10-11 King's Mews, WC1N 2ES

Structural Strategy Report for Planning Submission *incorporating Engineering Interpretation of Basement Impact Assessment*

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FLUID.STRUCTURES ENGINEERS AND TECHNICAL DESIGNERS

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1.0 INTRODUCTION

1.1 Background

Fluid Structures has been appointed by the client, G&T Kings Mews Ltd, to provide structural engineering input into the proposed redevelopment of the site at 10-11 King's Mews (London, WC1N 2ES), incorporating a new lower ground floor (basement) level structure and a new three storey frame above ground, fronting onto King's Mews.

Fluid has acted on the client's behalf to commission a Site Investigation and Basement Impact Assessment for the proposed scheme. This has been undertaken by Geotechnical and Environmental Associates (GEA), with guidance / assistance from Fluid Structures, and is described in a separate report, **Geotechnical and Environmental Associates; Desk Study and Basement Impact Assessment Report: 10-11 King's Mews, London, WC1N 2ES; October 2012**. GEA's Basement Impact Assessment report and this report together are intended to address the issues raised in the document **London Borough of Camden; Camden Planning Guidance document CPG4: Basements and Lightwells.**

1.2 Purpose

The purpose of this report is to;

- Provide a structural engineering interpretation of the Basement Impact Assessment and Site Investigation undertaken by Geotechnical and Environmental Associates.
- Identify and describe a safe method (or methods) of constructing the proposed new basement and also the new above-ground structure intended for the rear of the site.
- Demonstrate that the proposed method of forming the new basement will not adversely affect the structural stability of the neighbouring buildings, nor cause them to move excessively either during or subsequent to the proposed construction works.

In the study provided by Geotechnical and Environmental Associates (referenced above), the Basement Impact Assessment process is undertaken with specific reference to stages 1-4 as described in Camden document CPG4 (Screening, Scoping, Site Investigation, Impact Assessment). This report is intended to pick up on the 'Impact Assessment' stage of this study and to develop it further by identifying a sensible basement construction methodology for this specific site, given the particular ground conditions and boundary configurations that exist on the site, and in light of the need to ensure that the stability and integrity of the neighbouring structures is at no point jeopardised by the proposed works.

2.0 ABOUT FLUID STRUCTURES

Fluid Structures is one of the UK's leading design oriented structural engineering practices. The firm was established in 1999 and has gained an exemplary reputation for the quality of its engineering design. Fluid has been commissioned to work at the Science Museum (twice), and the Royal Festival Hall, and has acted as a consultant to the BBC. The sectors in which the company works regularly include education, retail, residential and commercial. Projects to date have ranged in value from £500,000 to in excess of £100 million.

Fluid's approach is characterised by a desire to develop an engineering solution that complements the architectural aspiration whilst also responding to the client's core requirements and maintaining a sensitivity to the priorities of other stakeholders, such as Planning Authorities; Conservation Officers; the Public and the End User.

The practice considers itself to be a technical design house and offers a number of areas of expertise that include:

- The appraisal and refurbishment of existing buildings and structures
- The design of complex basements and substructures
- Design of façade engineering including double façades and solar shading
- Value engineering reports on potential developments
- An in depth knowledge of construction materials including steel, concrete, timber, masonry, glass, aluminium and fabric
- Preparation of comparison matrices to determine appropriate construction solutions
- Sustainable design solutions: working within the constraints of individual projects to minimise the carbon footprint of buildings and maximise their positive impact in relation to the environment, the economy and society at large.

Fluid's experience demonstrates the practice's ability to deliver sensitive engineering solutions.

This report has been prepared by David Crookes, who is a Chartered Engineer with the Institution of Structural Engineers. It has been checked by John Graham, who is also chartered with the Institution of Structural Engineers.

3.0 GROUND CONDITIONS

3.1 Investigatory Work Undertaken

The investigatory works undertaken in relation to the site by Geotechnical and Environmental Associates (GEA) have comprised:

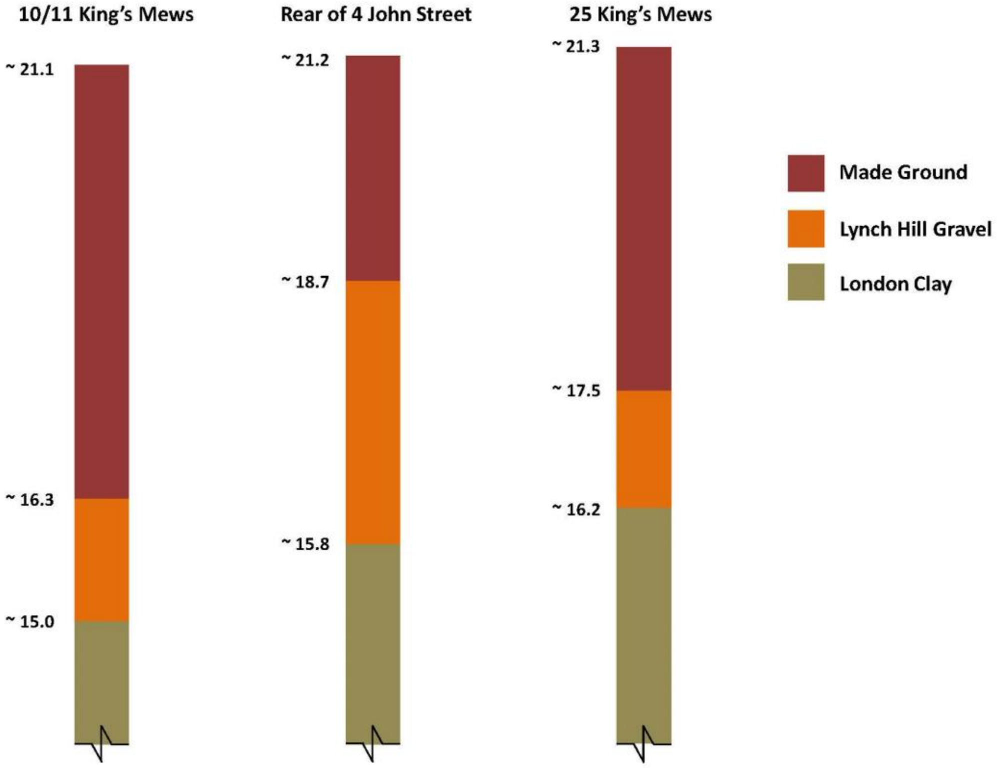
- A desk study, incorporating a review of geotechnical and hydrogeological maps for the local area, and also of historical ordnance maps.
- A Site Investigation, incorporating 1no. 15m long cable percussion borehole (BH1); 3no. manually excavated trial pits and the installation and monitoring of a groundwater monitoring standpipe, plus associated geotechnical and contamination testing of the soil samples recovered from the site.
- Review of data retrieved from previous Site Investigations undertaken by GEA at the rear of 4 John Street and also at 25 King's Mews. The site to the rear of 4 John Street is next door but one to 10/11 King's Mews. 25 King's Mews is approximately opposite the site to the rear of 4 John Street. These boreholes are both therefore approximately 20m from the boundary to 10/11 King's Mews.

3.2 Ground Conditions

The rear portion of the site as it stands was found to be capped with a 300mm thick concrete slab. Based on the borehole undertaken in the centre of the existing carpark, the ground strata on the site have been found to be as described below (from uppermost stratum, extending downwards):

- Made Ground, comprising silty sand, silty sandy clay, gravel, brick, concrete and coal fragments, extending to a depth of 4.80m below ground level.
- Lynch Hill Gravel, comprising slightly clayey sandy fine to coarse subrounded to angular gravel, extending to a depth of 6.10m below ground level.
- London Clay, proven to the maximum depth investigated.

If the data above is compared with that gathered from the other two nearby boreholes undertaken as part of previous Site Investigations, the ground strata profile varies as shown in the diagram overleaf. It is noted that the depth at which the Lynch Hill Gravel stratum begins is variable across the three boreholes, giving a minimum Made Ground thickness of 2.5m and a maximum thickness of 4.8m.



Ground Strata, based on borehole information (levels are provided in metres A.O.D)

3.3 Ground Water

Groundwater inflows were encountered at depths of 3.10m (in the Made Ground); 6.00m (in the Lynch Hill Gravel); and 13.80m (in the London Clay) during the Site Investigation undertaken by GEA. In two subsequent groundwater monitoring visits, the 'at rest' groundwater level was measured at 3.50m and 3.60m below ground level. This is presumed to be a 'perched' groundwater table that sits atop the (relatively) impermeable London Clay.

3.4 Ground Contamination

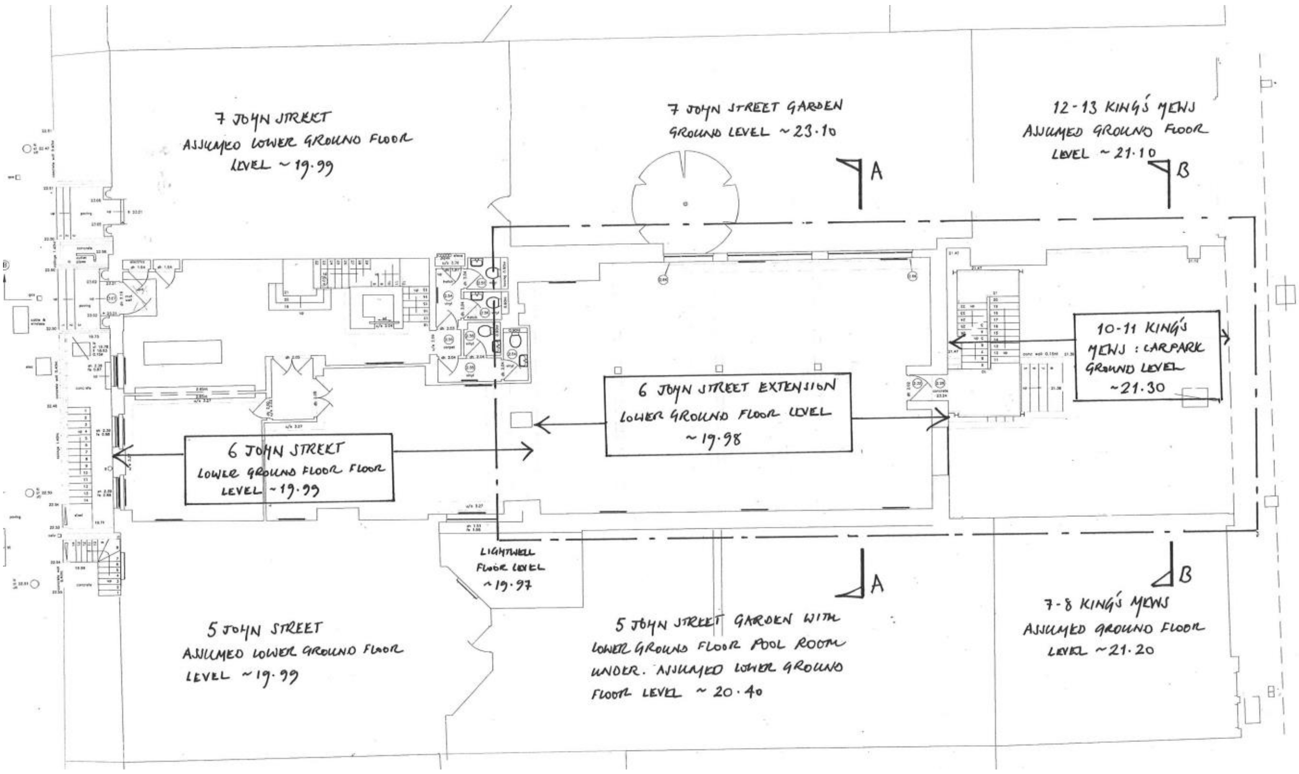
Elevated concentrations of lead were noted in the limited Made Ground samples that were tested by GEA, with no elevated concentrations of any other contaminants. GEA have undertaken a Site Specific Contamination Risk Assessment. This indicates that the elevated lead levels are unlikely to pose a risk to the site end users since the majority of the shallow Made Ground across the site will be excavated as part of the proposed site works, and the remainder of the proposed new building will cover the whole of the site, thereby creating a barrier between any remaining contaminated Made Ground and sensitive receptors.

3.5 Unexploded Ordnance

It is noted that the review of historical maps, and also of the London Bomb Damage Maps, as undertaken by GEA, indicates that the site is likely to have been bombed during World War II. Given that the site was a bomb target, the possibility of buried unexploded ordnance existing on the site cannot entirely be discounted (though the likelihood would appear low). This represents a potential risk during the proposed building works and therefore will be communicated to the contractor prior to the commencement of the works so that he can make necessary provision for monitoring by a UXO Specialist during the site works.

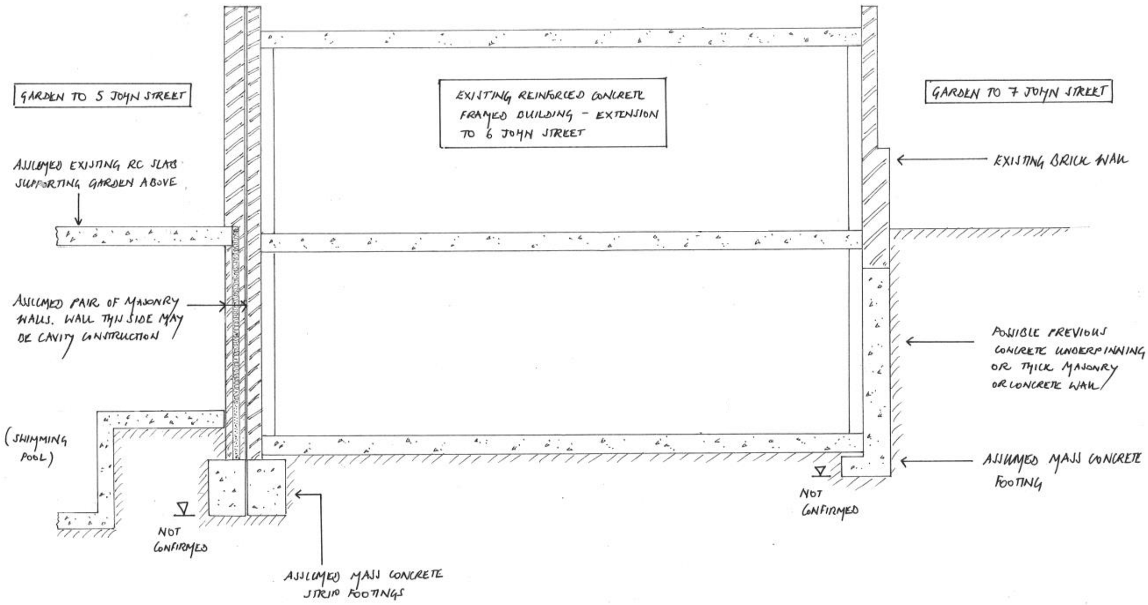
4.0 SITE AND BOUNDARY CONDITIONS

The 10-11 King's Mews site backs onto the rear of 6 John Street where a two storey (lower ground floor and upper ground floor level) extension has been constructed, and this structure would appear to comprise a reinforced concrete frame, with a reinforced concrete upper ground floor level and also, seemingly, a reinforced concrete roof slab. The walls to this building appear predominantly to be brick, possibly with some intermediate reinforced concrete columns. This building stops short of King's Mews by some 10m, leaving space at the rear of the site for a small carpark. The carpark ground level lines through approximately with that of the King's Mews road, and is thus some 1.2m above the lower ground floor level within the existing building adjacent, and some 2.0m below the upper ground floor level.

