# Beal Station, Berwick

## Geo-Environmental Ground Investigation Report

For: Defra Group Property

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# REVISIONS

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| First Issue | 2nd September 2022 | [redacted]<br>Alfie Leach | [redacted]<br>Andrew Edwards | |
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# APPENDICES

# 1.0 INTRODUCTION

This Geo-Environmental Ground Investigation report has been prepared at the request of Defra Group Property. Instructions to proceed were received in July 2022.

The c. 0.25 Ha rectangular site is located off Holy Island Road on the south-eastern outskirts of Wheldrake village, approximately 12.1km south-east of Berwick-upon-Tweed city centre at the approximate postcode TD15 2PB. The National Ordnance Survey (OS) grid reference for the centre of the site is 406183E, 642635N.

The site currently consists of a yard with associated non-residential hardstanding and grassed area. The site is bordered by fields to the south and east, railway tracks to the east and Holy Island Road to the west. Access to the site is off Holy Island Road along the northern site boundary. An aerial image of the site is included below, and a Site Location Plan (SI-01) is contained in Appendix 2.

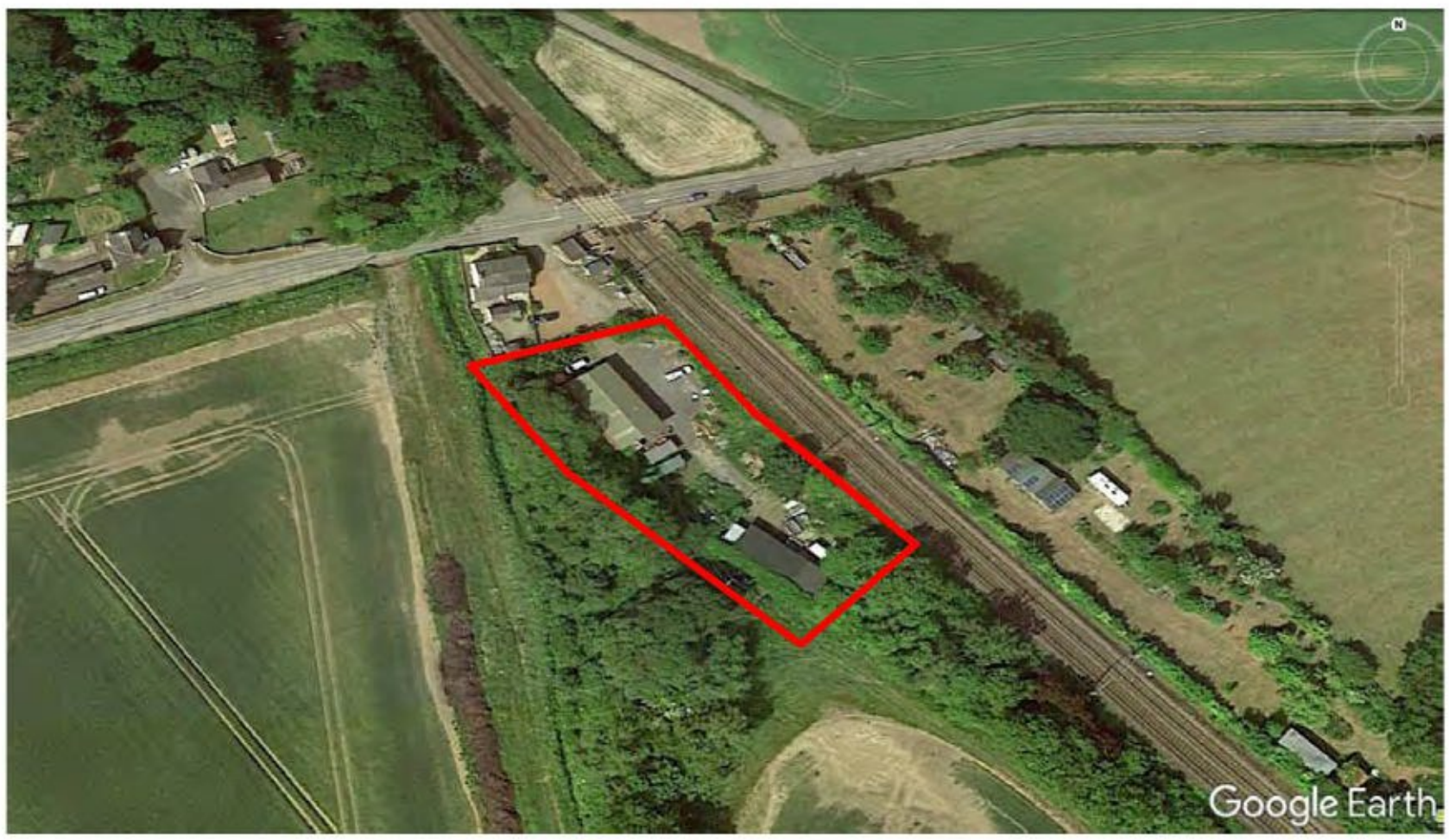



*Figure 1: Aerial image of the site dated January 2018. The approximate site boundary is highlighted in red.*

This Geo-Environmental Ground Investigation Report is to be used for submission to the Local Authority as part of a planning application for the redevelopment of the site. IGE have not been provided with technical details of the redevelopment, though it is understood to be a research unit with student accommodation on the upper floor.

## 1.1 Brief

The brief was to carry out an intrusive geo-environmental ground investigation for the site based upon the proposed development outlined in Section 1.0. The investigation was to include the following tasks:

a) Undertake appropriate exploratory holes and collect representative samples from exploratory holes and arrange appropriate chemical testing in accordance with the latest legal framework, record olfactory and / or visual evidence of contamination during intrusive works and undertake on site in-situ and laboratory geotechnical testing;

b) Formulate conceptual models to accommodate the findings of the ground investigation works in terms of the risk to human health, ground gas, controlled waters and the wider environment;

c) Identify the risks and evaluate whether a Phase 3 numerical risk assessment and/or a Remedial Strategy, is required;

d) Undertake an assessment of the ground conditions findings to provide initial recommendations for the proposed foundations or further works.

A report was to be provided to summarise the findings and recommendations.

## 1.2 Third Parties

## 2.0 SCOPE OF INVESTIGATION WORK

This geo-environmental ground investigation has been designed based on the Client's requirements in relation to the proposed development outlined in Section 1.0.

The ground investigation works were undertaken on the 27th July 2022 and comprised 3 No. dynamic sampling boreholes with carry on dynamic probing. Subsequent chemical and geotechnical laboratory testing was undertaken between 28th July – 30th August 2022.

Before ground investigation took place, the site was appraised for the likelihood of unexploded ordnance (UXO). The map for the site, obtained from Zetica, indicated that there is a low risk of UXO at the site. The Zetica map is contained in Appendix 4.

Drilling of dynamic sampling boreholes was carried out by RD Drilling Ltd. Testing of soil samples for environmental and geotechnical purposes was carried out by i2 Analytical in accordance with the Environment Agency's MCERTS (Monitoring Certification) quality assurance accreditation scheme. These organisations were appointed directly by IGE Consulting to carry out these contracting works.

The locations of the exploratory holes were topographically surveyed (X-Y-Z axis) with an accuracy of 20mm.

The ground investigation was undertaken in general accordance with:

- BS 5930 (2015) + A1 (2020) Code of Practice for Ground Investigation;
- BS 1377 (1990) Methods of test for Soils for Civil Engineering Purposes;
- BS 10175 (2011) Investigation of Potentially Contaminated Sites – Code of Practice; and
- BS EN 1997-2 (2007) Eurocode 7 – Geotechnical Design – Ground Investigation and Testing.

The sampling strategy for the site has been completed in accordance with CLR4 and the design of the investigation was carried out in accordance with R&D Technical

Report P 5-TR066, LCRM (2020) and BS:8485 (2015) + A1 (2019). Further details pertaining to the ground investigation works are outlined in the following sections.

The limitations of the investigation work and report are included in Appendix 1.

## 2.1 Dynamic sampling boreholes

In total 3 No. dynamic sampling boreholes were undertaken in the vicinity of the proposed development in the northern site section to depths of 5.00m – 6.00m bgl (0.54m – -0.62m AOD).

Dynamic Sample Boreholes were undertaken to achieve the following:

- to establish the thickness, extent and characteristics of any possible Made Ground and underlying natural superficial deposits;
- to undertake in-situ geotechnical testing within these deposits;
- to obtain samples from these deposits for classification and laboratory testing.

The locations of the dynamic sampling boreholes are shown on the Exploratory Hole Location Plan (SI-02) in Appendix 2 and the dynamic sampling borehole logs are contained in Appendix 5.

## 2.2 Dynamic Probe Holes

In total, 3 No. dynamic probe holes were undertaken following on at the base of dynamic sample boreholes to a depth of 11.50m – 12.20m bgl (-6.12m - -6.66m AOD) to determine the density of the underlying ground conditions and obtain equivalent SPT N-values.

Dynamic probe hole logs are contained in Appendix 6 and the locations of the dynamic probe holes are shown on the exploratory hole location plan in Appendix 2.

## 2.3 Site Testing and Sampling

The following site tests and sampling were carried out:

a) Retrieval of environmental samples and bulk disturbed samples from dynamic sampling sleeves for the purposes of chemical and geotechnical laboratory testing and classification.
b) Where possible, in-situ and ex-situ shear strength testing was undertaken within cohesive / fine grained material (clay) from the dynamic sampling borehole sleeve samples using a hand shear vane (HSV) 19mm and 33mm vane in accordance with BS1377-9.
c) Standard Penetration Tests (SPTs) were undertaken at regular 1.00m intervals between 1.00m and 5.45m bgl within the dynamic sampling boreholes.

## 2.4 Laboratory Testing

### 2.4.1 Chemical Laboratory Testing

4 No. soil samples were obtained during exploratory hole construction and sent to i2 Analytical laboratories for chemical testing. These samples were placed into sterile sealed containers to facilitate MCERTS chemical laboratory testing of potential contaminants. Chemical testing suites were based upon a wide range of possible contaminative sources, outlined below:

*Asbestos ID, sulphate, pH, nitrate, total and free cyanide, arsenic, barium, beryllium, boron, cadmium, chromium, chromium (hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc, Total Petroleum Hydrocarbon screen and Speciated Polyaromatic Hydrocarbons*.

### 2.4.2 Geotechnical Laboratory Testing

The following geotechnical laboratory tests were carried out on selected samples obtained from across the site:

a) Determination of moisture content, liquid limit and plastic limit in accordance with BS1377 Part 2, Methods 3.2, 4.4 and 5.0 (1990).

b) Determination of particle size analysis by dry / wet sieving in accordance with BS1377 Part 2, Method 9.2 (1990).

c) Sedimentation analysis by hydrometer method in accordance with BS1377-2 (1990), Methods 9.2 and 9.5.

d) BRE Special Digest Suite for aggressive ground conditions.

# 3.0 FINDINGS

## 3.1 Visual and Olfactory Contamination Findings

During the intrusive exploratory hole investigation works, the soils were examined carefully for both visual and olfactory evidence of contamination. No visual and / or olfactory evidence of contamination was encountered during the ground investigation.

## 3.2 Ground Conditions

The typical ground conditions encountered across the site are as follows:

- TOPSOIL comprising brown, fine **SAND** with frequent rootlets and grass to a depth of 0.03m – 0.05m bgl (5.51m – 5.33m AOD), underlain by;
- MADE GROUND comprising brown, slightly clayey, sandy **GRAVEL**, gravelly **SAND**, and firm gravelly, sandy **CLAY** to a depth of 1.35m – 2.00m bgl (4.19m – 3.38m AOD), underlain by;
- ALLUVIUM comprising soft to firm, greyish brown, slightly sandy, silty **CLAY** to a depth of 2.30m – 3.20m bgl (3.24m - 2.22m AOD), underlain by;
- ALLUVIUM comprising very soft to soft, dark greyish brown, slightly sandy, clayey **SILT** terminating between 5.00m – 6.00m bgl (0.54m – -0.64m AOD).

Ground conditions below 6.00m bgl unknown due to no sample recovery in dynamic probing method.

### 3.2.1 Obstructions

Cobble sets and bricks were encountered in dynamic sample borehole hand dug pits within the Made Ground near the surface. No other obstructions were encountered on-site during ground investigation works.

## 3.3 Water Strikes

No water strikes were recorded within strata representative of the Made Ground and Alluvium. For further details please refer to the dynamic sampling borehole logs in Appendix 5.

## 3.4 Geotechnical Site Testing

The results of the in-situ site tests undertaken during the ground investigation are summarised below.

### 3.4.1 Standard Penetration Tests

13 No. Standard Penetration Tests (SPT) were undertaken at regular 1.00m intervals during the construction of the dynamic sampling boreholes. The following table outlines the uncorrected N-values and corrected $N_{60}$ (energy ratio of 76%), derived from the standard penetration tests (SPT) undertaken in the Made Ground and Alluvium strata during the ground investigation works:

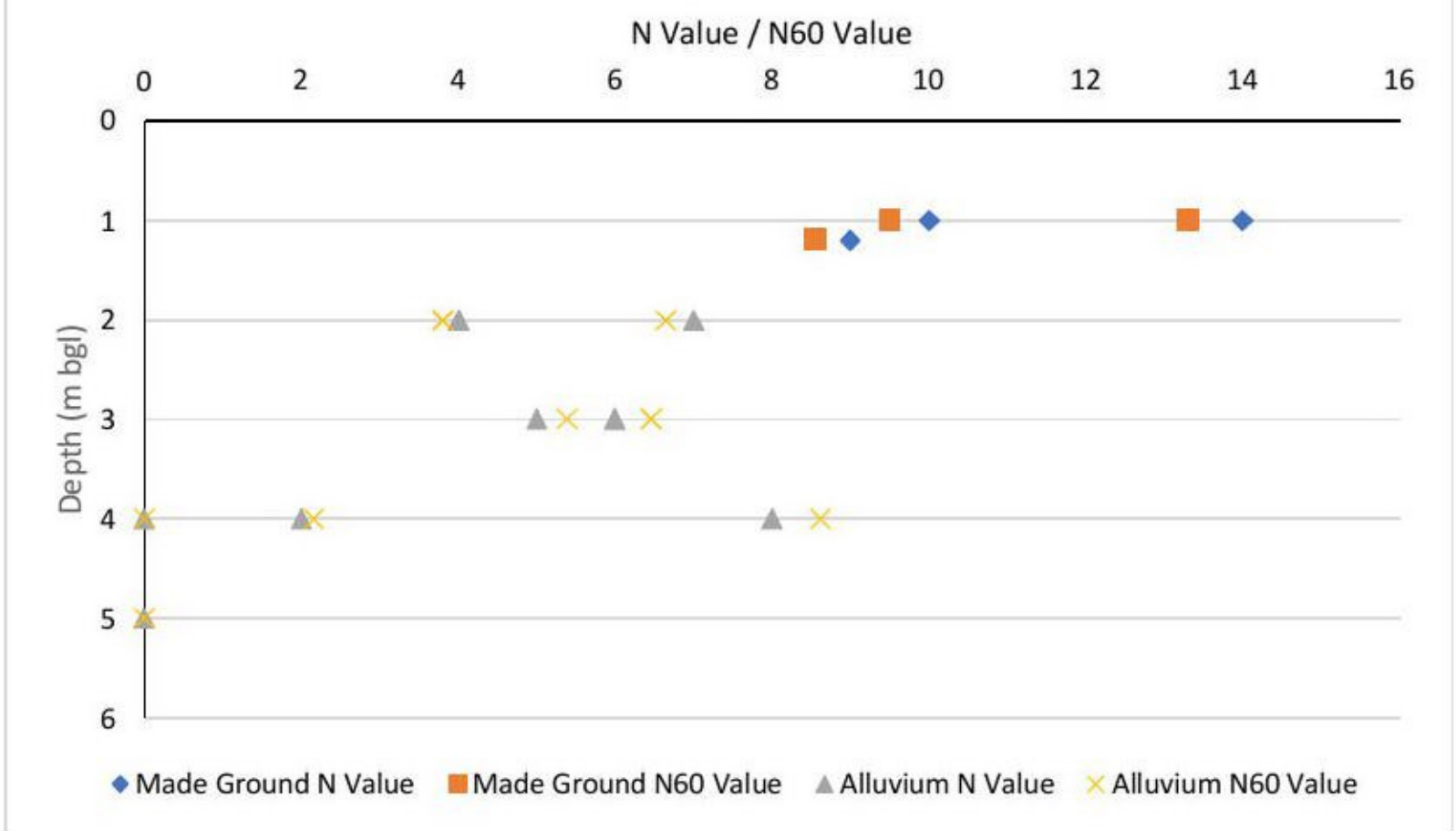
| Deposit Type | Depth Range of Test Start Depths m bgl (m AOD) | Number of Tests | Uncorrected N-value Range | Uncorrected N-value Average | Corrected $N_{60}$ Range | Corrected $N_{60}$ Average |
|---|---|---|---|---|---|---|
| MADE GROUND | 1.00 – 1.20 (4.54 – 4.18) | 3 | 9 - 14 | 11 | 9 - 13 | 11 |
| ALLUVIUM | 2.00 – 5.00 (3.54 – 0.38) | 10 | 0 - 8 | 4 | 0 - 9 | 4 |

It should be noted that a number of SPT tests and sampling barrel sunk under their own weight during hole construction, these are summarised below:

| Hole | Depth (m bgl) | SPT Rods / Barrel | Self Weight Penetration (mm) |
|---|---|---|---|
| DS01 | 4.00m | SPT Rods | 500 |
| DS01 | 5.00m | SPT Rods | 700 |
| DS02 | 4.00m | SPT Rods | 300 |
| DS02 | 4.00m | Sampling Barrel | 500 |
| DS03 | 4.00 | Sampling Barrel | 500 |

The following scatter graph shows that there is a negative correlation between uncorrected N-value / corrected $N_{60}$ and depth within the dynamic sample boreholes. This is indicative of the strata encountered with dense / cobbly Made Ground encountered at surface, underlain by firm clays, underlain by soft to very soft silts.

Given the very low SPT N values at the base of the dynamic sample boreholes, dynamic probe holes were undertaken to provide continuous density data at a greater depth.



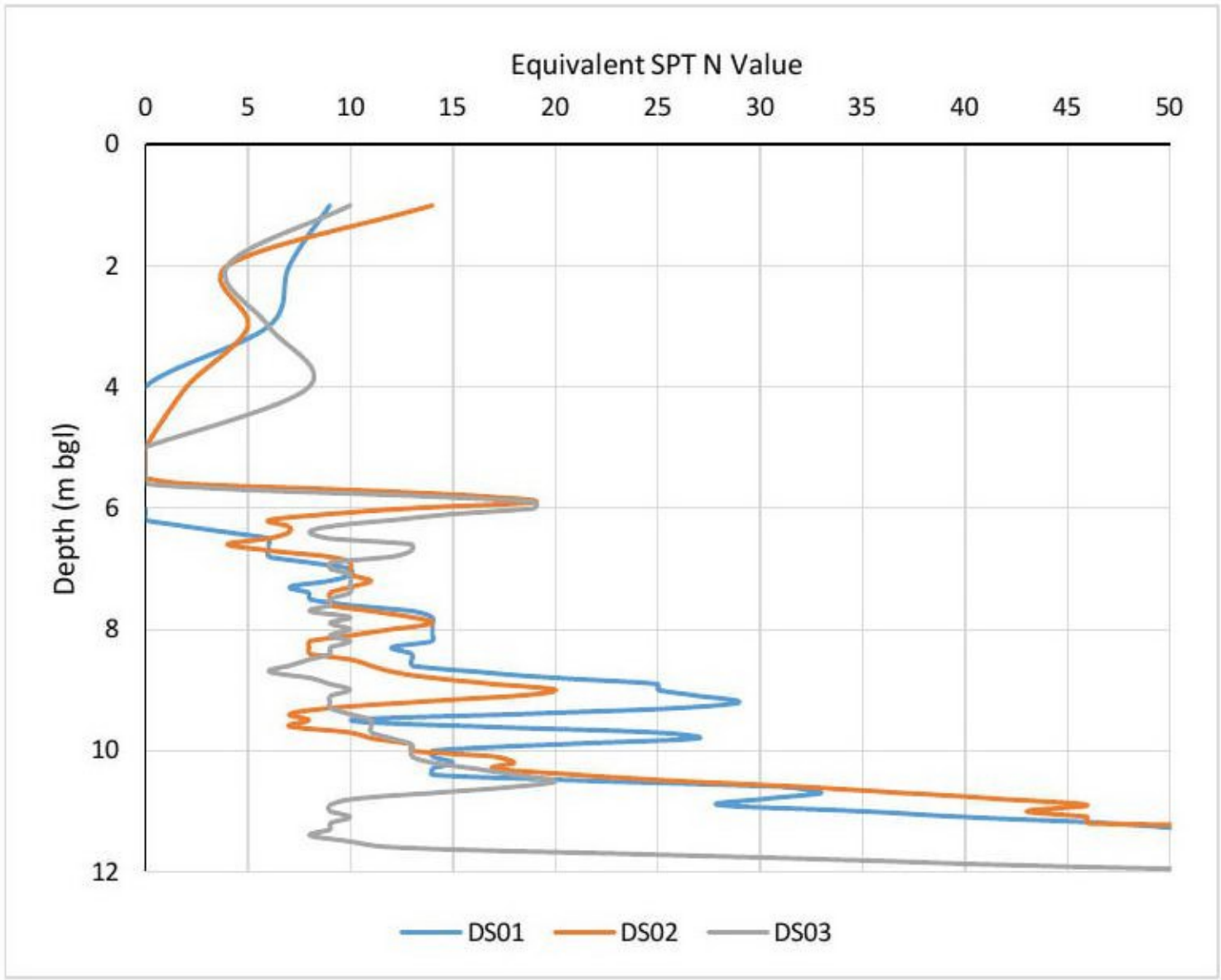
For detailed, specific information pertaining to the SPTs undertaken, refer to the dynamic sampling borehole logs contained within Appendix 5.

