REPORT ON GROUND INVESTIGATION AT UPPER PARLIAMENT STREET, LIVERPOOL

Report No: AG2183-15-V29
Date: April 2015
Status: Validated Issue 1

Prepared on behalf of Liverpool Mutual Homes and The Flanagan Group

REPORT STATUS SHEET

Client:	Liverpool Mutual Homes and The Flanagan Group
Report Title:	Report on Ground Investigation at Upper Parliament Street, Liverpool
Report Number:	AG2183-15-V29
Report Status:	Validated Issue 1
Date:	April 2015

		Date	Signed for and on behalf of Applied Geology Limited
Report Author	M Walker BSc (Hons) MSc Project Engineer	30/04/2015	
Checked	N Laws BSc (Hons) CGeol FGS Senior Engineer	30/04/2015	
Authorised	S Day BSc (Hons) MSc CGeol FGS SiLC Director	30/04/2015	

CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Objectives and Scope of Investigation

An area of land off Upper Parliament Street, Liverpool (the site) is being considered for development by Liverpool Mutual Homes and The Flanagan Group (the Clients). The proposals for the site comprise the construction of eight houses and two 3-storey apartment blocks with associated infrastructure, gardens and landscaped areas.

A Phase I Geoenvironmental Risk Assessment was previously undertaken for the site on behalf of the Client, by Applied Geology, report reference AG2183-15-U91 dated February 2015. Reference should be made to this report for details of historic site usage and environmental searches relevant to the site.

Applied Geology was subsequently appointed by the Clients to undertake a Phase II ground investigation in order to:

- Establish geological ground conditions and geotechnical parameters to assist in the safe and economic design of the proposed development.
- Support a planning application.

The terms of reference/brief for the works were mutually developed between PDW consultants (the Engineer) and Applied Geology and are outlined in our proposal reference AG15-4637let001 and estimate reference AG15-4637-01 dated 15th January 2015.

The scope of works undertaken by Applied Geology comprised:

- Ground investigation together with sampling, monitoring and a programme of laboratory testing.
- Assessment and reporting of the results of the works.

Underground service plans for the site were obtained by Applied Geology on the 2nd February 2015. A topographic survey drawing reference: 15A035/002, dated February 2015 was provided by the Engineer.

1.2 Report Layout

This report presents a brief description of the site and the previous desk study and the factual results of the intrusive investigations carried out. An interpretation of the ground conditions and a discussion/assessment of the findings is presented in the later report text sections. The main text of the report has been produced in a concise format, including the use of data tables to summarise key information where possible. The report should be read in conjunction with the general procedures detailed in Appendix E and General Notes given at the end of the main text, which provide details of investigation techniques, assessment methodology and standards, health & safety and limitations and exceptions of the report. Drawings and factual data including exploratory hole records and laboratory testing results are presented in the other Appendices.

2.0 SITE DESCRIPTION AND PROPOSALS

2.1 Site Description

The site is located in the southeast of Liverpool in the area of Granby. Upper Parliament Street forms the northern site boundary and Mulgrave Street the western site boundary. The Ordnance Survey grid reference for the centre of the site is SJ 363 893 as shown on the Site Location Plan in Appendix A. The site is irregular in shape and covers an area of approximately 0.8ha.

A site walkover survey was carried out by Applied Geology on 3rd February 2015. The site comprised a grassed landscaped area with paths leading from Upper Parliament Street to houses to the south. The site was elevated in the centre, with a raised hummocky ridge running along its length, parallel to Upper Parliament Street. Mature trees were present across the site. A metal fence formed the northern site boundary, with Upper Parliament Street beyond, and cut through the western part of the site. The remaining triangle of landscaped area beyond had no formal site boundaries. The eastern boundary comprised a palisade fence with a school beyond and the southern boundary comprised brick walls with gardens beyond.

2.2 Site Proposals

The proposals for the site comprise the construction of eight houses and two apartment blocks with associated infrastructure, gardens and landscaped areas, as shown on the Proposed Site Plan – Ground Floor (Drawing No. 01-02-A-001 dated July 2014) by Falconer Chester Hall, a copy of which is presented in Appendix A.

3.0 SUMMARY OF DESK STUDY INFORMATION

3.1 Site History

The site was part of open land until between 1851 and 1890 when houses and streets were constructed across the site. All of the houses were demolished at the end of the 1960's. During the 1970's the streets were removed and new houses were developed in the south and southeast of the site and then demolished between 1989 and 1993. The site has been undeveloped since. The surrounding area has been predominantly developed with residential properties, with a current hospital to the north, a works to the northeast and a former depot and a works to the east.

3.2 Anticipated Geology

Reference to the published 1:50,000 scale British Geological Survey (BGS) map, Sheet '96' [solid and drift edition] and the GroundSure Report indicates the site to be underlain by Glacial Till, comprising a sandy gravelly cobbly clay. Beneath this is the Wilmslow Sandstone Formation, comprising red brown/brick red fine to medium grained sandstone with sporadic siltstones. There are two faults in the vicinity of the site, one 130m west of the site, with the Helsby Sandstone Formation subcropping to the west of the fault and the other 166m east of the site, with the Chester Pebble Beds Formation subcropping to the east of the fault.

Made Ground is anticipated across the site associated with the various phases of residential development. The ridge running along the length of the site is likely to

comprise Made Ground. The former houses on site may have had cellars, which could remain in-situ (either as voids or be backfilled) or represent deep areas of Made Ground.

3.3 Hydrology and Hydrogeology

According to the GroundSure Report there are no surface watercourses within 500m of the site. The River Mersey is 2km southwest of the site at its closest. There are no recorded surface water abstractions within 2km of the site and no discharge consents within 500m of the site. According to the Environment Agency web site the Glacial Till is classified as Unproductive Strata and the Wilmslow Sandstone Formation as a Principal Aquifer.

3.4 Other Environmental Data

There are no recorded historical or currently operational landfill sites, waste treatment sites or fuel sites within 250m of the site. There are no recorded pollution incidents within 250m of the site. There are a number of significant industrial land uses within 250m of the site, comprising a seven of electricity substations, one being located on the site. An unknown type of works is located 235m to the northeast, and two chimneys are located 235m and 237m to the north.

3.5 Conceptual Site Model

The Conceptual Site Model outlined in the Phase I investigation is summarised in the table below.

Source	Pathway	Receptor	Risk*
Potential contaminants within Made Ground (on and off site)	Inhalation, ingestion, dermal contact	End users	Low
		Construction workers	Low**
	Migration through permeable strata/groundwater flows	Principal Aquifer (Wilmslow Sandstone Formation)	Low
Potential PCB's from electricity substation (on site)	Inhalation, ingestion, dermal contact	End users	Low
		Construction workers	Low**
	Migration through permeable strata/groundwater flows	Principal Aquifer (Wilmslow Sandstone Formation)	Low
Potential elevated sulphates in soils (on site)	Direct contact	Buried concrete	Low
Potential hydrocarbons from former depot (off site)	Migration through permeable strata/groundwater flows	End users	Low
		Construction workers	Low**
		Principal Aquifer (Wilmslow Sandstone Formation)	Low
		Buried concrete and water pipes	Low
Ground gas from Made Ground (methane, carbon dioxide) and hydrocarbon vapours – on site and off site	Migration/inhalation	End users	Low
		Construction workers	Low**

*** Definition of Risk Categories**
Low Risk: Contaminants may be present but are unlikely to be at levels to have unacceptable impact on key receptors, or pathways are likely to be minimal.
**Assumes good hygiene practices and use of appropriate PPE.

4.0 GROUND INVESTIGATION WORKS

4.1 Fieldwork

The following scope of fieldwork was undertaken on the 16th and 17th February 2015:

- 7 No Driven Continuous Sampling boreholes (ref DCS1 to DCS7) to depths of between 1.45m and 6.45m below ground level (bgl);
- 1 No Hand Excavated Trial Pit (ref HEP1) to a depth of 1.2m bgl.

The borehole and trial pit records are included in Appendix B with the in situ test results included in Appendix C.

The locations of the exploratory holes were selected and set out on site by Applied Geology. The boreholes were spread across the site in order to gain best overall coverage. The Hand Excavated Trial Pit was targeted to the location of an electrical substation of the site, in order to obtain a shallow soil sample for chemical analysis to check for the presence of PCBs.

The positions of the exploratory holes were defined by taping from identifiable features on the site plan. The locations are presented on Drawing No. AG2183-15-02 in Appendix A.

Headspace analysis was undertaken on samples of the Made Ground and natural soils using a PID meter.

4.2 Instrumentation and Monitoring

On completion of boring, 50mm diameter standpipes were installed in selected boreholes as follows, with further details included in the relevant borehole logs in Appendix B:

- DCS1, 2.0 to 4.0m bgl, Glaciofluvial Deposits;
- DCS4, 2.0 to 4.0m bgl, Glaciofluvial Deposits;
- DCS6, 1.0 to 4.0m bgl, Made Ground;
- DCS7, 3.0 to 4.0m bgl, Glaciofluvial Deposits.

Washed silica gravel (10mm) was used as the filter medium. Each standpipe was fitted with a push-in bung and single gas tap and was finished with flush metal cover concreted in place.

Ground gas and groundwater monitoring visits were undertaken on six occasions from 2nd March to 2nd April 2015, during one period of low and three periods of falling atmospheric pressure. Each monitoring well was monitored for concentrations of carbon dioxide, methane, oxygen, flow rates and differential pressures and water level. The monitoring results are included in Appendix C.

Falling head permeability tests were undertaken in DCS1 and DCS4 during the first monitoring visit.

4.3 Laboratory Testing

Geotechnical laboratory testing was undertaken on selected samples of Made Ground and natural soils and comprised the following:

- 4 No natural moisture content tests;
- 4 No Atterberg limit tests;
- 6 No BRE SD1 Greenfield (with pyrite) suite tests;
- 3 No BRE SD1 Brownfield (with pyrite) suite tests.

Chemical testing was undertaken based upon the desk study, walkover and site observations during the fieldwork. Nine samples of Made Ground were analysed for the following suite of contaminants:

- Selected metals suite [arsenic, cadmium, chromium (total, trivalent and hexavalent), copper, mercury, nickel, lead, zinc, selenium];
- Speciated (16 US EPA) Polycyclic Aromatic Hydrocarbons (PAH);
- Phenols (total);
- pH & soluble sulphate;
- Organic matter.

In addition, one of the above samples was submitted for 9 band Total Petroleum Hydrocarbon (TPH) testing due to a slightly elevated reading of Volatile Organic Compounds from headspace testing and one sample was submitted for polychlorinated biphenyls (PCBs) from the location of the former electrical substation. All nine samples were tested for the presence of asbestos fibres within the soil.

Laboratory test results are included in Appendix D.

5.0 GROUND CONDITIONS

5.1 Strata Encountered

Up to 4.0m of Made Ground was encountered overlying Glaciofluvial Deposits, which was generally found to overlie Glacial Till. Full details of the strata encountered are given on the borehole records presented in Appendix B. A generalised ground profile is presented below to summarise the information. SPT 'N' value versus depth and versus reduced level plots are included in Appendix A.

Stratum	Depth to Top of Stratum (m bgl)	Thickness (m)	Comments
Made Ground	GL	1.4 / 4.0	Thickest on top of the ridge (DCS3 and DCS6)
Glaciofluvial Deposits	1.4 - 4.0	1.9 / 2.9	
Glacial Till	3.3 – 5.8	0.65 + / 2.15+	Only encountered in DCS1, 2, 4 and 7

5.2 Made Ground

Made Ground was encountered across the site from the ground surface to depths of between 1.4m and 4.0m bgl. The greatest thicknesses of Made Ground were encountered in boreholes drilled on top of the central ridge running through the site. DCS5 was terminated at 1.45m bgl due to encountering an obstruction.

The Made Ground comprised grass over soft brown organic sandy frequently gravelly clay with gravel of fine to medium brick and concrete to depths of between 0.2m and 0.3m bgl. Underlying this was granular Made Ground comprising grey-brown/brown very sandy fine to coarse gravel/very gravelly fine to coarse sand with gravel of brick, concrete and occasional clinker and frequent cobbles of brick and concrete.

Standard Penetration Tests (SPTs) carried out in the granular Made Ground recorded SPT 'N' values of between N=3 and N=30 (very loose to medium dense/dense).

5.3 Glaciofluvial Deposits

Glaciofluvial Deposits were encountered in all but two of the exploratory holes (DCS5 in the centre of the site and HEP1 in the southwest) from depths of between 1.4m and 4.0m bgl to depths of between 3.3m and in excess of 5.8m bgl, achieving thicknesses of between 1.9m and 2.8m.

The stratum generally comprised grey/light-brown/brown frequently slightly gravelly medium to coarse sand with gravel of fine to medium subrounded quartzite, mudstone, siltstone and sandstone. Within DCS7 very soft grey-brown very sandy clay with frequent 0.1m thick sand bands was encountered from 4.6m to 5.8m bgl. A 0.2m thick clay band was encountered in DCS4 at a depth of 3.8m bgl.

SPTs carried out in the granular Glaciofluvial Deposits recorded SPT 'N' values of between N=4 and N=22, indicating the density of the soils to range from loose to medium dense. The density of the soils was generally found to decrease with depth, and may be a result of disturbance due to drilling below the water table.

The result of two Atterberg limit tests carried out in the cohesive Glaciofluvial Deposits gave results for liquid limits of 19% and 27%, plastic limits of 10% and 12%, plasticity indices of 9% and 15% (corrected to 14.6% and 17.9%) and natural moisture contents of 18% and 20%, classifying the soil as clay of low plasticity and low shrinkage potential.

5.4 Glacial Till

Glacial Till was encountered in four of the exploratory holes spread across the site (DCS1, 2, 4 and 7) at depths of between 3.3m and 5.8m bgl. The absence of the Glacial Till from DCS3 and DCS6 is likely a result of these boreholes being drilled on top of the ridge and thus terminated at shallower levels within the Glaciofluvial deposits. The Glacial Till was encountered to excess of 6.45m bgl with the base of the stratum not proven.

The strata generally comprised firm becoming stiff brown slightly sandy slightly gravelly clay with gravel of fine to medium subrounded quartzite, mudstone,

siltstone and sandstone. The top 0.4m of Glacial Till from DCS4 was found to be soft.

SPTs carried out in the Glacial Till recorded SPT 'N' values of between N=8 to N=20. The 'N' values suggest shear strengths of between 44kN/m^2 and 110kN/m^2, assuming $f_1 = 5.5$.

The results of two Atterberg limit tests carried out in the Glacial Till gave results for the liquid limits of 28% and 30%, plastic limits of 13%, plasticity indices of between 15% and 17% (corrected to between 13.9% and 16%) and moisture contents of between 17% and 20%, classifying the soils as clay of low plasticity and low shrinkage potential.

5.5 Groundwater and Falling head Permeability Tests

Groundwater was encountered in five of the exploratory holes during drilling at depths of 2.0m and 2.5m bgl, associated with the presence of granular Glaciofluvial Deposits.

Subsequent monitoring of the standpipes within DCS1, DCS4 and DCS7 (within the Glaciofluvial Deposits) recorded water levels of between 2.66m and 3.38m bgl. Groundwater was not recorded in the standpipe within DCS6 (Made Ground).

Falling head permeability tests were carried out during the first monitoring visit within the standpipes in DCS1 and DCS4. Each test indicated an initial rapid fall in water level, followed by a slower decline. Accordingly, the test results have each been interpreted twice resulting in indicative permeabilities of 1.1 to 1.7 x 10^{-5}m/s for the initial rapid drops and 2.5 x 10^{-6} to 2.9 x 10^{-7}m/s for the majority of the test periods.

5.6 Contamination

No obvious visual or olfactory evidence of any gross contamination was noted at the site during the ground investigation, with the exception of deep Made Ground across much of the site (particularly below the 'ridge') and occasional presence of ash/clinker. Headspace testing carried out on samples of the Made Ground recorded Volatile Organic Compound (VOC) concentrations of between less than detection limit (<0.1ppm) and 4.4ppm, the latter result from DCS3 at 0.5m bgl.

5.7 Soil Gas

Monitoring of the standpipes within the Made Ground and Glaciofluvial Deposits recorded methane concentrations of less than 0.1% by volume, carbon dioxide concentrations of between less than 0.1% vol and 7.4% vol, and oxygen concentrations of between 14.2% vol and 20.2% vol (marginally depleted to near atmospheric). The highest carbon dioxide and corresponding lowest oxygen concentrations were consistently from DCS4 and DCS7 within the Glaciofluvial Deposits, while DCS6 within the Made Ground recorded much lower concentrations of carbon dioxide and near atmospheric oxygen concentrations on all visits.
A maximum (3-minute average) flow rate of 1.7l/h was recorded, giving Gas Screening Values (SGVs) of 0.0017l/h for methane and 0.126l/h for carbon dioxide, calculated in accordance with CIRIA C665.

6.0 GEOENVIRONMENTAL ASSESSMENT

6.1 Human Health Risk Assessment

The results of the chemical testing on soils have been assessed as described in Appendix E, with specific details as follows:

- Proposed end-use – traditional houses with gardens and apartment blocks with landscaped areas;
- Screening criteria – residential with plant uptake, assuming 6% SOM;
- Two data sets have been derived, based on the ashy Made Ground encountered between 1.0-1.3m bgl in DCS4 and the remaining Made Ground across the site.

The spreadsheets summarising the laboratory results and relevant screening values for each dataset are presented in Appendix D. For determinands that have been found to exceed screening values, the following tables summarise the individual results, the corresponding screening values and the number of exceedences.

Made Ground

Contaminant	No of samples tested	Concentration Range (mg/kg)	Screening Value (mg/kg)	No. of exceedences
Lead	8	83 - 810	200	3

From this table it can be seen that a number of soil concentrations significantly exceed their corresponding screening value for lead. The three exceedences of lead are from DCS1, DCS2 and DCS3 within the shallow Made Ground (0.5-0.7m bgl). The results have been statistically analysed and copies of the resulting spreadsheets are included in Appendix D. The data was found to show a non-normal distribution and therefore a 95% Upper Confidence Limit (UCL) was calculated following the Chebychev Theorem. The result for the lead data set gives a 95% UCL of 593.5mg/kg which exceeds the screening criteria of 200mg/kg by a factor of 3, and requires further assessment or remediation.

