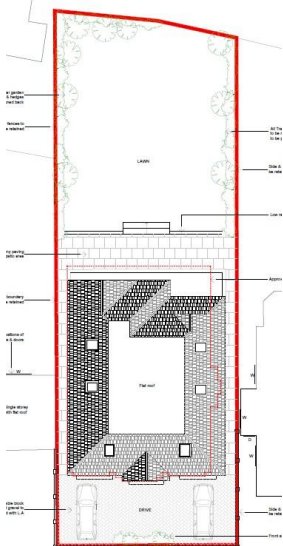




EARTH ENVIRONMENTAL  
& GEOTECHNICAL



## GeoEnvironmental Site Investigation Report

3 Sunningdale Avenue

Whitefield

On behalf of

Mr. Usman Ali



Earth Environmental & Geotechnical Ltd  
Houldsworth Mill Business Centre  
Houldsworth Street  
Stockport  
SK5 6DA

Tel : 01619756088

Email  
[headoffice@earthenvironmental.co.uk](mailto:headoffice@earthenvironmental.co.uk)

[www.earthenvironmental.co.uk](http://www.earthenvironmental.co.uk)

**GEOENVIRONMENTAL  
SITE INVESTIGATION  
REPORT**

**3 SUNNINGDALE AVENUE  
WHITEFIELD**

**Report Ref: A6184/24/SI**

**JANUARY 2025**

Prepared on Behalf of:

**Mr. Usman Ali**

By:

Earth Environmental & Geotechnical Ltd  
Houldsworth Mill Business & Arts Centre  
Houldsworth Street  
Stockport ASERTYUI900-[=]78  
SK5 6DA

DISTRIBUTION:

1 electronic copy      Mr. Usman Ali

## **GEOENVIRONMENTAL SITE INVESTIGATION REPORT**

### **3 SUNNINGDALE AVENUE, WHITEFIELD**

*Report Reference:* A6184/24/SI

*Version* B.0

*Date:* 15<sup>th</sup> January 2025

*Prepared for:* Mr. Usman Ali

*Prepared by:* Earth Environmental & Geotechnical Ltd  
Houldsworth Mill Business & Arts Centre  
Houldsworth Street  
Stockport  
SK5 6DA

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*Written by:*

**Tom Pudifoot**  
**GeoEnvironmental Consultant**

*Reviewed by:*



**Daniel Shanks**  
**Principal GeoEnvironmental Consultant**

*Approved by:*



**Adam Czarnecki**  
**Managing Director**

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## 1.0 EXECUTIVE SUMMARY

|                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Appointment                                                                                                                                                                                                                           | A site investigation has been commissioned by Mr. Usman Ali (the Client), to examine ground conditions for a proposed residential development at 3 Sunningdale Avenue, Whitefield.                                                                                                                                                                                                                                                                                                                                                                                                               |
| The Investigation                                                                                                                                                                                                                     | The investigation comprised three windowless sample boreholes with associated sampling, in situ testing, laboratory geotechnical and contamination testing, as well as two hand dug pits for contamination testing.                                                                                                                                                                                                                                                                                                                                                                              |
| The Site                                                                                                                                                                                                                              | The site comprises a recently demolished property located at 3 Sunningdale Avenue, approximately 1.4km southwest of Whitefield town centre.<br>The approximate National Grid Reference for the centre of the site is SD 79425 05239 (X: 379425, Y: 405239), with the closest postcode being M45 7GW. The site is recorded to be underlain by superficial Glaciofluvial deposits, comprising sand and gravel. The solid geology beneath the site is recorded as the Triassic Chester Pebble Beds Formation comprising reddish brown conglomerates interbedded with sandstones and rare mudstones. |
| Ground Conditions Encountered                                                                                                                                                                                                         | The exploratory holes generally encountered variable topsoil between ground level and a maximum depth of 0.40m bgl, as well as Made Ground between ground level and 1.20m bgl. This is underlain by superficial deposits of SAND to a maximum depth of 6.00m bgl, as well as occasional layers of CLAY and SILT.<br>Groundwater was not encountered during the ground investigation.                                                                                                                                                                                                             |
| Geotechnical Assessment                                                                                                                                                                                                               | Shallow strip/pad foundations placed in the superficial deposits, are considered appropriate for the current proposed development, dependent on allowable bearing pressures and tolerance of structures to settlement.<br>Pavement Design - preliminary design value = 1% in Made Ground.<br>Design Sulphate Class = DS-1<br>ACEC Site Classification = AC-1s                                                                                                                                                                                                                                    |
| Contamination Assessment                                                                                                                                                                                                              | Risk from contamination to groundworkers during development - <b>LOW</b> .<br>Risk from contamination to future residential end users - <b>LOW</b> .<br>No asbestos identified in the tested samples.<br>Soil Waste Assessment: 1no. sample tested, classified as Non-Hazardous in accordance with WM3.1.                                                                                                                                                                                                                                                                                        |
| <b><i>This sheet is intended to provide a summary only of the report. It does not provide a definitive engineering analysis for the purposes of costing or construction and is subject to the limitation of the agreed brief.</i></b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## 2.0 INTRODUCTION

---

### 2.1 Background

A site investigation has been commissioned by Archirama Ltd on behalf of Mr. Usman Ali (the Client), to examine ground conditions for a proposed development at 3 Sunningdale Avenue, Whitefield.

### 2.2 Existing Planning Applications

#### **2.2.1 Planning Application to Bury Metropolitan Council, Ref - 70105, dated September 2023.**

A planning application has been submitted for the site to Bury Metropolitan Council (Reference: 70105) for the demolition of the existing dwelling and erection of a replacement dwelling with associated external works. The application was approved with conditions in January 2024.

### 2.3 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) have been commissioned by the Client, to undertake a Site Investigation of the site in accordance with proposal A6184/24 dated 22<sup>nd</sup> August 2024. The objectives of this investigation are as follows:

- *Provide factual information on the work undertaken including sampling location plan, borehole logs, geotechnical and chemical testing.*
- *Tier 1 (semi-quantitative) risk assessment will be undertaken. This will compare the concentrations of soil contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g., existing/ future end users and site neighbours.*
- *Classification of soils for offsite disposal.*
- *Assessment of ground conditions for foundation design.*

### 2.4 Report Scope

This report presents full factual records of the site work carried out, the ground conditions encountered in the exploratory holes, the in-situ and laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on geotechnical design and potential ground contamination risks for the proposed development.

### 2.5 Limitations of the Study

The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information, improved practices or changes in legislation may require a reinterpretation of the report in whole or in part. EEG reserve the right to amend either conclusions or recommendations in light of any further information that may become available. The report is provided for the sole use by the client and is confidential to them.

Recommendations within this report are also based on exploratory records and examination of samples and, where applicable, laboratory tests. No liability can be accepted for conditions not

revealed by the boreholes and trial pits particularly at intervening locations. Whilst every effort is made to ensure accuracy of data supplied, all opinions expressed as to the spatial distribution of strata between sampling locations is for guidance only and no responsibility is accepted as to its accuracy.

### 3.0 SITE LOCATION & DESCRIPTION

The site is located at 3 Sunningdale Avenue, Whitefield approximately 1.4km southwest of Whitefield town centre.

The approximate National Grid Reference for the centre of the site is SD 79425 05239 (X: 379425, Y: 405239) with the closest postcode being M45 7GW.

The site is a roughly rectangular shaped parcel of land, with current access via Sunningdale Avenue to the northwest of the site. The maximum dimensions of the site are approximately 15m northeast to southwest, and 45m northwest to southeast. The site occupies an area of approximately 0.07 hectares.

The site comprises a recently demolished residential property (3 Sunningdale Avenue), bound by hedges and wooden fencing on all boundaries except from the northwestern boundary which is bound by Sunningdale Avenue. At the time of the investigation, demolition materials were present in the footprint of the former property.

The site is entirely surrounded by residential properties.

The site location is shown in the aerial photograph presented as Figure 1, below.

**Figure 1: Aerial Photograph Showing Site Location**



General site photographs are presented in Figure 2 overleaf.

