

Phase II Geoenvironmental Site Assessment

Site: Greenbrow Social Club, Wythenshawe, Manchester

Reference: 17-305-R1-1

Date: March 24





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QUALITY ASSURANCE

Report Reference	17-305-R1
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EXECUTIVE SUMMARY

Site Address	Greenbrow Social Club, Wythenshawe, Manchester, M23 2TU
Grid Reference	E 380842, N 387174
Site Area	0.3 Ha
Proposed Development	The client intends to construct a residential development comprising 8 No. low-rise residential dwellings and 15 No. apartments with associated gardens, car parking and infrastructure.
Current Site Use	<p>The site is an irregular shaped parcel of land located to the west of Greenbrow Road and to the north of Newall Road in Wythenshawe, Manchester.</p> <p>The disused Greenbrow Social Club is located in the centre of the site, with an associated courtyard area to the southwest. Metal access gates are present off Greenbrow Road. The gate in the northeast corner of the site leads to an access road and hardstanding parking area in the west of the site.</p> <p>Areas of soft cover are present in the south and east of the site. Mature trees are present beyond the southern site boundary and in the east and north of the site. A telephone mast is located adjacent to the east of the site.</p>
Site History	<p>Historical mapping suggests the site was historically agricultural land with Oldwood Road and a pond present in the east and two small buildings at the northern site boundary. The site was vacant by 1954 and the pond was infilled.</p> <p>The existing building was constructed in the 1970s and the site has remained in a similar configuration.</p>



ENVIRONMENTAL SETTING

Geology	Drift Geology	Glacial Till – CLAY, SAND, GRAVEL
	Bedrock Geology	Bollin Mudstone Member – MUDSTONE
	Faults	The nearest geological fault is located 446 m west, trending northwest to southeast.
Geomorphology	A review of relevant records indicates that the site has not been subject to significant anthropogenic changes, with the current site topography broadly representing natural landform associated with glacial deposition.	
Hydrogeology	A Secondary (undifferentiated) Aquifer has been recorded on site in the drift geology with a Secondary B Aquifer in the bedrock geology.	
	The site is not located within a source protection zone. There are no groundwater abstractions within 2km.	
Hydrology	The nearest surface water feature is Fairywell Brook located circa 170 m southwest.	
	The site is located within Flood Zone 1 - no risk of flooding	
Utility Locations	A formal drainage survey has not been completed, however manhole covers were noted during the site walkover. Utility connections will be available throughout the surrounding estates.	
Landfill Sites and Waste Sites	No landfill sites (current or historic) are located within 500 m of the site.	
Radon	Radon Class 1 - less than 1% of homes are estimated to be at or above the Action Level. No radon protection measures required.	
Unexploded Ordnance	The site is located within a moderate risk UXO area. Given the site has been redeveloped since World War II, and shallow bedrock is present, there is considered to be a low risk.	
PFAS	No potential current or historical sources of PFAS have been identified on site. No further risk assessment required.	
Hazardous Installations	No hazardous installations that could potentially prejudice the proposed construction of highly sensitive residential dwellings have been identified within influencing distance of the subject site.	

PREVIOUS REPORTS

The following previous report has been completed for the site:

-  **Dice Environmental** – Phase 1 Geo-Environmental Report (Ref: 100855, dated 19/12/2022), prepared for Bernard Taylor Partnership Ltd.

A full summary of the findings is provided in Section 1.5.



E3P GROUND INVESTIGATION

<p>Ground Works</p>	<p>E3P has completed an intrusive ground investigation comprising:</p> <ul style="list-style-type: none">  6 x window sample boreholes,  Construction of 4 No. environmental monitoring installations.
<p>Ground Conditions</p>	<p>Made Ground – 0.00 m bgl to 0.60 m bgl</p> <p>Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.30 m and 0.60 m bgl.</p> <p>Reworked topsoil was encountered in the south and east of the site to depths of between 0.20 – 0.50 m bgl. The topsoil comprises dark brown slightly gravelly clay with brick, plastic, sandstone and coal fragments.</p> <p>Asphalt was identified in WS102 and WS103 the northwest and west of the site to depths of 0.05 m and 0.10 m bgl. The asphalt is underlain by light orangish brown and greyish brown sandy gravel with limestone and sandstone. Black slightly clayey gravel of slag and clinker was noted in WS102 between 0.20 – 0.40 m bgl, underlain by dark greyish brown slightly gravelly clay with brick, siltstone, sandstone and coal fragments.</p>
	<p>Drift – 0.30 m bgl to 2.00 m bgl</p> <p>Drift deposits were encountered within all exploratory hole locations to a depth of 2.00 m bgl.</p> <p>The drift deposits generally comprise brown and grey slightly gravelly silty CLAY with sandstone and siltstone.</p> <p>Clayey gravelly SILT with siltstone was identified in WS103 between 0.50 – 2.00 m bgl.</p>
	<p>Solid – 2.00 m bgl to >2.42 m bgl</p> <p>Rockhead was encountered at 2.00 m bgl. The solid geology comprises brown and light grey weathered SILSTONE to depths in excess of 2.42 m bgl.</p>
	<p>Groundwater</p> <p>A groundwater strike was recorded as a slow ingress in WS104 at 2.00 m bgl.</p> <p>Monitoring recorded groundwater between depths of 1.22 m and 1.83 m bgl.</p>



CONTAMINATED LAND ASSESSMENT

<p>Human Health</p>	<p>The results of the Tier 2 risk assessment including a comparison of chemical analysis results against values for a residential end-use have indicated the presence of elevated heavy metals and non-volatile PAHs.</p> <p>The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed private gardens and soft landscaping where Made Ground remains to remove any potential for direct exposure to impacted soils.</p> <p>During remediation and enabling works, speciated mercury analysis should be completed to assess whether elemental mercury is present which may pose a risk to future site users through vapour inhalation. If elemental mercury is identified, it may be necessary to delineate and excavate the soils as hotspots and place them in an area of low sensitivity or remove the soils from site. Alternatively, if it is proven that there is no elemental mercury, a clean cover system will be sufficient.</p> <p>Asbestos has not been identified within any of the samples submitted for analysis.</p> <p>Further post-demolition investigations are required to confirm the findings of this initial assessment as and when full and unrestricted access is available.</p>
<p>Controlled Waters</p>	<p>In the absence of any significant sources, viable receptor and complete pollutant linkage, the site is considered to pose a low risk to controlled waters.</p>
<p>Ground Gas</p>	<p>Initial ground gas monitoring has not identified any elevated concentrations of carbon dioxide or methane which indicates that the site would be classified as CS1. Ground gas monitoring is currently ongoing, and a full assessment will be included as an addendum to this report.</p>
<p>Potable Infrastructure</p>	<p>Water</p> <p>Chemical analysis indicates no exceedances above the PE threshold, therefore it is anticipated that PE pipe will be suitable for the proposed potable water supply.</p> <p>This will need to be confirmed following the completion of a UKWIR risk assessment. Post-remediation and enabling works ground conditions may be different from those identified during this site investigation</p>



GEOTECHNICAL ASSESSMENT

Underground Obstructions & Subterranean hazards	<p>No obstructions were encountered during the ground investigation, however significant obstructions will be present beneath the existing building.</p> <p>As part of the process of creating a suitable platform for development, all subterranean obstructions will need to be excavated and removed beneath new structures and infrastructure. This will facilitate the construction of the proposed plots as intended.</p>
Allowable Capacity Bearing	<p>The underlying natural clay drift deposits have been assessed as being stiff high strength with a net allowable bearing capacity (ABC) in the order of 166 – 197 kN/m² at circa 1.00 m bgl. SILT in WS103 is stiff high strength with an ABC of 207 kN/m² at 1.00 m bgl.</p> <p>The weathered siltstone bedrock is dense with an ABC of <450 kN/m² at 2.00m bgl.</p>
Foundation Options	<p>At this time, it is not possible to accurately define the foundation types due to the absence of a detailed tree survey and final development levels.</p> <p>A process of remediation and enabling works will be required to remove any buried obstructions.</p> <p>Dependent on development levels, it is likely that plots could be constructed using traditional strip or trench fill foundations bearing on the shallow stiff CLAY or siltstone bedrock.</p> <p>Further investigation is required to confirm the ground conditions in the location of the existing building.</p>
Foundations Near Trees	<p>Foundation depths within the conjectured influence of former, existing or proposed trees will need to be deepened to ensure that structural loading bears within the underlying target founding stratum, which cannot be subject to volumetric instability associated with fluctuation in moisture content.</p>
Heave Precautions Near Trees	<p>Given that the underlying clay is of low volume change potential, heave precautions will not be required to the internal face of a foundation less than 1.5 m in depth. Heave precautions will be required to the underside of floor slabs (where there is no 200 mm void) and pile ground beams are required within the modelled influencing distance of trees.</p>
Building Floor Slabs	<p>Ground-bearing floor slabs are not considered viable given the anticipated depths of Made Ground > 600 mm and shallow cohesive soils.</p>
Soakaway Drainage	<p>Falling head permeability tests suggest soakaway drainage is unlikely to be suitable due to the presence of cohesive drift deposits.</p>
Sulphate Assessment	<p>Concrete classification will be DS-1 AC-1s.</p>
CBR Design %	<p>Natural clay soils will provide a CBR in the order of 3–5% during drier climatic periods. However, if water is allowed to shed onto the formation, the CBR will reduce to < 2%, which will require specialist engineering of the subgrade.</p>



Enabling Earthworks	<p>Development levels are unknown at this time; however, significant cut-and-fill works are not anticipated to prepare the development platform.</p> <p>As part of the earthworks design, materials should be assessed and characterised prior to re-use in the construction of upfill to a geotechnical design.</p> <p>All future earthworks should be completed in accordance with a Geotechnical Design Report (GDR) that will consider the ground model within the context of the potential for settlement induced by surcharge from earthworks, dynamic and permanent loading of the development and all known hazards.</p>
Civil Engineering Excavations	<p>The E3P Intrusive Ground Investigation has identified the presence of weathered/competent bedrock at a shallow depth, the presence of which will impede the excavation materials to form sewerage and drainage infrastructure and foundations.</p>
Waste Characterisation	<p>Any material that is to be disposed off-site should undergo assessment using Technical Guidance WM3: <i>Waste Classification – Guidance on the classification and assessment of waste</i>. This can be done upon request and in-line with the Environment Agency sampling frequencies.</p>

RECOMMENDATIONS

Based on the findings of the Geoenvironmental site assessment and the various conclusions drawn, the following additional works are recommended to be completed in due course:

- 🔍 Post demolition ground investigation;
- 🌳 Arboricultural Survey.
- 🔍 Geotechnical Earthworks Specification
- 🔍 Remediation And Enabling Works Strategy.



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DRAWING LIST

17-305-001 - Site Location Plan
17-305-002 - Proposed Development Plan
17-305-003 - Historical Features Plan
17-305-004 - Site Features Plan
17-305-005 - Exploratory Hole Location Plan
17-305-006 - Depth of Made Ground Plan
17-305-008 - Depth to Founding Strata Plan
17-305-010 - Conceptual Site Model
17-305-012 - Depth to Bedrock Plan
17-305-018 - Contamination Exceedances
17-305-022 - Cross Section Plan
17-305-023 - Cross Section Plan



1. INTRODUCTION

1.1. BACKGROUND

Shape Consulting Engineers Ltd have commissioned E3P to undertake a Phase II Geoenvironmental Site Assessment at Greenbrow Social Club in Wythenshawe, Manchester; herein referred to as the site.

This report is required to determine potential contaminated land liabilities, remediation requirements and geotechnical engineering works that will be required as part of the proposed residential development.

1.2. PROPOSED DEVELOPMENT

The client intends to construct a residential development comprising 8 No. low-rise residential dwellings and 15 No. apartments with associated gardens, car parking and infrastructure.

A snapshot of the Proposed Development Layout is indicated in Figure 1 below and Drawing 17-305-002 (APPENDIX IV).

Figure 1 Snapshot of Proposed Development





1.3. OBJECTIVES AND SCOPE

The objectives of the geoenvironmental investigation are as follows:

- ✿ Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available to complete a desk study in line with Environment Agency (EA) document Land Contamination: Risk Management (LCRM) (updated June 2023).
- ✿ Undertake a phase of sampling and analysis to provide an overview of the environmental issues identified.
- ✿ Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site concerning the site's future use and off-site receptors.
- ✿ Assess the geotechnical information and provide recommendations concerning foundations, pavement construction and floor slabs.
- ✿ Assess the coal mining-related information and provide recommendations regarding any future treatment; and,
- ✿ Provide recommendations regarding future works required.

1.4. SCOPE OF WORKS

The scope of works includes the elements included in Table 1.

Table 1 Scope of Works

GROUND INVESTIGATION
✿ Design of suitable ground investigation
✿ Window sample probeholes with the construction of environmental monitoring installations
✿ Soil and groundwater sampling
TESTING AND MONITORING
✿ In-situ geotechnical testing
✿ Chemical and geotechnical analysis
✿ Groundwater monitoring
✿ Ground gas monitoring
✿ Infiltration testing
ASSESSMENT AND REPORTING
✿ Factual and interpretative reporting
✿ Contamination risk assessment and conceptual site model
✿ Geotechnical assessment and interpretation



1.5. PREVIOUS REPORTS

The following report has been provided to E3P for review:

Table 2 Previous Reports

AUTHOR	TITLE / REFERENCE	CLIENT	DATE
Dice Environmental	Phase 1 Geo-Environmental Report	Bernard Taylor Partnership Ltd	19/12/2022

The key findings of the previous site investigation reports are summarised below, and where necessary, data has been used to support the E3P geoenvironmental site assessment.

- ✳ A disused former social club is present in the centre of the site, which is accessed via a footpath in the east. Hardstanding parking facilities are present in the west. A previous courtyard extends from the main building in the southwest.
- ✳ Historical mapping shows that the site contained a road between 1876 and 1960. A social club was built by 1992.
- ✳ The site is underlain by superficial strata of Glacial Till and bedrock of the Bollin Mudstone Member.
- ✳ The superficial geology is classified as a Secondary Undifferentiated Aquifer and the solid geology is classified as a Secondary B Aquifer.
- ✳ The site is not located within a Source Protection Zone. There are no groundwater abstraction licenses within 500m.
- ✳ A small stream is located approximately 195 m southwest.
- ✳ The site is located within an area where less than 1% of homes are above the radon action level.
- ✳ No significant source of ground gas has been identified.
- ✳ The site is not located within a coal mining reporting area.
- ✳ There are no active or historical landfills within 500 m.
- ✳ A telecommunications mast is present to the east of the site.
- ✳ Made Ground associated with the on-site roads, parking facilities and use as a social club may include heavy metals, PAHs, TPH and ACM.
- ✳ Dice Environmental suggest that there is a moderate risk to future site users and controlled waters. A Phase II intrusive investigation is recommended.

1.6. LIMITATIONS

The limitations of this report are presented in APPENDIX I.



1.7. RISK CLASSIFICATION

The description of risk classification and the likely action required as set out in CIRIA C552 are included in APPENDIX III.

1.8. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed or with whom an assignment has been agreed. Should any third party wish to use or rely upon the report's contents, written approval must be sought from E3P; a charge may be levied against such consent.



2. E3P GROUND INVESTIGATION

2.1. GENERAL OVERVIEW

A ground investigation has been designed based on the findings of the desk study, with exploratory holes advanced to target specific potential contaminant sources summarised in Section 1.5.

The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development.

Exploratory fieldwork was completed on the 1st of February 2024. The works are summarised in Table 3.

2.2. LIMITATIONS OF THE INVESTIGATION

The ground investigation was limited by the existing building, therefore a supplementary phase of post demolition ground investigation will be required.

2.3. SCOPE OF INVESTIGATION

A summary of the fieldwork completed are included in Table 3.

Table 3 Summary of Fieldwork

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (M BGL)	MONITORING WELLS RESPONSE ZONE (M BGL)
General Ground Conditions/ Former Road	WS101	Window Sample Probehole	2.31	1.0–2.0
General Ground Conditions/ Former Residential Dwelling	WS102		2.31	1.0–2.0
General Ground Conditions Including the Presence/Nature of Obstructions	WS103		2.33	N/A
	WS104		2.42	1.0–2.0
	WS105		2.34	N/A
General Ground Conditions/ Former Road	WS106		2.33	1.0–2.0

Window sample probeholes were advanced to undertake in-situ detailed geotechnical testing, obtain environmental samples and install groundwater and ground gas monitoring wells.

The sampling locations are illustrated in Drawing 17-305-005 (APPENDIX IV). The ground conditions encountered are indicated on the logs, which are provided in APPENDIX VI.

Return visits were made to monitor installations for groundwater level and gas concentrations. In addition, selected wells were purged and samples of groundwater recovered for chemical analysis.



2.4. IN-SITU STANDARD PENETRATION TESTING (SPT)

In-situ geotechnical testing was conducted using the standard penetration test (SPT) and, where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube.

The results are shown in the probehole logs in Appendix VI, presented in Table 18 and discussed in Section 12.0.

2.5. PERMEABILITY TESTS

Two falling head permeability tests were undertaken within environmental monitoring wells (WS102, WS106) in order to assess the likely permeability of the underlying strata to determine the potential suitability for soakaway drainage within the proposed development. The results are presented in Table 22 and the test certificates are included in Appendix X.

2.6. LABORATORY ANALYSIS

Selected soil samples were submitted for a range of chemical and geotechnical analysis, summarised in Table 4.

Table 4 Summary of Laboratory Analysis

CHEMICAL ANALYSIS
Metals
pH, total sulphate, water-soluble sulphate (2:1 extract)
Sulphide
Cyanide
Phenols
Total and speciated polycyclic aromatic hydrocarbons (PAHs)
Asbestos identification
Banded total petroleum hydrocarbons (TPHs)
Total Organic Carbon (TOC)
GEOTECHNICAL ANALYSIS
Atterberg limits determinations
Moisture content
Single-stage triaxial
Particle size distribution
One dimensional consolidation



2.7. STORAGE, PRESERVATION AND TRANSPORT OF SAMPLES

Measures taken to ensure the quality and integrity of the collected samples, from collection to receipt of the samples by the laboratory, are summarised in Table 5.

Table 5 Sample Integrity Information

SUBJECT	CHEMICAL SAMPLING	
Storage	Soil	Groundwater
	Glass jars supplied by the laboratory were used for the collection of soil samples to be analysed for VOCs. Plastic tubs were used to collect soil samples for metals analysis, and asbestos screening.	Glass vials supplied by the laboratory were used for the collection of samples to be analysed for VOCs. Samples to be analysed for lower volatility compounds were stored in laboratory-prepared glass jars.
Preservation	Soil and groundwater sample containers were filled to minimise headspace prior to sealing and stored at a low temperature within cool boxes with cooling aids to minimise the loss of volatile contaminants and reduce microbial activity during the collection of samples.	
Sample Integrity	Soil	Groundwater
	Dedicated disposable nitrile gloves were worn and changed between sample collections to prevent cross-contamination.	Groundwater samples were collected using dedicated plastic tubing, which was changed between monitoring well locations to prevent cross contamination.
Transport	Samples were stored and shipped in dedicated sample boxes provided by the laboratory. Sample details were recorded on the laboratory chain of custody form enclosed with the samples prior to dispatch. Scheduling information for the samples was confirmed with the laboratory via email.	

Chemical analysis has been undertaken by an accredited laboratory with the testing results summarised and discussed in Section 10 and the testing certificates included in Appendix VII.

Geotechnical samples were collected as required per location immediately after excavation, labelled and sealed to minimise moisture loss. The geotechnical samples were collected and couriered by a dedicated courier to an accredited geotechnical testing laboratory.

The testing results are summarised and discussed in Section 9 and the testing certificates included in Appendix VIII.



3. GROUND AND GROUNDWATER CONDITIONS

3.1. SUMMARY OF GROUND CONDITIONS

The ground investigation generally confirms the published geology and identifies the strata set out in Table 6.

Table 6 Summary of Strata

HOLE	DEPTH TO STRATUM (M BGL)				
	MADE GROUND	MADE GROUND TOPSOIL	SILTY CLAY	SILT	WEATHERED BEDROCK
WS101	–	0.00–0.30	0.30–2.00	–	2.00–2.31
WS102	0.00–0.60	–	0.60–2.00	–	2.00–2.31
WS103	0.00–0.50	–	–	0.50–2.00	2.00–2.33
WS104	–	0.00–0.45	0.45–2.00	–	2.00–2.42
WS105	–	0.00–0.50	0.50–2.00	–	2.00–2.34
WS106	0.20–0.50	0.00–0.20	0.50–2.00	–	2.00–2.33

3.2. MADE GROUND

Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.30 m and 0.60 m bgl.

Reworked topsoil was encountered in the south and east of the site to depths of between 0.20 – 0.50 m bgl. The topsoil comprises dark brown slightly gravelly clay with brick, plastic, sandstone and coal fragments.

Asphalt was identified in WS102 and WS103 in the northwest and west of the site to depths of 0.05 m and 0.10 m bgl. The asphalt is underlain by light orangish brown and greyish brown sandy gravel with limestone and sandstone. Black slightly clayey gravel of slag and clinker was noted in WS102 between 0.20 – 0.40 m bgl, underlain by dark greyish brown slightly gravelly clay with brick, siltstone, sandstone and coal fragments.

A Depth of Made Ground Plan is presented as Drawing 17-305-006 in APPENDIX IV.

3.3. DRIFT DEPOSITS

Drift deposits were encountered within all exploratory hole locations to a depth of 2.00 m bgl.

The drift deposits generally comprise brown and grey slightly gravelly silty CLAY with sandstone and siltstone.

Clayey gravelly SILT with siltstone was identified in WS103 between 0.50 – 2.00 m bgl.

3.4. SOLID GEOLOGY

Rockhead was encountered at 2.00 m bgl. The solid geology comprises brown and light grey weathered SILSTONE to depths in excess of 2.42 m bgl.



3.5. GROUNDWATER

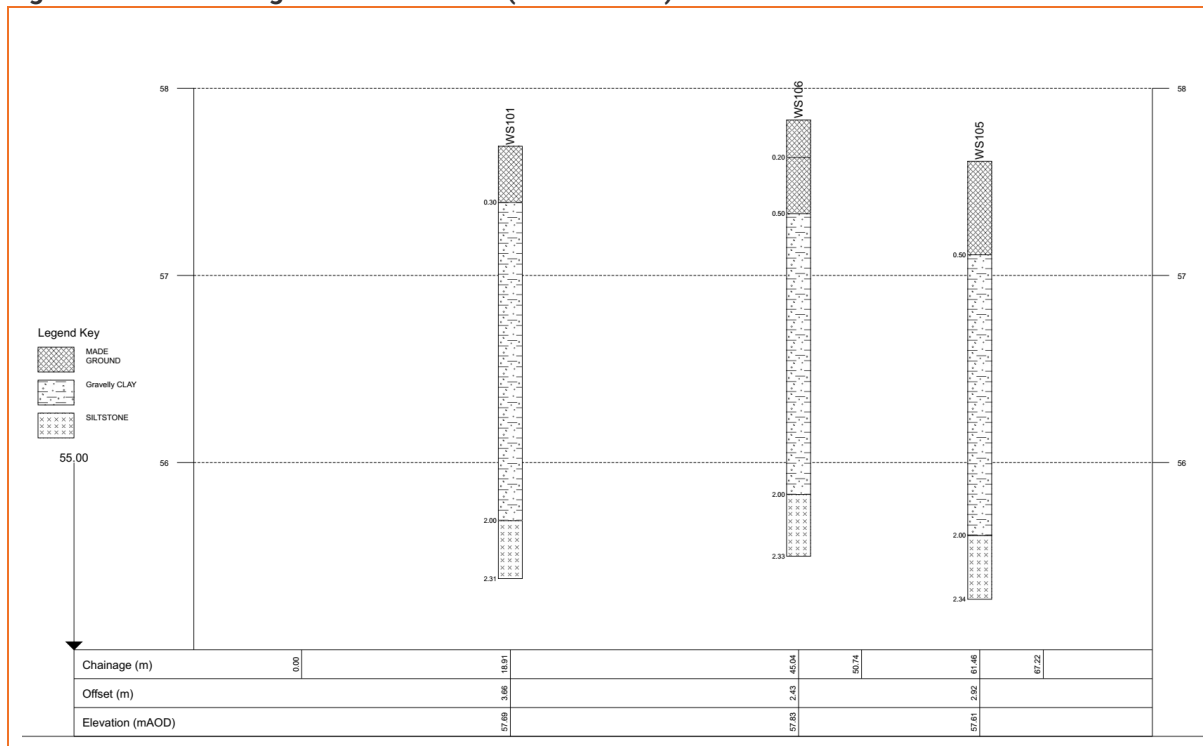
A groundwater strike was recorded as a slow ingress in WS104 at 2.00 m bgl.

