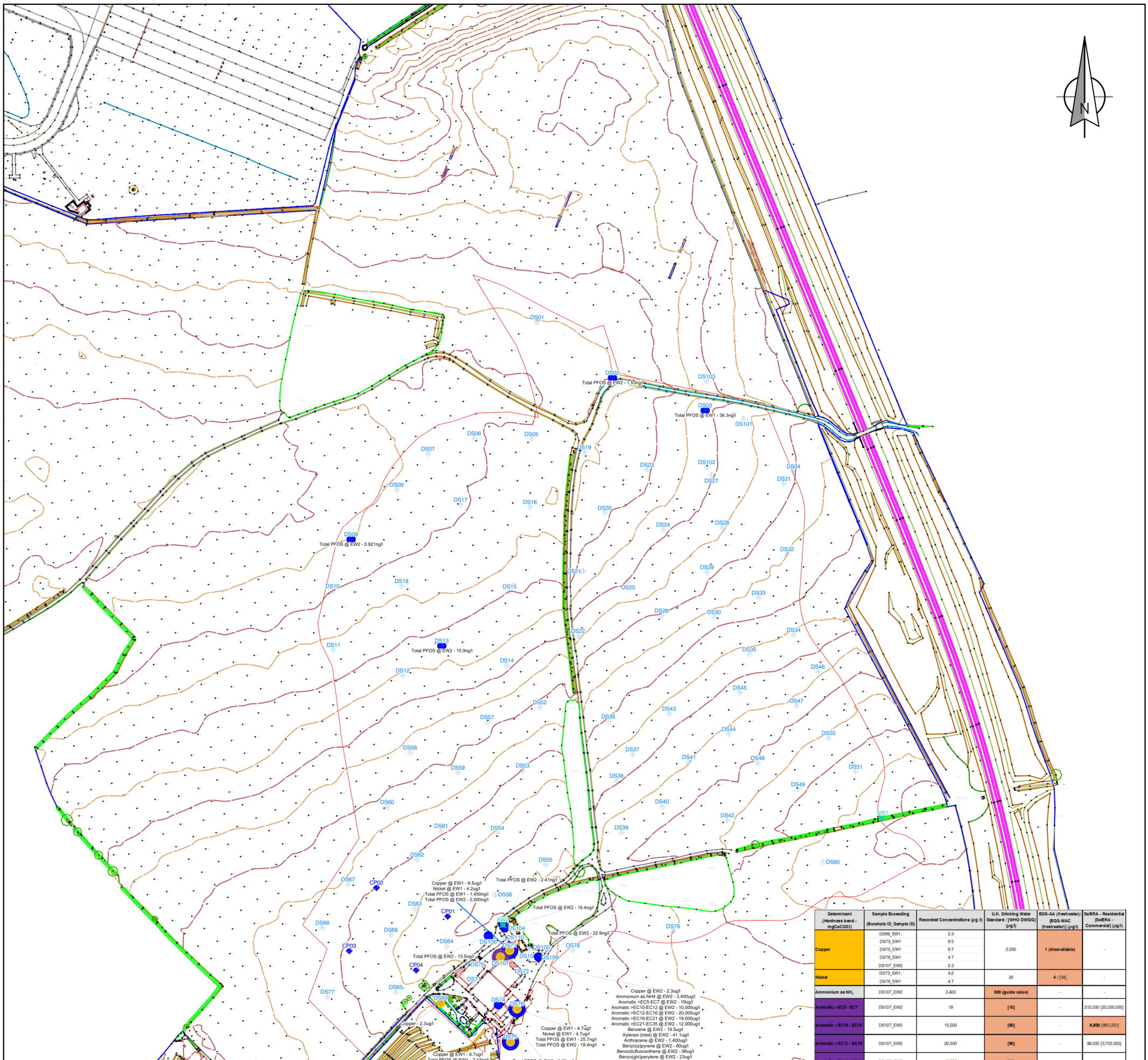
Certificate Number 5933
ISO 9001, ISO 14001


Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office © Crown Copyright Harrison Group Environmental Ltd., Kimberley Street, Norwich, NR2 2RJ. AL100021199

THIS DRAWING IS THE PROPERTY OF HARRISON GROUP LIMITED AND NO REPRODUCTION MAY BE MADE IN WHOLE OR IN PART WITHOUT PERMISSION

FM-Hn-D-0005

F:\Jobs 25000\25400\GC25457 Grange Farm, Alconbury Weald\Drawings\CAD files\GC25457 – DR103.dwg




| Determinant (Hardness band - mgCaCO3/l) | Sample Exceeding (Borehole ID_Sample ID) | Recorded Concentrations (µg /l) | U.K. Drinking Water Standard / [WHO DWQG] (µg/l) | EQS-AA (freshwater) / [EQS-MAC (freshwater)] (µg/l) | SoBRA - Residential (SoBRA - Commercial) (µg/l) |
|---|---|---|---|---|---|
| Copper | DS69_EW1, | 2.3 | 2,000 | 1 (bioavailable) | - |
| | DS73_EW1 | 6.5 | | | |
| | DS75_EW1 | 6.7 | | | |
| | DS76_EW1 | 4.7 | | | |
| | DS107_EW2 | 2.3 | | | |
| Nickel | DS73_EW1, | 4.2 | 20 | 4 / [34] | - |
| | DS76_EW1 | 4.7 | | | |
| Ammonium as $NH_4$ | DS107_EW2 | 3,400 | 500 (guide value) | - | - |
| Aromatic >EC5 - EC7 | DS107_EW2 | 19 | [10] | - | 210,000 [20,000,000] |
| Aromatic >EC10 - EC12 | DS107_EW2 | 10,000 | [90] | - | 6,800 [860,000] |
| Aromatic >EC12 - EC16 | DS107_EW2 | 20,000 | [90] | - | 99,000 [3,700,000] |
| Aromatic >EC16 - EC21 | DS107_EW2 | 19,000 | [90] | - | - |
| Aromatic >EC21 - EC35 | DS107_EW2 | 12,000 | [90] | - | - |
| Benzene | DS107_EW2 | 19.5 | 1 | 10 | 210 [20,000] |
| Xylenes (total) | DS107_EW2 | 41.1 | [500] | 30 | 9,500[a] [940,000] |
| Anthracene | DS107_EW2 | 1,400 | - | 0.1 | - |
| Benzo(a)pyrene | DS107_EW2 | 80 | 0.01 | 0.05 | - |
| Benzo(b)fluoranthene | DS107_EW2 | 98 | 0.1 | 0.03 | - |
| Benzo(ghi)perylene | DS107_EW2 | 23 | 0.1 | 0.002 | - |
| Benzo(k)fluoranthene | DS107_EW2 | 44 | 0.1 | 0.03 | - |
| Fluoranthene | DS107_EW2 | 2,400 | - | 0.1 | - |
| Indeno(1,2,3-cd)pyrene | DS107_EW2 | 21 | 0.1 | 0.002 | - |
| Naphthalene | DS107_EW2 | 10,000 | - | 2.4 | 220 [23,000,000] |
| Total PFOS (ng/l) | DS02_EW2 | 1.53 | {100ng/l} | 0.65ng/l / [36,000ng/l] | |
| | DS03_EW1 | 36.3 | | | |
| | DS09_EW2 | 0.921 | | | |
| | DS13_EW2 | 15.9 | | | |
| | DS73_EW1 | 1,450 | | | |
| | DS73_EW2 | 2,000 | | | |
| | DS74_EW2 | 8.32 | | | |
| | DS75_EW1 | 3.12 | | | |
| | DS75_EW2 | 0.818 | | | |
| | DS76_EW1 | 25.7 | | | |
| | DS76_EW2 | 18.4 | | | |
| | DS104_EW2 | 16.4 | | | |
| | DS106_EW2 | 15.5 | | | |
| | DS109_EW2 | 22.9 | | | |
| | SW2_EW2 | 2.41 | | | |