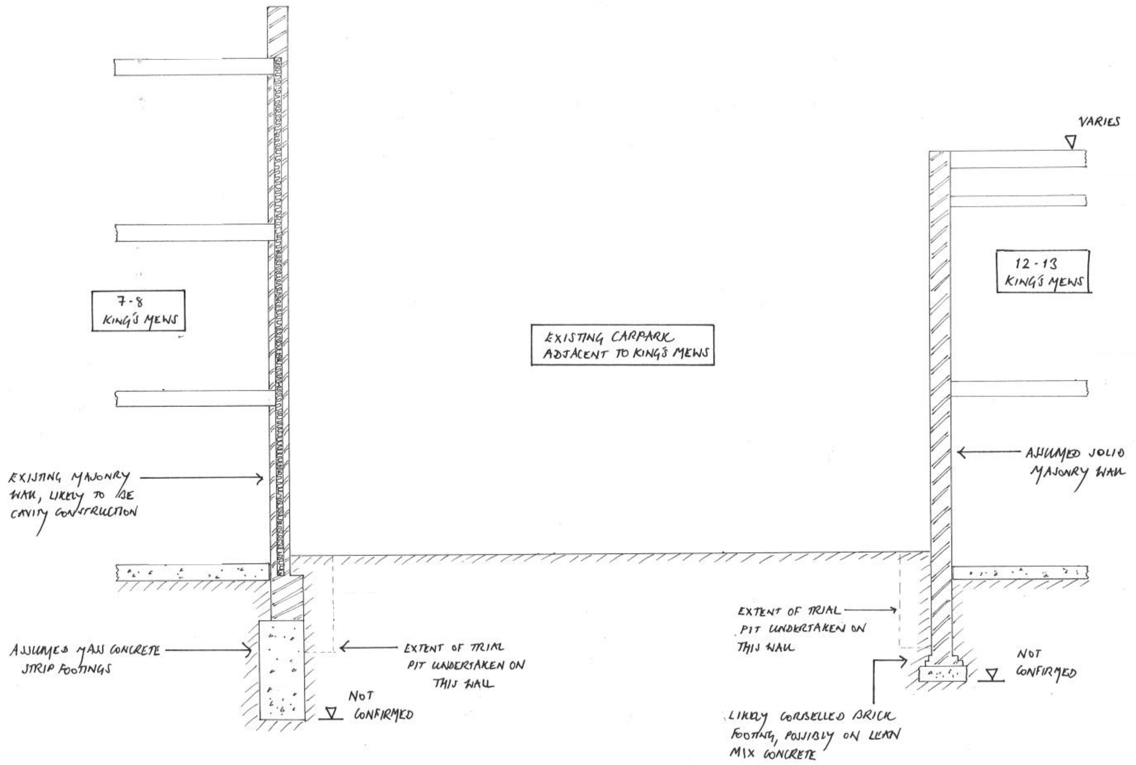


Existing site plan, showing approximate levels of lowest floors

The boundary conditions around the site are summarised in the figures that follow. It has not been possible to retrieve a great deal of information relating to the nature of the structures to either side of the site. However, the adjacent sites can be viewed clearly from high level within 6 John Street, and it has been possible to determine likely approximate overall party wall thicknesses from this position. A topographical survey has been carried out and this has indicated the 'garden' levels for the properties to either side of 6 John Street. Similarly, the ground floor levels to the buildings on King's Mews can be determined approximately based on the topographical survey information relating to the road. Finally, information has been retrieved from the Camden planning portal relating to proposed building works to 5 John Street and 7/8 King's Mews, and it is believed that these works have now been carried out. Fluid has also spoken with the structural engineers for this development and they have confirmed that the footings to the buildings on this side are strip footings, and not piles. It has also been possible to speak to the architect who has designed refurbishment works for 12/13 King's Mews, on the other side of 10/11, and he has confirmed that this building has no basement level. It is evident from the age of the building on this side that the footings, similarly, are likely to be strip footings rather than piles.



Existing section AA (refer to plan on previous page for section location)



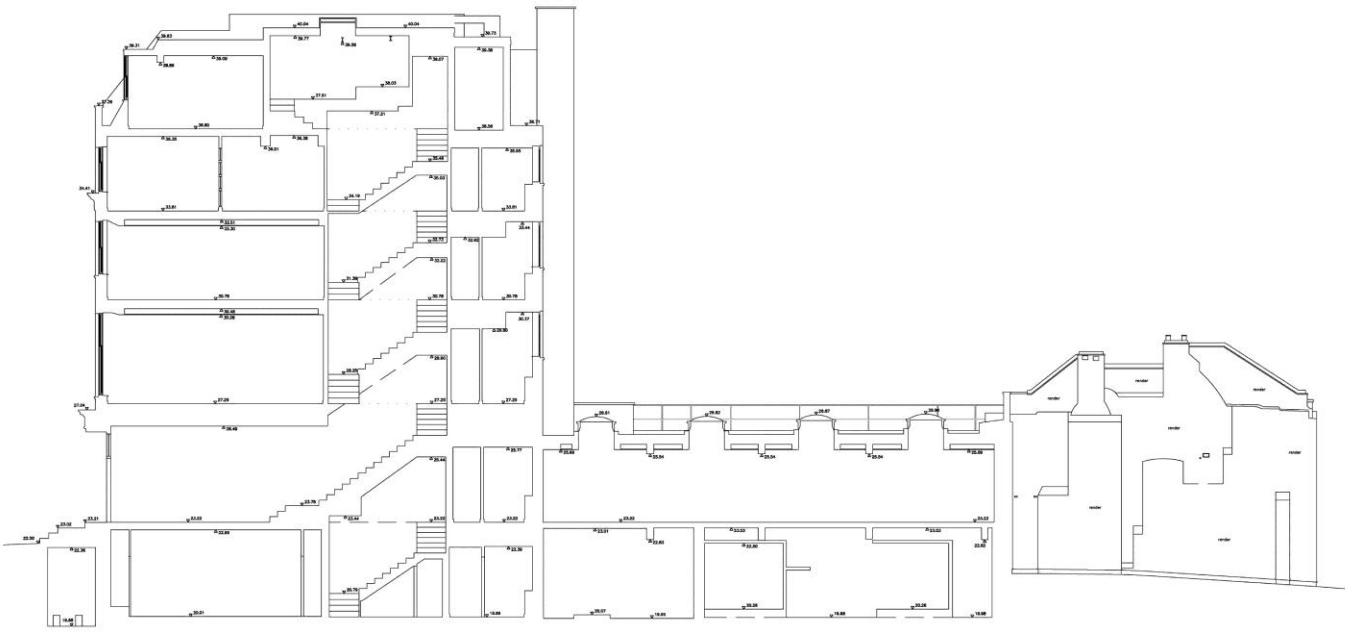
Existing Section BB (refer to plan on previous page for section location)

5.0 DESCRIPTION OF PROPOSED SCHEME

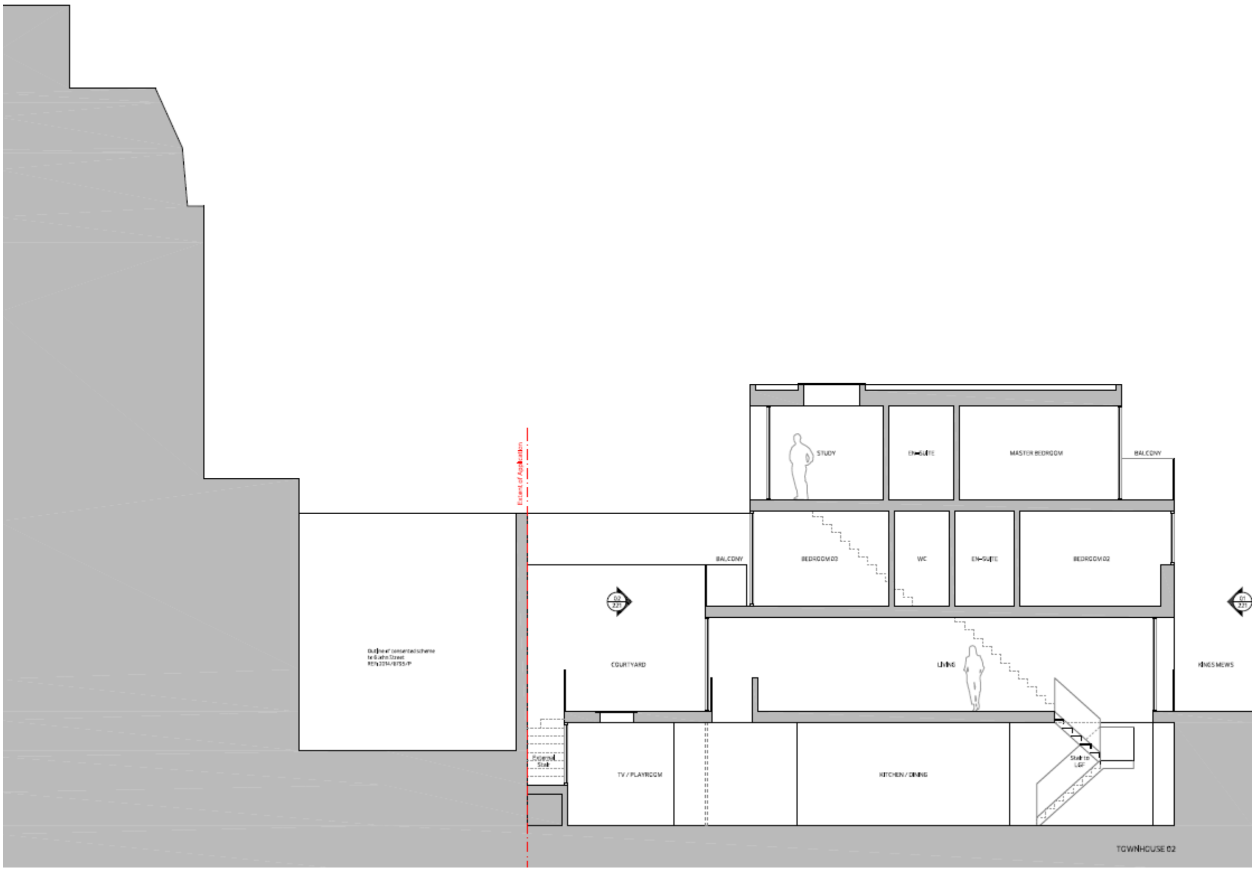
The proposed scheme at 10-11 King's Mews, comprises of two town houses fronting onto Kings Mews. The two storey building occupying the central part of the site between John Street and King's Mews is to be demolished and a new building is to be constructed. The new building will occupy both the plot of land directly adjacent to King's Mews and a portion of the site between John Street and King's Mews.

The new proposed building, comprising of two town houses fronting onto Kings Mew's will have a lower ground floor (basement) level, the floor level for which will be some 2.0m below the floor level of the existing lower ground floor to 6 John Street (and some 3.0m below the King's Mews street level). They will have a further three above ground storeys with a flat rear profile.

The lower ground floor level to the new property will incorporate the kitchen areas of town house 1 & 2. At ground level there are living spaces with an open rear courtyard. The first and second floors are occupied by guest and master bedrooms with circulation provided through staircases adjacent to the party walls.



Existing cross-section through long axis of site (King's Mews on right)



Proposed cross-section through long axis of site (King's Mews on right)

6.0 BASEMENT CONSTRUCTION METHODOLOGY

6.1 Foundation Strategy – Preferred Option

This section should be read with reference to section 8.0 of the report, **Geotechnical and Environmental Associates; Desk Study and Basement Impact Assessment Report: 10-11 King's Mews, London, WC1N 2ES; October 2012**. This section outlines the possible foundation and retaining wall strategies that could be used on the site.

It is proposed that the walls to the full perimeter of the site should be underpinned, most likely using mass concrete in the main, to facilitate the party wall awards. These concrete pins will extend to the natural Lynch Hill Gravel, thereby transferring the existing wall loads, and eventually the added loads from the new property, directly into natural ground. Mass concrete strip footings will be utilised within the new building footprint to support new wall and column loads, again taken down on to the Lynch Hill Gravel. It is noted that the Lynch Hill Gravel is observed to be a capable bearing stratum in the above GEA report, offering an allowable bearing pressure of $150kN/m^2$ (limited to ensure settlements are of negligible magnitude).

At this stage, it has been assumed that a suspended reinforced concrete slab, cast onto a void former, will be required at lower ground floor level, thereby allowing for heave effects, and with the slab designed for uplift resulting from a future high groundwater case. However, a further heave analysis will be undertaken during the detailed design stage to ascertain whether it is possible to employ a reinforced groundbearing slab.

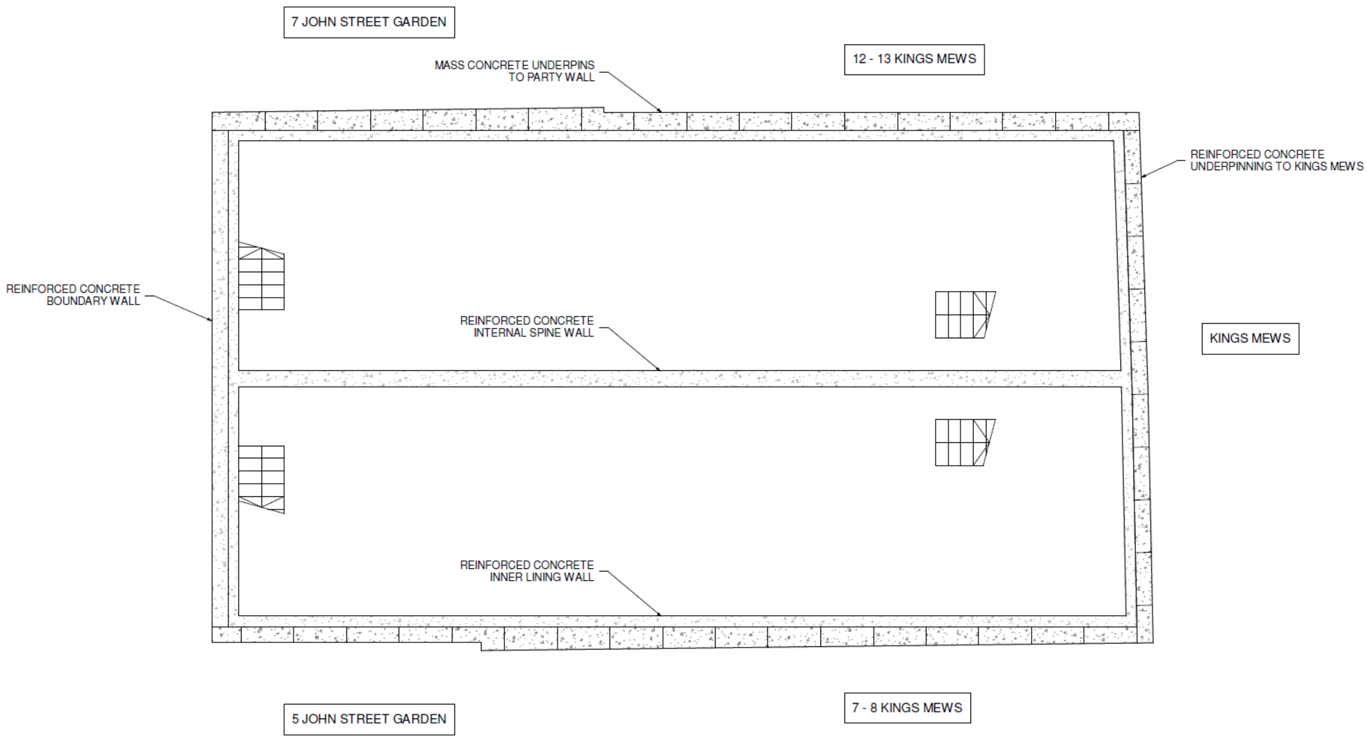
The perimeter walls to the lower ground floor level will comprise reinforced concrete, designed in general to act as propped retaining walls (propped by the ground floor level slab) in the permanent condition. In local cases where there is to be no ground floor level slab (adjacent to the terrace stair), these walls will be designed to cantilever off the lower ground level slab.

