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Victory Street
Liverpool

Phase II Interpretative Ground Assessment

30669-SUT-ZZ-00-RP-G-702-0002 (PHASE 2 GROUND
ASSESSMENT REPORT)

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SUTCLIFFE INVESTIGATIONS

Phase II Interpretative Ground Assessment

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FOREWORD (Geotechnical and Environmental Assessment)

This report has been prepared for the sole internal use and reliance of the Client named on page 1. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Sutcliffe Investigation; such authorisation not to be unreasonably withheld. If any unauthorised third party comes into possession of this report, they rely on it at their risk and the authors owe them no duty of care and skill.

The report presents observations and factual data obtained during our site investigation and provides an assessment of Geotechnical and environmental issues with respect to information provided by the Client regarding the proposed development. Further advice should be sought from Sutcliffe Investigation prior to significant revision of the development proposals. Primary aims of this exploratory phase of investigation were to identify salient geotechnical and environmental issues affecting the site to enable the client to obtain budget costs for the necessary site preparatory and remedial works.

The report should be read in its entirety, including all associated drawings and appendices. Sutcliffe Investigation cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context.

The findings and opinions conveyed in this report (including review of any third-party reports) are based on information obtained from a variety of sources as detailed within this report, and which Sutcliffe Investigation believes are reliable. All reasonable care and skill have been applied in examining the information obtained. Nevertheless, Sutcliffe Investigation cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

The report represents the findings and opinions of experienced Geotechnical and environmental consultants. Sutcliffe Investigations does not provide legal advice and the advice of lawyers may also be required.

Intrusive investigation can only investigate shallow ground beneath a small proportion of the total site area. It is possible therefore that the intrusive investigation undertaken by Sutcliffe Investigation, whilst fully appropriate, may not have encountered all significant subsurface conditions. Any opinions expressed as to the possible configuration of strata between or below exploratory holes are for guidance only and no responsibility is accepted as to its accuracy.

It should be borne in mind that the timescale over which the investigation was undertaken might not allow the establishment of equilibrium groundwater levels. Particularly relevant in this context is that groundwater levels are susceptible to seasonal and other variations and may be higher during the wetter periods than those encountered during this commission.

Where the report refers to the potential presence of invasive weeds such as Japanese Knotweed, or the presence of asbestos containing materials, it should be noted that the observations are for information only and should be verified by a suitably qualified expert.

This report assumes that ground levels will not change significantly from those existing at present. If this is not to be the case, then some modification to this report may be required.

It should be noted that the banning of the co-disposal of hazardous and non-hazardous waste was introduced in 2011, as a result of the implementation within the UK of the Landfill Directive. This will considerably affect the current practices and procedures for the handling and disposal of wastes, in particular hazardous wastes. In addition, it will be a requirement for all wastes to be pre-treated and to comply with certain waste acceptance procedures prior to sending wastes to landfill. The full potential effects of these important changes are not known at this stage, but it is perceived that disposal costs will rise, particularly for hazardous wastes, and waste pre-treatment may, in some cases, become an 'additional' redevelopment cost with regard to the remediation of contaminated sites.

Should this report recommend that materials could be excavated and removed off site for landfill disposal, then it should be noted that the costs, timescales and implications of the pending changes to waste management legislation couldn't be predicted at this stage. Sutcliffe Investigation will not be responsible for changing practices, etc that may affect the viability of necessary remedial actions or of the implications of potential alternative treatment techniques.

Sutcliffe Investigation reserves the right to amend their conclusions and recommendations in the light of further information that may become available. General notes and limitations relevant to all Sutcliffe Investigations are described in the Foreword and should be read in conjunction with this report.

Executive Summary

INTRODUCTION	Sutcliffe Investigations was instructed by One Manchester Limited to undertake a Phase I Preliminary Risk Assessment (PRA) of the site known as Victory Street, Manchester, M14 5WP. This report assesses the ground based geotechnical and environmental risks, constraints and liabilities associated with the proposed development of the site. This is required in support of the discharge of contaminated land planning conditions assigned to the site and to allow the design of economic foundation solutions.
SITE DESCRIPTION	The site comprises a vacant plot of land. The site is centred on National Grid Reference (NGR) 385060, 395080 and is approximately 0.07ha in area. It can be accessed from Victory Street to the east of the site.
DEVELOPMENT PROPOSAL	The proposed layout is for the construction of 4No. two storey houses with gardens and associated car parking facilities.
PRELIMINARY CONCEPTUAL MODEL	The earliest available historical map (1848) indicated that in the northern and southern parts of the site a building was noted. By the 1891 map edition the southern part of the site only notes to be occupied by a building. By circa 1907 a glass house is noted along the eastern boundary of the site, which is no longer mapped by circa 1922 to 1923 where 2No. glass houses are noted towards the western boundary. By circa 1949 to 1958 no buildings are mapped, presumed to be demolished, and the site is vacant. The site remains consistent until present day. Note: Upon reviewing the historical information there could be a potential for UXO risk onsite in relation to WWII bomb damage. This is identified through the absence of various buildings between pre WWII historical maps and the next available map post war (circa 1950 to 1957) both onsite and within the surrounding area. Although it is Sutcliffe's professional opinion that UXO potential to have a significant risk to the site is low, it cannot be fully discounted. The potential for significant contamination to have arisen at the site as a result of the current and former usage on site is considered to be low. Potential contaminants associated with such activities may comprise a wide range of metals, fuels, oils, acids, alkalis and asbestos.
PREVIOUS WORKS	Sutcliffe's have completed a Phase I Desk Study, a synopsis of which is provided in Section 2 of this report. No other previous studies are known to have been undertaken to Sutcliffe's knowledge.
SITE INVESTIGATION	Site work was undertaken on 28th January 2020 and consisted of: • 4No. Window Sample Holes. • Contamination samples from various depth in the made ground. • Leachate samples. • Gas monitoring wells. • Monitoring of ground gas / ground water with installed locations (Sutcliffe's 2020).
GROUND CONDITIONS	Made Ground: The made ground, comprises of topsoil encountered within all locations from ground level to a maximum depth of 0.30mbgl, consisting of grass over dark brown fine to medium SAND with root material. Underlying this is dark brownish light grey slightly ashy fine to medium grained SAND with fine to coarse brick fragments, encountered within all locations with the exception of WS102, to depths between 0.10m-1.50m bgl. Greyish brown mottled yellow sandy CLAY with brick fragments was encountered within WS101 only between 0.80-1.00mbgl. Natural Ground: Natural ground comprised of firm to very stiff brownish orange gravelly sandy CLAY with occasional coal fragments and mudstone encountered within all locations between depths of 1.00-5.45mbgl. Firm to very stiff brownish reddish sandy silty CLAY was encountered within WS101 and WS102 only between depths of 0.10-4.00mbgl.
GROUNDWATER	Groundwater was recorded in WS102 only at 3.00m during site investigation works, identified in association with perched water.

ENVIRONMENTAL RISK ASSESSMENT	Long Term Human Health - Elevated levels of Lead, Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenzo(ah)anthracene all indicate the presence of site wide contamination that will require remediation to be safe for Human Health. This will require the removal of material from site and the importing of clean tested material to create a capping break layer in garden areas on site, with hardcover providing a break layer in other areas of the site. Controlled Waters Risk Assessment - For controlled waters there are two assessment criteria, the Environmental Quality Standard (EQS) and the UK Drinking Water Standard (UKDWS). The UK DWS Leachate screening identified concentrations of Arsenic, Lead and Benzo(a)pyrene that could pose a risk to the Principal aquifer. However, due to the likely depth of groundwater and the effects of natural attenuation, the risk is unlikely to be significant. The EQS Leachate screening identified concentrations of Copper, Lead, Zinc, Sulphide as S, Fluoranthene, Benzo(b)fluoranthene Benzo(ghi)perylene and Indeno(123)pyrene that could pose a risk to the local surface water features. However, there are no surface water features within 250m of the site, as such the risk is unlikely to be significant.
ASBESTOS	No asbestos fibres were identified within any of the samples tested.
GROUND GAS RISK ASSESSMENT	Using CIRIA C665 – Assessing risks posed by hazardous ground gases to buildings the NHBC Traffic Light classification for the site is Amber 1, indicating that protective measures are required as part of the groundfloor design.
RADON	The site is not in a Radon Affected Area, as less than 1% of properties are above the Action Level. No radon protective measures are necessary.
GEOTECHNICAL ASSESSMENT	General - It is understood that consideration is being given to the development of 4No. two storey houses with gardens and associated car parking facilities. Due to the ground conditions encountered it would be Sutcliffe's recommendation that a piled foundation solution is adopted due to the poor ground conditions encountered (within WS102) and due to the close proximity of high water demand trees, in accordance with NHBC Chapter 4.2. Final pile design will be undertaken by a specialist piling contractor. Limited groundwater ingress was recorded during site investigation works but shallow groundwater levels were encountered during the subsequent monitoring. Sub-surface concrete that is only in contact with Made Ground can be Design Sulphate Class DS-1, with an ACEC Classification of AC-1s. Ground Floor Construction - Based upon the amount of Made Ground noted on site it is not recommended that a ground-bearing slab is utilised on site. Sutcliffe Investigations therefore propose a suspended P.C Unit ground floor be adopted. Geotechnical Uncertainty - Based on historic plans and/or field evidence, as the site has been subject to previous development there is potential for relic foundations, obstructions or basements etc. to be present on the site.
RECOMMENDATIONS	The following actions are recommended: • Design a Phase III Remediation & Validation Proposal for submission to planning department. • Design SMMP – management of material on and off site. • Good hygiene practices should be employed during construction work, in addition, the findings of this investigation should be included within the contractors H&S file and an assessment of risks associated with short term human health completed. No consumption of food or smoking should occur without prior hand washing. If dust is encountered, dust masks should be worn and dust suppression employed.

NOTE: The executive summary is an overview of the key findings and conclusions of the report. There may be other information contained in the body of the main report which puts into context the information presented within the executive summary. No reliance should be placed on the executive summary.

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1 Introduction

1.1 Terms of Reference

Sutcliffe Investigations was instructed by One Manchester Limited to undertake a Phase I Preliminary Risk Assessment (PRA) of the site known as Victory Street, Manchester, M14 5WP.

The location of the site is presented as *Figure 1*. The site is centred on National Grid Reference (NGR) 385060, 395080 and is approximately 0.07ha in area. An aerial photograph of the site is presented as *Figure 2*.

This report assesses the ground based geotechnical and environmental risks, constraints and liabilities associated with the proposed development of the site. This is required in support of the discharge of contaminated land planning conditions assigned to the site and to allow the design of economic foundation solutions.

1.2 Development Proposal & Legislative Context

Development Proposal

The proposed layout is shown in Bowker Sadler Architecture *Drawing (Ref: 18-042-0003-A)*. This report has been prepared in support of a planning application to develop the site for 4No. two storey houses with gardens and associated car parking facilities.

Sutcliffe projects have not been provided with any information relating to a proposed change in site levels. Therefore, it is anticipated that existing site levels will be retained to facilitate the proposed development option.

Legislative Context

The presence of contaminants which may pose a risk to human health or the environment is a material planning consideration. For planning it should be considered whether the site is suitable for its new use, and the responsibility for securing a safe development (including cumulative effects of pollution on health, and the potential sensitivity of the proposed development to adverse effects from pollution,) rests with the developer and/or landowner. Planning is concerned with the site's proposed use not its current use, where the amount of contamination is expected to be low relative to the level of risk. This is the opposite to Part 2A which considers high levels (significant harm) and the current use of the site.

Section 57 of the Environment Act 1995, adds Part 2A (ss.78A-18YC) to the Environmental Protection Act 1990 and contains the legislative framework for identifying and dealing with contaminated land. Where development is

undertaken on land which may be affected by contamination, the National Planning Policy Framework, paragraphs 120 to 122 considers pollution and remediation. This links the contaminated land regime within the development process.

For there to be an environmental liability associated with the site there must be a perceived source (a contaminant), a receptor (humans, living organisms or property) and a pathway between them. The potential presence of all of these aspects would result in a complete contaminant linkage.

In accordance with environmental legislation and the associated guidelines, assuming the site is to be redeveloped as housing, it should be noted that any redevelopment of the site could actually create new pathways that could increase the liabilities associated with the site. In addition, the basis of the intrusive ground assessment is to refine the preliminary conceptual model.

1.3 Site Location and Setting

The site is located at Victory Street, Manchester, M14 5WP at National Grid Reference (NGR) 385060, 395080 (*Figure 1*), and is approximately 3.33km south east from Manchester City Centre. It is surrounded on its western boundary by a recreational ground and school, on its remaining boundaries by residential properties with some local amenities and religious facilities.

A location plans and aerial photograph of the site are shown as *Figure 1 & 2*.

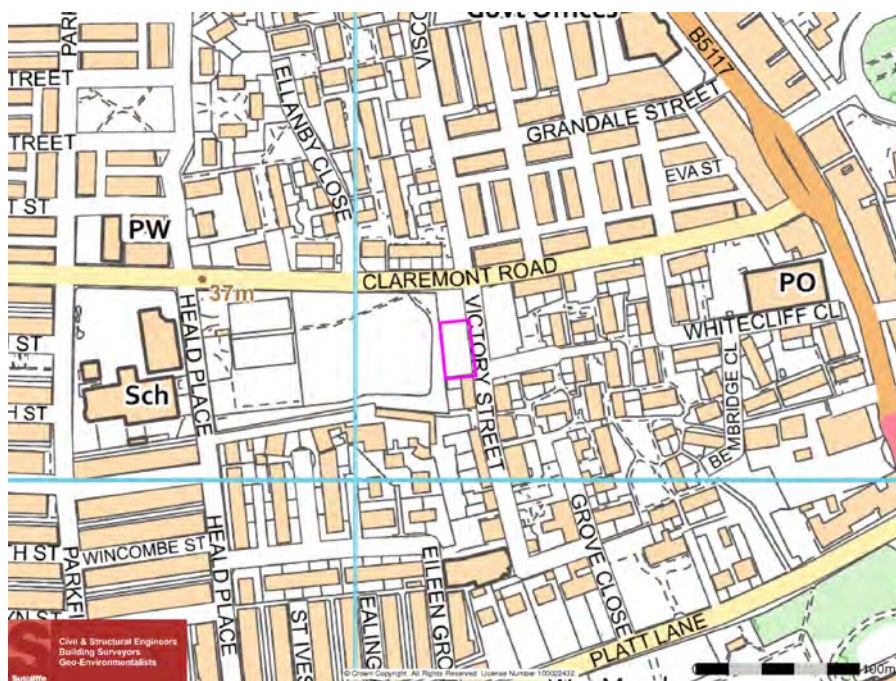


Figure 1: General Location of Site

1.4 Site Description and Layout

The site is square in shape and can be accessed via Victory Street to the east of the site. The site is relatively flat and in accordance with the surrounding topography. Bollards are noted along the eastern boundary and dense vegetation including trees are noted along the western boundary. The surfacing predominantly comprises of rough grass and mud. The site is currently undeveloped.

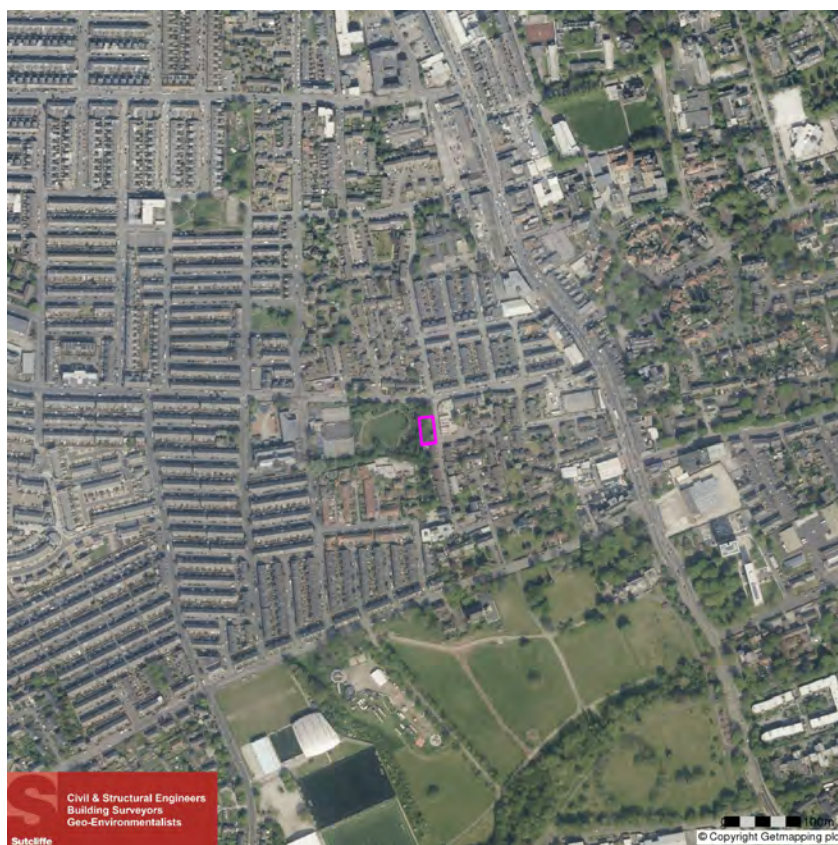


Figure 2: Aerial Photograph of the Site

1.5 Previous Studies

Sutcliffe's have completed a Phase I Preliminary Risk Assessment (PRA). (Report Reference: 30669-SUT-ZZ-00-RP-G-701-0001 (PHASE 1 REPORT)), a synopsis of which is provided in Section 2 of this report. No other previous studies are known to have been undertaken to Sutcliffe's knowledge.

1.6 Objectives & Scope of Assessment

The aim of the intrusive ground investigation is to identify potential geotechnical & environmental liabilities and constraints, associated with the development of the site area in support of the following:

- A planning application and the discharge of contaminated land conditions where reasonably practicable that may have been assigned to the site and to include the design of a remediation scheme, if required as part of the National Planning Policy Framework (NPPF).
- To assess the likelihood of reuse of materials that are site won or disposal options for surplus material.
- The preliminary design of detailed and economic foundations options inclusive of all information and specifications relating to foundation types, the location of underlying rock, (if encountered), preparation of ground, concrete grades, reuse of materials for both the proposed building, and the existing foundations.

2 Preliminary Conceptual Risk Assessment

2.1 Introduction

The Phase I PRA completed by Sutcliffe is summarised below. This report should be read in conjunction with *Report Ref.: 30669-SUT-ZZ-00-RP-G-701-0001 (PHASE 1 REPORT)*.

2.2 Site History

The earliest available historical map (1848) indicated that in the northern and southern parts of the site a building was noted. By the 1891 map edition the southern part of the site only notes to be occupied by a building. By circa 1907 a glass house is noted along the eastern boundary of the site, which is no longer mapped by circa 1922 to 1923 where 2No. glass houses are noted towards the western boundary. By circa 1949 to 1958 no buildings are mapped, presumed to be demolished, and the site is vacant. The site remains consistent until present day.

Note: *Upon reviewing the historical information there could be a potential for UXO risk onsite in relation to WWII bomb damage. This is identified through the absence of various buildings between pre WWII historical maps and the next available map post war (circa 1950 to 1957) both onsite and within the surrounding area. Although it is Sutcliffe's professional opinion that UXO potential to have a significant risk to the site is low, it cannot be fully discounted.*

With the exception of made ground potentially being present on site, no significant identifiable sources of environmental concern were identified. The potential for significant contamination to have arisen at the site as a result of the current and former usage on site is considered to be low. However, the possibility of contamination albeit likely to be localised cannot be discounted. Potential contaminants associated with such activities may comprise a wide range of metals, fuels, oils, acids, alkalis and asbestos.

The proposed development for the site is for 4No. two storey houses with gardens and associated car parking facilities.

2.3 Geotechnical Constraints

Coal Mining & Brine Subsidence

The site does not fall within a coal mining and / or a Brine Subsidence Areas. No further action is required.

Geology

There are no records of any artificial ground onsite however there is one record of artificial ground within 500m of the site located approximately 359m west of the site and is noted as Infilled Ground (Artificial Deposit).

The superficial deposits for the site are noted as Devensian Till (Diamicton) and the solid geology is noted as Chester Formation (sandstone).

No faults are noted within 500m of the site.

Historical Land Use

The site has been subject to previous development and therefore, the potential for relic foundations, basements and obstructions cannot be discounted.

2.4 Potential Contaminant Linkages

Sources

The likely contaminants from made ground associated with former site usage, infilling activity which may be present on site could include: heavy metals such as cadmium, chromium, copper, lead, nickel and zinc, asbestos, hydrocarbons and organic compounds such as Polycyclic Aromatic Hydrocarbons (PAHs). Furthermore, ground gases such as methane and carbon dioxide may be generated from areas of made ground material.

Although several potentially contaminative activities have taken place within the surrounding area, including the historic boot and metal polish works (36m east) and the unnamed works (7m west), the potential for contamination to have a significant risk to the site is deemed as low.

Therefore, the potential for off-site sources of contamination to impact the site is considered low.

The likely contaminants from previous land uses are shown below in *Table 2.1*.

Table 2.1: Potential Source(s) of contamination

Reference	Potential Sources (Onsite)	Potential Contaminants
S1 – Onsite	Made Ground (including demolition material)	All metals, fuel, TPH, , PAHs, asbestos and localised ground gas.

Receptors

The most sensitive receptors identified using the conceptual site model are considered to be site and adjacent site users, construction and maintenance

workers, controlled waters (Principal Aquifer and Secondary Undifferentiated Aquifer), infrastructure and buried services. These are most likely to be affected by made ground and any associated contaminants and gas generated from made ground, if present on site.

Human receptors would comprise construction workers, future site users and adjacent site users. It is likely that the exposure to contamination by construction workers will be limited due to the short exposure to the potential contamination and the use of PPE. If ground gases are produced this could be a potential risk to the future site users and properties and workers in confined spaces / trenches etc.

Due to the potential for contaminants to be present on site there is the potential for contaminants to leach and migrate to the underlying Principal Aquifer. Drift material is noted to be present under the site and is classified as Secondary Undifferentiated Aquifer; this will act as an aquiclude, reducing the risk to the underlying aquifer.

Table 2.2 below details the potential receptors.

Table 2.2: Receptors

Ref	Receptor	Description
R1	Current & future site users	Site users; personnel, general workers and maintenance workers.
R2	Construction Workers	Contractors working on the development of the site. Construction workers, maintenance workers or other personnel who may be directly exposed to contaminated materials in the course of their activities).
R3	Controlled Waters	Principal Aquifer and Secondary Undifferentiated Strata and on site drainage.
R4	Adjacent Site Users	Adjacent site users. Third-party land (i.e. the possibility of contamination migrating off-site onto third party land via contaminated groundwater, surface water run-off).
R5	Infrastructure / Buried services	Proposed buildings and buried services.

Pathways creating contaminant linkages

Table 2.3: Pathways

Ref	Pathway	Description
P1	Direct contact with potential contaminants.	Dermal absorption, ingestion and inhalation of contaminants via direct contact.
P2	Ingestion of potential contaminants.	Construction workers may come into contact during the site works. However, this will be for a short time and therefore limited exposure will occur. PPE can be used. Construction workers may come into contact during the site works, however this will be for a short time and therefore limited exposure will occur. PPE can be used and worn as a precaution to reduce the risk.
P3	Inhalation of potential contaminants.	
P4	Leaching and migration of contaminants.	Leaching of possible contaminants could migrate into the underlying Principal Aquifer via shallow groundwater. On site drainage is also at risk from shallow contamination, if present.
P5	Vertical and lateral migration of ground gases / vapours.	There is the potential for contaminants to be present on the site, which could generate ground gas & vapours on site.