Urban&Civic plc

| | |
|---|---|
| Client : Urban & Civic Alconbury Ltd | |
| Project : Grange Farm, Alconbury Weald | |
| Job No : GC25457 | Date : June 2024 |
| Drawing Title : Fieldwork Location Plan with Summary of Groundwater and Surface Water Exceedances | |
| Drawing No : GC25457 - DR103B | |
| Scale : 1:5000 @ A3 | |
| Drawn by : RW | Checked by : IH |
| Eastings : 523100 | Northings : 275350 |

Revision history

| Rev | Date | Revision Data |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

Key :

- Site Boundary
- CP01 — Cable Percussive Borehole
- DS101 — Dynamic Sampling Borehole
- SW1 — Surface Water Sample
- Metal Exceedances in Groundwater
- TPH / PAH Exceedances in Groundwater
- PFOS Exceedances in Groundwater

Notes :


harrisongroup ENVIRONMENTAL

Norwich: 01603 613111 London: 020 7537 9233
Cambridge: 01223 781585 Laboratory: 01603 416333
Email: info@harrisongroupuk.com
Website: www.harrisongroupuk.com


ISOQAR REGISTERED assurus.com 0026 | UKAS MANAGEMENT SYSTEMS | UKAS TESTING 4031

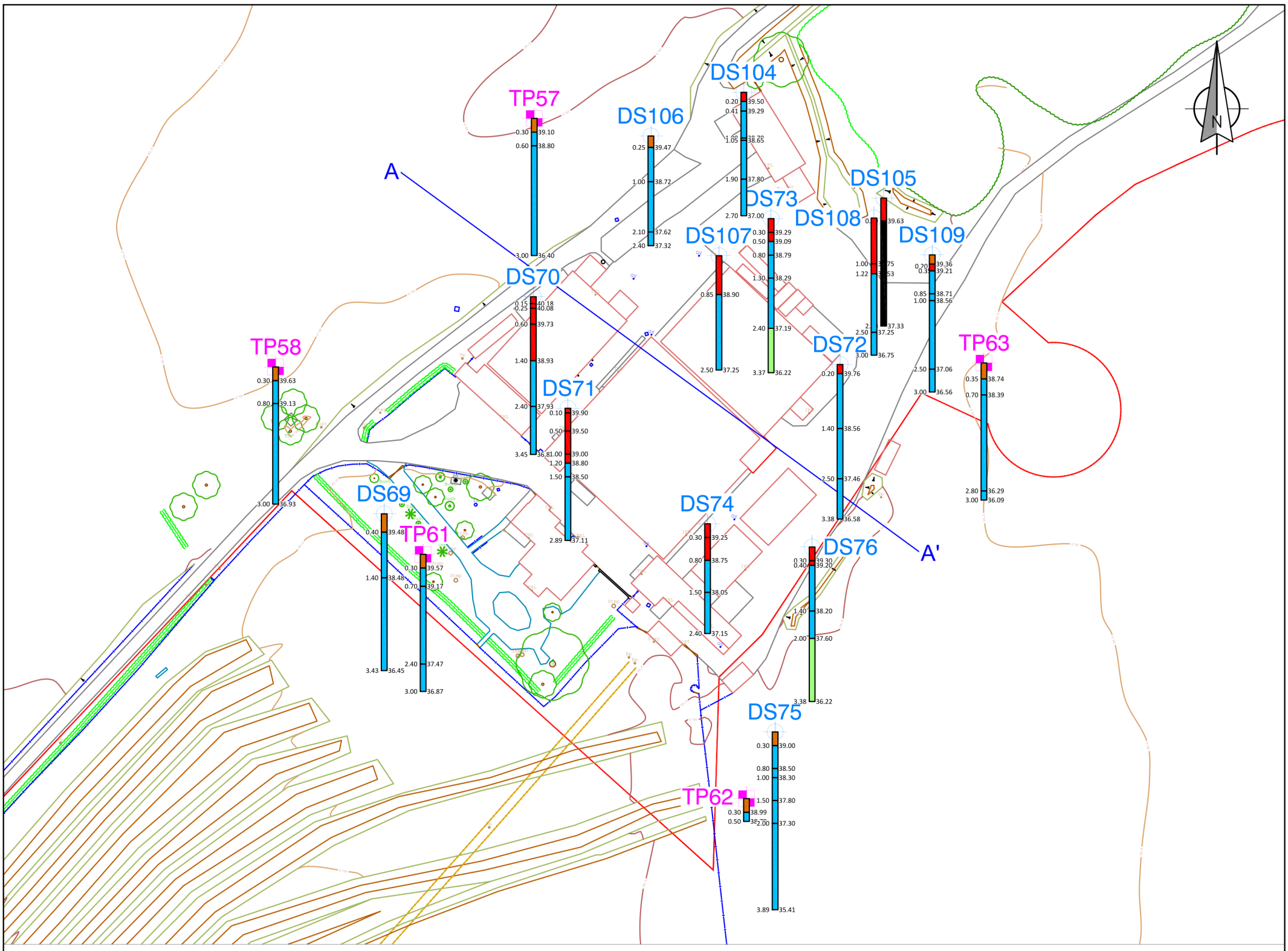
Certificate Number 5933
ISO 9001, ISO 14001


Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office © Crown Copyright Harrison Group Environmental Ltd., Kimberley Street, Norwich, NR2 2RJ. AL100021199

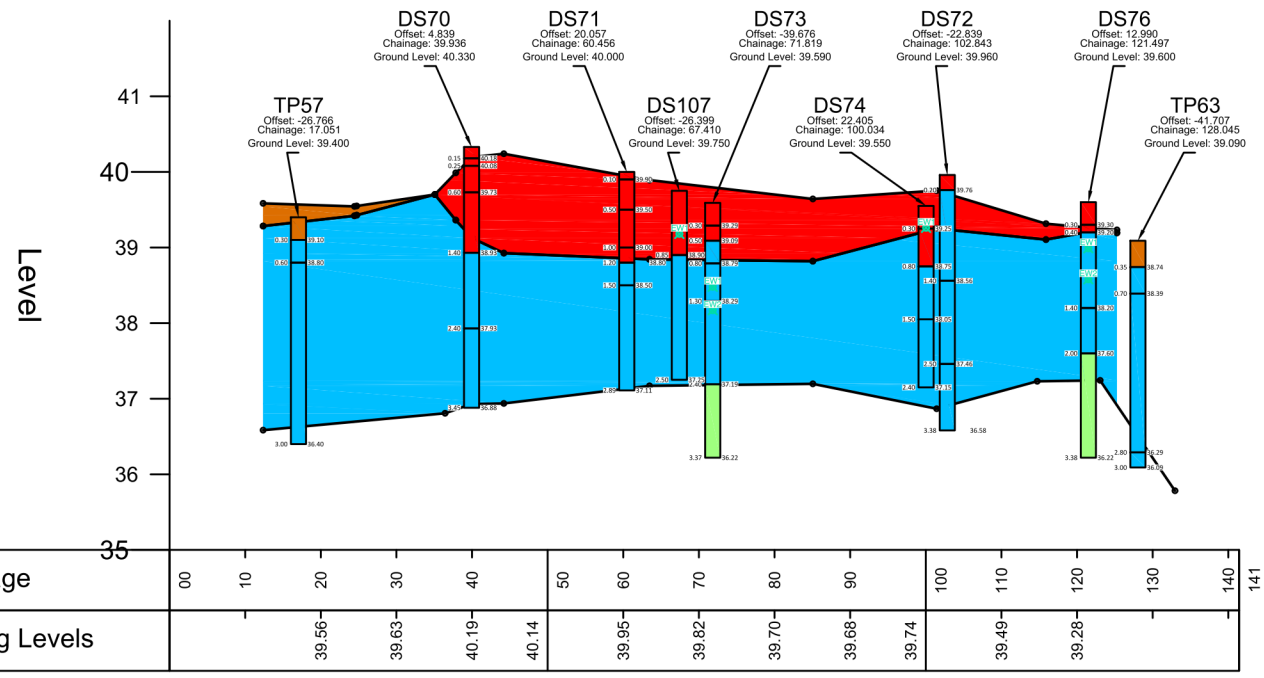
THIS DRAWING IS THE PROPERTY OF HARRISON GROUP LIMITED AND NO REPRODUCTION MAY BE MADE IN WHOLE OR IN PART WITHOUT PERMISSION