## Figure 2: General Site Photographs

Photograph taken viewing across the front of the site, facing east



Photograph taken viewing across the rear of the site, facing south



Photograph taken viewing across the rear of the site, facing east



Photograph showing representative soils (WS03)



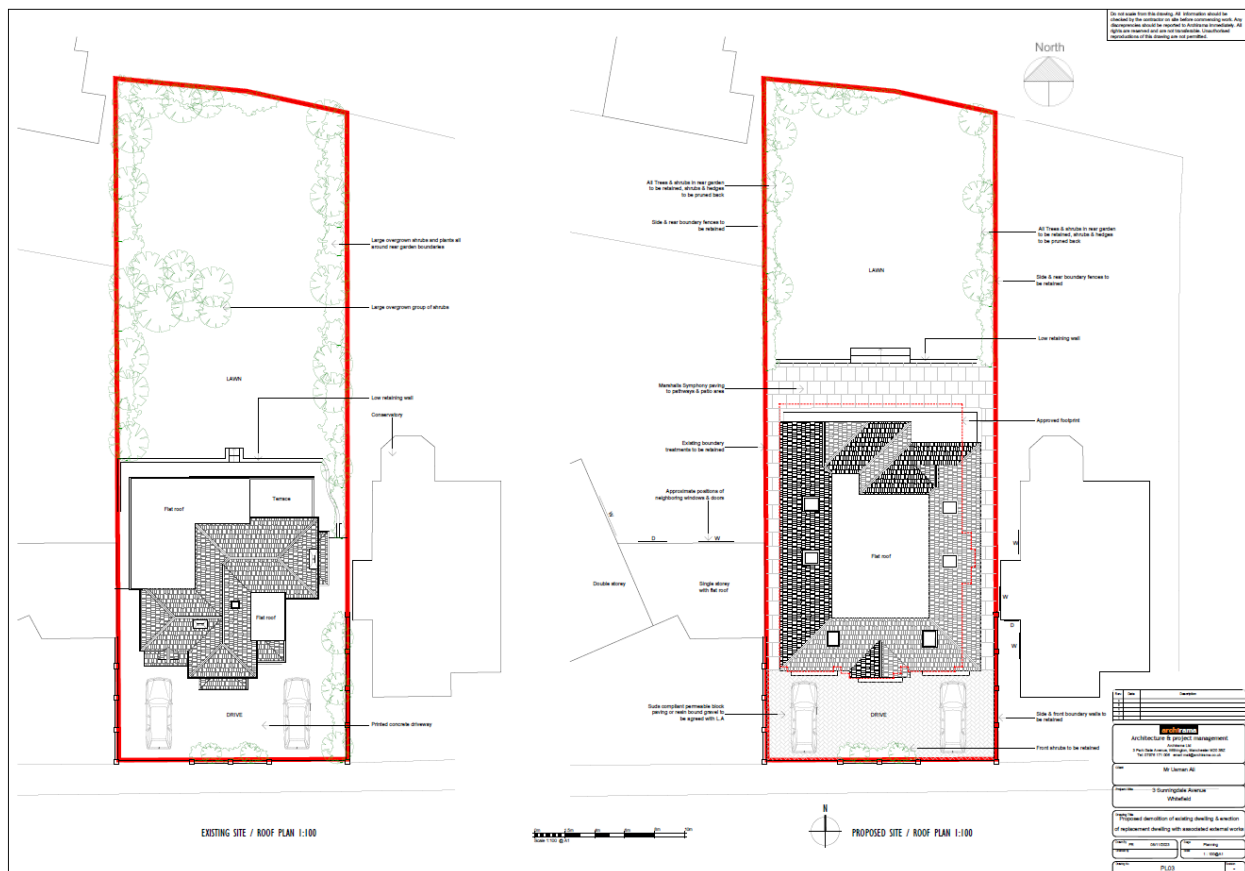
### 3.1 Proposed Development

It is understood that the client wishes to demolish the existing residential property and develop a new property on a larger footprint, along with associated external works.

The current site access will be maintained with the existing block paving driveway kept with dedicated vehicular parking spaces.

The proposed development layout details are shown in Figure 3 below.

**Figure 3: Proposed Development Plan**



## 4.0 SITE INVESTIGATION

### 4.1 Exploratory Fieldwork

The fieldwork was carried out by EEG on the 27<sup>th</sup> November 2024 and comprised:

- Three window sample boreholes (designated WS01 - WS03 inclusive) were each sunk to depths between 5.00m and 6.00m bgl. The boreholes were drilled with the intention of reaching 6.00m bgl however one terminated at 5.00m due to refusal in very dense sand. Window sampler boring was carried out with a modular, LMSR detachable rig, which uses a chain-driven trip hammer to drive sampling tubes or penetrometers into the ground. These tools are coupled to the anvil of the hammer by solid drill rods. Sampling tubes comprise “windowless samplers,” which are plain sampler tubes in which a continuous disturbed sample is recovered within a semi-rigid plastic liner. In order to reduce friction within the borehole, sampling tubes of progressively smaller diameter are used as the borehole depth increases. Sampler diameters generally range from between approximately 90mm to 50mm. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Groundwater observations were noted where possible. These observations relate to the time of the investigation only, and do not necessarily reflect seasonal fluctuations. Exploratory hole logs are included in Appendix 1.
- Two hand-dug pits were excavated to a depth of 1.00mbgl in order to obtain soil samples for chemical testing.

Exploratory hole locations were selected prior to the site works by EEG Ltd based on the proposed development and avoiding known services.

Table 1 below indicates the appropriate features targeted.

**Table 1: Sampling Location Justification**

| Exploratory Hole | Sampling Location                                  |
|------------------|----------------------------------------------------|
| WS01 - WS02      | Front of the proposed building                     |
| WS03             | Rear of the proposed building within new footprint |
| HDP01 – HDP02    | Within rear garden area for chemical testing       |

Each exploratory location was scanned using a Cable Avoidance Tool (CAT) in order to locate unrecorded underground services, and the exploratory locations were repositioned if necessary.

On completion, samples recovered from the site were taken to specialist laboratories for chemical and geotechnical testing.

Soil samples were recovered in 250g glass amber jars and 1kg plastic tubs. If collection was not possible the same day, then samples were stored in the sample storage fridge at the EEG offices below 4°C.

Samples were tracked using appropriate Chain of Custody forms provided by DETS.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III).

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930<sup>(2015+A1:2020)</sup> except where superseded by the soil and rock description methodology in BS EN14688-1<sup>(2002)</sup>, BS EN 14688-2<sup>(2004)</sup> and BS EN 14689-1<sup>(2003)</sup>.

All sampling locations were surveyed by use of a hand-held Trimble GeoXH GPS instrument that is capable of surveying to an accuracy of less than 10mm depending on satellite coverage, proximity to trees and building structures.

The descriptive terminologies such as firm, etc formerly used within older versions of BS5930 to describe strength now solely relate to consistency. Shear strength is now defined related to results obtained in the field (using a hand vane for example) or in the laboratory (from triaxial tests), as detailed in Table 2 (below).

**Table 2: Shear Strength Definitions**

| Term based on measurement | Undrained Strength ( $c_u$ ) definition in kN/m <sup>2</sup> (from BS EN ISO 14688-2: 2004, 5.3, Table 5) |
|---------------------------|-----------------------------------------------------------------------------------------------------------|
| Extremely Low Strength    | <10                                                                                                       |
| Very Low Strength         | 10 to 20                                                                                                  |
| Low Strength              | 20 to 40                                                                                                  |
| Medium Strength           | 40 to 75                                                                                                  |
| High Strength             | 75 to 150                                                                                                 |
| Very High Strength        | 150 to 300                                                                                                |
| Extremely High Strength   | 300 to 600                                                                                                |

An Exploratory Hole Location Plan is presented as Figure 4, overleaf.

Figure 4: Exploratory Hole Location Plan



A summary of exploratory holes and tests undertaken during the investigation are presented in Table 3 below.

