



EARTH ENVIRONMENTAL
& GEOTECHNICAL

GeoEnvironmental
Investigation

Old Market Street

Blackley

October 2022

On behalf of

FBJ Construction Ltd

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**GEOENVIRONMENTAL
SITE INVESTIGATION
REPORT**

**OLD MARKET STREET
BLACKLEY**

**Report Ref: A4932/22/SI
OCTOBER 2022**

Prepared on Behalf of:

FBJ Construction Ltd

By:

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Prepared for: FBJ Construction Ltd

Prepared by: Earth Environmental & Geotechnical Ltd
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1.0 EXECUTIVE SUMMARY

Appointment	A Site Investigation has been commissioned by FBJ Construction Ltd (the Client), to examine ground conditions for a proposed new residential development at a site off Old Market Street, Blackley.
The Investigation	The investigation comprised, two cable percussive boreholes and four trial pits with associated sampling and in situ testing, laboratory geotechnical and contamination testing.
The Site	The site is located in Old Market Street, Blackley, approximately 5.07km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SD 85463 02932 (X:385463, Y: 402932).
Ground Conditions Encountered	The exploratory holes generally encountered Made Ground to a maximum depth of 3.00m. Underlying the Made Ground in all exploratory boreholes were superficial deposits of Glaciofluvial Sheet Deposits comprising predominantly Sand to a maximum depth of 14.00m bgl. Clay was also encountered in BH2 to a maximum depth of 15.0m bgl. Groundwater was not encountered during the fieldwork.
Geotechnical Assessment	Shallow strip/pad foundations are not considered suitable for the proposed apartment building due to the depth of Made Ground below the proposed footprint (encountered to depths of 3.00m bgl). The apartment building may be founded on piles taken down to depth to a suitable founding stratum such as the Glaciofluvial Deposits comprising dense sand. Pavement Design – preliminary design value = 1% in Made Ground. Design Sulphate Class = DS-1 ACEC Site Classification = AC-1s
Contamination Assessment	Risk from contamination to groundworkers during development – Moderate to Low Soil chemical exceedances - Lead in 2no. samples, benzo (a, h) anthracene in 2no. samples Risk from contamination to future site users – Low due to removal of the pollutant linkage Asbestos was encountered in 2no. samples (<0.001% and 0.099% Chrysotile) Therefore, an Asbestos Management Plan is required Soil Waste Assessment - All samples classified as Non-Hazardous Ground Gas Assessment - Land Gas & Radon protection measures not required
<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>	

2.0 INTRODUCTION

2.1 Background

A Site Investigation has been commissioned by FBJ Construction Ltd (the Client), to examine ground conditions for a proposed new residential development at a site off Old Market Street, Blackley, Manchester following demolition of the former buildings.

2.2 Previous Investigations

The following reports have previously been prepared for the site by ECUS Environmental Consultants and Egniol Environmental Ltd and should be read in conjunction with this Site Investigation Report:

2.2.1 ECUS Environmental Consultants, Phase 1 Geo-Environmental Desk Study Report, dated February 2018

Historical records show the site has been developed since 1848, and a Cotton Mill was present from 1891. Various buildings have since been constructed and subsequently demolished on site.

Potential contaminants associated with the historical industrial buildings include polycyclic aromatic hydrocarbons (PAH), heavy metals, and asbestos.

Potential off-site sources of contamination include a historical landfill located 151m to the northwest of the site which may be a source of hazardous ground gas.

It was concluded that the risk from soil contamination to future residential end users was **MODERATE**. The risk to controlled waters was concluded to be **LOW** and the risk from hazardous ground gas was concluded to be **HIGH**.

An intrusive investigation was recommended to characterise the ground conditions and establish any contamination across the site.

2.2.2 Egniol Environmental Ltd, Phase II Geo-Environmental Investigation Report, dated December 2019

An intrusive Site Investigation was conducted by Egniol Consultant Ltd on the 25th of November 2019 and comprised three window sample boreholes to a maximum depth of 5.45m bgl. Standard Penetration Tests were conducted in-situ in accordance with BS EN ISO 22476-3.

A dual-purpose gas and groundwater monitoring well was installed in one of the window sample boreholes, however, no monitoring results are included within the report.

The boreholes revealed a sequence of Made Ground to a maximum depth of 1.30m bgl (WS101) comprising sandy gravel and cobbles of limestone, brick, and sandstone.

Beneath the Made Ground were superficial clay deposits with a maximum thickness of 1.75m, comprising generally a soft to firm brown very sandy gravelly CLAY containing mudstone and sandstone.

Superficial sand was encountered generally as a dense fine to coarse gravelly clayey SAND containing sandstone, mudstone, and some coal.

Groundwater was not encountered in any of the exploratory hole locations. Perched water was encountered in WS102 at 4.10m bgl.

A range of geotechnical testing was conducted on the site. It was concluded that the interbedded glacial deposits would be suitable for shallow foundations. However, piled foundations were recommended at the preliminary stage.

Chemical analyses were conducted on four soil samples retrieved from the exploratory holes. Testing included asbestos screen, metals, total and banded petroleum hydrocarbons, total and speciated polycyclic aromatic hydrocarbons. Results were compared to a Residential End Use without Plant Uptake criteria.

No contaminant exceedances were observed in the samples analysed. However, asbestos was identified as chrysotile in location WS101 at 0.40m bgl. The asbestos was quantified at <0.001%.

The report concluded that further delineation is required post-demolition due to the asbestos encountered. A deeper drilling method is required to investigate the basement area of the site.

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 A4922/22 dated 29th July 2022. 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, water and ground gas contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g., existing/ future end users and site neighbours.*
- *Classification of potential surplus 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 in Blackley, Manchester approximately 5km from Manchester City Centre. The approximate National Grid Reference for the centre of the site is SD 85463 02932 (X: 385463, Y: 402932), with the closest postcode being M9 8DX.

The site is a near rectangular shaped parcel of land with current access via heras fencing off Old Market Street. The maximum dimensions of the proposed site are 27m north to south and 28m east to west. The site occupies an area of approximately 0.10 hectares.

The surrounding area comprises predominantly of residential properties. A graveyard and public house are situated to the east of the site. An open green space is located immediately north of the site across Old Market Street.

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 east showing southern section of the site.



Photograph taken viewing west showing cable percussion rig on BH1.



Photograph showing the extent of excavation at TP3



Photograph taken viewing southwest showing general overview of the site. Note large slope in the southwest corner.



3.1 Proposed Development

It is understood that the client wishes to construct an apartment building with 12 two bed units and 6 one bed units, with parking and soft landscaping.

Site access will be retained via Old Market Street to the east of the site, via a new access road.

