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APPENDIX P – PREVIOUS SITE INVESTIGATION REPORT

PHASE I AND II GEO-ENVIRONMENTAL ASSESSMENT

2-12 HAREFIELD ROAD, UXBRIDGE, UB8 1JS

REC REFERENCE: 1CO102125P1R0

PREPARED FOR: BNP PARIBAS REAL ESTATE UKCANADA LIFE INVESTMENTS

DATE: SEPTEMBER 2016



National Consultancy, Locally Delivered

A CONCEPT LIFE SCIENCES COMPANY

QUALITY ASSURANCE

Issue/revision	Issue 1	Revision 1	Revision 2
Remarks	Draft		
Date	September 2016		
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Signature			
Position	Regional Director		
Project number	1CO102125p1r0		

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EXECUTIVE SUMMARY

Site Address	2-12 Harefield Road, Uxbridge, UB8 1JS	
Grid Reference	505506, 184464	
Site Area	0.92ha	
Current Site Use	The site comprised a high roof steel framed metal building occupied by Wickes and Halfords Stores with a large customer car park, secured good storage area, two access points and soft landscaped areas adjacent to the site boundaries.	
Proposed use	It is understood that the proposed development is likely to include approximately 6 to 8 storeys medium to high density residential accommodation with associated car parking, soft and hard standing areas.	
Site Investigation findings	**Made Ground**	Made Ground was encountered within all exploratory holes and typically comprised asphalt over friable light brown sandy GRAVEL or soft/firm brown sandy gravelly CLAY/SILT with low cobble content of fine to coarse flint, brick, asphalt, concrete, ash and clinker. Organic odours were noticed within WS105 and a maximum thickness of 1.00m was encountered within WS107.
	Lynch Hill Gravel Member	Lynch Hill Gravel Member was encountered in all window sample locations and typically comprised very dense sandy GRAVEL or gravelly SAND with low cobble content of flint. A hydrocarbon odour and oil-sheen on water were noticed within BH101 from 1.20m bgl to 7.80m bgl. A maximum thickness of 7.45m was encountered within BH101.
	London Clay Formation	London Clay Formation was encountered only in exploratory hole BH101 and typically comprised firm to very stiff brown to light blue to reddish brown mottled silty CLAY with occasional claystone and shell fragments. A thickness of 12.20m was encountered in BH101 which does not represent the full thickness of this stratum.
	Groundwater	Ground water was encountered within BH101 at 18.50m and 20.00m bgl which rose to 16.50m and 14.00m bgl respectively after 20 minutes. Groundwater was encountered at approximately 5.50m bgl during monitoring visits.
Site History	Historical maps indicate that the site has been used for several industrial activities since at least 1866 including an Iron Works, Smithy, Saw Pit, Engineering Works, and vehicle depot.	
Ground Gases	Based on the gas monitoring undertaken to date, the ground gas regime for the site can be classified as Characteristic Situation 1. However, please note that elevated VOC's were encountered during the intrusive works and during subsequent monitoring visits and therefore further assessment may be required to determine the need for vapour protection measures within the building design to protect against harm to human health from volatile compound build-up within the final development.	
Radon	The site is situated in an area where less than 1% of properties are above the radon action level and therefore no radon protective measures are necessary.	
Coal Mining / Land Stability	The site is unaffected by mining. No special precautions required.	
Revised Conceptual Site Model (CSM)	Currently the site potentially poses a significant risk to human health due to the presence of the following contaminants: ▶ **Beryllium:** (HP101 @ 0.30m-0.35m); ▶ **Lead:** (HP101 @ 0.30m-0.35m & WS107 @ 0.40m-0.50m);	

	▶ **Asbestos:** (HP101 @ 0.30m-0.35m & WS107 @ 0.40m-0.50m); and, ▶ **Dibenzo(a,h)anthracene:** (HP101 @ 0.30m-0.35m). Remedial measures are recommended within section 11 and may include the installation of a clean cover system. Please note that extra measures are required to prevent health risks to ground workers from asbestos contaminated soils. Additionally, the following excessive contaminants were found within the groundwater: ▶ **TPH:** (BH101) Further assessment may be required in order to fully characterise the TPH contamination within the groundwater underlying the site.
Preliminary Geotechnical Assessment	**Foundation Conditions and Bearing Capacity** It is recommended that foundations pass through this stratum and bear onto the underlying Lynch Hill Gravel encountered at depths ranging between 0.35 and 1.0mbgl. With regards to allowable bearing pressures, based on SPT tests an allowable bearing pressure of 400kN/m2 could be considered for the proposed scheme. This is based on limiting total settlements to 25mm, a factor of safety of 3 and a minimum founding depth of 1.0mbgl. All foundations should be designed by suitably qualified structural engineers. **Concrete Durability** Foundations within the Lynch Hill Gravel member should consider a concrete design of DS-1, AC1s. Foundations within the underlying bedrock should consider a concrete design of DS-4, AC-3s. **Pavements and Construction** Given the relatively thin veneer of Made Ground across the site it is assumed that this material will be stripped with roads and pavements constructed at the surface of the Lynch Hill Gravel Member. Due to the coarse grained nature of the Lynch Hill Gravel Member a design CBR value in excess of 20% could be considered. However, we would recommend that in situ testing such as plate load tests are undertaken prior to construction in order to confirm these.

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1CO102125-002 – Exploratory Hole Location Plan

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1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants Ltd have been commissioned by BNP Paribas, on behalf of their client., Canada Life Investments, hereafter referred to as 'the Client', to undertake a Phase I and II Geo-Environmental Assessment at 2-12 Harefield Road, Uxbridge, 'the Site'. A site location plan (Ref. 1CO102125-001) is presented within Appendix III.

The purpose of this report is to provide geo-environmental information on the potential development of the site including an assessment of potential constraints relating to the scheme.

1.2 Proposed Development

It is understood that the proposed development is likely to include approximately 6 to 8 storeys medium to high density residential accommodation with associated car parking, soft and hard standing areas.

1.3 Scope of Works

The main aims of the Geo-Environmental Assessment are as follows:

- Undertake a site walkover survey to evaluate the current state of the site with respect to future works and to identify any current areas of potential environmental concern;
- Review historical plans, geology, hydrogeology, site sensitivity, flood-plain issues, mining records and any local authority information available in order to complete a Desk Study in line with Environment Agency (EA) document Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11);
- Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors;
- Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs; and,
- Provide recommendations regarding future works required.

For the purpose of this investigation, all intrusive work has been limited to outdoor areas so as to cause minimal disruption to the stores' operation.

1.4 Source of information

Background information was sought from the following:

- GroundSure data search: GS-3249406 & GS-3249407;
- Historical mapping dated 1866 to 2014;
- Online planning records held by Hillingdon Council;
- Environment Agency Groundwater Vulnerability Map (http://maps.environment-agency.gov.uk/wiyby);

- HPA Indicative Atlas of Radon in England and Wales (HPA-RPD-033:2007);
- Radon: Guidance on protective measures for new buildings (BRE Document BR 211, 2007); and,
- British Geological Survey Online Mapping (http://www.bgs.ac.uk).

1.5 Risk Classification

REC Ltd has utilised the available data to classify the site on the basis of its likely contaminated land liability and potential for geotechnical constraints in relation to the property development. The risk classification definitions are summarised below:

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

1.6 Limitations of the Study

The limitations of this report are presented in Appendix I.

1.7 Confidentiality

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

2.0 SITE SETTING

2.1 Site Details

Site Address	2-12 Harefield Road, Uxbridge, UB8 1JS.
National Grid Reference	505506, 184464
Site Area	0.92ha

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location plan (ref. 1CO102125-001) is presented within Appendix III.

2.2 Current Site Use

Site Description

A site walkover was undertaken on 23rd August 2016. At this time the site comprised a high-roofed steel-framed metal building occupied by Wickes and Halfords Stores with a large customer car park, secured goods storage area, two access points and soft landscaped areas adjacent to the site boundaries.

The site topography was generally flat, however a reduced level with a metal panel retaining wall and concrete capping was identified adjacent to the eastern site boundary and separated from the store building by an alleyway. Metal stairs, which formed part of the stores' fire emergency route, were noted on the northeastern corner leading to a small wooded area along the northern site boundary into the customer car park. Storm drains and inspection chambers were located along the car park drive route. A mini electricity substation was situated in a soft landscaped area close to the western site boundary. Two access routes into the site were identified via Harefield Road on the west and Warwick Place on the southern tip. The boundaries of the site comprised a combination of wood panel fencings, metal post/wire fencing, low steel crash barrier and brick walls.

Where present, hardstanding appeared to be in good condition with minimal signs of wear.

Hazardous Materials Storage

No Above Ground Storage tanks (ASTs) were observed during the site walkover. No visual evidence of Underground Storage Tanks (USTs) were observed during the walkover.

Polychlorinated Biphenyls (PCBs)

Although the site walkover identified an electricity substation, an assessment of the equipment showed it is highly unlikely for any equipment with potential contaminative PCBs to be present within the substation. In addition, PCB's are generally immobile and as such we would generally test the soils beneath the slab post removal.

Waste Storage

No potentially hazardous waste streams were identified to be generated at the site.

2.3 Surrounding Area

The surrounding land uses are summarised below:

Direction	Land Use
North	Residential dwellings off Lancaster Road and commercial outlets beyond
East	Commercial outlets and residential dwellings beyond
South	Metropolitan Police Office/commercial outlets and Uxbridge High Street beyond
West	Harefield Road and commercial outlets/residential dwellings beyond

2.4 Unexploded Ordnance (UXO)

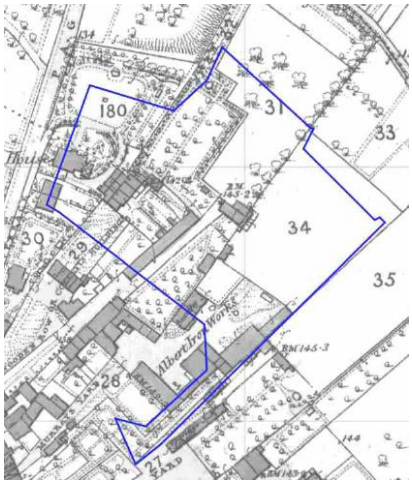
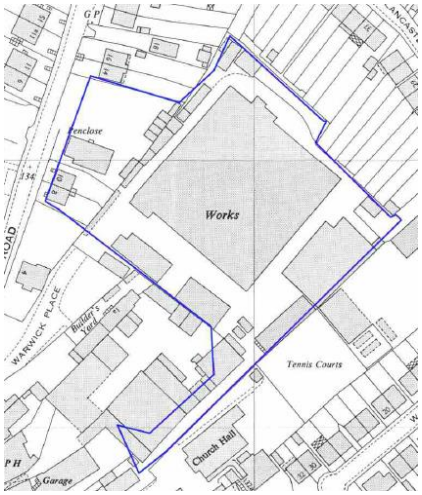
A review of a publicly available UXO Risk Assessment Map of Uxbridge area identified the site to be within a low to medium area of UXO risk. A particular reference was made to records of bombing at close proximity to the site. As a result, MACC International Ltd was contracted to provide UXO clearance of all proposed exploratory hole locations before and during ground investigation works.

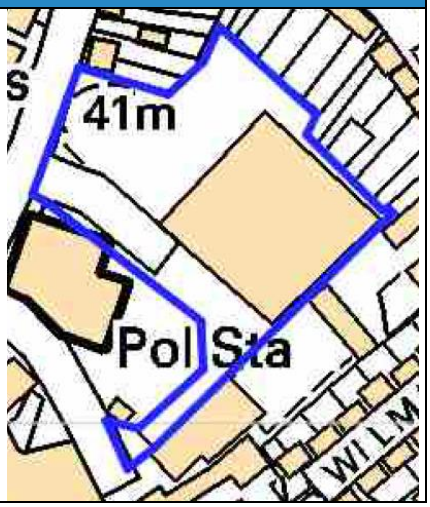
3.0 SITE HISTORY

3.1 Historical Development

A review of historical maps pertinent to the site is summarised in Table 3.1 below:

Table 3.1 Summary of Historical Land Uses

Map Edition	Historical Land Use	Historical Map
1866 – 1934 (1:2,500 & 1:10,560)	The site is shown comprising Penclose House near the western boundary, a row of terraced housing forming part of Wooden Row is across the south boundary. Albert Iron Works is located in the south of the site which includes a Smithy, a Saw Pit and two Platforms. A number of trees are shown across the entire site. The surrounding area is predominantly medium density residential immediately to the south of the site and low density residential / agricultural dwellings immediately to the north of the site. The road 'High Street' is present approximately 80m to the southwest of the site.	
1962 – 1992 (1:2,500 & 1:10,560)	Albert Iron Works is no longer shown on the map and a large 'Works' (incorporating several industrial processes including engineering works, builders merchants, and depots) is shown at the centre surrounded by smaller buildings around the site perimeter. Penclose House remains and an access road into the site is shown via Warwick Place on the southwestern boundary. Immediately to the north, east, and south are primarily medium density residential properties. Immediately west of the site lies the Uxbridge Court house. A builder's yard is present 20m to the southeast. A garage is present 20m southeast of the southernmost tip of the site boundary. A works is present 50m south of the site. The surrounding area experiences extensive urbanisation after 1938 and becomes surrounded with medium to high density residential dwellings by 1970.	

Map Edition	Historical Land Use	Historical Map
2002 – Present (1:2,500 & 1:10,560)	All existing buildings within the site appeared to have been demolished and a single building footprint is shown near the north-eastern corner of the site. 'Police Station' is labelled across the south-eastern corner of the site.	

3.2 Off-Site Historical Development

A review of potentially contaminative land uses identified on historical Ordnance Survey maps within 200m radius of the site are summarised below in Table 3.2:

Table 3.2 Summary of Potentially Contaminative Off-Site Historical Land Uses

Surrounding Feature	Distance (m)	Dates	Direction
Identified by GroundSure Data Search			
Motor Repair Works	1-35	1975-1988	SE
Garage	12	1972	SW
Unspecified Tank	19-23	1919-1993	SE
Electricity Substation	94-96	1972-1992	NE
Garage	110-120	1962	S
Unspecified Works	112	1970	W
Telephone Exchange	132 -163	1970-1989	SW
Electricity Substation	139-140	1975-1988	W
Canal	149-190	1868-1953	W
Terminus	153-175	1913-1938	W
Garage	154	1974	W
Railway Sidings	154-190	1932-1959	NW
Burial Ground	156-170	1868-1882	SE
Electricity Substation	159	1975	S
Cuttings	162-166	1932-1938	SE
Unspecified Tank	164	1914	N
Unspecified Commercial/Industrial	167-170	1938-1959	SE

Surrounding Feature	Distance (m)	Dates	Direction
Identified by GroundSure Data Search			
Brewery	174	1897	SW
Railway Building	176-196	1932	SE
Basin	178	1882	W
Electricity Substation	180-196	1975-1988	SE
Sawmills	181	1897	W
Fish Pond	182-191	1868-1882	SW
Sawmills	182-198	1897-1938	NW
Railway Sidings	183-194	1913-1932	SE
Electricity Substation	196-197	1972-1992	NE
Goods Shed	187	1935	SE
Unspecified Depot	190	1970-1975	SE
Unspecified Commercial/Industrial	192	1989	E
Cuttings	193	1913	E
Unspecified Mills	194	1959	NW
Bus Station	197	1989	SE
Railway Building	198	1938	NW

3.3 Planning History

Planning records held by the Local Planning Authority (Hillingdon Council) did not yield any environmentally-pertinent information with regards to historical development of the site.

4.0 ENVIRONMENTAL SETTING

4.1 Geology & Hydrogeology

A review of the online British Geological Survey (BGS) mapping for the site indicates that the site is underlain by the following geological sequence:

Geological Unit	Classification	Description	Aquifer Classification	Sensitivity
Superficial	Lynch Hill Gravel Member	Sand and Gravel	Principal	High
Bedrock	London Clay Formation	Clay, Silt and Sand	Unproductive	Low

Information obtained from the British Geological Survey (BGS) website indicates the site is underlain by superficial deposits of Lynch Hill Gravel Member comprising Sand and Gravel. The superficial deposits are underlain by the London Clay Formation comprising Clay, Silt and Sand.

Two historic boreholes (TQ08SE213 and TQ08SE214) located approximately 60m northeast and 80m southwest respectively confirmed the underlying geology as reported in the British Geological Survey database. Both boreholes described Made Ground over very dense Gravel with sands or clay of the Lynch Hill Gravel Member. In borehole (TQ08SE213), the Lynch Hill Gravel Member was underlain by the London Clay Formation at 4.40m bgl.

There are thirteen records of historical groundwater abstraction licences within 1.0km radius of the site. The licences relate to general/process washing at Harbour Properties Ltd, Arlington Business Park Group Ltd and A Sanderson & Son Ltd. The remaining licences are for spray irrigation at B T Smith & Son and Smiths Nurseries Ltd. The nearest licence is 542m north at Harbour Properties Ltd and Arlington Business Park Group Ltd. Expiry dates for all the licences are unknown.

There are no records of potable water abstraction licences within 1.0km of the site

The data search indicates that the site is underlain by a Principal Aquifer which is assumed to have high leaching potential due to its location within an urban environment and in absence of site specific details. The search report indicates the site is not within a groundwater Source Protection Zone (SPZ).

4.2 Geotechnical Data

Geotechnical Data presented within the Groundsure report identifies the following ground conditions:

Hazard	Designation
Shrink-Swell	Low
Landslides	Very Low
Soluble Rocks	Negligible
Compressible Ground	Negligible
Collapsible Rocks	Very Low
Running Sand	Very Low

4.3 Coal Mining & Ground Workings

There is no record of coal mining or natural cavities due to mineral extraction within an area that is affected by coal mining and therefore no Coal Mining Authority / Coal Mining Report was obtained for the purpose of this report. However, there are records non-coal mining activities relating to Chalk extraction on site and at 464m north of the site.

Twenty records of historical surface ground workings are identified within 250m radius of the site. The details of these features are given below:

- Canals located between 149m to 225m west and northwest of the site;
- Cuttings located between 162m to 212m east and southeast of the site;
- A single burial ground located 170m southeast;
- A fishpond located 191m southwest; and,
- A single gravel pit with the closest located 214m north of site.

There is no record of historical underground or current ground workings within 500m of the site.

4.4 Railways & Tunnels

A review of available data identified that Uxbridge Railway Station is located approximately 176m south east of site. However, there are twenty five records of historical railway features including railway sidings and buildings from 154m northwest and surrounding the site. There are no tunnels within a 250m radius of the site.

4.5 Hydrology

The nearest surface water feature is a primary river, Fray's River, approximately 100m west of the site. No chemical or biological data was available for this river.

There are no records of surface water abstraction licences within 1.0km of the site

The data search indicates that the site is not within an Environment Agency Floodplain Zone, however an Environmental Agency Zone 2 is located 100m west of site, relating to Fray's River. The site has a very low risk of flooding from rivers and the sea (RoFRaS). However, the site lies within a groundwater flooding susceptible area associated with the presence of superficial deposits overlying an unproductive bedrock.

