King’s Cross Methodist Church
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London
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Ground Investigation & Basement Impact Assessment

West London Mission Circuit

Transforming lives since 1887

September 2024

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Rev 2

Ground investigation | Geotechnical consultancy | Contaminated land assessment

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Contents

Executive summary

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

Brief

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of West London Mission Circuit, with respect to the redevelopment of the site through extensions to the upper floors and of the lower ground floor level beneath the entire footprint of the site. The purpose of the investigation has been to determine the ground conditions, to carry out an assessment of ground movements resulting from excavation of the proposed basement, to assess the extent of any contamination and to provide information to assist with the design of the basement structure and suitable foundations. The report also includes information required to comply with London Borough of Camden Planning Guidance (CPG) Basements, relating to the requirement for a Basement Impact Assessment (BIA).

Site history

On the earliest historical map studied, Greenwood's map of London dated 1827, part of the existing church, which is understood to have been constructed by 1824, is shown to occupy the site, although the southwestern boundary was undeveloped. By 1877, the surrounding area had been extensively developed with mainly residential streets. A large rectangular building, approximately 100 m southeast of the site, was labelled as 'London General Depository', and is annotated on the map dated 1916 as bottling stores. The aerial photograph dated 1946 shows the church building to have been extended across the remainder of the site and forming the present day layout. It was also by that time that a block of terraced houses directly to the southwest of the site had been demolished and replaced with a large building known as Belgrove House. The aerial photograph also indicates that a number of terraced buildings to the southwest of the site had been demolished, which according to the bomb damage map of the area, was as a result of World War II bombing. By 1953, the damaged buildings had been cleared and replaced by the existing four blocks of apartments, which were constructed across Birkenhead Street.

Ground conditions

Below a variable thickness of made ground, London Clay was found to overlie the Lambeth Group, which was proved to the full depth of investigation. The made ground was encountered to depths of between 0.22 m (14.84 m OD) and 2.20 m (14.96 m OD) and generally comprised brown, dark brown and dark grey clayey sandy silt with variable inclusions of gravel, brick, chalk and slate fragments. The London Clay initially comprised a weathered horizon of firm becoming stiff fissured high strength brown silty clay with partings of bluish grey and orange-brown silt, bluish grey staining along fissures and selenite crystals, which extended to depths of between 4.00 m (13.55 m OD) and 6.00 m (11.16 m OD). The weathered zone was underlain by typical unweathered London Clay which comprised stiff becoming very stiff fissured high strength to very high strength dark grey silty clay with pale grey veins, traces of selenite and occasional shell fragments and pyrite nodules, and was found to extend to a depth of 24.00 m (-6.84 m OD). Claystones were encountered at depths of 6.50 m (10.66 m OD) and 8.30 m (8.86 m OD) and below 18.00 m the clay increased in strength to extremely high strength and became sandy with partings of pale grey fine sand. The London Clay was underlain by the Lambeth Group, which comprised very stiff fissured reddish brown and brown mottled orange-brown and grey silty sandy clay, which was proved to the maximum depth investigated, of 30.00 m (-12.84 m OD).

Groundwater was not encountered during drilling and the standpipe installed in Borehole No 1 was recorded to be dry during two monitoring visits carried out over a one month period.

The contamination testing has revealed a single elevated concentration of lead within a sample of made ground recovered from Trial Pit No 1 at a depth of 0.2 m. This assessment is based upon the potential for risk to human health, which at this site is considered to be the critical risk receptor.

Recommendations

Excavations for the proposed lower ground floor extension will require temporary support to maintain stability and to prevent any excessive ground movements. Based on the observations to date, groundwater is not likely to be encountered within the basement excavation. On this basis, the most appropriate method of constructing the basement and supporting the excavation sides will be through conventional mass concrete underpinning coupled with the use of a bored piled wall outside of the footprint of the existing buildings. On the basis that groundwater is unlikely to be encountered within the basement excavation a contiguous bored piled wall may be the most suitable option. As the basement structure will not intercept the groundwater table, it is unlikely to have an effect on the local hydrogeology. There is considered to be a low risk to end users from contamination and therefore a requirement for remedial measures is not envisaged.

Basement Impact Assessment

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice.

Part 1: Investigation Report

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 Introduction

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by West London Mission Circuit, to carry out a desk study, ground investigation and ground movement assessment at the King's Cross Mission Church. The ground investigation works were originally carried out in 2014 to support an alternative redevelopment proposal and the scheme has subsequently been updated, such that a new report has now been completed. The scope of the previous investigation has been reviewed and is considered appropriate for the updated proposal.

This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC) in support of a planning application.

1.1 Proposed Development

It is understood that it is proposed to demolish the structure in the southwest of the site and extend the lower ground floor level across the remainder of the site, below this area. It is then proposed to construct a new overlying structure which will connect with the building in the northeast of the site. The third floor of that structure will be demolished and rebuilt in a new configuration. The new excavation will be supported through the underpinning of the party walls to the northeast and southwest and the installation of a contiguous pile wall at the rear of the site.

This report is specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to check the history of the site with respect to previous contaminative uses;
- to determine the ground conditions and their engineering properties;
- to use the above information to provide recommendations with respect to the design of suitable foundations and retaining walls;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and build environment;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, a desk study was carried out, followed by a ground investigation. The desk study comprised:

- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- a review of readily available geology maps;
- a review of bomb damage maps; and
- a walkover survey of the site carried out in conjunction with the fieldwork; and.

In the light of this desk study an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- a single borehole advanced to a depth of 30.00 m by a dismantlable cable percussion rig;
- two window sampler boreholes advanced to depths of 5.30 m and 6.20 m;
- a series of seven hand excavated trial pits to provide access to the foundations of the existing structure on the site;
- standard penetration tests (SPTs) carried out at regular intervals within the boreholes to provide quantitative data on the strength of the soils;

- the installation of a single groundwater monitoring standpipe to depths of 6.00 m, and two subsequent monitoring visits;
- testing of selected soil samples for contamination and geotechnical purposes; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

This report includes a contaminated land assessment which has been undertaken by a suitably qualified and competent professional in accordance with the methodology presented by the Environment Agency in their Land contamination risk assessment (LCRM)[1] published 19 April 2021. This involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. Risk management is divided into three stages; Risk Assessment, Options Appraisal and Remediation, and each stage comprises three tiers. The Risk Assessment stage includes preliminary risk assessment (PRA), generic quantitative risk assessment (GQRA) and detailed quantitative risk assessment (DQRA) and this report includes the PRA and GQRA.

The exploratory methods adopted in this investigation have been selected on the basis of the constraints of the site including but not limited to access and space limitations, together with any budgetary or timing constraints. Where it has not been possible to reasonably use an EC7 compliant investigation technique a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon engineering experience, local precedent where applicable and relevant published information.

1.3.1 Basement Impact Assessment

The work carried out includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment). These assessments form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG[2] and their Guidance for Subterranean Development[3] prepared by Arup (the "Arup report") in accordance with Policy A5 of the Camden Local Plan 2017. The aim of the work is to provide information on surface water, groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

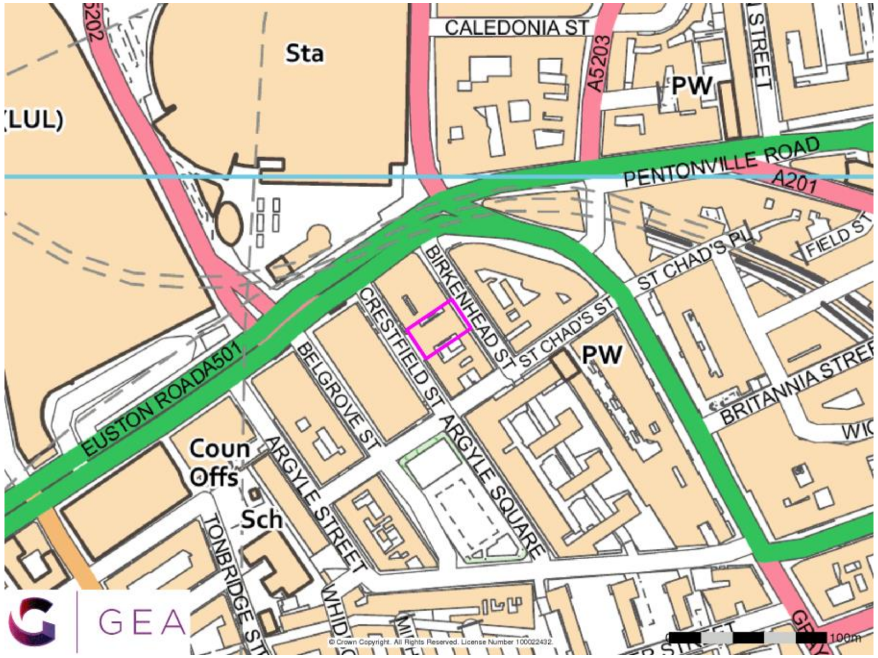
The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years' specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by Nick Mannix, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than ten years consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM. The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a Chartered Geologist (CGeol) and Fellow of the Geological Society (FGS) with some 30 years' experience in geotechnical engineering and engineering geology. All assessors meet the qualification requirements of the Council guidance.

1 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
2 London Borough of Camden Planning Guidance CPG (January 2021) *Basements*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

2.0 The Site

2.1 Site Description

The site is in the London Borough of Camden, approximately 100 m to the southeast of King's Cross railway station and 800 m northeast of Euston railway station. The site may be additionally located by National Grid Reference 530339,182911 and is shown on the map below.



The site covers a roughly rectangular shaped area with maximum dimensions of approximately 35 m northeast-southeast by 20 m northwest-southwest and is occupied by King's Cross Methodist Church. The building is formed of three storeys across the northeastern half of the site, which also includes a lower ground floor level that extends to a depth of approximately 2.00 m below ground level, whilst a two-storey section is present across the remainder of the site. Two lightwells are also present at basement level along the northern and southern extent of the three-storey section of the building and a small paved entrance courtyard is present along the boundary with Birkenhead Street.

The site fronts onto Birkenhead Street to the northeast and Crestfield Street to the southwest and is bordered to the northwest and southeast by four-storey terraced properties that include lower ground floor levels and mansard roofs. The existing building and associated areas of hardstanding occupy the entire site, which is therefore devoid of vegetation and with the exception of the varying levels due to the partial lower ground floor level, the site is essentially level, although topographically the surrounding area slopes up towards the north beyond King's Cross Station. A number of Network Rail and London Underground railway tunnels are present between 40 m and 50 m to the north of the site, below Euston Road.

2.2 Site History

The site history has been researched by reference to historical Ordnance Survey (OS) maps sourced from the Envirocheck database.

The earliest historical map studied, Greenwood's map of London dated 1827, shows both Crestfield Street and Birkenhead Street to have been constructed, although Birkenhead Street was known as Liverpool Street at that time. An extract of the map is shown overleaf, which indicates that the surrounding area had also been well developed by that time. In addition, a building is shown to already occupy the site, which is thought to be part of the existing church as an existing plaque on the wall of the church and online information indicates that the church was first constructed in 1824.

The earliest Ordnance Survey (OS) map studied, dated 1877, shows the site in more detail and occupied by a church building, although at that time it did not occupy the entire site, with the southwestern boundary undeveloped. It was by that time that the surrounding area had been extensively developed with mainly residential streets, although both King's Cross station and St Pancras Station had been constructed to the northwest. A large rectangular building, approximately 100 m southeast of the site, was labelled as 'London General Depository', which was later annotated on the map dated 1916 as bottling stores.

An aerial photograph dated 1946 shows the church building to have been extended across the remainder of the site to form the present day layout. It was also by that time that a block of terraced houses directly to the southwest of the site had been demolished and replaced with a large building known as Belgrove House. The aerial photograph also indicates that a number of terraced buildings to the southwest of the site had been demolished, presumably as a result of World War II (WWII) bomb damage. A review of the bomb damage map of the area confirms that these buildings were either totally destroyed or damaged beyond repair. The site however is not shown to have suffered any bomb damage during WWII.

By 1953, the damaged buildings had been cleared and replaced by the existing four blocks of apartments that were constructed across Liverpool Street, which had been renamed to Birkenhead Street. The site and surrounding area have remained essentially unchanged since that time to the present day, although some time after 1976, the bottling stores to the southeast of the site became a depot, which is still present today.

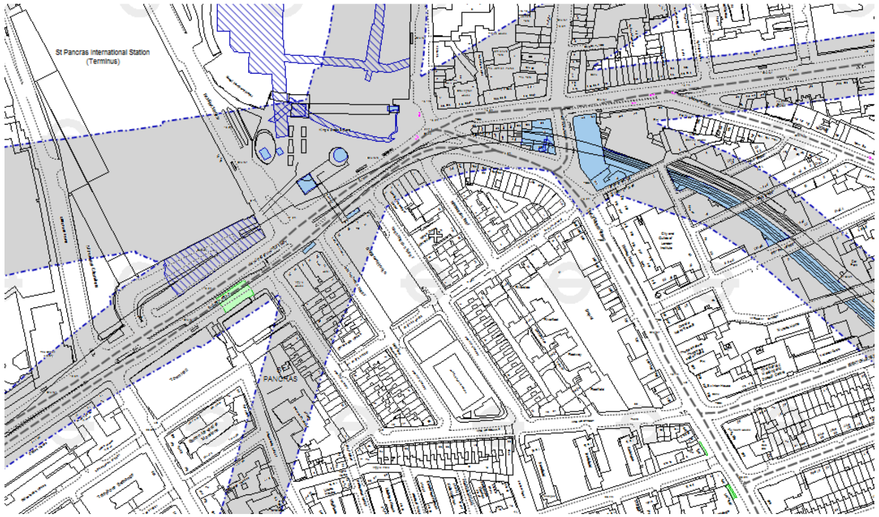
2.3 Other Information

A search of public registers and databases has been made via the Envirocheck database and relevant extracts from the search are appended. Full results of the search can be provided if required.

The search has revealed that there are no landfills, waste management, transfer, treatment or disposal sites within 500 m of the site. There have also not been any recorded pollution incidents to controlled waters within 250 m of the site and there are no registered contaminated land sites within 500 m.

The search has indicated that the site is located in an area where less than 1% of homes are affected by radon emissions; which is the lowest classification given by the Health Protection Agency (HPA) and therefore no radon protective measures will be necessary.

A search of online Transport for London (TfL) infrastructure maps[4] has indicated that the site is not located within the exclusion zones of any underground tunnels, as shown by the map extract below.



4 https://par.tfl.gov.uk/propertymap/Full.aspx

The plan below indicates lower ground floor and basement levels in the buildings neighbouring the site, which has been compiled using information from the site walkover and information available on the Local Authority planning portal.

2.4 Geology

The British Geological Survey (BGS) map of the area (sheet 256) indicates that the site is underlain by the London Clay Formation from the surface. According to the BGS memoir, the London Clay is homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine-grained sand.

Information from a number of previous GEA investigations and records held by the BGS of boreholes advanced close to the site, confirms that the London Clay Formation is present below a cover of made ground. Furthermore, the London Clay was found to extend to a depth of approximately 22 m below ground level, whereupon a thin layer of the Harwich Formation was present over the Reading Formation of the Lambeth Group.

2.5 Hydrology and Hydrogeology

The London Clay is classified as a Non-Aquifer and Unproductive Stratum, which refers to a soil or rock with low permeability that has a negligible effect on local water supply or river base flow, as defined by the Environment Agency (EA). On the basis of the above, groundwater is unlikely to be present within the London Clay, with the exception of perched groundwater within fissures and silt and sand partings.

Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-10} m/s and 1 x 10^{-8} m/s, with an even lower vertical permeability.

The topographical maps show that the nearest surface water feature is the Grand Union Canal, which is located approximately 590 m to the north of the site, which is therefore not within an area at risk from flooding, as defined by the EA.

The site is located approximately 90 m south of the former course of one of London's Lost Rivers, the River Fleet[5]. The source of the river is in Hampstead Heath from where it flowed southwards through Camden, Kentish Town and Kings Cross close to the site. From there it flowed through Clerkenwell and south down Farringdon Road, where it issued into the Thames below Blackfriars Bridge. Although the former river has been culverted, groundwater flow in the area is still likely to migrate towards the former line of the river.

Neither Birkenhead Street or Crestfield Street are listed in the Guidance for Subterranean Development[6] prepared by Arup as being at risk from surface water flooding, nor is there a record of them having suffered from such an event in the past. The site is however shown to be located close to an area with the potential to be at risk from surface water flooding, which is approximately 100 m to the northeast/east of the site.

The site is entirely covered by the existing buildings and hardstanding and will remain as such following the proposed redevelopment. As a result the majority of surface runoff currently drains into combined sewers in the road and this will remain the case following the development. There should not, therefore, be any requirement for any mitigation measures.

5 Barton, N, & Meyers, S (2016) *The Lost Rivers of London (revised and extended edition with colour maps).* Historical Publications Ltd.

6 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

2.6 Preliminary Risk Assessment

Part IIA of the Environmental Protection Act 1990, which was inserted into that Act by Section 57 of the Environment Act 1995, provides the main regulatory regime for the identification and remediation of contaminated land. The determination of contaminated sites is based on a "suitable for use" approach which involves managing the risks posed by contaminated land by making risk-based decisions. This risk assessment is carried out on the basis of a source-pathway-receptor approach.

2.6.1 Source

The historical usage of the site that has been established by the desk study and the site walkover indicates that the site does not have a potentially contaminative history by virtue of it having been occupied by a church since 1824 and as such no sources of potential contamination have been identified. In addition, the desk study has also not indicated any potential sources of contamination within the immediate surrounding area.

2.6.2 Receptor

The proposed use of the new building as a church on the lower levels with residential apartments above represents a relatively low sensitivity end-use. End users are not considered to be a particularly sensitive receptor and as the underlying London Clay is a Non-Aquifer, groundwater is not considered to be a sensitive receptor. Site workers will come into contact with underlying soils during the construction phase, as will new buried services. Neighbouring sites would also be considered to be moderately sensitive receptors.

2.6.3 Pathway

As the proposed building, including the basement level, will occupy the entire site, there is not considered to be a pathway between end users and the underlying soil. As groundwater is not expected to be present below the site, there is not considered to be a pathway by which contamination can migrate off or on to site, other than within any perched water movements within the made ground on the interface of the London Clay. This pathway is however considered to already be in existence. The construction phase is considered to be a pathway by which site workers and new buried services may come in contact with any contamination.

2.6.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a very low risk of there being a significant contaminant linkage at this site, which would result in a requirement for major remediation work. Furthermore as there is no evidence of filled ground within the vicinity, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site; there should thus be no need to consider soil gas exclusion systems.

3.0 Screening

The Camden planning guidance suggests that any development proposal that includes a basement should be screened to determine whether or not a full BIA is required.

