Phase II Geoenvironmental Site Assessment
New Smithfield Market, Barton and Redman

Reference: 12-757-R2-1
Date: July 2020

PHASE II GEOENVIRONMENTAL SITE ASSESSMENT

New Smithfield Market
Whitworth Street East
Openshaw
Manchester
M11 2WJ

Prepared for:

Russell WBHO

Report Ref: 12-757-R2-1
Date Issued: July 2020

E3P

Taylor Road
Trafford Park
Urmston
M41 7JQ

+ 44 (0) 161 707 9612
https://e3p.co.uk/

Registered in England
CRN: 807255262

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PREPARED BY	O Jackson		
QUALIFICATIONS	BSc (Hons), FGS, AMIEnvSc		
SIGNATURE			
CHECKED BY	S. Ellis		
QUALIFICATIONS	BSc (Hons), FGS, CEnv		
SIGNATURE			
AUTHORISED BY	A Edgar		
QUALIFICATIONS	BSc, MSc, PIEMA, MIEnvSc, CEnv		
SIGNATURE			

EXECUTIVE SUMMARY

Site Address	Whitworth Street East, Manchester, M11 2WJ	
Grid Reference	E388490, N397100	
Site Area	1.76Ha	
Current Site Use	The site is currently occupied by vehicle parking, industrial storage units and access associated with New Smithfield Market which is located immediately north. Storage of commercial material, including waste skips, is present on the site. Hardstanding is present across the site with peripheral landscaping in the central sector and south boundary with small trees and bushes.	
Proposed Development	E3P understands that Russell Construction propose to develop the subject site for a commercial end use. A proposed development layout indicates a steel portal frame building with external HGV loading areas and turning circle.	
Environmental Setting	**Drift Geology**	Glacial Till - BGS borehole logs indicate sandy silty Clay.
	Bedrock Geology	Chester Formation – Sandstone.
	Hydrogeology	Secondary A aquifer (Drift) overlying a principal aquifer (bedrock geology).
	Hydrology	The closest surface water feature is identified 136 m south and is unnamed. Corn Brook is 600 m west and the Ashton Canal is 1 km north of the site
	Flood Risk	The site is not within an area prone to fluvial flooding and there is limited potential for groundwater flooding to occur.
Site History	Historical mapping indicates the site was occupied by a locomotive and carriage works up to the mid-1900s, including railway tracks, cranes and tanks. Since circa 1970s, the New Smithfield Market comprising a series buildings for storage has occupied the site and surrounding area; the subject site is located within the vehicle access and parking area of the market. An electricity substation is shown on plans from pre 1978 until the present.	
Previous Reports	E3P has previously completed a Phase I and Phase II Geoenvironmental Site Assessment on the southern parcel of the subject site (Report Ref:12-757-r2 dated 2018) and a Phase I on the full development site. The pertinent points are included in this report.	
Utility Locations	A formal drainage survey has not been completed, However, service plans show that a combined water pipe passes east west through the centre of the site and surface water drains are present in the western and south western sector.	
Landfill Sites and Ground Gases	There is one historical landfill site located 141 m northeast which accepted inert waste and liquid sludge.	
Radon	Unaffected – No special precaution required.	
Coal Mining/Land Stability	According to the Coal Authority Interactive Map Viewer the site is not within a Development High Risk Area, and no mine entries are identified in the vicinity, therefore, no further action considered necessary.	

E3P INTRUSIVE GROUND INVESTIGATION

Site Investigation Works	E3P has completed a supplementary intrusive ground investigation at the site due to the planning boundary being extended in comparison to the previously completed GeoEnvironmental site assessment presented within report 12-757-r2 dated November 2018. Thus further investigation was required into the wider area of the site and comprised window sample boreholes, falling heads, concrete coring, a deep cable percussive borehole and environmental monitoring installations.
Ground Conditions	**Made Ground** Made Ground was encountered within all exploratory hole locations to depths of between 0.55 m and 2.55 m bgl (WS203, where full depth could not be proven). The majority of exploratory holes were covered by concrete or asphalt hardstand which was in turn generally underlain by a thin band of grey or black sandy gravel as a form of sub-base layer. Made Ground depths and composition was relatively consistent across the site. Concrete was found to be circa 0.30 m thick and asphalt was 0.08 m thick, with the exception of WS201, where asphalt was thicker at 0.25 m in the existing storage area. WS201 and WS205 identified a reworked brown gravelly clay with gravel of concrete, asphalt and brick. At WS202, WS204 and WS207 asphalt was found to be underlain by concrete, followed by a subbase. WS203 could not prove the full depth of Made Ground. This is due to there being a potential brick structure in the borehole locations, the thickness of brick and the nature of the gravel meant that the hole collapsed and could not be advanced. Within the previous report which was undertaken in the south eastern corner of the subject, identified Made Ground to a maximum proven depth of 5.00m bgl. Made ground typically comprised a layer of either asphalt or concrete overlying interbedded sands and gravels, in turn underlain by either a soft to firm dark coloured clay or a firm to stiff purple brown mottled grey gravelly clay.
	Drift Drift deposits were generally consistent across the site, predominantly comprising stiff, high-strength, brown, slightly gravelly CLAY with mudstone identified between 0.50 and 14.95 m bgl (CP201). The CLAY was identified within all locations except WS203, where the full extent of Made Ground could not be proven. The clay identified is similar to that found during the first phase of investigation. WS201 identified a band of clayey SILT underlain by a brown, slightly clayey, slightly silty SAND beneath the Made Ground, however the stiff CLAY was encountered at 1.50 m to the base of the borehole. CP201 identified an isolated area of granular SAND between 7.30 m bgl to 7.60 b bgl, which was saturated. No further granular deposits were identified at the site.
	Solid The solid bedrock geology was not encountered during this investigation, however, BGS boreholes infer bedrock at 76.20 m bgl (SJ89NE42).
	Groundwater Groundwater strikes were encountered as seepages from 0.40m with the shallow boreholes to 5.00m bgl. Within the deeper cable hole a groundwater strike was encountered at 7.30m bgl within a sand band between two clay bands.

CONTAMINATED LAND ASSESSMENT

Human Health	Due to the site currently being active, areas of the site could not be fully accessed. Therefore, it is recommended that when the site is vacant a series of trial pits and further chemical analysis is undertaken in order to fully appraise the site. One of the areas requiring further investigation is below the electricity substation for PCB analysis. A Tier I Human Health Risk Assessment has been undertaken using the chemical analysis results of the soils and comparing to the relevant Tier I criteria. This assessment has identified the presence of elevated lead (WS203 0.40m), amosite (WS206 0.40m) and semi-volatile organic compounds (SVOC) (WS201 0.60m). The Lead identified have primary pathway of dermal contact and ingestion. The asbestos has a pathway of fibre inhalation and the SVOCs through vapour inhalation. Lead has been identified within one location on the site (WS203 0.40m). The chronic risk to human health associated with the elevated concentrations on inorganic heavy metals can be mitigated through the construction of the proposed building and associated hard standing which will remove direct exposure between the contaminant source and site end user. The specific design and installation process for the appropriate cover systems and growing mediums will be clearly defined within the site remediation and enabling works strategy. With regards to the elevated SVOCs (4-Chloroaniline, 2-Methylnaphthalene, Dibenzofuran, 4-Nitroaniline, Carbazole, Anthraquinone) these present a potential volatilisation to indoor air risk. These elevated concentrations have only been identified within one area (south east the site) and are therefore potentially a hotspot and are likely sourced a hydrocarbon/ coal tar source related to the former industry on the site. Therefore, during a process of cut/fill enabling works, further delineation, assessment and potential hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on site in an area of no future sensitivity. However, when considering the proposed development layout, the area identified is due to be car parking and covered in hardstanding not beneath the building footprint. As such, there is a moderate risk to the end user but there still a risk to controlled waters that needs to be considered. Asbestos in the form of amosite has also been identified within localised areas in shallow Made Ground deposits (WS206, 0.40 m). Asbestos quantification records a concentration of <0.001%. No visual signs of ACM were encountered during the ground investigation; it is therefore likely that only trace fibres are present. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model. No chemical exceedances were identified within the Made Ground during the first phase of site investigation which included 14 samples from the south eastern sector of the subject site. However, during the most recent investigation contaminants were identified in the very south east of the subject site. Chemical analysis of the natural CLAY drift deposits (10 samples from across the site) has identified these soils to be acceptable for use as subsoil within any proposed landscaping areas; however, further chemical validation samples will be required to confirm this. There are no suitable sources of topsoil available on the site.

Controlled Waters	No water samples were able to be obtained as part of this assessment as only minimal amounts of water were present within the monitoring well positions when water sampling was attempted. This comparison indicates that the data exceeds the EQS values for the following inorganic compounds: • TPH Aromatic C12-C16 • TPH Aromatic C16-C35 It should be noted that leachate analysis is an aggressive test which overstates the risk. The TPH carbon bands C16 to C21 and C21 to C25 identified within the leachate samples are of a general low solubility, and therefore mobility, suggesting that these will not migrate to controlled water receptors. However, it must be noted that these were found in WS201 which is also where elevated SVOCs were identified within the soil samples and will undergo further investigation and delineation as part of the remediation works. The previously completed investigation in the southern sector of the site did not identify any contaminant exceedances that may pose a risk to controlled waters. Given the site is underlain by low-permeability, predominantly cohesive, glacial till deposits, which will afford protection to the underlying principal aquifer, there is considered to be a low risk to controlled waters and the wider environ as no complete pollutant linkage can be determined. Based on the above, upon completion of the works to identify the source of the contaminants identified in the vicinity of WS201 and further assessment, it is likely that there will be no unacceptable level of risk to the controlled water receptors.
Ground Gas	Characteristic Situation 1, no gas protection measures required (pending completion of gas monitoring). The previous site investigation classified the site as CS2, however the proposed building has now moved location and is now away from the area where elevated ground gases were identified. The final gas regime will be concluded once the full monitoring period is complete, allowances for CS2 should be made at the current time.
Potable Water Infrastructure	This will need to be confirmed following the completion of a UKWIR risk assessment, however it is likely that barrier pipe will be required. Post-remediation and enabling works ground conditions may be different from those identified during this site investigation.

GEOTECHNICAL ASSESSMENT

Underground Obstructions	Concrete and brick obstructions have been encountered within the Made Ground across the site at the surface and more extensively in WS203, indicative of relict foundations from the former buildings and railway tracks. Furthermore, upon removal of the current buildings on the site, it is likely that further obstructions in the form of foundations and utilities infrastructure will be identified. During a phase of cut-and-fill enabling works to create a developable platform, all below-ground obstructions will require grubbing out to the base of the Made Ground to enable the construction of proposed plots.
Allowable Bearing Pressure	The underlying CLAY drift deposits have been assessed as being very stiff, high-strength with a net ABP in excess 160 kN/m^2 at circa 1 m bgl and increasing with depth. Dense SAND was identified in one location (WS201 from 1.00m to 1.45m) within an ABP of 313kN/m^2.
Foundation Options	A phase of cut-and-fill enabling works will be required in order to create a proposed development platform suitable for a commercial development. Upon completion of these enabling works, it is likely that the most cost effective option for the majority of the site would be to utilise shallow pad foundations to support the portal frame of the proposed commercial/industrial building bearing at least 500mm below the stiff to very stiff medium to high strength cohesive soils. The previous report for the south eastern sector made recommendations for vibro stone columns but the location for the proposed structure has now been relocated to an area of more favourable ground conditions. It must be noted that if the foundations for the current buildings and infrastructure on-site are significant and during removal cause site wide disturbance to the underlying strata, it may be more cost effective to utilise vibro stone columns to support the pad foundations. However, disturbance of cohesive materials should be minimal and where clay soils are removed they must be re-engineered in accordance with an appropriate geotechnical specification. Trees are present on the site periphery. Foundations that are within influencing distance of these trees will require deepening to mitigate against the chance of heave.
Building Floor Slabs	A ground-bearing slab will be viable for the commercial structures; however, it will need to be constructed utilising a sub-base with the thickness designed by a structural engineer to ensure that settlement tolerances are taken into consideration. Due to the presence of substantial thickness of Made Ground across the site, is considered that ground-bearing floor slabs, whilst viable, will require detailed design to accommodate variability of the formation and account for differential settlement.

Building Floor Slabs *Continued…*	In order achieve an ABP of ~50 kN/m² for the floor slab the underlying soils will need to be engineered. Firstly the underlying obstructions will need to be removed and then the general underlying soils will need to be excavated, processed, placed and re-engineered or undertake ground improvement by HEIC (High Energy Impact Compaction) to ensure an ABP of ~50 kN/m² for a floor slab. The design needs to consider the variable thicknesses of the Made Ground and that upon removal of the obstructions no differential settlement is apparent. Where a ground-bearing floor slab is to be constructed within the conjectured zone of tree influence, the clay will need to be removed to ensure that any desiccated soil cannot swell and induce heave to the structure. Alternatively, it may be possible to design the structure to resist the influence of clay heave using exaggerated sub-base and additional reinforcement within the slab to be designed by the structural engineer. Where it is necessary to undertake cut-and-fill works utilising site-derived cohesive soils, careful consideration must be given to seasonal climatic conditions, which will have a significant impact of moisture conditions and the ability to compact clay soils in the wetter winter months. It may be necessary to undertake an element of stabilisation works through the addition of lime to ensure the soils can be engineered to the required performance standards. It would be possible to utilise soil stabilisation techniques that incorporate the addition of lime and OPC to construct a stiffened soil horizon with a CBR > 15% to constitute a sub-base replacement layer that could then be capped with Type 1 MOT. The use of soil stabilisation could be extended within the conjectured zone of tree influence to modify the structure of clay soils and negate the potential for volumetric instability. Depending on the design requirements of the proposed commercial care home structure, and its location on-site, it would be possible to utilise either a suspended or cast in-situ floor slab to incorporate the principals outlined above.
Heave Precautions	The underlying CLAY is of low volume change potential, heave precautions will not be required to the internal face of a foundation. However, heave precautions will be required to the underside of floor slabs (where there is no 200 mm void) or ground beams within the modelled influencing distance of trees. Where a ground-bearing floor slab is to be constructed within the conjectured zone of tree influence, the CLAY will need to be removed to ensure that any desiccated soil cannot swell and induce heave to the structure. Alternatively, it may be possible to design the structure to resist the influence of clay heave using exaggerated sub-base and additional reinforcement within the slab, to be designed by the structural engineer.
Soakaway Drainage	The Made Ground and soils are cohesive in nature and the falling head tests undertaken have proven the ground to be impermeable with limited soakage potential.

Sulphate Assessment	Based upon the results of the chemical analyses it is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with the recommendations provided in BRE *Special Digest 1* (2005). Elevated sulphate concentrations meeting Class DS-2, AC-2 were noted within the Made Ground deposits in WS201 and WS210 at 0.40 – 0.50 m bgl. However, upon completion of site enabling works it will, in all likelihood, be DS1 AC1s.
CBR Design %	Granular soils can be re-engineered to ensure a CBR in the order of 4–5% within the subgrade during favourable climatic conditions. Natural clay soils will provide a CBR in the order of 2–4% 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.
Cut/Fill	Development levels are unknown at this time; however, cut-and-fill works will be required to prepare the development platform. A geotechnical specification of works will be required to document filled material types, compaction methodologies and validation testing relevant to the proposed development end use.
Waste Characterisation	Any material that is to be disposed off-site should undergo assessment using Technical Guidance WM3: Waste Classification – Guidance on the classification and assessment of waste.

RECOMMENDATIONS

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

- **Post demolition ground investigations;**
- **Assessment of potential PCB impact below the former substation;**
- **Further investigation and assessment within the vicinity of WS201;**
- **Materials management plan;**
- **Geotechnical earthworks strategy (infrastructure);**
- **Remediation and enabling works strategy; and**
- **Build-phase contamination mitigation strategy.**

TABLE OF CONTENTS

EXECUTIVE SUMMARY 2

1. INTRODUCTION 11
1.1. Background 11
1.2. Proposed Development 11
1.3. Objectives 12
1.4. Limitations 12
1.5. Confidentiality 12
1.6. Previous Reports 13

2. GROUND INVESTIGATION 15
2.1. Limitations of the investigation 15
2.2. General Overview 15
2.3. In-Situ Standard Penetration Testing (SPT) 16
2.4. Permeability Tests 16
2.5. Laboratory Analysis 16

3. GROUND AND GROUNDWATER CONDITIONS 17
3.1. Summary of Ground Conditions 17
3.2. Made Ground 17
3.3. Drift Deposits 18
3.4. Solid Geology 18
3.5. Groundwater 18
3.6. Visual and Olfactory Evidence of Contamination 18
3.7. Soil Consistency 19
3.7.1. Side Stability and Ease of Excavation 19
3.8. Consolidation 22
3.9. Soil Infiltration 22
3.10. Soil Plasticity 23
3.11. pH and Sulphate 24
3.12. Ground Gas 24
3.13. Investigation Rationale 24
3.14. Monitoring Methodology 25

4. TIER I QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT 27
4.1. Human Health Risk Assessment 27
4.2. Controlled Waters Risk Assessment 31
4.3. Ground Gas 35
4.3.1. Sources of Ground Gas 36
4.3.2. Groundwater 36
4.3.3. Gas Flow 36
4.3.4. Gas Concentrations 36
4.3.5. Gas Assessment 37
4.4. Potable water supply 37
4.5. Conceptual Site Model 39

5. GEOTECHNICAL ASSESSMENT 43
5.1. Proposed Development 43
5.2. Summary of Ground Conditions 43
5.3. Site Preparation 44
5.4. Foundation Conditions and Assessment of Potential Bearing Capacities 44
5.5. Ground Floor Slabs 45
5.6. Heave Precautions 46
5.7. Highways Construction 47
5.8. Drainage 47

5.9. Concrete Durability 48
5.10. Excavations 48
5.11. Further Works 48
5.12. Construction Activity and Inspection 49
5.13. Geotechnical Risk Register 50

6. CONCLUSIONS AND RECOMMENDATIONS 52

APPENDIX I LIMITATIONS 56

APPENDIX II GLOSSARY 58

APPENDIX III DRAWINGS 61

APPENDIX IV PHOTOGRAPHS 63

APPENDIX V EXPLORATORY LOGS 69

APPENDIX VI CHEMICAL TESTING RESULTS 70

APPENDIX VII ORIGIN OF TIER I GENERIC ASSESSMENT CRITERIA 71

APPENDIX VIII GEOTECHNICAL TESTING RESULTS 74

APPENDIX IX FALLING HEAD PERMEABILITY TEST CERTIFICATES 75

DRAWING LIST

12-757-R1-001 - Site Location Plan
12-757-R1-002 - Proposed Development Plan
12-757-R1-003 - Historical Features Plan
12-757-R1-004 - Site Features Plan
12-757-R1-005 - Exploratory Hole Location Plan
12-757-R1-006 - Depth of Made Ground Plan
12-757-R1-007 - Depth to Founding Strata Plan
12-757-R1-008 - Development Constraints Plan
12-757-R1-009 - Foundation Zoning Plan
12-757-R1-010 - Conceptual Site Model
12-757-R1-018 – Contaminant Exceedance Plan

1. INTRODUCTION

1.1. BACKGROUND

E3P has been commissioned by Russells Construction to undertake a detailed Phase II Geoenvironmental Site Assessment for a parcel of commercial and industrial land at New Smithfield Market, Openshaw, Manchester.

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 development for a proposed commercial development.

The scope of work includes the following elements:

- Design of suitable intrusive ground investigation;
- Window sample probeholes with, and construction of, environmental monitoring installations;
- Deep cable percussive borehole;
- In-situ geotechnical testing;
- Chemical and geotechnical laboratory analysis;
- Groundwater monitoring and sampling;
- Ground gas monitoring;
- Contamination risk assessment and conceptual site model;
- Geotechnical assessment and interpretation; and
- Factual and interpretive reporting.

1.2. PROPOSED DEVELOPMENT

E3P understands that Russells Construction propose to develop the subject site for commercial end use. Drawing 12-757-002 (Appendix III) identifies the proposed development layout.

A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT

1.3. OBJECTIVES

The objectives of the geoenvironmental assessment are as follows:

- Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified.
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors.
- Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs.
- Provide recommendations regarding future works required.

1.4. LIMITATIONS

The limitations of this report are presented in Appendix I.

1.5. 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 contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.

1.6. PREVIOUS REPORTS

Pertinent points from the previously completed E3P Phase 1 Geoenvironmental Desk Study (ref: 12-757, dated August 2018) and E3P Geoenvironmental Desk Study (12-757r3 Dated July 2020) are as follows:

- The underlying geology of the site is Glacial Till (secondary A aquifer) overlying Chester Formation sandstone (principal aquifer).
- The closest surface water feature is identified 136m south. Corn Brook is 600 m west and the Ashton Canal is 1km north of the site.
- There is one historical landfill site located 141 m northeast which accepted inert waste and liquid sludge.
- No invasive plant species were identified during the site walkover; however, their presence cannot be ruled out and a Habitat Survey may be required.
- Given the developed nature of the site Made Ground and obstructions are anticipated.
- According to the Coal Authority Interactive Map Viewer the site is not within a Development High Risk Area, and no mine entries are identified in the vicinity, therefore, no further action considered necessary.
- Historical mapping indicates the site was occupied by a locomotive and carriage works up to the mid-1900s, including railway tracks, cranes and tanks. Since circa 1970s, the New Smithfield Market has occupied the site and surrounding area; the subject site is located within the vehicle access and parking area of the market .
- Historical and current commercial land uses on site, including a locomotive yard, as well as Made Ground, represent potential localised sources of mobile hydrocarbon contamination. Hardstanding across the site and underlying superficial Clay deposits reduce the potential for infiltration and migration of mobile contaminants, if present. However, considering the underlying principal aquifer, a moderate to high risk to controlled waters is identified. Made Ground associated with historical development may be a source of carbon dioxide and methane.
- Historical and commercial land uses on the site, as well as Made Ground represent potential localised sources of heavy metal, polycyclic aromatic hydrocarbon (PAH), petroleum hydrocarbon, asbestos, and ground gas. Considering the potential for direct contact during development works and within proposed landscaping areas, these potential sources of soil and groundwater contamination represent a moderate risk to construction workers and commercial end users.

Pertinent points from the previously completed E3P Ltd ground investigation (ref: 12-757-R1-1, dated November 2018) which was completed in the south east of the subject site, are as follows:

- Made Ground was encountered within all exploratory locations, up to a maximum proven depth of 5.00 m bgl (WS105). The depth of Made Ground varies significantly between exploratory holes however it is generally less than 2.50 m thick.
- Drift deposits were encountered to a maximum proven depth of 13.00 m bgl, by CP101. Drift deposits predominantly comprise very stiff high strength gravelly sandy CLAY.
- Water strikes were encountered during the Ground Investigation at depth of between 0.60 m to 4.00 m bgl
- Rockhead was not encountered in this investigation;

- The Tier I Human Health Risk Assessment has not identified any concentrations of contaminants of concern which exceed the Tier I screening values for the protection of human health; as such the site poses no unacceptable degree of risk to future commercial site users

- Given the absence of any potentially soluble / mobile contaminants of concern within the soil and absence of a viable exposure pathway, it is concluded the site poses no unacceptable degree of risk to the controlled water receptors and the wider environ based on leachate samples taken from the site.

- Ground gas monitoring indicates the site falls into Characteristic Situation 2; as such protection measures are required in the proposed development.

- Other than a possible service in TP105b no significant obstructions were identified within trial holes. However, relics are anticipated across the site due to the historical development;

- Based on the assessment of the relative undrained shear strength, in-situ densities and corresponding safe net ABP, the suitable target founding stratum has been identified as the firm to stiff high to very high strength CLAY at a depth of between 1.50 – 3.00 m bgl where an ABP in excess of 125kN/m² can generally be achieved

- The underlying cohesive deposits are of low to moderate volume change potential, heave precautions are required to the internal face of the external load bearing walls (outside or within tree influence).

- E3P consider it feasible to construct the commercial unit with pad foundations supported by VSC on an engineered sub-grade set at least 500 mm into the clay soils to support the associated ground bearing slab and infrastructure. The requirement for the vibro stone columns is due to the presence of the deep Made Ground on the site.

2. GROUND INVESTIGATION

2.1. LIMITATIONS OF THE INVESTIGATION

The investigation was undertaken on-site whilst the Smithfield Market buildings were present and active with frequent vehicle movements. Due to the investigation needing to be undertaken without detrimentally impacting the businesses operating on the site, some of the exploratory hole positions were not positioned in their ideal location and trial pitting was not permitted.

It is recommended that further investigation is undertaken upon demolition of the current on-site structures.

2.2. GENERAL OVERVIEW

A ground investigation has been designed based on the findings of the desk study and previous reports, with exploratory holes advanced to target specific potential contaminant sources and supplements a previous phases of works due to an expansion of the red-line boundary. The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development and has considered the findings of the previous phase of works.

Exploratory fieldwork was completed between 14th and 15th May 2020. The works are summarised in Table 2.1.

TABLE 2.1 SUMMARY OF FIELDWORK

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (m bgl)	MONITORING WELLS RESPONSE ZONE (m bgl)
Former Travelling crane	WS202	Window Samples Probehole	5.45	N/A
	WS207		1.00	N/A
	WS208		3.45	N/A
	WS209		3.45	0.5-1.0
	WS210		3.45	1.0-2.0
Former Groton Locomotive Works Buildings	WS201		5.45	0.5–1.0
	WS203		2.55	1.0–4.0
	WS204		5.45	1.0-5.0
	WS205		2.45	1.0-2.0
	WS206		4.45	1.0-4.0
	CP201	Cable Percussive Borehole	14.95	N/A

Window sample probeholes were advanced to investigate ground conditions, undertake in-situ detailed geotechnical testing, obtain environmental samples and install groundwater and ground gas monitoring wells whilst also being advanced to target specific contaminant sources.

A deep cable percussive borehole was advanced to identify the geotechnical properties and strengths of the underlying strata to greater depths.

The sampling locations are illustrated in Drawing 12-747-005 (Appendix III). The ground conditions encountered are indicated on the logs, which are provided in Appendix V.

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.

2.3. 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 V and presented in Table 3.5 and discussed in Section 5.