The waterproofing strategy for the basement will employ a drained cavity system, most likely in combination with either tanking to the perimeter walls, or the use of a waterproof additive in the concrete perimeter walls and basement slab.

The ground floor will also comprise a reinforced concrete slab, supported on the perimeter concrete walls and on some internal loadbearing (concrete) elements.

There is a possibility that the proposed underpinning will need to extend below the existing groundwater level. This is to be further investigated during the detailed stage via further groundwater monitoring, and additional window sampling to verify the depth at which the Lynch Hill Gravel stratum occurs. The single borehole undertaken on the proposed site indicates that the gravels are at a depth of 4.8m from the King's Mews roadway level, but it is anticipated that this may be a case specific to where the borehole was undertaken as the boreholes carried out on adjacent sites located the gravel stratum at shallower depths. Since it is highly plausible that the groundwater is typically perched on top of the underlying clays, it may well be that there is a small depth of dig required below the groundwater level to get to the gravels. The intention therefore will be to undertake a series of trial digs for the underpins at the commencement of the construction works, and to pump out any groundwater encountered. At this point, the time taken for the groundwater to return will be measured, and this will confirm whether underpinning to the depth required is viable. Although the excavations for the underpinning will be laterally propped at all times, as described below, these trial digs will also provide confirmation that the shallow soils are sufficiently cohesive, and not so collapsible as to prevent a safe, and structurally stable, process of underpinning. Of specific consideration will be the verification that, in excavating for each underpin, the loss or movement of soils from the sides and back of the pit can be minimised such that there would be negligible scope for settlement of the existing walls in the temporary condition.

Providing the trial pinning described above show favourable results, an underpinning methodology will be adopted as described below (in 6.2), and the final ground floor structure will be as outlined above. If, however, the trial pinning does not provide total confidence that this methodology is safe and viable then an alternative foundation strategy and construction methodology will be employed. This alternative approach is summarised in section 6.3 below.



Proposed basement structural plan

6.2 Construction Methodology – Preferred Option

To demonstrate the proposed construction methodology for the basement, it is best to consider two separate cases. The first of these cases applies to the central portion of the site, where the structure is bounded to either side by gardens/terraces (in the case of the southern site, with the terrace constructed over a lower ground floor level). The second case applies to the rear portion of the site, adjacent to King's Mews, where there are domestic scale properties to each side, neither of which has an existing lower ground floor. In practice, the construction works for the two cases will be being carried out simultaneously.

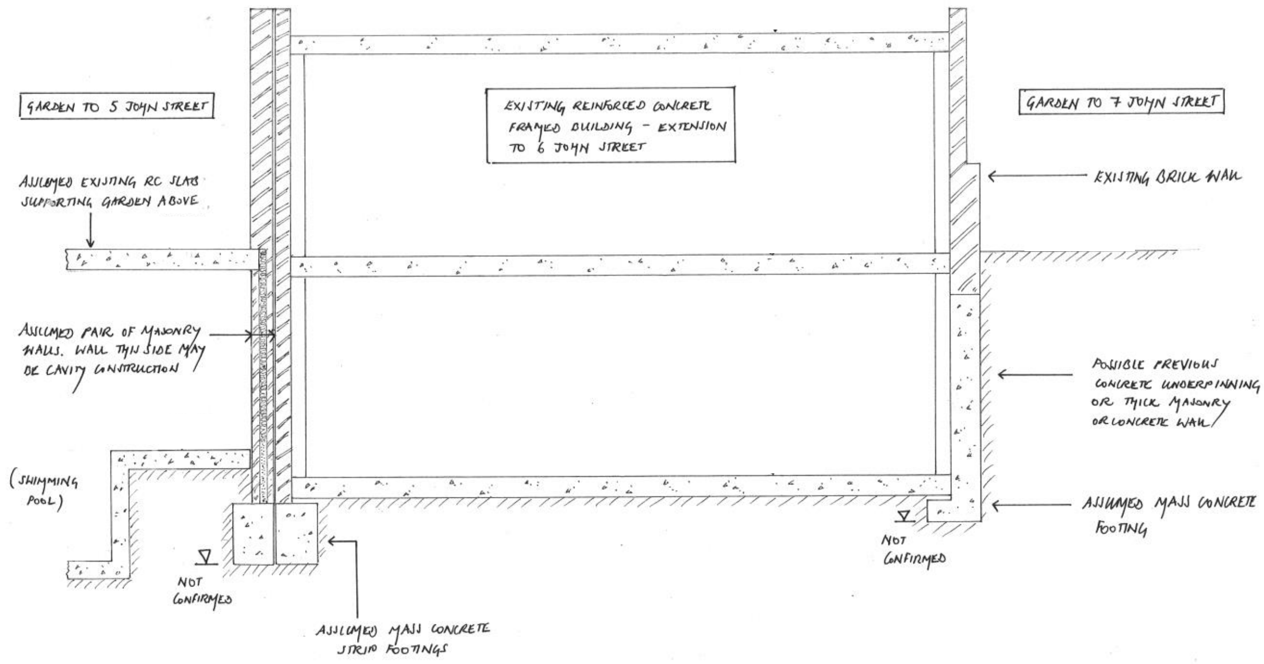
In each case, the underpinning itself is to be undertaken in a conventional hit and miss sequence, with the pins being taken down to the natural gravels. It is hoped that this process can be carried out in a single underpinning lift, but if the gravels are deep, underpinning in two lifts could be considered. The back of the excavation for each pin will be lined with trench sheeting and the excavations will be laterally propped throughout. If necessary, jet grouting will be employed to stabilise the ground locally. Any groundwater will be pumped out of each excavation before each pin is cast.

Basement Construction Methodology for Central Portion of Site

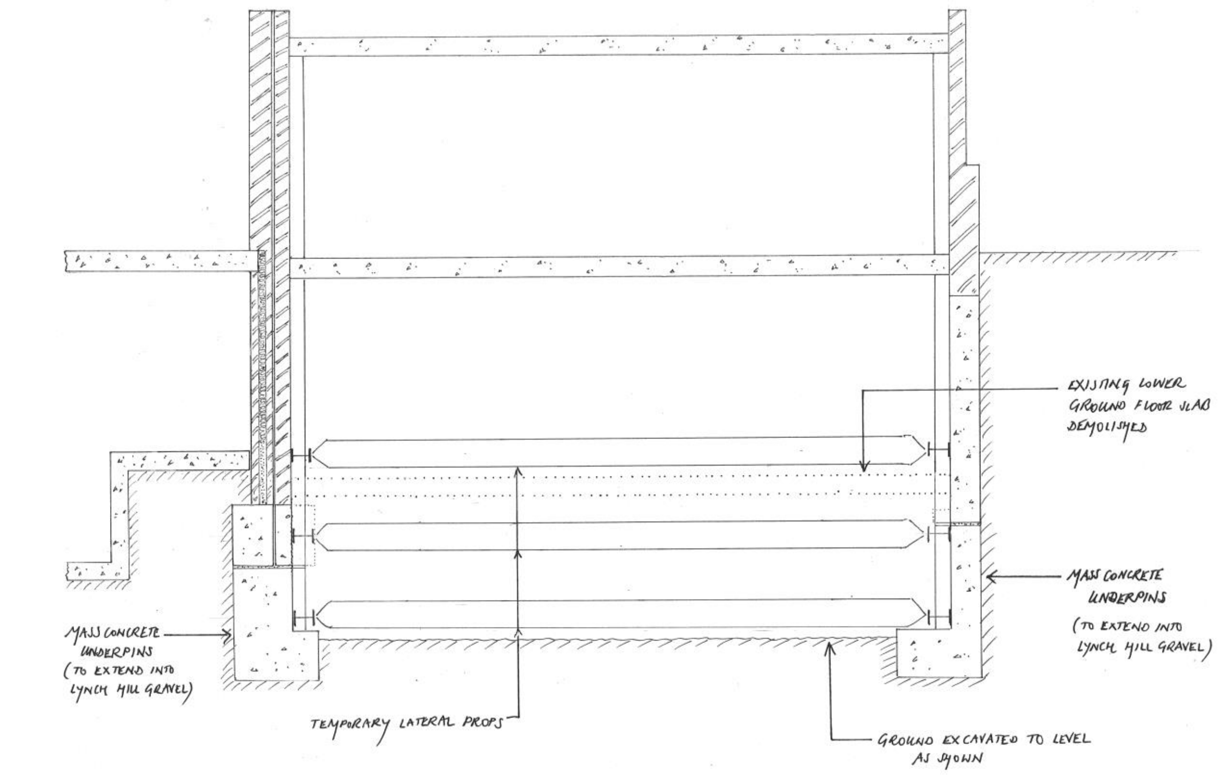
Refer to the diagrams overleaf showing the construction sequence.

The construction sequence can be summarised thus:

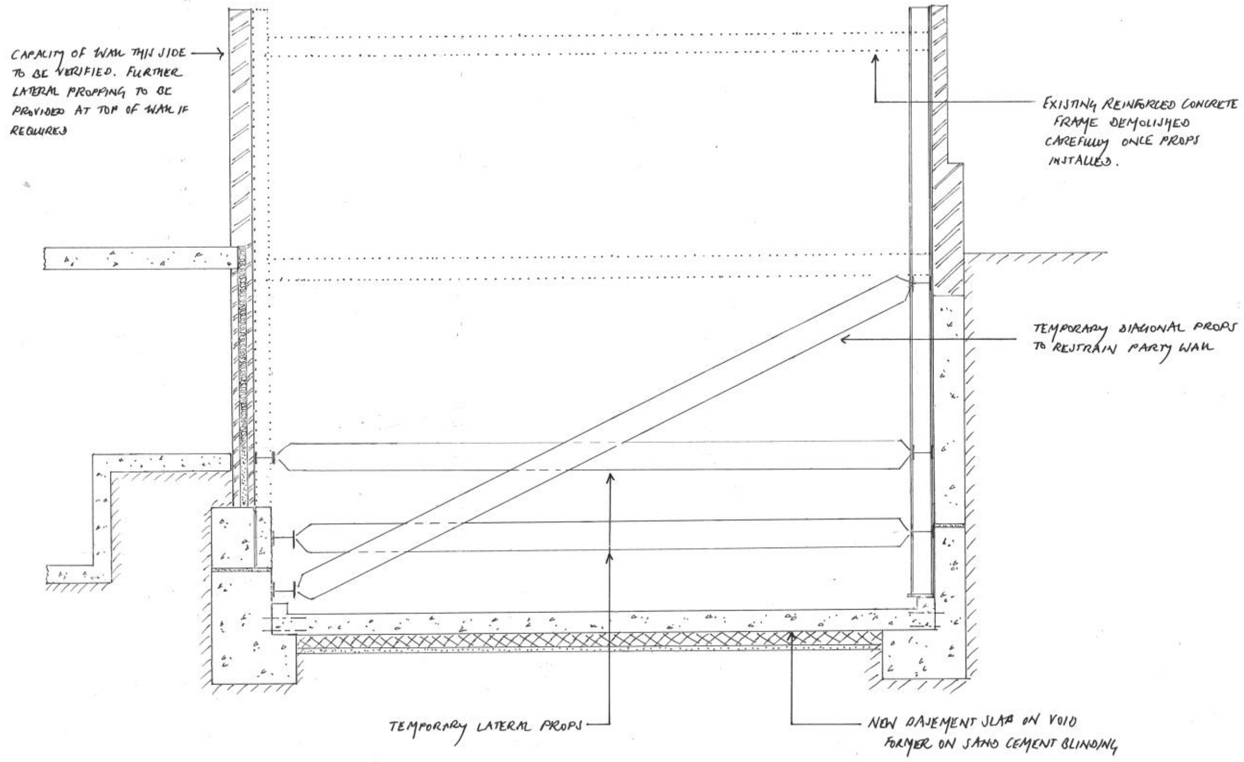
- Install low level lateral props running between party walls, just above existing lower ground floor slab level.
- Carefully demolish lower ground floor slab.
- Underpin perimeter walls in conventional hit and miss sequence, typically using mass concrete pins (reinforced concrete pins to be utilised on west side of site adjacent to the rear of the John Street property). Backfill after each underpin cast and packed.
- Excavate basement with small digger, installing lateral props at lower level as excavation proceeds.
- Excavate for and cast shallow footings within basement level footprint.
- Cast new basement level slab on void former on blinding, including swimming pool reinforced concrete base slab and walls.
- Install diagonal props from south side pins up to upper ground floor level on north side of plot, thereby mobilising passive earth pressure on south side of site against active earth pressure from garden on north side.
- Carefully demolish existing reinforced concrete frame structure and associated walls, leaving party wall / neighbour's wall in place.
- Cast perimeter reinforced concrete walls to basement level, retaining lateral props at upper ground floor slab level.
- Shutter up and cast upper ground floor level slab, leaving diagonal props to north garden in situ.
- Cast reinforced concrete retaining wall to upper ground floor level on north side of property. This to act as cantilevering wall in temporary condition.
- Remove diagonal props.