4.6 Radon Risk Potential

A review of available data has indicated that the site is in an area where less than 1% of properties are above the Action Level, and as such, no radon protection measures are deemed necessary.

4.7 Industrial Land Uses

The data search identifies 17 records of current industrial land uses within 200m of the site:

Company	Activity	Distance	Direction
Halfords	Vehicle Parts and Accessories	0m	On site
Tank	Tanks	22m	SE
Works	Unspecified Works or Factory	26m	SE
Courtwood Car Services	Vehicle Repair, Testing and Servicing	29m	NE
Hog Roast Caterer	Food and Beverage Industry Machinery	45m	SE
Electricity Substation	Electrical Features	102m & 200m	NE
Pest UK Uxbridge	Pest and Vermin Control	123m	SE
Extreme Supplies Ltd	Electronic Equipment		
Fireplace & Stove Co	Fireplaces and Mantelpieces		
D B J Auto Electrical	Vehicle Repair, Testing and Servicing	125m	E
Ealing & Action Gazette Classifieds Plc	Published Goods	172m	SE
IT Europa	Published Goods	173m	S
Armstrong	Bricks, Tiles, Clay and Ceramic Products		
Telephone Exchange	Telecommunication Features	192m	SW
Electricity Substation	Electrical Features	192m	S
Specsavers Hearcare	Disability and Mobility Equipment	195m	SW
P Tech Security	Electronic Equipment	199m	SE

There are no records of petrol and fuel sites or National Grid high voltage and high pressure gas transmission lines within 500m of the site.

4.8 Sensitive Land Uses

A review of available data has identified records of designated environmentally sensitive sites within a 2km radius of the site:

- The site is located within a Nitrate Vulnerable Zone;
- Fourteen records of London Area Greenbelt with the closest located 291m northwest;
- Five records of Local Nature Reserves (LNR) with the nearest located 1.1km north at Fray's Valley;
- Four records of Sites of Special Scientific Interest (SSSI) with the closest located 1.1km north of site at Fray's Farm Meadow; and,
- Four records of Ancient and Semi-Natural Woodland with nearest located 1.8km north of site, within Denham Country Park.

4.9 Site Sensitivity Assessment

It is considered the site is located within a **moderate** sensitivity setting due to the following:

- Although the bedrock aquifer has very low to moderate permeability, the overlying superficial

geology is recorded as a strata with high to very permeability;

- The underlying superficial geology is designated a 'Principal Aquifer' with high to very high permeability;
- The nearest groundwater abstraction is located 542m north of the site;
- Fray's River is the closest surface water feature located 100m west of the site;
- The Environmental Agency Zone 2 and Zone 3 flood affected areas lie within 250m of the site;
- The site lies within a Nitrate Vulnerable Zone; and,
- The site is located 291m northwest of the London Greenbelt Area.

5.0 CONSULTATIONS

5.1 Contaminated Land Officer

Hillingdon Borough Council has been contacted in relation to contamination concerns at the site via email. As at the time of writing this report, no response has been received from the Environmental Health Officer.

5.2 Landfill Sites and Waste Treatment Sites

A review of available information did not identify any historic or current landfill or waste sites within 1.0km of the site.

5.3 Regulatory Database

The following information has been obtained from a commercially available environmental database. The summary table only includes records not otherwise detailed in the report.

Table 5.1 Summary of Historical Data

Activity	0-249m	250-500m	Details
Part A(2) and Part B Activities and Enforcements	1	1	These Part B enforcements relate to one historic permit for respraying of vehicles by L H Jennings located 101m southwest and a current permit for dry cleaning by Brompton Dry Cleaners located 335m south.
Licensed Discharge Consents	2	7	Four sewage discharge consents for Braybourne Close located 218m northwest and 365m north are all recorded as surrendered while one sewage discharge consent for The Lock House located 322m northwest appears active. There are four miscellaneous discharge consents into surface water for 9-123 Harefield Road and all the consents are recorded as revoked.
Environment Agency Recorded Pollution Incidents	2	7	The nearest incident was located 214m north in 2002 for sewage material release with a Category 3 (minor) impact on air, water and land. One Category 2 (significant) impact was identified to water in 2002 494m north west for soil and clay release.
Historic IPC Authorisations	0	0	N/A
Planning Hazardous Substance Consents and Enforcements	0	0	N/A
Control of Major Accident Hazard (COMAH) sites	0	0	N/A
Notification of Installations Handling Hazardous Substances (NIHHS) sites	0	0	N/A
Part A(1) and IPPC Authorisations	0	0	N/A
Red List Discharge	0	0	N/A

Consents, List 1 and List 2 Dangerous Substances Inventory			
Fuel Stations Entries	0	0	N/A
Licensed Radioactive Substance	0	0	N/A
Sites determined as Contaminated Land under Part 2A EPA 2009	0	0	N/A

6.0 CONCEPTUAL SITE MODEL (CSM)

6.1 Initial CSM

In accordance with Environment Agency, CLR11 (2004) and BS10175 (Code of Practice for Investigation of Potentially Contaminated Land), REC Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

6.2 Contaminant Sources

6.2.1 On-site Potential Sources

Potential sources of contamination identified on site include:

- Made Ground associated with the historical development of the site;
- Historic site use (Iron Works, Builders Merchants, Engineering Works and Depot);
- Electricity Substation; and,
- Current land use of the site as Halfords and Wickes DIY stores.

6.2.2 Off-site Potential Sources

- Historic and active garage with nearest located 1m southeast of site;
- Unspecified Tank with the closest located 19m south east of site;
- Works located from 26m south east of site;
- Electricity Substations with the closest located 94m north east of site; and,
- Potentially infilled ground within canals (149m west), burial ground (156m southeast), cuttings (162m southeast) and fish pond (182m southwest).

6.3 Potential Pathways

Receptors may be potentially at risk from the identified potential sources of contamination via the following pathways:

- Migration of mobile contaminants on or off site via services, sewers and manmade conduits;
- Migration of gases through permeable strata within the Lynch Hill gravel Member;
- Direct contact, ingestion and inhalation of contaminants on site;
- Migration of contaminated dusts during earthworks;
- Migration of mobile contaminants into surface waters via groundwater;
- Migration of hazardous gases via permeable strata; and,
- Uptake of toxins/phytotoxins by plants.

6.4 Potential Receptors

The following potential receptors have been identified:

- Future site users (female child);
- Neighbouring residents (female child); and,

- Controlled waters (Principal Aquifer).

Construction workers are not considered to be a plausible receptor as exposure will be managed through the use of appropriate PPE and hygienic working practices, as required under HSE/ CDM regulations. Furthermore potential exposure to possible contaminants is not expected to be over prolonged work duration thereby limiting any impact to ground workers.

6.5 Preliminary Risk Assessment

CIRIA 552: Contaminated Land Risk Assessment 'A Guide to Good Practice' provides guidance on risk assessment taking into account factors such as severity of the potential harm that may arise from a successful pollutant linkage, potential magnitude of the hazard, and the sensitivity of the target receptor. Risk assessment is initially assessed by determining the severity of the potential hazard, which takes into account receptor sensitivity and the magnitude of the potential impact as detailed in Tables 6.1 & 6.2 below.

6.5.1 Severity

Table 6.1 Receptor sensitivity

Category	Human sensitivity	Environmental sensitivity
Very Low	Ground workers	Non-sensitive water course
Low	Commercial / Industrial	Secondary Aquifer
Medium	Residential without plant uptake	Principal Aquifer / Sensitive Watercourse
High	Residential with plant uptake	Groundwater Source Protection Zone

Table 6.2 Magnitude of Impact

Category	Example
No Impact	No identified or potential pollutants present
Slight Impact	Minor leaks and spills from fuel infrastructure, inert landfills
Moderate Impact	Major leaks and spills from fuel infrastructure
Gross Impact	Heavily contaminated industrial sites, hazardous landfills

Severity is subsequently assessed considering the potential receptor and magnitude of impact as outlined within Table 6.3.

Table 6.3 Determination of level of severity for potential hazards

	Receptor Sensitivity			
	Very Low	**Low**	**Moderate**	**High**
No Impact	Minor	Minor	Minor	Minor
Slight Impact	Minor	Minor	Minor	Mild

Moderate Impact	Minor	Minor	Mild	Medium
Gross Impact	Minor	Mild	Medium	Severe

6.5.2 Likelihood

The likelihood of an event is assessed while considering the potential for presence of a contaminant, presence of receptor, and the substantiality of the pollutant pathway. Likelihood is broken down into four separate categories within the CSM as shown in Table 6.4 below:

Table 6.4 Definitions of likelihood categories

Category	Definition
Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable.
Low Likelihood	Pollutant linkage may be present, and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Likely	Pollutant linkage may be present, and it is probable that the risk will occur over the long term.
High Likelihood	Pollutant linkage may be present, and risk is almost certain to occur in long term, or there is evidence of harm to the receptor.

6.5.3 Risk Rating

Table 6.5 demonstrates the methodology used to provide an overall risk rating within the preliminary CSM with respect to any potential sources of contamination that may affect the site. An overall risk rating is assigned to each potential contaminant considering the assessed likelihood and severity as determined using the methodologies within Tables 6.1 to 6.4.

Table 6.5 Level of risk rating for hazard definition

		Severity			
		Minor	**Mild**	**Medium**	**Severe**
Likelihood	**Unlikely**	Very Low	Very Low	Low	Low / Moderate
	Low Likelihood	Very Low	Low	Low / Moderate	Moderate
	Likely	Low	Low / Moderate	Moderate	High
	High Likelihood	Low / Moderate	Moderate	High	Very High

6.6 Conceptual Site Model

A site specific CSM has therefore been created using the above information and is provided on the following page.

Table 6.6 Conceptual Site Model

Source	Contaminant	Potential migration pathway	Potential Receptors	Likelihood	Severity	Overall Risk Rating	Active / Inactive
ON-SITE							
Made Ground associated with historical development	Heavy Metals (As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn)	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low / Moderate**	**Potentially Active –** further investigation recommended
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Polycyclic Aromatic Hydrocarbons (PAHs)	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low / Moderate**	
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Total Petroleum Hydrocarbons (TPHs)	Inhalation of vapours, Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low / Moderate**	
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Medium	**Moderate**	
	Asbestos Fibres In Soil	Inhalation of fibres	Future Site Users	Likely	Medium	**Moderate**	
	Potential production of ground gas (CH_4 and CO_2)	Inhalation of ground gases	Future Site Users	Likely	Mild	**Low / Moderate**	
Iron Works	Heavy Metals (As, Cr, Pb, Ni, V, Zn)	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low / Moderate**	**Potentially Active –** further investigation recommended
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Cyanide	Ingestion of soils, Dermal contact with soils	Future Site Users	Low Likelihood	Mild	**Low**	
		Vertical and lateral migration	Superficial Primary Aquifer	Low Likelihood	Mild	**Low**	
	Sulphates; pH	Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Asbestos Fibres In Soil	Inhalation of fibres	Future Site Users	Likely	Medium	**Moderate**	
	Phenol	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low / Moderate**	

		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Total Petroleum Hydrocarbons (TPHs)	Inhalation of vapours, Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low**	
		Vertical and lateral migration	Controlled Waters	Likely	Medium	**Moderate**	
	Polycyclic Aromatic Hydrocarbons (PAHs)	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Minor	**Low**	
		Vertical and lateral migration	Controlled Waters	Likely	Minor	**Low**	
	Polychlorinated Biphenyls (PCBs)	Ingestion of soils, Dermal contact with soils	Future Site Users	Low Likelihood	Minor	**Very Low**	
Engineering Works	Heavy Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, V, Zn)	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low / Moderate**	**Potentially Active –** further investigation recommended
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Cyanide	Ingestion of soils, Dermal contact with soils	Future Site Users	Low Likelihood	Mild	**Low**	
		Vertical and lateral migration	Superficial Primary Aquifer	Low Likelihood	Mild	**Low**	
	Sulphates; pH	Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low / Moderate**	
	Asbestos Fibres In Soil	Inhalation of fibres	Future Site Users	Likely	Medium	**Moderate**	
	Aromatic / Aliphatic Hydrocarbons	Inhalation of vapours, Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low**	
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Medium	**Moderate**	
	Polychlorinated Biphenyls (PCBs)	Ingestion of soils, Dermal contact with soils	Future Site Users	Low Likelihood	Minor	**Very Low**	
Vehicle Depot	Asbestos Fibres In Soil	Inhalation of fibres	Future Site Users	Likely	Medium	**Moderate**	**Potentially Active –** further investigation recommended
	Polycyclic Aromatic Hydrocarbons (PAHs)	Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Minor	**Low**	
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Minor	**Low**	

	Total Petroleum Hydrocarbons (TPHs)	Inhalation of vapours, Ingestion of soils, Dermal contact with soils	Future Site Users	Likely	Mild	**Low**	
		Vertical and lateral migration	Superficial Primary Aquifer	Likely	Medium	**Moderate**	
Electricity Substation	PCBs	Ingestion of soils, Dermal contact with soils	Future Site Users	Low Likelihood	Minor	**Very Low**	**Inactive –** PCB's have a very low mobility and we would recommend that testing is undertaken through the existing slab with access not possible during the works.

Source	Contaminant	Potential migration pathway	Potential Receptors	Likelihood	Severity	Overall Risk Rating	Active / Inactive
OFF-SITE							
Electricity substations (94m NE)	PCBs	Lateral migration onto site	Superficial Primary Aquifer	Unlikely	Mild	**Very Low**	**Inactive –** PCB's have a very low mobility and are unlikely to migrate to the site.
Works (26m SE)	Polycyclic Aromatic Hydrocarbons (PAHs)	Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low**	**Potentially Active –** further investigation recommended for risks to future site users.
	Total Petroleum Hydrocarbons (TPHs)	Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low**	
Infilled ground (closest canal located 149m west)	Potential production of ground gas (CH_4 and CO_2) in shallow organic impacted soils	Lateral and vertical migration onto site	Superficial Primary Aquifer	Unlikely	Mild	**Very Low**	**Potentially Active –** further investigation recommended for risks to future site users and controlled waters.
Unspecified Tank (19m SE)	Polycyclic Aromatic Hydrocarbons (PAHs)	Lateral migration onto site and Dermal contact with soils	Superficial Primary Aquifer	Likely	Mild	**Low**	**Potentially Active –** further investigation recommended for risks to future site users and controlled waters.
	Total Petroleum Hydrocarbons (TPHs)	Lateral migration onto site and Dermal contact with soils.	Superficial Primary Aquifer	Likely	Mild	**Low**	
	S/VOCs	Vertical and lateral migration	Superficial Primary Aquifer	Likely	Mild	**Low**	
Garage (Immediately SE of site boundary)	Total Petroleum Hydrocarbons (TPHs)	Lateral migration onto site and Dermal contact with soils.	Superficial Primary Aquifer	Likely	Mild	**Low**	**Potentially Active –** further investigation recommended for risks to future site users and controlled waters.

7.0 SITE INVESTIGATION

7.1 Desk Study Information

Potential contamination sources have been identified from the desk study and these are listed in Table 7.1 below:

Table 7.1 Summary of Potential Contaminant Sources

Potential Source	Potential Contaminants	Potential Impact
Made Ground (on-site)	Heavy Metals (As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn); Cyanide; sulphates; pH; PAHs; TPHs; Asbestos; Phenol; ground gas (CH4 and CO2).	Future site users; Neighbouring Residents; Controlled waters
Iron Works		
Engineering Works		
Off-site Historic Tanks (19m southeast)		
Infilled Grounds (closest 149m west)		
Off-site Works (closest 26m southeast)		
Historic and active garages (adjacent to the site)		

7.2 Site Investigation

A ground investigation has been designed based on the findings of the desk study with exploratory holes advanced where possible to target specific potential contaminant sources summarised in Table 7.1 above. In addition, exploratory holes have also been advanced where possible to provide information on baseline conditions across the site. The investigation has also been used to geotechnical information to assist in the design of foundations and construction of any future development.

Exploratory fieldwork was completed over three days between the dates of 28th August and 1st September 2016. A selection of site photographs are presented in Appendix VII and the works are summarised in Table 7.2 below:

Table 7.2 Summary of Fieldwork

Hole Location	Potential Source/Rationale	Type	Maximum Depth (m bgl)	Monitoring Wells Response Zone
WS101	To obtain information on baseline chemical and geotechnical conditions across the site.	Window Sample	1.20	N/A
WS102			1.30	0.70 – 1.30
WS103			1.00	N/A
WS104			1.00	N/A
WS105			1.20	N/A
WS106			1.20	0.50 – 1.20

WS107			1.55	1.00 – 1.50
HP101	To obtain information on baseline chemical conditions.	Hand Pit	1.10	N/A
BH101	To obtain information on underlying geological conditions within the proposed car park areas.	Borehole	20.00	1.00 – 7.00

Notes: m bgl – metres below ground level, N/A – Not applicable.

Soil and groundwater samples for chemical analysis were collected in appropriate sampling containers. All samples were subsequently stored in cooled boxes prior to submission to analytical laboratory. The samples were collected using appropriate PPE and sampling equipment which was cleaned at each location. A more detailed copy of REC sampling methodology, QA procedures and laboratory chain of custody forms can be provided upon request.

7.3 In-Situ Testing

7.3.1 Hand Shear Vanes

In-situ hand shear vane tests were carried out within the fine grained deposits at varying depths within WS107 and BH101 only. The results of the hand shear vane testing are presented on the exploratory hole logs included within Appendix IV, and discussed in Section 8.1.7.

7.3.2 Standard Penetration Tests

Standard Penetration Tests (SPT) were carried out within each of the window sample locations and cable percussive borehole location, from a depth of 1.20mbgl and at every metre thereafter, where possible. The testing was carried out to provide validation of ground consistency and strength observations. The results of the in-situ SPT testing are presented on the exploratory hole logs, included within Appendix IV.

7.3.3 Photo Ionisation Detection Tests

Photo ionisation detection (PID) tests were carried out on samples from the window sample and cable percussive borehole locations, where possible. The testing was carried out to detect the presence of Volatile Organic Compounds (VOCs) contamination within the encountered soil strata.

7.3.4 Unexploded Ordinance Clearance

As part of the site investigation procedure, MACC International Ltd was contracted to carry out UXO clearance of all exploratory hole locations in view of the recorded WWII bombing within the area. An Explosive Ordinance Disposal engineer attended site and all window sample locations were cleared to a depth of 2.00m bgl. The cable percussive borehole was initially cleared to a depth of 5.00m bgl with further down-hole clearance to 9.00m bgl.

7.4 Laboratory Analysis

7.4.1 Soil Chemical Analysis

Selected soil samples were submitted to UKAS accredited Scientific Analysis Laboratories (SAL) Ltd of Braintree a range of chemical analysis comprising, metals, pH, total sulphate, water soluble sulphate (2:1 extract), cyanide, phenols, total and speciated polycyclic aromatic hydrocarbons (PAHs),

asbestos and banded total petroleum hydrocarbons (TPH). The results of the chemical analysis are included in Appendix V and discussed in Section 9.