3.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendices E1, E2 and E3 which include a series of questions within screening flowcharts for surface flow and flooding, subterranean (groundwater) flow and land stability. The flowchart questions and responses to these questions are tabulated below.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for King’s Cross Methodist Church
1a. Is the site located directly above an aquifer?	No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit water in sufficient quantities to support groundwater abstractions or watercourses.
1b. Will the proposed basement extend beneath the water table surface?	No. The London Clay cannot support groundwater flow and cannot therefore support a water table consistent with a permeable water bearing strata.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	Yes. The site is located approximately 90 m to the south of the former River Fleet.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report confirms that the site is not located within this catchment area.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. The building and hard surfacing will cover the same proportion of the site as previous. The low permeability of the underlying London Clay would result in a low recharge in any case and consequently there would be little or no effect on groundwater.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No. Given that the site is underlain by clay soils and is unlikely to be suitable for a soakaway or similar SUDS based system, the site drainage will therefore be directed to public sewer. Site drainage will therefore be designed to generally maintain the existing situation.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No. There are no groundwater dependent ponds or spring lines present within 500 m of the site.

The above assessment has not identified any potential issues.

3.1.2 Stability Screening Assessment

Question	Response for King’s Cross Methodist Church
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No, as indicated on the Slope Angle Map Fig 16 of the Arup report.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No. The site is not to be significantly re-profiled as part of the development.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report.
5. Is the London Clay the shallowest strata at the site?	*Yes. As indicated on the geological map and Figures 3, 5 and 8 of the Arup report*
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	No.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of shrinkable London Clay.*
8. Is the site within 100 m of a watercourse or potential spring line?	*Yes. The site is approximately 90 m to the south of the former River Fleet.*
9. Is the site within an area of previously worked ground?	No. The geological map of the area and Figures 3, 4 and 8 of the Arup report do not indicate any worked ground.

Question	Response for King's Cross Methodist Church
10a. Is the site within an aquifer?	No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No.
11. Is the site within 50 m of Hampstead Heath ponds?	No.
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes. Crestfield Street borders the site to the southwest and the proposed excavation will extend to the site boundary along this elevation.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes. The neighbouring properties are known to have lower ground floor levels, but the exact level is unknown. A ground movement analysis has been completed as part of this investigation to predict the likely movements as a result of the excavation. This is reported in Part 3.0 of this report.*
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No.

The above assessment has identified the following potential issues that need to be assessed:

Q5 The London Clay is the shallowest strata beneath the site.
Q7 The site is in an area likely to be affected by seasonal shrink-swell.
Q8 The site is located within 100 m of a former watercourse.
Q12 The site is within 5 m of a highway or pedestrian right of way.
Q13 The development will significantly increase the differential depth of foundations relative to neighbouring properties.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for King's Cross Methodist Church
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Figure 14 of Arup report confirms that the site is not located within this catchment area.
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No. There will be no increase in the proportion of hardstanding at the site and any surface water at the site will continue be attenuated and discharged into the Thames Water sewers. The basement will entirely be beneath the footprint of the proposed building and the 1m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2021 does not apply across these areas.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. There will not be an increase in impermeable area across the ground surface above the basement.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. There will not be an increase in impermeable area across the ground surface above the basement.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. The proposal is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses as the surface water drainage regime will be unchanged and the land uses will remain the same.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	*No. The Camden Flood Risk Management Strategy dated 2013, North London Strategic Flood Risk Assessment dated 2008, and Environment Agency online flood maps show that the site has a low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses.*

The above assessment has not identified any potential issues.

4.0 Scoping and Site Investigation

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified potential impact factors.

4.1 Potential Impacts

The following potential impacts have been identified by the screening process.

Potential Impact	Consequence
Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	The site is approximately 90 m south of the former course line of the River Fleet. Whilst this feature may indicate a shallow groundwater table and may also pose a risk to the site from flooding, the former river has been culverted. Furthermore, the site is not shown to be an area at risk of flooding and therefore this is not considered to be an issue to the site or the proposed development.
Is the London Clay the shallowest strata at the site?	The London Clay is formed of highly shrinkable clay soils that are of high plasticity. This means that it can be affected by seasonal shrinking and swelling caused by tree growth and / or tree removal, which can lead to movement and instability of nearby structures. In addition, the unloading of the clay soils will result in heave movements, which can cause a level of damage to neighbouring structures.
Seasonal shrink-swell can result in foundation movements.	Multiple potential impacts depending on the specific setting of the basement development. For example, the implications of a deepened basement/foundation system on neighbouring properties should be considered.
Is the site located within 5 m of a public highway or pedestrian right of way?	The public walkway of both Crestfield Street and Birkenhead Street borders the site to the southwest and northeast respectively. The excavation of a basement can cause instability of such structures.
Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Where differential founding depths between adjacent foundations occur, it may result in structural damage to both the neighbouring structures and the proposed development if foundations are not designed to support additional loading or where neighbouring foundations are not underpinned.

Whilst the ground investigation was carried out prior to the completion of the screening and scoping sections, the scope of the previous investigation, as detailed below, is considered to have been sufficient in order to investigate the above potential impacts.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, a single borehole was drilled to a depth of 30.00 m using a dismantlable cable percussion drilling rig. Standard penetration tests (SPTs) were carried out at regular intervals in the borehole and disturbed and undisturbed samples were recovered for subsequent laboratory examination and testing. These boreholes were supplemented by two window sampler boreholes, advanced to depths of 5.30 m and 6.20 m under the supervision of a geotechnical engineer from GEA.

A groundwater monitoring standpipe was installed in the cable percussion borehole to a depth of 6.00 m and has subsequently been monitored on two occasions over a one month period.

In addition to the boreholes, seven trial pits were manually excavated adjacent to various existing external elevations and boundary walls in order to expose and allow the inspection of the existing foundations by the GEA engineer.

The borehole and trial pit records and results of the laboratory analyses are appended, together with a site plan indicating the exploratory positions. The Ordnance Datum (OD) levels shown on the borehole and trial pit records and quoted within this report have been interpolated from spot heights shown on a site plan (ref: SSK001, dated October 2014) provided by Consibee, the consulting engineers during the ground investigation.

4.3 Sampling Strategy

The borehole and trial pit locations were specified by the consulting engineers and positioned on site by GEA to provide optimum coverage of the site with due regard to the proposed development, whilst avoiding the areas of known services.

Four samples of the made ground have been tested for the presence of contamination. The analytical suite of testing was selected to identify a range of typical industrial contaminants for the purposes of general coverage. For this investigation the analytical suite for the soil included a range of metals, speciation of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The samples were also screened for the presence of asbestos. The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. A summary of the MCERTs accreditation and test methods are included with the attached results and further details are available upon request.

5.0 Ground Conditions

The investigation has encountered the expected ground conditions in that, below a variable thickness of made ground, the London Clay Formation was encountered and underlain by the Lambeth Group, which was proved to the maximum depth investigated.

5.1 Made Ground

The made ground was encountered to depths of between 0.22 m (14.84 m OD) and 2.20 m (14.96 m OD), with the greater thicknesses encountered where the boreholes were advanced from a higher level. It generally comprised brown, dark brown and dark grey clayey sandy silt with variable inclusions of gravel, brick, chalk and slate fragments.

With the exception of notable fragments of extraneous material, no visual or olfactory evidence of significant contamination was observed within these soils, although four samples have been analysed for a range of contaminants and the results are summarised in Section 5.5.

5.2 London Clay

The London Clay initially comprised a weathered horizon of firm becoming stiff fissured high strength brown silty clay with partings of bluish grey and orange-brown silt, bluish grey staining along fissures and selenite crystals. The initial horizon extended to depths of between 4.00 m (13.55 m OD) and 6.00 m (11.16 m OD), whereupon typical unweathered London Clay was encountered and comprised stiff becoming very stiff fissured high strength to very high strength dark grey silty clay with pale grey veins, traces of selenite and occasional shell fragments and pyrite nodules, which was proved to 24.00 m (-6.84 m OD).

Claystones were encountered at depths of 6.50 m (10.66 m OD) and 8.30 m (8.86 m OD) and below 18.00 m (-0.84 m OD) the clay increased in strength to extremely high strength and became sandy with partings of pale grey fine sand.

Atterberg limit tests have indicated the clay to be of high shrinkability with plasticity indices ranging from 47% and 52 %. The clay was also noted to generally increase in strength with depth with the undrained shear strength increasing from 92 kPa to 387 kPa.

These soils were observed to be free of any evidence of soil contamination.

5.3 Lambeth Group

This stratum consisted of the Upper Mottled Beds, which comprised very stiff fissured reddish brown and brown mottled orange-brown and grey silty sandy clay, which was proved to the maximum depth investigated, of 30.00 m (-12.84 m OD).

The soils were found to be of high shrinkability and free of any evidence of soil contamination.

5.4 Groundwater

Groundwater was not encountered during drilling of the boreholes and the standpipe installed in Borehole No 1 was recorded to be dry during two monitoring visits carried out over a one month period. A perched groundwater level of 0.30 m (14.58 m OD) was encountered in the made ground in Trial Pit No 2.

The condition of the standpipe installed in 2014 is not currently known and no additional monitoring has been carried out as the London Clay is not considered to be capable of supporting a water table.

5.5 Soil Contamination

The table below sets out the values measured within the four samples analysed; all concentrations are in mg/kg unless otherwise stated.

Determinant	TP1 0.20 m	TP3 0.40 m	TP4 0.10 m	TP5 0.30 m
pH	7.7	8.7	8.2	8.0
Arsenic	**82**	29	10	13
Cadmium	3.5	0.11	0.12	0.15
Chromium	56	24	45	48
Lead	**3000**	**2100**	50	33
Mercury	3.5	6.8	0.22	0.13
Selenium	0.99	< 0.20	< 0.20	< 0.20
Copper	430	76	37	38
Nickel	77	26	47	52
Zinc	1300	100	81	81
Total Cyanide	5.4	< 0.5	< 0.5	< 0.5
Total Phenols	< 0.3	< 0.3	< 0.3	< 0.3
Total PAH	57	15	<2	2.8
Sulphide	2.3	2.0	2.2	1.9
Benzo(a)pyrene	**5.0**	1.0	< 0.1	< 0.1
Naphthalene	0.23	< 0.1	< 0.1	0.13
TPH	150	25	<10	450
Total Organic Carbon %	**7.7**	1.7	0.5	0.51

Note: Figures in bold indicate values in excess of the generic guideline screening values.

In addition, all four samples of the made ground have been screened for the presence of asbestos and none was detected.

5.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern are those that have values in excess of generic human health risk-based guideline values, which are either the CLEA[7] Soil Guideline Values where available, the Suitable 4 Use Values[8] (S4UL) produced by LQM/CIEH calculated using the CLEA UK Version 1.07[9] software, or the DEFRA Category 4 Screening values[10], assuming a residential without plant uptake end use. The key generic assumptions for this end use are as follows:

7 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.

8 *The LQM/CIEH S4Uls for Human Health Risk Assessment* S4UL3065 November 2014

9 Contaminated Land Exposure Assessment (CL|EA) Software Version 1.071 Environment Agency 2015

10 CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be a young female aged less than six years old;
- that the exposure duration will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a terraced house.

It is considered that these assumptions are acceptable for this generic assessment of this site, albeit somewhat conservative as the residential units are located on the second and third floors and no areas of soft landscaping are proposed. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include;

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

The contamination testing has revealed the sample from Trial Pit No 1 at a depth of 0.20 m to contain elevated concentrations of Arsenic, Lead, Benzo(a)pyrene and total organic carbon. Additionally the sample from Trial Pit No 3 at a depth of 0.40 m was found to contain an elevated concentration of lead. No other elevated concentrations were recorded.

The significance of these results is considered further in Part 2 of the report.

5.6 Existing Foundations

Trial Pit No 1 was excavated adjacent to the northwestern party wall, but the base of footing was not encountered at the maximum extent of the trial pit, at a depth of 1.30 m (16.41 m OD). Trial Pit Nos 2 and 6 were also excavated adjacent to this party wall, although from a lower level. The foundations were found to be bearing on London Clay at 0.30 m (14.58 m OD) and 0.60 m (14.51 m OD) respectively.

Trial Pit No 3 was excavated adjacent to the northwestern elevation of the two-storey section of the church, which was found to be supported by a concrete footing bearing within the made ground at a depth of 0.70 m (16.33 m OD). Trial Pit No 4 was excavated at basement level, adjacent to the dividing wall between the two-storey section and the five-storey section of the church, which was found to be supported by brick footing bearing on the London Clay at a depth of 0.30 m (14.76 m OD).

The southeastern party wall was found to be supported by a concrete footing bearing within the London Clay at a depth of 0.60 m (14.45 m OD and 14.46 m OD), as indicated by Trial Pit Nos 5 and 7 respectively.

Logs and photographs are included within the appendix.

Part 2: Design Basis Report

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to the proposed development.

6.0 Ground Model

It is understood that it is proposed to demolish the existing structure in the southwest of the site and extend the lower ground floor level that exists across the remainder of the site, below this area. It is then proposed to construct a new overlying structure which will connect with the building in the northeast of the site. The existing 3rd floor of that structure will be demolished and rebuilt in a new configuration. The new excavation will be supported through the underpinning of the party walls to the northeast and southwest and the installation of a contiguous pile wall at the rear of the site.

The desk study has revealed that the site has not had a potentially contaminative historical use as it has been developed with the church since prior to 1827, and on the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- below a variable thickness of made ground, the London Clay Formation is present over the Lambeth Group, which was proved to the maximum depth investigated;
- the made ground generally extends to depths of between 0.22 m (14.84 m OD) and 2.20 m (14.96 m OD), with the greater thicknesses encountered from ground floor level;
- below the made ground, weathered London Clay extends to depths of between 4.00 m (13.55 m OD) and 6.00 m (11.16 m OD), and is underlain by typical unweathered London Clay to a depth of 24.00 m (-6.84 m OD);
- claystones were encountered at 6.50 m (10.66 m OD) and 8.30 m (8.86 m OD) and below 18.00 m (-0.84 m OD) the clay becomes increasingly more sandy with partings of pale grey sand;
- the London Clay is of high plasticity and increases in strength with depth, with the undrained shear strength increasing from 92 kPa to 387 kPa;
- the underlying Lambeth Group comprises very stiff fissured reddish brown and brown mottled orange-brown and grey silty sandy clay, which is present to the maximum depth investigated, of 30.00 m (-12.84 m OD);
- a continuous groundwater level has not been found beneath the site, although perched groundwater is present in close proximity of existing foundations; and
- contamination testing has revealed the made ground beneath the site to contain locally elevated concentrations of arsenic, lead, benzo(a)pyrene and total organic carbon.

7.0 Advice & Recommendations

It is understood that it is proposed to extend the existing lower ground floor level beneath the section of the site that is currently formed at ground level. The lower ground floor level will extend to a depth of the 4.00 m below ground level and formation level for the proposed basement should therefore be within the very stiff London Clay. It is understood that it is proposed to support the basement excavation through the use of a combination of underpins and contiguous piled walls. On the basis of the fieldwork and subsequent monitoring, groundwater is unlikely to be encountered within the basement excavation.

7.1 Basement Construction

The formation level for the basement is likely to be within the stiff London Clay at a depth of approximately 4.00 m below ground level. On the basis of the observations to date, significant groundwater inflows are not anticipated to be encountered within the basement excavation, although minor inflows from pockets of perched water within the made ground may be encountered. As with any basement project in low permeability soil, these inflows are unlikely to be prolonged and should be adequately dealt with using sump pumping.

There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of wall may be governed to a large extent by whether it is to be incorporated into the permanent works and have a load bearing function. The final choice will depend to a large extent on the need to protect nearby structures from movements, the required overall stiffness of the support system, and the need to control groundwater movement through the wall in the temporary condition. In this respect the stability of the adjacent buildings and surrounding highway structures will be paramount.

On the basis of the trial pit observations, the use of conventional mass concrete underpinning using a 'hit and miss' approach is likely to be the most suitable option of forming retaining walls. Perched groundwater may be encountered in close proximity of existing foundations, although as discussed above, these inflows should be adequately dealt with using sump pumping. It would however be prudent for the chosen contractor to have a contingency plan in place to deal with more significant inflows as a precautionary measure.

It is understood that it is proposed to utilise a contiguous bored pile wall along the rear boundary, which will have the advantage of being incorporated into the permanent works and being able to provide support for structural loads. Localised grouting and / or sump pumping may be necessary where perched water inflows are encountered. However, consideration could be given to the use of a secant bored pile wall which generally provides an additional amount of stiffness, negates the requirement for any secondary groundwater control and also maximises the useable space within the basement structure.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity and the timing of the provision of support to the wall will have an important effect on movements. In this respect the use of a top-down construction sequence may provide an appropriate construction method as casting of the slabs to the ground and first basement level will provide permanent support to the retaining walls. Careful workmanship will be required in the construction of the underpins and it is recommended that a suitable specialist contractor is consulted in this respect.

An assessment of the movements associated with the excavation is provided in Part 3 of this report.

7.1.1 Basement Retaining Walls

The following parameters are suggested for the design of the permanent basement retaining walls.

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (ϕ' – degrees)
Made ground	1700	Zero	27
London Clay	1950	Zero	23

Monitoring of the standpipe should be continued to assess the design water level but at this stage it would appear that groundwater may be assumed to be below basement level; the advice in BS8102:2009[11] should also be followed in this respect.

11 BS8102 (2009) *Code of practice for protection of below ground structures against water from the ground*

7.1.2 Basement Heave

The 4.00m deep excavation will result in a net unloading of around 75 kN/m^2, which will result in heave of the underlying London Clay. This will comprise immediate elastic movement, which will account for approximately 40 % of the total movement and be expected to be complete during the construction period, and long-term movements, which will theoretically take many years to complete. These movements will, to some extent, be mitigated by the loads applied by the proposed development, however the ground movements associated with the proposed basement excavation and construction have been considered in more detail in Part 3 of this report.

7.2 Spread Foundations

Moderate width strip or pad foundations bearing on the stiff London Clay below lower ground floor level at a depth of about 2.50 m may be designed to apply a net allowable bearing pressure of 150 kN/m^2. This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

If the made ground extends to depths that spread foundations become uneconomic piled foundations should be considered as an alternative.

The depth of the basement excavation is expected to be such that foundations will be placed below the depth of actual or potential desiccation, but this should be checked once the proposals have been finalised.

Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation. In this respect, it would be prudent to have all foundation excavations inspected by a suitably experienced engineer. Due allowance should be made for future growth of existing / proposed trees. The requirement for compressible material alongside foundations should be determined by reference to the NHBC guidelines.