2.5 Risk Evaluation

Each potential contaminant linkage is identified in *Table 2.4* below. An evaluation of the risk that each contaminant linkage poses to the project (as identified in the *Section 2*) has been undertaken, in general accordance with CIRIA guidance document C552, 2001 (as detailed in *Appendix B*).

The evaluation and the resultant actions identified are based on the available information presented within this report. A visual representation of the Preliminary CSM is presented as *Figure 3*.

The evaluation and resultant actions identified are based on available information presented within the Phase I PRA (*Report reference: 30669-SUT-ZZ-00-RP-G-701-0001 (PHASE 1 REPORT)*).

During the development there is a potential for short term human health risk to construction workers. These should be assessed and anticipated by the contractor under CDM Regulations 2015.

Table 2.4: Preliminary Risk Evaluation of Potential Contaminant Linkages

1. Hazard Identification		2. Hazard Assessment				3. Risk Estimation		4. Risk Evaluation	5. Managing the Risk
Contaminant Source		Pathway		Receptor		Consequence of risk being realised	Probability of risk being realised	Classification	Action required
S1	Made Ground (including demolition material)	P1	Dermal contact	R1/2	Site users	Medium	Low	Moderate / Low	It is possible that harm could arise to a designated receptor from an identified hazard. Investigation is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
		P2	Ingestion of soil / soil dust	R1/2	Site users	Medium	Low	Moderate / Low	
		P3	Inhalation of vapours / soil gas	R1/2	Site users	Severe	Unlikely	Moderate / Low	
		P4	Leaching and migration of contaminants	R3/5	Principal aquifer	Medium	Low	Moderate / Low	
		P5	Lateral migration of soil gas / vapours	R1	Site users	Severe	Unlikely	Moderate / Low	
				R4	Property	Severe	Unlikely	Moderate / Low	

3 Ground Investigation

3.1 Design Rationale

The aim and design of the ground assessment is to satisfy planning conditions assigned to the site by reference to the National Planning Policy Framework (NPPF). This will identify elevated concentrations of determinants with the aim of assessing long term human health risks to site users and groundwater resources. In addition, the works have been designed to allow the design of economic foundation solutions for the proposed new builds.

3.2 Fieldwork

Field works were undertaken on 28th January 2020 by PM Sampling, a specialist ground investigation contractor. All works were supervised by a suitably qualified Sutcliffe engineer. The investigation was carried out in general accordance with the following standards:

- *BS10175:2011+A2:2017 Investigation of Potentially Contaminated Sites – Code of Practice;*
- *R&D Technical Report P5-066/TR Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, 2001 (Environment Agency).*
- *BS 5930:2015 Code of practice for site investigations; and,*
- *BS EN ISO 22475-1:2006 Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution.*

Window sample logs collated as part of the ground investigation completed by Sutcliffe's are presented in *Appendix C*.

3.3 Health & Safety

Service plans for the development site have been obtained and are included as part of the Phase I PRA. A copy of these plans are maintained on site by the Sutcliffe engineer who is also responsible for clearing the areas to be investigated by use of a Cable Avoidance Tool (CAT) and signal generator (Genny).

3.4 Sampling Strategy

Due to the history of the site, with limited development having occurred, a non-targeted sampling strategy was used to obtain a site wide representation of the site and the potential contamination issues.

The site area is $700\text{m}^2 \div 4 \text{ sample positions} = 175\text{m}^2 \div 0.8 = 218.75$

$\sqrt{218.75\text{m}^2} = \text{a } 14.79\text{m grid.}$

Therefore this gives an 80% probability of finding a circular area of interest of 218.75m^2 .

A summary of exploratory hole detailing rationale is shown in *Table 3.1* below.

Table 3.1: Summary of Site Activities

Exploratory Hole ID	Location Rationale	Method	Completed Depth (mbgl)	Installation Details	Testing & Sampling details
WS101	General Site Coverage (GG, HH, CW)	Window Sampler	5.45	Standpipe installed to 4.00m bgl	SPTs, environmental, geotechnical
WS102	General Site Coverage (GG)	Window Sampler	5.45	Standpipe installed to 3.00m bgl	SPTs, Shear Vane, environmental, geotechnical
WS103	General Site Coverage (HH, CW)	Window Sampler	5.45	No installation	SPTs, Shear Vane, environmental, geotechnical
WS104	General Site Coverage (GG, HH, CW)	Window Sampler	5.45	Standpipe installed to 1.50m bgl	SPTs, environmental, geotechnical

GG – Ground Gas / CW – Controlled Water / HH – Human Health

A plan detailing the position of sampling locations on a proposed layout of the site is presented as *Drawing No 30669 – 700 – P1*.

3.5 Chemical Laboratory Testing

Selected soil samples (made ground) were collected at various depths and horizons and submitted for chemical analysis, details of which are presented in *Table 3.2*.

Table 3.2: Summary of Soils Analysis (Total & Leachate Concentrations)

Suite Reference	Analysis Suite
Soils Suite – Suite 2	<i>Metals suite, speciated (16) polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons according to the Total Petroleum Hydrocarbon Working Group (TPHCWG), asbestos screen, total cyanide, phenols and soil organic matter.</i>
Leachate – total	<i>Metals suite, speciated (16) PAHs.</i>

All samples were stored in airtight containers appropriately labelled and transported in cool boxes with icepacks maintained at 4°C, under completed chain of custody documentation to Envirolab laboratories.

All samples were analysed by MCERTS accredited soil analysis laboratory Envirolab under UKAS accredited methods. All samples have been taken in accordance with current British Standards.

Envirolab are appropriately accredited for the works required and are an approved supplier under the Sutcliffe's Quality Management System.

Analytical test certificates are presented in *Appendix D*.

TPH Speciated aromatic and aliphatic bands with BTEX analysis have been carried out in line with the TPHCWG. The toxicity and migration risk associated with a TPH is dependent on the specific aliphatic aromatic carbon banding. Of particular concern are the low molecular weight compounds, which are highly mobile and show a greater level of toxicity than the higher molecular weight compounds. Therefore a low TPH consisting of low molecular weight aliphatic and aromatic carbon banding compounds may present more of a risk than a high TPH consisting of heavy weight aliphatic and aromatic carbon banding compounds.

Based on the TPHCWG the aromatic band C5 – C7 is considered to consist only of Benzene and the aromatic band C7 – C8 of Toluene. Therefore, the more specific BTEX analysis has been used for risk assessment rather than the aromatic bands.

3.6 Drainage

It is recommended that the client / developer contact United Utilities with respect to capacity in existing foul and surface water sewers in the vicinity of the development area.

3.7 Water Supply

Please note the testing suite carried out for this site is for human health purposes and may not cover the suite of contaminants required by United Utilities for pipe selection and therefore further testing may be required.

3.8 Services

It is recommended that the client / developer contact the relevant service provided to ascertain the requirements for power reinforcement and / or relocation / diversion of existing services.

4 Ground Model

4.1 General

The following section describes the ground conditions encountered during the intrusive ground assessment completed by Sutcliffe. The ground comprises from ground level to a maximum depth of 1.50mbgl of made ground, overlying firm to very stiff brownish orange gravelly sandy CLAY with occasional coal fragments and mudstone and firm to very stiff reddish brownish orange silty sandy CLAY.

A summary of the strata depths and thicknesses is detailed in *Table 4.1*.

Table 4.1: Ground Conditions Encountered

Strata	Depths encountered (mbgl)		Thickness (m)		
	Min	Max	Min	Max	Average
Made Ground	0	1.50	0.10	1.20	0.45
Firm to very stiff brownish orange gravelly sandy CLAY with occasional coal fragments and mudstone.*	1.00	5.45*	0.70	4.45	2.37*
Firm to very stiff brownish reddish sandy silty CLAY.	0.10	4.00	0.40	1.20	0.80

* Final Depth of Strata not proven, average thickness on identified ground.

4.2 Made Ground

The made ground, comprises of topsoil encountered within all locations from ground level to a maximum depth of 0.30mbgl, consisting of grass over dark brown fine to medium SAND with root material. Underlying this is dark brownish light grey slightly ashy fine to medium grained SAND with fine to coarse brick fragments, encountered within all locations with the exception of WS102, to depths between 0.10m-1.50m bgl. Greyish brown mottled yellow sandy CLAY with brick fragments was encountered within WS101 only between 0.80-1.00m bgl.

Table 4.2: Material Properties MADE GROUND

Property	No. of Tests	Range	Average
SPT N Values	1	11	11

The characteristic values for the made ground are shown below in *Table 4.2* and *Plate 1*.

4.3 Natural Ground

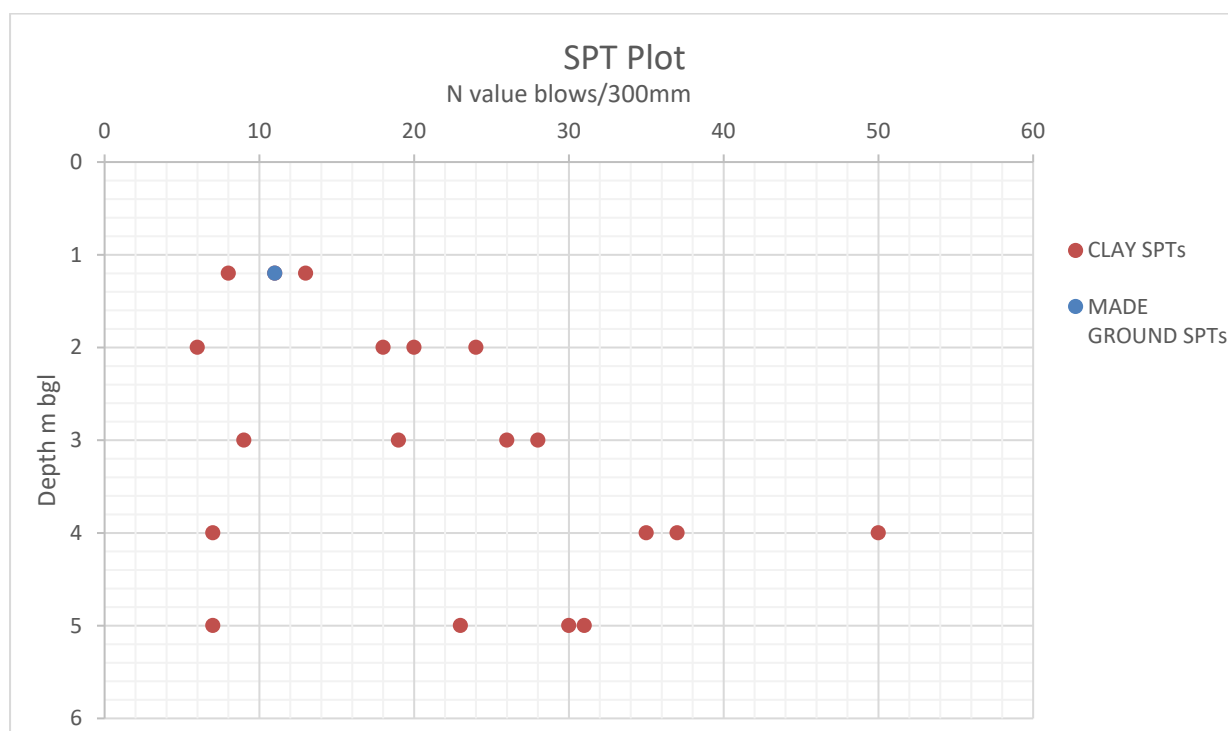
Natural ground comprised of firm to very stiff brownish orange gravelly sandy CLAY with occasional coal fragments and mudstone encountered within all locations between depths of 1.00-5.45m bgl. Firm to very stiff brownish reddish sandy silty CLAY was encountered within WS101 and WS102 only between depths of 0.10-4.00m bgl.

The characteristic values for the natural ground are shown below in *Table 4.3* and for both the natural ground and made ground in *Plate 1*.

Table 4.3: Material Properties CLAY

Property	No. of Tests	Range	Average
SPT N Values	19	6-50	21.16

Plate 1: Material Properties MADE GROUND & NATURAL GROUND



4.4 Field Evidence of Contaminated Soils

Field evidence of contamination was identified across site in the form of made ground encountered to depths of between 0.10-1.50m bgl.

4.5 Groundwater

Groundwater was recorded in WS102 only at 3.00m during site investigation works, identified in association with perched water.

In accordance with the agreed scope of works monitoring of groundwater installations completed by Sutcliffe's (2020) will be undertaken using an electronic ATEX Dipmeter on six occasions, results of which are presented in *Table 4.4*.

Table 4.4: Groundwater Monitoring Data

Location	Water Level (m bgl)					
	04.02.2020	26.02.2020	05.03.2020	01.04.2020	27.04.2020	06.05.2020
WS101	0.82	0.78	0.74	0.81	1.80	1.79
WS102	0.65	0.70	0.87	0.97	WELL OBSTRUCTED	0.97
WS104	DRY	0.79	0.86	0.89	1.00	1.08

Based on the Resting Groundwater Levels (RWLs) no discernible groundwater flow has been recorded.

A full set of groundwater monitoring data is presented as *Appendix E*.

5 Geotechnical Laboratory Testing and Assessment

General

In total four samples were recovered from site for the purpose of geotechnical laboratory testing from the following positions WS101 – WS104. A breakdown of the testing scheduled is set out in *Table 5.1* below.

Table 5.1: Geotechnical Testing

Borehole Number	Depth From (m)	Depth To (m)	Plasticity Index	Triaxial	Moisture Content	Particle Size Distribution
WS101	1.00	2.00	✓	✓	✓	
WS102	1.00	2.00	✓	✓	✓	
WS103	1.00	2.00				✓
WS104	1.00	2.00	✓	✓	✓	

Plasticity Index

A total of 3 samples were tested to determine the plasticity index of the underlying CLAY strata spread across WS101, WS102 and WS104 and taken from depths of between 1.00-2.00m bgl. The plasticity results and the modified plasticity index are outlined in *Table 5.2* below.

Table 5.2: Plasticity Test Results

Borehole Number	Depth From (m)	Depth To (m)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Modified Plasticity Index (%)	Soil Classification
WS101	1.00	2.00	19	43	17	26	95	24.70	CI
WS102	1.00	2.00	22	37	19	18	93	16.74	CI
WS103	1.00	2.00	22	47	19	28	95	26.60	CI

The results indicate that the underlying CLAY is intermediate/medium plasticity. Plasticity test results are included in *Appendix F*.

Desiccation Analysis

Based upon the plasticity results outlined above an inferred desiccation classification is set out below in *Table 5.3* this is based upon the 'Driscoll Rule' and is being used only to give a guide on whether the material may be desiccated. Where the result is either showing the ground to be desiccated or close to being classified as being desiccated additional desiccation testing is recommended to determine the true desiccation of the sampled material.

Table 5.3: Inferred Desiccation Analysis

Borehole Number	Depth From (m)	Depth To (m)	W (%)	0.4W _L (%)	Inferred Desiccation Result
WS101	1.00	2.00	19	17.2	Possibly Desiccated
WS102	1.00	2.00	22	14.8	Not Desiccated
WS103	1.00	2.00	22	18.8	Not Desiccated

Based upon this analysis the CLAY on site considered to not be desiccated within WS102 and WS103 and possibly desiccated within WS101. Therefore, additional desiccation testing may be required in the area of WS101 to determine if the ground is desiccated in this area.

Triaxial Testing

Triaxial testing was scheduled on 3 samples recovered from site spread across WS101, WS102 & WS104. The results of this testing is outlined below in Table 5.4.

Table 5.4: Triaxial Test Results

Borehole Number	Depth From (m)	Depth To (m)	Undrained Shear Strength (kPa)		
			Stage 1	Stage 2	Stage 3
WS101	1.00	2.00	234	253	260
WS102	1.00	2.00	43	51	60
WS103	1.00	2.00	150	161	163

The results of this testing indicate that the ground conditions are variable across the site, with the upper layer of clay strata being variable.

Particle Size Distribution

PSD testing was scheduled on 1No. sample recovered from WS103. The result of this testing is outlined below in Table 5.5.

Table 5.5: PSD Test Results

Borehole Number	Depth From (m)	Depth To (m)	Sieve Percentage (%)		
			Gravel	Sand	Silt/Clay
WS103	2.00	3.00	4	23	73

The results of this testing indicate that the sample from WS103 is noted as a dark brown grey slightly gravelly very sandy CLAY.

Hand Vane Testing

No laboratory hand vane tests were scheduled, however in situ shear vanes were completed within WS102 and WS103 on site. The results of this testing are outlined below in *Table 5.6*.

Table 5.6: Hand Vane Test Result

Borehole Number	Depth (m)	Average Reading (kPa)
WS102	2.80	78
	3.80	70
	4.80	70
WS103	2.80	130
	3.80	130
	4.80	130

Due to the nature of the ground conditions encountered, in situ shear vanes were only completed at two locations during site works, WS102 & WS103. All the sets of testing carried out at these two locations indicated an average reading of between 70kPa and 130kPa.

Stability

No evidence of instability was noted in the exploratory holes that were undertaken on site, however it is noted that these were only small diameter holes and that due to the amount of made ground noted on site shoring would likely be required if any groundworks are to be left open during site works.

Soluble Sulphate and pH

It is envisaged foundations will extend through the Made Ground and into the natural strata and samples taken from the Made Ground have been submitted for pH and water-soluble sulphate (2:1 soil/water extract) analysis.

The highest water-soluble sulphate concentration and the lowest pH value for the Made Ground is shown in *Table 5.7*.

Table 5.7: Soluble sulphate and pH classification

Soil Type	Lowest pH Values	Highest Soluble Sulphate Concentration (g/l)
Made Ground	8.13	0.04

Therefore, in accordance with Table C2 of BRE: Special Digest 1 2005, sub-surface concrete that is in contact with Made Ground should be Design Sulphate Class **DS-1**, with the ACEC classification of **AC-1s**.

A complete set of geotechnical laboratory certificates are presented in *Appendix F*.

5.1 Foundation Recommendations

General

It is understood that consideration is being given to the development of 4No. two storey houses with gardens and associated car parking facilities.

Due to the ground conditions encountered it would be Sutcliffe's recommendation that a piled foundation solution is adopted due to the poor ground conditions encountered (within WS102) and due to the close proximity of high water demand trees, in accordance with NHBC Chapter 4.2. Final pile design will be undertaken by a specialist piling contractor.

Limited groundwater ingress was recorded during site investigation works but shallow groundwater levels were encountered during the subsequent monitoring.

Sub-surface concrete that is only in contact with Made Ground can be Design Sulphate Class DS-1, with an ACEC Classification of AC-1s.

Ground Floor Construction

Based upon the amount of Made Ground noted on site it is not recommended that a ground-bearing slab is utilised on site. Sutcliffe Investigations therefore propose a suspended P.C Unit ground floor be adopted.

Designated Concrete Mixes

The following designated mix in accordance with BRE Special Digest SD1 and BS 8500: Part1: 2015 will be suitable for use on this site.

Table 5.8: Designated Concrete Mixes

Application	DS-1 Conditions (Made Ground and Natural) ACEC Class AC-1s
Unreinforced strip / trench fill footings	GEN1
Reinforced strip / trench fill footing (mesh reinforcement)	RC30
Reinforced strip / trench fill footings (rebar etc)	RC30
Unreinforced concrete floor slabs	GEN2
In situ reinforced concrete floor slabs	RC30

*Note: Although RC 30 is in line with BS8500, Sutcliffe Investigation recommend the use of RC35 for concrete used in structurally sensitive works, to provide greater certainty of compliance with strength verification tests. Tolerable mixes dispatched by a batching plant are +/- 10%, and delays on site can also result in deterioration of the concrete.

5.2 Geotechnical Uncertainty

Based on historic plans and/or field evidence, as the site has been subject to previous development there is potential for relic foundations, obstructions or basements etc. to be present on the site.

6 Long Term Human Health Risk Assessment

6.1 Soils – Long Term Human Health

Methodology

Based on the Preliminary Risk Assessment and Ground Model for this site, a Generic Quantitative Risk Assessment for human health has been undertaken in accordance with CLR and SR (SC050021 series) (DEFRA) guidance as well as CL:AIRE guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008 and comprises the following:

- *Selection of appropriate generic screening values for human health assessment.*
- *Creation of relevant datasets from which to undertake the assessment.*
- *Assessment of contamination distribution and comparison of site data to screening values using relevant statistical tests (in accordance with CIEH guidance).*
- *Assessment of risks to receptors.*
- *Determination of requirements for further investigation or remediation.*

Selection of Soil Screening Values

Soil screening values appropriate for a *residential with plant uptake* were selected.

Creation of Relevant Datasets

As part of the desk study assessment and Preliminary Conceptual Model, made ground was identified as the principal potential source identified for contamination in the risk evaluation (*Section 2.0*). Consequently the sampling strategy targeted made ground encountered on site.

Assessment

The soil analytical data has been assessed following CL:AIRE/CIEH guidance, CLR11 Model Procedures Section 2.3, and NHBC R&D Publication 66 2008 “*Guidance for the Safe Development of Housing on Land Affected by Contamination*”.

The purpose of human health risk assessment for planning is to decide whether the land is suitable for the proposed end use and does not pose a risk to human health. Therefore, the key question to answer is, “*Is there sufficient evidence that the true mean concentration is less than the critical concentration?*”

Statistics are used to assist in answering the key question raised above and to help decide whether to support a particular hypothesis. The null hypothesis is the starting point because it is believed to be true but needs to be proved.

In terms of planning, the hypotheses are as follows:

- *Null Hypothesis (H0) - the true mean is equal to, or greater than the critical concentration.*
- *Alternative Hypothesis (H1) - the true mean is less than the critical concentration.*

The null hypothesis needs to be rejected in order to confirm that the land does not pose a human health risk and is suitable for use under the planning regime.

Identification of Contaminants of Concern

The results of the soil analysis from the investigation are shown in *Appendix G*. These results were then compared against the relevant GACs for 5% soil organic matter (SOM). The average percentage SOM was 6.5% for 3 samples.

Elevated levels of contamination were recorded in all samples taken from site when assessed against the 5% SOM *residential with plant uptake* values. These are recorded below in *Table 6.1*.

Table 6.1: Statistical Analysis Results for Made Ground Stratum Top 1.00m

Contaminant	Guideline Assessment Value	95% ile	Mean Value Test	Max Value Test	No. of Outliers removed to pass
Lead	200 (C4SL)	1015.63968	Fails	No Outlier	N/A
Benzo(b)fluoranthene	3.7 (LQM 5%)	7.9947723	Inconclusive	No Outlier	N/A
Benzo(a)pyrene	3 (LQM 5%)	6.9197848	Inconclusive	No Outlier	N/A
Dibenzo(ah)anthracene	0.3 (LQM 5%)	0.7079072	Inconclusive	No Outlier	N/A

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There were three exceedances (all the samples) of the Lead screening value (WS101 @ 0.20-0.70m bgl, WS103 @ 0.20-0.60m bgl & WS104 @ 0.30-0.60m bgl). When the three elevated samples from the top 1.00m are ran through the statistical calculator they are shown to be fail with a 5% evidence level, with no outliers in the dataset. Lead is therefore shown to be a site wide issue and will need to be dealt with as part of the remediation of the site during the development.

There was one exceedance of the Benzo(b)fluoranthene screening value (WS101 @ 0.20-0.70m). When this elevated sample from the top 1.00m is ran through the statistical calculator it is shown as inconclusive with a 63% evidence

level, with no outliers in the dataset. Benzo(b)fluoranthene is therefore shown to be a site wide issue and will need to be dealt with as part of the remediation of the site during the development.