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 between 12th August 2022 and 15th August 2022 and comprised:

- Two 150mm diameter borehole (designated BH1 and BH2) were sunk to a depth of between 12.00m and 15.00m below existing ground level, using a light cable percussion boring rig. With this type of rig boreholes are advanced by the percussive action of drill tools suspended on a winch-driven steel cable. The tools generally include a clay-cutter for penetrating fine-grained soils, and a shell for use in coarse-grained, or “granular”, soils. Representative disturbed samples were recovered as boring proceeded. In addition, “undisturbed” 100mm diameter samples (U100’s) were recovered, as appropriate, using standard thick-walled, open-drive samplers, with a steel cutting shoe, dynamically driven by a sliding hammer. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Chiselling techniques, using a chisel or shell, were employed where necessary, to advance the boreholes through obstructions or into hard strata. Details of groundwater conditions were noted and are indicated on the attached borehole logs. These observations relate only to the time of boring, and do not necessarily reflect possible seasonal fluctuations. They may have been affected by the installation of casing, or the addition of water to aid boring. Borehole logs are included in Appendix 1.
- 50mm diameter standpipes were installed in both cable percussive boreholes to a maximum depth of 5.00m below ground level. Installation and backfill details are shown with the appropriate borehole log sheet. EEG carried out groundwater/ground gas monitoring in standpipes after the fieldwork period, the results of which are presented in Appendix 2.
- Four trial pits (designated TP1 to TP4 inclusive) were excavated by use of a JCB 3CX to a maximum depth of 4.00m bgl. Trial pits were backfilled immediately on completion of sampling and testing. Trial pit logs are presented in Appendix 1.

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

The cable percussive boreholes were positioned within the vicinity of the former basement, to determine the ground conditions beneath the proposed apartment building footprint. Trial pits were excavated across the site, including the proposed soft landscaped areas and car park, to determine the presence of any asbestos contamination. Some areas were restricted due to a slope within the demolition rubble.

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. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the DETS laboratory.

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^(2015+A1:2020) except where superseded by the soil and rock description methodology in BS EN14688-1⁽²⁰⁰²⁾, BS EN 14688-2⁽²⁰⁰⁴⁾ and BS EN 14689-1⁽²⁰⁰³⁾.

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.

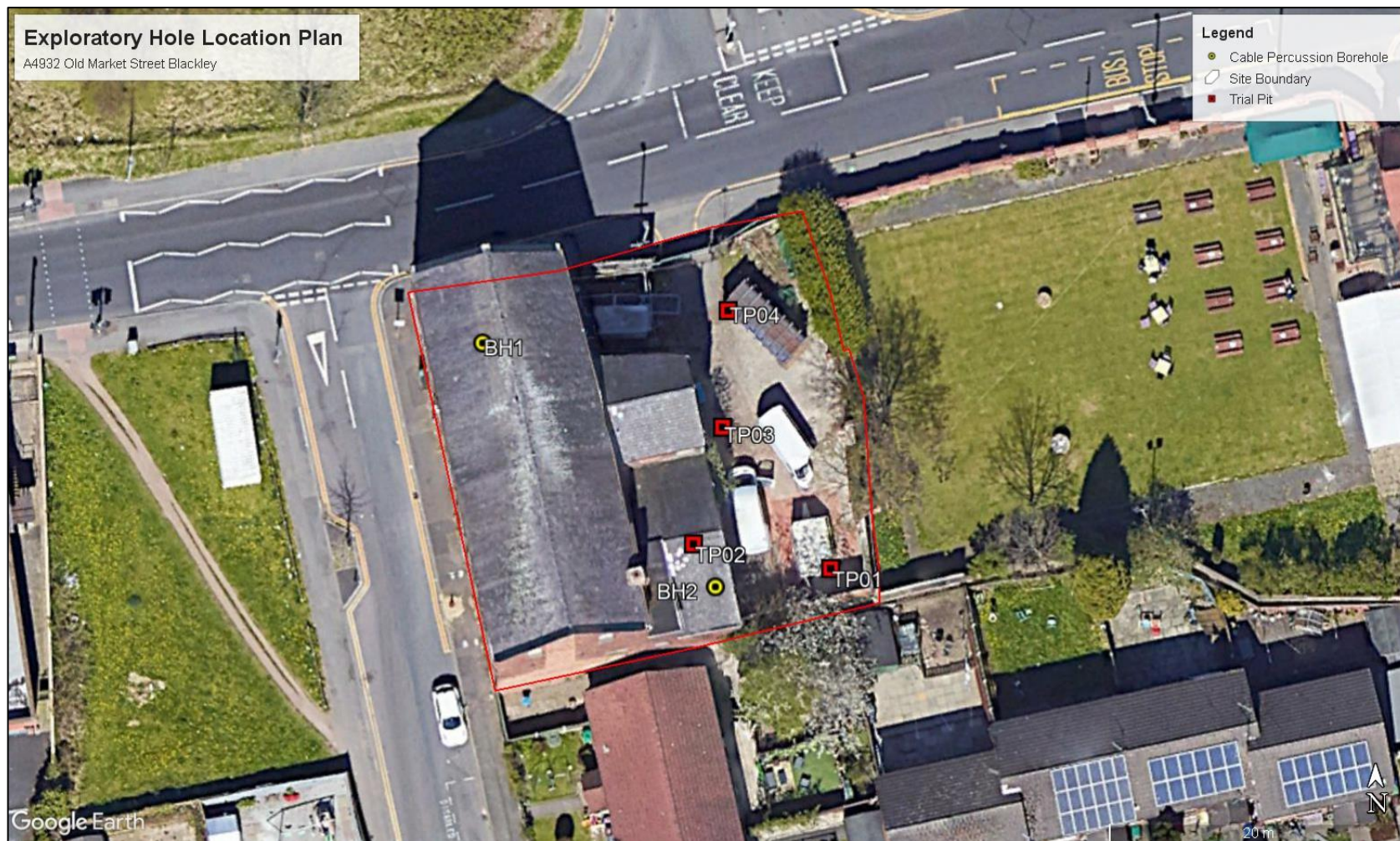
The descriptive terminologies such as firm, etc formerly used within older versions of BS5930 to describe strength now solely relate to consistency. Shear strength is now defined related to results obtained in the field (using a hand vane for example) or in the laboratory (from triaxial tests), as detailed in Table 1 below.

Table 1: Shear Strength Definitions

Term based on measurement	Undrained Strength (c_u) definition in kN/m^2 (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	130 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 undertaken during the investigation are presented in Table 2 below.

Table 2: Summary of Exploratory Holes Undertaken

Hole	Type*	Depth (m)	Date Started	Date Finished	Easting (m)	Northing (m)	Backfill Details**
BH1	CP	12.00	25/04/2022	25/04/2022	385456	402934	SP
BH2	CP	15.00	25/04/2022	25/04/2022	385480	402918	SP
TP1	TP	3.00	15/08/2022	15/08/2022	385472	402928	A
TP2	TP	1.60	15/08/2022	15/08/2022	385471	402920	A
TP3	TP	3.70	15/08/2022	15/08/2022	385477	402927	A
TP4	TP	4.00	15/08/2022	15/08/2022	385476	402934	A
*CP = Cable Percussive Borehole, TP = Trial Pit							
**A = Arisings, SP = Standpipe							

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 3, below.