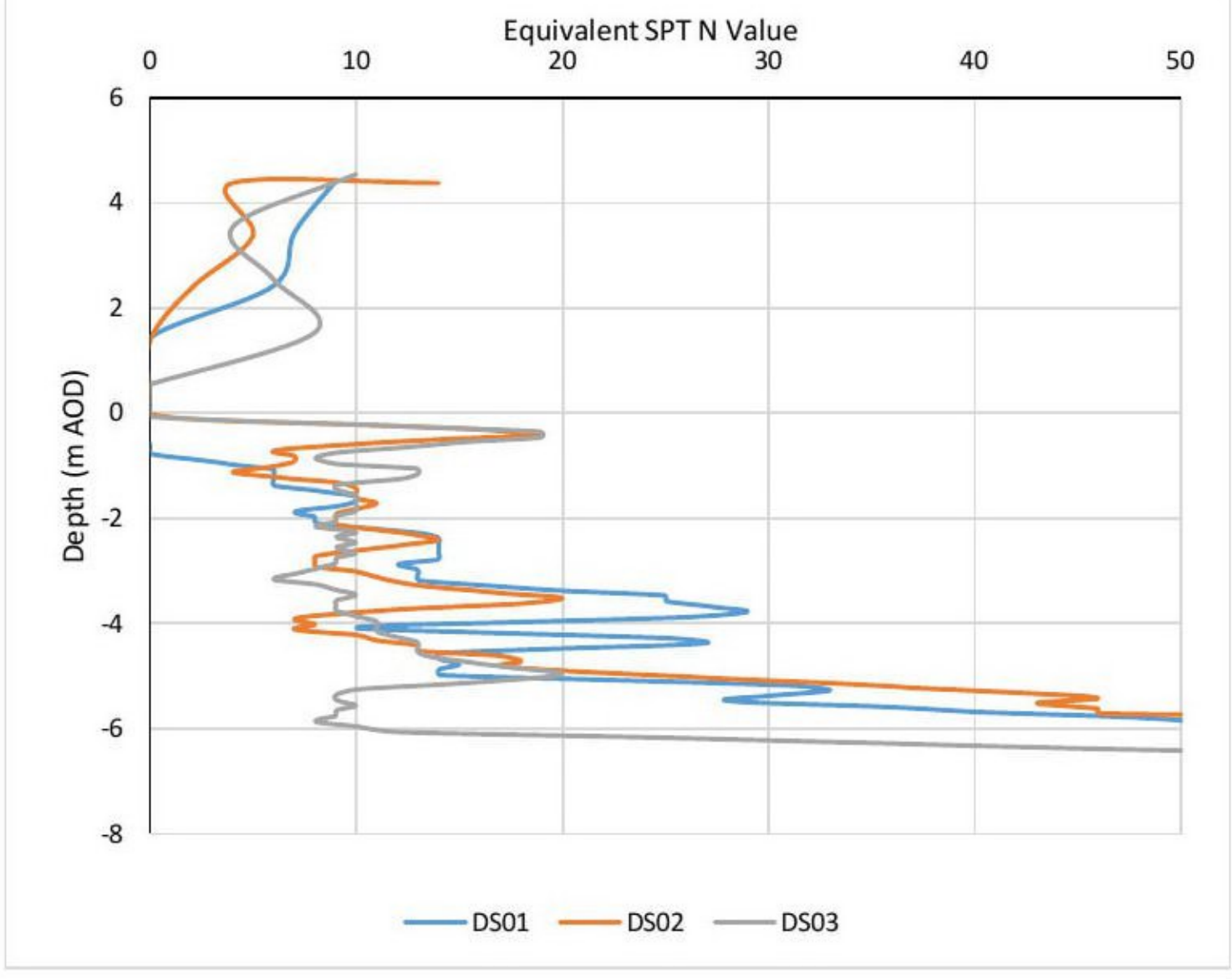
### 3.4.2 Dynamic Probe Holes Equivalent N-values

Equivalent SPT N-values have been derived from the three dynamic probe holes completed beneath the dynamic sample holes and have been summarised as follows:

| Depth (m bgl) | Equivalent N-value Range | Equivalent N-value Average |
|---|---|---|
| 5.00 – 5.50 | 0 | 0 |
| 5.50 – 6.00 | 0 – 19 | 8 |
| 6.00 – 6.50 | 0 – 19 | 7 |
| 6.50 – 7.00 | 4 – 13 | 8 |
| 7.00 – 7.50 | 7 – 11 | 10 |
| 7.50 – 8.00 | 8 – 14 | 11 |
| 8.00 – 8.50 | 8 – 14 | 11 |
| 8.50 – 9.00 | 6 – 25 | 13 |
| 9.00 – 9.50 | 7 – 29 | 16 |
| 9.50 – 10.00 | 7 – 27 | 14 |
| 10.00 – 10.50 | 13 – 21 | 15 |
| 10.50 – 11.00 | 9 – 46 | 27 |
| 11.00 – 11.50 | 8 – 72 | 34 |
| 11.50 – 12.00 | 10 – 63 | 34 |
| 12.00 – 12.50 | 57 | 57 |

Scatter graphs are included below of the equivalent N-values derived from the dynamic probe holes. A notable soft spot is recorded at 4.50m – 6.00m bgl (c. 0.00m AOD) in all exploratory holes with N-values of 0 recorded and rods noted to have sunk under their own weight. The dynamic probes reached a denser / firmer material at a depth of 11.00m – 12.00m bgl which may be approaching the interface of weathered bedrock. The equivalent SPT measurements from the dynamic sample boreholes have been included on the plots at depths of 1.00m – 5.00m bgl.




Full dynamic probe equivalent N-values are included on the dynamic probe hole logs, presented in Appendix 6.

## 3.5 Geotechnical Laboratory Testing

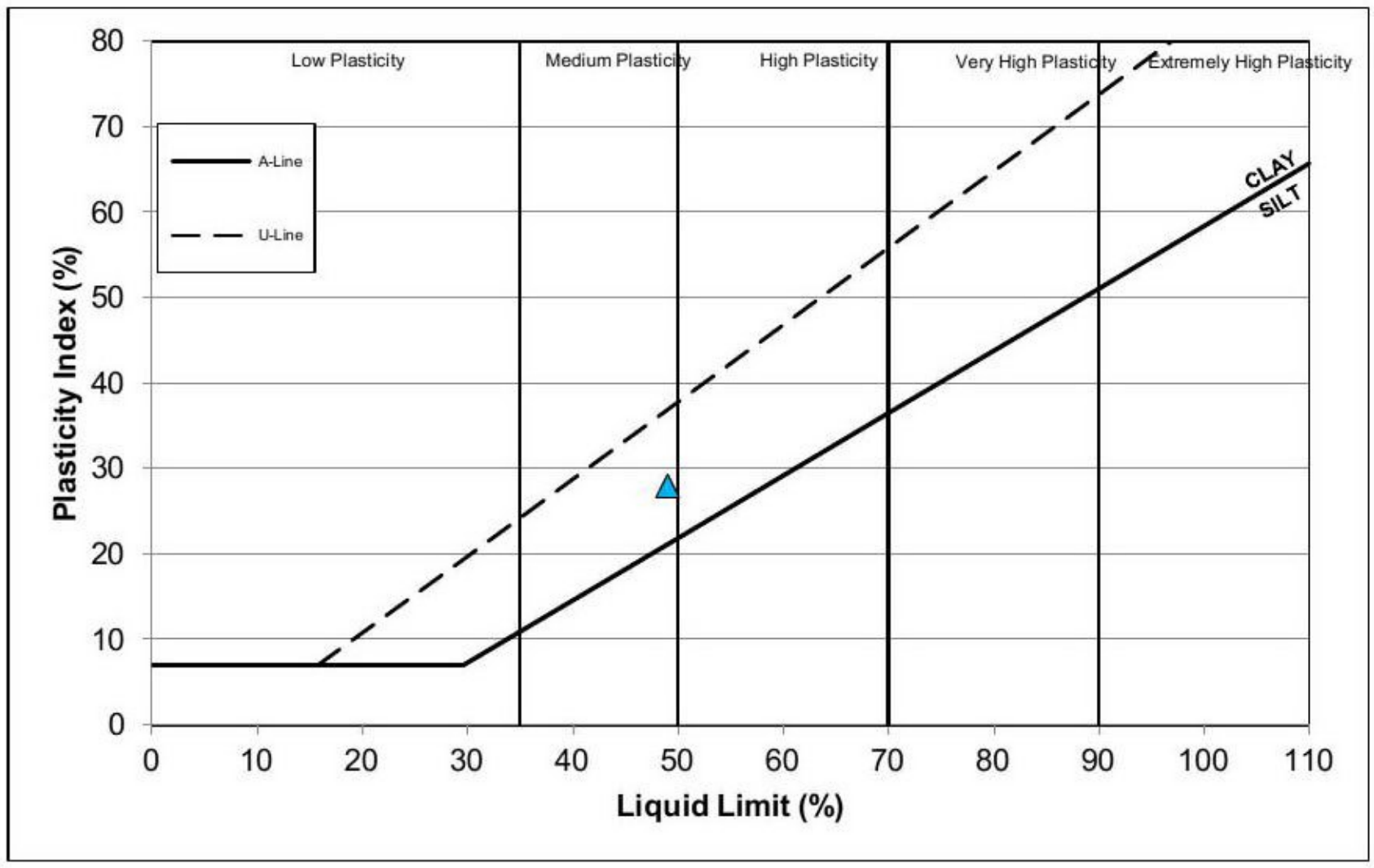
The results of the geotechnical laboratory tests undertaken during the ground investigation are summarised below.

### 3.5.1 Atterberg Limit Tests

Atterberg limit tests were undertaken on a single soil sample from the natural Alluvium. The results of the Atterberg testing are as follows:

| Sample | Sample Depth (m bgl) | Moisture Content (%) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index | Passing through 425 micron (%) | Modified Plasticity Index |
|---|---|---|---|---|---|---|---|
| DS01 | 2.20 – 2.50 | 17 | 49 | 21 | 28 | 100 | 28 |

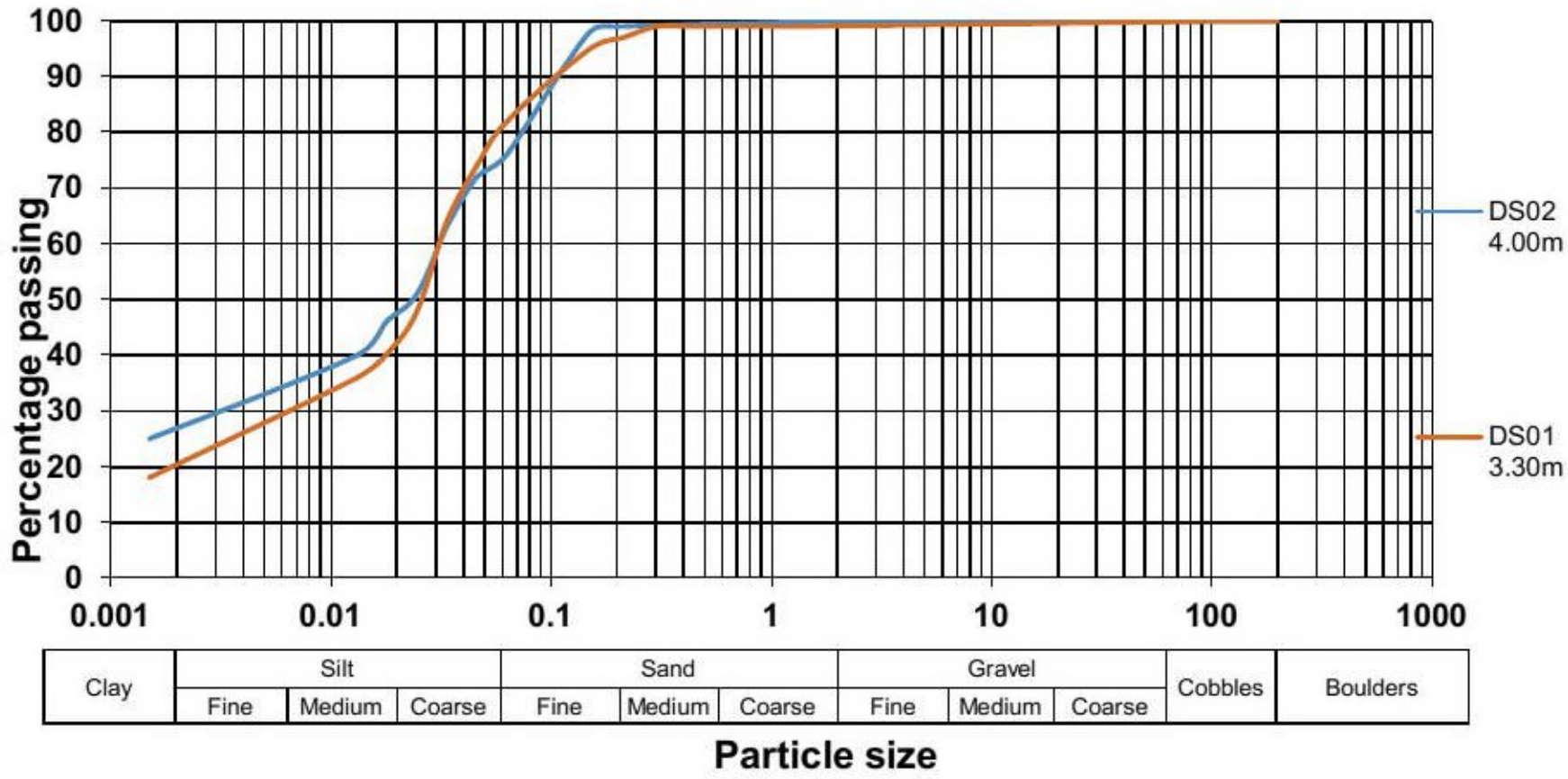
Orange = medium volume change potential.




The Atterberg Limit tests indicate that the Alluvium are of medium plasticity in-line with BS14688 Part 2 and of medium volume change potential in-line with NHBC Chapter 4.2 guidance. Full geotechnical test results are contained in Appendix 9.

### 3.5.2 Particle Size Distribution

The results of the PSD tests undertaken on two samples of Glacial Till are presented below.




Both PSD tests indicate that the material is a slightly sandy, clayey SILT in line with field descriptions. Full geotechnical test results are contained in Appendix 9.

### 3.5.3 BRE Special Digest Suite Testing

BRE SD1 testing suites were undertaken on 2 No. sample of Alluvium in order to determine the design sulphate levels and subsequently the Aggressive Chemical Environment for Concrete (ACEC)

| Sample | Depth (m bgl) | Strata | DS Class | ACEC Class |
|---|---|---|---|---|
| DS01 | 2.50 | Alluvium | DS-1 | AC-1 |
| DS02 | 2.90 | Alluvium | DS-3 | AC-3 |

Full chemical results are contained in Appendix 7 and geotechnical test results are contained in Appendix 9.

## 3.6 Environmental Laboratory Test Results

The findings of the chemical test results, summarised below, have been assessed against generic assessment criteria (GAC) for the purposes of screening allowable concentrations in comparison to the measured site concentrations. The GAC are defined based on the critical receptors identified at the site. Receptors are considered in relation to:

- Human health receptors (e.g. end-users, construction workers and the general public) via measured solid concentrations, and;
- Additional receptors may be relevant dependant on the site e.g. flora/fauna, water, buried concrete

The GAC adopted for assessment of soils in relation to Human Health are based on published LQM/CIEH S4ULs (2015) for those compounds for which published criteria are available for varying scenarios (residential, commercial, allotment, public open space). In the absence of LQM/CIEH S4ULs (2015) the following GAC defining documents are adopted - CL:AIRE Soil GAC for Human Health Assessment (2010) and Category 4 Screening Levels (C4SLs) (2014).

The primary risk to human receptors from free cyanide in soils is an acute risk (i.e. a single dose could have a lethal affect as opposed to adverse effects from cumulative intake (chronic affect)). There is no current UK guidance available for calculating acute risks from free cyanide, therefore an in-house methodology has been used to derive an acute GAC of 60 mg/kg for all exposure scenarios. The value is given for Free or Easily Liberatable Cyanide but should be used to assess Total Cyanide in the absence of cyanide speciation. In cases where the Total Cyanide exceeds the GAC then analysis for Free or Easily Liberatable Cyanide should be completed.

Appendix 8 contains the full screening tables for the Made Ground and Alluvium samples. All results have been assessed against the relevant GACs for a **residential end use without home grown produce** based on a concentration of **1% organic matter**.

The residential without home grown produce scenario has been selected as a conservative measure based on the development to include student accommodation.

### 3.6.1 Asbestos

An asbestos screen was performed on 2 No. samples of Made Ground. No asbestos was found to be present within any of the samples tested.

### 3.6.2 Polycyclic Aromatic Hydrocarbons

Of the sixteen PAH compounds, GAC exceedances were recorded in 3 No. compounds. Benzo(b)fluoranthene was recorded at a concentration of 6.4mg/kg, Benzo(a)pyrene was recorded at concentrations of 6.6mg/kg and dibenz(a,h)anthracene was recorded at concentrations of 1.1mg/kg. All exceedances were recorded in DS01 at 0.50m bgl within Made Ground.

### 3.6.3 Metal and metalloids

No exceedances of the GAC for any heavy metals or metalloids were recorded in any of the samples submitted for laboratory analysis for the residential without home grown produce scenario.

### 3.6.4 Total Petroleum Hydrocarbons (TPH)

Slightly elevated TPH compounds were recorded within both Made ground samples. The highest banded TPH recorded was DS01 at 0.50m which recorded TPH C10 – C25: 85mg/kg and C25 – C40: 98 mg/kg. The petroleum range C6 – C10 was recorded below detection level in both Made Ground Samples.

Full chemical test results are contained in Appendix 7 with the screening table in Appendix 8.

# 4.0 ENVIRONMENTAL CONCLUSIONS

## 4.1 Assessment of Environmental Results

Soil sample analyses have assessed the presence of contaminants and visual and olfactory evidence of contamination from dynamic sample boreholes and the concentrations at which they occur on a spatial basis across the site.

A single sample of Made Ground was found to have GAC exceedances in PAH compounds above the residential without home grown produce threshold. The sample was taken from DS01 at 0.50m bgl. Although this was a single sample, the Made Ground material was found to be site wide.

## 4.2 Conceptual Models

### 4.2.1 Human Health Risk Assessment

During the site investigation works a walkover was undertaken of the existing building which is used predominantly as a nature reserve storage area. The materials were inert (e.g. gate posts and fencing), no other sources of contamination were observed.

The site was previously used as a train station with associated buildings which have since been demolished. Subsequently, Made Ground was anticipated and encountered on the site during site investigation works associated with this demolished building. On-site Made Ground is considered a source of contamination.

The human health receptors identified include:

- End users (Nature reserve workers, volunteers and residing students).
- Construction workers.
- The general public and adjacent site users including from possible changes in ground gas regime following development.

The human health pathways identified include:

- Ingestion of soil directly (including on home grown produce) and indoor dust*;
- Inhalation of soil dust (indoor and outdoor);
- Dermal contact with soil (indoor and outdoor);

- Inhalation of soil vapours (indoor and outdoor);
- Oral background;
- Inhalation background.

** Treated as one pathway*

Conceptual Model for Human Health Risk Assessment

PAH exceedances were recorded within a sample of Made Ground at a depth of 0.50m bgl. The source of the Made Ground and subsequent contamination is likely to be the former demolished on-site railway building. The Made Ground was identified across the site from surface level to a maximum depth of 2.00m bgl.

For the majority of the site there is a lack of viable pathways for the contamination and much of the site is currently hardstanding or occupied by a building. Following development, the hardstanding area is understood to increase, however there is likely to be some open space or soft landscaping.

It is envisaged that the risks to construction workers can be mitigated with correct use of PPE and health and safety management. The end user may come into contact with site soils in soft landscaped areas. Consequently, remedial measures are deemed necessary in these areas to break any possible contaminative linkages.

Consequently, the risk to human health, including construction workers and the end users and construction workers, is deemed **low to moderate** as contaminative linkages may be present where the receptors may come into contact

In order to break the contaminative linkage from the on-site Made Ground, a clean cover system will need to be installed within areas of soft landscaping / public open space or Made Ground could be removed from the proposed areas of public open space / soft landscaping areas surrounding the proposed development. Both strategies would remove the contaminative risk to end users. An outline remedial strategy in Section 4.3.

### 4.2.2 Ground Gas Risk Assessment

Potential ground gas sources identified on-site include:

- Alluvium and potentially organic material within this.
- Made Ground.

Potential ground gas pathways identified on-site include:

- Preferential Migration Beneath Hardstanding, Along Foundations, Service Ducts and Trenches;
- Dissolved Gases Within Groundwater;
- Ingress Through Wall Cavities / Floors and Subsequent Accumulation;
- Inhalation of Ground Gas and Vapours;
- Vertical and Lateral Migration Through Granular Deposits / Granular Bands in Cohesive Deposits.

Potential ground gas receptors identified include:

- End users, and to a lesser extent, site workers, if confined spaces are present in which gases are able to accumulate;
- Building and structures.

Radon

The Indicative Atlas of Radon in England and Wales produced by the Health Protection Agency and British Geological Survey indicates that the site lies within an elevated radon potential area with 5 – 10% of homes above the action level. Consequently, BR211 (2015) indicates that **basic radon protection measures are necessary** in the construction of new dwellings or extensions. Extracts from the Radon Atlas of England and Wales for the site are contained within Appendix 3.

Conceptual Model for Ground Gas Risk Assessment

Based on the findings of the ground investigation works the conceptual model is as follows:

Made Ground was encountered at across the site to depths of 1.35m – 2.00m bgl. No organic or putrescible material was noted within the Made Ground and it was predominately granular in nature. The Total organic carbon was recorded to be 0.9%

and 2.9% in the two samples tested which is a relatively low organic content, particularly given the presence of PAHs and TPHs which would not contribute to ground gas generation. Therefore, on-site Made Ground is considered to be a low risk ground gas source.