FM-Hm-D-0005

F:\Jobs 25000\25400\GC25457 Grange Farm, Alconbury Weald\Drawings\CAD files\GC25457 – DR104.dwg




# SECTION A-A'




Urban&Civic plc

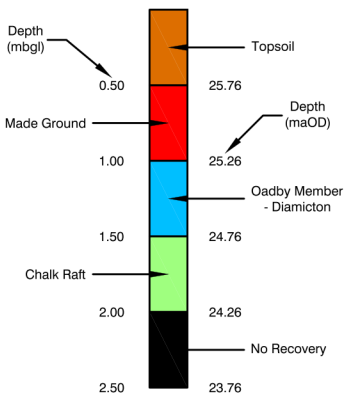
| | |
|---|---|
| Client : Urban & Civic Alconbury Ltd | |
| Project : Grange Farm, Alconbury Weald | |
| Job No : GC25457 | Date : June 2024 |
| Drawing Title : Fieldwork Location Plan - Grange Farm, Farmyard | |
| Drawing No : GC25457 - DR104 | |
| Scale : 1:1000 @ A3 | |
| Drawn by : RW | Checked by : IH |
| Eastings : 523100 | Northings : 275350 |

Revision history

| Rev | Date | Revision Data |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

Key :

- Site Boundary
- DCS01 — Dynamic Sampling Borehole
- TP01 — Machine Excavated Trial Pit
- A — A' Section Line




Notes :

harrisongroup ENVIRONMENTAL

Norwich: 01603 613111
Cambridge: 01223 781585
London: 020 7537 9233
Laboratory: 01603 416333

Email: info@harrisongroupuk.com
Website: www.harrisongroupuk.com

ISOQAR REGISTERED 0026 — UKAS MANAGEMENT SYSTEMS — UKAS TESTING 4031

Certificate Number 5933
ISO 9001, ISO 14001

Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office © Crown Copyright Harrison Group Environmental Ltd., Kimberley Street, Norwich, NR2 2RJ. AL100021199

THIS DRAWING IS THE PROPERTY OF HARRISON GROUP LIMITED AND NO REPRODUCTION MAY BE MADE IN WHOLE OR IN PART WITHOUT PERMISSION

Notes:
Do not scale from this drawing.
All contractors must visit the site and be responsible for taking and checking Dimensions.
All construction information should be taken from figured dimensions only.
Any discrepancies between drawings, specifications and site conditions must be brought to the attention of the supervising officer.
This drawing and the works depicted are the copyright of JTP.

This drawing is for planning purposes only. It is not intended to be used for construction purposes. Whilst all reasonable efforts are used to ensure drawings are accurate, JTP accept no responsibility or liability for any reliance placed on, or use made of, this plan by anyone for purposes other than those stated above.

## KEY

**2. Context**

Boundaries
- 2.1 Alconbury Weald Outline Planning Application Boundary
- 2.2 Grange Farm Outline Planning Application Boundary
- 2.3 Phase A Boundary
- Building Heights: note parameters listed on plan

Land Use
- Chapter 5 Residential (C2/C3)
- Chapter 6 Primary School (D1)
- Chapter 6 Local Centre including retail and community facilities (A1-A5, D1)

**3. Green Infrastructure**
- Informal Green Space
- 3.3 Village Approach
- 3.4 Community Parks
  - 3.4.1 Prestley Meadow Community Park
  - 3.4.2 The Spinneys Community Park
- 3.5 Pocket Parks
- 3.6 Local Centre Setting
- 3.7 The Spinneys
  - 3.7.1 Lodge Spinney
  - 3.7.2 Long Spinney
  - 3.7.3 Farm Spinney
- 3.8 Greenways
  - 3.8.1 Spinney Greenway
  - 3.8.2 Meadow Greenway
  - 3.8.3 Prestley Greenway
- 3.9 Grange Farm Allotments
- 3.10 Community Gardens
- Proposed Woodland Blocks

**4. Movement and Access**

4.3 Site Access Points
- Southern Link Road Access A/B
- Southern Link Road Access C

4.4 Street Hierarchy
- 4.4.1 Street Type B - Secondary Street
- Street Type B variant sections (B1-B6)
- 4.4.3 Street Type C - Tertiary Neighbourhood Bus Route
- 4.4.4 Street Type D - Tertiary Street and Cross Parcel Permeability
- 4.4.5 Street Type E - Tertiary Green Street and Cross Parcel Permeability

4.6 Active Travel Network
- New public bridleway
- Existing bridleway
- Rerouted bridleway
- Indicative Multi User Active Travel Route
- Indicative access locations for non-vehicular connections outside site boundary

4.7 Bus Network
- Indicative bus stop
- Bus Turnabout

4.8 Vehicular route to primary school/ local centre and allotments

4.9 Access to minor routes & parcels
- Access point: fixed location (for access to minor street, +/- 5m flexibility of location permitted)
- Access pont: indicative location

**5. Residential Built Form**

5.6 Residential Layout Design
5.6.2 Marker Buildings
- Key Groupings

5.6.3 Frontage Character Location Plan
- Country Park
- Green Corridors
- Village Approach
- Neighbourhood Street North
- Northern Park Edge
- Link Road North

**6. Community Uses Built Form**

6.2 Design Principles for Local Centre
- Potential retention of Grange Farm farmhouse
- Important active frontage to community buildings
- Indicative Car Park location

6.3 Design Principles for Primary School
- School Square
- Built form emphasis in key location

**8. Technical Details**

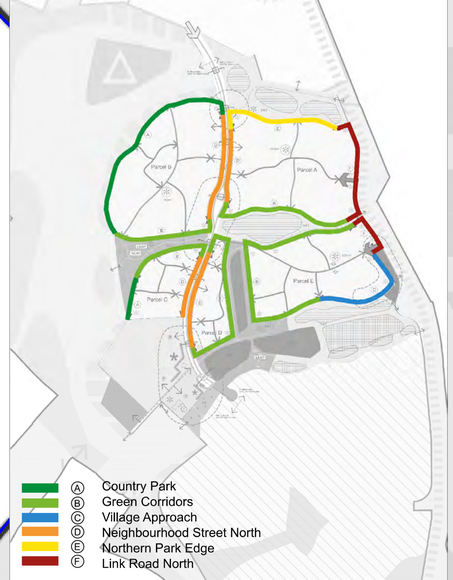
8.7 Water Management: Drainage approach & Suds
- Attenuation basin (dry)
- Wet pond
- Safeguarded attenuation basin for potential future phase