Some petroleum hydrocarbon fractions (C_{12} – C_{44}) were also detected in the Made Ground from DCS3 at a concentration of 100 mg/kg total TPH, however they were all well below the relevant screening criteria.

No Polychlorinated Biphenyls were detected in the location of the former electrical substation.

The asbestos screening tests did not detect the presence of any asbestos fibres.

Ashy Made Ground - DCS4

Contaminant	No of samples tested	Concentration (mg/kg)	Screening Value (mg/kg)
Arsenic	1	83	37
Lead	1	1600	200
Benzo[a]pyrene	1	11	5

From this table it can be seen that soil concentrations of arsenic, lead and benzo[a]pyrene significantly exceed their corresponding screening value from the ashy Made Ground encountered in DCS4 at 1.0-1.3m bgl. Given its depth, these results will mainly be relevant to risk to controlled waters and/or may have implications for off-site disposal if excavated.

6.2 Controlled Waters Risk Assessment

The testing on soils has found only elevated lead (with respect to human health screening criteria) across the site (which may not be that mobile) and only localised elevated concentrations of other determinands (arsenic and benzo(a)pyrene) associated with a thin layer of ashy Made Ground in one location (DCS4).

The presence of cohesive Glacial Till underlying the site would probably inhibit the downward migration of any mobile contamination to the underlying Principal Aquifer of the Wilmslow Sandstone Formation.

6.3 Conclusions and Recommendations

The above human health risk assessment has identified a potential risk to human health receptors due to elevated concentrations of lead present in the shallow Made Ground at the site. The upper parts of the Made Ground in the ridge area (DCS3 and DCS6) will be removed during levelling of the site. However, elevated lead in the Made Ground appears to be widespread so a reduction in levels will not remove the source. Given the absence of topsoil on site, clean topsoil will probably need to be imported to site for use in gardens and landscaped areas, so a cover layer system appears to be the most practicable remedial solution and will reduce the exposure pathway to end users.

By applying the calculated Upper 95% Confidence Limit for lead of 593.5mg/kg, assuming a cover concentration of 25mg/kg in any soils imported to site and a soil target value of 200mg/kg, a likely cover layer thickness of approximately 415mm has been calculated. A thinner cover layer of 300mm could be used in any very small front gardens and any soft landscaping, subject to discussions with and approval by the Local Authority EHO.

The ‘hot spot’ of contamination identified in DCS4 at a depth of 1.2m bgl is located beneath a proposed area of hardstanding/road and is not in an area where levels are to be significantly reduced. As a result, no exposure pathway is likely to exist to the end users as this is at a depth below that which typically can become exposed to human health receptors. No remediation is therefore deemed necessary at DCS4 to protect human health. However, similar soils could exist elsewhere on site,

potentially at shallower depths and the results also need to be taken into account for assessing the risk to controlled waters and also regarding H&S for ground workers.

The Glaciofluvial Deposits underlying the site is classified as a Secondary 'A' Aquifer, and may be at risk from the elevated concentrations of lead across the site and locally elevated concentrations of arsenic and benzo[a]pyrene within DCS4. A programme of groundwater sampling and testing is likely to be required in order to adequately assess this risk.

The underlying Principal Aquifer of the Wilmslow Sandstone Formation is considered to be at less risk from mobile contaminants given the presence of cohesive Glacial Till underlying the Glaciofluvial Deposits.

Issues with respect to ground gas and potential effects of contaminants on buried concrete and water supply pipework are included in Section 8.0.

7.0 GEOTECHNICAL ASSESSMENT

7.1 General

The proposals for the site comprise the construction of eight houses and two apartment blocks with associated infrastructure, gardens and landscaped areas. No loading information was made available at the time of writing this report, however the houses are likely to be lightly loaded, with slightly higher loads anticipated for the three storey apartment blocks.

The investigation has identified Made Ground (up to 4.0m bgl), overlying loose to medium dense Glaciofluvial Deposits, overlying cohesive firm to stiff Glacial Till. Groundwater was encountered within the Glaciofluvial Deposits during drilling at depths of between 2.0m and 3.0m bgl, and during subsequent monitoring at depths of between 2.66m and 3.68m bgl.

7.2 Foundation Design

It is envisaged that the site will be levelled, with the ridge removed to give a development area at similar levels to Upper Parliament Street and the adjoining properties. Given the depth of the Made Ground at formation level is unlikely to extend greater than 2.0m bgl, conventional trench fill foundations within the Glaciofluvial Deposits are considered suitable for the proposed structures. Although a minimum founding depth of 0.7m bgl will apply (low shrinkage potential clay), the borehole data suggests that founding depths of between 1.4m and 1.9m bgl are likely to be required.

Strip/trench fill foundations (up to 0.6m wide) competently designed to the above requirements may adopt a safe net design bearing pressures up to 100kN/m^2, with less than 25mm total settlement at this pressure. This is based on a typical 'N' value of N=8 using traditional methods of bearing capacity calculations e.g. as set out in Tomlinson 7th Edition and a factor of safety of 3 against bearing capacity failure.

Depending on the loads from the apartments, and given the generally low density of the Glaciofluvial Deposits (plus the presence of very soft/soft clays below in places), a piled foundation solution may be adopted for the apartments, possibly utilising

driven piles taken through the Made Ground and Glaciofluvial Deposits in to the underlying stiff Glacial Till. Consideration may also be given to a vibro replacement stone column foundation solution in this area. Allowable bearing pressures of 80kN/m^2 to 125kN/m^2 are typical for foundations placed on stone columns, however, it is recommended that a specialist contactor is consulted to assess the suitability of the soils to be treated and the achievable allowable bearing pressures.

The deep Made Ground encountered across the site may indicate the presence of infilled basements/cellars associated with former terraced residential dwellings, which may result in obstructions during the installation of the piles/vibro replacement stone columns. However, it is noted that all of the boreholes managed to penetrate the Made Ground, with the exception of DCS5.

If conditions, significantly at variance to those described herein are encountered, specialist geotechnical advice should be sought to make appropriate assessment and recommendations.

7.3 Floor Slab and Gas Protection

It is an NHBC requirement that suspended ground floor slabs are adopted where Made Ground exceeds 600mm in thickness. Where Made Ground is less than 600mm thick ground bearing slabs may be adopted, subject to proof rolling, removal of soft spots and replacement with a suitable compacted granular material. Due to the depth and nature of the Made Ground encountered on this site, suspended ground floor slabs are recommended across the site.

Based on the conceptual model, the ground conditions encountered and the calculated GSV for carbon dioxide, the site can be characterised as Situation 2 (CIRIA C665) or NHBC category Amber 1. Therefore, the installation of subfloor ventilation and a proprietary gas resistant membrane is recommended in accordance with BS8485.

7.4 Excavations

Following reduced level dig, excavations up to 1.9m deep are envisaged for the foundation excavations and service trenches. At these depths excavations are expected to be in a combination of Made Ground and Glaciofluvial Deposits. These materials may be prone to some short term instability and spalling and may need to be graded back to a stable angle or trench support should be provided. Trench support or the angle of batter should be designed by an appropriately qualified engineer or competent person to suit the required depth and the ground and groundwater conditions. Significant groundwater ingress is expected generally below 2.0m bgl, it is therefore recommended that some provision for obtaining sump pumping equipment is made to control any groundwater ingress and run off in wet weather conditions.

7.5 Pavement Design

Due to the inherent variability of the Made Ground, an equilibrium CBR value of 2% is recommended for this stratum. This may be higher following proof rolling. Care should be taken to ensure that the surface formation is protected as there is likelihood that it may become softened by the action of rain and plant, leading to

rutting and surface deterioration. The Made Ground is considered frost susceptible and should not be present within 450mm of the pavement construction surface.

7.6 Falling Head Permeability Tests

The results of the falling head permeability tests carried out indicate that the granular Glaciofluvial Deposits may be suitable for the use of conventional soakaway drainage. However, significant parts of the Glaciofluvial deposits are below the water table and the permeability tests gave mixed results. If soakaway drainage is to be used at the site, it is recommended that further groundwater monitoring is undertaken along with soakaway testing, in accordance with BRE 365 testing procedures, at the proposed soakaway locations.

7.7 Buried Concrete and Services

The results of the testing on the samples of Made Ground generally indicate characteristic values as following:

- water soluble sulphate: 1.3g/l;
- total potential sulphate: 0.27%;
- pH: 7.8.

The results have identified the Design Sulphate Class to be DS-2 with the Aggressive Chemical Environment for Concrete (ACEC) being AC-2 as defined by the BRE Special Digest 1, Concrete Aggressive Ground, 2005, assuming mobile groundwater.

The results of the testing of the natural soils generally indicate characteristic values as following:

- water soluble sulphate: 0.05g/l;
- total potential sulphate: 0.03%;
- pH: 7.5.

The results have identified the Design Sulphate Class to be DS-1 with the Aggressive Chemical Environment for Concrete (ACEC) being AC-1 as defined by the BRE Special Digest 1, Concrete Aggressive Ground, 2005, assuming mobile groundwater.

A Design Sulphate Class of DS-2 with an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2 should therefore be adopted across the site, owing to the site wide presence of Made Ground.

Further reference should be made to BRE Special Digest 1 for requirements in respect of types of cement and aggregate to be used and variations in type of concrete construction.

Petroleum hydrocarbons (C^{12} – C^{44}) were detected in the shallow Made Ground from DCS3 at a total concentration of 100mg/kg. Phenols were not detected in any of the samples tested.

7.8 Conclusions and Recommendations

Conventional strip/trench fill foundations placed through the Made Ground in to the underlying Glaciofluvial Deposits is considered suitable for the proposed houses. Depending on loadings, a deeper foundation solution utilising driven piles or vibro replacement stone columns may be required for the proposed apartment blocks.

Suspended floor slabs are recommended at the site, along with passive gas protection measures appropriate for a NHBC Amber 1 site.

The site may be suitable for the use of conventional soakaway drainage in the Glaciofluvial Deposits, however it is recommended that further soakaway testing is undertaken in accordance with BRE 365 in order to calculate a characteristic infiltration rate for the site.

Concrete design class DS-2 and AC-2 conditions are considered appropriate for the site.

Applied Geology Limited
Centrix House
Crow Lane East
Newton-le-Willows
Merseyside
WA129UY

April 2015

GENERAL NOTES

A) The assessment made in this report is based on the site terrain and ground conditions revealed by the various field investigations undertaken and also any other relevant data for the site including previous site investigation reports (if available) and desk study data. There may be special conditions appertaining to the site, however, which have not been revealed by the investigation and which have not, therefore, been taken into account in the report. The assessment may be subject to amendment in the light of additional information becoming available. It must be recognised that many of the Environmental Searches obtained during the course of the desk study are often lengthy. Applied Geology have, where appropriate and in the interests of simplicity, only reproduced the summary of the searches within the report. A full copy of all the search data is held at the Applied Geology office and is available for inspection if required.

B) The services provided are defined within our proposal and are carried out in line with the terms of appointment between Applied Geology and the Client.

C) Where any data supplied by the Client or other external source, including that from previous site investigations, has been used it has been assumed that the information is correct. No responsibility can be accepted by Applied Geology for inaccuracies within this data.

D) Whilst the report may express an opinion on possible configurations of strata between or beyond the exploratory locations, or on the possible presence of features based on either visual, verbal or published evidence this is for guidance only and no liability can be accepted for the accuracy.

E) Comments on groundwater (and landfill gas) conditions are based on observations made during the course of the present and past investigations or with reference to published data unless otherwise stated. It should be noted, however, that groundwater (and landfill gas) levels vary due to seasonal (or atmospheric conditions) or other effects.

F) The copyright of this report and other plans (and documents prepared by Applied Geology) is owned by Applied Geology and no such report, plan or document may be reproduced, published or adapted without the written consent of Applied Geology. Complete copies of the report may, however, be made and distributed by the Client as an expedient in dealing with matters related to its submission.

G) This report is prepared and written in the context of the proposals stated in the introduction to the report and should not be used in a differing context. Furthermore, new information, improved practices and legislation may necessitate an alteration to the report in whole or in part after its submission. Therefore with any change in circumstances or after the expiry of one year from the date of the report, the report should be referred to Applied Geology for re-assessment and if necessary, re-appraisal.

H) The survey was conducted and this report was prepared for the sole internal use and reliance of the Client. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Applied Geology. If an unauthorised third party comes into possession of this report they rely on it at their peril and Applied Geology owes them no duty of care and skill.

I) Ground conditions should be monitored during the construction of the works and the recommendations of the report re-evaluated in the light of this data by the supervising geotechnical or geo-environmental engineers.

J) Unless specifically stated, the investigation has not taken into account the possible effects of mineral extraction.

K) The works performed are not a comprehensive site characterisation and should not be construed as being such.

L) The findings of the geo-environmental risk assessment are based on information obtained from a variety of sources which Applied Geology believe to be correct. Applied Geology cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

M) The report represents the findings and opinions of experienced geo-environmental consultants. Applied Geology does not provide legal advice and the advice of lawyers may be required.

N) Conditions at the site are subject to change from the time of the site inspection.

O) It is possible that researches carried out by Applied Geology, whilst fully appropriate for a phase 1 desk study, failed to indicate the existence of important information sources. Assuming such indicators actually exist, their information could not have been considered in the formulation of Applied Geology findings and opinions.

P) The economic viability of the proposals referred to in the report, or of the solutions put forward to any problems encountered, depends on very many factors in addition to geotechnical considerations and hence its evaluation is outside the scope of this report.

Q) Applied Geology operates as a Consultancy and does not operate it's own laboratory for soil testing, this work being sub contracted to known and respected, generally UKAS accredited, laboratories. Applied Geology can therefore not be held responsible for the testing carried out.

LIST OF REFERENCES COMMONLY USED BY APPLIED GEOLOGY IN REPORTS

SECTION/TITLE	AUTHOR/PUBLICATION
LABORATORY TESTING	
BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes	BSI
SITE WORK	
Guidelines for Combined Geoenvironmental and Geotechnical Investigations. Issue 2. March 2006	AGS
BS 5930:1999 + A2 (2010). Code of Practice for Site Investigation.	BSI
BS 10175:2011 Code of Practice for the Investigation of Potentially Contaminated Sites	BSI
FOUNDATION DESIGN	
BRE Special Digest 1: 2005 Third Edition. Concrete in Aggressive Ground	BRE
NHBC Standards, Chapter 4.2: Building Near Trees. 2011	National House Building Council
Foundations in Chalk (CIRIA Project Report 11). 1993	CIRIA
Engineering in Chalk (C574). 2002	CIRIA
Engineering in Mercia Mudstone (C570). 2001	CIRIA
SOIL GAS	
Radon: Guidance on Protective Measures for New Buildings. 2007 Ed.	Department of the Environment, Transport and the Regions and BRE
Indicative Atlas of Radon in Scotland (HPA – CRCE-023). 2011	HPA
Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments. BS8485:2007	BSI
Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present (C665). 4th Ed, 2007	NHBC & RSK Group
GROUNDWATER	
BRE Digest 365: Soakaway Design. 2003	BRE
CONTAMINATION ASPECTS (Soil & Groundwater)	
Cover Systems for Land Regeneration. Thickness of Cover Systems for Contaminated Land. 2004. BR465	AGS/BRE
Generic Assessment Criteria for Human Health Risk Assessment. 2009	Chartered Institute of Environmental Health. Land Quality Management.
Model Procedures for the Management of Contaminated Land. Contaminated Land Report 11 September 2004	DEFRA / Environment Agency
The UK Approach for Evaluating Human health Risks from Petroleum Hydrocarbons in Soils. February 2005.	Environment Agency
Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination. 2006.	Environment Agency
An ecological risk assessment framework for contaminants in soil. Science Report SC070009/SR1 September 2008	Environment Agency
Guidance on desk studies and conceptual site models in ecological risk assessment. Science Report SC070009/SR2a October 2008	Environment Agency
Guidance on the use of soil screening values in ecological risk assessment. Science Report SC070009/SR2b October 2008	Environment Agency
Guidance on the use of bioassays in ecological risk assessment. Science Report SC070009/SR2c October 2008	Environment Agency
Guidance on the use of ecological surveys in ecological risk assessment. Science Report SC070009/SR2c October 2008	Environment Agency
Guidance on the attribution of cave and effect in geological risk assessment. Science Report SC070009/SR2e October 2008	Environment Agency
Planning Policy Statement 23: Planning and Pollution Control. 2004.	HMSO
Method for Deriving Site Specific Human Health Criteria for Contaminants in Soil. Report no. LQ01. April 2010	Scotland & Northern Ireland Forum for Environmental Research. Land Quality Management Ltd.
Sampling Strategies for Contaminated Land. Contaminated Land Research Report no.4. 1994	DoE
NHBC Standards, Chapter 4.1: Land Quality – Managing Ground Conditions. 2011	National House Building Council
ATRISK^{soil} Soil Screening Values	Atkins
CLEA Software (Version 1.06)	Environment Agency
The Water Supply (Water Quality) Regulations. 2011	DWI
Prioritisation & Categorisation Procedure For Sites Which May Be Contaminated (CLR Report No6)	Department of the Environment, Contaminated Land Research Report
Code of Practice for the Investigation & Mitigation of Possible Petroleum-Based Land Contamination. 1993	The Institute of Petroleum
Piling & Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. 2001	Environment Agency

DISPOSAL OF SOIL	
The Waste Management Licensing Regulations Waste Management the Duty of Care. A Code of Practice	Department of the Environment
UK Soil Framework Directive. Annex II - 1999/31/EC and Annex III - 91/689/EEC	
BURIED SERVICES	
Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites. (10/WM/03/21). 2010	UK Water Industries Research
Effects of Organic Chemicals in Contaminated Land on Buried Services (DWQ 9025, Report 2982(P)). 1992	Department of the Environment
The Impact of Contaminated Land on Buried Electrical Cables (CONTAM-2.5AM). 1998	ERA Technology
PAVEMENT DESIGN	
Interim Advice Note 73/06 Rev 1, 2009. Design Guidance for Road Pavement Foundations (Draft HD25)	Highways Agency
HEALTH & SAFETY ASPECTS	
A Guide for Safe Working on Contaminated Sites (Report 132)	CIRIA
Protection of Workers and the General Public During the Development of Contaminated Land (HSG66)	Health & Safety Executive
Construction (Design & Management) Regulations 2006 (CDM)	Health & Safety Executive
Control of Substances Hazardous to Health Regulations 2002	Health & Safety Executive
Workplace Exposure Limits. EH40/2005	Health & Safety Executive
Trenching Practice. Guidance on Groundwater Control (Report 97)	CIRIA
Control of Groundwater for Temporary Works (Report 113)	CIRIA