There was one exceedance of the Benzo(a)pyrene screening value (WS101 @ 0.20-0.70m). When this elevated sample from the top 1.00m is ran through the statistical calculator it is shown as inconclusive with a 60% evidence level, with no outliers in the dataset. Benzo(a)pyrene is therefore shown to be a site wide issue and will need to be dealt with as part of the remediation of the site during the development.

There was one exceedance of the Dibenzo(ah)anthracene screening value (WS101 @ 0.20-0.70m). When this elevated sample from the top 1.00m is ran through the statistical calculator it is shown as inconclusive with a 56% evidence level, with no outliers in the dataset. Dibenzo(ah)anthracene is therefore shown to be a site wide issue and will need to be dealt with as part of the remediation of the site during the development.

It should be noted that the screening values for Aliphatics EC12-16, Aliphatics EC16-35 and Aliphatics EC35-44 are based upon the theoretical lower saturation limit for the compounds in question. The lower saturation limit has been used for these contaminants as the CLEA calculated SGV/GAC is greater than the lower saturation limit and vapour inhalation is an important contributor to exposure (SR4).

Soil screening tables are shown in *Appendix G*.

Asbestos

No asbestos fibres were identified within any of the samples tested.

Discussion

The statistical analysis indicates that the null hypothesis cannot be rejected for all the contaminants must be accepted for Lead, Benzo(b)fluoranthene, Benzo(a)pyrene & Dibenzo(ah)anthracene. For all other contaminants the alternative hypothesis can be accepted.

Conclusions

Currently the site does pose a risk to human health, and remediation works will be required as part of the development to ensure that the site is suitable for occupation and no longer poses a risk to human health.

Given the extent of the identified contamination a site wide strip will be required to a depth of 600mm, with a capping layer being placed in garden areas to bring site levels back up. It would be anticipated that the remainder of the site that is not formed of gardens/landscaping will be covered by hardstanding, this along

with the capping system would provide a break layer to source pathway receptor linkages.

7 Controlled Waters Risk Assessment

7.1 Methodology

Based on the Preliminary Risk Assessment and Ground Model for this site, a Level 1 Screening Assessment has been undertaken in general accordance with Environment Agency guidance Environment Agency Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, 2006.

The methodology comprises:

- Identification of potential contaminant linkages.
- Selection of appropriate generic screening values for controlled waters.
 - o *Screening measured concentrations of leachate against the generic screening values available for UK Drinking Water Standards (UK DWS) and Environmental Quality Standards (EQS).*
- Assessment of contaminant distribution and risk to receptors.
 - o *Identification of contaminants of concern and relevant contaminant linkages.*
 - o *Identification of potential contaminants and contaminant linkages which are no longer of concern.*

Identification of Potential Contaminant Linkages

Contaminant linkages have been identified in *Section 3.0* between the made ground and the underlying aquifer via infiltration and/or migration of dissolved phase contaminants.

Selection of Generic Screening Values

Screening values for Drinking Water Standards (DWS) have been used to assess leachability. DWS are relevant to potable receptors (Principal Aquifer).

Environmental Quality Standards (EQS) screening values have been used to assess risks to surface water resources.

Leachate Screening – UK DWS & EQS

Metals, TPHCWG and Speciated PAHs were assessed. Exceedances of relevant UK DWS and EQS screening criteria were encountered, details of which are identified in *Table 7.1 & 7.2*. It should be noted that several determinants have limits of detection greater than their respective screening values. Due to the level of uncertainty associated with such results, these exceedances are not considered significant and are excluded from the table below.

Table 7.1: Leachate Exceedances Summary - DWS

Determinant	DWS Screening Value (µg/l)	Range of concentrations (µg/l)	Location and depth of outliers, if present
Arsenic	10	2-12	WS101(0.20-0.70mbgl) – 12µg/l
Lead	10	39-266	WS101(0.20-0.70mbgl) – 141µg/l WS103(0.20-0.60mbgl) – 39µg/l WS104(0.30-0.60mbgl) – 266µg/l
Benzo(a)pyrene	0.01	<0.01-0.03	WS101(0.20-0.70mbgl) – 0.03µg/l

Table 7.2: Leachate Exceedances Summary - EQS

Determinant	EQS Screening Value (µg/l)	Range of concentrations (µg/l)	Location and depth of outliers, if present
Copper	1	9-30	WS101(0.20-0.70mbgl) – 30µg/l WS103(0.20-0.60mbgl) – 15µg/l WS104(0.30-0.60mbgl) – 9µg/l
Lead	14	39-266	WS101(0.20-0.70mbgl) – 141µg/l WS103(0.20-0.60mbgl) – 39µg/l WS104(0.30-0.60mbgl) – 266 µg/l
Zinc	10.9	12-64	WS101(0.20-0.70mbgl) – 64µg/l WS103(0.20-0.60mbgl) – 27µg/l WS104(0.30-0.60mbgl) – 12µg/l
Sulphide as S	0.25	<0.1-0.5	WS103(0.20-0.60mbgl) – 0.5µg/l
Fluoranthene	0.12	0.07-0.17	WS101(0.20-0.70mbgl) – 0.17µg/l
Benzo(b)fluoranthene	0.017	<0.01-0.05	WS101(0.20-0.70mbgl) – 0.05µg/l WS104(0.30-0.60mbgl) – 0.02µg/l
Benzo(ghi)perylene	0.0082	<0.01-0.03	WS101(0.20-0.70mbgl) – 0.03µg/l
Indeno(123cd)pyrene	0.002	<0.01-0.03	WS101(0.20-0.70mbgl) – 0.03µg/l

Leachate screening tables are presented in *Appendix G*. Analytical certificates are presented in *Appendix D*.

Contaminant Distributions and Risk to Receptors

Several determinands exceeded the DWS and EQS screening values. However, the risk to controlled waters (groundwater & surface waters) is diminished as a result of the following:

- The site is underlain by a layer of Glacial Till which is classified as Unproductive Strata that will act as an aquiclude impeding the flow of water to the underlying Principal Aquifer.

Conclusion

Exceedances of DWS and EQS screening criteria are not considered significant given the likely depth to groundwater, effects of natural attenuation, lack of nearby potable groundwater abstractions and the absence of any surface water courses that could be in continuity with ground water beneath the site.

8 Ground Gas Risk Assessment

8.1 CIRIA C665 Assessment

Gas monitoring wells were installed in 3No exploratory hole locations (WS101, WS102 and WS104) as part of the 2020 ground investigation completed by Sutcliffe's.

An full copy of all gas monitoring readings and water levels can be found in *Appendix E*.

8.2 Methodology

A ground gas risk assessment has been undertaken in general accordance with the British Standard BS8485:2015+A1:2019, "*Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings*".

The guidance is written specifically for use by designers of gas protection measures relating to the development of a site. Reference has also been made to the CIRIA document C665:2007: "*Assessing Risks Posed By Hazardous Ground Gases To Buildings*" and to the Health and Safety Executive document EH40/2005 "Workplace Exposure Limits".

Our assessment comprises the following:

- *Review of results.*
- *Calculation of Gas Screening Values for methane (CH₄) and carbon dioxide (CO₂).*
- *Assessment of risks from ground gas.*
- *Development options.*

8.3 Review of Field Data

Six (6) rounds of gas monitoring have been undertaken to date. Gas monitoring was undertaken using a fully calibrated GA2000 gas monitor which measured concentrations of oxygen, carbon dioxide and methane as well as gas flow emission rates.

The findings are summarised below and the results are presented in full in *Appendix E*. Calibration certificates are also presented in *Appendix E*.

Table 8.1: Summarised Ground Gas Monitoring Data

Maximum gas readings encountered during monitoring						
Location	MAX CH ₄ %	MAX CO ₂ %	MIN O ₂ %	MAX ppm	Atmospheric Pressure mb	MAX Flow Rate l/hr
4 th February 2020						
WS101	0.2	3.5	18.8	-	1018	14.2
WS102	0.2	3.9	18.0	-	1018	0.0
WS104	0.2	0.3	21.0	-	1018	0.0
26 th February 2020						
WS101	0.2	3.3	18.7	-	1001	10.4
WS102	0.2	0.5	20.1	-	1001	0.0
WS104	0.2	2.0	17.5	-	1001	0.0
5 th March 2020						
WS101	0.2	5.0	15.3	-	995	5.1
WS102	0.2	2.8	17.4	-	995	0.0
WS104	0.2	1.9	18.4	-	995	0.0
1 st April 2020						
WS101	0.5	2.9	18.7	-	1018	4.2
WS102	0.6	3.1	18.8	-	1018	0.0
WS104	0.5	3.0	19.0	-	1018	0.0
27 th April 2020						
WS101	0.0	8.3	13.8	-	1008	-0.2
WS102	WELL OBSTRUCTED					
WS104	0.1	1.3	19.9	-	1008	-0.3
6 th May 2020						
WS101	0.0	8.1	13.1	-	1009	-0.2
WS102	0.6	3.1	18.8	-	1009	0.0
WS104	0.1	1.3	19.8	-	1009	-0.1

8.4 Calculation of Gas Screening Values

Methane (CH₄)

Positive concentrations of methane (maximum concentration 0.6%) were recorded during the monitoring visits and a worst case flow rate of 14.2l/hr. The GSV will be calculated as:

Limiting volume flow rate of gas = gas concentration x measured borehole flow rate

$$= 0.006 \times 14.2 \text{ (gas concentration in table is \%)}$$

$$= 0.0852$$

The GSV classifies the site as Green for Methane.

Carbon Dioxide (CO₂)

Positive concentrations of methane (maximum concentration 8.3%) were recorded during the monitoring visits and a worst case flow rate of 14.2l/hr. The GSV will be calculated as:

Limiting volume flow rate of gas = gas concentration x measured borehole flow rate

$$= 0.083 \times 14.2 \text{ (gas concentration in table is \%)}$$

$$= 1.1786$$

The GSV classifies the site as Amber 1 for Carbon Dioxide.

8.5 Radon

According to the Envirocheck Report, the site is not within a radon affected area, as <1% of homes are above the action level. No radon protection measures are necessary in the construction of new dwellings or extensions.

8.6 Discussion

In accordance with CIRIA C665 the ground gas monitoring results indicate that the site has a Gas Screening Value (GSV) of 0.0852l/hr for methane and 1.1786l/hr for carbon dioxide.

This results in the site being classified as **Amber 1** and require protective measures to be installed.

Additionally, CIRIA C665 states in Table 8.7 (NHBC) that for a typical Carbon Dioxide maximum concentration above 5% that an **Amber 1** classification be considered. As there has been one reading above 5% CO₂ during the monitoring period it is Sutcliffe's recommendation that the site is classified as Amber 1 under the NHBC Traffic light system. This classifies the site as having a low to intermediate gas regime identified, which requires low to intermediate level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414 (Johnson, 2001). Membranes should always be fitted by a specialist contractor. Ventilation of the sub-floor voids should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.

Using BS8485:2015+A1:2019, "*Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings*" a

total of 3.5 points is required for the proposed end use, *Table 7.2* details the protection measures required to achieve this point total.

Table 7.2 BS8485 (2015+A1:2019) Point Score Summary

GAS PROTECTION SCORES FOR THE STRUCTURAL BARRIER			SCORE
Floor and substructure design			
Precast suspended segmental subfloor (i.e. beam and block)			0
PROTECTION ELEMENT SYSTEM	SCORE	COMMENTS	
Gas protection scores for ventilation protection measures			
Passive sub floor dispersal layer: Media used to provide the dispersal layer are: • Clear void • Polystyrene void former blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	Very good performance	2.5	The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B of BS8485:2015. Passive ventilation should be designed to meet at least “good performance”.
Gas protection score for the gas resistant membrane			
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method_; • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (eg settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (eg penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools etc); • Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and, • Verified in accordance with CIRIA C735.		2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. For example, a minimum 0.40mm thickness (equivalent to 370g/m² for polyethylene) reinforced membrane (virgin polymer) meets the performance criteria opposite. If a membrane is installed that does not meet all the criteria opposite then the score is zero.

8.7 Groundwater Protection Measures

There is some evidence at this stage of significant perched water either in the made ground or in the natural stratum encountered on site that would suggest

special groundwater protection measures to the building foundations are required.

9 Land Contamination Risks and Remediation Requirements

9.1 Revised Conceptual Model

Based on the findings of the human health, the preliminary conceptual model has been revised and finalised as shown in *Figure 4*. The drawing shows all contaminant linkages from the preliminary conceptual model, identifying those which remain relevant.

9.2 Discounted Contaminant Linkages

Controlled Waters – Groundwater & Surface Waters

Groundwater Resources

The UK DWS Leachate screening identified concentrations of Arsenic, Lead and Benzo(a)pyrene that could pose a risk to the Principal aquifer. However, due to the likely depth of groundwater and the effects of natural attenuation, the risk is unlikely to be significant.

Surface Water Resources

The EQS Leachate screening identified concentrations of Copper, Lead, Zinc, Sulphide as S, Fluoranthene, Benzo(b)fluoranthene Benzo(ghi)perylene and Indeno(123)pyrene that could pose a risk to the local surface water features. However, there are no surface water features within 250m of the site, as such the risk is unlikely to be significant.

9.3 Remaining Potential Contaminant Linkages

Long Term Human Health

Elevated levels of Lead, Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenzo(ah)anthracene all indicate the presence of site wide contamination that will require remediation to be safe for Human Health. This will require the removal of material from site and the importing of clean tested material to create a capping break layer in garden areas on site, with hardcover providing a break layer in other areas of the site.

Construction workers may be exposed via dermal contact, ingestion and inhalation of soil / dust during the construction period. Adjacent site users may also be exposed to contaminated soils via inhalation of dust generated during the construction phase.

Ground Gas

Based on the results of the gas monitoring and due to elevated CO₂ readings, an **Amber 1** classification is recommended for the site, as such as gas membrane will be required as part of the ground floor design in all the new houses on site.

Table 9.1: Summary of Remaining Contaminant Linkages

1. Hazard Identification		2. Hazard Assessment				3. Risk Estimation		4. Risk Evaluation	5. Managing the Risk
Contaminant Source		Pathway		Receptor		Consequence of risk being realised	Probability of risk being realised	Classification	Action required
Table 3.1: Sources		Table 3.2: Receptors		Table 3.3: Pathways					
S1	Made Ground (including demolition material)	P1	Direct contact	R1	Future site users,	Medium	Likely	Moderate	As site wide contamination has been identified a 600mm site strip is required across the site, with a capping layer placed in all proposed garden/landscaped areas. This, combined with the associated hardstanding will break the source pathway receptor linkages. Based on the gas monitoring data collated the site would be classified as Amber 1 and will require a gas membrane to be installed as part of the ground floor design.
		P2	Ingestion	R2	Construction workers	Medium	Likely	Moderate	
		P3	Inhalation of dust / vapours	R4	Adjacent site users	Medium	Unlikely	Low	
		P1	Direct contact	R5	Infrastructure / Buried Services	Mild	Unlikely	Very Low	
		P5	Vertical and lateral migration of ground gas	R1	Future site users,	Severe	Low	Moderate	
				R2	Construction Workers	Severe	Low	Moderate	
				R4	Adjacent	Severe	Unlikely	Moderate / Low	
				R5	Infrastructure / Buried Services	Severe	Unlikely	Moderate / Low	

9.4 Additional Works Required to Assess Outstanding Contaminant Linkages

Based on the proposed development plan, the risk to future site users, with respect to areas of new gardens included within the planning boundary, a remediation strategy will be required and will include validation of imported material and site derived material scheduled for reuse would need to be designed to assess the risks to future site users.

9.5 Remediation Requirements

Human Health – Soils

Elevated levels of Lead, Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenzo(ah)anthracene all indicate the presence of site wide contamination that will require remediation to be safe for Human Health. This will require the removal of material from site and the importing of clean tested material to create a capping break layer in garden areas on site, with hardcover providing a break layer in other areas of the site. This will require the removal of 600mm material from site and the importing of clean tested material to create a capping break layer in garden areas on site, with hardcover providing a break layer in other areas of the site.

Human Health – Ground Gas

Ground gas monitoring has indicated elevated levels of Carbon Dioxide on site and due to the highest recorded concentrations of Carbon Dioxide it is recommended that the site is classified as Amber 1 under the NHBC Traffic light system as outline in CIRIA C665. As such gas protection measures will be required as part of the development of the site.

Controlled Waters

Exceedances of DWS and EQS screening criteria are not considered significant given the likely depth to groundwater, effects of natural attenuation, dilution factors, protection afforded by the overlying Glacial Till. The site concentrations detected within the made grounds are not considered to pose a significant risk to the Principal aquifer or surface water features in the surrounding area.

10 Recommendations

10.1 Further works

The following actions are recommended:

- Design a Phase III Remediation & Validation Proposal for submission to planning department.
- Design SMMP – management of material on and off site.
- Good hygiene practices should be employed during construction work, in addition, the findings of this investigation should be included within the contractors H&S file and an assessment of risks associated with short term human health completed. No consumption of food or smoking should occur without prior hand washing. If dust is encountered, dust masks should be worn and dust suppression employed.

References

BRE Special Digest (1991) 'Sulphate and acidic resistance of concrete in the ground' **363**

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DETR/Partners in Technology (1997) Passive venting of soil gases beneath buildings research report-guide for design.

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Environment Agency (2002) 'Department for Environment, Food and Rural Affairs and The Environment Agency. 'Priority Contaminants For The Assessment Of Land', Environment Agency, Bristol. CLR report No. 8

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Appendix A – General Notes

Generic Notes – Sutcliffe Investigations

Environmental Setting

General

Third party information obtained from the British Geological Survey (BGS), the Coal Authority, the Local Authority etc is presented in the Correspondence Appendix of the Geoenvironmental Report.

Geology, Mining & Quarrying

In order to establish the geological setting of a site, Sutcliffe Investigations refer to BGS maps for the area and the relevant geological memoir.

A coal mining report is obtained from the Coal Authority. Further information is sourced from the Local Authority and by reference to current and historical OS plans.

Landfills

Sutcliffe Investigations obtain data from the Landmark Information Group, the Environment Agency and the Local Authority with respect to known areas of landfilling within 250m of the proposed development site. Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Radon

Radon is a colourless, odourless gas, which is radioactive. It is formed in strata that contain uranium and radium (most notably granite) and can move through fissures eventually discharging to atmosphere, or the spaces under and within buildings. Where radon occurs in high concentrations, it can pose a risk to health.

In order to assess potential risks associated with radon gas, Sutcliffe Investigations refer to BRE Report BR211, 1999: *“Radon: guidance on protective measures for new dwellings”*.

BR211 provides a preliminary indication of the measures required for a particular site, but it is also often necessary to request a Stage 2 Protective Measures Site Report from the BGS.

The level of protection needed is site-specific and is determined by reference to the radon potential map for the area followed by a geological assessment of the site. This information is contained in the Annexes of BR211.

Annex A – derived from statistical analysis of radon measurements in existing houses carried out by the NRPB and grouped on 5km grid.

Annex B – based on an assessment of the same radon measurements grouped by geological units. The maps show the 5km grid squares underlain completely or in part, by geological units which potentially exceed the action levels for radon protective measures. The grid squares are coded according to highest potential within the square. In many cases the actual geological radon potential varies considerably within a grid square.

Sutcliffe Investigations adopt the following procedure when assessing risk associated with radon.

Firstly, Annex A maps are reviewed to see whether the site requires full, basic or no measures. If the site is in a dark brown square, full radon protection measures are required. If the site is in a light brown square, reference should be made to Annex B.

Secondly, Annex B maps are reviewed to see whether a further geological assessment is required which may result in upgrading the result from Annex A. If a site lies within a shaded square, it may require radon protection and Sutcliffe Investigations request a Stage 2 Protective Measures Site Report from the BGS.

If the site is in a square that is not coloured or shaded in either set of maps then no radon protection is needed and therefore a BGS Report is not normally necessary.

The BGS geological assessment involves checking whether the site is on or close to a geological unit that has statistically been found to have elevated radon potential. The geological assessment is based on either 1:50,000 or the 1:250,000 scale data. The search area specified as part of the request is increased by 50m in areas where 1:50,000 data is available and by 500m in areas with 1:250,000 scale data to allow for potential inaccuracies in the position of boundaries. The BGS report indicates the highest level of protection required within the search area and its buffer zone.

When requesting a BGS report, Sutcliffe Projects select the search radius carefully, since too large a search radius may result in the inclusion of areas underlain by geological units of a higher radon potential, thereby giving rise to recommending too high a level of protection.

The report also includes (where available), a list of the geological units included in the assessment. Sutcliffe Investigations check that these actually underlie the site, rather than the buffer zone only.

On the basis of radon measurements in dwellings and on their geological interpretation, the BGS report stipulates the level of protective measures required for the proposed development site, and this could be:

1. no measures
2. basic measures or
3. full measures

Details of these measures are provided in the Hazardous Gas section of this Geoenvironmental Report.

Hydrogeology

Sutcliffe Investigations obtain information from the Environment Agency (EA) and the Landmark Information Group with respect to:

- groundwater quality
- recorded pollution incidents
- licensed groundwater abstractions

Reference is also made to the EA document "Policy and Practice for the Protection of Groundwater" (1998) and the relevant Groundwater Vulnerability Map.

Bedrock and any overlying granular Drift deposits are classified by the EA.

Major aquifers: *"Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public water supply and other purposes".*

Minor aquifers: *"Fractured or potentially fractured rocks which do not have a high primary permeability, or other formations or variable permeability. Although these aquifers will seldom produce large quantities of water for abstractions, they are important both for local supplies and in supplying base flow to rivers".*

Non-aquifers: *"Formations which are generally regarded as containing insignificant quantities of groundwater. However groundwater flow through such rocks, although imperceptible, does take place and needs to be considered in assessing the risk associated with persistent pollutants. Some non-aquifers can yield water in sufficient quantities for domestic use".*

Groundwater vulnerability is determined by 4 variables:

1. The presence and nature of overlying soil (the weathered zone affected by living organisms; soil in the UK can extend up to 2m in depth). Physical properties of the soil affect the downward passage of water and its ability to attenuate pollutants. The EA make reference to a three-fold classification of soil types:-
 - Soils of **low** leaching potential are defined as “soils in which the pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal, or they have the ability to attenuate diffuse pollutants”.
 - Soils of **intermediate** leaching potential are defined as “soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-absorbed diffuse source pollutants and liquid discharges could penetrate the soil layer”.
 - Soils of high leaching potential are defined as “soils with little ability to attenuate diffuse source pollutants and in which non-absorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater”.

In urban areas and restored mineral workings the soil information is based on fewer observations than elsewhere. A worst-case vulnerability (H) is therefore assumed for these areas and for current mineral workings by the EA. All are given a designation of **HU** unless proved otherwise.

2. The presence and nature of Drift, which often overlies bedrock. Where Drift is of substantial thickness and low permeability, it can provide an effective barrier to surface pollutant migration. Permeability Drift is classified as a Minor Aquifer except where it is in probable hydraulic continuity with a Major Aquifer, where it is regarded as part of the Major Aquifer unless proven otherwise by site investigation.
3. The nature of the geological strata (bedrock). Rocks that contain groundwater in exploitable quantities are called aquifers.
4. The depth of the unsaturated zone; i.e. that part of the aquifer which lies above the water table.

The EA have also designated Source Protection Zones, which are based on proximity to a groundwater source (springs, wells and abstraction boreholes). The size of a Source Protection Zone may vary from tens to several thousand hectares.