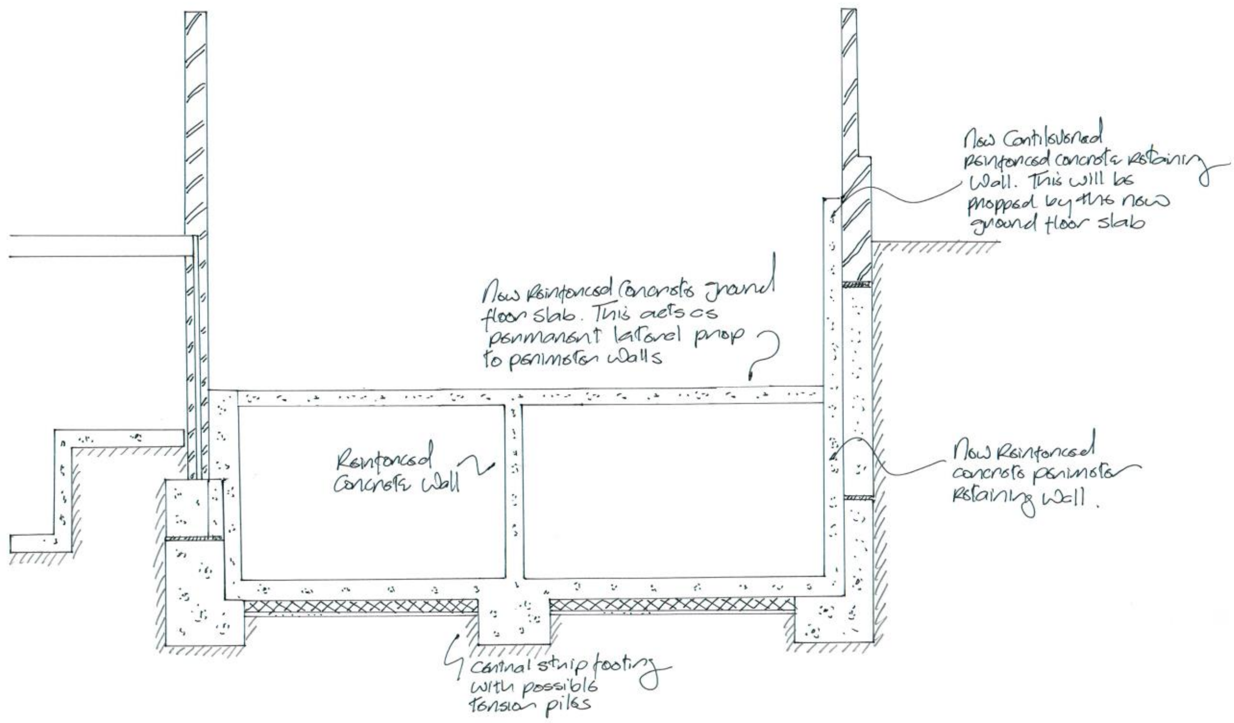
[1] Existing configuration



[2] Underpinning complete, excavation complete, lateral propping in place



[3] Perimeter walls laterally propped; existing RC frame demolished



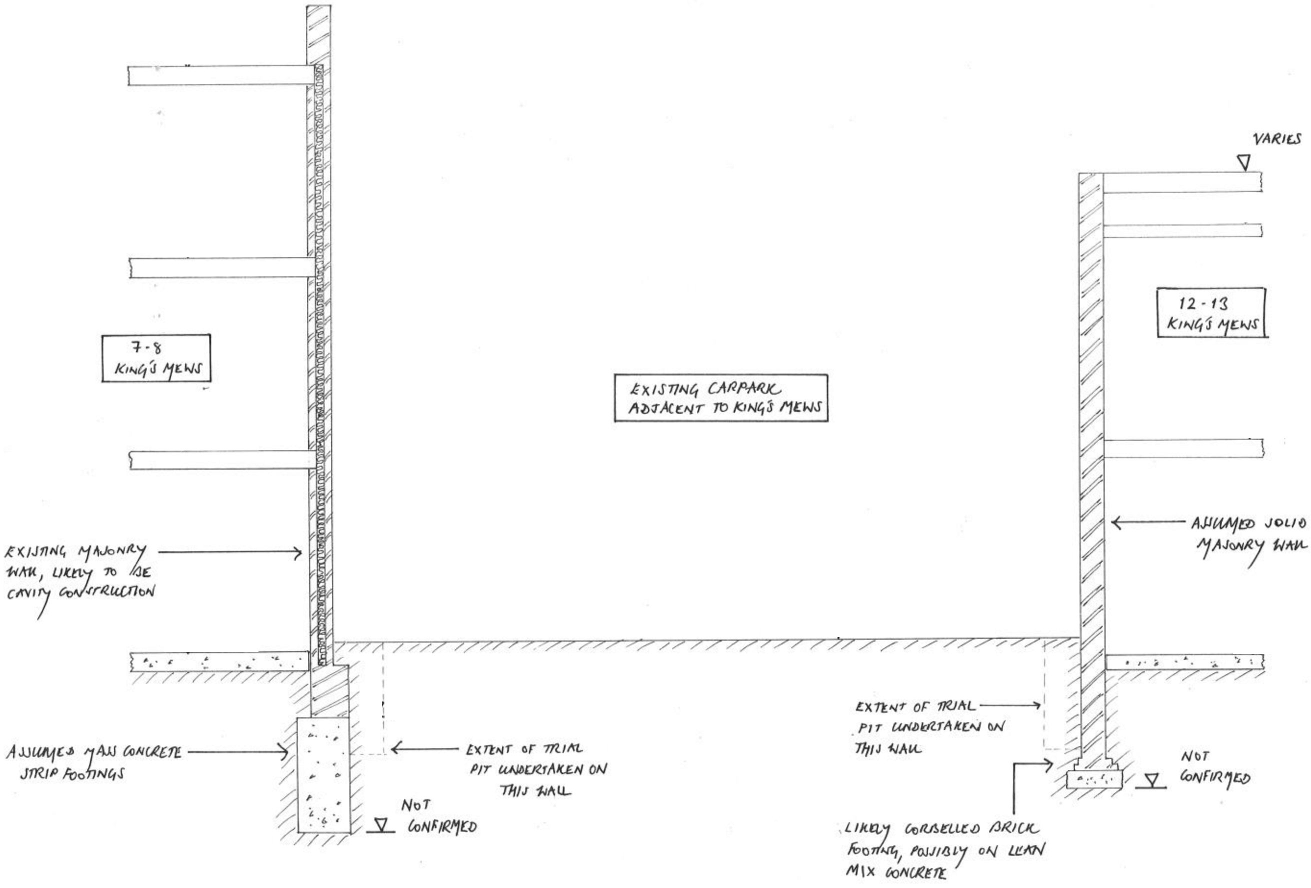
[4] Substructure works complete

Basement Construction Methodology for Rear Portion (East Side) of Site

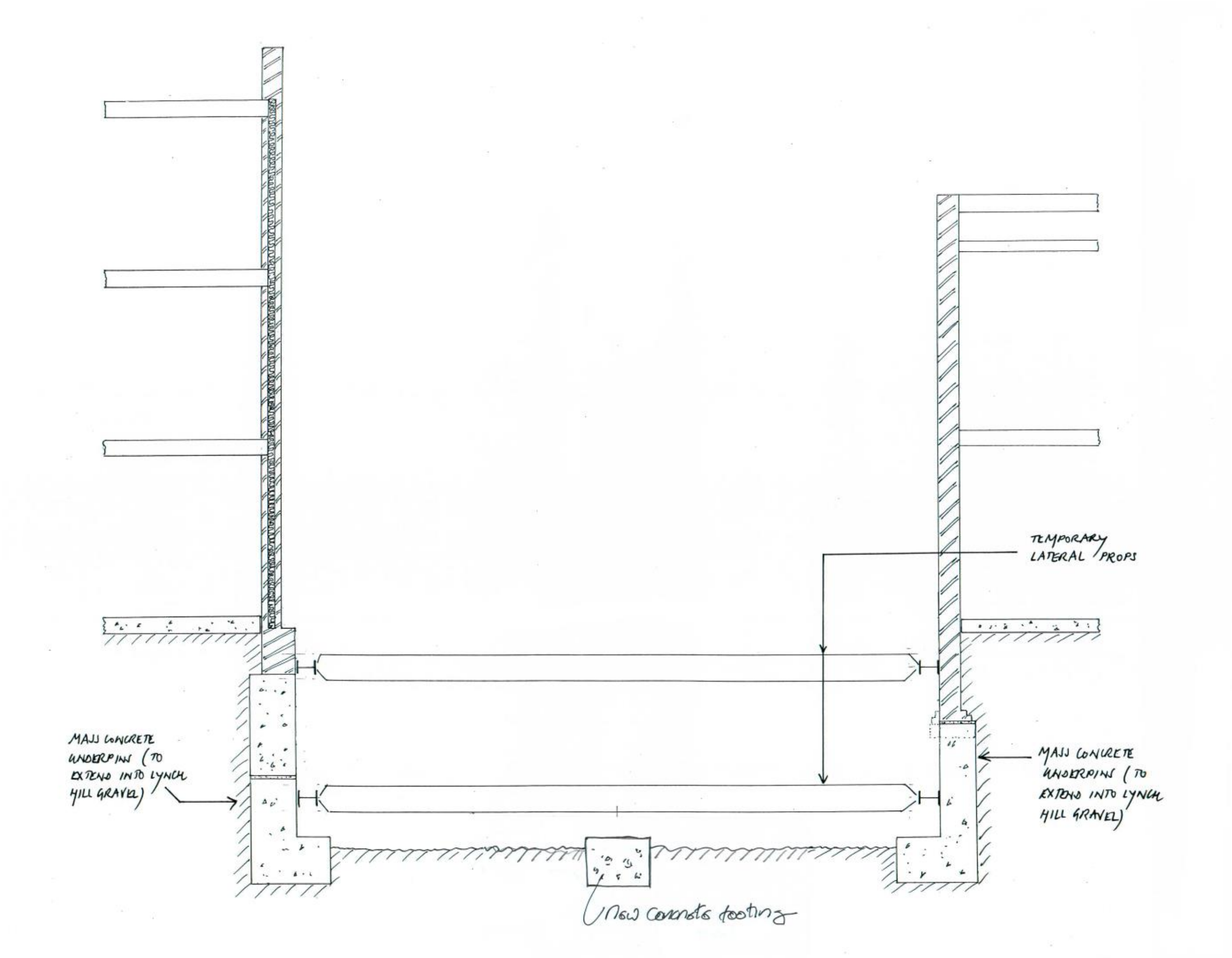
Refer to the diagrams below showing the construction sequence.

The construction sequence can be summarised thus:

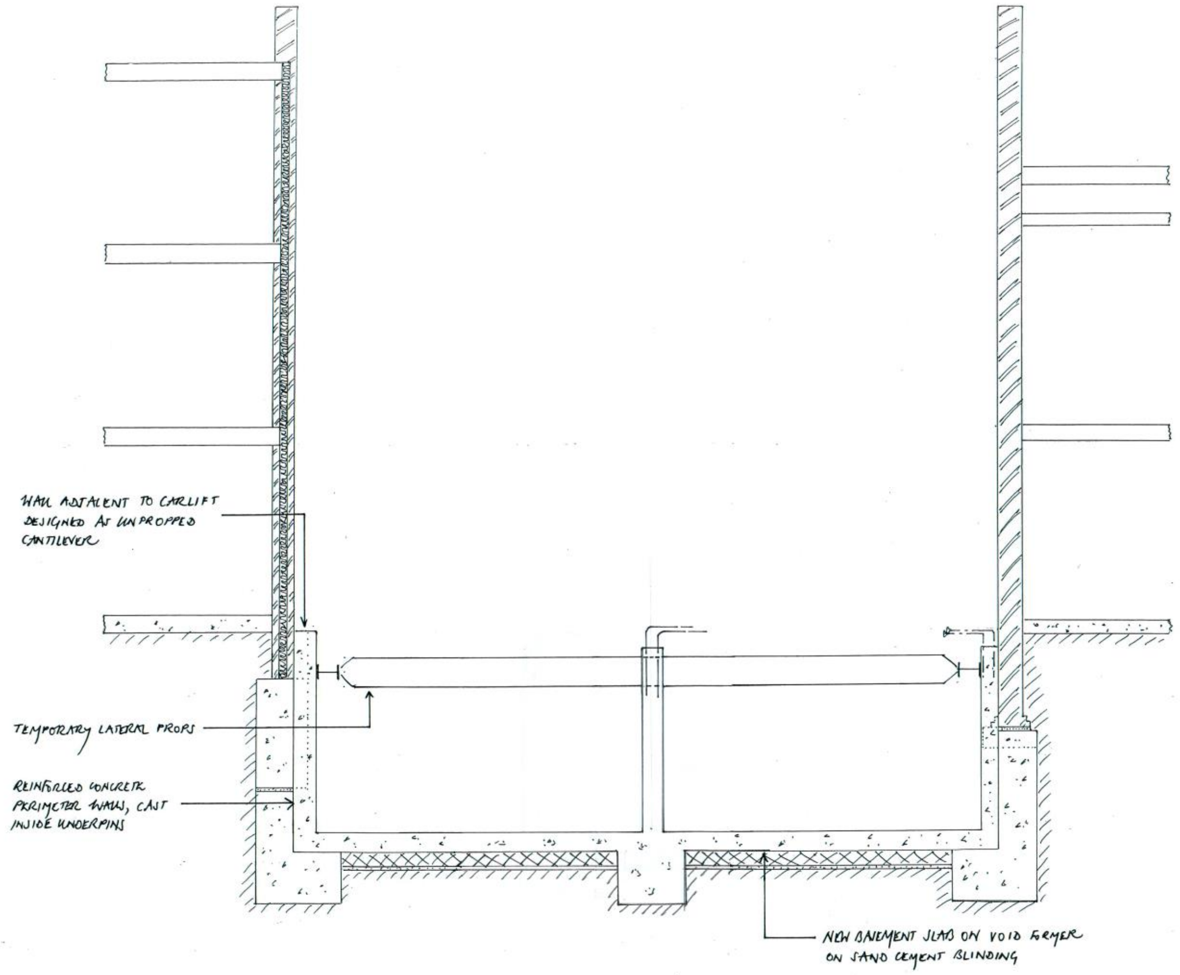
- Underpin perimeter wall in conventional hit and miss sequence, typically using mass concrete pins (reinforced concrete pins to be employed on east side of site, running adjacent to King's Mews). Backfill after each underpin cast and packed.
- Install low level lateral props running between party walls, just above existing ground level.
- Excavate basement with small digger, installing lateral props at lower level as excavation proceeds (including diagonal props to underpins adjacent to King's Mews).
- Excavate for and cast shallow footings within basement level footprint.
- Cast new basement level slab on void former on blinding.
- Cast perimeter reinforced concrete walls to basement level, retaining lateral props at upper ground floor slab level. (Note retaining wall by carpit will be designed to act as cantilevering retaining wall as this wall is not propped by the upper ground floor slab in the permanent condition).
- Shutter up and cast upper ground floor level slab.
- Remove remaining lateral props.



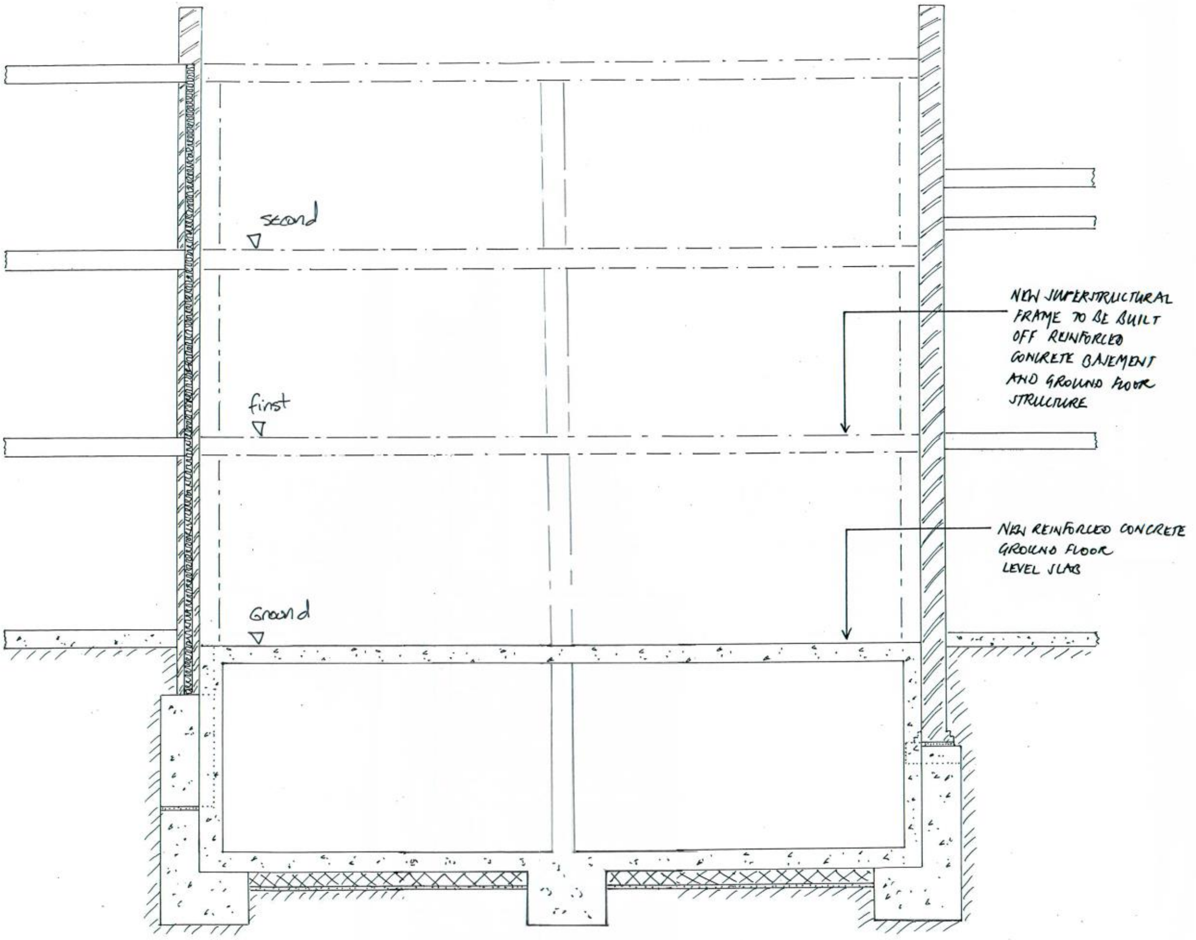
[1] Existing configuration



[2] Underpinning complete, excavation complete, lateral propping in place



[3] Reinforced concrete basement slab and perimeter walls cast



[4] Substructure works complete

6.3 Foundation Strategy and Construction Methodology – Alternative Option

Should it be determined via trial underpins that underpinning is not an appropriate option, the recommended alternative will be to form the perimeter walls to the basement with contiguous piled walls, installed within the existing boundary walls to the site. These piles will be continuous flight augured mini piles, installed with a small rig and using guide walls to minimise the distance from the existing boundary wall faces to the centreline of the piles. (Note if it is found during the trial underpinning that the groundwater is very high and the soil very free-draining then the use of a secant piled wall will be contemplated in lieu of a contiguous piled wall).