Monitoring was undertaken using an electronic dip meter and interface probe to record the depth to groundwater and the thickness of any free-phase hydrocarbon product, if present. These results are summarised in Table 13.

3.6. GEOLOGICAL CROSS SECTION

A geological cross section is included in APPENDIX IV, and a snapshot is shown below in Figure 2.

Figure 2 Geological Cross Section (North-South)



3.7. VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

Visual and olfactory evidence of potential contamination has not been identified during the site investigation.

3.8. OBSTRUCTIONS

No obstructions were identified during the preliminary ground investigation, however all boreholes refused on shallow weathered bedrock.

Obstructions will be present beneath the existing building.



4. TIER 2 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 2 qualitative land risk assessment with respect to human health, controlled waters and ground gas to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

4.1. DEVIATING SAMPLES

Best practice sampling procedures including the use of appropriate sampling containers and adhering to the laboratory holding times for each contaminant analysis, were undertaken in order to avoid samples being deviating.

No deviations were reported.

4.2. SAMPLE ANALYSIS POPULATION

Table 7 summarises the chemical analysis testing scheduled.

Table 7 Summary of Testing Schedule

TYPE OF SAMPLE	NO. OF SAMPLES	DETERMINANDS
Made Ground: Topsoil	4	Speciated PAH
	4	pH, heavy metals, asbestos ID, TOC
	4	Banded TPH
Made Ground	2	Speciated PAH
	2	pH, heavy metals, asbestos ID, TOC
	2	Banded TPH
	1	Leachate
Natural CLAY	2	Speciated PAH
	2	pH, heavy metals, asbestos ID, TOC
	2	Banded TPH
Natural SILT	1	Speciated PAH
	1	pH, heavy metals, asbestos ID, TOC
	1	Banded TPH

4.3. HUMAN HEALTH RISK ASSESSMENT

At Tier 2 stage, the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published in LQM/CIEH S4UL (S4UL3267).

Where Tier 2 screening values are not provided by LQM, other screening values have been used and these are referenced in Table 8.

The Tier 2 screening values for residential with plant uptake have been utilised for this assessment due to the proposed development being a residential end use. To remain conservative at an early stage, the screening values based on a 1% SOM have been utilised for this assessment.

The results of the comparison have been summarised in Table 8.



Table 8 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use (with plant uptake)

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PL	ASSESSMENT
Arsenic	mg/kg	37	9	30	-	1	No Further Action
Cadmium	mg/kg	11	9	1.5	-	1	No Further Action
Chromium (VI)	mg/kg	6.0	9	<1.8	-	1	No Further Action
Lead	mg/kg	200**	9	1400 210	WS102 0.20 m WS104 0.15 m	1	Further Action
Mercury	mg/kg	1.2	9	2.1 1.7	WS102 0.20 m WS104 0.15 m	4	Further Action
Nickel	mg/kg	130	9	31	-	1	No Further Action
Selenium	mg/kg	250	9	<1.0	-	1	No Further Action
Copper	mg/kg	2400	9	100	-	1	No Further Action
Zinc	mg/kg	3700	9	380	-	1	No Further Action
Cyanide – Total	mg/kg	791	9	1.2	-	1	No Further Action
Phenols – Total	mg/kg	120	9	<1.0	-	1	No Further Action
Asbestos	Fibres	NFD	9	NFD	-	3	No Further Action
Naphthalene	mg/kg	2.3	9	0.18	-	4	No Further Action
Acenaphthylene	mg/kg	170	9	0.27	-	2	No Further Action
Acenaphthene	mg/kg	210	9	0.66	-	1	No Further Action
Fluorene	mg/kg	170	9	0.42	-	1	No Further Action
Phenanthrene	mg/kg	95	9	4.6	-	2	No Further Action
Anthracene	mg/kg	2400	9	0.95	-	2	No Further Action
Fluoranthene	mg/kg	280	9	5.9	-	2	No Further Action
Pyrene	mg/kg	620	9	5.2	-	2	No Further Action
Benzo(a)Anthracene	mg/kg	7.2	9	2.8	-	2	No Further Action
Chrysene	mg/kg	15	9	3.2	-	2	No Further Action
Benzo(b)Fluoranthene	mg/kg	2.6	9	3.5 2.9	WS102 0.20 m WS104 0.15 m	2	Further Action
Benzo(k)Fluoranthene	mg/kg	77	9	1.9	-	2	No Further Action
Benzo(a)Pyrene	mg/kg	2.2	9	3.3 2.4	WS102 0.20 m WS104 0.15 m	2	Further Action
Indeno(123-cd)Pyrene	mg/kg	27	9	1.5	-	2	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	0.24	9	0.45 0.33	WS102 0.20 m WS104 0.15 m	2	Further Action
Benzo(ghi)Perylene	mg/kg	320	9	1.8	-	2	No Further Action
TPH C5-C6 (aliphatic)*	mg/kg	42	9	<0.1	-	4	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	100	9	<1.0	-	4	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	27	9	<1.0	-	4	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	74	9	<2.0	-	4	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	140	9	4.8	-	4	No Further Action
TPH C16-C21 (aromatic)*	mg/kg	260	9	23	-	1	No Further Action
TPH C21-C35 (aromatic)*	mg/kg	1100	9	74	-	1	No Further Action

Notes

PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation

Abbreviations: GAC = general assessment criteria, N = number of samples, MC = maximum concentration; Loc of Ex = location of exceedance; PL = Contaminant Pathway; NFD = no fibres detected.

The pathway noted in the table is the primary pathway, however it may not be the only pathway of that contaminant

* The Tier 2 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. E3P has utilised the Tier 2 values for aliphatic compounds for the volatile and semi volatile fractions (C5-C12) and the Tier 2 values for aromatic compound for the non-volatile fractions (C12-C35). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

** Tier 2 GAC for lead taken from C4SL CL:AIRE



Referring to Table 8, the result of this direct comparison indicates that the data exceeds the screening criteria for a residential end use for the following contaminants:

Inorganics

-  Lead
-  Mercury

Organics

-  Benzo(b)Fluoranthene
-  Benzo(a)Pyrene
-  Dibenzo(a,h)Anthracene

4.3.1. EXPOSURE PATHWAYS

The main exposure pathways based on the Tier 2 exceedances are:

-  Soil ingestion (PL1);
-  Vapour inhalation (indoor) (PL4);
-  Dermal contact and ingestion (PL2); and
-  Consumption of homegrown vegetables (PL1).

4.3.2. HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed private gardens and soft landscaping where Made Ground remains to remove any potential for direct exposure to impacted soils.

The specific design and installation process for the appropriate cover systems will be clearly defined within the site remediation and enabling works strategy.

During remediation and enabling works, speciated mercury analysis should be completed to assess whether elemental mercury is present which may pose a risk to future site users through vapour inhalation. If elemental mercury is identified, it may be necessary to delineate and excavate the soils as hotspots and place them in an area of low sensitivity or remove the soils from site. Alternatively, if it is proven that there is no elemental mercury, a clean cover system will be sufficient.

Asbestos has not been identified during the ground investigation, however, asbestos may be present within the existing building. If any visual asbestos is identified during remediation and construction works, visible ACM will need to be removed off site and impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 3.



Figure 3 Asbestos Risk Mitigation Conceptual Site Model



Notes

ND None Detect

0.001% Soils may contain $\leq 0.001\%$ asbestos using composite testing to ensure there is no potential risk to human health. This value is present within areas where there may be a short term low level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (dust suppression)

0.1% Soils at a depth of $>1.00\text{m}$ bgl may contain $<0.1\%$ asbestos using composite testing where they will not be likely to be disturbed in the future and will therefore be in an area of low sensitivity. Risk assessment completed in accordance with Asbestos JIWG risk assessment tools.

Undefined- this will be dependent upon soils encountered during earthworks, which may be placed at these depths to ensure no potential risk to human health.

Chemical analysis of the natural clay drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas; however, further chemical validation samples may be required to meet regulatory sampling frequency. There are no suitable sources of topsoil available on the site.

Further post-demolition investigations are required to confirm the findings of this initial assessment as and when full and unrestricted access is available.



4.4. CONTROLLED WATERS RISK ASSESSMENT

E3P has undertaken a controlled waters risk assessment for the site based on the consideration of the conceptual site model and the sensitive receptors which are summarised in Table 9.

Table 9 Controlled Waters Conceptual Model and Sensitivity Profile

DISCUSSION		SENSITIVITY RATING
Contaminant Source		
Made Ground The soil analysis has identified elevated concentrations of heavy metals and non-volatile PAH compounds in the shallow Made Ground.		Low
Pathway		
Vertical Migration Clay deposits are present beneath the Made Ground to circa 2.00 m bgl. Shallow weathered bedrock has been identified. The presence of this low permeability drift will offer some protection to the underlying aquifer.		Medium
Lateral Migration Lateral migration of contaminants is considered unlikely due to the presence of shallow cohesive soils underlain by weathered bedrock.		Low
Receptor		
Aquifer Classification in Superficial Drift Deposits	Secondary Undifferentiated Aquifer	Low
Aquifer Classification in Bedrock	Secondary B Aquifer	Low
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not affected.	Low
Distance to the Closest Groundwater Abstraction Point	None identified within a 2 km radius.	Low
Is the Site Located Within 50 m of a Surface Watercourse?	Fairywell Brook is located 170 m southwest.	Low

The ICSM developed within the context of the site setting has identified a viable pollutant pathway, which would be the downward migration of potentially mobile phase-soluble contaminants towards the underlying Secondary B aquifer. The sensitivity of the aquifer is reduced given there are no groundwater abstractions within 2 km.

The Tier 2 assessment in line with LCRM (2023) has included a comparison of leachate analysis from samples of the Made Ground and groundwater samples to drinking water standards (DWS) and environmental quality standards (EQS).

DWS will be viewed as a priority given the pollutant linkage is with the bedrock aquifer, however where there are no regulatory guidance values for DWS, the EQS will be utilised in their absence.

Water samples were obtained utilising a bailer.

These are presented in Table 10.



Table 10 Comparison of Groundwater and Leachate Analysis with Tier 2 Screening Levels

DETERMINAND	UNIT	EQS ^{1, 2}	DWS _{3, 4}	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA								
Arsenic	µg/l	50	10	2	2.36	-	1	<1.0	-	No Further Action
Cadmium	µg/l	0.08-0.25	5	2	0.03	-	1	<0.08	-	No Further Action
Chromium (VI)	µg/l	3.4	-	2	-	-	1	<5.0	-	No Further Action
Chromium (III)	µg/l	4.7	50	2	1.6	-	1	1.8	-	No Further Action
Copper	µg/l	1	2000	2	16	-	1	46	-	No Further Action
Total Cyanide	µg/l	1	50	2	<1.0	-	1	1.7	-	No Further Action
Lead	µg/l	1.2	10	2	<0.2	-	1	14	WS106 0.40m	Further Discussion
Mercury	µg/l	-	1.0	2	<0.05	-	1	<0.5	-	No Further Action
Nickel	µg/l	4	20	2	3.8	-	1	3.9	-	No Further Action
Selenium	µg/l	-	10	2	40 15	WS102 WS104	1	<4.0	-	Further Discussion
Zinc	µg/l	10.9	-	2	30	WS104	1	14	WS106 0.40m	Further Discussion
pH	6-9			2	7.7 - 7.8	-	1	7.7	-	No Further Action
Polycyclic Aromatic Hydrocarbons										
Naphthalene	µg/l	2	10*	2	<0.01	-	1	<0.01	-	No Further Action
Anthracene	µg/l	0.1	10*	2	<0.01	-	1	<0.01	-	No Further Action
Benzo[b]fluoranthene	µg/l	0.00017*	10*	2	<0.01	-	1	<0.01	-	No Further Action
Benzo[k]fluoranthene	µg/l	0.00017*	10*	2	<0.01	-	1	<0.01	-	No Further Action
Benzo(a)pyrene	µg/l	0.00017*	10*	2	<0.01	-	1	<0.01	-	No Further Action
Indeno(123-cd)pyrene	µg/l	0.00017*	10*	2	<0.01	-	1	<0.01	-	No Further Action
Fluoranthene	µg/l	0.0063	10*	2	<0.01	-	1	<0.01	-	No Further Action
Benzo(ghi)perylene	µg/l	1.7-4	10*	2	<0.01	-	1	<0.01	-	No Further Action
Aromatic Hydrocarbon										
TPH C5-C7 (benzene)	µg/l	10	1	2	<1.0	-	1	<1.0	-	No Further Action
TPH C7-C8 (toluene)	µg/l	74	700	2	<1.0	-	1	<1.0	-	No Further Action



DETERMINAND	UNIT	EQS ^{1,2}	DWS _{3,4}	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
		AA								
TPH C8-C10 (xylene)	µg/l	30	300	2	<1.0	-	1	<1.0	-	No Further Action
TPH C10-C12 (naphthalene)	µg/l	2	90	2	<10	-	1	<10	-	No Further Action
TPH C12-C16	µg/l	-	90	2	<10	-	1	<10	-	No Further Action
TPH C16-C35	µg/l	-	90	2	<10	-	1	<10	-	No Further Action
Aliphatic Hydrocarbon										
TPH C5-C6	µg/l	-	1000 ⁵	2	<1.0	-	1	<1.0	-	No Further Action
TPH C6-C8	µg/l	-	1000 ⁵	2	<1.0	-	1	<1.0	-	No Further Action
TPH C8-C10	µg/l	-	300	2	<1.0	-	1	<1.0	-	No Further Action
TPH C10-C12	µg/l	-	300	2	<10	-	1	<10	-	No Further Action
TPH C12-C16	µg/l	-	300	2	<10	-	1	<10	-	No Further Action
TPH C16-C21	µg/l	-	300 ^{**}	2	<10	-	1	<10	-	No Further Action
TPH C21-C35	µg/l	-	300 ^{**}	2	<10	-	1	<10	-	No Further Action
Volatile Organic Compounds										
Tetrachloroethylene	µg/l	0.4	10	2	<3.0	-	0	-	-	No Further Action
Trichloroethylene	µg/l	10	10	2	<3.0	-	0	-	-	No Further Action
Trichlorobenzene	µg/l	0.4	-	2	<3.0	-	0	-	-	No Further Action
Trichloromethane	µg/l	2.5	-	2	<3.0	-	0	-	-	No Further Action
Dichloromethane	µg/l	20	200	2	<3.0	-	0	-	-	No Further Action
Carbon Tetrachloride	µg/l	12	3	2	<3.0	-	0	-	-	No Further Action
Vinyl Chloride	µg/l	-	0.3	2	<3.0	-	0	-	-	No Further Action

Notes

Solubility <0.01µg/l

AA – Annual Average

* Polyaromatic hydrocarbons (PAH) - Benzo(a)pyrene (BaP), Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the biota EQS or the corresponding AA-EQS in water

** There are no WHO Guideline Values for aliphatic fractions C16-C21 and C21-C35, therefore the guideline value for aliphatic fractions inclusive of C8-C16 (300µg/l) has been applied.

1. The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)
2. The Water Supply (Water Quality) Regulations 2018 (legislation.gov.uk)
3. Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum (who.int)
4. CL:AIRE publishes Petroleum Hydrocarbons in Groundwater guidance (claire.co.uk)
5. A total TPH criteria of 1000 mg/kg will act as a surrogate criterion for remaining aliphatic and aromatic TPH fractions.



4.4.1. CONTROLLED WATER RISK ASSESSMENT AND MITIGATION

This comparison indicates that the data exceeds the DWS values for the following inorganic compounds:

-  Lead (leachate)
-  Selenium (groundwater)
-  Zinc (leachate and groundwater)

There is no DWS for zinc, therefore the data has been compared to the EQS.

It should be noted that leaching tests were undertaken alongside groundwater and surface water testing. The leachate test is aggressive (de-ionised water) and is not in aqueous equilibrium (steady state) within the solid sample. This may cause rapid dissolution and overestimation of the aqueous phase concentrations compared to groundwater in contact with contaminated soils. Although dissolution may be reduced for highly hydrophobic contaminants, such as B(a)P it is likely that the initial leaching will remove the most readily available hydrocarbons and subsequent flushing would reduce the leachable concentrations.

4.4.2. DISCUSSION OF CONTROLLED WATERS RISK ASSESSMENT

No significant source of mobile contamination has been identified. Made Ground has been encountered to a maximum depth of 0.60 m bgl.

The site is underlain by CLAY and SILT to circa 2.00 m bgl, underlain by shallow weathered SILTSTONE bedrock. The presence of this low permeability drift will offer some protection to the underlying Secondary B aquifer.

Heavy metal and PAH contamination has been identified in the shallow granular Made Ground and reworked topsoil. The Made Ground will largely be removed during the enabling works, therefore this will reduce the risk to controlled waters.

The identified heavy metals in leachate and groundwater samples are generally of low solubility and mobility, therefore migration towards controlled waters receptors is considered unlikely.

The sensitivity of the Secondary B aquifer is reduced given there are no groundwater abstractions within 2km.

Fairywell Brook is located circa 170 m southwest of the site, so is therefore considered a low risk due to distance.

There is considered to be a low risk to controlled waters and the wider environ as no complete pollutant linkage can be determined.



4.5. GROUND GAS RISK ASSESSMENT

4.5.1. RATIONALE

Hazardous ground gas qualitative risk assessment is based on a conceptual site model (CSM) similar to that used for soil and groundwater contamination sources (i.e., source pathway receptor pollutant linkages).

The risk can be assessed based on knowledge of the ground conditions and CSM and a measure of hazardous gas concentrations and gas flow at the site within monitoring standpipes.

4.5.2. SOURCES AND PATHWAYS OF GROUND GAS

Table 11 summarises the potential sources and pathways of ground gas within the context of the recorded site setting and proposed development.

Table 11 Identified Potential Sources of Ground Gas

SOURCE

Made Ground

Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.30 m and 0.60 m bgl. No significant putrescible materials were identified which could be considered a potential gassing source.

The presence of deep Made Ground >1.50m bgl elsewhere on the site is not anticipated.

Drift Strata

Drift deposits were encountered within all exploratory hole locations to a depth of 2.00 m bgl.

The drift deposits generally comprise brown and grey slightly gravelly silty CLAY with sandstone and siltstone. Clayey gravelly SILT with siltstone was identified in WS103 between 0.50 – 2.00 m bgl.

No gassing sources have been identified in the drift stratum.

Solid Strata

Rockhead was encountered at 2.00 m bgl. The solid geology comprises brown and light grey weathered SILSTONE to depths in excess of 2.42 m bgl.

No gassing sources have been identified in the bedrock geology.

Landfill Sites

There are no active or historical landfills within 500 m of the site.

Other Gases

The site is located within an area where less than 1 % of homes are above the Action Level, therefore radon protection measures are not required.

The CIRIA C665 guidance on gas risk assessment includes recommendations for periods and frequencies for monitoring visits. These recommendations take into account the nature of the proposed development and the likely generation potential of the source.

The proposed development comprises private residential properties, which would be classified as a Type A development (high sensitivity) in accordance with BS8485:2015+A1:2019. However, it is considered that the likely generation potential of the identified gas sources (taking into account the likelihood of future increases in gas generation) would be best classified as very low.



Therefore within the context of the proposed residential end-use and ground gas generation potential, the gas assessment requires six visits over three months, with at least two sets of readings at low or falling atmospheric pressure.

4.5.3. GROUND GAS RISK ASSESSMENT METHODOLOGY

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in:

- ✳ CIRIA Report 665 – Assessing risks posed by hazardous ground gases to buildings (2007)
- ✳ BS8485:2015+A1:2019 – Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

BS8485 provides guidance on the level of gas protection requirements based upon the characteristic situation (CS) and the proposed development based on building type.

Therefore, in accordance with BS8485, based on the measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) shall be derived for each monitoring point, from which the site characteristic hazardous gas flow rate (Q_{hgs}), and then the Characteristic Situation (CS) can be determined.

The following equation should be utilised:

$$Q_{hg} = q \left(\frac{C_{hg}}{100} \right)$$

Where:

q is the measured flow rate (in litres per hour) of combined gases from the monitoring standpipe
 C_{hg} is the measured hazardous gas concentration (in percentage volume/volume).

The subsequent derived gas screening value (GSV) should be the maximum Q_{hg} (flow rate x concentration as a percentage volume) for all the monitoring events.

A 'worst case check' may be carried out using the maximum recorded flow in any hole with the maximum concentration in any hole to present the plausible worst case conditions. Adoption of the worst case Q_{hg} requires thorough justification and reference to the CSM.

The final derived GSV can then be used to characterise the site as summarised in Table 12.



Table 12 Site Characterisation by GSV (BS8485:2015)

CS	HAZARD POTENTIAL	GSV (L/HR) FOR METHANE AND CARBON DIOXIDE	ADDITIONAL FACTORS
CS1	Very Low	< 0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	< 0.70	Typical measured flow rate <70 l/h (otherwise consider an increase to CS3)
CS3	Moderate	< 3.5	N/A
CS4	Moderate to High	< 15	N/A
CS5	High	< 70	N/A
CS6	Very High	> 70	N/A

Notes

- 1) The CS is equivalent to the characteristic GSV in CIRIA C665.
- 2) The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter should be considered.
- 3) Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, multiplied by the concentration in the air stream of the particular gas being considered.
- 4) The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

4.5.4. MONITORING METHODOLOGY

Concentrations of methane (CH₄), carbon dioxide (CO₂) and oxygen (O₂) (hydrogen sulphide) were measured using a calibrated infrared gas analyser (GFM435) with gas flow rates measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 300 seconds (5 minutes) at each location, increasing to 600 seconds if elevated concentrations identified, at which point the maximum concentration of CH₄ and CO₂, together with the lowest concentration of O₂ were recorded.

The results of the ground gas monitoring are presented in Table 13.

In addition to the raw data, the results for each individual standpipe have been assessed with reference to guidance provided in BS8485:2015. Based on the initial peak measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) have been derived for each monitoring point, from which an individual Characteristic Situation (CS) can ultimately be determined.

4.5.5. SUMMARY OF MONITORING RESULTS

Table 13 presents of the ground gas and groundwater monitoring results to date.