Hydrology

Sutcliffe obtains information from the Environment Agency and the Landmark Information Group with respect to:

- Surface water quality
- Recorded pollution incidents
- Licensed abstractions (groundwater & surface waters)
- Licensed discharge consents
- Site susceptibility to flooding

The EA have set **water quality** targets for all rivers. These targets are known as River Quality Objectives (RQOs). The water quality scheme used to set RQO planning targets is known as the River Ecosystem scheme. The scheme comprises five classes (RE1 to RE5) which reflect the chemical quality requirements of communities of plants and animals occurring in our rivers.

General Quality Assessment (GQA) grades reflect actual water quality. They are based on the most recent analytical testing undertaken by the EA. There are six GQA grades (denoted A to F) defined by the concentrations of biochemical oxygen demand, total ammonia and dissolved oxygen.

The susceptibility of a site to **flooding** is assessed by reference to a Flood Map on the Environment Agency's website. These maps provide shows natural floodplains – areas potentially at risk of flooding if a river rises above its banks or high tides and stormy seas cause flooding in coastal areas.

There are different kinds of area shown on the Flood Map:

1. Dark blue areas could be flooded by the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year, or by a river by a flood that has a 1% (1 in 200) or greater chance of happening each year.
2. Light blue areas show the additional extend of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance or occurring each year.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

The maps also show all flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, or floods from the sea with a 0.5% (1 in 200) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

The Agency's assessment of the likelihood of flooding from rivers and the sea at any location is based on the presence and effect of all flood defences, predicted flood levels and ground levels.

It should also be noted that as the floodplain shown is the 1 in 100 year (or 1 in 200 year as appropriate) areas outside this may be flooded by more extreme floods (e.g. the 1 in 1000 year flood). Also, parts of the areas shown at risk of flooding will be flooded by lesser floods (e.g. the 1 in 5 year flood). In some places due to the shape of the river valley the smaller floods will flood a very similar extent to larger floods but to a lesser depth.

If a site falls within a floodplain, it is recommended that a flood survey be undertaken by a specialist consultant who can advise on appropriate mitigating measures; i.e. raising slab levels, provision of storage etc.

COMAH & Explosive Sites

Sutcliffe Investigations obtain information from the Landmark Information Group with respect to COMAH or explosive sites within 1km of the proposed development site. Sutcliffe Investigations' report refers to any that are present and recommends that the Client seeks further advice from the HSE.

Areas around COMAH sites (chemical plants etc) are zoned with respect to the implementation of emergency plans. The HSE are a statutory consultee to the local planning authority for all COMAH sites. The COMAH site may have to revise its emergency action plan if development occurs. This might be quite straightforward or could entail significant expenditure. Consequently, the COMAH site may object to a proposed development (although it is the Local Authority who have final say and they are likely to place more weight on advice from the HSE).

Preliminary Conceptual Ground Model

The site's environmental setting (and proposed end use) is used by Sutcliffe Investigations to assess the significance of any contamination encountered during the subsequent ground investigation.

Generic Notes – Sutcliffe Geoenvironmental Investigations

2. Ground Investigation Fieldwork

General

Sutcliffe Ground Investigations are undertaken in accordance with current UK guidance including:

- BS5930:1999 “*Code of practice for site investigation*”
- BS10175:2001 “*Code of practice for the identification of potentially contaminated sites*”
- Contaminated Land Reports 1 to 6, most notably CLR Report No. 4 “*Sampling strategies for contaminated land*”
- “*Guidance on the protection soil sampling strategies for land contamination*” – EA R&D Technical report P5-066/TR (2001)
- AGS: 1996 “*Guide to the selection of Geotechnical Soil Laboratory Testing*”

Exploratory hole logs are represented in Appendices to this Geoenvironmental Report. These logs include details of the:

- Investigation technique adopted
- Samples taken
- Descriptions of the solid strata and any groundwater encountered
- Results of any insitu testing
- Any gas/groundwater monitoring well installed

Exploratory Hole Locations

Exploratory hole locations are selected by Sutcliffe Investigations, prior to commencement of fieldwork, to provide a representative view of the strata beneath the site and to target potential contaminant sources identified during the preliminary investigation (desk study). Additional exploratory locations are often determined by the site engineer in light of the ground conditions actually encountered; this enables better delineation of the depth and lateral extent of organic contamination, poor ground, relict structures etc.

Investigation Techniques

Ground conditions can be investigated by a number of techniques; the procedures used are in general accordance with BS5930: 1999 and BS1377: 1990. Techniques most commonly used by Sutcliffe Investigations include:

- Machine excavated trial pits, usually equipped with a backactor and a 0.6m wide bucket
- Cable percussive (Shell & Auger) boreholes, typically using 150mm diameter tools and casing
- Window or windowless sampling boreholes. Constraints associated with existing buildings, operations and underground service runs can render some sites partly or wholly inaccessible to a mechanical excavator. In such circumstances, window sampling is often the most appropriate technique. A window sampling drilling rig can be manoeuvred in areas of restricted access and results in minimal disturbance of the ground (a 150mm diameter tarmac/concrete core can be lifted and put to one side). However, it should be noted that window sampling allows only a limited inspection of the ground (especially made ground with a significant proportion of coarse material).
- Rotary percussive open-hole probeholes are typically drilled using a tricone rock roller bit with air as the flushing medium. Probeholes are generally lined through made ground with temporary steel casing to prevent hole collapse.

Where installed, gas/groundwater monitoring wells typically comprise a lower slotted section, surrounded by a filter pack of 10mm non-calcareous gravel and an upper plain section surrounded in part by a bentonite seal and in part by gravel or arisings. The top of the plain pipe is cut off below ground level and the monitoring well protected by a square, stopcock type manhole cover set in concrete, or the plain pipe is cut off just above ground level and the well protected by 100mm diameter steel borehole helmet set in concrete.

Monitoring well details, including the location of the response zone and bentonite seal are presented on the relevant exploratory hole logs.

Insitu Testing

Where relative densities of granular materials given on the trial pit and window sample logs are based on visual inspection only, they do not relate to any specific bearing capacities. However, wherever possible, Sutcliffe Investigations employ a mackintosh probe to assess relative density. Mackintosh probe results can be related to approximate allowable bearing capacities.

The relative densities of granular materials encountered in cable percussive boreholes are based on Standard Penetration Test (SPT) results. SPTs are carried out boreholes, in accordance with BS 1377 1990, Part 9 Section 3.3. Where full penetration (600mm) is not possible, N values are calculated by linear extrapolation and are shown on the logs as $N^* = x$.

The strength of cohesive deposits is determined using a hand shear vane.

Shear strength test results reported on trial pit logs are considered to be more reliable than those reported on window sample logs. Significant sample disturbance occurs during window sampling and consequently shear strength results on disturbed window samples are generally lower than results obtained during trial pitting, in-situ or in large excavated blocks.

Sampling

Representative soil/fill samples are taken at regular intervals from the exploratory holes to assist in description of the ground and to allow selected laboratory testing to be performed. The type of sample taken is dependent on the nature of the stratum and the purpose of the analysis.

Where the soils encountered contain a significant proportion of coarse grained material, truly representative samples are not typically obtained – only the finer fraction is placed in sample containers. However, a visual estimate of the amount of coarse material is made on site.

NB: Coarse constituents not sampled are defined as: coarse gravel, cobble and boulder (i.e. any 'particles' with an average diameter greater than 20mm).

Occasionally, unrepresentative 'spot' samples are also taken from some exploratory locations for contaminant analysis, typically where unusual, localised pockets of materials are encountered.

Samples of soil for chemical testing are placed into 1 litre plastic tubs prior to delivery to the selected laboratory. Samples of water are taken in one litre brown glass bottles and stored in cool boxes, at a temperature of approximately 4°C, until delivery to the selected laboratory. Soil/fill samples for organic analysis are also stored in cool boxes.

Groundwater

Where encountered during fieldwork, groundwater is recorded on exploratory hole logs. If monitoring wells are installed, groundwater levels are also recorded on one or more occasions after completion of the fieldwork.

It should be borne in mind that the rapid excavation rates used during a ground investigation may not allow the establishment of equilibrium water levels. Water levels are likely to fluctuate with season/rainfall and could be substantially higher at wetter times of the year than those found during this investigation.

Long term monitoring of standpipes or piezometers is always recommended if water levels are likely to have a significant effect on earthworks or foundation design.

Description of Strata

The soils encountered during an Sutcliffe's ground investigation are described (logged) in general accordance with BS 5930. The descriptions and depth of strata encountered are presented on the exploratory hole logs and summarised in the Ground Conditions section within the main body of text.

The materials encountered in the trial pits are logged, samples taken and tests performed on the in-situ materials in the excavation faces, to depths of up to 1.2m; below this depth these operations are conducted at the surface on disturbed samples recovered from the excavation.

Key to Exploratory Hole Logs

Keys to logs are presented in the Appendix(ces) containing the logs. These are two keys – Symbols and Legends and Terms and Definitions.

Health and Safety

All work was carried out in accordance with the procedures detailed in the DGEL Health and Safety Manual and SUKD health and Safety Procedures.

Generic Notes – Sutcliffe Geoenvironmental Investigations

3. Geotechnical Laboratory Tests

General

Soil Samples are delivered to the laboratory for testing along with a schedule of testing drawn up by Sutcliffe Investigations. All tests are carried out in accordance with BS 1377:1990.

The test results are presented as received in an Appendix to this Geoenvironmental Report.

The following laboratory testing are routinely carried out on a selection of samples:

- Atterberg limits & moisture contents
- Soluble sulphate & pH

The additional tests are typically only scheduled where significant earthworks regrade is anticipated:

- Grading
- Compaction tests
- Particle density

Atterberg Limits & Moisture Content

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

PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised April 2003) which advocates the use of modified Plasticity Index (I'p) defined as:

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

ie if PI is 30%, but the soil contains 80% < 425µm, then I'p = 30 * 80/100 = 24%

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

Sutcliffe Investigations 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 (ie differentiate between residual soil and alluvium)
- The number of results in each class and
- The actual values

Unless the judgement strongly indicates otherwise, Sutcliffe Investigations typically adopt a conservative approach and recommend assumption of the higher classification.

Soluble Sulphate and pH

Sulphates in soil and groundwater are the chemical agents most likely to attack sub-surface concrete, resulting in expansion and softening of the concrete to a mush. Another common cause of concrete deterioration is groundwater acidity.

The rate of chemical attack depends on the concentration of aggressive ions and their replenishment at the reaction surface. The rate of replenishment is related to the presence and mobility of groundwater.

Sutcliffe Investigations refer to BRE Special Digest 1 (SD1) "Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment" (2001). SD 1 provides definitions of:

- The nature of the site (Greenfield, brownfield or pyretic)
- The groundwater regime (static, mobile or highly mobile)
- The Design Sulphate Class (DC Class) and
- The Aggressive Chemical Environment for Concrete (ACEC Class)

Sutcliffe reports clearly state each of the above for the site being considered.

The concentrations of sulphate in aqueous soil/fill extracts are determined in the laboratory using the gravimetric method. The results are expressed in terms of SO_4 for direct comparison with BS 5328:1997. The pH value of each sample was determined by the electrometric method.

SD1 also discusses determination of "representative" sulphate concentration from a number of tests. Essentially if <10 samples of a given soil-type have been tested, the highest measured sulphate concentration should be taken. If >10 samples have been tested, the mean of the highest 20% of the sulphate test can be taken. With respect to groundwater, the highest sulphate concentration should always be taken.

With respect to pH (soil & groundwater) the value used is the lowest value if <10 samples have been tested and the mean of the lowest 20% if >10 samples have been tested.

Generic Notes – Sutcliffe Investigations Geoenvironmental Investigations

4. Contamination Laboratory Analysis & Interpretation (including WAC)

General

An assessment of potential contaminants associated with the former usages of the site is undertaken with reference to CLR 8 “*Potential contaminants for the assessment of land*” and the relevant DETR Industry Profile(s).

Common Inorganic Contaminants

These include:

- Metals, most notably cadmium, copper, chromium, mercury, lead, nickel and zinc
- Semi-metals, most notably arsenic, selenium and (water soluble) boron
- Non-metals, most notably sulphur
- Inorganic anions, most notably cyanides (free & complex), sulphates, sulphides and nitrates

With respect to the terminology used by most analytical laboratories:

Total cyanide = Free cyanide + Complex cyanide

Total cyanide (CN) is determined by acid extraction; whereas free cyanide is the water soluble fraction.

Complex cyanide is “bound” in compounds and is hard to breakdown. Laboratory determination of complex CN involves subjecting the sample to uv digestion for determination of both free and total CN.

Thiocyanate (SCN) is a different species combined with sulphur.

Elemental sulphur (S) and free sulphur are the same. Total sulphur is all forms, including that present in sulphates (SO₄) sulphates etc.

There are 2 forms of chromium (Cr), chromium VI and chromium III. Chromium VI is the more toxic of these. In soils, total chromium is determined by a strong aqua regia acid digestion. Chromium VI is an empirical method based on a water extract test.

Common Organic Contaminants

Petroleum hydrocarbons are a mixture of hydrocarbons produced from the distillation of crude oil. They include aliphatics (alkanes, alkenes and cycloalkanes), aromatics (single or multi benzene ringed compounds) and hydrocarbon-like compounds containing minor amounts of oxygen, sulphur or nitrogen.

Petroleum hydrocarbons can be grouped based on the carbon number range:-

GRO – Gasoline Range Organics (typically C₆ to C₁₀). Also referred to as PRO – Petroleum Range Organics

DRO – Diesel Range Organics (typically C₁₀ to C₂₈)

LRO – Lubricating Oil Range Organics (typically C₂₈ to C₄₀)

MRO – Mineral Oil Range Organics (typically C₁₈ to C₄₄)

However, it should be borne in mind that the terms “GRO” and “DRO” analysis are purely descriptive terms, the exact definition of which varies.

Total Petroleum Hydrocarbons (TPH) is also a poorly defined term; some testing laboratories regard TPH as hydrocarbons ranging from C₅ – C₄₀, whereas other define TPH as C₁₀ – C₃₀.

The composition of a TPH plume migrating through the ground can vary significantly; this is primarily dictated by the nature of the source (eg petrol, diesel, engine oil etc). Furthermore, different hydrocarbons are affected differently by weathering processes and this can result in further variation in the chemical composition of the TPH.

Gasoline contains light aliphatic hydrocarbons rapidly (especially within the C4 to C5 range) that will evaporate. The aromatic hydrocarbons in gasoline are primarily benzene, toluene, ethylbenzene and xylenes, referred to as BTEX. Small amounts of polyaromatic hydrocarbons (PAHs) such as benzo(a)pyrene may also be present.

Diesel and light fuel oils have higher molecular weights than gasoline. Consequently, they are less volatile and less water soluble. About 25 to 35% is composed of aromatic hydrocarbons. BTEX concentrations are generally low.

Heavy Fuel Oils are typically dark in colour and considerably more viscous than water. They contain 15 to 40% aromatic hydrocarbons. Polar NSO compounds are also present.

Lubricating Oils are relatively viscous and insoluble in groundwater. They may contain 10 to 30% aromatics, including the heavier PAHs. NSO compounds are also common.

Polycyclic Aromatic Hydrocarbons (PAHs) have more than two fused benzene rings as a structural characteristic. PAH compounds are present in both petrol and diesel, although insignificantly lower concentrations than in coal tars. Certain PAH compounds are carcinogenic (Benzo(a)pyrene) and/or mobile in the environment (naphthalene).

Polychlorinated Biphenyls (PCBs)

Volatile Organic Compounds (VOCs) The volatile organic compound (VOC) headspace concentration of all soil samples was made with a photoionization detector (PID) fitted with a 10.2 eV lamp. This gives a semi-quantitative VOC concentration record as parts per million (ppm) (Vol/Vol). Prior to the VOC headspace reading, the background levels of VOCs were recorded. The PID was recalibrated with standard isobutylene in zero air after every 10 headspace readings.

Semi-Volatile Organic Compounds (sVOCs)

Phenols

Solvents, pesticides, herbicides

Dioxins & furans

Methods of Analysis (Organic Compounds)

Toluene Extractable Matter (TEM) results provide a screening test for organic contamination. The sample is air dried at 30°C and ground prior to addition of the solvent (toluene). The solvent extraction is aggressive and most organic compounds (fuels, oils, tars, humic material, animal fats and vegetable oil) are dissolved, as are some other inorganic contaminants such as sulphur. However, the volatiles (lighter fuel fraction etc) are lost during evaporation of the solvent.

Total Petroleum Hydrocarbon (TPH) by IR (also known as mineral oil by some testing laboratories) is undertaken on "as received" samples. Tetrachloroethylene is the solvent, and fluorosil is used to removed humic material, animal fats and vegetable oil. Consequently this analysis detects a wide range of "mineral" organics from volatiles (BTEX and gasoline) through diesel and oils to tars (including the very heavy, stable tars such as asphalt and bitumen).

TPH by GC-FID is more refined analytical technique which only detects hydrocarbons (aliphatic and aromatic) in the range C₁₀ to C₄₀ (volatiles, heavy tars, humic material and sulphur are not detected). The laboratory can provide a breakdown of the TPH results into diesel range organics (**DRO**) and heavier lubricating oil range organics (**LRO**).

GRO (PRO) by GC-FID analysis detects the more volatile C₆ – C₉ hydrocarbons (aliphatic and aromatic) including those organic compounds present in petrol.

Speciated VOC (by GC-MS) analysis quantifies the concentrations of 30 USA-EPA priority compounds. These include chlorinated alkanes and alkenes (in the molecular weight range chloroethane to tetrachloroethane); trimethylbenzenes; and the 4 BTEX compounds (benzene, ethyl-benzene, toluene & xylene).

Speciated sVOC by (GC-MS) analysis quantifies the concentration of a variety of organic compounds, including the 16 USA-EPA priority PAHs, phenols, 7 USA EPA priority PCB congeners, herbicides & pesticides.

Note: PAHs are hydrocarbons and consequently (where present) will be picked up when scheduling TPH by GC-FID. Naphthalene (the lightest PAH) is also one of the 58 US EPA VOCs.

Speciated TPH by GC-FID provides a “banded” TPH, initially split into aromatic and aliphatic fractions and then further divided into fraction specific carbon bandings based upon behavioural characteristics.

Note: Risk assessment models require physiochemical properties (solubilities, toxicities etc) of compounds in order to model their behaviour in the environment. These physiochemical properties cannot be derived from a single “TPH”, “GRO” or “DRO” value. However, the carbon banded fractions can be used in risk assessment models.

If the relative proportion of each carbon banding within the “TPH” impact at a site is known, the risks posed by each individual fraction can be assessed and a simple back calculation applied to calculate an overall “TPH” screening value based upon the percentage weight fraction of each banding present in the “TPH”. Specialised analytical techniques and data interpretation skills are required to identify each carbon banding.

Current Guidance

The UK approach to the consideration of contaminated land is based upon the principles of risk assessment. This in turn is founded upon the use of so called source⇒ pathway⇒ target principles in order to establish the presence or potential presence of a pollutant linkage.

Sutcliffe Investigations adopt a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate guidance levels, intervention levels or remedial targets.

In March 2002 DEFRA and the Environment Agency published a series of technical research papers (R & D Publications CLR 7, 8, 9 and 10) introducing the UK approach to the assessment of risk to **human health** from land contamination. This methodology and approach represents current scientific knowledge and thinking. The overall methodology also included the Contaminated Land Exposure Model (CLEA) and some Soil Guidance Values (SGV's).

At the time of writing this report, these guidelines only address seven contaminants and the development of both the CLEA model and additional SGV's is ongoing. Where published, SGV's have been utilised as intervention values for the purpose of an initial Tier 1 assessment.

Where SGV's were not published at the time of writing this report, appropriate Tier 1 human health related assessment have been based upon information that was best available at the time of the study.

With respect to the assessment of potential **phytotoxic effects** of contaminants, Sutcliffe Investigations refer to “The Soil Code” (Maff, 1998) for copper and zinc. The CLEA SGV is adopted for nickel.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, ‘Sulphate and Acid Resistance of Concrete in the Ground’, 2001.

With respect to the interpretation of the calorific values, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 “Notes on the fire hazards of contaminated land” which states that:

“In general it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn”.

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate concentrations with the appropriate water quality standard. Depending upon the specific characteristics and environmental setting of the site the appropriate standard is likely to be one of the following:

- Water Supply (Water Quality) Regulations 1989
- Environmental Quality Standards (for Freshwater)
- The Surface Waters (Abstraction for Drinking Water) Regulations

The tier 1 risk assessment of **landfill gas** is undertaken through reference to the following documents:

- Approved Document C, Building Regulations 1991
- CIRIA Report 149, “Protecting Development from Methane”, 1995

Should any Tier 1 criteria be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

- Undertake further statistical following the approach set out in Appendix A of CLR 7 in order to determine whether contaminant concentrations of inorganic contaminants within soil/fill actually present a risk (only applicable to assessing the risk to human health).
- Based on a qualitative risk assessment, advocate an appropriate level of remediation to “break” the pollutant linkage – for example the removal of the contaminated materials or the provision of a clean cover.
- Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.

However, the issue of **averaging area** requires further consideration. CLR 7 is ambiguous and could be interpreted as advocating the concept of a single garden as an appropriate averaging area.

This concept has massive implications with respect to ground investigation design and cost. To comply, investigations for residential development on brownfield sites would need to recover and analyse about 6 samples from each garden; this implies exploratory locations on a very tight grid, perhaps 5m to 10m spacings, with a huge increase in the number of samples analysed (cf test schedules currently issued by most practitioners).

In any case, Sutcliffe Investigations consider the concept of a single garden as an averaging area to be inappropriate. Statistical analysis of sample results by fill type, and/or by former use in a given sub-area of the site (i.e. with reference to the Conceptual Site Model), is considered a more appropriate methodology.

Analysis by soil/fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil/fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass; ie contamination would be normally be more pervasive and significant in granular soils than cohesive soils.

There is a suggestion in para 4.7 of CLR 7 that the approach outlined above was intended and the Environment Agency have confirmed that an averaging area can be larger than a single garden, if:

- Contaminant concentrations are within the same statistical population as determined using the maximum value test. The sample data being representative of the averaging area and the mean concentration of the averaging area.
- “Hot spots” are treated as separate zones or averaging areas (as defined by the maximum value test).
- The sampling strategy takes into account uncertainty (spatial heterogeneity) in contaminant concentration

Waste Classification & WAC

In the context of waste soils generated by remediation and/or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated ‘natural soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds).
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds).

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

From 16th July 2005, landfill operators will require Waste Acceptance Criteria (WAC) laboratory data, if soil is classified as **hazardous** and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Sutcliffe Investigations typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated for example where redevelopment proposals include basement construction etc.

If off-site disposal of soils classified as hazardous waste were undertaken during redevelopment, then WAC analysis should be scheduled at an early stage in the remediation programme.

However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous. These contaminants can often be dealt with by alternative technologies (eg by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (eg WAC) is required.

Generic Notes – Sutcliffe Investigations

5. Hazardous Gas

General

Hazardous gas is considered to be any mixture of potentially explosive, toxic or asphyxiating gases, most notably methane, carbon dioxide and oxygen (deficiency).

In addition, radon, a naturally occurring radioactive gas is also considered. Further information about radon is included in Notes 1 – Environmental Setting.

Assessment of potential risks associated with hazardous gas are based on a review of data obtained from the Landmark information Group, the Environment Agency and the Local Authority and the British Geological Survey.

Reference is also made to historical OS plans, which are inspected for evidence of backfilled quarries, railway cuttings, colliery spoil tips etc.

Where landfilling has occurred within 250m of the site boundary, the Local Planning Authority may request a landfill gas investigation in accordance with the Town and Country Planning General Development Order, 1988.