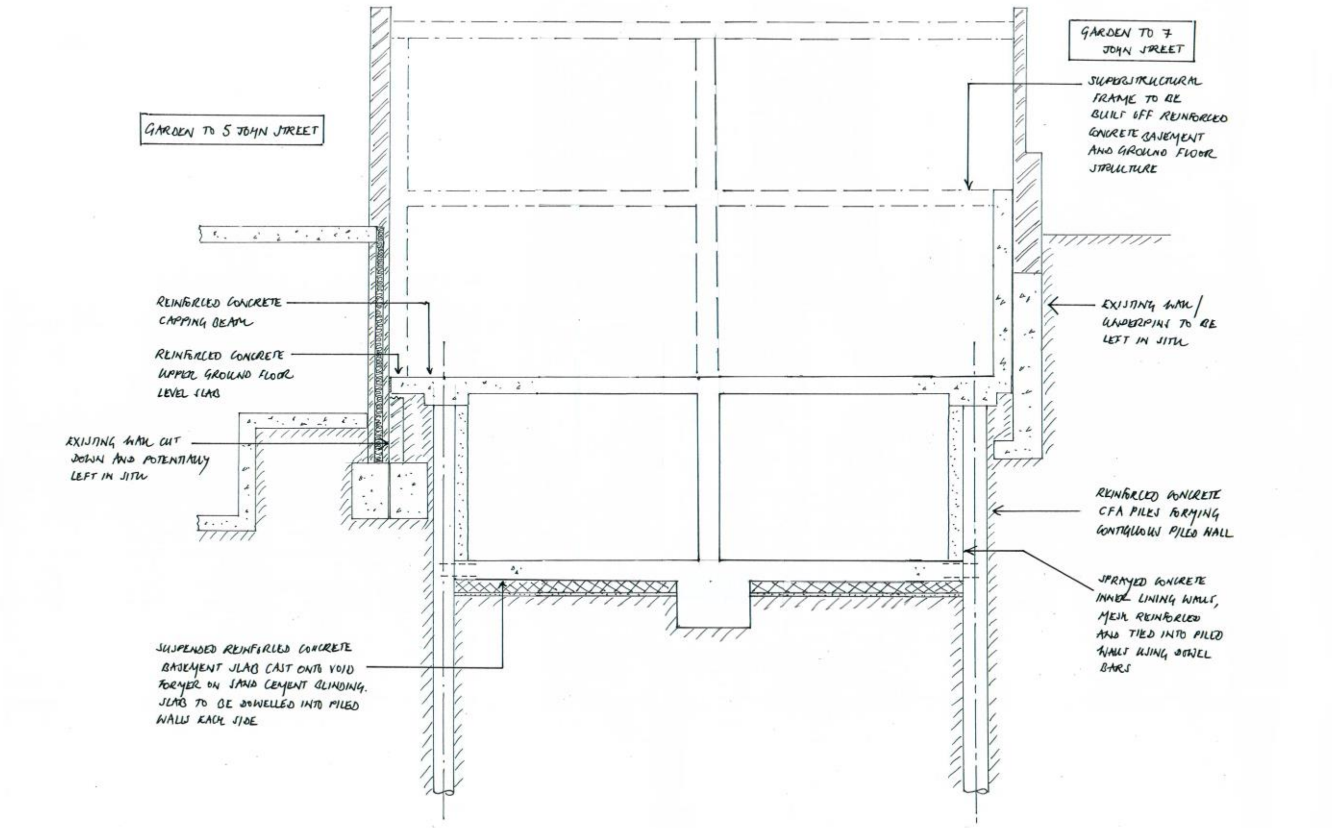
Piles will also be installed as foundations within the basement footprint (with these to be broken out down to basement level as excavation of the basement proceeds).

A capping beam will be cast on top of the piled walls, and this will be laterally propped whilst the basement is excavated, thereby allowing the piles to act as propped cantilever retaining walls in the temporary condition. Any groundwater will be pumped out as the excavation proceeds.

After excavation, the basement will essentially be constructed as a reinforced concrete 'box' (basement slab, sprayed concrete basement walls and ground floor slab) sitting inside the contiguous piled walls, and supported on the perimeter piles, and the internal piles, as permanent foundations. In the permanent condition, the contiguous piled walls can continue to act to retain the soil and surcharge pressures acting behind the walls. The sprayed concrete walls will be mesh reinforced and tied back into the piles via dowel bars at regular centres. They will be designed to span between piles under the worst case groundwater pressure arising from a future high groundwater event. In cases where there is no upper ground floor level slab (for example at the car pit and stair void), a shuttered concrete wall, cast in front of the piled wall, may be employed, designed to sustain the worst case soil and groundwater pressures as a vertical cantilever in the permanent case.

Again, waterproofing of the basement will be by means of a drained cavity system, in combination with either tanking to the perimeter walls, or the use of a waterproof additive in the concrete perimeter walls and basement slab.

This approach offers the advantage that retaining walls can essentially be installed before any excavation takes place. By propping at the head of the piles, and by employing piles with sufficient stiffness in themselves, during the subsequent excavation, there is minimal scope for lateral movement of the soil behind the piles at any level. Hence this methodology safeguards the stability of the surrounding properties very effectively, providing the piles and lateral propping are competently designed.



Typical cross-section (taken through central portion of site) show alternative piling option

Again, the basement construction methodology is best considered in terms of two cases: the central portion of the site and the rear (King's Mews) side of the site.

The construction sequence for the central (west side) portion of the site can be summarised thus:

- Install low level lateral props running between party walls, just above existing lower ground floor slab level.
- Carefully demolish lower ground floor slab.
- Lay granular fill across site and compact to form piling mat.
- Install concrete guide walls for piling rig.
- Install contiguous piled wall inside perimeter walls using low headroom mini-piling rig, sequentially moving lateral props as piling proceeds.
- Install piles, where required, within basement footprint.
- Break down heads of piles and cast reinforced concrete capping beam on top of piled wall.
- Excavate to depth of capping beam and install lateral props running between capping beams.
- Excavate basement with small digger, pumping out any groundwater encountered. Break out internal piles during excavation works, down to eventual basement level.

- Cast new basement level slab on void former on blinding. Slab to be dowelled into piled walls to each side.
- Install diagonal props from south side capping beam up to upper ground floor level on north side of plot.
- Carefully demolish existing reinforced concrete frame structure and associated walls, leaving party wall / neighbour's wall in place.
- Install dowels and mesh reinforcement and construct sprayed concrete wall in front of piles.
- Shutter up and cast upper ground floor level slab, leaving diagonal props to north garden in situ.
- Cast reinforced concrete retaining wall to upper ground floor level on north side of property. This to act as cantilevering wall in temporary condition.
- Remove diagonal props.

The construction sequence for the rear (east side) portion of the site can be summarised thus:

- Break out existing carpark slab, lay granular fill across site and compact to form piling mat.
- Install concrete guide walls for piling rig.
- Install contiguous piled wall inside perimeter walls.
- Install piles, where required, within basement footprint.
- Break down heads of piles and cast reinforced concrete capping beam on top of piled wall.
- Excavate to depth of capping beam and install lateral props running between capping beams.
- Excavate basement with small digger, pumping out any groundwater encountered. Break out internal piles during excavation works, down to eventual basement level.
- Cast new basement level slab on void former on blinding. Slab to be dowelled into piled walls to each side.
- Install dowels and mesh reinforcement and construct sprayed concrete wall in front of piles.
- Shutter up and cast upper ground floor level slab.
- Remove remaining lateral props.

7.0 SUPERSTRUCTURE CONSTRUCTION METHODOLOGY

The superstructure to the proposed new property will be a framed structure, most likely constructed in steelwork, though the use of reinforced concrete will also be considered, in light of its extensive employment at basement level. The columns to the structural frame will sit inside the party walls, thereby avoiding any substantial increase in the load acting directly on the party walls.

The new upper floor structures will comprise one of the following:

- Primary steel beams supporting secondary timber joists with plywood overlaid.
- Primary steel beams supporting secondary steel beams, in turn supporting a shallow concrete slab cast onto metal deck as permanent formwork.
- Reinforced concrete beams supporting concrete solid slabs.

Stability of the new structural frame will rely on the use of the above floor structures as diaphragms to transfer lateral loads out to shear walls. On the longitudinal (east-west) axis, the existing party walls will be employed as shear walls as well as a central spine wall. On the north-south axis, a limited number of walls (either side of the central spine wall) will be cross braced throughout their full height so that they may act as shear walls.

8.0 CONCLUSIONS

8.1 A Basement Impact Assessment has been undertaken by Geotechnical and Environmental Associates, and this should be read carefully alongside this report. The Basement Impact Assessment concludes that:

- The site is underlain by an aquifer, and the basement will most probably encounter the groundwater table. However, the basement will not form a significant barrier to groundwater flow and therefore will not have an adverse effect on the local hydrogeology.
- The site is within 5m of a highway (King's Mews). However, providing the basement walls are appropriately designed and propped, the excavation for the basement will not have an adverse effect on the stability of the highway.
- The basement will increase the differential depth of the foundations relative to neighbouring properties. However, providing the basement is designed and constructed in accordance with best practice, there is no reason for the excavation of the basement to cause instability of the surrounding structures.

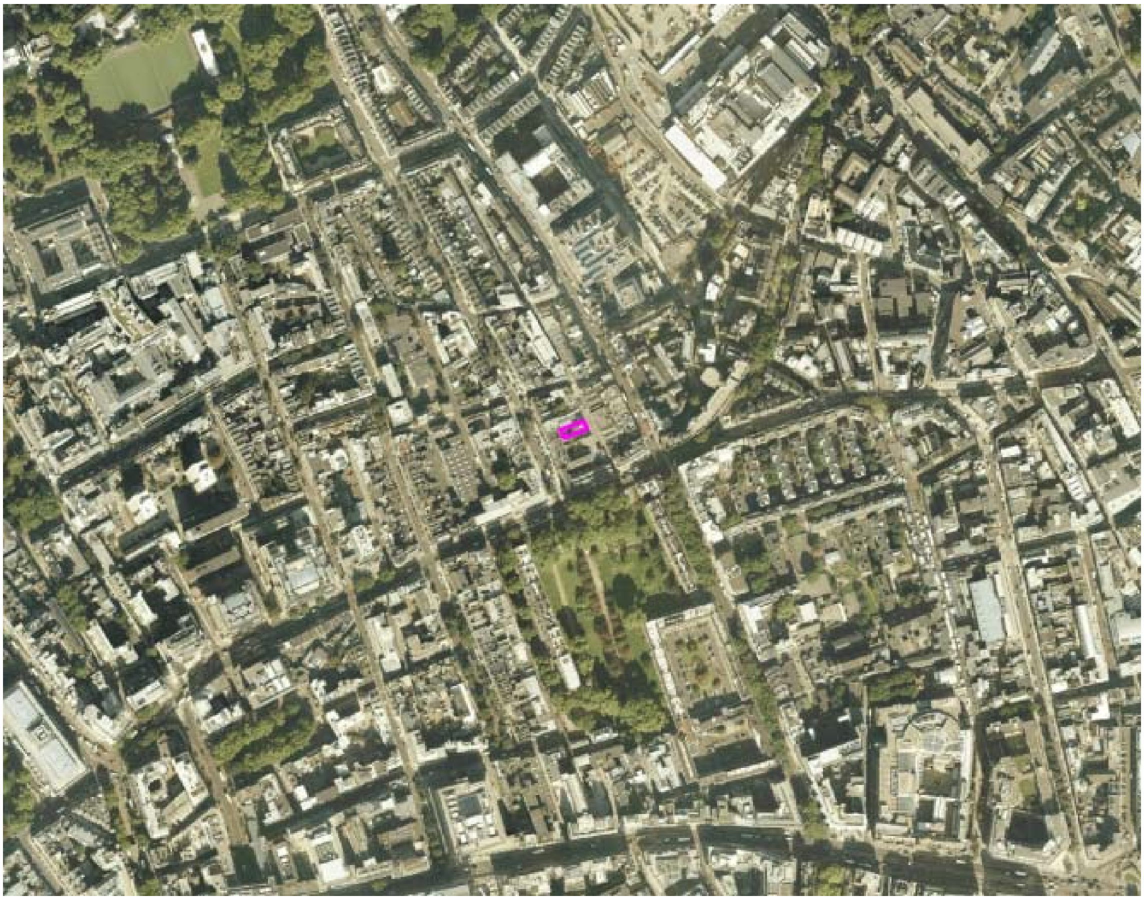
8.2 The Site Investigation has determined that the typical ground strata on the site comprise Made Ground, to a depth of up to 4.8m below ground level, overlying Lynch Hill Gravel, to a typical depth of 6.1m below ground level, overlying London Clay. The equilibrium groundwater level has not necessarily been confirmed but initial groundwater monitoring indicated a groundwater level of approximately 3.5m below ground level. The trial pits undertaken to date, coupled with the knowledge of the existing ground levels at the property and in the adjacent properties, indicates that the walls bounding the site are typically supported on strip foundations which may well terminate in the existing Made Ground.

8.3 In light of the above, the recommended basement construction method is to underpin the perimeter walls, extending down into the gravels; to laterally prop the perimeter walls before excavating the basement (installing further lateral props during excavation); and then to construct a reinforced concrete basement slab, basement walls and ground floor level slab, thus forming a rigid concrete box inside the perimeter walls. This approach will minimise the scope for movement of the surrounding soils and the adjacent structures at every stage.

8.4 The ground conditions are not considered ideal for the above approach given the depth of the gravels and the relatively shallow groundwater. It is therefore recommended that measures be undertaken in advance to confirm the viability of the above construction method. These will include further groundwater monitoring, additional window sampling, and trial underpinning. In the event that these measures show underpinning not to be a suitable approach, an alternative basement construction method will be employed, utilising contiguous piled walls installed inside the site boundary walls.

8.5 It is observed that the approach described in 8.4 has been proposed so as to ensure that the right basement construction methodology is selected, with the foremost objective of minimising movement of the soils surrounding the site during the works, and thereby safeguarding the stability of the surrounding structures at all stages.

Desk Study & Basement Impact Assessment Report



10 - 11 King's Mews
London
WC1N 2ES

Client Mr Philip Laniado

Engineer Fluid Structures

J12197

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Geotechnical & Environmental Associates

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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 Fluid Structures, on behalf of Mr Philip Laniado, with respect to the construction of a new three-storey terraced property with a single level basement. The purpose of the investigation has been to research the history of the site with respect to possible contaminative uses, to determine the ground and hydrogeological conditions, to assess the extent of any contamination and to provide information to assist with the design of the basement and suitable foundations for the proposed development. The report also includes a Basement Impact Assessment carried out in accordance with guidelines from London Borough of Camden in support of a planning application.