Table 13 Summary of Ground Gas Monitoring Results

WELL	DATE	CH ₄ INITIAL (%V/V)	CH ₄ STEADY (%V/V)	CH ₄ Q _{hg} (l/hr)	CO ₂ INITIAL (%V/V)	CO ₂ STEADY (%V/V)	CO ₂ Q _{hg} (l/hr)	O ₂ (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	PEAK FLOW (l/hr)	STEADY FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS101	12/02/2024	0.1	0.1	0.0001	2.2	2.1	0.0022	13.0	995	Rising	0.1	0.1	1.00 – 2.00	1.84	1.55
	06/03/2024	0.1	0.1	0.0001	4.7	4.7	0.0047	3.3	1013	Rising	0.1	0.1		1.83	1.78
WS102	12/02/2024	0.1	0.1	0.0001	1.3	1.3	0.0013	17.3	994	Rising	0.1	0.1	1.00 – 2.00	1.90	1.22
	06/03/2024	0.1	0.1	0.0001	1.6	1.6	0.0016	16.4	1013	Rising	0.1	0.1		1.84	1.31
WS104	12/02/2024	0.1	0.1	0.0001	2.9	2.9	0.0029	16.7	995	Rising	0.1	0.1	1.00 – 2.00	1.98	1.53
	06/03/2024	0.1	0.1	0.0001	2.6	2.5	0.0026	16.7	1012	Rising	0.1	0.1		2.00	1.83
WS106	12/02/2024	0.1	0.1	0.0001	2.4	2.4	0.0024	16.4	994	Rising	0.1	0.1	1.00 – 2.00	1.92	Dry
	06/03/2024	0.1	0.1	0.0001	2.4	2.1	0.0024	18.3	1011	Rising	0.1	0.1		1.91	1.53

Notes

CIRIA Characteristic Situation

Q_{hg}



CS1

<0.07

Typical Max CO₂ <5 % Typical Max CH₄ <1 %

CS2

<0.7

Flow rate not to exceed 70 l/hr otherwise consider increase to CS3

CS3

<3.5

CS4

<15

Quantitative Risk Assessment required to evaluate scope of protective measures

Values in **BOLD** exceed CS1 Thresholds

Values in **BLUE** denote water above level of response zone (flooded)





4.5.6. GROUNDWATER

Groundwater was recorded between depths of 1.22 m and 1.83 m bgl.

However, due to the predominantly low permeability cohesive drift stratum, it is likely that water levels are representative of surface water collecting within the standpipes and not a true representation of groundwater.

4.5.7. BAROMETRIC PRESSURE

Visit 1 was undertaken during a period of relatively low/rising pressure, with pressure recorded to be between 994–995 m bar.

Visit 2 was undertaken during a period of relatively high/rising pressure, with pressure recorded to be between 1011–1013 m bar.

Further visits will be undertaken over representative conditions.

4.5.8. GAS FLOW

Throughout the monitoring completed to date, flow rates were recorded to be 0.1 l/hr (limit of detection of the analyser).

4.5.9. GAS CONCENTRATIONS

The maximum methane value recorded within the monitoring wells was 0.1% v/v (limit of detection of the analyser).

Carbon dioxide concentrations were recorded at concentrations ranging from 0.1% v/v to 4.7 % v/v (WS101).

4.5.10. RADON RISK

The site is located within an area where less than 1 % of homes are above the Action Level, therefore radon protection measures are not required.

4.5.11. CONCLUSION

The determined Characteristic Situation for each borehole is presented in Table 14.

Table 14 Gas Risk Profile and Location

WELL	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH ₄ (%V/V)	MAX CH ₄ Q _{hg} (l/hr)	MAX CO ₂ (%V/V)	MAX CO ₂ Q _{hg} (l/hr)	CHARACTERISTIC SITUATION
WS101	1.55 – 1.78	0.1	0.1	0.0001	4.7	0.0047	CS1
WS102	1.22 – 1.31	0.1	0.1	0.0001	1.6	0.0016	CS1
WS104	1.53 – 1.83	0.1	0.1	0.0001	2.9	0.0029	CS1
WS106	1.53	0.1	0.1	0.0001	2.4	0.0024	CS1





Initial ground gas monitoring has not identified any elevated concentrations of carbon dioxide or methane which indicates that the site would be classified as CS1. Ground gas monitoring is currently ongoing, and a full assessment will be included as an addendum to this report.

Any significant depths of Made Ground or organic materials in the location of the infilled pond would likely be removed as part of the engineering works for the site access, therefore there is considered to be a low risk.

Precautionary CS2 measures are required at this stage until the full ground gas monitoring regime has been completed.

4.6. POTABLE WATER SUPPLY

This section provides a summary of the site investigation data with reference to the selection of potable water supply pipework. The assessment is made with reference to the UK Water Industry Research (UKWIR) publication "Guidance on the selection of Water Supply Pipes to be used in Brownfield Sites"

Table 15 Pipeline Selection PE Threshold Concentrations

CONTAMINANT GROUP	PE-THRESHOLD (MG/KG)	CONCENTRATIONS AT CURRENT PIPELINE DEPTH (MG/KG)
Total VOC	0.5	N/A
Total BTEX And MTBE	0.1	N/A
Total SVOCs (Excluding PAH and those substances marked with an *)	2	N/A
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2	<1.0
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10	<6.0
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	<10
Phenols (From SVOC Analysis)*	2	N/A
Cresols and Chlorinated Phenols (From SVOC Analysis)	2	N/A
Ethers*	0.5	N/A
Nitrobenzene*	0.5	N/A
Ketones*	0.5	N/A
Aldehydes*	0.5	N/A
Amines	Fail	N/A
Other Consideration		
Are there any exceedances of the PE threshold outside of the pipeline depth?	No	
Is free product present in soil and groundwater?	None	
Could hydrocarbon impact at greater depth than current pipeline depth be mobilised by rising groundwater levels?	No hydrocarbon impact has been identified.	
Will soils impacted with above determinands likely be utilised elsewhere on site?	N/A	
Will soils be imported to site as part of any future earth works	Currently unknown. The importation of materials may affect the WIR Risk Assessment which should be updated after completion.	

Notes - Pipe line depth normally between 0.75m–1.35m

Based on the assessment of current site conditions it is likely that PE pipe will be suitable for the proposed development.





4.7. DEVELOPED CONCEPTUAL SITE MODEL

Following the completion of the intrusive site investigation, chemical analysis and risk assessment, the conceptual model shown in Table 16 has been prepared for the site.

Table 16 **Developed Conceptual Model**

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
SOIL						
HUMAN HEALTH						
Made Ground Heavy metals (lead, mercury), non-volatile PAHs	Accidental ingestion and/or dermal contact with contaminated soil and/or leachate. PL1/PL2 Inhalation of contaminated dust. PL3	Human Health – construction workers	Likely	Low	Elevated concentrations of lead, mercury and non-volatile PAHs have been identified in the shallow Made Ground in WS102 and WS104. Recommendation: Construction works to be completed with appropriate PPE and welfare facilities.	Low
		Human Health – end users	Likely	Low	Development of the road hardstanding and engineered clean cover system shall break migration pathways to end users. Recommendation:	Low





CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
					Cover system to garden and landscaped areas will prevent exposure to future site users.	
Made Ground Asbestos (Asbestos containing materials (ACM) and loose fibres)	Inhalation (of fibres). Construction works disturbing bound material and releasing fibres. PL3	Human Health - Site personnel, end land users, and users of adjacent sites	Low likelihood	Low	Asbestos has not been identified in the soils analysed to date. Asbestos may be present within the existing building. Recommendation: A pre-demolition survey will be required. Cover system to garden and landscaped areas will prevent exposure to future site users. Construction works completed with PPE and provision of welfare.	Low
Made Ground Possible volatile mercury	Inhalation of vapours. PL4 Migration through permeable strata and preferential pathways.	Human Health – end users Human Health – Off-site receptors	Low likelihood	Low	Elevated concentrations of total mercury have been identified in the shallow Made Ground in WS102 and WS104. Recommendation:	Low





CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
					During remediation and enabling works, speciated mercury analysis should be completed to assess whether elemental mercury is present which may pose a risk to future site users through vapour inhalation.	
Made Ground Sulphate from potential ash within the Made Ground.	Sulphate attack on concrete. PL6	Building concrete	Low likelihood	Low	The soils meet class DS-1, AC-1s. Recommendation: Concrete should be designed in accordance with the chemical testing results.	Low
Made Ground Organic contaminants such as hydrocarbons	Ingestion of tainted water supply. PL7	Human Health – End Users Water pipeline	Low likelihood	Low	No elevated concentrations of TPH have been identified at pipeline depth (0.75–1.35 m). Recommendation: PE pipe is likely to be suitable following a pipeline risk assessment.	Low
Made Ground Phytotoxic contaminants	Direct contact (plant uptake). PL8	Flora	Low likelihood	Low	Contamination has been identified within the shallow Made Ground which may be taken up by flora in soft landscaping.	Low





CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
					Recommendation: Installation of a clean cover system within areas of soft landscaping to prevent plant uptake of contaminants.	
CONTROLLED WATERS						
Mobile contaminants (Made Ground)	Leaching of contaminants from Made Ground through infiltration and percolation of rainwater. PL5	Controlled waters, underlying Secondary aquifer B	Low likelihood	Low	The Tier 2 assessment identified exceedances of the EQS for zinc, selenium and lead. The sensitivity of the bedrock aquifer is reduced given there are no groundwater abstractions within 2km. Recommendation: No further assessment is required.	Low
		Infrastructure and services	Low likelihood	Low	Infrastructure and services shall be designed to resist chemical attack and ingress.	Low
Groundwater	Contact with contaminated groundwater. PL2	Human Health – site personnel	Low likelihood	Low	Groundwater is known to be below construction level and as such, is expected to not rise above ground level or the final level of the road.	Low





CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
	Contaminants leached from the Made Ground and from off-site sources may be mobilised to greater distances through advective flow. PL5	Human Health – end users	Low likelihood	Low	Low permeability clay soils are present across the site which will inhibit migration. Groundwater will need to be considered for surrounding developments.	Low
GROUND GAS						
Ground gases (Made Ground, Infilled Pond)	Inhalation of ground gas. PL4	Human Health – site personnel	Low likelihood	Low	Monitoring completed to date suggests a classification of CS1 and gas protection measures are not likely to be required. Recommendation: Completion of the monitoring programme. Any significant depths of Made Ground or organic materials in the location of the infilled pond would likely be removed as part of the engineering works for the site access, therefore there is considered to be a low risk.	Low
	Accumulation of ground gas in confined spaces (asphyxiation or explosion)	Human Health – end users	Low likelihood	Low		Low
		Infrastructure and services	Low likelihood	Low		Low





CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	MIGRATION PATHWAYS	RECEPTORS				
Radon	Inhalation of ground gas. PL4	Human Health – site personnel	Unlikely	Low	The site is in an area where less than 1% of homes are above the Radon Action Level, therefore no further assessment is required.	Very low
	Accumulation of ground gas in confined spaces (carcinogenic)	Human Health – end users	Unlikely	Low		Very low

Main Exposure Pathways:

PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = vapour/gas inhalation; PL5 = vertical / lateral migration; PL6 = corrosion of concrete; PL7=tainting of water supply; PL8 = uptake by plants.

LEVEL OF RISK

Very Low	
Low	
Low/Moderate	
Moderate	
Moderate/High	
High	





5. GEOTECHNICAL ASSESSMENT

5.1. SOIL CONSISTENCY

Undrained shear strength values were measured using laboratory undrained triaxial tests. Results of the tests are presented in Appendix VIII indicate the clay soils to be firm. Strength test data is generally consistent with the field descriptions of the aforementioned soils.

Results of the standard penetration tests, including undrained shear strengths derived from SPTs are included in Table 18.

Table 17 Summary of Undrained Shear Strength in Triaxial Compression – Laboratory Test				
LOCATION	SAMPLE DEPTH (m)	LAB DESCRIPTION	UNDRAINED SHEAR STRENGTH (kN/m²)	CONSISTENCY
WS105	0.50–1.00	Firm brown slightly gravelly sandy CLAY.	55	Firm





Table 18 **Standard/Cone Penetration Test Results**

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE (N ₁) ₆₀	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m ²)	ALLOWABLE BEARING CAPACITY (kN/m ²)*
WS101	1.00	Gravelly CLAY	16	16.13	N/A	High Strength	Very Stiff	80.65	165.82
	2.00	Weathered SILTSTONE	50	45.68	Dense	N/A	N/A	N/A	456.77
WS102	1.00	Gravelly CLAY	19	19.15	N/A	High Strength	Very Stiff	95.77	196.91
	2.00	Weathered SILTSTONE	50	45.68	Dense	N/A	N/A	N/A	456.77
WS103	1.00	Gravelly SILT	20	20.16	N/A	High Strength	Very Stiff	100.81	207.28
	2.00	Weathered SILTSTONE	50	45.68	Dense	N/A	N/A	N/A	456.77
WS104	1.00	Gravelly CLAY	19	19.15	N/A	High Strength	Very Stiff	95.77	196.91
	2.00	Weathered SILTSTONE	50	45.68	Dense	N/A	N/A	N/A	456.77
WS105	1.00	Silty CLAY	19	19.15	N/A	High Strength	Very Stiff	95.77	196.91
	2.00	Weathered SILTSTONE	50	45.68	Dense	N/A	N/A	N/A	456.77
WS106	1.00	Silty CLAY	19	19.15	N/A	High Strength	Very Stiff	95.77	196.91
	2.00	Weathered SILTSTONE.	50	45.68	Dense	N/A	N/A	N/A	456.77





NOTES

* The Allowable Bearing Capacity (ABC) should be considered indicative.

The interpretation of in situ mass undrained shear strength (c_u) data from SPT Blow Count (N) results and the influence of the Plasticity Index (PI) was reported in Standard Penetration Test in Insensitive Clays and Soft Rocks. Stroud (1974). The standard penetration test and the engineering properties of glacial materials subsequently. Stroud and Butler (1975) and (1989).

Allowable bearing capacity on sands. Soil Mechanics in Engineering Practice Terzaghi, K. & Peck, R.B. 1996.





5.2. CONSOLIDATION

A sample of Glacial Till was submitted for oedometer analysis. The results are provided in Table 19.

Table 19 Oedometer Consolidation Results

LOCATION	DEPTH (M)	SAMPLE TYPE	MOISTURE CONTENT (%)	OEDOMETER CONSOLIDATION		
				PRESSURE RANGE (kPa)	M _v (m ² /MN)	C _v (m ² /year)
WS105	0.50 – 1.00	U100	23	0–15	0.769	2.467
				15–30	0.680	2.007
				30–60	0.442	1.922
				60–120	0.284	1.933
				120–15	0.100	1.766

When considered at over-burden pressure with an additional load of 110 kPa the coefficient of volume compressibility (M_v) ranged from 0.100 m²/MN up to 0.284 m²/MN. The material is considered to be medium compressibility.

The rate at which settlement is likely to occur is determined by the coefficient of consolidation (C_v). As shown in Table 19, the coefficient ranges from 1.766 m²/yr to 2.467 m²/yr. The rate at which settlement will occur is increased by the presence of sand within the Glacial Till and it is likely that settlement will occur over a period of months to years.

5.3. PARTICLE SIZE DISTRIBUTION

Particle Size Distribution Tests have been undertaken on selected samples of cohesive material via wet sieve to obtain information on the soil fractions. The results are included in Table 20. The full results can be found in Appendix VIII.

Table 20 Summary of Particle Size Distribution Test Results

LOCATION	DEPTH (M)	SOIL FRACTION (%)			
		COBBLES	GRAVEL	SAND	SILT/CLAY
WS103	1.00 (Natural)	0	28	13	59
WS105	0.50 – 1.00 (Natural)	0	5	18	77

5.4. SOIL PLASTICITY

The liquid and plastic limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average plasticity index (PI) for each “type” of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth.

E3P typically only consider a soil to be shrinkable if the proportion finer than 63 µm is > 35%.





PI results are compared against guidance given in the NHBC standards, Chapter 4.2 (revised January 2014), which advocates the use of modified plasticity index (I_p), defined as:

$$I_p = I_p \times (\% < 425 \mu\text{m} / 100)$$

In other words, if PI is 30%, but the soil contains 80% < 425 μm, then I_p = 30 × 80/100 = 24%.

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425 μm sieve is routinely reported by testing labs.

E3P apply engineering judgement where PI results are spread over a range of classifications. Consideration is given to the average values for each particular soil type (differentiate between residual soil and alluvium), the number of results in each class and the actual values.

The Atterberg limits determinations, summarised in Table 21, show the clay to be of low plasticity.

Table 21 Summary of Plasticity Index Test results

LOCATION	DEPTH (M)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 MM SIEVE (%)	MODIFIED PLASTICITY INDEX	NHBC VOLUME CHANGE POTENTIAL
WS101	2.00	19	23	42	19	97	18.43	Low
WS105	1.00	20	21	41	20	93	18.6	Low
WS106	2.00	16	20	37	17	98	16.66	Low

The results of the Atterberg limits testing confirmed that the soils would be deemed to be “Low Volume Change Potential” in accordance with the classification system utilised by the LABC/NHBC industry guidance.

5.5. SOIL INFILTRATION

In-situ variable (falling) head permeability tests were undertaken within the monitoring well installations located in two probeholes (WS102, WS106). Tests in WS102 and WS106 were undertaken within monitoring wells with response zones located in the natural cohesive drift stratum.

The results are presented in Table 22 and the test certificates are included within Appendix X.

Table 22 Soil Infiltration Results

LOCATION	DEPTH (M)	MATERIAL	TEST NO.	SOIL INFILTRATION RATE (M/S)
WS102	1.00–2.00	Slightly gravelly silty CLAY	1	2.68E-06
WS106	1.00–2.00	Slightly gravelly silty CLAY	1	2.4E-06

The tests indicate that the cohesive drift deposits have poor soakage potential.





Therefore, considering the significant volumes of low permeability clay on the site, it is considered that soakaway drainage is unlikely to be suitable for the proposed development. However, the application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – *Soakaway Design*

5.6. PH AND SULPHATE

Chemical analyses for pH and soluble sulphate content contained in APPENDIX VII (summarised in Table 23), shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE *Special Digest 1* (2005).

Table 23 Summary of pH and Sulphate Data

LOCATION	DEPTH (M)	SO ₄ IN 2:1 WATER/SOIL (MG/L)	PH VALUE	CLASSIFICATION
WS101	0.10	8.46	7.9	DS-1, AC-1s
WS101	0.80	6.55	8.3	DS-1, AC-1s
WS102	0.20	18.3	8.2	DS-1, AC-1s
WS103	0.20	22.4	7.9	DS-1, AC-1s
WS103	1.10	14.2	8.7	DS-1, AC-1s
WS104	0.15	16.4	7.8	DS-1, AC-1s
WS105	0.30	15.6	7.9	DS-1, AC-1s
WS105	1.20	29.8	8.0	DS-1, AC-1s
WS106	0.20	93.1	8.0	DS-1, AC-1s

5.6.1. HIGHWAYS AND CONCRETE

MCHW Series 600 provides a criteria of 1500 mg/l for water-soluble sulfate within 500mm of any concrete structure. A second criteria of 300 mg/l is given with respect to soils within 500mm of steel structures.

5.7. GROUNDWATER

Table 24 Summary of Groundwater Strikes

LOCATION	DEPTH (M BGL)	DESCRIPTION OF STRIKE	STRATA	EVIDENCE OF CONTAMINATION
Site Investigation Water Strike Information				
WS104	2.00	Slow seepage	CLAY	No
LOCATION	DEPTH RANGE (M BGL)	PERIOD OF MONITORING	WEATHER CONDITIONS DURING MONITORING	COMMENTS
Groundwater Monitoring Summary from Installations				
WS101	1.55 – 1.78	February – March	Dry	N/A
WS102	1.22 – 1.31	February – March	Dry	N/A





LOCATION	DEPTH (M BGL)	DESCRIPTION OF STRIKE	STRATA	EVIDENCE OF CONTAMINATION
WS104	1.53 – 1.83	February – March	Dry	N/A
WS106	1.53	February – March	Dry	N/A

Perched water strikes have been located on site during the investigation, these were typically associated with Made Ground overlying natural cohesive which created a perched waterbody.

5.8. SITE PREPARATION

Our assessment has been based on the fact that the site will be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the *Manual of Contract Documents for Highway Works (MCHW)*. This should include the following:

- ✳️ Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill.
- ✳️ Demolition of all existing buildings and removal of all hardstanding.
- ✳️ Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill.
- ✳️ Buried structures and old foundations should be excavated from below the proposed development footprint with the resulting void backfilled.

5.9. FOUNDATION CONDITIONS AND ASSESSMENT OF POTENTIAL BEARING CAPACITIES

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has undertaken an assessment of the safe allowable bearing capacity (ABC) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum. The results of this assessment are summarised in Table 25.

Table 25 Summary of ABC

GRANULAR SOILS			
Description	Depth (Range m bgl)	Relative Density	Allowable Bearing Capacity (kN/m ²)
Weathered SILTSTONE	2.00–2.42	Dense	457
COHESIVE SOILS			
Description	Depth (range m bgl)	Undrained Shear Strength (Cu) (kN/m ²)	Allowable Bearing Capacity (kN/m ²)
Stiff CLAY with sand lenses (WS101)	1.00–1.45	81	166
Stiff silty CLAY	1.00–1.45	96	197
Stiff SILT (WS103)	1.00–1.45	101	207





The underlying natural clay drift deposits have been assessed as being stiff high strength with a net allowable bearing capacity (ABC) in the order of 166 – 197 kN/m² at circa 1.00 m bgl. SILT in WS103 is stiff high strength with an ABC of 207 kN/m² at 1.00 m bgl.

The weathered siltstone bedrock is dense with an ABC of >450 kN/m² at 2.00 m bgl.

5.10. FOUNDATIONS OPTIONS APPRAISAL

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe allowable bearing capacity, the following recommendations have been developed for the site of the potential foundation solutions that may be adopted for the future residential development. The suitable target founding stratum has been identified as the underlying stiff glacial clays and silts and weathered siltstone bedrock.

At this time, it is not possible to accurately define the foundation types due to the absence of a detailed tree survey and final development levels.

A process of remediation and enabling works will be required to remove any buried obstructions.

Dependent on development levels, it is likely that plots could be constructed using traditional strip or trench fill foundations bearing on the shallow stiff CLAY or siltstone bedrock.

Further investigation is required to confirm the ground conditions in the location of the existing building.

Foundation depths should take account of the presence of existing and proposed trees, with foundations deepened locally to mitigate the potential for volumetric instability attributed to fluctuations in moisture content, in accordance with the requirements of NHBC standards.

It is recommended that at working drawing stage a foundation schedule is prepared for the development, taking account of the physical change of natural clay soils and the current/proposed locations of trees.

5.11. GROUND FLOOR SLABS

Current building control regulations require that where infilled ground is present to depths in excess of 600 mm, or where the substratum is variable in terms of the structure and settlement potential, or where clay soils are present within the influence of existing or proposed trees, a suspended floor slab is required.

In this instance, it is considered that for the majority of substructures, the underlying stratum would have in excess of 600 mm of infill or shallow cohesive soils and, as such, a suspended floor slab will be required.

Where a cast in-situ suspended slab is utilised with no subfloor void, appropriate compressible material (heave precautions) will be required in the construction of the substructure.

In clay soils if the foundation depth is greater than 1.5m, allowance should be made in the design for heave. This must incorporate either a clear void of a specified minimum depth under the suspended floor, or a proprietary compressible material/void former below the underside of the floor construction.

Ground bearing slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.5m. Under these circumstances a suspended floor construction should be used.





5.12. HEAVE PRECAUTIONS

The site has been proven to be underlain by clay soils which are susceptible to volumetric instability due to fluctuations in moisture content, particularly within influencing distance of trees as per the NHBC/LABC conjectures zones of influence.

The clay has been determined as being of low volume change potential. Table 26 shows where heave precautions are required for a trench fill, pier and beam and pile and beam foundation types which are in the zone of influence of trees which are to remain or be removed.