7.3 Piled Foundations

For the ground conditions at this site some form of bored pile could be considered. In view of the limited thickness of made ground and underlying clay soils, conventional rotary bored piles could be adopted with relatively short lengths of casing. Alternatively consideration could be given to the use of bored piles installed using continuous flight auger (cfa) techniques, which would negate the requirement for temporary casing.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, based on the SPT and cohesion / level graph in the appendix.

Stratum	Depths m [level m OD]	kN / m^2
Ultimate Skin Friction		
Basement Excavation	GL to 4.00 m	Ignore
London Clay	4.00 m to 24.00 m	Increasing linearly from 45 to 125
Lambeth Group	24.00 m to 30.00 m	Increasing linearly from 100 to 150
Ultimate End Bearing		
London Clay	15.00 m to 24,00 m	Increasing linearly from 1530 to 1980
Lambeth Group	24.00 m to 30.00 m	Increasing linearly from 1800 to 2700

BS EN 1997-1:2004; Eurocode 7: Geotechnical Design Part 1 (Eurocode 7) provides factors to be applied to the ultimate skin friction and ultimate end bearing capacity in calculating pile resistance ($R_{d,GEO}$). For bored piles, in the absence of either working load tests or combined working load tests and preliminary pile tests, a model factor of 1.4 should be combined with a factor of 1.6 to be applied to the skin friction, and with a factor of 2.0 to be applied to the end bearing.

On the basis of the above, the table opposite shows the estimated pile resistance for 450 mm diameter piles at various depths. Average ultimate skin friction has been limited to 110 kN/m^2 and an adhesion factor of 0.5 has been adopted, in accordance with guidance from the London District Surveyors Association (LDSA)[12].

12 LDSA (2017) *Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA

Pile diameter mm	Toe Depth (m)	Pile length (m)	$R_{d,GEO}$ (kN)
450	15.00	11.00	535
	20.00	16.00	890

In order to determine the required pile lengths, the above outline pile resistances need to be compared with structural loads (actions) that have been factored to determine the design effect, in accordance with Eurocode 7.

The above examples are not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of an appropriate piling scheme and their attention should be drawn to the presence of inconsistent layers of granular soil within the Lambeth Group and the associated groundwater and stability issues this could produce.

In the design of piled foundations, the effect of potential future shrinkage and swelling of the clay should be taken into account.

7.4 Raft Foundation

Given the ground conditions at this site, a raft foundation would be considered a viable option, although the suitability of a raft foundation will depend on the resultant net load of the new structure, taking into consideration the overburden and potential heave associated with the basement excavation. The raft would need to be designed to be rigid to resist any variation in upwards and downwards forces, in order to prevent differential movements. In this respect, if a raft is considered and once the loads have been finalised, it would be prudent to carry out additional analysis in order to determine the likely heave / settlements associated with the use of a raft foundation.

7.5 Shallow Excavations

On the basis of the borehole findings, it is considered that it will be generally feasible to form relatively shallow excavations terminating within the made ground or London Clay without the requirement for lateral support, although localised instabilities may occur where more granular material or groundwater is encountered.

Significant inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the made ground, particularly within the vicinity of existing foundations, although such inflows should be suitably controlled by sump pumping.

If deeper excavations are considered or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

7.6 Lower Ground Floor Slab

Following excavation of the lower ground floor level, the floor slab will need to be suspended over a void or a layer of compressible material to accommodate the anticipated heave, unless the slab can be suitably reinforced to cope with these movements.

7.7 Effect of Sulphates

Generally high concentrations of total sulphate have been measured in selected soil samples and therefore indicate that buried concrete could be designed in accordance with Class DS-4 conditions of Table C2 of BRE Special Digest 1: SD1 Third Edition (2005). The measured pH conditions are near neutral and therefore on the basis of static groundwater conditions being assumed for buried concrete an ACEC classification of AC-3s may be adopted.

The guidelines contained in the above digest should be followed in the design of foundation concrete.

7.8 Contamination Risk Assessment

The desk study has revealed that the site has not had a potentially contaminative historical use as it has been developed with the church since prior to 1827. Furthermore, no there are no potential offsite sources of contamination that are considered to pose a risk to the site.

The contamination testing has revealed the sample from Trial Pit No 1 at a depth of 0.20 m to contain elevated concentrations of Arsenic, Lead, Benzo(a)pyrene and total organic carbon. Additionally the sample from Trial Pit No 3 at a depth of 0.40 m was found to contain an elevated concentration of lead. No other elevated concentrations were recorded.

The measured contamination is not present in a volatile form and does not therefore pose a risk to the site through the production of soil gas or vapours. The development will essentially remove all of the made ground below the existing ground level in the southwest of the site and the site will be entirely covered by the building such that a direct contact pathway between the contaminated soil and end uses will not exist post development.

The source of the benzo(a)pyrene, arsenic and lead concentrations are not known but fragments of extraneous material including ash and tarmac were recorded within the made ground at the site and such fragments are considered likely to represent the source of the contamination. Therefore a risk to groundwater, adjacent sites and buried services is not envisaged; though it may be prudent to carry out leachate testing to confirm this view and the requirements with respect to new buried services should be checked with the local water provider.

The measures contamination will pose a risk to site workers during the groundworks through a direct contact pathway. The identified risks are discussed further below.

7.8.1 Protection of Site Workers

Site workers should be made aware of the potential contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE[13] and CIRIA[14] and the requirements of the Local Authority Environmental Health Officer.

A watching brief should be maintained during the site works and if any suspicious soil is encountered, it should be inspected by a suitably qualified engineer and further testing carried out if required.

13 HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land* HMSO

14 CIRIA (1996) *A guide for safe working on contaminated sites.* Report 132, Construction Industry. Research and Information Association

7.9 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process, and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3[15] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[16] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £103.70 per tonne (about £190.00 per m^3) or at the lower rate of £3.30 per tonne (roughly £6.00 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

Based on the technical guidance provided by the EA it is considered likely that the soils encountered during this ground investigation, as represented by the chemical analyses carried out, would be generally classified as follows.

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Current applicable rate of Landfill Tax
Made ground	Inert non-hazardous (17 05 04)	No	£103.70/tonne (Standard rate)
Made ground (containing high lead concentrations)	Hazardous (17 05 04)	Unlikely	£103.70/tonne (Standard rate)

15 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition

16 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Current applicable rate of Landfill Tax
Natural Soils	Inert (17 05 04)	Should not be required but confirm with receiving landfill	£3.30 / tonne (Reduced rate for uncontaminated naturally occurring rocks and soils)

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[17] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

17 Environment Agency 23 Oct 2007 *Regulatory Position Statement Treating non-hazardous waste for landfill - Enforcing the new requirement*

Part 3: Ground Movement Analysis

This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme discussed in Part 2 and the information obtained from the investigation, presented in Part 1 of the report.

8.0 Introduction

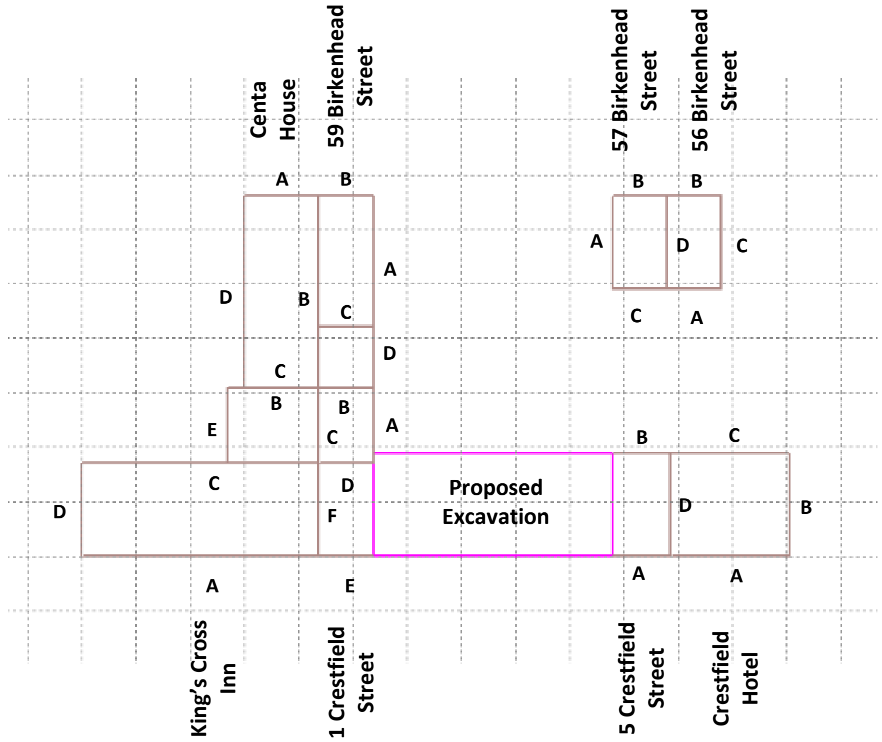
The sides of an excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed and the efficiency or stiffness of any support structures used.

An analysis has been carried out of the likely movements arising from the proposed excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

8.1 Basis of Ground Movement Assessment

Sensitive structures relevant to this assessment include Nos 1 and 5 Crestfield Street, Crestfield Hotel and King's Cross Inn, which front onto Crestfield Street to the southwest, and Nos 56, 57 and 59 Birkenhead Street and Centa House, which all front onto Birkenhead Street to the northeast.

The structures are known to have lower ground floor levels but the depth of these levels is unknown and in the interest of conservatism, formation level for each of the sensitive structures has been assumed to be at a depth of 1.00 m. A plan detailing the nearby sensitive structures is shown opposite.



8.2 Construction Sequence

Formation level for the lower ground floor level will be at a depth of about 4.00 m below existing street level. It is understood that the preferred method of retaining wall construction is through a combination of the installation of a contiguous piled walls and the underpinning of sections of the existing foundations of the party walls in a traditional hit and miss approach.

The below construction sequence has been assumed to facilitate the analysis.

1. demolition of the existing buildings in southwest of site;
2. installation of contiguous bored pile retaining wall and cast capping beams and install temporary props to capping beam;
3. underpinning of the existing foundations carried out in a single stage and install temporary props to head of underpinned walls;
4. excavation down to formation level of lower ground floor, propping wall sections as necessary;
5. cast lower ground floor slab;
6. cast vertical basement structure; and,
7. progress with superstructure works and remove temporary support.

8.3 Temporary Support to Underpinned Walls

It is understood that construction of retaining walls will be undertaken in a 'hit and miss' underpinning sequence, in stages to be agreed with the temporary works engineer. This type of construction should generally be undertaken in short sections not exceeding 1.00 m to 1.20 m in length, with no adjacent pin to be excavated until a minimum of 48 hours after the adjacent pin has been cast and dry-packed placed, with the sides of the excavation adequately shored and propped.

The walls will be adequately laterally propped and the concrete will be cast and adequately cured prior to excavation of the basement and removal of the formwork and supports. It is assumed that the new retaining walls will not be cantilevered at any stage during the construction process.

It is assumed that adequate temporary propping of the new retaining walls, particularly at the top level, will occur at all times during excavation of the proposed basement and will remain in place until the construction of permanent concrete floor slabs.

8.4 Temporary Support to Piled Walls

Following the installation of the contiguous bored pile walls and associated capping beams, temporary props will be installed, and the basement excavation will proceed. The detail of section sizes and spacings will be finalised by the contractor but it is anticipated that the general philosophy adopted will be for diagonal braces to be used across the corners or returns of the basement walls whilst props will be positioned at regular intervals along the long walls of the basement.

Where horizontal restraint cannot be provided by other parts of the piled wall the prop forces can be provided by so-called 'flying shores' where the reaction to horizontal forces is provided by pile caps, gravity blocks or basement thickenings in the centre of the excavation.

It is anticipated that steel temporary props will be used with strut forces spread along the wall by steel waling beams fixed to the piles. Although the detail of the propping is to be finalised there is the option to use hydraulic 'active' props where the propping force is applied prior to excavation in order to minimise movement at critical locations. Excavation will proceed in stages and in broad terms the order of operations will be install capping beam props then excavate to formation level.

8.5 Permanent Works

The foundations will be cast prior to the final excavation and will be used to provide a stable base for propping. When the final excavation depths have been reached, the permanent works will be formed, which are likely to comprise the finished floor slab and the installation of beams at ground floor level to support the walls in the overall term.

If the construction sequence and propping arrangement is altered, the ground movement assessment should be updated. An unpropped wall could increase the anticipated movements by a factor of 1.5 which may result in unacceptable levels of movement occurring on the public footpath and roadway and the services beneath.

9.0 Ground Movements

An assessment of ground movements within and surrounding the excavation has been undertaken using the P-Disp and X-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The X-Disp and P-Disp programs have been used to predict ground movements likely to arise from the excavation and construction of the proposed basement. This includes the heave / settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement). Both the P-Disp and X-Disp programs are commonly used within the ground engineering industry and are considered to be appropriate tools for the purpose of this analysis.

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction approximately parallel with Birkenhead Street and Crestfield Street, whilst the y-direction is perpendicular. Vertical movement is in the z-direction.

The proposed excavation has been modelled as a single polygon, which will be formed through a combination of the construction of contiguous bored pile wall and underpinning of the foundations of the existing structures.

It is assumed that suitable propping will be provided during the construction of the basement and in the permanent condition, such that the walls can be considered to be stiff for the purpose of the ground movement modelling.

The full outputs of all the analyses can be provided on request but samples of the output movement contour plots are included within the appendix.

9.1 Ground Movements – Surrounding the Basement

9.1.1 Model Used

For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are the default values within CIRIA report C760[18], which were derived from a number of historic case studies.

Installation of underpins:

For the X-Disp analysis, the installation curves for a panel-like planar diaphragm wall have been adopted for the horizontal and vertical ground movements resulting from the retaining wall installation as most appropriate for the soil movement relationship for walls installed by underpinning techniques.

Installation of piled retaining walls:

The installation curves for a contiguous bored pile wall have been adopted for the horizontal and vertical ground movements resulting from the installation of the piled walls. For the purposes of the assessment it has been assumed that the piles will be installed to have a toe depth of 4 m below ground level, although it is understood that this level may be altered by the piling contractor and the analysis should be updated if this is the case.

An embedment to exposure ratio of 1 to 1 would be reasonable for a propped wall such as this and the X-Disp model has been analysed on this basis.

Excavation Phase:

As it is assumed that the walls will be embedded into the clay and adequately propped at the head, the ground movement curves for 'excavations in front of a high stiffness wall' have been adopted to provide an estimate of the likely movements from the subsequent excavations.

9.1.2 Results

The movements predicted by X-Disp are summarised in the table below; the results are presented below subsequent tables to the degree of accuracy required and in to allow predicted variations in ground movements and in to allow predicted variations in ground movements around the structure to be illustrated but may not reflect the anticipated accuracy of the predictions.

18 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

Phase of Works	Wall Movement (mm)	
	Vertical Settlement	Horizontal Movement
Installation of contiguous bored pile wall and underpins	2.0 to 3.0	2.0 to 3.0
Combined Installation and Excavation Movements	3.0 to 5.0	5.0 to 8.0

The analysis has indicated that the maximum vertical settlement and horizontal movements that will result from wall installation are between 2 mm and 3 mm, with the movements arising from the combined wall installation and excavation phases increasing to between 3 mm and 5 mm of vertical settlement and between 5 mm and 8 mm of horizontal movement.

The movements set out in the table and discussed above are the maximum movements and the analysis has indicated that they occur immediately or just outside the line of the retaining walls, and also account for the likely overprediction of movements within re-entrant corners included within the model.

9.2 Ground Movements – Resulting from Excavation

9.2.1 Model Used

Unloading of the London Clay will take place as a result of the excavation of the proposed basements and the reduction in vertical stress will cause heave to take place. Undrained soil parameters have been used to estimate the potential short-term movements, which include the "immediate" or elastic movements as a result of the basement excavation. Drained parameters have been used to provide an estimate of the total long-term movement.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data[19] and a well-established method has been used to provide estimated values. The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data[20] and a well-established method has been used to provide estimated values.

Relationships of $E_u = 500\ C_u$ and $E' = 300\ C_u$ for the cohesive soils and 2000 x SPT N for granular soils have been used to obtain values of Young's modulus.

The soil parameters used in this analysis and tabulated below have been derived from the onsite investigation and extrapolated where the parameters were required below the depths of the boreholes. A rigid boundary for the analysis has been set at around 70 m (-53 m OD) below the existing ground level, as reference to nearby BGS borehole data indicates this to the level of the base of the Lambeth Group. Below this depth, the soils can be considered essentially incompressible.

Stratum	Depth Range (m)	Eu (MPa)	E'(MPa)
Made Ground	17.0 to 15.0	10.00	10.00
London Clay	15.0 to -7.0	37.5 to 110.0	22.5 to 66.0
Lambeth Group	-7.0 to -53	110.0 to 270.0	66.0 to 162.0

The 2.00 m deep excavation of the basement will result in a net unloading of around 39 kN/m^2, assuming a unit weight of overburden of 19.5 kN/m^2, which will result in the heave of the underlying London Clay.

The proposed loads of the new structure within the lower ground floor excavation have been provided by Price & Myers in a drawing titled preliminary Structural Load Drawings (drawing reference GMA-099, dated July 2024) and these loads have been included within the analysis as a series of polygonal loads acting as slab thickenings which extend 450 mm below the finished slab level. The dimensions of the loads were not known at the time of the analysis, and have been modelled to reduced the bearing pressure of the loads to around 150 kN/m^2.

9.2.2 Results

The predicted movements are summarised in the table below; the results are presented opposite and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure(s) to be illustrated, but may not reflect the anticipated accuracy of the predictions. In the table overleaf, heave movements are shown as negative.

19 Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension.* CIRIA Special Publication 200

20 Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension.* CIRIA Special Publication 200

	Short-term Movement	Total Movement
Below lower ground floor slab	-6.0 to -1	-4 to -14
Below new foundations	-5.0 to 1.0	-1.0 to -11.0

The P-Disp analysis indicates that, by the time the basement construction is complete, up to 5.0 mm of heave is likely to have taken place beneath the lower ground floor slab, which increases to between 1 mm and 14 mm of heave where new loads are applied.

If a compressible material is used beneath the slab, it will need to be designed to be able to resist the potential uplift forces generated by the ground movements. In this respect, potential heave pressures are typically taken to equate to around 40% of the total unloading pressure.

10.0 Damage Assessment

In addition to the above assessment of the likely movements that will result from the proposed development, any neighbouring buildings within the zone of influence of the excavations are considered to be sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 6.4 of CIRIA report C760[21].

The sensitive structures outlined previously have been modelled as displacement lines in the analysis along which the damage assessment has been undertaken.

10.1 Damage to Neighbouring Structures

The ground movements resulting from the piling and basement excavation phases have been calculated using X-Disp modelling software to carry out an assessment of the likely damage to adjacent properties and the results are discussed below.