Sources

Potential sources of hazardous gas are:

- Landfill sites
- Made ground, especially where significant depths are present
- Shallow mineworks associated with coal extraction
- Geological strata, including peat, organic silts, coal-bearing strata and limestone (reaction with acidic waters), granite (radon)
- Groundwater can sometimes act as a “carrier” for hazardous gas
- Leakages from pipelines or storage tanks
- Sewers, septic tanks and cess pits

Generation

Wherever biodegradable material is deposited, landfill gas (principally a mixture of methane and carbon dioxide) is likely to be generated by microbial activity. Carbon dioxide is an asphyxiant and toxic; methane is flammable and a mixture containing between 5% and 15% methane by volume in air is explosive. Landfill gas in the ground is unlikely in itself to pose a significant risk, though it may damage vegetation. However, infiltration of landfill gas into confined spaces (e.g. cellars, services, etc) may give rise to considerable risk.

There is no typical figure for the length of time that landfill gas will be evolved, but at many sites significant gas generation continues for at least 15 years after the last deposit of waste.

Migration

Gas migration from a landfill site may occur in several ways. It may migrate through adjacent strata; the distance of migration being dependent on the pressure gradients, volume of gas and permeability of the strata. Where there are faults, cavities and fissures within the strata, gas may move considerable distances. Other migration pathways for gas include man-made features such as mine shafts, roadways and underground services.

Gas migration is influenced by a number of climatic factors, such as atmospheric pressure variations, water table level variations and the influence of a covering of snow or ice over the surface of the site and surrounding area.

Current Guidance

Guidance on landfill gas monitoring control at landfill sites is given two technical memoranda, Waste Management Paper Nos. 26 and 27 published by the Department of the Environment.

Waste Management Paper 27, 1991 recommends that no dwellings should be constructed within 50m of any landfill that has the capacity to produce large volumes of landfill gas. No garden should extend to within 10m of the landfilled waste. However, development closer to landfill has been permitted where a comprehensive gas risk assessment has been completed (typically based on a minimum of 6 to 12 month monitoring programme) and appropriate gas exclusion measures designed.

The current advice with regard to monitoring for landfill gas is that if the trigger value of 1% volume (20% LEL) for methane and 1.5% volume for carbon dioxide is exceeded then remedial/control measures will be required.

It should be noted that the guideline limit for carbon dioxide of 1.5% volume recommended in Waste Management paper No. 27 is the short term (10 minute) occupational exposure limit for carbon dioxide quoted by the Health and Safety Executive in their publication EH40. The long term (8 hour) occupational exposure limit for carbon dioxide is 0.5% volume.

Approved Document C to the Department of the Environment's Building Regulations 1992 requires what where there may be gaseous contamination of the ground but the level of methane is unlikely to exceed 1% by volume, the ground floor of any house or similar small building shall be constructed of suspended concrete and ventilated as described in BRE Digest Report "Construction of New Buildings on Gas Contaminated Land". The document also requires specific design measures to be taken if a level of 5% volume carbon dioxide exists or is exceeded within the ground.

Although the above guidance is still relevant it has been more recently updated within the following documents published by the Construction Industry Research and Information Association (CIRIA).

CIRIA Report 149	'Protecting Development from Methane' (1995)
CIRIA Report 150	'Methane Investigation Strategies' (1995)
CIRIA Report 151	'Interpreting Measurement of Gas in the Ground' (1995)
CIRIA Report 152	'Risk Assessment for Methane and other gases from the ground' (1995)

The above documents are intended to provide advice on how to investigate and deal with the gas contaminated ground with respect to development.

CIRIA Report 149 characterised sites based on the recorded methane/carbon dioxide concentration and emission rates recorded during a suitable gas investigation. Characteristic situation 1 is deemed to be the lowest risk scenario with the risk rating increasing up to 6. The characteristic situations are classified as follows:

Gassing regime in ground			
Methane (% by volume in air)	Carbon dioxide (% by volume in air)	Emission rate ¹ (m/s)	Characteristic situation ²
< 0.1	< 1.5	not detected	1
> 0.1 – 1	> 1.5 – 5	not detected	2
> 1 - 5	< 5	not detected	3
> 5 – 20	< 20	< 0.01	4
> 20	> 20	> 0.01 – 0.05	5
> 20	> 20	> 0.05	6

Notes:

1. Emission rate values measures as equivalent total gas flow velocity from a 50mm diameter borehole: for methods of measurement see Crowhurst and Manchester (1992).
2. Highest measures parameter used as determining factor.

CIRIA Report 151 (1995) identified that there is currently inadequate guidance on trigger concentrations for ground gases. The current emphasis on using gas concentrations for trigger values particularly in Waste Management Paper 27 and the Building Regulations, should be revised to consider gas pressures, borehole flow rates and estimated surface emission rates.

It was concluded that the most important aspect of relating the gas regime below or adjacent to a site, to the risk it poses to any development, is the surface emission rate i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. This is considered further in the DETR Partners in Technology Report 'Passive venting of soil gases beneath buildings' (September 1997).

CIRIA Report 149 (1995), reference Table 28, reviewed over 100 case studies of development affected by gas to establish current UK practices for gas control. The report classified the gassing regimes found within 6 Characteristic Situations. The highest measures parameter, either methane or carbon dioxide concentration and/or emission rate were used to define the Characteristic Situation for each case history site. The report then related the typical range of mitigation measures that has been adopted at each study site to the characteristic gas situation.

To achieve a more consistent design of protection measures Table 28 of CIRIA 149 was rewritten (Wilson and Card, 1999) in terms of borehole gas volume flow rate and gas concentrations, as reproduced in the table below. This was done to reflect the importance of recognising the gas surface emission rate.

Characteristic situations based on Gas Flux

Characteristic Situation	Limiting CH ₄ Concentration (% v/v)	Limiting CO ₂ Concentrations (% v/v)	Limiting Borehole Flow Velocity (m/s)	Limiting Borehole Gas Volume Flow (litre/hour)	
				CH ₄	CO ₂
1	< 0.1	< 0.1	< 0.005	< 0.035	< 0.035
2	< 1.0	< 1.5	< 0.005	< 0.35	< 0.5
3	< 5.0	< 5.0	< 0.005	< 1.75	< 1.75
4	< 20	< 20	< 0.01	< 14	< 14
5	> 20	> 20	< 0.05	< 70	< 70
6	> 20	> 20	< 0.05	> 70	> 70

Gas Monitoring Procedure

Sutcliffe Investigations adopt a standard gas monitoring procedure, in accordance with CIRIA guidance. This procedure involves the measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration on site immediately prior to and on completion of monitoring.
- Gas emission rate.
- Methane, oxygen and carbon dioxide concentrations using an infra-red gas analyser.
- Standing water level using a dipmeter.

In addition, ground conditions at each sampling location are recorded together with prevailing weather conditions and any other observations such as any vandalism.

Where samples of gas are required for laboratory analysis, Gresham Tubes are used. Gas concentrations in the well are typically recorded immediately before and after retrieval of a sample.

Appendix B – Ciria Guidance Document C552 2001

RISK ASSESSMENT FOR THE WATER ENVIRONMENT

The risk assessment has been developed to provide a greater level of standardisation. It includes relevant elements from TAG (Transport Analysis Guidance) Table 1 relating to the features described as river, floodplain, groundwater and stillwaters, including their attributes/services and selected/modified indicators of quality and possible measures. Two additional columns have been added for 'grading' and 'importance level'. These columns expand on the limited number of examples provided in TAG Table 2. Table 1 has been developed with reference to TAG, Highways Agency's 'New Approach to Appraisal' (NATA), the Water Framework Directive and other sources as referenced in the table.

Table 1 here relies on easily available data to avoid unnecessary data collection. Should inadequate data be available a 'worst case' should be assumed. The table is designed to act as a guide to determining importance and to raise the level of compatibility in predicting the significance of impacts on the water environment.

Once Table 1 has been used to determine the importance of the environmental attributes that may be affected by a particular development project, Tables 3 and 4 of TAG Unit 3.3.11 can be used to estimate the significance of potential impacts. These tables are reproduced here as Tables 2 and 3 respectively. Table 2 provides a methodology for determining impact magnitude. Table 3 is a matrix that allows the significance of the impact to be calculated based on the impact magnitude and the importance of the attribute. The significance of impacts can range from 'insignificant' to 'very significant'.

**Table 1: Water features, their attributes, indicators of quality, grading and importance
(adapted from Table 1 of TAG unit 3.3.11)**

Feature	Attribute / Service	Indicator of Quality	Measure	Grading	Importance Level
River	Water Supply	Chemical water quality	Environment Agency's Chemical General Quality Assessment (GQA)	A B C-D E-F	Very High High Medium Low
		Industrial / agricultural abstractions	Location and volume of abstraction	All abstractions within 2km downstream: >1000m ³ /day 500-1000m ³ /day 50-499m ³ /day <50m ³ /day	Very High High Medium Low
		Drinking water supply	Classification defined within The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996. No 3001 ²	Classification: DW1 or DW2 within critical travel time for pollution downstream DW3 within critical time downstream Not designated	Very High High Medium - Low
	Biodiversity ³	Biological Water Quality	Environment Agency's Biological GQA ¹	A B C-D E-F	Very High High Medium Low
		Fisheries Quality	Fisheries status as defined within the Freshwater Fish Directive 78/659/EEC	Designated salmonid fishery Designated cyprinid fishery Undesignated fishery Not a fishery	Very High High Medium Low

Feature	Attribute / Service	Indicator of Quality	Measure	Grading	Importance Level
River	Transport and dilution of waste product	Surface Water / effluent discharges	Type of discharges with reference to the EC Dangerous Substances Directive (76/464/EEC and Daughter Directives)	All discharges within 2km up or downstream: List I List II Other discharge / no discharge	Very High - High Medium Medium - Low
	Recreation	Riverside access	Presence / absence of route and importance	National trail / cycleway Regional trail Definitive footpath / bridleway No route	Very High High Medium Low
		Presence of clubs/ recreation use	Presence / absence	Club recreation use present No club / recreation use	Very High - High - Medium Low
	Conveyance of flow and material	Presence of water courses	Size of watercourses ⁵	Main River > 10m wide Main River < 10m wide Ordinary watercourse >5m wide Other	Very High High Medium Low
Floodplain	Flood defence	Importance in relation to flood defence	Status of flood plain area	Designated washland Active floodplain Existing defended area Does not flood	Very High High Medium Low
			Return period	> (ie more frequent then) 1 in 25 years < 1 in 25 years <1 in 100 years (urban) <1 in 50 years <1 in 200 years	Very High High Medium Medium Low
Groundwater	Water supply	Industrial / agricultural abstractions	Location and volume of abstraction	All abstraction points within zone of influence of development: >1000m3/day >500-1000m3/day 50-499m3/day <50m3/day	Very High High Medium Low
		Drinking water supply	Presence of potable public supply or private water supply within zone of influence of development	Public supply Private water supply >10m3/day or serves >50 people ⁶ Other private water supply No supply	Very High High Medium Low
		Groundwater vulnerability	Source protection status	Within zone 1,2 or 3 of a source protection zone Not within a source protection zone	Very High High Medium Low
			Classification of aquifer vulnerability	Major aquifer with H soils or I soils or U soils. Minor aquifer with H soils or U soils Major aquifer with L soils. Minor aquifer with L soils or non aquifer	Very High High Medium Low
	Conveyance of flood flows	Acceptance potential of flood flows	Soil type / groundwater table levels ⁸	Gravels with low water table (>1m below infiltration point) Sands with low water table All soil types with high water table Clay	Very High High Medium Low
Stillwaters (lakes and ponds)	Biodiversity ³	Biological water quality	Classification system to be developed under the Water Framework Directive for ecological status / potential		
		Fisheries quality	Fisheries status as defined within the Freshwater Fish Directive 78/659/EEC	Designated salmonid fishery Designated cyprinid fishery Undesignated fishery Not a fishery	Very High-high High - medium Medium - low Low
	Water supply	Use for abstraction	Presence / absence	Abstraction No abstraction	Very High - High - Medium ⁹ Low
				Club recreation use present No club / recreation use	Very High - High - Medium ⁴ Low
	Recreation	Presence of clubs / recreation use	Presence / absence		

Notes to Table 1

- 1 If the river is unclassified and hence has no GQA grade, the quality can be measured or assumptions can be made based on the grade of the nearest classified stretch.
- 2 An importance level of high or very high must also be awarded if the water feature provides more than 10m3/day of drinking water, or serves more than 50 people, which is the definition used in the Water Framework Directive to define drinking water protected areas.
- 3 Conservation value is not included, as this should be included within an ecology/nature conservation assessment.
- 4 This required judgement on a case by case basis because the importance of use by people is being assessed, and they are sensitive to being categorised as unimportant. Careful assessment is thus required, using as much data as possible eg on the facilities, their scale and frequency of use, membership levels and economic value.
- 5 An importance level of 'Medium' or greater must also be awarded if a river has a catchment greater than 10km2, as this means that it will be classified as a water body under the Water Framework Directive. Other measures are available for describing the ability of watercourses to convey flow and material (such as the carrying capacity of the channel for flood flows) and could if necessary be substituted.
- 6 Based on criteria given within the Water Framework Directive for features to be designated as drinking water protected areas.
- 7 Adapted from NRA Policy and Practice for the Protection of Groundwater, Groundwater Vulnerability Sheets, NRA 1994. Because soil information in urban areas is less reliable and based on fewer observations than in rural areas, the worst case is assumed and such land is classified as being high of leaching potential. H = high, I = Intermediate, L = Low and U = Unclassified leaching potential.
- 8 This uses a coarse basis of permeability together with the ability of the existing ground conditions to accept additional flows. For example, gravels in a river floodplain are unlikely to have a high acceptance potential because of raised water table due to river flows. Sands above a relatively dry substrata would have a high potential, however caution is required in areas such as chalk with highly fluctuating groundwater levels.
- 9 Depends on use of water, volume abstracted etc. An importance level of 'High' or 'Very high' must be awarded if the water feature provides more than 10m3/day of drinking water, or serves more than 50 people, which is the definition used in the Water Framework Directive to define drinking water protected areas.

Table 2: Criteria for determining impact magnitude (reproduced from Table 3 of TAG unit 3.3.11)

Magnitude	Criteria	Example
Major	Results in loss of attribute	- Loss of EC designated Salmonid fishery - Compromise employment source - Pollution of potable source of abstraction - Change in GQA grade of river reach - Loss of flood storage / increased flood risk
Moderate	Results in impact on integrity of attribute or loss of part of attribute	- Loss in productivity of a fishery - Contribution of a significant proportion of the effluent in the receiving river, but insufficient to change its GQA grade - Reduction in the economic value of the feature
Minor	Results in minor impact on attribute	Measurable change in attribute, but of limited size and/or proportion
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use / integrity	- Discharges to watercourse but no significant loss in quality, fishery productivity or biodiversity - No significant impact on the economic value of the feature - No increase in flood risk

**Table 3: Significance Criteria of Potential Impacts
(Reproduced from Table 4 of TAG unit 3.3.11)**

Magnitude of Potential impact	Importance of Attribute			
	Very High	High	Medium	Low
Major	Very Significant	Very Significant	Significant	Low Significant
Moderate	Very Significant	Significant	Low Significant	Insignificant
Minor	Significant	Low Significant	Insignificant	Insignificant
Negligible	Low Significant	Insignificant	Insignificant	Insignificant

Table 4: Proposed impact assessment summary table

Feature	Attribute / Service	Importance Level	Magnitude of Impact	Significance of Impact
River	Water Supply	Very High	Minor	Significant

References

- 1 The Highways Agency et al, Design Manual for Roads and Bridges, Vol 11. Environmental Assessment, 1993.
- 2 DETR 'Guidance on the New Approach to Appraisal, 1998.
- 3 Department for Transport, Transport Analysis Guidance (TAG) 2003

RISK ASSESSMENT METHODOLOGY

GENERAL

The purpose of this appendix is to describe in detail the concepts underlying the risk based approach to assessing potentially contaminated land, introduce the roles of key legislation and describe the qualitative methodology adopted for evaluating and characterising risk.

Current best practice in the UK promotes a risk-based approach to dealing with both soil and groundwater contamination. The principal aim of the approach is to ensure protection of human health and the environment in a thorough, transparent and cost-effective manner.

Fundamental to the risk-based approach is the concept that for 'Contaminated Land' to be designated, as a consequence of historic activities, a pathway for contamination must be shown to exist between a source of contamination and a receptor. The combined presence of a source, pathway and a receptor is described as a 'pollutant linkage'.

The concepts associated with a contaminant source, pathway and receptor are defined in DETR Circular 02/2000 'Contaminated Land Environmental Protection Act 1990: Part II A'. A **source** of contamination may be considered as a 'substance, which is in, on or under land that has the potential to cause harm or to cause pollution of controlled waters'. A **receptor** can be considered as either 'a living organism, a group of living organisms, an ecological system or a piece of property which is being, or could be harmed, by a contaminant or controlled waters which are being, or could be, polluted by a contaminant'. A **pathway** may be considered as one or more routes by, or through, which a receptor is being, or could be, exposed to or affected, by a contaminant. Typical pathways may include migration in groundwater, surface water run-off or infiltration, inhalation, dermal contact and ingestion.

The risks posed by an identified pollutant linkage can often be mitigated by removing the source of contamination, treating the source of contamination, blocking the relevant pathway(s) or by protecting the receptor.

PRINCIPLES OF RISK EVALUATION

The risk evaluation methodology presented below is qualitative in nature, and is therefore a subjective method. It is based upon guidance presented in CIRIA publication referenced C552, 'Contaminated land risk assessment - A guide to good practice', 2001 and involves the classification of the following.

The magnitude of the potential **consequence** (severity) of risks occurring (Table 1).

The magnitude of the **probability** (likelihood) of the risk occurring (Table 2).

These are then considered in conjunction to give a risk matrix (Table 3)

Table 1 - Classification of consequence

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in “significant harm” as defined by the Environmental Protection Act 1990, Part IIA. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health (“significant harm” as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (Note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000).	Concentrations of a contaminant from site exceed the generic or site-specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services (“significant harm” as defined in the <i>Draft Circular on Contaminated Land</i> , DETR, 2000). Damage to sensitive buildings/structures/ services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discolouration of concrete.

Table 2 - Classification of probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 3 - Comparison of consequence against probability

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table 4 - Description of the classified risks and likely action required

Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

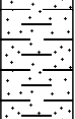
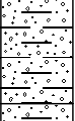
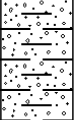
Table 5 - Response action likely to be required in relation to estimated risk

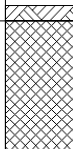
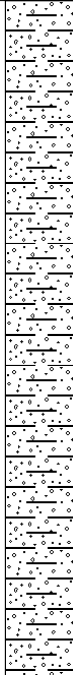
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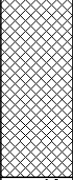
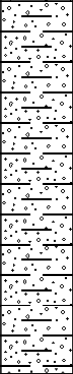
	Mitigation and remedial measures required
	Mitigation and remedial measures likely
	Remedial measures unlikely
	Remedial measures not required

Appendix C –Window Sample & Borehole Logs

 Sutcliffe Investigations					Site Victory Street, Manchester		Number WS101		
Excavation Method Drive-in Windowless Sampler		Dimensions		Ground Level (mOD)		Client One Manchester		Job Number 30669LG	
		Location		Dates 28/01/2020		Engineer AT		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20-0.70	ES1				(0.20) 0.20 (0.60) 0.80 (0.20) 1.00	Grass over dark brown fine to medium grained SAND with root material (TOPSOIL) MADE GROUND (dark brown slightly ashy fine to medium grained SAND with fine to coarse brick fragments) MADE GROUND (grey brown with yellow mottling sandy CLAY with fine brick fragments)	  		
1.20-1.65	SPT N=11		1,1/2,3,2,4			Stiff to very stiff brown slightly sandy gravelly CLAY. Sand is fine Gravel is fine to medium subrounded to subangular and of mixed lithology			
2.00-2.45	SPT N=24		3,3/5,5,6,8		(2.60)				
3.00-3.45	SPT N=26		3,3/4,5,7,10						
4.00-4.45	SPT N=37		5,6/8,8,10,11		3.60 (0.40) 4.00	Very stiff brown with orange brown banding slightly silty slightly sandy CLAY. Sand is fine			
5.00-5.45	SPT N=30		4,6/6,7,7,10		(1.45) 5.45	Very stiff brown slightly sandy gravelly CLAY. Sand is fine Gravel is fine to medium subrounded to subangular and of mixed lithology			
						Complete at 5.45m			
Remarks Borehole dry							Scale (approx) 1:50	Logged By AT	Figure No. 30669LG.WS101

 Sutcliffe Investigations						Site Victory Street, Manchester		Number WS102	
Excavation Method Drive-in Windowless Sampler		Dimensions		Ground Level (mOD)		Client One Manchester		Job Number 30669LG	
		Location		Dates 28/01/2020		Engineer AT		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20-0.70	ES1				0.10	Grass over dark brown fine to medium grained SAND with root material (TOPSOIL)			
					(1.20)	Firm brown and red brown sandy CLAY. Sand is fine to medium			
1.20-1.65	SPT N=8		1,1/1,2,2,3		1.30	Firm brown slightly silty slightly sandy slightly gravelly CLAY. Sand is fine Gravel is fine to medium subangular to subrounded and of mixed lithology			
					(0.70)				
2.00-2.45	SPT N=6		1,1/1,1,2,2		2.00	Firm brown sandy gravelly CLAY with fine to medium sand bands. Sand is fine to medium Gravel is fine to medium subangular to subrounded and of mixed lithology			
2.80	HVP 78kPa								
3.00-3.45	SPT N=9		Water strike(1) at 3.00m, no rise after 20 mins. 1,1/2,2,2,3						
					(3.45)				
3.80	HVP 70kPa								
4.00-4.45	SPT N=7		2,2/2,2,2,1						
4.80	HVP 70kPa								
5.00-5.45	SPT N=7		1,1/2,2,2,1						
					5.45	Complete at 5.45m			
Remarks							Scale (approx) 1:50	Logged By AT	Figure No. 30669LG.WS102

 Sutcliffe Investigations						Site Victory Street, Manchester		Number WS103	
Excavation Method Drive-in Windowless Sampler		Dimensions		Ground Level (mOD)		Client One Manchester		Job Number 30669LG	
		Location		Dates 28/01/2020		Engineer AT		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.20-0.70	ES1				0.10	Grass over dark brown fine to medium grained SAND with root material (TOPSOIL)			
					(0.90)	MADE GROUND (dark brown fine to medium grained SAND with fine to coarse brick fragments and half bricks)			
1.20-1.65	SPT N=13		1,1/2,3,4,4		1.00	Very stiff brown slightly sandy gravelly CLAY with fine coal fragments. Sand is fine Gravel is fine to medium subrounded to subangular and of mixed lithology			
2.00-2.45	SPT N=18		2,3/3,4,5,6						
2.80	HVP 130kPa								
3.00-3.45	SPT N=19		2,3/3,4,4,8						
3.80	HVP 130kPa								
4.00-4.45	SPT N=50		4,6/8,18,9,15						
4.80	HVP 130kPa								
5.00-5.45	SPT N=31		6,7/6,7,8,10						
					5.45	Complete at 5.45m			
Remarks							Scale (approx)	Logged By	
							1:50	AT	
							Figure No. 30669LG.WS103		