**Table 3: Summary of Exploratory Holes Undertaken**

| Hole                                             | Type* | Depth (m) | Date Started | Date Finished | Easting (m) | Northing (m) | Backfill Details** |
|--------------------------------------------------|-------|-----------|--------------|---------------|-------------|--------------|--------------------|
| WS01                                             | WS    | 6.00      | 27/11/2024   | 27/11/2024    | 379415      | 405253       | A                  |
| WS02                                             | WS    | 5.00      | 27/11/2024   | 27/11/2024    | 379418      | 405259       | A                  |
| WS03                                             | WS    | 6.00      | 27/11/2024   | 27/11/2024    | 379424      | 405241       | A                  |
| HDP01                                            | HDP   | 1.00      | 27/11/2024   | 27/11/2024    | 379433      | 405232       | A                  |
| HDP02                                            | HDP   | 1.00      | 27/11/2024   | 27/11/2024    | 379439      | 405232       | A                  |
| *WS = Window Sample Borehole, HDP = Hand-Dug Pit |       |           |              |               |             |              |                    |
| **A = Arisings                                   |       |           |              |               |             |              |                    |

## 4.2 Laboratory Testing

### 4.2.1 Geotechnical Testing

A programme of laboratory testing was carried out on samples taken from the various strata to assist in classification and determine the engineering properties of the materials underlying the site. The tests were scheduled by EEG and carried out by Murray Rix. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 4, below.

**Table 4: Summary of Laboratory Geotechnical Tests Undertaken**

| TEST                                          | STANDARD                       | No. |
|-----------------------------------------------|--------------------------------|-----|
| Particle size distribution (wet)              | BS1377:1990 Part 2, Clause 9.2 | 2   |
| Moisture Content                              | BS1377:1990 Part 2, Clause 3.2 | 2   |
| Liquid Limit, Plastic Limit, Plasticity Index | BS1377:1990 Part 2, Clause 4/5 | 2   |
| Sulphate content of 2:1 soil: water extract   | BS1377:1990 Part 3, Clause 5   | 3   |
| pH value                                      | BS1377:1990 Part 3, Clause 9   | 3   |

The results of the laboratory geotechnical tests are discussed in Section 6 and included in Appendix 2.

### 4.2.2 Environmental Testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by EEG, and carried out by DETS, a UKAS and MCERTS accredited laboratory.

Chemical analyses were carried out on 5no. soil samples and were submitted for the following suite of determinants:

*Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO<sub>4</sub>), Sulphide, pH, Soil Organic Matter, PCB's, Speciated Petroleum Hydrocarbons (TPH) and Speciated Polyaromatic Hydrocarbons (PAH).*

Full results of the laboratory contamination tests are discussed in Section 8 and included in Appendix 3.

## 5.0 GROUND CONDITIONS ENCOUNTERED

### 5.1 Soil Profile Encountered

BGS digital mapping shows the site is recorded to be underlain by superficial Glaciofluvial deposits, comprising sand and gravel.

The solid geology beneath the site is recorded as the Triassic Chester Pebble Beds Formation, comprising reddish brown conglomerates interbedded with sandstones and rare mudstones. The sequence of strata encountered beneath the site was as follows:

- **TOPSOIL** - was encountered in two exploratory hole locations between ground level and to a maximum depth of 0.40m bgl, comprising:
  - CLAY, with variable quantities of sand and gravel of mudstone, sandstone.
- **MADE GROUND** - was encountered in three exploratory hole locations between ground level and to a maximum depth of 1.20m bgl, comprising:
  - SAND, with variable quantities of gravel of red brick, concrete and asphalt.
- **SUPERFICIAL DEPOSITS** - were encountered in all exploratory hole locations, to a maximum depth of 6.00m bgl, comprising:
  - SAND, with variable quantities of clay, silt and gravel of mudstone and sandstone.
  - SILT, with variable quantities of sand.
  - CLAY, with variable quantities of sand and gravel of mudstone and sandstone.

The depths of the various materials encountered in the exploratory holes are summarised in Table 5, below.

**Table 5: Summary of Ground Conditions Encountered**

| Hole  | Depth to Stratum (m bgl) |             |             |                             |             | Groundwater (Investigation) (m bgl) |
|-------|--------------------------|-------------|-------------|-----------------------------|-------------|-------------------------------------|
|       | TOPSOIL                  | MADE GROUND | SILT        | SAND                        | CLAY        |                                     |
| WS01  | -                        | GL – 0.40   | 2.10 – 2.30 | 0.40 – 2.10<br>2.30 - 6.00+ | -           | -                                   |
| WS02  | -                        | GL – 1.20   | -           | 1.20 - 6.00+                | -           | -                                   |
| WS03  | -                        | GL – 0.60   | -           | 0.60 – 6.00+                | -           | -                                   |
| HDP01 | GL - 0.40                | -           | -           | 0.40 -1.00+                 | -           | -                                   |
| HDP02 | GL - 0.40                | -           | -           | -                           | 0.40 -1.00+ | -                                   |

### 5.2 Observable Indications of Contamination

No observable signs of visual or olfactory contamination were identified during the site investigation.

### **5.3 Obstructions**

No man made; sub-surface obstructions were encountered during the site investigation.

### **5.4 Groundwater**

Groundwater was not encountered during the site investigation.

## 6.0 ENGINEERING PROPERTIES OF SOILS ENCOUNTERED

### 6.1 General

The following sections discuss the engineering properties of the strata encountered, based on results of in situ testing and laboratory testing obtained during this investigation.

The results of laboratory geotechnical testing are summarised in Table 6.

**Table 6: Summary of Laboratory Geotechnical Test Results**

| Location | Depth (m) | Strata* | CLASSIFICATION       |                  |                   |                      |                               |                |              |              |              |                                   | Undrained Shear Strength (kN/m <sup>2</sup> ) | CHEMICAL |                                               |
|----------|-----------|---------|----------------------|------------------|-------------------|----------------------|-------------------------------|----------------|--------------|--------------|--------------|-----------------------------------|-----------------------------------------------|----------|-----------------------------------------------|
|          |           |         | Moisture Content (%) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) | Modified Plasticity Index (%) | PSD Gravel (%) | PSD Sand (%) | PSD Silt (%) | PSD Clay (%) | Bulk Density (Mg/m <sup>3</sup> ) | Dry Density (Mg/m <sup>3</sup> )              | pH Value | Water Soluble Sulphate SO <sub>4</sub> (mg/l) |
| WS01     | 2.20      | SILT    | 22.6                 | N/A              | NP                | N/A                  | NP                            | -              | -            | -            | -            | -                                 | -                                             | -        | -                                             |
| WS01     | 3.00      | SAND    | -                    | -                | -                 | -                    | -                             | 0              | 96           | 4            | -            | -                                 | -                                             | -        | -                                             |
| WS02     | 0.60      | SAND    | -                    | -                | -                 | -                    | -                             | -              | -            | -            | -            | -                                 | -                                             | 7.9      | 190                                           |
| WS02     | 2.80      | SAND    | -                    | -                | -                 | -                    | -                             | -              | -            | -            | -            | -                                 | -                                             | 7.6      | 220                                           |
| WS03     | 0.50      | SAND    | -                    | -                | -                 | -                    | -                             | 7              | 34           | 45           | 14           | -                                 | -                                             | 7.1      | 130                                           |
| HP02     | 0.80      | CLAY    | 21.1                 | 28               | 16                | 12                   | 11                            | -              | -            | -            | -            | -                                 | -                                             | -        | -                                             |

\*N/A = Not Applicable \*\*NP = Non-Plastic

### 6.2 Topsoil & Made Ground

Topsoil was encountered in the two hand dug pits, HP01 – HP02, between ground level and a maximum depth of 0.40m below ground level. Made ground was encountered in all of the exploratory boreholes, between ground level and to a maximum depth of 1.20m bgl.

Due to the material encountered, no geotechnical testing was carried out in the topsoil or the made ground

### 6.3 Superficial Deposits

As discussed in Section 5, material interpreted as superficial deposits was encountered as variable SAND, SILT and CLAY in all of the exploratory hole locations.