20/02/12

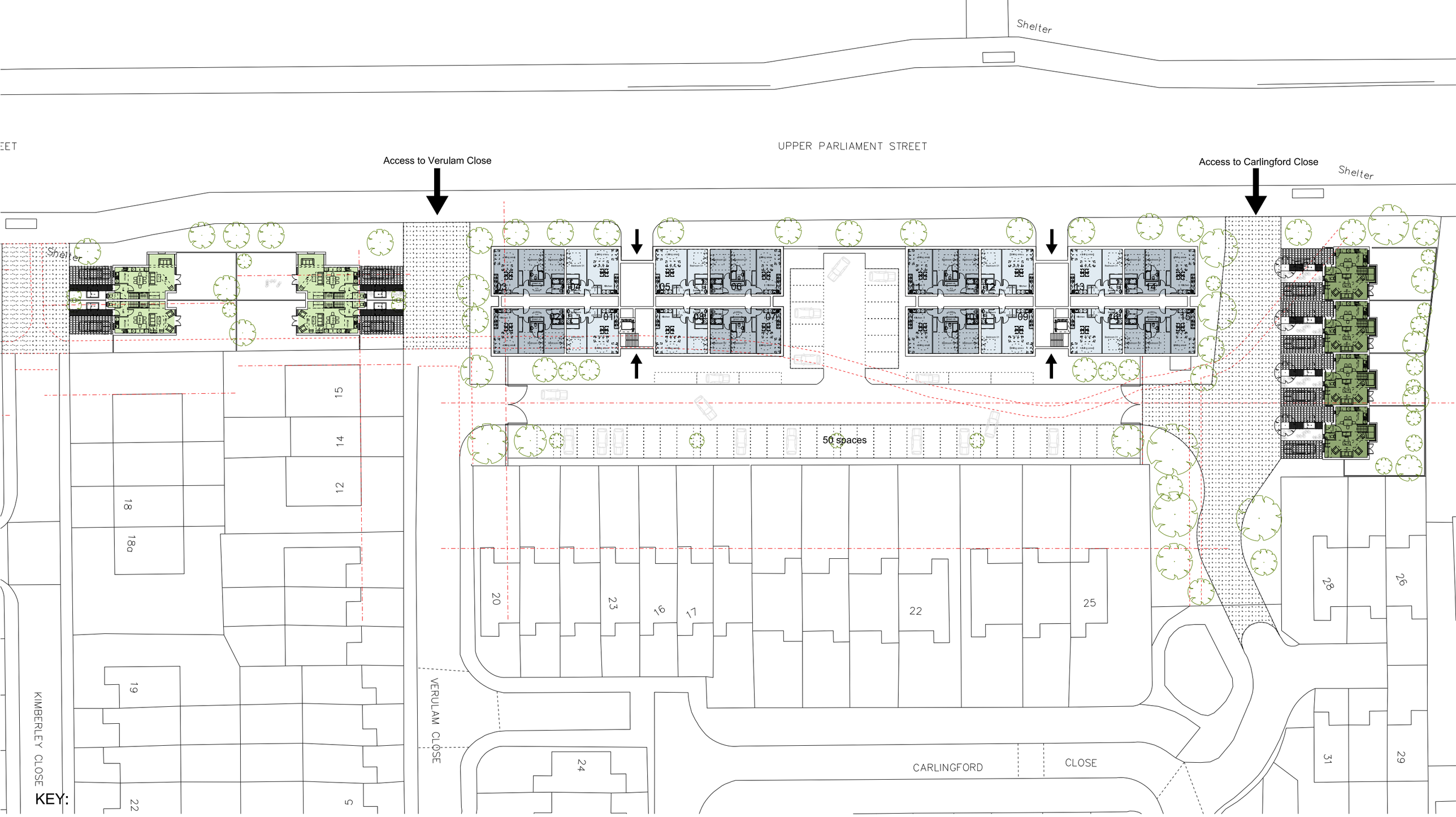
APPENDIX A

Site Location Plan

Site: **Upper Parliament Street, Liverpool**
Title: **Taken from Ordnance Survey (1:50,000) Map 108, Liverpool, Southport and Wigan**

NGR: **SJ 363 893** Project No: **AG2183-15**

APPLiED GEOLOGY



KEY:

- Res. 1 bed apartment 48sqm - 24 no. of apartments
- Res. 2 bed apartment 65sqm - 24 no. of apartments
- Res. 2 bed house 77sqm - 4 no. of homes
- Res. 3 bed house 90sqm - 4 no. of homes

FALCONER CHESTER HALL

FCH

No 12 Temple Street, Liverpool, L2 5RH Telephone +44(0)151 243 5800
5th Floor, 22 Soho Square, London, W1D 4NS Telephone +44(0) 203 137 7393

www.fcharchitects.com

Project Title
Upper Parliament Street Feasibility

Drawing Title
Proposed Site Plan - Ground Floor

Client
Flanagan Group

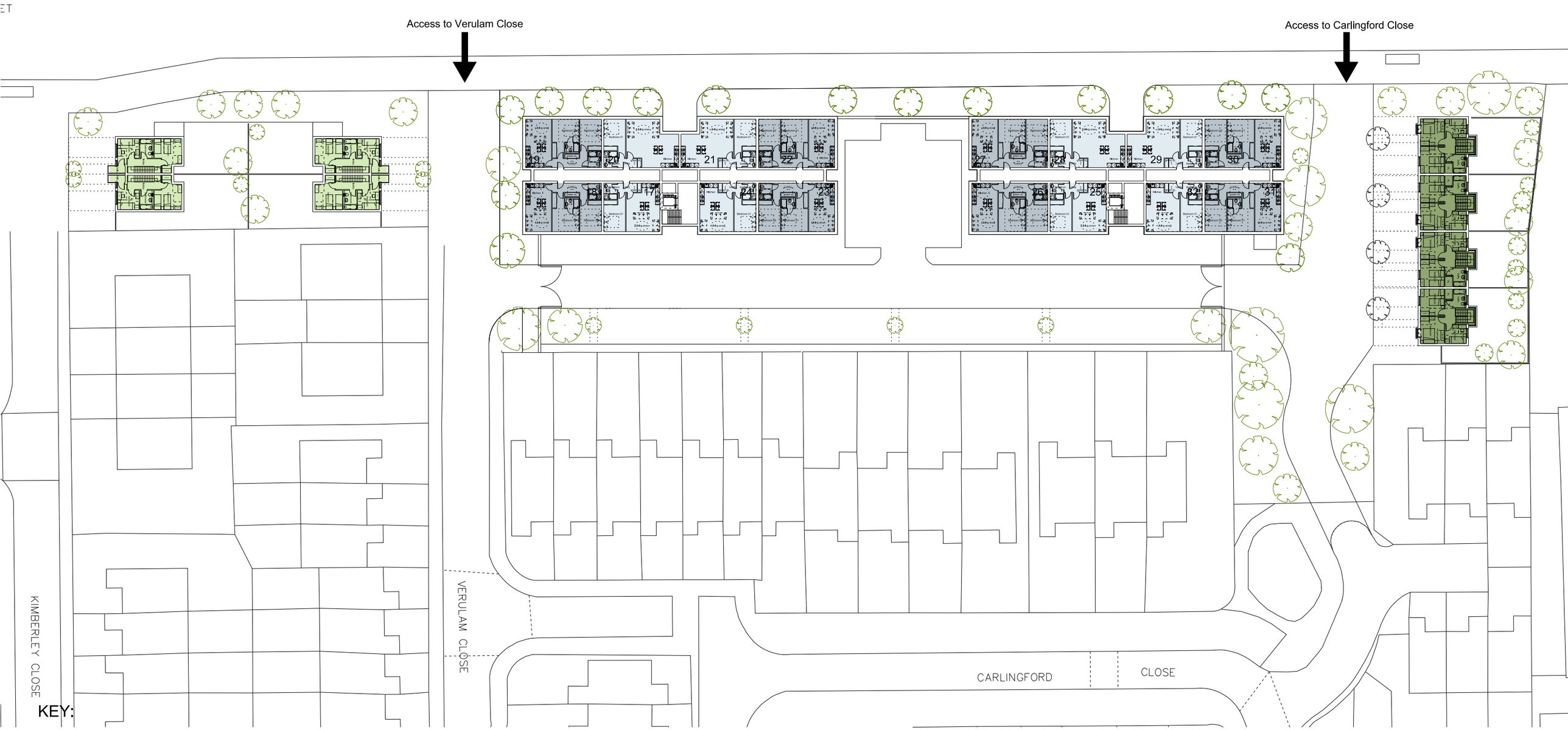
Drawn By
AS

Date
July 2014

Scale
1:500@A3

Project No.
P14-058

Drawing No.
01-02-A-001



KEY:

- Res. 1 bed apartment 48sqm - 24 no. of apartments
- Res. 2 bed apartment 65sqm - 24 no. of apartments
- Res. 2 bed house 77sqm - 4 no. of homes
- Res. 3 bed house 90sqm - 4 no. of homes

FALCONER CHESTER HALL

FCH

No 12 Temple Street, Liverpool, L2 5RH Telephone +44(0)151 243 5800
5th Floor, 22 Soho Square, London, W1D 4NS Telephone +44(0) 203 137 7393

www.fcharchitects.com

Project Title
Upper Parliament Street Feasibility

Drawing Title
Proposed Site Plan - First Floor

Client
Flanagan Group

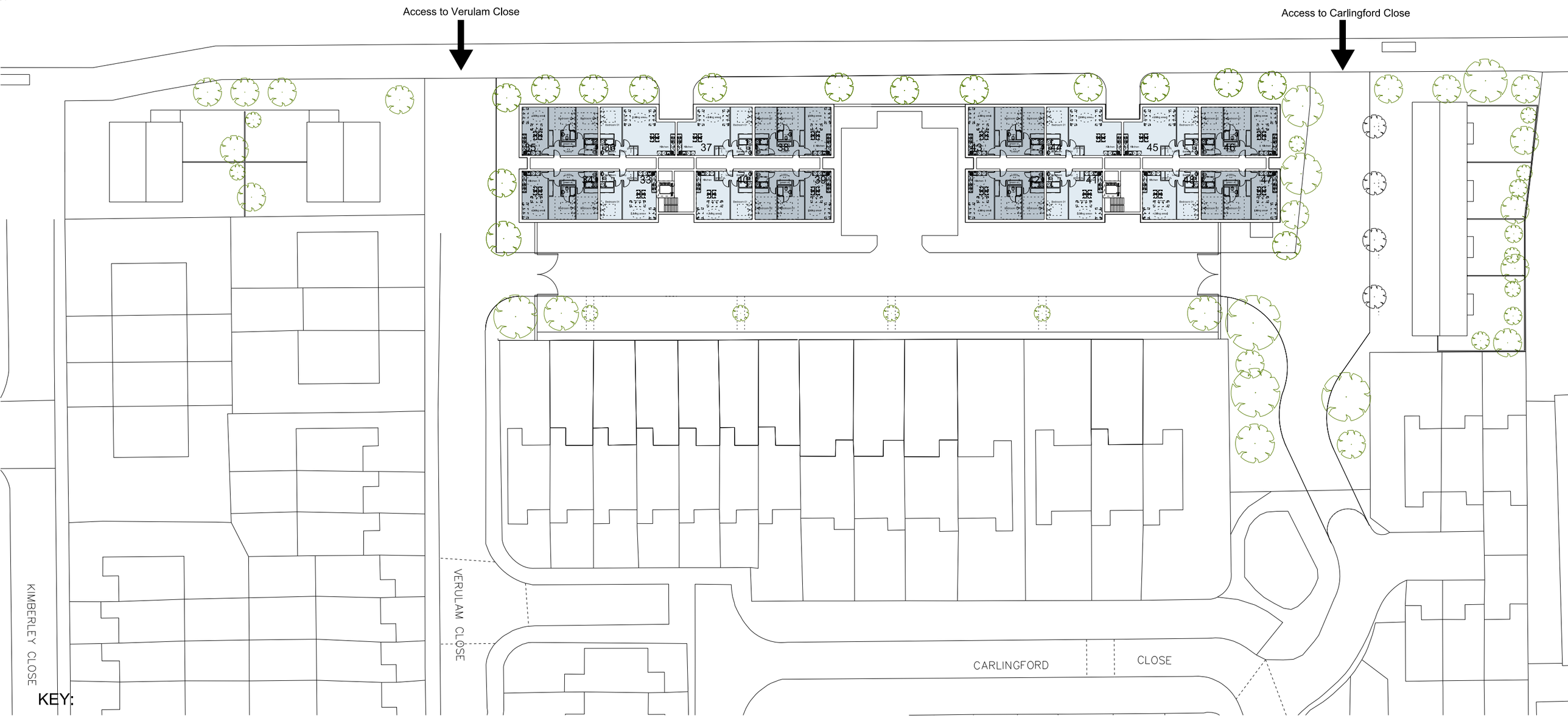
Drawn By
AS

Date
July 2014

Scale
1:500@A3

Project No.
P14-058

Drawing No.
01-02-A-002



KEY:

- Res. 1 bed apartment 48sqm - 24 no. of apartments
- Res. 2 bed apartment 65sqm - 24 no. of apartments
- Res. 2 bed house 77sqm - 4 no. of homes
- Res. 3 bed house 90sqm - 4 no. of homes

FALCONER
CHESTER
HALL

FCH

No 12 Temple Street, Liverpool, L2 5RH Telephone +44(0)151 243 5800
5th Floor, 22 Soho Square, London, W1D 4NS Telephone +44(0) 203 137 7393

Project Title
Upper Parliament Street Feasibility

Drawing Title
Proposed Site Plan - Second Floor Plan

Client
Flanagan Group

Drawn By
AS

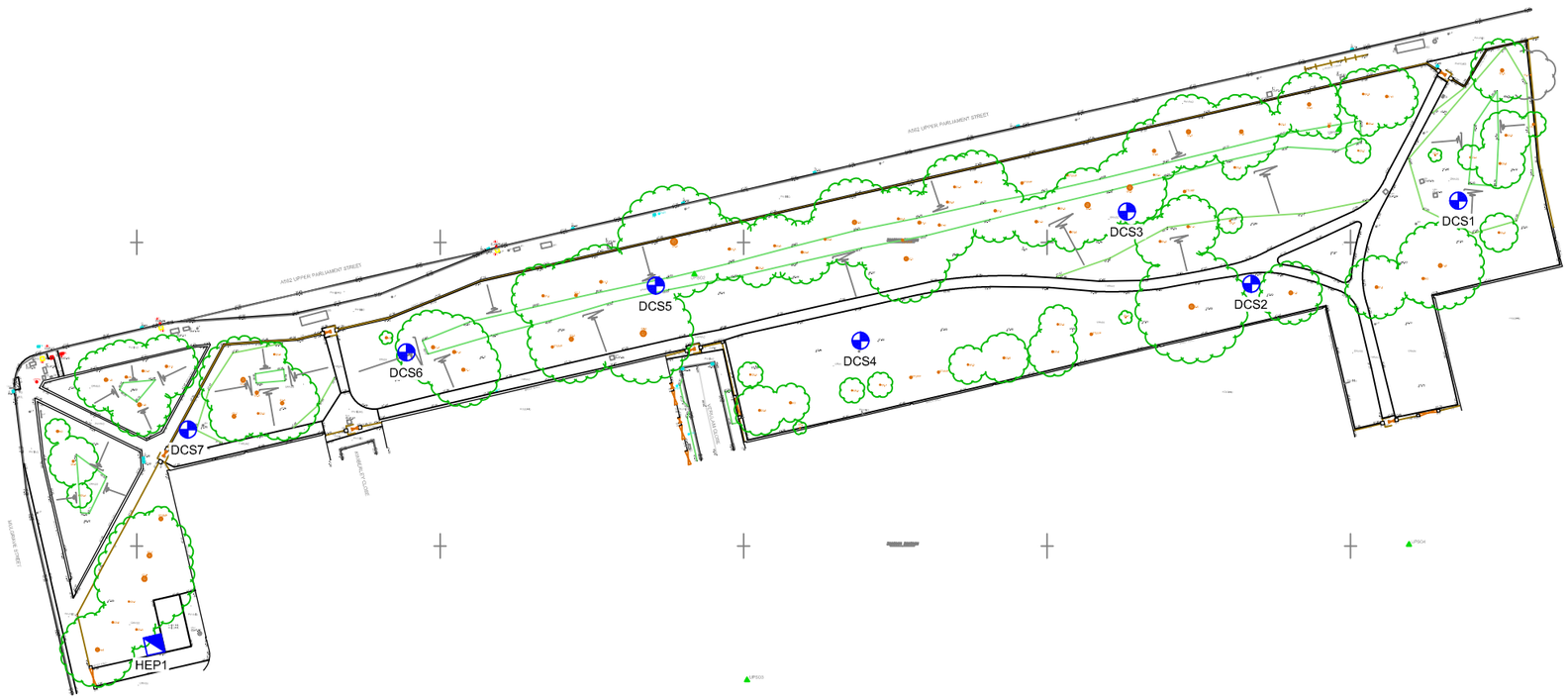
Date
July 2014

Scale
1:500@A3

Project No.
P14-058

Drawing No.
01-02-A-003

www.fcharchitects.com



KEY:

HEP1 — Hand Excavated Foundation Inspection Pit

DCS1 — Driven Continuous Sampling Borehole

Drawing based on Survey Operations, drawing No:15A035/002 and 15A035/003 dated February 2015.