8.8 Play provision strategy
- NEAP
- LEAP

**Utilities**

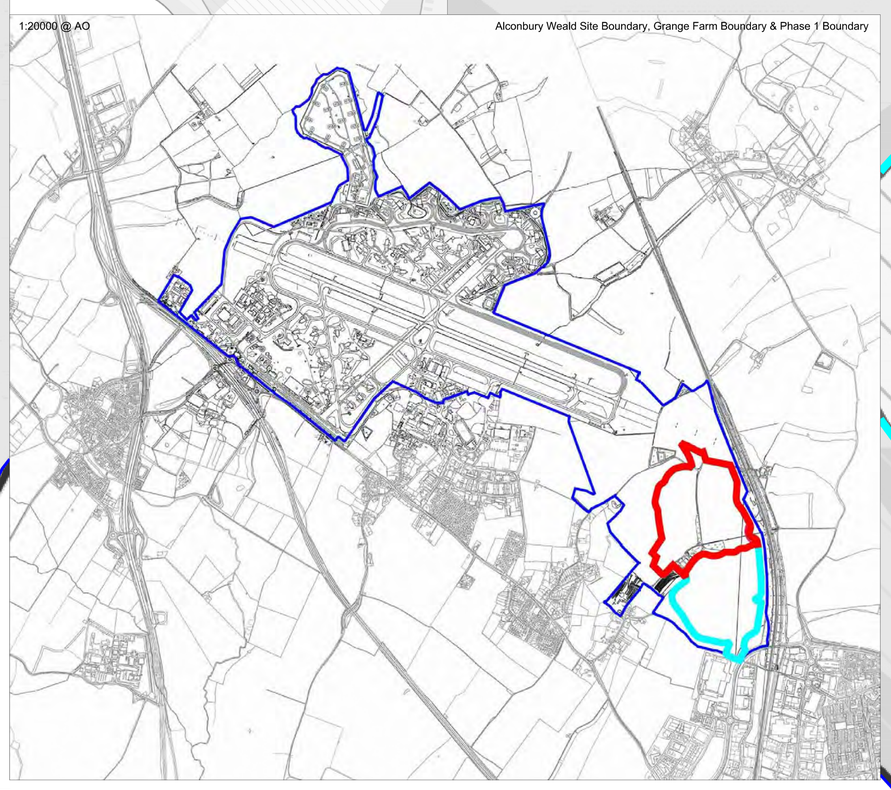
Refer to Design Code Technical Details Chapter 8 for further technical information including indicative locations for gas governers and electricity sub-stations.

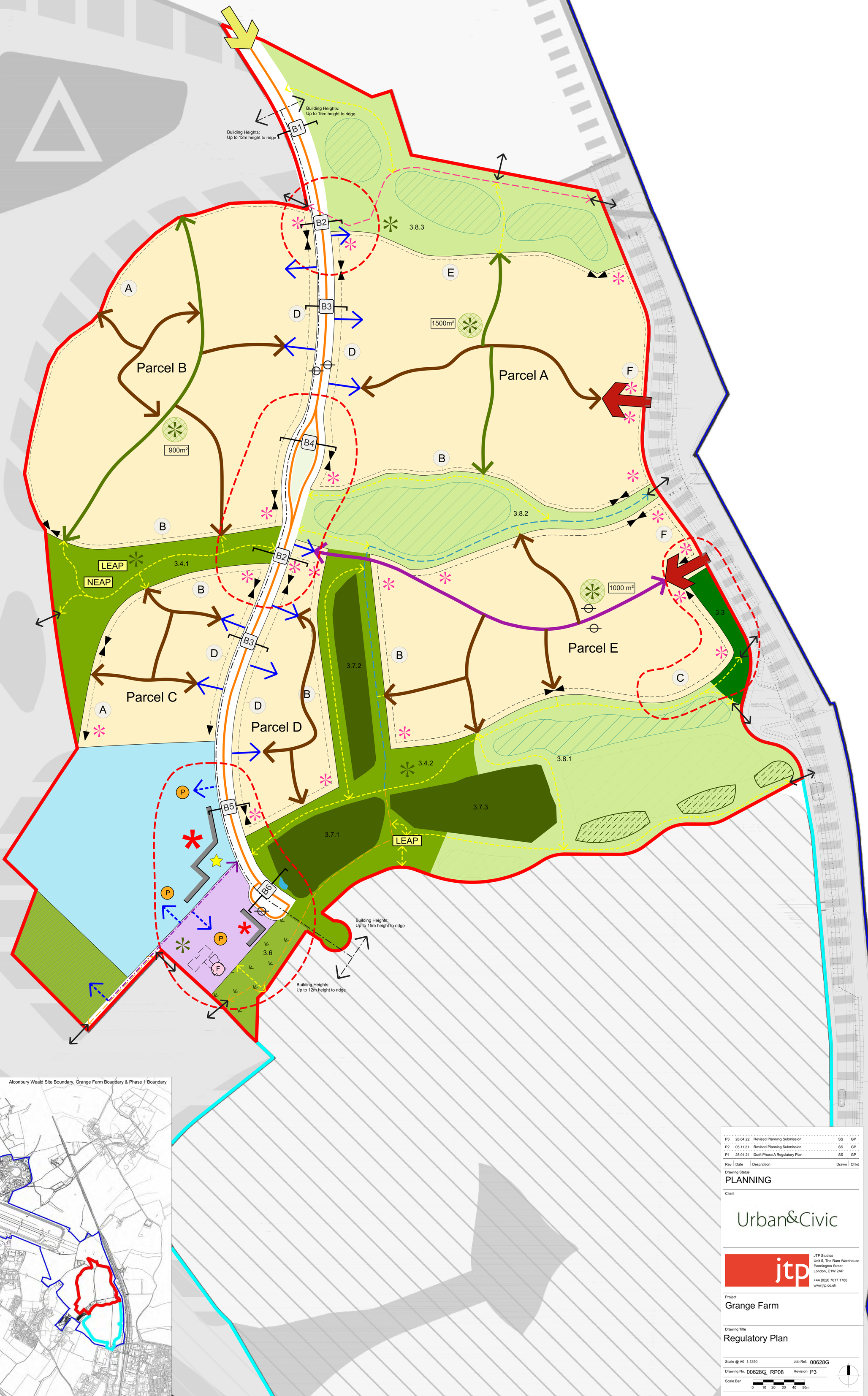
1:10000 @ AO — Grange Farm Frontage Characters




- Ⓐ Country Park
- Ⓑ Green Corridors
- Ⓒ Village Approach
- Ⓓ Neighbourhood Street North
- Ⓔ Northern Park Edge
- Ⓕ Link Road North

1:20000 @ AO — Alconbury Weald Site Boundary, Grange Farm Boundary & Phase 1 Boundary






| Rev | Date | Description | Drawn | Chkd |
|---|---|---|---|---|
| P3 | 28.04.22 | Revised Planning Submission | SS | GP |
| P2 | 05.11.21 | Revised Planning Submission | SS | GP |
| P1 | 25.01.21 | Draft Phase A Regulatory Plan | SS | GP |

Drawing Status
PLANNING

Client
Urban&Civic


jtp
JTP Studios
Unit 5, The Rum Warehouse
Pennington Street
London, E1W 2AP
+44 (0)20 7017 1780
www.jtp.co.uk


Project
Grange Farm

Drawing Title
Regulatory Plan

Scale @ A0 1:1250 — Job Ref. 00628G
Drawing No. 00628G_ RP08 — Revision P3
Scale Bar 0 10 20 30 40 50m

# APPENDIX B
# DATASHEETS

# DATASHEET: GROUND INVESTIGATION METHODS

This datasheet provides basic details of the methods employed during the undertaking of ground investigations. Detailed method statements may be provided if requested or further information may be obtained from the relevant British Standards or other quoted publications. Investigations are generally carried out in accordance with BS 5930:2015 + A1:2020, "Code of practice for ground investigations", BS 10175:2011+A2:2017, "Investigation of potentially contaminated sites – Code of Practice, and BS EN ISO 1997-2:2007, "Eurocode 7 – Geotechnical design – Part 2: Ground investigation and testing".