7.4.2 Water Chemical Analysis

A single water sample was submitted to UKAS accredited Scientific Analysis Laboratories (SAL) Ltd of Manchester for chemical analysis comprising, metals, cyanide, phenols, total and speciated polycyclic aromatic hydrocarbons (PAHs), banded total petroleum hydrocarbons (TPH), hardness, pH and sulphate. The results of the chemical analysis are included in Appendix V and discussed in Section 9.

7.4.3 Geotechnical Laboratory Analysis

Selected soil samples were submitted to UKAS accredited Professional Soils Laboratory, based in Doncaster, where the following geotechnical tests were undertaken:

- Particle Size Distribution (Wet & Dry Sieve Method); and,
- Quick Undrained Triaxial Test on U100 samples.

The results of the geotechnical testing are presented within Appendix VI and discussed in Section 10.

7.5 Hand Excavated Pit

A single hand excavated pit (HP101) was undertaken on a soft ground at the northeast corner of the site. The pit was advanced to a depth of 1.10m bgl using hand digging tools. The pit provided samples for chemical analysis as part of the investigation.

The location of the hand pit is shown on the exploratory hole location plan (ref. 1CO102137-002) and the result of chemical analysis is included in Appendix V and discussed in Section 9.

7.6 Land Gas and Groundwater Monitoring

Four land gas and groundwater monitoring wells were installed on site and three return monitoring visits were carried out.

Concentrations of methane (CH_4), carbon dioxide (CO_2) and Oxygen (O_2) were measured using a gas analyser (GFM435), calibrated to a reference standard (before and after each survey) and gas flow rates were measured using an internal flow pod. Gas measurements were recorded for a minimum of ninety seconds at each location, at which point the maximum concentration of CH_4 and CO_2 together with the lowest concentration of O_2 were recorded.

Groundwater monitoring was undertaken using an electronic dip meter to record the depth to groundwater.

The results of ground gas and groundwater monitoring are presented within Table 8.5. Groundwater conditions are discussed within Section 8.2 and ground gas results are discussed in Section 9.3.

8.0 GROUND AND GROUNDWATER CONDITION

8.1 Ground Conditions

8.1.1 Summary of Ground Conditions

The ground investigation generally confirmed the published geology and identifies the strata set out in Table 8.1 below. Exploratory hole logs are included in Appendix IV.

Table 8.1 Summary of Ground Conditions Encountered

Stratum	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
Made Ground	Ground Level	Ground Level	1.00 (WS107)
Lynch Hill Gravel Member	0.35	7.80	7.25 (BH101)
London Clay Formation	7.80 (BH101)	20.00 (BH101)	>12.20 NP

NP – Not proven

8.1.2 Made Ground

Made Ground was encountered within all exploratory holes and typically comprised asphalt over friable light brown sandy GRAVEL or soft/firm brown sandy gravelly CLAY/SILT with low cobble content. Sand comprised fine to coarse grained while gravel comprised angular to subrounded, fine to coarse flint, brick, asphalt, concrete, ash and clinkers. Cobbles are angular to subrounded flint, brick and concrete. Organic odours were noticed within WS105 and a maximum thickness of 1.00m was encountered within WS107.

8.1.3 Superficial Deposits (Lynch Hill Gravel Member)

Lynch Hill Gravel Member was encountered in all window sample locations but was fully proven within the BH101 and typically comprised very dense sandy GRAVEL or gravelly SAND with low cobble content. Sand comprised fine to coarse grained while gravel comprised angular to subrounded, fine to coarse flint. Cobbles are angular to subrounded flints.

A hydrocarbon odour and oily sheen on the groundwater were noticed in within BH101 from 1.20m bgl to 7.80m bgl.

8.1.4 Solid Geology (London Clay Formation)

London Clay Formation was encountered only in exploratory hole BH101 and typically comprised firm to very stiff brown to light blue to reddish brown mottled or multi-coloured silty CLAY with occasional claystone and shell fragments. A thickness of 12.20m was encountered in BH101 which does not represent the full thickness of this stratum.

8.1.5 Soil Consistency

Standard Penetration Test results shown in Table 8.2 below indicates that the Lynch Hill Gravel Member has a relative density of dense to very dense with ‘n’ values ranging from 40 to over 50. Due to the density of this stratum, all window sample locations were terminated at shallow depths with the deepest hole advanced to 1.55m bgl (WS107). However, the London Clay Formation encountered within BH101 had ‘n’ values ranging from 11 to over 50 corresponding to firm to very

stiff indicating a very low to very high strength stratum. Figure 8.1 below illustrates the graphical relationship between SPT 'N' values and depth for fine and coarse grained soils.

Table 8.2 Summary of the soil consistency/relative density

Borehole	Start Depth (m bgl)	Strata Type	SPT "N" Value	Consistency / Density	Approximate Undrained Shear Strength (kN/m^2)
WS101	1.00	Coarse grained	>50	Very Dense	-
WS102	1.00	Coarse grained	40	Dense	-
WS103	1.00	Coarse grained	>50	Very Dense	-
WS104	1.00	Coarse grained	>50	Very Dense	-
WS105	1.00	Coarse grained	>50	Very Dense	-
WS106	1.00	Coarse grained	>50	Very Dense	-
WS107	1.00	Fine grained	13	Firm	59
	1.50	Coarse grained	>50	Very Dense	-
BH101	1.20	Coarse grained	>50	Very Dense	-
	2.00	Coarse grained	>50	Very Dense	-
	3.00	Coarse grained	>50	Very Dense	-
	4.00	Coarse grained	48	Dense	-
	5.00	Coarse grained	>50	Very Dense	-
	6.50	Coarse grained	42	Dense	-
	8.00	Fine grained	11	Firm	50
	11.00	Fine grained	25	Stiff	113
	12.50	Fine grained	45	Very Stiff	203
	15.50	Fine grained	>50	Very Stiff	225
	18.50	Fine grained	>50	Very Stiff	225
	20.00	Fine grained	>50	Very Stiff	225

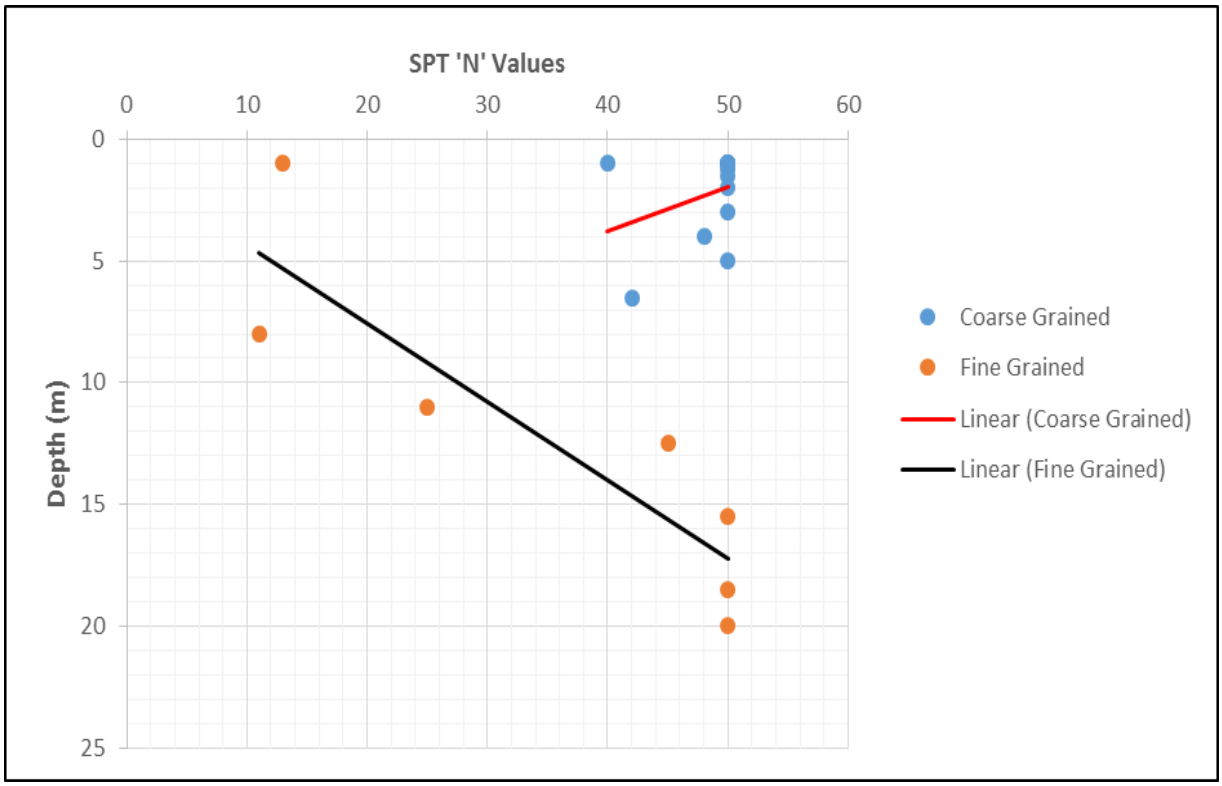


Figure 8.1: SPT 'N' Value vs Depth plot

A review of the above graph indicates SPT 'n' values for fine grained soils (clay and silt) increased with increasing depth which corresponds with the recorded very low to very high strength. Additionally, the coarse grained soil (sand and gravel) had SPT 'n' values ranging from 40 to over 50 corresponding to dense to very dense relative density which explained the difficulty encountered in advancing the window sample holes beyond shallow depths.

8.1.6 pH and Sulphate

The results of the pH and soluble sulphate analyses, presented within Appendix V and summarised below within Table 8.3, indicates that the near surface soils within both the Made Ground and superficial Lynch Hill Gravel Member meet class DS-1 / AC1.

Selected samples from BH101 were tested for pH, water soluble sulphate, total sulphur and total potential sulphate, from which the Aggressive Chemical Environment for Concrete (ACEC) was calculated using BRE Special Digest 1: 2005-Concrete in Aggressive Ground. The results indicated the bedrock London Clay Formation at depth of 8.00m bgl (immediately underlying the superficial deposits) to have a Total Potential Sulphate (TPS) of 1.77% which meets DS-4 / AC3s. Also, a similar sample at 12.00m bgl had a slightly elevated TPS of 0.27 which meets DS-2 / AC1s.

A single groundwater sample from BH101 was tested for pH and water soluble sulphate and the results indicated a pH of 8.2 and water soluble sulphate of 35mg/l which meets DS-1 / AC1d concrete classification in accordance with BRE Special Digest 1: 2005-Concrete in Aggressive Ground.

Table 8.3 Summary of pH and Sulphate Data

Location	Depth (m)	pH Value	Water soluble SO4 (mg/l)	Acid soluble SO4 (%)	Total Sulphur (%)	Total Potential Sulphate (%)	Oxidisable SO4 (g/l)	Concrete Classification
WS102	1.20-1.30	7.2	70	-	-	-	-	DS-1 / AC1s
WS107	1.45-1.55	7.0	70	-	-	-	-	DS-1 / AC1s
BH101	1.20-1.70	8.6	20	-	-	-	-	DS-1 / AC1s
BH101	5.00-5.50	8.1	10	-	-	-	-	DS-1 / AC1s
BH101	8.00	7.6	360	-	0.59	1.77	-	DS-4 / AC3s
BH101	12.00	8.5	90	-	0.09	0.27	-	DS-2 / AC1s
BH101	16.50	8.6	80	-	0.07	0.21	-	DS-1 / AC1s
BH101	19.50	8.7	70	-	0.04	0.12	-	DS-1 / AC1s
BH101	Water	8.2	35	-	-	-	-	DS-1 / AC1d

8.1.7 Undrained Shear Strength

Undrained shear strengths derived from in-situ SPT testing indicate the bedrock London Clay Formation to be of very low to very high strength, as detailed below in Table 8.4.

Hand Vane results recorded on fine grained soils within WS107 and BH101 indicate a general increase in undrained shear strength with increasing depth. Figure 8.2 below illustrates the relationship between undrained shear strength and depth in fine grained soil within BH101 only.

Table 8.4 Summary of In-situ Shear Strength Testing on Fine Grained Stratum

Location	Depth (m bgl)	Stratum	Consistency	Undrained Shear Strength (KN/m2)	Strength
WS107	1.00	Clay	Firm	59	Medium Strength
BH101	8.00	Clay	Firm	50	Medium Strength
BH101	11.00	Clay	Stiff	113	High Strength
BH101	12.50	Silt	Very Stiff	203	Very High Strength
BH101	15.50	Silt	Very Stiff	225	Very High Strength
BH101	18.50	Clay	Very Stiff	225	Very High Strength
BH101	20.00	Clay	Very Stiff	225	Very High Strength

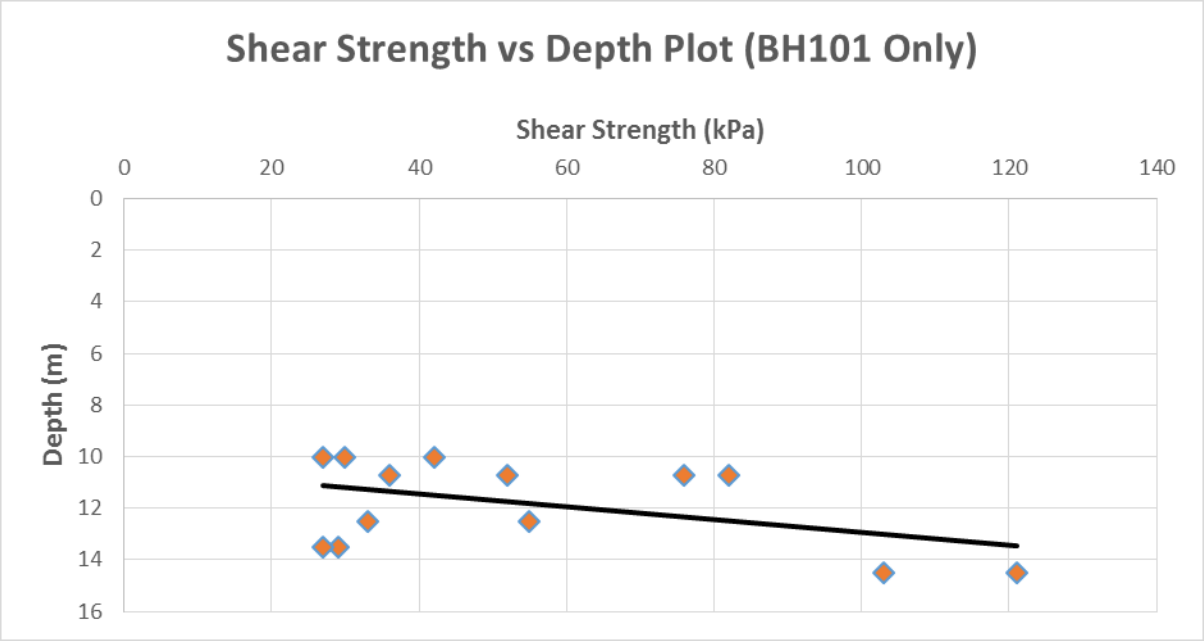


Figure 8.2: Shear Strength vs Depth plot

The above graph shows a plot of undrained shear strength vs depth recorded in fine grained soil within BH101. The graph shows a gradual increase in undrained shear strength with increasing depth within the fine grained soil.

8.2 Groundwater Conditions

Ground water was encountered within BH101 at 18.50m and 20.00m bgl which rose to 16.50m and 14.00m bgl respectively after 20 minutes. The analysis of different strata within the BH101 suggests a likely presence of perched aquifer at the base of the superficial gravel layer. The low SPT 'n' value of 11 recorded at 8.00m bgl near the transition zone between the superficial Lynch Hill Gravel Member and the London Clay Formation further supports a likely presence of groundwater at the base of the gravel layer. During monitoring, all window sample locations were dry during all three

monitoring visits. However, BH101 showed groundwater between 5.17m and 5.62m bgl during all three monitoring visits.

8.3 Ground Gas

Four exploratory hole locations were installed with ground gas monitoring equipment including WS102, WS106, WS107 and BH101. The results of the ground gas monitoring are presented in Table 8.5 overleaf:

Table 8.5 Summary of ground gas and groundwater monitoring results to date

Well	Date	PID	Flow (l/hr)		Low O_2 %v/v	Concentration CH_4		CH_4 Qhg l/hr	Concentration CO_2		CO_2 Qhg l/hr	Atmospheric Pressure (mbar)	Response Zone (mbgl)	Depth to Water (mbgl)	Response zone flooded?
			Peak	Steady		Peak %v/v	Steady %v/v		Peak %v/v	Steady %v/v					
WS102	06/09/2016	-	<0.1	<0.1	15.0	<0.1	<0.1	<0.0001	2.4	2.4	0.0024	1019 - steady	0.70-1.28	Dry	No
	14/09/2016	-	<0.1	<0.1	17.3	<0.1	<0.1	<0.0001	1.6	1.6	0.0016	1006 - rising	0.70-1.25	Dry	No
	19/09/2016	10.5	<0.1	<0.1	15.1	<0.1	<0.1	<0.0001	2.3	2.3	0.0023	1019 - steady	0.70-1.25	Dry	No
WS106	06/09/2016	-	<0.1	<0.1	21.0	<0.1	<0.1	<0.0001	<0.1	<0.1	<0.0001	1019 - steady	0.50-1.29	Dry	No
	14/09/2016	-	<0.1	<0.1	20.0	<0.1	<0.1	<0.0001	0.7	0.7	0.0007	1006 - rising	0.50-1.25	Dry	No
	19/09/2016	18.0	<0.1	<0.1	20.9	<0.1	<0.1	<0.0001	<0.1	<0.1	<0.0001	1019 - steady	0.50-1.25	Dry	No
WS107	06/09/2016	-	<0.1	<0.1	20.7	<0.1	<0.1	<0.0001	<0.1	<0.1	<0.0001	1019 - steady	1.00 -1.50	Dry	No
	14/09/2016	30.2	<0.1	<0.1	20.8	<0.1	<0.1	<0.0001	0.1	0.1	0.0001	1005 - rising	1.00-1.48	Dry	No
	19/09/2016	16.2	<0.1	<0.1	20.7	<0.1	<0.1	<0.0001	0.1	0.1	0.0001	1019 - steady	1.00-1.48	Dry	No
BH101	06/09/2016	-	<0.1	<0.1	20.1	<0.1	<0.1	<0.0001	0.2	0.2	0.0002	1019 - steady	1.00-6.47	5.56	No
	14/09/2016	17.6	<0.1	<0.1	19.8	<0.1	<0.1	<0.0001	0.4	0.4	0.0004	1005 - rising	1.00-6.37	5.62	No
	19/09/2016	27.2	<0.1	<0.1	18.6	<0.1	<0.1	<0.0001	0.8	0.8	0.0008	1019 - steady	1.00-6.35	5.17	No

9.0 TIER II GENERIC QUANTITATIVE CONTAMINATED LAND RISK ASSESSMENT

9.1 Human Health

At a Tier II stage, the long term (chronic) toxicity risk to human health is assessed by utilising appropriate and conservative generic assessment criteria (GAC) to determine whether there are actual or potential unacceptable risks at the site and if any viable pollutant linkages are present.