Table 3: Summary of Laboratory Geotechnical Tests Undertaken

TEST	STANDARD	No.
Liquid Limit, Plastic Limit, Plasticity Index	BS1377:1990 Part 2, Clause 4/5	2
Particle size distribution (wet)	BS1377:1990 Part 2, Clause 9.2	8
Sulphate content of 2:1 soil: water extract	BS1377:1990 Part 3, Clause 5	8
pH value	BS1377:1990 Part 3, Clause 9	8

The results of the laboratory geotechnical tests are discussed in Section 6 and included in Appendix 3.

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 eight 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 (SO₄), Sulphide, pH, Soil Organic Matter, Extractable Petroleum Hydrocarbons (EPH), Speciated Petroleum Hydrocarbon and Speciated Polyaromatic Hydrocarbons (PAH).

Full results of the laboratory contamination tests are discussed in Section 8 and included in Appendix 4.

Chemical analyses were also carried out on two groundwater samples and were submitted for the following suite of determinants:

Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO₄), Sulphide, pH, Total Organic Carbon (TOC), Extractable Petroleum Hydrocarbons (EPH), Speciated Petroleum Hydrocarbon and Speciated Polyaromatic Hydrocarbons (PAH).

Full results of the laboratory contamination tests are discussed in Section 9 and included in Appendix 4.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Soil Profile Encountered

BGS digital mapping shows the site is underlain by superficial deposits of Glaciofluvial Deposits comprising sand and gravel. The solid geology beneath the site is recorded as the Manchester Marls Formation, comprising mudstone (Permian Age). The sequence of strata encountered beneath the site was as follows:

- **Made Ground** – Variable Made Ground was encountered in all of the exploratory holes to a maximum depth of 3.00m bgl, comprising:
 - Sandy GRAVEL comprising concrete, redbrick, metal fragments, plastic fragments, and sandstone.
 - Sandy gravelly CLAY comprising redbrick and sandstone.
 - Gravelly SAND comprising redbrick, concrete, wood, plastic, cable, and fabric.
 - Redbrick COBBLES.
- **Superficial Deposits** –

Sand was encountered in all exploratory holes to a maximum depth of 14.00m bgl, comprising:

- Slightly gravelly SAND containing gravel of sandstone.
- Slightly gravelly silty SAND containing gravel of sandstone
- Gravelly SAND containing gravel of sandstone with cobbles of sandstone
- Clayey slightly gravelly SAND containing gravel of sandstone

Clay was encountered in exploratory holes BH1 and BH2 to a maximum depth of 15.00m bgl, comprising:

- Sandy gravelly CLAY containing gravel of sandstone
- Sandy silty CLAY

The depths of the various materials encountered in the exploratory holes are summarised in Table 4, below.

Table 4: Summary of Ground Conditions Encountered

Hole	Depth to Stratum (m bgl)				GROUNDWATER (m bgl)
	MADE GROUND		SUPERFICIAL DEPOSITS		
	Granular	Cohesive	SAND	CLAY	
BH1	0 – 2.60	-	3.00 – 12.00+	2.60 – 3.00	-
BH2	0 – 1.50	1.50 – 3.00	3.00 – 14.00	14.00 – 15.00+	-
TP1	0 – 0.60	-	0.60 – 3.00+	-	-
TP2	0 – 1.60+	-	-	-	-
TP3	0 – 2.50	-	2.50 – 3.70+	-	-
TP4	0 – 0.30	-	0.30 – 4.00+	-	-
Depths in red indicate termination within the Made Ground.					

5.2 Observable Indications of Contamination

Gravel/cobbles of red brick, concrete, plastic, and metal fragments were observed in the Made Ground encountered on site, but these materials are generally considered inert.

No other visual or olfactory indications of contamination were observed.

5.3 Obstructions and Voids

No man-made obstructions were encountered in any of the exploratory hole locations.

5.4 Groundwater

No groundwater was encountered in any of the exploratory hole locations throughout the fieldwork and subsequent monitoring.

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 the following table.

Table 5: Summary of Laboratory Geotechnical Test Results

Location	Depth (m)	Strata*	CLASSIFICATION								CHEMICAL	
			Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Modified Plasticity Index (%)	PSD Gravel (%)	PSD Sand (%)	PSD Silt/Clay (%)	pH Value	Water Soluble Sulphate SO ₄ (mg/l)
BH2	4.50 – 4.95	SAND	-	-	-	-	-	3	29	68	7.0	100
BH2	6.00 – 6.50	SAND	-	-	-	-	-	0	55	45	7.1	80
BH2	9.00 – 9.50	SAND	-	-	-	-	-	0	53	47	7.1	80
BH2	10.50 – 11.00	SAND	-	-	-	-	-	0	53	47	7.6	190
BH2	14.00 – 14.45	SAND	-	-	-	-	-	64	9	27	7.6	190
BH2	14.50 – 15.00	CLAY	14.2	30	13	17	17	18	16	66	-	-
BH1	1.50 – 1.95	MG	-	-	-	-	-	-	-	-	8.0	330
BH1	6.00 – 6.45	SAND	-	-	-	-	-	0	81	19	7.0	100
BH1	7.50 – 7.95	SAND	-	-	-	-	-	0	76	24	7.0	110
BH1	9.00 – 9.45	SAND	-	-	-	-	-	0	54	46	7.2	90
BH1	12.00 – 12.95	CLAYEY SAND	24.5	29	12	17	13	-	-	-	-	-

6.2 Made Ground

Variable Made Ground was encountered in all of the exploratory hole locations between ground level and 3.00m below ground level.

SPT tests carried out in the Made Ground were corrected for drilling energy efficiency and overburden pressure and resulted in **N1(60) values** of between 19 and 50, as shown on the SPT v Depth Plot in Figure 5 (overleaf).

The **water-soluble sulphate** content of the Made Ground sample was 330 mg/l SO₄, with a **pH value** of 8.0.

Made Ground is not typically considered to be a suitable founding material, and as such, no geotechnical testing was carried out on the material.

6.3 Superficial Deposits

As discussed in Section 5, soils interpreted to represent the Glaciofluvial Deposits were encountered as variable SAND and CLAY in all of the exploratory hole locations.

6.3.1 Sand

Sand was encountered in all exploratory hole locations at depths between ground level and 14.00m.

The **water-soluble sulphate** content of the sand samples ranged between 80 mg/l and 190mg/l SO₄, with **pH values** of between 7.0 and 7.6.

SPT tests carried out in the sand and resulted in **N values** of between 19 and 50, as shown on the SPT v Depth Plot in Figure 5 (overleaf).

Seven **Particle Size Distribution** (PSD) tests were carried out on the sand samples. A breakdown of results can be observed in Table 5, above. The laboratory generally described the material as a brown slightly clayey silty SAND with rare gravel.

Recommended N values and derived design values for the granular soils are summarised in Table 6, below.