Alluvium was encountered across the site and this is considered a potential ground gas source. Although Alluvium is considered to be a ground gas source, the ground gas generation potential of alluvium is typically very low and, based on BS8576 (2013) Figure 6: Decision Matrix Tool, alluvium is typically a very low ground gas source. Any methane generated by the Alluvium deposits are likely to bind to any organics within the deposit rather than migrate. No organic or putrescible materials were noted during the drilling of dynamic sample boreholes to a depth of 6.00m bgl. The majority of the Alluvium deposits encountered on-site were also cohesive deposits which would reduce migration of ground gas, reducing pathways. Consequently, the on-site Alluvium deposits are considered a low risk.

Therefore, the overall ground gas risk of the site is considered to be **low** given low risk sources are present. This should be revised if organic material / potential sources are identified during earthworks.

Although the ground gas risk is considered low, give the requirement for basic radon measures which includes a radon protection membrane, it is recommended that a dual radon and ground gas membrane is utilised as a conservative measure.

### 4.2.3 Controlled Waters Risk Assessment

Groundwater sources identified on-site include:

- Made Ground

The controlled water receptors include:

- Groundwater contained within the underlying Secondary A Superficial Aquifer (Alluvium).
- Groundwater contained within the Secondary A bedrock Aquifer (Alston Formation). The depth to this is anticipated to be c. 10.00m – 14.50m bgl.

- Surface Water – including off-site unnamed stream located adjacent to the western site boundary flowing from south to north.

The controlled waters pathways include:

- Vertical migration along current and future foundations and pooling at base / beneath foundations.
- Vertical migration through granular Made Ground, topsoil and granular natural bands in natural deposits.
- Lateral migration along low permeability Made Ground and / or natural cohesive deposits and pooling at relative low points.
- Lateral migration along historic drainage.
- Negligible infiltration through low-permeability natural cohesive deposits.
- Migration along cracks and fissures in bedrock.
- Migration along groundwater flow.
- Overland flow

<u>Conceptual Model for Controlled Waters Risk Assessment</u>

The site has historically been used as a railway station and associated goods yard and therefore associated Made Ground was present across the site. As previously discussed, elevated concentrations of PAH compounds were identified and therefore Made Ground is considered a contaminative source.

No groundwater strikes were recorded during the site investigation works and cohesive Alluvium deposits were recorded directly beneath the on-site Made Ground. The cohesive deposits would act as an aquitard to contamination migration to the underlying aquifers. If a piled foundation solution is utilised, there is a risk of creating a vertical migration pathway. However, this is unlikely given piles will be in close contact with surrounding soil and no groundwater was identified at shallow depth to facilitate vertical migration.

A watercourse is present adjacent to the western site boundary, however as no shallow water table was identified during works lateral migration to the adjacent surface water feature is considered unlikely, particularly as PAHs are relatively

immobile. Therefore, seasonal variation of groundwater is also unlikely to lead to migration to the adjacent surface water feature.

An increase in hardstanding post-development will further reduce contaminative linkages due to less water infiltration and the anticipated presence of additional drainage. Consequently, the site is not considered to pose a significant risk to controlled waters; the risk is deemed low and no further assessment or remedial measures is deemed necessary.

## 4.3 Outline Remedial Strategy

As discussed in section 4.1, given the human health GAC exceedances of PAHs in samples of Made Ground on-site, an outline remedial strategy is deemed necessary for areas of soft landscaping.

### 4.3.1 Remedial Measures

To remediate the human health risks to the end user, a 300mm clean cover system is to be installed across any areas of soft landscaping to break contaminative linkages.

This is to consist of:

- A minimum of 300mm suitable topsoil, underlain by
- A hi-viz permeable geotextile marker

### 4.3.2 Validation Requirements

Once the clean cover system has been installed, validation requirements include:

- Details of the source of the cover material;
- Waste transfer notes to provide evidence of source (where soils are imported);
- Confirmation of cover depth by either measurement tape or topographical survey with photographs.
- Imported topsoil and subsoil is required to be tested at source prior to import to confirm suitability. All topsoil and subsoil, whether site-won or imported is required to be tested at the following frequency:

| Source | Material End Use | Sampling Frequency[1] |
|---|---|---|
| Greenfield Source: | Topsoil | 1 per 200m³ |
| | Subsoil | 1 per 200m³ |
| Brownfield Source: | Topsoil | 1 per 50m³ |
| | Subsoil | 1 per 100m³ |
| | General Fill [2] | 1 per 1000m³ |

1. Minimum 3 samples regardless of volume.
2. 'General Fill' is material used primarily to raise levels, specifically not within areas of private gardens, public open space, or soft landscaping e.g., 6F2.

The above remedial measures should be reassessed following the receipt of a finalised externals layout including levels.

No suitable topsoil or subsoil is noted to be present on the site within achievable depths to 'win', consequently it is anticipated that the garden materials will require importation of subsoils and topsoil.

# 5.0 GEOTECHNICAL CONCLUSIONS

## 5.1 Geotechnical Assessment of Ground Conditions

The ground investigation works have revealed that the ground conditions at the site are relatively consistent comprising a thin topsoil cover underlain by Made Ground, underlain by Alluvium.

The principal strata identified are outlined in further detail below.

### 5.1.1 Topsoil

Topsoil was encountered in DS01 and DS02 comprising brown, fine sand with frequent rootlets to a depth of 0.03m – 0.05m bgl. The thin thickness and very limited coverage of topsoil and Made Ground constituents immediately underlying it (e.g. cobble setts and bricks) makes this material unsuitable for reuse within the proposed development.

### 5.1.2 Made Ground

Made Ground was encountered in all dynamic sample boreholes and varied in composition but was predominately granular sands and gravels to a depth of 1.35m – 2.00m bgl. DS02 recorded cohesive Made Ground from 0.50m – 1.35m bgl. Cobbles of brick and cobble setts were noted in the upper portion of Made Ground across the site. SPT N values of 9 – 14 and N60 values of 9 – 13 were recorded within the Made Ground, however these may not have been representative given the high gravel and cobble content recorded.

### 5.1.3 Alluvium

Alluvium was encountered in all dynamic sample boreholes. Cohesive soft to firm, silty clay was encountered at depths of 1.35m – 2.80m bgl underlain by very soft to soft, slightly sandy, clayey silt to at least 6.00m bgl where the deepest dynamic sample borehole terminated.

10 No. SPTs were carried out within the Alluvium. The N values obtained varied from 0 – 8 with a mean of 4, the corrected N60 values varied from 0 - 9 with a mean of 4.

A single Atterberg limit test was undertaken in the upper cohesive Alluvium deposits and indicated that the material is of medium plasticity and medium volume change potential.

Dynamic Probes undertaken from 5.00m – 12.20m bgl are likely to have passed through Alluvium, however no sample recovery is undertaken in this method of testing. Average equivalent N Values remained under 10 to a depth of 7.00m bgl and then increased with depth with holes terminating at 11.50m – 12.20m bgl.

This strata is not considered a suitable founding strata given the low SPT N Values and high silt content.

## 5.2 Groundwater

No groundwater strikes were recorded during the site investigation works. Given the nature of the underlying material and high silt content, if water is encountered at any point during construction dewatering and trench stability is likely to be required. There is likely to be considerable seasonal variation on-site given historical imagery shows surface water in neighbouring fields.

Where any excavations are to be made i.e. for drainage purposes, given the presence of low strength natural deposits, it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.

## 5.3 Mining / Geological Assessment

The site lies does not lie within a Coal Authority Mining Reporting Area. No other mining is recorded on or in close proximity of the site. The British Geological survey record the underlying bedrock as the Alston Formation comprising limestone, sandstone, siltstone and mudstones. Bedrock was not encountered on site, with works to investigate the solid geology beyond the scope of this investigation.

## 5.4 Foundations

A suitable founding strata was not encountered during the dynamic borehole sampling, therefore, dynamic probing was undertaken to provide continuous density data with greater depth. Low strength Alluvium was encountered throughout the dynamic sample boreholes and the dynamic probes found that the underlying material had high equivalent N Values from c. 11.00m – 12.00m bgl. This depth may relate to the start of underlying weathered bedrock interface, however this cannot be confirmed without sample recovery.

Following the findings of the site investigation works, traditional strip or trench foundations are not considered feasible. The low SPT N Values at depth and high silt content would not be suitable for a ground improvement utilising vibro stone column (VSC) solution. Additionally the existing building is within too close a proximity for this treatment works to be undertaken.

Consequently, it is recommended that a piled foundation solution is adopted for the proposed development.

If a piled solution is utilised, consultation with a specialist piling contractor will be required. Pile types are likely to be end bearing onto the underlying bedrock anticipated to be present at a depth of between 10.00m – 14.50m bgl. Further deep site investigation works may be required to confirm this (e.g. cable percussive boreholes or rotary boreholes). Given the proximity of the existing neighbouring building on site, a non-percussive pile may be required.

Numerous established trees were noted to be present along the site boundaries. Due to the medium volume change potential of the clays recorded on-site, it is recommended that an arboricultural survey is undertaken for detailed foundation design and heaver precaution requirements.

Once more detailed proposed development plans are known, a review of the foundation solutions may offer alternative solution i.e. raft.

## 5.5 Floor Slabs

Suspended floor slabs will be required for the proposed development. This is due to greater than 0.60m bgl of Made Ground being present across the site. Ground bearing slabs are also not deemed suitable where the foundation depth is greater than 1.50m bgl within tree influence. The floor slab design will be subject to the foundation solution of the development.

## 5.6 Concrete Classification

In accordance with BRE Special Digest 1: Concrete in Aggressive Ground (2005), worst case soluble sulphates were recorded within design sulphate levels DS-3 and subsequently within the Aggressive Chemical Environment for Concrete (ACEC) classification of AC-3 within the underlying silts.

# 6.0 RECOMMENDATIONS

- Following confirmation of the finalised proposed development, detailed design including earthworks design, proposed levels and arboricultural survey (tree survey) it is recommended that the above conclusions are re-appraised to determine the suitability.
- It is recommended that further deep site investigation (e.g. cable percussive boreholes) are undertaken if a piled foundation solution is utilised for the proposed development.
- The conclusions of this report should be agreed with relevant regulatory authorities prior to the commencement of works.

# APPENDIX 1

# LIMITATIONS OF INVESTIGATION WORK AND REPORT AND CONTAMINATED LAND LEGISLATIVE FRAMEWORK

## LIMITATIONS OF REPORT

This consultancy report was compiled and carried out by IGE Consulting Limited ('IGE') for the client, as defined in the main report (the 'client'), on the basis of a defined programme and scope of works and the terms of a contract between IGE and the client. IGE undertook this with all reasonable skill and care, taking into account the limits of the scope of works required by the client, the prevailing site conditions, the time scale involved and the resources, including financial and manpower resources, agreed between IGE and the client. IGE cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered outwith the agreed scope of works.

Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices. This report may not be relied upon, or transferred to, by any other party without the written agreement of its author. If a third party relies on this report, it does so wholly at its own and sole risk and IGE disclaims any liability to such parties.

It is IGE's understanding that this report is to be used for the purpose described in the 'Brief' section of this report. That purpose was a significant factor in determining the scope and the services to be provided. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without IGE's review and advice shall be at the client's sole and own risk.

The information contained in this report is protected by disclosure under Part 3 of the Environmental Information Regulations 2004 pursuant to the provisions of Regulation 12(5) without the consent in writing of a Director of IGE.

This report is a function of the date it was written and should be read in light of any subsequent changes in legislation, statutory requirements and industry practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal

provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of IGE. In the absence of such written advice of IGE, reliance on the report in the future shall be at the client's own and sole risk. Should IGE be requested to review the report in the future, IGE shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between IGE and the client.

The observations and conclusions described in this report are based solely upon the scope of works agreed between the client and IGE. IGE has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report. IGE is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the agreed scope of works. For the avoidance of doubt, this report is strictly limited to the nature of contamination contained within the ground and groundwater at the site. The report does not cover environmental aspects such as air or noise pollution and ground vibrations and the like. In addition, ecological matters relating to wildlife, flora and fauna have not been investigated as part of this report. In particular, the site has not been inspected for the presence or otherwise of invasive species (e.g. Japanese Knotweed). It is recommended that the client appoints a specialist in this subject to carry out a detailed inspection / survey of the site if its presence is suspected. Where mention has been made to the suspected presence asbestos or asbestos-containing materials this is for indicative purposes only and does not constitute or replace full and proper surveys.

Throughout the report the term ‘geotechnical’ is used to describe aspects relating to the physical nature of the site (such as foundation requirements) and the term ‘geo-environmental’ is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. The geo-environmental sections are written in broad agreement with BS 10175:2011+A2 2017.

## LIMITATIONS OF INVESTIGATION WORK

### Desk Study References

This report is based upon IGE's observations of existing physical conditions at the site gained from a walkover survey of the site together with IGE's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. Reliance has been placed on this publicly available data obtained from the sources identified in the main report. When using the information, it has been assumed that it is correct. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst IGE have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report. IGE did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services. IGE is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to IGE and including the doing of any independent investigation of the information provided to IGE except when otherwise provided in the terms of the contract between the client and IGE.

### Historical Mapping

Historical Ordnance Survey maps do not provide a comprehensive description of a site history. They provide details of the site from a date prior to the publication of the map (i.e. a snapshot in time). The period between map editions can be substantial (i.e. several decades). Not all map series are available for every date range in many areas of the UK and therefore there will be gaps in this mapped record for some sites. Potentially contaminative land uses could have been present and removed during such periods and may therefore not form a part of this particular record. In addition, there will be potentially contaminative land uses which are not identified on the map records such as small scale storage / use of hazardous materials, illegal / unlicensed

waste disposal activities etc. Different map series identify different features utilising different symbols which can result in features that remain on-site being removed from maps. Some features are also not mapped for security reasons (e.g. airfields and other military installations). These areas are mostly shown as blank areas on historical maps.

**Site Walkover**

During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not be made known or accessible.

**Flooding**

Flooding in this report is defined as flooding caused by the sea, ditches, rivers, streams, ponds, lakes, reservoirs and the like. It does not extend to flooding caused by surcharged piped drainage systems and investigations into flooding of this nature are excluded from this report.

**Extent of Contamination Studies**

Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.

The conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the reporting in full. The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the site.

## PLANNING CONTEXT

The National Planning Policy Framework (NPPF, 2019) states that the purpose of the planning system is to contribute to the achievement of sustainable development. In order to do this the planning system has three overarching objectives, one of which directly relates to the potential for pollution and contaminated land:

- *'**environmental objective** - to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy'.*

In accordance with this environmental objective, Paragraph 118 clarifies that 'making effective use of land' includes to:

- *'give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land'*.

In accordance with this environmental objective, Paragraph 170 clarifies that' conserving and enhancing the natural environment includes:

- *'preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability*'; and
- *'remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate'.*

Paragraph 178 of the NPPF states that planning policies and decisions for developments should also ensure that:

- *'a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation)*'; and,

- '*after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990'*; and
- '*adequate site investigation information, prepared by a competent person, is available to inform these assessments'*.

This report has been prepared and authorised by staff that are competent as defined in the NPPF.

## CONTAMINATED LAND LEGISLATIVE FRAMEWORK

Environmental risks are assessed in accordance with Contaminated Land (England) (Amendment) Regulations (2012), Part IIA of the Environmental Protection Act 1990, and Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, DEFRA (2012). Part IIA provides a statutory definition of contaminated land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that:

(a) Significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) Significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.

Risk from contamination is assessed by consideration of possible linkages between contaminant sources and potential receptors which could be harmed or polluted and the potential pathways between them – known as the Contaminant Linkage. For a risk of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A source – a substance that is capable of causing pollution or harm;
- A receptor – something which could be adversely affected by the contaminant;
- A pathway – a route by which the contaminant can reach the receptor.

If one of these elements is absent there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

The Environment Agency Land Contamination: Risk Management (LCRM 2020) provides the technical framework for structured decision making about land contaminations. LCRM (2020) advocates a phased approach to risk assessment comprising:

- Preliminary Risk Assessment (PRA) – desk study and qualitative assessment;

- Generic Quantitative Risk Assessment (GQRA) – assessment of contaminant concentrations against generic assessment criteria;
- Detailed Quantitative Risk Assessment (DQRA) – detailed site-specific risk assessment and development of site-specific assessment criteria.

Each of these phases follows the same basic steps but adds site specific details and further certainty into the assessment as the stages progress. The basic steps are:

- Hazard Identification and hazard assessment- development or refinement of the source – pathway – receptor conceptual model, and identification of potential pollutant linkages;
- Risk Estimation – qualitative risk estimation predicting magnitude and probability of potential consequences that may arise as a result of a hazard.
- Risk Evaluation – deciding whether a risk is unacceptable.

The key to the classification is that the designation of risk is based upon the consideration of both:

(a) The magnitude of the potential consequence which takes into account both the potential severity of the hazard and the sensitivity of the receptor;
(b) The magnitude of probability which takes into account both the presence of the hazard and receptor and the integrity of the pathway.

Generic Quantitative Risk Assessment (GQRA) will utilise generic assessment criteria (GAC) for the purposes of screening allowable concentrations in comparison to the measured site concentrations. The GAC are defined based on the critical receptors identified at the site. Receptors are considered in relation to:

- Human health receptors (e.g. site users) via measured solid concentrations;
- The water environment (e.g. groundwater and surface water) via measured leachate / water concentrations.

Additional receptors may be relevant dependant on the site e.g. flora/fauna, water supply pipes, buried concrete.

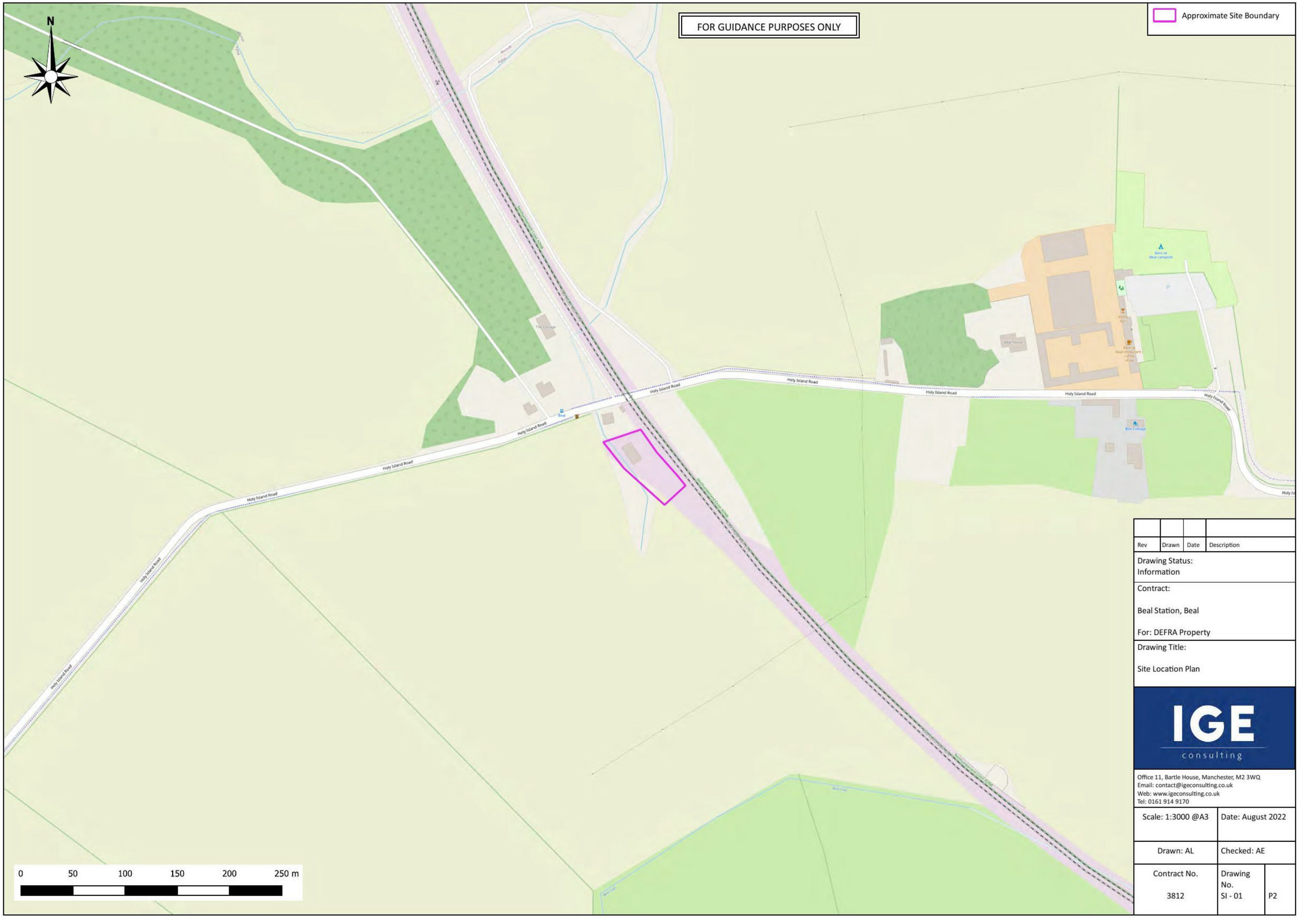
The GAC adopted for assessment of soils in relation to Human Health are based on published Soil Guideline Values (SGV) in 2009 for those compounds for which published criteria are available for varying scenarios (residential, commercial, allotment). In the absence of SGVs the following GAC defining documents are adopted - LQM/CIEH S4ULs (2015), CL:AIRE Soil GAC for Human Health Assessment (2010) and Category 4 Screening Levels (C4SL's) (2014).

GACs for waters must be selected to assess potential risks to the identified environmental receptors. There are numerous UK and European guidelines for waters based on the site situation and different receptors. GACs utilised include - The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2009 (Part 7: Groundwater Threshold Values), UK Drinking Water Standards (2000), Environmental Quality Standards, World Health Organisation concentrations, Environment Agency guidance concentrations and United States Environmental Protection Agency – Region 9 GACs.