To undertake the Tier II assessment within the context of the development proposal, REC has determined that the most appropriate GAC values available will be those based upon a residential land use with public open play area.

The following assessment, summarised below and overleaf in Table 9.1, has primarily adopted the S4UL (Suitable for Use Levels reference values published by LQM/CIEH in 2015, the S4ULs). Currently, no published GAC value is available for cyanide and therefore REC has utilised the Environmental Agency Contaminated Land Exposure Assessment Tool (CLEA v1.06) to derive the relevant GAC for this proposed land use. Due to the absence of a published lead GAC for direct use within the planning regime, the 2014 Defra C4SL (Category 4 Screening Level) has been used as this value is considered to incorporate the latest toxicological, bioaccessibility and exposure modelling research to date.

Table 9.1: Summary of Generic Human Health Toxicity Assessment for Residential without Plant Uptake

Determinand	GAC (mg/kg)	GAC Source	n	[mc] (mg/kg)	Exceedences	Primary Pathways	Assessment
Inorganics							
Arsenic	40	(i)	8	27	N/A	1	NFA
Barium	1300	(iv)	8	540		1	
Beryllium	**1.7**	**(i)**	**8**	**2.1**	**HP101(0.30m-0.35m)**	**1, 3**	**See Discussion**
Boron	11000	(i)	8	<1	N/A	1, 2	NFA
Cadmium	85	(i)	8	1.1		1, 2	
Chromium (III)	910	(i)	8	130		3	
Chromium (VI)	6	(i)	8	1		1, 2, 3	
Copper	7100	(i)	8	110		1, 2	
Lead	**310**	**(iii)**	**8**	**880**	**WS107(0.40m-0.50m) & HP101 (0.30m-0.35m)**	**1, 2**	**See Discussion**
Mercury [Inorganic]	56	(i)	8	<1.0	N/A	1, 2	NFA
Nickel	180	(i)	8	77		1	
Selenium	430	(i)	8	<3		1, 2	
Vanadium	1200	(i)	8	79		1, 2	
Zinc	40000	(i)	8	1200		1, 2	
Cyanide [Total]	530	(iv)	8	2		1	
Asbestos	**D.**	**(v)**	**8**	**D.**	**WS107(0.40m-0.50m) & HP101 (0.30m-0.35m)**	**3**	**See Discussion**
Organics – Phenol and PAHs							
Phenols	440	(ii)	8	<1	N/A	2	NFA
Acenaphthene	3000	(ii)	8	0.2		2	
Acenaphthylene	2900	(ii)	8	0.3		2	
Anthracene	31000	(ii)	8	0.8		2	

Determinand	GAC (mg/kg)	GAC Source	n	[mc] (mg/kg)	Exceedences	Primary Pathways	Assessment
Benzo(a)anthracene	11	(ii)	8	5.6		1	
Benzo(a)pyrene	3.2	(ii)	8	2.3		1	
Benzo(b)fluoranthene	3.9	(ii)	8	3.2		1	
Benzo(ghi)perylene	360	(ii)	8	1.5		1	
Benzo(k)fluoranthene	110	(ii)	8	2.5		1	
Chrysene	30	(ii)	8	6.1		1	
Dibenzo(a,h)anthracene	**0.31**	**(ii)**	**8**	**0.4**	**HP101 (0.30m-0.35m)**	**1**	**See Discussion**
Fluoranthene	1500	(ii)	8	9.0	N/A	1, 2	N/A
Fluorene	2800	(ii)	8	0.2		2	
Indeno(123-cd)pyrene	45	(ii)	8	1.4		1	
Naphthalene	2.3	(ii)	8	0.3		4	
Phenanthrene	1300	(ii)	8	3.8		2	
Pyrene	3700	(ii)	8	6.9		1, 2	
Organics – TPHs							
TPH C_5-C_6	42	(ii)	8	<0.10	N/A	4	N/A
TPH C_6-C_8	100	(ii)	8	<0.10		4	
TPH C_8-C_{10}	27	(ii)	8	<0.10		4	
TPH C_{10}-C_{12}	130	(ii)	8	<2		4	
TPH C_{12}-C_{16}	1100	(ii)	8	<2		1, 2	
TPH C_{16}-C_{21}	1900	(ii)	8	24		1	
TPH C_{21}-C_{35}	1900	(ii)	8	230		1	

Key for Table 9.1

[mc] Maximum Concentration Recorded
D. Fibres detected
N.D. No significant / trace presence of fibres detected (Limit of Detection = <0.001%)

Primary Pathways

1 Ingestion of soil and indoor dust and / or oral background exposure;
2 Consumption of home-grown produce and attached soil;
3 Inhalation of dust (background and indoor);
4 Inhalation of vapour (background and indoor);

Generic Assessment Criteria (GAC) Sources

(i) LQM/CIEH Suitable For Use Level (S4UL) (2015);
(ii) S4UL – Conservative Assessment Approach of 1% SOM;
(iii) Defra Category 4 Screening Level (2014);
(iv) CLEA 1.06 Derived Value;
(v) Control of Asbestos Regulations 2012 (CAR-SOIL, 2012).

Referring to Table 9.1, the results of this direct comparison indicates that the screening values have been exceeded for the following determinants:

- **Beryllium:** (HP101 @ 0.30m-0.35m);
- **Lead:** (HP101 @ 0.30m-0.35m & WS107 @ 0.40m-0.50m);
- **Asbestos:** (HP101 @ 0.30m-0.35m & WS107 @ 0.40m-0.50m); and,
- **Dibenzo(a,h)anthracene:** (HP101 @ 0.30m-0.35m)

9.1.1 Beryllium

Inhalation and ingestion of dust and or soil which includes indoor dust and background exposure are the main exposure pathways for beryllium. The concentration of beryllium (2.1mg/kg) found exclusively within HP101 at 0.30m-0.35m bgl shows a marginal exceedance above the generic assessment criteria GAC value of 1.7mg/kg. Based on the proposed development which comprises medium to high density multi-storey residential dwelling with soft and hard standing public areas and no gardens, it is highly unlikely that this level of exceedance will pose any significant risk to human health and controlled waters. Therefore, no further action is required in view of potential exposure to future occupants of the proposed development.

9.1.2 Lead

The main exposure pathways for lead are ingestion of soil, indoor dust and background exposure, and consumption of home-grown produce with attached soil. Elevated concentrations of lead are recorded within WS107 at depth of 0.40m-0.50m bgl and HP101 at depth of 0.30m-0.35m bgl respectively. In both locations, the exceedances are more than twice the recommended GAC value of 310mg/kg for developments without home-grown produce. As a result, additional investigation is recommended to properly delineate the vertical and lateral extent of the lead within the Made Ground stratum.

9.1.3 Asbestos

Asbestos main exposure pathway is through inhalation of dust containing asbestos fibres as background exposure or indoor dusts. Asbestos fibres were identified in soil samples from WS107 (0.40m-0.50m) bgl and HP101 (0.30m-0.35m) bgl and further investigation indicates Chrysotile fibres were found in WS107 while Chrysotile fibres with Chrysotile Asbestos Containing Material (ACM) were detected in HP101. Due to the presence of asbestos and ACM, WAC Testing is recommended for samples from these two locations to determine the appropriate waste classification in view of removal and subsequent disposal.

Consideration should also be given to the protection of construction workers during the main development when these soils maybe disturbed.

9.1.4 Dibenzo(a,h)anthracene

Dibenzo(a,h)anthracene is one of the determinants within Polycyclic Aromatic Hydrocarbon (PAH) group of contaminants. The main exposure pathway is ingestion of soil, indoor dust and or oral background exposure. A marginal elevated concentration of Dibenzo(a,h)anthracene was recorded within HP101 only at a depth of 0.30m-0.35m bgl. As private gardens are not part of the proposed development, the likelihood of exposure to future users is very low and marginal exceedance makes it unlikely to pose risk to human health.

9.2 Controlled waters

The groundwater vulnerability map shows the site is underlain by Principal Aquifer of the superficial Lynch Hill Gravel Member with high leaching potential due to its location within an urban environment and in absence of site specific data. The superficial deposit is underlain by the London Clay Formation which is considered to be an unproductive aquifer.

A single groundwater sample collected from BH101 during ground gas and groundwater monitoring was tested for REC standard metal suite, Total and Speciated USEPA 16 PAHs and TPHs. A

comparison of the results with recommended Generic Assessment Criteria (GAC) for human health toxicity risk assessment is presented in Table 9.2 below.

Table 9.2: Summary of Groundwater Generic Human Health Toxicity Assessment for Residential Development without Private Gardens

Determinand	Units	Assessment Value	BH101
Inorganics			
Arsenic	µg/l	10[3]	1.5
Barium	µg/l	700[3]	92
Beryllium	µg/l	4[4]	<0.05
Boron	µg/l	2400[3]	130
Cadmium	µg/l	1.5[1]	1.4
Chromium VI	µg/l	3.4[1]	<3
Chromium	µg/l	50[1]	3
Copper	µg/l	40[1]	2.8
Lead	µg/l	10[3]	<0.3
Mercury	µg/l	0.07[1]	<0.05
Nickel	µg/l	200[3]	13
Selenium	µg/l	40[3]	1.7
Vanadium	µg/l	100[1]	3
Zinc	µg/l	75[1]	7
Cyanide (Total)	µg/l	5[1]	<10*
pH		6-9 [1]	8.2
Total Hardness ($CaCO_3$)	mg/l	-	240
Organics – Phenol and PAHs			
Acenaphthene	µg/l	-	<0.01
Acenaphthylene	ug/l	-	0.05
Anthracene	µg/l	0.4[1]	<0.01
Benzo(a)anthracene	µg/l	-	<0.01
Benzo(a)pyrene	µg/l	0.03[1]	<0.01
Benzo(b)fluoranthene	µg/l	-	<0.01
Benzo(ghi)perylene	µg/l	-	<0.01
Benzo(k)fluoranthene	µg/l	-	<0.01
Chrysene	µg/l	-	<0.01
Dibenzo(ah)anthracene	µg/l	-	<0.01
Fluoranthene	µg/l	1.0[1]	0.03
Fluorene	µg/l	-	<0.01
Indeno(123-cd)pyrene	µg/l	-	<0.01
Naphthalene	µg/l	10.0[1]	<0.01
Phenanthrene	µg/l	-	<0.01
Pyrene	µg/l	-	0.32
Phenols (Mono)	µg/l	7.7 [1]	<0.02
Organics – TPHs			
TPH (total)	**µg/l**	**300[5]**	**410**

Key:
(1) Environmental Quality Standard – Fresh Water
(2) Water Framework Directive
(3) World Health Organisation Drinking Water Guideline Values
(4) US EPA - National Primary Drinking Water Regulations (NPDWRs)
Petroleum Products in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality, WHO (WHO/SDE/WSH/05.08/123);

* Cyanide is below Laboratory Limit of Detection and therefore considered to be negligible risk.

The Tier II risk assessment indicates the groundwater sample displayed the following elevated concentrations against the relevant surface water and drinking water screening values:

- **Cyanide**;
- **TPH (total)**.

It should additionally be noted that although the laboratory detection limit (LOD) of cyanide is above the Environmental Quality Standard (10ug/l), samples with concentrations below LOD are generally considered unlikely to be of concern.

The site is considered to be a **moderate** sensitivity setting with respect to controlled waters on the basis that the site is underlain by superficial deposit Principal Aquifer with high leaching potential. There is a number of groundwater abstraction point with closest located 542m north of the site. The nearest surface water feature is located 110m west with interconnected culverts and tributaries.

9.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published within BS 8485:2015.

Three return monitoring visits were undertaken over a period of three weeks between 6th and 19th September 2015 with varying atmospheric pressure conditions between 1005mbar and 1019mbar. A maximum concentration of 2.4% v/v carbon dioxide was recorded in WS102. Methane levels were all <0.1% v/v. All borehole flow rates were 0.1l/hr.

In accordance with the methodology outlined within BS8485:2015, REC have utilised the results of the ground gas monitoring surveys to calculate a tentative borehole hazardous gas flow rate (Qhg), previously known as a Gas Screening Value (GSV).

Table 9.3

Flow rate (L/h)	Maximum CH_4 (%)	Maximum CO_2 (%)	CH_4 Qhg (L/h)	CO_2 Qhg Rate (L/h)	Implied CH_4 CS	Implied CO_2 CS
<0.1	<0.1	2.4	<0.0001	0.0024	1	1

CS : Characteristic Situation
Qhg : Hazardous gas flow rate

The maximum implied Characteristic Situation for the site has therefore been calculated by combining the maximum observed flow rate and maximum observed concentrations during any monitoring event. This methodology provides a 'worst case scenario' in order to characterise the highest potential risk to human health from ground gas at the site.

On the basis of measurements in Table 9.3, the site maximum site hazardous gas flow rate is considered to be <0.0024 L/h, which is the worst case for both methane and carbon dioxide. A maximum site hazardous gas flow rate of <0.0024 L/h lies well within the range of GSV values for CS1 (<0.07 L/h). As such, the gas regime for the site can be classified as Characteristic Situation 1 (CS1) based on the limited monitoring visits undertaken.

Elevated Volatile Organic Compound (VOC) readings were monitored during the return visits. As such, we would recommend that this risk is assessed further in order to assess whether a gas protection membrane is required.

9.4 Revised Conceptual Site Model

The initial conceptual site model has been revised in light of the ground investigation and is based on the identified contaminant sources and pathways as shown in Table 9.5 below.

Table 9.4 Identified Contaminant Sources and Pathways

Source	Contaminant	Pathway
Made Ground	Beryllium	Ingestion of soil, indoor dust and or oral background exposure; and, inhalation of indoor and or background dust.
	Lead	Ingestion of soil, indoor dust and or oral background exposure; and, consumption of home-grown produce with attached soil.
	Asbestos	Inhalation of indoor and or background dust.
	Dibenzo (a,h) anthracene	Ingestion of soil, indoor dust and or oral background exposure;

The revised conceptual site model has been developed for the proposed development based upon the outcomes of the Tier II Generic Quantitative Risk Assessment to human health and controlled waters. This summarises the understanding of surface and sub-surface features, the potential contaminant sources, transport pathways and receptors, as detailed below and summarised in Table 9.4 above.

Table 9.5 Revised Conceptual Site Model

Receptor	Potential Risk	Current Residual Risk	Mitigation
Human Health	*Uptake of contaminants by food plants grown in contaminated soil*	NO	**Provision of a clean cover system will mitigate the risk.** This is only required in areas of soft landscaping as the pathway is broken by the presence of the building footprint and hard standing areas. Although concentrations of methane and carbon dioxide would indicate that no gas protection measures are required, given that Volatile Organic Compounds (VOC's) were monitored within all well locations further assessment will be required to determine whether **gas protections measures** should be installed.
	Ingestion	YES	
	Inhalation	YES	

Note: Uptake of contaminants by home-grown produce is not considered a residual risk due to the fact that the proposed development will not include private gardens where food plants may be cultivated.

10.0 GEOTECHNICAL ASSESSMENT

10.1 Proposed Development

It is our understanding that these works have been commissioned in order to support the potential development of the site into a medium to high density 6 to 8 storey residential development with possible soft/hard standing areas.

Details of the proposed loadings are unknown, as such this report represents a general precis of foundation options and commentary on potential development constraints.

10.2 Summary of Ground and Groundwater Conditions

Ground conditions identified at the site are summarised in Section 8.0 and typically comprised Made Ground, encountered in all exploratory locations, from ground level to maximum depth of 1.00m bgl (WS107) overlying the Lynch Hill Gravel Member with a maximum thickness of 7.25m recorded in BH101. The Lynch Hill Gravel Member was underlain by the London Clay Formation which was not fully proven.

No groundwater was encountered within any of the exploratory holes locations with the exception of the cable percussive borehole (BH101) which recorded groundwater at 18.50 and 20.00m bgl. After 20 minutes standing time, the groundwater level rose to 16.50m and 14.00m bgl respectively. However, given that potable water was added in order to drill through the Lynch Hill Gravel, groundwater within this stratum cannot be discounted.

Return groundwater monitoring visits indicated groundwater levels ranging between 5.17 and 5.62mbgl in BH101 only. The remaining locations were dry during all return monitoring visits.

10.3 Foundation Conditions and Bearing Capacity

10.3.1 Shallow Foundations (pad or strip)

Made Ground is not considered a suitable founding material due to the inherent variability of the material which may give rise to unpredictable total and differential settlements. It is therefore recommended that foundations pass through this stratum and bear onto the underlying Lynch Hill Gravel encountered at depths ranging between 0.35 and 1.0mbgl.

With regards to allowable bearing pressures, based on SPT tests an allowable bearing pressure of 400kN/m^2 could be considered for the proposed scheme. This is based on limiting total settlements to 25mm, a factor of safety of 3 and a minimum founding depth of 1.0mbgl.

Given that groundwater was monitored at depths well below likely foundation depths, no allowance has been made for reducing the allowable bearing pressure accordingly.

All foundations should be designed by suitably qualified structural engineers.

10.3.2 Piled Foundations

In consideration of prevailing ground conditions alone, a choice of pile type of various lengths and diameters can be designed to bear into the strata encountered beneath the site. However general site conditions, environs and proximity to adjacent extant structures and foundations are all influential in choice of piling system.

It should be noted that for Continuous Flight Augur (CFA) piles there are certain practical constraints when considering the incorporation of large amounts of pile reinforcement and also their emplacement in ground with potential obstructions. There is also the risk of collapse or necking of the pile bore should the flights be withdrawn and the hole left unsupported. For these reasons it is recommended that a competent and experienced specialist piling contractor undertakes all piling works, adopting appropriate controls and that their advice should be sought at the earliest opportunity.

For preliminary purposes the following initial pile carrying capacities have been calculated in Table 10.1. When undertaking these preliminary calculations the following parameters have been used:

- Undrained shear strength values derived in the field and laboratory;
- Adhesion Factor of 0.45 based on CFA piles;
- Factors of safety of 1.5 on side resistance and 3 on base resistance; and,
- Global Factor of safety of 2.5.

Table 10.1 Pile Carrying Capacities

Depth (mbgl)	Pile Carrying Capacity (kN)		
	300mm dia	450mm dia	600mm dia
15	180	300	400
20	400	600	850

10.4 Ground Floor Slab

Given that a piled foundation will be utilised it is therefore assumed that a suspended floor slab will be adopted. This would also negate the possibility of differential settlements between the floor and the shell of the proposed development.

Where suspended floor slabs are employed ventilation of the under floor void will be required to address condensation. Land gas protection measures will also need to be incorporated where required depending on the findings of the additional works.

It is recommended that advice should be sought from a suitably qualified structural engineer with regard to the design and construction of the floor slab.

10.5 Concrete Durability

Based upon the results of the chemical analyses summarised in Table 8.3, it is considered that provided foundation are restricted to the Lynch Hill Gravel, subsurface concrete can be designed in accordance with Design Sulphate Class DS-1, and Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1. However, if foundations are to pass into the underlying London Clay Formation beneath, subsurface concrete should be designed in accordance with Design Sulphate Class DS-4, and Aggressive Chemical Environment for Concrete Classification (ACEC) AC-3.