Table 6: Summary of Design Parameters (Sand)

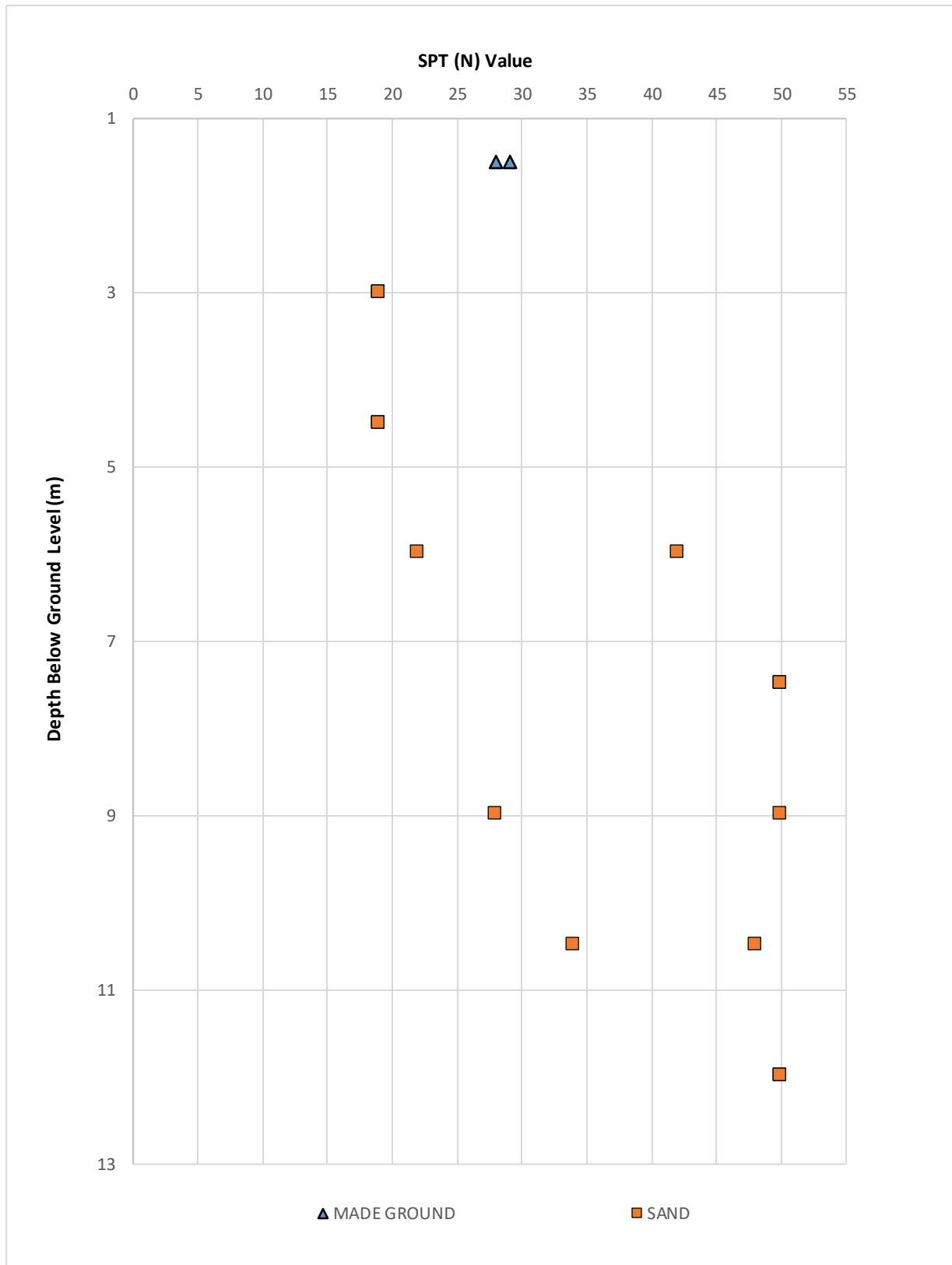
Depth	SPT N Value Range	Average N Value	Design N Value	Equivalent Soil Density	Angle of Internal Friction (degrees)**
3.00	19	19	19	Medium Dense	32.8
4.50	19	19	19	Medium Dense	32.8
6.00	22 – 42	32	27	Medium Dense	35.2
7.50	50	50	50	Very Dense	41
9.00	28 – 50	39	33.5	Dense	37
10.50	34 – 48	41	37.5	Dense	38
12.00	50	50	50	Very Dense	41
13.50	50	50	50	Very Dense	41
*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 an **angle of shearing resistance** of $\phi=32.8$ at 3.00m and 4.00m bgl.

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

Figure 6: SPT v Depth Plot



6.3.2 Clay

Clay was encountered in exploratory holes BH1 and BH2 between 14.00m and 15.00m below ground level.

No **SPT Tests** were carried out in the clay due to the lack of clay recovery across the site.

Atterberg Limit tests were carried out on one sample of clay and one sample of clayey sand. Results of the tests reported **liquid limit** values in the range 29% to 30% and **plastic limit** values in the range 12% to 13%, resulting in values of **plasticity index** of 17%. These results suggest the samples of clay tested are of **low plasticity** as shown on the Plasticity Chart in Figure 6, overleaf.

For design purposes, a value of plasticity index = 17% is recommended, based on the upper quartile of the results.

In accordance with NHBC Chapter 4.2 Building Near Trees ⁽²⁰⁰³⁾ soils can be classified in terms of volume change potential, using the relationship:

$$I_p' = I_p \times \frac{\% \text{ less than } 425\mu\text{m}}{100\%}$$

I_p' = modified plasticity index,
 I_p = plasticity index.

Based on the laboratory test results, the above relationship and Table 1 of NHBC Chapter 4.2, the samples of Clay are shown to have a **low to medium volume change potential**.