The building damage reports for sensitive structures highlighted above are included in the appendix and indicate that predominantly the damage to the adjoining and nearby structures due to basement construction are between damage categories 'Negligible (0)', with the exception of five sensitive structures predicted as 'Very Slight (1)'.

A summary of the structures indicated as affected is included below, and the structures suffering damage exceeding category 'Negligible (0)' are highlighted in bold.

Structure	Elevation	Max tensile strain %	Category*
King's Cross Inn	Wall A	0.026	Negligible (0)
	Wall B	None	Below Limit of Sensitivity
	Wall C	0.039	Negligible (0)
	Wall D	None	Below Limit of Sensitivity
	Wall E	None	Below Limit of Sensitivity
59 Birkenhead Street	Wall A	None	Below Limit of Sensitivity
	Wall B	None	Below Limit of Sensitivity
	Wall C	None	Below Limit of Sensitivity

21 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

Structure	Elevation	Max tensile strain %	Category*
	Wall D	None	Below Limit of Sensitivity
Centa House	Wall A	None	Below Limit of Sensitivity
	Wall B	None	Below Limit of Sensitivity
	Wall C	None	Below Limit of Sensitivity
	Wall D	None	Below Limit of Sensitivity
5 Crestfield Street	Wall A	0.021	Negligible (0)
	Wall B	0.042	Negligible (0)
57 Birkenhead Street	Wall A	None	Below Limit of Sensitivity
	Wall B	None	Below Limit of Sensitivity
	Wall C	None	Below Limit of Sensitivity
	Wall D	None	Below Limit of Sensitivity
56 Birkenhead Street	Wall A	None	Below Limit of Sensitivity
	Wall B	None	Below Limit of Sensitivity
	Wall C	None	Below Limit of Sensitivity
Crestfield Hotel	Wall A	0.026	Negligible (0)
	Wall B	None	Below Limit of Sensitivity
	Wall C	0.026	Negligible (0)
	Wall D	<0.001	Negligible (0)
1 Crestfield Street	Wall A	<0.001	Negligible (0)
	Wall B	<0.001	Negligible (0)
	Wall C	0.043	Negligible (0)
	Wall D	**0.071**	**Very Slight (1)**
	Wall E	0.045	Negligible (0)
	Wall F	0.009	Negligible (0)

*From Table 6.4 of C760: Classification of visible damage to walls.

The results discussed above are based on individual building lines, or walls, that in some instances, have been further divided up within the analysis into a series of segments that are assumed to be able to move independently of one another, with the most critical segment determining the result for the entire wall. In reality, this is unlikely to be the case as the walls will behave as single stiff elements that are also joined continuously with the rest of the structure.

The results therefore provide a conservative estimate of the behaviour of each of the sensitive structures and overestimate the degree of damage, although they provide a useful indication of the most critical structures within the adjoining properties that may require further assessment, as detailed below.

10.2 Monitoring of Ground Movements

The predictions of ground movement based on the ground movement analysis should be checked by monitoring of the adjacent properties and structures. The structures to be monitored during the construction stages should include the existing property and the neighbouring structure assessed above. Condition surveys of the above existing structures should be carried out before and after the proposed works.

The precise monitoring strategy will be developed at a later stage, and it will be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

10.3 Impact on Existing Services

The results of statutory services searches have indicated that all of the known nearby services are located below the roadway of Crestfield Street. These include the Thames Water Assets and the Gas services which are located more than 5 m from the edge of the excavation and BT services which are located approximately 3 m from the edge of the excavation. At these distance the movements will be less than 2 mm in magnitude and it is therefore considered that the basement construction will not have a significant impact on existing services. This is also the case with respect to the movement that can be anticipated on the public street itself. As such, any damage should be limited to within acceptable limits.

10.4 Sensitivity Analysis

In view of the lack of published monitoring data and ground movement curves associated with the use of underpins to support a basement excavation and in order to provide further reassurance with respect to the potential damage that could be sustained by adjacent structures in this respect, a sensitivity analysis has been carried out on the basis that vertical and horizontal movements of 5 mm per stage of underpinning are experienced for a single storey of underpinning, assumed to be around 3.00 m, in height. The sensitivity analysis has concluded that the impact on existing services, the public street of Crestfield Street and the nearby sensitive structures will generally be of similar magnitude to those predicted by the initial analysis and the full results are appended for completeness.

No 1 Crestfield Street Wall D is predicted to sustain category 2 damage within the sensitivity analysis. In both the original analysis and the sensitivity analysis the movements have been assessed on the basis of a 2 m underpin and excavation, as this is the proposed excavation depth. However, the surrounding sensitive structures have been conservatively assessed as having foundations extending to a depth of 1 m below ground level, to account for the existing lower ground floor levels. The proposed 1 m of underpinning and excavation below the foundations of the adjacent structures should not, therefore, be expected to move as much as a full storey of underpinning such that it should be possible to restrict movements to the 3 mm vertical settlement and 5 mm of horizontal movement. Therefore, the damage should be restricted to Category 1 (Very Slight).

11.0 GMA Conclusions

The analysis has concluded that the predicted damage to the neighbouring properties from the construction of the proposed basements would be 'Negligible' to 'Very Slight'.

On this basis, the damage that has been predicted to occur as a result of the construction the proposed basement falls within the limits acceptable to the London Borough of Camden assuming that the careful control is taken during construction of the proposed excavations, and monitoring will be required to ensure that no excessive movements occur that would lead to damage in excess of these limits.

The separate phases of work, including piling and subsequent excavation of the proposed basement, will in practice be separated by a number of weeks. This will provide an opportunity for the ground movements during and immediately after installation of the retaining walls to be measured and the data acquired can be fed back into the design and compared with the predicted values. Such a comparison will allow the ground model to be reviewed and the predicted wall movements to be reassessed prior to the main excavation taking place so that propping arrangements can be adjusted if required.

Part 4: Basement Impact Assessment

This section of the report evaluates the direct and indirect implications of the proposed project, based on the findings of the previous screening and scoping, site investigation and ground movement assessment.

12.0 Introduction

The screening identified a number of potential impacts. The desk study and ground investigation information has been used below to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

12.1 Potential Impacts

The table below summarises the previously identified potential impacts and the additional information that is now available from the ground investigation in consideration of each impact.

Potential Impact	Consequence
London Clay is the shallowest stratum at the site.	The London Clay is prone to seasonal shrink-swell (subsidence and heave).
Seasonal shrink-swell can result in foundation movements.	Multiple potential impacts depending on the specific setting of the basement development. For example, the implications of a deepened basement/foundation system on neighbouring properties should be considered.
The excavation is within 5 m of Crestfield Street.	Should the design of retaining walls and foundations not take into account the presence of nearby infrastructure, it may lead to the structural damage of footways, highways and associated buried services.
The development will significantly increase the differential depth of foundations relative to neighbouring properties.	The stability of neighbouring structures will need to be ensured throughout the development. A ground movement analysis is proposed to predict the likely movements as a result of the excavation.
The site within 100 m of the former River Fleet	The potential for the basement to influence the local groundwater regime which could impact the watercourse, should be considered .

The results of the site investigation have therefore been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The Former River Fleet

The river has been culverted and whilst any groundwater is still likely to migrate towards the line of the river, at a distance of 90 m, it is not considered to pose a risk to the site from flooding. Furthermore the investigation has indicated the absence of a groundwater table below the site and therefore the former river is not considered to have any influence over groundwater movements below the site and it will not have an effect on the basement development. Furthermore, as the basement excavation will not extend below the groundwater table, it will not affect groundwater flows towards the former river course.

London Clay is the shallowest stratum / Seasonal Shrink-Swell

The investigation indicated that beneath a variable thickness of made ground, the London Clay is present. The London Clay has been classified as being of high volume change potential, which are prone to seasonal shrink-swell (settlement and heave).

Shrinkable clay is present within a depth that can be affected by tree roots. Numerous trees are present on the site, although desiccation was not observed within the natural soils. The proposed basement is likely to extend below the potential depth of root action, but this should be confirmed once proposals have been finalised.

Location of public highway

The proposed basement excavation will take place in close proximity of the footways to both Birkenhead Street and Crestfield Street. As indicated in the CMS produced by Conisbee, it is proposed to install a contiguous bored piled wall along both these elevations in order to maintain the stability of the footway structures. The ground movement analysis has indicated that movements along the public highway are likely to be less than 5 mm and therefore within normal tolerable limits.

Differential founding depths

The party walls are currently founded on conventional strip foundations bearing on the London Clay. These foundations will be underpinned as part of the basement construction, which will prevent differential founding depths and maintain structural stability. This has been confirmed by the results of the ground movement analysis which has indicated that any building damage is likely to be Category 0 (negligible) to Category 1 (very slight).

12.2 BIA Conclusions

A Basement Impact Assessment has been carried out following the information and guidance published by the London Borough of Camden. It has been concluded that the proposed development is unlikely to result in any impacts of concern.

12.3 Non-Technical Summary of Evidence

This section provides a short summary of the evidence acquired and used to form the conclusions made within the BIA.

12.3.1 Screening

The following table provides the evidence used to answer the subterranean (groundwater flow) screening questions.

Question	Evidence
1a. Is the site located directly above an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.
1b. Will the proposed basement extend beneath the water table surface?	Previous nearby GEA investigations and BGS archive borehole records.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	Topographical and historical maps acquired as part of the desk study, reference to the Lost Rivers of London and Figures 11 and 12 of the Arup report.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	Figures 12 and 14 of the Arup report
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	A site walkover and existing plans of the site have confirmed the proportions of hardstanding and soft landscaping, which have been compared to the proposed drawings to determine the changes in the proportions.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	The details of the proposed development do not indicate the use of soakaway drainage.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report.

The following table provides the evidence used to answer the land stability screening questions.

Question	Evidence
1. Does the existing site include slopes, natural or manmade, greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report and confirmed during a site walkover
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	The details of the proposed development provided do not include the re-profiling of the site to create new slopes
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	
5. Is the London Clay the shallowest strata at the site?	Geological maps and Figures 3, 5 and 8 of the Arup report
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	The details of the proposed development.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	Knowledge on the ground conditions of the area and reference to NHBC guidelines were used to make an assessment of this, in addition to a visual inspection of the buildings carried out during the site walkover.
8. Is the site within 100 m of a watercourse or potential spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report
9. Is the site within an area of previously worked ground?	Geological maps and Figures 3, 5 and 8 of the Arup report
10. Is the site within an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.

Question	Evidence
11. Is the site within 50 m of Hampstead Heath ponds?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report
12. Is the site within 5 m of a highway or pedestrian right of way?	Site plans and the site walkover.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Camden planning portal and the site walkover confirmed the position of the proposed basement relative the neighbouring properties.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Maps and plans of infrastructure tunnels were reviewed.

The following table provides the evidence used to answer the surface water flow and flooding screening questions.

Question	Evidence
1. Is the site within the catchment of the pond chains on Hampstead Heath?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	A site walkover confirmed the current site conditions and the details provided on the proposed development, including reference to the FRA for the site.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	Flood risk maps acquired from the Environment Agency as part of the desk study, Figure 15 of the Arup report, the Camden Flood Risk Management Strategy dated 2013 and the North London Strategic Flood Risk Assessment dated 2008, and reference to the site specific FRA.

12.3.2 Scoping and Site Investigation

The questions in the screening stage that there were answered 'yes', were taken forward to a scoping stage and the potential impacts discussed in Section 4.0 of this report, with reference to the possible impacts outlined in the Arup report.

A ground investigation has been carried out, which has allowed an assessment of the potential impacts of the basement development on the various receptors identified from the screening and scoping stages. Principally the investigation aimed to establish the ground conditions, including the groundwater level, the engineering properties of the underlying soils to enable suitable design of the basement development and the configuration of existing party wall foundations. The findings of the investigation are discussed in Section 5.0 of this report and summarized in both Section 7.0 and the Executive Summary.

12.3.3 Impact Assessment

Section 14.0 of this report summarises whether, on the basis of the findings of the investigation, the potential impacts still need to be given consideration and identifies ongoing risks that will require suitable engineering mitigation. Section 9.0 of this report also provides recommendations for the design of the proposed development.

A ground movement analysis and building damage assessment has been carried out and its findings are presented in Part 3.

13.0 Outstanding Risks & Issues

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of this investigation, or where issues have been identified by this investigation that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work may be required.

13.1 Site-Specific Risks

Monitoring of the standpipe should be continued to determine equilibrium groundwater levels and to establish any seasonal fluctuations. Ideally, trial excavations extending to as close to the full depth of the proposed basement as possible should be carried out to determine likely groundwater inflows into the basement excavation.

This investigation has identified the presence of contamination and there may be a requirement for a separate remediation proposals report to be prepared to comply with planning requirements. The remediation will need to be supervised and verified by a geoenvironmental engineer and a completion or validation report will also probably be required to support the planning application.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed.

It is recommended that movement monitoring is carried out on all structures prior to and during the proposed basement construction.

These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk

13.2 General Risks

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the general ground conditions based on the discrete points at which the ground was sampled, but there may be ground conditions (including soil, rock, gas and groundwater) elsewhere on site that have not been revealed by this investigation and therefore could not have been taken into account in this report. The ground conditions should be subject to review as the development proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

The comments made regarding gas and groundwater are based on observations made during the period the work has been carried out. Conditions may vary as a result of seasonal or other effects.

Where any conclusions and recommendations contained in this report have been based upon information provided by others, it has been assumed that all relevant information has been provided by those parties and that such information is accurate. Any such information has not been independently verified by GEA, unless otherwise stated in the report. GEA accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to GEA from others.

Appendix

a. Field Work

Site Plan
Borehole Records
Trial Pit Records

b. Lab Testing

Geotechnical Test Results
SPT & Cohesion/Depth Graph
Chemical Test Results
Generic Risk Based Screening Values

c. Desk Study

Risk Assessment Tables
Envirocheck Extracts
Historical Maps
UXO Preliminary Risk Assessment

d. Ground Movement Analysis

PDisp Analysis – Short Term Movements
PDisp Analysis – Total Movements
XDisp Analysis – All Input Data
XDisp Analysis – Installation Movements
XDisp Analysis – Installation & Excavation Movements
XDisp Analysis – Building Damage Assessment Results

appendix a

Field Work

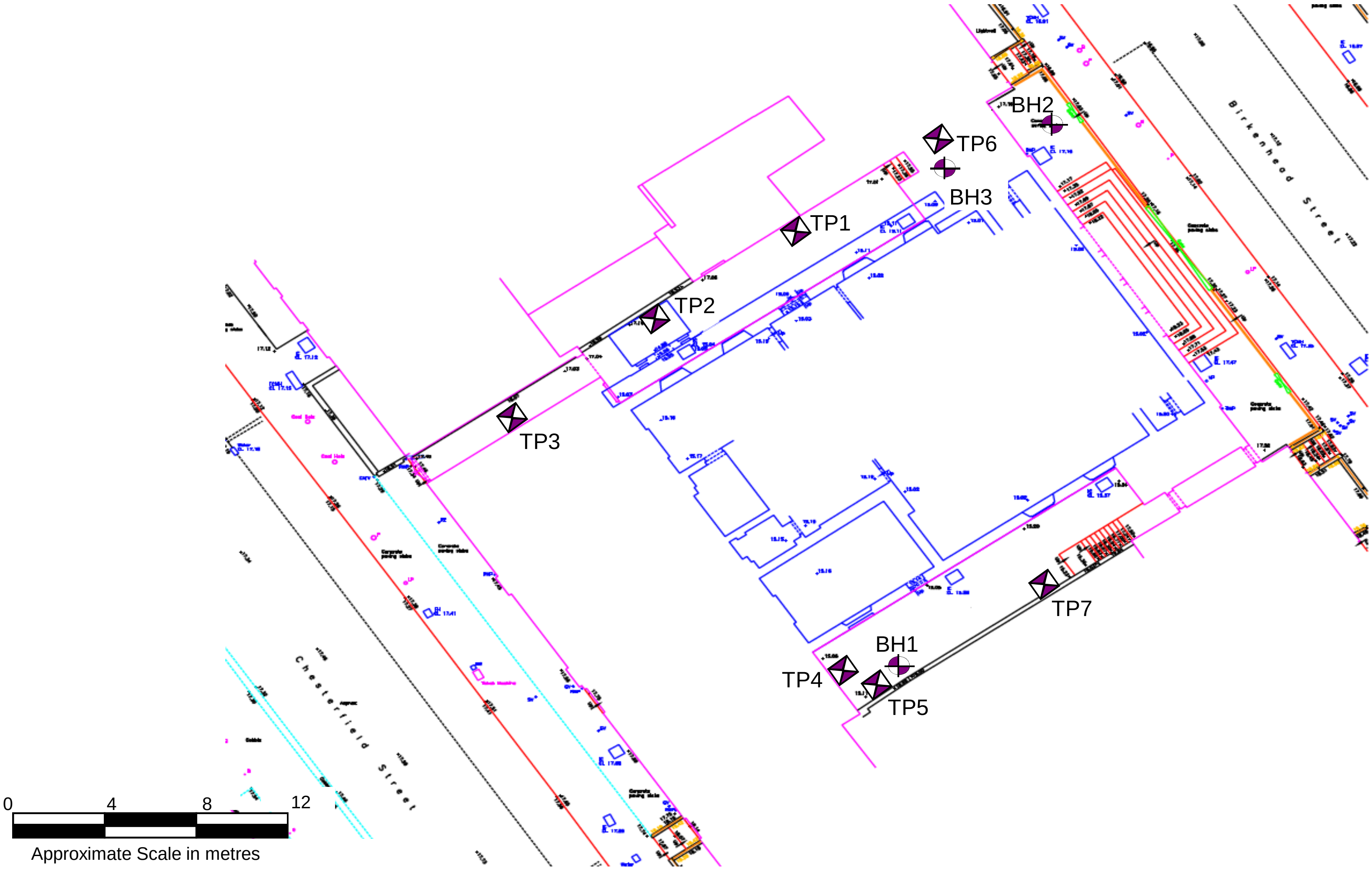
Site Plan
Borehole Records
Trial Pit Records

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Site Plan

Site	King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	**Job Number**	J14336
Client	West London Mission	**Sheet**	1 / 1
Engineer	Conisbee		



Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	**Number** **BH1**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Drive-in Window Sampler		15.06	West London Mission	J14336
	Location	**Dates** 14/11/2014	**Engineer** Conisbee	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				14.97	(0.09) 0.09	Concrete		
				14.84	(0.13) 0.22	Made Ground (crushed brick and gravel)		
						Firm fissured brown CLAY with partings of bluish grey and orange-brown silt, bluish grey staining along fissures and selenite crystals		
1.00	D1							
2.00	D2				(4.28)	claystone fragments encountered at 2.5 m		
3.00	D3							
4.50	D4			10.56	4.50	Stiff fissured grey CLAY with pale grey veins, traces of selenite and fine shells		
5.50	D5				(1.70)			
				8.86	6.20			
						Terminated at 6.30m		

Remarks	**Scale (approx)**	**Logged By**
Borehole advanced through the base of Trial Pit No 5 at a depth of 0.85 m. Groundwater not encountered. Borehole terminated due to the strength of the clay.	1:50	ML
	Figure No. J14336.BH2	

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	**Borehole Number** **BH2**

Boring Method	**Casing Diameter**	**Ground Level (mOD)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 3.00m	17.16	West London Mission	J14336
	Location	**Dates** 14/11/2014- 17/11/2014	**Engineer** Conisbee	**Sheet** 1/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.30)	Paving slab over concrete			
					16.86	0.30				
0.35 0.50	D1 B1						Made Ground (dark grey clayey sandy silt with gravel and crushed brick)			
						(1.90)				
1.20-1.65 1.20-1.65	CPT N=6 B2		DRY	1,0/1,2,1,2						
1.75	D2									
2.00-2.45 2.00-2.45	CPT N=14 B3	2.00	DRY	1,2/3,3,3,5						
					14.96	2.20	Firm becoming stiff fissured high strength brown silty CLAY with partings of bluish grey and orange-brown silt, bluish grey staining along fissures and selenite crystals			
2.75	D3									
3.00-3.45	U1									
3.75	D4									
4.00-4.45 4.00	SPT N=15 D5	3.00	DRY	1,3/3,3,4,5		(3.80)				
4.75	D6									
5.00-5.45	U2									
6.00	D7				11.16	6.00	Stiff becoming very stiff fissured high stength to very high strength dark grey silty CLAY with pale grey veins, traces of selenite and occasional fine shells and pyrite nodules			
6.50-6.95 6.50	SPT N=25 D8	3.00	DRY	3,6/8,8,4,5						
							claystone encountered at 6.50 m			
7.50	D9									
8.00-8.45	U3									
							claystone encountered at 8.30 m			
9.00	D10									
9.50-9.95 9.50	CPT N=18 D11	3.00	DRY	3,2/3,4,5,6						

Remarks
2 hrs spent manhandling drilling rig and tools into position.
Excavating services insepction pit to 1.2 m for 1 hr. Groundwater not encountered.
Groundwater monitoring standpipe installed to 6.00 m, see separate sheet for the monitoring results.
2 hrs spent removing spoil and washing down drilling area.