10.6 Excavations

It is recommended that where man entry into excavations deeper than 1.20m is required that either excavations are shored or that the sides of excavations are battered to a safe angle of repose.

Excavations should be protected during construction in order to avoid potentially excessive softening caused by wet weather or potential shrink and swell caused by periods of hot weather.

10.7 Construction Activity and Inspection

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

- It is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and floor slabs;
- Excavations should be protected during construction in order to avoid potentially excessive softening caused by wet weather or potential shrink and swell caused by periods of hot weather; and,
- Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 utilised.

10.8 Pavements and Construction

Due to the extensive underground services within the area of proposed car parking, it was considered unsafe to undertake in-situ DCP testing. Therefore, an average estimated CBR value has been determined in accordance with Design Manual for Roads and Bridges Volume 7: Pavement Design and Maintenance.

Given the relatively thin veneer of Made Ground across the site it is assumed that this material will be stripped with roads and pavements constructed at the surface of the Lynch Hill Gravel Member. Due to the coarse grained nature of the Lynch Hill Gravel Member a design CBR value in excess of 20% could be considered. However, we would recommend that in situ testing such as plate load tests are undertaken prior to construction in order to confirm these.

As with good construction practice it is recommended the formation level be inspected and that any areas of soft/loose deleterious strata are replaced with an appropriately compacted coarse grained medium. Likewise, any hard spots should also be removed to guard against reflective cracking in the pavement. Proof rolling/compaction of the formation level should be carried out prior to laying the new pavement.

11.0 CONCLUSIONS AND RECOMMENDATIONS

The investigation has identified potentially significant risks to human health from contaminants (Beryllium, lead, asbestos, dibenzo(a,h)anthracene) found within the shallow Made Ground at the site. Without further action at the site to break the pollutant pathway, the site should currently be considered unacceptable for its proposed end use. In addition, additional works are required in order to determine whether land gas protection measures are required.

Based on the ground conditions encountered, it is likely that CFA piles could be adopted end bearing into the London Clay Formation.

Therefore REC recommends that remedial works are undertaken in order to remove any significant risks to human health and controlled waters. Recommended actions are as follows:

- Installation of clean cover system within area of soft standing. Alternatively, should the development comprise large areas of hard standing, this could also be used to sever the pathway between the source and the receptor;
- Due to the presence of asbestos and ACM, WAC Testing is recommended to determine the appropriate waste classification in view of removal and subsequent disposal. In addition, consideration should also be given to the protection of construction workers during the main development when these soils maybe disturbed including damping down, air monitoring and the use of specialist PPE;
- Further ground investigation works around BH101 where the groundwater was observed to comprise an oily sheen in order to determine whether this is an on-site or off-site source. A large vent pipe was visible within the Police Station site adjacent to this location which may indicate the presence of an underground fuel tank. Contact was made with the Police Station in order to determine whether this feature was present, however, no response was received;
- Further works will be required to determine whether land gas protection measures are to be incorporated into the proposed scheme. This will include volatile gas sampling and additional monitoring visits;
- Further ground investigation works should also be undertaken beneath the existing building footprint on a standard grid spacing in order to expand the data set for the site;
- Production of a Remediation Method Statement will be required in order to implement any remedial measures.

The above recommendations will need to be confirmed with the Local Authority prior to design.

END OF REPORT

APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Ltd and the Client as indicated in Section 1.2.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not be made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. In addition to the above REC Ltd note that when investigating, or developing, potentially contaminated land it is important to recognise that sub-surface conditions may vary spatially and also with time. The absence of certain ground, ground gas, and contamination or groundwater conditions at the positions tested is not a guarantee that such conditions do not exist anywhere across the site. Due to the presence of existing buildings and structures access could not be obtained to all areas. Additional contamination may be identified following the removal of the buildings or hard standing.
7. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
8. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.
9. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
10. This report presents an interpretation of the geotechnical information established by excavation, observation and testing. Whilst every effort is made in interpretative reporting to assess the soil conditions over the Site it should be noted that natural strata vary from point to point and that man made deposits are subject to an even greater diversity. Groundwater conditions are dependent on seasonal and other factors. Consequently there may be conditions present not revealed by this investigation.
11. REC can not be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.
12. Rather, this investigation has been undertaken to provide a preliminary characterisation of the existing sub-surface geotechnical characteristics and make up and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
13. This investigation has been undertaken to reasonably characterise existing sub-surface conditions and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

APPENDIX II

GLOSSARY

TERMS

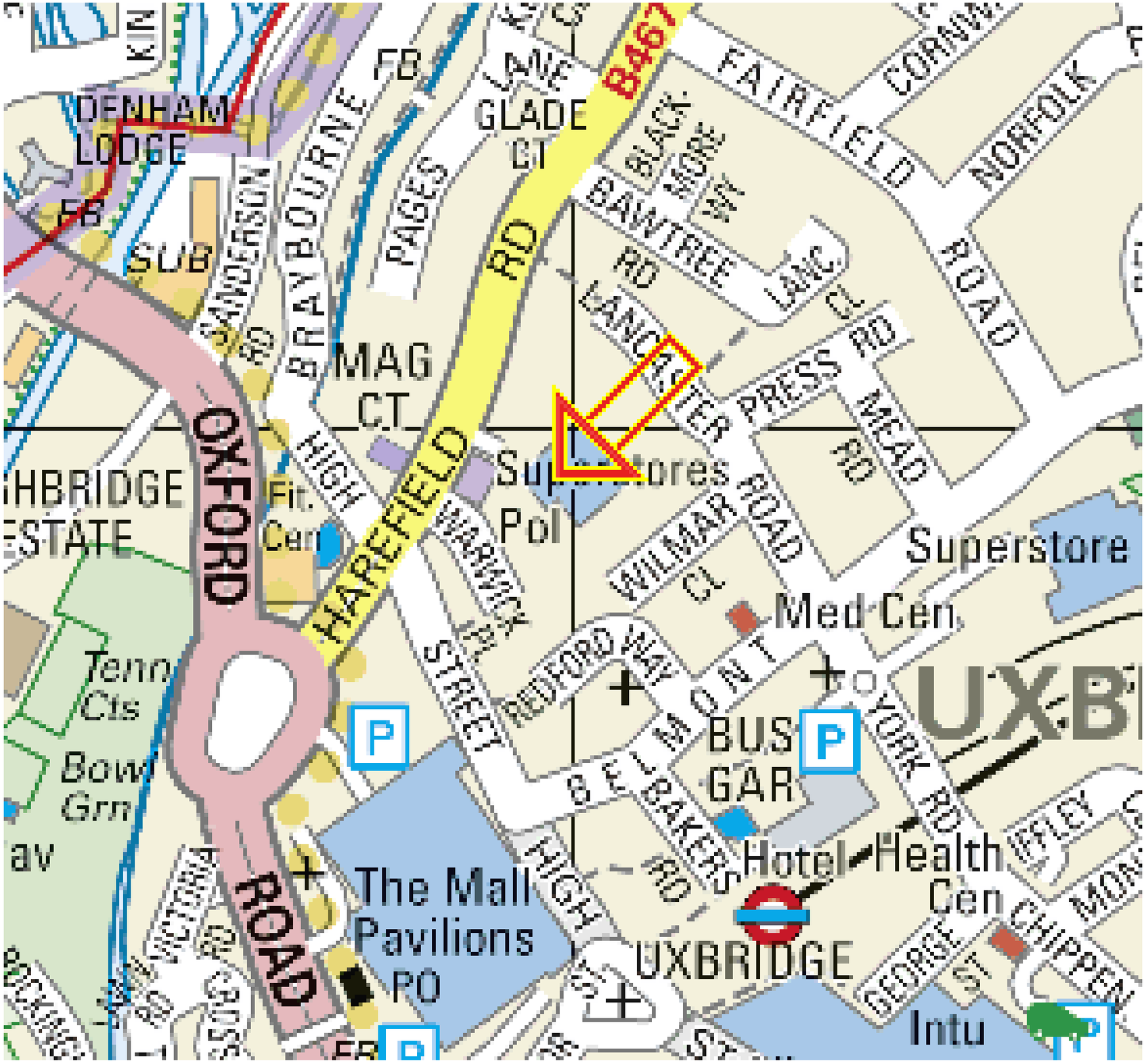
AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

APPENDIX III

DRAWINGS

KEY:

N
W E
S



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Job Title:
2-12 Harefield Road, Uxbridge

Client:
BNP Paribas

Job No: **1CO102125**
Drawn By: **EC**
Approved by: **CP**

Notes:
Not drawn to scale

Drawing Title:
1CO102125-001
Site Location plan

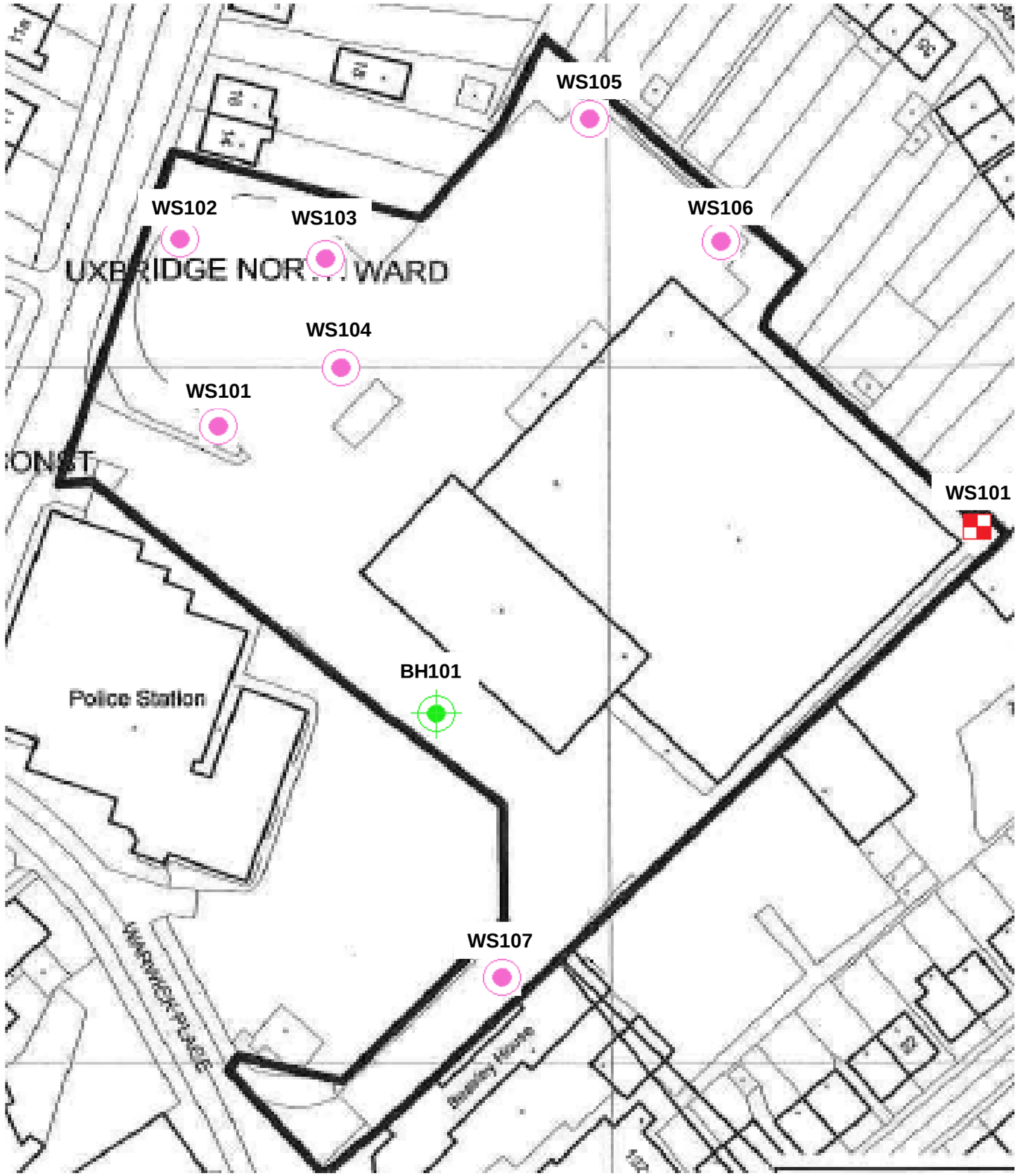
KEY:

N
W E
S

Proposed Cable Percussive Borehole (to 30.0m)

8no. window Samples to 5.0mbgl

Hand Pit



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Job Title: **2-12 Harefield Road, Uxbridge**

Client: **BNP Paribas**

Job No: **1CO102125**

Drawn By: **EC**

Approved by: **CP**

Notes: **Not drawn to scale**

Drawing Title: **1CO102125-002 Exploratory Hole Location plan**

APPENDIX IV

EXPLORATORY HOLE LOGS

Borehole Log

Borehole No. **BH101** Sheet 1 of 3

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: / Northing:	Hole Type: CP
Location:	Uxbridge, UB8 1JS	Plant:	Cable Percussive Rig	Level (m AOD): / Final Depth (m): 20.00	Scale: 1:50
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 30/08/2016 / End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.20 - 0.30	ES		0.15			Asphalt [MADE GROUND]
		0.50	D		0.55			Friable light brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete. Cobbles are angualr to subrounded flint, brick and concrete. [MADE GROUND]
		0.50 - 0.75	B					
		0.60 - 0.70	ES					
		0.80	D					
		1.20	SPT	50 (12,13/50 for 95mm)	1.20			Very dense brown clayey sandy GRAVEL with low cobble content. Sand fine to coarse. Gravel is angular to subrounded, fine to coarse flint. Cobbles are angular to subrounded flint. [LYNCH HILL GRAVEL MEMBER]
		1.20 - 1.70	B					
		2.00	SPT	50 (13,12/50 for 125mm)				Very dense brown sandy GRAVEL with low cobble content. Sand fine to coarse. Gravel is subangular to rounded, fine to coarse flint. Cobbles are angular to subrounded flint. Suspected hydrocarbon odour with black oil sheen on water from borehole. [LYNCH HILL GRAVEL MEMBER]
		2.00 - 2.50	B					
		3.00	SPT	50 (13,12/50 for 125mm)				*... below 3.00mbgl: Hydrocarbon odour and staining ceased.*
		3.00 - 3.50	B					
		4.00	SPT	48 (11,11/48 for 200mm)				
		4.00 - 4.50	B					
		5.00	SPT	N=50 (11,11/50 for 240mm)				
		5.00 - 5.50	B					*... below 5.50mbgl: Brown interbedded clayey sandy GRAVEL.*
		6.50	SPT	N=42 (9,9/9,10,11,12)				
		6.50 - 7.00	B					
		7.80	D		7.80			Firm brown silty CLAY with occasional soft shells. [LONDON CLAY FORMATION]
		8.00	D					
		8.00	SPT	N=11 (1,2/2,2,3,4)				
		9.50 - 9.75	U					
		10.00		HVP=27				Continued on Next Sheet

Remarks:

GPR EM and UXO Survey carried out prior to drilling and downhole magnetometry was undertaken at regular intervals up to 9.00m bgl during drilling. Inspection pit hand excavated to 1.20m bgl. Groundwater encountered at 20.00m bgl rising 14.00m bgl after 20 minutes. Hole terminated at 20.00mbgl due to unstable sidewall collapse at 18.50m bgl. Hole backfilled to 7.00m bgl using arisings. 50mm internal diameter monitoring standpipe installed to 7.00m bgl and finished with a flush fitting cover.

Borehole Log

Borehole No. **BH101**

Sheet 2 of 3

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type CP
Location:	Uxbridge, UB8 1JS	Plant:	Cable Percussive Rig	Level (m AOD): Final Depth (m): 20.00	Scale: 1:50
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 30/08/2016 End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00		HVP=30				*... below 10.0mbgl: becoming dark grey clayey SILT.*
		10.00		HVP=42				
		10.00	D					
		10.70		HVP=36	10.70			Stiff brittle brown to light blue mottled CLAY occasionally interlayered with dark grey clayey silt. [LONDON CLAY FORMATION]
		10.70		HVP=52				
		10.70		HVP=76				
		10.70		HVP=82				
		10.70	D					
		11.00	D					
		11.00	SPT	N=25 (4,4/5,6,6,8)				
		12.00	D					*... below 12.00mbgl: whitish very brittle and reddish stained possible claystone.*
		12.50		HVP=33	12.50			Very stiff orangeish brown to light blue to reddish multi coloured clayey SILT with occasional claystone. [LONDON CLAY FORMATION]
		12.50		HVP=55				
		12.50	D					
		12.50	SPT	N=45 (6,5/8,10,11,16)				
		13.50		HVP=27				
		13.50		HVP=29				
		13.50	D					
		14.00 - 14.45	U					
		14.50		HVP=103				
		14.50		HVP=121				
		14.50	D					
		15.50	D					
		15.50	SPT	N=50 (9,9/50 for 265mm)				
		16.50	D		16.50			Very stiff reddish brown to light blue to reddish mottled silty CLAY. [LONDON CLAY FORMATION]
		17.00 - 17.45	U					
		17.50	D					
		18.50	D					*... below 18.5mbgl:becoming grey brown slightly clayey SILT.*
		18.50	SPT	50 (12,13/50 for 155mm)				
		19.50	D					
		20.00	D		20.00			

Continued on Next Sheet

Remarks:

GPR EM and UXO Survey carried out prior to drilling and downhole magnetometry was undertaken at regular intervals up to 9.00m bgl during drilling. Inspection pit hand excavated to 1.20m bgl. Groundwater encountered at 20.00m bgl rising 14.00m bgl after 20 minutes. Hole terminated at 20.00mbgl due to unstable sidewall collapse at 18.50m bgl. Hole backfilled to 7.00m bgl using arisings. 50mm internal diameter monitoring standpipe installed to 7.00m bgl and finished with a flush fitting cover.

Borehole Log

Borehole No. **BH101**

Sheet 3 of 3

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type CP
Location:	Uxbridge, UB8 1JS	Plant:	Cable Percussive Rig	Level (m AOD): Final Depth (m): 20.00	Scale: 1:50
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 30/08/2016 End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.00	SPT	50 (11,11/50 for 225mm)				End of Borehole at 20.00m

Remarks:

GPR EM and UXO Survey carried out prior to drilling and downhole magnetometry was undertaken at regular intervals up to 9.00m bgl during drilling. Inspection pit hand excavated to 1.20m bgl. Groundwater encountered at 20.00m bgl rising 14.00m bgl after 20 minutes. Hole terminated at 20.00mbgl due to unstable sidewall collapse at 18.50m bgl. Hole backfilled to 7.00m bgl using arisings. 50mm internal diameter monitoring standpipe installed to 7.00m bgl and finished with a flush fitting cover.