Prior to any excavation being undertaken, service plans are obtained and/or a service tracing team may be employed to locate and mark up service locations. A surface sweep using a cable avoidance tool (CAT) is undertaken, in order to avoid services and service inspection pits are generally hand excavated prior to commencing work with any mechanical plant.

## CABLE PERCUSSIVE BOREHOLES

The cable percussive borehole drilling rig may be towed by a 4x4 pick up or similar vehicle and is capable of forming cased boreholes to depths of up to 50m. The hole may be formed at diameters from 300mm down to the more typical 150mm, with disturbed samples obtained direct from the drilling tools. The equipment requires a minimum 2m access width, and the rig itself is 6m long (11m including tow). A rough 3m x 5m base area is required for drilling, but each site should be considered on specifics.

The technique can penetrate dense made ground, rubble and concrete or weathered rock/thin bands of rock using a chisel. However, in some cases these materials can form obstructions.

Sampling is generally carried out in accordance with BS EN ISO 22475-1:2021, "Geotechnical investigation and testing – Sampling methods and groundwater measurements - Part 1 – Technical principles for the sampling of soil, rock and groundwater". A variety of disturbed samples can be obtained for both geotechnical and environmental purposes and undisturbed samples including U100 (thick-walled OS-TK/W), UT100 (thin-walled OS-T/W) and piston samples (PS-T/W) may be obtained. Standard in-situ testing may include Standard or Cone Penetration Tests (SPT/CPT) to BS EN ISO 22476-3:2005+A1:2011, "Geotechnical investigation and testing – Field testing – Part 3 – Standard penetration test"; vane testing in accordance with BS 22476-9, 2020, "Geotechnical investigation and testing – Field testing – Part 9 – Field vane test" and permeability testing in accordance with BS EN ISO 22282-1-6, Geotechnical investigation and testing – Geohydraulic testing – Parts 1 to 6.

Instrumentation/standpipes/monitoring wells can be installed, otherwise the borehole would be backfilled with spoil, or where instructed bentonite, concrete or sand may be used. Excess spoil is either removed from site or left in a tidy heap nearby.

In wet drilling conditions (beneath groundwater level) or where water needs to be added to facilitate drilling, the spoil can spread over a wide area through splashing and flow of the spoil from the tools, unless precautions are taken to prevent this. Conversely, the system can be very clean for instance when drilling through dry clay soil.

## DYNAMIC SAMPLING (WINDOW SAMPLER) BOREHOLES

The dynamic sampling (DS) drilling system comprises a series of varying diameter (100mm down to 36mm) steel tubes of either 1m length, and in the case of window (rather than windowless) having a slot or window cut along the side. The tubes are driven into the ground using a light percussive hammer attached to solid rods and withdrawn by use of a jack. The hammer may be machine mounted (wheeled or tracked) or for restricted access work, handheld. The soil sample is forced up into the tube during the driving, samples being obtained directly through the slot or window, or in the case of windowless, in plastic liners in the steel tube. The sampler generally achieves depths of around 5m in favourable soils. Use of a super heavy tracked rig allows samples to be retrieved in liners to depths of up to 10m in suitable ground conditions.

Sampling can be carried out from the boreholes in accordance with BS EN ISO 22475-1:2021 and SPT testing can be undertaken in accordance with BS EN ISO 22476-3:2005+A1:2011. In addition, small diameter standpipes/monitoring wells can be installed to facilitate the sampling and monitoring of gas and groundwater.

## MONITORING WELL INSTALLATIONS

All types of boreholes can be fitted with monitoring wells to enable subsequent sampling and monitoring of groundwater and ground gas levels. Monitoring wells are usually of upvc or hdpe material, although steel may also be used in certain circumstances. Various diameters are available from 19mm upwards, depending upon the size of the borehole. 38mm or 50mm diameter wells are the most commonly used. Wells generally have slotted lower sections which may have a geomesh filter and then are surrounded with a filter medium such as single sized gravel. The upper sections are generally solid casing which is usually grouted to produce a seal with the surrounding ground. The top of the well is generally fitted with a removable cap that may include a gas valve to enable future gas monitoring. The installation is usually protected by a lockable cover set in a concrete base. Details of monitoring well installations and associated backfill are given on the relevant borehole records.

## GROUNDWATER MONITORING

Groundwater monitoring is undertaken using an electronic dip meter, which records the depth to water in a standpipe or monitoring well. Alternatively, down-hole pressure transducers can be utilised, which can record variations over an extended period; this is particularly useful for monitoring variations due to tidal influences, when undertaking permeability tests, draw down tests, or when undertaking soakaway testing. Where a non-aqueous phase liquid (e.g. floating hydrocarbon layer) is present, an interface meter is utilised to measure the thickness.

## GROUND GAS MONITORING

Ground gas composition and flow monitoring may be undertaken where monitoring wells have been installed. Both flow (litres per hour) and composition (%) are measured using a portable infra-red multi-gas meter, calibrated for methane, carbon dioxide, carbon monoxide, hydrogen sulphide and oxygen. Records are also taken of atmospheric pressure, and relative pressure. The results are presented in the appendix of the report on the relevant records.

Ground gas monitoring can also be undertaken on a continuous basis using in-situ GasClam instrumentation where specific projects warrant accurate identification and quantification of the ground gas regime.

## MACHINE EXCAVATED TRIAL PITS

Machine excavated trial pits are undertaken using a wheeled backhoe or tracked 360 excavator. The hole is progressed, with the supervising Geotechnical Engineer taking samples and/ or carrying out in-situ testing as appropriate. No access may be made in to

unstable/ contaminated pits, or into pits greater than 1.20m deep. Where man access is required, shoring can be provided and installed to maintain stability of the excavation. The trial pits are backfilled in compacted layers, with spoil heaped up in order to allow for future settlement. Pits may be taken to a maximum of 4.50m depth in favourable conditions.

Machine excavated trial pits require relatively large clear working areas in which to be carried out and can cause considerable disturbance to the ground surface.

**HAND EXCAVATED TRIAL PITS**

Hand excavated pits may be undertaken for a variety of reasons, which include service observation pits, obtaining near surface samples, and examining foundations of existing buildings. Pits are excavated using a shovel, postholers and other suitable equipment. Shoring is necessary where pits are to be extended greater than 1.2mbgl and deep excavations may take a considerable time to undertake. Detailed records of hand excavated pits are only normally recorded where foundation depths and detailed information is required.

**TRIAL PIT SOAKAWAY TESTING**

Soakaway tests are undertaken in machine excavated trial pits to determine the infiltration rate of the soils on a site in accordance with BRE Digest 365, “Soakaway design”. The trial pit is excavated using a mechanical excavator and vertical sides are trimmed square and accurate measurements of the pit dimensions are made. In granular soils the pit is backfilled with coarse single size gravel to the top of the natural soils to prevent collapse of pit sides upon filling with water. Where granular fill is used a temporary perforated monitoring well is installed over the depth of the trial pit prior to backfilling. This allows monitoring of the water level by an electronic dip-meter or pressure transducer. In cohesive soils, granular fill may not be required, and a monitoring installation is replaced by a fixed datum bar placed across one end of the pit. The water level is monitored using a tape or dip-meter. The pit is rapidly filled with water from a bowser / tanker to fill the pit to its maximum effective depth in a short time. Care is taken to prevent the collapse of pit walls. The pit is filled and allowed to drain three times to 25% full where ground conditions and time constraints allow. The water level is recorded at intervals sufficiently close to define water level versus time. The three fillings should be on the same or consecutive days. The soil infiltration rate (f) is calculated from the time taken for the water level to fall from 75% to 25% effective storage depth in the pit, using the lowest f value the three tests for design.