2.4. PERMEABILITY TESTS

Four falling head permeability tests were undertaken within environmental monitoring wells (WS204, WS205, WS206 and WS210) 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 3.7 and the test certificates are included within Appendix IX.

2.5. LABORATORY ANALYSIS

Selected soil samples were submitted for a range of chemical analysis comprising:

- Metals;
- pH, total sulphate, water-soluble sulphate (2:1 extract);
- Sulphide;
- Cyanide;
- Phenols;
- Total and speciated polycyclic aromatic hydrocarbons (PAHs);
- Semi Volatile Organic Compounds (SVOC);
- Asbestos identification and quantification; and,
- Speciated and banded total petroleum hydrocarbon (TPH).

I2 Analytical undertook the analytical work and the testing results are included in Appendix VI and discussed in Section 4.

Selected samples were submitted to PSL Laboratory where the following geotechnical tests were undertaken:

- Atterberg limits determinations;
- One dimensional consolidations; and
- Single-stage triaxial tests.

Laboratory analysis sheets are included in Appendix VIII and are summarised in Section 3.

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 3.1.

TABLE 3.1 SUMMARY OF STRATA

HOLE	DEPTH TO STRATUM (m bgl)				
	MADE GROUND	SOFT CLAY	ORGANIC SILT	STIFF CLAY	SAND
WS201	0.0–0.90	–	0.9-1.2	1.5-5.45	1.2-1.5
WS202	0.0–0.60	–	–	0.6-5.45	–
WS203	0.0–2.55	–	–	–	–
WS204	0.0–0.60	–	–	0.6-5.45	–
WS205	0.0–0.90	–	–	0.9-2.45	–
WS206	0.0-0.50	–	–	0.5-4.45	–
WS207	0.0-0.70	–	–	0.7-1.00	–
WS208	0.0-0.80	–	–	0.8-3.45	–
WS209	0.0-0.80	–	–	0.8-3.45	–
WS210	0.0-0.60	–	–	0.6-3.45	–
CP201	0.0-1.10	–	–	1.1-7.30 7.60-14.95	7.3-7.60

3.2. MADE GROUND

Made Ground was encountered within all exploratory hole locations to depths of between 0.55 m and 2.55 m bgl (WS203, where full depth could not be proven). The majority of exploratory holes were covered by concrete or asphalt hardstand which was in turn generally underlain by a thin band of grey or black sandy gravel as a form of sub-base layer.

Made Ground depths and composition was relatively consistent across the site. Concrete was found to be circa 0.30 m thick and asphalt was 0.08 m thick, with the exception of WS201, where asphalt was thicker at 0.25 m in the existing storage area. WS201 and WS205 identified a reworked brown gravelly clay with gravel of concrete, asphalt and brick. At WS202, WS204 and WS207 asphalt was found to be underlain by concrete, followed by a subbase.

WS203 could not prove the full depth of Made Ground. This is due to there being a potential brick structure in the borehole locations, the thickness of brick and the nature of the gravel meant that the hole collapsed and could not be advanced.

Within the previous report which was undertaken in the south eastern corner of the subject, identified Made Ground to a maximum proven depth of 5.00m bgl. Made ground typically comprised a layer of either asphalt or concrete overlying interbedded sands and gravels, in turn underlain by either a soft to firm dark coloured clay or a firm to stiff purple brown mottled grey gravelly clay.

3.3. DRIFT DEPOSITS

Drift deposits were generally consistent across the site, predominantly comprising stiff, high-strength, brown, slightly gravelly CLAY with mudstone identified between 0.50 and 14.95 m bgl (CP201). The CLAY was identified within all locations except WS203, where the full extent of Made Ground could not be proven. The clay identified is similar to that found during the first phase of investigation.

WS201 identified a band of clayey SILT underlain by a brown, slightly clayey, slightly silty SAND beneath the Made Ground, however the stiff CLAY was encountered at 1.50 m to the base of the borehole. CP201 identified an isolated area of granular SAND between 7.30 m bgl to 7.60 b bgl, which was saturated. No further granular deposits were identified at the site.

3.4. SOLID GEOLOGY

The solid bedrock geology was not encountered during this investigation, however, BGS boreholes infer bedrock at 76.20 m bgl (SJ89NE42).

3.5. GROUNDWATER

Groundwater strikes were encountered as seepages between 0.40 and 7.30 m bgl. The depth of the seepages are shown on the exploratory hole records in Appendix V and are summarised in Table 3.2.

TABLE 3.2 SUMMARY GROUNDWATER STRIKES

LOCATION	DEPTH TO STRIKE (m)	NOTES
WS208	0.40	Perched water within the Made Ground
WS209	0.80	Perched water within the Made Ground
WS207	0.90	Perched water within the Made Ground
CP201	7.30	Ingress in SAND

3.6. VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

Visual and olfactory evidence of potential contamination has been identified during the site investigation and these are summarised in Table 3.3.

TABLE 3.3 SUMMARY VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

LOCATION	DEPTH (m)	STRATUM	NOTES
WS201	0.50	Made Ground	hydrocarbon odour and black staining
WS203	0.30	Made Ground	Black staining
WS207	0.25	Made Ground	Black staining

3.7. SOIL CONSISTENCY

Undrained shear strength values were measured using laboratory undrained triaxial tests. Results of the tests are presented in Table 3.4, which indicate the clay soils to vary between stiff and very stiff. 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 3.5.

TABLE 3.4 SUMMARY OF UNDRAINED SHEAR STRENGTH TEST RESULTS

LOCATION	SAMPLE DEPTH (m)	LAB DESCRIPTION	UNDRAINED SHEAR STRENGTH (kN/m^2)	CONSISTENCY
WS204	2.50	Stiff, brown gravelly sandy CLAY	94	Stiff
CP201	5.00	Very stiff brown slightly gravelly sandy CLAY	207	Very Stiff

3.7.1. SIDE STABILITY AND EASE OF EXCAVATION

The presence of brick and concrete cobbles within the Made Ground deposits meant that in certain places, boring was slow through the Made Ground due to the gravel content. The natural strata was bored with relative ease until circa 3.00 m bgl where stiffness of clay impeded boring depths.

Concrete and brick obstructions have been encountered within the Made Ground across the site at the surface and more extensively in WS203, indicative of relict foundations from the former buildings and railway tracks.

Furthermore, upon removal of the current buildings on the site, it is likely that further obstructions in the form of foundations and utilities infrastructure will be identified.

TABLE 3.5 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)
WS201	1	SAND	31	31.25	Dense	N/A	N/A	N/A
WS201	2	CLAY	19	17.36	N/A	High strength	Very Stiff	86.79
WS201	3	CLAY	22	19.13	N/A	High strength	Very Stiff	95.66
WS201	4	CLAY	28	23.66	N/A	High strength	Very Stiff	118.28
WS201	5	CLAY	29	24.06	N/A	High strength	Very Stiff	120.30
WS202	1	CLAY	25	25.20	N/A	High strength	Very Stiff	126.02
WS202	2	CLAY	18	16.44	N/A	High strength	Very Stiff	82.22
WS202	3	CLAY	39	33.92	N/A	Very high strength	Very Stiff	169.58
WS202	4	CLAY	50	42.24	N/A	Very high strength	Very Stiff	211.21
WS202	5	CLAY	50	41.48	N/A	Very high strength	Very Stiff	207.41
WS204	1	CLAY	30	30.24	N/A	Very high strength	Very Stiff	151.22
WS204	2	CLAY	24	21.92	N/A	High strength	Very Stiff	109.62
WS204	3	CLAY	18	15.65	N/A	High strength	Very Stiff	78.27
WS204	4	CLAY	30	25.35	N/A	High strength	Very Stiff	126.73
WS204	5	CLAY	50	41.48	N/A	Very high strength	Very Stiff	207.41
WS205	1	CLAY	19	19.15	N/A	High strength	Very Stiff	95.77
WS205	2	CLAY	50	45.68	N/A	Very high strength	Very Stiff	228.38
WS206	1	CLAY	21	21.17	N/A	High strength	Very Stiff	105.86
WS206	2	CLAY	29	26.49	N/A	High strength	Very Stiff	132.46
WS206	3	CLAY	27	23.48	N/A	High strength	Very Stiff	117.40

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)
WS206	4	CLAY	50	42.24	N/A	Very high strength	Very Stiff	211.21
WS208	1	CLAY	35	35.29	N/A	Very high strength	Very Stiff	176.43
WS208	2	CLAY	50	45.68	N/A	Very high strength	Very Stiff	228.38
WS208	3	CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41
WS209	1	CLAY	18	18.15	N/A	High strength	Very Stiff	90.73
WS209	2	CLAY	35	31.97	N/A	Very high strength	Very Stiff	159.87
WS209	3	CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41
WS210	1	CLAY	20	20.16	N/A	High strength	Very Stiff	100.81
WS210	2	CLAY	24	21.92	N/A	High strength	Very Stiff	109.62
WS210	3	CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41
CP201	1	CLAY	29	29.24	N/A	High strength	Very Stiff	146.18
CP201	2	CLAY	31	28.32	N/A	High strength	Very Stiff	141.60
CP201	3	CLAY	33	28.70	N/A	High strength	Very Stiff	143.49
CP201	6.5	CLAY	34	27.76	N/A	High strength	Very Stiff	138.79
CP201	8.5	CLAY	32	25.86	N/A	High strength	Very Stiff	129.28
CP201	10	CLAY	42	33.82	N/A	Very high strength	Very Stiff	169.10
CP201	11.5	CLAY	36	27.31	N/A	High strength	Very Stiff	136.53
CP201	13	CLAY	41	29.42	N/A	High strength	Very Stiff	147.09
CP201	14.5	CLAY	43	29.28	N/A	High strength	Very Stiff	146.41

3.8. CONSOLIDATION

Two undisturbed samples of Glacial Till were submitted for oedometer analysis. The results are provided in Table 3.6.

TABLE 3.6 OEDOMETER CONSOLIDATION RESULTS

LOCATION	DEPTH (m)	SAMPLE TYPE	MOISTURE CONTENT (%)	OEDOMETER CONSOLIDATION		
				PRESSURE RANGE (kPa)	Mv (m^2/MN)	Cv (m^2/year)
WS204	2.50	U100	14	0-55	0.249	26.321
				55-110	0.173	13.031
				110-220	0.135	8.363
				220-440	0.084	5.313
				440-55	0.027	4.570
CP201	5.00	U100	14	0-103	0.280	33.486
				103-206	0.117	7.861
				206-412	0.095	3.313
				412-824	0.055	2.447
				824-103	0.022	3.357

When considered at overburden pressure with an additional load of 110 kPa the coefficient of volume compressibility (Mv) ranged form 0.135 m^2/MN up to 0.117 m^2/MN. The material is considered to be medium compressibility.

3.9. SOIL INFILTRATION

In-situ falling head permeability tests were undertaken within the monitoring well installations located in four probeholes, WS204, WS205, W206 and WS210. All of the installations were noted to be dry prior to the test being undertaken, therefore the tests were undertaken in the unsaturated zone. Tests were undertaken within monitoring wells with response zones located in the natural cohesive drift stratum.

The results are presented in Table 3.7 and the test certificates are included within Appendix IX.

TABLE 3.7 SOIL INFILTRATION RESULTS

LOCATION	DEPTH (m)	MATERIAL	TEST No.	SOIL INFILTRATION RATE (m/s)
WS204	1.0–3.0	Very stiff slightly gravelly CLAY	1	3.99E-07
WS205	1.0-2.0	Very stiff slightly gravelly CLAY	1	4.06E-06
WS206	1.0-3.0	Very stiff slightly gravelly CLAY	1	1.04E-06
WS210	1.0–1.8	Very stiff slightly gravelly CLAY	1	1.56E-06

Soil infiltration was taken over the wetted area from between 75% and 25% of the effective depth. All tests showed that soakage potential was significantly reduced due to the cohesive drift deposits.

Therefore, considering the presence of low-permeability clay on the site, soakaway drainage may not be suitable for the proposed development. However, the application of soakaway drainage will ultimately be dependent on the specific requirements of the development.

In order to fully assess the soakage potential of the underlying soils full BRE365 soakaway testing will be required. All soakaways should be designed in accordance with BRE Special Digest 365 – Soakaway Design.

3.10. 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:

$$I'p = Ip \times (\% < 425\ \mu m/100)$$

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 3.8, show the CLAY to be of low plasticity below the proposed commercial shed however the previous site investigation in the south east of the site identified moderate plasticity CLAY.

TABLE 3.8 SUMMARY OF PLASTICITY INDEX TEST RESULTS

LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 µm SIEVE (%)	MODIFIED PLASTICITY INDEX
WS202	2.00	17	21	42	21	91	19.11
WS204	2.00	16	19	38	19	90	17.1
WS205	1.00	16	20	40	20	87	17.4
CP201	1.00	16	21	41	20	92	18.4

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

3.11. pH AND SULPHATE

Chemical analyses for pH and soluble sulphate content contained in Appendix VI (summarised in Table 3.9), 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).

Elevated sulphate concentrations meeting Class DS-2, AC-2 were noted within the Made Ground deposits in WS206 (0.40 m) and WS210 (0.50 m).

TABLE 3.9 SUMMARY OF pH AND SULPHATE DATA

LOCATION	DEPTH (m)	pH VALUE	SO_4 IN 2:1 WATER/SOIL (g/l)	CLASSIFICATION
WS201	1.00	8.7	0.060	DS-1, AC-1
WS202	3.00	8.3	0.068	DS-1, AC-1
WS204	0.50	9.2	0.330	DS-1, AC-1
WS204	2.00	8.5	0.046	DS-1, AC-1
WS206	0.40	7.9	0.520	DS-2, AC-2
WS206	3.00	8.4	0.079	DS-1, AC-1
WS209	3.00	8.5	0.062	DS-1, AC-1
WS210	0.50	8.1	1.000	DS-2, AC-2
WS210	1.50	8.3	0.160	DS-1, AC-1

3.12. GROUND GAS

A ground gas assessment has been completed in accordance with guidance provided within CIRIA 665 – *Assessing risk posed by hazardous ground gases to buildings*.

3.13. INVESTIGATION RATIONALE

The ICSM has identified that the underlying Made Ground may represent a potential source of ground gas generation. Based on the identification of these sources, E3P has determined that the site represents a moderate ground gas source generation potential.

Within the context of the proposed commercial end use and ground gas generation potential, the gas assessment requires that 6 visits are required over 3 months, with at least two sets of readings at low or falling atmospheric pressure as set out within CIRIA 665 Tables 5.5a and 5.5b.

The spacing requirements for monitoring wells are detailed within CIRIA 665 Table 4.2, which indicates that for moderate gas hazard sites (older domestic landfill sites, disused shallow mine workings, hydrocarbon vapour sources) and a low sensitivity development, nominal well spacing should be between 25 m and 50 m.

TABLE 3.10 GROUND GAS MONITORING LOCATION RATIONALE

LOCATION	GROUND GAS SOURCE	DEPTH OF MONITORING WELL (m)
WS201	Made Ground	0.50–1.00
WS204	Natural Ground	1.00–5.00
WS205	Natural Ground	1.00-2.00
WS206	Natural Ground	1.00-4.00
WS209	Natural Ground	0.50-1.00
WS210	Natural Ground	1.00-2.00

3.14. MONITORING METHODOLOGY

Concentrations of methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) were measured using a calibrated infra-red gas analyser (GFM435) with gas flow rates were measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 60 seconds at each location, at which point the maximum concentration of CH_4 and CO_2, together with the lowest concentration of O_2 were recorded. The results of the ground gas monitoring are presented in Table 3.11.

TABLE 3.11 SUMMARY OF GROUND GAS MONITORING RESULTS

WELL	DATE	CH_4 INITIAL (%V/V)	CH_4 STEADY (%V/V)	CH_4 GSV (l/hr)	CO_2 INITIAL (%V/V)	CO_2 STEADY (%V/V)	CO_2 GSV (l/hr)	O_2 (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS201	27/5/20	0.1	0.1	0.0001	**6.9**	**6.9**	0.0069	12.9	1009	Steady	0.1	0.50-1.00	1.10	0.99
	2/6/20	0.1	0.1	0.0001	**6.5**	**6.5**	0.0065	13.3	1012	Falling	0.1		1.10	0.96
	30/6/20	0.1	0.1	0.0016	**7.9**	**7.9**	0.1264	8.8	997	Falling	1.6		1.1	0.86
WS204	27/5/20	0.1	0.1	0.0001	0.1	0.1	0.0001	20.7	1009	Steady	0.1	1.00–5.00	3.05	2.05
	2/6/20	0.1	0.1	0.0001	0.1	0.1	0.0001	20.8	1012	Falling	0.1		3.05	2.03
	30/6/20	Flooded											N/A	N/A
WS205	27/5/20	0.1	0.1	0.0001	0.5	0.5	0.0005	20.1	1009	Steady	0.1	1.00-2.00	1.98	1.50
	2/6/20	0.1	0.1	0.0001	0.4	0.4	0.0004	20.4	1012	Falling	0.1		1.98	1.47
	30/6/20	Could not access											N/A	N/A
WS206	27/5/20	0.1	0.1	0.0001	0.2	0.2	0.0002	20.7	1009	Steady	0.1	1.00-4.00	3.20	1.35
	2/6/20	0.1	0.1	0.0001	0.3	0.3	0.0003	20.8	1012	Falling	0.1		3.21	1.33
	30/6/20	0.1	0.1	0.00026	0.7	0.7	0.00182	19.6	997	Falling	0.26		3.25	1.68
WS209	27/5/20	0.1	0.1	0.00013	3.5	3.5	0.00455	13.5	1009	Steady	0.13	0.50-1.00	1.05	0.76
	2/6/20	0.1	0.1	0.0001	3.2	3.2	0.0032	13.9	1012	Falling	0.1		1.05	0.75
	30/6/20	0.1	0.1	0.00026	4.2	4.2	0.01092	15.3	997	Falling	0.26		1.07	0.66
WS210	27/5/20	0.1	0.1	0.0001	0.1	0.1	0.0001	19.4	1009	Steady	0.1	1.00-2.00	1.93	1.48
	2/6/20	0.1	0.1	0.0001	0.1	0.1	0.0001	19.6	1012	Falling	0.1		1.94	1.44
	30/6/20	0.1	0.1	0.00052	0.1	0.1	0.00052	19.2	997	Falling	0.52		1.9	1.45

4. TIER I QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 1 qualitative risk assessment to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

4.1. HUMAN HEALTH RISK ASSESSMENT

At Tier 1 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).

The results of this comparison have been summarised within Table 4.1.

TABLE 4.1 SUMMARY OF INORGANIC AND HYDROCARBON TOXICITY ASSESSMENT FOR A COMMERCIAL END USE

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PATH-WAY	ASSESSMENT
Arsenic	mg/kg	640	13	74	N/A	1	No Further Action
Cadmium	mg/kg	190	13	<0.2	N/A	1	No Further Action
Chromium (VI)	mg/kg	33	13	< 4.0	N/A	1	No Further Action
Lead	mg/kg	1100	13	1700	WS203 0.40m	1	**Further Action**
Mercury	mg/kg	58	13	1.3	N/A	3	No Further Action
Nickel	mg/kg	980	13	89	N/A	1	No Further Action
Selenium	mg/kg	12000	13	1.4	N/A	1	No Further Action
Copper	mg/kg	68000	13	480	N/A	1	No Further Action
Zinc	mg/kg	730000	13	480	N/A	1	No Further Action
Cyanide – Total	mg/kg	791	13	2	N/A	1	No Further Action
Phenols – Total	mg/kg	210	9	< 1.0	N/A	1	No Further Action
Asbestos	Fibres	NFD	7	Amosite	WS206 0.40m	4	**Further Action**
Naphthalene	mg/kg	190	13	4.9	N/A	3	No Further Action
Acenaphthylene	mg/kg	83000	13	0.52	N/A	2	No Further Action
Acenaphthene	mg/kg	84000	13	41	N/A	1	No Further Action
Fluorene	mg/kg	63000	13	29	N/A	1	No Further Action
Phenanthrene	mg/kg	22000	13	62	N/A	2	No Further Action
Anthracene	mg/kg	520000	13	16	N/A	2	No Further Action
Fluoranthene	mg/kg	23000	13	57	N/A	2	No Further Action
Pyrene	mg/kg	54000	13	44	N/A	2	No Further Action
Benzo(a)Anthracene	mg/kg	170	13	23	N/A	2	No Further Action
Chrysene	mg/kg	350	13	18	N/A	2	No Further Action
Benzo(b)Fluoranthene	mg/kg	44	13	26	N/A	2	No Further Action
Benzo(k)Fluoranthene	mg/kg	1200	13	7.9	N/A	2	No Further Action
Benzo(a)Pyrene**	mg/kg	35	13	20	N/A	2	No Further Action
Indeno(123-cd)Pyrene	mg/kg	500	13	10	N/A	2	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	3.5	13	3.5	N/A	2	No Further Action
Benzo(ghi)Perylene	mg/kg	3900	13	12	N/A	2	No Further Action
TPH C5-C6 (aliphatic)	mg/kg	3200	1	<0.001	N/A	3	No Further Action
TPH C6-C8 (aliphatic)	mg/kg	7800	1	<0.001	N/A	3	No Further Action
TPH C8-C10 (aliphatic)	mg/kg	2000	1	<0.001	N/A	3	No Further Action
TPH C10-C12 (aliphatic)	mg/kg	9700	1	3.9	N/A	3	No Further Action
TPH C12-C16 (aliphatic)	mg/kg	59000	1	23	N/A	1	No Further Action
TPH C16-C35 (aliphatic)	mg/kg	1600000	1	<0.001	N/A	1	No Further Action
TPH C5-C7 (aromatic)	mg/kg	26000	1	<0.001	N/A	1	No Further Action

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PATH-WAY	ASSESSMENT
TPH C7-C8 (aromatic)	mg/kg	56000	1	<0.001	N/A	3	No Further Action
TPH C8-C10 (aromatic)	mg/kg	3500	1	4.1	N/A	3	No Further Action
TPH C10-C12 (aromatic)	mg/kg	16000	1	97	N/A	3	No Further Action
TPH C12-C16 (aromatic)	mg/kg	36000	1	200	N/A	3	No Further Action
TPH C16-C21 (aromatic)	mg/kg	28000	1	87	N/A	1	No Further Action
TPH C21-C35 (aromatic)	mg/kg	28000	1	< 0.001	N/A	1	No Further Action
TPH C5-C6 (aliphatic)*	mg/kg	3200	12	<1.0	N/A	3	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	7800	12	<0.1	N/A	3	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	2000	12	<0.1	N/A	3	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	16000	12	3.3	N/A	3	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	36000	12	13	N/A	3	No Further Action
TPH C16-C21 (aromatic)*	mg/kg	28000	12	120	N/A	1	No Further Action
TPH C21-C35 (aromatic)*	mg/kg	28000	12	300	N/A	1	No Further Action
4-Chloroaniline	mg/kg	-	1	2.3	WS201 0.60m	3	Further Action
2-Methylnaphthalene	mg/kg	-	1	2.9	WS201 0.60m	3	Further Action
Dibenzofuran	mg/kg	-	1	11	WS201 0.60m	3	Further Action
4-Nitroaniline	mg/kg	-	1	0.9	WS201 0.60m	3	Further Action
Carbazole	mg/kg	-	1	1.7	WS201 0.60m	3	Further Action
Anthraquinone	mg/kg	-	1	3.5	WS201 0.60m	3	Further Action

Notes
Main pathways: PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = vapour inhalation (indoor), PL4 = dust inhalation; PL5 = vertical/lateral migration; PL6 = corrosion of concrete; PL7=tainting of water supply; PL8 = uptake by plants
Abbreviations: GAC = general assessment criteria, n = number of samples, MC = maximum concentration; Loc of Ex = location of exceedance; NFD = no fibres detected.

Referring to Table 4.1, the results of this direct comparison indicates that the data exceeds the screening criteria for a commercial end use for the following contaminants:

- Lead
- Amosite
- 4-Chloroaniline
- 2-Methylnaphthalene
- Dibenzofuran
- 4-Nitroaniline
- Carbazole
- Anthraquinone

Asbestos in the form of loose amosite fibres has been identified in the granular Made Ground in WS206 and has been quantified as <0.001%.

The soil in WS201 was tested for SVOCs due to noting a hydrocarbon odour within the lithology. The results have identified the presence of several semi-volatile compounds in this location.

The laboratory analysis confirms that the main constituents of concern are asbestos and heavy metals.

In relation to these exceedances, the following can be determined:

- The main exposure pathways based on the Tier I exceedances are:
  - Soil ingestion;
  - Vapour inhalation (indoor);
  - Dermal contact and ingestion;
  - Consumption of homegrown vegetables; and
  - Fibre/dust inhalation.
- The exceedances for all determinands are associated with shallow Made Ground deposits (0.60 m).

The previous site investigation undertaken by E3P in the south eastern sector of the subject site did not identify any contaminants of concern in the 14 samples taken.

HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

Due to the site currently being active, areas of the site could not be fully accessed. Therefore, it is recommended that when the site is vacant a series of trial pits and further chemical analysis is undertaken in order to fully appraise the site. One of the areas requiring further investigation is below the electricity substation for PCB analysis.

A Tier I Human Health Risk Assessment has been undertaken using the chemical analysis results of the soils and comparing to the relevant Tier I criteria. This assessment has identified the presence of elevated lead (WS203 0.40m), amosite (WS206 0.40m) and semi-volatile organic compounds (SVOC) (WS201 0.60m).

The Lead identified have primary pathway of dermal contact and ingestion. The asbestos has a pathway of fibre inhalation and the SVOCs through vapour inhalation.