## APPENDIX 2

## FIGURES AND DRAWINGS:

- Proposed Development Plan
- SI – 01 - Site location Plan
- SI – 02 – Exploratory Hole Location Plan
- Proposed Development Plan




| | | | |
|---|---|---|---|
| Rev | Drawn | Date | Description |

Drawing Status:
Information

Contract:

Beal Station, Beal

For: DEFRA Property

Drawing Title:

Site Location Plan

IGE consulting

Office 11, Bartle House, Manchester, M2 3WQ
Email: contact@igeconsulting.co.uk
Web: www.igeconsulting.co.uk
Tel: 0161 914 9170

| | |
|---|---|
| Scale: 1:3000 @A3 | Date: August 2022 |
| Drawn: AL | Checked: AE |
| Contract No. 3812 | Drawing No. SI - 01 P2 |

FOR GUIDANCE PURPOSES ONLY

406160E

406180E

406200E

406220E

642640N

642620N

642600N

DS01

DS02

DS03

Approximate Site Boundary

**IGE Site Investigation Works**

Proposed Development

Dynamic Sample Borehole

0 5 10 15 20 25 m

| Rev | Drawn | Date | Description |
|---|---|---|---|
| | | | |

Drawing Status:
Information

Contract:

Beal Station, Beal

For: DEFRA Property

Drawing Title:

Exploratory Hole Location Plan

IGE consulting

Office 11, Bartle House, Manchester, M2 3WQ
Email: contact@igeconsulting.co.uk
Web: www.igeconsulting.co.uk
Tel: 0161 914 9170

| Scale: 1:250 @A3 | Date: August 2022 | |
|---|---|---|
| Drawn: AL | Checked: AE | |
| Contract No. 3812 | Drawing No. SI - 02 | P2 |


m 0 2 4 6 8 10 12 14 16 18 20
SCALE
1:200

| | |
|---|---|
| Drawn By: CFC | Project start date: 07/22 |
| Checked By: JF | Date: 13.07.22 |
| Drawing Scale: 1:200 @ A3 | |
| Drawing Status: CONCEPT | |

This drawing is to be read in conjunction with all engineers and specialists drawings along with all relevant specifications.

All permissions & approvals are to be obtained prior to commencement of any works on site.

All gridlines, dimensions, building lines, etc. are to be checked carefully on site prior to the commencement of any works.

All workmanship and materials shall comply with current Building Regulations, British Standards, Codes of Practice and N.H.B.C. requirements.

All materials shall be fixed, applied or mixed in accordance with manufacturer's instructions or specifications and all materials shall be suitable for their purpose.

Dimensions are not to be scaled from this drawing.

Any discrepancies between the information given by engineers and other specialists must be brought to the attention of the designer prior to the commencement of any works.

Where it is required that inspection be made by the local authority this shall be arranged by the contractor to suit their programme.

The contractor shall comply with the health and safety requirements as set out by the CDM Regulations, The Health and Safety Executive.

Prior to commencing work the contractor shall carry out an internal and external condition survey of the existing building and shall take into account everything necessary for the proper execution of the works, to the satisfaction of the 'Inspector' whether indicated on the drawing or not.

| Rev. | Date | Description |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Project Descrption:
NEW FACILITY AT LINDISFARNE
NATIONAL NATURE RESERVE

Project Address:
LINDISFARNE NATIONAL
NATURE RESERVE
BERWICK-UPON-TWEED

Client:
NATURAL ENGLAND

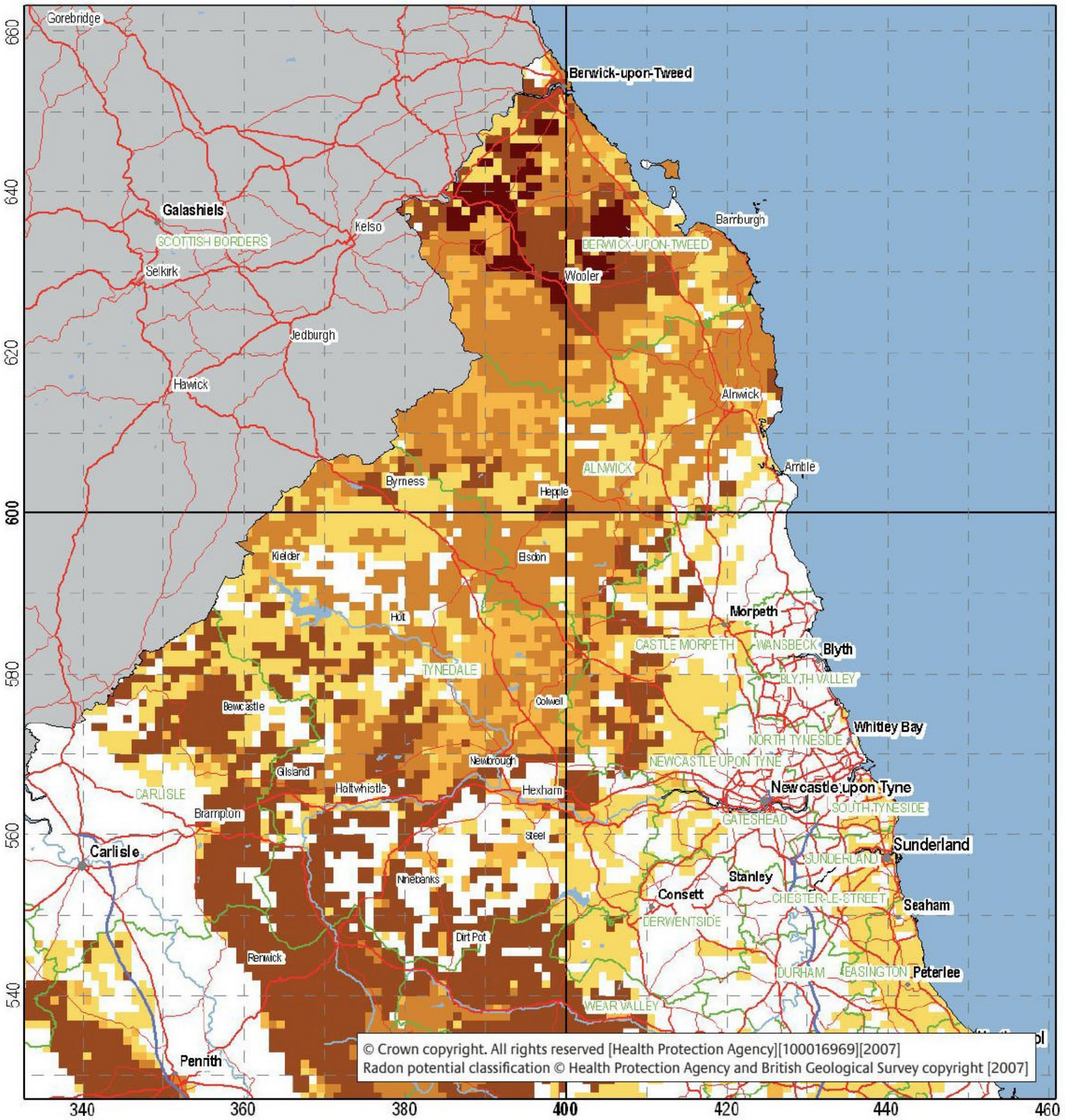
firth ARCHITECTS
Firth Associates Limited
Jubilee House
East Beach
Lytham
Lancashire FY8 5FT
email@firthassociates.com
www.firtharchitects.com
01253 734036
RIBA
arb

Drawing Title:
PROPOSED SITE PLAN

| Drawing Number: | Revision |
|---|---|
| NNR-LDF / 010 | |

# APPENDIX 3

# EXTRACTS OF RADON ATLAS FOR ENGLAND AND WALES




The colours show the maximum percentage band within each 1-km grid square of the national grid (see page 4). The best estimate for an individual property in a coloured square can be obtained for a small charge from www.ukradon.org. The white squares, the 0-1% band, contain no Affected Areas as defined by the HPA.

**Percentage of homes at or above the Action Level**

- 0 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 30
- Greater than 30

**Settlements**

- Newcastle upon Tyne
- Berwick-upon-Tweed
- Alnwick
- Hepple

**Roads**

- Motorways
- Primary Roads
- A Roads
- B Roads

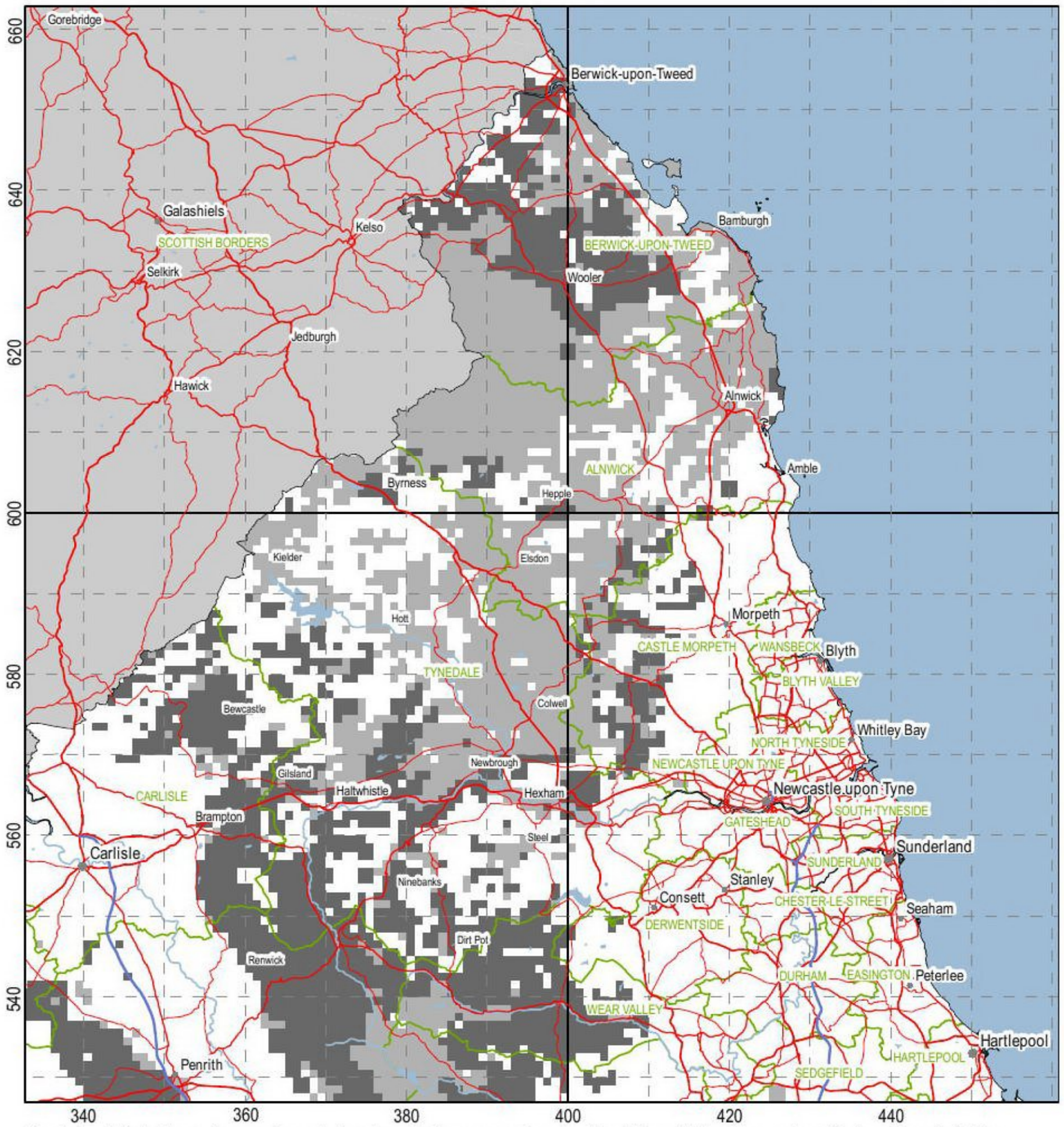
**National Grid**

- 100-km
- 10-km

**Other Features**

- LOCAL ADMINISTRATIVE DISTRICT
- Water features

**MAP 20 Northumberland, 100-km grid squares NT and NU (axis numbers are the coordinates of the national grid)**




The shading indicates the maximum requirements for radon protective measures in any location within each 1-km grid square to satisfy the guidance in Building Regulations Approved Document C. The requirement for an existing building with a valid postal address can be obtained for a small charge from www.ukradon.org. The requirement for a site without a postal address is available through the British Geological Survey GeoReports service, http://shop.bgs.ac.uk/GeoReports/.

Level of protection required
- None
- Basic
- Full

Settlements
- Newcastle upon Tyne
- Berwick-upon-Tweed
- Alnwick
- Hepple

Roads
- Motorways
- Primary Roads
- A Roads
- B Roads

National Grid
- 100-km
- 10-km

Other Features
- LOCAL ADMINISTRATIVE DISTRICT
- Water features

Map 20 Northumberland, 100-km grid squares NT and NU (axis numbers are the coordinates of the National Grid)

# APPENDIX 4

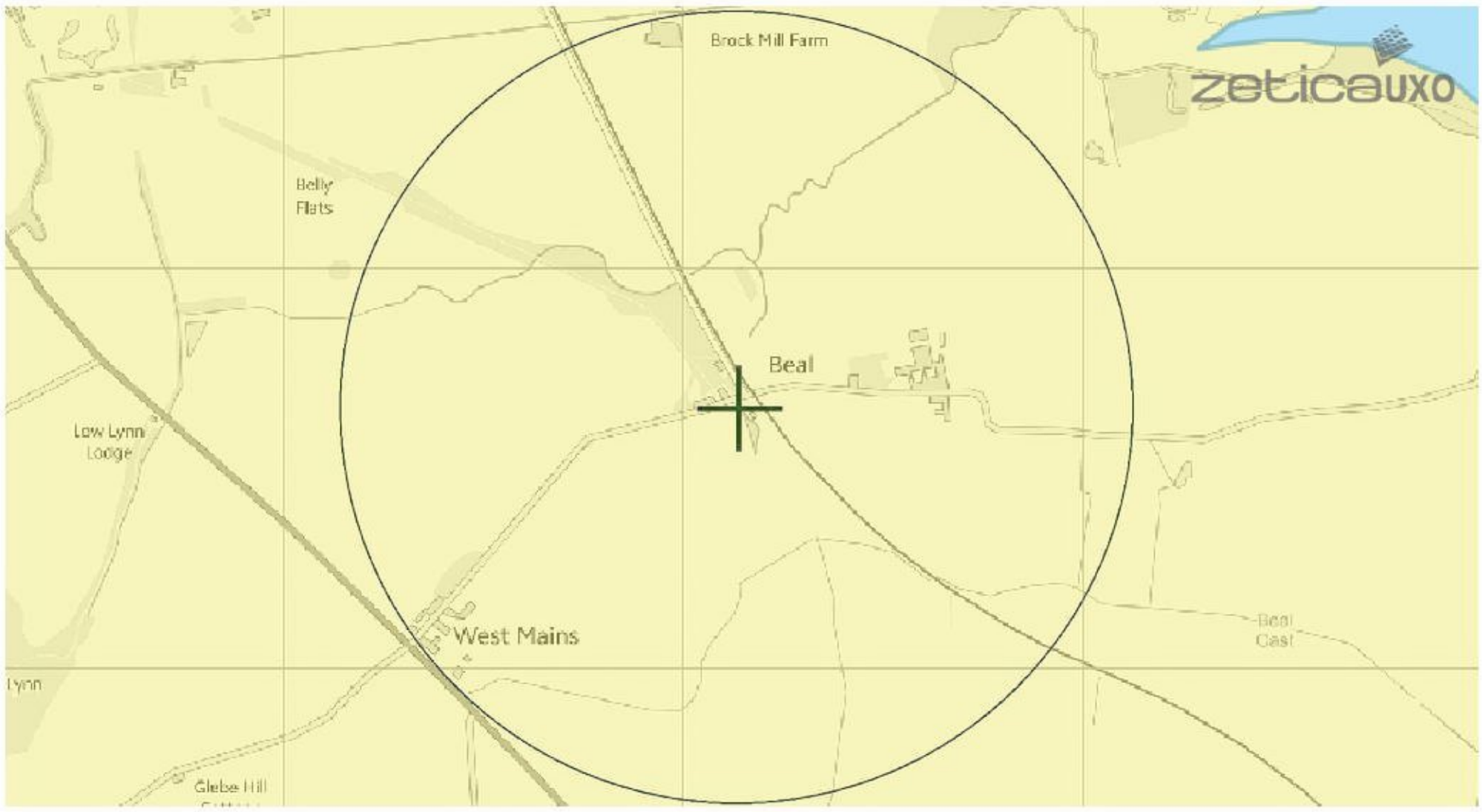
# ZETICA UXO RISK MAP

# UNEXPLODED BOMB RISK MAP

zeticauxo

**SITE LOCATION**

Map Centre: 406144,642657




**LEGEND**

- **High:** Areas indicated as having a bombing density of 50 bombs per 1000acre or higher.
- **Moderate:** Areas indicated as having a bombing density of 15 to 49 bombs per 1000acre.
- **Low:** Areas indicated as having 15 bombs per 1000acre or less.

**miltary** | **industry** | **UXO find**
**transport** | **dock** | **Luftwaffe targets**
**utilities** | **Bombing decoy** | **other**

### How to use your Unexploded Bomb (UXB) risk map?

The map indicates the potential for Unexploded Bombs (UXB) to be present as a result of World War Two (WWII) bombing.

You can incorporate the map into your preliminary risk assessment* for potential Unexploded Ordnance (UXO) for a site. Using this map, you can make an informed decision as to whether more in-depth detailed risk assessment* is necessary.

### What do I do if my site is in a moderate or high risk area?

Generally, we recommend that a detailed UXO desk study and risk assessment is undertaken for sites in a moderate or high UXB risk area.

Similarly, if your site is near to a designated Luftwaffe target or bombing decoy then additional detailed research is recommended.

More often than not, this further detailed research will conclude that the potential for a significant UXO hazard to be present on your site is actually low.

**Never plan site work or undertake a risk assessment using these maps alone. More detail is required, particularly where there may be a source of UXO from other military operations which are not reflected on these maps.**

### If my site is in a low risk area, do I need to do anything?

If both the map and other research confirms that there is a low potential for UXO to be present on your site then, subject to your own comfort and risk tolerance, works can proceed with no special precautions.

A low risk really means that there is no greater probability of encountering UXO than anywhere else in the UK.

If you are unsure whether other sources of UXO may be present, you can ask for one of our **pre-desk study assessments (PDSA)**

### If I have any questions, who do I contact?

tel: **+44 (0) 1993 886682**

email: **uxo@zetica.com**

web: **www.zeticauxo.com**

The information in this UXB risk map is derived from a number of sources and should be used in conjunction with the accompanying notes on our website: **(https://zeticauxo.com/downloads-and-resources/risk-maps/)**



It is important to note that this map is not a UXO risk assessment and should not be reported as such when reproduced.

*Preliminary and detailed UXO risk assessments are advocated as good practice by industry guidance such as CIRIA C681 'Unexploded Ordnance (UXO), a guide for the construction industry'.