 Sutcliffe Investigations						Site Victory Street, Manchester		Number WS104	
Excavation Method Drive-in Windowless Sampler		Dimensions		Ground Level (mOD)		Client One Manchester		Job Number 30669LG	
		Location		Dates 28/01/2020		Engineer AT		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.30-0.70	ES1				(0.30) 0.30	Grass over dark brown fine to medium grained SAND with root material (TOPSOIL)			
1.20-1.65	SPT N=11		1,1/2,2,3,4		(1.20) 1.50	MADE GROUND (light grey brown fine grained SAND with fine to coarse brick fragments)			
2.00-2.45	SPT N=20		2,2/4,4,5,7		(1.50) 3.00	Stiff to very stiff brown with grey veining slightly sandy gravelly CLAY with occasional fine coal fragments. Sand is fine to medium Gravel is fine to medium subangular to angular and of mudstone			
3.00-3.45	SPT N=28		5,5/5,7,7,9		3.00 (2.45)	Very stiff brown grey slightly sandy gravelly CLAY with occasional fine coal fragments. Sand is fine to medium Gravel is fine to medium subangular to angular and of mudstone			
4.00-4.45	SPT N=35		6,6/7,8,8,12		(2.45) 5.45	Complete at 5.45m			
5.00-5.45	SPT N=23		1,1/4,6,6,7						
Remarks Borehole dry							Scale (approx) 1:50	Logged By at	Figure No. 30669LG.WS104

Appendix D – Analytical Certificates

FINAL ANALYTICAL TEST REPORT SUPPLEMENT TO TEST REPORT 20/00975/2

Amendments: Request for Additional Analysis

Envirolab Job Number: 20/00975
Issue Number: 3

Date: 21 April, 2020

Client: Sutcliffe
18-20 Harrington Street
Liverpool
L2 9QA

Project Manager: Sara Hale; Adrian Lewis; David Bowen; Alex Tosh
Project Name: Victory Street, Manchester
Project Ref: 30669LG
Order No: 7969
Date Samples Received: 29/01/20
Date Instructions Received: 31/01/20
Date Analysis Completed: 21/04/20

Prepared by:



Holly Neary-King
Administration & Client Services Supervisor

Approved by:



John Gustafson
Managing Director

Envirolab Job Number: 20/00975

Client Project Name: Victory Street, Manchester

Client Project Ref: 30669LG

Lab Sample ID	20/00975/1	20/00975/2	20/00975/3	20/00975/4	20/00975/5	20/00975/7	20/00975/8	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS101	WS102	WS103	WS104	WS101	WS103	WS104			
Depth to Top	1.00	1.00	2.00	1.00	0.20	0.20	0.30			
Depth To Bottom	2.00	2.00	3.00	2.00	0.70	0.60	0.60			
Date Sampled	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20			
Sample Type	Soil - U	Soil - U	Soil - U	Soil - U	Soil	Soil	Soil			
Sample Matrix Code					4AB	4ABE	4AB			
% Moisture at <40C _A	-	-	-	-	17.0	15.9	16.1	% w/w	0.1	A-T-044
% Stones >10mm _A	-	-	-	-	12.1	22.3	3.1	% w/w	0.1	A-T-044
pH _D ^{M#}	-	-	-	-	8.13	8.27	8.54	pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	-	-	-	0.04	<0.01	<0.01	g/l	0.01	A-T-026s
Sulphate (acid soluble) _D ^{M#}	-	-	-	-	920	710	800	mg/kg	200	A-T-028s
Cyanide (total) _A ^{M#}	-	-	-	-	<1	<1	1	mg/kg	1	A-T-042sTCN
Phenols - Total by HPLC _A	-	-	-	-	<0.2	<0.2	<0.2	mg/kg	0.2	A-T-050s
Sulphide _A	-	-	-	-	<5	<5	110	mg/kg	5	A-T-S2-s
Sulphur (elemental) _D ^{M#}	-	-	-	-	31	10	<5	mg/kg	5	A-T-029s
Organic matter _D ^{M#}	-	-	-	-	10.0	4.8	4.7	% w/w	0.1	A-T-032 OM
Arsenic _D ^{M#}	-	-	-	-	25	11	10	mg/kg	1	A-T-024s
Boron (water soluble) _D ^{M#}	-	-	-	-	<1.0	1.1	<1.0	mg/kg	1	A-T-027s
Cadmium _D ^{M#}	-	-	-	-	1.5	1.1	0.6	mg/kg	0.5	A-T-024s
Copper _D ^{M#}	-	-	-	-	107	69	25	mg/kg	1	A-T-024s
Chromium _D ^{M#}	-	-	-	-	29	26	19	mg/kg	1	A-T-024s
Chromium (hexavalent) _D	-	-	-	-	<1	<1	<1	mg/kg	1	A-T-040s
Chromium (trivalent)	-	-	-	-	29	26	19	mg/kg	1	Calc
Lead _D ^{M#}	-	-	-	-	620	357	842	mg/kg	1	A-T-024s
Mercury _D	-	-	-	-	0.76	0.99	0.45	mg/kg	0.17	A-T-024s
Nickel _D ^{M#}	-	-	-	-	26	19	14	mg/kg	1	A-T-024s
Selenium _D ^{M#}	-	-	-	-	2	<1	<1	mg/kg	1	A-T-024s
Zinc _D ^{M#}	-	-	-	-	410	217	106	mg/kg	5	A-T-024s
Leachate Prep NRA (10:1) _A	-	-	-	-	*	*	*			A-T-001
pH (leachable) _A [#]	-	-	-	-	7.69	7.69	7.88	pH	0.01	A-T-031w
Sulphate (leachable) _A [#]	-	-	-	-	8.54	25.26	<1.00	mg/l	1	A-T-026w
Cyanide (total) (leachable) _A [#]	-	-	-	-	<0.005	<0.005	<0.005	mg/l	0.005	A-T-042wTCN
Phenols (total by HPLC) (leachable) _A	-	-	-	-	<0.01	<0.01	<0.01	mg/l	0.01	A-T-050w
Sulphide (leachable) _A	-	-	-	-	<0.1	0.5	<0.1	mg/l	0.1	A-T-S2-w
DOC (leachable) _A [#]	-	-	-	-	4.7	3.8	3.6	mg/l	0.2	A-T-032w
Arsenic (leachable) _A [#]	-	-	-	-	12	2	4	µg/l	1	A-T-025w
Boron (leachable) _A [#]	-	-	-	-	18	32	<10	µg/l	10	A-T-025w
Cadmium (leachable) _A [#]	-	-	-	-	<1	<1	<1	µg/l	1	A-T-025w
Copper (leachable) _A [#]	-	-	-	-	30	15	9	µg/l	1	A-T-025w

Envirolab Job Number: 20/00975

Client Project Name: Victory Street, Manchester

Client Project Ref: 30669LG

Lab Sample ID	20/00975/1	20/00975/2	20/00975/3	20/00975/4	20/00975/5	20/00975/7	20/00975/8	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS101	WS102	WS103	WS104	WS101	WS103	WS104			
Depth to Top	1.00	1.00	2.00	1.00	0.20	0.20	0.30			
Depth To Bottom	2.00	2.00	3.00	2.00	0.70	0.60	0.60			
Date Sampled	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20			
Sample Type	Soil - U	Soil - U	Soil - U	Soil - U	Soil	Soil	Soil			
Sample Matrix Code					4AB	4ABE	4AB			
Chromium (leachable) _A [#]	-	-	-	-	1	2	12	µg/l	1	A-T-025w
Chromium (hexavalent) (leachable) _A	-	-	-	-	<0.05	<0.05	<0.05	mg/l	0.05	A-T-040w
Chromium (trivalent) (leachable)	-	-	-	-	<0.05	<0.05	<0.05	mg/l	0.05	Calc
Lead (leachable) _A [#]	-	-	-	-	141	39	266	µg/l	1	A-T-025w
Mercury (leachable) _A [#]	-	-	-	-	<0.1	<0.1	<0.1	µg/l	0.1	A-T-025w
Nickel (leachable) _A [#]	-	-	-	-	2	2	1	µg/l	1	A-T-025w
Selenium (leachable) _A [#]	-	-	-	-	<1	<1	<1	µg/l	1	A-T-025w
Sulphur (elemental/free) (leachable) _A	-	-	-	-	<0.1	<0.1	<0.1	mg/l	0.1	A-T-029w
Zinc (leachable) _A [#]	-	-	-	-	64	27	12	µg/l	1	A-T-025w
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	Appended	Appended	-	Appended	-	-	-		0.1	Subcon SS
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	Appended	Appended	-	Appended	-	-	-		1	Subcon SS
1.10a PSD (Grading/63um/sand fraction/wet sieve) BS1377 pt 2 1990 cl 9.2 _A [#]	-	-	Appended	-	-	-	-		0.1	Subcon SS
1.11 Soil Suction, Filter Paper Method (Desiccation) BRE IP4/93 _A	-	-	US	-	-	-	-	N/A		Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9 _A [#]	Appended	Appended	-	Appended	-	-	-			Subcon SS
TPH total (>C6-C40) (leachable) _A	-	-	-	-	<80	<80	<80	µg/l	80	A-T-007w

Envirolab Job Number: 20/00975

Client Project Name: Victory Street, Manchester

Client Project Ref: 30669LG

Lab Sample ID	20/00975/1	20/00975/2	20/00975/3	20/00975/4	20/00975/5	20/00975/7	20/00975/8	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS101	WS102	WS103	WS104	WS101	WS103	WS104			
Depth to Top	1.00	1.00	2.00	1.00	0.20	0.20	0.30			
Depth To Bottom	2.00	2.00	3.00	2.00	0.70	0.60	0.60			
Date Sampled	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20			
Sample Type	Soil - U	Soil - U	Soil - U	Soil - U	Soil	Soil	Soil			
Sample Matrix Code					4AB	4ABE	4AB			
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	-	-	-	-	NAD	NAD	NAD			A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	-	-	-	-	N/A	N/A	N/A			A-T-045

Envirolab Job Number: 20/00975

Client Project Name: Victory Street, Manchester

Client Project Ref: 30669LG

Lab Sample ID	20/00975/1	20/00975/2	20/00975/3	20/00975/4	20/00975/5	20/00975/7	20/00975/8	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS101	WS102	WS103	WS104	WS101	WS103	WS104			
Depth to Top	1.00	1.00	2.00	1.00	0.20	0.20	0.30			
Depth To Bottom	2.00	2.00	3.00	2.00	0.70	0.60	0.60			
Date Sampled	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20			
Sample Type	Soil - U	Soil - U	Soil - U	Soil - U	Soil	Soil	Soil			
Sample Matrix Code					4AB	4ABE	4AB			
PAH-16MS										
Acenaphthene _A ^{M#}	-	-	-	-	1.41	0.22	0.07	mg/kg	0.01	A-T-019s
Acenaphthylene _A ^{M#}	-	-	-	-	0.11	0.03	0.02	mg/kg	0.01	A-T-019s
Anthracene _A ^{M#}	-	-	-	-	2.35	0.36	0.20	mg/kg	0.02	A-T-019s
Benzo(a)anthracene _A ^{M#}	-	-	-	-	6.36	1.48	0.95	mg/kg	0.04	A-T-019s
Benzo(a)pyrene _A ^{M#}	-	-	-	-	5.53	1.33	0.81	mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	-	-	-	-	6.41	1.65	1.02	mg/kg	0.05	A-T-019s
Benzo(ghi)perylene _A ^{M#}	-	-	-	-	2.22	0.61	0.44	mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	-	-	-	-	2.28	0.52	0.33	mg/kg	0.07	A-T-019s
Chrysene _A ^{M#}	-	-	-	-	6.23	1.54	1.02	mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	-	-	-	-	0.57	0.16	0.10	mg/kg	0.04	A-T-019s
Fluoranthene _A ^{M#}	-	-	-	-	14.6	3.00	1.78	mg/kg	0.08	A-T-019s
Fluorene _A ^{M#}	-	-	-	-	1.16	0.15	0.06	mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	-	-	-	-	2.67	0.72	0.47	mg/kg	0.03	A-T-019s
Naphthalene _A ^{M#}	-	-	-	-	0.48	0.05	<0.03	mg/kg	0.03	A-T-019s
Phenanthrene _A ^{M#}	-	-	-	-	11.2	1.86	1.02	mg/kg	0.03	A-T-019s
Pyrene _A ^{M#}	-	-	-	-	13.5	2.80	1.73	mg/kg	0.07	A-T-019s
Total PAH-16MS _A ^{M#}	-	-	-	-	77.1	16.5	10	mg/kg	0.01	A-T-019s

Envirolab Job Number: 20/00975

Client Project Name: Victory Street, Manchester

Client Project Ref: 30669LG

Lab Sample ID	20/00975/1	20/00975/2	20/00975/3	20/00975/4	20/00975/5	20/00975/7	20/00975/8	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS101	WS102	WS103	WS104	WS101	WS103	WS104			
Depth to Top	1.00	1.00	2.00	1.00	0.20	0.20	0.30			
Depth To Bottom	2.00	2.00	3.00	2.00	0.70	0.60	0.60			
Date Sampled	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20			
Sample Type	Soil - U	Soil - U	Soil - U	Soil - U	Soil	Soil	Soil			
Sample Matrix Code					4AB	4ABE	4AB			
PAH-16MS (leachable)										
Acenaphthene (leachable) _A	-	-	-	-	0.14	0.17	0.09	µg/l	0.01	A-T-019w
Acenaphthylene (leachable) _A	-	-	-	-	<0.01	0.03	<0.01	µg/l	0.01	A-T-019w
Anthracene (leachable) _A	-	-	-	-	0.06	0.03	0.04	µg/l	0.01	A-T-019w
Benzo(a)anthracene (leachable) _A	-	-	-	-	0.05	<0.01	<0.01	µg/l	0.01	A-T-019w
Benzo(a)pyrene (leachable) _A	-	-	-	-	0.03	<0.01	<0.01	µg/l	0.01	A-T-019w
Benzo(b)fluoranthene (leachable) _A	-	-	-	-	0.05	<0.01	0.02	µg/l	0.01	A-T-019w
Benzo(ghi)perylene (leachable) _A	-	-	-	-	0.03	<0.01	<0.01	µg/l	0.01	A-T-019w
Benzo(k)fluoranthene (leachable) _A	-	-	-	-	<0.01	<0.01	<0.01	µg/l	0.01	A-T-019w
Chrysene (leachable) _A	-	-	-	-	0.07	<0.01	0.03	µg/l	0.01	A-T-019w
Dibenzo(ah)anthracene (leachable) _A	-	-	-	-	<0.01	<0.01	<0.01	µg/l	0.01	A-T-019w
Fluoranthene (leachable) _A	-	-	-	-	0.17	0.07	0.09	µg/l	0.01	A-T-019w
Fluorene (leachable) _A	-	-	-	-	0.10	0.14	0.10	µg/l	0.01	A-T-019w
Indeno(123-cd)pyrene (leachable) _A	-	-	-	-	0.03	<0.01	<0.01	µg/l	0.01	A-T-019w
Naphthalene (leachable) _A	-	-	-	-	0.07	0.30	0.05	µg/l	0.01	A-T-019w
Phenanthrene (leachable) _A	-	-	-	-	0.32	0.23	0.24	µg/l	0.01	A-T-019w
Pyrene (leachable) _A	-	-	-	-	0.15	0.05	0.07	µg/l	0.01	A-T-019w
Total PAH-16MS (leachable) _A	-	-	-	-	1.27	1.02	0.73	µg/l	0.01	A-T-019w

Envirolab Job Number: 20/00975

Client Project Name: Victory Street, Manchester

Client Project Ref: 30669LG

Lab Sample ID	20/00975/1	20/00975/2	20/00975/3	20/00975/4	20/00975/5	20/00975/7	20/00975/8	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS101	WS102	WS103	WS104	WS101	WS103	WS104			
Depth to Top	1.00	1.00	2.00	1.00	0.20	0.20	0.30			
Depth To Bottom	2.00	2.00	3.00	2.00	0.70	0.60	0.60			
Date Sampled	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20	28-Jan-20			
Sample Type	Soil - U	Soil - U	Soil - U	Soil - U	Soil	Soil	Soil			
Sample Matrix Code					4AB	4ABE	4AB			
TPH UKCWG										
Ali >C5-C6 _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
Ali >C6-C8 _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
Ali >C8-C10 _A	-	-	-	-	<1	<5	<1	mg/kg	1	A-T-055s
Ali >C10-C12 _A ^{M#}	-	-	-	-	<1	<5	<1	mg/kg	1	A-T-055s
Ali >C12-C16 _A ^{M#}	-	-	-	-	3	<5	1	mg/kg	1	A-T-055s
Ali >C16-C21 _A ^{M#}	-	-	-	-	4	<5	2	mg/kg	1	A-T-055s
Ali >C21-C35 _A	-	-	-	-	35	639	16	mg/kg	1	A-T-055s
Ali >C35-C44 _A	-	-	-	-	14	<5	5	mg/kg	1	A-T-055s
Total Aliphatics _A	-	-	-	-	56	639	24	mg/kg	1	A-T-055s
Aro >C5-C7 _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
Aro >C7-C8 _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
Aro >C8-C10 _A	-	-	-	-	3	<5	2	mg/kg	1	A-T-055s
Aro >C10-C12 _A ^{M#}	-	-	-	-	6	<5	2	mg/kg	1	A-T-055s
Aro >C12-C16 _A	-	-	-	-	33	6	9	mg/kg	1	A-T-055s
Aro >C16-C21 _A ^{M#}	-	-	-	-	101	35	23	mg/kg	1	A-T-055s
Aro >C21-C35 _A ^{M#}	-	-	-	-	452	353	110	mg/kg	1	A-T-055s
Aro >C35-C44 _A	-	-	-	-	24	16	10	mg/kg	1	A-T-055s
Total Aromatics _A	-	-	-	-	621	410	158	mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C44) _A	-	-	-	-	677	1050	184	mg/kg	1	A-T-055s
BTEX - Benzene _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
BTEX - Toluene _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
BTEX - m & p Xylene _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
BTEX - o Xylene _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s
MTBE _A [#]	-	-	-	-	<0.01	<0.01	<0.01	mg/kg	0.01	A-T-022s

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts.

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Sutcliffe, 18-20 Harrington Street, Liverpool, L2 9QA

Project No: 20/00975

Project: Victory Street, Manchester

Date Received: 31/01/2020 (am)

Clients Project No: 30669LG

Cool Box Temperatures (°C): 8.8

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Appendix E - Ground Gas & Groundwater Monitoring Data

	SUTCLIFFE INVESTIGATIONS					GAS MEASUREMENTS AND WATER LEVELS	Sheet No.: 1 of 1			
	TEL: 0151 227 3155						Atmospheric Pressure: 1018mb			
	FAX: 0151 227 3156						Weather: Clear/Cloudy			
							Pressure Trend: Rising			
	VISIT No.: 1									
	CLIENT: One Manchester Ltd					SITE: Victory Street, Manchester				
Date of Fieldwork: 04.02.20					Logged By: JS		Job No.: 30669LG			
B/H REF	CH ₄		CO ₂	O ₂	Relative Pressure	Flow Rate	P.I.D	Base of Borehole	Water Level	Reduced Water
	%LEL	%by vol	%by vol	%by vol	(mb)	(l/h)		(mbgl)	(mbgl)	(m) A.O.D
WS101		0.2	1.2	20.4	0.06	14.2		4	0.82	
		0.2	1.2	19.5						
		0.2	3.5	18.9						
		0.2	3.5	18.8						
WS102		0.2	0.4	21.2	0.07	0		2.6	0.65	
		0.2	3.5	19.3						
		0.2	3.9	18						
		0.2	3.9	18						
WS104		0.2	0.2	21.1	0.08	-0.1		1.1	DRY	
		0.2	0.3	21.1						
		0.2	0.2	21						
		0.2	0.3	21						
COMMENTS:										
INSTRUMENT USED:				ACCURACY OF INSTRUMENT (% by volume)	CH ₄		CO ₂		O ₂	
					± 0.5% @ 5%		± 0.5% @ 5%			
					± 1.0% @15%		± 1.0% @15%		± 1.0%	
					±3.0% @>15%		±3.0% @>15%			

A = Accumulated Type Sample
l/h = Litres per hour
%LEL = Lower Explosive Limit (for CH4 in air 100% = 5% by volume)

SS = Steady State Type Sample
mb = Millibar

P = Peak Type Sample
mbgl = Metres Below Ground Level

	SUTCLIFFE INVESTIGATIONS					GAS MEASUREMENTS AND WATER LEVELS	Sheet No.: 1 of 1			
	TEL: 0151 227 3155						Atmospheric Pressure: 1001mb			
	FAX: 0151 227 3156						Weather: Clear/Cloudy			
							Pressure Trend: Steady			
	VISIT No.: 2					SITE: Victory Street, Manchester				
	CLIENT: One Manchester Ltd					Job No.: 30669LG				
	Date of Fieldwork: 26.02.20					Logged By: JS				
B/H REF	CH ₄		CO ₂	O ₂	Relative Pressure	Flow Rate	P.I.D	Base of Borehole	Water Level	Reduced Water
	%LEL	%by vol	%by vol	%by vol	(mb)	(l/h)		(mbgl)	(mbgl)	(m) A.O.D
WS101		0.2	1	21	-0.38	10.4		4	0.78	
		0.2	2.9	19.5						
		0.2	3.3	18.9						
		0.2	3.3	18.7						
WS102		0.2	0.5	20.4	-0.73	0		2.6	0.7	
		0.2	0.3	20.1						
		0.2	0.1	20.3						
		0.2	0.1	20.7						
WS104		0.2	0.4	20.2	-0.17	0		1.1	0.79	
		0.2	1.9	19.3						
		0.2	2	18.8						
		0.2	2	17.5						
COMMENTS:										
INSTRUMENT USED:				ACCURACY OF INSTRUMENT (% by volume)	CH ₄		CO ₂		O ₂	
					± 0.5% @ 5%		± 0.5% @ 5%			
					± 1.0% @15%		± 1.0% @15%		± 1.0%	
					±3.0% @>15%		±3.0% @>15%			

A = Accumulated Type Sample
l/h = Litres per hour
%LEL = Lower Explosive Limit (for CH4 in air 100% = 5% by volume)

SS = Steady State Type Sample
mb = Millibar

P = Peak Type Sample
mbgl = Metres Below Ground Level

	SUTCLIFFE INVESTIGATIONS					GAS MEASUREMENTS AND WATER LEVELS	Sheet No.: 1 of 1			
	TEL: 0151 227 3155						Atmospheric Pressure: 995mb			
	FAX: 0151 227 3156						Weather: Clear/Cloudy			
							Pressure Trend: Falling			
	VISIT No.: 3									
	CLIENT: One Manchester Ltd					SITE: Victory Street, Manchester				
Date of Fieldwork: 05.03.20					Logged By: JS		Job No.: 30669LG			
B/H REF	CH ₄		CO ₂	O ₂	Relative Pressure	Flow Rate	P.I.D	Base of Borehole	Water Level	Reduced Water
	%LEL	%by vol	%by vol	%by vol	(mb)	(l/h)		(mbgl)	(mbgl)	(m) A.O.D
WS101		0.2	1.5	20.3	-0.11	5.1		4	0.79	
		0.2	4.9	19.2						
		0.2	5	18						
		0.2	5	15.3						
WS102		0.2	0.4	20.3	-0.1	0		2.6	0.87	
		0.2	2.7	19.8						
		0.2	2.8	18.9						
		0.2	2.8	17.4						
WS104		0.2	0.3	20.7	-0.11	0		1.1	0.86	
		0.2	0.3	20						
		0.2	1.9	19.6						
		0.2	1.9	18.4						
COMMENTS:										
INSTRUMENT USED:				ACCURACY OF INSTRUMENT (% by volume)	CH ₄		CO ₂		O ₂	
					± 0.5% @ 5%		± 0.5% @ 5%			
					± 1.0% @15%		± 1.0% @15%		± 1.0%	
					±3.0% @>15%		±3.0% @>15%			