Scale (approx)	**Logged By**
1:50	ML
Figure No.	
J14336.BH1	

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	**Borehole Number** **BH2**
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 3.00m	**Ground Level (mOD)** 17.16	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 14/11/2014-17/11/2014	**Engineer** Conisbee	**Sheet** 2/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50	D12									
11.00-11.45	U4									
12.00	D13									
12.50	D14			14/11/2014:DRY						
12.50-12.95	SPT N=24	3.00	DRY	17/11/2014:DRY 3,4/5,6,6,7						
13.50	D15									
14.00-14.45	U5									
15.00	D16									
15.50-15.95	SPT N=27	3.00	DRY	4,5/5,6,7,9						
16.50	D17									
17.00-17.45	U6					(18.00)				
18.00	D18						becoming slightly sandy with partings of pale grey fine sand below 18.00 m			
18.50-18.95 18.50	SPT N=31 D19	3.00	DRY	5,6/7,7,8,9						
19.50	D20									

Remarks	**Scale (approx)** 1:50	**Logged By** ML
	Figure No. J14336.BH1	

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	**Borehole Number** **BH2**

Boring Method	**Casing Diameter**	**Ground Level (mOD)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 3.00m	17.16	West London Mission	J14336
	Location	**Dates** 14/11/2014- 17/11/2014	**Engineer** Conisbee	**Sheet** 3/3

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
20.00-20.45	U7						becoming extremely high strength from 20.00 m			
21.00	D21									
21.50-21.95 21.50	SPT N=33 D22	3.00	DRY	5,6/7,8,9,9						
						(18.00)				
22.50	D23									
23.00	U8									
					-6.84	24.00	Very stiff fissured reddish brown and brown mottled orange-brown and grey silty sandy CLAY			
24.00	D24									
24.50-24.95 24.50	SPT N=30 D25	3.00	DRY	4,5/6,6,8,10						
25.50	D26									
26.00-26.45 26.00	SPT N=40 D27	3.00	DRY	4,6/8,8,11,13						
						(6.00)				
27.00	D28									
27.50-27.95 27.50	SPT N=44 D29	3.00	DRY	2,6/8,9,12,15						
28.50	D30									
29.55-30.00 29.55	CPT N=50 D31	3.00	DRY	11,50/50 17/11/2014:DRY						
					-12.84	30.00				

Remarks	**Scale (approx)**	**Logged By**
	1:50	ML
	Figure No. J14336.BH1	

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware,Herts
SG12 7QE

Site	Borehole Number
King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	BH2

Installation Type	Dimensions	Client	Job Number
		West London Mission	J14336

Location	Ground Level (mOD)	Engineer	Sheet
	17.16	Conisbee	1/1

Level (mOD)	Depth (m)	Description
16.96	0.20	Concrete
16.66	0.50	Bentonite Seal
		Gravel Filter
15.16	2.00	Slotted Standpipe
11.16	6.00	General Backfill
-12.84	30.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
14/11/14	10:00			DRY		15:00	12.50	3.00	DRY	
17/11/14	9:00	12.50	3.00	DRY		14:00	30.00	3.00	DRY	

Instrument Groundwater Observations

Inst. [A] Type :

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks
25/11/14		DRY		
13/12/14		DRY		

Remarks

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW	**Number** **BH3**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Drive-in Window Sampler		17.55	West London Mission	J14336
	Location	**Dates** 14/11/2014	**Engineer** Conisbee	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				17.47	(0.08) 0.08	Brick block paving		
				16.85	(0.62) 0.70	Made Ground (brown clay with gravel, brick and abundant pottery fragments)		
				15.85	(1.00) 1.70	Made Ground (dark brown clayey sandy silt with gravel, brick, chalk, slate and pottery fragments)		
				13.55	(2.30) 4.00	Firm fissured brown CLAY with partings of bluish grey and orange-brown silt and selenite crystals		
				12.25	(1.30) 5.30	Stiff fissured dark grey CLAY with pale grey veins and traces of selenite		
						Terminated at 5.30m		

Remarks
Borehole advanced through the base of Trial Pit 6 at a depth of 1.5 m.
Groundwater not encountered.
Borehole terminated due to the strength of the clay.

Scale (approx)	**Logged By**
1:50	ML

Figure No.
J14336.BH3

Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware,Herts
SG12 7QE

Standard Penetration Test Results

Site : King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW

Client : West London Mission

Engineer : Conisbee

Job Number J14336

Sheet 1 / 1

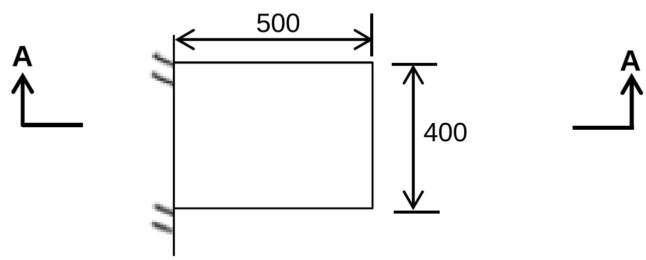
Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm 1	Seating Blows per 75mm 2	Blows for each 75mm penetration 1	2	3	4	Result	Comments
BH2	1.20	1.35	1.65	CPT	1	0	1	2	1	2	N=6	
BH2	2.00	2.15	2.45	CPT	1	2	3	3	3	5	N=14	
BH2	4.00	4.15	4.45	SPT	1	3	3	3	4	5	N=15	
BH2	6.50	6.65	6.95	SPT	3	6	8	8	4	5	N=25	
BH2	9.50	9.65	9.95	CPT	3	2	3	4	5	6	N=18	
BH2	12.50	12.65	12.95	SPT	3	4	5	6	6	7	N=24	
BH2	15.50	15.65	15.95	SPT	4	5	5	6	7	9	N=27	
BH2	18.50	18.65	18.95	SPT	5	6	7	7	8	9	N=31	
BH2	21.50	21.65	21.95	SPT	5	6	7	8	9	9	N=33	
BH2	24.50	24.65	24.95	SPT	4	5	6	6	8	10	N=30	
BH2	26.00	26.15	26.45	SPT	4	6	8	8	11	13	N=40	
BH2	27.50	27.65	27.95	SPT	2	6	8	9	12	15	N=44	
BH2	29.55	29.70	30.00	CPT	11	50	50				N=50	

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Excavation Method Manual	**Dimensions** 500 x 400 x 1300	**Ground Level (mOD)** 17.71	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** 1
			Client West London Mission	**Job Number** J14336
	Location	**Dates** 04/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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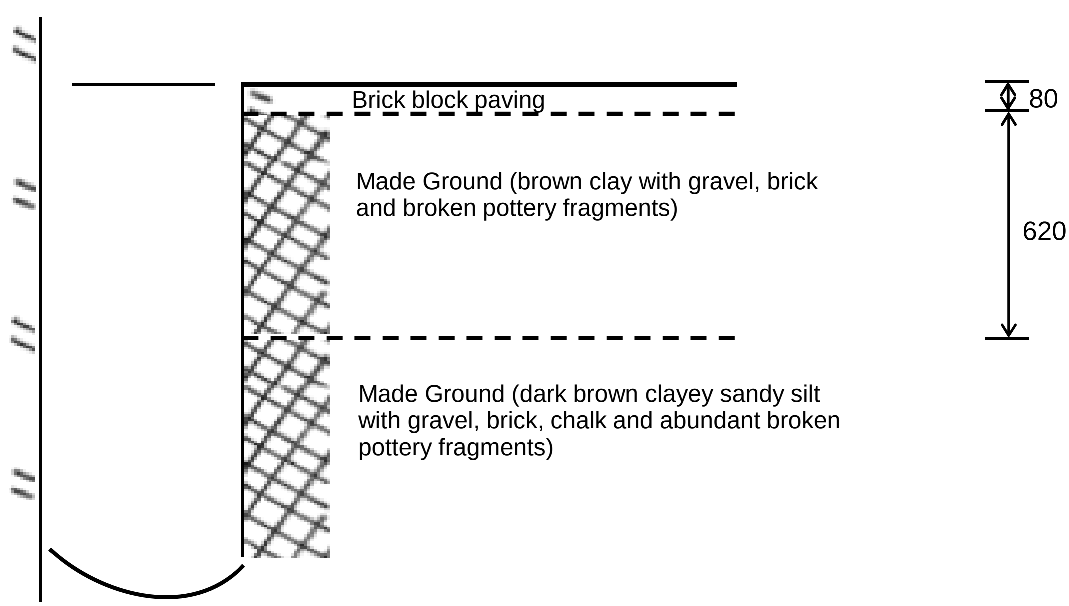


Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved.	1:20
Sides of trial pit remained stable during excavation	Borehole No 3 advanced through base of trial pit.	Logged by:
Groundwater: Not encountered		ML

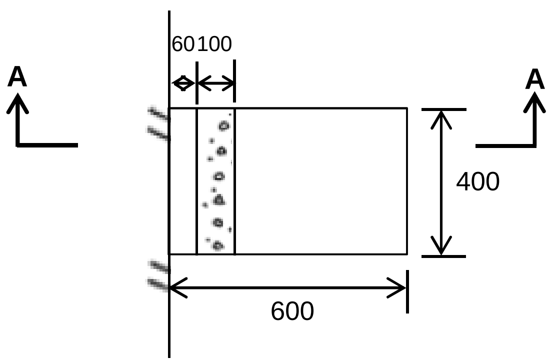
Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	Site Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	Trial Pit Number 1

Excavation Method **Manual**	**Dimensions** 500 x 400 x 1300	**Ground Level (mOD)** 17.71	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 04/11/2014	**Engineer** Conisbee	**Sheet** 2 / 2

Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved.	1:20
Sides of trial pit remained stable during excavation	Borehole No 3 advanced through base of trial pit.	Logged by:
Groundwater: Not encountered		ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW		**Trial Pit Number** 2
Excavation Method Manual	**Dimensions** 600 x 400 x 400	**Ground Level (mOD)** 14.88	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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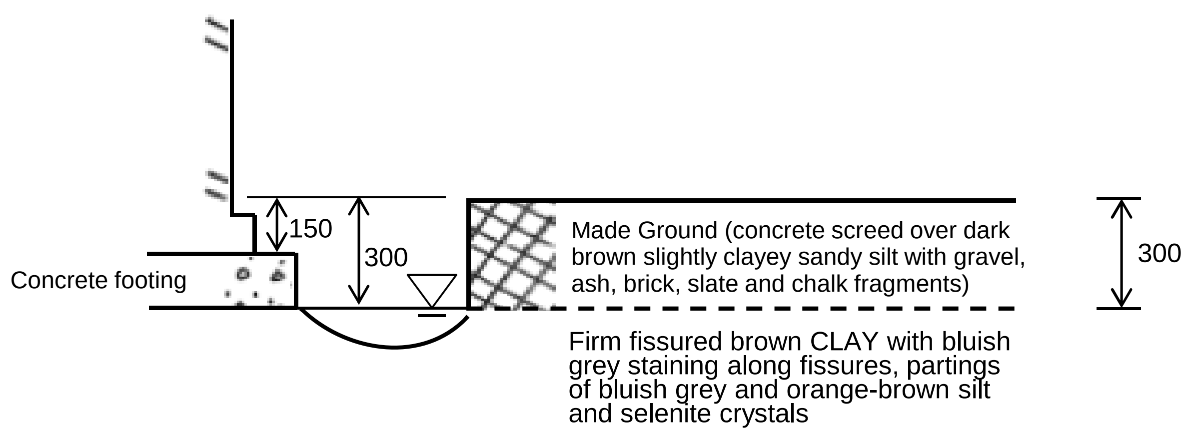


Remarks: All dimensions in millimetres Sides of trial pit remained stable during excavation Groundwater: Standing at 0.30 m	Scale: 1:20 Logged by: ML

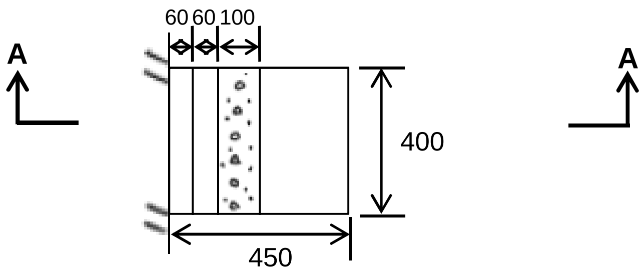
Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	Site Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	Trial Pit Number 2

Excavation Method **Manual**	**Dimensions** 600 x 400 x 400	**Ground Level (mOD)** 14.88	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Standing at 0.30 m	ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG		**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **3**
Excavation Method **Manual**	**Dimensions** 450 x 400 x 800	**Ground Level (mOD)** 17.03	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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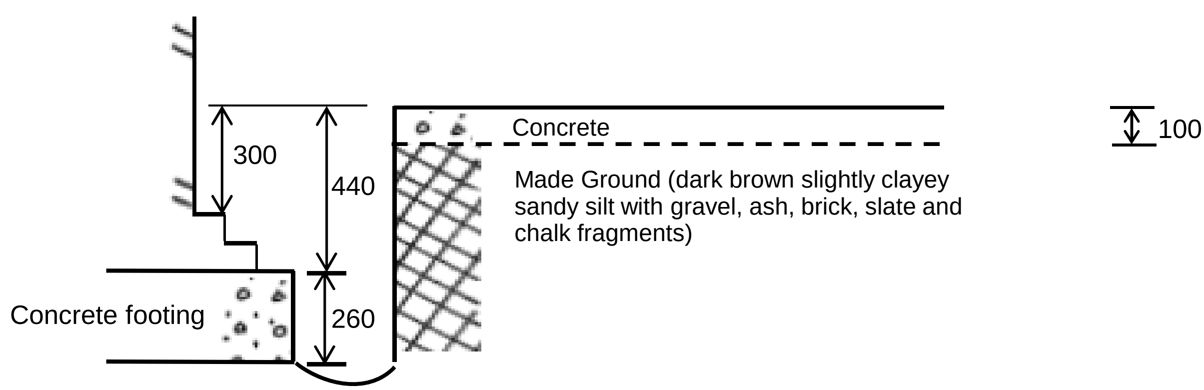


Remarks:		Scale:
All dimensions in millimetres	Sample: 0.4 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: Not encountered		ML

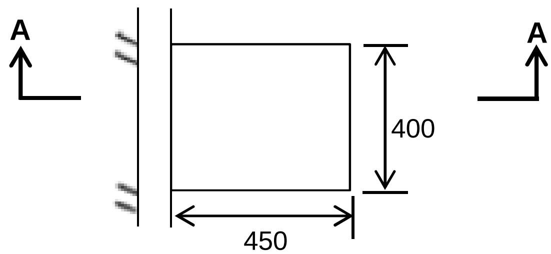
Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **3**

Excavation Method **Manual**	**Dimensions** 450 x 400 x 800	**Ground Level (mOD)** 17.03	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Remarks:		Scale:
All dimensions in millimetres	Sample: 0.4 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: Not encountered		ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG		**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **4**
Excavation Method **Manual**	**Dimensions** 450 x 400 x 450	**Ground Level (mOD)** 15.06	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 14/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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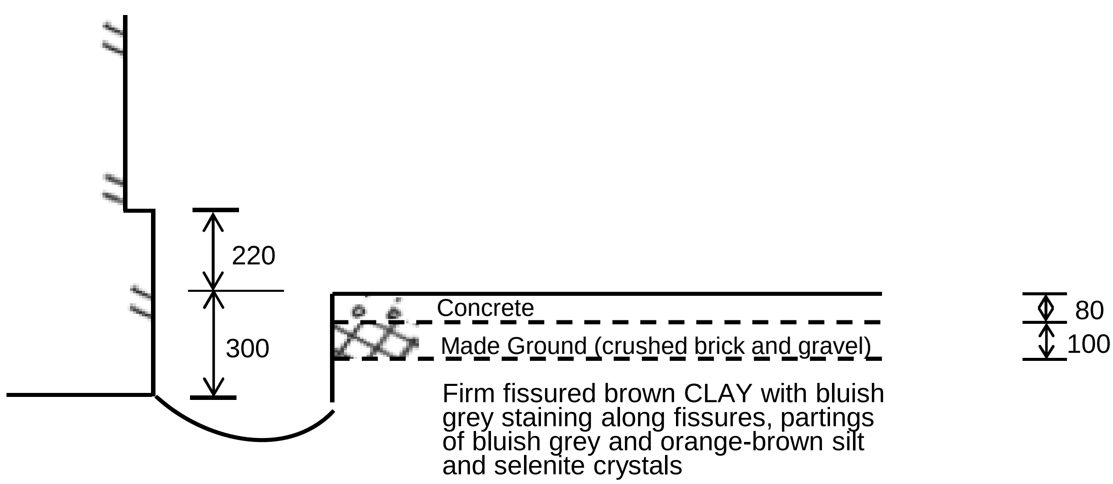