**IN-SITU CBR TESTS**

The California Bearing Ratio (CBR) test was originally conceived as a laboratory test to measure the strength of subgrade materials for pavement design purposes. The in-situ variation of the test is now widely used for assessment of the subgrade and is carried out in accordance with BS 1377: Part 9: 1990. The test set up consists of a manually operated gearbox mounted onto a stable platform (usually a 4x4 vehicle or backhoe excavator). A load ring is attached beneath the gearbox, along with a strain gauge and various extension rods with a solid plunger on the end. The gearbox is manually operated to force the plunger into the ground at a constant rate, the resultant stress is recorded by the load ring and the movement of the plunger is measured by the strain gauge acting upon a datum bar placed across the test area. The results are presented in the appendix of the report on the relevant record.

**PLATE BEARING TESTS**

The plate bearing test is carried out in accordance with BS 1377: Part 9: 1990. This method covers the determination of the vertical deformation and strength characteristics of soil in-situ by assessing the force and amount of penetration with time when a rigid plate is made to penetrate the soil. The test is used to evaluate the load deformation characteristics of the soil beneath the plate without entailing the effects of sample disturbance. The method may be carried out at the ground surface, in pits, trenches or adits and at the bottom of a borehole. Kentledge is usually a tracked excavator or loaded dumper.

Results may be used to directly assess settlements in equivalent foundations although size and depth differences may preclude such use. Results may also be used to assess plate modulus of elasticity ($E_{PLT}$) and the coefficient of sub-grade reaction ($K_s$), both in accordance with BS EN 1997-2:2007. Estimated CBR vales may also be derived in accordance with equation 2.4 provided in DRMB CD225, revision 1.

**TRL DYNAMIC CONE PENETROMETER TEST (TRL DCP)**

The TRL (Transport Research Laboratory) Dynamic Cone Penetrometer is an instrument designed for the rapid in-situ measurement of the structural properties of existing road pavements constructed with unbound materials. Continuous measurements are made down to a depth of 850mm, or when extension rods are use, the subgrade strata beneath can be penetrated to a depth of 2 metres. These measurements are converted to CBR values and Layer Stiffness Modulus. Where pavement layers have different strengths, the boundaries can be identified and the thickness of the layers determined, similarly with the strata beneath.

The TRL DCP uses an 8kg hammer dropping through a height of 575mm and a 60° cone having a maximum diameter of 20mm. (this punches a clearance hole to ensure there is no friction on the rods.) The instrument is held vertically, and the hammer raised to the top of the instrument and allowed to fall freely. The resulting penetration of the rod is measured, and the number of blows recorded for a penetration of about 10mm (the number of blows carried out per reading of penetration can be varied to suit the strength of the layer). After the DCP is carefully withdrawn by hand cones shall be checked by measurement regularly to check the wear and replaced when necessary. From DRMB CS229, “Data for pavement assessment” equation 6.39.3, a calculation is then applied to the mm/blow to calculate the CBR value using the following relationship with was developed by the Transport Research Laboratory

$$\mathbf{CBR = 10^{(2.48-1.057 \times Log10P)}}$$

where:

P is the penetration rate in mm per blow.

The following equation has been used (after Powell et al. 1984 and included in DMRB CD225, “Design for new pavement foundations” revision 1) to give an estimated value of Stiffness Modulus E, acknowledging a degree of uncertainty:

$$\mathbf{E = 17.6(CBR)^{0.64}\ MPa}$$

**LIGHT WEIGHT DEFLECTOMETER TESTING**

The Light Weight Deflectometer (LWD) apparatus is used to provide in-situ measurement of the foundation surface modulus (E) of the subgrade for use in pavement design. The test method is set out in BS 1924-2:2018, 9.2 “Hydraulically bound and stabilised

materials for civil engineering purposes, Part 2, Sample preparation and testing of materials during and after treatment" but is also referenced in ASTM Standard E2583-07: 2011 "Standard test method for measuring deflections with a light weight deflectometer (LWD)".

The standard test equipment comprises a 300mm diameter plate which is dynamically loaded through a buffer system to produce a load pulse of 15ms to 30ms duration using a 10kg weight falling from a variable height (generally less than 1m) to impart a target stress in the order of 100kN/$m^2$ (100+/-5 kN/$m^2$). The actual stress imparted is measured by a load cell within the equipment and the resulting deflection is measured by a geophone in the centre of the plate to a precision of +/-2μm.

Load and deflection data are recorded and transferred via bluetooth to a smart phone device that stores the data and allows calculation of the foundation surface modulus. Data can be uploaded in the field from the smart phone via the internet. The results from the LWD can also be converted to estimated CBR values in accordance with equation 2.4 given in DMRB document CD225 revision 1, "Design for new pavement foundations"

$$\mathbf{E = 17.6\ (CBR)^{0.64}\ MPa}$$

# DATASHEET: GENERAL RISK ASSESSMENT METHODOLOGY

The pollutant links and initial conceptual ground model provide a potential 'source-pathway-receptor' analysis for the site based on the information presented in the report. Qualitative risk assessment allows for a consideration of the relative risk or hazard due to each potential linkage. Risk assessment is an iterative process, and as such must start at a general level, gradually becoming more specific as more cycles are performed based on better information.

An initial estimation of risk can be undertaken using the methodology set out in CIRIA 552 (2001), "Contaminated land risk assessment. A guide to good practice". This involves classification of the magnitude of the potential consequence (severity) of risk occurring (Table D1) and magnitude of the probability (likelihood) of the risk occurring (Table D2). These are then used to produce a risk category (Table D3).

| Classification | Definition | Examples |
|---|---|---|
| **Severe** | Short-terms (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-terms risk to a particular ecosystem or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000). | High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied). |
| **Medium** | Chronic damage to human health ("significant harm" as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000). | Concentrations of a contaminant from site exceed the generic or site-specific assessment criteria. Leaching of contaminants from a site to a Principal or Secondary Aquifer. Death of a species within a designated nature reserve. |
| **Mild** | Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ("significant harm" as defined in the *Draft Circular on Contaminated Land*, DETR, 2000). Damage to sensitive buildings/structures/ services or the environment. | Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability). |
| **Minor** | Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Easily repairable effects of damage to buildings, structures and services. | The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete. |

**Table D1 Classification of Consequence**

| Classification | Definition |
|---|---|
| **High Likelihood** | There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution. |
| **Likely** | There is a pollution linkage, and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term. |
| **Low Likelihood** | There is a pollution linkage, and circumstances are possible, under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term. |
| **Unlikely** | There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the long term. |

**Table D2 Classification of Probability**

| | | 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 | Very low risk |
| | **Unlikely** | Moderate/low risk | Low risk | Very low risk | Very low risk |

**Table D3 Definition of Risk (Comparison of Consequence Against Probability)**

## DATASHEET: GENERAL RISK ASSESSMENT METHODOLOGY (CONT.)

| | |
|---|---|
| **Very High Risk** | There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised is likely to result in a substantial liability.<br>Urgent investigation (if not undertaken already) and remediation are likely to be required. |
| **High Risk** | Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability.<br>Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely to be necessary over the longer term. |
| **Moderate Risk** | It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.<br>Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term. |
| **Low Risk** | It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild. |
| **Very Low Risk** | There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe. |

**Table D4 Description of the Classified Risks and Likely Action Required**

The process described above represents the general qualitative risk assessment methodology used by Harrison Group Environmental in the context of the report in which it was represented and may not necessarily be transferable to all situations.