A = Accumulated Type Sample
l/h = Litres per hour
%LEL = Lower Explosive Limit (for CH4 in air 100% = 5% by volume)

SS = Steady State Type Sample
mb = Millibar

P = Peak Type Sample
mbgl = Metres Below Ground Level

	SUTCLIFFE INVESTIGATIONS					GAS MEASUREMENTS AND WATER LEVELS	Sheet No.: 1 of 1			
	TEL: 0151 227 3155						Atmospheric Pressure: 1018			
	FAX: 0151 227 3156						Weather: Overcast			
							Pressure Trend: Falling			
	VISIT No.: 4									
	CLIENT: One Manchester Ltd					SITE: Victory Street, Manchester				
Date of Fieldwork: 01.04.2020					Logged By: JS		Job No.: 30669LG			
B/H REF	CH ₄		CO ₂	O ₂	Relative Pressure	Flow Rate	P.I.D	Base of Borehole	Water Level	Reduced Water
	%LEL	%by vol	%by vol	%by vol	(mb)	(l/h)		(mbgl)	(mbgl)	(m) A.O.D
WS101		0.5	0.9	20	-0.14	4.2		4	0.81	
		0.5	2.9	19.7						
		0.5	2.9	18.7						
		0.5	2.9	18.7						
WS102		0.6	0.4	20.5	-0.16	0		2.65	0.97	
		0.6	2.7	19.5						
		0.6	3.1	18.8						
		0.6	3.1	18.8						
WS104		0.4	0.3	19.9	-0.18	0		1.1	0.89	
		0.5	1	19.8						
		0.5	1.4	19						
		0.5	3	19						
COMMENTS:										
INSTRUMENT USED:				ACCURACY OF INSTRUMENT (% by volume)	CH ₄		CO ₂		O ₂	
					± 0.5% @ 5%		± 0.5% @ 5%			
					± 1.0% @15%		± 1.0% @15%		± 1.0%	
					±3.0% @>15%		±3.0% @>15%			

A = Accumulated Type Sample
l/h = Litres per hour
%LEL = Lower Explosive Limit (for CH4 in air 100% = 5% by volume)

SS = Steady State Type Sample
mb = Millibar

P = Peak Type Sample
mbgl = Metres Below Ground Level

	SUTCLIFFE INVESTIGATIONS					GAS MEASUREMENTS AND WATER LEVELS	Sheet No.: 1 of 1			
	TEL: 0151 227 3155						Atmospheric Pressure: 1008			
	FAX: 0151 227 3156						Weather: Sunny			
							Pressure Trend: Steady			
	VISIT No.: 5									
	CLIENT: One Manchester Ltd					SITE: Victory Street, Manchester				
Date of Fieldwork: 27.04.20					Logged By: AT		Job No.: 30669LG			
B/H REF	CH ₄		CO ₂	O ₂	Relative Pressure	Flow Rate	P.I.D	Base of Borehole	Water Level	Reduced Water
	%LEL	%by vol	%by vol	%by vol	(mb)	(l/h)		(mbgl)	(mbgl)	(m) A.O.D
WS101		0.0	0.1	21.0	-0.16	-0.2		4.0	1.8	
		0.0	8.3	14.2						
		0.0	8.3	13.8						
		0.0	8.3	13.8						
WS102		WELL OBSTRUCTED								
WS104		0.1	0.1	20.9	-0.17	-0.3		1.1	1.0	
		0.1	1.2	20.1						
		0.1	1.3	19.9						
		0.1	1.3	19.9						
COMMENTS:										
INSTRUMENT USED:				ACCURACY OF INSTRUMENT (% by volume)	CH ₄		CO ₂		O ₂	
					± 0.5% @ 5%		± 0.5% @ 5%			
					± 1.0% @15%		± 1.0% @15%		± 1.0%	
					±3.0% @>15%		±3.0% @>15%			

A = Accumulated Type Sample
l/h = Litres per hour
%LEL = Lower Explosive Limit (for CH4 in air 100% = 5% by volume)

SS = Steady State Type Sample
mb = Millibar

P = Peak Type Sample
mbgl = Metres Below Ground Level

	SUTCLIFFE INVESTIGATIONS					GAS MEASUREMENTS AND WATER LEVELS	Sheet No.: 1 of 1			
	TEL: 0151 227 3155						Atmospheric Pressure: 1009			
	FAX: 0151 227 3156						Weather: Sunny			
							Pressure Trend: Rising			
	VISIT No.: 6									
	CLIENT: One Manchester Ltd					SITE: Victory Street, Manchester				
Date of Fieldwork: 06.05.2020					Logged By: AT		Job No.: 30669LG			
B/H REF	CH ₄		CO ₂	O ₂	Relative Pressure	Flow Rate	P.I.D	Base of Borehole	Water Level	Reduced Water
	%LEL	%by vol	%by vol	%by vol	(mb)	(l/h)		(mbgl)	(mbgl)	(m) A.O.D
WS101		0	0.1	21.1	-0.1	-0.2		4	1.79	
		0	5	20.4						
		0	8.1	16.2						
		0	8.1	13.1						
WS102		0.6	0.4	20.5	-0.1	0		2.65	0.97	
		0.6	2.7	19.5						
		0.6	3.1	18.8						
		0.6	3.1	18.8						
WS104		0.1	1.2	20.3	-0.16	-0.1		1.12	1.08	
		0.1	1.2	20.1						
		0.1	1.2	19.9						
		0.1	1.3	19.8						
COMMENTS:										
INSTRUMENT USED:				ACCURACY OF INSTRUMENT (% by volume)	CH ₄		CO ₂		O ₂	
					± 0.5% @ 5%		± 0.5% @ 5%			
					± 1.0% @15%		± 1.0% @15%		± 1.0%	
					±3.0% @>15%		±3.0% @>15%			

A = Accumulated Type Sample
l/h = Litres per hour
%LEL = Lower Explosive Limit (for CH4 in air 100% = 5% by volume)

SS = Steady State Type Sample
mb = Millibar

P = Peak Type Sample
mbgl = Metres Below Ground Level

Appendix F – Geotechnical Laboratory Certificates



STRUCTURAL SOILS LTD
TEST REPORT



Report No. 784344 R2

Date 21-February-2020 Contract 20/00975

Client Envirolab Ltd
Address Units 7 & 8 Sandpits Business Park
Mottram Road
Hyde
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client 31/01/2020
Testing Started 11/02/2020
Testing Completed 21/02/2020

Client Reference 20/00975
Client Order No. P0742960
Instruction Type Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4
Particle Size Distribution BS1377:Part 2:1990,clause 9.2
Undrained shear strength triaxial compression without pore pressure measurement
(multistage loading) BS1377:Part 7:1990,clause 8.5

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

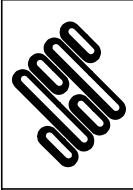
Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail luke.fisher@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425µm	Description of Sample
WS101	20/00975/1	U	1.00	19	43	17	26	95	Dark brown slightly sandy slightly gravelly CLAY
WS102	20/00975/2	U	1.00	22	37	19	18	93	Dark brown slightly sandy slightly gravelly CLAY
WS104	20/00975/4	U	1.00	22	47	19	28	95	Dark brown slightly sandy slightly gravelly CLAY



**STRUCTURAL
SOILS LTD**

Contract:

20/00975

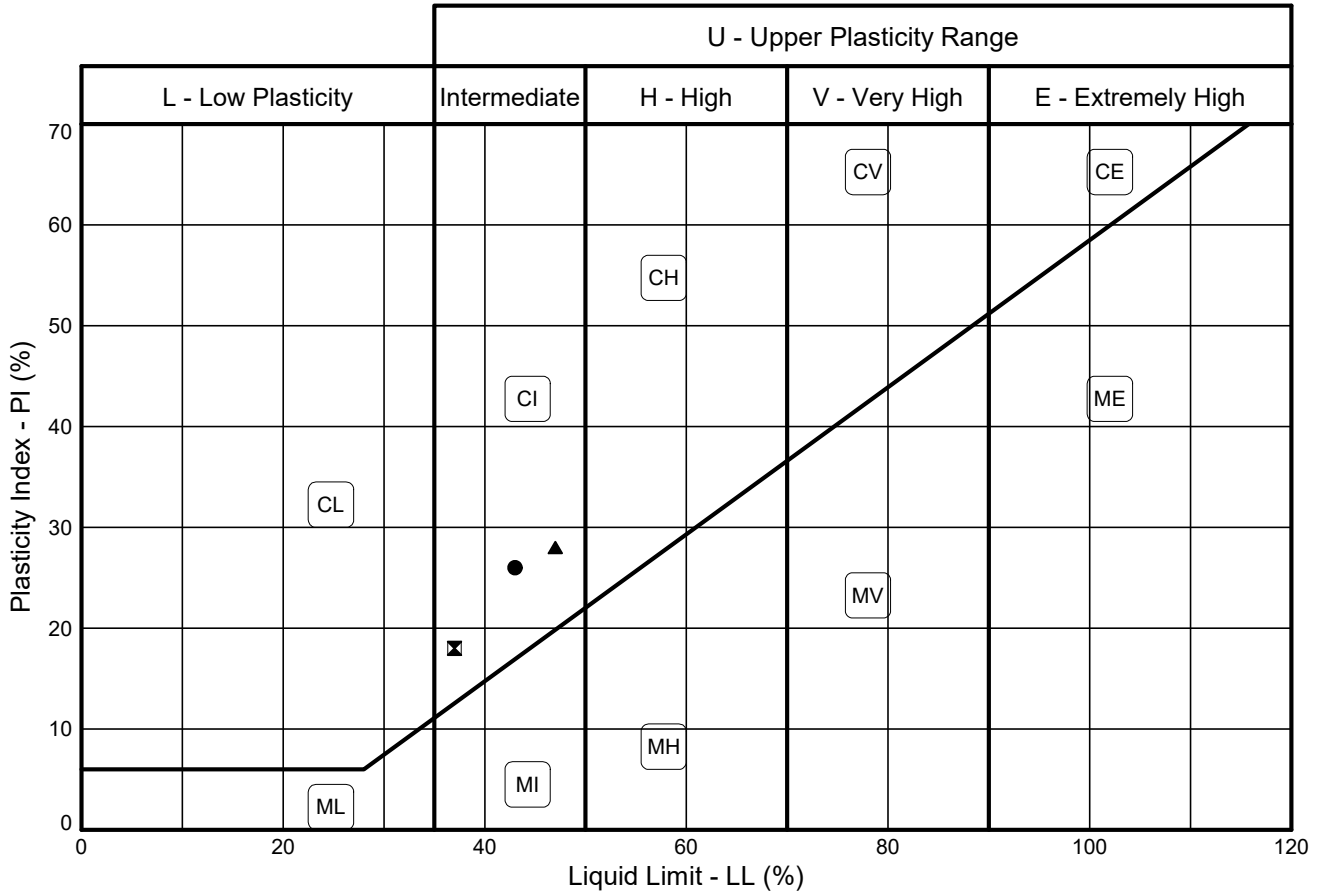
Contract Ref:

784344



PLASTICITY CHART - PI Vs LL

In accordance with BS5930:2015
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425µm %	Lab location	Notes
Exploratory Position ID	Sample	Depth (m)										
●	WS101	20/00975/1U	1.00	3.2/4.3/5.3/5.4	4.2.4	19	43	17	26	95	C	
⊠	WS102	20/00975/2U	1.00	3.2/4.3/5.3/5.4	4.2.4	22	37	19	18	93	C	
▲	WS104	20/00975/4U	1.00	3.2/4.3/5.3/5.4	4.2.4	22	47	19	28	95	C	

Tested in accordance with the following clauses of BS1377-2:1990.

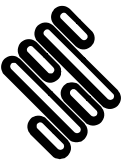
- 3.2 - Moisture Content
- 4.3 - Cone Penetrometer Method
- 4.4 - One Point Cone Penetrometer Method
- 4.6 - One Point Casagrande Method
- 5.3 - Plastic Limit Method
- 5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

- 4.2.3 - Natural State
- 4.2.4 - Wet Sieved

Key: * = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)



STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By

Date

[Signature]

LORNA WHITWORTH

18/02/20

Contract

20/00975

Contract Ref:

784344



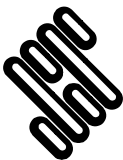
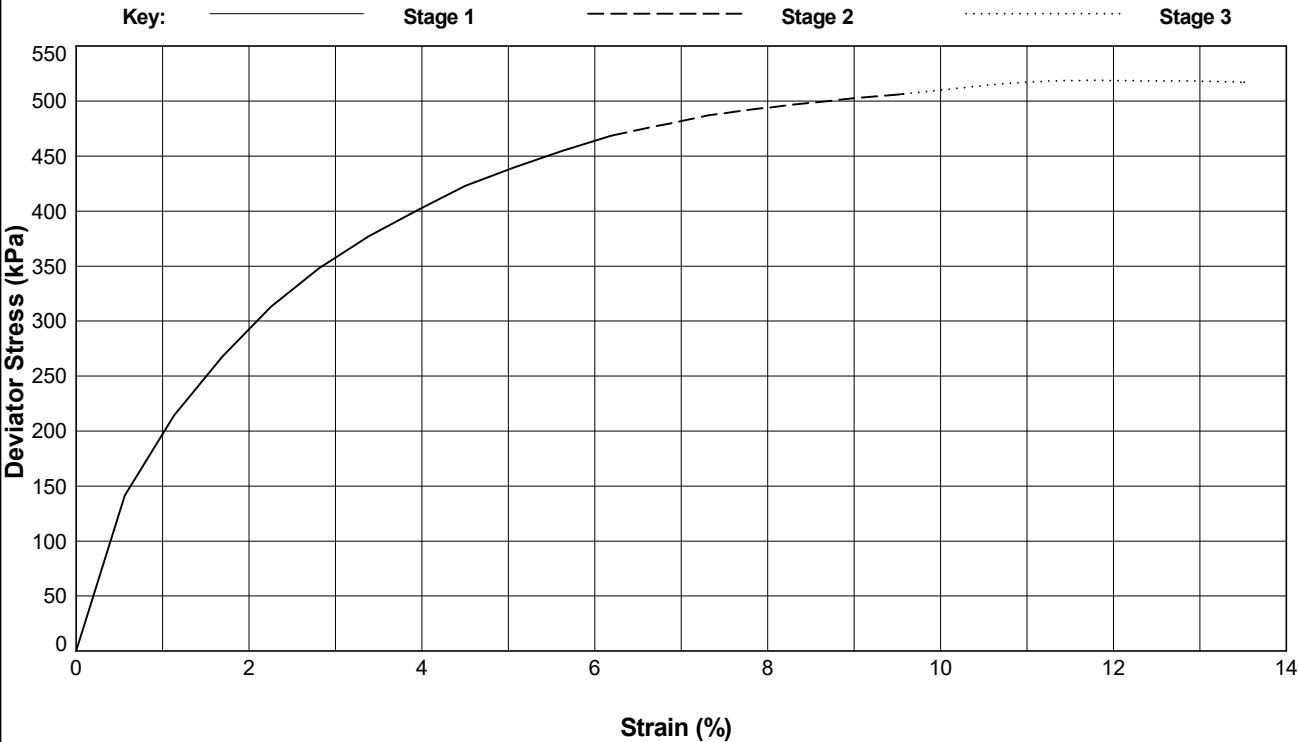
UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

In accordance with BS1377:Part 7:1990, Clause 9

Window Sample: **WS101** Sample Ref: **20/00975/1** Sample Type: **U** Depth (m): **1.00**

Description : **Dark brown slightly sandy slightly gravelly CLAY**

STAGE NUMBER		1	2	3
SAMPLE DETAILS	Sample Condition	Undisturbed		
	Orientation of sample	Vertical		
	Diameter (mm)	82.50		
	Height (mm)	177.67		
	Moisture Content (%)	17		
	Bulk Density (Mg/m ³)	2.17		
	Dry Density (Mg/m ³)	1.85		
TEST DETAILS	Membrane Thickness (mm)	0.38	0.38	0.38
	Rate of Axial Displacement (%/min)	2.00	2.00	2.00
	Cell Pressure (kPa)	10	20	40
	Membrane Correction (kPa)	0.73	1.02	1.19
	Corrected Deviator Stress (kPa)	469	506	519
	Undrained Shear Strength (kPa)	234	253	260
	Strain at Failure (%)	6.2	9.6	11.8
	Mode of Failure			Brittle



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LUKE FISHER

LUKE FISHER

Date

18/02/20

Contract

20/00975

Contract Ref:

784344



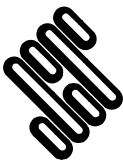
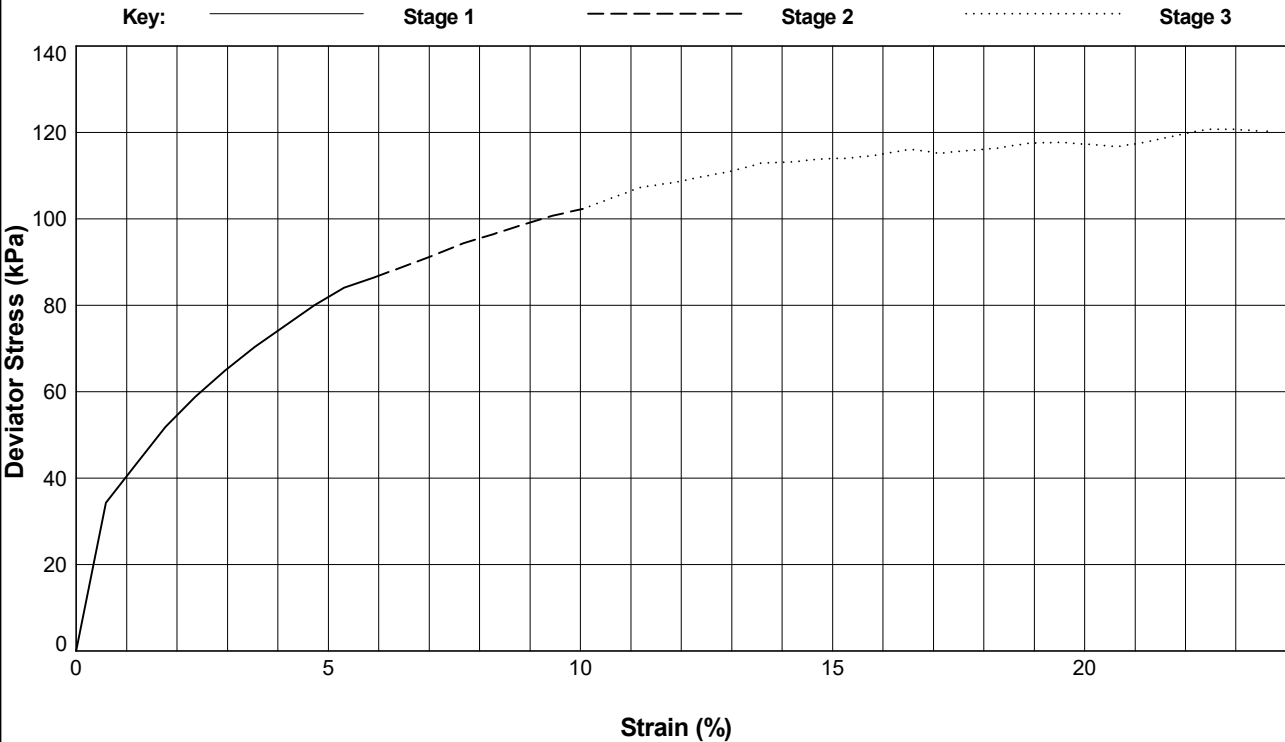
UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

In accordance with BS1377:Part 7:1990, Clause 9

Window Sample: **WS102** Sample Ref: **20/00975/2** Sample Type: **U** Depth (m): **1.00**

Description : **Dark brown slightly sandy slightly gravelly CLAY**

STAGE NUMBER		1	2	3
SAMPLE DETAILS	Sample Condition	Undisturbed		
	Orientation of sample	Vertical		
	Diameter (mm)	83.17		
	Height (mm)	169.33		
	Moisture Content (%)	16		
	Bulk Density (Mg/m ³)	2.19		
	Dry Density (Mg/m ³)	1.90		
TEST DETAILS	Membrane Thickness (mm)	0.34	0.34	0.34
	Rate of Axial Displacement (%/min)	2.00	2.00	2.00
	Cell Pressure (kPa)	10	20	40
	Membrane Correction (kPa)	0.62	0.95	1.71
	Corrected Deviator Stress (kPa)	86	102	121
	Undrained Shear Strength (kPa)	43	51	60
	Strain at Failure (%)	5.9	10.0	22.4
	Mode of Failure			Compound



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UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

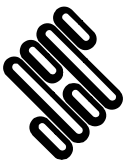
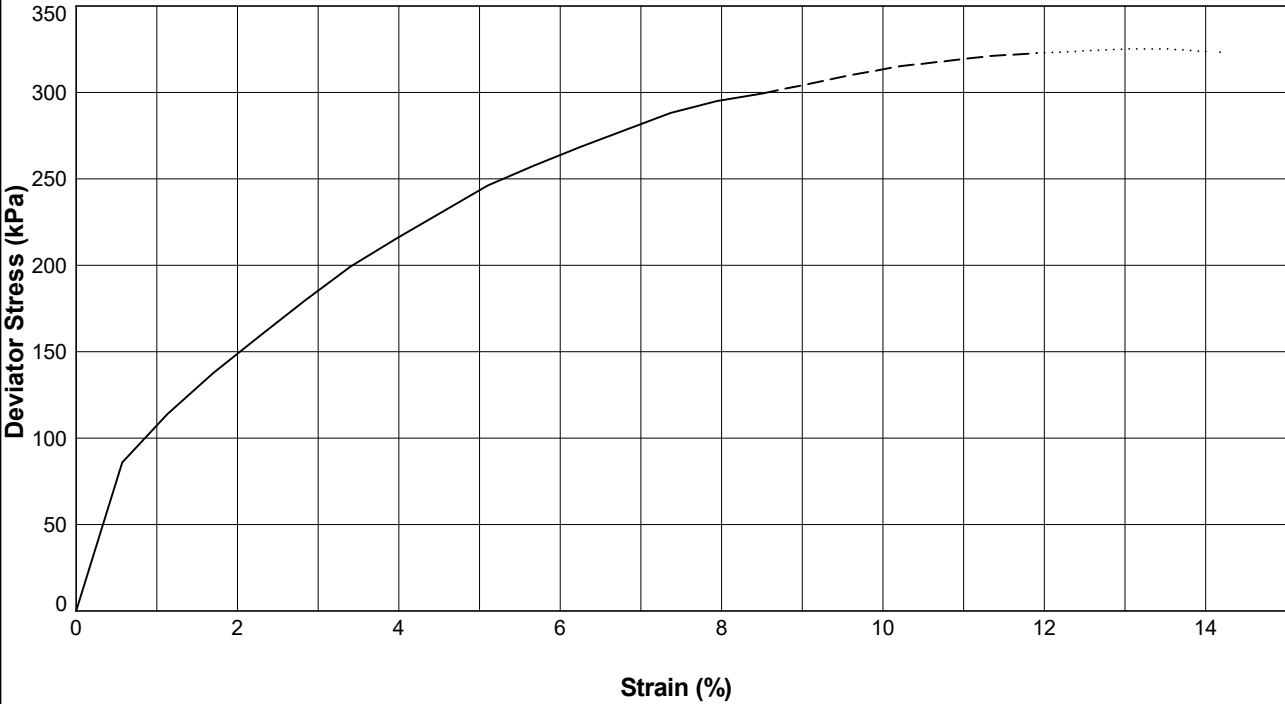
In accordance with BS1377:Part 7:1990, Clause 9