Remarks:		Scale:
All dimensions in millimetres	Sample: 0.2 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: Not encountered		ML

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **4**

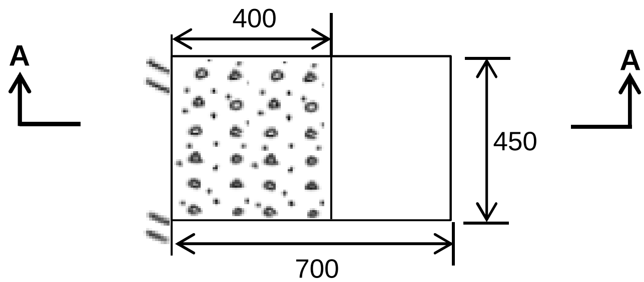
Excavation Method **Manual**	**Dimensions** 450 x 400 x 450	**Ground Level (mOD)** 15.06	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 04/11/2014	**Engineer** Conisbee	**Sheet** 2 / 2

Remarks:		Scale:
All dimensions in millimetres	Sample:0.4 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: Not encountered		ML

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **5**

Excavation Method **Manual**	**Dimensions** 700 x 450 x 650	**Ground Level (mOD)** 15.05	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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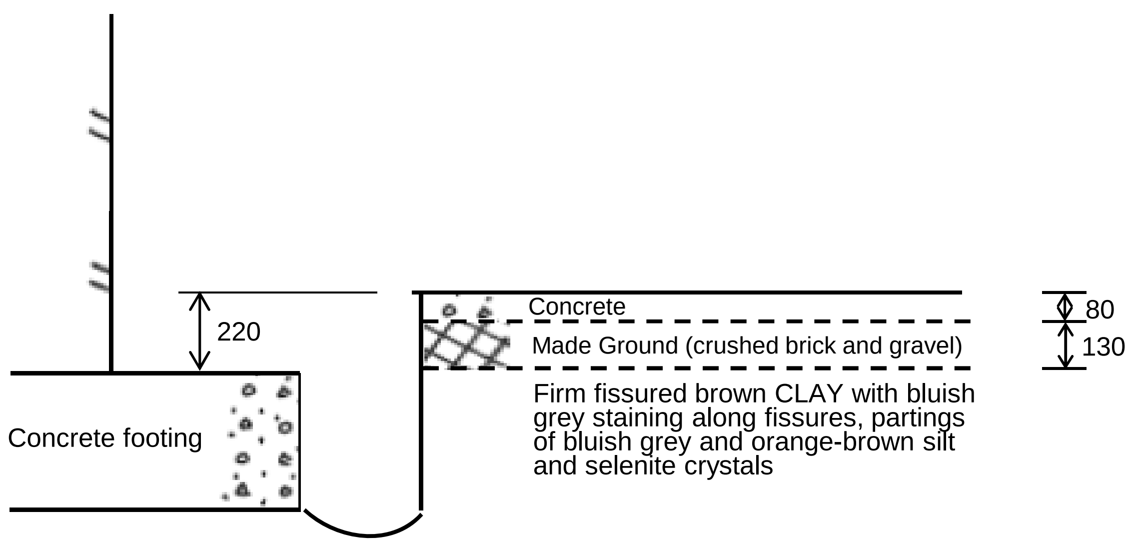


Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	ML

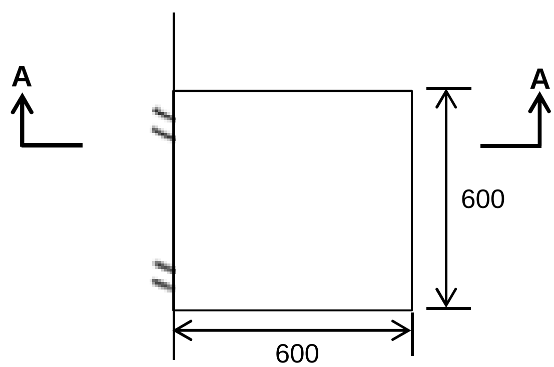
GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG		Site Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	Trial Pit Number **5**
Excavation Method Manual	**Dimensions** 700 x 450 x 650	**Ground Level (mOD)** 15.05	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 2 / 2

Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	ML

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **6**

Excavation Method **Manual**	**Dimensions** 600 x 600 x 650	**Ground Level (mOD)** 15.11	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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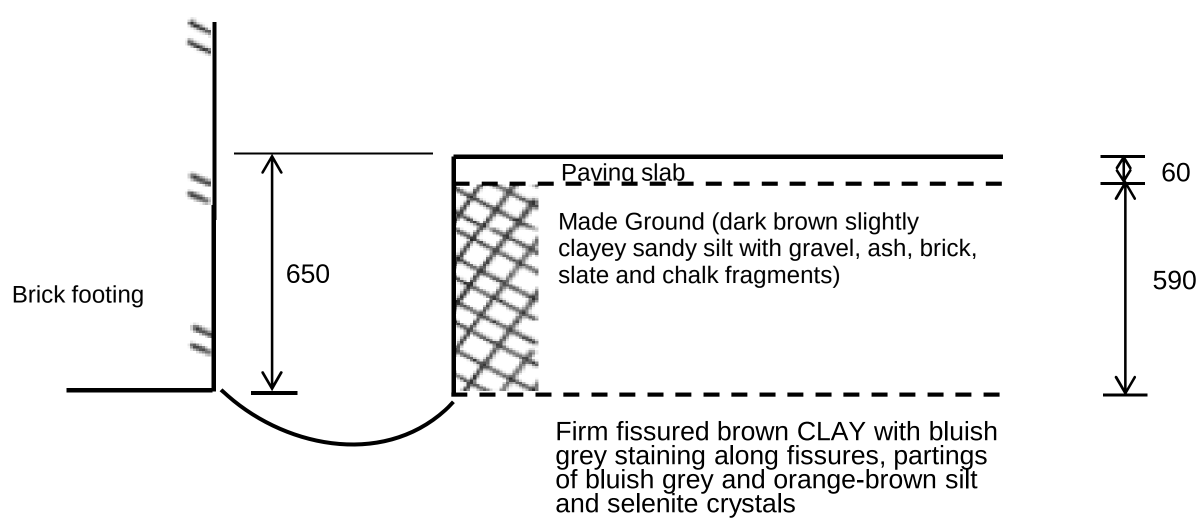


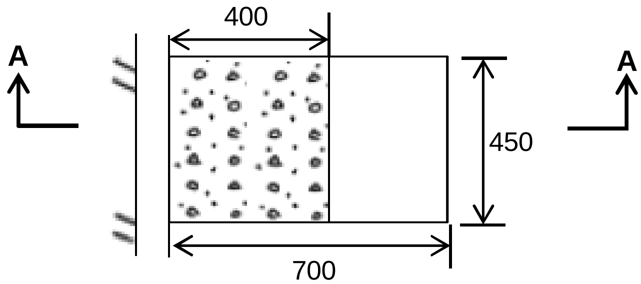
Remarks:		Scale:
All dimensions in millimetres	Sample: 0.2 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: Not encountered		ML

GEA Geotechnical & Environmental Associates — Tyttenhanger House, Coursers Road, St Albans, Herts AL4 0PG			**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** 6
Excavation Method Manual	**Dimensions** 600 x 600 x 650	**Ground Level (mOD)** 15.11	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 05/11/2014	**Engineer** Conisbee	**Sheet** 2 / 2

Remarks:		Scale:
All dimensions in millimetres	Sample: 0.2 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: Not encountered		ML

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** 7
Excavation Method Manual	**Dimensions** 700 x 450 x 700	**Ground Level (mOD)** 15.06	**Client** West London Mission	**Job Number** J14336
	Location	**Dates** 04/11/2014	**Engineer** Conisbee	**Sheet** 1 / 2

Plan: -



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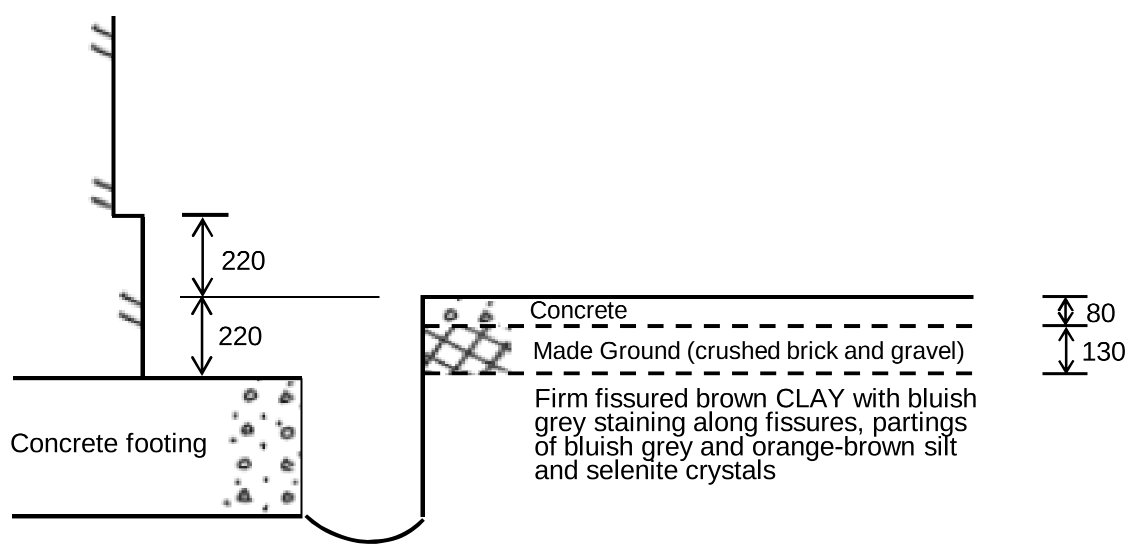


Remarks:		Scale:
All dimensions in millimetres	Sample: 0.3 m	1:20
Sides of trial pit remained stable during excavation	Borehole No 2 advanced through base of trial pit.	Logged by:
Groundwater: not encountered		ML

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** Kings Cross Mehtodist Church, Birkenhead Street, London WC1H 8BW	**Trial Pit Number** **7**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Manual	700 x 450 x 700	15.06	West London Mission	J14336
	Location	**Dates**	**Engineer**	**Sheet**
		04/11/2014	Conisbee	2 / 2

Remarks:		Scale:
All dimensions in millimetres	Sample: 0.3 m	1:20
Sides of trial pit remained stable during excavation	Borehole No 2 advanced through base of trial pit.	Logged by:
Groundwater: not encountered		ML

appendix b

Lab Testing

Geotechnical Test Results
SPT & Cohesion/Depth Graph
Chemical Test Results
Generic Risk Based Screening Values
Generic Risk Based Groundwater Screening Values

Project Name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ			**Samples Received:**	24/11/2014
				Project Started:	24/11/2014
Client:	GEA			**Testing Started:**	03/12/2014
Project No:	J14336	**Our job/report no:**	17886	**Date Reported:**	04/12/2014

K4 SOILS

Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
BH1	D3	2.75	Brown silty CLAY with traces of selenite crystals	34	73	26	47	100	
BH1	D7	6.00	Dark grey and occasional brown silty CLAY	33	79	30	49	100	
BH1	D25	24.50	Brown silty CLAY	26	80	29	51	100	
BH2	D2	2.00	Brown silty CLAY with traces of selenite crystals	32	76	24	52	100	

UKAS TESTING 2519

Summary of Test Results

BS 1377 : Part 2 : Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method.
BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index.
BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method.

Checked and Approved
Initials: K.P
Date: 04/12/2014

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU

Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Project Name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ				K4 SOILS
Client:	GEA	Project no:	J14336		
		Our job no:	17886		

Borehole No:	Sample No:	Depth m	Description	pH	Sulphate content (g/l)
BH1	D4	3.75	Brown CLAY	7.8	3.19
BH1	D10	9.00	Dark grey slightly gravelly CLAY (gravel is fm and sub-angular to angular)	7.9	1.03
BH1	D17	16.50	Dark grey silty CLAY	7.9	1.13
BH1	D23	27.00	Reddish brown, blue grey and grey silty CLAY	8.1	0.43
BH2	D3	3.00	Grey brown silty CLAY with orange brown sandy pockets and selenite crystals	7.7	3.12

Summary of Test Results

BS 1377 : Part 3 :Clause 5 : 1990

Determination of sulphate content of soil and ground water : gravimetric method

Date 04/12/2014

Checked and Approved

Initials : kp

Client :	GEA	**Our Job/report no:**	17886	**Samples Rec :**	24/11/2014	**Testing Started:**	03/12/2014
Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ	**Project No:**	**J14336**	**Project Started:**	24/11/2014	**Date reported:**	04/12/2014

BH / TP No	Sample no / ref	Sample depth (m)	Description	Moisture content (%)	Bulk Density (Mg/m3)	Dry density (Mg/m3)	Cell Pressure (kPa)	Strain at failure (%)	Max Deviator Stress (kPa)	Mode of failure	Shear Strength (kPa)	Phi (deg)
BH1	U1	3.00	High strength fissured brown silty CLAY	28	1.98	1.55	60	5.0	229	Brittle	115	NA
BH1	U2	5.00	High strength fissured brown slightly blue grey mottled CLAY with selenite crystals	32	1.97	1.49	100	5.6	184	Brittle	92	NA
BH1	U3	8.00	High strength fissured dark grey CLAY	30	1.97	1.51	160	4.5	220	Brittle	110	NA
BH1	U4	11.00	Medium strength fissured brown slightly blue grey mottled CLAY with brown fine sand partings	32	1.95	1.49	220	6.6	148	Brittle	74	NA
BH1	U5	14.00	Very high strength fissured dark grey CLAY	27	2.04	1.61	280	3.5	354	Brittle	177	NA
BH1	U6	17.00	Very high strength slightly fissured dark grey CLAY with light grey fine sand partings	21	2.11	1.74	340	12	547	Brittle	274	NA
BH1	U7	20.00	Extremely high strength fissured dark grey CLAY with light grey fine sand partings	25	2.09	1.68	400	5.6	655	Brittle	327	NA
BH1	U8	23.00	Very high strength fissured dark grey CLAY with light grey fine sand partings	22	2.11	1.73	460	8.6	447	Brittle	224	NA

K4 SOILS

Summary of Undrained Triaxial Compression Testing

BS 1377 : Part 7 : Clause 8 : 1990

Checked and approved

Initials kp

UKAS TESTING 2519

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ			**Samples Received:**	24/11/2014
				Project Started:	24/11/2014
Client:	GEA			**Testing Started:**	03/12/2014
Project no:	J14336	**Our job /report no:**	17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1	**Sample no:**	U1	**Depth (m):**	3.00

Soil Description: High strength fissured brown silty CLAY

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	201.0
Diameter	mm	102.0
Moisture Content	%	28
Bulk Density	Mg/m³	1.98
Dry Density	Mg/m³	1.55

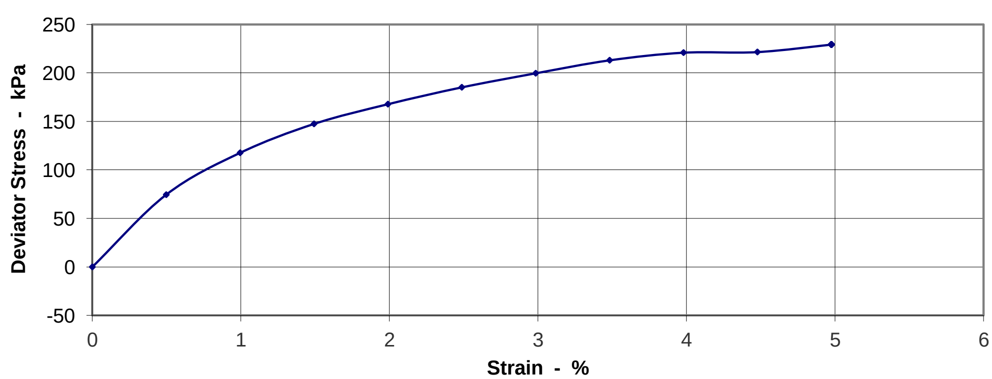
Test Details

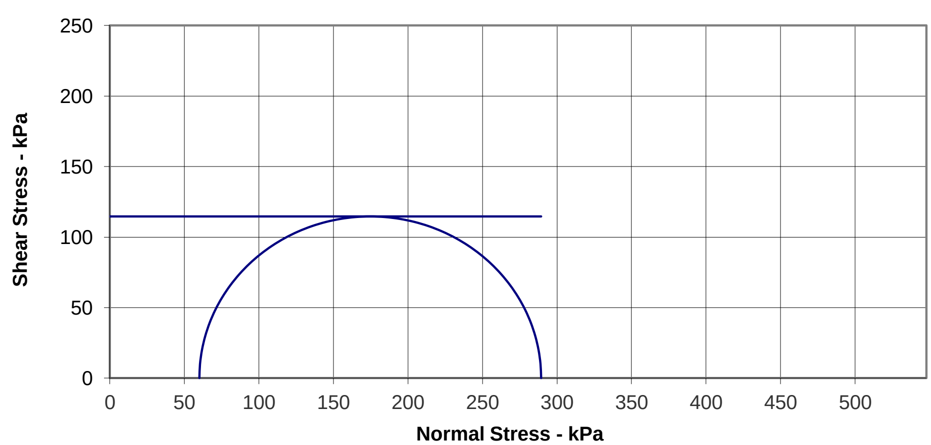
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.25
Rate of Axial Displacement	%/min	1.99
Cell Pressure	kPa	60
Strain at Failure	%	5.0
Maximum Deviator Stress	kPa	229
Shear Strength	kPa	115
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters		
C	115	kPa
Phi	0.0	°

Specimen 1





K4 SOILS LABORATORY
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Tel:01923711288 Fax:01923711311
E-mail: k4soils@aol.com

Approved Signatories: **K.Phaure(Tech.Mgr)**
J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ			**Samples Received:**	24/11/2014
				Project Started:	24/11/2014
Client:	GEA			**Testing Started:**	03/12/2014
Project no:	J14336	**Our job /report no:**	17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1	**Sample no:**	U2	**Depth (m):**	5.00

Soil Description: High strength fissured brown slightly blue grey mottled CLAY with selenite crystals

Sample Details

Specimen		1
Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	32
Bulk Density	Mg/m³	1.97
Dry Density	Mg/m³	1.49