# DATASHEET: GROUNDWATER SCREENING VALUES

Appropriate water quality standards and screening thresholds were selected in order to assess existing groundwater quality using selected indicator contaminants. Specifically, the groundwater screening values were selected from the following published limits and guideline values:

**EA, 2016, FRESH WATERS SPECIFIC POLLUTANTS AND OPERATIONAL ENVIRONMENTAL QUALITY STANDARDS (EQS)1**

The EA has compiled applicable Environmental Quality Standards (EQS) for the assessment of surface water discharges from the following key sources:

- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
- The Groundwater (Water Framework Directive) (England), Direction 2016

The following EQS values are presented:

- EQS-AA - This is the Annual Average standard, sometimes referred to as the long-term standard. Releases for assessment against this standard are often called 'long-term' releases.
- EQS-MAC -This is the 'Maximum Allowable Concentration', sometimes referred to as the short-term standard. It is normally represented as a 95-percentile concentration over a year. Releases for assessment against this standard are often called 'short-term' releases.

**THE WATER FRAMEWORK DIRECTIVE (STANDARDS AND CLASSIFICATION) DIRECTIONS (ENGLAND AND WALES) 2015. THE WATER FRAMEWORK DIRECTIVE (WFD) (2000/60/EC).**

As part of the WFD implementation, 90$^{th}$ percentile standards are included for biochemical oxygen demand (BOD) and total ammonia, defining the water quality (high, good, moderate, poor) associated with different pollutant levels[2]. These are summarised in table 1 below:

| Type of standard | Total ammonia (mg $NH_4$-N/l) | BOD (mg/l) |
|---|---|---|
| High | 0.3 | 4 |
| Good | 0.6 | 5 |
| Moderate | 1.1 | 6.5 |
| Poor | 2.5 | 9 |

**Table 1 WFD 90th percentile Standards for Ammonia and BOD in Rivers**

**SOCIETY OF BROWNFIELD RISK ASSESSMENT (SoBRA), 2017, DEVELOPMENT OF GENERIC ASSESSMENT CRITERIA FOR ASSESSING VAPOUR RISKS TO HUMAN HEALTH FROM VOLATILE CONTAMINANTS IN GROUNDWATER. VERSION 1.0**

SoBRA has published a selected list of generic assessment criteria ($GAC_{gwvap}$) aiming to aid in the assessment of vapour risk arising from volatile contaminants in groundwater in the UK. The $GAC_{gwvap}$ are intended as a conservative screening tool that may be used to aid in assessing long-term risks to human health from inhalation of vapours arising from contaminant-impacted groundwaters and accumulating in an indoor space.

The $GAC_{gwvap}$ have been developed in line with UK risk assessment guidance (e.g., DEFRA and Environment Agency. They have been derived for two land use scenarios (residential and commercial) using generic assumptions regarding site setting, soil types, building construction, and receptor behaviour, though $GAC_{gwvap}$ parameter values are considered to be precautionary for the vast majority of commercial and residential properties.

**DRINKING WATER STANDARDS**

Since the bedrock aquifer at the site is classified as a 'Principal Aquifer', drinking water standards for the protection of public health were also included as part of the screening values. The values were selected according to the following hierarchy of source references:

- Schedule 1 - The Water Supply (Water Quality) Regulations 2016 (Drinking Water Standards)
- World Health Organization, 2011, Guidelines for drinking-water quality, fourth edition

**Petroleum Hydrocarbons**

There are no EQS or UK Drinking Water Standards for Total Petroleum Hydrocarbons (TPH) or aggregated TPH Fractions. EQS values have been published for individual constituent compounds (benzene, toluene, ethylbenzene) and PAH compounds; these have been compiled from the sources reviewed above. Recent guidance regarding the selection of groundwater screening values for TPH fractions has been provided in the following:

- CL:AIRE, 2017. Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies. CL:AIRE, London. ISBN 978-1-905046-31-7[3].

Table 2 summarises the fraction specific ground water quality standards reviewed in the CL:AIRE report (WHO Drinking Water Quality Guidelines, 2008)[4], which have been applied for reported TPH fractions. It is noted that the fractions analysed in this study do not

1 https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit
[2] 90$^{th}$ percentile standards are standards require derivation of the 90th percentile for the monitored concentrations over a minimum of 8 quarterly sampling rounds over a 2 year period.
[3] Download at www.claire.co.uk/phg.
[4] World Health Organization (WHO), 2008. Petroleum products in drinking-water. Background document for development of WHO guidelines for drinking water quality. WHO/SDE/WSH/05.08/123.

exactly correspond to the published fractions. In that case, the lowest value for a published fraction included within the analysed range was used.

| TPH Fraction | Aliphatic fraction (µg/l) | Aromatic fraction (µg/l) |
|---|---|---|
| EC>5-EC6 | 15000 | 10 (benzene) |
| EC>6-EC8 | 15000 | 700 (toluene) |
| EC>8-EC10 | 300 | 300 (ethylbenzene), 500 (xylenes) |
| EC>10-EC12 | 300 | 90 |
| EC>12-EC16 | 300 | 90 |
| EC>16-EC21 | - | 90 |
| EC>21-EC35 | - | 90 |

**Table 2 Recommended Groundwater Screening Values based on WHO Drinking Water Guidelines**

# APPENDIX C
# FIELDWORK RECORDS/DATA

harrisongroup ENVIRONMENTAL

# Cable Percussive Borehole Record

**CP01**

Sheet 1 of 3

| | | | |
|---|---|---|---|
| Project ID: **GC25457** | Client: Urban & Civic Alconbury Ltd | E: 522942.98 | N: 275063.50 |
| Location: Grange Farm, Alconbury Weald | Consultant: | Date: 02/01/2024 - 03/01/2024 | |
| | Plant used: Dando 2000 | SPT Hammer Serial No: SI2 (ER: 67%) | |

| Geology Description | Depth (m) | Elevation (maOD) 39.59 | Sample / In-Situ Test Information: Type | Depth | Results / Remarks | Date - Depth (m) Casing (Water) | Installation & Backfill |
|---|---|---|---|---|---|---|---|
| TOPSOIL. Soft dark brown slightly gravelly silty CLAY. Gravel is sub-angular to rounded fine to medium flint and chalk. Abundant rootlets present. [TOPSOIL] | | | D1 | 0.20 | | | |
| | 0.40 | 39.19 | B1 | 0.40 - 1.00 | | | |
| Soft to firm brown and greyish brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular to rounded fine to coarse chalk with rare flint. [OADBY MEMBER - DIAMICTON] | | | SPT(S) | 1.20 | N=11 (2,2/2,3,3,3) | 1.10 (Dry) | |
| | | | D2 | 1.20 | | | |
| | | | D3 | 1.20 - 1.65 | | | |
| | 2.00 | 37.59 | UT1 | 2.00 - 2.45 | Blows = 72. 100% recovered. | | |
| Firm greyish brown slightly sandy slightly gravelly silty CLAY with low cobble content. Gravel is sub-angular to rounded fine to medium chalk. Cobbles are chalk and flint. [OADBY MEMBER - DIAMICTON] *From 2.50m: Becoming stiff.* | | | D4 | 2.50 | | | |
| | | | SPT(S) | 3.00 | N=13 (2,3/3,3,3,4) | 1.10 (Dry) | |
| | | | D5 | 3.00 - 3.45 | | | |
| | | | UT2 | 4.00 - 4.45 | Blows = 75. 80% recovered. | | |
| | | | D6 | 4.50 | | | |
| | | | SPT(S) | 5.00 | N=15 (3,4/3,3,4,5) | 1.10 (Dry) | |
| | | | D7 | 5.00 - 5.45 | | | |
| | | | UT3 | 6.50 - 6.95 | Blows = 100. 100% recovered. | | |
| *From 7.00m: Becoming stiff and grey. Flint gravel no longer present.* | | | D8 | 7.00 | | | |
| | | | SPT(S) | 8.00 | N=24 (4,4/5,5,6,8) | 1.10 (Dry) | |
| | | | D9 | 8.00 - 8.45 | | | |
| | | | UT4 | 9.50 - 9.95 | Blows = 100. 90% recovered. | | |
| | | | D10 | 10.00 | | | |

| Chiselling Details | | Water Added Records | | Water Strike | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depths (m) | Duration (hh:mm) | Depths (m) | Litres | Date | Strike Depth (m) | Depth Sealed (m) | Casing Depth (m) | Time Elapsed (mins) | Standing Level (m) | Remarks |
| | | | | | | | | | | No groundwater encountered |

| Hole Diameter by Depth | | Casing Diameter by Depth | |
|---|---|---|---|
| Depth (m) | Diameter (mm) | Depth (m) | Diameter (mm) |
| 20.00 | 150 | 1.10 | 150 |