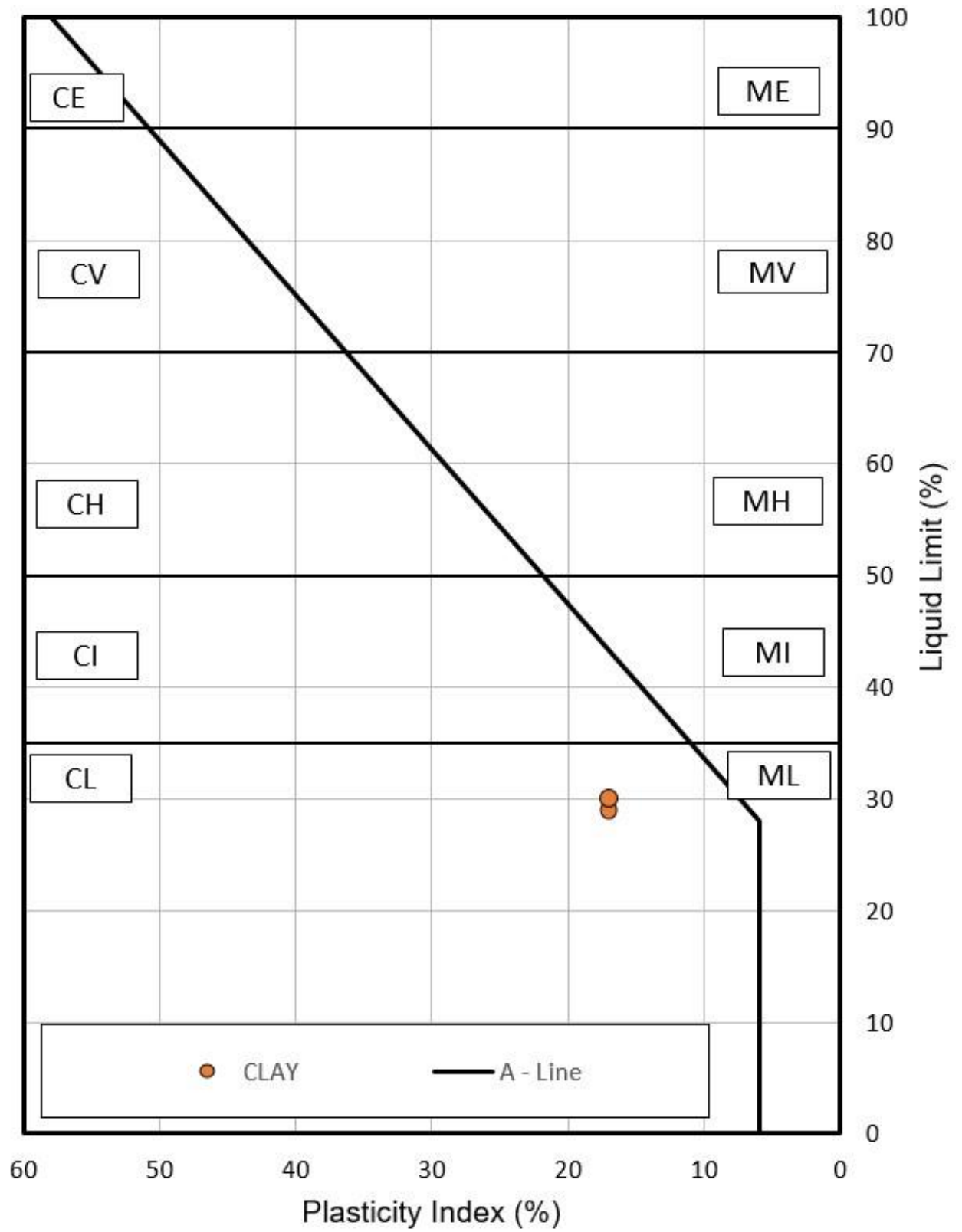
The **Natural Moisture Content** (NMC) and **Liquid Limit** (LL) of the soil can be used to give an indication of **soil desiccation**, i.e., where the NMC is less than 40% of the LL, the soil is inferred to be desiccated, as summarised in Table 7, below.

Table 7: Soil Desiccation Indicators in the Clay

Location	Depth (m)	Liquid Limit (%)	40% Liquid Limit (%)	Natural Moisture Content (%)	Desiccation
BH2	14.50 – 15.00	30	12	14.2	No
BH1	12.00 – 12.95	29	11.6	24.5	No

The results in the above table show that the samples tested show no evidence of desiccation.

Figure 6: Plasticity Chart



7.0 GEOTECHNICAL ASSESSMENT

7.1 Proposed Development

It is understood that the client wishes to construct a three-storey apartment block, consisting of 12 two beds units and 6 one bed units and associated car parking spaces and small areas of soft landscaping. Site access will be retained via Old Market Street to the north of the site.

Detailed information regarding structural loadings and proposed foundation type was not available, however, we anticipate the loadings to be up to 75kN/m².

7.2 Ground Conditions Encountered

The exploratory holes generally encountered Made Ground to a maximum depth of 3.00m. Underlying the Made Ground in all exploratory boreholes were Glaciofluvial Deposits comprising predominantly Sand to a maximum depth of 14.00m bgl. Clay was encountered in BH2 to a maximum depth of 15.0m bgl.

Groundwater was not encountered during the fieldwork or during subsequent monitoring in the standpipes.

7.3 Foundation Considerations

Based on the ground conditions encountered, conventional shallow strip/pad foundations are not considered suitable for the apartment building. The main consideration is the significant thickness of Made Ground encountered beneath the building footprint (up to 3.00m thickness in places).

Therefore, alternative methods such as pile foundations are considered more suitable for the development. Pile foundations are discussed below in section 7.3.1.

7.3.1 Piled Foundations

In areas of deep made ground or unfavourable bearing capacities, foundation loading may be transferred via piles taken down to depth to a suitable founding stratum such as the very dense sand.

A variety of pile types may be used, including bored and continuous flight auger (CFA) piles. Driven piles may be suitable, subject to environmental and noise/vibration constraints.

Because of the various advantages and limitations of each pile type, and the cost implications, advice should be sought from specialist piling contractors to determine the most suitable and cost-effective type. They should also be able to give recommended pile diameters and depths and likely pile capacities, with guaranteed performance. It is recommended a pile test be carried out to confirm pile capacities. In assessing the pile capacities, contractors should make an allowance for the effects of negative skin friction, particularly in the made ground and soft clays.

There may be differential settlement between piled structures and the surrounding ground level. Provision should, therefore, be made to make up ground levels at threshold positions, loading bays, vehicle access doorways, etc. Alternatively, these materials should be removed and replaced in a controlled manner by suitable existing materials or imported engineered fill.

It is essential the advice of a specialist piling contractor is sought and that positive assurances are provided by the piling contractor that their proprietary system can provide the required working loads in the ground conditions encountered.

7.4 Pavement Design

The ground investigation identified the soil type at the subgrade level to typically be Made Ground.

A conservative design CBR value of 1% should be adopted in areas where Made Ground is encountered at subgrade level, where encountered.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable made ground. 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 8: 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 near 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⁽²⁰⁰⁵⁾, 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.

All natural materials on site should be capable of being excavated using conventional excavating machinery.

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' ⁽¹⁹⁹¹⁾ 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 9: 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	B
pH (alkaline)	7 - 8	8 - 9	9 - 10	10 - 12	12	7.5 - 9.3	A - C
Arsenic	0 - 30	30 - 50	50 - 100	100 - 500	500	< 2 - 14	A
Cadmium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 0.2 - 0.8	A
Chromium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	3 - 17	A
Copper	0 - 100	100 - 200	200 - 500	500 - 2500	2500	< 4 - 28	A
Lead	0 - 500	500 - 1000	1000 - 2000	2000 - 1%	1.0%	< 4 - 699	A - B
Mercury	0 - 1	1 - 3	3 - 10	10 - 50	50	< 1	A
Nickel	0 - 20	20 - 50	50 - 200	200 - 1000	1000	< 3 - 11	A
Zinc	0 - 250	250 - 500	500 - 1000	1000 - 5000	5000	10 - 219	A
Boron	0 - 2	2 - 5	5 - 50	50 - 250	250	< 1 - 1.6	A
Selenium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 3	A
Barium	0 - 500	500 - 1000	1000 - 2000	2000 - 1.0%	1.0%	10 - 278	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	4 - 22	A
Sulphate	0 - 2000	2000 - 5000	5000 - 1%	1% - 5%	5.05%	< 200 - 2.13%	A - D
Sulphide	0 - 10	10 - 20	20 - 100	100 - 500	500	< 5	A
Cyanide (free)	0 - 1	1 - 5	5 - 50	50 - 100	100	< 2	A
Phenol	0 - 2	2 - 5	5 - 50	50 - 250	250	< 2	A

Based on the above results, the soils are ranging from contaminated to uncontaminated. A slightly contaminated concentration of pH (acid) and lead were observed. A contaminated concentration of pH (alkaline) was also observed. A heavily contaminated concentration of sulphate was observed. The remaining values are present in uncontaminated concentrations.