APPLiED GEOLOGY

Centrix House
Crow Lane East
Newton-le Willows
Merseyside
WA12 9UY

Tel: 01925 273054
Fax: 01925 273001
email: admin@appliedgeology.co.uk

Client:
LIVERPOOL MUTUAL HOMES AND
THE FLANAGAN GROUP

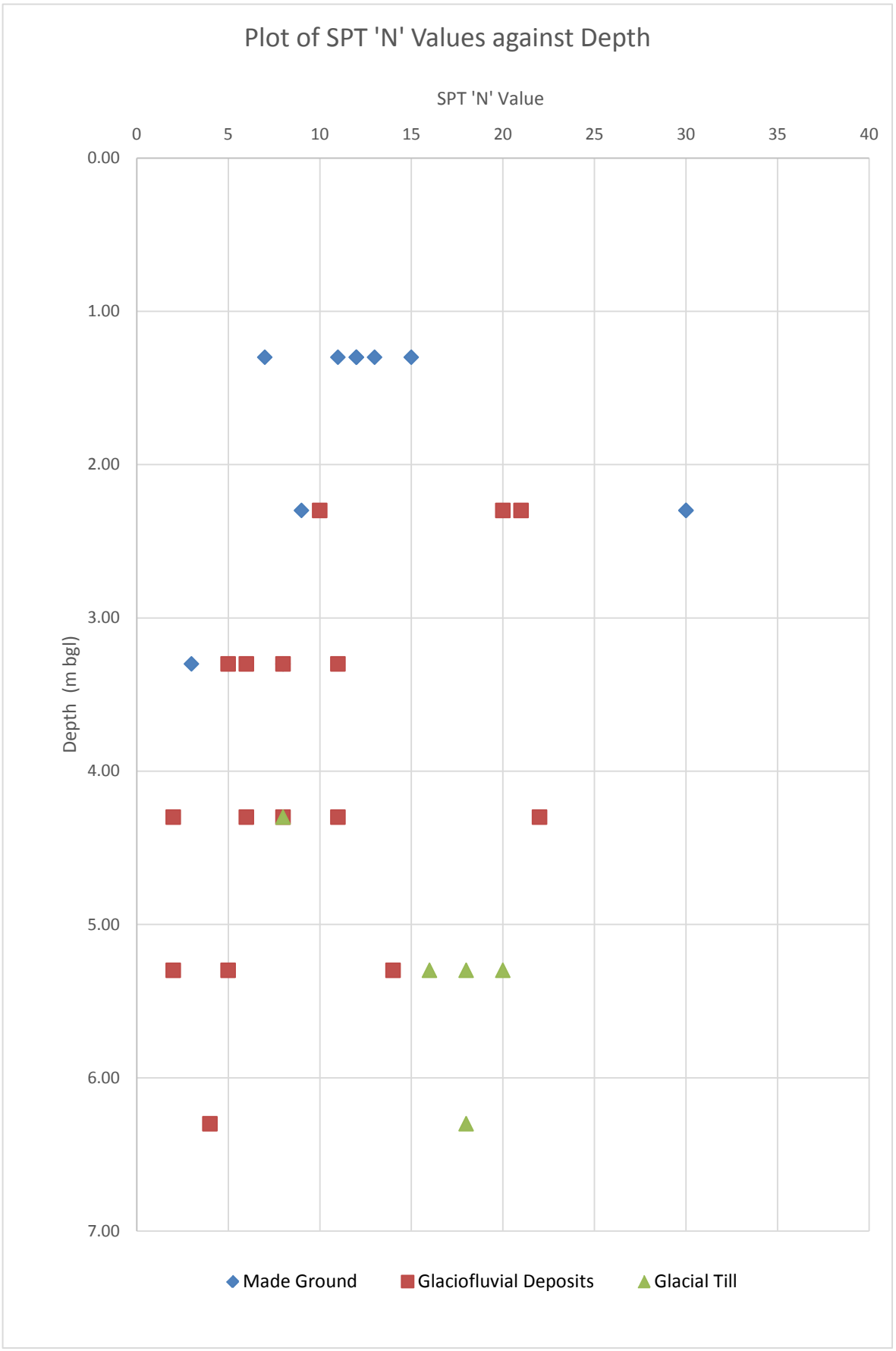
Project:
UPPER PARLIAMENT STREET, LIVERPOOL

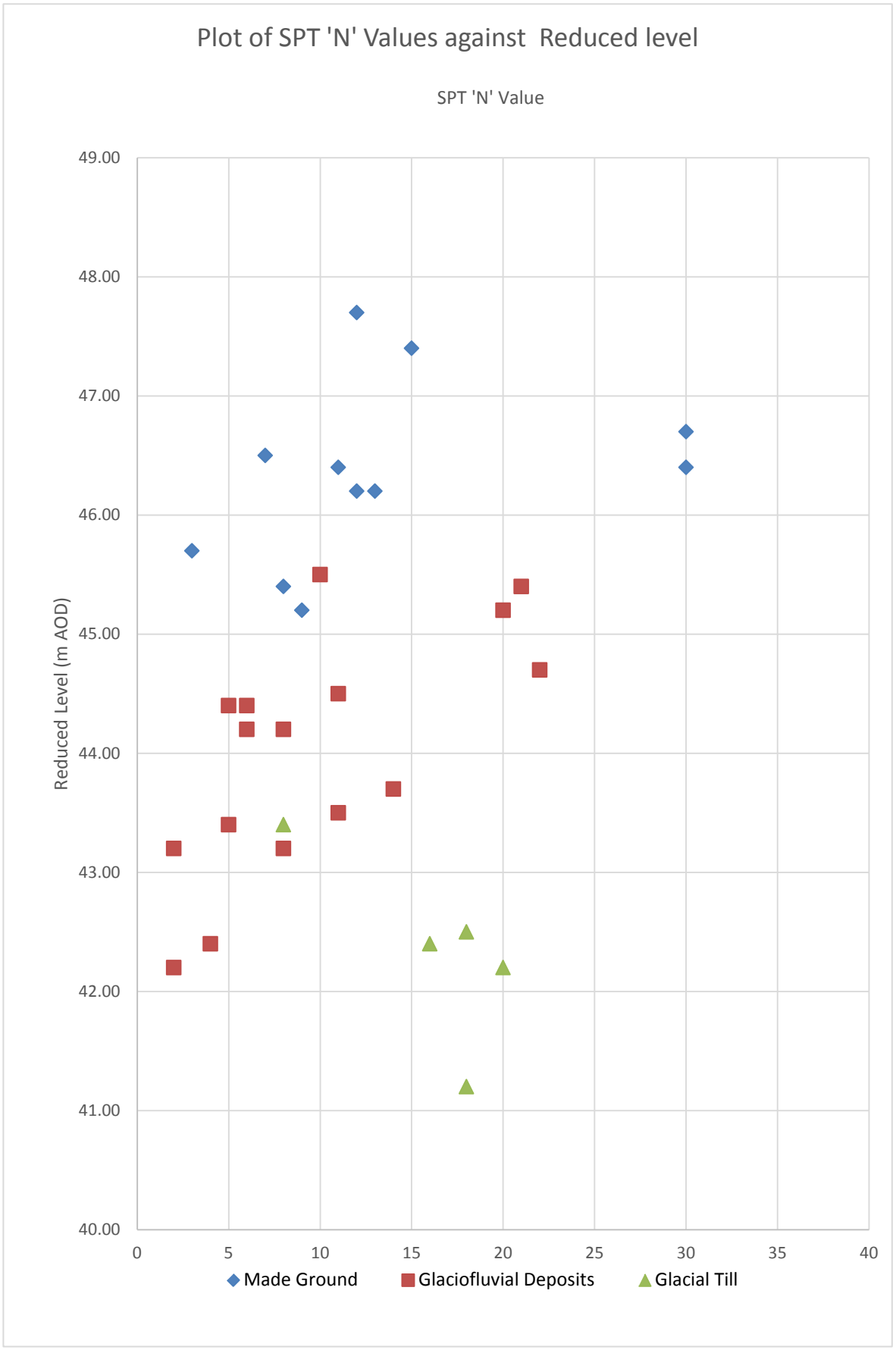
Title:
EXPLORATORY HOLE LOCATION PLAN

Drawn By:	Checked By:	Paper Size:
JS	MW	A3

Scale:	Date:
1:1000	31.03.2015

Drawing No:	Revision:
AG2183-15-02	0


Plot of SPT 'N' Values against Depth
SPT 'N' Value
0
5
10
15
20
25
30
35
40
Depth (m bgl)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Made Ground
Glaciofluvial Deposits
Glacial Till


Plot of SPT 'N' Values against Reduced level
SPT 'N' Value
Reduced Level (m AOD)
49.00
48.00
47.00
46.00
45.00
44.00
43.00
42.00
41.00
40.00
0
5
10
15
20
25
30
35
40
Made Ground
Glaciofluvial Deposits
Glacial Till

APPENDIX B

APPLiED GEOLOGY Tel: 02476511822 Fax: 02476697682	Job No. AG2183-15	Site: Upper Parliament Street, Liverpool Client: Liverpool Mutual Homes & Flanagan Group Engineer: PDW Consultants	Borehole Log DCS1 Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
16/02/2015	101mm to 3.00m 92mm to 4.00m 79mm to 5.00m	47.80m AOD	MW	NL	1:50
Method		**Depth (m)**	**Co-ordinates**		**Ground Slope**
Driven Continuous Sampling		5.45	-		

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
	0.30	ES	0.10				Grass over soft brown organic sandy slightly silty CLAY. Gravel is fine to medium angular brick and concrete. (MADE GROUND)	47.50	0.30		
	0.70	ES	0.10								
	1.00	SPT		7N 7/300			Loose grey brown very sandy fine to coarse GRAVEL with frequent cobbles of brick and concrete. Gravel is fine to coarse angular concrete and brick. (MADE GROUND)				
2.00 ▽	2.00	SPT		10N 10/300			Loose grey slightly gravelly medium to coarse SAND. Gravel is fine subrounded mudstone and sandstone. (GLACIOFLUVIAL DEPOSITS)	45.90	1.90		
	2.50	D									
	3.00	SPT		11N 11/300			Below 3.00m bgl: Becoming medium dense.				
	4.00	SPT		11N 11/300							
	4.80	D			13/30	17.00	Firm becoming stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium subrounded quartzite, mudstone, sandstone and siltstone. (GLACIAL TILL)	43.50	4.30		
	5.00	SPT		18N 18/300							
							End of Borehole at 5.45 m	42.35	5.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.00m bgl. Cased to 2.00m bgl. 50mm diameter standpipe installed to 4.00m bgl, plain pipe ground level to 2.00m with bentonite seal and slotted pipe 2.00m to 4.00m with gravel pack. Borehole backfilled with arisings from 4.00 to 5.45m bgl.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
2.00	-	-	-	16/02/2015	

APPLiED GEOLOGY Tel: 02476511822 Fax: 02476697682	Job No. AG2183-15	Site: Upper Parliament Street, Liverpool Client: Liverpool Mutual Homes & Flanagan Group Engineer: PDW Consultants	Borehole Log DCS2 Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
16/02/2015	101mm to 3.00m 92mm to 4.00m 79mm to 5.00m	47.70m AOD	MW	NL	1:50
Method		**Depth (m)**	**Co-ordinates**		**Ground Slope**
Driven Continuous Sampling		5.45	-		

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
							Grass over soft brown organic sandy CLAY. (MADE GROUND)	47.50	0.20		
	0.50	ES	0.10				Medium dense brown very gravelly fine to coarse SAND with frequent cobbles of brick and concrete. Gravel is fine to coarse angular concrete and brick. (MADE GROUND)				
	1.00	SPT		11N 11/300							
							Below 1.20m bgl: Becoming very clayey.	46.30	1.40		
	1.50	ES	0.10				Medium dense light brown fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)				
	1.70	D									
2.00	2.00	SPT		21N 21/300			Below 1.80m bgl: Becoming grey.				
▽											
	3.00	SPT		5N 5/300			Below 2.70m bgl: Becoming slightly gravelly with gravel of fine to coarse subrounded to subangular quartzite, mudstone and sandstone.				
							Below 3.00m bgl: Becoming loose.	44.40	3.30		
	3.60	D			13/28	20.00	Soft grey sandy slightly gravelly CLAY. Gravel is fine to medium subrounded to subangular quartzite, mudstone, sandstone and siltstone. (GLACIAL TILL)				
	4.00	SPT		8N 8/300			Below 3.70m bgl: Becoming firm and red-brown.				
	4.80	D									
	5.00	SPT		16N 16/300			Below 5.00m bgl: Becoming stiff.				
							End of Borehole at 5.45 m	42.25	5.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.0m bgl. Cased to 2.0m bgl. Borehole backfilled with arisings on completion.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
2.50	-	-	-	16/02/2015	

APPLiED GEOLOGY Tel: 02476511822 Fax: 02476697682	Job No. AG2183-15	Site: Upper Parliament Street, Liverpool Client: Liverpool Mutual Homes & Flanagan Group Engineer: PDW Consultants	Borehole Log DCS3 Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
16/02/2015	101mm to 3.00m 92mm to 4.00m 79mm to 5.00m	49.00m AOD	MW	NL	1:50
Method		**Depth (m)**	**Co-ordinates**		**Ground Slope**
Driven Continuous Sampling		5.45	-		

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
							Grass over soft brown organic sandy CLAY. (MADE GROUND)	48.80	0.20		
	0.50	ES	4.40				Medium dense dark brownish-grey very gravelly fine to coarse SAND with frequent cobbles of brick, concrete and siltstone. Gravel is fine to coarse angular concrete and brick. (MADE GROUND)				
	1.00	SPT		12N 12/300							
	1.50	ES	0.10								
2.00	2.00	SPT		30N 30/300							
	2.80	ES	0.10								
	3.00	SPT		3N 3/300			Below 3.00m bgl: Becoming very loose.				
							Medium dense brown fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)	45.50	3.50		
	3.80	D									
	4.00	SPT		22N 22/300							
	5.00	SPT		14N 14/300							
							End of Borehole at 5.45 m	43.55	5.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.0m bgl. Cased to 2.0m bgl. Borehole backfilled with arisings on completion. Borehole drilled on top of ridge.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
No Groundwater Encountered					

APPLiED GEOLOGY
Tel: 02476511822
Fax: 02476697682

Job No. AG2183-15

Site: Upper Parliament Street, Liverpool
Client: Liverpool Mutual Homes & Flanagan Group
Engineer: PDW Consultants

Borehole Log
DCS4
Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
16/02/2015	101mm to 3.00m 92mm to 4.00m 79mm to 5.00m	47.50m AOD	MW	NL	1:50

Method	Depth (m)	Co-ordinates	Ground Slope
Driven Continuous Sampling	5.45	-	

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
	0.20	ES	0.10				Grass over soft brown organic sandy slightly gravelly CLAY. Gravel is fine to medium angular brick. (MADE GROUND)	47.25	0.25		
	0.60	ES	0.10				Medium dense brown gravelly fine to coarse SAND with frequent cobbles of brick and concrete. Gravel is fine to coarse angular brick, concrete and clinker. (MADE GROUND) From 1.0m - 1.3m bgl: Becoming ashy with gravel of fine clinker.				
	1.00	SPT		13N							
	1.20	ES	0.10	13/300			Below 1.6m bgl: Becoming very clayey.				
▽	2.00	SPT		20N 20/300			Medium dense brown fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)	45.60	1.90		
	2.60	D									
	3.00	SPT		6N 6/300			Below 3.00m bgl: Becoming loose.				
	3.90	D			12/27	20.00	Soft grey slightly sandy CLAY. (GLACIOFLUVIAL DEPOSITS)	43.70	3.80		
	4.00	SPT		8N 8/300			Loose brown fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)	43.50	4.00		
	4.60	D					Firm becoming stiff grey slightly sandy CLAY. (GLACIAL TILL)	42.80	4.70		
	5.00	SPT		20N 20/300			End of Borehole at 5.45 m	42.05	5.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.00m bgl. Cased to 2.00m bgl. 50mm diameter standpipe installed to 4.00m bgl, plain pipe ground level to 2.00m with bentonite seal and slotted pipe 2.00m to 4.00m with gravel pack. Borehole backfilled with arisings from 4.00m to 5.45m bgl.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
2.00	-	-	-	16/02/2015	

APPLiED GEOLOGY Tel: 02476511822 Fax: 02476697682	Job No. AG2183-15	Site: Upper Parliament Street, Liverpool Client: Liverpool Mutual Homes & Flanagan Group Engineer: PDW Consultants	Borehole Log DCS5 Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
17/02/2015	101mm to 1.45m	48.90m AOD	MW	NL	1:50
Method		**Depth (m)**	**Co-ordinates**		**Ground Slope**
Driven Continuous Sampling		1.45	-		

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
	0.20	ES	0.10				Grass over soft brown organic sandy slightly gravelly CLAY. Gravel is fine to coarse subrounded brick. (MADE GROUND)	48.60	0.30		
	0.70	ES	0.10				Brown sandy fine to coarse GRAVEL with frequent cobbles of brick, concrete and sandstone. Gravel is fine to coarse angular concrete, brick and clinker. (MADE GROUND)				
							End of Borehole at 1.45 m	47.45	1.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.0m bgl. Borehole backfilled with arisings on completion. Borehole drilled on top of ridge.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
No Groundwater Encountered					

APPLiED GEOLOGY Tel: 02476511822 Fax: 02476697682	Job No. AG2183-15	Site: Upper Parliament Street, Liverpool Client: Liverpool Mutual Homes & Flanagan Group Engineer: PDW Consultants	Borehole Log DCS6 Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
17/02/2015	101mm to 3.00m 92mm to 4.00m 79mm to 6.00m	48.70m AOD	MW	NL	1:50

Method	Depth (m)	Co-ordinates	Ground Slope
Driven Continuous Sampling	6.45	-	

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
							Grass over soft brown organic sandy CLAY. (MADE GROUND)	48.50	0.20		
	0.40	ES	0.10				Medium dense brown sandy fine to coarse GRAVEL with frequent cobbles of brick and concrete. Gravel is fine to coarse angular concrete and brick. (MADE GROUND)				
	1.00	SPT		15N 15/300							
▽	2.00	SPT ES	0.10	30N 30/300							
	3.00	SPT		8N 8/300			Below 3.00m bgl: Becoming loose.				
	4.00	SPT		6N 6/300			Loose brown fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)	44.70	4.00		
	4.60	D									
	5.00	SPT		5N 5/300							
	5.70	D					Below 5.5m bgl: Clay pockets. Below 5.6m bgl: Becoming slightly gravelly with gravel of fine subrounded quartzite, mudstone and siltstone. Below 6.00m bgl: Becoming very loose.				
	6.00	SPT		4N 4/300							
							End of Borehole at 6.45 m	42.25	6.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.00m bgl. Cased to 2.00m bgl. 50mm diameter standpipe installed to 4.00m bgl, plain pipe ground level to 1.00m with bentonite seal and slotted pipe 1.00m to 4.00m with gravel pack. Borehole backfilled with arisings from 4.00m to 6.45m bgl.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
2.00	-	-	-	16/02/2015	