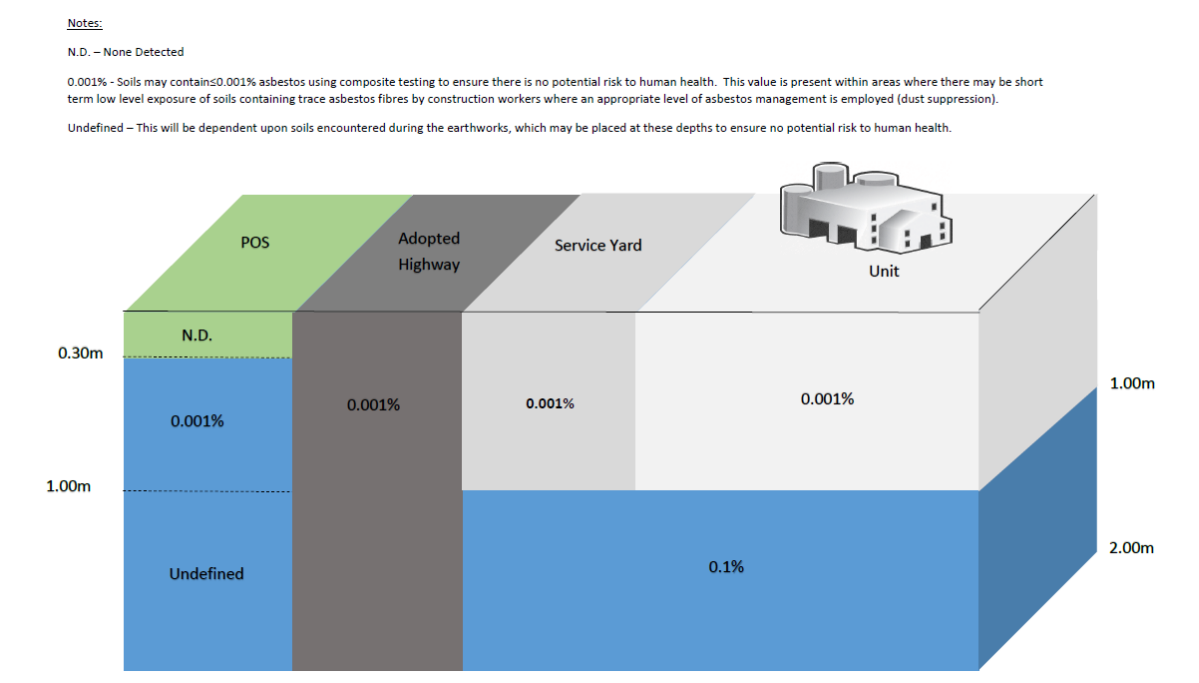
Lead has been identified within one location on the site (WS203 0.40m). The chronic risk to human health associated with the elevated concentrations on inorganic heavy metals can be mitigated through the construction of the proposed building and associated hard standing which will remove direct exposure between the contaminant source and site end user.

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

With regards to the elevated SVOCs (4-Chloroaniline, 2-Methylnaphthalene, Dibenzofuran, 4-Nitroaniline, Carbazole, Anthraquinone) these present a potential volatilisation to indoor air risk. These elevated concentrations have only been identified within one area (south east the site) and are therefore potentially a hotspot and are likely sourced a hydrocarbon/ coal tar source related to the former industry on the site. Therefore, during a process of cut/fill enabling works, further delineation, assessment and potential hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on site in an area of no future sensitivity. However, when considering the proposed development layout, the area identified is due to be car parking and covered in hardstanding not beneath the building footprint. As such, there is a moderate risk to the end user but there still a risk to controlled waters that needs to be considered.

Asbestos in the form of amosite has also been identified within localised areas in shallow Made Ground deposits (WS206, 0.40 m). Asbestos quantification records a concentration of <0.001%. No visual signs of ACM were encountered during the ground investigation; it is therefore likely that only trace fibres are present. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 4.1.

FIGURE 4.1 ASBESTOS RISK MITIGATION CONCEPTUAL SITE MODEL



No chemical exceedances were identified within the Made Ground during the first phase of site investigation which included 14 samples from the south eastern sector of the subject site. However, during the most recent investigation contaminants were identified in the very south east of the subject site.

Chemical analysis of the natural CLAY drift deposits (10 samples from across the site) has identified these soils to be acceptable for use as subsoil within any proposed landscaping areas; however, further chemical validation samples will be required to confirm this. There are no suitable sources of topsoil available on the site.

4.2. CONTROLLED WATERS RISK ASSESSMENT

The site sensitivity with respect to controlled waters is summarised within Table 4.2.

TABLE 4.2 CONTROLLED WATERS SENSITIVITY PROFILE

RISK PROFILE	DISCUSSION	SENSITIVITY RATING
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not located within a Groundwater Source Protection Zone	**LOW**
Distance to the Closest Groundwater Abstraction Point	The closest groundwater abstractions are 397 m southwest for process water.	**LOW-MODERATE**
Aquifer Classification in Superficial Drift Deposits	The underlying superficial deposits are classified as a secondary A aquifer.	**HIGH**
Aquifer Classification in Bedrock	Principal aquifer.	**HIGH**
Viability for Anthropogenic Soil in Direct Contact with Aquifer (Drift or Bedrock)	Where the base of Made Ground has been proven, the underlying drift is predominantly cohesive.	**LOW/ MODERATE**
Is the Site Located Within 50 m of a Surface Watercourse?	The risk to surface water is negligible given the absence of a viable receptor within influencing distance of the site.	**LOW**
SUMMARY The ICSM developed within the context of the site setting has only identified a single viable pollutant linkage, which would be the downward migration of potentially mobile phase-soluble contaminants towards the underlying secondary A aquifer within the drift and Principal within the bedrock. However, the overall sensitivity of this receptor is reduced given the presence of low permeability drift deposits and the absence of any potable groundwater abstraction and thus the potential for the creation of a complete pollutant linkage.		

To further refine the ICSM, E3P has undertaken an initial qualitative assessment of the soil data analysis to assess the potential for a source of separate-phase or dissolved-phase contamination originating from either a defined on-site source or from impacted soils. This assessment is summarised in Table 4.3.

TABLE 4.3 QUALITATIVE RISK TO CONTROLLED WATERS FROM SOIL ANALYTICAL RESULTS

BTEX > 1 mg/kg	The soil data analysis has not identified any detectable concentrations of TPH C5 to C6 that might otherwise be indicative of VOC impact.
Total VOC > 1 mg/kg	
Total SVOC > 1 mg/kg	SVOC analysis identified concentrations above 1 mg/kg in WS201.
C5-C10 > 5 mg/kg	All concentrations are below the laboratory LOD.
C10-C12 > 10 mg/kg	All concentrations are slightly above or below the laboratory LOD.
C12-C16 > 50 mg/kg	Concentrations above 50 mg/kg have been identified at WS201.
Phenols > 2 mg/kg	All concentrations are below the laboratory LOD.
Naphthalene > 2 mg/kg	Naphthalene has been identified at concentrations greater than 2 mg/kg at WS201 and WS209.
Total PAH > 10 mg/kg	Total concentrations of low-solubility PAH compounds greater than 10 mg/kg have been detected in the soil analysis at WS201, WS203 and WS209.
PCB > 1 mg/kg	A substation is present on site and dates from circa 1978 when the site was redeveloped as the market. Investigation was not able to be carried out In the vicinity of the substation due to live services.

Heavy metals > 500 mg/kg	Concentrations of heavy metals are all below 500 mg/kg with the exception of lead in WS203.

E3P have previously undertaken a controlled waters risk assessment within report referenced 12-757-r1 dated November 2018 utilising two leachate samples. The assessment concluded that:

'*no elevated concentrations of potential contaminants of concerns have been identified when compared with Tier I GACs for controlled waters.*

As such, the site is considered to pose no unacceptable level of risk to controlled water.'

In due consideration of the ICSM, which has identified a potential pollutant linkage associated with the migration towards the underlying secondary A aquifer, E3P has undertaken a Tier I controlled waters risk assessment. The Tier I assessment has included a comparison of leachate analysis from samples of the Made Ground to drinking water standards in the first instance and in absence of these, to environmental quality standards (EQS).

These are presented in Table 4.4.

TABLE 4.4 COMPARISON OF GROUNDWATER ANALYSIS WITH TIER 1 SCREENING LEVELS

DETERMINAND	UNIT	EQS SCREENING VALUE[1, 2, 3]	DWS [3,4,5]	N		MC	LOC. OF EX	ASSESSMENT
		AA		L	GW			
Arsenic	µg/l	50	10	1	0	< 1.1	N/A	No Further Action
Cadmium	µg/l	0.08-0.25	5	1	0	<0.08	N/A	No Further Action
Chromium (VI)	µg/l	3.4	–	1	0	< 5.0	N/A	No Further Action
Chromium (III)	µg/l	4.7	50	1	0	1.0	N/A	No Further Action
Copper	µg/l	1	2000	1	0	8.1	N/A	No Further Action
Total Cyanide	µg/l	1	50	1	0	1.3	N/A	No Further Action
Lead	µg/l	1.2	10	1	0	< 1.0	N/A	No Further Action
Mercury	µg/l	–	1.0	1	0	< 0.5	N/A	No Further Action
Nickel	µg/l	4	20	1	0	3.3	N/A	No Further Action
Selenium	µg/l	–	10	1	0	< 4.0	N/A	No Further Action
Zinc	µg/l	10.9	–	1	0	8.1	N/A	No Further Action
pH	6–9			1	0	7.9	N/A	No Further Action
PAH								
Naphthalene	µg/l	2	10*	1	0	2.1	N/A	No Further Action
Anthracene	µg/l	0.1		1	0	3.7	N/A	No Further Action
Benzo[b]fluoranthene	µg/l	0.00017*		1	0	<0.01	N/A	No Further Action
Benzo[k]fluoranthene	µg/l	0.00017*		1	0	<0.01	N/A	No Further Action
Benzo(a)pyrene	µg/l	0.00017*		1	0	<0.01	N/A	No Further Action
Indeno(123-cd)pyrene	µg/l	0.00017*		1	0	<0.01	N/A	No Further Action
Fluoranthene	µg/l	0.0063		1	0	1.2	N/A	No Further Action
Benzo(ghi)perylene	µg/l	1.7–4		1	0	<0.01	N/A	No Further Action
TPH-Aromatic								

DETERMINAND	UNIT	EQS SCREENING VALUE[1, 2, 3]	DWS [3,4,5]	N		MC	LOC. OF EX	ASSESSMENT
		AA		L	GW			
TPH C5-C6 (benzene)	µg/l	10	1	1	0	< 1.0	N/A	No Further Action
TPH C6-C8 (toluene)	µg/l	74	700	1	0	< 1.0	N/A	No Further Action
TPH C8-C10 (ethyl benzene)	µg/l	20	300	1	0	< 1.0	N/A	No Further Action
TPH C10-C12 (xylene)	µg/l	30	500	1	0	< 10	N/A	No Further Action
TPH C12-C16	µg/l	2	90[5]	1	0	600	WS201	**Further Action**
TPH C16-C35	µg/l	50#	90[5]	1	0	450	WS201	**Further Action**
TPH Aliphatic[5]								
TPH C5-C6	µg/l	–	15000	1	0	<1.0	N/A	No Further Action
TPH C6-C8	µg/l	–	15000	1	0	<1.0	N/A	No Further Action
TPH C8-C10	µg/l	–	300	1	0	<1.0	N/A	No Further Action
TPH C10-C12	µg/l	–	300	1	0	<10	N/A	No Further Action
TPH C12-C16	µg/l	–	300	1	0	<10	N/A	No Further Action
TPH C16 – C21	µg/l	–	300**	1	0	<10	N/A	No Further Action
TPH C21-C35	µg/l	–	300**	1	0	<10	N/A	No Further Action
VOC								
Tetrachloroethylene	µg/l	0.4	10	0	0	N/A	N/A	N/A
Trichloroethylene	µg/l	10	10	0	0	N/A	N/A	N/A
Trichlorobenzene	µg/l	0.4	–	0	0	N/A	N/A	N/A
Trichloromethane	µg/l	2.5	–	0	0	N/A	N/A	N/A
Dichloromethane	µg/l	20	200	0	0	N/A	N/A	N/A
Carbon Tetrachloride	µg/l	12	3	0	0	N/A	N/A	N/A
Vinyl Chloride	µg/l	–	0.3	0	0	N/A	N/A	N/A

Notes
Solubility <0.01µg/l
AA – Annual Average
MAC- Maximum Admissible Concentration
* 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 Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations (2015)
2. Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)
3. Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances
4. Council Directive on the quality of water intended for human consumption (Drinking Water Directive)
5. WHO Guidelines for Drinking Water Quality. Third edition (2004)

CONTROLLED WATER RISK ASSESSMENT AND MITIGATION

No water samples were gathered as part of this assessment as only minimal amounts of water were present within the monitoring well positions when water sampling was attempted.

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

- TPH Aromatic C12-C16
- TPH Aromatic C16-C35

It should be noted that leachate analysis is an aggressive test which overstates the risk.

The TPH carbon bands C16 to C21 and C21 to C25 identified within the leachate samples are of a general low solubility, and therefore mobility, suggesting that these will not migrate to controlled water receptors. However, it must be noted that these were found in WS201 which is also where elevated SVOCs were identified within the soil samples and will undergo further investigation and delineation as part of the remediation works. The previously completed investigation in the southern sector of the site did not identify any contaminant exceedances that may pose a risk to controlled waters.

Given the site is underlain by low-permeability, predominantly cohesive, glacial till deposits, which will afford protection to the underlying principal aquifer, there is considered to be a low risk to controlled waters and the wider environ as no complete pollutant linkage can be determined.

Based on the above, upon completion of the works to identify the source of the contaminants identified in the vicinity of WS201 and further assessment, it is likely that there will be no unacceptable level of risk to the controlled water receptors.

4.3. GROUND GAS

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). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

CIRIA C665 and NHBC Report No 10627-R01 provide assessments for carbon dioxide and methane based upon gas screening values (GSVs) utilising flow rates and concentrations. The site-based GSVs for steady state methane and carbon dioxide are based upon the following equation:

$$GSV = \frac{concentration\ (by\ vol)}{100} \times flowrate\ (1\ /\ hr)$$

The GSVs within CIRA C665 are based upon all buildings other than standard commercial houses. The thresholds for GSVs based upon CIRIA guidance are provided within Table 4.5 (below).

TABLE 4.5 THRESHOLDS FOR GAS SCREENING VALUES (GSV) IN ACCORDANCE WITH CIRIA C665 – COMMERCIAL END USE

CIRIA – NO SUBFLOOR VOID	
CLASSIFICATION	**GSV (METHANE AND CARBON DIOXIDE)**
CS1	< 0.07
CS2	< 0.70
CS3	< 3.5
CS4	< 15

CIRIA – NO SUBFLOOR VOID	
CLASSIFICATION	**GSV (METHANE AND CARBON DIOXIDE)**
CS5	< 70
CS6	> 70

4.3.1. SOURCES OF GROUND GAS

The Phase I report and subsequent ground investigation has identified the following potential sources of ground gas:

- Made Ground deposits;
- Landfill 141 m east of the site.

The previous report undertaken by E3P installed gas monitoring wells within window sample probeholes to 5m bgl. Four ground gas monitoring visits were undertaken over a 4 week period within the monitoring identifying elevated readings of carbon dioxide and thus the site within the original redline boundary (within the south eastern sector of the current subject site) was classified as Characteristic Situation 2. The full details of the assessment are outlined within the Ground Gas Addendum Report (Report ref: 12-757-L1 March 2019).

It must be noted that the gas assessment detailed within report 12-757-L1 March 2019 is not below the proposed commercial structure.

The final gas regime will be concluded once the full monitoring period is complete, allowances for CS2 should be made at the current time.

4.3.2. GROUNDWATER

During the initial monitoring visits, groundwater levels were observed to increase minimally. The greatest groundwater change occurred within WS210 where levels increased by 0.04 m over the monitoring period. Window sample locations are mostly set within a low-permeability clay stratum and groundwater may be a result of surface water collecting in the well rather than a measure of true groundwater.

4.3.3. GAS FLOW

During the initial monitoring visits, a positive flow of up to 0.13l/hr was noted in all locations. The measure of positive flow is considered to be the result of groundwater fluctuations and flooding of the well causing compression – as opposed to gas generation – as the highest flows are recorded during periods of high groundwater levels.

Negative flows are indicative of back pressure from wind being greater than the active flow from the wells. Negative flows have not been recorded during the initial visits.

4.3.4. GAS CONCENTRATIONS

Methane has been recorded within all monitoring wells at maximum concentrations of 0.1% v/v. No elevated concentrations were recorded within any of the remaining monitoring wells.

Carbon dioxide concentrations were recorded within all the monitoring wells at concentrations ranging from 0.1% v/v to 6.9% v/v (WS201). The maximum carbon dioxide levels were also associated with low oxygen concentrations and appear to be associated with Made Ground, identified in WS201 and also hydrocarbon odours due to the degradation of hydrocarbon impact within soils.

4.3.5. GAS ASSESSMENT

In accordance with the methodology outlined with the CIRIA publication C665, E3P have utilised the results of the ground gas monitoring surveys to calculate a tentative gas screening value (GSV). The GSVs for the monitoring positions are summarised in Table 4.6.

TABLE 4.6 GAS RISK PROFILE AND LOCATION

LOCATION	MAX CH_4 (% v/v)	GSV (l/hr)	MAX CO_2 (% v/v)	GSV (l/hr)	CLASSIFICATION
WS201	0.1	0.0001	6.9	0.0069	Amber 1/CS2
WS204	0.1	0.0001	0.1	0.0001	Green/CS1
WS205	0.1	0.0001	0.5	0.0005	Green/CS1
WS206	0.1	0.0001	0.3	0.0003	Green/CS1
WS209	0.1	0.00013	3.5	0.00455	Green/CS1
WS210	0.1	0.0001	0.1	0.0001	Green/CS1

The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.

Preliminary ground gas monitoring suggests that the site can be predominantly classified as CS1, however, WS201 which is away from the proposed on-site structure has been assessed as being CS2 due to the elevated CO_2 concentrations identified. However, further delineation is recommended in the area of WS201.

Upon completion of the gas monitoring schedule and remedial works it is likely that no gas protection measures will be required.

4.4. 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 4.7 PIPELINE SELECTION PE THRESHOLD CONCENTRATIONS

CONTAMINANT GROUP	PE-THRESHOLD (mg/kg)	CONCENTRATIONS AT CURRENT PIPELINE DEPTH (mg/kg)
Total VOC	0.5	<1.0
Total BTEX And MTBE	0.1	<1.0
Total SVOCs (Excluding PAH and those substances marked with an *)	2	315 (WS201)
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2	<1.0
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10	26.9 (WS201)
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	543 (WS210)
Phenols (From SVOC Analysis)*	2	<0.2
Cresols and Chlorinated Phenols (From SVOC Analysis)	2	<0.1

CONTAMINANT GROUP	PE-THRESHOLD (mg/kg)	CONCENTRATIONS AT CURRENT PIPELINE DEPTH (mg/kg)
Ethers*	0.5	NA
Nitrobenzene*	0.5	NA
Ketones*	0.5	NA
Aldehydes*	0.5	NA
Amines	Fail	NA
Other Consideration		
Are there any exceedances of the PE threshold outside of the pipeline depth?	Yes	
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 – heavy end hydrocarbon impact and low solubility PAH has been identified within Made Ground. Groundwater levels are generally significantly deeper than pipeline depth or absent due to the cohesive nature of the underlying drift. Where impact has been identified (WS201, WS210) this is not located with the footprint of the proposed building or within the likely pipeline route, furthermore shallow groundwater has not been identified.	
Will soils impacted with above determinands likely be utilised elsewhere on site?	No	
Will soils be imported to site as part of any future earth works	Currently unknown, however it is unlikely soils will be required to be imported to site.	

Notes - Pipe line depth normally between 0.75m–1.35m, samples from 0.50 m and 1.50 m considered at this stage due to the unknown of final development levels

Based on the assessment of current site conditions it is likely that barrier pipe will be required at the proposed development.

4.5. CONCEPTUAL SITE MODEL

Following the completion of the intrusive site investigation, chemical analysis and risk assessment, the conceptual model shown in Table 4.8 has been prepared for the site.

TABLE 4.8 CONCEPTUAL MODEL

POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
PL1 PL2	Heavy metals (in Made Ground	Dermal contact. Dermal contact and ingestion..	Future site users. Off-site receptors)	Likely	High	LOW
Assessment: Heavy metals (lead) identified withing Made Ground at 0.40 m in WS201. Heavy metals pose a risk to the end user via dermal contact with soils and ingestion of soils and would require a cover system over the area to break the pollutant linkage. With respect to the proposed development, the area in the vicinity of WS201 is to be car parking, thus covered in hardstanding which would provide a suitable barrier to the elevated heavy metals. However, should any landscaping be done on the boundaries of the area, a suitable growing medium will be required of clean subsoil and topsoil to ensure there is no residual risk to the end user. **Recommendation:** Cover system to landscaped areas will prevent exposure to future site users. Construction works completed with PPE and provision of welfare.						
PL3	Semi Volatile Organic Compound and Total Petroleum Hydrocarbon (Made Ground)	Inhalation of vapours. Migration through permeable strata and preferential pathways.	Future site users. Off-site receptors.	Likely	Moderate	LOW
Assessment: Likely probability as a source of semi volatile contamination identified in WS201 at 0.40 m. Leakages/spillages of volatile contamination are considered possible considering the former use of the site in this area. There is a potential risk to the end user via the inhalation of vapours occurring from the contaminants, however, when considering the proposed development layout, the area identified is due to be car parking and covered in hardstanding not beneath the building footprint. As such, there is a moderate risk to the end user.						

POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
Recommendation: During a process of cut/fill enabling works, further delineation, assessment and potential hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on site in an area of no future sensitivity. However, when considering the proposed development layout, the area identified is due to be car parking and covered in hardstanding not beneath the building footprint. As such, there is a moderate risk to the end user but there still a risk to controlled waters that needs to be considered.						
PL4	Polchlorinated Biphenyls (Electricity Substation)	Dermal contact and ingestion	Site Workers and site end users	Likely	**Moderate**	**LOW**
Assessment and Recommendation: The are below the current substation could not be accessed at this time, therefore this area will require investigation upon removal of the substation in order to fully assess the risk.						
PL5	ACM in Made Ground	Inhalation of dust.	Future site users. Buildings. Off-site land users.	Likely	**Moderate**	**LOW**
Assessment: Asbestos has been identified at a concentration of <0.001% in WS206 in shallow Made Ground. This has the potential to pose a high risk to future site users through the inhalation of asbestos fibres. However, when considering the proposed development, this location is not due to be redeveloped and is to be retained in its current configuration. Thus, there will be no disturbance to soils in this area and the risk of the contaminant affecting the end user is therefore reduced. Should this development plan change, soils in this area may require excavation and placement in an area of low sensitivity on site, to ensure no residual risk to the end user. **Recommendation:** No further works unless a change in development is planned. With reference to the E3P Asbestos Conceptual Site Model, Made Ground deposits will require placement below hardstanding or buildings or a cover system in order to mitigate the risks to future commercial end users. Where asbestos has been identified >0.1% the impacted Made Ground will require removal from site by a licensed waste handler or placement at depth in POS, with subsequent validation sampling to determine if asbestos remains at this location. Construction works completed with PPE and provision of welfare.						

POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
PL6	Methane, carbon dioxide (potentially infilled features on and within 250 m of the site)	Migration through permeable strata and preferential pathways. Accumulation resulting in asphyxiation / explosion.	Future site users. Buildings. Off-site land users.	Likely	Moderate	**To be determined**
Assessment: The presence of carbon dioxide is considered likely when referring to the gas monitoring data obtained to date which infers CS2 measures may be required. Although, it must be noted that this gas was identified within a well that is not proposed to be within the building footprint, is installed within shallow Made Ground (WS201). Gas wells installed within natural deposits have confirmed the absence of harmful gases based on the readings taken to date and infer CS1. The presence of cohesive deposits may inhibits the migration of gases. A full classification to the site cannot be given, however, until the completion of the gas monitoring regime. **Recommendation:** Preliminary ground gas monitoring suggests that the site can be predominantly classified as CS1, however, WS201 which is away from the proposed on-site structure has been assessed as being CS2 due to the elevated CO_2 concentrations identified. Given an absence of any volatile hydrocarbon impact within the soil samples tested, it is considered that chemically resistant membranes will not be required. However, further delineation is recommended in the area of WS201. Upon completion of the gas monitoring schedule and remedial works it is likely that no gas protection measures will be required.						
PL7	Total petroleum hydrocarbon, SVOC (Made Ground)	Surface runoff. Migration through permeable strata and preferential pathways. Perched waters migration.	Groundwater (Secondary A aquifer, Principal Aquifer)	Low Likelihood	Moderate	**LOW**
Assessment: Low likelihood probability as significant sources of mobile contamination have not been identified. TPH identified within leachate sample from WS201 are heavy end fractions that are not considered to be mobile. Additionally, Glacial Till across the site, beneath the Made Ground where contamination has been identified, may reduce downward migration into the underlying bedrock aquifer.						

POLLUTANT LINKAGE	CONTAMINANT (SOURCE)	PATHWAY	RECEPTOR	PROBABILITY	CURRENT RISK	RESIDUAL RISK AFTER MITIGATION
Recommendation: Given the site is underlain by low-permeability, predominantly cohesive, glacial till deposits, which will afford protection to the underlying principal aquifer, there is considered to be a low risk to controlled waters and the wider environ. Upon completion of the works to identify the source of the contaminants identified in the vicinity of WS201 and further assessment, it is likely that there will be no unacceptable level of risk to the controlled water receptors.						
PL8	Sulphate (Made Ground)	Sulphate attack on concrete.	Building structure.	Unlikely	Moderate/Low	**LOW**
Assessment: Unlikely probability as elevated sulphates are identified at WS206 and WS210, which are not proposed to be beneath the building structure when referring to the proposed development plan. Chemical analyses for pH and soluble sulphate in locations beneath the proposed structure, shows that the soils at the site generally meet Class AC-1s with a Design Sulphate Class of DS-1. **Recommendation:** Concrete will need to be designed in accordance with classification of AC-1s with a Design Sulphate Class of DS-1.						
PL9	Organic contaminants such as hydrocarbons, solvents (Made Ground, locomotive works)	Ingestion of tainted water supply.	Future site users. Water pipes.	Likely	Moderate	**LOW**
Assessment: Likely probability as contamination anticipated at pipeline depth in the vicinity of WS201 and WS210 (0.50–1.50 m). **Recommendation:** Barrier Pipe may be required unless soils containing the elevated levels of TPH are removed during remediation and enabling works.						