Table 26 Position of Heave Precautions

SITUATION	TRENCH FILL	PIER AND BEAM	PILE AND BEAM
External trench fill and pier foundations. Unless NHBC is satisfied that the soil is not desiccated compressible material should be provided to the:	Inside faces of external wall foundations deeper than 1.5m, based on the appropriate tree height.	All faces of pier foundations deeper than 1.5m, based on the appropriate tree height.	N/A
External ground beams. Unless NHBC is satisfied that the soil is not desiccated, compressible material or void formers should be provided to the:	N/A	Inside faces	Inside faces
Internal trench fill foundations and ground beams. Compressible material required:	No	No	No
External and internal ground beams. Compressible material, void former or void should be provided to the underside of:	N/A	All	All
Heave precautions required for proposed trees where the soil is not desiccated:	No	No	No

Note: Information taken from NHBC Standards 2024, Chapter 4.2, Table 8 – Position of heave precautions

A summary of heave precautions is presented in Table 27.

Table 27 Summary of Heave Precautions

VOLUME CHANGE POTENTIAL	VOID DIMENSION AGAINST SIDE OF FOUNDATION AND GROUND BEAM	VOID DIMENSION UNDER GROUND BEAMS, AND SUSPENDED IN-SITU CONCRETE GROUND FLOOR	VOID DIMENSION UNDER SUSPENDED PRECAST CONCRETE AND TIMBER FLOORS ⁽¹⁾
High	35mm	150mm	300mm
Medium	25mm	100mm	250mm
Low	0mm	50mm	200mm

In addition to the requirements of the 'Drainage' section, drainage near trees should incorporate additional provisions. Where there is a volume change potential within the ground, the provisions include:





- ✳ Increased falls to cater for any ground movement.
- ✳ Deeper and wider backfill of granular material.
- ✳ A drainage system that is capable of movement should heave and shrinkage occur.
- ✳ Drainage pipes should not be encased in concrete.
- ✳ Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

5.13. HIGHWAYS CONSTRUCTION

A programme of remediation and enabling works will be required to remediate the proposed road subgrade in accordance with the requirements of the Manual of Contract Documents for Highway Works Volume 1 Specification For Highway Works (Series 600-Earthworks) for a method compaction.

5.14. DRAINAGE

Where loose or soft materials have been identified at drainage invert levels, there will need to be consideration for the use of reinforced pipe bedding.

Shrinkage and heave of clay soils can affect pipelines. To protect against the effects of heave, drainage should be designed:

- ✳ To take account of potential ground movement as shown in Table 28, including where pipes and services pass through substructure walls or foundations.
- ✳ With gradients which may need to be steeper.
- ✳ To use alternative means of catering for the movement when sufficient falls cannot be provided, for example, by deepening the excavation and laying pipework on a granular bedding of suitable thickness to reduce the extent of potential movement.

Table 28 Potential Ground Movement for Drainage

VOLUME CHANGE POTENTIAL	HIGH	MEDIUM	LOW
Potential ground movement	150mm	100mm	50mm

5.15. EXCAVATIONS

It is considered that near-surface excavations will be feasible.

Site observations indicated that excavations should be feasible in the near surface with normal plant, however shallow weathered bedrock is present at 2.00 m bgl. It is anticipated that any obstructions will be grubbed out during the reduced-level dig for the substructure works.

However, due to the depth and variability of the Made Ground and likelihood of trench collapse, it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.





Table 29 Civil Engineering Excavation Risk Matrix

RISK ITEM	PRESENT	COMMENT
Running Sands	No	No running sand has been identified.
Minor Water Ingress	Yes	Minor water ingress will require localised dewatering/sump pumping during the construction of site drainage infrastructure. Ingress of water into foundation excavation will potentially flood foundation excavations, limiting the viability of spread foundations to be constructed.
Shallow Bedrock	Yes	Shallow bedrock has been identified at 2 m below current ground levels. The presence of bedrock will impede excavation for drainage infrastructure using traditional excavation plant and equipment.

5.16. CONSTRUCTION ACTIVITY AND INSPECTION

The following activities and inspections should be incorporated in to the site works:

- ✳ Due to the variability of the soils at the site, it is recommended that sufficient allowance is made for the inspection of formations and subformations to foundations and pavement construction.
- ✳ Excavations where access is required should be subject to a risk assessment from a competent person and, where appropriate, mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 should be utilised.
- ✳ It is considered that dewatering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to provision of space for settling tanks or an attenuation pond.
- ✳ Where access to confined spaces is required, appropriate mitigation measures should be addressed within the construction stage health and safety plan. Particular account should be taken of the gas results.
- ✳ The presence of potential contamination and mitigation measures should be addressed as part of the construction stage health and safety plan and should include measures to design out the risks, reduce their impact and, finally, to include the use of personnel protective equipment (PPE).



5.17. DEVELOPED GEOTECHNICAL RISK REGISTER

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Remediation of contaminated soils	TBC	TBC	Elevated total mercury has been identified in the shallow Made Ground in WS102 and WS104. Material deemed to have a potential vapour risk may require hotspot removal, resulting the requirement to backfill the resulting void. Should significant backfill be needed deeper or specialist foundations may be required in those areas.
Bedrock	All	100	Shallow bedrock is identified, this represents a significant risk in terms of the viability for excavations to install infrastructure using standard construction equipment.
Cohesive Stratum overlying shallow Bedrock (<3.00m)	All	100	The soils are classified as low volume change potential, therefore the risk is considered to be low.
Obstructions	All	50	Obstructions will be present beneath the existing building.
Artificially levelled and filled platforms	All	100	The site appears to have been levelled and artificially backfilled.
Trench collapse	All	100	Made Ground present beneath the site is likely to be loosely compacted and possibly prone to collapse.
Mature trees	Periphery	50	Arboriculture survey required to determine areas of potential tree influence.
Volume change potential clay	All	N/A	The soils are classified as low volume change potential, therefore heave precautions are not likely to be required.
Infilled pond	North East	20	Shallow bedrock is present, therefore significant depths of soft organic deposits or Made Ground are not anticipated in the location of the infilled pond.
Concrete design	All	N/A	The soils meet class DS-1, AC-1s.
Low-permeability ground	All	100	Soakaways unlikely to be effective in areas where low permeability cohesive deposits are present.



POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Services/sensitive structures	TBC	TBC	A full utility survey will be required. Piling may not be possible within close proximity to any sensitive infrastructure.
Abnormal foundation solutions	TBC	TBC	Shallow bedrock is present, therefore an abnormal foundation solution is not anticipated.
Areas not investigated	Centre	50	Further investigation will be required following demolition of the existing building.
Enabling Earthworks	All	100	All proposed earthworks will need to be designed by a suitably qualified geotechnical engineer in accordance with NHBC Chapter 4.6. The earthworks design will incorporate a Geotechnical Specification for Earthworks that will define protocols to ensure no unacceptable future risk.

5.18. FURTHER WORKS

Based on the findings of the intrusive site investigation, the following additional works are recommended to be completed in due course:

- ✦ Post demolition ground investigation.
- ✦ Arboricultural survey.
- ✦ Geotechnical Earthworks Strategy (infrastructure).
- ✦ Remediation and Enabling Works Strategy.

END OF REPORT



APPENDIX I

LIMITATIONS



1. This report and its findings should be considered concerning the terms of reference and objectives agreed upon between E3P and the client, as indicated in Section 1.3.
2. For the work, reliance has been placed on publicly available data from the sources identified. The information is not necessarily exhaustive, and further information relevant to the Site may be available from other sources. When using the information, it has been assumed that it is correct. No attempt has been made to verify the information.
3. This report has been produced following current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and require advice from legal professionals.
4. During the site walkover, a reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the Site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the Site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and does not constitute or replace full and proper surveys.
8. The report's executive summary, conclusions and recommendations sections provide an overview and guidance only. They should not be relied on explicitly without fully considering the report's context.
9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that it was prepared for. The copyright in this report and other plans and documents designed by E3P is owned by them, and no such plans or documents may be reproduced, published or adapted without written consent. However, complete copies of this may be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied. Still, no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement.
10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.



APPENDIX II

GLOSSARY



TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation





MCV	Moisture condition value	WRAP	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	WTE	Water table elevation
m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	SSRT	Site Specific Remediation Target
PSD	Particle Size Distribution	DD	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	Mc	Moisture Content
ρ	Bulk Density	GPR	Ground Penetrating Radar
NDP	Nuclear Density Probe	FFL	Finished Floor Level
LEL	Lower Explosive Limit	UKWIR	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	LOD	Limit of Detection



APPENDIX III

RISK CLASSIFICATION



risk classification

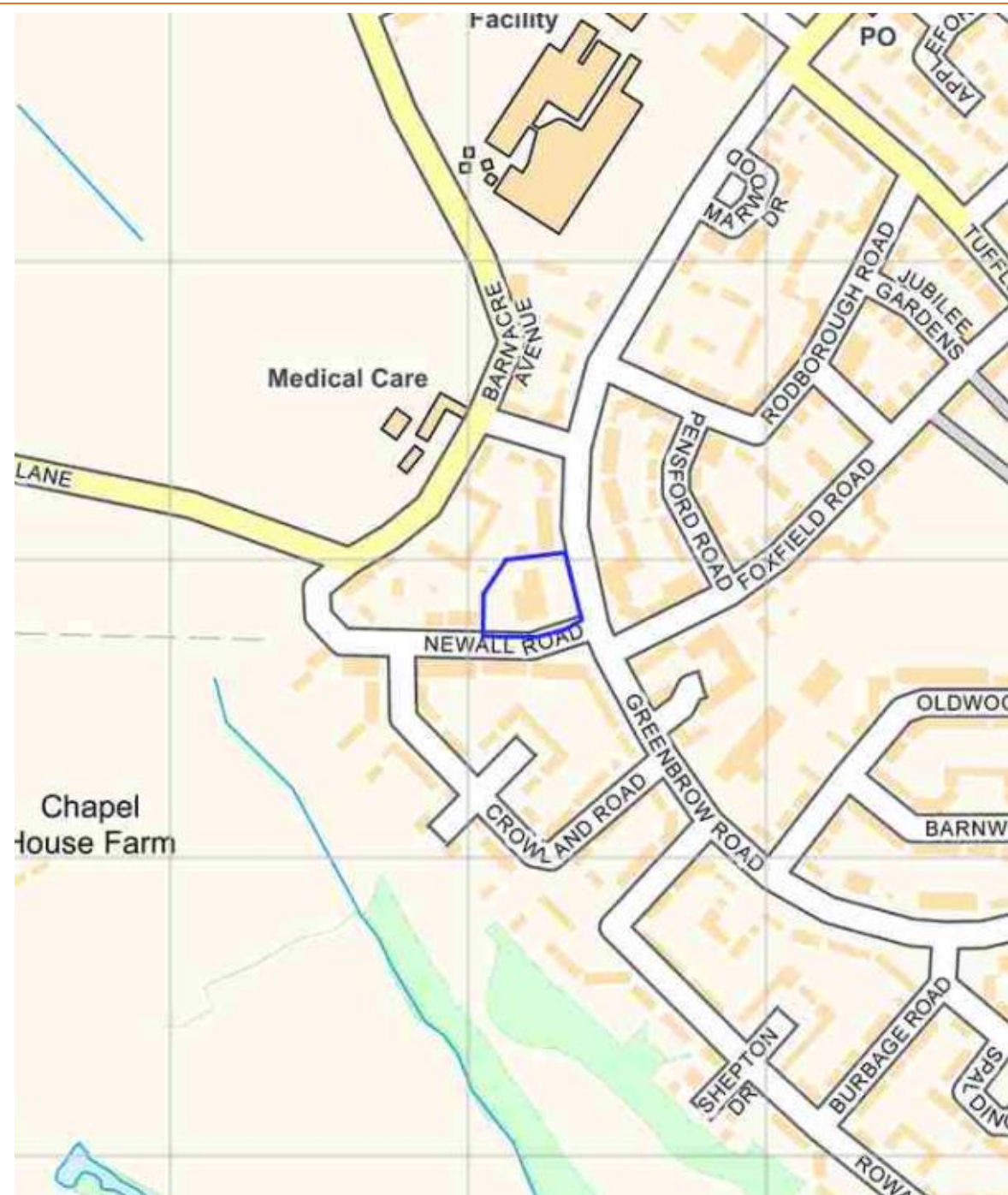
RISK	DEFINITION
Low	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property.
Low Moderate	<p>There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property with regard to the proposed use.</p> <p>However, minor issues may require further consideration in the event of future redevelopment of the Site.</p>
Moderate	<p>Some potential contaminated land liabilities/geotechnical constraints are likely to affect the property as a result of historical and/or current activities.</p> <p>The risks identified are unlikely to pose an immediate significant issue but the purchaser/developer may wish to make further enquiries of the vendor or undertake further environmental improvements. Redevelopment of the Site will likely require further site investigation.</p>
Moderate High	Some potentially significant contaminated land liabilities/geotechnical constraints have been identified at the property that requires further assessment, including intrusive ground investigations.
High	Significant potential contaminated land liabilities/geotechnical constraints have been identified at the property. Further assessment including intrusive ground investigation will be required to determine the level of risk and associated liability.



APPENDIX IV DRAWINGS



DRAWING 17-305-001 – Site Location Plan





Notes:					
P1	REVA	08.03.2024	CB	AS	AS
Phase	Issue	Date	Drawn	Checked	PM

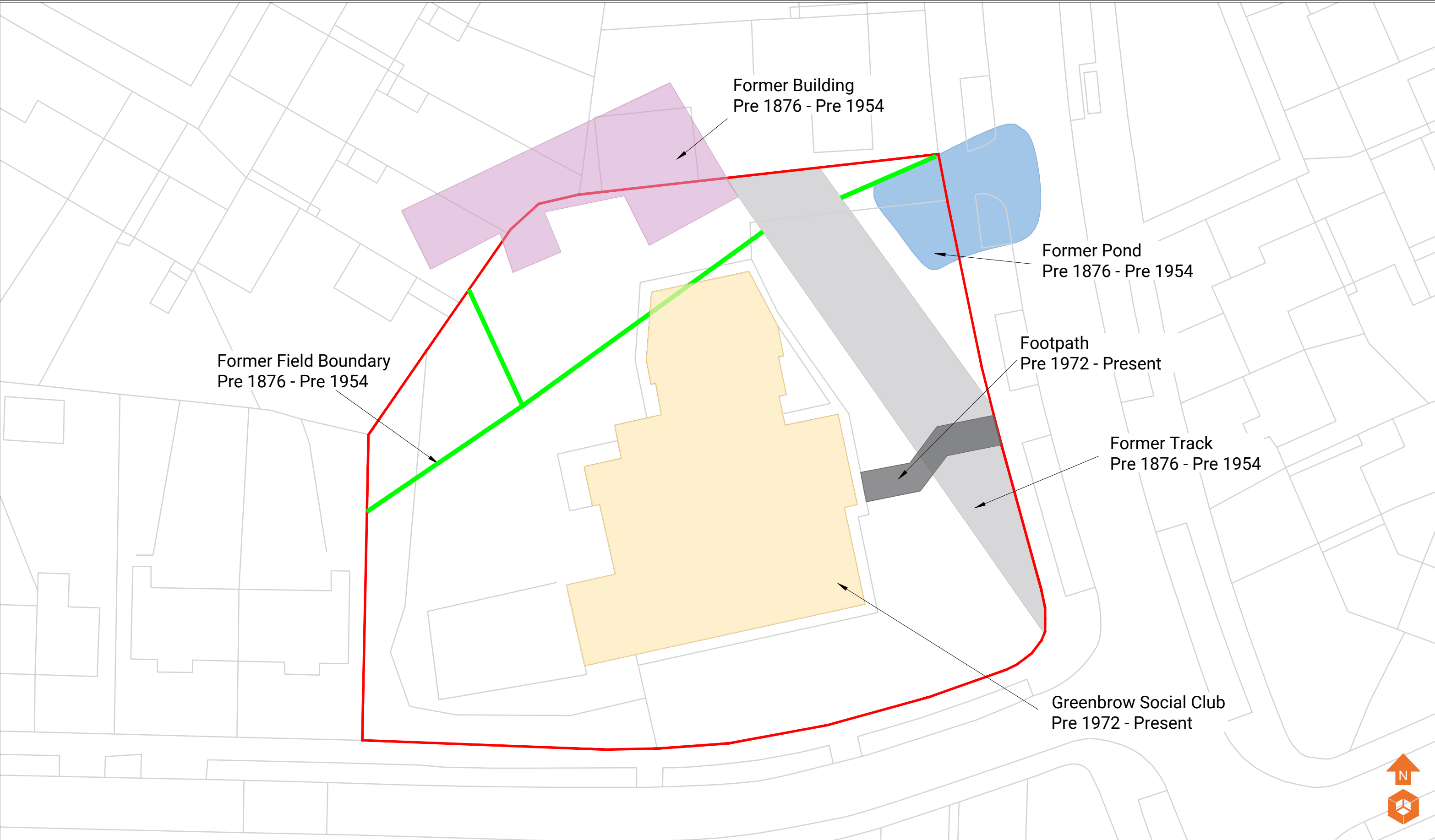
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Shape Consulting Engineers	
Job Title:	
Greenbrow Social Club	

Job No:	
17-305	
Drawing No:	
002	
Date:	
08.03.2024	
Scale:	
NTS @ A3	
Drawing Title:	
Proposed Development Plan	



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<div>Historical Features</div> <div><div></div>Former Field Boundary (Pre 1876 - Pre 1954)</div> <div><div></div>Former Pond (Pre 1876 - Pre 1954)</div> <div><div></div>Former Track (Pre 1876 - Pre 1954)</div> <div><div></div>Former Building (Pre 1876 - Pre 1954)</div> <div><div></div>Greenbrow Social Club (Pre 1972 - Present)</div> <div><div></div>Footpath (Pre 1972 - Present)</div>
--



- Site Features**
- Existing Building (Disused Social Club)
 - Mature Trees
 - Soft Cover
 - Fenced Courtyard
 - Storage Hatch
 - Telephone Mast
 - Hardstanding / Car Park
 - Footpath
 - Access Gate

Notes:

P1	REVA	08.03.2024	CB	AS	AS
Phase	Issue	Date	Drawn	Checked	PM

Client:

Shape Consulting Engineers

Job Title:

Greenbrow Social Club

Job No:

17-305

Drawing No:

004

Date:

08.03.2024

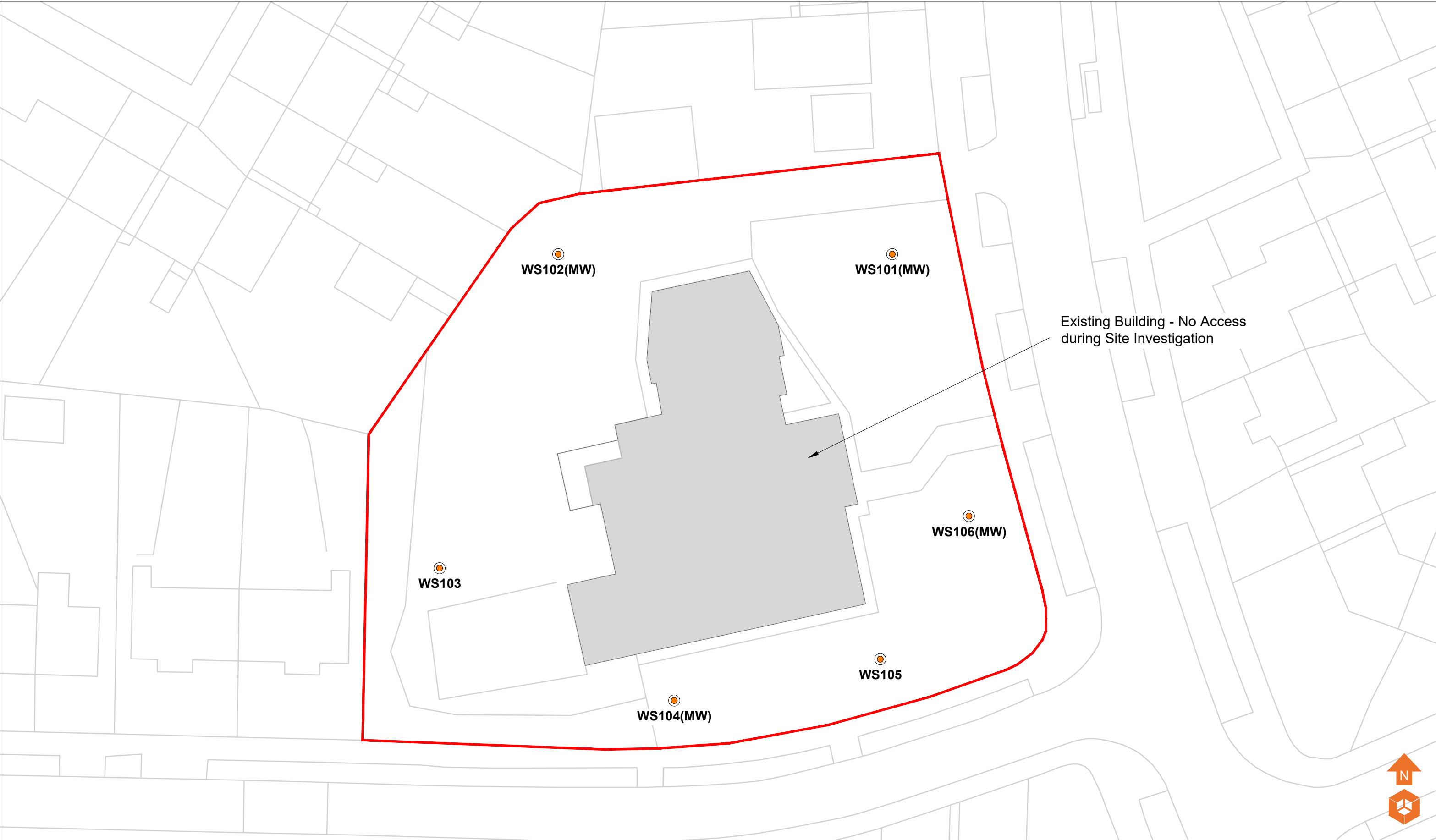
Scale:

NTS @ A3



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Location Symbols

- Approximate Window Sample Probehole Location (E3P Location February 2024)
- Approximate Window Sample Probehole Location with Install (E3P Location February 2024)
- Existing Building - No Access

Notes:

P1	REVA	04.03.2024	CB	AS	AS
Phase	Issue	Date	Drawn	Checked	PM

Client:

Shape Consulting Engineers

Job Title:

Greenbrow Social Club

Job No:

17-305

Drawing No:

005

Date:

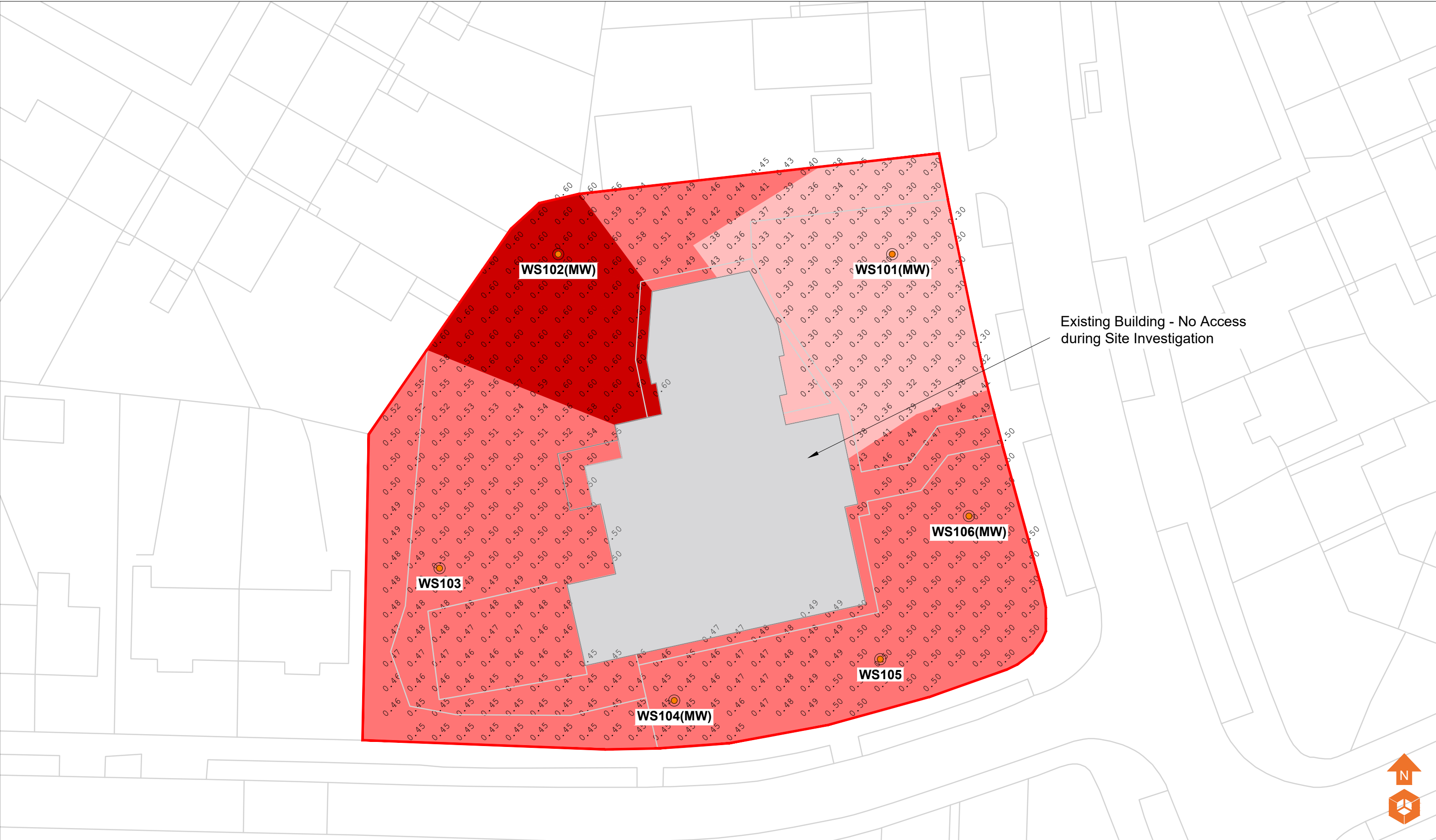
04.03.2024

Scale:

NTS @ A3

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Location Symbols

- Approximate Window Sample Probehole Location (E3P Location February 2024)
- Approximate Window Sample Probehole Location with Install (E3P Location February 2024)
- Existing Building - No Access

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.19m
- Depth of Made Ground 0.20 - 0.39m
- Depth of Made Ground 0.40 - 0.59m
- Depth of Made Ground >0.60m

Notes:

P1	REVA	08.03.2024	CB	AS	AS
Phase	Issue	Date	Drawn	Checked	PM

Client:

Shape Consulting Engineers

Job Title:

Greenbrow Social Club

Job No:

17-305

Drawing No:

006

Date:

08.03.2024

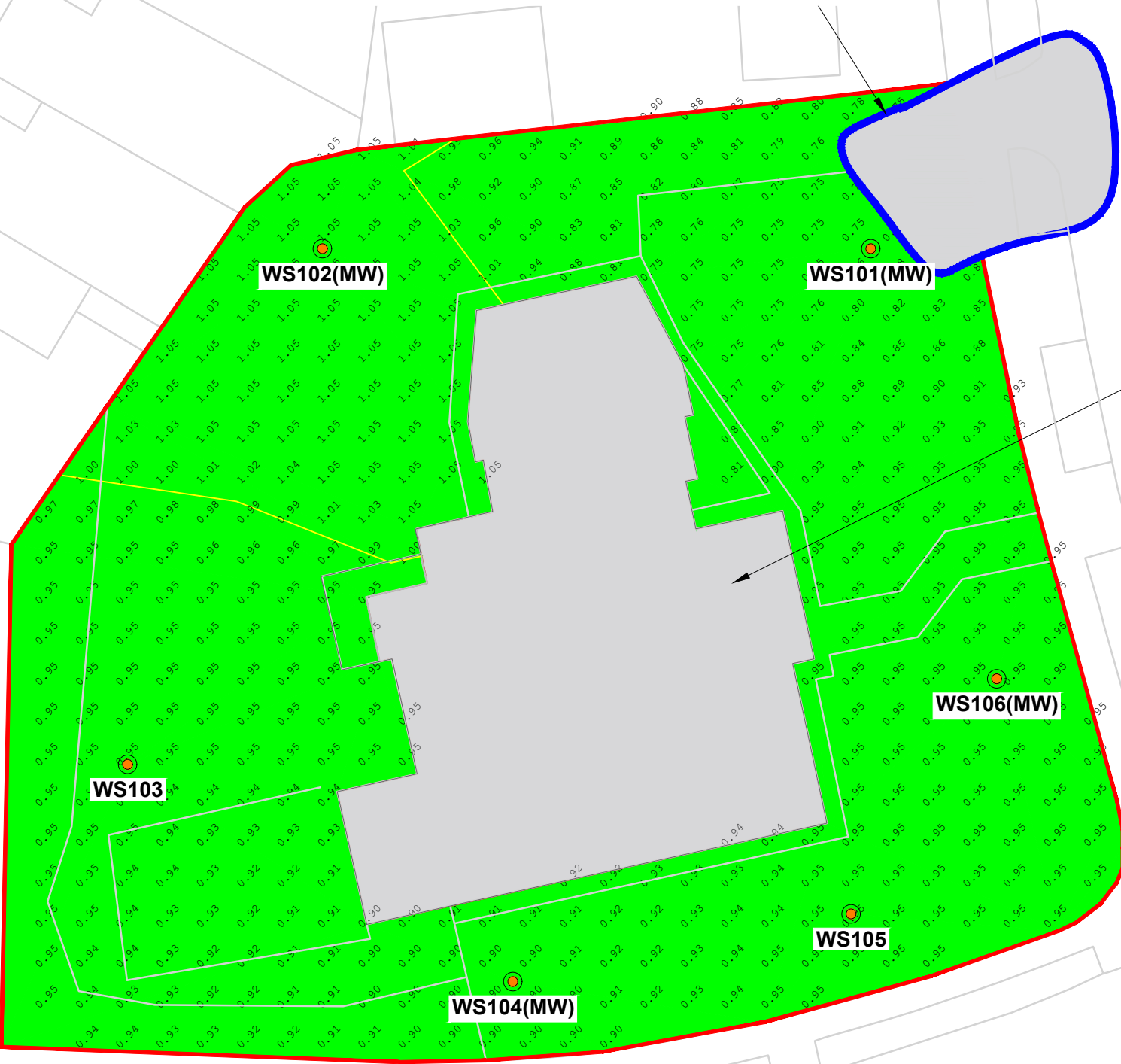
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Further Investigation Required in the Location of the Infilled Pond.



Existing Building - No Access during Site Investigation



- Location Symbols**
- Approximate Window Sample Probehole Location (E3P Location February 2024)
 - Approximate Window Sample Probehole Location with Install (E3P Location February 2024)
 - Existing Building - No Access

- Shallow Spread Footings**
- Depth to Founding Strata 0.00 - 1.24m
 - Depth to Founding Strata 1.25 - 1.49m
- Mass Trench Fill Footings**
- Depth to Founding Strata 1.50 - 1.74m
 - Depth to Founding Strata 1.75 - 1.99m
 - Depth to Founding Strata 2.00 - 2.24m
- Engineered Footings**
- Depth to Founding Strata 2.25 - 2.49m
 - Depth to Founding Strata >2.50m

Notes:

Depth to Founding Strata does not Consider Anthropogenic Influence or Trees and is an Indicative Assessment

P1	REVB	11.03.2024	CB	NS	NS
P1	REVA	08.03.2024	CB	NS	NS
Phase	Issue	Date	Drawn	Checked	PM

Client:

Shape Consulting Engineers

Job Title:

Greenbrow Social Club

Job No:

17-305

Drawing No:

008

Date:

11.03.2024

Scale:

NTS @ A3

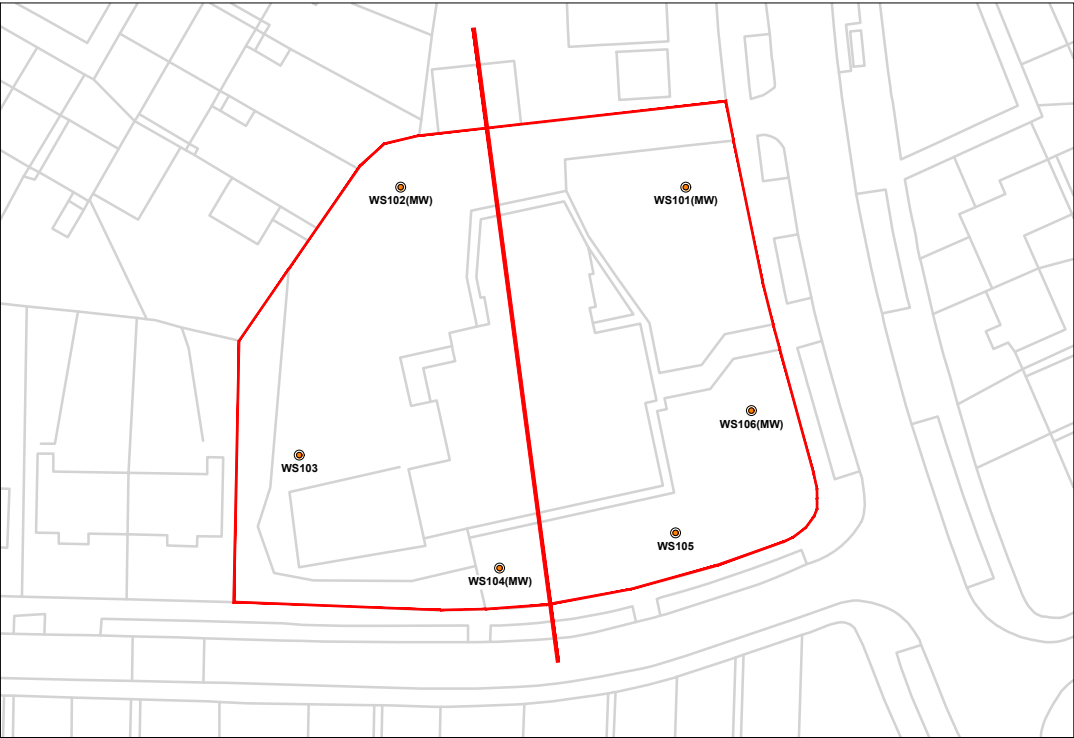
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Depth to Founding Strata Plan



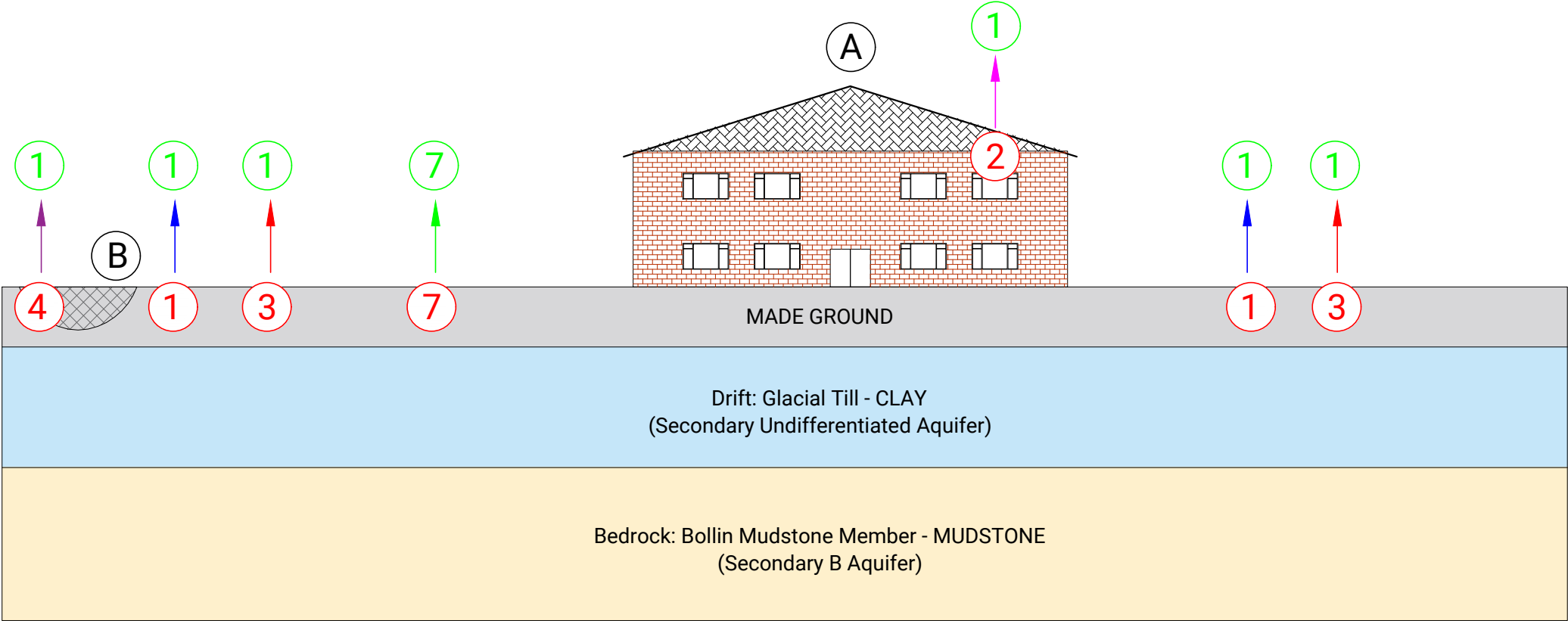
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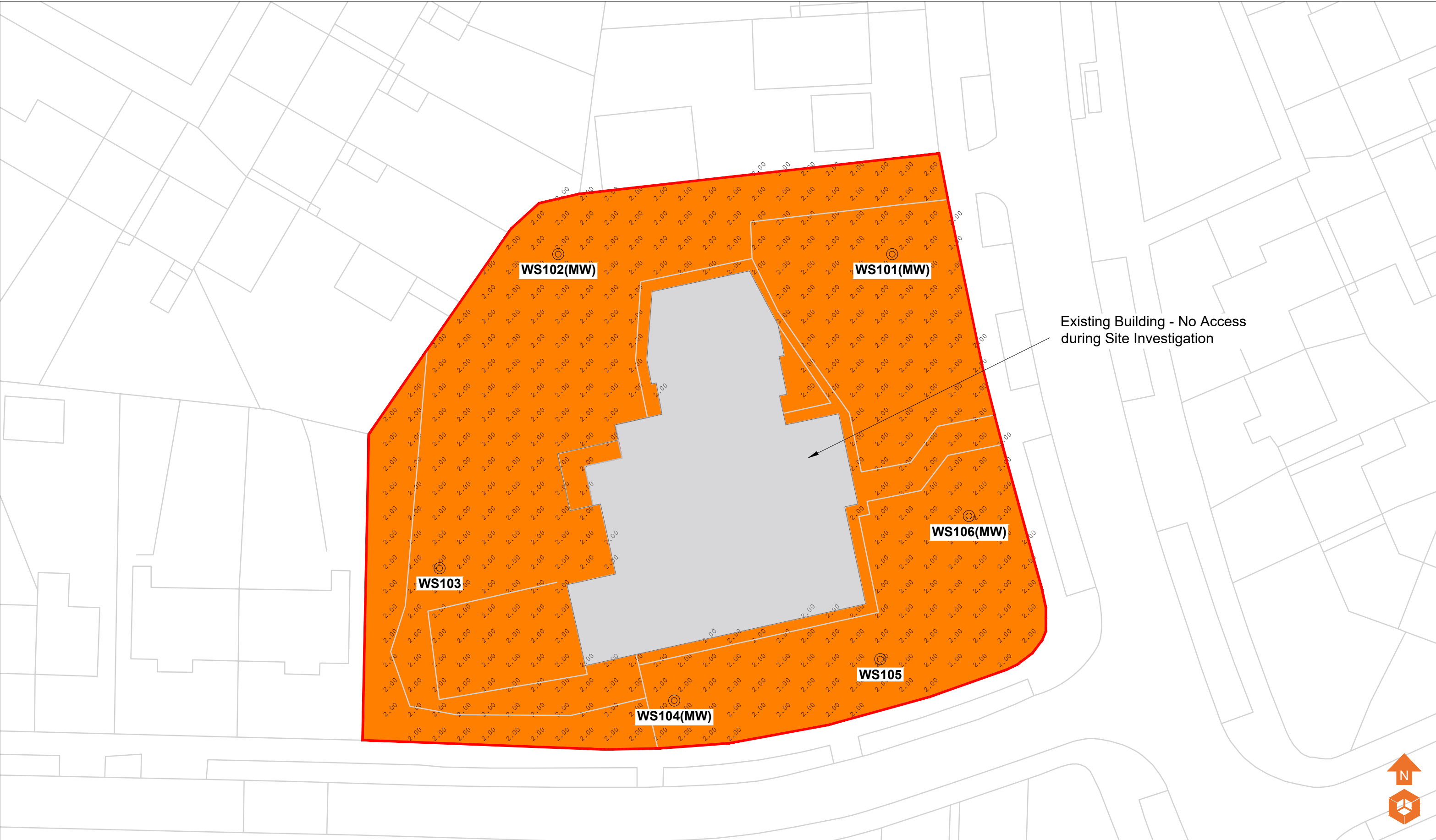


NORTH

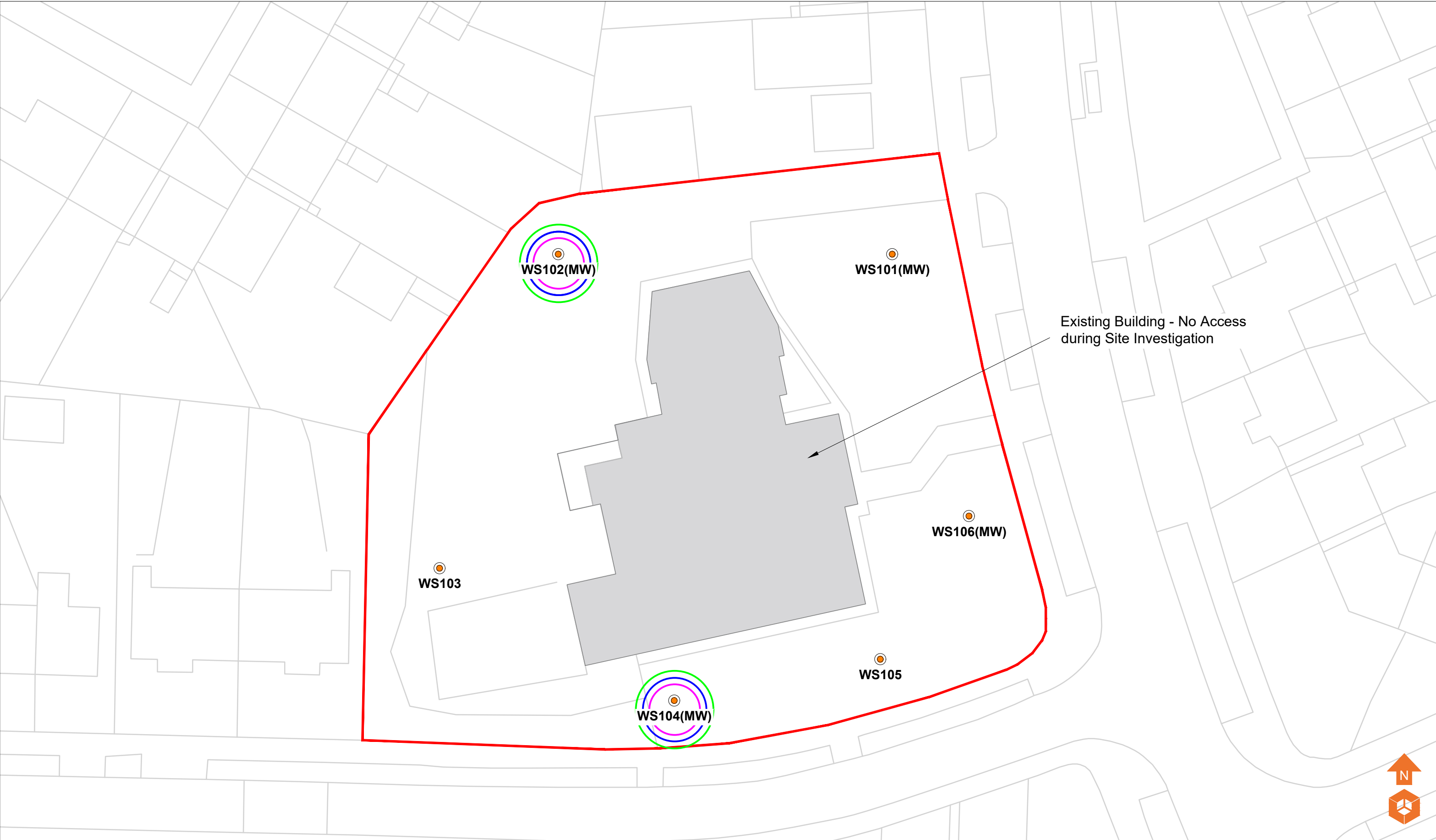
SOUTH



<div>Geology Key</div> <div><div><div></div>Made Ground</div><div><div></div>Drift: Glacial Till - CLAY</div><div><div></div>Bedrock: Bollin Mudstone Member - MUDSTONE</div></div>	<div>Sources</div> <div><div>①</div>Heavy Metals, Non Volatile PAH's (Made Ground)</div> <div><div>②</div>Possible ACM (Existing Building)</div> <div><div>③</div>Possible Volatile Mercury (Made Ground)</div> <div><div>④</div>Ground Gases (Infilled Pond)</div> <div><div>⑦</div>Phytotoxic Contaminants (Made Ground)</div>
---	--



<div>Location Symbols</div> <div><div><div><div></div><div>WS101</div></div><div>Approximate Window Sample Probehole Location (E3P Location February 2024)</div></div><div><div><div><div></div><div>WS103(MW)</div></div><div>Approximate Window Sample Probehole Location with Install (E3P Location February 2024)</div></div><div><div><div></div><div></div></div><div>Existing Building - No Access</div></div></div></div>		<div>Depth to Bedrock (m)</div> <div><div><div><div></div><div>Depth to Bedrock 0.00 - 0.99m</div></div><div><div></div><div>Depth to Bedrock 1.00 - 1.99m</div></div><div><div></div><div>Depth to Bedrock >2.00m</div></div></div></div>		<div>Notes:</div>						<div>Client:</div> <div>Shape Consulting Engineers</div>		<div>Job No:</div> <div>17-305</div>		<div>Date:</div> <div>08.03.2024</div>		<div><div><div><div></div><div>e3p</div></div><div>Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk</div></div></div>			
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												<div>Drawing Title:</div> <div>Depth to Bedrock Plan</div>							