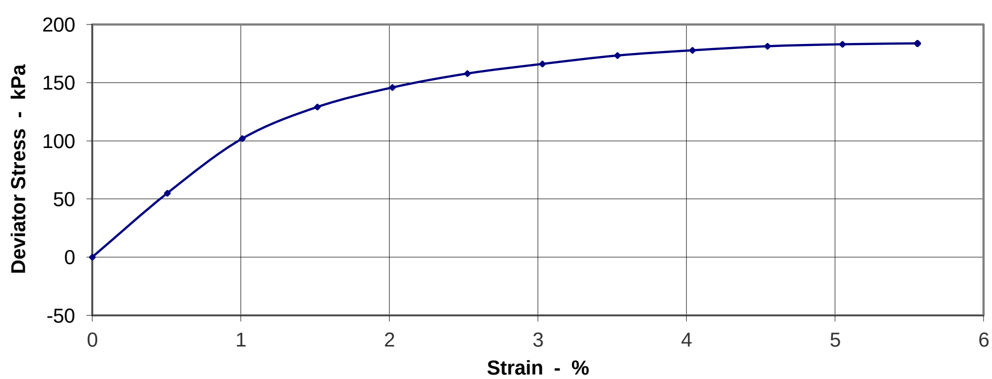
Test Details

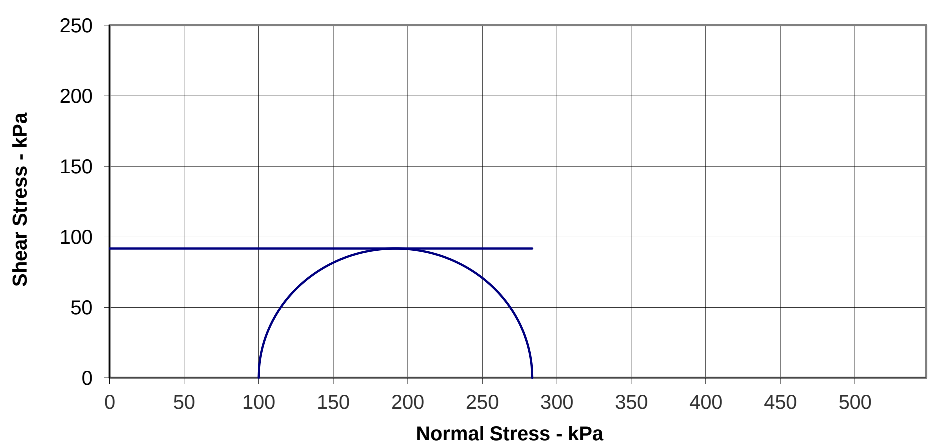
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.28
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	100
Strain at Failure	%	5.6
Maximum Deviator Stress	kPa	184
Shear Strength	kPa	92
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters		
C	92	kPa
Phi	0.0	°

Specimen 1





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Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ			**Samples Received:**	24/11/2014
				Project Started:	24/11/2014
Client:	GEA			**Testing Started:**	03/12/2014
Project no:	J14336	**Our job /report no:**	17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1	**Sample no:**	U3	**Depth (m):**	8.00

Soil Description: High strength fissured dark grey CLAY

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	30
Bulk Density	Mg/m^3	1.97
Dry Density	Mg/m^3	1.51

Test Details

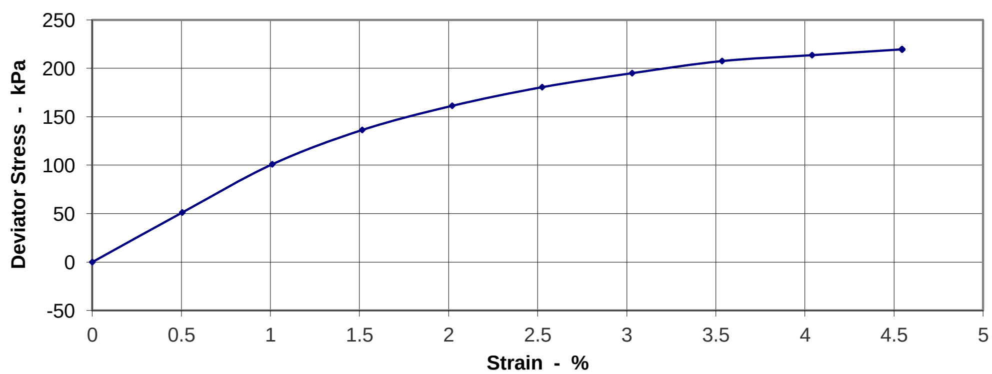
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.23
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	160
Strain at Failure	%	4.5
Maximum Deviator Stress	kPa	220
Shear Strength	kPa	110
Mode of Failure		Brittle

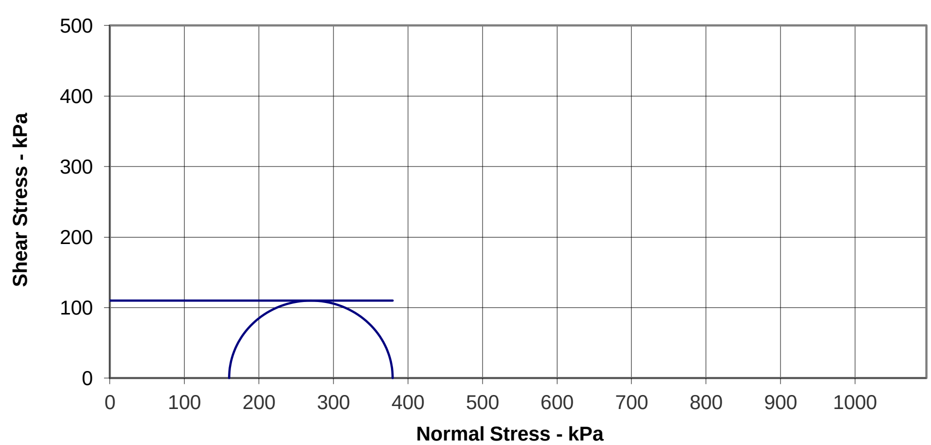
Position and orientation within the original sample

Shear Strength Parameters

C	110 kPa
Phi	0.0 °

Specimen 1





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Checked and Approved
Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ			**Samples Received:**	24/11/2014
				Project Started:	24/11/2014
Client:	GEA			**Testing Started:**	03/12/2014
Project no:	J14336	**Our job /report no:**	17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1	**Sample no:**	U4	**Depth (m):**	11.00

Soil Description: Medium strength fissured brown slightly blue grey mottled CLAY with brown fine sand partings

Sample Details — **Specimen 1**

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	32
Bulk Density	Mg/m³	1.95
Dry Density	Mg/m³	1.49

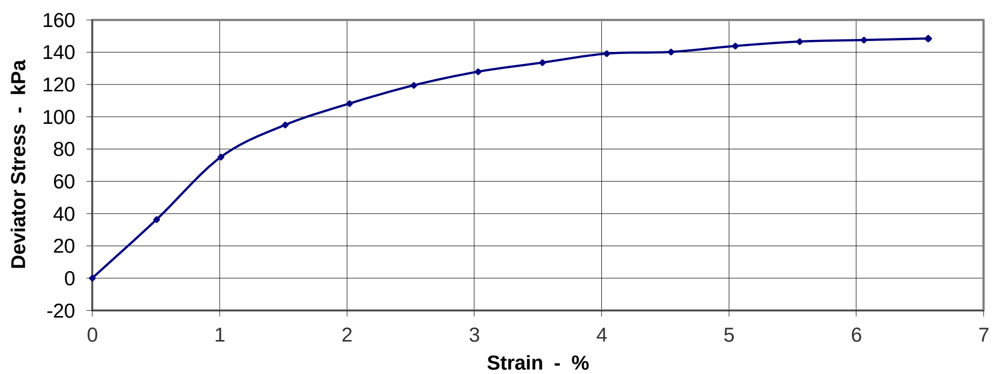
Test Details

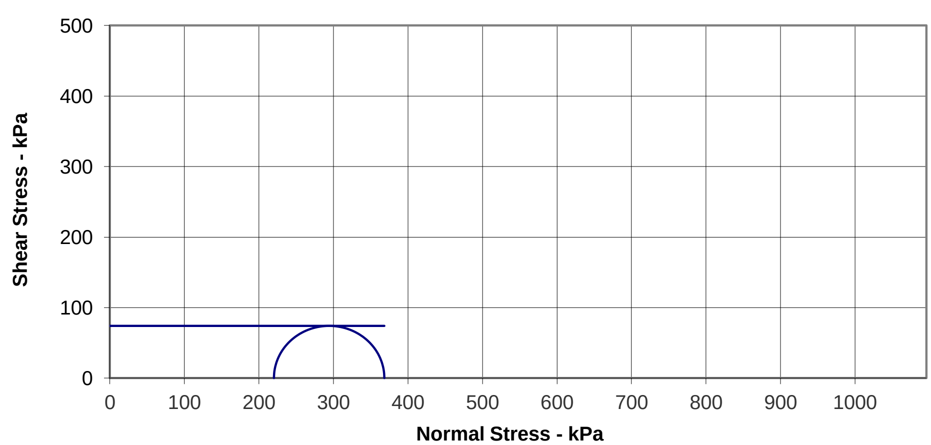
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.32
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	220
Strain at Failure	%	6.6
Maximum Deviator Stress	kPa	148
Shear Strength	kPa	74
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters	
C	74 kPa
Phi	0.0 °

Specimen 1





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Test results relate only to the sample numbers shown above

Checked and Approved
Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS	Report of Undrained Triaxial Compression Test
	BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ			**Samples Received:**	24/11/2014
				Project Started:	24/11/2014
Client:	GEA			**Testing Started:**	03/12/2014
Project no:	J14336	**Our job /report no:**	17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1	**Sample no:**	U5	**Depth (m):**	14.00

Soil Description: Very high strength fissured dark grey CLAY

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	27
Bulk Density	Mg/m³	2.04
Dry Density	Mg/m³	1.61

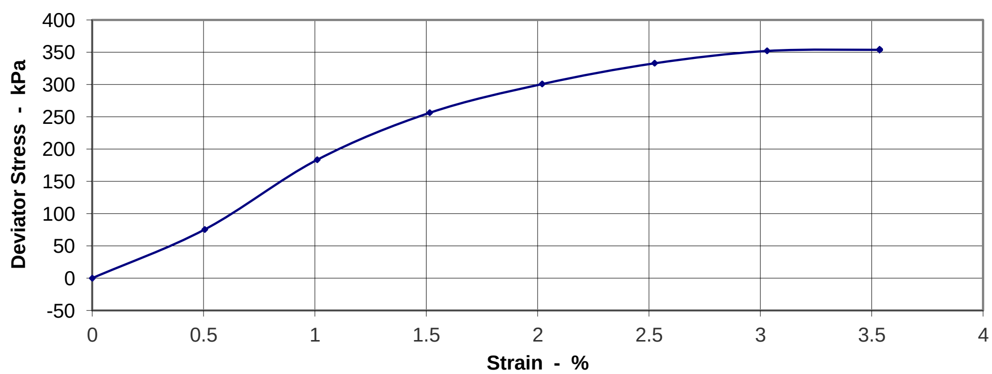
Test Details

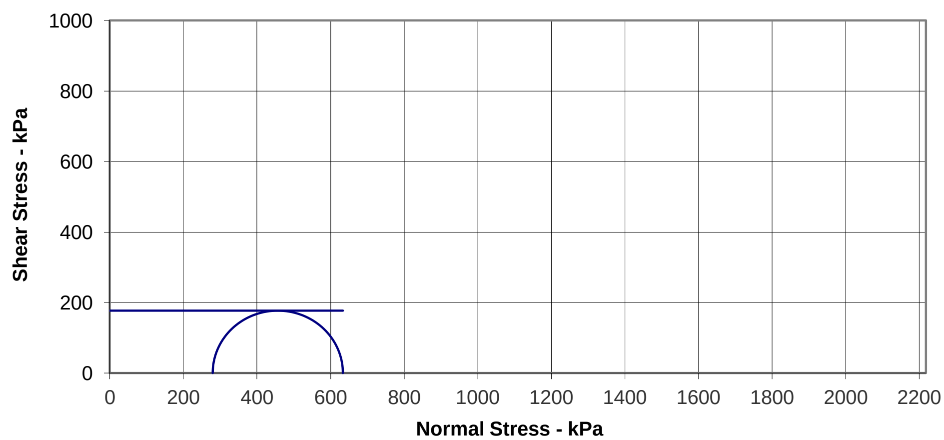
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.19
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	280
Strain at Failure	%	3.5
Maximum Deviator Stress	kPa	354
Shear Strength	kPa	177
Mode of Failure		Brittle

Position and orientation within the original sample

Shear Strength Parameters		
C	177	kPa
Phi	0.0	°

Specimen 1





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Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ	**Samples Received:**	24/11/2014
		Project Started:	24/11/2014
Client:	GEA	**Testing Started:**	03/12/2014
Project no:	J14336 **Our job /report no:** 17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1 **Sample no:** U6	**Depth (m):**	17.00

Soil Description: Very high strength slightly fissured dark grey CLAY with light grey fine sand partings

Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	21
Bulk Density	Mg/m³	2.11
Dry Density	Mg/m³	1.74

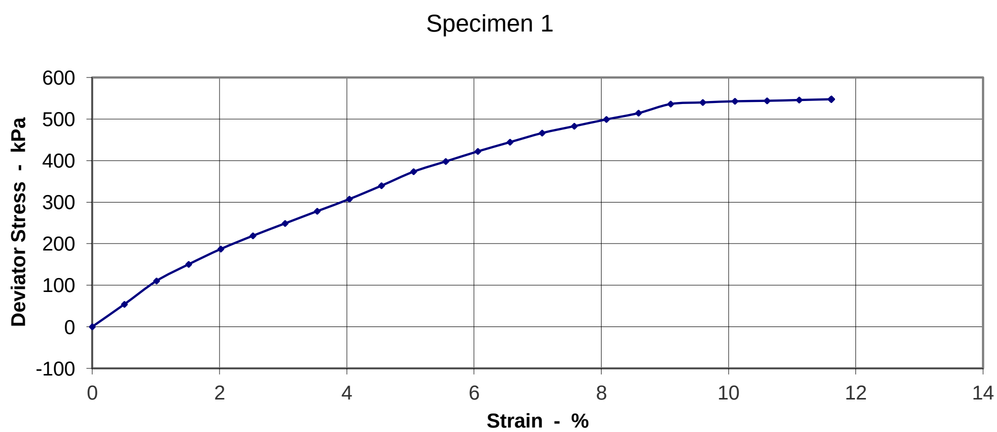
Position and orientation within the original sample

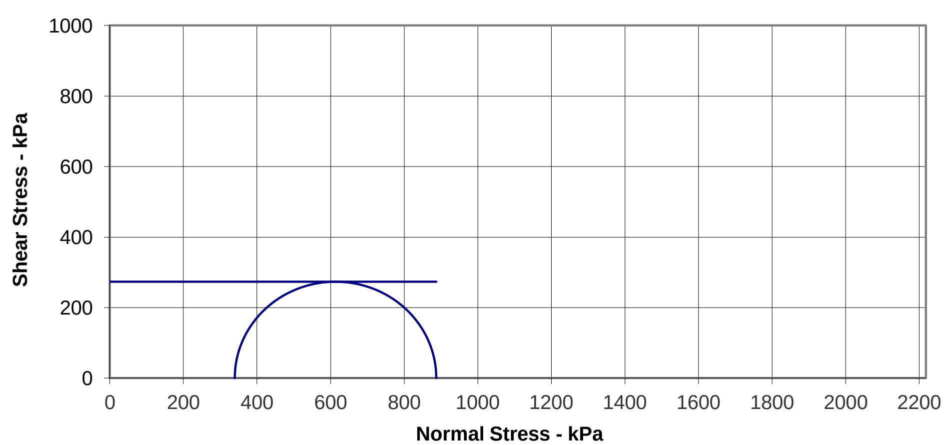
Test Details

Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.50
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	340
Strain at Failure	%	11.6
Maximum Deviator Stress	kPa	547
Shear Strength	kPa	274
Mode of Failure		Brittle

Shear Strength Parameters

C	274	kPa
Phi	0.0	°





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Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name: King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ		**Samples Received:**	24/11/2014
		Project Started:	24/11/2014
Client: GEA		**Testing Started:**	03/12/2014
Project no: J14336	**Our job /report no:** 17886	**Date Reported:**	04/12/2014
BH / TP no: BH1	**Sample no:** U7	**Depth (m):**	20.00

Soil Description: Extremely high strength fissured dark grey CLAY with light grey fine sand partings

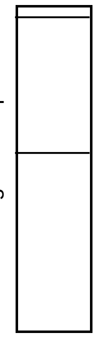
Sample Details — Specimen 1

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	25
Bulk Density	Mg/m³	2.09
Dry Density	Mg/m³	1.68

Test Details

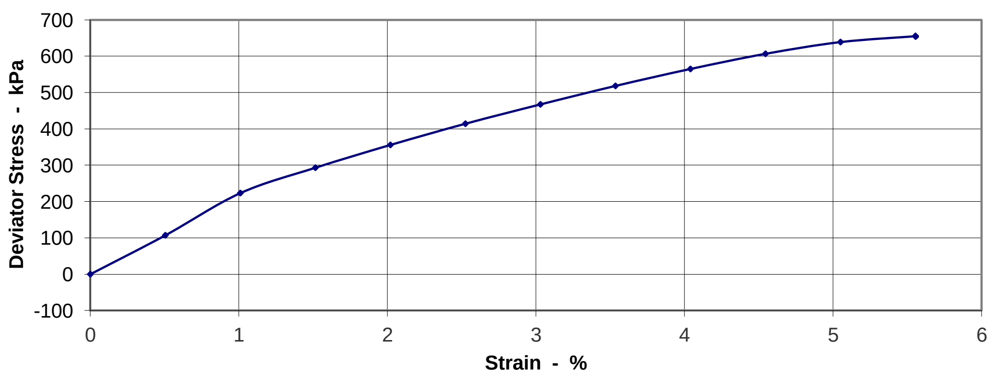
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.28
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	400
Strain at Failure	%	5.6
Maximum Deviator Stress	kPa	655
Shear Strength	kPa	327
Mode of Failure		Brittle

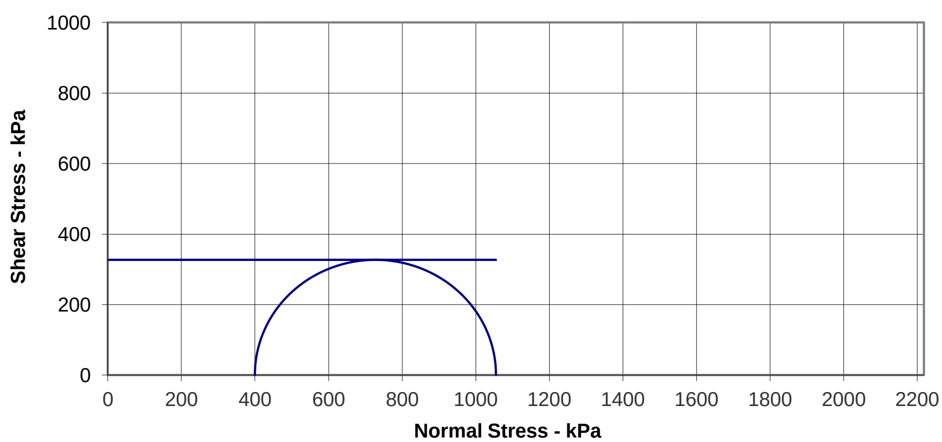
Position and orientation within the original sample