#### 6.3.1 Sand

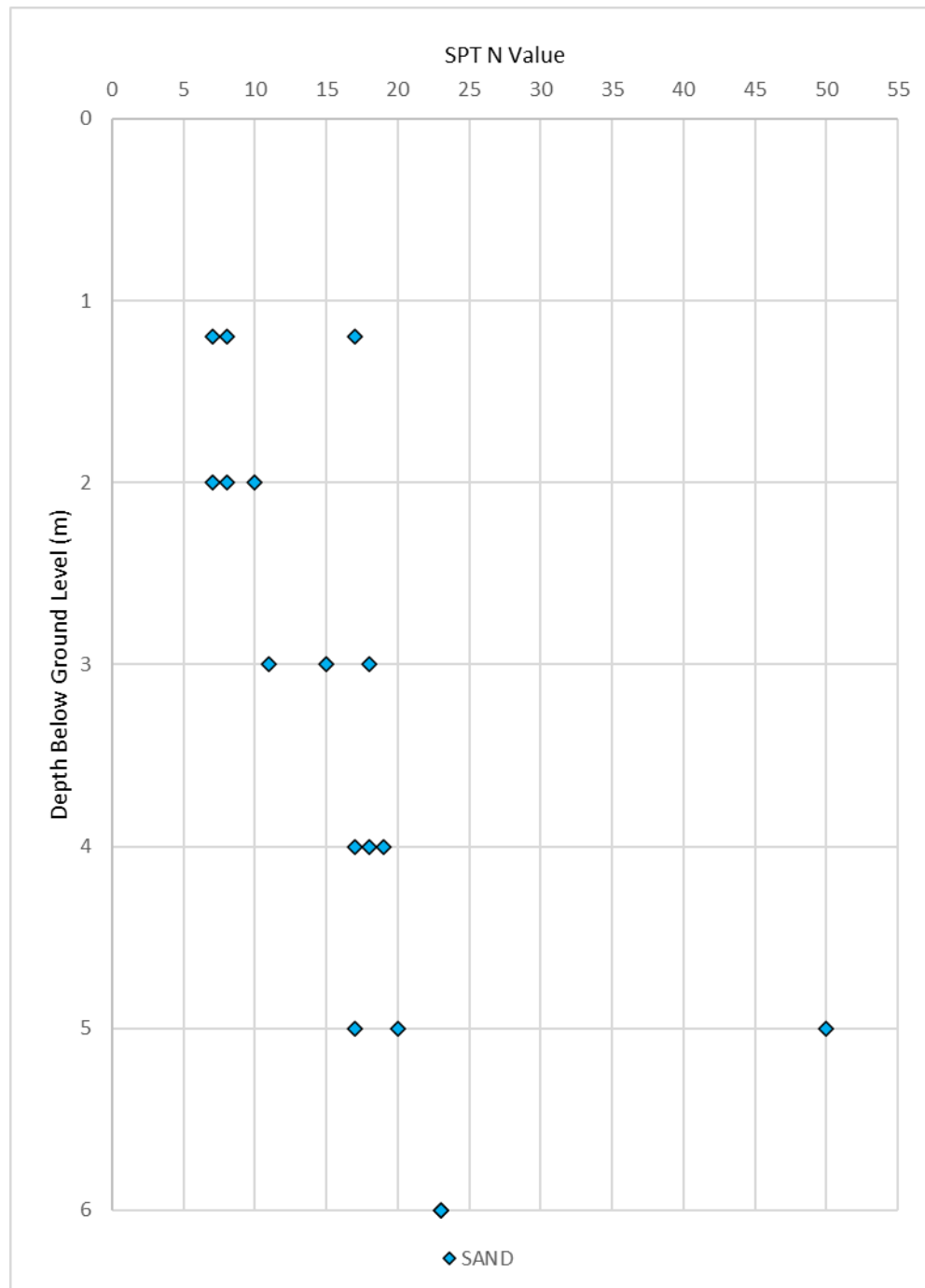
Sand was encountered in all exploratory hole locations except HP02, at depths between 0.40m and to a maximum depth of 6.00m bgl.

The **water-soluble sulphate** content of three sand samples ranged between 130mg/l – 220mg/l SO<sub>4</sub>, with **pH values** ranging between 7.1 – 7.9.

**Particle Size Distribution** (PSD) tests were carried out on two samples of sand. A breakdown of the test results is shown in Table 6 above and in Appendix 2.

SPT tests carried out in the sand resulted in **SPT N values** between 7 and 50, as shown on the SPT v Depth Plot, in Figure 5 (below). The results suggest the sand is loose to very dense.

**Figure 5: SPT v Depth Plot**



Recommended N values and derived design values for the granular soils are summarised in Table 7, below.

**Table 7: Summary of Design Parameters (Sand)**

| Depth                                                           | SPT N Value Range | Average N Value | Design N Value* | Equivalent Soil Density | Angle of Internal Friction (degrees)** |
|-----------------------------------------------------------------|-------------------|-----------------|-----------------|-------------------------|----------------------------------------|
| 1.20                                                            | 7 - 17            | 11              | 8               | Loose                   | 29.3                                   |
| 2.00                                                            | 7 - 10            | 8               | 8               | Loose                   | 29.3                                   |
| 3.00                                                            | 11 - 18           | 15              | 13              | Medium Dense            | 30.9                                   |
| 4.00                                                            | 17 - 19           | 18              | 18              | Medium Dense            | 32.5                                   |
| 5.00                                                            | 17 - 50           | 29              | 19              | Medium Dense            | 32.8                                   |
| 6.00                                                            | 23                | 23              | 23              | Medium Dense            | 34.0                                   |
| *Based on lower quartile N value                                |                   |                 |                 |                         |                                        |
| **Based on the correlation by Peck, Hanson and Thornburn (1974) |                   |                 |                 |                         |                                        |

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used.

Based on the correlation by Peck, Hanson and Thornburn (1974), this gives a range of **angle of shearing resistance** of between  $\phi=29.3^\circ$  and  $34.0^\circ$ .

For assessing settlements average ground conditions will give a more realistic value of settlements, and the average of N values should be used.

### 6.3.2 Clay & Silt

Clay was encountered in one exploratory hole location, HDP02 at a depth of between 0.40m and 1.00m. As the clay was encountered outside of the footprint of the proposed development, no in-situ testing was undertaken on this stratum.

An Atterberg Limit test was carried out on the sample of clay. Results of the test reported a **liquid limit** of 28% and a **plastic limit** of 16% and 19%, resulting in a **plasticity index** of 12%. These results suggest the clay to be of **low plasticity**. Results are shown on the Plasticity Chart in Figure 6, overleaf.

The **Natural Moisture Content** (NMC) and **Liquid Limit** (LL) of the soil can be used to give an indication of **soil desiccation**, i.e., where the NMC is less than 40% of the LL, the soil is inferred to be desiccated, as summarised in Table 8, below.

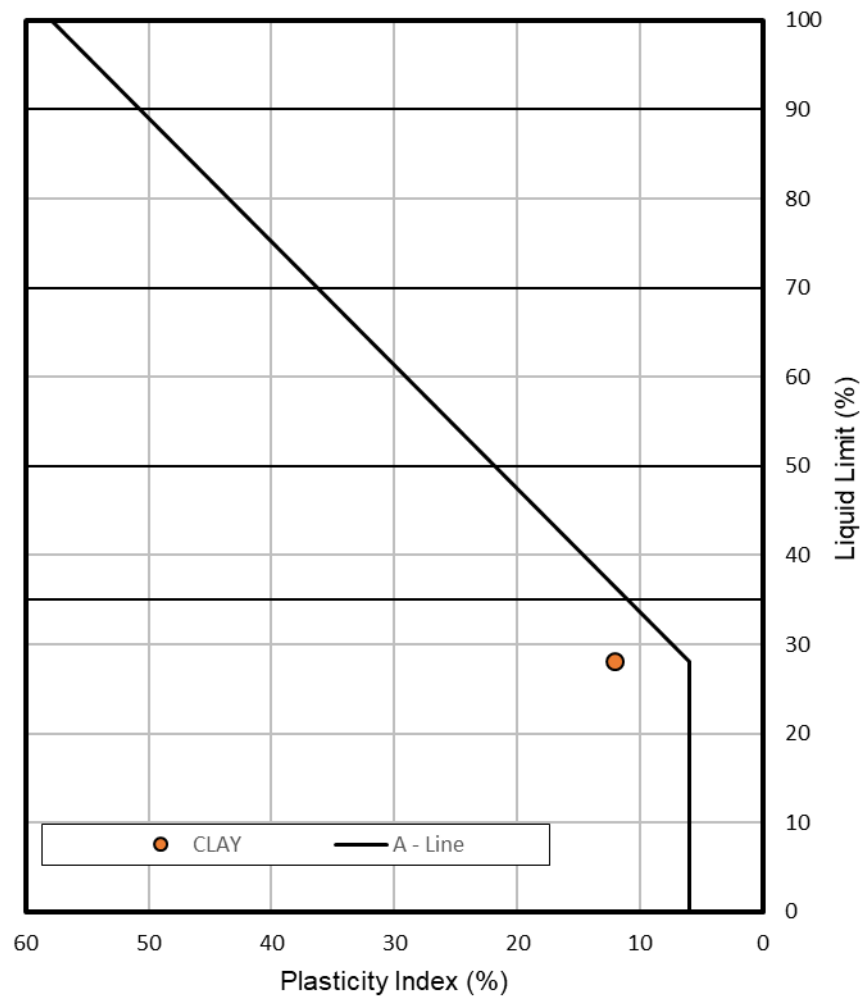
**Table 8: Soil Desiccation Indicators in the Clay**