Remarks:

1. Inspection pit from GL to 1.20m.
2. Installation: 50mm standpipe fitted with gas tap, bung and top hat cover, GL to 1.00m plain, 1.00m to 5.00m slotted.
3. Backfill: GL to 1.00m bentonite, 1.00m to 5.00m gravel, 5.00m to 20.00m arisings.


Norwich Office: 01603 613111
London Office: 020 7537 9233
Cambridge Office: 01223 781585
Colchester Office: 01206 986675
Testing Services: 01603 416333
E-mail: info@harrisongroupuk.com
Website: www.harrisongroupuk.com


AGS

| Drilled by: | Logged by: | Checked by: | |
|---|---|---|---|
| T Hobdell | IH | IH | Fm-Hn-R-3067-Rev H |

# Cable Percussive Borehole Record

**CP01** | Sheet 2 of 3

| | | | |
|---|---|---|---|
| Project ID: **GC25457** | Client: Urban & Civic Alconbury Ltd | E: 522942.98 | N: 275063.50 |
| Location: Grange Farm, Alconbury Weald | Consultant: | Date: 02/01/2024 - 03/01/2024 | |
| | Plant used: Dando 2000 | SPT Hammer Serial No: SI2 (ER: 67%) | |

| Geology Description | Legend | Depth (m) | Elevation (maOD) 39.59 | Sample / In-Situ Test Information: Type | Depth | Results / Remarks | Date - Depth (m) Casing (Water) | Installation & Backfill |
|---|---|---|---|---|---|---|---|---|
| Firm greyish brown slightly sandy slightly gravelly silty CLAY with low cobble content. Gravel is sub-angular to rounded fine to medium chalk. Cobbles are chalk and flint. [OADBY MEMBER - DIAMICTON] | | | | SPT(S) | 11.00 | N=29 (5,5/5,7,8,9) | 1.10 (Dry) | |
| | | | | D11 | 11.00 - 11.45 | | | |
| *From 12.50m: Becoming very stiff with rare gravel of fine mudstone.* | | | | UT5 | 12.50 - 12.95 | Blows = 100. 100% recovered. | | |
| | | | | D12 | 13.00 | | | |
| | | | | SPT(S) | 14.00 | N=39 (5,6/6,8,11,14) | 1.10 (Dry) | |
| | | | | D13 | 14.00 - 14.45 | | | |
| | | | | | | | 02/01/2024 - 14.45 1.10 (Dry) 03/01/2024 - 14.45 1.10 (Dry) | |
| *From 15.00m: Cobbles of chalk no longer present.* | | | | UT6 | 15.50 - 15.95 | Blows = 100. 60% recovered. | | |
| | | | | D14 | 16.00 | | | |
| | | | | SPT(S) | 17.00 | 50 (5,7/8,11,14,17 for 67mm) | 1.10 (Dry) | |
| | | | | D15 | 17.00 - 17.45 | | | |
| | | | | D16 | 18.00 | | | |
| | | | | UT7 | 18.50 - 18.95 | Blows = 100. 100% recovered. | | |
| | | | | SPT(S) | 20.00 | 48 (7,9/14,19,15 for 20mm) | 1.10 (Dry) | |
| | | | | D17 | 20.00 - 20.32 | | | |

| Chiselling Details | | Water Added Records | | Water Strike | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depths (m) | Duration (hh:mm) | Depths (m) | Litres | Date | Strike Depth (m) | Depth Sealed (m) | Casing Depth (m) | Time Elapsed (mins) | Standing Level (m) | Remarks |
| | | | | | | | | | | No groundwater encountered |

| Hole Diameter by Depth | | Casing Diameter by Depth | |
|---|---|---|---|
| Depth (m) | Diameter (mm) | Depth (m) | Diameter (mm) |
| 20.00 | 150 | 1.10 | 150 |

Remarks:

1. Inspection pit from GL to 1.20m.
2. Installation: 50mm standpipe fitted with gas tap, bung and top hat cover, GL to 1.00m plain, 1.00m to 5.00m slotted.
3. Backfill: GL to 1.00m bentonite, 1.00m to 5.00m gravel, 5.00m to 20.00m arisings.


Norwich Office: 01603 613111
London Office: 020 7537 9233
Cambridge Office: 01223 781585
Colchester Office: 01206 986675
Testing Services: 01603 416333
E-mail: info@harrisongroupuk.com
Website: www.harrisongroupuk.com


AGS

Drilled by: T Hobdell | Logged by: IH | Checked by: IH

# Cable Percussive Borehole Record

**CP01** | Sheet 3 of 3

| | | | |
|---|---|---|---|
| Project ID: **GC25457** | Client: Urban & Civic Alconbury Ltd | E: 522942.98 | N: 275063.50 |
| Location: Grange Farm, Alconbury Weald | Consultant: | Date: 02/01/2024 - 03/01/2024 | |
| | Plant used: Dando 2000 | SPT Hammer Serial No: SI2 (ER: 67%) | |

| Geology Description | Legend | Depth (m) | Elevation (maOD) 39.59 | Sample / In-Situ Test Information: Type | Depth | Results / Remarks | Date - Depth (m) Casing (Water) | Installation & Backfill |
|---|---|---|---|---|---|---|---|---|
| Firm greyish brown slightly sandy slightly gravelly silty CLAY with low cobble content. Gravel is sub-angular to rounded fine to medium chalk. Cobbles are chalk and flint. [OADBY MEMBER - DIAMICTON] | | 20.32 | 19.27 | | | | 03/01/2024 - 20.00 1.10 (Dry) | |
| Borehole completed at 20.32m. | | | | | | | | |

| Chiselling Details | | Water Added Records | | Water Strike | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depths (m) | Duration (hh:mm) | Depths (m) | Litres | Date | Strike Depth (m) | Depth Sealed (m) | Casing Depth (m) | Time Elapsed (mins) | Standing Level (m) | Remarks |
| | | | | | | | | | | No groundwater encountered |

| Hole Diameter by Depth | | Casing Diameter by Depth | |
|---|---|---|---|
| Depth (m) | Diameter (mm) | Depth (m) | Diameter (mm) |
| 20.00 | 150 | 1.10 | 150 |

Remarks:

1. Inspection pit from GL to 1.20m.
2. Installation: 50mm standpipe fitted with gas tap, bung and top hat cover, GL to 1.00m plain, 1.00m to 5.00m slotted.
3. Backfill: GL to 1.00m bentonite, 1.00m to 5.00m gravel, 5.00m to 20.00m arisings.


Norwich Office: 01603 613111
London Office: 020 7537 9233
Cambridge Office: 01223 781585
Colchester Office: 01206 986675
Testing Services: 01603 416333
E-mail: info@harrisongroupuk.com
Website: www.harrisongroupuk.com


AGS

Drilled by: T Hobdell | Logged by: IH | Checked by: IH