Window Sample: **WS104** Sample Ref: **20/00975/4** Sample Type: **U** Depth (m): **1.00**

Description : **Dark brown slightly sandy slightly gravelly CLAY**

STAGE NUMBER		1	2	3
SAMPLE DETAILS	Sample Condition	Undisturbed		
	Orientation of sample	Vertical		
	Diameter (mm)	82.50		
	Height (mm)	176.33		
	Moisture Content (%)	19		
	Bulk Density (Mg/m ³)	2.09		
	Dry Density (Mg/m ³)	1.75		
TEST DETAILS	Membrane Thickness (mm)	0.42	0.42	0.42
	Rate of Axial Displacement (%/min)	0.24	0.24	0.24
	Cell Pressure (kPa)	10	20	40
	Membrane Correction (kPa)	1.03	1.32	1.41
	Corrected Deviator Stress (kPa)	300	323	325
	Undrained Shear Strength (kPa)	150	161	163
	Strain at Failure (%)	8.5	11.9	13.0
	Mode of Failure			Compound

Key: Stage 1 Stage 2 Stage 3



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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2 of BS1377:Part 2:1990

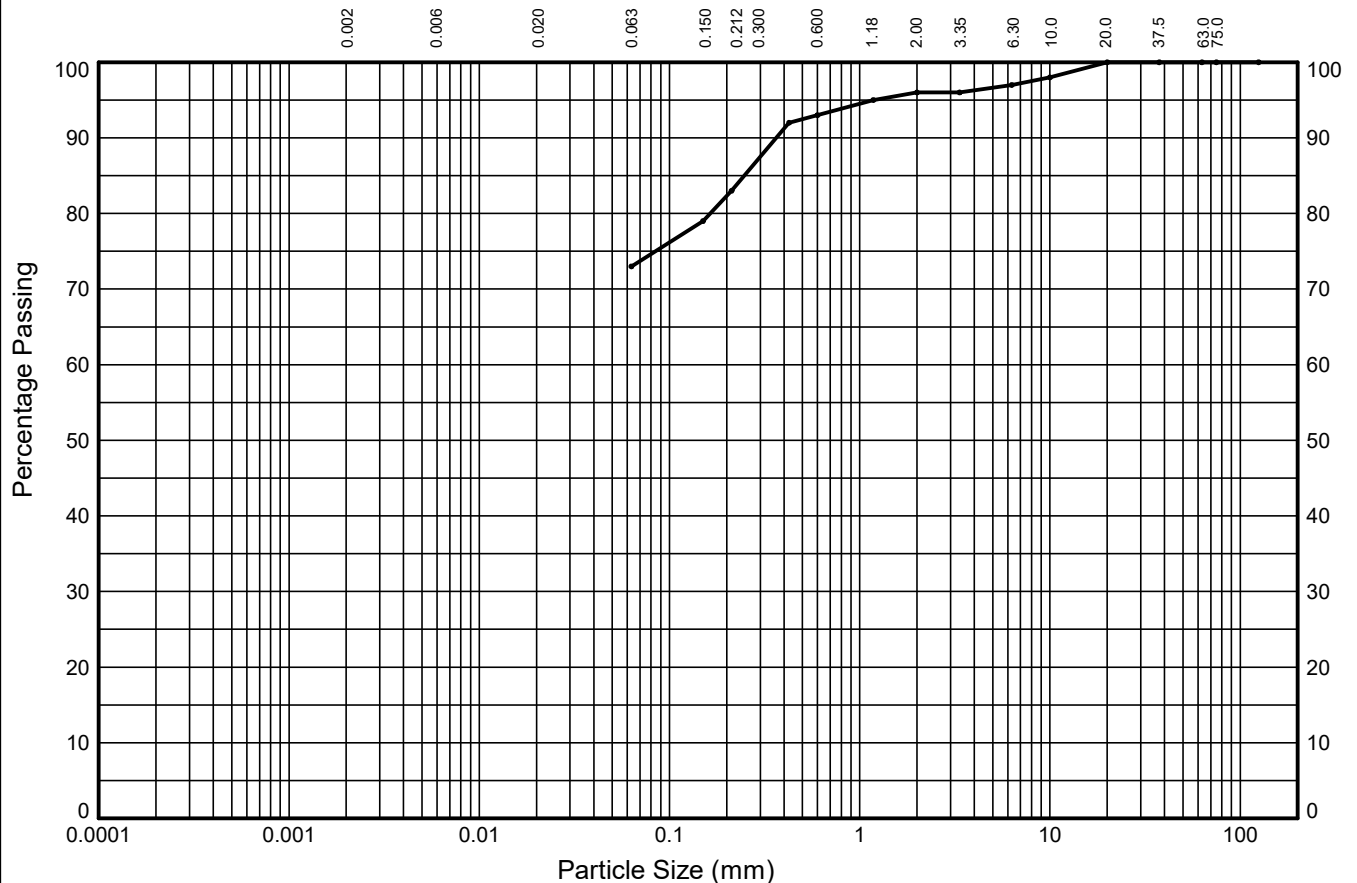
NON-STANDARD TEST

Window Sample: **WS103**

Sample Ref: **20/00975/3**

Sample Type: **U**

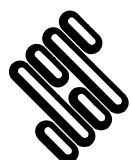
Depth (m): **3.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	-	-	-	9%	11%	3%	1%	3%	0%	
	SILT			SAND			GRAVEL			
73%				23%			4%			0%

Test Sieve (mm)	Percent Passing (%)	Particle Diameter (mm)	Percent Passing (%)	Coefficients	
125.0	100			D ₁₀ (mm)	NA
75.0	100			D ₁₅ (mm)	NA
63.0	100			D ₃₀ (mm)	NA
37.5	100			D ₅₀ (mm)	NA
20.0	100			D ₆₀ (mm)	NA
10.0	98			D ₈₅ (mm)	0.247
6.30	97			D ₉₀ (mm)	0.364
3.35	96			C _U	NA
2.00	96			C _C	NA
1.18	95			Soil Description: Dark brown grey slightly gravelly very sandy CLAY	
0.600	93				
0.425	92				
0.212	83				
0.150	79				
0.063	73				
Sedimentation sample was not pre-treated					

Key: C_U = Uniformity coefficient. C_C = Coefficient of curvature as defined in BS EN ISO 14688-2



STRUCTURAL SOILS
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Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By

Lorna Whitworth

LORNA WHITWORTH

Date

20/02/20

Contract

20/00975

Contract Ref:

784344



Appendix G - Soil Screening Tables



Job Name:	Victory Street, Manchester
Job Number:	30669LG

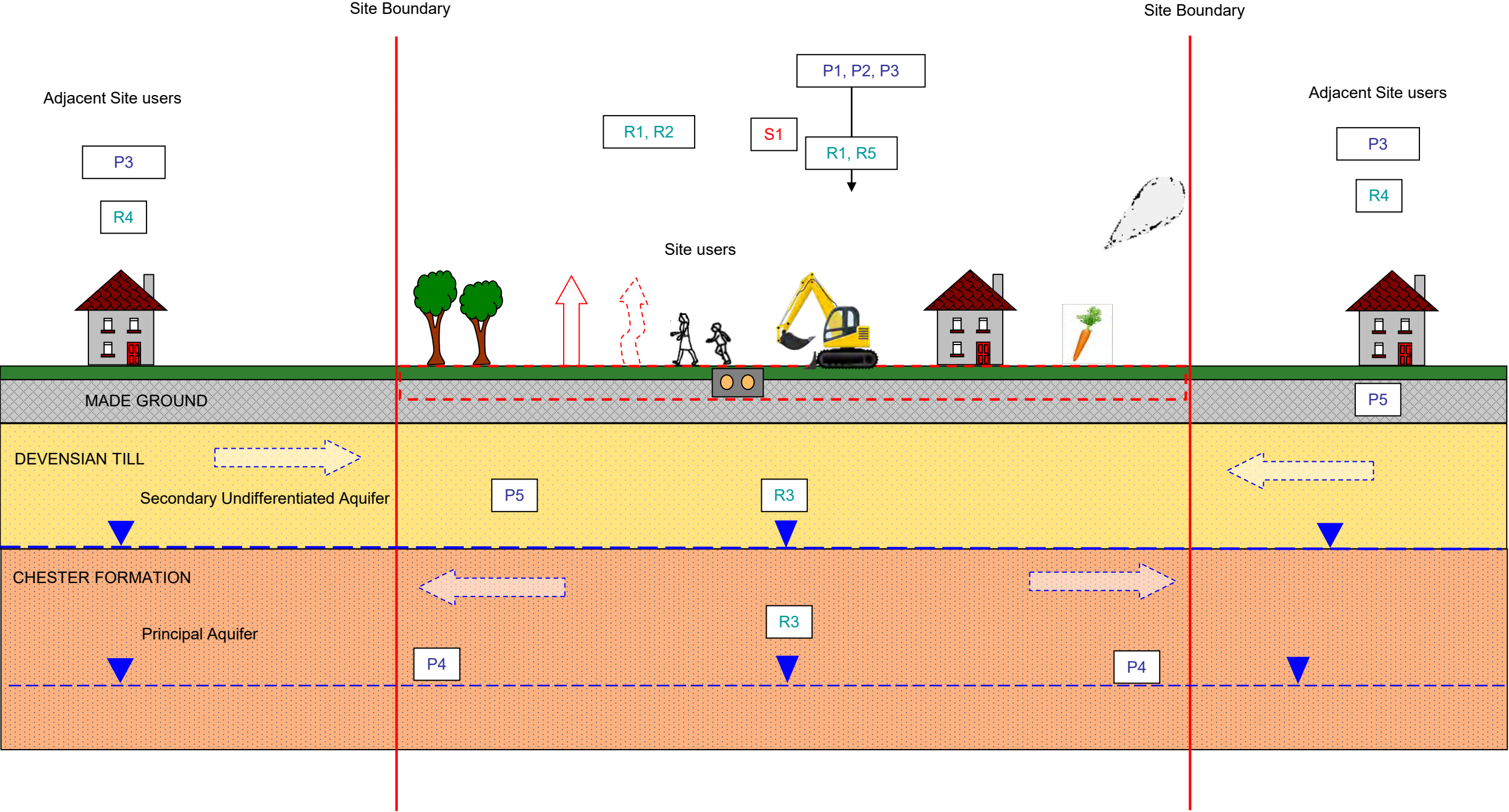
ATKINS REVISED 31/03/11, CATEGORY 4 - APRIL 2014, LQM JAN 2015							WS101	WS103	WS104
RESIDENTIAL WITH PLANT UPTAKE							0.20	0.20	0.30
							0.70	0.60	0.60
							28-Jan-20	28-Jan-20	28-Jan-20
Contaminant	Units	Category 4 Screening Values (6%)	Atkins At Risk	SOM 1%	SOM 2.5%	SOM 5%	Soil	Soil	Soil
Arsenic (Total)	mg/kg	37			37		25	11	10
Boron (Soluble)	mg/kg				290		<1.0	1.1	<1.0
Cadmium (Total)	mg/kg	26			11		1.5	1.1	0.6
Chromium III	mg/kg				910		29	26	19
Chromium VI	mg/kg	21			6		<1	<1	<1
Copper (Total)	mg/kg				2400		107	69	25
Lead (Total)	mg/kg	200					620	357	842
Mercury (Total)	mg/kg				40		0.76	0.99	0.45
Nickel (Total)	mg/kg				180		26	19	14
Selenium (Total)	mg/kg				250		2	<1	<1
Zinc (Total)	mg/kg				3700		410	217	106
Cyanide (Total)	mg/kg		34				<0.005	<0.005	<0.005
Phenols (Total)	mg/kg			280	550	1100	<0.2	<0.2	<0.2
Organic matter	%						10	4.8	4.7
Sulphate (Acid Soluble)	mg/kg						920	710	800
Sulphate as Water Soluble	g/l						0.04	<0.01	<0.01
Sulphide	mg/kg						<5	<5	110
pH	pH units						8.13	8.27	8.54
Sulphur (Elemental)	mg/kg						31	10	<5
Asbestos							NAD	NAD	NAD
>> TPH SUITE <<									
TPH (Total)									
Total Aliphatic									
>C5 to C6 aliphatic	mg/kg			42	78	160	<0.01	<0.01	<0.01
>C6 to C8 aliphatic	mg/kg			100	230	530	<0.01	<0.01	<0.01
>C8 to C10 aliphatic	mg/kg			27	65	150	<1	<5	<1
>C10 to C12 aliphatic	mg/kg			130	330	760	<1	<5	<1
>C12 to C16 aliphatic	mg/kg			1100	2400	4300	3	<5	1
>C16 to C35 aliphatic	mg/kg			65000	92000	110000	39	639	29
>C35 to C44 aliphatic	mg/kg			65000	92000	110000	14	<5	5
Total Aromatic									
>C5 to C7 aromatic (Benzene)	mg/kg			70	140	300	<0.01	<0.01	<0.01
>C7 to C8 aromatic (Toluene)	mg/kg			130	290	660	<0.01	<0.01	<0.01
>C8 to C10 aromatic	mg/kg			34	83	190	3	<5	2
>C10 to C12 aromatic	mg/kg			74	180	380	6	<5	2
>C12 to C16 aromatic	mg/kg			140	330	660	33	6	9
>C16 to C21 aromatic	mg/kg			260	540	930	101	35	23
>C21 to C35 aromatic	mg/kg			1100	1500	1700	452	353	110
>C35 to C44 aromatic	mg/kg			1100	1500	1700	24	16	10
>> BTEX SUITE <<									
benzene	mg/kg	0.87		0.87	0.17	0.37	<0.01	<0.01	<0.01
toluene	mg/kg			130	290	660	<0.01	<0.01	<0.01
ethylbenzene	mg/kg			47	110	260	<0.01	<0.01	<0.01
M&P Xylene	mg/kg			56	130	310	<0.01	<0.01	<0.01
O-Xylene	mg/kg			60	140	330	<0.01	<0.01	<0.01
>> PAH SUITE <<									
naphthalene	mg/kg			2.3	5.6	13	0.48	0.05	<0.03
acenaphthylene	mg/kg			170	420	920	0.11	0.03	0.02
acenaphthene	mg/kg			210	510	1100	1.41	0.22	0.07
fluorene	mg/kg			170	400	860	1.16	0.15	0.06
phenanthrene	mg/kg			95	220	440	11.2	1.86	1.02
anthracene	mg/kg			2400	5400	11000	2.35	0.36	0.2
fluoranthene	mg/kg			280	560	890	14.6	3	1.78
pyrene	mg/kg			620	1200	2000	13.5	2.8	1.73
benzo(a)anthracene	mg/kg			7.2	11	13	6.36	1.48	0.95
chrysene	mg/kg			15	22	27	6.23	1.54	1.02
benzo(b)fluoranthene	mg/kg			2.6	3.3	3.7	6.41	1.65	1.02
benzo(k)fluoranthene	mg/kg			77	93	100	2.28	0.52	0.33
benzo(a)pyrene	mg/kg	5		2.2	2.7	3	5.53	1.33	0.81
dibenzo(ah)anthracene	mg/kg			0.24	0.28	0.3	0.57	0.16	0.1
benzo(ghi)perylene	mg/kg			320	340	350	2.22	0.61	0.44
indeno(123cd)pyrene	mg/kg			27	36	41	2.67	0.72	0.47



Job Name:	Victory Street, Manchester
Job Number:	30669LG

	LEACHATES			WS101	WS103	WS104
CAS Number:	Units	Site Specific Guidelines		0.20	0.20	0.30
Sample Ref				0.70	0.60	0.60
Determinand Name		EQS	UK DWS	28-Jan-20	28-Jan-20	28-Jan-20
Leachate Prep (10:1 Std NRA)*						
Arsenic (Soluble)*	µg/l	50	10	12	2	4
Boron (Soluble)	µg/l	1000	1000	18	32	<10
Cadmium (Soluble)	µg/l	0.45 - 1.5	5	<1	<1	<1
Chromium Trivalent (Soluble)	µg/l	4.7	50	<0.05	<0.05	<0.05
Chromium Hexavalent (Soluble)	µg/l	3.4	50	<0.05	<0.05	<0.05
Copper (Soluble)	µg/l	1	2000	30	15	9
Lead (Soluble)	µg/l	14	10	141	39	266
Mercury (Soluble)	µg/l	0.07	1	<0.1	<0.1	<0.1
Nickel (Soluble)	µg/l	34	20	2	2	1
Selenium (Soluble)*	µg/l		10	<1	<1	<1
Sulphur (Free)	mg/l			<0.1	<0.1	<0.1
Zinc (Soluble)	µg/l	10.9	5000	64	27	12
Cyanide (Total)*	mg/l	1	50	<0.005	<0.005	<0.005
Phenols (Total)	µg/l	7.7		<0.01	<0.01	<0.01
Sulphate as SO3	mg/l	400	250	8.54	25.26	<1.00
Sulphide as S	µg/l	0.25		<0.1	0.5	<0.1
pH	pH units			7.69	7.69	7.88
TPH Total C6-C40 (leachable)				<80	<80	<80
>> PAH SUITE <<*						
naphthalene*	µg/l	130		0.07	0.3	0.05
acenaphthylene*	µg/l			<0.01	0.03	<0.01
acenaphthene*	µg/l			0.14	0.17	0.09
fluorene*	µg/l			0.1	0.14	0.1
phenanthrene*	µg/l			0.32	0.23	0.24
anthracene*	µg/l	0.1		0.06	0.03	0.04
fluoranthene*	µg/l	0.12		0.17	0.07	0.09
pyrene*	µg/l			0.15	0.05	0.07
benzo(a)anthracene*	µg/l			0.05	<0.01	<0.01
chrysene*	µg/l			0.07	<0.01	0.03
benzo(b)fluoranthene*	µg/l	0.017		0.05	<0.01	0.02
benzo(k)fluoranthene*	µg/l	0.017		<0.01	<0.01	<0.01
benzo(a)pyrene*	µg/l	0.27	0.01	0.03	<0.01	<0.01
dibenzo(ah)anthracene*	µg/l			<0.01	<0.01	<0.01
benzo(ghi)perylene*	µg/l	0.0082		0.03	<0.01	<0.01
indeno(123cd)pyrene*	µg/l	0.002		0.03	<0.01	<0.01

Figure 3: Preliminary Conceptual Model



Key		
S1 – Potentially Contaminated Soil - Onsite		
R1 Future site Users		
R2 Construction Workers		
R3 Controlled waters		
R4 Adjacent Site Users		
R5 Infrastructure & Buried services		
P1 Direct Contact		
P2 Ingestion		
P3 Inhalation		
P4 Leaching & Migration		
P5 Vertical & lateral migration of ground gas		

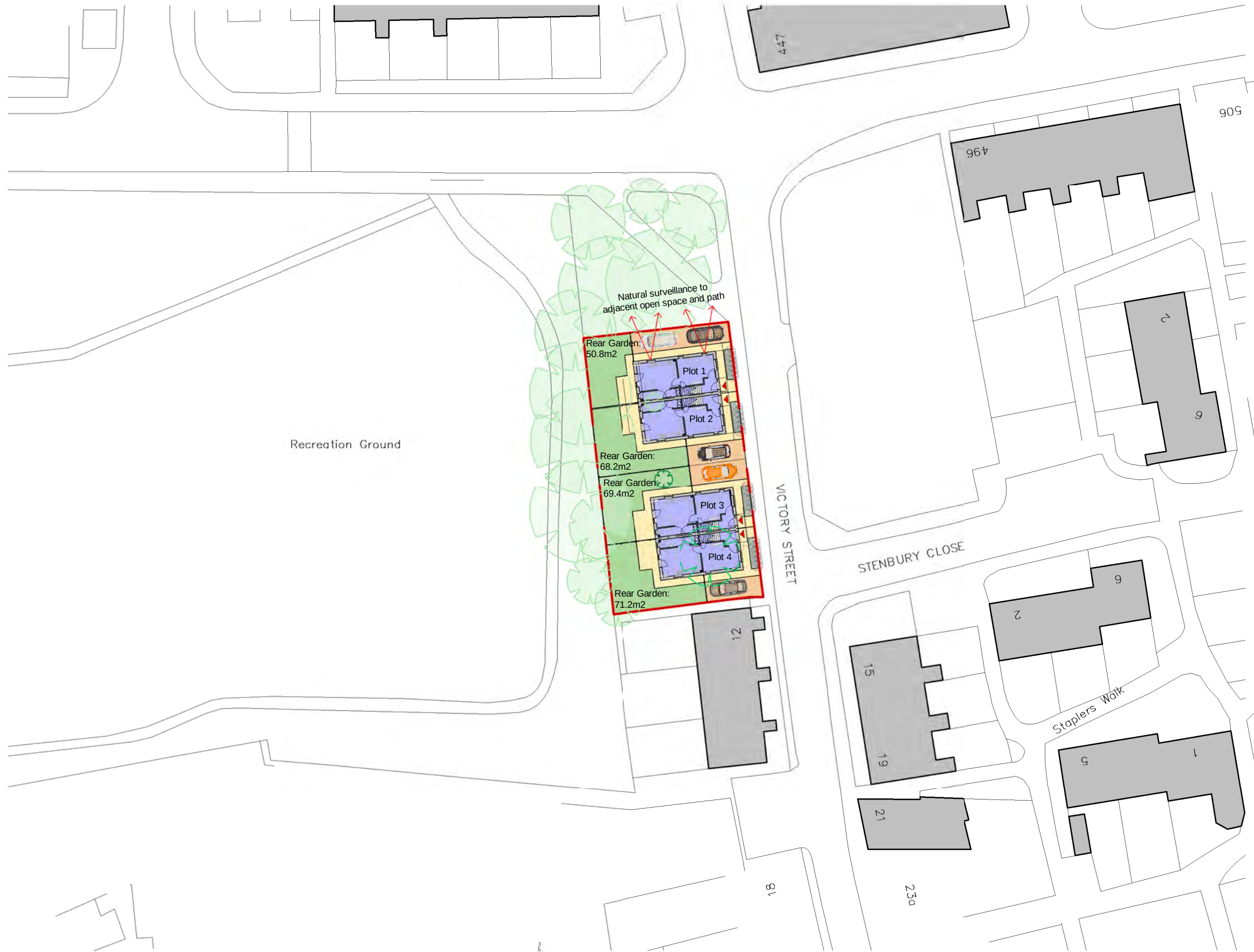
	Client: One Manchester Limited		
	Project: Victory Street, Manchester		
	Title: Preliminary Conceptual Site Model (CSM)		
Purpose: Report	Draft		Scale (at A3)
	Issue	1	Not to scale
Issuing Office: Liverpool	Drawing number		Version
Telephone: 0151 227 3155			A

Figure 4: Revised Conceptual Model



Drawing No 30669 – 700 – P1 – Site Investigation on Proposed Layout

Drawing (Ref: 18-042-0003-A)



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■ CHECK ALL DIMENSIONS ON SITE

■ DRAWING TO BE READ IN CONJUNCTION WITH THE HEALTH AND SAFETY PLAN AND ALL RELEVANT RISK ASSESSMENTS

A 17.01.19 DC Scale 1:500, plots indicated, plot setting adjusted, existing trees indicated CL

REV.	DATE	DRN.	CHKD.
------	------	------	-------

PROJECT Victory Street, Rusholme				
CLIENT One Manchester				
DRAWING Site A, Sketch Layout				
SCALE 1 : 500	SHEET SIZE @ A3	DRAWN DC	CHECKED CL	DATE 17/01/19

BOWKER SADLER ARCHITECTURE

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JOB No 18-042	DRAWING No 0003	REVISION A
STATUS Feasibility		