| Location | Depth (m) | Liquid Limit (%) | 40% Liquid Limit (%) | Natural Moisture Content (%) | Desiccation |
|----------|-----------|------------------|----------------------|------------------------------|-------------|
| HDP02    | 0.80      | 28               | 11                   | 21.1                         | No          |

The result in the above table shows that there is no evidence of desiccation in the clay sample tested.

Silt was encountered exclusively as a 0.20m layer within WS01. An Atterberg Limit test was conducted on a sample collected from this silt layer; however, the lab testing reported the material as Non-Plastic.

**Figure 6: Plasticity Chart**



## **7.0 GEOTECHNICAL ASSESSMENT**

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### **7.1 Proposed Development**

It is understood that the client wishes to demolish the existing residential property and develop a new property, along with associated external works.

Detailed information regarding structural loadings and proposed foundation type was not available at the time of authoring this report.

### **7.2 Ground Conditions Encountered**

The exploratory holes generally encountered either topsoil between ground level and a maximum depth of 0.40m bgl or made ground from ground level to a maximum depth of 1.20m bgl. This was underlain by superficial deposits of sand with layers of clay and silt to a maximum depth of 6.00m bgl.

Groundwater was not encountered during the ground investigation.

### **7.3 Foundation Considerations**

Based on the ground conditions encountered, conventional shallow depth foundations (strip/pad), placed in the superficial deposits, should be suitable for the site, providing the anticipated structural loadings are relatively low and subject to tolerance of structure to settlement.

Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered, such as ground improvement and piles.

#### **7.3.1 Conventional Shallow Depth Strip/Pad Foundations**

Strip/pad foundations should be taken down below any Topsoil or Made Ground and placed in the natural sand deposits. If any Made Ground, particularly loose or soft material, is encountered at foundation level this should be excavated and replaced with suitable granular fill or the foundation extended at least 150mm into suitable natural strata.

Foundations should be placed in materials of similar bearing and consolidation characteristics to avoid potential differential settlement occurring. Should foundations cross from cohesive to granular soils, nominal reinforcement should be incorporated to avoid the effects of differential settlement.

Table 9 overleaf, summarises anticipated allowable bearing pressures for strip/pad foundations placed in the superficial deposits. The bearing capacities are calculated based on Hansen's <sup>(1978)</sup> method and assuming a factor of safety against bearing capacity failure of 3.

Groundwater was not encountered during the investigation, therefore for the purpose of the calculation, groundwater has been assumed to be at 6.00m bgl, which is the base of the deepest borehole drilled.

**Table 9: Summary of Allowable Bearing Pressures**

| Foundation Strata | Design Value (Section 8) | Foundation Depth (m bgl) | Foundation Type | Foundation Size (m) | Allowable Bearing Pressure (kN/m <sup>2</sup> ) |
|-------------------|--------------------------|--------------------------|-----------------|---------------------|-------------------------------------------------|
| SAND              | $\phi = 29.3^\circ$      | 1.0                      | Strip           | 0.4                 | 154                                             |
|                   |                          |                          |                 | 0.9                 | 164                                             |
|                   |                          |                          | Pad             | 1.0 x 1.0           | 220                                             |
|                   |                          |                          |                 | 2.0 x 2.0           | 229                                             |
|                   | $\phi = 29.3^\circ$      | 1.5                      | Strip           | 0.4                 | 228                                             |
|                   |                          |                          |                 | 0.9                 | 236                                             |
|                   |                          |                          | Pad             | 1.0 x 1.0           | 332                                             |
|                   |                          |                          |                 | 2.0 x 2.0           | 332                                             |
|                   | $\phi = 29.3^\circ$      | 2.0                      | Strip           | 0.4                 | 303                                             |
|                   |                          |                          |                 | 0.9                 | 310                                             |
|                   |                          |                          | Pad             | 1.0 x 1.0           | 446                                             |
|                   |                          |                          |                 | 2.0 x 2.0           | 440                                             |
|                   | $\phi = 29.3^\circ$      | 2.5                      | Strip           | 0.4                 | 377                                             |
|                   |                          |                          |                 | 0.9                 | 385                                             |
|                   |                          |                          | Pad             | 1.0 x 1.0           | 561                                             |
|                   |                          |                          |                 | 2.0 x 2.0           | 551                                             |

Table 10 below summarises anticipated settlements of the above foundations in sand based on design values discussed in Section 6. Settlement in granular soils typically comprises a large amount of immediate settlement as loads are applied and a smaller proportion of consolidation settlement, which will occur over a longer period.

As the proposed foundation loading is not known, for the purposes of these calculations a foundation loading of 75kN/m<sup>2</sup> has been used.

**Table 10: Summary of Anticipated Settlements (Granular)**

| Foundation Depth<br>(m bgl) | Foundation Strata | Foundation Type | Foundation Size<br>(m) | Pad Foundation Loading<br>(kN/m²) | Settlement* (mm) |             |               |
|-----------------------------|-------------------|-----------------|------------------------|-----------------------------------|------------------|-------------|---------------|
|                             |                   |                 |                        |                                   | Lower Limit      | Upper Limit | Best Estimate |
| 1.0 - 1.5                   | SAND              | Strip           | 0.4                    | 75                                | 2                | 10          | 3             |
|                             |                   |                 | 0.9                    | 75                                | 3                | 18          | 6             |
|                             |                   | Pad             | 1.0 x 1.0              | 75                                | 2                | 13          | 4             |
|                             |                   |                 | 2.0 x 2.0              | 75                                | 3                | 21          | 7             |
| 2.0 - 2.5                   |                   | Strip           | 0.4                    | 75                                | 2                | 18          | 5             |
|                             |                   |                 | 0.9                    | 75                                | 4                | 31          | 9             |
|                             |                   | Pad             | 1.0 x 1.0              | 75                                | 3                | 22          | 6             |
|                             |                   |                 | 2.0 x 2.0              | 75                                | 5                | 35          | 15            |
| *Immediate settlement       |                   |                 |                        |                                   |                  |             |               |

Floor slabs should be designed as suspended if Made Ground of 600mm thickness or greater is present. Made ground is not considered an appropriate bearing stratum due to its variable nature. Floor slabs may be designed as ground bearing where Made Ground is excavated and replaced with suitable granular fill.

All foundation excavations should be inspected by a suitable qualified engineer to prove that the founding strata is suitable and uniform along the length of the foundation, and capable of taking the anticipated structural loadings. If foundations cross from granular to cohesive soils, nominal reinforcement should be incorporated.

## 7.4 Pavement Design

The ground investigation identified the soil type at the subgrade level to typically be topsoil or Made Ground underlain by clay or sand. Based on the recommendations for design CBR values provided in Interim advice note 73/06, Revision 1 (2009), a conservative design CBR value of 1% should be adopted in areas where topsoil or made ground is encountered at subgrade level.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable material. In this context a flexible pavement design may be required.