DESK STUDY FINDINGS

The earliest map studied, Greenwood's Map of London dated 1827, shows both John Street and King's Mews to have been constructed and the site developed with what was presumably a terraced building. The earliest Ordnance Survey map, dated 1877, shows the site in more detail, occupied by a terraced mews building with a rear courtyard garden that separates the site from a terraced building fronting onto John Street to the west. The surrounding area at this time was also extensively developed. The site remained unchanged until some time between 1946 and 1953, when the original terraced building was demolished, as was the building directly to the south, most likely as a result of bomb damage sustained during the Second World War. The western half of the site remained as a garden area to No 6 John Street until some time between 1968 and 1974, when the existing two-storey extension to No 6 John Street was constructed. The site and surrounding area have remained essentially unchanged since that time until the present day.

GROUND CONDITIONS

Below a surface covering of concrete hardstanding and a significant thickness of made ground, Lynch Hill Gravel was encountered and was in turn underlain by the London Clay Formation, which was proved to the maximum depth investigated. The concrete was found to be 300 mm in thickness and reinforced with 6 mm reinforcement. The made ground extended to a depth of 4.80 m (16.29 m OD) and comprised a layer of brown silty sand with crushed brick and concrete fragments over dark brown silty sandy clay with gravel, brick, concrete and coal fragments. The underlying Lynch Hill Gravel comprised medium dense brown slightly clayey sandy fine to coarse subrounded to angular gravel and extended to a depth of 6.10 m (14.99 m OD). Below this depth, the London Clay comprised an initial weathered horizon of firm fissured brown silty clay with partings of bluish grey silt, which extended to a depth of 6.40 m (14.69 m OD). The initial horizon was found to be underlain by typical unweathered London Clay, comprising stiff becoming very stiff fissured high strength to very high strength dark grey silty clay with partings of brownish grey silt and traces of selenite, which was proved to the maximum depth investigated of 15.00 m (6.09 m OD).

Groundwater monitoring has recorded groundwater at depths of 3.50 m (17.59 m OD) and 3.60 m (17.49 m OD). Contamination testing has indicated elevated concentrations of lead within the made ground.

RECOMMENDATIONS

On the basis of the borehole findings, formation level for the new basement will still be within the made ground. Consideration may be given to traditional mass concrete underpinning, although the concrete underpins will need to extend beyond the made ground and will therefore need to extend to a depth of at least 4.80 m in order to bear within the Lynch Hill Gravel. Consideration will need to be given to the instability of the made ground, which may result in loss of ground below party wall foundations, and the presence of groundwater inflows, which may preclude the use of conventional underpinning Trial excavations and further monitoring would be prudent in this respect. Although the proposed basement structure is likely to intercept the groundwater table, given the topographical setting and neighbouring surrounding structures, it is unlikely to have a detrimental effect on the local hydrogeology. In addition, the nature of the proposed development and the site setting is such that it will not affect the stability of existing slopes and therefore neighbouring properties.

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 (GEA) has been commissioned by Fluid Structures, on behalf of Mr Philip Laniado, to carry out a site investigation at the site of 10 – 11 Kings Mews, London WC1N 2ES.

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 in support of a planning application.

1.1 Proposed Development

It is proposed to demolish the existing two-storey extension to No 6 John Street and subsequently construct a three-storey house across the entire site, with a single level basement that will extend to depths of 3.00 m and 4.50 m. The deeper part of the basement will house an indoor swimming pool.

This report is specific to the proposed development and the advice herein should be reviewed once the development proposals have been finalised.

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 assess the possible impact of the proposed development on the local hydrogeology and slope stability;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to determine the configuration of existing foundations;
- 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 readily available geological and hydrogeological maps;
- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- a walkover survey of the site carried out in conjunction with the fieldwork.

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

- a single cable percussion borehole, advanced to a depth of 15.00 m, by means of a standard cable percussion drilling rig;
- standard penetration tests (SPTs), carried out at regular intervals in the borehole, to provide additional quantitative data on the strength of the soils;
- a series of three manually excavated trial pits, to investigate the extent and bearing stratum of existing foundations;
- the installation of a groundwater monitoring standpipe in the borehole to a depth of 6.20 m, and two subsequent monitoring visits over a one month period;
- laboratory testing of selected soil samples for geotechnical purposes and for the presence of contamination; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

The report includes a contaminated land assessment which has been undertaken in accordance with the methodology presented in Contaminated Land Report (CLR) 11[1] and 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. The risk assessment is thus divided into three stages comprising Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Site-Specific Risk Assessment.

The work carried out includes a Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), both of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup. The aim of this work is to provide information on the groundwater conditions specific to this site.

1.3.1 Qualifications

The BIA elements of the work have been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng) and member of the Institution of Civil Engineers (MICE), who has over 20 years specialist experience in ground engineering. The assessment has 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 25 years experience in geotechnical engineering, engineering geology and hydrogeology. Both assessors meet the Geotechnical Specialist

1 *Model Procedures for the Management of Land Contamination* issued jointly by the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) Sept 2004
2 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

criteria of the Site Investigation Steering Group and satisfy the qualification requirements of the Council guidance.

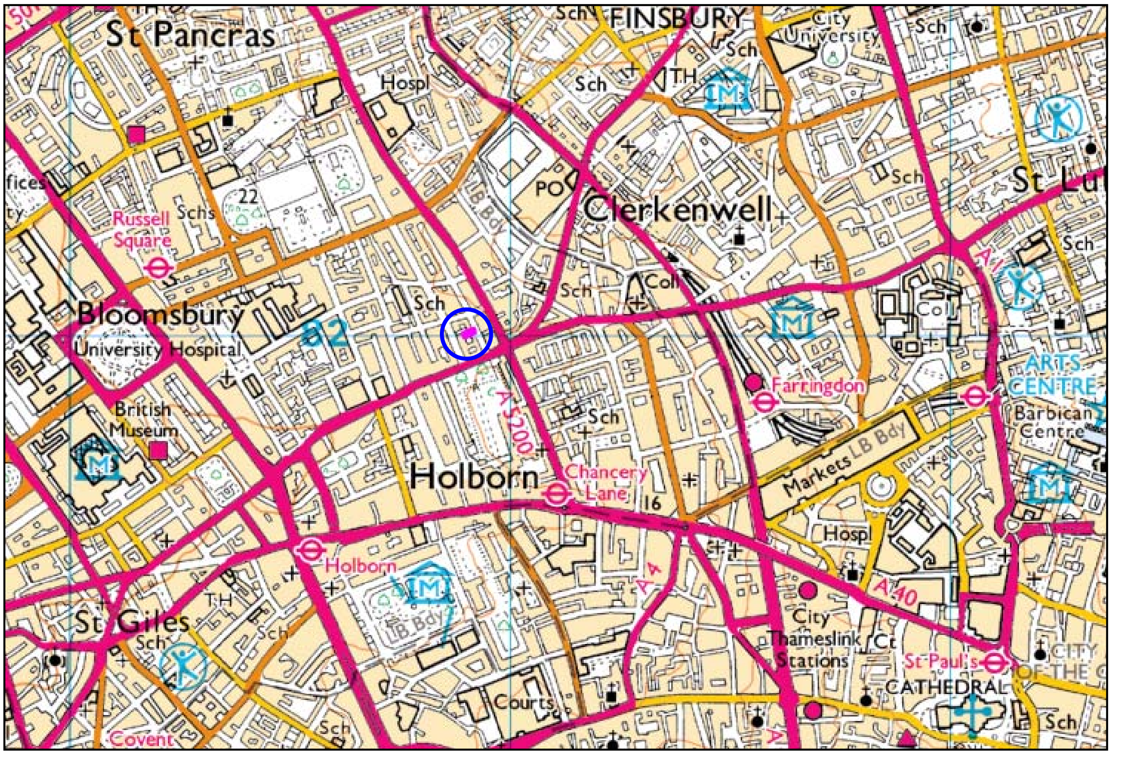
1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located in central London, approximately 400 m north of Chancery Lane London Underground station and 600 m northwest of Farringdon railway station. It may be additionally located by National Grid Reference 530900,182000 and is shown on the map below.



The site forms a rectangular area with dimensions of approximately 25 m east-west by 10 m north-south and is currently occupied by a two-storey rear extension to No 6 John Street and associated concrete driveway. The site as a whole fronts onto King’s Mews to the east and is bordered to the north by No 12 King’s Mews, a recently refurbished two-storey house and associated garden, to the south by the three-storey house and courtyard garden of No 9 King’s Mews and to the west by No 6 John Street, a four-storey building with a mansard roof and single level basement that extends to depth of approximately 2.0 m below ground level, approximately 1.0 m below the level of the site. The basement also extends to the same depth below the two-storey extension, which occupies the western half of the site and is currently used as offices. The eastern half of the site is covered in concrete hardstanding and used for parking by employees and a vehicle repair garage, which is present on the opposite side of King's Mews, approximately 20 m to the northeast of the site. This part of the site does not currently include a basement level.

The site is devoid of vegetation and slopes gently down to the east along with the topography of the surrounding area, which also slopes down to towards the south / southeast.

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 map studied, Greenwood's Map of London dated 1827, shows both John Street and King's Mews to have been constructed and the site developed with what was presumably a terraced building. The earliest Ordnance Survey map, dated 1877, shows the site in more detail, occupied by a terraced mews building with a rear courtyard garden that separates the site from a terraced building fronting onto John Street to the west. The surrounding area at this time was also extensively developed. The site remained unchanged until some time between 1946 and 1953, when the original terraced building was demolished, as was the building directly to the south, most likely as a result of bomb damage sustained during the Second World War. This has been confirmed through the review of the adjacent bomb damage map, which indicates that the building on site was damaged beyond repair.

The western half of the site remained as a garden area to No 6 John Street until some time between 1968 and 1974, when the existing two-storey extension to No 6 John Street was constructed. The site and surrounding area have remained essentially unchanged since that time until the present day.

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.

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.

2.4 Geology

The Geological Survey map of the area (sheet 256) indicates that the site is underlain by Lynch Hill Gravel over the London Clay Formation.

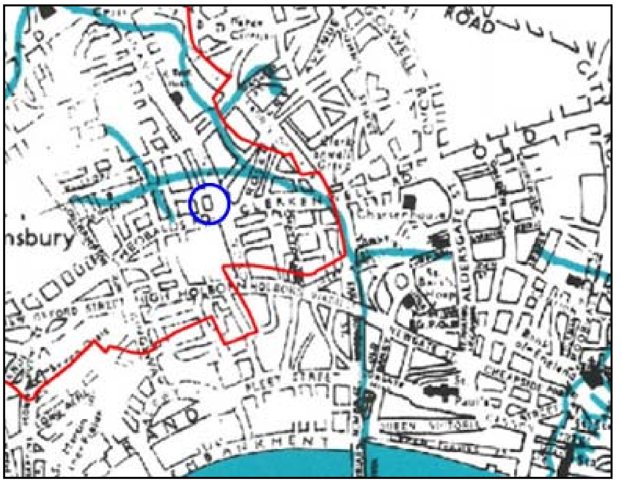
Two ground investigations have been previously carried out by GEA within close proximity of the site. One was carried out to the rear of No 4 John Street, approximately 10 m to the south of the site, and encountered made ground to a depth of 2.5 m, whereupon the Lynch Hill Gravel was encountered and extended to a depth of 5.4 m. Below this depth the London Clay Formation was encountered and proved to the maximum investigated of 10.0 m.

The other investigation was carried out at No 25 King's Mews, approximately 20 m to the southeast of the site. The investigation encountered a significant thickness of made ground to depths of 3.6 m and 4.0 m, whereupon the Lynch Hill Gravel was encountered and comprised dense orange-brown silty coarse sand with fine to medium angular gravel to a depth of 5.1 m. Below this depth, the London Clay was encountered and proved to the maximum depth investigated.

2.5 Hydrology and Hydrogeology

The Lynch Hill Gravel is classified as a Secondary 'A' Aquifer, which refers to a stratum with low permeability that has negligible significance for water supply or river base flow, as defined by the Environment Agency (EA). The London Clay is classified as a Non-Aquifer and Unproductive Stratum

The topographical maps show that there are no surface water features within 1 km of the site, which is also not located in the catchment of the Hampstead Ponds. The site is not within an area at risk from flooding as defined by the EA and in addition, King's Mews is not listed as being at risk from surface water flooding, nor is there a record of it having suffered from such an event in the past.



Historically, a tributary of the River[4] Fleet, one of London's "lost" rivers, flowed in an easterly direction approximately 200 m to the north of the site, as shown by the adjacent map extract. The source of this river is in Hampstead, north London and flowed in a generally southerly direction towards the River Thames. The tributary to the north of the site, issued into the main river channel to the west of the site, from where the river flowed south along Farringdon Road and issued into the Thames below Blackfriars Bridge. Although the river is no longer an open water course, surface and near surface waters, along with groundwater within the Lynch Hill

4 Nicholas Barton (2000) *London's Lost Rivers.* Historical Publications Ltd

gravel, will still flow towards the former river course, which has mostly been culverted or diverted through sewers. Groundwater below the site is therefore likely to be flowing in an easterly / southeasterly direction, with the local topography and towards the former river course.

The permeability of the Lynch Hill Gravel is expected to range between about 1 x 10^{-6} m/s and 1 x 10^{-4} m/s, whereas in contrast, any groundwater flow within the London Clay will be at a very slow rate, due to its negligible permeability. The permeability will be predominantly secondary, through fissures in the clay. Published data indicates the horizontal permeability of the London Clay to generally range between 1 x 10^{-11} m/s and 1 x 10^{-9} m/s.

The aforementioned GEA site investigations measured groundwater at depths of between 3.9 m and 4.2 m, during a programme of groundwater monitoring.

The site is completely covered by the existing building and hardstanding and therefore there is currently very little opportunity for infiltration of rain water into the ground beneath the site and the majority of surface runoff is likely to drain into combined sewers in the road.

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 terraced building that was most likely to be a residential dwelling. Since the demolition of that building, the site has partly been occupied by part of an office building and a concrete driveway. It is possible that minor spillages may have occurred from parked cars in the driveway area, although the existing concrete hardstanding was noted to be in good condition with no visible signs of past leakage or staining. There are thus no sources of contamination on the site.

Apart from a small vehicle repair garage, approximately 50 m northeast of the site, there have been no off-site potential sources of contamination identified, including historical and existing landfill sites.

2.6.2 Receptor

It is proposed to redevelop the site with a new three-storey residential house and therefore end users represent relatively high sensitivity receptors. The underlying Lynch Hill Gravel is classified as a Secondary ‘A’ aquifer; therefore groundwater and thus off site sensitive receptors are considered to be potential receptors. Site workers will come into contact with underlying soils during the construction phase, as will new buried services.

2.6.3 Pathway

The new terraced house will occupy the whole of the site with no areas of soft landscaping proposed; end users will therefore be isolated from the underlying soils by the presence of the new development. In addition, the excavation of the basement is likely to remove some, if not all, of the made ground from below the site and thus remove any contamination within the fill materials. Being underlain by a Secondary 'A' Aquifer, the groundwater is considered to be a potential pathway for mobile contaminants to move off site. The construction phase is also 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 LBC guidance suggests that any development proposal that includes a subterranean 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 Surface Flow and Flooding

Question	Response for rear of 6 John Street
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No
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
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No
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
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	No
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?	No

3.1.2 Subterranean (groundwater) Flow

Question	Response for rear of 6 John Street
1a. Is the site located directly above an aquifer?	Yes
1b. Will the proposed basement extend beneath the water table surface?	Unknown / possible
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No
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
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

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

Q1a The site is located directly above an aquifer.
Q1b It is possible that the proposed basement will extend below the water table.

3.1.3 Slope Stability

Question	Response for rear of 6 John Street
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No
5. Is the London Clay the shallowest strata at the site?	No
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?	No
8. Is the site within 100 m of a watercourse or potential spring line?	No
9. Is the site within an area of previously worked ground?	No
10. Is the site within an aquifer?	Yes
11. Is the site within 50 m of Hampstead Heath ponds?	No

Question	Response for rear of 6 John Street
12. Is the site within 5 m of a highway or pedestrian right of way?	Yes
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes
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:

Q10 The site is within an aquifer.
Q12 The site is within 5 m of a highway.
Q13 The basement will increase the differential depth of foundations relative to neighbouring properties.