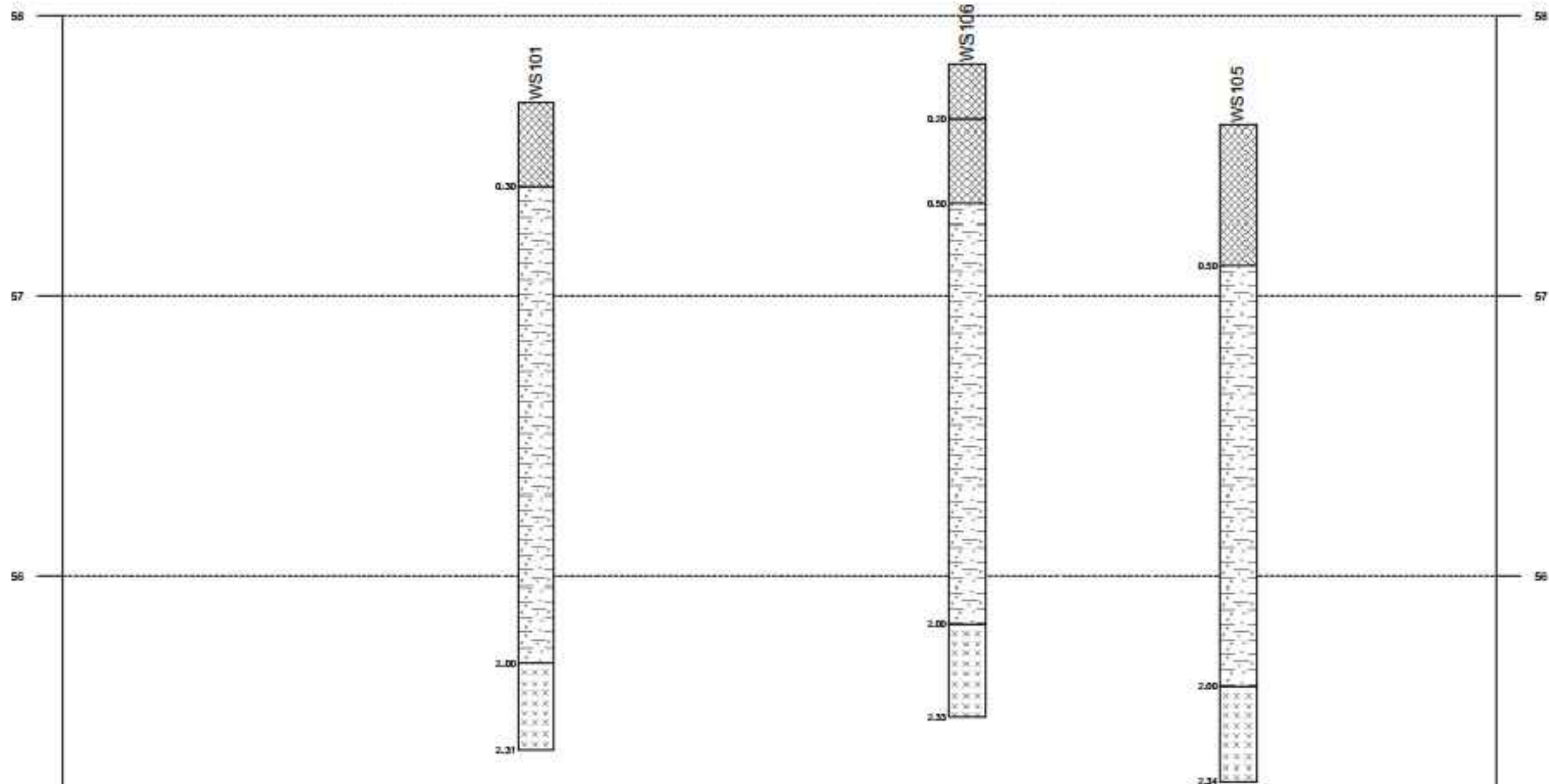


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P1	REVA	08.03.2024	CB	NS	NS															
Phase	Issue	Date	Drawn	Checked	PM															
						Job Title:	Drawing Title:		The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.											
						Greenbrow Social Club		Contamination Exceedances Plan												

Legend Key



55.00



Chainage (m)	0.00	18.91	45.04	60.74	61.46	67.22
Offset (m)		3.06	2.43		2.92	
Elevation (mAOD)		57.09	57.63		57.51	

Notes:

Client:

Shape Consulting Engineers

Job No:

17-305

Date:

14.03.2024

Drawing No:

022

Scale:

NTS @ A3



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Job Title:

Greenbrow Social Club

Drawing Title:

Cross Sections Plan

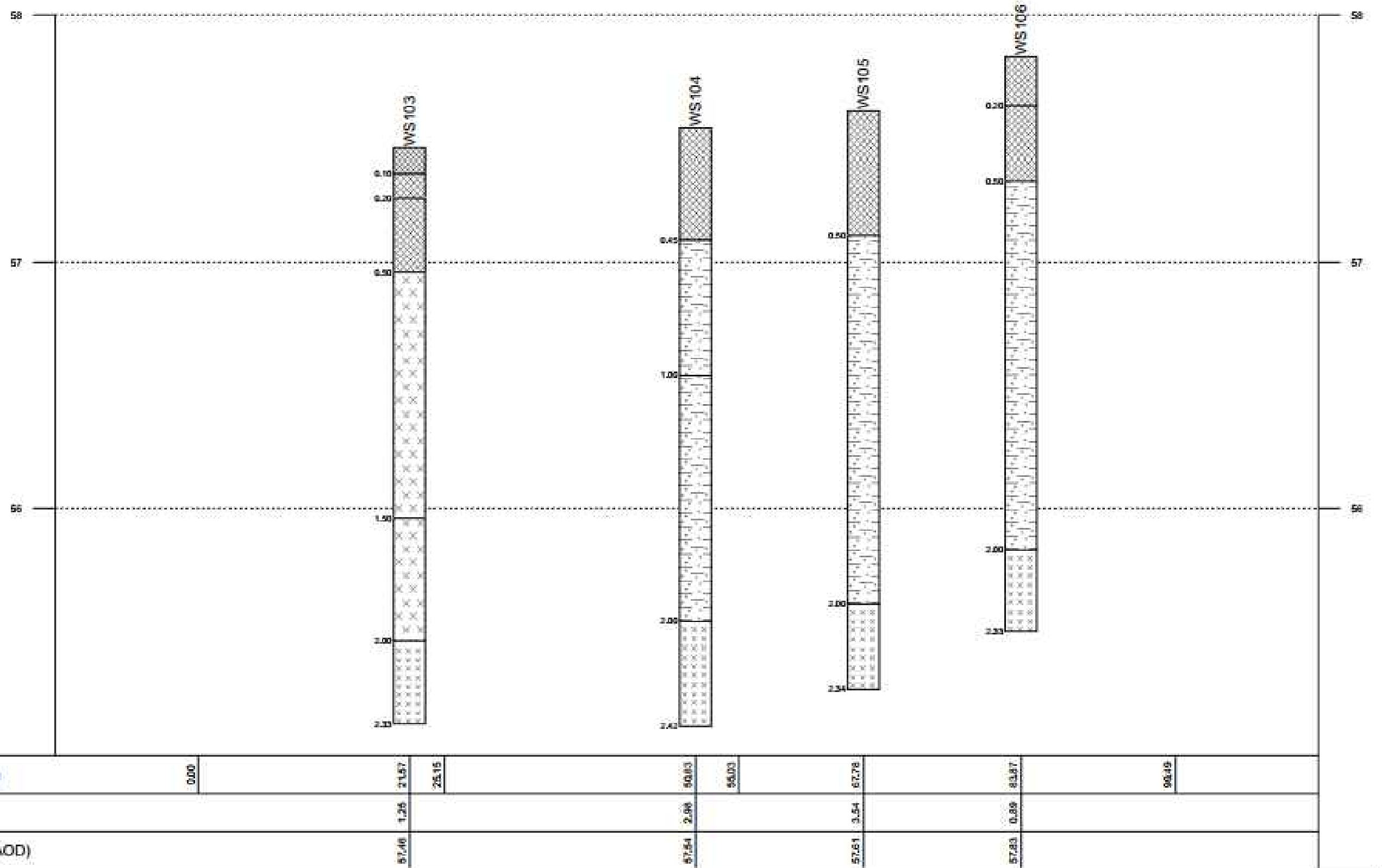
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Phase	Issue	Date	Drawn	Checked	PM

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Legend Key

	MADE GROUND
	Bituminous Material
	Gravelly CLAY
	SILT
	SILTSTONE

55.00



Notes:

Client:

Shape Consulting Engineers

Job No:

17-305

Date:

14.03.2024

Drawing No:

023

Scale:

NTS @ A3


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Job Title:

Greenbrow Social Club

Drawing Title:

Cross Sections Plan

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P1	REVA	14.03.2024	OW	NS	NS
Phase	Issue	Date	Drawn	Checked	PM

APPENDIX V

PHOTOGRAPHS



PLATE 1 SITE ACCESS (NORTHEAST SECTOR)



PLATE 2 VIEW OF EASTERN SECTOR





PLATE 3 CAR PARKING AREA – WESTERN SECTOR



PLATE 4 OUTDOOR COURTYARD





PLATE 5 SOUTHERN SECTOR



PLATE 6 WS106 ARISINGS



APPENDIX VI

EXPLORATORY HOLE LOGS





Borehole Log

Borehole No.

WS102

Sheet 1 of 1

Project Name: Greenbrow Social Club

Project No.
17305

Co-ords: 380828.59 - 387195.19

Hole Type
WS

Location: Wythenshawe

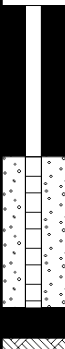
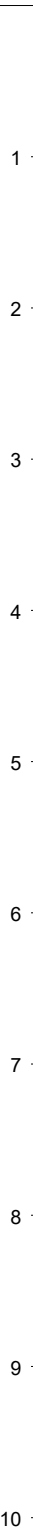
Level: 57.69

Scale
1:50

Client: Shape Consulting Engineers Ltd

Dates: 01/02/2024 -

Logged By
M.Dimes

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.05 0.10 0.20 0.40 0.60	57.64 57.59 57.49 57.29 57.09		MADE GROUND: Asphalt.	
		1.00	D	N=19 (2,2/3,5,5,6)				MADE GROUND: Light greyish brown sandy gravel. Gravel is fine to coarse angular to subrounded of limestone and sandstone.	
		1.00						MADE GROUND: Black slightly clayey gravel. Gravel is fine to medium angular to subangular of slag and clinker.	
								MADE GROUND: Dark greyish brown mottled orange slightly clayey sandy gravel. Gravel is fine to coarse angular to subrounded of brick, slag, and clinker.	
		1.90	ES					MADE GROUND: Dark greyish brown slightly gravelly clay (reworked). Gravel is fine to coarse angular to subrounded of brick, siltstone, sandstone, and coal fragments.	
		2.00	D		2.00	55.69		Very stiff high strength light grey slightly gravelly silty CLAY (friable). Gravel is fine to coarse subangular to subrounded of siltstone.	
		2.00		50 (9,12/50 for 160mm)	2.31	55.38		Dense light grey weathered SILTSTONE.	
								End of borehole at 2.31 m	

Remarks

1. Terminated at 2.31 m bgl on weathered SILTSTONE. 2. Monitoring Well intalled - Response zone 1.00 m to 2.00 m bgl.





Borehole Log

Borehole No.

WS103

Sheet 1 of 1

Project Name: Greenbrow Social Club

Project No.
17305

Co-ords: 380816.47 - 387163.81

Hole Type
WS

Location: Wythenshawe

Level: 57.46

Scale
1:50

Client: Shape Consulting Engineers Ltd

Dates: 01/02/2024 -

Logged By
M.Dimes

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.20	ES	N=20 (2,2/3,5,5,7)	0.10	57.36		MADE GROUND: Asphalt.	1	
					0.20	57.26		MADE GROUND: Light orangish brown sandy gravel. Gravel is fine to coarse angular to subrounded of limestone and sandstone.		
					0.50	56.96		MADE GROUND: Greyish brown sandy gravelly clay (reworked). Gravel is fine to coarse angular to subrounded of brick, sandstone, and siltstone.		
		1.00	D					Very stiff high strength orangish brown clayey gravelly SILT. Gravel is fine to coarse subangular to subrounded of siltstone.		
		1.00	ES					Light grey clayey gravelly SILT. Gravel is fine to coarse subangular to subrounded of siltstone.		
					1.50	55.96			2	
		1.10						Dense brownish grey weathered SILTSTONE.		
		2.00	D	50 (7,10/50 for 180mm)	2.00	55.46				
		2.00			2.33	55.13				
								End of borehole at 2.33 m		
										3
										4
								5		
								6		
								7		
								8		
								9		
								10		



Borehole Log

Borehole No.

WS104

Sheet 1 of 1

Project Name: Greenbrow Social Club

Project No.
17305

Co-ords: 380840.73 - 387150.75

Hole Type
WS

Location: Wythenshawe

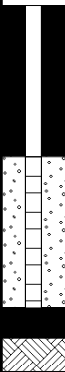
Level: 57.54

Scale
1:50

Client: Shape Consulting Engineers Ltd

Dates: 01/02/2024 -

Logged By
M.Dimes

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.15	ES	N=19 (2,2/3,4,5,7)	0.45	57.09		<p>MADE GROUND: Dark brown slightly gravelly clay with frequent rootlets (reworked topsoil). Gravel is fine to coarse fine to coarse angular to subrounded of brick, plastic, and sandstone.</p> <p>Grey mottled orangish brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse subangular to subrounded of sandstone, siltstone, and coal fragments.</p> <p>Very stiff high strength light grey slightly sandy slightly gravelly very silty CLAY. Gravel is fine to coarse subangular to subrounded of siltstone and sandstone.</p>	1
		0.90	ES		1.00	56.54			
		1.00	D						
		1.00							
		2.00	D	50 (6,6/50 for 265mm)	2.00	55.54		Dense brownish grey weathered SILTSTONE.	2
		2.00			2.42	55.12		End of borehole at 2.42 m	
									3
									4
									5
									6
									7
									8
									9
									10

Remarks

1. Terminated at 2.42 m bgl on weathered SILTSTONE. 2. Water strike (minor ingress) at 2.00 m bgl. 3. Monitoring Well installed - Response zone 1.00 m to 2.00 m bgl.





Borehole Log

Borehole No.

WS105

Sheet 1 of 1

Project Name: Greenbrow Social Club

Project No.
17305

Co-ords: 380858.63 - 387155.27

Hole Type
WS

Location: Wythenshawe

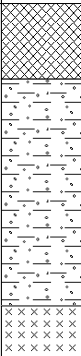
Level: 57.61

Scale
1:50

Client: Shape Consulting Engineers Ltd

Dates: 01/02/2024 -

Logged By
M.Dimes

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.30	ES	N=19 (2,2/3,5,5,6)	0.50	57.11		MADE GROUND: Brown slightly gravelly clay with frequent rootlets (reworked topsoil). Gravel is fine to coarse angular to subrounded of brick, sandstone, and plastic. Very stiff high strength orangish brown mottled greyish brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse subangular to subrounded of sandstone and siltstone.	1		
		0.50 - 1.00	U								
		1.00	D								
		1.00	ES								
				1.20							
				2.00	D	50 (6,10/50 for 185mm)	2.00	55.61		Dense greyish orange weathered SILTSTONE.	2
				2.00			2.34	55.27			
							----- End of borehole at 2.34 m				3
											4
											5
									6		
									7		
									8		
									9		
									10		

Remarks

1. Terminated at 2.34 m bgl on weathered SILTSTONE





Borehole Log

Borehole No.

WS106

Sheet 1 of 1

Project Name: Greenbrow Social Club

Project No.
17305

Co-ords: 380869.67 - 387167.78

Hole Type
WS

Location: Wythenshawe

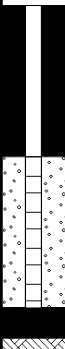
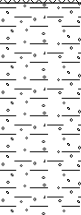
Level: 57.83

Scale
1:50

Client: Shape Consulting Engineers Ltd

Dates: 01/02/2024 -

Logged By
M.Dimes

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.20	57.63		MADE GROUND: Dark brown slightly gravelly clay with frequent rootlets (reworked topsoil). Gravel is fine to coarse angular to subrounded of brick, sandstone and plastic.	1
		0.40	L		0.50	57.33			
		1.00	D						
		1.00							
		1.80	ES	N=19 (3,3/3,4,5,7) 50 (6,10/50 for 180mm)				MADE GROUND: Dark orangish brown slightly sandy slightly gravelly clay. Gravel is fine to coarse angular to subrounded of sandstone, brick, and coal fragments. Very stiff high strength orangish brown silty slightly gravelly CLAY. Gravel is fine to coarse subangular to subrounded of siltstone and sandstone.	2
		2.00	D		2.00	55.83			
		2.00							
		2.00							
					2.33	55.50		Dense reddish brown weathered SILTSTONE.	3
								End of borehole at 2.33 m	4
									5
									6
									7
									8
									9
									10

Remarks

1. Terminated at 2.33 m bgl on weathered SILTSTONE. 2. Monitoring Well intalled - Response zone 1.00 m to 2.00 m bgl.



APPENDIX VII

CHEMICAL TESTING

RESULTS

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Analytical Report Number : 24-001298

Replaces Analytical Report Number: 24-001298, issue no. 1
Client sampling date amended.
Sample date added to all samples as per clients request

Project / Site name:	Green Brow	Samples received on:	02/02/2024
Your job number:	17 305	Samples instructed on/ Analysis started on:	02/02/2024
Your order number:	007340	Analysis completed by:	09/02/2024
Report Issue Number:	2	Report issued on:	04/03/2024
Samples Analysed:	9 soil samples - 1 leachate sample		

Signed: *A. Czerwińska*

Agnieszka Czerwińska
Reporting Specialist
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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

Analytical Report Number: 24-001298
Project / Site name: Green Brow
Your Order No: 007340

Lab Sample Number	108414	108415	108416	108417	108418
Sample Reference	WS101	WS101	WS102	WS103	WS103
Sample Number	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)	0.10	0.80	0.20	0.20	1.10
Date Sampled	01/02/2024	01/02/2024	01/02/2024	01/02/2024	01/02/2024
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		

Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	26	15	23	15	11
Total mass of sample received	kg	0.1	NONE	0.4	0.3	0.3	0.4	0.4

Asbestos

Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	WEM	WEM	WEM	WEM	WEM

General Inorganics

pH (L099)	pH Units	N/A	MCERTS	7.9	8.3	8.2	7.9	8.7
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	1.2	< 1.0	< 1.0
Total Sulphate as SO ₄	mg/kg	50	MCERTS	550	280	1100	230	350
Water Soluble SO ₄ 1hr extraction	mg/kg	2.5	MCERTS	17	13	37	45	28
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	8.46	6.55	18.3	22.4	14.2
Sulphide	mg/kg	1	MCERTS	1.1	< 1.0	3.4	9.6	< 1.0
Total Sulphur	mg/kg	50	MCERTS	450	120	550	280	120
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	4	0.6	3.7	1.1	0.2

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	0.06	< 0.05	0.1	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.27	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	0.11	< 0.05	0.14	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	0.08	< 0.05	0.17	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.92	0.09	2.8	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	0.2	< 0.05	0.39	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	2.1	0.42	5.5	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	2	0.37	5.6	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.1	0.37	2.8	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	1.2	0.41	3.2	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	1.5	0.47	3.5	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	0.46	0.23	1.9	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.2	0.27	3.3	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.61	0.18	1.5	< 0.05	< 0.05
Dibenzo(a,h)anthracene	mg/kg	0.05	MCERTS	0.15	0.07	0.45	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.72	0.22	1.8	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	12.4	3.1	33.3	< 0.80	< 0.80
-----------------------------	-------	-----	-----------	------	-----	------	--------	--------

Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	20	7.6	28	5.7	7.1
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	1.5	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	22	29	20	24	27
Copper (aqua regia extractable)	mg/kg	1	MCERTS	63	27	72	23	13
Lead (aqua regia extractable)	mg/kg	1	MCERTS	150	35	1400	22	5.3
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.7	< 0.3	2.1	< 0.3	< 0.3

Analytical Report Number: 24-001298
Project / Site name: Green Brow
Your Order No: 007340

Lab Sample Number				108414	108415	108416	108417	108418
Sample Reference				WS101	WS101	WS102	WS103	WS103
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	0.80	0.20	0.20	1.10
Date Sampled				01/02/2024	01/02/2024	01/02/2024	01/02/2024	01/02/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	22	25	29	19	24
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	140	65	380	51	47

Petroleum Hydrocarbons

TPH (>C5 - C10) HS_ID_TOTAL	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (>C5 - C6) HS_ID_TOTAL	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (>C6 - C8) HS_ID_TOTAL	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (>C8 - C10) HS_ID_TOTAL	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (>C10 - C12) EH_CU_ID_TOTAL_#1_#2	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH (>C12 - C16) EH_CU_ID_TOTAL_#1_#2	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
TPH (>C16 - C21) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	< 10	< 10	23	< 10	< 10
TPH (>C21 - C35) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	31	< 10	74	< 10	< 10
TPH (>C35 - C40) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	< 10	< 10	12	< 10	< 10

TPH Total >C5 - C40 EH_CU+HS_ID_TOTAL_#1_#2	mg/kg	10	NONE	47	< 10	110	< 10	17
TPH (C10 - C40) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	47	< 10	110	< 10	17

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number: 24-001298
Project / Site name: Green Brow
Your Order No: 007340

Lab Sample Number	108419	108420	108421	108422
Sample Reference	WS104	WS105	WS105	WS106
Sample Number	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)	0.15	0.30	1.20	0.20
Date Sampled	01/02/2024	01/02/2024	01/02/2024	01/02/2024
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status	

Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	20	17	15	15
Total mass of sample received	kg	0.1	NONE	0.3	0.4	0.4	0.9

Asbestos

Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	WEM	WEM	WEM	WEM

General Inorganics

pH (L099)	pH Units	N/A	MCERTS	7.8	7.9	8	8
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0
Total Sulphate as SO ₄	mg/kg	50	MCERTS	520	420	150	350
Water Soluble SO ₄ 1hr extraction	mg/kg	2.5	MCERTS	33	31	60	190
Water Soluble SO ₄ (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	16.4	15.6	29.8	93.1
Sulphide	mg/kg	1	MCERTS	3.8	1.5	< 1.0	1.8
Total Sulphur	mg/kg	50	MCERTS	430	240	79	170
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	2.4	1.2	0.2	0.5

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	0.18	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	0.66	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	0.42	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	4.6	< 0.05	< 0.05	0.14
Anthracene	mg/kg	0.05	MCERTS	0.95	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	5.9	0.31	< 0.05	0.19
Pyrene	mg/kg	0.05	MCERTS	5.2	0.29	< 0.05	0.17
Benzo(a)anthracene	mg/kg	0.05	MCERTS	2.6	0.18	< 0.05	0.07
Chrysene	mg/kg	0.05	MCERTS	2.6	0.2	< 0.05	0.1
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	2.9	0.25	< 0.05	0.12
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	1.1	0.12	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	2.4	0.17	< 0.05	0.11
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.1	0.12	< 0.05	< 0.05
Dibenzo(a,h)anthracene	mg/kg	0.05	MCERTS	0.33	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.4	0.16	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	32.3	1.94	< 0.80	0.9
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	30	11	5.3	6.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	37	26	31	30
Copper (aqua regia extractable)	mg/kg	1	MCERTS	83	34	100	23
Lead (aqua regia extractable)	mg/kg	1	MCERTS	210	47	5.7	31
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	1.7	< 0.3	< 0.3	< 0.3

Analytical Report Number: 24-001298
Project / Site name: Green Brow
Your Order No: 007340

Lab Sample Number				108419	108420	108421	108422
Sample Reference				WS104	WS105	WS105	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.15	0.30	1.20	0.20
Date Sampled				01/02/2024	01/02/2024	01/02/2024	01/02/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	29	22	31	25
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	150	72	63	87