APPLiED GEOLOGY
Tel: 02476511822
Fax: 02476697682

Job No. AG2183-15

Site: Upper Parliament Street, Liverpool
Client: Liverpool Mutual Homes & Flanagan Group
Engineer: PDW Consultants

Borehole Log
DCS7
Sheet 1 of 1

Date	Diameter (mm)	Ground Level	Logged By	Checked By	Scale
17/02/2015	101mm to 3.00m 92mm to 4.00m 79mm to 5.00m 69mm to 6.00m	47.50m AOD	MW	NL	1:50

Method	Depth (m)	Co-ordinates	Ground Slope
Driven Continuous Sampling	6.45	-	

Date & Casing Depth	Depth (m)	Sample Type	PID (ppm)	SPT N or Cu	PL/ LL	NMC	Description of Strata	O.D Level	Depth (m)	Stand Pipe	Legend
	0.10	ES	0.10				Grass over soft brown organic sandy CLAY. (MADE GROUND)	47.30	0.20		
	0.50	ES	0.10				Medium dense brown very sandy fine to coarse GRAVEL with frequent cobbles of brick and concrete. Gravel is fine to coarse angular concrete and clinker. (MADE GROUND)				
	1.00	SPT	1.20	12N 12/300							
	1.60	ES									
▽	2.00	SPT		9N 9/300			Below 2.00m bgl: Becoming loose.				
							Below 2.5m bgl: Becoming very clayey.				
	3.00	SPT D		8N 8/300			Loose brown fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)	44.60	2.90		
	3.80	D					From 3.40m -3.90m bgl: Occasional fiberous organic bands upto 0.1m thick with sulphurous odour.				
	4.00	SPT		2N 2/300			Below 4.00m bgl: Becoming very loose.				
	4.80	D			10/19	18.00	Very soft grey-brown sandy CLAY. (GLACIOFLUVIAL DEPOSITS)	42.90	4.60		
	5.00	SPT		2N 2/300			Below 5.0m bgl: Frequent sand bands up to 0.1m thick.				
	6.00	SPT		18N 18/300			Stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine subrounded to subangular quartzite sandstone and mudstone. (GLACIAL TILL)	41.70	5.80		
							End of Borehole at 6.45 m	41.05	6.45		

GENERAL REMARKS:

Hand dug service inspection pit excavated to 1.00m bgl. Cased to 2.00m bgl. 50mm diameter standpipe installed to 4.00m bgl, plain pipe ground level to 3.00m with bentonite seal and slotted pipe 3.00m to 4.00m with gravel pack. Borehole bakcfilled with arisings from 4.00m to 6.45m bgl.

GROUNDWATER

Struck	Cased	20 mins	Sealed	Date	Remarks
2.00	-	-	-	16/02/2015	

APPLiED GEOLOGY
Tel: 02476511822
Fax: 02476697682

Job No. AG2183-15

Site: Upper Parliament Street, Liverpool
Client: Liverpool Mutual Homes & Flanagan Group
Engineer: PDW Consultants

Trial Pit Log
HEP1
Sheet 1 of 1

Method	Date	Logged By	Checked By	Scale
Hand dug	17/02/2015	MW	NL	1:25

Length (m)	Breadth (m)	Orientation	Depth (m)	Ground Level	Co-ordinates	Ground Slope
0.30	0.30	-	1.20	47.40m AOD	-	

Depth (m)	SOIL SAMPLES/TESTS Type	Strength	PID (ppm)	PL/LL %	M/C %	Ease of Dig	Description of Strata	O.D Level	Depth (m)	Legend
0.20	ES		0.10				Grass over soft brown organic sandy CLAY. (MADE GROUND)			
								47.10	0.30	
0.70	ES		0.10				Brown clayey gravelly fine to coarse SAND with frequent cobbles of brick and concrete. Gravel is fine to coarse angular brick, concrete and clinker. (MADE GROUND)			
							End of Trial Pit at 1.20 m	46.20	1.20	

GROUNDWATER DETAILS:
Groundwater not encountered.

STABILITY OF PIT WALLS:
Stable.

GENERAL REMARKS:
Hand dug pit excavated in location of former electrical substation.
Pit backfilled with arisings on completion.

KEY

SAMPLES B = Bulk, D = Tub, W = Water, ES = Amber Glass Jar, CBR = CBR Test, SPT = Insitu Penetration Test

SHEAR STRENGTH (kN/m2) V=Hand Vane P=Hand Penetrometer

GROUNDWATER ▽ Entry, ▼ Standing Level

Ease of Dig E = Easy, M = Moderate, H = Hard, VH = Very Hard

APPENDIX C

Gas Monitoring Equipment Specification and Accuracy Details

Instrument Specifications

Instrument	Atmospheric Pressure Range	Temperature Range	Flow Range	Flow Resolution	Borehole Pressure Range	Test Time	Flow Volume
GFM 430	800 to 1200 mbar+/- 1m bar	-10°C to + 40°C	-30 to +30 l/hr	0.1l/hr	+1000 to - 1000 Pa	N/A	-
Mini Rae 2000	-	0 - 45°C	-	-	-	-	-
Pro Check Tiger	-	-20 to + 60°C (Certified to -15 to + 45°C)	-	-	-	-	-

Instrument Accuracy

Instrument		Methane	Lower Explosive Limit	Carbon Dioxide	Oxygen	Volatile Organic Compounds	Hydrogen Sulphide	Carbon Monoxide
GFM430	Detection Range	0-100%	0-100%	0 -100%	0-25%	NA	1500ppm response 30 secs	1000ppm response 30 Secs
	Detection Accuracy	+/- 0.2% @ 5% 1.0% @30% 3.0% @ 100% Response 20 secs	+/-4% of LEL Response 40 secs	Accuracy 0.1% @10% 3.0% @40% 3% @ 100% Response 20 Secs	+/- 0.5% Response 20 secs	NA	5% of fs	5% of fs
Mini Rae 2000	Detection Range	N/A	N/A	N/A	N/A	0-99ppm - 0.1ppm 2 sec 100-1999ppm 1.0ppm 2 sec 2000-10000 ppm 1.0 ppm 2 sec	N/A	N/A
	Detection Accuracy	N/A	N/A	N/A	N/A	0-2000 ppm +/- 2ppm or 10% >2000ppm +/- 20% reading (For Isobutylene 100ppm)	N/A	N/A
Pro Check Tiger	Detection Range	N/A	N/A	N/A	N/A	1 ppb - 10,000 ppm	N/A	N/A
	Detection Accuracy	N/A	N/A	N/A	N/A	+/- 1ppb +- 5% of actual displayed accuracy +/- One digit Response < 2sec	N/A	N/A

Calibration Frequency

Instruments are calibrated annually.

Details of the instrument calibration certificates and service records are available if required.

Equipment Serial Numbers

GFM430 - (10071, 10072, 10347)

Mini Rae 2000 - (110-901200, 110-901321)

Pro Check Tiger - (108308)

APPLiED GEOLOGY

Ground Gas Monitoring and Flow Results

Project/Site Name Upper Parliament Sreet, Liverpool

Project Number AG2183-15

Date and Time of Monitoring 02/03/2015

Phase of Monitoring 1

BH No.	Flow Range (litres/hr over 3 mins)			Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		Installed Depth (m bgl)	Diameter of installation (mm)	Water level (m bgl)	Base of installation check (m bgl)
	Max	Min	Avg		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady				
DCS1	0.1	-0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	0.9	0.9	20.1	20.1	4.00	50	2.66	3.70
DCS4	0.1	-0.1	0.1	<1	<0.1	<0.1	<0.1	<0.1	5.7	5.7	15.6	15.6	4.00	50	2.85	3.74
DCS6	2.5	-0.7	1.6	5	<0.1	<0.1	<0.1	<0.1	1.0	1.0	19.5	19.5	4.00	50	Dry	4.03
DCS7	0.2	-0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	5.8	5.8	14.8	14.8	4.00	50	3.30	4.00

Meterological Data

Atmospheric Pressure (mb)	992-992
Pressure Rising or Falling	Steady
Weather Conditions	Overcast
Atmospheric Oxygen (% vol)	20.9
Wind Speed & Direction	Calm
Ambient Air Tempertaure (°C)	4

Site Data

Monitoring Personnel	Mathew Walker		
GPS Instrument			
Equipment Used	GFM	PID	Flowmeter
Equipment Serial Number	10071		10071
Ground Conditions (vegetation stress, visual contamination)			

General Notes

Instrument specification data and calibration information is provided on a separate data sheet

APPLiED GEOLOGY

Ground Gas Monitoring and Flow Results

Project/Site Name Upper Parliament Sreet, Liverpool

Project Number AG2183-15

Date and Time of Monitoring 06/03/2015

Phase of Monitoring 2

BH No.	Flow Range (litres/hr over 3 mins)			Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		Installed Depth (m bgl)	Diameter of installation (mm)	Water level (m bgl)	Base of installation check (m bgl)
	Max	Min	Avg		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady				
DCS1	0.6	-0.2	-0.1	<1	<0.1	<0.1	<0.1	<0.1	0.7	0.7	19.9	19.9	4.00	50	2.69	3.60
DCS4	<0.1	-0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	5.3	5.3	15.6	15.6	4.00	50	2.86	3.13
DCS6	0.1	-0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	0.9	0.9	19.8	19.8	4.00	50	Dry	4.03
DCS7	0.9	<0.1	0.4	1	<0.1	<0.1	<0.1	<0.1	5.8	5.8	14.9	14.9	4.00	50	3.30	4.00

Meterological Data

Atmospheric Pressure (mb)	1022-1022
Pressure Rising or Falling	Steady
Weather Conditions	Overcast
Atmospheric Oxygen (% vol)	20.9
Wind Speed & Direction	Calm
Ambient Air Tempertaure (°C)	7

Site Data

Monitoring Personnel	Mathew Walker		
GPS Instrument			
Equipment Used	GFM	PID	Flowmeter
Equipment Serial Number	10071		10071
Ground Conditions (vegetation stress, visual contamination)			

General Notes

Instrument specification data and calibration information is provided on a separate data sheet

APPLiED GEOLOGY

Ground Gas Monitoring and Flow Results

Project/Site Name Upper Parliament Sreet, Liverpool

Project Number AG2183-15

Date and Time of Monitoring 16/03/2015

Phase of Monitoring 3

BH No.	Flow Range (litres/hr over 3 mins)			Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		Installed Depth (m bgl)	Diameter of installation (mm)	Water level (m bgl)	Base of installation check (m bgl)
	Max	Min	Avg		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady				
DCS1	0.3	<0.1	0.2	1	<0.1	<0.1	<0.1	<0.1	0.8	0.8	20.1	20.1	4.00	50	2.69	3.42
DCS4	-0.2	-0.4	-0.4	-2	<0.1	<0.1	<0.1	<0.1	7.0	7.0	14.2	14.2	4.00	50	2.86	3.17
DCS6	0.2	-0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	1.1	1.1	19.3	19.3	4.00	50	Dry	4.03
DCS7	-0.7	-0.9	-0.9	-5	<0.1	<0.1	<0.1	<0.1	6.2	6.2	14.3	14.3	4.00	50	3.30	4.00

Meterological Data

Atmospheric Pressure (mb)	1016-1016
Pressure Rising or Falling	Steady
Weather Conditions	Overcast
Atmospheric Oxygen (% vol)	20.9
Wind Speed & Direction	Calm
Ambient Air Tempertaure (°C)	5

Site Data

Monitoring Personnel	Mathew Walker		
GPS Instrument			
Equipment Used	GFM	PID	Flowmeter
Equipment Serial Number	10071		10071
Ground Conditions (vegetation stress, visual contamination)			

General Notes

Instrument specification data and calibration information is provided on a separate data sheet

APPLiED GEOLOGY

Ground Gas Monitoring and Flow Results

Project/Site Name Upper Parliament Sreet, Liverpool

Project Number AG2183-15

Date and Time of Monitoring 24/03/2015

Phase of Monitoring 4

BH No.	Flow Range (litres/hr over 3 mins)			Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		Installed Depth (m bgl)	Diameter of installation (mm)	Water level (m bgl)	Base of installation check (m bgl)
	Max	Min	Avg		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady				
DCS1	<0.1	-0.4	-0.3	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.1	20.1	4.00	50	2.63	3.40
DCS4	0.1	-0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	0.8	0.8	20.3	20.3	4.00	50	2.89	3.17
DCS6	1.0	0.6	0.6	4	<0.1	<0.1	<0.1	<0.1	0.9	0.9	20.0	20.0	4.00	50	Dry	4.03
DCS7	-0.4	-1.0	-0.7	-3	<0.1	<0.1	<0.1	<0.1	6.3	6.3	14.2	14.2	4.00	50	3.38	3.96

Meterological Data

Atmospheric Pressure (mb)	1002-1001
Pressure Rising or Falling	Falling
Weather Conditions	Overcast
Atmospheric Oxygen (% vol)	20.9
Wind Speed & Direction	Calm
Ambient Air Tempertaure (°C)	7

Site Data

Monitoring Personnel	Mathew Walker		
GPS Instrument			
Equipment Used	GFM	PID	Flowmeter
Equipment Serial Number	10071		10071
Ground Conditions (vegetation stress, visual contamination)			

General Notes

Instrument specification data and calibration information is provided on a separate data sheet

APPLiED GEOLOGY

Ground Gas Monitoring and Flow Results

Project/Site Name Upper Parliament Sreet, Liverpool

Project Number AG2183-15

Date and Time of Monitoring 30/03/2015

Phase of Monitoring 5

BH No.	Flow Range (litres/hr over 3 mins)			Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		Installed Depth (m bgl)	Diameter of installation (mm)	Water level (m bgl)	Base of installation check (m bgl)
	Max	Min	Avg		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady				
DCS1	2.2	1.0	1.7	8	<0.1	<0.1	<0.1	<0.1	1.0	0.9	19.8	20.1	4.00	50	2.71	3.40
DCS4	-0.4	-0.9	-0.4	-3	<0.1	<0.1	<0.1	<0.1	7.4	7.4	14.6	14.6	4.00	50	2.91	3.13
DCS6	1.8	<0.1	0.4	2	<0.1	<0.1	<0.1	<0.1	1.1	1.1	19.6	19.6	4.00	50	Dry	4.03
DCS7	1.2	-0.4	0.4	3	<0.1	<0.1	<0.1	<0.1	6.4	6.4	14.0	14.0	4.00	50	3.32	4.00

Meterological Data

Atmospheric Pressure (mb)	1002-1002
Pressure Rising or Falling	Falling
Weather Conditions	Overcast
Atmospheric Oxygen (% vol)	20.9
Wind Speed & Direction	Calm
Ambient Air Tempertaure (°C)	7

Site Data

Monitoring Personnel	Mathew Walker		
GPS Instrument			
Equipment Used	GFM	PID	Flowmeter
Equipment Serial Number	10071		10071
Ground Conditions (vegetation stress, visual contamination)			

General Notes

Instrument specification data and calibration information is provided on a separate data sheet

APPLiED GEOLOGY

Ground Gas Monitoring and Flow Results

Project/Site Name Upper Parliament Sreet, Liverpool

Project Number AG2183-15

Date and Time of Monitoring 02/04/2015

Phase of Monitoring 6

BH No.	Flow Range (litres/hr over 3 mins)			Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		Installed Depth (m bgl)	Diameter of installation (mm)	Water level (m bgl)	Base of installation check (m bgl)
	Max	Min	Avg		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady				
DCS1	0.4	-0.4	-0.2	-1	<0.1	<0.1	<0.1	<0.1	0.8	0.8	19.8	19.8	4.00	50	2.69	3.40
DCS4	-0.2	-0.7	-0.4	-3	<0.1	<0.1	<0.1	<0.1	7.3	7.3	14.9	14.9	4.00	50	2.89	3.15
DCS6	-0.2	-0.4	-0.2	-2	<0.1	<0.1	<0.1	<0.1	0.9	0.9	19.8	19.8	4.00	50	Dry	4.03
DCS7	0.3	<0.1	0.2	1	<0.1	<0.1	<0.1	<0.1	6.4	6.4	14.2	14.2	4.00	50	3.27	4.00

Meterological Data

Atmospheric Pressure (mb)	1012-1012
Pressure Rising or Falling	Falling
Weather Conditions	Cloudy
Atmospheric Oxygen (% vol)	20.9
Wind Speed & Direction	Calm
Ambient Air Tempertaure (°C)	5

Site Data

Monitoring Personnel	Mathew Walker		
GPS Instrument			
Equipment Used	GFM	PID	Flowmeter
Equipment Serial Number	10071		10071
Ground Conditions (vegetation stress, visual contamination)			

General Notes

Instrument specification data and calibration information is provided on a separate data sheet