Main exposure pathways:
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = vapour inhalation (indoor), PL4 = dust inhalation; PL5 = Vertical/lateral migration;
PL6 = Corrosion of concrete; PL7=Tainting of water supply;

5. GEOTECHNICAL ASSESSMENT

5.1. PROPOSED DEVELOPMENT

Russells Construction intends to construct a commercial development comprising a large unit warehouse with associated landscaping, estate roads and infrastructure. Drawing 12-757-002 (Appendix III) identifies the proposed development layout.

5.2. SUMMARY OF GROUND CONDITIONS

MADE GROUND:

Made Ground was encountered within all exploratory hole locations to depths of between 0.55 m and 2.55 m bgl (WS203, where full depth could not be proven). The majority of exploratory holes were covered by concrete or asphalt hardstand which was in turn generally underlain by a thin band of grey or black sandy gravel as a form of sub-base layer.

Made Ground depths and composition was relatively consistent across the site. Concrete was found to be circa 0.30 m thick and asphalt was 0.08 m thick, with the exception of WS201, where asphalt was thicker at 0.25 m in the existing storage area. WS201 and WS205 identified a reworked brown gravelly clay with gravel of concrete, asphalt and brick. At WS202, WS204 and WS207 asphalt was found to be underlain by concrete, followed by a subbase.

WS203 could not prove the full depth of Made Ground. This is due to there being a potential brick structure in the borehole locations, the thickness of brick and the nature of the gravel meant that the hole collapsed and could not be advanced.

Within the previous report which was undertaken in the south eastern corner of the subject, identified Made Ground to a maximum proven depth of 5.00m bgl. Made ground typically comprised a layer of either asphalt or concrete overlying interbedded sands and gravels, in turn underlain by either a soft to firm dark coloured clay or a firm to stiff purple brown mottled grey gravelly clay.

DRIFT

Drift deposits were generally consistent across the site, predominantly comprising stiff, high-strength, brown, slightly gravelly CLAY with mudstone identified between 0.50 and 14.95 m bgl (CP201). The CLAY was identified within all locations except WS203, where the full extent of Made Ground could not be proven. The clay identified is similar to that found during the first phase of investigation.

WS201 identified a band of clayey SILT underlain by a brown, slightly clayey, slightly silty SAND beneath the Made Ground, however the stiff CLAY was encountered at 1.50 m to the base of the borehole. CP201 identified an isolated area of granular SAND between 7.30 m bgl to 7.60 b bgl, which was saturated. No further granular deposits were identified at the site.

SOLID

The solid bedrock geology was not encountered during this investigation, however, BGS boreholes infer bedrock at 76.20 m bgl (SJ89NE42).

GROUNDWATER

Groundwater strikes were encountered as seepages between 0.40 and 7.30 m bgl.

5.3. SITE PREPARATION

The site should 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 concrete hardstanding.
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill.
- Buried structures and old foundations have been encountered on site. These should be excavated from below the proposed development footprint with the resulting void backfilled.

5.4. 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 net safe allowable bearing pressure (ABP) 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 5.1.

TABLE 5.1 SUMMARY OF ABPS

GRANULAR SOILS			
Description	**Depth (Range m bgl)**	**Relative Density**	**Allowable Bearing Pressure (kN/m^2)**
SAND (WS201)	1.00-1.45	Dense	313
COHESIVE SOILS			
Description	**Depth (range m bgl)**	**Undrained Shear Strength (Cu) (kN/m^2)**	**Allowable Bearing Pressure (kN/m^2)**
Very Stiff CLAY	1.00–3.45	78-96	160-197
Very Stiff CLAY	1.00-5.45	106-143	217-295
Very Stiff CLAY	1.00-5.45	146-228	300-470
Very Stiff CLAY (CP201)	6.50-10.45	129-169	266-348
Very Stiff CLAY (CP201)	11.50-14.95	136-147	281-302

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe net allowable bearing pressure, the suitable target founding stratum has been identified as the underlying very stiff CLAY and localised area of dense SAND in excess of 1.00m bgl, where an ABP in excess of 160 kN/m^2 can be achieved.

However, prior to the detailed design of suitable foundations solutions, a programme of remediation and enabling works will be required to remove any buried obstructions and cut/fill the site to provide suitable development platform levels.

Upon completion of these enabling works, it is likely that the most cost effective option for the majority of the site would be to utilise shallow pad foundations to support the portal frame of the proposed commercial/industrial building bearing at least 500mm below the stiff to very stiff medium to high strength cohesive soils.

The previous report for the south eastern sector made recommendations for vibro stone columns but the location for the proposed structure has now been relocated to an area of more favourable ground conditions.

It must be noted that if the foundations for the current buildings and infrastructure on-site are significant and during removal cause site wide disturbance to the underlying strata, it may be more cost effective to use vibro stone columns to support the pad foundations. However, disturbance of cohesive materials should be minimal and where clay soils are removed they must be re-engineered in accordance with an appropriate geotechnical specification.

Trees are present on the site periphery. Foundations that are within influencing distance of these trees will require deepening to mitigate against the chance of heave.

TABLE 5.2 ANTICIPATED FOUNDATIONS

LOCATION	ANTICIPATED FOUNDING STRATA DEPTH (m bgl)	GROUND WATER (m bgl)	TREES	FOUNDATION TYPE	TYPE OF CONCRETE	REMARKS
WS201	1.95	N/A	N	VSC / Pad	DS-1 AC-1s	Due to the likely disturbance of soils upon removal of the current structures, it is likely that VSC into very stiff CLAY to support pad foundation will be required.
WS202	<2.55	N/A	N	VSC / Pad	DS-1 AC-1s	
WS203	1.45	N/A	N	VSC / Pad	DS-1 AC-1s	
WS204	1.45	N/A	N	VSC / Pad	DS-1 AC-1s	
WS205	1.45	N/A	N	VSC / Pad	DS-1 AC-1s	
WS206	1.45	N/A	N	VSC / Pad	DS-1 AC-1s	
WS207	<1.00	0.90	N	VSC / Pad	DS-1 AC-1s	
WS208	1.45	0.40	N	VSC / Pad	DS-1 AC-1s	
WS209	1.45	0.80	N	VSC / Pad	DS-1 AC-1s	
WS210	1.45	N/A	N	VSC / Pad	DS-1 AC-1s	
CP201	1.45	7.30	N	VSC / Pad	DS-1 AC-1s	

A detailed foundation zoning plan is included as Drawing 12-757-009 in Appendix III.

5.5. GROUND FLOOR SLABS

A ground-bearing slab will be viable for the commercial structures; however, it will need to be constructed utilising a sub-base with the thickness designed by a structural engineer to ensure that settlement tolerances are taken into consideration.

Due to the presence of substantial thickness of Made Ground across the site, is considered that ground-bearing floor slabs, whilst viable, will require detailed design to accommodate variability of the formation and account for differential settlement.

In order achieve an ABP of ~50 kN/m² for the floor slab the underlying soils will need to be engineered. Firstly the underlying obstructions will need to be removed and then the general underlying soils will need to be excavated, processed, placed and re-engineered or undertake ground improvement by HEIC (High Energy Impact Compaction) to ensure an ABP of ~50 kN/m² for a floor slab. The design needs to consider the variable thicknesses of the Made Ground and that upon removal of the obstructions no differential settlement is apparent.

Where a ground-bearing floor slab is to be constructed within the conjectured zone of tree influence, the clay will need to be removed to ensure that any desiccated soil cannot swell and induce heave to the structure. Alternatively, it may be possible to design the structure to resist the influence of clay heave using exaggerated sub-base and additional reinforcement within the slab to be designed by the structural engineer.

Where it is necessary to undertake cut-and-fill works utilising site-derived cohesive soils, careful consideration must be given to seasonal climatic conditions, which will have a significant impact of moisture conditions and the ability to compact clay soils in the wetter winter months. It may be necessary to undertake an element of stabilisation works through the addition of lime to ensure the soils can be engineered to the required performance standards.

It would be possible to utilise soil stabilisation techniques that incorporate the addition of lime and OPC to construct a stiffened soil horizon with a CBR > 15% to constitute a sub-base replacement layer that could then be capped with Type 1 MOT. The use of soil stabilisation could be extended within the conjectured zone of tree influence to modify the structure of clay soils and negate the potential for volumetric instability.

Depending on the design requirements of the proposed commercial care home structure, and its location on-site, it would be possible to utilise either a suspended or cast in-situ floor slab to incorporate the principals outlined above.

5.6. 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 conjectured zones of influence.

As the clay is deemed to be low volume change potential, heave precautions are not required to the internal face of the external load-bearing walls (outside or within tree influence).

If a ground beam is to be constructed within the zone of tree influence, heave precautions are required to the underside of this and edge beams.

If the ground floor slab is constructed with a cast in-situ suspended floor slab, then heave precautions that can tolerate 50 mm of clay swelling are required within any part of the floor slab to be located within the zone of influence of a tree.

A summary of heave precautions is presented in Table 5.3.

TABLE 5.3 SUMMARY OF HEAVE PRECAUTIONS

		MINIMUM VOID DIMENSION FOR FOUNDATIONS, GROUND BEAMS AND SUSPENDED IN-SITU CONCRETE GROUND FLOORS		MINIMUM VOID DIMENSIONS UNDER PRECAST CONCRETE AND SUSPENDED TIMBER FLOORS
Plasticity Index of Soil	**Required Foundation Depth (m)**	**Thickness of Void Former Against Side of Foundation or Ground Beam (mm)**	**Thickness of Void Former on Underside of Edge Beam and Floor Slab (mm)**	**Void Dimension (mm)**
High Plasticity (> 40)	> 2.5	Engineer Design		Engineer Design
	2.0–2.5	35	150	300
	1.5–2.0	25	75	
Moderate Plasticity (20–40)	> 2.5	Engineer Design		Engineer Design
	2.0–2.5	25	100	250
	1.5–2.0	25	50	
Low Plasticity (< 20)	2.0–2.5	N/A	50	200
	> 2.0	No Special Precautions		

5.7. 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.

It is considered that the material can be re-engineered using method compaction to achieve a CBR in excess of 5% if works are completed in favourable climatic conditions.

5.8. DRAINAGE

The presence of substantial depths of Made Ground across some areas of the site (WS203) may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

Furthermore, the site is predominantly underlain by circa 1–2 m of low-permeability gravelly CLAY. Therefore, as confirmed by the falling head tests, the use of soakaway drainage will be limited, and as the lateral continuity of the Made Ground cannot be assured, it is not recommended that soakaways are utilised for disposal of surface water runoff.

If soakaway drainage is to be considered, full BRE 365 testing must be completed to inform the detailed design.

5.9. CONCRETE DURABILITY

Based upon the results of the chemical analyses it is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with the recommendations provided in BRE *Special Digest 1* (2005).

Elevated sulphate concentrations meeting Class DS-2, AC-2 were noted within the Made Ground deposits in WS201 and WS210 at 0.40 – 0.50 m bgl. However, upon completion of site enabling works it will, in all likelihood, be DS1 AC1s.

5.10. EXCAVATIONS

Site observations indicated that excavations should be feasible in the near surface with normal plant; however, obstructions were identified in the near surface, including former foundations and former floor slabs. 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.

If local pumping of groundwater is required during the advancement of excavations for the proposed foundations then consideration should be given to the potential for dewatering gravels in the surrounding areas that may cause structural damage to building substructures in close proximity to the site.

TABLE 5.4 CIVIL ENGINEERING EXCAVATION RISK MATRIX

RISK ITEM	PRESENT	COMMENT
Running Sands	No	Running sands have not been identified.
Minor Water Ingress	No	N/A
Shallow Bedrock	No	N/A

5.11. 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;
- Assessment of potential PCB impact below the former substation;
- Further investigation and assessment within the vicinity of WS201;
- Materials management plan;
- Geotechnical earthworks strategy (infrastructure);
- Remediation and enabling works strategy; and
- Full three-dimensional earthworks cut/fill model.

5.12. CONSTRUCTION ACTIVITY AND INSPECTION

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

- 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).

5.13. GEOTECHNICAL RISK REGISTER

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Remediation of contaminated soils	On site	TBC	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	N/A	N/A	Shallow bedrock is not present
Obstructions	On-site	80	Site has been subject to significant historical development and the current on-site features will have underlying obstructions and infrastructure that will require removal prior to the proposed development.
Artificially levelled and filled platforms	N/A	N/A	Not present
Retaining walls	N/A	N/A	Not present
Trench collapse	N/A	N/A	Not present
Mature trees	Periphery	5%	Semi mature trees are present on the periphery of the site and maybe within influencing distance of the proposed building.
Volume change potential clay	On site	0	The site is underlain by cohesive soils assessed as having low volume change potential.
Peat	N/A	N/A	Not present
Running sands	N/A	N/A	Data searches indicate low risk.
Ground dissolution	N/A	N/A	Data searches indicate no hazard.
Concrete design	On site	100	Soils beneath the proposed building are classified DS1 AC1s
Low-permeability ground	On site	100	Soakaways unlikely to be effective in areas where low permeability cohesive deposits are present or where areas of potentially contaminated soil and groundwater are present.

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Services/sensitive structures	On site	10	A review of online services has identified a number of services within the site boundary which should be considered sensitive in this case. Piling may not be possible within close proximity to any sensitive infrastructure.
Abnormal foundation solutions	N/A	N/A	Not present
Mining	N/A	N/A	Not present
Slope	N/A	N/A	Not present

6. CONCLUSIONS AND RECOMMENDATIONS

CONTAMINATED LAND ASSESSMENT

Human Health	Due to the site currently being active, areas of the site could not be fully accessed. Therefore, it is recommended that when the site is vacant a series of trial pits and further chemical analysis is undertaken in order to fully appraise the site. One of the areas requiring further investigation is below the electricity substation for PCB analysis. A Tier I Human Health Risk Assessment has been undertaken using the chemical analysis results of the soils and comparing to the relevant Tier I criteria. This assessment has identified the presence of elevated lead (WS203 0.40m), amosite (WS206 0.40m) and semi-volatile organic compounds (SVOC) (WS201 0.60m). The Lead identified have primary pathway of dermal contact and ingestion. The asbestos has a pathway of fibre inhalation and the SVOCs through vapour inhalation. Lead has been identified within one location on the site (WS203 0.40m). The chronic risk to human health associated with the elevated concentrations on inorganic heavy metals can be mitigated through the construction of the proposed building and associated hard standing which will remove direct exposure between the contaminant source and site end user. The specific design and installation process for the appropriate cover systems and growing mediums will be clearly defined within the site remediation and enabling works strategy. With regards to the elevated SVOCs (4-Chloroaniline, 2-Methylnaphthalene, Dibenzofuran, 4-Nitroaniline, Carbazole, Anthraquinone) these present a potential volatilisation to indoor air risk. These elevated concentrations have only been identified within one area (south east the site) and are therefore potentially a hotspot and are likely sourced a hydrocarbon/ coal tar source related to the former industry on the site. Therefore, during a process of cut/fill enabling works, further delineation, assessment and potential hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on site in an area of no future sensitivity. However, when considering the proposed development layout, the area identified is due to be car parking and covered in hardstanding not beneath the building footprint. As such, there is a moderate risk to the end user. Asbestos in the form of amosite has also been identified within localised areas in shallow Made Ground deposits (WS206, 0.40 m). Asbestos quantification records a concentration of <0.001%. No visual signs of ACM were encountered during the ground investigation; it is therefore likely that only trace fibres are present. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model.

Human Health *Continued…*	No chemical exceedances were identified within the Made Ground during the first phase of site investigation which included 14 samples from the south eastern sector of the subject site. However, during the most recent investigation contaminants were identified in the very south east of the subject site. Chemical analysis of the natural CLAY drift deposits (10 samples from across the site) has identified these soils to be acceptable for use as subsoil within any proposed landscaping areas; however, further chemical validation samples will be required to confirm this. There are no suitable sources of topsoil available on the site.
Controlled Waters	No water samples were gathered as part of this assessment as only minimal amounts of water were present within the monitoring well positions when water sampling was attempted. This comparison indicates that the data exceeds the EQS values for the following inorganic compounds: - TPH Aromatic C12-C16 - TPH Aromatic C16-C35 It should be noted that leachate analysis is an aggressive test which overstates the risk. The TPH carbon bands C16 to C21 and C21 to C25 identified within the leachate samples are of a general low solubility, and therefore mobility, suggesting that these will not migrate to controlled water receptors. However, it must be noted that these were found in WS201 which is also where elevated SVOCs were identified within the soil samples and will undergo further investigation and delineation as part of the remediation works. The previously completed investigation in the southern sector of the site did not identify any contaminant exceedances that may pose a risk to controlled waters. Given the site is underlain by low-permeability, predominantly cohesive, glacial till deposits, which will afford protection to the underlying principal aquifer, there is considered to be a low risk to controlled waters and the wider environ as no complete pollutant linkage can be determined. Based on the above, upon completion of the works to identify the source of the contaminants identified in the vicinity of WS201 and further assessment, it is likely that there will be no unacceptable level of risk to the controlled water receptors.
Controlled Waters	Given the site is underlain by low-permeability, predominantly cohesive, glacial till deposits, which will afford protection to the underlying Principal aquifer within the bedrock, there is considered to be a low risk to controlled waters and the wider environ as no complete pollutant linkage can be determined. Based on the above, upon completion of the works to identify the source of the contaminants identified in the vicinity of WS201 and further assessment, it is likely that there will be no unacceptable level of risk to the controlled water receptors.

Ground Gas	Characteristic Situation 1, no gas protection measures required (pending completion of gas monitoring). The previous site investigation classified the site as CS2, however the proposed building has now moved location and is now away from the area where elevated ground gases were identified. The final gas regime will be concluded once the full monitoring period is complete, allowances for CS2 should be made at the current time .
Potable Water	This will need to be confirmed following the completion of a UKWIR risk assessment, however it is likely that barrier pipe will be required. Post-remediation and enabling works ground conditions may be different from those identified during this site investigation.

GEOTECHNICAL ASSESSMENT

Concrete and brick obstructions have been encountered within the Made Ground across the site at the surface and more extensively in WS203, indicative of relict foundations from the former buildings and tracks.

Further upon removal of the current buildings on the site, it is likely that further obstructions in the form of foundations and utilities infrastructure will be identified.

During a phase of cut-and-fill enabling works to create a developable platform, all below-ground obstructions will require grubbing out to the base of the Made Ground to enable the construction of proposed plots.

The underlying CLAY drift deposits have been assessed as being very stiff, high-strength with a net ABP in excess 160 kN/m2 at circa 1 m bgl and increasing within depth.

Dense SAND was identified in one location (WS201 from 1.00m to 1.45m) within an ABP of 313kN/m2.

A phase of cut-and-fill enabling works will be required in order to create a proposed development platform suitable for a commercial development. Upon completion of these enabling works, it is likely that the most cost effective option for the majority of the site would be to utilise shallow pad foundations to support the portal frame of the proposed commercial/industrial building bearing at least 500mm below the stiff to very stiff medium to high strength cohesive soils.

The previous report for the south eastern sector made recommendations for vibro stone columns but the location for the proposed structure has now been relocated to an area of more favourable ground conditions.

It must be noted that if the foundations for the current buildings and infrastructure on-site are significant and during removal cause site wide disturbance to the underlying strata, it may be more cost effective to utilise vibro stone columns to support the pad foundations. However, disturbance of cohesive materials should be minimal and where clay soils are removed they must be re-engineered in accordance with an appropriate geotechnical specification.

A ground-bearing slab will be viable for the commercial structures; however, it will need to be constructed utilising a sub-base with the thickness designed by a structural engineer to ensure that settlement tolerances are taken into consideration.

Due to the presence of substantial thickness of Made Ground across the site, is considered that ground-bearing floor slabs, whilst viable, will require detailed design to accommodate variability of the formation and account for differential settlement. The soft clays identified will need to be considered as part of the floor slab design as they may require removal or treatment.

In order achieve a an ABP of ~50 kN/m² for the floor slab the underlying soils will need to be engineered. Firstly the underlying obstructions will need to be removed and then the general underlying soils will need to be excavated, processed, placed and re-engineered or undertake ground improvement by HEIC (High Energy Impact Compaction) to ensure an ABP of ~50 kN/m² for a floor slab.

Where a ground-bearing floor slab is to be constructed within the conjectured zone of tree influence, the clay will need to be removed to ensure that any desiccated soil cannot swell and induce heave to the structure. Alternatively, it may be possible to design the structure to resist the influence of clay heave using exaggerated sub-base and additional reinforcement within the slab to be designed by the structural engineer.

Where it is necessary to undertake cut-and-fill works utilising site-derived cohesive soils, careful consideration must be given to seasonal climatic conditions, which will have a significant impact of moisture conditions and the ability to compact clay soils in the wetter winter months. It may be necessary to undertake an element of stabilisation works through the addition of lime to ensure the soils can be engineered to the required performance standards.

It would be possible to utilise soil stabilisation techniques that incorporate the addition of lime and OPC to construct a stiffened soil horizon with a CBR > 15% to constitute a sub-base replacement layer that could then be capped with Type 1 MOT. The use of soil stabilisation could be extended within the conjectured zone of tree influence to modify the structure of clay soils and negate the potential for volumetric instability.

Depending on the design requirements of the proposed commercial care home structure, and its location on-site, it would be possible to utilise either a suspended or cast in-situ floor slab to incorporate the principals outlined above.

END OF REPORT

APPENDIX I
LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the client as indicated in Section 1.3.

2. For the work, reliance has been placed on publicly available data obtained 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 it is correct. No attempt has been made to verify the information.

3. This report has been produced in accordance with 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 requires advice from legal professionals.

4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not 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 do not constitute or replace full and proper surveys.

8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.

9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, 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, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.

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

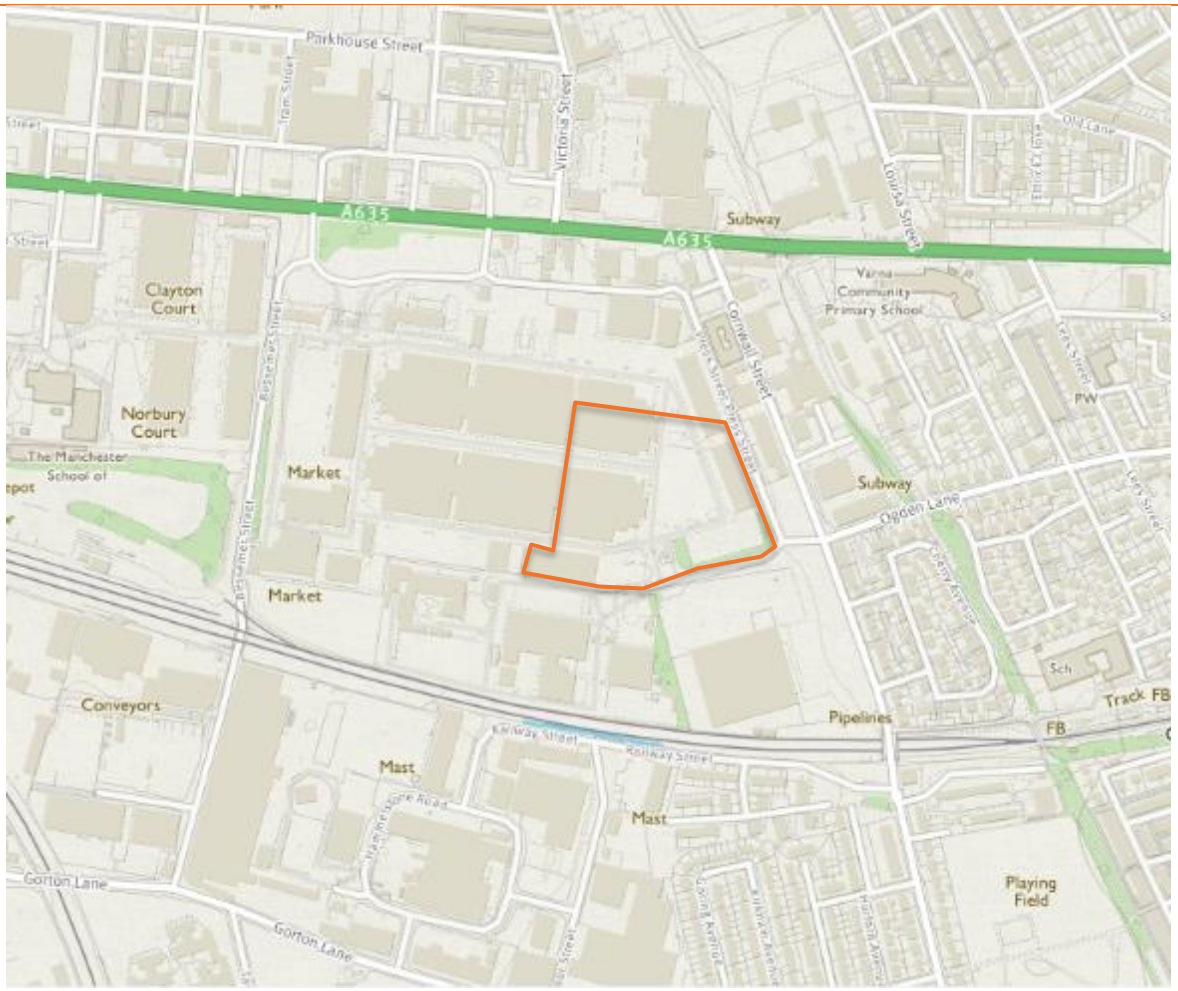
TERMS

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/m^3**	Milligram per metre cubed
% v/v	Percent volume in air	**m bgl 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/m^2**	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
DRAWINGS

DRAWING 12-757-001 – SITE LOCATION PLAN



Substation Pre 1978 - Present

Asphalt

Concrete

Storage Units Pre 1977 - Present

Storage Units

Former Works Buildings Pre 1977 - Present

Storage Units Pre 1977 - Present

Former Works Buildings Pre 1977 - Present

Former Traveling Crane Pre 1950 - Pre 1977

Former Works Buildings Pre 1977 - Present

Former Railway Tracks 1893 - Pre 1977

Former Traveling Crane Pre 1950 - Pre 1977

Historical Features

- Storage Units
- Former Works Buildings
- Former Traveling Crane
- Substation
- Former Railway Tracks