Trial Pit Log

Borehole No. **HP101**

Sheet 1 of 1

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type IP
Location:	Uxbridge, UB8 1JS	Plant:	Hand Excavated	Level (m AOD): Final Depth (m): 1.10	Scale: 1:10
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 01/09/2016 End Date: 01/09/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30 - 0.35	ES					Friable dark grey to brown sandy gravelly SILT. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick and clinker. Fragments of asbestos containing material. [MADE GROUND]
					0.60			Friable orange to brown sandy gravelly SILT. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint. Occasional rare plant rootlets. [LYNCH HILL GRAVEL MEMBER]
		1.00 - 1.10	ES		1.00			End of Borehole at 1.10m

Remarks:

Location cleared for services using a Cable Avoidance Tool. Pit hand excavated with tools to 1.10m bgl. No groundwater encountered. Hole backfilled with arinings.

Stability: Stable

Pit Dimensions *(m)*

Length:

Width:

Depth: 1.10

CONCEPT LIFE SCIENCES
DELIVERING SCIENCE

Borehole Log

Borehole No. **WS101**

Sheet 1 of 1

Project Name: 2-12 Harefield Road	Proj. ID: 1CO102125	Easting: / Northing:	Hole Type: WS
Location: Uxbridge, UB8 1JS	Plant: Dando Terrier	Level (m AOD): / Final Depth (m): 1.20	Scale: 1:30
Client: Canda Life Investments	Crew: Borehole Solutions Ltd	Start Date: 31/08/2016 / End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.25 - 0.30	ES		0.10			Asphalt [MADE GROUND]
					0.50			Friable light brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete. Cobbles are angular to subrounded flint, brick and concrete. [MADE GROUND]
		0.80 - 0.85	ES		0.65			Concrete [MADE GROUND]
		1.00	SPT	N=50 (4,4/50 for 270mm)				Loose friable brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium flint. [LYNCH HILL GRAVEL MEMBER]
		1.10 - 1.20	D		1.10			Very dense brown sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subrounded fine to medium flint. [LYNCH HILL GRAVEL MEMBER]
					1.20			End of Borehole at 1.20m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.20m bgl. No groundwater encountered. Hole terminated at 1.20m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. Hole backfilled with arisings and surface reinstated with asphalt.

Borehole Log

Borehole No. **WS102**

Sheet 1 of 1

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type WS
Location:	Uxbridge, UB8 1JS	Plant:	Dando Terrier	Level (m AOD): Final Depth (m): 1.30	Scale: 1:30
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 31/08/2016 End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20 - 0.30	ES		0.10			Asphalt [MADE GROUND] Friable light brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete with low cobble content. Cobbles are angular to subrounded flint and concrete. [MADE GROUND]
		0.90 - 1.00 1.00	ES SPT	N=40 (5,5/7,7,12,12,14)	0.80			Dense brown gravelly SAND. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint. [LYNCH HILL GRAVEL MEMBER]
		1.20 - 1.30	D		1.30			End of Borehole at 1.30m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.20m bgl. No groundwater encountered. Hole terminated at 1.30m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. 50mm internal diameter monitoring standpipe installed to 1.20m bgl and finished with a flush fitting cover.

Borehole Log

Borehole No. **WS103**

Sheet 1 of 1

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type WS
Location:	Uxbridge, UB8 1JS	Plant:	Dando Terrier	Level (m AOD): Final Depth (m): 1.00	Scale: 1:30
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 31/08/2016 End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10			Asphalt [MADE GROUND]
		0.35 - 0.40	ES		0.50			Friable light brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete. Cobbles are angualr to subrounded flint, concrete and brick. [MADE GROUND]
		0.70 - 0.75	ES					Very dense brown gravelly SAND. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint. [LYNCH HILL GRAVEL MEMBER]
		1.00	SPT	50 (11,11/50 for 130mm)	1.00			End of Borehole at 1.00m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.00m bgl. No groundwater encountered. Hole terminated at 1.00m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. Hole backfilled with arisings and surface reinstated with asphalt.

Borehole Log

Borehole No. **WS104**

Sheet 1 of 1

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type WS
Location:	Uxbridge, UB8 1JS	Plant:	Dando Terrier	Level (m AOD): Final Depth (m): 1.00	Scale: 1:30
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 31/08/2016 End Date: 31/08/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20 - 0.30	ES		0.10 0.20			Asphalt [MADE GROUND]
		0.40 - 0.45	ES					Friable light brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete. Cobbles are angular to subrounded flint, brick and concrete. [MADE GROUND]
		0.70 - 0.75	ES		0.60			Soft dark grey to brown sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, ash and clinker. Cobbles are angular to subrounded flint and concrete. [MADE GROUND]
		1.00	SPT	50 (14,14/50 for 140mm)	1.00			Very dense brown sandy GRAVEL. Sand fine to coarse. Gravel is angular to subrounded, fine to coarse flint. [LYNCH HILL GRAVEL MEMBER]
								End of Borehole at 1.00m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.0m bgl. No groundwater encountered. Hole terminated at 1.00m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. Hole backfilled with arisings and surface reinstated with asphalt.

Borehole Log

Borehole No. **WS105**

Sheet 1 of 1

Project Name: 2-12 Harefield Road	Proj. ID: 1CO102125	Easting: / Northing:	Hole Type: WS
Location: Uxbridge, UB8 1JS	Plant: Dando Terrier	Level (m AOD): / Final Depth (m): 1.20	Scale: 1:30
Client: Canda Life Investments	Crew: Borehole Solutions Ltd	Start Date: 01/09/2016 / End Date: 01/09/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.25 - 0.30	ES		0.10			Asphalt [MADE GROUND]
		0.50 - 0.60	ES		0.35			Friable light brown to gery sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete. Cobbles are angular to subrounded flint and concrete. Evidence of slight organic odour present. [MADE GROUND]
		0.80 - 1.00	B					Very dense brown sandy GRAVEL. Sand is fine to coarse grained. Gravel is angular to subrounded, fine to coarse flint. [LYNCH HILL GRAVEL MEMBER]
		1.00	SPT	50 (14,14/50 for 205mm)	1.20			End of Borehole at 1.20m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.20m bgl. No groundwater encountered. Hole terminated at 1.20m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. Hole backfilled with arisings and surface reinstated with asphalt.

Borehole Log

Borehole No. **WS106**

Sheet 1 of 1

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type WS
Location:	Uxbridge, UB8 1JS	Plant:	Dando Terrier	Level (m AOD): Final Depth (m): 1.20	Scale: 1:30
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 01/09/2016 End Date: 01/09/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30 - 0.40	ES		0.10			Asphalt [MADE GROUND]
		0.70 - 0.75	ES		0.30 0.40			Friable light brown to gery sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone and concrete. Cobbles are angular to subrounded flint, brick and concrete. Evidence of slight organic odour present. [MADE GROUND]
		1.00	SPT	50 (11,11/50 for 215mm)				Soft to firm dark grey to black to brown multi coloured clayey sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint with clinker. Cobbles are angular to subrounded flint and concrete [MADE GROUND]
		1.00 - 1.20	B		1.20			Very dense brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint. with low cobble content. Cobbles are angular to subrounded flint. [LYNCH HILL GRAVEL MEMBER]
								End of Borehole at 1.20m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.20m bgl. No groundwater encountered. Hole terminated at 1.20m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. 50mm internal diameter monitoring standpipe installed to 1.20m bgl and finished with a flush fitting cover.

Borehole Log

Borehole No. **WS107**

Sheet 1 of 1

Project Name:	2-12 Harefield Road	Proj. ID:	1CO102125	Easting: Northing:	Hole Type WS
Location:	Uxbridge, UB8 1JS	Plant:	Dando Terrier	Level (m AOD): Final Depth (m): 1.55	Scale: 1:30
Client:	Canda Life Investments	Crew:	Borehole Solutions Ltd	Start Date: 01/09/2016 End Date: 01/09/2016	REC Engineer: MN

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10			Concrete with reinforced steel rods [MADE GROUND]
		0.40 - 0.50	ES					Loose light grey to brown sandy GRAVEL with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick, roadstone, concrete and clinker. Cobbles are angualr to subrounded flint, brick and concrete. [MADE GROUND]
					0.70			Firm orange to brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse flint, brick with rare clinker. [MADE GROUND]
		0.90 - 1.00	ES					
		1.00		HVP=146	1.00			Firm brown sandy slightly gravelly CLAY. Sand is fine to coarse grained. Gravel is angular to subrounded, fine to coarse flints. [LYNCH HILL GRAVEL MEMBER]
		1.00	SPT	N=13 (2,2/2,2,2,7)				
		1.20		HVP=167				
		1.30		HVP=152				
		1.45 - 1.55	D		1.40			Very dense brown clayey sandy GRAVEL with low cobble content. Sand fine to coarse. Gravel is angular to subrounded, fine to coarse flint. Cobbles are angular to subrounded flint. [LYNCH HILL GRAVEL MEMBER]
		1.50	D					
		1.50	SPT	50 (24,25/50 for 220mm)	1.55			End of Borehole at 1.55m

Remarks:

GPR EM and UXO Survey carried out prior to drilling. Inspection pit hand excavated to 1.20m bgl. No groundwater encountered. Hole terminated at 1.55m bgl due to dense ground conditions. SPT refusal confirmed very dense ground. 50mm internal diameter monitoring standpipe installed to 1.50m bgl and finished with a flush fitting cover.

APPENDIX V

CHEMICAL ANALYSIS

SCIENTIFIC ANALYSIS LABORATORIES
DELIVERING SCIENCE

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Certificate of Analysis

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Report Number: 598629-2

Date of Report: 15-Sep-2016

Customer: Resource Environmental Consultants Ltd
Capital Business Centre
22 Carlton Road
South Croydon
CR2 0BS

Customer Contact: Mr Tim Conibear

Customer Job Reference: 1CO102125
Customer Purchase Order: 001666
Customer Site Reference: 2-12 Harefield Road
Date Job Received at SAL: 07-Sep-2016
Date Analysis Started: 09-Sep-2016
Date Analysis Completed: 15-Sep-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Chelsea Entwistle
Project Management

Issued by :
Chelsea Entwistle
Project Management

SAL Reference: 598629
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Soil Analysed as Soil
REC002S (SE)

				SAL Reference	**598629 002**	**598629 011**	**598629 018**	**598629 019**	**598629 020**
				Customer Sample Reference	**WS102 @ 0.20-0.30m**	**BH101 @ 1.20-1.70m**	**WS101 @ 0.25-0.35m**	**WS104 @ 0.20-0.30m**	**WS105 @ 0.25-0.30m**
				Date Sampled	**31-AUG-2016**	**30-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**	**01-SEP-2016**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T257	A40	2	mg/kg	**15**	**6**	**9**	**9**	**11**
Barium	T257	A40	2	mg/kg	**86**	**14**	**53**	**55**	**63**
Beryllium	T245	A40	0.5	mg/kg	**0.6**	<0.5	<0.5	<0.5	**0.7**
Boron (water-soluble)	T82	A40	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	T257	A40	0.1	mg/kg	**0.4**	<0.1	<0.1	**0.1**	<0.1
Chromium	T257	A40	0.5	mg/kg	**20**	**130**	**16**	**16**	**24**
Copper	T257	A40	2	mg/kg	**42**	**7**	**11**	**14**	**16**
Lead	T257	A40	2	mg/kg	**110**	**6**	**36**	**62**	**31**
Mercury	T245	A40	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	T257	A40	0.5	mg/kg	**20**	**77**	**14**	**13**	**16**
Selenium	T257	A40	3	mg/kg	<3	<3	<3	<3	<3
Vanadium	T257	A40	0.1	mg/kg	**30**	**18**	**29**	**27**	**36**
Zinc	T257	A40	2	mg/kg	**150**	**27**	**41**	**48**	**53**
Asbestos ID	T27	A40			Asbestos not detected	Asbestos not detected	Asbestos not detected	Asbestos not detected	Asbestos not detected
Chromium VI	T6	A40	1	mg/kg	<1	<1	**1**	<1	<1
pH	T7	A40			**10.0**	**8.6**	**11.1**	**11.5**	**11.1**
Soil Organic Matter	T287	A40	0.1	%	**1.9**	<0.1	**0.5**	**1.6**	**1.0**
(Water Soluble) SO4 expressed as SO4	T242	A40	0.01	g/l	**0.34**	**0.02**	**0.36**	**0.23**	**0.22**
SO4(Total)	T102	A40	0.02	%	**0.21**	<0.02	**0.59**	**0.39**	**0.22**
Cyanide(Total)	T921	AR	1	mg/kg	<1	<1	<1	<1	<1
Phenols(Mono)	T921	AR	1	mg/kg	<1	<1	<1	<1	<1

SAL Reference: 598629
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Soil Analysed as Soil
REC002S (SE)

				SAL Reference	**598629 021**	**598629 022**	**598629 023**
				Customer Sample Reference	**WS106 @ 0.30-0.40m**	**WS107 @ 0.40-0.50m**	**HP101 @ 0.30-0.35m**
				Date Sampled	**01-SEP-2016**	**01-SEP-2016**	**01-SEP-2016**
				Type	**Clay**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Arsenic	T257	A40	2	mg/kg	**11**	**25**	**27**
Barium	T257	A40	2	mg/kg	**87**	**460**	**540**
Beryllium	T245	A40	0.5	mg/kg	**0.8**	**1.5**	**2.1**
Boron (water-soluble)	T82	A40	1	mg/kg	<1	<1	<1
Cadmium	T257	A40	0.1	mg/kg	**0.2**	**0.6**	**1.1**
Chromium	T257	A40	0.5	mg/kg	**22**	**23**	**32**
Copper	T257	A40	2	mg/kg	**20**	**110**	**100**
Lead	T257	A40	2	mg/kg	**50**	**760**	**880**
Mercury	T245	A40	1.0	mg/kg	<1.0	<1.0	<1.0
Nickel	T257	A40	0.5	mg/kg	**16**	**23**	**47**
Selenium	T257	A40	3	mg/kg	<3	<3	<3
Vanadium	T257	A40	0.1	mg/kg	**35**	**46**	**79**
Zinc	T257	A40	2	mg/kg	**62**	**460**	**1200**
Asbestos ID	T27	A40			Asbestos not detected	Chrysotile Fibres Detected	Chrysotile Fibres Detected Chrysotile ACM Detected
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1
pH	T7	A40			**8.3**	**10.2**	**8.1**
Soil Organic Matter	T287	A40	0.1	%	**1.3**	**6.7**	**11**
(Water Soluble) SO4 expressed as SO4	T242	A40	0.01	g/l	**0.04**	**0.11**	**0.02**
SO4(Total)	T102	A40	0.02	%	**0.03**	**0.28**	**0.10**
Cyanide(Total)	T921	AR	1	mg/kg	<1	**2**	**1**
Phenols(Mono)	T921	AR	1	mg/kg	<1	<1	<1

SAL Reference: 598629
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**598629 003**	**598629 009**	**598629 012**	**598629 013**	**598629 014**
				Customer Sample Reference	**WS102 @ 1.20-1.30m**	**WS107 @ 1.45-1.55m**	**BH101 @ 5.00-5.50m**	**BH101 D4 @ 8.00m**	**BH101 D8 @ 12.00m**
				Date Sampled	**31-AUG-2016**	**01-SEP-2016**	**31-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**
				Type	**Clay**	**Clay**	**Sandy Soil**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
(Water Soluble) SO4 expressed as SO4	T242	A40	0.01	g/l	**0.07**	**0.07**	**0.01**	**0.38**	**0.09**
SO4(Total)	T102	A40	0.02	%	-	-	-	**0.11**	**0.06**
Sulphur (total)	T6	A40	0.01	%	-	-	-	**0.59**	**0.09**
pH	T7	A40			**7.2**	**7.0**	**8.1**	**7.6**	**8.5**

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Soil Analysed as Soil
Miscellaneous

SAL Reference	**598629 015**	**598629 016**
Customer Sample Reference	**BH101 D13 @ 16.50m**	**BH101 D16 @ 19.50m**
Date Sampled	**31-AUG-2016**	**31-AUG-2016**
Type	**Clay**	**Clay**

Determinand	Method	Test Sample	LOD	Units		
(Water Soluble) SO4 expressed as SO4	T242	A40	0.01	g/l	**0.08**	**0.07**
SO4(Total)	T102	A40	0.02	%	**0.03**	**0.02**
Sulphur (total)	T6	A40	0.01	%	**0.07**	**0.04**
pH	T7	A40			**8.6**	**8.7**

SAL Reference: 598629
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Soil Analysed as Soil
MCERTS Preparation

SAL Reference					**598629 002**	**598629 003**	**598629 009**	**598629 011**	**598629 012**
Customer Sample Reference					**WS102 @ 0.20-0.30m**	**WS102 @ 1.20-1.30m**	**WS107 @ 1.45-1.55m**	**BH101 @ 1.20-1.70m**	**BH101 @ 5.00-5.50m**
Date Sampled					**31-AUG-2016**	**31-AUG-2016**	**01-SEP-2016**	**30-AUG-2016**	**31-AUG-2016**
Type					**Sandy Soil**	**Clay**	**Clay**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**5.1**	**5.4**	**15**	**7.1**	**3.3**
Retained on 2mm	T2	A40	0.1	%	**64.4**	**44.2**	**18.9**	**71.2**	**83.3**

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Soil Analysed as Soil
MCERTS Preparation

SAL Reference					**598629 013**	**598629 014**	**598629 015**	**598629 016**	**598629 018**
Customer Sample Reference					**BH101 D4 @ 8.00m**	**BH101 D8 @ 12.00m**	**BH101 D13 @ 16.50m**	**BH101 D16 @ 19.50m**	**WS101 @ 0.25-0.35m**
Date Sampled					**31-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**
Type					**Clay**	**Clay**	**Clay**	**Clay**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**20**	**11**	**19**	**23**	**8.9**
Retained on 2mm	T2	A40	0.1	%	**27.7**	**1.7**	**3.2**	**2.2**	**51.8**

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Soil Analysed as Soil
MCERTS Preparation

SAL Reference					**598629 019**	**598629 020**	**598629 021**	**598629 022**	**598629 023**
Customer Sample Reference					**WS104 @ 0.20-0.30m**	**WS105 @ 0.25-0.30m**	**WS106 @ 0.30-0.40m**	**WS107 @ 0.40-0.50m**	**HP101 @ 0.30-0.35m**
Date Sampled					**31-AUG-2016**	**01-SEP-2016**	**01-SEP-2016**	**01-SEP-2016**	**01-SEP-2016**
Type					**Sandy Soil**	**Sandy Soil**	**Clay**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Moisture @105C	T162	AR	0.1	%	**8.9**	**9.3**	**8.8**	**22**	**5.5**
Retained on 2mm	T2	A40	0.1	%	**37.5**	**24.8**	**43.4**	**43.4**	**33.7**

SAL Reference: 598629
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Soil Analysed as Soil
Total and Speciated USEPA16 PAH (SE) (MCERTS)