Consideration should also be given to the use of geotextiles to allow reduction of capping thickness. For examples biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce capping thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site. For guidance, the following table gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

**Table 11: Comparison of Capping Thickness with and without Geotextile**

| CBR                                                                                                                                                                                | Unreinforced        |         |       | Reinforced with Tensar Geogrid |         |              |       |                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------|-------|--------------------------------|---------|--------------|-------|------------------|
|                                                                                                                                                                                    | Sub-base            | Capping | Total | Sub-base                       | Capping | No. of grids | Total | Thickness saving |
| 0.5%                                                                                                                                                                               | Design not suitable |         |       | 200mm                          | 400mm   | 2            | 600mm | -                |
| 1.0%                                                                                                                                                                               | 150mm               | 600mm   | 750mm | 400mm                          | 0       | 1            | 400mm | 350mm            |
| 1.5%                                                                                                                                                                               | 150mm               | 600mm   | 750mm | 310mm                          | 0       | 1            | 310mm | 440mm            |
| 2.0%                                                                                                                                                                               | 150mm               | 600mm   | 750mm | 260mm                          | 0       | 1            | 260mm | 490mm            |
| 3.0%                                                                                                                                                                               | 150mm               | 350mm   | 500mm | 210mm                          | 0       | 1            | 210mm | 290mm            |
| 4.0%                                                                                                                                                                               | 150mm               | 300mm   | 450mm | 175mm                          | 0       | 1            | 175mm | 275mm            |
| 5.0%                                                                                                                                                                               | 150mm               | 250mm   | 400mm | 160mm                          | 0       | 1            | 160mm | 240mm            |
| These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements, the advice of specialist contractor should be sought. |                     |         |       |                                |         |              |       |                  |

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

## 7.5 Chemical Attack on Buried Concrete

Chemical tests (see Appendices) show low levels of water-soluble sulphates and neutral conditions. Based on these conditions, it is recommended that for concrete placed in natural strata the Design Sulphate Class for the site, as defined in BRE Special Digest 1<sup>(2005)</sup>, be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s. The recommendations of BRE Special Digest 1 should be followed for concrete foundations and ground bearing floor slabs.

## **7.6 Suitability of Excavated Materials**

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer once these have been prepared by the relevant parties.

Granular made ground and natural sand could be suitable for re-use as structural fill, providing it is not contaminated and does not contain excessive amounts of clay and providing moisture contents are controlled during placement. The control of moisture contents will be important as the cohesive content of this stratum is likely to be sensitive to moisture content changes.

## **7.7 Temporary Works**

Formations will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations in Made Ground are likely to be unstable and should be battered back to an angle of 1 in 2, or a system of close sheeting and shoring adopted to ensure stability, and in particular where personnel are required to enter excavations. All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered near surface within excavations, particularly during the wetter months of the year. Pumping of excavations from a suitable located sump is likely to be required to keep excavations dry.

## 8.0 SOIL CONTAMINATION RISK ASSESSMENT

### 8.1 Tier I Human Health Soil Risk Assessment – Groundworkers During Development

To assess the risk of soil contamination to construction and ground workers during development, guidelines from the HSE Document 'Protection of workers and the general public during development of contaminated land' <sup>(1991)</sup> are used. The document assesses soil contamination test results and classifies the site as being uncontaminated or contaminated with varying degrees of contamination from 'slight' to 'unusually heavy.' The guideline values and laboratory test results are summarised in the following table:

**Table 12: Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land**

| Contaminant    | Typical Values* for: |                      |              |                     |                               | Test Results | Class |
|----------------|----------------------|----------------------|--------------|---------------------|-------------------------------|--------------|-------|
|                | Uncontaminated Soils | Slight Contamination | Contaminated | Heavy Contamination | Unusually Heavy Contamination |              |       |
|                | Class A              | Class B              | Class C      | Class D             | Class E                       |              |       |
| pH (acid)      | 6 - 7                | 5 - 6                | 4 - 5        | 2 - 4               | <2                            | 5.4 - 6.3    | A - B |
| pH (alkaline)  | 7 - 8                | 8 - 9                | 9 - 10       | 10 - 12             | 12                            | 8.3 - 11.1   | B - D |
| Arsenic        | 0 - 30               | 30 - 50              | 50 - 100     | 100 - 500           | 500                           | 3 - 25       | A     |
| Cadmium        | 0 - 1                | 1 - 3                | 3 - 10       | 10 - 50             | 50                            | < 0.2 - 0.5  | A     |
| Chromium       | 0 - 100              | 100 - 200            | 200 - 500    | 500 - 2500          | 2500                          | 5 - 14       | A     |
| Copper         | 0 - 100              | 100 - 200            | 200 - 500    | 500 - 2500          | 2500                          | 6 - 36       | A     |
| Lead           | 0 - 500              | 500 - 1000           | 1000 - 2000  | 2000 - 1%           | 1.0%                          | 5 - 123      | A     |
| Mercury        | 0 - 1                | 1 - 3                | 3 - 10       | 10 - 50             | 50                            | < 1          | A     |
| Nickel         | 0 - 20               | 20 - 50              | 50 - 200     | 200 - 1000          | 1000                          | 7 - 11       | A     |
| Zinc           | 0 - 250              | 250 - 500            | 500 - 1000   | 1000 - 5000         | 5000                          | 20 - 86      | A     |
| Boron          | 0 - 2                | 2 - 5                | 5 - 50       | 50 - 250            | 250                           | < 1          | A     |
| Selenium       | 0 - 1                | 1 - 3                | 3 - 10       | 10 - 50             | 50                            | < 2          | A     |
| Barium         | 0-500                | 500-1000             | 1000-2000    | 2000-1.0%           | 1.0%                          | 10 - 111     | A     |
| Beryllium      | 0 - 5                | 5 - 10               | 10 - 20      | 20 - 50             | 50                            | < 0.5 - 0.6  | A     |
| Vanadium       | 0 - 100              | 100 - 200            | 200 - 500    | 500 - 2500          | 2500                          | 7 - 20       | A     |
| Sulphate       | 0 - 2000             | 2000 - 5000          | 5000 - 1%    | 1% - 5%             | 5.05%                         | < 200 - 1882 | A     |
| Sulphide       | 0 - 10               | 10 - 20              | 20 - 100     | 100 - 500           | 500                           | < 5          | A     |
| Cyanide (free) | 0 - 1                | 1 - 5                | 5 - 50       | 50 - 100            | 100                           | < 1          | A     |
| Phenol         | 0 - 2                | 2 - 5                | 5 - 50       | 50 - 250            | 250                           | < 2          | A     |

Based on the above results, the soils are generally classified as uncontaminated, however the pH ranges from uncontaminated to heavily contaminated. Therefore, there is a **LOW** potential risk from soil contamination to construction workers, ground workers and members of the public during construction.

## 8.2 Tier I Human Health Soil Risk Assessment – Future Site Users

The following section provides a Human Health Soil Assessment for future site users. Based on the proposed development type, the following section compares the results of contamination analyses to residential types of end development as specified by Defra/LQM/CIEH. As part of the contamination assessment, the chemical results obtained by EEG have been screened against accepted compliance criteria, namely:

- Defra C4SL Health Criteria Values (March 2014), where available; and
- Tier 1 assessment values - based on LQM/CIEH Suitable 4 Use Levels <sup>(2015)</sup> (S4ULs).

The contaminated land guidance has recently changed the evaluation of risk from 'minimal' (SGVs) to 'low' (referred to as Lowest Level of Toxicological Concern (LLTCs)). The policy companion document and supporting letter by DEFRA, states that C4SLs 'could be used under the planning regime, as well as within Part 2A'.

Based on these comments EEG considers the justifications and assumptions used to generate 'low' risk are suitable for the planning regime.

Where no C4SLs have been generated EEG will use the LQM S4ULs. Similar assumptions and land use to C4SLs have been used. However, toxicological information has been based on 'minimal risk' as per previous guidelines and assumptions. If contaminants are not present as C4SLs or S4ULs then EEG will use CL:AIRE GACs. These follow the 'minimal' risk principal and more stringent exposure parameters and will be conservative.

EEG consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P) and naphthalene. This is due to B(a)P possibly being a carcinogen and most toxic of the PAHs and naphthalene the most volatile and soluble. The new C4SLs indicate B(a)P as a surrogate marker for carcinogenic PAHs, since the risk from other non-carcinogenic PAHs are considered negligible. Naphthalene will be treated separately using the LQM S4ULs.