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	23.06.2020	LM	SE
P1	REVA	19.06.2020	LM	SE

Client: Russells Construction

Job No: 12-757

Date: 23.06.2020

Drawing No: 003

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Historical Features Plan

e3p

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

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Site Features

- Concrete
- Car Park
- Main Access Road
- Storage Units
- Storage
- Gatehouse
- Concrete Wall

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	25.06.2020	LM	SE
P1	REVA	17.06.2020	LM	SE

Client: Russells Construction

Job No: 12-757

Date: 25.06.2020

Drawing No: 004

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Site Features Plan

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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

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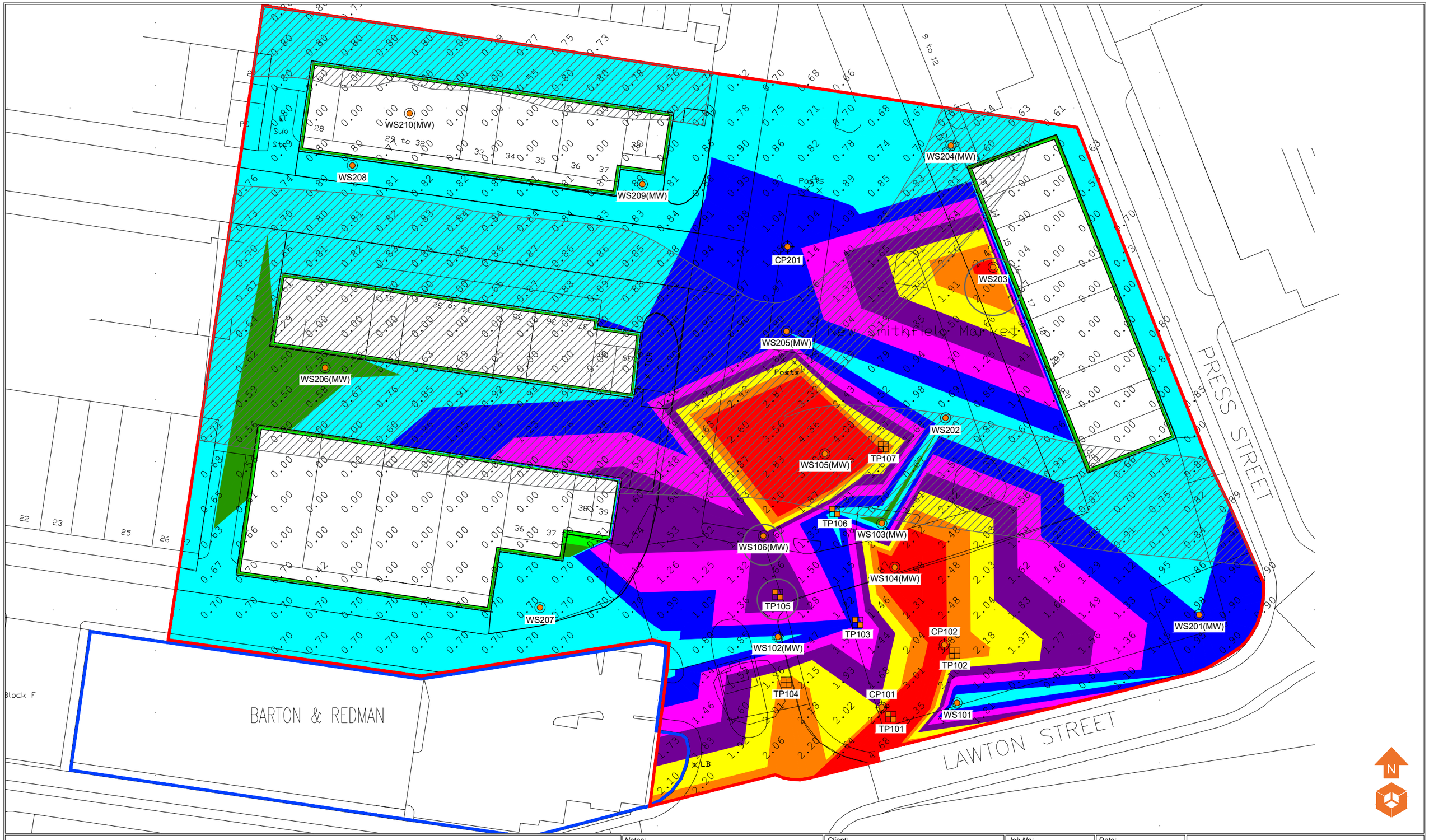

Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.29m
- Depth of Made Ground 0.30 - 0.59m
- Depth of Made Ground 0.60 - 0.89m
- Depth of Made Ground 0.90 - 1.19m
- Depth of Made Ground 1.20 - 1.49m
- Depth of Made Ground 1.50 - 1.79m
- Depth of Made Ground 1.80 - 2.09m
- Depth of Made Ground 2.10 - 2.49m
- Depth of Made Ground >2.50m

- Depth of Made Ground may be deeper due to known Services
- Hole Refused on Obstruction

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVD	23.07.2020	LM	SE
P1	REVC	16.07.2020	CB	SE
P1	REVB	26.06.2020	LM	SE
P1	REVA	18.06.2020	LM	SE

Client: Russells Construction

Job No: 12-757

Date: 23.07.2020

Drawing No: 006

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Depth to Made Ground Plan

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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

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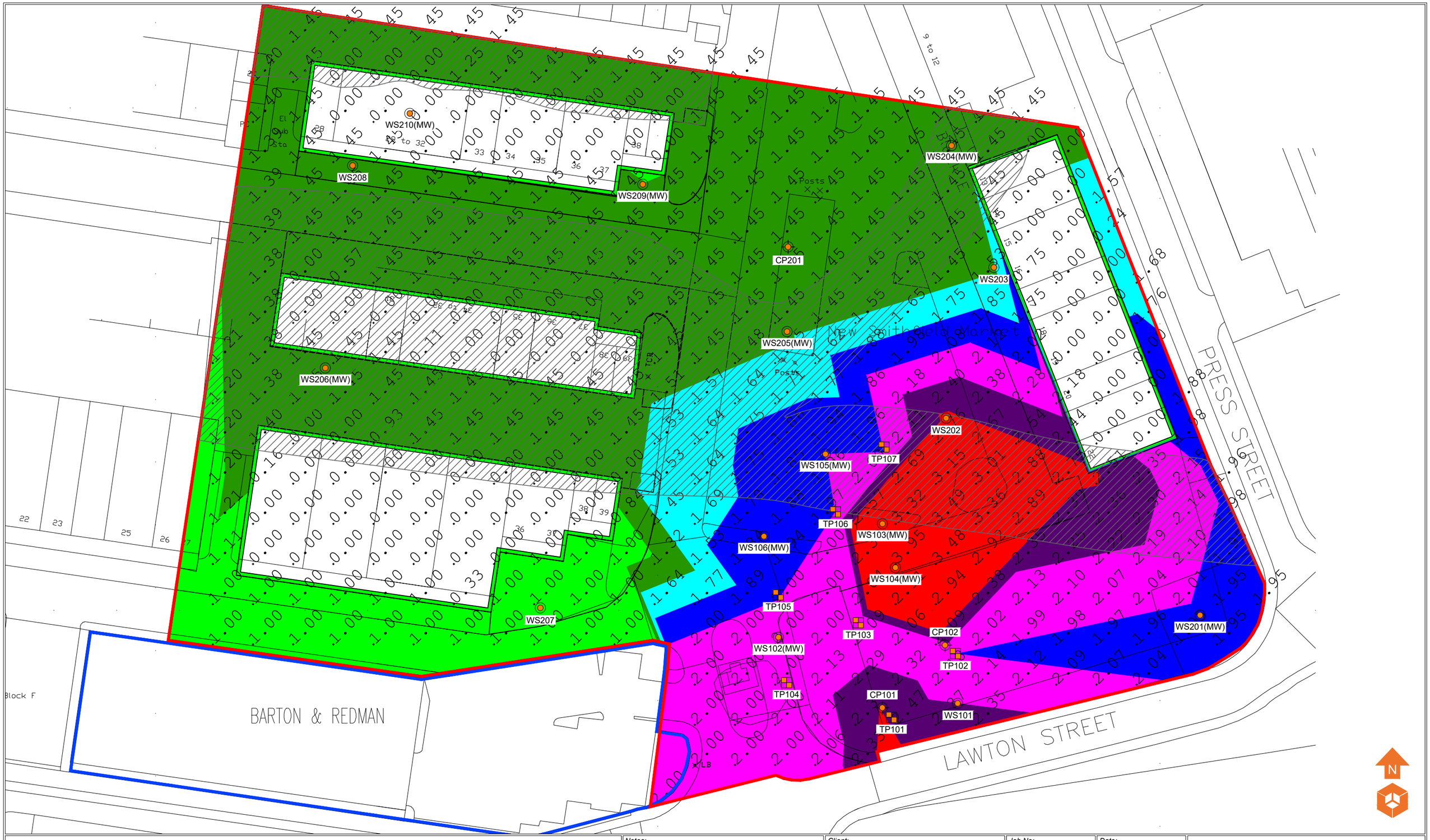

Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location

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

- Depth to Founding Strata may be deeper due to known Services

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVD	23.07.2020	LM	SE
P1	REVC	16.07.2020	CB	SE
P1	REVB	25.06.2020	LM	SE
P1	REVA	18.06.2020	LM	SE

Client: Russells Construction

Job No: 12-757

Date: 23.07.2020

Drawing No: 007

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Depth to Founding Strata Plan

e3p

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

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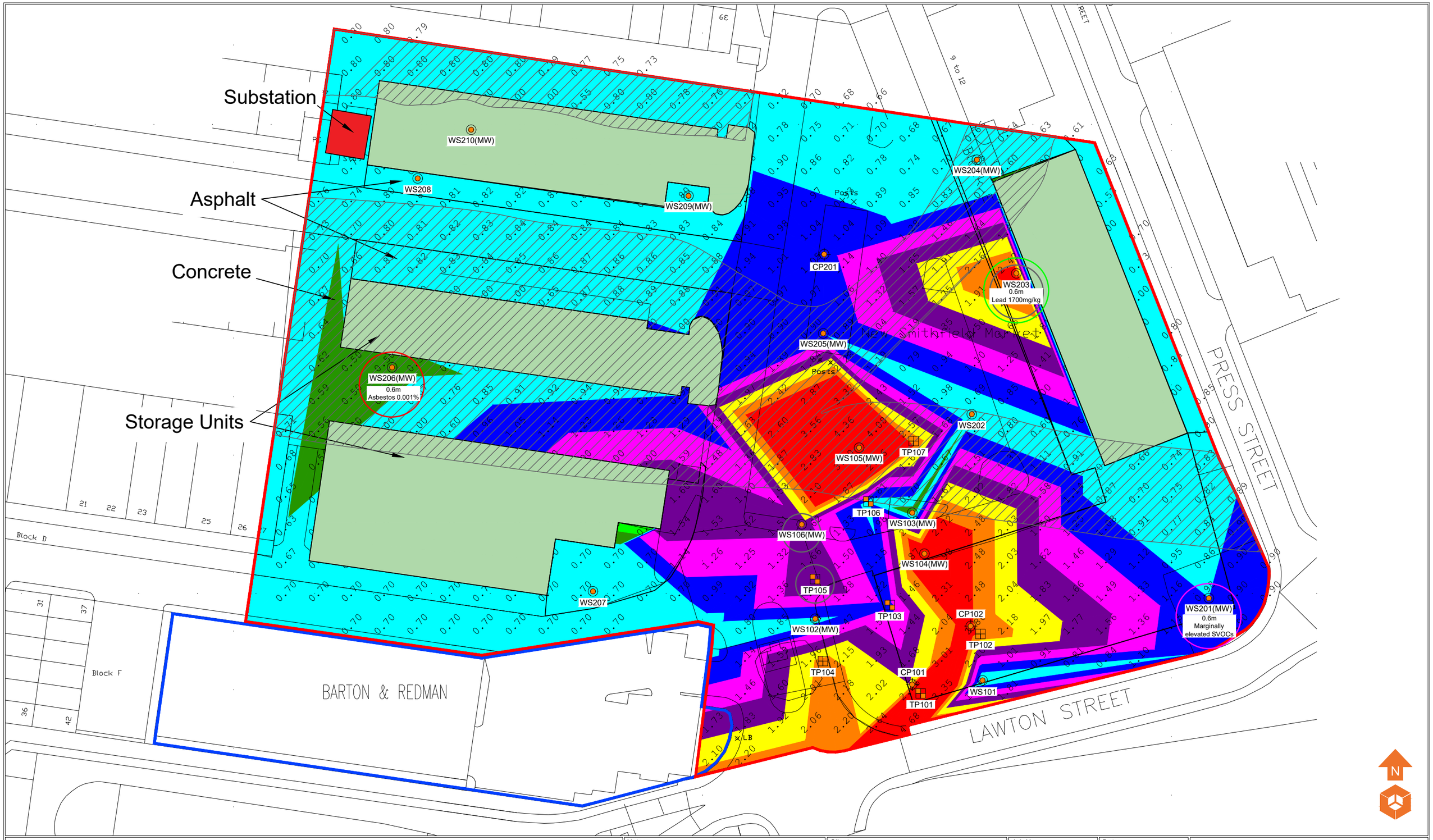

Development Constraints Features

- Substation
- Storage Units

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.29m
- Depth of Made Ground 0.30 - 0.59m
- Depth of Made Ground 0.60 - 0.89m
- Depth of Made Ground 0.90 - 1.19m
- Depth of Made Ground 1.20 - 1.49m
- Depth of Made Ground 1.50 - 1.79m
- Depth of Made Ground 1.80 - 2.09m
- Depth of Made Ground 2.10 - 2.49m
- Depth of Made Ground >2.50m

- Depth of Made Ground may be deeper due to known Services
- Hole Refused on Obstruction

Contamination Exceedances

- Asbestos
- SVOC
- Lead

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	23.07.2020	LM	SE
P1	REVA	18.06.2020	LM	SE

Client: Russells Construction

Job No: 12-757

Date: 23.07.2020

Drawing No: 008

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Development Constraints Plan

e3p
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

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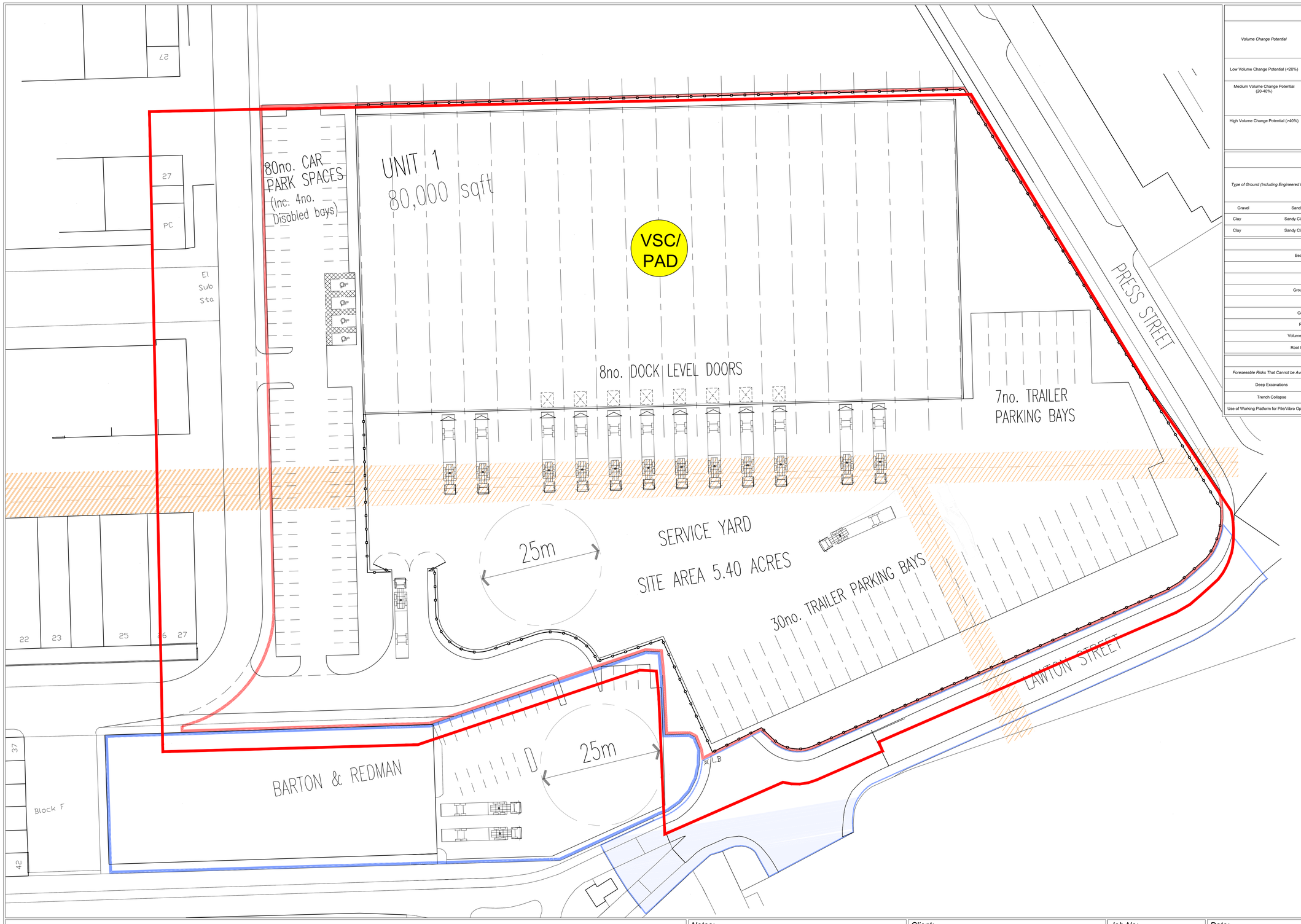

Summary of Heave Precaution Requirements

Volume Change Potential	*Required Foundation Depth (m)*	*Minimum Void Dimensions for Foundations, Ground Beams & Suspended In-Situ Concrete Ground Floors*		*Minimum Void Dimensions Under Pre-Cast Concrete & Suspended Timber Floors*
		Thickness of Void Former Against Side of Foundation of Ground Beam (mm)	*Thickness of Void Former on Underside of Edge Beam & Floor Slab (mm)*	*Void Dimension (mm)*
Low Volume Change Potential (<20%)	>2.00	No Special Precautions		200
	2.00-2.50	-	50	
Medium Volume Change Potential (20-40%)	1.50-2.00	25	50	250
	2.00-2.50	25	100	
	>2.50	Engineer Design		Engineer Design
High Volume Change Potential (>40%)	1.50-2.00	25	75	300
	2.00-2.50	35	150	
	>2.50	Engineer Design		Engineer Design

Minimum Width of Strip Footings

Type of Ground (Including Engineered Fill)		*Condition of Ground*	*Total Load of Load-Bearing Walling more than (kN/linear metre)*					
			20	30	40	50	60	70
			Minimum Width of Strip Foundation (mm)					
Gravel	Sand	Medium Dense to Dense	250	300	400	500	600	650
Clay	Sandy Clay	Stiff	250	300	400	500	600	650
Clay	Sandy Clay	Firm	300	350	450	600	750	850

Items Considered

Bearing Capacity	TBC
Trees	TBC
Historical	TBC
Groundwater Table	TBC
FFL	TBC
Contamination	TBC
Remediation	TBC
Volume Change Potential	TBC
Root Protection Areas	TBC

Residual Risks

Foreseeable Risks That Cannot be Avoided	*Applicable (Y/N)*	*Action to Reduce Risk*	Justification for Design Decision
Deep Excavations	Y	Identify locations on drawing and depths on schedule	Lesser risk than other alternatives
Trench Collapse	Y	Risk highlighted on drawing	Lesser risk than other alternatives
Use of Working Platform for Pile/Vibro Operations	Y	Compliance with working platform directive required	Pile/Vibro foundation less risky than other alternatives

Anticipated Foundation Types

- TS — **Traditional Strip Foundations** — Minimum depth 900mm below proposed Final Finished Level. Maximum safe bearing pressure limited to 100kN/m2.
- MT — **Mass Trench Fill Foundations** — Minimum depth 1200mm below proposed Final Finished Level. Maximum safe bearing pressure limited to 100kN/m2.
- V — **Vibro Stone Ground Compaction** — In accordance with NHBC Chapter 4.2
- P — **Piled Foundations** — Where the maximum foundation depth exceeds 2.50m a piled foundation option rather than a trench fill / deep reinforced strip foundations may be adopted. Column or line loads supported by ground beams.
- R — **Raft Foundations** — Maximum safe bearing pressure limited to 50kN/m2 on approved engineered granular fill. Raft foundations to be designed by a structural engineer in accordance with Chapter 4.5 of NHBC 2013. Raft foundations are considered suitable to mitigate against potential influence of clay heave / desiccation in accordance with Section 4.2, sub section D7E.
- TB — **Traditional Strip / Trench Block Foundations** — Traditional strip founded at 450mm below current level with build up in Trench Block and subsequent backfill to development level.
- **Colours on Plot Corners to be Used When Referring to Foundation Schedule.** (Pending Final Layout & Levels)

Depth to Target Founding Strata

- Footings 0.75 - 0.90m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 0.90 - 1.25m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 1.25 - 1.50m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 1.50 - 1.75m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 1.75 - 2.00m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 2.00 - 2.25m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 2.25 - 2.50m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2

Engineered Foundation Solutions

- Footings >2.50m Deep — From Final Finished Level. In accordance with NHBC Chapter 4.2
- Vibro
- Low Volume Change Potential Clay — Heave precautions required to underside of cast in-situ floor slab (with no sub-floor void) within conjected zone of tree influence. Heave precautions not required to foundation.

Structural Design Risk Management

Abnormal residual risks associated with the design outcomes on the drawing:

1 ....

2 ....

Notes:

Client: Russells Construction

Job No: 12-757

Date: 19.06.2020

Drawing No: 009

Scale: NTS

P1	REVA	19.06.2020	LM	SE
Phase	Issue	Date	Drawn	Checked

Job Title: Barton & Redman, Manchester

Drawing Title: Concept Foundation Zoning Plan

e3p

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

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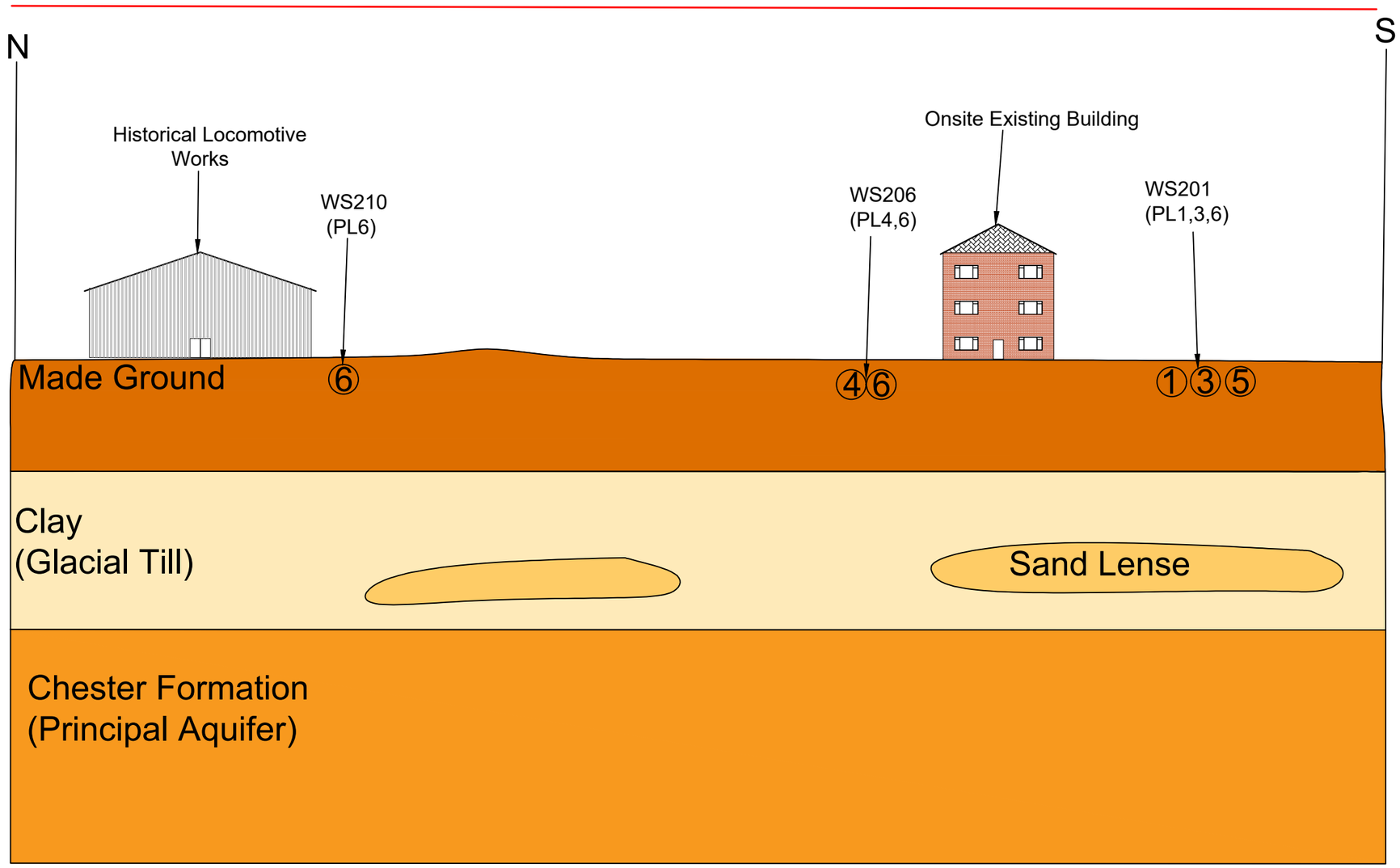
ID	SOURCE	EXPOSURE	POTENTIAL PATHWAY
PL1 PL2	Heavy Metals, heavy end Hydrocarbons & Non Volatile Polycyclic Aromatic Hydrocarbon (PAH)	Dermal Contact and Ingestion of Soils	Construction Workers & end users
PL3	Semi Volatile Polycyclic Aromatic, and petroleum and diesel range Hydrocarbon Compounds, Chlorinated Hydrocarbons	Volatilisation / Accumulation, Vapour Inhalation	Construction Workers & end users
PL4	Asbestos Containing Materials (ACM)	Fibre / Dust Inhalation	Construction Workers, Residential End Users &Third Party Property
PL5	Hazardous Ground Gases (Infilled Features on and within 250m of the site)	Inhalation of Gas	Construction Workers and end users
PL6	Water Soluble mobile Contaminants	Vertical and Lateral Migration	Secondary A Aquifer / Surface Water Courses
PL7	Sulphate (Made Ground)	Corrosion of Concrete	Foundations and Concrete
PL8	Organic Contaminants such as hydrocarbons	Corrosion of Pipeline	Potable Water Supply