Petroleum Hydrocarbons

TPH (>C5 - C10) HS_ID_TOTAL	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0
TPH (>C5 - C6) HS_ID_TOTAL	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1
TPH (>C6 - C8) HS_ID_TOTAL	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0
TPH (>C8 - C10) HS_ID_TOTAL	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0
TPH (>C10 - C12) EH_CU_ID_TOTAL_#1_#2	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0
TPH (>C12 - C16) EH_CU_ID_TOTAL_#1_#2	mg/kg	4	MCERTS	4.8	< 4.0	< 4.0	< 4.0
TPH (>C16 - C21) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10
TPH (>C21 - C35) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	15	< 10	< 10	< 10
TPH (>C35 - C40) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10

TPH Total >C5 - C40 EH_CU+HS_ID_TOTAL_#1_#2	mg/kg	10	NONE	31	< 10	< 10	< 10
TPH (C10 - C40) EH_CU_ID_TOTAL_#1_#2	mg/kg	10	MCERTS	31	< 10	< 10	< 10

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number: 24-001298
Project / Site name: Green Brow

Your Order No: 007340

Lab Sample Number				108423
Sample Reference				WS106
Sample Number				None Supplied
Depth (m)				0.40
Date Sampled				01/02/2024
Time Taken				None Supplied
Analytical Parameter (Leachate Analysis)	Units	Limit of detection	Accreditation Status	

General Inorganics

pH (automated)	pH Units	N/A	ISO 17025	7.7
Total Cyanide (Low Level 1 µg/l)	µg/l	1	NONE	1.7

Speciated PAHs

Naphthalene	µg/l	0.01	ISO 17025	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01
Dibenzo(a,h)anthracene	µg/l	0.01	NONE	< 0.01
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01

Total PAH

Total EPA-16 PAHs	µg/l	0.16	NONE	< 0.16
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Heavy Metals / Metalloids

Arsenic (dissolved)	µg/l	1	ISO 17025	< 1.0
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0
Chromium (dissolved)	µg/l	0.4	ISO 17025	1.8
Copper (dissolved)	µg/l	0.7	ISO 17025	46
Lead (dissolved)	µg/l	1	ISO 17025	14
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5
Nickel (dissolved)	µg/l	0.3	ISO 17025	3.9
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0
Zinc (dissolved)	µg/l	0.4	ISO 17025	14

Analytical Report Number: 24-001298
Project / Site name: Green Brow

Your Order No: 007340

Lab Sample Number				108423
Sample Reference				WS106
Sample Number				None Supplied
Depth (m)				0.40
Date Sampled				01/02/2024
Time Taken				None Supplied
Analytical Parameter (Leachate Analysis)	Units	Limit of detection	Accreditation Status	

Petroleum Hydrocarbons

TPH - Aliphatic >C5 - C6 _{HS_ID_AL}	µg/l	1	ISO 17025	< 1.0
TPH - Aliphatic >C6 - C8 _{HS_ID_AL}	µg/l	1	ISO 17025	< 1.0
TPH - Aliphatic >C8 - C10 _{HS_ID_AL}	µg/l	1	ISO 17025	< 1.0
TPH - Aliphatic >C10 - C12 _{EH_ID_AL_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aliphatic >C12 - C16 _{EH_ID_AL_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aliphatic >C16 - C21 _{EH_ID_AL_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aliphatic >C21 - C35 _{EH_ID_AL_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aliphatic >C5 - C35 _{HS+EH_ID_AL_#1_#2_MS}	µg/l	10	NONE	< 10

TPH - Aromatic >EC5 - EC7 _{HS_ID_AR}	µg/l	1	ISO 17025	< 1.0
TPH - Aromatic >EC7 - EC8 _{HS_ID_AR}	µg/l	1	ISO 17025	< 1.0
TPH - Aromatic >EC8 - EC10 _{EH_ID_AR_#1_#2_MS}	µg/l	1	ISO 17025	< 1.0
TPH - Aromatic >EC10 - EC12 _{EH_ID_AR_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aromatic >EC12 - EC16 _{EH_ID_AR_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aromatic >EC16 - EC21 _{EH_ID_AR_#1_#2_MS}	µg/l	10	NONE	< 10
TPH - Aromatic >EC21 - EC35 _{EH_ID_AR_#1_#2_MS}	µg/l	10	NONE	< 10

TPH (C10 - C40) _{EH_ID_TOTAL_#1_#2_MS}	µg/l	10	NONE	< 10
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VOCs

MTBE (Methyl Tertiary Butyl Ether)	µg/l	3	NONE	< 3.0
Benzene	µg/l	3	ISO 17025	< 3.0
Toluene	µg/l	3	ISO 17025	< 3.0
Ethylbenzene	µg/l	3	ISO 17025	< 3.0
p & m-xylene	µg/l	3	ISO 17025	< 3.0
o-xylene	µg/l	3	ISO 17025	< 3.0

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number : 24-001298

Project / Site name: Green Brow

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
108414	WS101	None Supplied	0.1	Brown loam and sand with gravel and vegetation
108415	WS101	None Supplied	0.8	Brown sandy clay
108416	WS102	None Supplied	0.2	Brown loam and sand with gravel and vegetation
108417	WS103	None Supplied	0.2	Brown clay and loam with gravel and vegetation
108418	WS103	None Supplied	1.1	Brown sandy clay
108419	WS104	None Supplied	0.15	Brown loam and sand with gravel and vegetation
108420	WS105	None Supplied	0.3	Brown loam and clay with gravel and vegetation
108421	WS105	None Supplied	1.2	Brown sandy clay with vegetation
108422	WS106	None Supplied	0.2	Brown clay and sand

Analytical Report Number : 24-001298

Project / Site name: Green Brow

Water matrix abbreviations:

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in Soil	Asbestos Identification with the use of polarised light microscopy in conjunction with dispersion staining techniques	In-house method based on HSG 248, 2021	A001B	D	ISO 17025
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate (Walkley Black Method)	In-house method	L009B	D	MCERTS
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode	In-house method	L010	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically (up to 30°C)	In-house method	L019B	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight	In-house method based on British Standard Methods and MCERTS requirements.	L019B	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L038B	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES	In-house method	L038B	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES	In-house method	L038B	D	MCERTS
Sulphate, water soluble, in soil (1hr extraction)	Sulphate, water soluble, in soil (1hr extraction)	In-house method	L038B	D	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L039B	W	ISO 17025
Speciated EPA-16 PAHs and/or Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds (including PAH) in soil by extraction in dichloromethane and hexane followed by GC-MS	In-house method based on USEPA 8270	L064B	D	MCERTS
Total petroleum hydrocarbons with carbon banding by GC-MS/GC-MS HS in leachate	Determination of total petroleum hydrocarbons in leachate by GC-MS/GC-MS HS with carbon banding aliphatic and aromatic	In-house method	L070B/L088	W	ISO 17025
Total petroleum hydrocarbons by GC-MS/GC-MS HS in leachate	Determination of total petroleum hydrocarbons in leachate by GC-MS/GC-MS HS	In-house method	L070B/L088	W	NONE
BTEX and/or Volatile organic compounds in leachate	Determination of volatile organic compounds in leachate by headspace GC-MS	In-house method based on USEPA 8260	L073B	W	ISO 17025
Total petroleum hydrocarbons by GC-FID/GC-MS HS in soil	Determination of total petroleum hydrocarbons in soil by GC-FID/GC-MS HS	In-house method	L076B/L088	D/W	MCERTS
Hexavalent chromium in leachate	Determination of hexavalent chromium in leachate by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method	L080	W	ISO 17025

Analytical Report Number : 24-001298

Project / Site name: Green Brow

Water matrix abbreviations:

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in NaOH and addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method	L080	W	MCERTS
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	MCERTS
Total cyanide (low level) in leachate	Determination of total cyanide by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement	In-house method	L099	D	MCERTS
pH at 20°C in leachate (automated)	Determination of pH in leachate by electrometric measurement	In-house method	L099	W	ISO 17025
Speciated EPA-16 PAHs and/or Semi-volatile organic compounds in leachate	SVOCs and PAHs in leachate	In-house method	L102B		ISO 17025
Organic 2:1 Leachate		In-house method	L020B	W	NONE

For method numbers ending in 'UK' or 'A' analysis have been carried out in our laboratory in the United Kingdom (Watford).

For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).

For method numbers ending in 'PL' or 'B' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.

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



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Environmental Science

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Analytical Report Number : 24-003045

Project / Site name:	Green Brow	Samples received on:	13/02/2024
Your job number:	17 305	Samples instructed on/ Analysis started on:	13/02/2024
Your order number:	007408	Analysis completed by:	20/02/2024
Report Issue Number:	1	Report issued on:	20/02/2024
Samples Analysed:	2 water samples		

Signed:

Dominika Liana
Junior Reporting Specialist
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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



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Analytical Report Number: 24-003045

Project / Site name: Green Brow

Your Order No: 007408

Lab Sample Number				117166	117167
Sample Reference				WS102	WS104
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				12/02/2024	12/02/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)				Units	Limit of detection
				Accreditation Status	

General Inorganics

pH (L099)	pH Units	N/A	ISO 17025	7.8	7.7
Total Cyanide (Low Level 1 µg/l)	µg/l	1	NONE	< 1.0	< 1.0
Dissolved Organic Carbon (DOC)	mg/l	0.1	ISO 17025	4.78	8.96

Total Phenols

Total Phenols (Monohydric) Low Level 1ug/l	µg/l	1	NONE	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Dibenzo(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01



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Environmental Science

Analytical Report Number: 24-003045

Project / Site name: Green Brow

Your Order No: 007408

Lab Sample Number				117166	117167
Sample Reference				WS102	WS104
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				12/02/2024	12/02/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		

Heavy Metals / Metalloids

Arsenic (dissolved)	µg/l	0.15	ISO 17025	2.36	1.41
Cadmium (dissolved)	µg/l	0.02	ISO 17025	< 0.02	0.03
Chromium (dissolved)	µg/l	0.2	ISO 17025	1.6	1.3
Copper (dissolved)	µg/l	0.5	ISO 17025	12	16
Lead (dissolved)	µg/l	0.2	ISO 17025	< 0.2	< 0.2
Manganese (dissolved)	µg/l	0.05	ISO 17025	1.1	3.9
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05	< 0.05
Nickel (dissolved)	µg/l	0.5	ISO 17025	2.7	3.8
Selenium (dissolved)	µg/l	0.6	ISO 17025	40	15
Zinc (dissolved)	µg/l	0.5	ISO 17025	7	30

Cadmium (dissolved)	mg/l	0.00008	ISO 17025	< 0.00008	< 0.00008
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0

Petroleum Hydrocarbons

TPH - Aliphatic >C5 - C6 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH - Aliphatic >C6 - C8 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH - Aliphatic >C8 - C10 HS_1D_AL	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH - Aliphatic >C10 - C12 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aliphatic >C12 - C16 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aliphatic >C16 - C21 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aliphatic >C21 - C35 EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aliphatic >C5 - C35 HS+EH_1D_AL_#1_#2_MS	µg/l	10	NONE	< 10	< 10

TPH - Aromatic >EC5 - EC7 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH - Aromatic >EC7 - EC8 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH - Aromatic >EC8 - EC10 HS_1D_AR	µg/l	1	ISO 17025	< 1.0	< 1.0
TPH - Aromatic >EC10 - EC12 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aromatic >EC12 - EC16 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aromatic >EC16 - EC21 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aromatic >EC21 - EC35 EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10
TPH - Aromatic >EC5 - EC35 HS+EH_1D_AR_#1_#2_MS	µg/l	10	NONE	< 10	< 10

TPH (C10 - C40) EH_1D_TOTAL_#1_#2_MS	µg/l	10	NONE	< 10	< 10
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Environmental Science

Analytical Report Number: 24-003045

Project / Site name: Green Brow

Your Order No: 007408

Lab Sample Number				117166	117167
Sample Reference				WS102	WS104
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				12/02/2024	12/02/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)				Units	Limit of detection
				Accreditation Status	

VOCs

Chloromethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Chloroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Bromomethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Vinyl Chloride	µg/l	3	NONE	< 3.0	< 3.0
Trichlorofluoromethane	µg/l	3	NONE	< 3.0	< 3.0
1,1-Dichloroethene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Trans 1,2-dichloroethylene	µg/l	3	ISO 17025	< 3.0	< 3.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1-Dichloroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
2,2-Dichloropropane	µg/l	3	NONE	< 3.0	< 3.0
Chloroform	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1,1-Trichloroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2-Dichloroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1-Dichloropropene	µg/l	3	ISO 17025	< 3.0	< 3.0
Cis-1,2-dichloroethene	µg/l	3	ISO 17025	< 3.0	< 3.0
Benzene	µg/l	3	ISO 17025	< 3.0	< 3.0
Carbontetrachloride	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2-Dichloropropane	µg/l	3	ISO 17025	< 3.0	< 3.0
Trichloroethene	µg/l	3	ISO 17025	< 3.0	< 3.0
Dibromomethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Bromodichloromethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Cis-1,3-dichloropropene	µg/l	3	ISO 17025	< 3.0	< 3.0
Trans-1,3-dichloropropene	µg/l	3	ISO 17025	< 3.0	< 3.0
Toluene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1,2-Trichloroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
1,3-Dichloropropane	µg/l	3	ISO 17025	< 3.0	< 3.0
Dibromochloromethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Tetrachloroethene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2-Dibromoethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Chlorobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1,1,2-Tetrachloroethane	µg/l	3	ISO 17025	< 3.0	< 3.0
Ethylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
p & m-xylene	µg/l	3	ISO 17025	< 3.0	< 3.0
Styrene	µg/l	3	ISO 17025	< 3.0	< 3.0
Bromoform	µg/l	3	ISO 17025	< 3.0	< 3.0
o-xylene	µg/l	3	ISO 17025	< 3.0	< 3.0
Isopropylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,1,2,2-Tetrachloroethane	µg/l	3	NONE	< 3.0	< 3.0
Bromobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
n-Propylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
2-Chlorotoluene	µg/l	3	ISO 17025	< 3.0	< 3.0
4-Chlorotoluene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,3,5-Trimethylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
tert-Butylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2,4-Trimethylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
sec-Butylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,3-Dichlorobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
p-Isopropyltoluene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,4-Dichlorobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2-Dichlorobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0



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Environmental Science

Analytical Report Number: 24-003045

Project / Site name: Green Brow

Your Order No: 007408

Lab Sample Number				117166	117167
Sample Reference				WS102	WS104
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				12/02/2024	12/02/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status		
Butylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2-Dibromo-3-chloropropane	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2,4-Trichlorobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0
Hexachlorobutadiene	µg/l	3	ISO 17025	< 3.0	< 3.0
1,2,3-Trichlorobenzene	µg/l	3	ISO 17025	< 3.0	< 3.0

SVOCs

Aniline	µg/l	0.05	NONE	< 0.05	< 0.05
Phenol	µg/l	0.05	NONE	< 0.05	< 0.05
2-Chlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroethyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05
1,3-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
1,2-Dichlorobenzene	µg/l	0.05	NONE	< 0.1	< 0.1
1,4-Dichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroisopropyl)ether	µg/l	0.05	NONE	< 0.05	< 0.05
2-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachloroethane	µg/l	0.05	NONE	< 0.05	< 0.05
Nitrobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
4-Methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Isophorone	µg/l	0.05	NONE	< 0.05	< 0.05
2-Nitrophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4-Dimethylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
Bis(2-chloroethoxy)methane	µg/l	0.05	NONE	< 0.05	< 0.05
1,2,4-Trichlorobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
2,4-Dichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chloroaniline	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachlorobutadiene	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chloro-3-methylphenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4,6-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2,4,5-Trichlorophenol	µg/l	0.05	NONE	< 0.05	< 0.05
2-Methylnaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05
2-Chloronaphthalene	µg/l	0.05	NONE	< 0.05	< 0.05
Dimethylphthalate	µg/l	0.05	NONE	< 0.05	< 0.05
2,6-Dinitrotoluene	µg/l	0.05	NONE	< 0.05	< 0.05
2,4-Dinitrotoluene	µg/l	0.05	NONE	< 0.1	< 0.1
Dibenzofuran	µg/l	0.05	NONE	< 0.05	< 0.05
4-Chlorophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05
Diethyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
4-Nitroaniline	µg/l	0.05	NONE	< 0.05	< 0.05
Azobenzene	µg/l	0.05	NONE	< 0.05	< 0.05
Bromophenyl phenyl ether	µg/l	0.05	NONE	< 0.05	< 0.05
Hexachlorobenzene	µg/l	0.05	NONE	< 0.050	< 0.050
Carbazole	µg/l	0.05	NONE	< 0.05	< 0.05
Dibutyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05
Anthraquinone	µg/l	0.05	NONE	< 0.05	< 0.05
Butyl benzyl phthalate	µg/l	0.05	NONE	< 0.05	< 0.05

3+4-Methylphenol	µg/l	0.1	NONE	< 0.10	< 0.10
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U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected



4041



Environmental Science

Analytical Report Number : 24-003045

Project / Site name: Green Brow

Water matrix abbreviations:

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW	In-house method based on USEPA Method 6020 & 200.8 for the determination of trace elements in water by ICP-MS	L012B	W	ISO 17025
Dissolved Organic Carbon in water	Determination of dissolved organic carbon in water by TOC/DOC NDIR Analyser	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L037B	W	ISO 17025
Total petroleum hydrocarbons with carbon banding by GC-MS/GC-MS HS in water	Determination of total petroleum hydrocarbons in water by GC-MS/GC-MS HS with carbon banding aliphatic and aromatic	In-house method	L070B/L088	W	ISO 17025
Total petroleum hydrocarbons by GC-MS/GC-MS HS in water	Determination of total petroleum hydrocarbons in water by GC-MS/GC-MS HS	In-house method	L070B/L088	W	NONE
BTEX and/or Volatile organic compounds in water	Determination of volatile organic compounds in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA 8260	L073B	W	ISO 17025
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW	L080	W	ISO 17025
Monohydric phenols (low level) in water	Determination of phenols in water by continuous flow analyser. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	NONE
Total cyanide (low level) in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	NONE
pH at 20°C in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In-house method	L099	W	ISO 17025
Speciated EPA-16 PAHs and/or Semi-volatile organic compounds in water	Determination of semi-volatile organic compounds (including PAH) in leachate by extraction in dichloromethane followed by GC-MS	In-house method based on USEPA 8270	L102B	W	ISO 17025
Phenols in water by GC-MS	Determination of phenols in water by GC-MS	In-house method	L102B	W	NONE
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices: SW, GW, PW, PrW (Al, Cu, Fe,Zn)	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L039B	W	ISO 17025

For method numbers ending in 'UK' or 'A' analysis have been carried out in our laboratory in the United Kingdom (Watford).

For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).

For method numbers ending in 'PL' or 'B' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30°C.

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

APPENDIX VIII

GEOTECHNICAL TESTING

RESULTS



LABORATORY REPORT



Contract Number: PSL24/0929

Report Date: 22 February 2024

Client's Reference: 17-305

Client Name: E3P
Taylor Road
Urmston
Manchester
M41 7JQ

For the attention of: Max Dimes

Contract Title: Green Brow

Date Received: 6/2/2024

Date Commenced: 6/2/2024

Date Completed: 22/2/2024

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Managing Director)

R Berriman
(Associate Director)

S Royle
(Laboratory Manager)

L Knight
(Assistant Laboratory Manager)

S Eyre
(Senior Technician)

T Watkins
(Senior Technician)

5 – 7 Hexthorpe Road,
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Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

Green Brow

Contract No:

PSL24/0929

Client Ref:

17-305

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

[illegible]

SYMBOLS : NP : Non Plastic

*** : Liquid Limit and Plastic Limit Wet Sieved.**



Green Brow

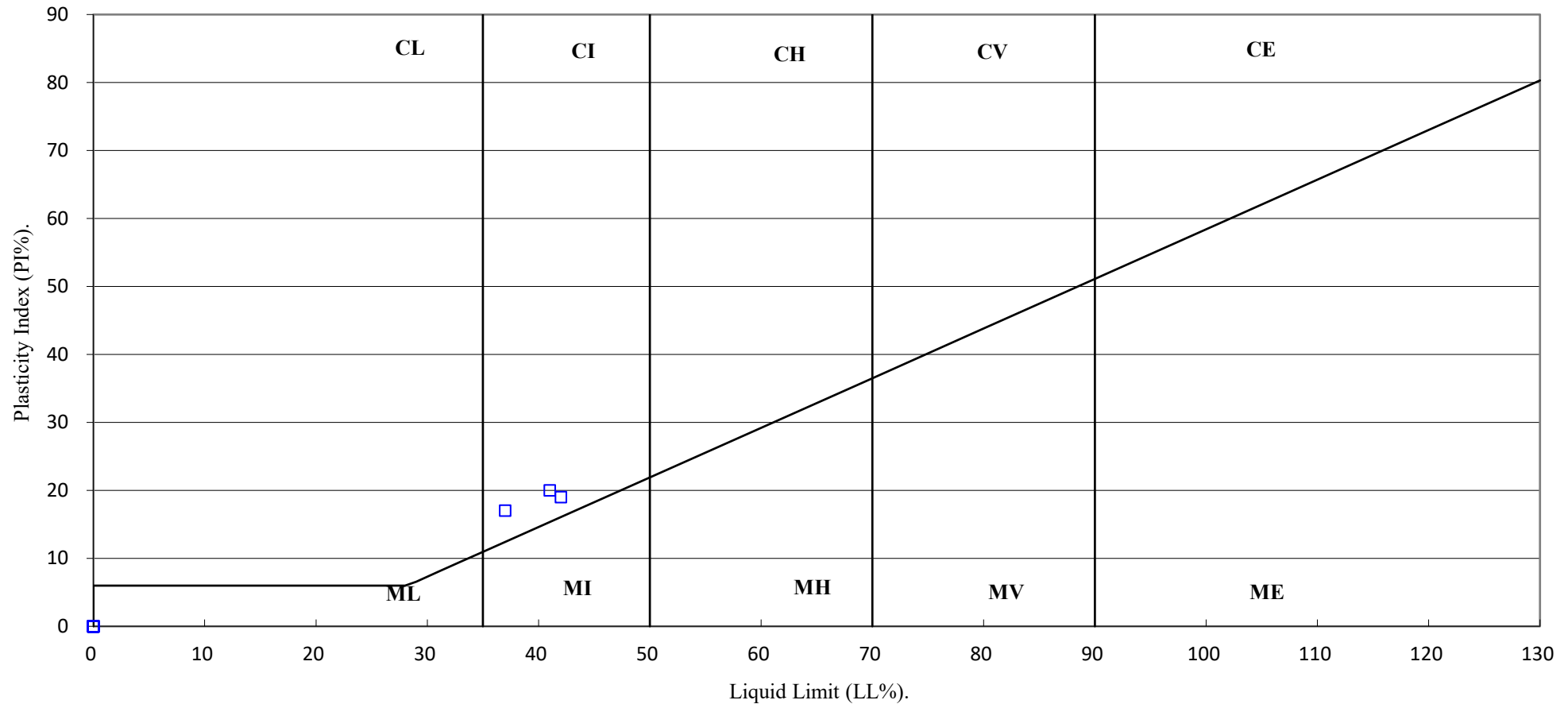
Contract No:

PSL24/0929

Client Ref:

17-305

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



Green Brow

Contract No:

PSL24/0929

Client Ref:

17-305

PARTICLE SIZE DISTRIBUTION TEST

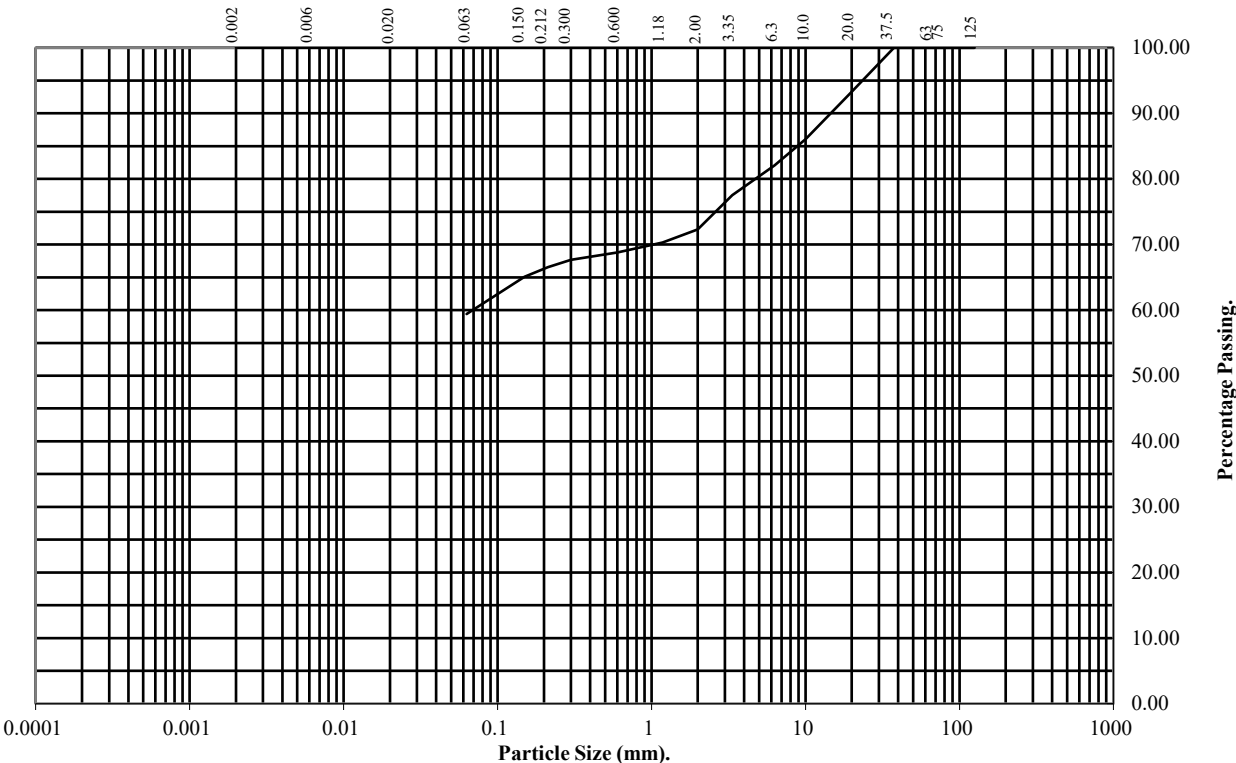
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: WS103 Top Depth (m): 1.00

Sample Number: Base Depth(m):

Sample Type: SPT



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	93
10	86
6.3	82
3.35	78
2	72
1.18	70
0.6	69
0.3	68
0.212	67
0.15	65
0.063	59

Soil Fraction	Total Percentage
Cobbles	0
Gravel	28
Sand	13
Silt/Clay	59

Remarks:

See Summary of Soil Descriptions



Green Brow

Contract No:
PSL24/0929
Client Ref:
17-305

PARTICLE SIZE DISTRIBUTION TEST

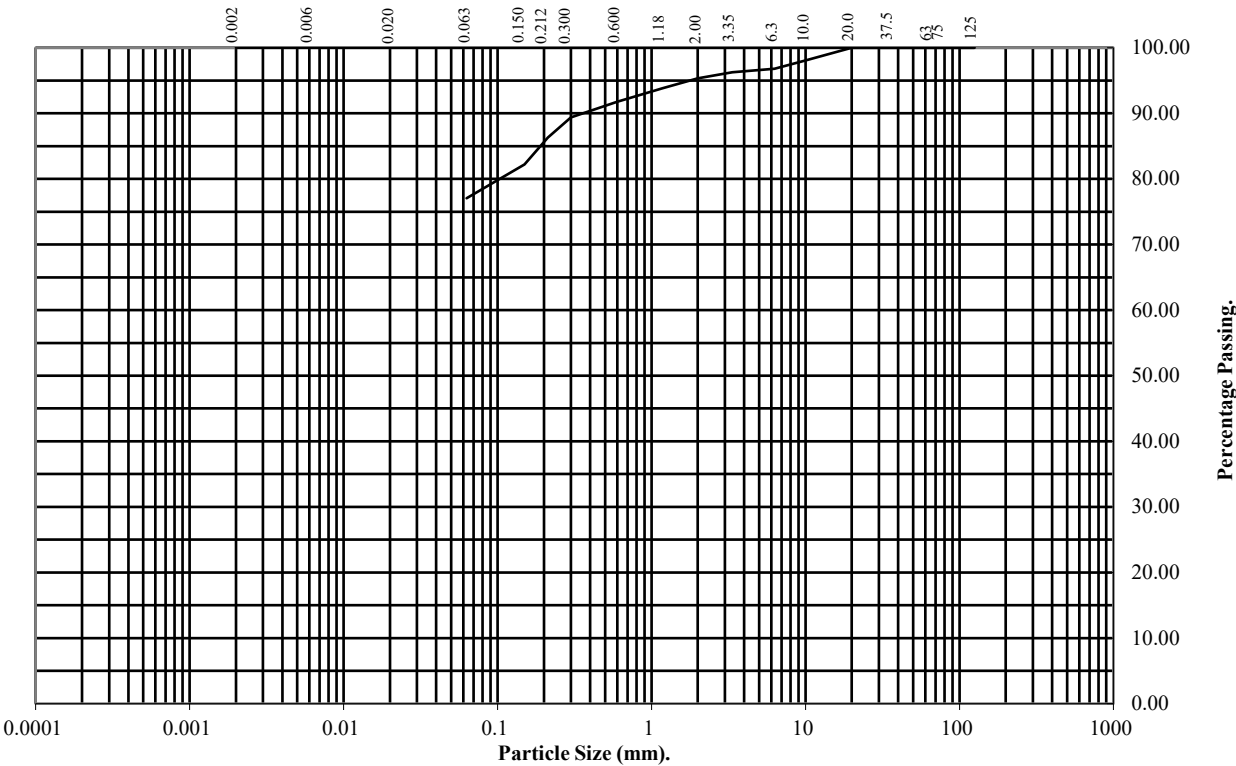
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: WS105 Top Depth (m): 0.50

Sample Number: Base Depth(m): 1.00

Sample Type: U



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	98
6.3	97
3.35	96
2	95
1.18	94
0.6	92
0.3	89
0.212	86
0.15	82
0.063	77

Soil Fraction	Total Percentage
Cobbles	0
Gravel	5
Sand	18
Silt/Clay	77

Remarks:

See Summary of Soil Descriptions



Green Brow

Contract No:
PSL24/0929
Client Ref:
17-305

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

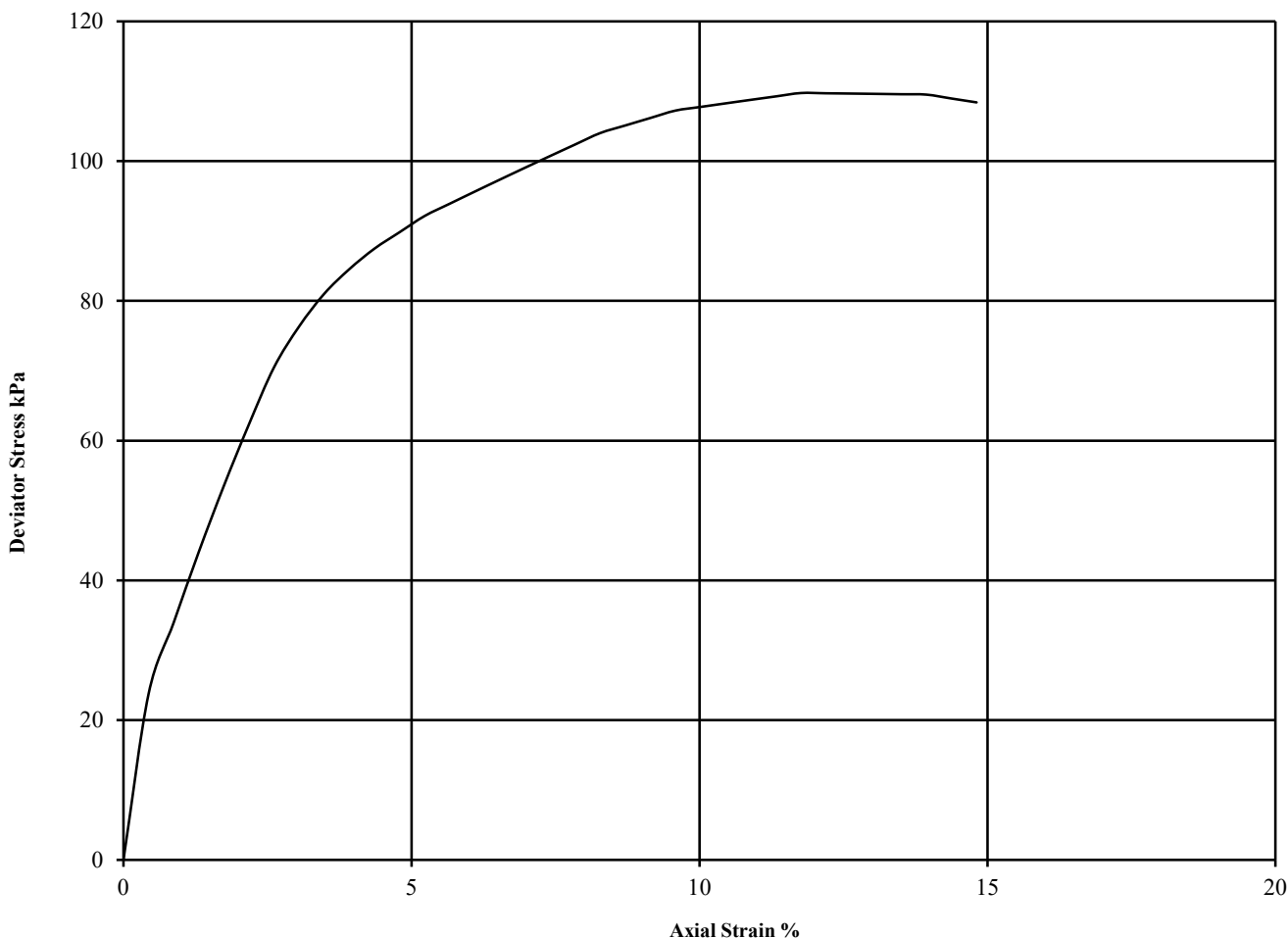
Hole Number: WS105

Top Depth (m): 0.50

Sample Number:

Base Depth (m): 1.00

Sample Type U



Diameter (mm):		88	Height (mm):		202	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell	Corr. Max.	Shear	Failure Strain (%)	Mode of Failure	Undisturbed Sample
				Pressure	Deviator	Strength			Sample taken from top of tube
				(kPa)	Stress	Cu			Rate of strain = 2 %/min
				(kPa)	(kPa)	Latex Membrane used 0.2 mm thick,			
				θ_3	$(\theta_1-\theta_3)_f$	$^{1/2}(\theta_1-\theta_3)_f$			Correction applied 0.40
1	22	1.99	1.64	15	110	55	11.8	Plastic	See summary of soil descriptions



Green Brow

Contract No:

PSL24/0929

Client Ref:

17-305

ONE DIMENSIONAL CONSOLIDATION TEST

BS 1377: Part 5: 1990: Clause 3

Hole Number: WS105

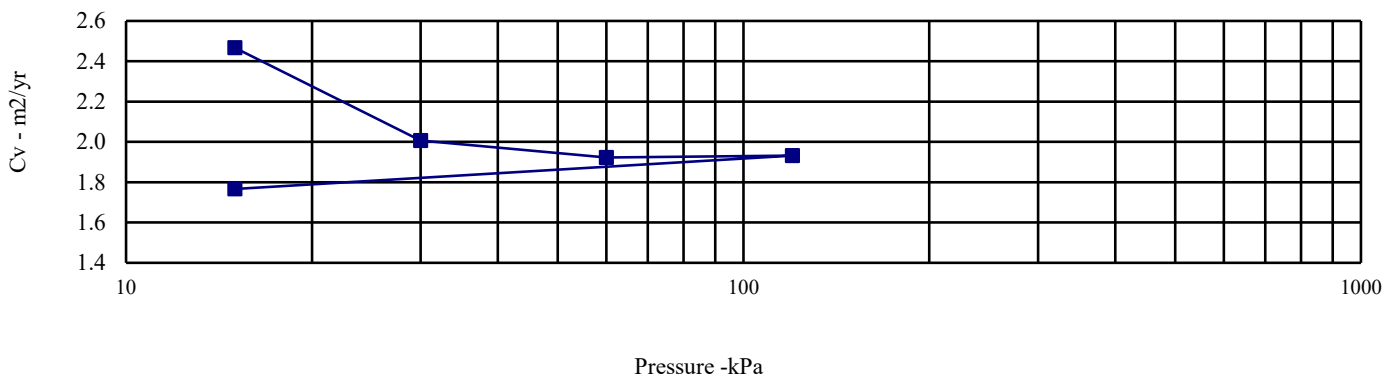
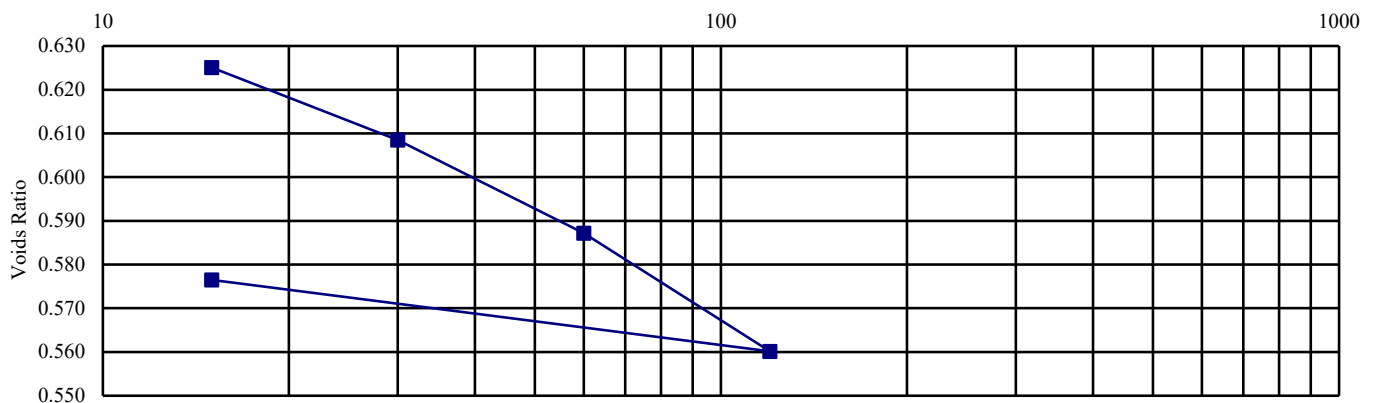
Top Depth (m): 0.50

Sample Number:

Base Depth (m) : 1.00

Sample Type: U

Initial Conditions		Pressure Range		Mv	Cv	Specimen location	
Moisture Content (%):	23	kPa		m2/MN	m2/yr	within tube:	Top
Bulk Density (Mg/m3):	1.98	0	15	0.769	2.467	Method used to	
Dry Density (Mg/m3):	1.61	15	30	0.680	2.007	determine CV:	T90
Voids Ratio:	0.644	30	60	0.442	1.922	Nominal temperature	
Degree of saturation:	93.2	60	120	0.284	1.933	during test 'C':	20
Height (mm):	20.034	120	15	0.100	1.766	Remarks:	
Diameter (mm)	75.025					See summary of soil descriptions	
Particle Density (Mg/m3):	2.65						
Assumed							



Green Brow

Contract No:
PSL24/0929
Client Ref:
17-305

APPENDIX IX

ORIGIN OF CHEMICAL ASSESSMENT CRITERIA



CONSTITUENT	ORIGIN OF RISK ASSESSMENT VALUE
Arsenic	2014 LQM/CIEH S4ULs
Cadmium	2014 LQM/CIEH S4ULs
Chromium	2014 LQM/CIEH S4ULs
Lead	2014 LQM/CIEH S4ULs
Mercury	2014 LQM/CIEH S4ULs – methylmercury
Nickel	2014 LQM/CIEH S4ULs
Selenium	2014 LQM/CIEH S4ULs
Copper	2014 LQM/CIEH S4ULs
Zinc	2014 LQM/CIEH S4ULs
Cyanide – Total	2014 LQM/CIEH S4ULs
Phenols – Total	2014 LQM/CIEH S4ULs
Naphthalene	General assessment criteria (GAC) developed by CIEH/LQM Suitable 4 Use Levels with supporting data from SR3, SR7 and existing Tox report where applicable. 1% SOM.
Acenaphthylene	
Acenaphthene	
Fluorene	
Phenanthrene	
Anthracene	
Fluoranthene	
Pyrene	
Benzo(a)Anthracene	
Chrysene	
Benzo(b/k)Fluoranthene (iii)	
Benzo(a)Pyrene	
Indeno(123-cd)Pyrene	
Dibenzo(a,h)Anthracene	
Benzo(ghi)Perylene	
TPH C ₅ -C ₆ (aliphatic)	
TPH C ₆ -C ₈ (aliphatic)	
TPH C ₈ -C ₁₀ (aliphatic)	
TPH C ₁₀ -C ₁₂ (aliphatic)	
TPH C ₁₂ -C ₁₆ (aromatic)	
TPH C ₁₆ -C ₂₁ (aromatic)	
TPH C ₂₁ -C ₃₅ (aromatic)	



APPENDIX X

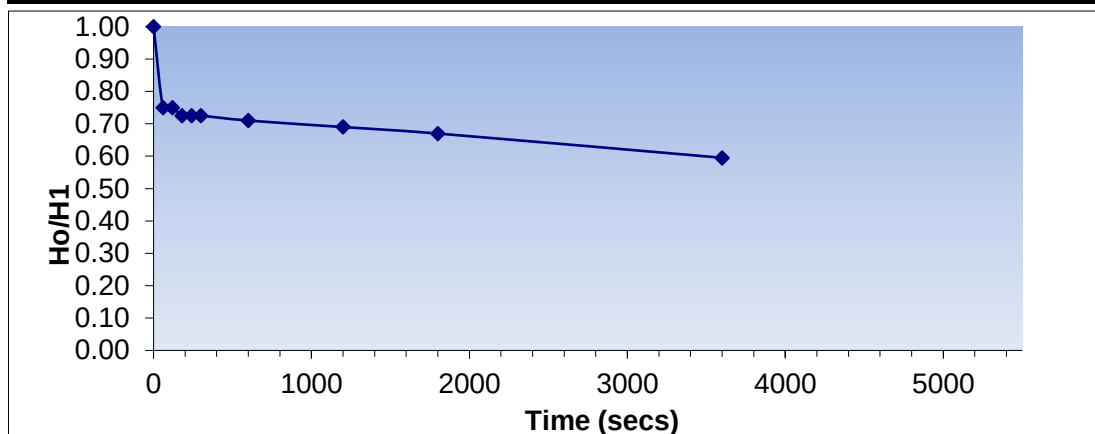
FALLING HEAD TEST

CERTIFICATES

Falling Head Test**Borehole:** **WS102** **Test No:** **1**

Contract No:	17-305	Casing Diameter: (m)	0.05
Contract Title:	Greenbrow	Height of Casing:	0
Date of Test:	22/02/2024	Depth of Borehole: (m)	2.00

Recorded Time			Total Time (secs)	Depth (m)		H/Ho
Hours	Minutes	Seconds				
0	0	0	0	0	0	1.0000
0	1	0	60	0.5	60	0.7500
0	2	0	120	0.5	120	0.7500
0	3	0	180	0.55	180	0.7250
0	4	0	240	0.55	240	0.7250
0	5	0	300	0.55	300	0.7250
0	10	0	600	0.58	600	0.7100
0	20	0	1200	0.62	1200	0.6900
0	30	0	1800	0.66	1800	0.6700
1	0	0	3600	0.81	3600	0.5950



General Approach

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

k = permeability of soil
 F = Intake Factor (figures 6 & 7, BS5930:1999)
 H_1 = variable head measured at time t_1 after commencement of test
 H_2 = variable head measured at time t_2 after commencement of test
 A = Cross sectional area of borehole casing or standpipe as appropriate.

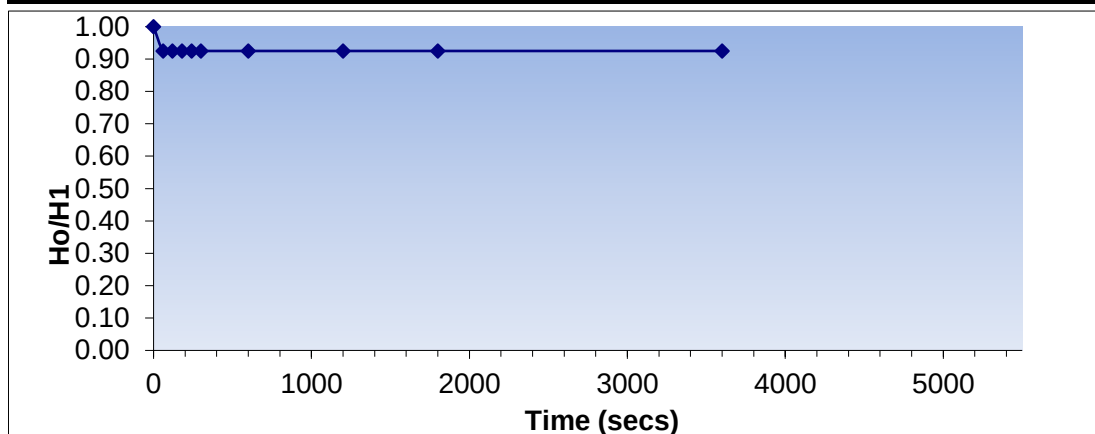
$H_1 =$	0.75	$t_1 =$	60
$H_2 =$	0.67	$t_2 =$	1800
		$F =$	1.28

 $A = 0.00196349 \text{ m}^2$
Coefficient of Permeability, $k = 2.68\text{E-}06 \text{ m/s}$

Falling Head Test**Borehole:** **WS106** **Test No:** **1**

Contract No:	17-305	Casing Diameter: (m)	0.05
Contract Title:	Greenbrow	Height of Casing:	0
Date of Test:	22/02/2024	Depth of Borehole: (m)	2.00

Recorded Time			Total Time (secs)	Depth (m)		H/Ho
Hours	Minutes	Seconds				
0	0	0	0	0	0	1.0000
0	1	0	60	0.15	60	0.9250
0	2	0	120	0.15	120	0.9250
0	3	0	180	0.15	180	0.9250
0	4	0	240	0.15	240	0.9250
0	5	0	300	0.15	300	0.9250
0	10	0	600	0.15	600	0.9250
0	20	0	1200	0.15	1200	0.9250
0	30	0	1800	0.15	1800	0.9250
1	0	0	3600	0.15	3600	0.9250



General Approach

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

k = permeability of soil
 F = Intake Factor (figures 6 & 7, BS5930:1999)
 H_1 = variable head measured at time t_1 after commencement of test
 H_2 = variable head measured at time t_2 after commencement of test
 A = Cross sectional area of borehole casing or standpipe as appropriate.

$$H_1 = 0.925$$

$$H_2 = 0.925$$

$$t_1 = 60$$

$$t_2 = 1800$$

$$F = 1.28$$

$$A = 0.00196349 \text{ m}^2$$

Coefficient of Permeability, $k = 2.4\text{E-}06$ m/s