				SAL Reference	**598629 002**	**598629 011**	**598629 018**	**598629 019**	**598629 020**
				Customer Sample Reference	**WS102 @ 0.20-0.30m**	**BH101 @ 1.20-1.70m**	**WS101 @ 0.25-0.35m**	**WS104 @ 0.20-0.30m**	**WS105 @ 0.25-0.30m**
				Date Sampled	**31-AUG-2016**	**30-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**	**01-SEP-2016**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T16	AR	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
Fluorene	T16	AR	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
Phenanthrene	T16	AR	0.1	mg/kg	**0.2**	<0.1	<0.1	<0.1	<0.1
Anthracene	T16	AR	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	<0.1
Fluoranthene	T16	AR	0.1	mg/kg	**0.4**	**0.1**	<0.1	**0.1**	<0.1
Pyrene	T16	AR	0.1	mg/kg	**0.4**	<0.1	<0.1	**0.1**	<0.1
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	**0.2**	<0.1	<0.1	**0.1**	<0.1
Chrysene	T16	AR	0.1	mg/kg	**0.2**	**0.1**	<0.1	**0.1**	<0.1
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	**0.1**	**0.1**	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	**0.1**	**0.1**	<0.1	<0.1	<0.1
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	**0.1**	**0.1**	<0.1	<0.1	<0.1
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
PAH(total)	T16	AR	0.1	mg/kg	**2.2**	**0.6**	<0.1	**0.5**	<0.1

SAL Reference: 598629
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Soil Analysed as Soil
Total and Speciated USEPA16 PAH (SE) (MCERTS)

				SAL Reference	**598629 021**	**598629 022**	**598629 023**
				Customer Sample Reference	**WS106 @ 0.30-0.40m**	**WS107 @ 0.40-0.50m**	**HP101 @ 0.30-0.35m**
				Date Sampled	**01-SEP-2016**	**01-SEP-2016**	**01-SEP-2016**
				Type	**Clay**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Naphthalene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.3**
Acenaphthylene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.3**
Acenaphthene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.2**
Fluorene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.2**
Phenanthrene	T16	AR	0.1	mg/kg	<0.1	**0.2**	**3.8**
Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.8**
Fluoranthene	T16	AR	0.1	mg/kg	<0.1	**0.6**	**9.0**
Pyrene	T16	AR	0.1	mg/kg	<0.1	**0.5**	**6.9**
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	<0.1	**0.4**	**5.6**
Chrysene	T16	AR	0.1	mg/kg	<0.1	**0.5**	**6.1**
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	<0.1	**0.3**	**3.2**
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	<0.1	**0.2**	**2.5**
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	<0.1	**0.2**	**2.3**
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	<0.1	<0.1	**1.4**
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.4**
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	<0.1	<0.1	**1.5**
PAH(total)	T16	AR	0.1	mg/kg	<0.1	**3.0**	**44**

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Customer Reference: 1CO102125

Soil Analysed as Soil
Suite C

				SAL Reference	**598629 002**	**598629 011**	**598629 018**	**598629 019**	**598629 020**
				Customer Sample Reference	**WS102 @ 0.20-0.30m**	**BH101 @ 1.20-1.70m**	**WS101 @ 0.25-0.35m**	**WS104 @ 0.20-0.30m**	**WS105 @ 0.25-0.30m**
				Date Sampled	**31-AUG-2016**	**30-AUG-2016**	**31-AUG-2016**	**31-AUG-2016**	**01-SEP-2016**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
TPH (C5-C6)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C6-C8)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C8-C10)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C10-C12)	T219	AR	2	mg/kg	<2	<2	<2	<2	<2
TPH (C12-C16)	T219	AR	2	mg/kg	<2	<2	<2	<2	<2
TPH (C16-C21)	T219	AR	2	mg/kg	<2	<2	<2	<2	<2
TPH (C21-C35)	T219	AR	2	mg/kg	**26**	**4**	<2	<2	<2

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Soil Analysed as Soil
Suite C

				SAL Reference	**598629 021**	**598629 022**	**598629 023**
				Customer Sample Reference	**WS106 @ 0.30-0.40m**	**WS107 @ 0.40-0.50m**	**HP101 @ 0.30-0.35m**
				Date Sampled	**01-SEP-2016**	**01-SEP-2016**	**01-SEP-2016**
				Type	**Clay**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
TPH (C5-C6)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10
TPH (C6-C8)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10
TPH (C8-C10)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10
TPH (C10-C12)	T219	AR	2	mg/kg	<2	<2	<2
TPH (C12-C16)	T219	AR	2	mg/kg	<2	<2	<2
TPH (C16-C21)	T219	AR	2	mg/kg	<2	<2	**24**
TPH (C21-C35)	T219	AR	2	mg/kg	<2	<2	**230**

Index to symbols used in 598629-2

Value	Description
AR	As Received
A40	Assisted dried < 40C
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos subcontracted to REC Limited
Retained on 2mm is removed before analysis
Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis except TPH Banded

Method Index

Value	Description
T27	PLM
T219	GC/FID (SE)
T287	Calc TOC/0.58
T921	Colorimetry (CF) (MCERT)
T7	Probe
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T82	ICP/OES (Sim)

T245	ICP/OES (Aqua Regia Extraction)
T16	GC/MS
T2	Grav
T54	GC/MS (Headspace)
T6	ICP/OES
T102	ICP/OES (HCl extract)
T162	Grav (1 Dec) (105 C)
T257	ICP/OES (SIM) (Aqua Regia Extraction)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Sulphur (total)	T6	A40	0.01	%	M	013-016
Moisture @105C	T162	AR	0.1	%	N	002-003,009,011-016,018-023
Retained on 2mm	T2	A40	0.1	%	N	002-003,009,011-016,018-023
Arsenic	T257	A40	2	mg/kg	M	002,011,018-023
Barium	T257	A40	2	mg/kg	U	002,011,018-023
Beryllium	T245	A40	0.5	mg/kg	U	002,011,018-023
Boron (water-soluble)	T82	A40	1	mg/kg	N	002,011,018-023
Cadmium	T257	A40	0.1	mg/kg	M	002,011,018-023
Chromium	T257	A40	0.5	mg/kg	M	002,011,018-023
Copper	T257	A40	2	mg/kg	M	002,011,018-023
Lead	T257	A40	2	mg/kg	M	002,011,018-023
Mercury	T245	A40	1.0	mg/kg	U	002,011,018-023
Nickel	T257	A40	0.5	mg/kg	M	002,011,018-023
Selenium	T257	A40	3	mg/kg	U	002,011,018-023
Vanadium	T257	A40	0.1	mg/kg	U	002,011,018-023
Zinc	T257	A40	2	mg/kg	M	002,011,018-023
Asbestos ID	T27	A40			SU	002,011,018-023
Chromium VI	T6	A40	1	mg/kg	N	002,011,018-023
pH	T7	A40			M	002-003,009,011-016,018-023
Soil Organic Matter	T287	A40	0.1	%	N	002,011,018-023
(Water Soluble) SO4 expressed as SO4	T242	A40	0.01	g/l	M	002-003,009,011-016,018-023
SO4(Total)	T102	A40	0.02	%	M	002,011,013-016,018-023
Cyanide(Total)	T921	AR	1	mg/kg	M	002,011,018-023
Phenols(Mono)	T921	AR	1	mg/kg	M	002,011,018-023
TPH (C5-C6)	T54	AR	0.10	mg/kg	N	002,011,018-023
TPH (C6-C8)	T54	AR	0.10	mg/kg	N	002,011,018-023
TPH (C8-C10)	T54	AR	0.10	mg/kg	N	002,011,018-023
TPH (C10-C12)	T219	AR	2	mg/kg	U	002,011,018-023
TPH (C12-C16)	T219	AR	2	mg/kg	U	002,011,018-023
TPH (C16-C21)	T219	AR	2	mg/kg	U	002,011,018-023
TPH (C21-C35)	T219	AR	2	mg/kg	U	002,011,018-023
Naphthalene	T16	AR	0.1	mg/kg	U	002,011,018-023
Acenaphthylene	T16	AR	0.1	mg/kg	U	002,011,018-023
Acenaphthene	T16	AR	0.1	mg/kg	M	002,011,018-023
Fluorene	T16	AR	0.1	mg/kg	M	002,011,018-023
Phenanthrene	T16	AR	0.1	mg/kg	U	002,011,018-023
Anthracene	T16	AR	0.1	mg/kg	M	002,011,018-023
Fluoranthene	T16	AR	0.1	mg/kg	N	002,011,018-023
Pyrene	T16	AR	0.1	mg/kg	N	002,011,018-023
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	M	002,011,018-023
Chrysene	T16	AR	0.1	mg/kg	M	002,011,018-023
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	U	002,011,018-023
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	N	002,011,018-023
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	M	002,011,018-023
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	M	002,011,018-023
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	M	002,011,018-023
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	M	002,011,018-023
PAH(total)	T16	AR	0.1	mg/kg	U	002,011,018-023

SCIENTIFIC ANALYSIS LABORATORIES
DELIVERING SCIENCE

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

3 Crittall Drive
Springwood Industrial Estate
Braintree
Essex
CM7 2RT
Tel : 01376 560120
Fax : 01376 552923

Report Number: 599145-1

Date of Report: 15-Sep-2016

Customer: Resource Environmental Consultants Ltd
Capital Business Centre
Unit 19a Carlton Road
South Croydon
CR2 0BS

Customer Contact: Mr Tim Conibear

Customer Job Reference: 1CO102125
Customer Purchase Order: 1686
Customer Site Reference: 2-12 Harefield Road
Date Job Received at SAL: 08-Sep-2016
Date Analysis Started: 12-Sep-2016
Date Analysis Completed: 15-Sep-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

Report checked and authorised by :
Chelsea Entwistle
Project Management

Issued by :
Chelsea Entwistle
Project Management

SAL Reference: 599145
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Water Analysed as Water
REC 002W

SAL Reference	**599145 001**
Customer Sample Reference	**BH101**
Date Sampled	**06-SEP-2016**

Determinand	Method	Test Sample	LOD	Units	
As (Dissolved)	T281	F	0.0002	mg/l	**0.0015**
Ba (Dissolved)	T281	F	0.001	mg/l	**0.092**
Be (Dissolved)	T281	F	0.00005	mg/l	<0.00005
B (Dissolved)	T281	F	0.05	mg/l	**0.13**
Cd (Dissolved)	T281	F	0.00002	mg/l	**0.00014**
Cr (Dissolved)	T281	F	0.001	mg/l	**0.003**
Cu (Dissolved)	T281	F	0.0005	mg/l	**0.0028**
Pb (Dissolved)	T281	F	0.0003	mg/l	<0.0003
Hg (Dissolved)	T281	F	0.00005	mg/l	<0.00005
Ni (Dissolved)	T281	F	0.001	mg/l	**0.013**
Se (Dissolved)	T281	F	0.0005	mg/l	**0.0017**
V (Dissolved)	T281	F	0.002	mg/l	**0.003**
Zn (Dissolved)	T281	F	0.002	mg/l	**0.007**
Total Hardness expressed as CaCO3	T649	F	10	mg/l	**240**
Chromium VI	T686	F	0.003	mg/l	<0.003
Cyanide(Total)	T546	F	0.01	mg/l	<0.01
Sulphate	T686	F	0.5	mg/l	**35**
pH	T7	F			**8.2**
Phenols(Mono)	T546	F	0.02	mg/l	<0.02

SAL Reference: 599145
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Water Analysed as Water
Total and Speciated USEPA16 PAH (SE)

SAL Reference	**599145 001**
Customer Sample Reference	**BH101**
Date Sampled	**06-SEP-2016**

Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T149	AR	0.01	µg/l	(13) <0.01
Acenaphthylene	T149	AR	0.01	µg/l	**0.05**
Acenaphthene	T149	AR	0.01	µg/l	<0.01
Fluorene	T149	AR	0.01	µg/l	<0.01
Phenanthrene	T149	AR	0.01	µg/l	<0.01
Anthracene	T149	AR	0.01	µg/l	<0.01
Fluoranthene	T149	AR	0.01	µg/l	**0.03**
Pyrene	T149	AR	0.01	µg/l	**0.32**
Benzo(a)Anthracene	T149	AR	0.01	µg/l	<0.01
Chrysene	T149	AR	0.01	µg/l	<0.01
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	<0.01
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	<0.01
Benzo(a)Pyrene	T149	AR	0.01	µg/l	<0.01
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	<0.01
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	<0.01
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	<0.01
PAH(total)	T149	AR	0.01	µg/l	**0.40**

SAL Reference: 599145
Project Site: 2-12 Harefield Road
Customer Reference: 1CO102125

Water Analysed as Water
Suite C

SAL Reference	**599145 001**
Customer Sample Reference	**BH101**
Date Sampled	**06-SEP-2016**

Determinand	Method	Test Sample	LOD	Units	
TPH (C5-C6)	T215	AR	0.010	mg/l	<0.010
TPH (C6-C8)	T215	AR	0.010	mg/l	<0.010
TPH (C8-C10)	T215	AR	0.010	mg/l	<0.010
TPH (C10-C12)	T219	AR	0.02	mg/l	<0.02
TPH (C12-C16)	T219	AR	0.02	mg/l	**0.08**
TPH (C16-C21)	T219	AR	0.02	mg/l	**0.13**
TPH (C21-C35)	T219	AR	0.02	mg/l	**0.15**

Index to symbols used in 599145-1

Value	Description
F	Filtered
AR	As Received
13	Results have been blank corrected.
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

TPH Banded: These samples have been analysed exceeding recommended holding times. It is possible therefore that the results provided may be compromised.

Method Index

Value	Description
T215	GC/MS (Headspace)(LV)
T281	ICP/MS (Filtered)
T7	Probe
T149	GC/MS (SIR)
T219	GC/FID (SE)
T649	ICP/OES (Calc)
T546	Colorimetry (CF)
T686	Discrete Analyser

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
As (Dissolved)	T281	F	0.0002	mg/l	U	001
Ba (Dissolved)	T281	F	0.001	mg/l	U	001
Be (Dissolved)	T281	F	0.00005	mg/l	U	001
B (Dissolved)	T281	F	0.05	mg/l	U	001
Cd (Dissolved)	T281	F	0.00002	mg/l	U	001
Cr (Dissolved)	T281	F	0.001	mg/l	U	001
Cu (Dissolved)	T281	F	0.0005	mg/l	U	001
Pb (Dissolved)	T281	F	0.0003	mg/l	U	001
Hg (Dissolved)	T281	F	0.00005	mg/l	U	001
Ni (Dissolved)	T281	F	0.001	mg/l	U	001
Se (Dissolved)	T281	F	0.0005	mg/l	U	001
V (Dissolved)	T281	F	0.002	mg/l	U	001
Zn (Dissolved)	T281	F	0.002	mg/l	U	001
Total Hardness expressed as CaCO3	T649	F	10	mg/l	U	001
Chromium VI	T686	F	0.003	mg/l	U	001
Cyanide(Total)	T546	F	0.01	mg/l	U	001
Sulphate	T686	F	0.5	mg/l	U	001
pH	T7	F			U	001
Phenols(Mono)	T546	F	0.02	mg/l	U	001

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
TPH (C5-C6)	T215	AR	0.010	mg/l	N	001
TPH (C6-C8)	T215	AR	0.010	mg/l	N	001
TPH (C8-C10)	T215	AR	0.010	mg/l	N	001
TPH (C10-C12)	T219	AR	0.02	mg/l	U	001
TPH (C12-C16)	T219	AR	0.02	mg/l	U	001
TPH (C16-C21)	T219	AR	0.02	mg/l	U	001
TPH (C21-C35)	T219	AR	0.02	mg/l	U	001
Naphthalene	T149	AR	0.01	µg/l	U	001
Acenaphthylene	T149	AR	0.01	µg/l	U	001
Acenaphthene	T149	AR	0.01	µg/l	U	001
Fluorene	T149	AR	0.01	µg/l	U	001
Phenanthrene	T149	AR	0.01	µg/l	U	001
Anthracene	T149	AR	0.01	µg/l	U	001
Fluoranthene	T149	AR	0.01	µg/l	U	001
Pyrene	T149	AR	0.01	µg/l	U	001
Benzo(a)Anthracene	T149	AR	0.01	µg/l	U	001
Chrysene	T149	AR	0.01	µg/l	U	001
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	N	001
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	U	001
Benzo(a)Pyrene	T149	AR	0.01	µg/l	U	001
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	U	001
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	U	001
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	U	001
PAH(total)	T149	AR	0.01	µg/l	N	001

APPENDIX VI

GEOTECHNICAL ANALYSIS

LABORATORY REPORT

4043

Contract Number: PSL16/4217

Report Date: 23 September 2016

Client's Reference: 1CO102125

Client Name: REC
Osprey House
Pacific Quay
Broadway
Manchester
M50 2UE

For the attention of: Michael Nworah

Contract Title: 2-12 Harefield Road, Uxbridge

Date Received: 13/9/2016
Date Commenced: 13/9/2016
Date Completed: 23/9/2016

Notes: Opinions and Interpretations are outside the UKAS Accreditation

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

Checked and Approved Signatories:

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

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

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
BH101	3	B	2.00	2.50	Brown very sandy slightly silty GRAVEL
BH101	4	B	3.00	3.50	Brown very sandy slightly silty GRAVEL
BH101	1	U	9.50	9.75	Very stiff brown sandy CLAY.
BH101	2	U	14.00	14.45	Hard brown mottled grey very sandy CLAY.
BH101	3	U	17.00	17.45	Hard brown mottled grey very sandy CLAY.