CSM Features

- Made Ground
- Clay (Glacial Till)
- Sand Lense
- Chester Formation (Principal Aquifer)

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	25.06.2020	LM	OJ
P1	REVA	17.06.2020	LM	OJ

Client: Russells Construction

Job No: 12-757

Date: 17.06.2020

Drawing No: 010

Scale: NTS

Job Title: Barton & Redman, Manchester

Drawing Title: Conceptual Site Model

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

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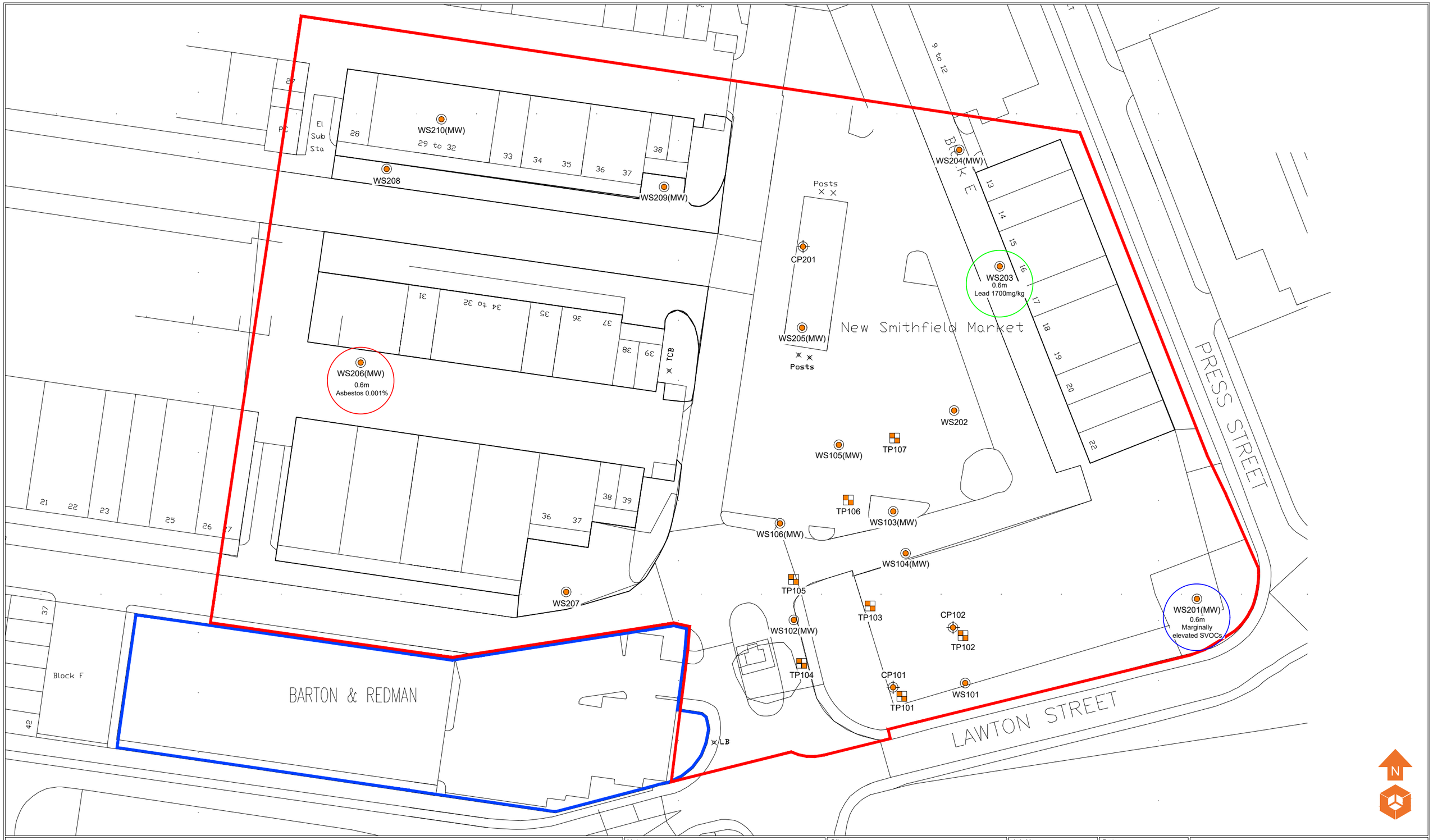

Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location

Contamination Exceedances

- Asbestos
- SVOC
- Lead

Notes:

P1	REVA	09.07.2020	LM	SE
Phase	Issue	Date	Drawn	Checked

Client: Russells Construction

Job No: 12-757

Date: 09.07.2020

Drawing No: 018

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Contamination Exceedances Plan

e3p

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

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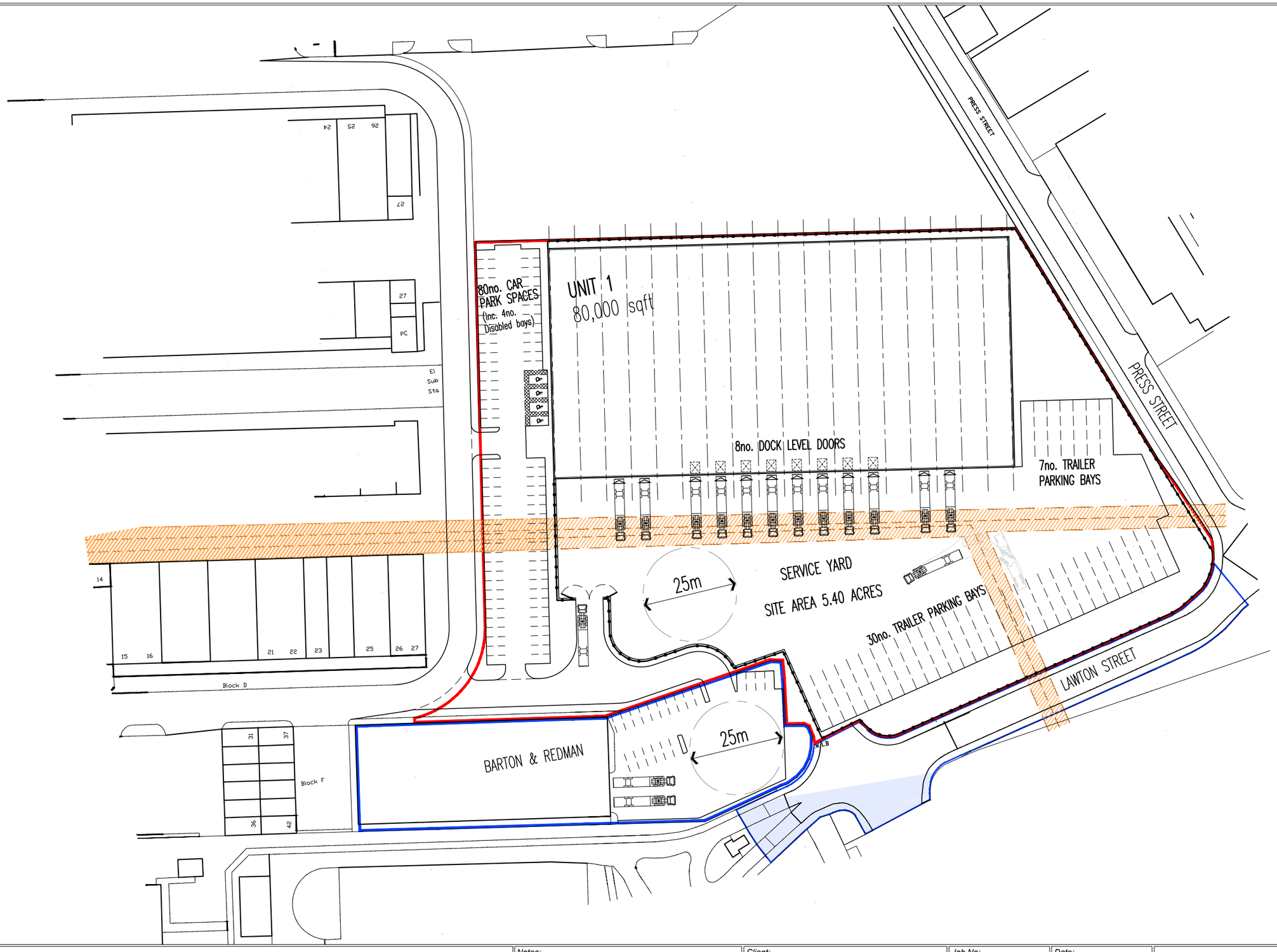

Notes:	Client:	Job No:	Date:
	Russells Construction	12-757	18.06.2020
		Drawing No: 002	Scale: NTS @ A3

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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

Phase	Issue	Date	Drawn	Checked
P1	REVA	18.06.2020	LM	SE

Job Title: Barton & Redman, Manchester

Drawing Title: Proposed Development Plan

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	18.05.2020	LM	SE
P1	REVA	29.05.2020	CB	SE

Client: Russells Construction

Job No: 12-757

Date: 29.05.2020

Drawing No: 005

Scale: NTS @ A3

Job Title: Barton & Redman, Manchester

Drawing Title: Exploratory Hole Location Plan

e3p
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

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APPENDIX IV
PHOTOGRAPHS

PLATE 1 VIEW OF CENTRAL AREA OF SITE

PLATE 2 VIEW OF STORAGE UNITS AT SITE IN BLOCK E

PLATE 3 VIEW OF AREA WITHIN WAREHOUSE D

PLATE 4 VIEW OF ASPHALT AREA IN SOUTH EAST OF SITE

PLATE 5 WS201 ARISINGS FROM LEFT TO RIGHT

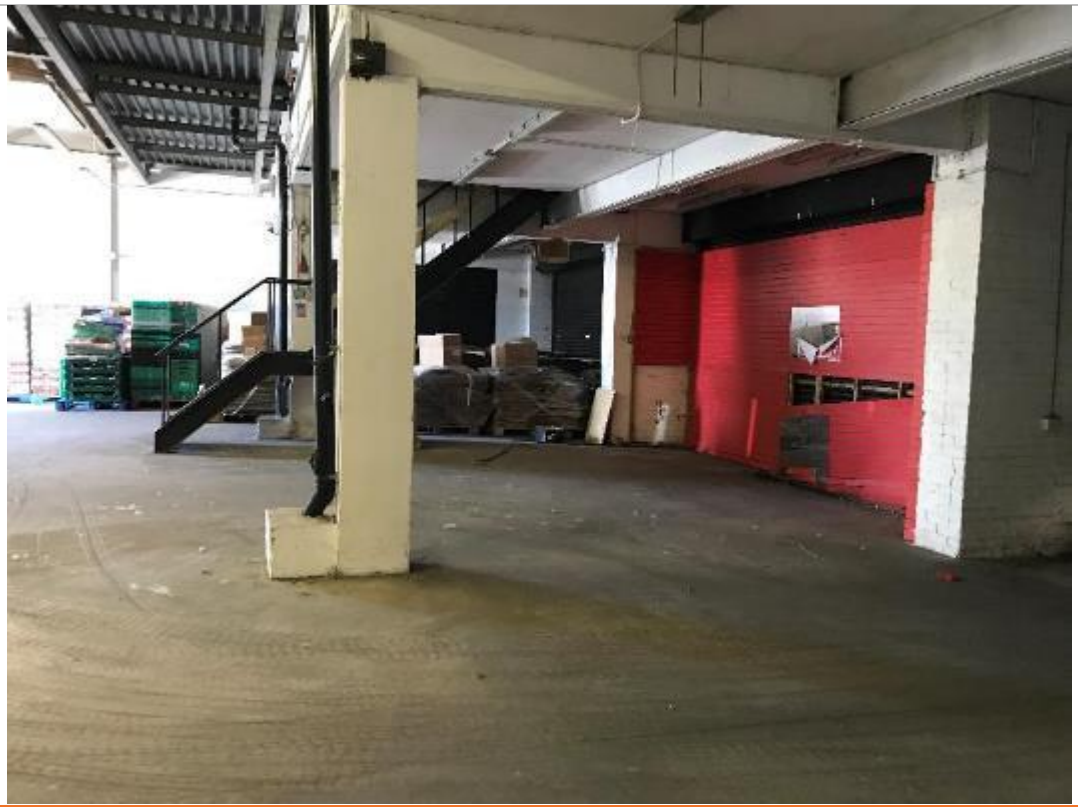
PLATE 6 COMPOSITION OF HARDSTANDING

PLATE 7 WS203 ARISINGS

PLATE 8 WS209 ARISINGS FROM LEFT TO RIGHT

PLATE 9 MAIN ACCESS ROAD

PLATE 10 VIEW WITHIN STORAGE UNIT



APPENDIX V
EXPLORATORY LOGS

Borehole Log

Borehole No.
WS201
Sheet 1 of 1

Project Name: Barton & Redman	Project No. 12757	Co-ords: 388594E - 397099N	Hole Type WS
Location: Manchester		Level: 67.89 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.25	67.89		MADE GROUND: Asphalt.
		0.60	ES		0.50	67.64		MADE GROUND: Grey sandy gravel (sub-base). Gravel is fine to medium angular to sub-angular of sandstone.
		1.00	ES		0.90	67.39		MADE GROUND: Firm brown gravelly clay (reworked). Gravel is medium to coarse angular to subrounded of sandstone and brick. (Rare black staining and slight hydrocarbon odour.)
		1.00	SPT	N=31 (10,12/12,8,5,6)	1.20	66.98		Brown clayey SILT.
					1.50	66.68		Dense brown slightly clayey slightly silty fine to medium SAND.
		2.00	SPT	N=19 (3,3/4,4,5,6)				Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		3.00	SPT	N=22 (4,4/5,5,6,6)				
		4.00	SPT	N=28 (6,5/5,6,7,10)				
		5.00	SPT	N=29 (7,4/6,6,7,10)				
					5.45	66.39		End of Borehole at 5.45m

Remarks
1. Complete. 2. Slight hydrocarbon odour in Made Ground 3. Coring 10 minutes. 4. Monitoring well installed.

Borehole Log

Borehole No. **WS202** Sheet 1 of 1			
Project Name: Barton & Redman	Project No. 12757	Co-ords: 388557E - 397141N	Hole Type WS
Location: Manchester		Level: 67.35 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.08	67.35		MADE GROUND: Asphalt.
					0.25	67.27		MADE GROUND: Concrete
		0.40	ES					MADE GROUND: Grey sandy gravel (sub-base). Gravel is medium to coarse angular to sub-angular of sandstone.
					0.60	67.10		Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Becoming very stiff very high strength at circa 3.00m bgl).
		1.00	SPT	N=25 (3,4/5,6,8,6)				
		2.00	SPT	N=18 (2,3/5,5,4,4)				
		3.00	ES					
		3.00	SPT	N=39 (3,3/6,8,12,13)				
		4.00	SPT	N=50 (10,10/15,12,12,11)				
		5.00	SPT	50 (15,15/50 for 15mm)				
					5.45	66.75		End of Borehole at 5.45m

Remarks

1. Complete. 2. Coring 10 minutes

Borehole Log

Borehole No.
WS203
Sheet 1 of 1

Project Name: Barton & Redman	Project No. 12757	Co-ords: 388563E - 397170N	Hole Type WS
Location: Manchester		Level: 67.50 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.40	ES		0.30	67.50		MADE GROUND: Concrete
					0.50	67.20		MADE GROUND: Black sandy gravel. Gravel is fine to medium subangular to subrounded of brick and sandstone.
		1.00	SPT	N=7 (5,3/2,2,1,2)				MADE GROUND: Red gravel. Gravel is medium to coarse angular to subangular of brick. (Frequent black staining, no odour)
		2.00	SPT	N=5 (2,1/1,2,1,1)				
		2.50	SPT	N=50 (25,/50,0,0,0)	2.55	67.00		End of Borehole at 2.55m
		3.00	SPT	0 (25 for 50mm/0 for 0mm)				

1 2 3 4 5 6 7 8 9 10

Remarks
1. Refusal in made ground. 2. Coring 10 minutes. 3. Collapsed at 2.50m bgl.

Borehole Log

Borehole No. **WS204** Sheet 1 of 1			
Project Name: Barton & Redman	Project No. 12757	Co-ords: 388555E - 397192N	Hole Type WS
Location: Manchester		Level: 67.46 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.08	67.46		MADE GROUND: Asphalt.
					0.30	67.38		MADE GROUND: Concrete
		0.50	ES		0.60	67.16		MADE GROUND: Brownish grey sandy gravel (sub-base). Gravel is medium to coarse angular to sub-angular of sandstone and brick.
		1.00	SPT	N=30 (6,6/8,10,8,4)				Very stiff very high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Becoming very stiff high strength at circa 2.00m bgl) (Becoming very stiff very high strength at circa 5.00m bgl).
		2.00	ES					
		2.00	SPT	N=24 (4,4/8,6,4,6)				
		2.50	U					
		3.00	SPT	N=18 (3,2/2,6,4,6)				
		4.00	SPT	N=30 (2,8/7,7,9,7)				
		5.00	SPT	50 (11,12/50 for 8mm)				
					5.45	66.86		End of Borehole at 5.45m

Remarks

1. Complete. 2. Monitoring well installed. 3. Coring 10 minutes

Borehole Log

Borehole No.
WS205
Sheet 1 of 1

Project Name: Barton & Redman	Project No. 12757	Co-ords: 388525E - 397153N	Hole Type WS
Location: Manchester		Level: 67.40 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	ES		0.30	67.40		MADE GROUND: Concrete
								MADE GROUND: Firm brown gravelly clay (reworked). Gravel is medium to coarse angular to subrounded of concrete asphalt and brick.
		1.00	SPT	N=19 (3,4/4,4,5,6)	0.90	67.10		Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Becoming very stiff very high strength at circa 2.00m bgl).
		1.50	U					
		2.00	SPT	50 (4,5/50 for 275mm)				
					2.45	66.50		End of Borehole at 2.45m

Remarks
1. Refusal in stiff CLAY 2. Coring 15 minutes 3. Monitoring well installed.

Borehole Log

Borehole No.
WS206
Sheet 1 of 1

Project Name: Barton & Redman	Project No. 12757	Co-ords:	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description	
					0.30			MADE GROUND: Concrete	
		0.40	ES		0.50			MADE GROUND: Reddish brown gravel. Gravel is fine subangular to subrounded of brick and sandstone.	
					0.90			Stiff light brown grey mottled slightly gravelly CLAY. Gravel is fine subangular to subrounded of mudstone.	
		1.00	SPT	N=21 (6,6/6,6,3,6)				Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Becoming very stiff very high strength at circa 4.00m bgl).	1
		1.50	U						
		2.00	ES						2
		2.00	SPT	N=29 (3,5/6,5,9,9)					
		3.00	SPT	N=27 (4,4/6,6,6,9)					3
		4.00	SPT	50 (12,16/50 for 8mm)					4
					4.45			End of Borehole at 4.45m	
									5
									6
									7
									8
									9
									10

Remarks
1. Refusal in stiff CLAY 2. Coring 10 minutes 3. Monitoring well installed.

Borehole Log

Borehole No. **WS207** Sheet 1 of 1			
Project Name: Barton & Redman	Project No. 12757	Co-ords: 388474E - 397105N	Hole Type WS
Location: Manchester		Level: 66.81 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.08	66.81		MADE GROUND: Asphalt.
					0.25	66.73		MADE GROUND: Concrete
								MADE GROUND: Red clayey gravel. Gravel is medium to coarse angular to subangular of brick. (Rare black staining, no odour)
	0.90				0.70	66.56		Stiff brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
					1.00	66.11		End of Borehole at 1.00m

Remarks

1. Refusal on sandstone cobble 2. Water strike at 0.90 m bgl 3. Coring 10 minutes

Borehole Log

Borehole No. **WS208** Sheet 1 of 1			
Project Name: Barton & Redman	Project No. 12757	Co-ords: 388435E - 397186N	Hole Type WS
Location: Manchester		Level: 66.78 m AOD	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.40	0.20	ES		0.30	66.78		MADE GROUND: Concrete
					0.80	66.48		MADE GROUND: Dark brown slightly sandy gravel (sub-base). Gravel is fine to medium angular to sub-angular of sandstone and rare concrete and brick.
		1.00	SPT	N=35 (8,7/10,8,10,7)				Very stiff very high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		2.00	SPT	N=60 (8,12/12,16,18,14)				
		3.00	SPT	50 (16,20/50 for 4mm)				
					3.45	65.98		End of Borehole at 3.45m

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Remarks

1. Refusal in stiff CLAY 2. Coring 10 minutes 3. Water strike at 0.40 m bgl

Borehole Log

Borehole No.
WS209
Sheet 1 of 1

Project Name:	Barton & Redman	Project No. 12757	Co-ords: 388496E - 397184N
Location:	Manchester		Level: 66.84 m AOD
Client:	Russells Construction		Dates: 15/05/2020

Hole Type: WS
Scale: 1:50
Logged By: O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	ES		0.30	66.84		MADE GROUND: Concrete
	0.80	1.00	SPT	N=18 (3,3/4,4,4,6)	0.80	66.54		MADE GROUND: Dark brown slightly sandy gravel (sub-base). Gravel is fine to medium angular to sub-angular of sandstone and rare concrete and brick.
		2.00	SPT	N=35 (5,6/7,7,8,13)				Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Soft at 0.80 m, rare organic matter throughout) (Becoming very stiff very high strength at circa 2.00m bgl).
		2.50	SPT	50 (6,7/50 for 40mm)				
		3.00	ES					
		3.00	SPT	50 (6,7/50 for 265mm)	3.44	66.04		End of Borehole at 3.44m

Remarks
1. Refusal in stiff CLAY 2. Coring 15 minutes 3. Water strike at 0.90 m bgl. 4. Monitoring well installed.