# APPENDIX 5

# DYNAMIC SAMPLE BOREHOLE LOGS AND PHOTOGRAPHS

IGE consulting
Office 11, Bartle House, Oxford Court
Manchester M2 3WQ
email: contact@igeconsulting.co.uk
web: www.igeconsulting.co.uk
tel: 0161 914 9170

# Dynamic Sample Borehole Log

ver. 1.5

Dynamic Sample No.
**DS01**
Sheet 1 of 2

| | | | |
|---|---|---|---|
| Project Name: | Beal Station | Co-ords: | 406174E - 642645N |
| Location: | Berwick-upon-Tweed | Level (m AOD): | 5.42 |
| Client: | Defra Group Property | Date: | 27/07/2022 |
| | | Weather: | Overcast |

Project No.: 3812
Logged By: AL
Checked By: LM

| Well / Backfill | Water Strikes | Sample and In Situ Testing Depth(m) | Type | Results | Depth (m) | Level (m AOD) | Stratum Description |
|---|---|---|---|---|---|---|---|
| | | | | | 0.05 | 5.37 | Brown, fine SAND with frequent rootlets. TOPSOIL. Brown, slightly gravelly, predominantly fine SAND with high cobble content. Cobbles are angular to subangular of sandstone (50%) and limestone (50%). Gravel is angular to subangular, fine to coarse of limestone (50%), sandstone (40%) and red brick (10%). MADE GROUND |
| | | 0.50 | ES | 1kg | | | |
| | | 1.20 | SPT | N=9 (1,1/4,1,2,2) | 1.30 | 4.12 | Light grey, slightly sandy, angular, fine to coarse GRAVEL of limestone. MADE GROUND |
| | | 2.00 | SPT | N=7 (4,2/1,1,2,3) | 2.00 | 3.42 | Firm, greyish brown, CLAY. ALLUVIUM |
| | | 2.35 | B | 5kg | | | |
| | | 2.50 | ES | 1kg | | | |
| | | 2.50 | | HVP=81 | | | |
| | | 2.70 | | HVP=70 | | | *Becoming soft and silty from 2.80m bgl.* |
| | | 2.90 | | HVP=37 | | | |
| | | 3.00 | SPT | N=6 (1,1/1,1,2,2) | 3.20 | 2.22 | Soft, dark greyish brown, slightly gravelly, slightly sandy, clayey SILT. Gravel is angular, fine to medium of shell fragments (90%) and coal (10%). ALLUVIUM |
| | | 3.50 | B | 5kg | | | |
| | | 3.50 | | HVP=10 | | | |
| | | 3.70 | | HVP=12 | | | *Becoming very soft at 3.80m bgl.* |
| | | 4.00 | SPT | N=0 (0,0/0,0,0,0) | | | |
| | | 4.75 | B | 5kg | | | |
| | | 5.00 | SPT | N=0 (0,0/0,0,0,0) | | | |

Remarks:

SPT at 4.00m bgl - 500mm self weight penetration.
SPT at 5.00m bgl - 700mm self weight penetration.

| Water Strike | | Casing Details | | Sample Sleeve Runs | | |
|---|---|---|---|---|---|---|
| Depth Strike | Remarks | Depth Base | Diameter | Depth Top (m) | Depth Base (m) | Diameter (mm) |
| | No strike | 3.00 | 100 | 0.00 | 1.00 | HDP 100% rec |
| | | | | 1.00 | 2.00 | 87 100% rec |
| | | | | 2.00 | 3.00 | 77 100% rec |
| | | | | 3.00 | 4.00 | 67 100% rec |
| | | | | 4.00 | 5.00 | 57 100% rec |

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tel: 0161 914 9170

# Dynamic Sample Borehole Log

ver. 1.5

Dynamic Sample No.
**DS01**
Sheet 2 of 2

| | | | |
|---|---|---|---|
| Project Name: | Beal Station | Co-ords: | 406174E - 642645N |
| Location: | Berwick-upon-Tweed | Level (m AOD): | 5.42 |
| Client: | Defra Group Property | Date: | 27/07/2022 |
| | | Weather: | Overcast |

Project No.: 3812
Logged By: AL
Checked By: LM

| Well / Backfill | Water Strikes | Sample and In Situ Testing Depth(m) | Type | Results | Depth (m) | Level (m AOD) | Stratum Description |
|---|---|---|---|---|---|---|---|
| | | | | | | | Soft, dark greyish brown, slightly gravelly, slightly sandy, clayey SILT. Gravel is angular, fine to medium of shell fragments (90%) and coal (10%). ALLUVIUM |
| | | | | | 6.00 | -0.58 | Dynamic Sample terminated at 6.00m. |

6
7
8
9
10

Remarks:
SPT at 4.00m bgl - 500mm self weight penetration.
SPT at 5.00m bgl - 700mm self weight penetration.

| Water Strike | | Casing Details | | Sample Sleeve Runs | | |
|---|---|---|---|---|---|---|
| Depth Strike | Remarks | Depth Base | Diameter | Depth Top (m) | Depth Base (m) | Diameter (mm) |
| | No strike | 3.00 | 100 | 0.00 | 1.00 | HDP 100% rec |
| | | | | 1.00 | 2.00 | 87 100% rec |
| | | | | 2.00 | 3.00 | 77 100% rec |
| | | | | 3.00 | 4.00 | 67 100% rec |
| | | | | 4.00 | 5.00 | 57 100% rec |

# Dynamic Sample Borehole Photos

**DS01**

Beal Station

**Image 1.** WS01 runs :
*Viewed left to right and top to bottom:*
*1.00-2.00m bgl*
*2.00-3.00m bgl*
*3.00-4.00m bgl*
*4.00-5.00m bgl*
*5.00-6.00m bgl*

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# Dynamic Sample Borehole Log

ver. 1.5

Dynamic Sample No.
**DS02**
Sheet 1 of 1

| | | | |
|---|---|---|---|
| Project Name: | Beal Station | Co-ords: | 406168E - 642647N |
| Location: | Berwick-upon-Tweed | Level (m AOD): | 5.38 |
| Client: | Defra Group Property | Date: | 27/08/2022 |
| | | Weather: | Overcast |

Project No.: 3812
Logged By: AL
Checked By: LM

| Well / Backfill | Water Strikes | Sample and In Situ Testing Depth(m) | Type | Results | Depth (m) | Level (m AOD) | Stratum Description |
|---|---|---|---|---|---|---|---|
| | | | | | 0.03 | 5.35 | Brown, fine SAND with frequent rootlets. TOPSOIL |
| | | | | | 0.25 | 5.13 | Dark grey, subangular COBBLE SETS of dolerite. MADE GROUND |
| | | 0.30 | B | 5kg | | | Dark grey, gravelly, fine to coarse, ashy SAND. Gravel is angular to subrounded, fine to medium of clinker. MADE GROUND |
| | | 0.60 | ES | 1kg | 0.50 | 4.88 | Firm, light brown, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse of sandstone (80%), limestone (10%), and red brick (10%). MADE GROUND |
| | | 1.00 | SPT | N=14 (3,3/4,5,2,3) | | | |
| | | | | | 1.35 | 4.03 | Soft to firm, dark greyish brown, slightly sandy, silty CLAY. ALLUVIUM |
| | | 1.70 | | HVP=61 | | | |
| | | 1.75 | B | 5kg | | | |
| | | 1.80 | | HVP=50 | | | |
| | | 2.00 | SPT | N=4 (1,1/1,1,1,1) | | | |
| | | | | | | | *Soft from 2.5m bgl.* |
| | | 2.60 | | HVP=40 | | | |
| | | | | | 2.80 | 2.58 | Very soft, dark greyish brown, slightly sandy, clayey SILT. ALLUVIUM |
| | | 2.90 | ES | 1kg | | | |
| | | 3.00 | SPT | N=5 (0,1/1,1,2,1) | | | |
| | | 4.00 | SPT | N=2 (0,0/0,0,1,1) | | | |
| | | 4.25 | B | 5kg | | | |
| | | 4.50 | | HVP=7 | | | |
| | | | | | 5.00 | 0.38 | Dynamic Sample terminated at 5.00m. |

Remarks:

SPT at 4.00m bgl - 300mm self weight penetration.
Barrel sunk under self weight from 4.00m - 4.50m bgl.

| Water Strike | | Casing Details | | Sample Sleeve Runs | | |
|---|---|---|---|---|---|---|
| Depth Strike | Remarks | Depth Base | Diameter | Depth Top (m) | Depth Base (m) | Diameter (mm) |
| | No strike | 2.00 | 100 | 0.00 | 1.00 | HDP 100% rec |
| | | | | 1.00 | 2.00 | 87 90% rec |
| | | | | 2.00 | 3.00 | 77 90% rec |
| | | | | 3.00 | 4.00 | 67 10% rec |
| | | | | 4.00 | 5.00 | 57 80% rec |

# Dynamic Sample Borehole Photos

**DS02**

Beal Station

**Image 1.** WS02 runs:
*Viewed left to right and top to bottom:*
*0.00-1.00m bgl*
*1.00-2.00m bgl*
*2.00-3.00m bgl*
*3.00-4.00m bgl*
*4.00-5.00m bgl*

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# Dynamic Sample Borehole Log

ver. 1.5

Dynamic Sample No.
**DS03**
Sheet 1 of 1

| | | | |
|---|---|---|---|
| Project Name: | Beal Station | Co-ords: | 406165E - 642641N |
| Location: | Berwick-upon-Tweed | Level (m AOD): | 5.54 |
| Client: | Defra Group Property | Date: | 27/08/2022 |
| | | Weather: | Overcast |

Project No.: 3812
Logged By: AL
Checked By: LM

| Well / Backfill | Water Strikes | Sample and In Situ Testing Depth(m) | Type | Results | Depth (m) | Level (m AOD) | Stratum Description |
|---|---|---|---|---|---|---|---|
| | | 0.10 | ES | | | | Light grey, gravelly, fine to coarse, SAND. Gravel is angular, fine to coarse of concrete (50%), red brick (50%) MADE GROUND |
| | | | | | 0.25 | 5.29 | Multicoloured, subrounded to well rounded, fine to coarse GRAVEL of sandstone (20%), mudstone (20%), dolerite (20%), limestone (20%) and flint (20%). MADE GROUND |
| | | | | | 0.45 | 5.09 | Light greyish brown, slightly clayey, sandy, angular to subangular, fine to coarse, GRAVEL of sandstone (60%), limestone (30%) and red brick (10%). MADE GROUND |
| | | 0.80 | ES | | | | |
| | | 1.00 | SPT | N=10 (2,2/3,1,3,3) | | | |
| | | | | | 1.60 | 3.94 | Soft, dark greyish brown, slightly sandy, silty CLAY. ALLUVIUM |
| | | 2.00 | SPT | N=4 (1,1/1,1,1,1) | | | |
| | | 2.30 - 2.60 | B | | 2.30 | 3.24 | Soft, dark brownish grey, slightly sandy, clayey SILT. ALLUVIUM |
| | | 3.00 | SPT | N=6 (0,1/2,1,1,2) | | | *Becoming brown from 3.00m bgl.* |
| | | 4.00 - 4.30 | B | | | | |
| | | 4.00 | SPT | N=8 (1,2/2,2,2,2) | | | |
| | | | | | 5.00 | 0.54 | Dynamic Sample terminated at 5.00m. |

Remarks:
Sample liner barrel sunk under self weight from 4.00m - 4.50m bgl.

| Water Strike | | Casing Details | | Sample Sleeve Runs | | |
|---|---|---|---|---|---|---|
| Depth Strike | Remarks | Depth Base | Diameter | Depth Top (m) | Depth Base (m) | Diameter (mm) |
| | No strike | 2.00 | 100 | 0.00 | 1.00 | HDP 100% rec |
| | | | | 1.00 | 2.00 | 77 100% rec |
| | | | | 2.00 | 3.00 | 67 40% rec |
| | | | | 3.00 | 4.00 | 57 20% rec |
| | | | | 4.00 | 5.00 | 57 5% rec |

# Dynamic Sample Borehole Photos

**DS03**

Beal Station

**Image 1.** WS03 runs :
*Viewed left to right and top to bottom:*
*0.00-1.00m bgl*
*1.00-2.00m bgl*
*2.00-3.00m bgl*
*3.00-4.00m bgl*
*4.00-5.00m bgl*

# APPENDIX 6

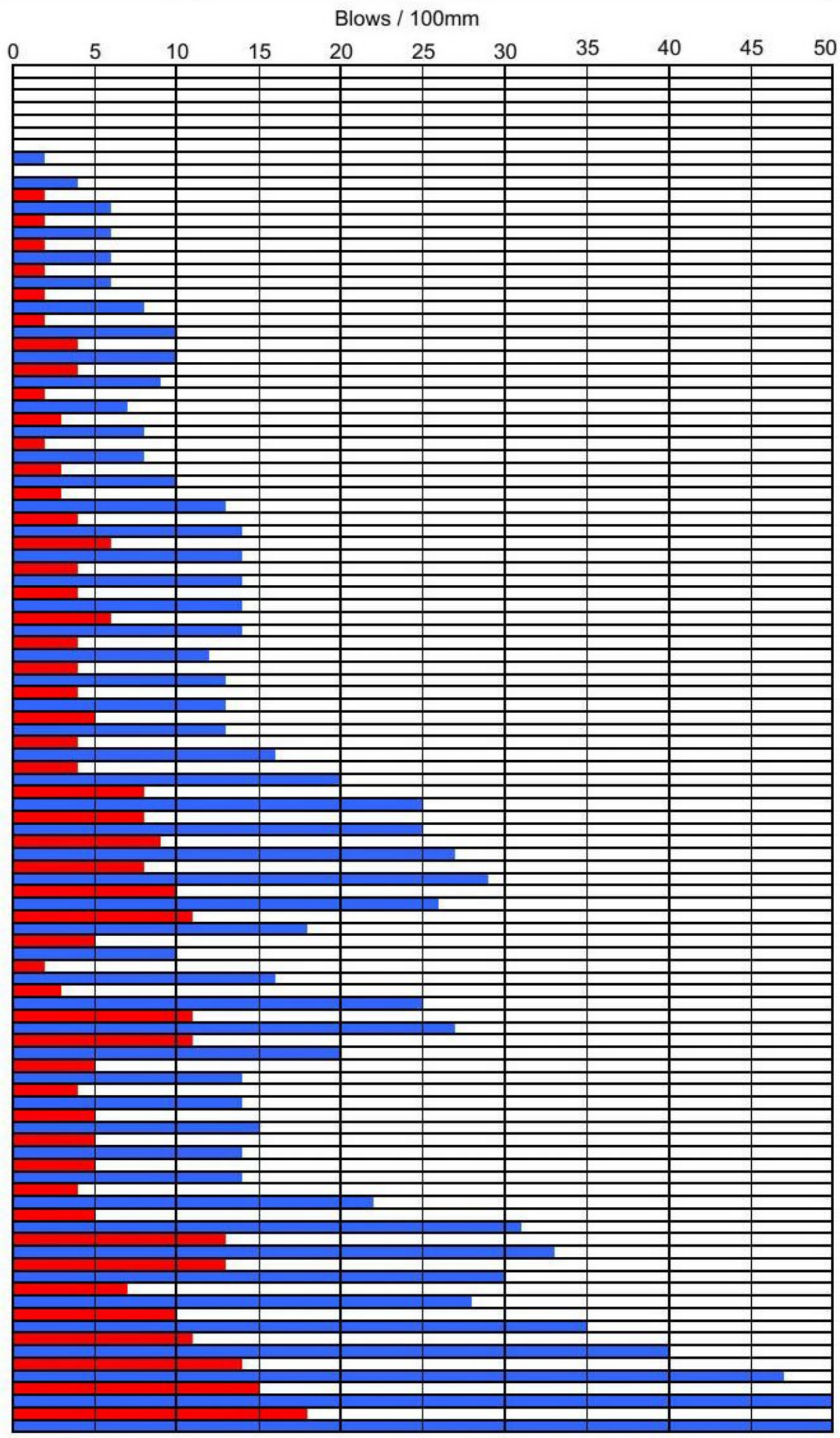
# DYNAMIC PROBE LOGS

# DYNAMIC PROBE TEST RESULTS SHEET

| | |
|---|---|
| SITE: | Beal Station, Beal |
| DRILLER: | RD Drilling |
| PROBE NUMBER: | DP01 |
| DATE: | 27-Jul-22 |

DPSH IN ACCORDANCE WITH BS 1377: PART 9: CLAUSE 3.2
PROBE HOLE BACKFILLED: Yes
REMARKS: Hole commenced at the base of DS01 at 6.00m bgl

| Depth (m) | Blows / 100mm | Approximate SPT 'N' value* |
|---|---|---|
| 6.0 | 0 | 0 |
| 6.1 | 0 | 0 |
| 6.2 | 0 | 0 |
| 6.3 | 0 | 2 |
| 6.4 | 0 | 4 |
| 6.5 | 2 | 6 |
| 6.6 | 2 | 6 |
| 6.7 | 2 | 6 |
| 6.8 | 2 | 6 |
| 6.9 | 2 | 8 |
| 7.0 | 2 | 10 |
| 7.1 | 4 | 10 |
| 7.2 | 4 | 9 |
| 7.3 | 2 | 7 |
| 7.4 | 3 | 8 |
| 7.5 | 2 | 8 |
| 7.6 | 3 | 10 |
| 7.7 | 3 | 13 |
| 7.8 | 4 | 14 |
| 7.9 | 6 | 14 |
| 8.0 | 4 | 14 |
| 8.1 | 4 | 14 |
| 8.2 | 6 | 14 |
| 8.3 | 4 | 12 |
| 8.4 | 4 | 13 |
| 8.5 | 4 | 13 |
| 8.6 | 5 | 13 |
| 8.7 | 4 | 16 |
| 8.8 | 4 | 20 |
| 8.9 | 8 | 25 |
| 9.0 | 8 | 25 |
| 9.1 | 9 | 27 |
| 9.2 | 8 | 29 |
| 9.3 | 10 | 26 |
| 9.4 | 11 | 18 |
| 9.5 | 5 | 10 |
| 9.6 | 2 | 16 |
| 9.7 | 3 | 25 |
| 9.8 | 11 | 27 |
| 9.9 | 11 | 20 |
| 10.0 | 5 | 14 |
| 10.1 | 4 | 14 |
| 10.2 | 5 | 15 |
| 10.3 | 5 | 14 |
| 10.4 | 5 | 14 |
| 10.5 | 4 | 22 |
| 10.6 | 5 | 31 |
| 10.7 | 13 | 33 |
| 10.8 | 13 | 30 |
| 10.9 | 7 | 28 |
| 11.0 | 10 | 35 |
| 11.1 | 11 | 40 |
| 11.2 | 14 | 47 |
| 11.3 | 15 | 51 |
| 11.4 | 18 | 53 |




Dynamic probe value (Blows/100mm)  Approximate SPT 'N' value

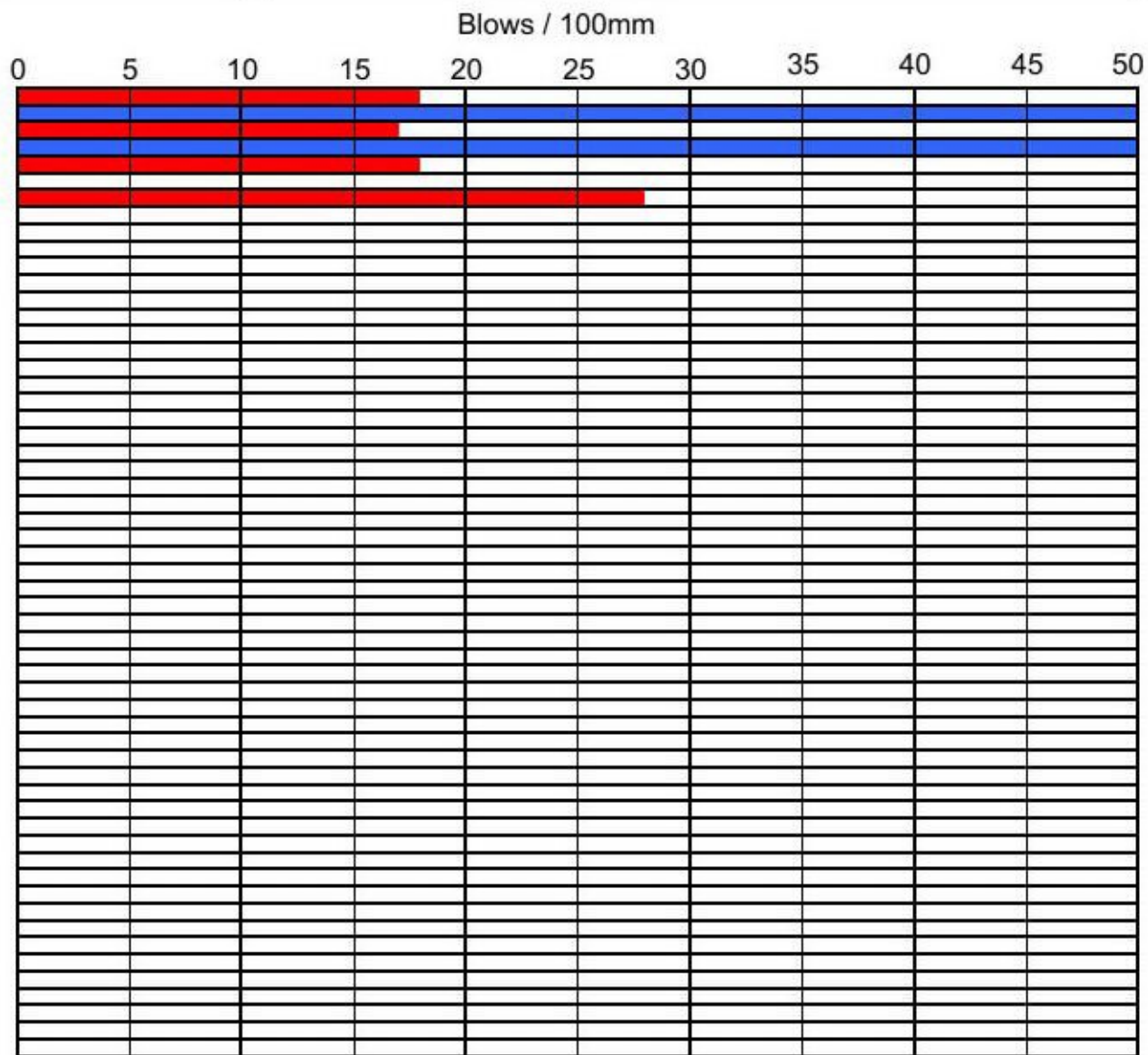
* Value is indicative only and must not be relied upon for design purposes

# DYNAMIC PROBE TEST RESULTS SHEET

| | |
|---|---|
| SITE: | Beal Station, Beal |
| DRILLER: | RD Drilling |
| PROBE NUMBER: | DP01 p2 |
| DATE: | 27-Jul-22 |

DPSH IN ACCORDANCE WITH BS 1377: PART 9: CLAUSE 3.2
PROBE HOLE BACKFILLED: Yes
REMARKS: Hole commenced at the base of DS01 at 6.00m bgl

| Depth (m) | Blows / 100mm | Approximate SPT 'N' value* |
|---|---|---|
| 11.5 | 18 | 53 |
| 11.6 | 17 | 63 |
| 11.7 | 18 | |
| 11.8 | 28 | |