Therefore, there is a **MODERATE to LOW** potential risk from soil contamination to construction workers, ground workers and members of the public during construction. Appropriate measures, such as PPE, site health plans, and appropriate disposal of material arisings will further mitigate this risk.

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/CIH. 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 ⁽²⁰¹⁵⁾ (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 Residential End Use without plant uptake criteria.

The soil chemical testing results are summarised in Table 10, overleaf.

Table 10: Soil Results Comparison with C4SL/S4UL Values

Determinand	C4SL/S4UL Levels Residential with Homegrown Produce (mg/kg)	C4SL/S4UL Levels Residential without Homegrown Produce (mg/kg)	BH2 1.50m	BH2 3.00m	BH1 1.50m	TP1 3.00m	TP2 1.50m	TP3 2.50m	TP4 2.00m	No of Exceedances
			Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	
Arsenic	37	40	7	14	14	7	11	3	< 2	0
Beryllium	1.7	1.7	< 0.5	0.6	0.5	< 0.5	< 0.5	< 0.5	< 0.5	0
Boron	290	11000	< 1	1.1	1.6	< 1	1.3	< 1	< 1	0
Cadmium	22	150	< 0.2	0.8	0.3	< 0.2	0.3	< 0.2	< 0.2	0
Chromium	910	910	16	17	13	10	11	5	3	0
Chromium VI	21	21	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Copper	2400	7100	17	28	22	16	23	6	< 4	0
Lead	200	310	24	269	699	43	325	5	< 3	2
Mercury	40	56	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	180	8	11	9	9	8	4	< 3	0
Selenium	250	430	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Vanadium	410	1200	22	21	18	13	18	7	4	0
Zinc	3700	40000	41	146	219	37	215	16	10	0
Benzene	0.87	0.38	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Toluene	660	880	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0
Ethylbenzene	260	83	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
o-xylenes	310	88	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
m-xylenes	310	82	0.5	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
p-xylenes	310	79	0.5	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0
Aliphatic EC >5-6	160	42	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0
Aliphatic EC >6-8	530	100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aliphatic EC >8-10	150	27	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >10-12	760	130	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aliphatic EC >12-16	4300	1100	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >16-21	110000	65000	< 3	< 3	< 3	< 3	< 3	< 3	< 3	0
Aliphatic EC >21-35	110000	65000	< 10	< 10	18	< 10	29	< 10	< 10	0
Aromatic EC >5-7	300	370	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0

Aromatic EC >7-8	660	860	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0
Aromatic EC >8-10	190	47	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >10-12	380	250	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0
Aromatic EC >12-16	660	1800	< 2	7	< 2	< 2	4	< 2	< 2	0
Aromatic EC >16-21	930	1900	< 3	45	< 3	< 3	25	< 3	< 3	0
Aromatic EC >21-35	1700	1900	< 10	46	< 10	< 10	76	< 10	< 10	0
Naphthalene	2.3	2.3	< 0.1	0.35	< 0.1	< 0.1	0.18	< 0.1	< 0.1	0
Acenaphthylene	210	2900	< 0.1	0.28	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	170	3000	< 0.1	0.38	< 0.1	< 0.1	0.26	< 0.1	< 0.1	0
Fluorene	170	2800	< 0.1	0.61	< 0.1	< 0.1	0.18	< 0.1	< 0.1	0
Phenanthrene	95	1300	0.5	6.34	0.38	< 0.1	1.96	< 0.1	< 0.1	0
Anthracene	2400	31000	0.13	1.49	< 0.1	< 0.1	0.51	< 0.1	< 0.1	0
Fluoranthene	280	1500	0.59	8.11	0.69	< 0.1	3.99	< 0.1	< 0.1	0
Pyrene	620	3700	0.53	7.59	0.63	< 0.1	3.69	< 0.1	< 0.1	0
Benzo(a)anthracene	7.2	11	0.25	3.3	0.42	< 0.1	2.52	< 0.1	< 0.1	0
Chrysene	15	30	0.24	3.24	0.51	< 0.1	2.24	< 0.1	< 0.1	0
Benzo(a)pyrene	5	5.3	0.22	2.83	0.39	< 0.1	2.63	< 0.1	< 0.1	0
Benzo(b)fluoranthene	2.6	3.9	0.2	2.69	0.47	< 0.1	2.88	< 0.1	< 0.1	0
Benzo(k)fluoranthene	77	110	< 0.1	1.08	0.19	< 0.1	0.81	< 0.1	< 0.1	0
Indeno(1,2,3-cd) pyrene	27	45	< 0.1	1.33	0.28	< 0.1	1.53	< 0.1	< 0.1	0
Dibenz (a h) anthracene	0.24	0.31	< 0.1	0.38	< 0.1	< 0.1	0.39	< 0.1	< 0.1	2
Benzo(ghi)perylene	320	390	< 0.1	1.12	0.22	< 0.1	1.21	< 0.1	< 0.1	0
Phenol	280	750	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0

Concentrations in red are above the assessment criteria based on a Residential End Use without Homegrown Produce

Based on the above table, potential contaminants of concern have been found in exceedance of long-term human health screening criteria for a Residential End Use without plant uptake in gardens.