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.

Screening Flowchart Question	Potential Impact
Is the site directly underlain by an aquifer?	The site is underlain by the Secondary Aquifer of the Lynch Hill Gravel. These soils are capable of supporting groundwater supplies at a local level and in some cases form an important source for river base flow. Should the basement intercept the groundwater, it can cause fluctuations in local groundwater levels.
Will the proposed basement extend beneath the water table?	Being underlain by a Secondary A aquifer it is possible that the proposed basement will extend beneath the water table, which can cause fluctuations in local groundwater levels. This is more the case if foundations penetrate the base of the granular soils and bear in the underlying London Clay.
Is the site within 5 m of a highway or pedestrian right of way?	King's Mews runs adjacent to the eastern boundary of the site. The excavation of the basement may result in loss of ground from below the highway, causing instability. The stability of the highway and other surrounding structures will need to be ensured at all times.
Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	The exact depth of the neighbouring foundations are not known, in order to excavate the basement, it is possible that the foundations of the neighbouring properties will need to be underpinned or supported by new retaining walls. The extension of the foundations may cause instability of adjacent properties and this will need to be checked during the design of the basement retaining walls.

These potential impacts have been investigated through the site investigation, as detailed below.

4.2 Exploratory Work

The investigation was limited to just the eastern half of the site by the presence of the existing two-storey structure. Therefore, as far as possible within these restrictions, in order to meet the objectives described in Section 1.2, a single cable percussion borehole was drilled to a depth of 15.00 m (6.09 m OD). Standard penetration tests (SPTs) were carried out at regular intervals in the borehole and disturbed and undisturbed samples were recovered for subsequent laboratory examination, geotechnical testing and contamination analysis. A groundwater monitoring standpipe was installed in the borehole to a depth of 6.20 m (14.89 m OD) and has subsequently been monitored on two occasions over a one month period.

In addition to the borehole, a series of three trial pits was manually excavated adjacent to the northern and southern elevations of the adjacent buildings in order to determine the configuration of existing foundations.

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 logs have been interpolated from spot heights shown a site section drawing (ref: E201, dated, May 2008), drawn by Foundation Architecture and provided by the structural engineers.

4.3 Sampling Strategy

The borehole was positioned on site by GEA in an accessible area in the centre of the site, whilst avoiding known buried services. The trial pit locations were specified by the consulting engineers and confirmed on site by GEA to avoid known buried services.

A single sample of made ground was subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. 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 soil sample was selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification.

The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

5.0 GROUND CONDITIONS

The investigation has encountered the expected ground conditions in that, below a surface covering of concrete hardstanding and a significant thickness of made ground, Lynch Hill Gravel was encountered and was in turn underlain by the London Clay Formation, which was proved to the maximum depth investigated.

5.1 Made Ground

The concrete was found to be 300 mm in thickness and reinforced in places with 6 mm reinforcement. The underlying made ground extended to a depth of 4.80 m (16.29 m OD) and comprised a layer of brown silty sand crushed brick and concrete fragments over dark brown silty sandy clay with gravel, brick, concrete and coal fragments.

Significant thicknesses of made ground were also encountered in the other GEA investigations carried out along King's Mews. It is possible that such thicknesses are present due to the demolition of previous buildings and / or the building up of levels prior to the construction of the existing terraces. Equally, it is possible that the significant thickness of made ground encountered on the site is present due to the demolition / destruction of the previous building due to bomb damage.

With the exception of notable fragments of extraneous material, such as brick and coal fragments, no visual or olfactory evidence of significant contamination was observed within these soils, although a single sample has been analysed for a range of contaminants and the results are discussed in Section 5.5.

5.2 Lynch Hill Gravel

The underlying Lynch Hill Gravel comprised brown slightly clayey sandy fine to coarse subrounded to angular gravel and extended to a depth of 6.10 m (14.99 m OD). The results of SPTs have indicated the gravel to be in a medium dense condition.

These soils were observed to be free of any contamination.

5.3 London Clay

This stratum comprised an initial weathered horizon of firm fissured brown silty clay with partings of bluish grey silt, which extended to a depth of 6.40 m (14.69 m OD). The initial horizon was found to be underlain by typical unweathered London Clay, comprising stiff becoming very stiff fissured high strength to very high strength dark grey silty clay with partings of brownish grey silt and traces of selenite, which was proved to the maximum depth investigated of 15.00 m (6.09 m OD).

Plasticity index tests have indicated the clay to be of high shrinkability. These soils were observed to be free of any evidence of soil contamination.

5.4 Groundwater

Seepages of groundwater were encountered during the drilling of the borehole at depths of 3.10 m (17.99 m OD) and 6.00 m (15.09 m OD) in the made ground and Lynch Hill Gravel respectively. A deeper inflow was encountered in the London Clay at a depth of 13.80 m (7.29 m OD), which rose to a depth of 6.50 m (14.69 m OD) after a 20 minute rest period.

Subsequent monitoring visits, carried out approximately one week and three weeks after installation, recorded groundwater at depths of 3.50 m (17.59 m OD) and 3.60 m (17.49 m OD). It would be prudent to carry out further monitoring in order establish equilibrium levels and the effect of any seasonal variations.

5.5 Soil Contamination

A single sample of made ground was tested for a range of contaminants and the results are included in the appendix. The results of the contamination testing have indicated an elevated concentration of lead. No elevated concentrations of any of the other contaminants were identified.

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. To this end the contaminants of concern are those that have values in excess of a generic human health risk based guideline value, which is either that of the CLEA[5] Soil Guideline Value where available, or is a Generic Guideline Value calculated using the CLEA UK Version 1.06 software assuming a residential end use. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be a young female child aged 0 to 6 years old;
- that young children will not have prolonged exposure to the site;
- that the exposure duration will be 6 years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of homegrown produce, consumption of soil adhering to homegrown produce, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a two-storey small terraced house

It is considered that these assumptions are acceptable for this generic first assessment of this site, albeit slightly conservative. As the proposed house and basement cover the entire site, the majority of the exposure pathways between the contamination and end users are not considered to be active. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix. The risk to groundwater is considered later in the report.

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.

5 *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.

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

5.6 Existing Foundations

Trial Pits were excavated adjacent to the northern and southern party walls. Each of the trial pits were terminated at a depth of 1.50 m (19.69 m OD) within the made ground, without the base of the footings being proved, as it was not possible to excavate further without the provision of shoring materials.

Minor instabilities occurred within the made ground, although groundwater was not encountered in any of the trial pits. 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 foundation options and other aspects of the development.

6.0 INTRODUCTION

Consideration is being given to the redevelopment of this site through the demolition of the existing two-storey extension to No 6 John Street and subsequent construction of a three-storey house across the entire site, with a single level basement that will extend to depths of 3.00 m and 4.50 m, levels of approximately 18.00 m OD and 16.50 m OD. Loads are not known at this stage but are anticipated to relatively light to moderate.

7.0 GROUND MODEL

The desk study has revealed that the site has not had a potentially contaminative history, having apparently been developed with a terraced house prior to the existing two-storey office extension and driveway. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows.

- Beneath a surface covering of concrete hardstanding and a significant thickness of made ground, Lynch Hill Gravel is present overlying the London Clay Formation, which was proved to the maximum depth investigated;
- the concrete hardstanding is 300 mm in thickness and reinforced in places with 6 mm reinforcement;
- the made ground extends to a depth of 4.80 m (16.29 m OD) and comprises a layer of brown silty sand crushed brick and concrete fragments over dark brown silty sandy clay with gravel, brick, concrete and coal fragments;
- the Lynch Hill Gravel comprises medium dense brown slightly clayey sandy fine to coarse subrounded to angular gravel to a depth of 6.10 m (14.99 m OD);
- the weathered London Clay comprises firm fissured brown silty clay with partings of bluish grey silt to a depth of 6.40 m (14.69 m OD);
- typical unweathered London Clay comprising stiff becoming very stiff fissured high strength to very high strength dark grey silty clay with partings of brownish grey silt and traces of selenite extends to the maximum depth investigated of 15.00 m (6.09 m OD);
- groundwater has been measured at depths of 3.50 m (17.59 m OD) and 3.60 m (17.49 m OD) during two monitoring visits, carried out over a one month period; and
- the contamination analysis has indicated an elevated concentration of lead within the single sample of made ground tested.

8.0 ADVICE AND RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to maintain stability of the surrounding structures and to prevent any excessive ground movements. Based on the groundwater observations to date, groundwater is not expected to be encountered within the basement excavation.

The excavation of a 3.00 m and 4.50 m deep basement will result in a formation level in the made ground, at levels of approximately 18.00 m OD and 16.50 m OD. On the basis of the single borehole, new foundations will need to extend to a depth of 4.80 m (16.29 m OD) in order to bear within the Lynch Hill Gravel, which should provide an eminently suitable bearing stratum for spread foundations excavated from basement level. However, the groundwater monitoring to date has indicated that it will not be possible to reach the Lynch Hill Gravel without encountering groundwater inflows and further investigation would be prudent to determine the depth to the gravel across the remainder of the site coupled with further monitoring and trial excavations.

8.1 Basement Excavation

It is understood that it is proposed to excavate a single level basement to depths of 3.00 m and 4.50 m, levels of 18.00 m OD and 16.50 m OD. Groundwater has been measured at depths of 3.50 m (17.59 m OD) and 3.60 m (17.49 m OD) on two occasions over a one month period, although it is not thought that the standpipe had reached an equilibrium level and therefore these measurements are not considered to represent true groundwater level. It would therefore be prudent to continue monitoring the standpipe in order to establish equilibrium levels, although on the basis of the groundwater observations to date, groundwater is likely to be encountered in the deeper parts of the basement excavation.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and surrounding structures and to protect against perched groundwater inflows. The choice of wall may be governed to a large extent by the access restrictions and 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 view of the fact that the site forms part of a terrace of buildings, the stability of neighbouring structures, including the existing highway, will be paramount.

One option of forming the basement retaining walls is through the use of traditional concrete underpinning constructed by means of a “hit and miss” approach. The viability of this method will depend on whether or not the made ground will remain sufficiently stable to allow the underpins to be formed and whether significant groundwater inflows are encountered above the surface of the gravel. It is possible that this method will result in localised instability of the made ground and consequent loss of ground from below adjacent foundations. This may not be significant if the foundations are relatively deep and / or are sufficiently stiff to bridge over any loosened areas. In this respect trial excavations to the proposed basement depth should be carried out to confirm the stability of the soil and whether or not any groundwater inflows can be suitably controlled. If trial excavations indicate traditional underpinning to be impractical, consideration could be given to the use of jet grouting to aid stability or bored pile retaining walls.

Consideration could be given to the use of a contiguous bored pile wall, with localised grouting to prevent any perched water inflows. However, the use of a secant bored pile wall would negate the need for secondary groundwater control and maximise the usable space within the basement.

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. In this respect the timing of the provision of support to the wall will have an important effect on movements.

8.1.1 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	1800	Zero	27
Lynch Hill Gravel	1850	Zero	32
London Clay	2000	Zero	25

Based on the monitoring to date, groundwater is likely to be encountered within the deeper parts of the excavation, although monitoring of the standpipe should be continued in order to establish equilibrium levels. Consideration should be given to the risk of groundwater and surface water collecting behind the retaining walls and unless a fully effective drainage system can be ensured it would be prudent to assume a design water level equivalent to two-thirds of the retained height. The advice in BS8102:2009[6] should be followed in the design of the basement retaining walls and with regard to waterproofing requirements.

8.1.2 Basement Heave

The excavation of an approximately 3.00 m to 4.50 m thickness of soil will result in an unloading of between 55 kN/m^2 and 80 kN/m^2. This unloading will result in heave of the underlying London Clay, which will comprise short term elastic movement and longer term swelling that will continue over a number of years. These movements will be mitigated to some extent by the remaining thickness of gravel and the pressure applied by the proposed building, although it is recommended that a more detailed analysis of the possible heave should be carried out once the basement design has been finalised.

8.2 Spread Foundations

The excavation of the basement will result in a formation level within the made ground. Therefore foundations will need to extend to a depth of 4.80 m (14.99 m OD) in order to bear within the Lynch Hill Gravel. It should be possible to adopt moderate width pad or strip foundations in the dense sand and gravel, designed to apply a net allowable bearing pressure of 150 kN/m^2. This value incorporates an adequate factor of safety to protect against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

The viability of spread foundations depends whether it will be feasible to reach the Lynch Hill Gravel without encountering significant groundwater inflows. Based on the monitoring to date, it will not be feasible and groundwater will be encountered before the competent soil is reached. However, as only a single borehole has been advanced on the site, it is possible that

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

the Lynch Hill Gravel is present at shallower depths and further investigation should be carried out to confirm this if a spread foundation or traditional underpinning solution is to be pursued. Monitoring of the standpipe should also be continued and trial excavations would be prudent in this respect.

8.3 Basement Raft Foundation

The suitability of a raft foundation will depend on the net pressure applied by the new structure at basement level, which is anticipated to be relatively light, given the proposed three-storey domestic building.

The basement excavation will result in a net unloading of between approximately 55 kN/m^2 and 80 kN/m^2 which will result in heave of the underlying soils, although this will be resisted to some extent by the remaining thickness of gravel and the loads applied by the new buildings. The raft would need to be designed to be rigid to resist the variation in upwards and downwards forces and it is recommended that further analysis of the likely movements is carried out if a raft foundation is considered and once the loads and design have been finalised.

8.4 Piled Foundations

Should piled foundations be considered, for the ground conditions at this site, some form of bored pile is likely to be the most appropriate type, as the noise and vibrations associated with driven piles is likely to render their use unacceptable. A conventional rotary augered pile may be appropriate, with temporary casing installed into the top of the clay in order maintain stability and prevent perched groundwater inflows. Alternatively the use of bored piles installed using continuous flight auger (cfa) techniques could be considered, which would not require the provision of temporary casing. It should also be noted that a deeper groundwater inflow was encountered at a depth of 13.80 m within the London Clay and rose to 6.5 m. The final choice of pile type will be largely governed by the access restrictions and working area, which at this site is very small and it is most likely that the use of mini piling techniques will be required.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, which have been based on the SPT & Cohesion / depth graph in the appendix.

Ultimate Skin Friction		**kN/m^2**
Made Ground	GL to 4.0 m	Ignore (basement)
Lynch Hill Gravel	4.0 m to 5.0 m	25
London Clay ($\alpha = 0.5$)	5.0 m to 15.0 m	Increasing linearly from 40 to 100
Ultimate End Bearing		**kN/m^2**
London Clay	12.0 m to 15.0 m	Increasing linearly from 1400 to 1800

In the absence of pile tests, guidance from the London District Surveyors Association[7] (LDSA) suggests that a factor of safety of 2.6 should be applied to the above coefficients in the computation of safe theoretical working loads. On the basis of the above coefficients and a factor of safety of 2.6, it has been estimated that a 300 mm diameter pile founding at a depth of 15 m below ground level, a toe level of 6.09 m OD, should provide a safe working load of about 280 kN.

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 a suitable piling scheme for this site.

8.5 Basement Floor Slabs

Following the excavation of the basement, it should be possible to adopt a ground bearing slab following a proof rolling exercise and the infilling of any soft spots with suitably compacted granular fill. Consideration may need to be given to suspending the slab over a void in order to accommodate heave movements, unless the slab can be suitably reinforced to withstand these pressures. The requirement for heave protection should be reviewed once the proposed levels and loads are known. Groundwater has been measured close to the base of the basement and therefore there may be a requirement to design the slab to withstand groundwater pressure. BS8102 states that for basements not exceeding 4m deep, a design water level should be ¾ of the depth of the excavation.