As a preliminary screening assessment, all results have been compared to residential end use criteria.

The soil chemical testing results are summarised in Table 13, overleaf.

**Table 13: Soil Results Comparison with C4SL/S4UL Values**

| Determinand                             | C4SL/S4UL<br>Levels<br>Res w/ HP<br>1% SOM<br>(mg/kg) | WS01<br>0.30m<br>MG | WS02<br>0.40m<br>MG | WS03<br>0.90m<br>MG | HDP01<br>0.30m<br>TOPSOIL | HDP02<br>0.10m<br>TOPSOIL | No of<br>Exceedances |
|-----------------------------------------|-------------------------------------------------------|---------------------|---------------------|---------------------|---------------------------|---------------------------|----------------------|
| <b>Metals</b>                           |                                                       |                     |                     |                     |                           |                           |                      |
| Arsenic                                 | 37                                                    | 4                   | 3                   | 4                   | 25                        | 24                        | 0                    |
| Beryllium                               | 1.7                                                   | 0.6                 | < 0.5               | < 0.5               | 0.5                       | < 0.5                     | 0                    |
| Boron                                   | 290                                                   | < 1                 | < 1                 | < 1                 | < 1                       | < 1                       | 0                    |
| Cadmium                                 | 22                                                    | 0.3                 | < 0.2               | < 0.2               | 0.5                       | 0.3                       | 0                    |
| Chromium                                | 910                                                   | 10                  | 5                   | 7                   | 14                        | 12                        | 0                    |
| Chromium VI                             | 21                                                    | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Copper                                  | 2400                                                  | 16                  | 6                   | 13                  | 36                        | 24                        | 0                    |
| Lead                                    | 200                                                   | 28                  | 5                   | 9                   | 123                       | 100                       | 0                    |
| Inorganic Mercury                       | 40                                                    | 1.1                 | < 1                 | < 1                 | < 1                       | < 1                       | 0                    |
| Nickel                                  | 180                                                   | 10                  | 7                   | 9                   | 11                        | 11                        | 0                    |
| Selenium                                | 250                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Vanadium                                | 410                                                   | 14                  | 7                   | 9                   | 20                        | 19                        | 0                    |
| Zinc                                    | 3700                                                  | 41                  | 20                  | 26                  | 86                        | 55                        | 0                    |
| <b>Petroleum Hydrocarbons</b>           |                                                       |                     |                     |                     |                           |                           |                      |
| Benzene                                 | 0.87                                                  | < 0.002             | < 0.002             | < 0.002             | < 0.002                   | < 0.002                   | 0                    |
| Toluene                                 | 660                                                   | < 0.005             | < 0.005             | < 0.005             | < 0.005                   | < 0.005                   | 0                    |
| Ethylbenzene                            | 260                                                   | < 0.002             | < 0.002             | < 0.002             | < 0.002                   | < 0.002                   | 0                    |
| o-xylenes                               | 310                                                   | < 0.002             | < 0.002             | < 0.002             | < 0.002                   | < 0.002                   | 0                    |
| m-xylenes                               | 310                                                   | 0.004               | < 0.002             | < 0.002             | < 0.002                   | < 0.002                   | 0                    |
| p-xylenes                               | 310                                                   | 0.004               | < 0.002             | < 0.002             | < 0.002                   | < 0.002                   | 0                    |
| Aliphatic EC >5-6                       | 160                                                   | < 0.01              | < 0.01              | < 0.01              | < 0.01                    | < 0.01                    | 0                    |
| Aliphatic EC >6-8                       | 530                                                   | < 0.05              | < 0.05              | < 0.05              | < 0.05                    | < 0.05                    | 0                    |
| Aliphatic EC >8-10                      | 150                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Aliphatic EC >10-12                     | 760                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Aliphatic EC >12-16                     | 4300                                                  | < 3                 | < 3                 | < 3                 | < 3                       | < 3                       | 0                    |
| Aliphatic EC >16-21                     | 110000                                                | < 3                 | < 3                 | < 3                 | < 3                       | < 3                       | 0                    |
| Aliphatic EC >21-35                     | 110000                                                | < 10                | < 10                | < 10                | < 10                      | < 10                      | 0                    |
| Aromatic EC >5-7                        | 300                                                   | < 0.01              | < 0.01              | < 0.01              | < 0.01                    | < 0.01                    | 0                    |
| Aromatic EC >7-8                        | 660                                                   | < 0.05              | < 0.05              | < 0.05              | < 0.05                    | < 0.05                    | 0                    |
| Aromatic EC >8-10                       | 190                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Aromatic EC >10-12                      | 380                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Aromatic EC >12-16                      | 660                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |
| Aromatic EC >16-21                      | 930                                                   | < 3                 | < 3                 | < 3                 | < 3                       | < 3                       | 0                    |
| Aromatic EC >21-35                      | 1700                                                  | < 10                | < 10                | < 10                | < 10                      | < 10                      | 0                    |
| <b>Polycyclic Aromatic Hydrocarbons</b> |                                                       |                     |                     |                     |                           |                           |                      |
| Naphthalene                             | 2.3                                                   | < 0.1               | < 0.1               | < 0.1               | 0.22                      | 0.40                      | 0                    |
| Acenaphthylene                          | 210                                                   | < 0.1               | < 0.1               | < 0.1               | < 0.1                     | < 0.1                     | 0                    |
| Acenaphthene                            | 170                                                   | < 0.1               | < 0.1               | < 0.1               | 0.18                      | 0.29                      | 0                    |
| Fluorene                                | 170                                                   | < 0.1               | < 0.1               | < 0.1               | < 0.1                     | 0.19                      | 0                    |
| Phenanthrene                            | 95                                                    | 0.17                | < 0.1               | < 0.1               | 0.75                      | 1.17                      | 0                    |
| Anthracene                              | 2400                                                  | < 0.1               | < 0.1               | < 0.1               | 0.18                      | 0.25                      | 0                    |
| Fluoranthene                            | 280                                                   | 0.21                | < 0.1               | 0.16                | 0.70                      | 0.98                      | 0                    |
| Pyrene                                  | 620                                                   | 0.16                | < 0.1               | 0.15                | 0.55                      | 0.84                      | 0                    |
| Benzo(a)anthracene                      | 7.2                                                   | < 0.1               | < 0.1               | < 0.1               | 0.18                      | 0.24                      | 0                    |
| Chrysene                                | 15                                                    | < 0.1               | < 0.1               | < 0.1               | 0.24                      | 0.25                      | 0                    |
| Benzo(a)pyrene                          | 5                                                     | < 0.1               | < 0.1               | < 0.1               | 0.13                      | 0.22                      | 0                    |
| Benzo(b)fluoranthene                    | 2.6                                                   | < 0.1               | < 0.1               | < 0.1               | 0.17                      | 0.23                      | 0                    |
| Benzo(k)fluoranthene                    | 77                                                    | < 0.1               | < 0.1               | < 0.1               | < 0.1                     | < 0.1                     | 0                    |
| Indeno(1,2,3-cd) pyrene                 | 27                                                    | < 0.1               | < 0.1               | < 0.1               | < 0.1                     | < 0.1                     | 0                    |
| Dibenzo (a, h) anthracene               | 0.24                                                  | < 0.1               | < 0.1               | < 0.1               | < 0.1                     | < 0.1                     | 0                    |
| Benzo(ghi)perylene                      | 320                                                   | < 0.1               | < 0.1               | < 0.1               | < 0.1                     | < 0.1                     | 0                    |
| <b>Phenols</b>                          |                                                       |                     |                     |                     |                           |                           |                      |
| Phenol                                  | 280                                                   | < 2                 | < 2                 | < 2                 | < 2                       | < 2                       | 0                    |

Based on the above table, no contaminant concentrations were found in exceedance of the screening criteria relevant to a residential with plant uptake end use.

**Asbestos fibres** were not identified in the soil samples analysed.

Due to the presence of the adjacent substation, the soil samples were tested for 12 congeners of Polychlorinated biphenyls (**PCBs**). No **PCBs** were identified in the soil samples tested.