APPLiED GEOLOGY

APPLiED GEOLOGY

Variable Head Permeability Test Data Sheet

Job Name Upper Parliament Street, Liverpool

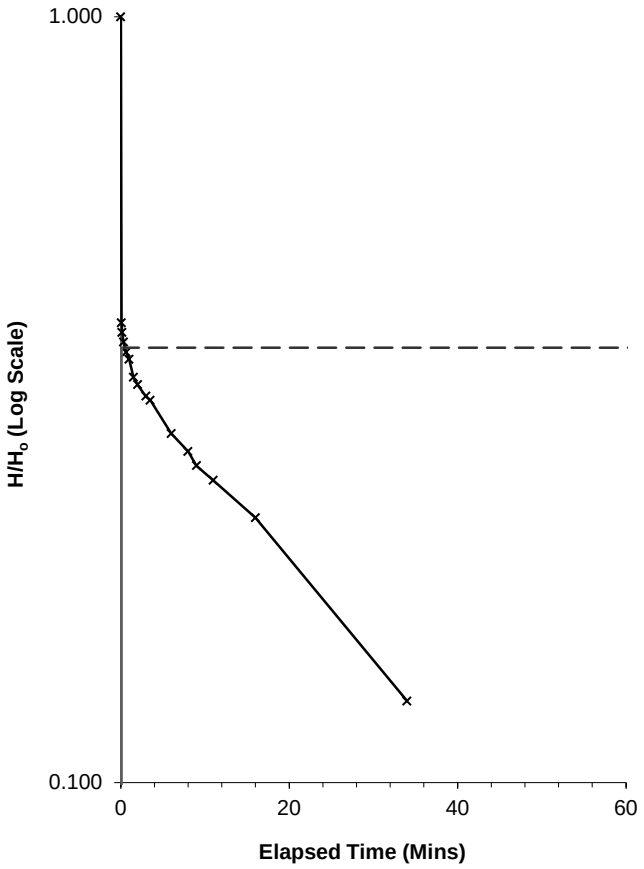
Job Number AG2183-15

Borehole No DCS1

Field Data

Elapsed Time (t) (mins)	Depth to water from top of casing or standpipe (m)	Head (H) (m)	Head Ratio (H/H_o)
0.0	0.00	2.66	1.000
0.1	1.60	1.06	0.398
0.2	1.63	1.03	0.387
0.3	1.66	1.00	0.376
0.7	1.69	0.97	0.365
1.0	1.71	0.95	0.357
1.5	1.76	0.90	0.338
2.0	1.78	0.88	0.331
3.0	1.81	0.85	0.320
3.5	1.82	0.84	0.316
6.0	1.90	0.76	0.286
8.0	1.95	0.72	0.271
9.0	1.97	0.69	0.259
11.0	2.00	0.66	0.248
16.0	2.07	0.59	0.222
34.0	2.32	0.34	0.128

Plot of H/H_o against Time



Permeability Results

Does Plot of Time vs Head Ratio go below H/Ho = 0.37? **Yes** *Use Basic Time Lag*

Yes *Use General Approach*

Basic Time Lag Approach:

k = A/FT

Basic Time Lag T= 0.5 mins

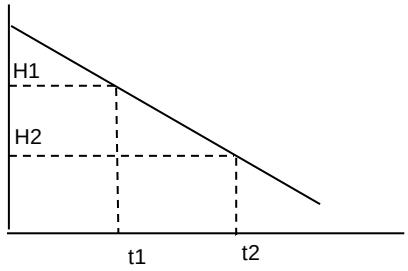
Permeability k= 1.70E-05 m/sec

General Approach:

k = [A/F(t2-t1) loge (H1/H2)]

H1 1.06 m t1 0.100 mins

H2 0.34 m t2 34.000 mins



Permeability k= 2.86E-07 m/sec

APPLIED GEOLOGY

Variable Head Permeability Test Data Sheet

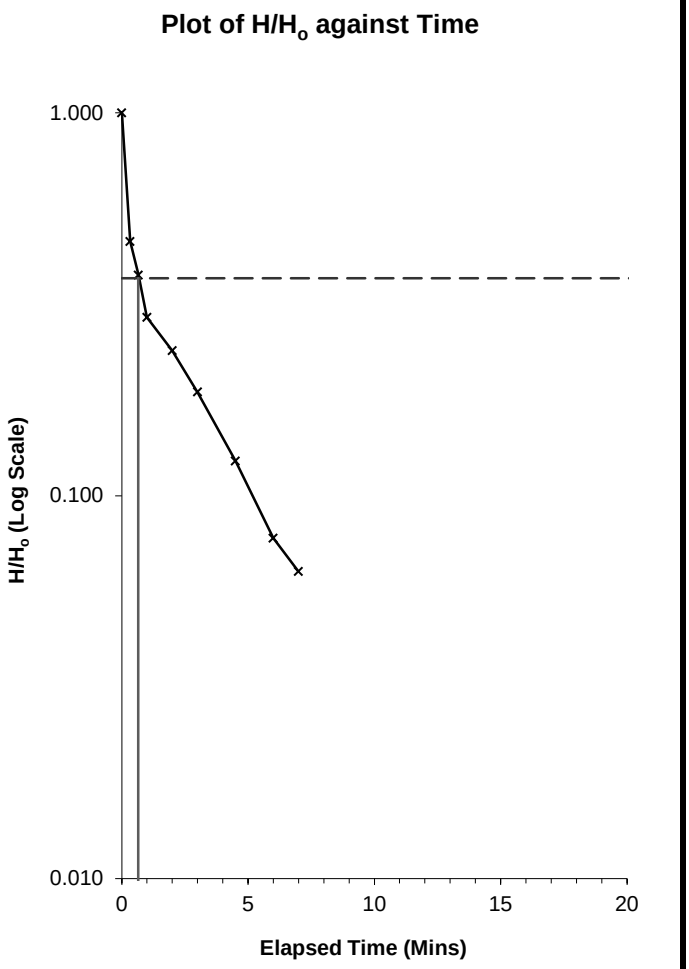
Job Name Upper Parliament Street, Liverpool

Job Number AG2183-15

Borehole No DCS4

Field Data

Elapsed Time (t) (mins)	Depth to water from top of casing or standpipe (m)	Head (H) (m)	Head Ratio (H/H_o)
0.0	0.00	2.84	1.000
0.3	1.53	1.31	0.461
0.7	1.77	1.07	0.377
1.0	2.01	0.83	0.292
2.0	2.16	0.68	0.239
3.0	2.31	0.53	0.187
4.5	2.49	0.35	0.123
6.0	2.62	0.22	0.077
7.0	2.66	0.18	0.063



Permeability Results

Does Plot of Time vs Head Ratio go below H/Ho = 0.37? **Yes** *Use Basic Time Lag*

Yes *Use General Approach*

Basic Time Lag Approach:

k = A/FT

Basic Time Lag T= 0.75 mins

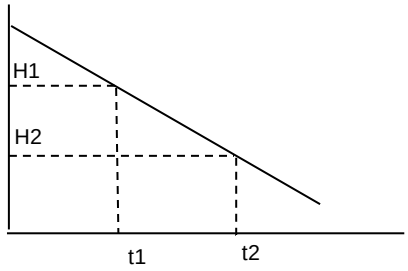
Permeability k= 1.13E-05 m/sec

General Approach:

k = [A/F(t2-t1) loge (H1/H2)]

H1 1.31 m t1 0.300 mins

H2 0.18 m t2 7.000 mins



Permeability k= 2.52E-06 m/sec

APPENDIX D

SOIL CHEMICAL RESULTS COMPARED AGAINST SCREENING VALUES FOR HUMAN HEALTH

Site: Upper Parliament Street, Liverpool
Job No: AG2183-15

Land Use: Residential with plant uptake
Dataset: All Made Ground
Soil Organic Matter (%) 6

		Made Ground								ashy Made Ground			
Exploratory Hole Reference		DCS1	DCS2	DCS3	DCS3	DCS4	DCS6	DCS7	HDP1	DCS4			
Depth (m)		0.7	0.5	0.5	2.8	0.3	2	0.1	0.7	1.2			
Strata		MG	MG	MG	MG	MG	MG	MG	MG	MG			
	Units										**No. of samples (n)**	**Soil Screening Value (6% SOM)**	**Source/Justification**
Organic Matter (%)	%	3.8	2.9	4.1	1.7	3.1	1.9	6.4	4.1	50	8		
pH		8.8	8.6	8.5	8.2	8	8.8	8.1	8	7.8	8		
Arsenic	mg kg-1	11	23	18	15	14	18	9.8	25	83	8	37	C4SL (2014)
Cadmium	mg kg-1	0.28	0.39	0.5	0.27	0.29	0.21	0.42	2.2	1.4	8	26	C4SL (2014)
Chromium	mg kg-1	22	25	16	18	23	16	14	34	18	8	627	AG derived using published data & CLEA v1.06
Chromium (Hexavalent)	mg kg-1	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	8	26.0	C4SL (2014)
Copper	mg kg-1	35	59	53	44	43	45	29	69	310	8	2300	AG derived using published data & CLEA v1.06
Lead	mg kg-1	460	810	330	160	83	150	89	170	1600	8	200	C4SL (2014)
Mercury	mg kg-1	0.23	0.68	0.45	1.8	0.24	0.32	0.19	0.5	1.1	8	170	AG derived using published data & CLEA v1.06
Nickel	mg kg-1	18	19	15	11	17	13	9.6	18	76	8	130	Atkins ATRISK (March 2011)
Selenium	mg kg-1	**0.2**	0.33	0.52	**0.2**	0.75	**0.2**	0.27	**0.2**	4.6	8	350	Atkins ATRISK (March 2011)
Zinc	mg kg-1	110	290	170	170	96	130	79	320	1400	8	3750	AG derived using published data & CLEA v1.06
Naphthalene	mg kg-1	0.14	0.25	0.19	**0.1**	**0.1**	0.2	**0.1**	**0.1**	1.1	8	8.7	LQM GAC (December 2009)
Acenaphthylene	mg kg-1	0.17	0.1	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	0.81	8	850	LQM GAC (December 2009)
Acenaphthene	mg kg-1	0.92	0.68	0.48	**0.1**	**0.1**	0.35	**0.1**	**0.1**	1.7	8	1000	LQM GAC (December 2009)
Fluorene	mg kg-1	0.75	0.55	0.36	**0.1**	**0.1**	0.22	**0.1**	**0.1**	1.9	8	780	LQM GAC (December 2009)
Phenanthrene	mg kg-1	9.6	5	3.1	**0.1**	**0.1**	1.7	0.74	**0.1**	12	8	380	LQM GAC (December 2009)
Anthracene	mg kg-1	0.57	1	0.54	**0.1**	**0.1**	0.3	0.15	**0.1**	1.9	8	9200	LQM GAC (December 2009)
Fluoranthene	mg kg-1	13	5.6	4.4	0.65	0.7	2.2	1.3	0.84	18	8	670	LQM GAC (December 2009)
Pyrene	mg kg-1	14	6	4.9	0.72	0.78	2.6	1.4	0.9	24	8	1600	LQM GAC (December 2009)
Benzo[a]anthracene	mg kg-1	3	2.2	1.4	0.19	0.2	0.88	0.33	0.21	11	8	*	
Chrysene	mg kg-1	6	3.6	1.5	0.37	0.32	0.83	0.41	0.33	15	8	*	
Benzo[b]fluoranthene	mg kg-1	3.5	2.1	2.3	0.53	0.45	1.2	0.58	0.22	14	8	*	
Benzo[k]fluoranthene	mg kg-1	1.2	0.69	0.95	0.23	0.28	0.52	0.32	0.28	5	8	*	
Benzo[a]pyrene	mg kg-1	2.2	2	1.9	0.43	0.41	0.94	0.55	0.46	11	8	5	C4SL (2014)
Dibenzo[a,h]anthracene	mg kg-1	0.42	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	0.14	1.9	8	*	
Indeno[1,2,3-cd]pyrene	mg kg-1	1.1	0.82	0.86	0.32	0.21	0.64	0.34	0.22	4.9	8	*	
Benzo[g,h,i]perylene	mg kg-1	1.3	1	1.2	0.37	0.33	0.59	0.62	0.23	6.5	8	*	
Phenols	mg kg-1	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	8	420	EA SGV (2009)
TPH >C5-C6	mg kg-1			**1**							1	110	LQM GAC (December 2009)
TPH >C6-C7	mg kg-1			**1**							1	280	LQM GAC (December 2009)
TPH >C7-C8	mg kg-1			**1**							1	611	LQM GAC (December 2009)
TPH >C8-C10	mg kg-1			**1**							1	110	LQM GAC (December 2009)
TPH >C10-C12	mg kg-1			**1**							1	346	LQM GAC (December 2009)
TPH >C12-C16	mg kg-1			5.8							1	593	LQM GAC (December 2009)
TPH >C16-C21	mg kg-1			15							1	770	LQM GAC (December 2009)
TPH >C21-C35	mg kg-1			71							1	1230	LQM GAC (December 2009)
TPH >C35-C44	mg kg-1			10							1	1230	LQM GAC (December 2009)
Total Petroleum Hydrocarbons	mg kg-1			100							1		
Total PCB's	mg kg-1								**0.1**		1		
Asbestos	%	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	9		

Key -
Value within sample set exceeds screening value
Values in **bold** are reported at the laboratory limit of detection
Benzo(a)pyrene has been used as a 'surrogate marker for genotoxic PAH' as discussed in Appendix E of CL:AIRE SP1010 'Development of C4SL for Assessment of Land Affected by Contamination', December 2013.
This allows assessment of the combined carcinogenic risk associated with genotoxic PAH using only b(a)p. Genotoxic PAHs include Benz(a)pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(ah)anthracene, Indeno(123cd)pyrene, Benzo(ghi)perylene and

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Amended Report

Report Number:	15-03806 Issue-2		
Initial Date of Issue:	23-Feb-2015	**Date of Re-Issue:**	20-Apr-2015
Client:	Applied Geology		
Client Address:	Centrix House Crow Lane East Newton Le Willos Merseyside WA12 9UY		
Contact(s):	Matthew Walker Peter Gabrielle		
Project:	AG2183-15 Upper Parliament Street, Liverpool		
Quotation No.:		**Date Received:**	19-Feb-2015
Order No.:	07568	**Date Instructed:**	24-Feb-2015
No. of Samples:	19		
Turnaround: (Wkdays)	38	**Results Due Date:**	20-Apr-2015
Date Approved:	20-Apr-2015		

Approved By:

Details: Darrell Hall, Laboratory Director

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Project: AG2183-15 Upper Parliament Street, Liverpool

Client: Applied Geology			**Chemtest Job No.:**		15-03806	15-03806	15-03806	15-03806	15-03806	15-03806	15-03806	15-03806	15-03806
Quotation No.:			**Chemtest Sample ID.:**		104862	104863	104865	104866	104867	104868	104870	104872	104874
Order No.: 07568			Client Sample Ref.:		MG	MG	MG	MG	MG	MG	MG	MG	MG
			Client Sample ID.:		DCS1	DCS2	DCS3	DCS3	DCS3	DCS4	DCS4	DCS5	DCS6
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.70	0.50	0.50	1.50	2.80	0.30	1.20	0.70	2.00
			Bottom Depth(m):										
			Date Sampled:		16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	17-Feb-15	17-Feb-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Organic Matter	M	2625	%	0.4	3.8	2.9	4.1		1.7	3.1	50		1.9
Arsenic	M	2450	mg/kg	1	11	23	18		15	14	83		18
Cadmium	M	2450	mg/kg	0.1	0.28	0.39	0.50		0.27	0.29	1.4		0.21
Chromium	M	2450	mg/kg	1	22	25	16		18	23	18		16
Chromium (Hexavalent)	N	2490	mg/kg	0.5	< 0.50	< 0.50	< 0.50		< 0.50	< 0.50	< 0.50		< 0.50
Copper	M	2450	mg/kg	0.5	35	59	53		44	43	310		45
Lead	M	2450	mg/kg	0.5	460	810	330		160	83	1600		150
Magnesium (Water Soluble)	N	2120	g/l	0.01	< 0.010	< 0.010	< 0.010	< 0.010	0.030	< 0.010	< 0.010	< 0.010	< 0.010
Mercury	M	2450	mg/kg	0.1	0.23	0.68	0.45		1.8	0.24	1.1		0.32
Nickel	M	2450	mg/kg	0.5	18	19	15		11	17	76		13
Selenium	M	2450	mg/kg	0.2	< 0.20	0.33	0.52		< 0.20	0.75	4.6		< 0.20
Zinc	M	2450	mg/kg	0.5	110	290	170		170	96	1400		130
Naphthalene	M	2700	mg/kg	0.1	0.14	0.25	0.19		< 0.10	< 0.10	1.1		0.20
Acenaphthylene	M	2700	mg/kg	0.1	0.17	0.10	< 0.10		< 0.10	< 0.10	0.81		< 0.10
Acenaphthene	M	2700	mg/kg	0.1	0.92	0.68	0.48		< 0.10	< 0.10	1.7		0.35
Fluorene	M	2700	mg/kg	0.1	0.75	0.55	0.36		< 0.10	< 0.10	1.9		0.22
Phenanthrene	M	2700	mg/kg	0.1	9.6	5.0	3.1		< 0.10	< 0.10	12		1.7
Anthracene	M	2700	mg/kg	0.1	0.57	1.0	0.54		< 0.10	< 0.10	1.9		0.30
Fluoranthene	M	2700	mg/kg	0.1	13	5.6	4.4		0.65	0.70	18		2.2
Pyrene	M	2700	mg/kg	0.1	14	6.0	4.9		0.72	0.78	24		2.6
Benzo[a]anthracene	M	2700	mg/kg	0.1	3.0	2.2	1.4		0.19	0.20	11		0.88
Chrysene	M	2700	mg/kg	0.1	6.0	3.6	1.5		0.37	0.32	15		0.83
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	3.5	2.1	2.3		0.53	0.45	14		1.2
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	1.2	0.69	0.95		0.23	0.28	5.0		0.52
Benzo[a]pyrene	M	2700	mg/kg	0.1	2.2	2.0	1.9		0.43	0.41	11		0.94
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	0.42	< 0.10	< 0.10		< 0.10	< 0.10	1.9		< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	1.1	0.82	0.86		0.32	0.21	4.9		0.64
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	1.3	1.0	1.2		0.37	0.33	6.5		0.59
Total Of 16 PAH's	M	2700	mg/kg	2	58	32	24		3.8	3.7	130		13
Total Phenols	M	2920	mg/kg	0.3	< 0.30	< 0.30	< 0.30		< 0.30	< 0.30	< 0.30		< 0.30
TPH >C5-C6	N	2670	mg/kg	1			< 1.0						
TPH >C6-C7	N	2670	mg/kg	1			< 1.0						
TPH >C7-C8	N	2670	mg/kg	1			< 1.0						

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Project: AG2183-15 Upper Parliament Street, Liverpool