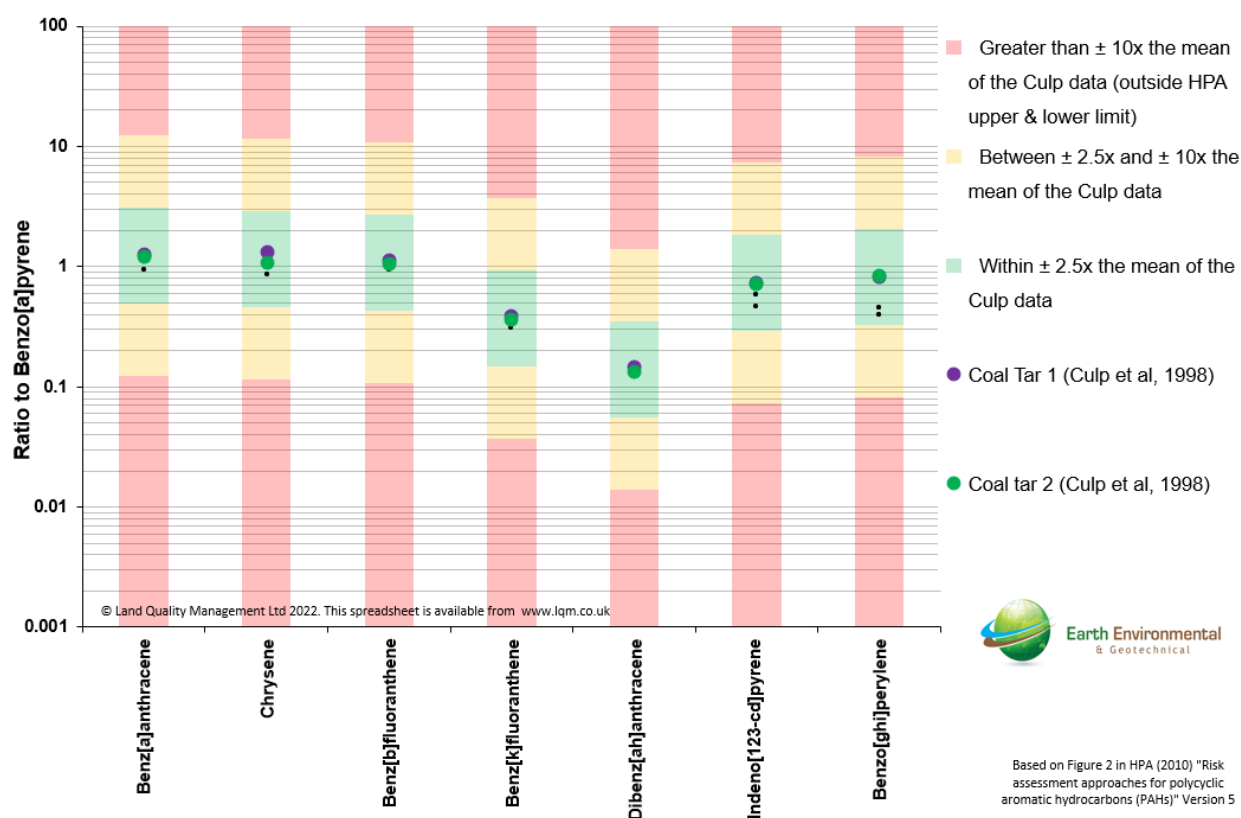
The soil contaminant exceedances include:

- **Lead** in 2no. samples: BH1 at 1.50m (699mg/kg) and TP2 at 1.50m (325mg/kg)
- **Dibenz (a, h) anthracene (PAH)** in 2no. samples: BH2 at 3.00m (0.38mg/kg) and TP2 at 1.50m (0.39mg/kg).

A plot showing the ratio of benzo(a)pyrene to the other eight genotoxic PAHs in soil samples BH2 at 3.00m and TP2 at 1.50m, indicates that the mixture is sufficiently similar to that of the coal tar mixtures tested by Culp et al. (1998).

Figure 7 (below) shows the data is within 2.5x the mean of the Culp data, therefore it is recommended that benzo(a)pyrene be used as a surrogate marker approach in the assessment of carcinogenic risks posed by PAHs in the soil.

Figure 7: Risk Assessment for Polycyclic Aromatic Hydrocarbons (PAHs)



The concentration of volatile organic compounds in the headspace of soil samples was measured using the photo ionisation detector (9.8eV lamp). The peak concentrations ranged from 0.51ppm (BH2 at 1.50m) and 5.66ppm (BH1 at 7.50m).

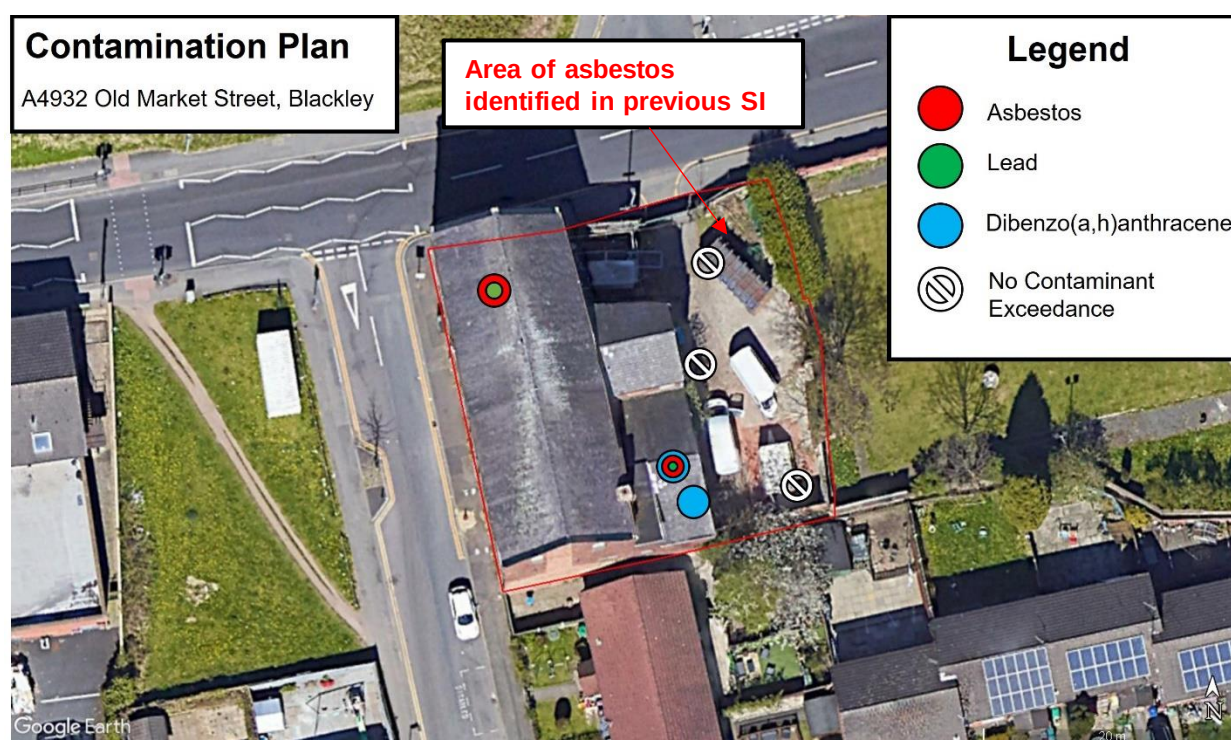
Asbestos was also identified in two of the samples tested, see Table 11 overleaf. Therefore, an Asbestos Management Plan will need to be produced for the site.

Table 11: Summary of Asbestos Encountered

Location	Depth (m bgl)	Asbestos Type	Sample Matrix	Quantification
BH1	1.50	Chrysotile	Loose Fibres	<0.001%
TP2	1.50	Chrysotile	Loose Fibres	0.099%

A plan showing the extent of the soil contamination is shown in Figure 8 below.

Figure 8 Soil Contamination Plan



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 12 below and presented in full in Appendix 5.

Table 12: Waste Classification of Soils

Location	Depth (m bgl)	WM3.1 Classification	Comments
BH2	1.50	Non-Hazardous	-
BH2	3.00	Non-Hazardous	-
BH1	1.50	Non-Hazardous	-
TP1	3.00	Non-Hazardous	-
TP2	1.50	Non-Hazardous	-
TP3	2.50	Non-Hazardous	-
TP4	2.00	Non-Hazardous	-

Table 12 above shows that the soil samples collected from the exploratory boreholes were classified as **Non-Hazardous** in accordance with WM3.1.

Further Waste Acceptance Criteria (WAC) testing may prove that this material is acceptable as inert waste.