Borehole Log

Borehole No. **WS210** Sheet 1 of 1			
Project Name: Barton & Redman	Project No. 12757	Co-ords:	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Russells Construction		Dates: 15/05/2020	Logged By O Jackson

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.30			MADE GROUND: Concrete
		0.50	ES		0.60			MADE GROUND: Red gravel. Gravel is medium to coarse angular to subangular of brick.
		1.00	SPT	N=20 (3,4/5,4,5,6)				Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Becoming very stiff very high strength at circa 3.00m bgl).
		1.50	ES					
		2.00	SPT	N=24 (5,4/6,5,6,7)				
		3.00	SPT	N=50 (7,7/8,12,12,18)				
					3.45			End of Borehole at 3.45m

Remarks

1. Refusal in stiff CLAY 2. Coring 15 minutes. 3. Monitoring well installed.

Borehole Log

Borehole No. **CP201**

Sheet 1 of 2

Project Name: Barton & Redman	Project No. 12757	Co-ords: 388524.13 - 397161.39	Hole Type CP
Location: Manchester		Level: 67.38	Scale 1:50
Client: Russells Construction		Dates: 14/05/2020 -	Logged By O Jackson

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.30	67.08		MADE GROUND: Concrete
					1.10	66.28		MADE GROUND: Firm brown gravelly clay (reworked). Gravel is medium to coarse angular to subrounded of concrete asphalt and brick.
		1.00		N=29 (3,4/6,7,9,7)				Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		2.00 2.00	B	N=31 (1,2/5,7,9,10)				
		3.00 3.00	B	N=33 (2,3/4,7,10,12)				
		4.00		50 (2,4/50 for 231mm)				
		5.00	U					
		6.50 6.50	B	N=34 (3,4/6,7,10,11)				
	▼				7.30	60.08		Brown medium SAND.
					7.60	59.78		Very stiff high strength brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. (Becoming very stiff very high strength at circa 10.00m bgl) (Becoming very stiff high strength at circa 11.50m bgl).
		8.00	B					
		8.50		N=32 (4,5/6,7,9,10)				

Continued on next sheet

Remarks

1. Complete. 2. Coring 15 minutes 3. Water strike at 7.30 m bgl, rose to 6.90 m bgl

Borehole Log

Borehole No. **CP201**

Project Name: Barton & Redman	Project No. 12757	Co-ords: 388524.13 - 397161.39	Hole Type CP
Location: Manchester		Level: 67.38	Scale 1:50
Client: Russells Construction		Dates: 14/05/2020 -	Logged By O Jackson

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		10.00		N=42 (3,4/7,10,11,14)				
		11.50		N=36 (4,6/8,9,9,10)				
		13.00	B					
		13.00		N=41 (5,7/9,12,10,10)				
		14.50		N=43 (6,7/10,11,10,12)				
					14.95	52.43		End of borehole at 14.95 m

11 12 13 14 15 16 17 18 19 20

Remarks
1. Complete. 2. Coring 15 minutes 3. Water strike at 7.30 m bgl, rose to 6.90 m bgl

APPENDIX VI
CHEMICAL TESTING RESULTS

Olivia Jackson
e3p
Taylor Road
Urmston
Manchester
M41 7JQ

e: ojackson@e3p.co.uk

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

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

Analytical Report Number : 20-10218

Project / Site name:	Smithfield Market, Barton and Redman	**Samples received on:**	18/05/2020
Your job number:	12-757	**Sample instructed/ Analysis started on:**	18/05/2020
Your order number:	12-757-OJ-D	**Analysis completed by:**	26/05/2020
Report Issue Number:	1	**Report issued on:**	29/05/2020
Samples Analysed:	1 leachate sample - 13 soil samples		

Signed: A. Czerwińska

Agnieszka Czerwińska

Technical Reviewer (Reporting Team)
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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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513344	1513345	1513346	1513347	1513348
Sample Reference				WS201	WS201	WS202	WS202	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.60	1.00	0.40	3.00	0.40
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
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	%	N/A	NONE	12	14	2.8	12	9.9
Total mass of sample received	kg	0.001	NONE	1.6	0.70	0.70	0.65	0.65
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	-	Not-detected
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	-	-	-	-	-
Asbestos Quantification Total	%	0.001	ISO 17025	-	-	-	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	8.7	-	8.3	-
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	-	250	-	290	-
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	120	-	140	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.060	-	0.068	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	59.9	-	67.6	-
Sulphide	mg/kg	1	MCERTS	-	13	-	< 1.0	-
Total Sulphur	mg/kg	50	MCERTS	-	540	-	200	-
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	-	0.8	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	0.35
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	1.6
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	0.93
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	14
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	2.7
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	24
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	24
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	12
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	8.6
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	11
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	5.2
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	11
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	4.5
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	1.6
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	< 0.05	5.6
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	< 0.80	< 0.80	< 0.80	128

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513344	1513345	1513346	1513347	1513348
Sample Reference				WS201	WS201	WS202	WS202	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.60	1.00	0.40	3.00	0.40
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	10	3.3	7.0	6.0	74
Barium (aqua regia extractable)	mg/kg	1	MCERTS	180	-	160	-	500
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.72	-	0.19	-	1.3
Boron (water soluble)	mg/kg	0.2	MCERTS	1.1	-	0.3	-	0.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	1.0	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	6.8	-	28	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	79	7.2	17	17	480
Lead (aqua regia extractable)	mg/kg	1	MCERTS	88	4.8	30	10	1700
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	1.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	22	9.8	13	32	89
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	1.4	1.4
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	26	-	14	-	47
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	99	21	74	56	480
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Toluene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
p & m-xylene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
o-xylene	µg/kg	1	MCERTS	< 1.0	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	-	-	-	-

Petroleum Hydrocarbons

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513344	1513345	1513346	1513347	1513348
Sample Reference				WS201	WS201	WS202	WS202	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.60	1.00	0.40	3.00	0.40
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	-	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	3.9	-	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	23	-	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	24	-	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	25	-	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	75	-	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	-	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	4.1	-	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	97	-	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	200	-	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	87	-	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	380	-	-	-	-
TPH (C5 - C6)	mg/kg	1	NONE	-	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C6 - C8)	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C8 - C10)	mg/kg	0.1	MCERTS	-	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	2	MCERTS	-	< 2.0	< 2.0	< 2.0	< 2.0
TPH (C12 - C16)	mg/kg	4	MCERTS	-	< 4.0	< 4.0	< 4.0	11
TPH (C16 - C21)	mg/kg	1	MCERTS	-	< 1.0	< 1.0	< 1.0	120
TPH (C21 - C35)	mg/kg	1	MCERTS	-	< 1.0	< 1.0	< 1.0	280
TPH (C35 - C40)	mg/kg	10	MCERTS	-	< 10	< 10	< 10	26
TPH Total C5 - C40	mg/kg	10	MCERTS	-	< 10	< 10	< 10	440

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513344	1513345	1513346	1513347	1513348
Sample Reference				WS201	WS201	WS202	WS202	WS203
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.60	1.00	0.40	3.00	0.40
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	-	-	-	-
Phenol	mg/kg	0.2	ISO 17025	< 0.2	-	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	-	-	-	-
Isophorone	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	4.9	-	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	2.3	-	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	-	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	2.9	-	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	-	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	41	-	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	11	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	-	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	0.9	-	-	-	-
Fluorene	mg/kg	0.05	MCERTS	29	-	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	-	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	62	-	-	-	-
Anthracene	mg/kg	0.05	MCERTS	16	-	-	-	-
Carbazole	mg/kg	0.3	MCERTS	1.7	-	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	-	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	3.5	-	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	57	-	-	-	-
Pyrene	mg/kg	0.05	MCERTS	44	-	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	-	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	12	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	8.9	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	5.8	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	3.1	-	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	4.6	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.7	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.63	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	2.1	-	-	-	-

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513349	1513350	1513351	1513352	1513353
Sample Reference				WS204	WS204	WS206	WS206	WS209
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	2.00	0.40	3.00	0.20
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
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	%	N/A	NONE	9.4	12	12	13	20
Total mass of sample received	kg	0.001	NONE	0.65	0.55	0.70	0.70	1.1
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	Amosite	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Detected	-	Not-detected
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	-	-	< 0.001	-	-
Asbestos Quantification Total	%	0.001	ISO 17025	-	-	< 0.001	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9.2	8.5	7.9	8.4	-
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	2
Total Sulphate as SO_4	mg/kg	50	MCERTS	1200	320	1300	340	-
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	670	93	1000	160	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.33	0.046	0.52	0.079	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	334	46.4	518	78.6	-
Sulphide	mg/kg	1	MCERTS	7.0	8.9	3.7	< 1.0	-
Total Sulphur	mg/kg	50	MCERTS	520	310	640	160	-
Total Organic Carbon (TOC)	%	0.1	MCERTS	0.5	-	-	-	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	2.5
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.52
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	2.4
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	1.8
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.44	< 0.05	21
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	4.9
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.61	< 0.05	36
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.61	< 0.05	38
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.36	< 0.05	23
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.36	< 0.05	18
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.31	< 0.05	26
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.25	< 0.05	7.9
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.40	< 0.05	20
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	10
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	3.5
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	12
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	3.34	< 0.80	227

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513349	1513350	1513351	1513352	1513353
Sample Reference				WS204	WS204	WS206	WS206	WS209
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	2.00	0.40	3.00	0.20
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.8	7.9	10	8.5	61
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	340
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	-	-	-	2.1
Boron (water soluble)	mg/kg	0.2	MCERTS	-	-	-	-	0.3
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.3	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	22	26	22	27	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	28	17	59	20	320
Lead (aqua regia extractable)	mg/kg	1	MCERTS	37	18	100	23	490
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	0.3	< 0.3	0.7
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	24	31	21	30	46
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	1.1	< 1.0	1.3	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	58
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	77	58	86	64	160

Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	-	-	-	-	-
Toluene	µg/kg	1	MCERTS	-	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
p & m-xylene	µg/kg	1	MCERTS	-	-	-	-	-
o-xylene	µg/kg	1	MCERTS	-	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	-

Petroleum Hydrocarbons

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513349	1513350	1513351	1513352	1513353
Sample Reference				WS204	WS204	WS206	WS206	WS209
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	2.00	0.40	3.00	0.20
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	-
TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH (C6 - C8)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C8 - C10)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	3.3
TPH (C12 - C16)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	13
TPH (C16 - C21)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	110
TPH (C21 - C35)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	190
TPH (C35 - C40)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	13
TPH Total C5 - C40	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	340

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513349	1513350	1513351	1513352	1513353
Sample Reference				WS204	WS204	WS206	WS206	WS209
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	2.00	0.40	3.00	0.20
Date Sampled				15/05/2020	15/05/2020	15/05/2020	15/05/2020	15/05/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	-	-	-	-
Phenol	mg/kg	0.2	ISO 17025	-	-	-	-	-
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-	-	-
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-	-	-
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-	-	-
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-	-	-
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Methylphenol	mg/kg	0.2	NONE	-	-	-	-	-
Isophorone	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-	-	-
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-	-	-
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-	-	-
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-	-	-
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-	-	-
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-	-	-
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-	-	-
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-	-	-
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-	-	-
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-	-	-
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	-	-
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	-	-
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-	-	-
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-	-	-
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-	-	-
Fluorene	mg/kg	0.05	MCERTS	-	-	-	-	-
Azobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-	-	-
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-	-	-
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Carbazole	mg/kg	0.3	MCERTS	-	-	-	-	-
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-	-	-
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-	-	-
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	-	-

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513354	1513355	1513356		
Sample Reference				WS209	WS210	WS210		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.00	0.50	1.50		
Date Sampled				15/05/2020	15/05/2020	15/05/2020		
Time Taken				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		
Moisture Content	%	N/A	NONE	14	9.2	12		
Total mass of sample received	kg	0.001	NONE	0.70	0.70	0.70		
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-		
Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected	-		
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	-	-	-		
Asbestos Quantification Total	%	0.001	ISO 17025	-	-	-		
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.5	8.1	8.3		
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1		
Total Sulphate as SO_4	mg/kg	50	MCERTS	280	2000	410		
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	120	2000	310		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.062	1.0	0.16		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	62.1	1010	156		
Sulphide	mg/kg	1	MCERTS	< 1.0	2.0	< 1.0		
Total Sulphur	mg/kg	50	MCERTS	150	860	190		
Total Organic Carbon (TOC)	%	0.1	MCERTS	0.9	-	-		
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.34	< 0.05		
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.36	< 0.05		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.22	< 0.05		
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.26	< 0.05		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.21	< 0.05		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.20	< 0.05		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.23	< 0.05		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	1.82	< 0.80		

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513354	1513355	1513356		
Sample Reference				WS209	WS210	WS210		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.00	0.50	1.50		
Date Sampled				15/05/2020	15/05/2020	15/05/2020		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.8	6.2	6.2		
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-		
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	-	-		
Boron (water soluble)	mg/kg	0.2	MCERTS	-	-	-		
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2		
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0		
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	30	19	19		
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	31	16		
Lead (aqua regia extractable)	mg/kg	1	MCERTS	11	58	11		
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3		
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	34	15	24		
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	1.0	< 1.0	< 1.0		
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-		
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	57	62	46		

Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	-	-	-		
Toluene	µg/kg	1	MCERTS	-	-	-		
Ethylbenzene	µg/kg	1	MCERTS	-	-	-		
p & m-xylene	µg/kg	1	MCERTS	-	-	-		
o-xylene	µg/kg	1	MCERTS	-	-	-		
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-		

Petroleum Hydrocarbons

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513354	1513355	1513356		
Sample Reference				WS209	WS210	WS210		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.00	0.50	1.50		
Date Sampled				15/05/2020	15/05/2020	15/05/2020		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-		
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-		
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-		
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-		
TPH (C5 - C6)	mg/kg	1	NONE	< 1.0	< 1.0	< 1.0		
TPH (C6 - C8)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1		
TPH (C8 - C10)	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1		
TPH (C10 - C12)	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0		
TPH (C12 - C16)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0		
TPH (C16 - C21)	mg/kg	1	MCERTS	< 1.0	23	< 1.0		
TPH (C21 - C35)	mg/kg	1	MCERTS	< 1.0	300	< 1.0		
TPH (C35 - C40)	mg/kg	10	MCERTS	< 10	220	< 10		
TPH Total C5 - C40	mg/kg	10	MCERTS	< 10	550	< 10		

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Lab Sample Number				1513354	1513355	1513356		
Sample Reference				WS209	WS210	WS210		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.00	0.50	1.50		
Date Sampled				15/05/2020	15/05/2020	15/05/2020		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	-	-	-		
Phenol	mg/kg	0.2	ISO 17025	-	-	-		
2-Chlorophenol	mg/kg	0.1	MCERTS	-	-	-		
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	-	-	-		
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-		
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	-	-	-		
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	-	-	-		
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	-	-	-		
2-Methylphenol	mg/kg	0.3	MCERTS	-	-	-		
Hexachloroethane	mg/kg	0.05	MCERTS	-	-	-		
Nitrobenzene	mg/kg	0.3	MCERTS	-	-	-		
4-Methylphenol	mg/kg	0.2	NONE	-	-	-		
Isophorone	mg/kg	0.2	MCERTS	-	-	-		
2-Nitrophenol	mg/kg	0.3	MCERTS	-	-	-		
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	-	-	-		
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	-	-	-		
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	-	-	-		
Naphthalene	mg/kg	0.05	MCERTS	-	-	-		
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	-	-	-		
4-Chloroaniline	mg/kg	0.1	NONE	-	-	-		
Hexachlorobutadiene	mg/kg	0.1	MCERTS	-	-	-		
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	-	-	-		
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	-	-	-		
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	-	-	-		
2-Methylnaphthalene	mg/kg	0.1	NONE	-	-	-		
2-Chloronaphthalene	mg/kg	0.1	MCERTS	-	-	-		
Dimethylphthalate	mg/kg	0.1	MCERTS	-	-	-		
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	-	-	-		
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-		
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-		
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	-	-	-		
Dibenzofuran	mg/kg	0.2	MCERTS	-	-	-		
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	-	-	-		
Diethyl phthalate	mg/kg	0.2	MCERTS	-	-	-		
4-Nitroaniline	mg/kg	0.2	MCERTS	-	-	-		
Fluorene	mg/kg	0.05	MCERTS	-	-	-		
Azobenzene	mg/kg	0.3	MCERTS	-	-	-		
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	-	-	-		
Hexachlorobenzene	mg/kg	0.3	MCERTS	-	-	-		
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-		
Anthracene	mg/kg	0.05	MCERTS	-	-	-		
Carbazole	mg/kg	0.3	MCERTS	-	-	-		
Dibutyl phthalate	mg/kg	0.2	MCERTS	-	-	-		
Anthraquinone	mg/kg	0.3	MCERTS	-	-	-		
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-		
Pyrene	mg/kg	0.05	MCERTS	-	-	-		
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	-	-	-		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-		
Chrysene	mg/kg	0.05	MCERTS	-	-	-		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-		

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Analytical Report Number: 20-10218
Project / Site name: Smithfield Market, Barton and Redman
Your Order No: 12-757-OJ-D

Certificate of Analysis - Asbestos Quantification

Methods:

Qualitative Analysis

The samples were analysed qualitatively for asbestos by polarising light and dispersion staining as described by the Health and Safety Executive in HSG 248.

Quantitative Analysis

The analysis was carried out using our documented in-house method A006-PL based on HSE Contract Research Report No: 83/1996: Development and Validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (Davies et al, 1996) and HSG 248. Our method includes initial examination of the entire representative sample, then fractionation and detailed analysis of each fraction, with quantification by hand picking and weighing.

The limit of detection (reporting limit) of this method is 0.001 %.

The method has been validated using samples of at least 100 g, results for samples smaller than this should be interpreted with caution.

Both Qualitative and Quantitative Analyses are UKAS accredited.

Sample Number	Sample ID	Sample Depth (m)	Sample Weight (g)	Asbestos Containing Material Types Detected (ACM)	PLM Results	Asbestos by hand picking/weighing (%)	Total % Asbestos in Sample
1513351	WS206	0.40	147	Loose Fibres	**Amosite**	< 0.001	**< 0.001**

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman

Your Order No: 12-757-OJ-D

Lab Sample Number				1513371				
Sample Reference				WS201				
Sample Number				None Supplied				
Depth (m)				0.60				
Date Sampled				15/05/2020				
Time Taken				None Supplied				
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.9				
Total Cyanide (Low Level 1 µg/l)	µg/l	1	ISO 17025	1.3				
Total Phenols								
Total Phenols (monohydric)	µg/l	1	ISO 17025	3.7				
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	2.1				
Acenaphthylene	µg/l	0.01	ISO 17025	2.6				
Acenaphthene	µg/l	0.01	ISO 17025	140				
Fluorene	µg/l	0.01	ISO 17025	38				
Phenanthrene	µg/l	0.01	ISO 17025	16				
Anthracene	µg/l	0.01	ISO 17025	3.7				
Fluoranthene	µg/l	0.01	ISO 17025	1.2				
Pyrene	µg/l	0.01	ISO 17025	0.71				
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				
Dibenz(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	0.2	NONE	200				
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	1.1	ISO 17025	< 1.1				
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	1.0				
Copper (dissolved)	µg/l	0.7	ISO 17025	8.1				
Lead (dissolved)	µg/l	1	ISO 17025	< 1.0				
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5				
Nickel (dissolved)	µg/l	0.3	ISO 17025	3.3				
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0				
Zinc (dissolved)	µg/l	0.4	ISO 17025	8.1				

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Analytical Report Number: 20-10218

Project / Site name: Smithfield Market, Barton and Redman

Your Order No: 12-757-OJ-D

Lab Sample Number				1513371				
Sample Reference				WS201				
Sample Number				None Supplied				
Depth (m)				0.60				
Date Sampled				15/05/2020				
Time Taken				None Supplied				
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/l	1	ISO 17025	< 1.0				
Toluene	µg/l	1	ISO 17025	< 1.0				
Ethylbenzene	µg/l	1	ISO 17025	< 1.0				
p & m-xylene	µg/l	1	ISO 17025	< 1.0				
o-xylene	µg/l	1	ISO 17025	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/l	10	NONE	< 10				
Petroleum Hydrocarbons								
TPH1 (C10 - C40)	µg/l	10	NONE	1100				
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	600				
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	450				
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	1100				

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Analytical Report Number : 20-10218

Project / Site name: Smithfield Market, Barton and Redman

* 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 *
1513344	WS201	None Supplied	0.60	Brown clay and sand with gravel.
1513345	WS201	None Supplied	1.00	Brown clay and sand.
1513346	WS202	None Supplied	0.40	Brown gravel.**
1513347	WS202	None Supplied	3.00	Brown clay.
1513348	WS203	None Supplied	0.40	Grey sand with brick and gravel.
1513349	WS204	None Supplied	0.50	Brown clay and sand with brick.
1513350	WS204	None Supplied	2.00	Brown clay.
1513351	WS206	None Supplied	0.40	Brown clay with gravel.
1513352	WS206	None Supplied	3.00	Brown clay and sand.
1513353	WS209	None Supplied	0.20	Grey sandy gravel.**
1513354	WS209	None Supplied	3.00	Brown clay.
1513355	WS210	None Supplied	0.50	Brown sand with brick.
1513356	WS210	None Supplied	1.50	Brown clay.

** Non MCERTS Matrix

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number : 20-10218

Project / Site name: Smithfield Market, Barton and Redman

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

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 disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Asbestos Quantification - Gravimetric	Asbestos quantification by gravimetric method - in house method based on references.	HSE Report No: 83/1996, HSG 248, HSG 264 & SCA Blue Book (draft).	A006-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BS EN 12457-1 (2:1) Leachate Prep	2:1 (as recieved, moisture adjusted) end over end extraction with water for 24 hours. Eluate filtered prior to analysis.	In-house method based on BSEN12457-1.	L043-PL	W	NONE
BTEX and MTBE in leachates (Monoaromatics)	Determination of BTEX and MTBE in leachates by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
D.O. for Gravimetric Quant if Screen/ID positive	Dependent option for Gravimetric Quant if Screen/ID positive scheduled.	In house asbestos methods A001 & A006.	A006-PL	D	NONE
Hexavalent chromium in leachate	Determination of hexavalent chromium in leachate by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	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.	L039-PL	W	ISO 17025
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Monohydric phenols in leachate - LOW LEVEL 1 ug/l	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
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 (skalar)	L080-PL	W	MCERTS
pH at 20oC in leachate	Determination of pH in leachate by electrometric measurement.	In house method.	L005-PL	W	ISO 17025
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS

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Analytical Report Number : 20-10218

Project / Site name: Smithfield Market, Barton and Redman

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Speciated EPA-16 PAHs in leachate	Determination of PAH compounds in leachate by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L102B-PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
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-PL	D	MCERTS
Total cyanide in leachate - 1µg/l	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-PL	W	ISO 17025
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
TPH in (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	D	MCERTS
TPH1 (Leachates)	Determination of dichloromethane extractable hydrocarbons in leachate by GC-MS.	In-house method	L070-PL	W	NONE
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

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

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APPENDIX VII
ORIGIN OF TIER I GENERIC 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)	

The Tier 1 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 1 values for aliphatic compounds for the volatile and semi-volatile fractions (C_5-C_{12}) and the Tier 1 values for aromatic compound for the non-volatile fractions (C_{12}-C_{35}). The comparison of total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

CONTROLLED WATERS

* Sum of The specified compounds are benzo[b]fluoranthene (CAS 205-99-2), benzo[k]fluoranthene (CAS 207-08-9), benzo[g,h,i]perylene (CAS 191-24-2) and indeno[1,2,3-c,d]pyrene (CAS 193-39-5)

1) The Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations (2015)
2) Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)
3) Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances
4) Council Directive on the quality of water intended for human consumption (Drinking Water Directive)
5) WHO Guidelines for Drinking Water Quality. Third edition (2004)

APPENDIX VIII GEOTECHNICAL TESTING RESULTS

LABORATORY REPORT

4043

Contract Number: PSL20/2515

Report Date: 05 June 2020

Client's Reference: 12-757

Client Name: E3P
Taylor Road
Urmston
Manchester
M41 7JQ

For the attention of: Olivia Jackson

Contract Title: Smithfield Market, Barton and Redman

Date Received: 21/5/2020
Date Commenced: 21/5/2020
Date Completed: 5/6/2020

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:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
S Royle (Laboratory Manager)	S Eyre (Senior Technician)	L Knight (Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
WS202		Tub	2.00		Brown slightly gravelly sandy CLAY.
WS204		Tub	2.00		Brown slightly gravelly sandy CLAY.
WS204		Liner	2.50	3.00	Stiff brown gravelly sandy CLAY.
WS205		Tub	1.00		Brown slightly gravelly sandy CLAY.
CP201		Tub	1.00		Brown slightly gravelly sandy CLAY.
CP201		Liner	5.00	5.30	Very stiff brown slightly gravelly sandy CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

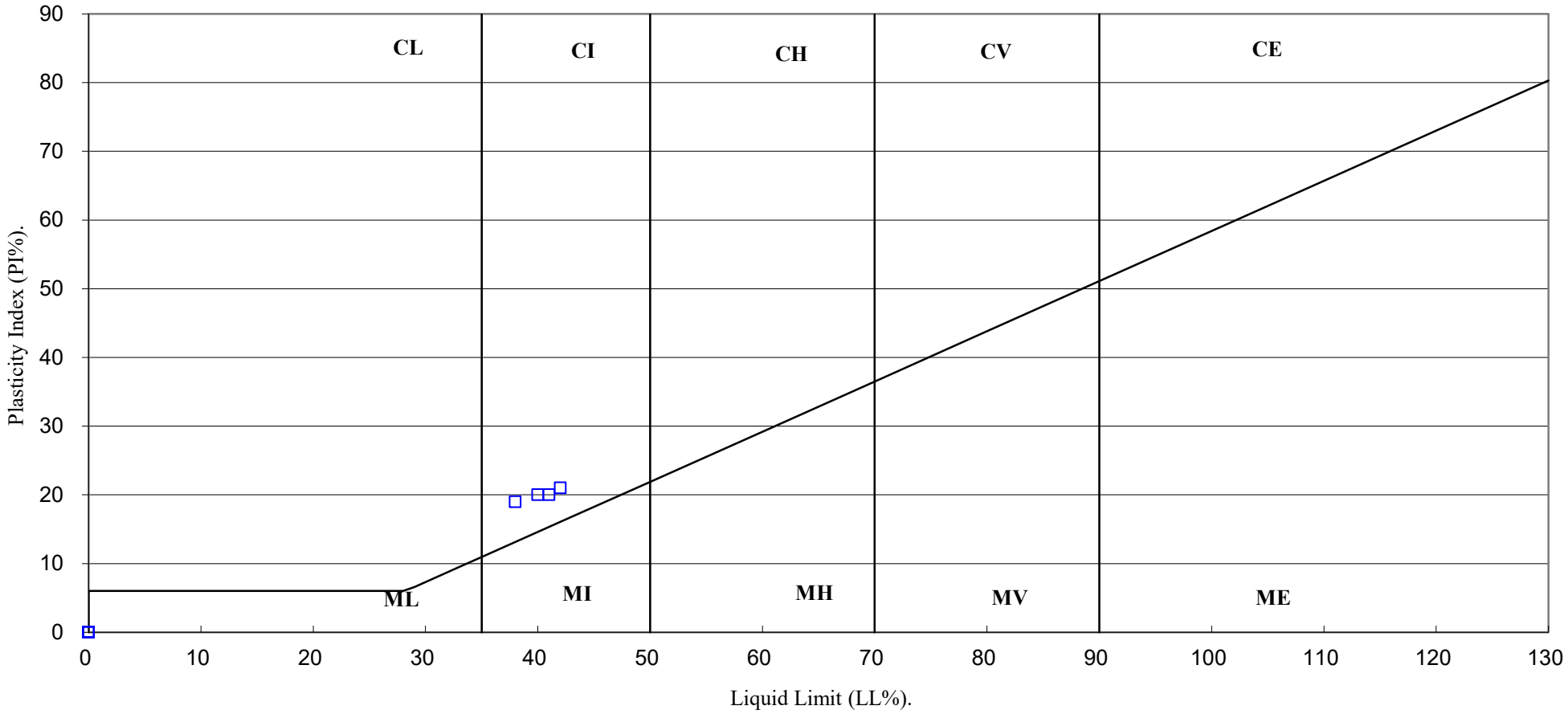
(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
WS202		Tub	2.00		17			42	21	21	91	Intermediate plasticity CI.
WS204		Tub	2.00		16			38	19	19	90	Intermediate plasticity CI.
WS205		Tub	1.00		16			40	20	20	87	Intermediate plasticity CI.
CP201		Tub	1.00		16			41	21	20	92	Intermediate plasticity CI.