Dynamic probe value (Blows/100mm)  Approximate SPT 'N' value

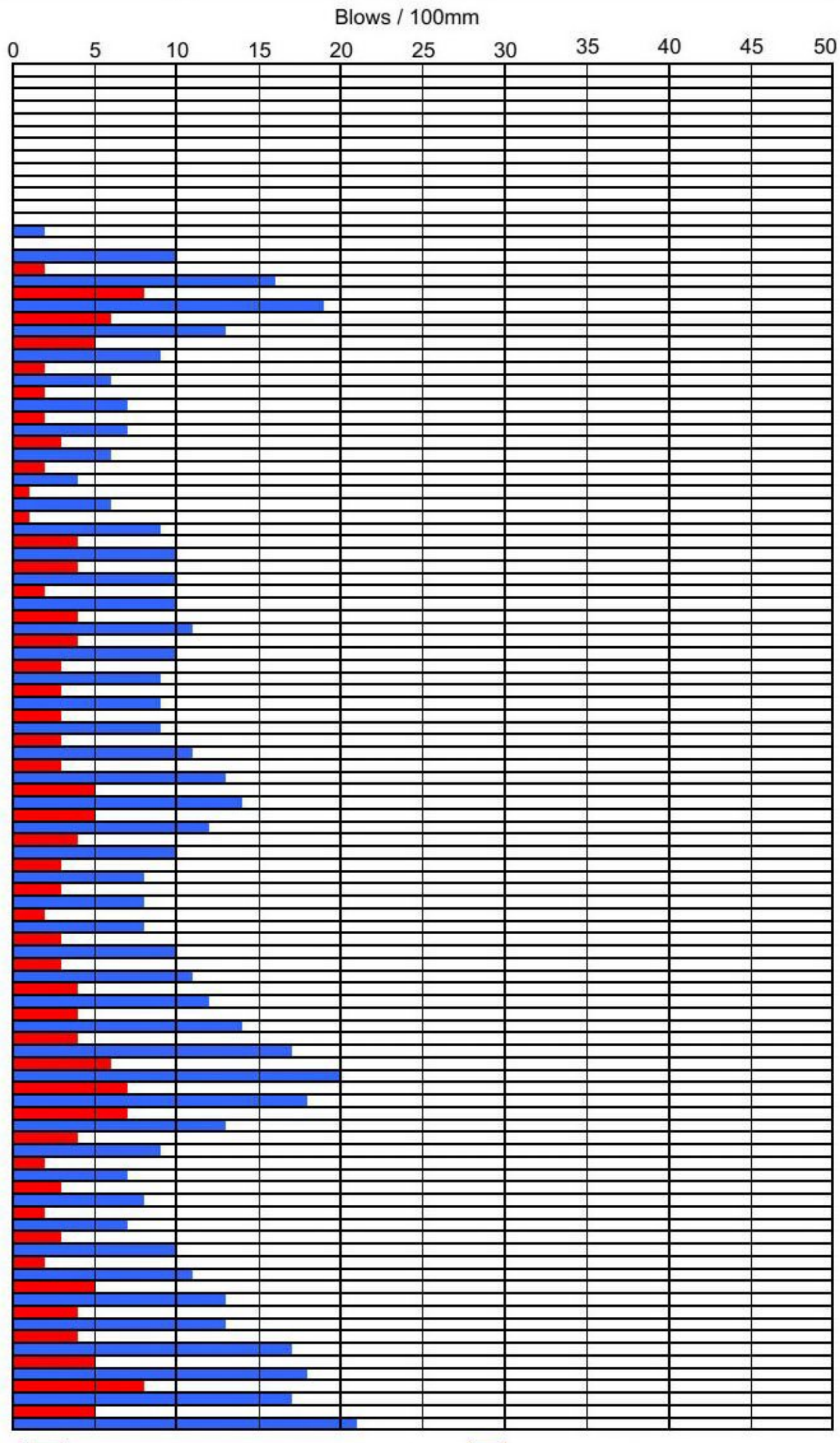
* Value is indicative only and must not be relied upon for design purposes

# DYNAMIC PROBE TEST RESULTS SHEET

| | |
|---|---|
| SITE: | Beal Station, Beal |
| DRILLER: | RD Drilling |
| PROBE NUMBER: | DP02 |
| DATE: | 27-Jul-22 |

DPSH IN ACCORDANCE WITH BS 1377: PART 9: CLAUSE 3.2
PROBE HOLE BACKFILLED: Yes
REMARKS: Hole commenced at the base of DS02 at 5.00m bgl

| Depth (m) | Blows / 100mm | Approximate SPT 'N' value* |
|---|---|---|
| 5.0 | 0 | 0 |
| 5.1 | 0 | 0 |
| 5.2 | 0 | 0 |
| 5.3 | 0 | 0 |
| 5.4 | 0 | 0 |
| 5.5 | 0 | 0 |
| 5.6 | 0 | 2 |
| 5.7 | 0 | 10 |
| 5.8 | 2 | 16 |
| 5.9 | 8 | 19 |
| 6.0 | 6 | 13 |
| 6.1 | 5 | 9 |
| 6.2 | 2 | 6 |
| 6.3 | 2 | 7 |
| 6.4 | 2 | 7 |
| 6.5 | 3 | 6 |
| 6.6 | 2 | 4 |
| 6.7 | 1 | 6 |
| 6.8 | 1 | 9 |
| 6.9 | 4 | 10 |
| 7.0 | 4 | 10 |
| 7.1 | 2 | 10 |
| 7.2 | 4 | 11 |
| 7.3 | 4 | 10 |
| 7.4 | 3 | 9 |
| 7.5 | 3 | 9 |
| 7.6 | 3 | 9 |
| 7.7 | 3 | 11 |
| 7.8 | 3 | 13 |
| 7.9 | 5 | 14 |
| 8.0 | 5 | 12 |
| 8.1 | 4 | 10 |
| 8.2 | 3 | 8 |
| 8.3 | 3 | 8 |
| 8.4 | 2 | 8 |
| 8.5 | 3 | 10 |
| 8.6 | 3 | 11 |
| 8.7 | 4 | 12 |
| 8.8 | 4 | 14 |
| 8.9 | 4 | 17 |
| 9.0 | 6 | 20 |
| 9.1 | 7 | 18 |
| 9.2 | 7 | 13 |
| 9.3 | 4 | 9 |
| 9.4 | 2 | 7 |
| 9.5 | 3 | 8 |
| 9.6 | 2 | 7 |
| 9.7 | 3 | 10 |
| 9.8 | 2 | 11 |
| 9.9 | 5 | 13 |
| 10.0 | 4 | 13 |
| 10.1 | 4 | 17 |
| 10.2 | 5 | 18 |
| 10.3 | 8 | 17 |
| 10.4 | 5 | 21 |



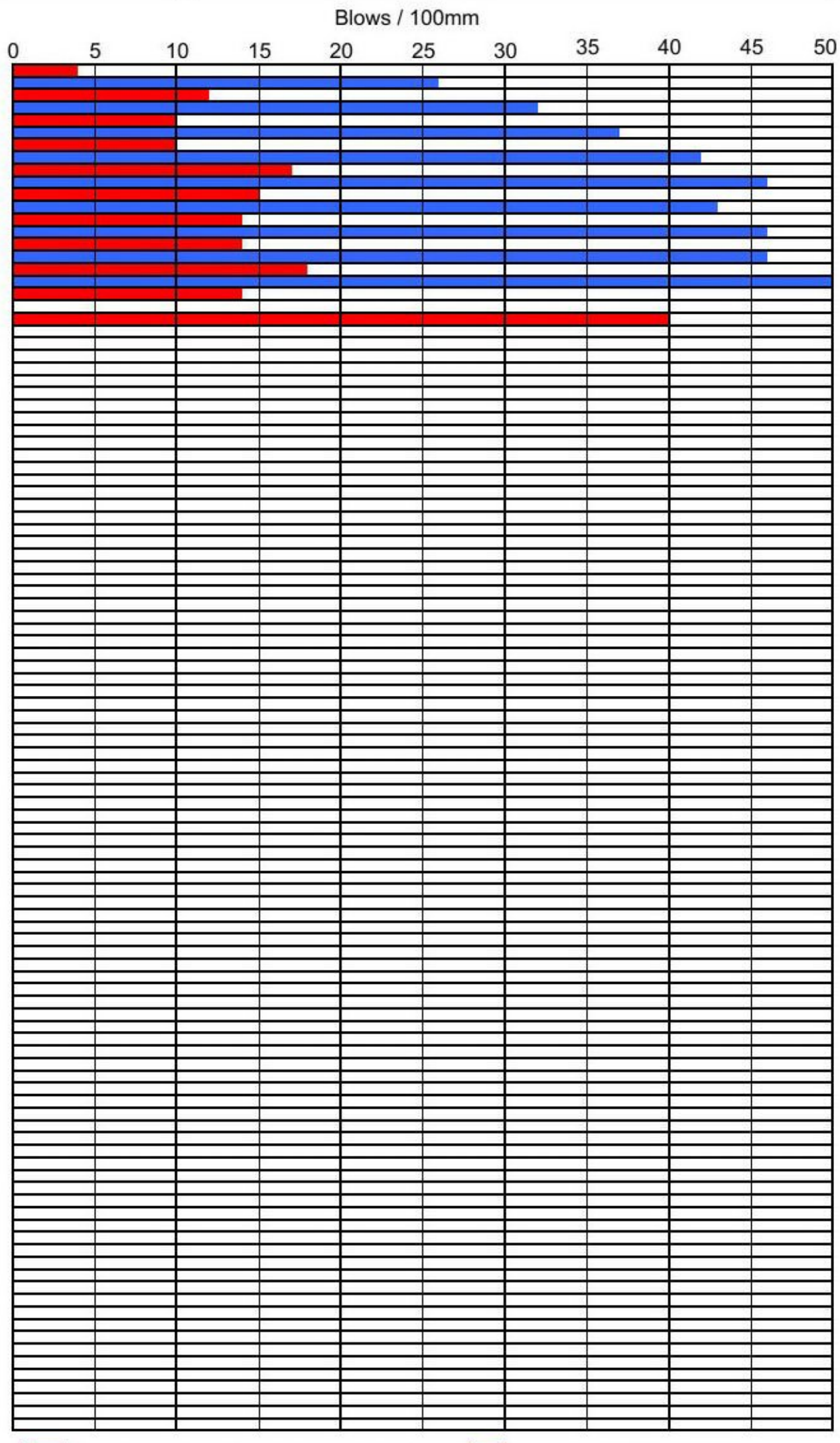

* Value is indicative only and must not be relied upon for design purposes

# DYNAMIC PROBE TEST RESULTS SHEET

| | |
|---|---|
| SITE: | Beal Station, Beal |
| DRILLER: | RD Drilling |
| PROBE NUMBER: | DP02 p2 |
| DATE: | 27-Jul-22 |

DPSH IN ACCORDANCE WITH BS 1377: PART 9: CLAUSE 3.2
PROBE HOLE BACKFILLED: Yes
REMARKS: Hole commenced at the base of DS02 at 5.00m bgl

| Depth (m) | Blows / 100mm | Approximate SPT 'N' value* |
|---|---|---|
| 10.5 | 4 | 26 |
| 10.6 | 12 | 32 |
| 10.7 | 10 | 37 |
| 10.8 | 10 | 42 |
| 10.9 | 17 | 46 |
| 11.0 | 15 | 43 |
| 11.1 | 14 | 46 |
| 11.2 | 14 | 46 |
| 11.3 | 18 | 72 |
| 11.4 | 14 | |
| 11.5 | 40 | |




Dynamic probe value (Blows/100mm)  Approximate SPT 'N' value

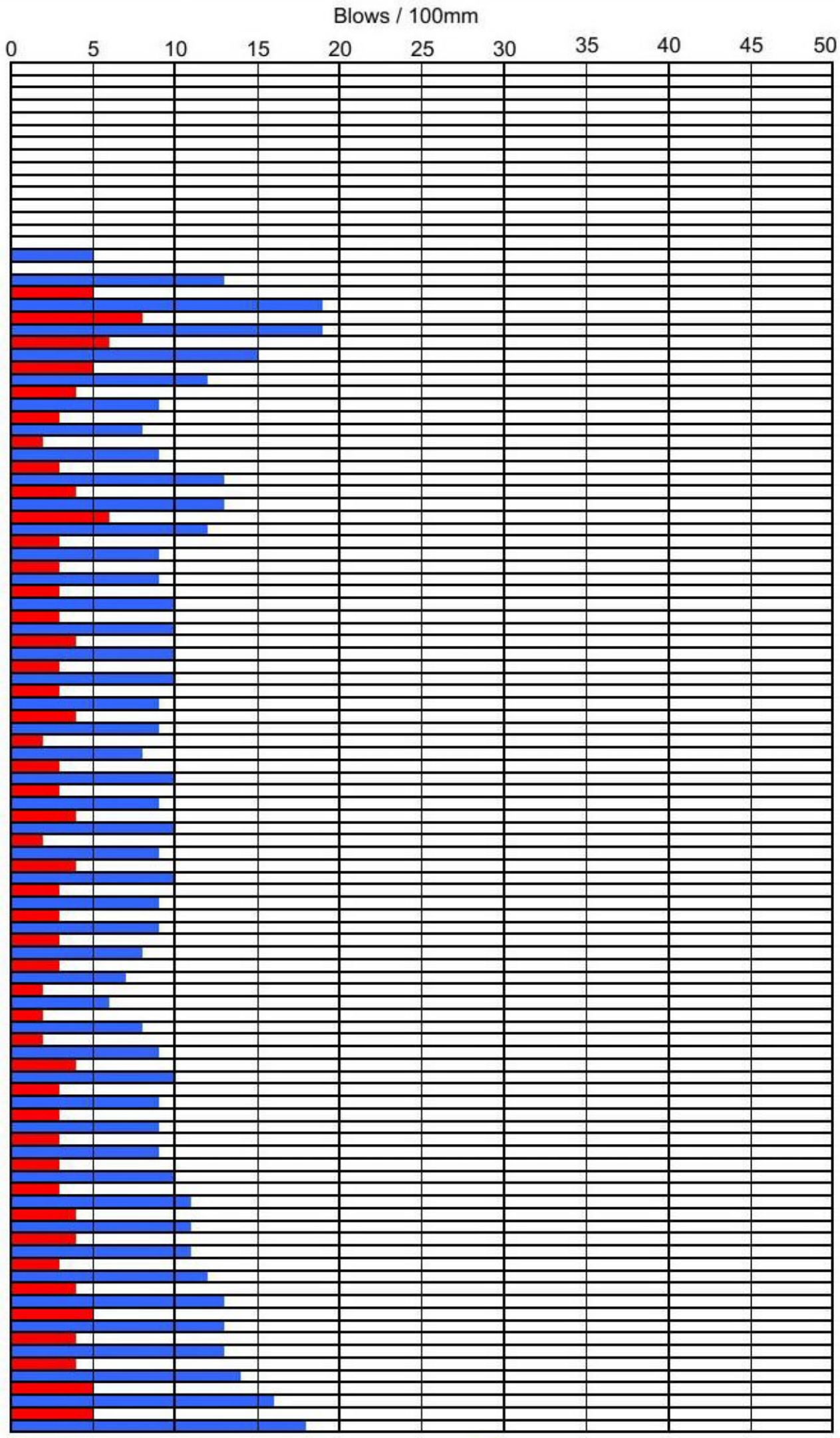
* Value is indicative only and must not be relied upon for design purposes

# DYNAMIC PROBE TEST RESULTS SHEET

| | |
|---|---|
| SITE: | Beal Station, Beal |
| DRILLER: | RD Drilling |
| PROBE NUMBER: | DP03 |
| DATE: | 27-Jul-22 |

DPSH IN ACCORDANCE WITH BS 1377: PART 9: CLAUSE 3.2
PROBE HOLE BACKFILLED: Yes
REMARKS: Hole commenced at the base of DS03 at 5.00m bgl

| Depth (m) | Blows / 100mm | Approximate SPT 'N' value* |
|---|---|---|
| 5.0 | 0 | 0 |
| 5.1 | 0 | 0 |
| 5.2 | 0 | 0 |
| 5.3 | 0 | 0 |
| 5.4 | 0 | 0 |
| 5.5 | 0 | 0 |
| 5.6 | 0 | 0 |
| 5.7 | 0 | 5 |
| 5.8 | 0 | 13 |
| 5.9 | 5 | 19 |
| 6.0 | 8 | 19 |
| 6.1 | 6 | 15 |
| 6.2 | 5 | 12 |
| 6.3 | 4 | 9 |
| 6.4 | 3 | 8 |
| 6.5 | 2 | 9 |
| 6.6 | 3 | 13 |
| 6.7 | 4 | 13 |
| 6.8 | 6 | 12 |
| 6.9 | 3 | 9 |
| 7.0 | 3 | 9 |
| 7.1 | 3 | 10 |
| 7.2 | 3 | 10 |
| 7.3 | 4 | 10 |
| 7.4 | 3 | 10 |
| 7.5 | 3 | 9 |
| 7.6 | 4 | 9 |
| 7.7 | 2 | 8 |
| 7.8 | 3 | 10 |
| 7.9 | 3 | 9 |
| 8.0 | 4 | 10 |
| 8.1 | 2 | 9 |
| 8.2 | 4 | 10 |
| 8.3 | 3 | 9 |
| 8.4 | 3 | 9 |
| 8.5 | 3 | 8 |
| 8.6 | 3 | 7 |
| 8.7 | 2 | 6 |
| 8.8 | 2 | 8 |
| 8.9 | 2 | 9 |
| 9.0 | 4 | 10 |
| 9.1 | 3 | 9 |
| 9.2 | 3 | 9 |
| 9.3 | 3 | 9 |
| 9.4 | 3 | 10 |
| 9.5 | 3 | 11 |
| 9.6 | 4 | 11 |
| 9.7 | 4 | 11 |
| 9.8 | 3 | 12 |
| 9.9 | 4 | 13 |
| 10.0 | 5 | 13 |
| 10.1 | 4 | 13 |
| 10.2 | 4 | 14 |
| 10.3 | 5 | 16 |
| 10.4 | 5 | 18 |



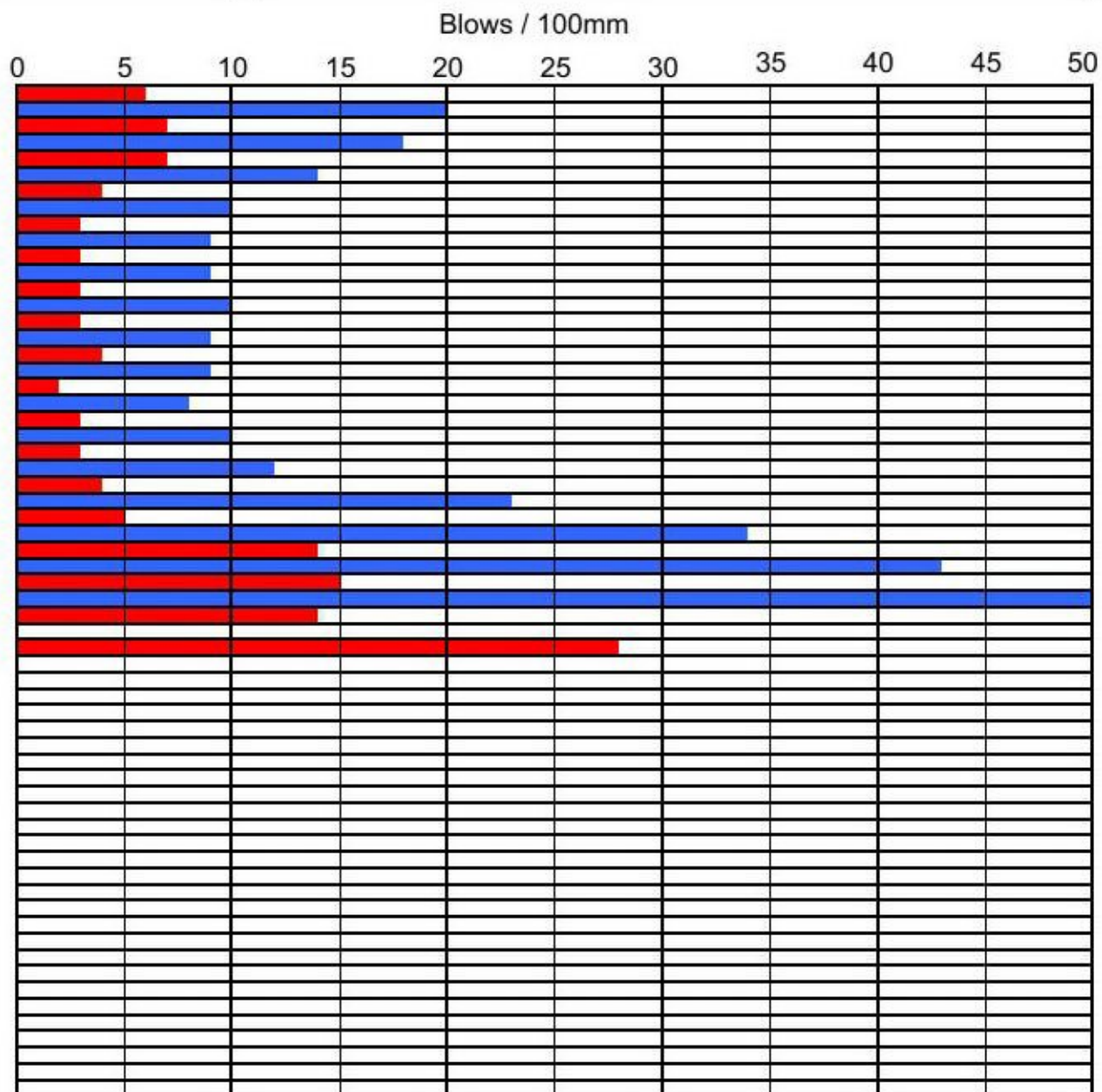

* Value is indicative only and must not be relied upon for design purposes

# DYNAMIC PROBE TEST RESULTS SHEET

| | |
|---|---|
| SITE: | Beal Station, Beal |
| DRILLER: | RD Drilling |
| PROBE NUMBER: | DP03 p2 |
| DATE: | 27-Jul-22 |

DPSH IN ACCORDANCE WITH BS 1377: PART 9: CLAUSE 3.2
PROBE HOLE BACKFILLED: Yes
REMARKS: Hole commenced at the base of DS03 at 5.00m bgl

| Depth (m) | Blows / 100mm | Approximate SPT 'N' value* |
|---|---|---|
| 10.5 | 6 | 20 |
| 10.6 | 7 | 18 |
| 10.7 | 7 | 14 |
| 10.8 | 4 | 10 |
| 10.9 | 3 | 9 |
| 11.0 | 3 | 9 |
| 11.1 | 3 | 10 |
| 11.2 | 3 | 9 |
| 11.3 | 4 | 9 |
| 11.4 | 2 | 8 |
| 11.5 | 3 | 10 |
| 11.6 | 3 | 12 |
| 11.7 | 4 | 23 |
| 11.8 | 5 | 34 |
| 11.9 | 14 | 43 |
| 12.0 | 15 | 57 |
| 12.1 | 14 | |
| 12.2 | 28 | |




Dynamic probe value (Blows/100mm)  Approximate SPT 'N' value

* Value is indicative only and must not be relied upon for design purposes

# APPENDIX 7

# CHEMICAL LABORATORY TEST RESULTS

**Alfie Leach**
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**e:** alfieleach@igeconsulting.co.uk

i2 Analytical Ltd.
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Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