Client: Applied Geology			Chemtest Job No.:		15-03806	15-03806	15-03806	15-03806	15-03806	15-03806	15-03806	15-03806	15-03806
Quotation No.:			Chemtest Sample ID.:		104862	104863	104865	104866	104867	104868	104870	104872	104874
Order No.: 07568			Client Sample Ref.:		MG	MG	MG	MG	MG	MG	MG	MG	MG
			Client Sample ID.:		DCS1	DCS2	DCS3	DCS3	DCS3	DCS4	DCS4	DCS5	DCS6
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.70	0.50	0.50	1.50	2.80	0.30	1.20	0.70	2.00
			Bottom Depth(m):										
			Date Sampled:		16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	16-Feb-15	17-Feb-15	17-Feb-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
TPH >C8-C10	N	2670	mg/kg	1			< 1.0						
TPH >C10-C12	N	2670	mg/kg	1			< 1.0						
TPH >C12-C16	N	2670	mg/kg	1			5.8						
TPH >C16-C21	N	2670	mg/kg	1			15						
TPH >C21-C35	N	2670	mg/kg	1			71						
TPH >C35-C44	N	2670	mg/kg	1			10						
Total TPH >C5-C44	N	2670	mg/kg	10			100						
Sulphate (Acid Soluble)	M	2430	%	0.01				0.11				0.039	
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.01	< 0.010	0.11	0.028	1.3	1.3	0.052	0.016	0.010	1.3
ACM Type	U	2192			-	-	-		-	-	-		-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		No Asbestos Detected
Moisture	N	2030	%	0.02	10	8.6	9.5	9.6	8.5	14	20	11	8.9
Stones	N	2030	%	0.02	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Soil Colour	N				Brown	Brown	Brown		Brown	Brown	Brown		Brown
Other Material	N				Stones	Stones	Stones		Stones	Stones	Stones		Stones
Soil Texture	N				Sand	Sand	Sand		Sand	Sand	Sand		Sand
pH	M	2010			8.8	8.6	8.5	8.9	8.2	8.0	7.8	9.7	8.8
Total Sulphur	M	2175	%	0.01				0.090				0.090	
Chloride (Extractable)	M	2220	g/l	0.01				0.015				0.014	
Nitrate (Extractable)	N	2220	g/l	0.01				< 0.010				< 0.010	
PCB 28	M	2810	mg/kg	0.01									
PCB 52	M	2815	mg/kg	0.01									
PCB 101	M	2815	mg/kg	0.01									
PCB 118	M	2815	mg/kg	0.01									
PCB 153	M	2815	mg/kg	0.01									
PCB 138	M	2815	mg/kg	0.01									
PCB 180	M	2810	mg/kg	0.01									
Total PCBs (7 Congeners)	N	2815	mg/kg	0.1									

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Project: AG2183-15 Upper Parliament Street, Liverpool

Client: Applied Geology			Chemtest Job No.:		15-03806	15-03806	15-03806
Quotation No.:			Chemtest Sample ID.:		104875	104877	104879
Order No.: 07568			Client Sample Ref.:		MG	MG	MG
			Client Sample ID.:		DCS7	DCS7	HED1
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		0.10	1.60	0.70
			Bottom Depth(m):				
			Date Sampled:		17-Feb-15	17-Feb-15	17-Feb-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Organic Matter	M	2625	%	0.4	6.4		4.1
Arsenic	M	2450	mg/kg	1	9.8		25
Cadmium	M	2450	mg/kg	0.1	0.42		2.2
Chromium	M	2450	mg/kg	1	14		34
Chromium (Hexavalent)	N	2490	mg/kg	0.5	< 0.50		< 0.50
Copper	M	2450	mg/kg	0.5	29		69
Lead	M	2450	mg/kg	0.5	89		170
Magnesium (Water Soluble)	N	2120	g/l	0.01	< 0.010	< 0.010	< 0.010
Mercury	M	2450	mg/kg	0.1	0.19		0.50
Nickel	M	2450	mg/kg	0.5	9.6		18
Selenium	M	2450	mg/kg	0.2	0.27		< 0.20
Zinc	M	2450	mg/kg	0.5	79		320
Naphthalene	M	2700	mg/kg	0.1	< 0.10		< 0.10
Acenaphthylene	M	2700	mg/kg	0.1	< 0.10		< 0.10
Acenaphthene	M	2700	mg/kg	0.1	< 0.10		< 0.10
Fluorene	M	2700	mg/kg	0.1	< 0.10		< 0.10
Phenanthrene	M	2700	mg/kg	0.1	0.74		< 0.10
Anthracene	M	2700	mg/kg	0.1	0.15		< 0.10
Fluoranthene	M	2700	mg/kg	0.1	1.3		0.84
Pyrene	M	2700	mg/kg	0.1	1.4		0.90
Benzo[a]anthracene	M	2700	mg/kg	0.1	0.33		0.21
Chrysene	M	2700	mg/kg	0.1	0.41		0.33
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	0.58		0.22
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	0.32		0.28
Benzo[a]pyrene	M	2700	mg/kg	0.1	0.55		0.46
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	< 0.10		0.14
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	0.34		0.22
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	0.62		0.23
Total Of 16 PAH's	M	2700	mg/kg	2	6.7		3.8
Total Phenols	M	2920	mg/kg	0.3	< 0.30		< 0.30
TPH >C5-C6	N	2670	mg/kg	1			
TPH >C6-C7	N	2670	mg/kg	1			
TPH >C7-C8	N	2670	mg/kg	1			

Results Summary - Soil

Project: AG2183-15 Upper Parliament Street, Liverpool

Client: Applied Geology			**Chemtest Job No.:**		15-03806	15-03806	15-03806
Quotation No.:			**Chemtest Sample ID.:**		104875	104877	104879
Order No.: 07568			Client Sample Ref.:		MG	MG	MG
			Client Sample ID.:		DCS7	DCS7	HED1
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		0.10	1.60	0.70
			Bottom Depth(m):				
			Date Sampled:		17-Feb-15	17-Feb-15	17-Feb-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
TPH >C8-C10	N	2670	mg/kg	1			
TPH >C10-C12	N	2670	mg/kg	1			
TPH >C12-C16	N	2670	mg/kg	1			
TPH >C16-C21	N	2670	mg/kg	1			
TPH >C21-C35	N	2670	mg/kg	1			
TPH >C35-C44	N	2670	mg/kg	1			
Total TPH >C5-C44	N	2670	mg/kg	10			
Sulphate (Acid Soluble)	M	2430	%	0.01		0.098	
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.01	0.019	< 0.010	0.018
ACM Type	U	2192			-		-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected		No Asbestos Detected
Moisture	N	2030	%	0.02	12	12	15
Stones	N	2030	%	0.02	< 0.020	< 0.020	< 0.020
Soil Colour	N				Brown		Brown
Other Material	N				Stones		Stones
Soil Texture	N				Sand		Sand
pH	M	2010			8.1	8.6	8.0
Total Sulphur	M	2175	%	0.01		0.030	
Chloride (Extractable)	M	2220	g/l	0.01		< 0.010	
Nitrate (Extractable)	N	2220	g/l	0.01		< 0.010	
PCB 28	M	2810	mg/kg	0.01			< 0.010
PCB 52	M	2815	mg/kg	0.01			< 0.010
PCB 101	M	2815	mg/kg	0.01			< 0.010
PCB 118	M	2815	mg/kg	0.01			< 0.010
PCB 153	M	2815	mg/kg	0.01			< 0.010
PCB 138	M	2815	mg/kg	0.01			< 0.010
PCB 180	M	2810	mg/kg	0.01			< 0.010
Total PCBs (7 Congeners)	N	2815	mg/kg	0.1			< 0.10

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

TESTCONSULT LIMITED
Ruby House, 40A Hardwick Grange, Warrington WA1 4RF
Tel (01925) 286880 Fax (01925) 286881

LABORATORY TEST CERTIFICATE
Contamination Analysis

Project :	Upper Parliament Street, Liverpool	**Job No.:**	
Client :	Applied Geology Limited	**Lab Ref No.:**	SA18817/02
	Unit 23, Abbey Park	**Date Received:**	24/02/2015
	Stareton	**Date Tested:**	11/03/2015
	Kenilworth CV8 2LY	**Date Reported:**	13/03/2015
Originator:	**Matthew Walker**	**Material:**	Analysed as soil

Soil Suite	**Units**	**DCS7 @ 3.0m**				
pH		7.51				
Chloride (water soluble)	g/l	<0.01				
Nitrate (water soluble)	g/l	<0.01				
Sulphate (total)	% w/w	<0.02				
Sulphate (water-soluble)	g/l	0.05				
Sulphur (total)	mg/kg	670				
Magnesium (water soluble)	mg/l	1.9				
EMR	%	<0.1				
% Stones	% w/w	11.0				
Moisture Content @ <30ºC	% w/w	16.1				
Ammonia (water soluble)	mg/kg	22.92				
Sample Description		1A				

Sample description key: 1 - Sand, 2 - Loam, 3 - Clay, 4 - Sand/Loam mix, 5 - Sand/Clay mix, 6 - Clay/Loam mix, 7 - Other

Suffixed with: A - Stones, B - Construction Rubble, C - Visible Hydrocarbons, D - Vegetation, E - Glass/Metal, G - Strong Odour, G - Other

Approved Signature

TESTCONSULT LIMITED

■ Liam Williams, Operations Manager

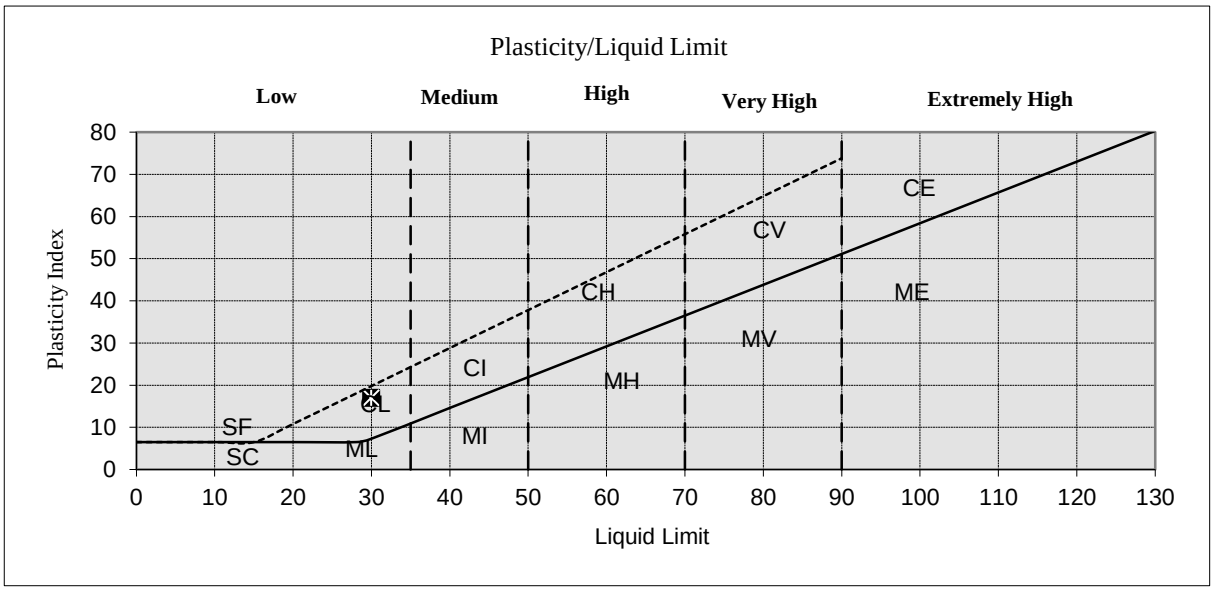
TESTCONSULT LIMITED
Ruby House, 40A Hardwick Grange, Warrington WA1 4RF
Tel (01925) 286880 Fax (01925) 286881

UKAS TESTING 0955

LABORATORY TEST REPORT
LIQUID & PLASTIC LIMIT TESTS BS 1377: Part 2: 1990 Cl 4.4,5.3

Site:	Upper Parliament Street, Liverpool	**Job No.:**	
Client:	Applied Geology Limited	**Lab Ref No.:**	SA18817/01
	Unit 23, Abbey Park	**Sample Ref.:**	DCS1 @ 4.8m
	Stareton	**Date Received:**	24/02/2015
	Kenilworth CV8 2LY	**Date Tested:**	02/03/2015
Originator:	**Matthew Walker**	**Date Reported:**	04/03/2015

Sampling Certificate	**No**
Sampled By	**Client**
Sample Type	**Disturbed**
Sample Preparation Method	**As Received**
MATERIAL	**Brown Slightly Sandy Gravelly Clay**
Retained 425 micron (%)	**5.6**
Natural Moisture Content (%)	**17**
Liquid Limit (single point)(%)	**30**
Plastic Limit (%)	**13**
Plasticity Index	**17**



Approved Signature
TESTCONSULT LIMITED
■ Liam Williams, Operations Manager

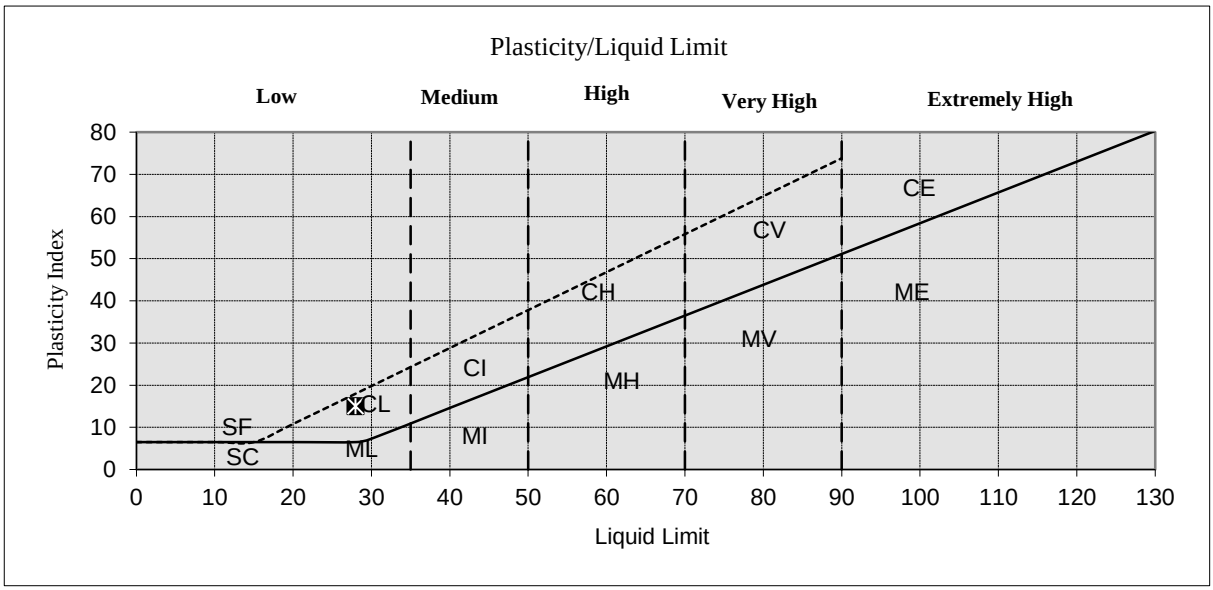
TESTCONSULT LIMITED
Ruby House, 40A Hardwick Grange, Warrington WA1 4RF
Tel (01925) 286880 Fax (01925) 286881

UKAS TESTING 0955

LABORATORY TEST REPORT
LIQUID & PLASTIC LIMIT TESTS BS 1377: Part 2: 1990 Cl 4.4,5.3

Site:	Upper Parliament Street, Liverpool	**Job No.:**	
Client:	Applied Geology Limited	**Lab Ref No.:**	SA18817/02
	Unit 23, Abbey Park	**Sample Ref.:**	DCS2 @ 3.6m
	Stareton	**Date Received:**	24/02/2015
	Kenilworth CV8 2LY	**Date Tested:**	03/03/2015
Originator:	**Matthew Walker**	**Date Reported:**	04/03/2015

Sampling Certificate	**No**
Sampled By	**Client**
Sample Type	**Disturbed**
Sample Preparation Method	**As Received**
MATERIAL	**Brown Slightly Sandy Gravelly Clay**
Retained 425 micron (%)	**6.8**
Natural Moisture Content (%)	**20**
Liquid Limit (single point)(%)	**28**
Plastic Limit (%)	**13**
Plasticity Index	**15**



Approved Signature
TESTCONSULT LIMITED
■ Liam Williams, Operations Manager

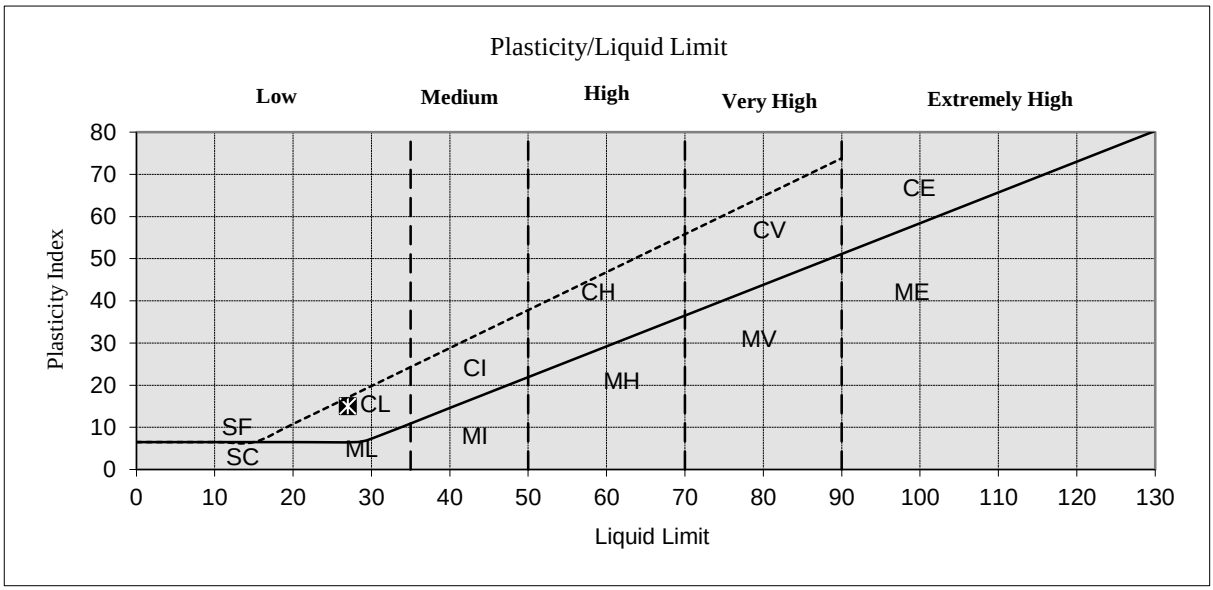
TESTCONSULT LIMITED
Ruby House, 40A Hardwick Grange, Warrington WA1 4RF
Tel (01925) 286880 Fax (01925) 286881