SYMBOLS : NP : Non Plastic *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043	PSL Professional Soils Laboratory	Smithfield Market, Barton and Redman	Contract No: PSL20/2515
			Client Ref: 12-757

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL Professional Soils Laboratory	Smithfield Market, Barton and Redman	Contract No: PSL20/2515
			Client Ref: 12-757

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

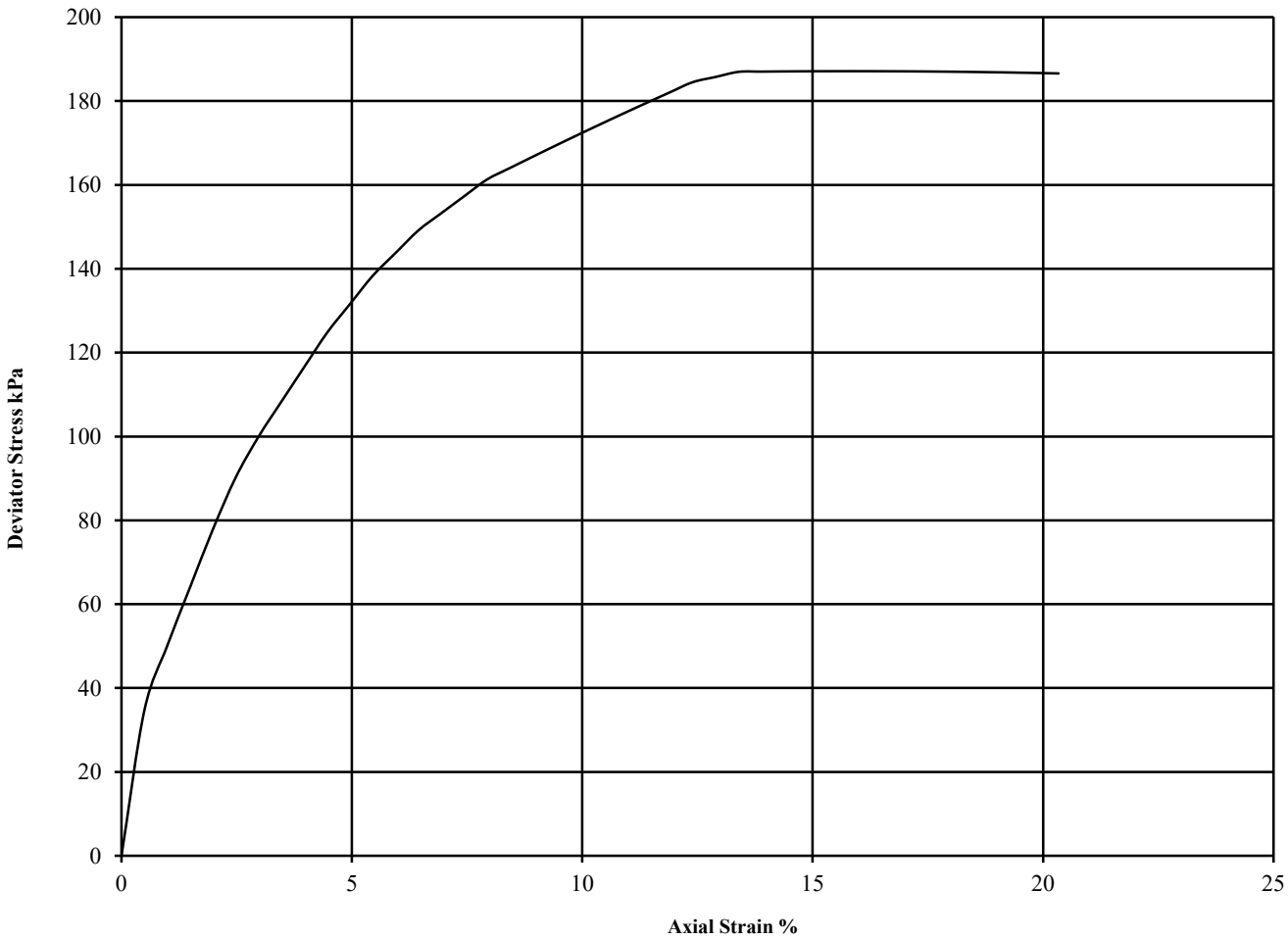
WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number: WS204 **Top Depth (m):** 2.50

Sample Number: **Base Depth (m):**

Sample Type Liner



Diameter (mm):		62	Height (mm):		125	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.53
1	11	2.18	1.97	55	187	94	15.9	Plastic	See summary of soil descriptions

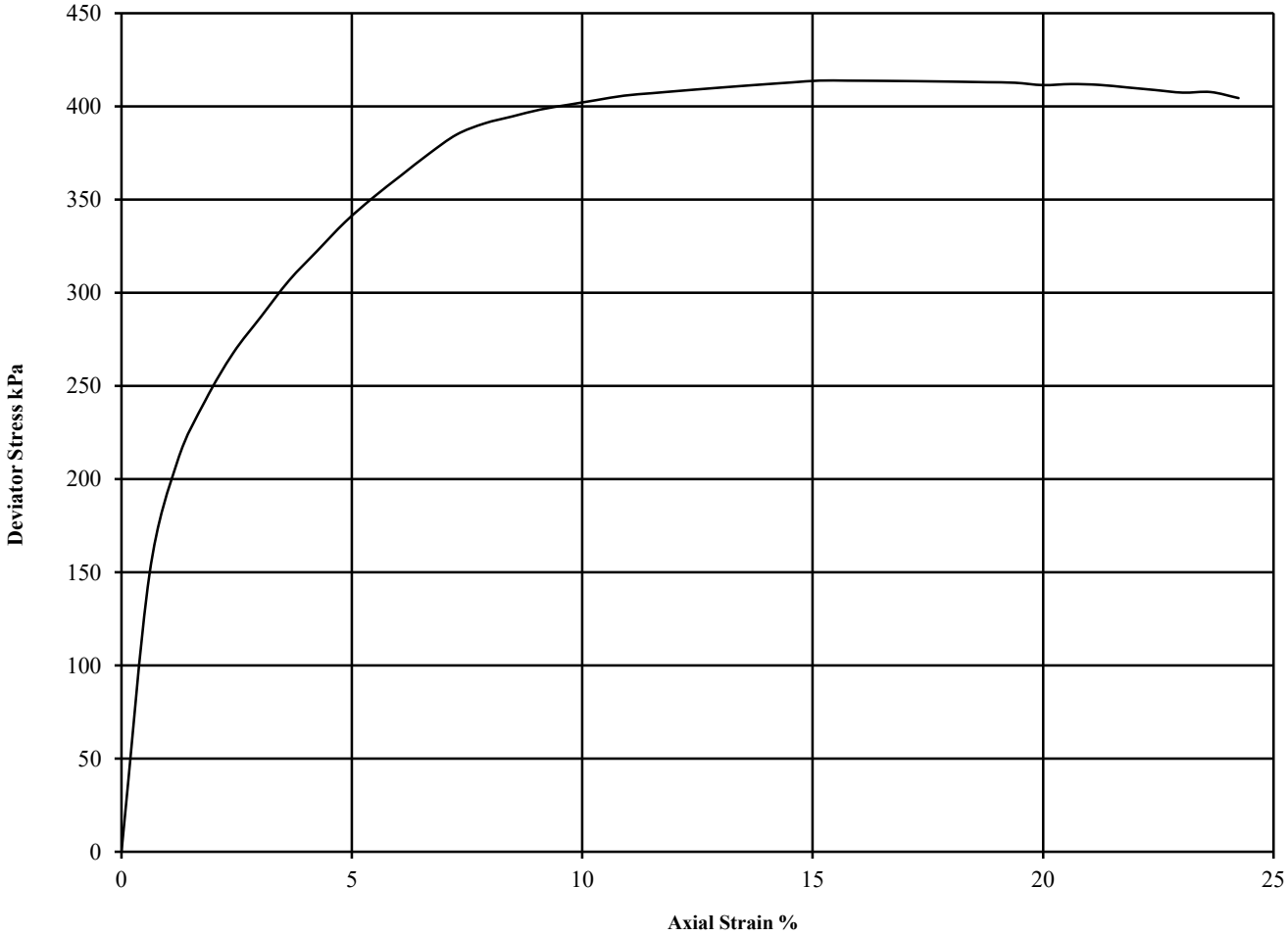
UKAS TESTING 4043	PSL Professional Soils Laboratory	Smithfield Market, Barton and Redman	**Contract No:** PSL20/2515 **Client Ref:** 12-757

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP201**	**Top Depth (m):**	**5.00**
Sample Number:		**Base Depth (m):**	**5.30**
Sample Type	**Liner**		



Diameter (mm):		100	Height (mm):		165	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.35
1	12	2.25	2.00	103	414	207	15.2	Plastic	See summary of soil descriptions

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Smithfield Market, Barton and Redman**	**Contract No:** PSL20/2515
			Client Ref: 12-757

ONE DIMENSIONAL CONSOLIDATION TEST

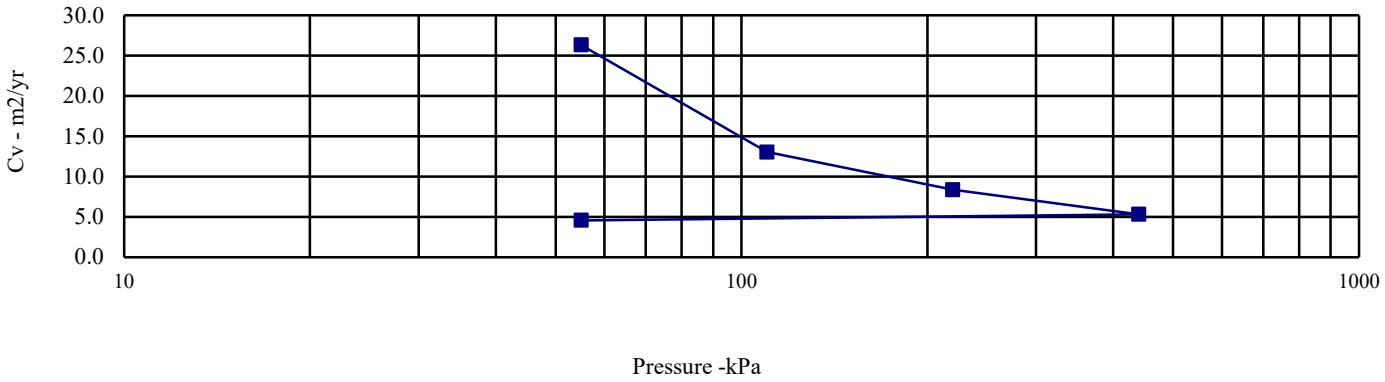
BS 1377: Part 5: 1990: Clause 3

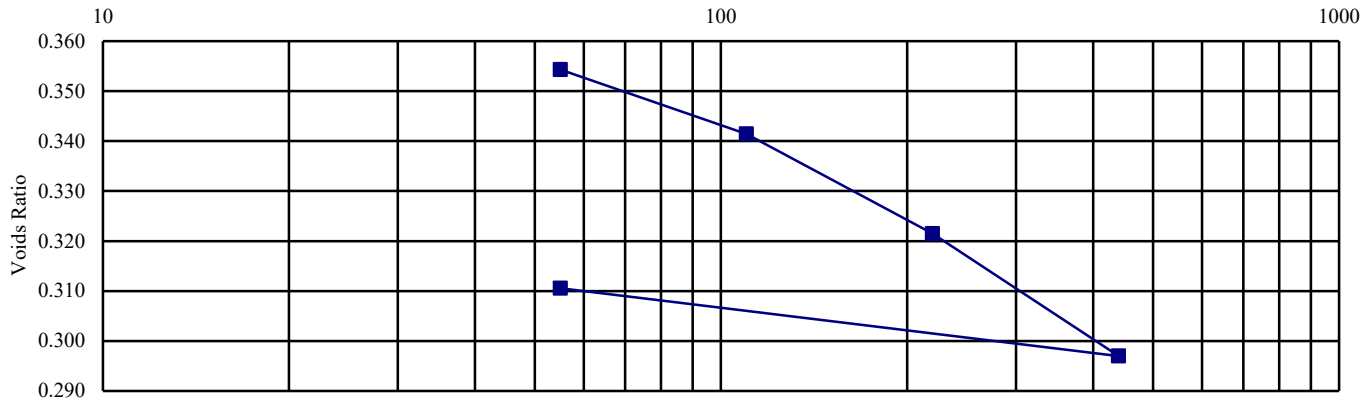
Hole Number: WS204 **Top Depth (m):** 2.50

Sample Number: **Base Depth (m) :** 3.00

Sample Type: Liner

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	14						
Bulk Density (Mg/m3):	2.20	0	55	0.249	26.321	Method used to determine CV:	T90
Dry Density (Mg/m3):	1.93	55	110	0.173	13.031		
Voids Ratio:	0.373	110	220	0.135	8.363	Nominal temperature during test ' C:	20
Degree of saturation:	98.8	220	440	0.084	5.313		
Height (mm):	19.838	440	55	0.027	4.570	Remarks: See summary of soil descriptions	
Diameter (mm)	50.003						
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043	PSL Professional Soils Laboratory	Smithfield Market, Barton and Redman	Contract No: PSL20/2515
			Client Ref: 12-757

ONE DIMENSIONAL CONSOLIDATION TEST

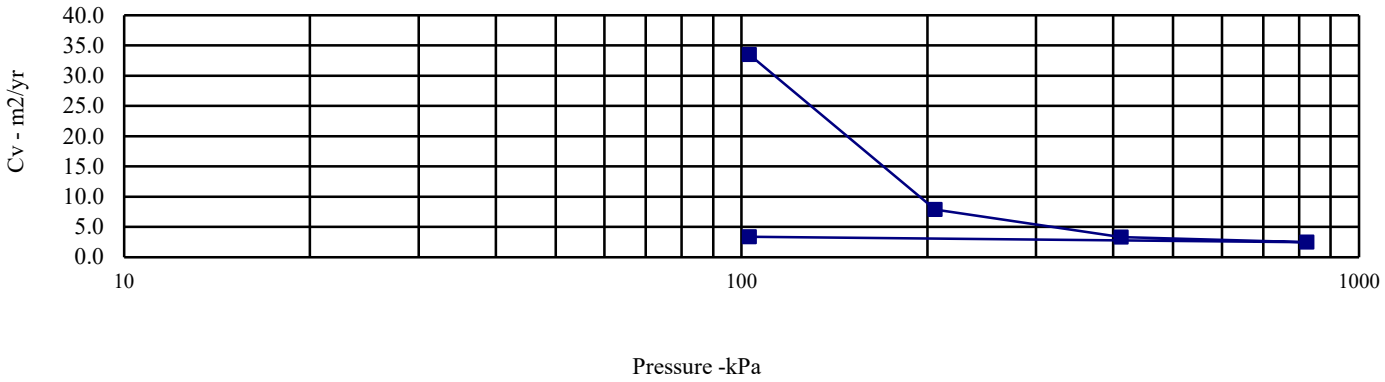
BS 1377: Part 5: 1990: Clause 3

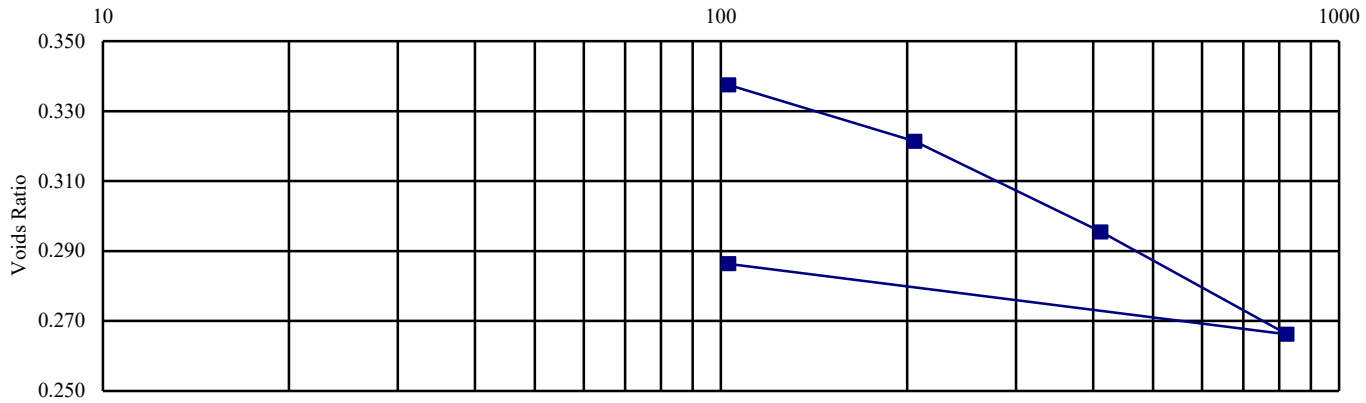
Hole Number: CP201 **Top Depth (m):** 5.00

Sample Number: **Base Depth (m) :** 5.30

Sample Type: Liner

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	14						
Bulk Density (Mg/m3):	2.19	0	103	0.280	33.486	Method used to determine CV:	T90
Dry Density (Mg/m3):	1.92	103	206	0.117	7.861		
Voids Ratio:	0.377	206	412	0.095	3.313	Nominal temperature during test ' C:	20
Degree of saturation:	97.6	412	824	0.055	2.447		
Height (mm):	20.132	824	103	0.022	3.357	Remarks: See summary of soil descriptions	
Diameter (mm)	75.02						
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043	PSL Professional Soils Laboratory	Smithfield Market, Barton and Redman	Contract No: PSL20/2515
			Client Ref: 12-757

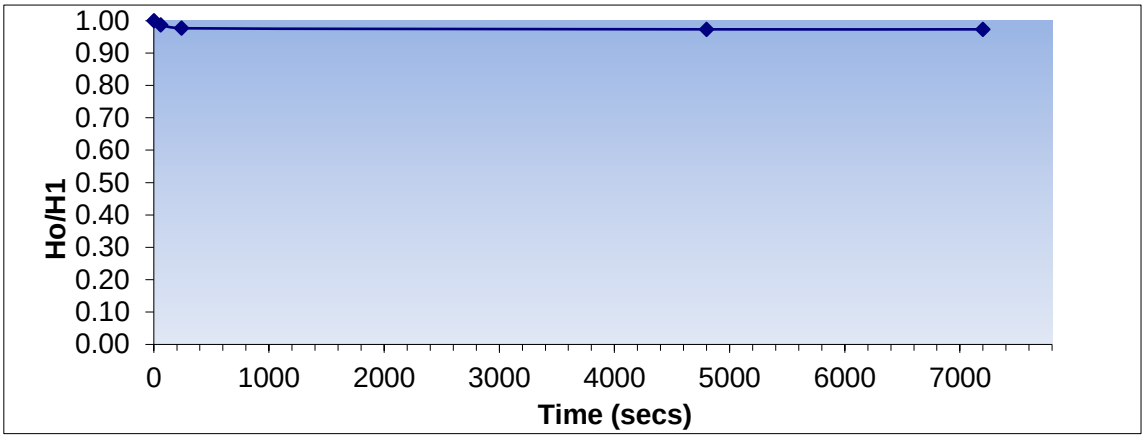
APPENDIX IX
FALLING HEAD PERMEABILITY TEST CERTIFICATES

Falling Head Test

Borehole: WS204 **Test No:** 1

Contract No:	12-757	Casing Diameter: (m)	0.05
Contract Title:	New Smithfield Market	Height of Casing:	0
Date of Test:	26/05/2020	Depth of Borehole: (m)	3.00

Recorded Time			Total Time			H/Ho
Hours	Minutes	Seconds	(secs)	Depth (m)		
0	0		0	0	0	1.0000
0	1		60	0.04	60	0.9867
0	4		240	0.07	240	0.9767
0	80		4800	0.08	4800	0.9733
0	120		7200	0.08	7200	0.9733
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	



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 appropiate.

H_1 =	0.9867	t_1 =	60
H_2 =	0.9733	t_2 =	4800
		F=	2.86

A = 0.00196349 m^2

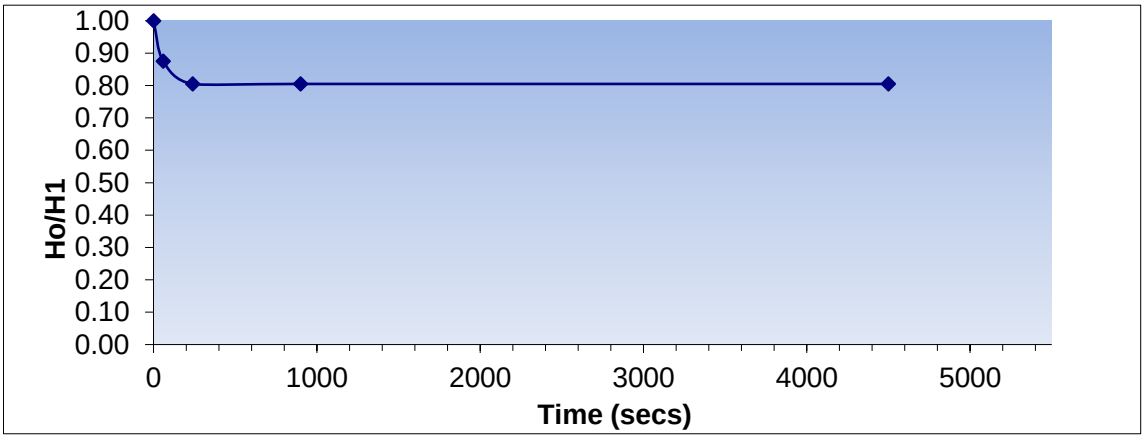
Coefficient of Permeability, k = **3.99E-07** m/s

Falling Head Test

Borehole: WS205 **Test No:** 1

Contract No:	12-757	Casing Diameter: (m)	0.05
Contract Title:	New Smithfield Market	Height of Casing:	0
Date of Test:	26/05/2020	Depth of Borehole: (m)	2.00

Recorded Time			Total Time			H/Ho
Hours	Minutes	Seconds	(secs)	Depth (m)		
0	0		0	0	0	1.0000
0	1		60	0.25	60	0.8750
0	4		240	0.39	240	0.8050
0	15		900	0.39	900	0.8050
0	75		4500	0.39	4500	0.8050
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000



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 appropiate.

H_1 =	0.875	t_1 =	60
H_2 =	0.805	t_2 =	900
		F=	1.7

A = 0.00196349 m^2

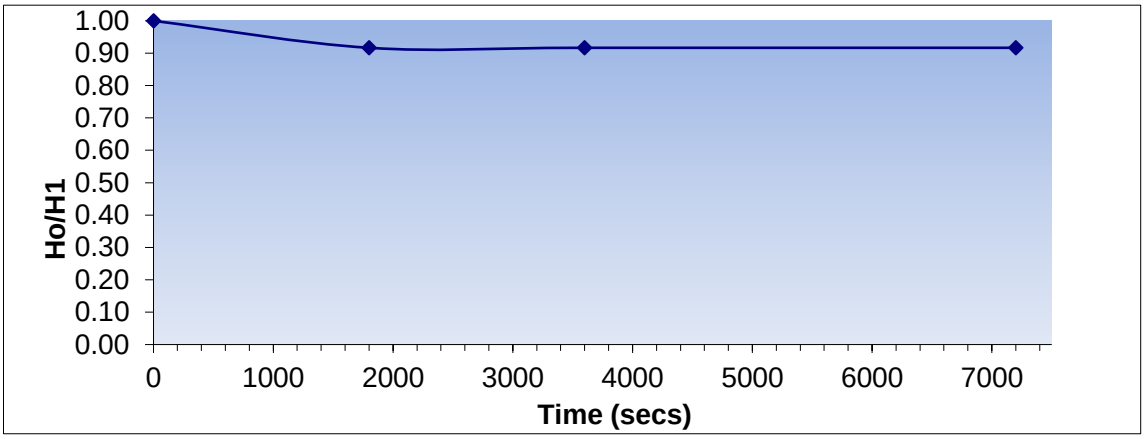
Coefficient of Permeability, k = **4.06E-06** m/s

Falling Head Test

Borehole: WS206 **Test No:** 1

Contract No:	12-757	Casing Diameter: (m)	0.05
Contract Title:	New Smithfield Market	Height of Casing:	0
Date of Test:	26/05/2020	Depth of Borehole: (m)	3.00

Recorded Time			Total Time			H/Ho
Hours	Minutes	Seconds	(secs)	Depth (m)		
0	0		0	0	0	1.0000
0	30		1800	0.25	1800	0.9167
0	60		3600	0.25	3600	0.9167
0	120		7200	0.25	7200	0.9167
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000



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 appropiate.

H_1 =	0.9167	t_1 =	1800
H_2 =	0.9167	t_2 =	3600
		F=	2.86

A = 0.00196349 m^2

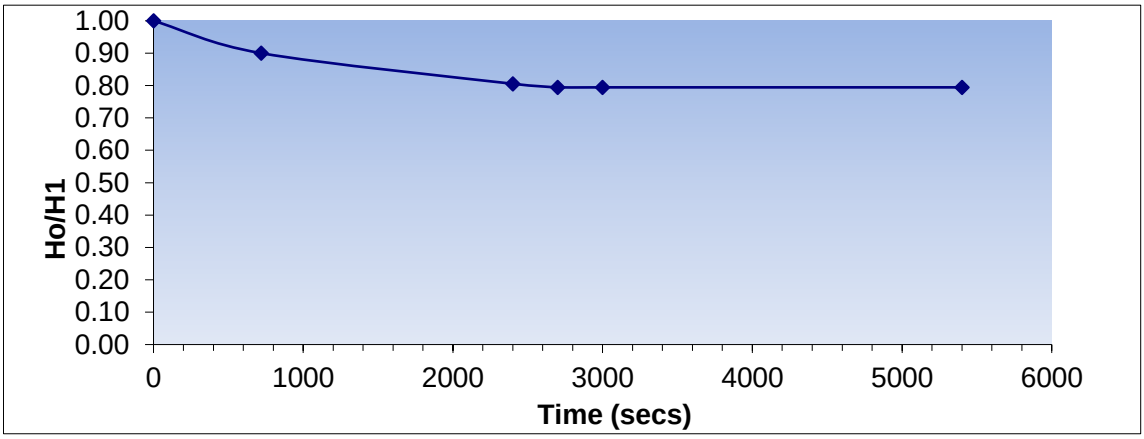
Coefficient of Permeability, k = **1.04E-06** m/s

Falling Head Test

Borehole: WS210 **Test No:** 1

Contract No:	12-757	Casing Diameter: (m)	0.05
Contract Title:	New Smithfield Market	Height of Casing:	0
Date of Test:	26/05/2020	Depth of Borehole: (m)	1.80

Recorded Time			Total Time			H/Ho
Hours	Minutes	Seconds	(secs)	Depth (m)		
0	0		0	0	0	1.0000
0	12		720	0.18	720	0.9000
0	40		2400	0.35	2400	0.8056
0	45		2700	0.37	2700	0.7944
0	50		3000	0.37	3000	0.7944
0	90		5400	0.37	5400	0.7944
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000
0			0		0	1.0000



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 appropiate.

H_1 =	0.9	t_1 =	720
H_2 =	0.7944	t_2 =	3000
		F=	1.7

A = 0.00196349 m^2

Coefficient of Permeability, k = **1.56E-06** m/s