Asbestos can affect the waste classification of soil, if the concentration is greater than 0.1%, the soil will automatically be classified as Hazardous waste. As asbestos quantification of the sample taken from BH1 at 1.50m revealed a value of <0.001% and the sample from TP2 at 1.50m revealed a value of 0.099%, this does not affect the Waste Classification as stated above.

9.0 GROUND GAS AND RADON GAS CONTAMINATION RISK ASSESSMENT

9.1 Radon Gas

The site is not located within a Radon Affected Area as defined by the Health Protection Agency, as less than 1% of properties are above the Action Level of exposure and therefore radon protection measures are not necessary.

9.2 Analyses of Monitoring Results

The potential risk associated with gases being generated in the ground (whether from natural or man-made sources) depends on the concentrations of gas and its flow rate to the surface. These factors are assessed by monitoring of the gas installations in the boreholes. The variable nature of gas generation and the effect of barometric pressure on gas flow, means that the volume of gas potentially reaching the ground surface is normally inconsistent over time.

The monitoring visits were conducted between 22nd August 2022 and 27th September 2022. The results recorded methane (CH₄) levels of 0.0% to 0.1% v/v with carbon dioxide (CO₂) levels of 0.1% to 4.9% v/v. Oxygen concentrations of between 15.4% and 21.3% v/v were also recorded.

The concentration of volatile organic compounds in the monitoring wells was measured using the photo ionisation detector (9.8eV lamp). The peak concentrations ranged from 6.4ppm (BH1) and 8.3ppm (BH2).

The installation of monitoring wells includes a 1m plain pipe with a bentonite seal from the ground surface. Therefore, when the water level in the monitoring well is shallower than 1m, the gas concentrations in the headspace of the well may not represent a true reflection of the ground gas regime at the site. However, no water was found in any of the boreholes.

Concentrations and Flow Rates

With regard to flow rates, for the purposes of the ground gas risk assessment BS8485:2015 states that a plausible worst-case condition should be calculated based on the maximum recorded flow in any standpipe in that strata (and zone) with the maximum gas concentration in any other standpipe in that strata (and zone) but discounting any peak instantaneous flows and negative flows that have been judged to be unrepresentative of a possible worst case.

If this worse case check indicates that a greater hazard could reasonably exist, then either this worst case should be adopted as the GSV, or further monitoring should take place to provide evidence that the worst case should not be used,

Flow rates were locally recorded at the site, with a maximum peak flow rate of 0.1 litres/hour. The flow rates remained low throughout the monitoring visits.

Atmospheric pressure was recorded to be between 994mb and 1021mb and therefore over a period of low pressure.

Full results of the monitoring to date are presented in Appendix 2.

Table 13 overleaf, adapted from Table 2 of BS8485: 2015, shows a summary of the current UK practice with respect to appropriate gas protection measures based upon a Gas Screening Value (GSV).

A GSV for the area has been obtained by multiplying the maximum concentration of gas by the steady flow rate of 0.1l/hr adopted for assessment purposes.

- Carbon dioxide: maximum flow rate = 0.1 l/hr, max concentration = 4.9%
- Methane: maximum flow rate = 0.1 l/hr, max concentration = 0.1%

Based on the above figures, the GSV is calculated as:

- **Carbon Dioxide:** $GSV = 0.1 \times 4.9 / 100 = \mathbf{0.0049 \text{ litres/hour}}$
- **Methane:** $GSV = 0.1 \times 0.1 / 100 = \mathbf{0.0001 \text{ litres/hour}}$

The above results suggest the area Characteristic Situation 4, i.e., “very low”, in accordance with Table 13 overleaf.

Protection Measures

On the basis of the foregoing preliminary assessment, ground gas protection measures are not considered necessary.

Table 13: Characteristic Situation by Gas Screening Value

<i>Characteristic Situation</i>	<i>Hazard Potential</i>	<i>Gas Screening Value CH₄ or CO₂ (l/hr)</i>	<i>Additional Factors</i>	<i>Typical source of generation</i>
1	Very Low	<0.07	Typically, < 1% methane Typically, < 5% carbon dioxide	Typical made ground
2	Low	<0.7	Borehole air flow rate to not exceed 70l/hr otherwise consider increase to Characteristic Situation 3	Typical made ground
3	Moderate	<3.5		Old landfill, inert waste, flooded mineworkings
4	Moderate to High	<15	Quantitative risk assessment	Mineworkings susceptible to flooding, completed landfill
5	High Risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very High Risk	>70		Recent landfill site

10.0 CONCLUSIONS & RECOMMENDATIONS

10.1 Soil Contamination

There is a **low to moderate** potential risk from soil contamination to construction workers and ground workers during development, and appropriate measures such as PPE, site health plans, appropriate disposal of material arisings will be required to mitigate this risk.

The chemical testing results have been compared to conservative assessment criteria for the long-term protection of human health and have found exceedances in lead in 2no. samples and Dibenzo (a, h) anthracene in 2no. samples.

The lead exceedances identified in BH1 and BH2 are located beneath the proposed building footprint or hardstanding which will break the pollutant linkage. There was no contamination identified beneath the proposed landscaped areas, therefore the risk to end users is low.

The surrogate PAH marker Benzo(a)pyrene was below the assessment criteria (< 5mg/ kg) in the soil samples and therefore there is no risk of carcinogenic PAHs to residential end users.

10.2 Asbestos

Asbestos was identified in two of the samples tested and quantified to be between 0.001% and 0.099%. Asbestos was also encountered in the previous SI conducted by Egniol (WS101).

Therefore, an Asbestos Management Plan is required for the site to determine the risk of airborne fibre release and to outline protection measures.

It is recommended that any asbestos impacted soils are placed at a depth of 1m below proposed areas of hardstanding and covered by a geomembrane warning layer for future users should the site be redeveloped.

10.3 Foundations

Conventional shallow strip/pad foundations are not considered suitable for the proposed apartment building due to the depth of Made Ground below the proposed footprint (encountered to depths of 3.00m bgl).

The apartment building may be founded on piles taken down to depth to a suitable founding stratum such as the Glaciofluvial Deposits comprising dense sand.

10.4 Land Gas

Based on results of the gas monitoring, the risk of ground gas is very low and protection against the ingress of ground gas will not be required at the site.

10.5 Soil Disposal

Soils should be disposed of at a suitable site, registered to take the levels of contamination encountered. The soils collected at all borehole locations have been classified as Non-Hazardous for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

10.6 Pavement Design

Based on the findings of the site investigation, the soil type at subgrade level was typically Made Ground. 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, where encountered.

10.7 Risk to Buried (Water) Services

It is considered that, due to the absence of BTEX & MTBE, phenols, aliphatic and aromatic hydrocarbon contamination, standard materials should be suitable for new water pipes in the area. However, 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⁽²⁰⁰²⁾, 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).

10.8 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.

10.9 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

MONITORING RESULTS

APPENDIX 3

GEOTECHNICAL TESTING RESULTS

APPENDIX 4

CHEMICAL TESTING RESULTS

APPENDIX 5

SOIL WASTE ASSESSMENT

APPENDIX 6

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 2022 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 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. 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.