**t:** 01923 225404
**f:** 01923 237404
**e:** reception@i2analytical.com

# Analytical Report Number : 22-74986

| | | | |
|---|---|---|---|
| **Project / Site name:** | Beal Station, Berwick | **Samples received on:** | 29/07/2022 |
| **Your job number:** | 3812 | **Samples instructed on/ Analysis started on:** | 02/08/2022 |
| **Your order number:** | 3812-01 | **Analysis completed by:** | 08/08/2022 |
| **Report Issue Number:** | 1 | **Report issued on:** | 08/08/2022 |
| **Samples Analysed:** | 4 soil samples | | |

**Signed** [redacted]

Anna Goc
Junior Reporting Specialist
**For & on behalf of i2 Analytical Ltd.**

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

**Analytical Report Number: 22-74986**
**Project / Site name: Beal Station, Berwick**
**Your Order No: 3812-01**

| Lab Sample Number | | | | 2371344 | 2371345 | 2371346 | 2371347 |
|---|---|---|---|---|---|---|---|
| Sample Reference | | | | DS01 | DS01 | DS02 | DS03 |
| Sample Number | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| Depth (m) | | | | 0.50 | 2.50 | 2.90 | 0.10 |
| Date Sampled | | | | 27/07/2022 | 27/07/2022 | 27/07/2022 | 27/07/2022 |
| Time Taken | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | |
| Stone Content | % | 0.1 | NONE | 33 | < 0.1 | < 0.1 | 68 |
| Moisture Content | % | 0.01 | NONE | 3.5 | 19 | 22 | 2.9 |
| Total mass of sample received | kg | 0.001 | NONE | 0.8 | 0.8 | 0.8 | 0.8 |
| Asbestos in Soil | Type | N/A | ISO 17025 | Not-detected | - | - | Not-detected |
| Asbestos Analyst ID | N/A | N/A | N/A | SZS | N/A | N/A | SZS |

**General Inorganics**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| pH - Automated | pH Units | N/A | MCERTS | 7.8 | 7.9 | 8.2 | 10.8 |
| Total Cyanide | mg/kg | 1 | MCERTS | < 1.0 | - | - | < 1.0 |
| Free Cyanide | mg/kg | 1 | MCERTS | < 1.0 | - | - | < 1.0 |
| Total Sulphate as SO4 | % | 0.005 | MCERTS | - | 0.008 | 0.037 | - |
| Water Soluble Sulphate as SO4 16hr extraction (2:1) | mg/kg | 2.5 | MCERTS | 32 | - | - | 440 |
| Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent) | g/l | 0.00125 | MCERTS | 0.016 | 0.022 | 0.12 | 0.22 |
| Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent) | mg/l | 1.25 | MCERTS | 15.9 | 22.1 | 121 | 220 |
| Water Soluble Chloride (2:1) (leachate equivalent) | mg/l | 0.5 | MCERTS | - | 8.1 | 16 | - |
| Total Sulphur | % | 0.005 | MCERTS | - | 0.011 | 0.208 | - |
| Ammoniacal Nitrogen as NH4 | mg/kg | 0.5 | MCERTS | - | 1 | 12 | - |
| Ammonium as NH4 (10:1 leachate equivalent) | mg/l | 0.05 | MCERTS | - | 0.1 | 1.19 | - |
| Organic Matter (automated) | % | 0.1 | MCERTS | 2.9 | - | - | 0.9 |
| Water Soluble Nitrate (2:1) as N (leachate equivalent) | mg/l | 2 | NONE | - | < 2.0 | < 2.0 | - |
| Water Soluble Nitrate (2:1) as NO3 | mg/kg | 2 | NONE | 19 | - | - | 6.2 |
| Water Soluble Nitrate (2:1) as NO3 (leachate equivalent) | mg/l | 5 | NONE | 9.7 | - | - | < 5.0 |

**Speciated PAHs**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Naphthalene | mg/kg | 0.05 | MCERTS | 0.27 | - | - | < 0.05 |
| Acenaphthylene | mg/kg | 0.05 | MCERTS | 0.48 | - | - | < 0.05 |
| Acenaphthene | mg/kg | 0.05 | MCERTS | 0.28 | - | - | < 0.05 |
| Fluorene | mg/kg | 0.05 | MCERTS | 0.45 | - | - | < 0.05 |
| Phenanthrene | mg/kg | 0.05 | MCERTS | 5.4 | - | - | 1.3 |
| Anthracene | mg/kg | 0.05 | MCERTS | 1.3 | - | - | 0.24 |
| Fluoranthene | mg/kg | 0.05 | MCERTS | 13 | - | - | 2 |
| Pyrene | mg/kg | 0.05 | MCERTS | 10 | - | - | 1.5 |
| Benzo(a)anthracene | mg/kg | 0.05 | MCERTS | 9 | - | - | 1.3 |
| Chrysene | mg/kg | 0.05 | MCERTS | 5 | - | - | 0.83 |
| Benzo(b)fluoranthene | mg/kg | 0.05 | MCERTS | 6.4 | - | - | 1 |
| Benzo(k)fluoranthene | mg/kg | 0.05 | MCERTS | 5.7 | - | - | 0.86 |
| Benzo(a)pyrene | mg/kg | 0.05 | MCERTS | 6.6 | - | - | 0.99 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.05 | MCERTS | 3.5 | - | - | 0.57 |
| Dibenz(a,h)anthracene | mg/kg | 0.05 | MCERTS | 1.1 | - | - | < 0.05 |
| Benzo(ghi)perylene | mg/kg | 0.05 | MCERTS | 4.1 | - | - | 0.66 |

**Total PAH**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Speciated Total EPA-16 PAHs | mg/kg | 0.8 | MCERTS | 72.4 | - | - | 11.3 |

**Analytical Report Number: 22-74986**
**Project / Site name: Beal Station, Berwick**
**Your Order No: 3812-01**

| Lab Sample Number | | | | 2371344 | 2371345 | 2371346 | 2371347 |
|---|---|---|---|---|---|---|---|
| Sample Reference | | | | DS01 | DS01 | DS02 | DS03 |
| Sample Number | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| Depth (m) | | | | 0.50 | 2.50 | 2.90 | 0.10 |
| Date Sampled | | | | 27/07/2022 | 27/07/2022 | 27/07/2022 | 27/07/2022 |
| Time Taken | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | |
| **Heavy Metals / Metalloids** | | | | | | | |
| Arsenic (aqua regia extractable) | mg/kg | 1 | MCERTS | 6.9 | - | - | 5.3 |
| Barium (aqua regia extractable) | mg/kg | 1 | MCERTS | 290 | - | - | 180 |
| Boron (water soluble) | mg/kg | 0.2 | MCERTS | 0.7 | - | - | 0.6 |
| Cadmium (aqua regia extractable) | mg/kg | 0.2 | MCERTS | < 0.2 | - | - | < 0.2 |
| Chromium (hexavalent) | mg/kg | 1.2 | NONE | < 1.2 | - | - | < 1.2 |
| Chromium (aqua regia extractable) | mg/kg | 1 | MCERTS | 18 | - | - | 28 |
| Copper (aqua regia extractable) | mg/kg | 1 | MCERTS | 43 | - | - | 48 |
| Lead (aqua regia extractable) | mg/kg | 1 | MCERTS | 250 | - | - | 110 |
| Mercury (aqua regia extractable) | mg/kg | 0.3 | MCERTS | < 0.3 | - | - | < 0.3 |
| Nickel (aqua regia extractable) | mg/kg | 1 | MCERTS | 15 | - | - | 22 |
| Selenium (aqua regia extractable) | mg/kg | 1 | MCERTS | < 1.0 | - | - | < 1.0 |
| Vanadium (aqua regia extractable) | mg/kg | 1 | MCERTS | 33 | - | - | 82 |
| Zinc (aqua regia extractable) | mg/kg | 1 | MCERTS | 130 | - | - | 100 |
| Magnesium (water soluble) | mg/kg | 5 | NONE | - | < 5.0 | 17 | - |
| Magnesium (leachate equivalent) | mg/l | 2.5 | NONE | - | < 2.5 | 8.7 | - |
| **Petroleum Hydrocarbons** | | | | | | | |
| Petroleum Range Organics (C6 - C10) HS_1D_TOTAL | mg/kg | 0.1 | MCERTS | < 0.1 | - | - | < 0.1 |
| TPH C10 - C40 EH_CU_1D_TOTAL | mg/kg | 10 | MCERTS | 180 | - | - | 69 |
| TPH2 (C6 - C10) HS_1D_TOTAL | mg/kg | 0.1 | MCERTS | < 0.1 | - | - | < 0.1 |
| TPH C6 - C40 EH_CU+HS_CU_1D_TOTAL | mg/kg | 10 | NONE | 180 | - | - | 69 |
| TPH (C10 - C25) EH_CU_1D_TOTAL | mg/kg | 10 | MCERTS | 85 | - | - | 23 |
| TPH (C25 - C40) EH_CU_1D_TOTAL | mg/kg | 10 | MCERTS | 98 | - | - | 46 |

U/S = Unsuitable Sample  I/S = Insufficient Sample

**Analytical Report Number : 22-74986**
**Project / Site name: Beal Station, Berwick**

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

| Lab Sample Number | Sample Reference | Sample Number | Depth (m) | Sample Description * |
|---|---|---|---|---|
| 2371344 | DS01 | None Supplied | 0.5 | Brown loam and sand with vegetation and stones. |
| 2371345 | DS01 | None Supplied | 2.5 | Brown clay and loam. |
| 2371346 | DS02 | None Supplied | 2.9 | Brown sandy clay. |
| 2371347 | DS03 | None Supplied | 0.1 | Brown loam and clay with rubble and stones. |

**Analytical Report Number : 22-74986**
**Project / Site name: Beal Station, Berwick**

**Water matrix abbreviations:**
**Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)**

| Analytical Test Name | Analytical Method Description | Analytical Method Reference | Method number | Wet / Dry Analysis | Accreditation Status |
|---|---|---|---|---|---|
| Sulphate, water soluble, in soil (16hr extraction) | Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent). | In house method. | L038-PL | D | MCERTS |
| Metals in soil by ICP-OES | Determination of metals in soil by aqua-regia digestion followed by ICP-OES. | In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil. | L038-PL | D | MCERTS |
| Asbestos identification in soil | Asbestos Identification with the use of polarised light microscopy in conjunction with dispersion staining techniques. | In house method based on HSG 248 | A001-PL | D | ISO 17025 |
| Boron, water soluble, in soil | Determination of water soluble boron in soil by hot water extract followed by ICP-OES. | In-house method based on Second Site Properties version 3 | L038-PL | D | MCERTS |
| Free cyanide in soil | Determination of free cyanide by distillation followed by colorimetry. | In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar) | L080-PL | W | MCERTS |
| Magnesium, water soluble, in soil | Determination of water soluble magnesium by extraction with water followed by ICP-OES. | In-house method based on TRL 447 | L038-PL | D | NONE |
| Moisture Content | Moisture content, determined gravimetrically. (30 oC) | In house method. | L019-UK/PL | W | NONE |
| Nitrate, water soluble, in soil | Determination of nitrate by reaction with sodium salicylate and colorimetry. | In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction. | L078-PL | D | NONE |
| Speciated EPA-16 PAHs in soil | Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards. | In-house method based on USEPA 8270 | L064-PL | D | MCERTS |
| pH in soil (automated) | Determination of pH in soil by addition of water followed by automated electrometric measurement. | In house method. | L099-PL | D | MCERTS |
| PRO (Soil) | Determination of hydrocarbons C6-C10 by headspace GC-MS. | In-house method based on USEPA8260 | L088-PL | W | MCERTS |
| Stones content of soil | Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight. | In-house method based on British Standard Methods and MCERTS requirements. | L019-UK/PL | D | NONE |
| TPH2 (Soil) | Determination of hydrocarbons C6-C10 by headspace GC-MS. | In-house method based on USEPA8260 | L088-PL | W | MCERTS |
| Total cyanide in soil | Determination of total cyanide by distillation followed by colorimetry. | In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar) | L080-PL | W | MCERTS |
| Ammonium as NH4 in soil | Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction. | In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton | L082-PL | W | MCERTS |
| TPH Oils (Soils) | Determination of extractable hydrocarbons in soil by GC-MS/FID. | In-house method with silica gel split/clean up. | L076-PL | D | MCERTS |
| DRO (Soil) | Determination of extractable hydrocarbons in soil by GC-MS/FID. | In-house method with silica gel split/clean up. | L076-PL | D | MCERTS |

**Analytical Report Number : 22-74986**
**Project / Site name: Beal Station, Berwick**

**Water matrix abbreviations:**
**Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)**

| Analytical Test Name | Analytical Method Description | Analytical Method Reference | Method number | Wet / Dry Analysis | Accreditation Status |
|---|---|---|---|---|---|
| TPH Banding in Soil by FID | Determination of hexane extractable hydrocarbons in soil by GC-FID. | In-house method, TPH with carbon banding and silica gel split/cleanup. | L076-PL | D | MCERTS |
| Organic matter (Automated) in soil | Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate. | In house method. | L009-PL | D | MCERTS |
| Hexavalent chromium in soil (Lower Level) | Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry. | In-house method | L080-PL | W | NONE |
| Total Sulphate in soil as % | Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES. | In house method. | L038-PL | D | MCERTS |
| Total Sulphur in soil as % | Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES. | In house method. | L038-PL | D | MCERTS |
| D.O. for Gravimetric Quant if Screen/ID positive | Dependent option for Gravimetric Quant if Screen/ID positive scheduled. | In house asbestos methods A001 & A006. | A006-PL | D | NONE |
| TPH C6 - C40 (soil) | Determination of TPH bands by HS-GC-MS/GC-FID | TPH> C10 Dry soil n-house method with silica gel split/clean up. TPH <C10 by Wet by HS-GC-MS | L088/L076 | | NONE |
| Water Soluble Nitrate (2:1) as N in soil | Determination of nitrate by reaction with sodium salicylate and colorimetry. | In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction. | L078-PL | W | NONE |
| Chloride, water soluble, in soil | Determination of Chloride colorimetrically by discrete analyser. | In house method. | L082-PL | D | MCERTS |
| Water Soluble Nitrate (leachate equivalent) | Determination of nitrate by reaction with sodium salicylate and colorimetry. | In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction. | L078-PL | D | NONE |
| Sulphate, water soluble, in soil | Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent). | In house method. | L038-PL | D | MCERTS |

**For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.**
**For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.**
**Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.**

**Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.**

**Analytical Report Number : 22-74986**
**Project / Site name: Beal Station, Berwick**

**Water matrix abbreviations:**
**Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)**

| Analytical Test Name | Analytical Method Description | Analytical Method Reference | Method number | Wet / Dry Analysis | Accreditation Status |
|---|---|---|---|---|---|

## Information in Support of Analytical Results

**List of HWOL Acronyms and Operators**

| Acronym | Descriptions |
|---|---|
| HS | Headspace Analysis |
| MS | Mass spectrometry |
| FID | Flame Ionisation Detector |
| GC | Gas Chromatography |
| EH | Extractable Hydrocarbons (i.e. everything extracted by the solvent(s)) |
| CU | Clean-up - e.g. by Florisil®, silica gel |
| 1D | GC - Single coil/column gas chromatography |
| 2D | GC-GC - Double coil/column gas chromatography |
| Total | Aliphatics & Aromatics |
| AL | Aliphatics |
| AR | Aromatics |
| #1 | EH_2D_Total but with humics mathematically subtracted |
| #2 | EH_2D_Total but with fatty acids mathematically subtracted |
| _ | Operator - understore to separate acronyms (exception for +) |
| + | Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total |

# APPENDIX 8

# CHEMICAL RESULT SCREENING

**Project:** Beal Station, Beal

**Job No:** 3812

| Lab Sample Number | | | 2371344 | 2371347 | Statistical Analysis | | | | | GAC - S4UL unless stated Statistical Results | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Reference | | | DS01 | DS03 | | | | | | | | | |
| Sample Number | | | None Supplied | None Supplied | | | | | | | | | |
| Depth (m) | | | 0.50 | 0.10 | | | | | | | | | |
| Date Sampled | | | 27/07/2022 | 27/07/2022 | | | | | | | | | |
| Time Taken | | | None Supplied | None Supplied | | | | | | | | | |
| **Analytical Parameter (Soil Analysis)** | **Units** | **LoD** | | | Count | Standard Deviation | Minimum | Maximum | Average | Maximum | **1% Residential without Home Grown Produce** | Pass/ Fail | Exceedances |
| Stone Content | % | 0.1 | 33 | 68 | 2 | 24.75 | 33.0 | 68.0 | 50.5 | 68.0 | | | |
| Moisture Content | % | 0.01 | 3.5 | 2.9 | 2 | 0.42 | 2.90 | 3.50 | 3.20 | 3.50 | | | |
| Total mass of sample received | kg | 0.001 | 0.8 | 0.8 | 2 | 0.00 | 0.800 | 0.800 | 0.800 | 0.800 | | | |
| Asbestos in Soil Screen / Identification Name | Type | N/A | Not-detected | Not-detected | 0 | - | - | - | - | | | | |
| **General Inorganics** | | | | | | | | | | | | | |
| pH - Automated | pH Units | N/A | 7.8 | 10.8 | 2 | 2.12 | 7.80 | 10.80 | 9.30 | | | | |
| Total Cyanide | mg/kg | 1 | 1 | 1 | 2 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | **60** | Pass | 0 |
| Free Cyanide | mg/kg | 1 | 1 | 1 | 2 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | **60** | Pass | 0 |
| Water Soluble Sulphate as SO4 16hr extraction (2:1) | mg/kg | 2.50 | 32 | 440 | 2 | 288.50 | 32.00 | 440.00 | 236.00 | | | | |
| Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent) | g/l | 0.00125 | 0.016 | 0.22 | 2 | 0.14425 | 0.01600 | 0.22000 | 0.11800 | | | | |
| Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent) | mg/l | 1.25 | 15.9 | 220 | 2 | 144.32 | 15.90 | 220.00 | 117.95 | | | | |
| Water Soluble Chloride (2:1) (leachate equivalent) | mg/l | 0.5 | - | - | 0 | - | 0.0 | 0.0 | - | | | | |
| Organic Matter (automated) | % | 0.1 | 2.9 | 0.9 | 2 | 1.41 | 0.90 | 2.90 | 1.90 | | | | |
| Water Soluble Nitrate (2:1) as NO3 | mg/kg | 2 | 19 | 6.2 | 2 | 9.05 | 6.20 | 19.00 | 12.60 | | | | |
| Water Soluble Nitrate (2:1) as NO3 (leachate equivalent) | mg/l | 5 | 9.7 | 5 | 2 | 3.32 | 5.00 | 9.70 | 7.35 | | | | |
| **Speciated PAHs** | | | | | | | | | | | | | |
| Naphthalene | mg/kg | 0.05 | 0.27 | 0.05 | 2 | 0.16 | 0.05 | 0.27 | 0.16 | 0.27 | **2.30** | Pass | 0 |
| Acenaphthylene | mg/kg | 0.05 | 0.48 | 0.05 | 2 | 0.30 | 0.05 | 0.48 | 0.27 | 0.48 | **2900** | Pass | 0 |
| Acenaphthene | mg/kg | 0.05 | 0.28 | 0.05 | 2 | 0.16 | 0.05 | 0.28 | 0.17 | 0.28 | **3000** | Pass | 0 |
| Fluorene | mg/kg | 0.05 | 0.45 | 0.05 | 2 | 0.28 | 0.05 | 0.45 | 0.25 | 0.45 | **2800** | Pass | 0 |
| Phenanthrene | mg/kg | 0.05 | 5.4 | 1.3 | 2 | 2.90 | 1.30 | 5.40 | 3.35 | 5.40 | **1300** | Pass | 0 |
| Anthracene | mg/kg | 0.05 | 1.3 | 0.24 | 2 | 0.75 | 0.24 | 1.30 | 0.77 | 1.30 | **31000** | Pass | 0 |
| Fluoranthene | mg/kg | 0.05 | 13 | 2 | 2 | 7.78 | 2.00 | 13.00 | 7.50 | 13.00 | **1500** | Pass | 0 |
| Pyrene | mg/kg | 0.05 | 10 | 1.5 | 2 | 6.01 | 1.50 | 10.00 | 5.75 | 10.00 | **3700** | Pass | 0 |
| Benzo(a)anthracene | mg/kg | 0.05 | 9 | 1.3 | 2 | 5.44 | 1.30 | 9.00 | 5.15 | 9.00 | **11.00** | Pass | 0 |
| Chrysene | mg/kg | 0.05 | 5 | 0.83 | 2 | 2.95 | 0.83 | 5.00 | 2.92 | 5.00 | **30** | Pass | 0 |
| Benzo(b)fluoranthene | mg/kg | 0.05 | 6.4 | 1 | 2 | 3.82 | 1.00 | 6.40 | 3.70 | 6.40 | **3.90** | Fail | 1 |
| Benzo(k)fluoranthene | mg/kg | 0.05 | 5.7 | 0.86 | 2 | 3.42 | 0.86 | 5.70 | 3.28 | 5.70 | **110** | Pass | 0 |
| Benzo(a)pyrene | mg/kg | 0.05 | 6.6 | 0.99 | 2 | 3.97 | 0.99 | 6.60 | 3.80 | 6.60 | **3.20** | Fail | 1 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.05 | 3.5 | 0.57 | 2 | 2.07 | 0.57 | 3.50 | 2.04 | 3.50 | **45** | Pass | 0 |
| Dibenz(a,h)anthracene | mg/kg | 0.05 | 1.1 | 0.05 | 2 | 0.74 | 0.05 | 1.10 | 0.58 | 1.10 | **0.31** | Fail | 1 |
| Benzo(ghi)perylene | mg/kg | 0.05 | 4.1 | 0.66 | 2 | 2.43 | 0.66 | 4.10 | 2.38 | 4.10 | **360** | Pass | 0 |
| **Total PAH** | | | | | | | | | | | | | |
| Speciated Total EPA-16 PAHs | mg/kg | 0.8 | 72.4 | 11.3 | 2 | 43.20 | 11.30 | 72.40 | 41.85 | | | | |
| **Heavy Metals / Metalloids** | | | | | | | | | | | | | |
| Arsenic (aqua regia extractable) | mg/kg | 1 | 6.9 | 5.3 | 2 | 1.13 | 5.30 | 6.90 | 6.10 | 6.90 | **40** | Pass | 0 |
| Barium (aqua regia extractable) | mg/kg | 1 | 290 | 180 | 2 | 77.78 | 180.00 | 290.00 | 235.00 | 290.00 | **1300.00** | Pass | 0 |
| Boron (water soluble) | mg/kg | 0.2 | 0.7 | 0.6 | 2 | 0.07 | 0.60 | 0.70 | 0.65 | 0.70 | **11000** | Pass | 0 |
| Cadmium (aqua regia extractable) | mg/kg | 0.2 | 0.2 | 0.2 | 2 | 0.00 | 0.20 | 0.20 | 0.20 | 0.20 | **85** | Pass | 0 |
| Chromium (hexavalent) | mg/kg | 1.2 | 1.2 | 1.2 | 2 | 0.00 | 1.20 | 1.20 | 1.20 | 1.20 | **6** | Pass | 0 |
| Chromium (aqua regia extractable) | mg/kg | 1 | 18 | 28 | 2 | 7.07 | 18.00 | 28.00 | 23.00 | 28.00 | **910** | Pass | 0 |
| Copper (aqua regia extractable) | mg/kg | 1 | 43 | 48 | 2 | 3.54 | 43.00 | 48.00 | 45.50 | 48.00 | **7100** | Pass | 0 |
| Lead (aqua regia extractable) | mg/kg | 1 | 250 | 110 | 2 | 98.99 | 110.00 | 250.00 | 180.00 | 250.00 | **310** | Pass | 0 |
| Mercury (aqua regia extractable) | mg/kg | 0.3 | 0.3 | 0.3 | 2 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 | **56** | Pass | 0 |
| Nickel (aqua regia extractable) | mg/kg | 1 | 15 | 22 | 2 | 4.95 | 15.00 | 22.00 | 18.50 | 22.00 | **180** | Pass | 0 |
| Selenium (aqua regia extractable) | mg/kg | 1 | 1 | 1 | 2 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | **430** | Pass | 0 |
| Vanadium (aqua regia extractable) | mg/kg | 1 | 33 | 82 | 2 | 34.65 | 33.00 | 82.00 | 57.50 | 82.00 | **1200** | Pass | 0 |
| Zinc (aqua regia extractable) | mg/kg | 1 | 130 | 100 | 2 | 21.21 | 100.00 | 130.00 | 115.00 | 130.00 | **40000** | Pass | 0 |
| **Petroleum Hydrocarbons** | | | | | | | | | | | | | |
| Petroleum Range Organics (C6 - C10) | mg/kg | 0.1 | 0.1 | 0.1 | 2 | 0.00 | 0.10 | 0.10 | 0.10 | | | | |
| TPH C10 - C40 | mg/kg | 10 | 180 | 69 | 2 | 78.49 | 69.00 | 180.00 | 124.50 | | | | |
| TPH2 (C6 - C10) | mg/kg | 0.1 | 0.1 | 0.1 | 2 | 0.00 | 0.10 | 0.10 | 0.10 | | | | |
| TPH C6 - C40 | mg/kg | 10 | 180 | 69 | 2 | 78.49 | 69.00 | 180.00 | 124.50 | | | | |
| TPH (C10 - C25) | mg/kg | 10 | 85 | 23 | 2 | 43.84 | 23.00 | 85.00 | 54.00 | | | | |
| TPH (C25 - C40) | mg/kg | 10 | 98 | 46 | 2 | 36.77 | 46.00 | 98.00 | 72.00 | | | | |