UKAS TESTING 4043

PSL Professional Soils Laboratory

Checked / Approved		Date	23/09/16	Contract No:
2-12 Harefield Road, Uxbridge				PSL16/4217
				Client Ref:
				1CO102125

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
BH101	1	U	9.50	9.75	21							
BH101	2	U	14.00	14.45	12							
BH101	3	U	17.00	17.45	11							

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

UKAS TESTING 4043

PSL Professional Soils Laboratory

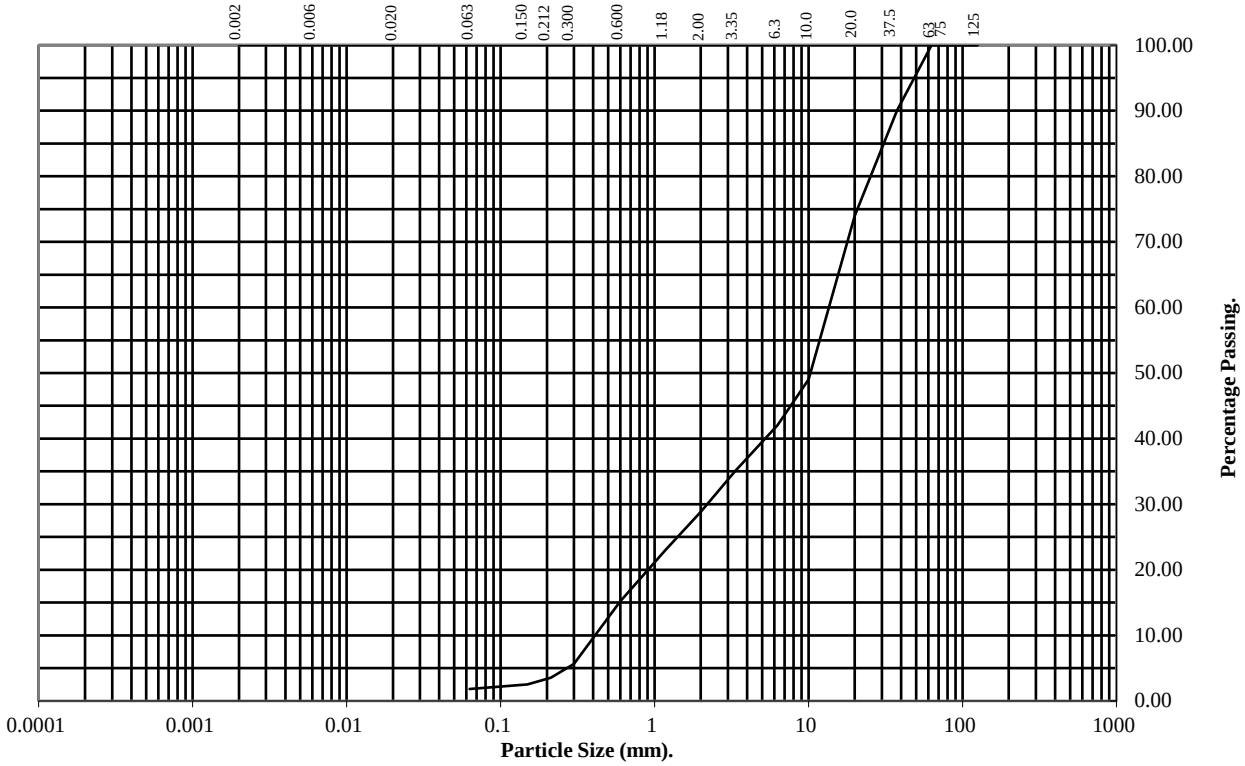
Checked / Approved		Date	23/09/16	Contract No:
2-12 Harefield Road, Uxbridge				PSL16/4217
				Client Ref:
				ICO102125

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number:	**BH101**	**Top Depth (m):**	**2.00**
Sample Number:	**3**	**Base Depth(m):**	**2.50**
Sample Type:	**B**		



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	90
20	74
10	49
6.3	42
3.35	35
2	29
1.18	23
0.6	15
0.3	6
0.212	4
0.15	3
0.063	2

Soil Fraction	Total Percentage
Cobbles	0
Gravel	71
Sand	27
Silt/Clay	2

Remarks:

See summary of soil descriptions.

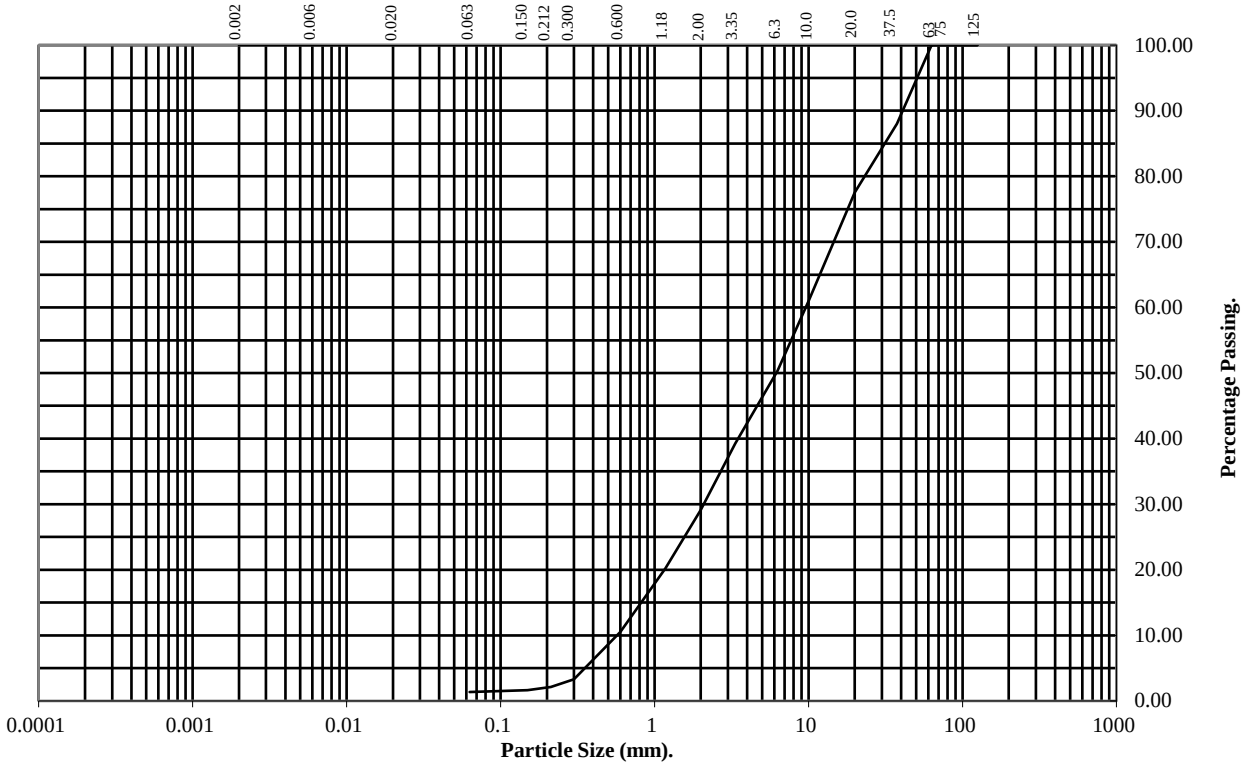
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date** 23/09/16	**Contract No:** PSL16/4217
		2-12 Harefield Road, Uxbridge			**Client Ref:**

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number:	**BH101**	**Top Depth (m):**	**3.00**
Sample Number:	**4**	**Base Depth(m):**	**3.50**
Sample Type:	**B**		



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	88
20	78
10	61
6.3	50
3.35	39
2	29
1.18	20
0.6	11
0.3	3
0.212	2
0.15	2
0.063	1

Soil Fraction	Total Percentage
Cobbles	0
Gravel	71
Sand	28
Silt/Clay	1

Remarks:

See summary of soil descriptions.

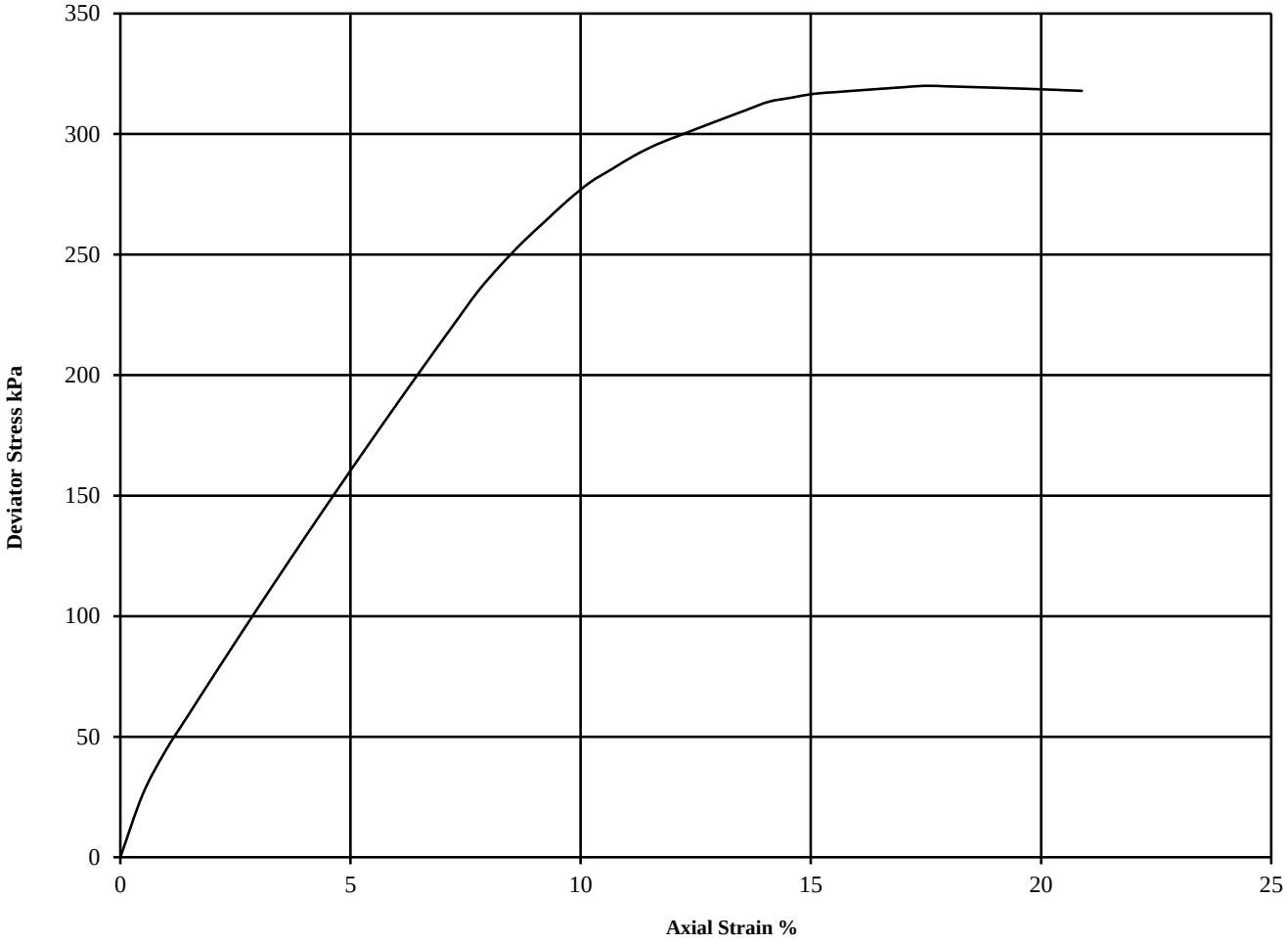
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date** 23/09/16	**Contract No:** PSL16/4217
		2-12 Harefield Road, Uxbridge			**Client Ref:**

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**BH101**	**Top Depth (m):**	**9.50**
Sample Number:	**1**	**Base Depth (m):**	**9.75**
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.34
1	21	1.96	1.62	190	320	160	17.5	Plastic	See summary of soil descriptions.

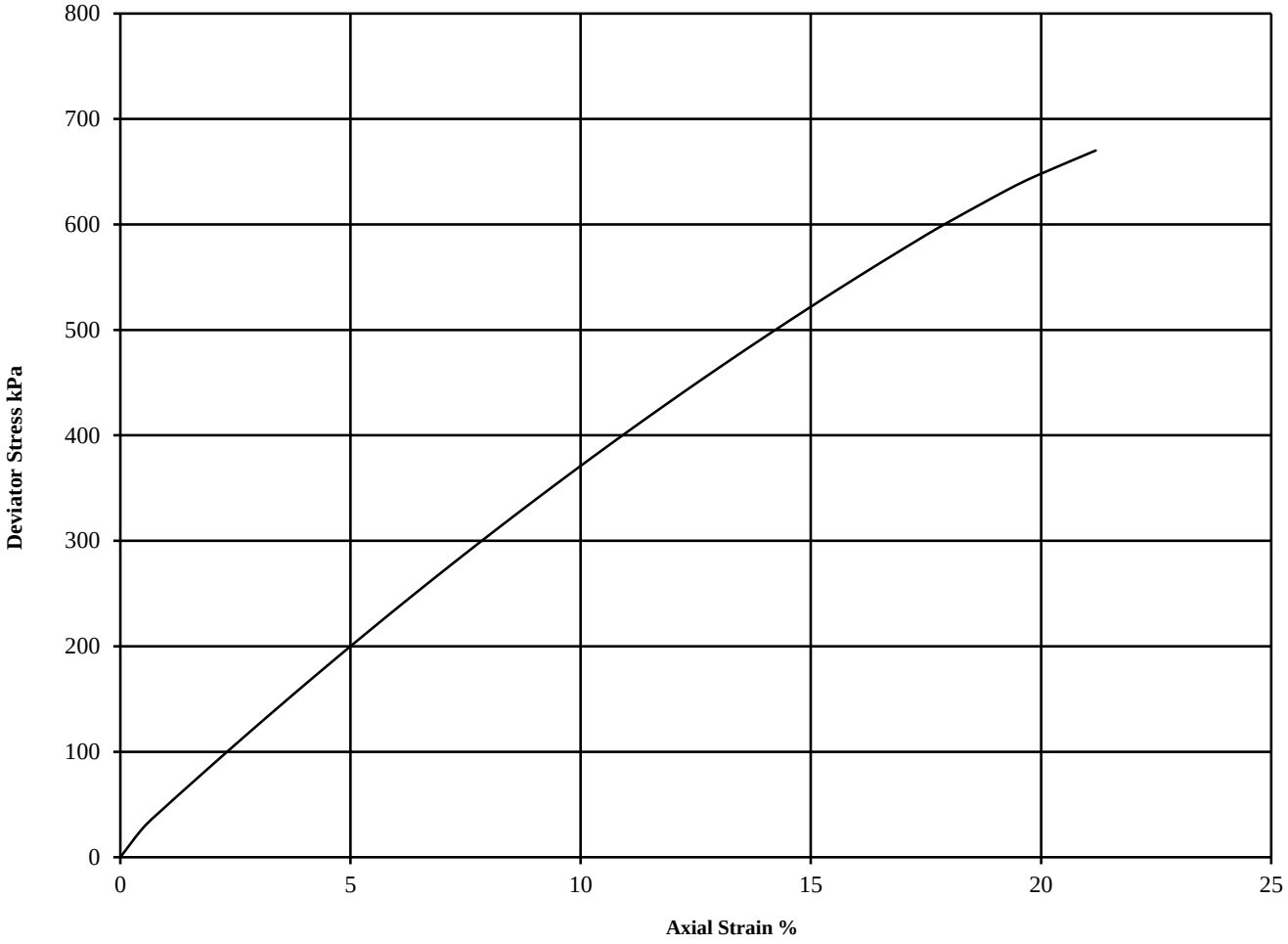
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	BHH	**Date** 23/09/16	**Contract No:** PSL16/4217
		2-12 Harefield Road, Uxbridge			**Client Ref:** 1CO102125

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**BH101**	**Top Depth (m):**	**14.00**
Sample Number:	**2**	**Base Depth (m):**	**14.45**
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		207.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.33
1	12	2.23	1.98	280	670	335	21.2	Plastic	See summary of soil descriptions.

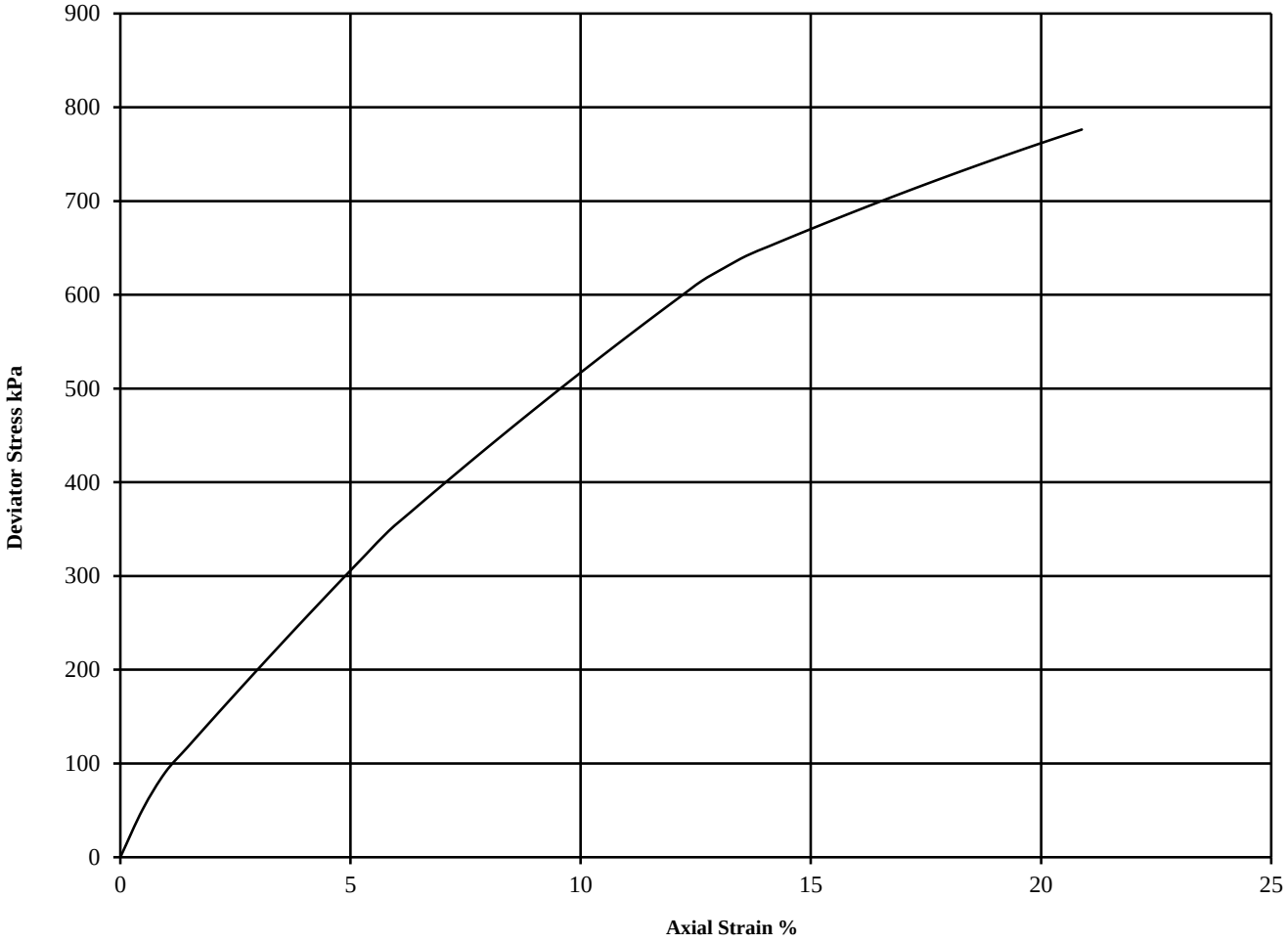
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date**	**23/09/16**	**Contract No:**
		2-12 Harefield Road, Uxbridge			**PSL16/4217**
					Client Ref:
					1CO102125

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**BH101**	**Top Depth (m):**	**17.00**
Sample Number:	**3**	**Base Depth (m):**	**17.45**
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.33
1	11	2.22	2.00	340	776	388	20.9	Plastic	See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	BHH	**Date** 23/09/16	**Contract No:** PSL16/4217
		2-12 Harefield Road, Uxbridge			**Client Ref:** 1CO102125

APPENDIX VII

PHOTOGRAPHS



Plate 1: Overview of the northern part of the site facing south.



Plate 2: Overview of the northern part of the site facing east.



PLATE 3: Overview of the eastern end of the site facing north.



PLATE 4: Goods vehicle access on the southern tip.



PLATE 5: Cable Percussive Borehole location with flush cover over monitoring installation.



PLATE 6: Window Sample location backfilled and reinstated with asphalt.

APPENDIX VIII

HISTORIC MAPS