UKAS TESTING 0955

LABORATORY TEST REPORT
LIQUID & PLASTIC LIMIT TESTS BS 1377: Part 2: 1990 Cl 4.4,5.3

Site:	Upper Parliament Street, Liverpool	**Job No.:**	
Client:	Applied Geology Limited	**Lab Ref No.:**	SA18817/03
	Unit 23, Abbey Park	**Sample Ref.:**	DCS4 @ 3.9m
	Stareton	**Date Received:**	24/02/2015
	Kenilworth CV8 2LY	**Date Tested:**	03/03/2015
Originator:	**Matthew Walker**	**Date Reported:**	04/03/2015

Sampling Certificate	**No**
Sampled By	**Client**
Sample Type	**Disturbed**
Sample Preparation Method	**As Received**
MATERIAL	**Brown Slightly Sandy Gravelly Clay**
Retained 425 micron (%)	**2.3**
Natural Moisture Content (%)	**20**
Liquid Limit (single point)(%)	**27**
Plastic Limit (%)	**12**
Plasticity Index	**15**



Approved Signature
TESTCONSULT LIMITED
■ Liam Williams, Operations Manager

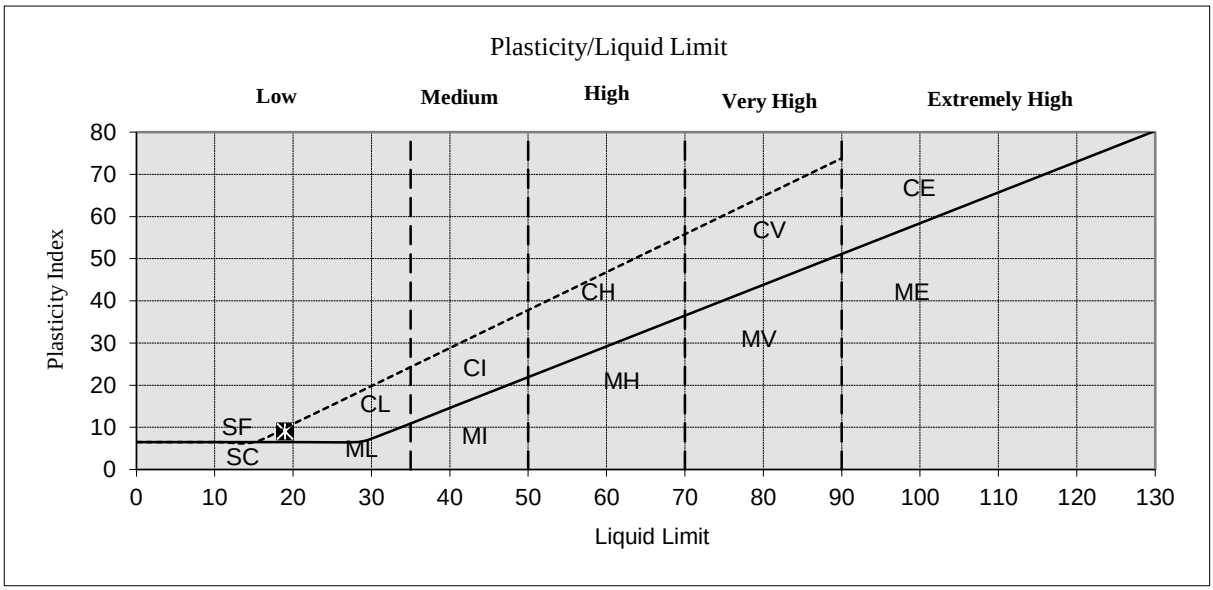
TESTCONSULT LIMITED
Ruby House, 40A Hardwick Grange, Warrington WA1 4RF
Tel (01925) 286880 Fax (01925) 286881

UKAS TESTING 0955

LABORATORY TEST REPORT
LIQUID & PLASTIC LIMIT TESTS BS 1377: Part 2: 1990 Cl 4.4,5.3

Site:	Upper Parliament Street, Liverpool	**Job No.:**	
Client:	Applied Geology Limited	**Lab Ref No.:**	SA18817/04
	Unit 23, Abbey Park	**Sample Ref.:**	DCS7 @ 4.8m
	Stareton	**Date Received:**	24/02/2015
	Kenilworth CV8 2LY	**Date Tested:**	03/03/2015
Originator:	**Matthew Walker**	**Date Reported:**	04/03/2015

Sampling Certificate	**No**
Sampled By	**Client**
Sample Type	**Disturbed**
Sample Preparation Method	**As Received**
MATERIAL	**Soft Brown Sandy Gravelly Clay**
Retained 425 micron (%)	**5.5**
Natural Moisture Content (%)	**18**
Liquid Limit (single point)(%)	**19**
Plastic Limit (%)	**10**
Plasticity Index	**9**



Approved Signature
TESTCONSULT LIMITED
■ Liam Williams, Operations Manager

TESTCONSULT LIMITED
Ruby House, 40A Hardwick Grange, Warrington WA1 4RF
Tel (01925) 286880 Fax (01925) 286881

LABORATORY TEST CERTIFICATE
Contamination Analysis

Project :	Upper Parliament Street, Liverpool	**Job No.:**	
Client :	Applied Geology Limited	**Lab Ref No.:**	SA18817/01
	Unit 23, Abbey Park	**Date Received:**	24/02/2015
	Stareton	**Date Tested:**	11/03/2015
	Kenilworth CV8 2LY	**Date Reported:**	13/03/2015
Originator:	**Matthew Walker**	**Material:**	Analysed as soil

Soil Suite	Units	DCS1 @ 2.5m	DCS2 @ 3.6m	DCS3 @ 3.8m	DCS4 @ 3.9m	DCS6 @ 4.6m
pH		7.86	7.75	7.92	7.53	7.74
Chloride (water soluble)	g/l	<0.01	0.01	0.01	<0.01	<0.01
Nitrate (water soluble)	g/l	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate (total)	% w/w	<0.02	<0.02	<0.02	0.02	<0.02
Sulphate (water-soluble)	g/l	0.05	0.02	0.04	0.05	0.02
Sulphur (total)	mg/kg	101	96	67	113	115
Magnesium (water soluble)	mg/l	3.0	44.1	4.7	13.4	2.4
EMR	%	<0.1	<0.1	<0.1	<0.1	<0.1
% Stones	% w/w	13.3	9.9	2.5	11.9	8.1
Moisture Content @ <30ºC	% w/w	14.8	17.1	6.0	15.4	19.0
Ammonia (water soluble)	mg/kg	4.248	13.56	16.44	13.44	6.288
Sample Description		1A	3A	1A	5A	1A

Sample description key: 1 - Sand, 2 - Loam, 3 - Clay, 4 - Sand/Loam mix, 5 - Sand/Clay mix, 6 - Clay/Loam mix, 7 - Other

Suffixed with: A - Stones, B - Construction Rubble, C - Visible Hydrocarbons, D - Vegetation, E - Glass/Metal, G - Strong Odour, G - Other

Approved Signature

TESTCONSULT LIMITED

■ Liam Williams, Operations Manager

APPENDIX E

APPENDIX E

STANDARD FIELDWORK AND ASSESSMENT PROCEDURES

Scope of Work

The scope of work undertaken is defined in Section 1.1 of the Report. It should be noted that Applied Geology Limited does not provide arboricultural surveys or specialist surveys for the detection of invasive plant species (such as Japanese Knotweed) or protected species of wildlife. Information from environmental and ecological datasets is included from a review of the MAGIC (Multi-Agency Geographic Information for the Countryside) website, however, if a full assessment of Environmental or Ecological aspects is required, it is recommended that other specialists are consulted. Similarly, information on flood risk is included obtained from the Environment Agency Web site and the GroundSure report but this is not intended to be a full hydrological study and if a flood risk assessment is needed, additional analysis by others is recommended to confirm this aspect of the development.

Fieldwork

Fieldwork is generally carried out, in accordance with BS5930 (1999) "Code of Practice for Site Investigations", BS10175 Investigation of Potentially Contaminated Sites, and the Association of Geotechnical and Geo-environmental Specialist Guidelines for Good Practice in Site Investigations (August 1998)

Prior to commencement on site, statutory services plans are generally obtained and verbal enquiries are also made regarding the positions of private or statutory services on site. Prior to excavation or drilling, locations are scanned with a cable avoidance tool (CAT) and service pits are generally excavated at borehole positions, where possible.

Descriptions and depths of the various strata recovered are presented on the exploratory hole records, reproduced in the report appendices, together with sample depths, the results of in-situ testing, comments on groundwater inflows, and any other pertinent information. The strata descriptions are in accordance with BS5930:1999 incorporating Amendment No 2 (2010). Disturbed plastic pot and glass amber jar samples are recovered from the various strata and stored and transported in cool boxes, where relevant, for possible future laboratory testing.

Light cable percussion boreholes are generally drilled using a Pilcon Wayfarer or Dando rig and are advanced using equipment to bore 200/150mm diameter boreholes. Disturbed plastic pot samples are recovered from all deposits encountered to allow examination and laboratory testing. Certain strata are cased off due to their tendency to collapse, particularly in the presence of groundwater inflows and/or to reduce the risk of cross contamination. In situ Standard Penetration Tests, using Split Spoon (SPT) and Cone (CPT) are undertaken in the boreholes to provide a measure of the relative density of the granular (coarse grained) deposits or shear strength of the clay/chalk/ weathered rock deposits using industry recognised correlation guidelines of shear strength against SPT "N" value results. Within the fine grained (cohesive) deposits, "undisturbed" 100mm driven open tube samples were recovered from the various deposits to provide samples for examination and laboratory testing. On encountering groundwater, boring is usually suspended for 20 minutes while any rise in water level is recorded. Full details of the groundwater observations and monitoring results during boring operations are included on the borehole records. All boreholes without monitoring wells installed are usually backfilled with arisings upon completion, unless otherwise stated on the individual logs.

Unless otherwise stated on the relevant logs, trial pits are excavated using a wheeled backhoe excavator, usually with a 0.6m wide bucket. The excavations are logged from the ground surface by an Engineering Geologist / Geo-environmental Engineer and relevant field testing, appropriate to the soils encountered, is carried out on samples brought to the surface. Disturbed soil samples are collected from selected horizons for subsequent laboratory testing. The trial pits are usually unshored and where reasonable, left open for a period of time to allow observations of pit stability

and depth and inflow rate of any groundwater ingress. The excavations are backfilled with arisings prior to moving on to the next position. Any trial pits carried out as part of this or previous investigations may represent soft spots and conduits/sumps for groundwater or surface water. In excavations, such materials may also be loose and unstable.

Driven Continuous Sampling (DCS) boreholes are drilled using a track mounted Global mini-rig or similar using sampling tubes of varying diameter (decreasing with depth). Samples of the deposits encountered are recovered in 1m long clear plastic liners, which are logged and sub-sampled on site by an Engineering Geologist. Generally for geotechnical investigations, during the drilling process in-situ Standard Penetration Tests (SPTs) are undertaken at selected depths to determine the relative density of coarse grained deposits encountered or the in-situ strength of fine grained deposits by comparing the SPT "N" value results with published empirical data. Groundwater seepages are noted during drilling if encountered. All boreholes without monitoring wells installed are usually backfilled with arisings upon completion.

Unless specifically stated in the report, exploratory hole locations should be regarded as approximate. Consideration should be given to accurate location of the exploratory holes where it is considered they may impact on proposed development.

Laboratory Testing

The geotechnical testing was carried out in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes and was undertaken by a UKAS accredited specialist laboratory. Chemical testing was undertaken by a UKAS accredited specialist chemical testing laboratory and MCERTS accredited methods, in accordance with Environment Agency recommendations, were specified where available.

Contamination Assessment – Human Health

Applied Geology Limited has followed the guidance given in the CLR 11 publication and other available guidance to assess the contaminant concentrations. Details of the methodology followed are briefly outlined below.

The available chemical data is sorted into appropriate datasets depending on sampling regime and ground conditions. An initial generic quantitative risk assessment is undertaken on this data using statistical tests, where appropriate, and appropriate screening values.

Risk to human health has been initially assessed by comparing soil results against various published statutory and non-statutory screening criteria. These have been sourced from the following, in order of preference:

- Environment Agency/DEFRA, Soil Guideline Values (SGV) published in 2009 and 2014 using the new CLEA model and DEFRA Category 4 Screening Levels (C4SL);
- LQM/CIEH Generic Assessment Criteria (LQM GAC V2) Version 2, 2009;
- EIC/AGS/CL:AIRE Soil Generic Assessment Criteria, 2010.

Reference has also been made to the Soil Screening Values (SSV) derived by Atkins (ATRISKsoil) and updated and published on their website in March 2011.

However, due to the difference in soil type used by Atkins to derive their screening values, Applied Geology has also generated their own screening criteria for various end-uses/SOM combinations but only using published toxicological data (from the above sources) to generate GAC using CLEA v1.06. Applied Geology GAC has therefore generally been used in preference to Atkins SSV as they are more comparable with the EA, LQM/CIEH and EIC/AGS screening values.

In March 2014, DEFRA published a new series of soil screening values, termed Category 4 Screening Levels (C4SL), which are intended to allow identification of those sites that fall within Category 4 (not contaminated) and are therefore able to be developed with no further remedial

action. The C4SL are considered to represent a contamination level that is 'low' from a toxicological view point, and is therefore considered to be 'acceptable'.

Historically, the level of contamination has been assessed with reference to SGV/GAC values which were derived to represent a 'minimal' level of contamination. The SGV/GAC values are still valid and can be used alongside C4SL, however both screening values are only intended to provide guidance as to the level of contamination, and where concentrations fall below these screening values, the site is not contaminated (and is within Category 4). Exceedance of a SGV/GAC/C4SL does not automatically indicate that an 'unacceptable' risk exists at a site; simply that further consideration of that particular contaminant is required.

The latest guidance from the HPA advises that for the assessment of speciated Polyaromatic Hydrocarbons (PAH) contamination benzo(a)pyrene (b(a)p) can be used as a surrogate marker for 'genotoxic' (gene damaging) PAHs. The surrogate marker approach estimates the toxicity of a mixture of PAHs in an environmental matrix by using data from toxicity studies in which a PAH mixture of known composition was tested. Exposure to the surrogate marker (b(a)p for C4SL) is assumed to represent exposure to all the PAHs in the environmental matrix. Thus, the level of toxicity ascribed to the surrogate represents the toxicity of the PAH mixture. This allows an assessment of the combined carcinogenic risk associated with genotoxic PAHs using only b(a)p.

Contamination Assessment – Controlled Waters

Risks to Controlled Waters have been assessed by following the guidance given in the CLR11 Model Procedures Report (EA 2004) and EA publication "Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination (EA 2006)".

This guidance presents a recommended methodology comprising several levels of assessment for deriving site-specific remedial objectives (Target Values) for contaminated soils and/ or groundwater in order to protect the aquatic environment. The different levels of assessment are summarised below.

Level	Soil Source	Groundwater Source
1	Partition into leachate	Not applicable
2	As above, plus attenuation in the unsaturated zone and dilution in the aquifer	Direct comparison to appropriate quality standards
3	As above, plus lateral attenuation in the saturated zone to off-site compliance point	Lateral attenuation in the saturated zone to off-site compliance point

*soil leachate extraction test results used if available and appropriate.

Effectively the Level 1 soil and Level 2 groundwater assessments are preliminary. The other level is a detailed assessment requiring the use of suitable software, which is outside the scope of this investigation.

From the available soil, leachate and groundwater results, chemicals of concern are selected which are then directly compared to appropriate published standards. The principal standards used to assess the potential risks to controlled waters are the UK drinking water standards (UK DWS) and the Environment Agency's Environmental Quality Standards (EQS), which are derived for the protection of aquatic life.

Waste Soil Disposal

A specific categorisation and assessment of potential waste soils arising from the proposed development has not been undertaken as part of the investigation, unless otherwise detailed in the report text. However, generic comments and advice are made below for the reader.

Any excavated soil material and excess spoil disposed of off-site should be treated as Waste and classified as Inert, Non-hazardous or Hazardous for off-site disposal prior to removal from site as required by the “Duty of Care” (Environmental Protection Act, 1990) legislation together with Annex II of Directive 1999/31/EC (“Landfill Directive”).

All waste soils should be sorted to prevent mixtures of waste types. Where possible, any waste soil should be recycled and the volume of soil to be disposed of should be minimised. Initially, Basic Characterisation of the waste is required whereby the material should be described and its source of origin recorded (a site plan, exploratory hole records and the certificates of chemical analysis in this report should be included).

This should also include data on its composition and leaching behaviour, its European Waste Catalogue (EWC) code, and where relevant any hazardous properties according to Annex III of Directive 91/689/EEC. This information should be provided to the licensed waste contractor.

Soils excavated on many sites would generally fall under the EWC description “Soil and Stones”, EWC code 17 05 04 with restrictions excluding topsoil and peat. Waste Acceptance Criteria (WAC) testing is required for all other Inert wastes and Hazardous Waste where relevant but not for non-hazardous waste.

Any asbestos must be disposed of by suitably licensed contractors to a suitably licensed facility.

Health & Safety Aspects

As outlined within the HSE publication ‘Successful Health and Safety Management - HSG65’, this report should inform your development of safe systems of work and information as an input into the safety management system.

When developing risk control systems we suggest making reference to the CIRIA report 132 "A guide for safe working on contaminated sites" and the HSE document "Protection of workers and the general public during the development of contaminated land – HSG66". All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.

The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations.

Trench support or the angle of batter should be designed by an appropriately qualified engineer or competent person to suit the required depth and the ground and groundwater conditions.

Care should be taken when digging excavations to prevent undermining or causing loss of support to the foundations of the nearby adjoining structures. Surcharging such as from spoil or vehicle movements close to excavation sides should be avoided

Practical guidance on trench excavation is given in CIRIA Report 97 Trenching Practice. Guidance on groundwater control is given in CIRIA Report 113 Control of groundwater for temporary works. Temporary works should be designed by a suitably qualified engineer or a competent person particularly where personnel access is necessary, in accordance with the requirements of the Construction (Design and Management) (CDM) Regulations.