**GAC used: LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment (3rd edition, 2015)**

**Category 4 Screening Levels (March 2014) used for Arsenic**

**In-house methodology used for Cyanide - no GAC currently available**

**Exceeded GAC & C4SL**

**Exceeded GAC but not C4SL**

**Recorded below laboratory detection limit**

**This spreadsheet has been developed by IGE Consulting Ltd**

# APPENDIX 9

# GEOTECHNICAL LABORATORY TEST RESULTS

# TEST CERTIFICATE

**DETERMINATION OF LIQUID AND PLASTIC LIMITS**

Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

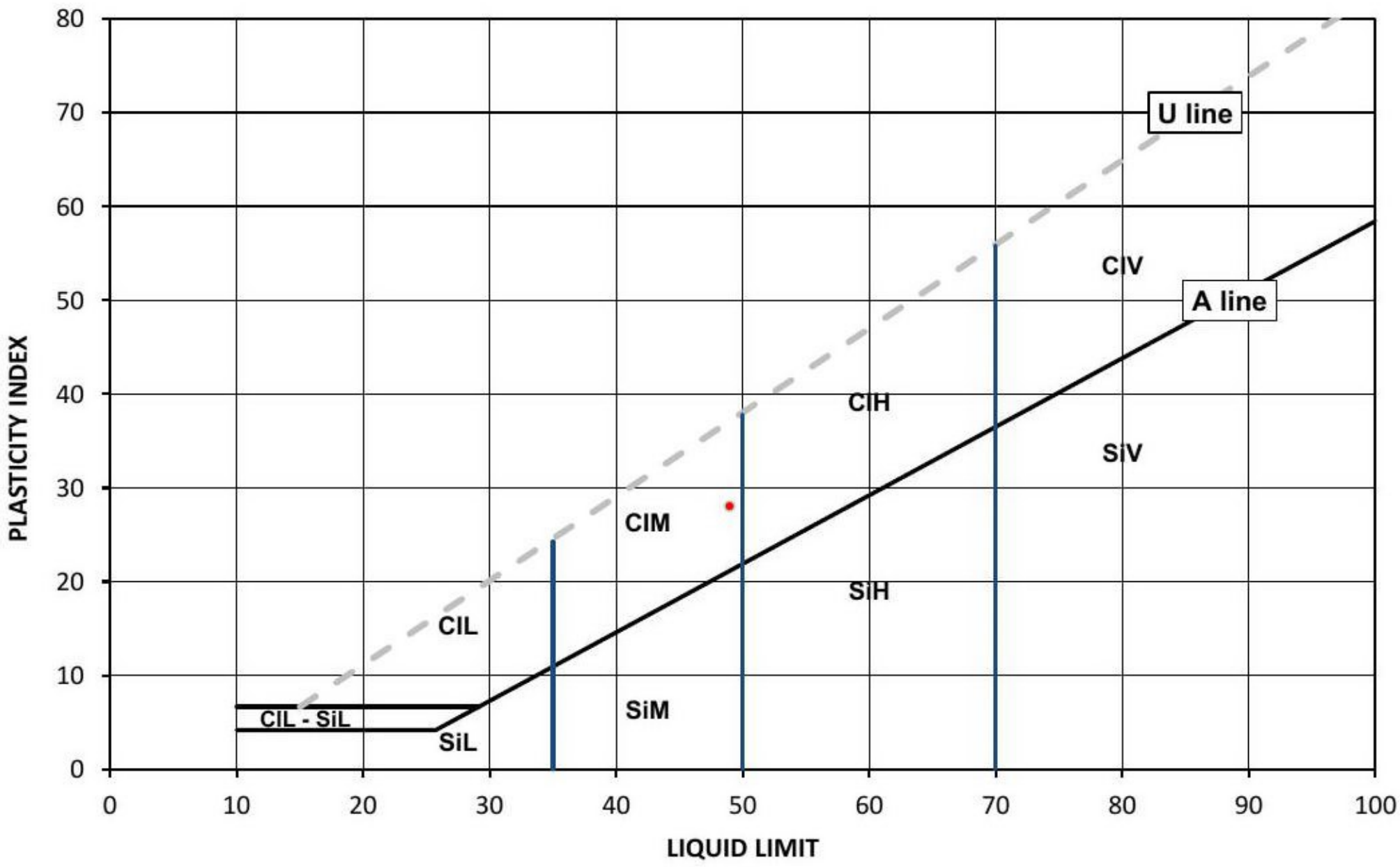
| | | | |
|---|---|---|---|
| Client: | IGE Consulting | Client Reference: | 3812 |
| Client Address: | Office 11, Bartle House,<br>Oxford Court, Manchester,<br>M2 3WQ | Job Number: | 22-74984 |
| | | Date Sampled: | 27/07/2022 |
| | | Date Received: | 29/07/2022 |
| Contact: | Alfie Leach | Date Tested: | 08/08/2022 |
| Site Address: | Beal Station, Berwick | Sampled By: | Not Given |

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

## Test Results:

| | | | |
|---|---|---|---|
| Laboratory Reference: | 2371332 | Depth Top [m]: | 2.20 |
| Hole No.: | DS01 | Depth Base [m]: | 2.50 |
| Sample Reference: | Not Given | Sample Type: | B |
| Sample Description: | Brownish grey slightly sandy CLAY | | |
| Sample Preparation: | Tested in natural condition | | |

| As Received Water Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|---|---|---|---|---|
| 17 | 49 | 21 | 28 | 100 |




Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

| | | Plasticity | | Liquid Limit |
|---|---|---|---|---|
| Cl | Clay | L | Low | below 35 |
| Si | Silt | M | Medium | 35 to 50 |
| | | H | High | 50 to 70 |
| | | V | Very high | exceeding 70 |
| | | O | Organic | append to classification for organic material ( eg ClHO ) |

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:



**Signed:** [redacted]

Katarzyna Koziel
Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 19/08/2022

**GF 232.12**

# SUMMARY REPORT

## DETERMINATION OF WATER CONTENT

Tested in Accordance with: BS 1377-2: 1990: Clause 3.2

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client: IGE Consulting

Client Address: Office 11, Bartle House,
Oxford Court, Manchester,
M2 3WQ

Contact: Alfie Leach

Site Address: Beal Station, Berwick

Client Reference: 3812
Job Number: 22-74984
Date Sampled: 27/07/2022
Date Received: 29/07/2022
Date Tested: 08/08/2022
Sampled By: Not Given

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

### Test results

| Laboratory Reference | Hole No. | Sample | | | | Description | Remarks | WC | Sample preparation / Oven temperature at the time of testing | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Reference | Depth Top m | Depth Base m | Type | | | % | | | | |
| 2371332 | DS01 | Not Given | 2.20 | 2.50 | B | Brownish grey slightly sandy CLAY | | 17 | Sample was quartered, oven dried at 106 °C | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |

Comments:



**Signed:** Katarzyna Koziel

Katarzyna Koziel
Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 19/08/2022

**GF 099.16**

# TEST CERTIFICATE

## DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Tested in Accordance with: BS 1377-2: 1990

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

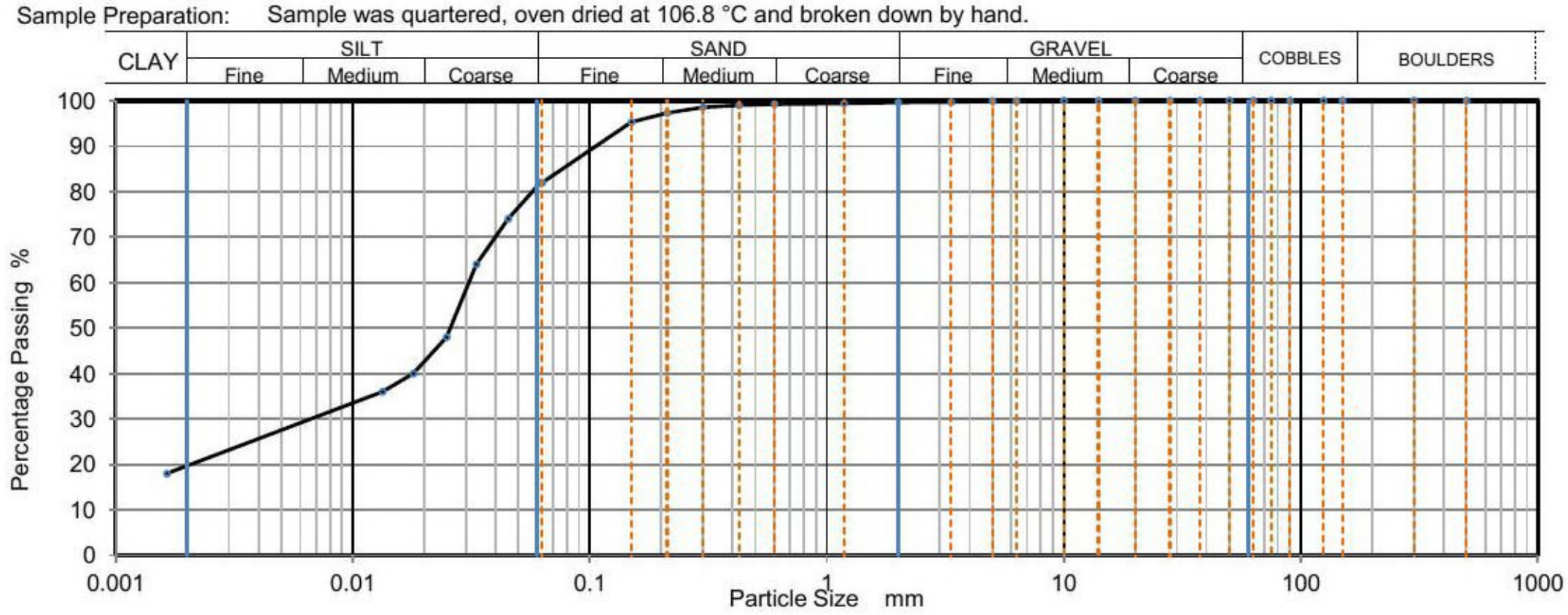
Environmental Science

| | | | |
|---|---|---|---|
| Client: | IGE Consulting | Client Reference: | 3812 |
| Client Address: | Office 11, Bartle House,<br>Oxford Court, Manchester,<br>M2 3WQ | Job Number: | 22-74984 |
| | | Date Sampled: | 27/07/2022 |
| | | Date Received: | 29/07/2022 |
| Contact: | Alfie Leach | Date Tested: | 08/08/2022 |
| Site Address: | Beal Station, Berwick | Sampled By: | Not Given |

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 2371333 | Depth Top [m]: | 3.30 |
| Hole No.: | DS01 | Depth Base [m]: | 3.70 |
| Sample Reference: | Not Given | Sample Type: | B |
| Sample Description: | Brown sandy clayey SILT | | |
| Sample Preparation: | Sample was quartered, oven dried at 106.8 °C and broken down by hand. | | |




| Sieving | | Sedimentation | |
|---|---|---|---|
| Particle Size mm | % Passing | Particle Size mm | % Passing |
| 500 | 100 | 0.0619 | 82 |
| 300 | 100 | 0.0452 | 74 |
| 150 | 100 | 0.0332 | 64 |
| 125 | 100 | 0.0248 | 48 |
| 90 | 100 | 0.0180 | 40 |
| 75 | 100 | 0.0133 | 36 |
| 63 | 100 | 0.0016 | 18 |
| 50 | 100 | | |
| 37.5 | 100 | | |
| 28 | 100 | | |
| 20 | 100 | | |
| 14 | 100 | | |
| 10 | 100 | | |
| 6.3 | 100 | | |
| 5 | 100 | | |
| 3.35 | 100 | Particle density | (assumed) |
| 2 | 100 | 2.65 | Mg/m3 |
| 1.18 | 99 | | |
| 0.6 | 99 | | |
| 0.425 | 99 | | |
| 0.3 | 99 | | |
| 0.212 | 97 | | |
| 0.15 | 95 | | |
| 0.063 | 82 | | |

| Sample Proportions | % dry mass |
|---|---|
| Very coarse | 0 |
| Gravel | 0 |
| Sand | 18 |
| Silt | 62 |
| Clay | 20 |

| Grading Analysis | | |
|---|---|---|
| D100 | mm | 10 |
| D60 | mm | 0.0309 |
| D30 | mm | 0.00666 |
| D10 | mm | |
| Uniformity Coefficient | | > 19 |
| Curvature Coefficient | | |

Uniformity Coefficient calculated in accordance with BS EN ISO 14688-2:2018

Note: Tested in Accordance with BS1377:Part 2:1990, clauses 9.2 and 9.5

Remarks:



**Signed:** Katarzyna Koziel

Katarzyna Koziel
Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 19/08/2022

**GF 100.21**

4041

# TEST CERTIFICATE

## DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Tested in Accordance with: BS 1377-2: 1990

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

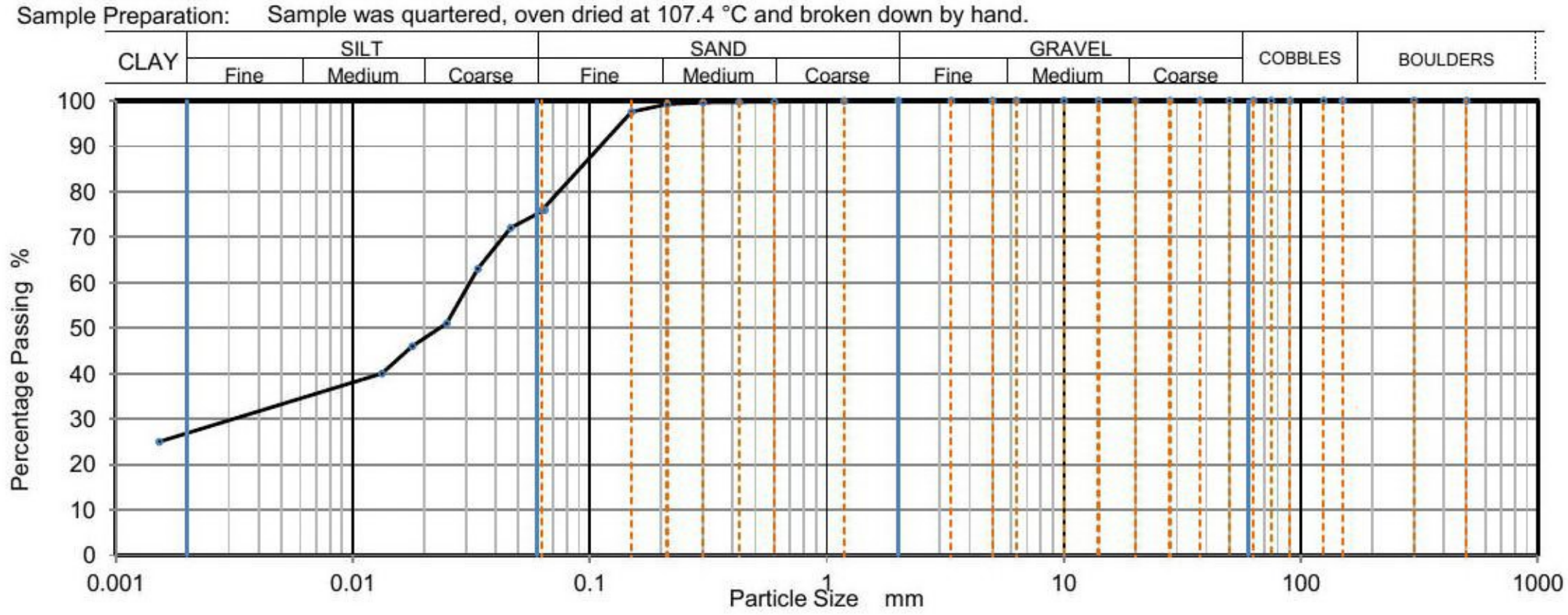
Environmental Science

| | | | |
|---|---|---|---|
| Client: | IGE Consulting | Client Reference: | 3812 |
| Client Address: | Office 11, Bartle House,<br>Oxford Court, Manchester,<br>M2 3WQ | Job Number: | 22-74984 |
| | | Date Sampled: | 27/07/2022 |
| | | Date Received: | 29/07/2022 |
| Contact: | Alfie Leach | Date Tested: | 08/08/2022 |
| Site Address: | Beal Station, Berwick | Sampled By: | Not Given |

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

## Test Results:

| | | | |
|---|---|---|---|
| Laboratory Reference: | 2371334 | Depth Top [m]: | 4.00 |
| Hole No.: | DS02 | Depth Base [m]: | 4.50 |
| Sample Reference: | Not Given | Sample Type: | B |
| Sample Description: | Brown sandy very clayey SILT | | |
| Sample Preparation: | Sample was quartered, oven dried at 107.4 °C and broken down by hand. | | |




| Sieving | | Sedimentation | |
|---|---|---|---|
| Particle Size mm | % Passing | Particle Size mm | % Passing |
| 500 | 100 | 0.0644 | 76 |
| 300 | 100 | 0.0463 | 72 |
| 150 | 100 | 0.0337 | 63 |
| 125 | 100 | 0.0248 | 51 |
| 90 | 100 | 0.0178 | 46 |
| 75 | 100 | 0.0132 | 40 |
| 63 | 100 | 0.0015 | 25 |
| 50 | 100 | | |
| 37.5 | 100 | | |
| 28 | 100 | | |
| 20 | 100 | | |
| 14 | 100 | | |
| 10 | 100 | | |
| 6.3 | 100 | | |
| 5 | 100 | | |
| 3.35 | 100 | Particle density | (assumed) |
| 2 | 100 | 2.65 | Mg/m3 |
| 1.18 | 100 | | |
| 0.6 | 100 | | |
| 0.425 | 100 | | |
| 0.3 | 100 | | |
| 0.212 | 99 | | |
| 0.15 | 98 | | |
| 0.063 | 76 | | |

| Sample Proportions | % dry mass |
|---|---|
| Very coarse | 0 |
| Gravel | 0 |
| Sand | 24 |
| Silt | 49 |
| Clay | 27 |

| Grading Analysis | | |
|---|---|---|
| D100 | mm | 3.35 |
| D60 | mm | 0.0311 |
| D30 | mm | 0.00302 |
| D10 | mm | |
| Uniformity Coefficient | | > 20 |
| Curvature Coefficient | | |

Uniformity Coefficient calculated in accordance with BS EN ISO 14688-2:2018

Note: Tested in Accordance with BS1377:Part 2:1990, clauses 9.2 and 9.5

Remarks:



**Signed:** Katarzyna Koziel

Katarzyna Koziel
Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 19/08/2022

**GF 100.21**