Shear Strength Parameters		
C	327	kPa
Phi	0.0	°

Specimen 1





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Initials: kp
Date: 04/12/2014

UKAS TESTING 2519

K4 SOILS

Report of Undrained Triaxial Compression Test

BS 1377 : Part 7 : 1990 Clause 8.0

Project name:	King's Cross Methodist Church, 58 Birkenhead Street, London W1U 2QJ	**Samples Received:**	24/11/2014
		Project Started:	24/11/2014
Client:	GEA	**Testing Started:**	03/12/2014
Project no:	J14336 **Our job /report no:** 17886	**Date Reported:**	04/12/2014
BH / TP no:	BH1 **Sample no:** U8	**Depth (m):**	23.00

Soil Description: Very high strength fissured dark grey CLAY with light grey fine sand partings

Sample Details **Specimen 1**

Sample Condition		Undisturbed
Height	mm	198.0
Diameter	mm	102.0
Moisture Content	%	22
Bulk Density	Mg/m³	2.11
Dry Density	Mg/m³	1.73

Test Details

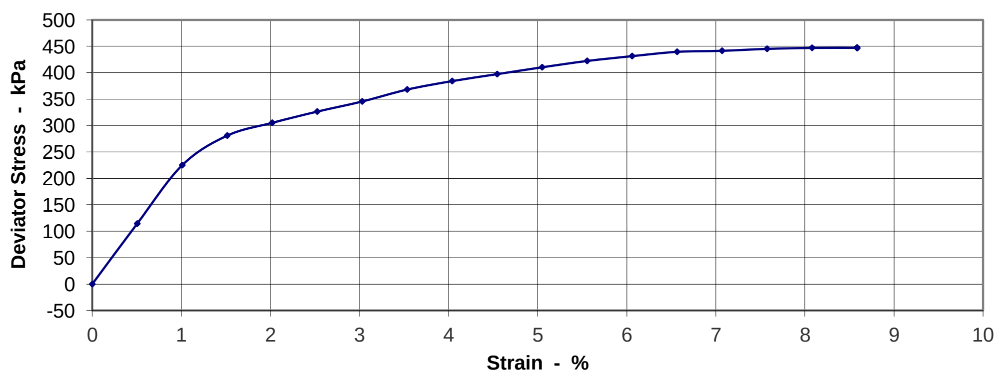
Membrane Thickness	mm	0.2
Membrane Correction	kPa	0.39
Rate of Axial Displacement	%/min	2.02
Cell Pressure	kPa	460
Strain at Failure	%	8.6
Maximum Deviator Stress	kPa	447
Shear Strength	kPa	224
Mode of Failure		Brittle

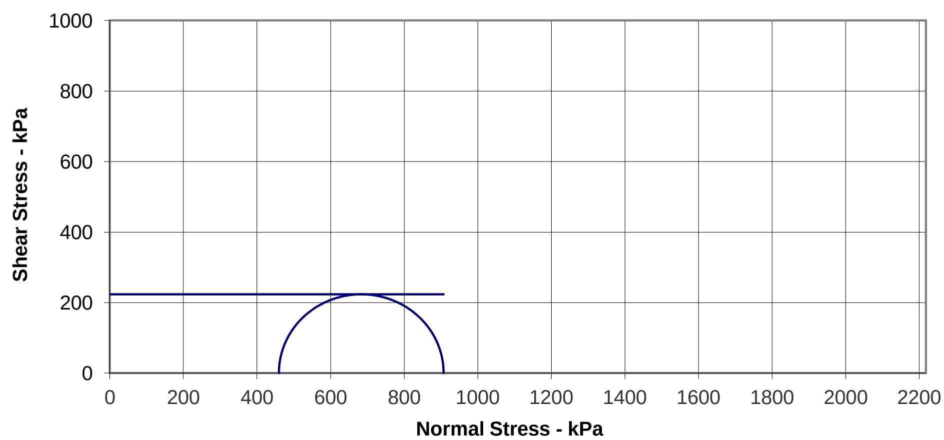
Position and orientation within the original sample

Shear Strength Parameters

C	224	kPa
Phi	0.0	°

Specimen 1





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UKAS TESTING 2519

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SPT & Cohesion / Depth Graph

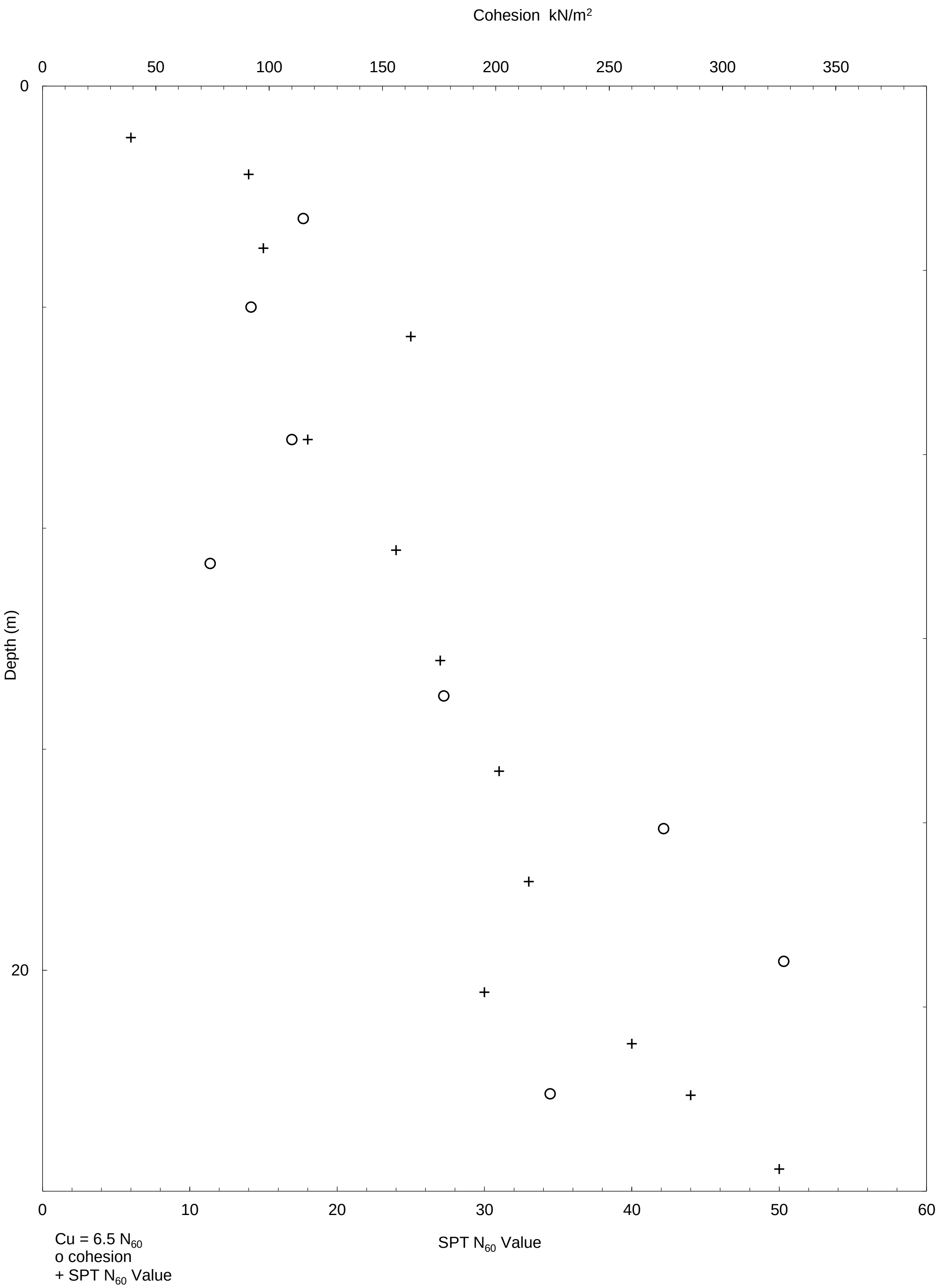
Site King's Cross Methodist Church, 58 Birkenhead Street, London WC1H 8BW

Client West London Mission

Engineer Price & Myers

Job Number J24145

Sheet 1 / 1



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UKAS TESTING 2183

Final Report

Report Number:	14-14697 Issue-1		
Initial Date of Issue:	27-Nov-14		
Client:	GEA		
Client Address:	Tyttenhanger House Coursers Road Saint Albans Hertfordshire AL4 0PG		
Contact(s):	Matt Legg		
Project:	J14336 Kings Cross Methodist Church, Birkenhead St		
Quotation No.:		**Date Received:**	20-Nov-14
Order No.:	J14336	**Date Instructed:**	20-Nov-14
No. of Samples:	4	**Results Due:**	27-Nov-14
Turnaround: (Weekdays)	3		
Date Approved:	27-Nov-14		
Approved By:			

K T Jones

Details: Keith Jones, Technical Manager

The results reported herein relate only to the material supplied to the laboratory.
This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Results Summary - Soil

Project: J14336 Kings Cross Methodist Church, Birkenhead St

Client: GEA	**Chemtest Job No.:**				14-14697	14-14697	14-14697	14-14697
Quotation No.:	**Chemtest Sample ID.:**				71752	71753	71754	71755
Order No.: J14336	Client Sample Ref.:							
	Client Sample ID.:				TP1	TP3	TP4	TP5
	Sample Type:				SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.2	0.4	0.4	0.3
	Bottom Depth(m):							
	Date Sampled:				14-Nov-14	14-Nov-14	14-Nov-14	14-Nov-14
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Moisture	N	2030	%	0.02	24	13	22	23
Stones	N	2030	%	0.02	< 0.020	< 0.020	< 0.020	< 0.020
Soil Colour	N				brown	brown	brown	brown
Other Material	N				stones	stones	none	none
Soil Texture	N				sand	sand	clay	clay
pH	M	2010			7.7	8.7	8.2	8.0
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.01	1.4	0.28		0.19
Chloride (Extractable)	U	2220	g/l	0.01	0.027	0.020	< 0.010	0.017
Cyanide (Total)	M	2300	mg/kg	0.5	5.4	< 0.50	< 0.50	< 0.50
Sulphide (Easily Liberatable)	M	2325	mg/kg	0.5	2.3	2.0	2.2	1.9
Sulphate (Total)	M	2430	mg/kg	100	22000	7400	600	6000
Arsenic	M	2450	mg/kg	1	82	29	10	13
Cadmium	M	2450	mg/kg	0.1	3.5	0.11	0.12	0.15
Chromium	M	2450	mg/kg	1	56	24	45	48
Copper	M	2450	mg/kg	0.5	430	76	37	38
Mercury	M	2450	mg/kg	0.1	3.5	6.8	0.22	0.13
Nickel	M	2450	mg/kg	0.5	77	26	47	52
Lead	M	2450	mg/kg	0.5	3000	2100	50	33
Selenium	M	2450	mg/kg	0.2	0.99	< 0.20	< 0.20	< 0.20
Zinc	M	2450	mg/kg	0.5	1300	100	81	81
Total Organic Carbon	M	2625	%	0.2	7.7	1.7	0.50	0.51
TPH >C5-C6	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
TPH >C6-C7	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
TPH >C7-C8	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
TPH >C8-C10	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
TPH >C10-C12	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	4.6
TPH >C12-C16	N	2670	mg/kg	1	< 1.0	< 1.0	2.9	150
TPH >C16-C21	N	2670	mg/kg	1	27	6.9	5.3	250
TPH >C21-C35	N	2670	mg/kg	1	120	18	< 1.0	48
Total TPH >C5-C35	N	2670	mg/kg	10	150	25	< 10	450
Naphthalene	M	2700	mg/kg	0.1	0.23	< 0.10	< 0.10	0.13
Acenaphthylene	M	2700	mg/kg	0.1	0.40	0.16	< 0.10	0.21
Acenaphthene	M	2700	mg/kg	0.1	0.16	0.17	< 0.10	0.24

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Results Summary - Soil

Project: J14336 Kings Cross Methodist Church, Birkenhead St

Client: GEA	**Chemtest Job No.:**				14-14697	14-14697	14-14697	14-14697
Quotation No.:	**Chemtest Sample ID.:**				71752	71753	71754	71755
Order No.: J14336	Client Sample Ref.:							
	Client Sample ID.:				TP1	TP3	TP4	TP5
	Sample Type:				SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.2	0.4	0.4	0.3
	Bottom Depth(m):							
	Date Sampled:				14-Nov-14	14-Nov-14	14-Nov-14	14-Nov-14
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Fluorene	M	2700	mg/kg	0.1	0.16	0.12	< 0.10	0.40
Phenanthrene	M	2700	mg/kg	0.1	2.8	1.6	< 0.10	1.2
Anthracene	M	2700	mg/kg	0.1	0.61	0.32	< 0.10	0.23
Fluoranthene	M	2700	mg/kg	0.1	8.2	2.6	< 0.10	0.13
Pyrene	M	2700	mg/kg	0.1	10	2.8	< 0.10	0.22
Benzo[a]anthracene	M	2700	mg/kg	0.1	4.6	1.2	< 0.10	< 0.10
Chrysene	M	2700	mg/kg	0.1	6.6	1.8	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	6.9	1.5	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	3.0	0.69	< 0.10	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.1	5.0	1.0	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	3.2	0.46	< 0.10	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	1.1	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	3.7	0.49	< 0.10	< 0.10
Total Of 16 PAH's	M	2700	mg/kg	2	57	15	< 2.0	2.8
Total Phenols	M	2920	mg/kg	0.3	< 0.30	< 0.30	< 0.30	< 0.30

Chemtest

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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

Geotechnical & Environmental Associates
www.gea-ltd.co.uk

Generic Risk-Based Soil Screening Values

Site	King's Cross Methodist Church, 58a Birkenhead Street, London WC1H 8BW	**Job Number**	J24145
Client	West London Mission Ciruit	**Sheet**	1 / 2
Engineer	Price & Myers		

Proposed End Use **Residential without plant uptake**

Soil Organic Matter content % **1.0**

Contaminant	Screening Value mg/kg	Data Source
Metals		
Arsenic	40	C4SL
Cadmium	149	C4SL
Chromium (III)	910	S4UL
Chromium (VI)	21	C4SL
Copper	7,100	S4UL
Lead	310	C4SL
Elemental Mercury	1.2	S4UL
Inorganic Mercury	56	S4UL
Nickel	180	S4UL
Selenium	595	SGV
Zinc	40,000	S4UL
Anions		
Soluble Sulphate	500 mg/l	Structures
Sulphide	50	Structures
Chloride	400	Structures
Others		
Organic Carbon (%)	6	Methanogenic potential
Total Cyanide	140	WRAS
Total Mono Phenols	310	SGV
PAH		
Naphthalene	2.33	S4UL
Acenaphthylene	2,900	S4UL
Acenaphthene	3,000	S4UL
Fluorene	2,800	S4UL
Phenanthrene	1,300	S4UL
Anthracene	31,000	S4UL
Fluoranthene	1,500	S4UL
Pyrene	3,700	S4UL
Benzo(a)anthracene	11.0	S4UL
Chrysene	30	S4UL
Benzo(b)fluoranthene	3.9	S4UL
Benzo(k)fluoranthene	110.0	S4UL
Benzo(a)pyrene	4.65	C4SL
Indeno(1 2 3 cd)pyrene	45.0	S4UL
Dibenz(a h)anthracene	0.32	S4UL
Benzo (g h i)perylene	360	S4UL
Total PAH Screen	**66.4**	B(a)P / 0.15

Contaminant	Screening Value mg/kg	Data Source
Hydrocarbons		
Banded TPH (8-10)	72	Calc1
Banded TPH (10-12)	385	Calc1
Banded TPH (12-16)	2769	Calc1
Banded TPH (16-21)	2923	Calc1
Banded TPH (21-35)	2923	Calc1
Benzene	0.89	C4SL
Toluene	120	SGV
Ethyl Benzene	65	SGV
Xylene	42	SGV
Aliphatic C5-C6	42	S4UL
Aliphatic C6-C8	100	S4UL
Aliphatic C8-C10	27	S4UL
Aliphatic C10-C12	130	S4UL
Aliphatic C12-C16	1100	S4UL
Aliphatic C16-C35	65,000	S4UL
Aromatic C6-C7	See Benzene	S4UL
Aromatic C7-C8	See Toluene	S4UL
Aromatic C8-C10	47	S4UL
Aromatic C10-C12	250	S4UL
Aromatic C12-C16	1800	S4UL
Aromatic C16-C21	1900	S4UL
Aromatic C21-C35	1900	S4UL
PRO (C_5 –C_{10})	337	Calc2
DRO (C_{12} –C_{28})	69,800	Calc2
Lube Oil (C_{28} –C_{44})	66,900	Calc2
TPH	**500**	Trigger to consider speciated testing
Chlorinated Solvents		
1,1,1 trichloroethane (TCA)	9	S4UL
tetrachloroethane (PCA)	1.5	S4UL
tetrachloroethene (PCE)	0.32	C4SL
trichloroethene (TCE)	0.0097	C4SL
1,2-dichloroethane (DCA)	0.16	C4SL
vinyl chloride (Chloroethene)	0.015	C4SL
tetrachloromethane (Carbon tetra	0.026	S4UL
trichloromethane (Chloroform)	1.2	S4UL

Notes

Concentrations measured below these screening values may be considered to represent 'uncontaminated conditions' which pose a 'LOW' risk to human health. Concentrations measured in excess of these values indicate a potential risk which require further, site specific risk assessment.

C4SL - Defra Category 4 Screening value based on Low Level of Toxicological Risk

SGV - Soil Guideline Value, derived from the CLEA model and published by Environment Agency 2009 - where not superseded by C4SL

S4UL - LQM/CIEH Suitable for use Level (2015) based on 'minimal' level of risk

Calc1 - sum of thresholds for Ali & Aro fractions - assuming a 35% Aro:65% Ali ratio as is commonly encountered in the soil

Calc2 - sum of nearest available carbon range specified including BTEX for PRO fraction

Total PAH based on B(a)P / 0.15 - GEA experience indicates that Benzo(a) pyrene rarely exceeds 15% of the total PAH concentration