### 8.3 Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of June 2018, "Guidance on the classification and assessment of waste" has been carried out on soils recovered from the site, using HazWasteOnline.

The results are summarised in Table 14 below and presented in full in Appendix 4.

**Table 14: Waste Classification of Soils**

| Location | Depth (m bgl) | WM3.1 Classification | WAC Testing Classification     | Comments          |
|----------|---------------|----------------------|--------------------------------|-------------------|
| WS01     | 0.30          | Non-Hazardous        | Stable Non- Reactive Hazardous | Elevated Fluoride |
| WS02     | 0.40          | Non-Hazardous        | -                              | -                 |
| WS03     | 0.70          | Non-Hazardous        | -                              | -                 |
| HDP01    | 0.30          | Non-Hazardous        | -                              | -                 |
| HDP02    | 0.10          | Non-Hazardous        | -                              | -                 |

The above table shows that all tested samples collected from the site have been classified as **Non-Hazardous** in accordance with WM3.1.

One of the soil samples has been submitted for Waste Acceptance Criteria (WAC) testing. This sample (WS01 at 0.30m) is recorded to exceed the criteria for disposal at an inert waste facility, due to elevated Fluoride. Material from around this location should be accepted as Stable Non-Reactive Hazardous waste in a Non-Hazardous Landfill.

For Waste Acceptance Criteria (WAC) testing, EEGL have compared solid waste and leachate values with guideline values in Landfill Regulations. The following table summarises the results of the solid waste analysis and leachate testing, together with limit values for Non-Hazardous waste and Hazardous waste as described in the Landfill Regulations.

Further WAC testing on the remaining samples may prove that the material is acceptable as inert waste.

**Table 15: Summary of WAC Test Results**

| Determinand                              | Landfill Regulations Limits<br>(mg/kg unless otherwise indicated) |                                                   |                    | WS01<br>0.30m<br>(mg/kg) |
|------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------|--------------------|--------------------------|
|                                          | Inert Waste                                                       | Stable Non-<br>Reactive<br>non-hazardous<br>waste | Hazardous<br>Waste |                          |
| TOC (%)                                  | 3%                                                                | 5%                                                | 6%                 | 1                        |
| Loss on ignition (%)                     | -                                                                 | -                                                 | 10%                | 3.80                     |
| BTEX (mg/kg)                             | 6                                                                 | -                                                 | -                  | < 0.05                   |
| Sum of PCBs (mg/kg)                      | 1                                                                 | -                                                 | -                  | < 0.1                    |
| Mineral Oil (mg/kg)                      | 500                                                               | -                                                 | -                  | < 10                     |
| Total PAH (mg/kg)                        | 100                                                               | -                                                 | -                  | < 1.7                    |
| pH (units)                               | -                                                                 | < 6                                               | -                  | 11.1                     |
| Acid Neutralisation<br>Capacity (mol/kg) | -                                                                 | <i>To be evaluated</i>                            |                    | 1.9                      |
| Arsenic                                  | 0.5                                                               | 2                                                 | 25                 | 0.034                    |
| Barium                                   | 20                                                                | 100                                               | 300                | 0.285                    |
| Cadmium                                  | 0.04                                                              | 1                                                 | 5                  | < 0.002                  |
| Chromium                                 | 0.5                                                               | 10                                                | 70                 | 0.028                    |
| Copper                                   | 2                                                                 | 50                                                | 100                | 0.286                    |
| Mercury                                  | 0.01                                                              | 0.2                                               | 2                  | 0.0013                   |
| Molybdenum                               | 0.5                                                               | 10                                                | 30                 | 0.069                    |
| Nickel                                   | 0.4                                                               | 10                                                | 40                 | 0.0178                   |
| Lead                                     | 0.5                                                               | 10                                                | 50                 | < 0.002                  |
| Antimony                                 | 0.06                                                              | 0.7                                               | 5                  | < 0.002                  |
| Selenium                                 | 0.1                                                               | 0.5                                               | 7                  | 0.0237                   |
| Zinc                                     | 4                                                                 | 50                                                | 200                | 0.27                     |
| Chloride                                 | 800                                                               | 15000                                             | 25000              | 29                       |
| Fluoride                                 | 10                                                                | 150                                               | 500                | <b>10.2</b>              |
| Sulphate                                 | 1000                                                              | 20000                                             | 50000              | 253                      |
| Total Dissolved Solids                   | 4000                                                              | 60000                                             | 100000             | 2169                     |
| Phenol Index                             | 1                                                                 | -                                                 | -                  | < 0.5                    |
| DOC                                      | 500                                                               | 800                                               | 1000               | 185                      |

## 9.0 CONCLUSIONS & RECOMMENDATIONS

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### 9.1 Soil Contamination

There is a **LOW** potential risk from soil contamination to construction workers and ground workers during development.

Based on the results of the chemical testing, no contaminant concentrations were found to exceed the screening criteria relevant to a residential with plant uptake end use.

Therefore, the risk to future end users is considered **LOW** and no further remedial action is considered necessary.

### 9.2 Asbestos

No asbestos fibres were identified in the samples tested during this investigation.

### 9.3 Foundations

Shallow strip/pad foundations placed in the superficial deposits, are considered appropriate for the current proposed development, dependent on allowable bearing pressures and tolerance of structures to settlement.

Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered, such as ground improvement and piles.

It recommended that for foundations and ground floor slabs in contact with the made ground, the Design Sulphate Class should be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1.

### 9.4 Soil Disposal

Soils should be disposed of at a suitable site, registered to take the levels of contamination encountered. All tested soil samples have been classified as Non-Hazardous for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

Further Waste Acceptance Criteria (WAC) testing conducted on one of the tested samples provides a classification which exceeds the criteria for disposal as inert waste. The material surrounding the tested location (WS01 at 0.30m bgl) should therefore be accepted as Stable Non-Reactive Hazardous waste in a Non-Hazardous landfill.

Consultation with local landfills/ waste sites, is recommended prior to the removal of material off-site.

### 9.5 Pavement Design

Based on the findings of the site investigation, the soil type at subgrade level was typically made ground underlain by variable sand. Based on the recommendations for design CBR values provided in Interim advice note 73/06, Revision 1 (2009), a conservative design CBR value of 1% should be adopted in areas where made ground is encountered at subgrade level.

## **9.6 Risk to Buried (Water) Services**

It is considered that, due to the absence of hydrocarbons in the tested soils, standard materials are likely to be suitable for new water pipes. Further advice should be sought from the local water company.

Previous guidance on buried water pipes was contained in Water Regulations Advisory Scheme (WRAS) Guidance Note No. 9-04-03<sup>(2002)</sup>, however this has been superseded by the UK Water Industry Research Report 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' Ref 10/WM/03/21 (January 2011).

## **9.7 Site Personnel**

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on-site washing facilities should be available.

## **9.8 Other Matters**

Due diligence is required during the construction period, and should any further evidence of contamination be found, appropriate investigation and / or action should be taken. The significance of any contamination not discovered by this investigation is outside the scope of this report.

## **APPENDIX 1**

### **EXPLORATORY HOLE LOGS**

## **APPENDIX 2**

### **GEOTECHNICAL TESTING RESULTS**

## **APPENDIX 3**

### **SOIL CHEMICAL TESTING RESULTS**

## **APPENDIX 4**

### **SOIL WASTE ASSESSMENT**

## **APPENDIX 5**

### **REPORT LIMITATIONS**

## **REPORT LIMITATIONS**

This contract was completed by Earth Environmental & Geotechnical Ltd on the basis of a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget, and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd provides no other representation or warranty whether express or implied, is made in relation to the services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of Earth Environmental & Geotechnical Ltd.

If a third party relies on this report, it does so wholly at its own and sole risk and Earth Environmental & Geotechnical Ltd disclaims any liability to such parties.

It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important factor in determining the scope and level of the services. Should the purpose for which the report is used, or the proposed use of the site change, this report will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2025 and should be read in light of any subsequent changes in legislation, statutory requirements, and industry best 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 Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full of 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. Further Earth Environmental & Geotechnical Ltd was not authorised and 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, during the performance of the services. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data 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 Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.