8.6 Effect of Sulphates

Moderate 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-2 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 mobile groundwater conditions being assumed for buried concrete an ACEC classification of AC-2 may be adopted.

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

8.7 Site Specific Risk Assessment

The results of chemical testing have indicated an elevated concentration of lead within the single made ground sample tested. Although the exact source is unknown, the made ground was noted as containing abundant amounts of extraneous material, such as coal, charcoal, brick and concrete and it is therefore likely that the contamination is attributable to fragments of such material being present in the sample tested. Lead is a common constituent of made ground that may include products of demolition, as it can originate from paint, roofing materials and pipework, amongst other sources.

Whilst the above contamination can pose a risk to end users, the proposed building will occupy the whole site, thus providing a barrier between any contamination in the made ground and sensitive receptors. In any case, the excavation of the basement is likely to remove the majority of the made ground from site, therefore removing the source of the contamination. On this basis, remediation in order to protect end users, groundwater or adjacent sites is not envisaged.

7 LDSA (2009) *Foundations No 1 – Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA Publication

The contamination does however pose a risk to site workers in the short term.

8.7.1 Site Workers

The chemical analyses have highlighted the presence of lead concentrations within the made ground, which could be potentially toxic and pose an unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust. 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[8] and CIRIA[9] and the requirements of the Local Authority Environmental Health Officer.

A watching brief should also be maintained during the groundwork, and if suspicious soils are encountered then a suitably qualified engineer should inspect the soils and further testing carried out if required.

8.8 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[10], will need to be disposed of to a licensed tip. 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 going to landfill is subject to landfill tax at either the standard rate of £64 per tonne (about £120 per m^3) or at the lower rate of £2.50 per tonne (roughly £5 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 rocks and soils, which are accurately described as such in terms of the 2011 Order[11], would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[12] it is considered likely that the made ground from this site, as represented by the chemical analyses carried out, would be classified as NON-HAZARDOUS waste under the waste code 17 05 04 (soils and stones containing dangerous substances) and would be taxable at the standard rate. It is likely that the natural soils, if separated out, could be classified as an INERT waste also under the waste code 17 05 03. This material would be taxable at the lower rate, if accurately described as naturally occurring clay in terms of the 2011 Order on the waste transfer note. As the site has not had a potentially contaminative history, WAC leaching tests are unlikely to be required for such inert waste going to landfill. This would however need to be confirmed by the receiving landfill site.

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

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

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

10 CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice* Version 2, March 2011

11 *Landfill Tax (Qualifying Material) Order 2011*

12 Environment Agency (2008) *Hazardous Waste: Interpretation of the definition and classification of hazardous waste. Technical Guidance* WM2 Second Edition Version 2.2, May 2008

out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[13] 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" on site by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils and its likely landfill taxable rate 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. If consideration were to be given to the re-use of the soil as a structural fill on this or another site, in accordance with the Code of Practice for the definition of waste, it would be necessary to confirm its suitability for use, its certainty of use and to confirm that only as much material is to be used as is required for the specific purpose for which it was being used. A materials management plan could then be formulated and a tracking system put in place such that once placed the material would no longer be regarded as being a waste and thus waste management licensing and landfill tax would not apply.

9.0 BASEMENT IMPACT ASSESSMENT

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.

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

Screening Flowchart Question	Site Investigation Conclusions
Is the site directly underlain by an aquifer?	The investigation has confirmed that the site is underlain by Lynch Hill Gravel, a Secondary 'A' Aquifer.
Will the proposed basement extend beneath the water table?	On the basis of the findings of the investigation the deeper parts of the proposed basement will extend below the measured groundwater level.
Is the site within 5 m of a highway or pedestrian right of way?	King's Mews runs adjacent to the eastern boundary of the site.
Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Trial pits have indicated the existing foundations to be bearing at a depth in excess of 1.5 m and it is likely that, in order to excavate the basement, the party wall foundations will need to be underpinned or supported by new retaining walls. The extension of the foundations will increase the differential depth of foundations.

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.

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

Site is underlain by an aquifer

The current development proposal includes the excavation of a 3.00 m and 4.50 m deep basement, prior to the construction of a new three-storey terraced house. The formation level of the final basement will be within the made ground, although foundations will need to extend to the Lynch Hill Gravel, which has been identified at a depth of 4.80 m in one location.

Where the construction of a basement intercepts the groundwater table, groundwater will be diverted around the basement structure. The effect that this will have on groundwater flow will be governed by several factors, including the size of the basement, the gradient of the local topography and thus the groundwater level contours, the permeability of the underlying geology and the shape and orientation of the basement structure compared to the local topography and groundwater flow direction. These factors may lead to a rise in the upstream groundwater level and reduction in downstream groundwater level, which has the potential to affect the local hydrogeology and sensitive features, such as springs and wells. The increase in hydraulic gradient as result of these groundwater level fluctuations, may also give rise to higher flow velocities at the sides of the basement structure, which could result in the subsurface erosion or piping of loose sandy material. This could cause a loss of material from around and below foundations of adjacent properties and therefore cause instability. All of these factors should be considered in assessing the likely effect of the proposed basement structure on the hydrogeological setting.

Groundwater has been recorded during monitoring visits at depths of 3.50 m (17.59 m OD) and 3.60 m (17.49 m OD) and therefore the deeper parts of the proposed basement are likely to intercept the groundwater table. In addition, new foundations will need to extend to a depth of at least 4.80 m to found on competent strata. It should however be noted that the groundwater levels measured are not considered to represent equilibrium level and it is therefore recommended that further monitoring is carried out.

Although the proposed basement is likely to encounter the groundwater table, the majority of the surrounding upstream buildings in this area already contain basement structures. In addition, given the size of the site, the basement will not form a substantial barrier to groundwater flow, which, given the hydrogeological and topographical setting of the site, is likely to be very slow and towards the southeast. Furthermore, given the granular, free-draining, nature of the underlying geology, groundwater will be still be able to flow freely around the proposed basement structure. On the basis of all the above, the basement structure will not have an adverse affect on the local hydrogeology, such that it will cause an increase in hydraulic gradient on the upstream side.

As the site is occupied in its entirety by buildings and hardstanding in the existing condition, the current proposals will not increase the proportion of hard surfaced areas on the site and therefore the volume of surface water inflow from surface run-off is unlikely to change due to the proposed development. The desk study research has indicated that the site is not within close proximity of the Hampstead Ponds and nor is it located in close proximity to an existing or historical water course. Therefore the site is not at risk from flooding and in particular the site is not located within an area at risk from surface water flooding. On this basis a flood risk assessment should not be required.

Location of public highway

King's Mews is located adjacent to the eastern boundary of the site. The stability of this road and the other surrounding structures, should be ensured at all times. Given the size of the site, the excavation of the basement is unlikely to compromise the stability of the highway, provided that the basement retaining walls are designed to current best practise, including the use of temporary support systems where necessary, as detailed within this report.

The basement increasing the differential depth of foundations

As the site forms part of a terrace of buildings, existing party wall foundations will need to be underpinned or supported by new retaining walls. Consideration maybe given to the use of traditional concrete underpinning, although due to the thickness of made ground present on site, it is recommended that trial excavations are carried out in order to check the stability of the fill material and the depth to the natural soil. It is possible that this method may result in loss of ground from below existing foundations. This should not be an issue provided that the existing foundations are sufficiently able to bridge across any loose material. Minimising the width of the individual underpins would be beneficial in this respect. In any case, if the depth of the made ground is considered to be as such that traditional underpinning is not economical or viable, then consideration will need to be given to the use of piled underpinning.

As detailed above, provided that the basement structure is designed and constructed using current best practise, there is no reason for the excavation of the basement to cause instability of the surrounding structures. In fact, the trial pitting carried out as part of this investigation, has indicated that the existing foundations are likely to be bearing on made ground and therefore extending the foundations to more a competent strata will improve the stability of the overall structures.

The site is not located on a slope of greater than 7° and nor will the proposed development alter existing or create new slopes of such angles. Therefore the new basement development will not have an effect on slope stability and a slope stability analysis should not be required.

10.0 OUTSTANDING RISKS AND 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.

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 ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

Continued monitoring of the standpipe installed in the borehole should be carried out to allow equilibrium groundwater levels to be established and the magnitude of any seasonal variations in level to be determined. In addition, it has been recommended within this report that trial excavations are carried out, in order to suitably assess the stability of the made ground, the rate of any groundwater inflows and the depth to the natural soil in other areas. It would also be prudent to investigate the ground conditions in the west of the site to determine whether traditional underpinning is feasible.

These areas of doubt should be drawn to the attention of prospective contractors and sufficient contingency should be provided to cover the outstanding risk.

APPENDIX

Borehole Record

SPT Summary Sheet

Trial Pit Records

Geotechnical Test Results

SPT & Cohesion / Depth Graph

Chemical Analyses (Soil)

Generic Risk Based Screening Values

Envirocheck Extracts

Historical Maps

Site Plan

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	**Site** 10 - 11 King's Mews, London, WC1N 2ES	**Borehole Number** **BH1**
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 6.50m	**Ground Level (mOD)** 21.09	**Client** Philip Laniado	**Job Number** J12197
	Location	**Dates** 13/08/2012	**Engineer** Fluid Structures	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water
						(0.30)	Tarmac over concrete with 6 mm reinforcement	
					20.79	0.30	Made ground (brown silty sand with crushed brick and concrete fragments)	
1.20-1.65 1.20	CPT N=1 B1	1.00	DRY	1,0/0,0,1,0				
						(2.70)		
2.00-2.45 2.00	CPT N=3 B2	2.00	DRY	1,0/1,0,1,1				
					18.09	3.00	Made Ground (dark brown silty sandy clay with gravel, brick and coal fragments)	▼1
3.00-3.45 3.00	CPT N=3 B3	3.00	DRY	1,2/1,0,1,1 Seepage(1) at 3.10m, no rise after 20 mins, sealed at 3.50m.				
						(1.80)		
4.00-4.45 4.00	CPT N=6 B4	4.00	DRY	1,1/1,2,1,2				
					16.29	4.80	Medium dense brown slightly clayey sandy fine to coarse subrounded to angular GRAVEL	
5.00-5.45 5.00	CPT N=15 B5	5.00	DRY	1,2/3,3,4,5				
						(1.30)		
6.00	B6			Seepage(2) at 6.00m, no rise after 20 mins, sealed at 6.50m.				▼*
					14.99	6.10 (0.30)	Firm fissured brown silty CLAY with partings of bluish grey silt	
					14.69	6.40	Stiff becoming very stiff fissured high strength to very high strength dark grey silty CLAY with partings of brownish grey silt and traces of selenite	▼3
6.00-6.45	CPT N=8	6.00	DRY	2,1/1,2,2,3				
6.70	D1							
7.50-7.95	U1							
8.00	D2							
9.00-9.45 9.00	SPT N=19 D3	6.50	DRY	3,3/4,4,5,6				

Remarks
Excavating services inspection pit from ground level to 1.2 m for 2 hrs.
Groundwater monitroing standpipe installed in borehole to a depth of 6.20 m.
30 mins spent tidying borehole area.

Scale (approx)	Logged By
1:50	ML

Figure No.
J12197.BH1

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Borehole Number
10 - 11 King's Mews, London, WC1N 2ES	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 6.50m	21.09	Philip Laniado	J12197

Location	Dates	Engineer	Sheet
	13/08/2012	Fluid Structures	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50-10.95	U2									
11.00	D4									
12.00-12.45 12.00	SPT N=26 D5	6.50	DRY	5,5/6,6,7,7						
						(8.60)				
13.50-13.95	U3									
				Slow(3) at 13.80m, rose to 6.50m in 20 mins.					∇3	
14.00	D6									
14.50-14.95 14.50	SPT N=31 D7	6.50	DRY	6,6/7,7,8,9						
					6.09	15.00				
							Complete at 15.00m			

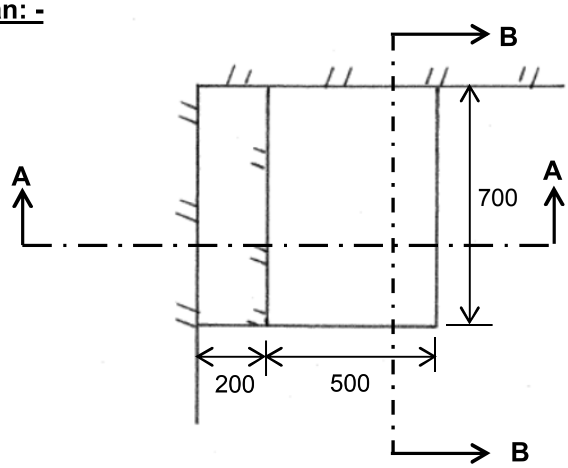
Remarks

Scale (approx)	Logged By
1:50	ML

Figure No. J12197.BH1

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	Site 10 - 11 King's Mews, London WC1N 2ES		Trial Pit Number 1
Excavation Method Manual	**Dimensions** 700 x 700 x 1500	**Ground Level (mOD)** 21.09	**Client** Mr Philip Lanaido	**Job Number** J12197
	Location	**Dates** 28/09/2012	**Engineer** Fluid Structures	**Sheet** 1 / 3

Plan: -



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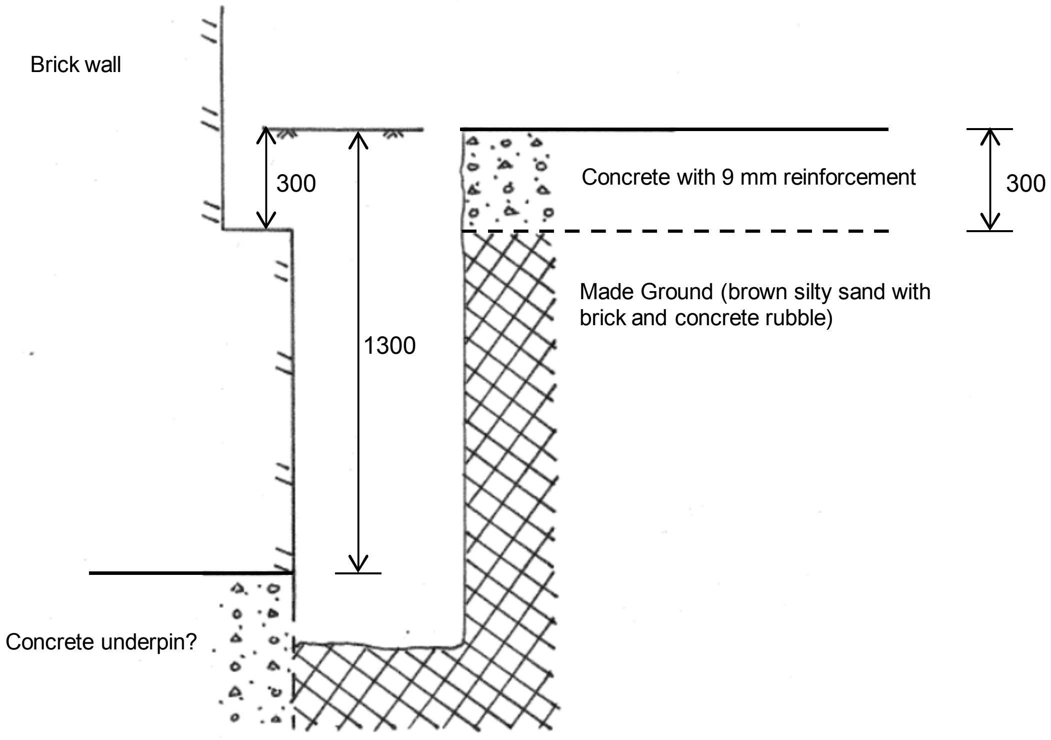
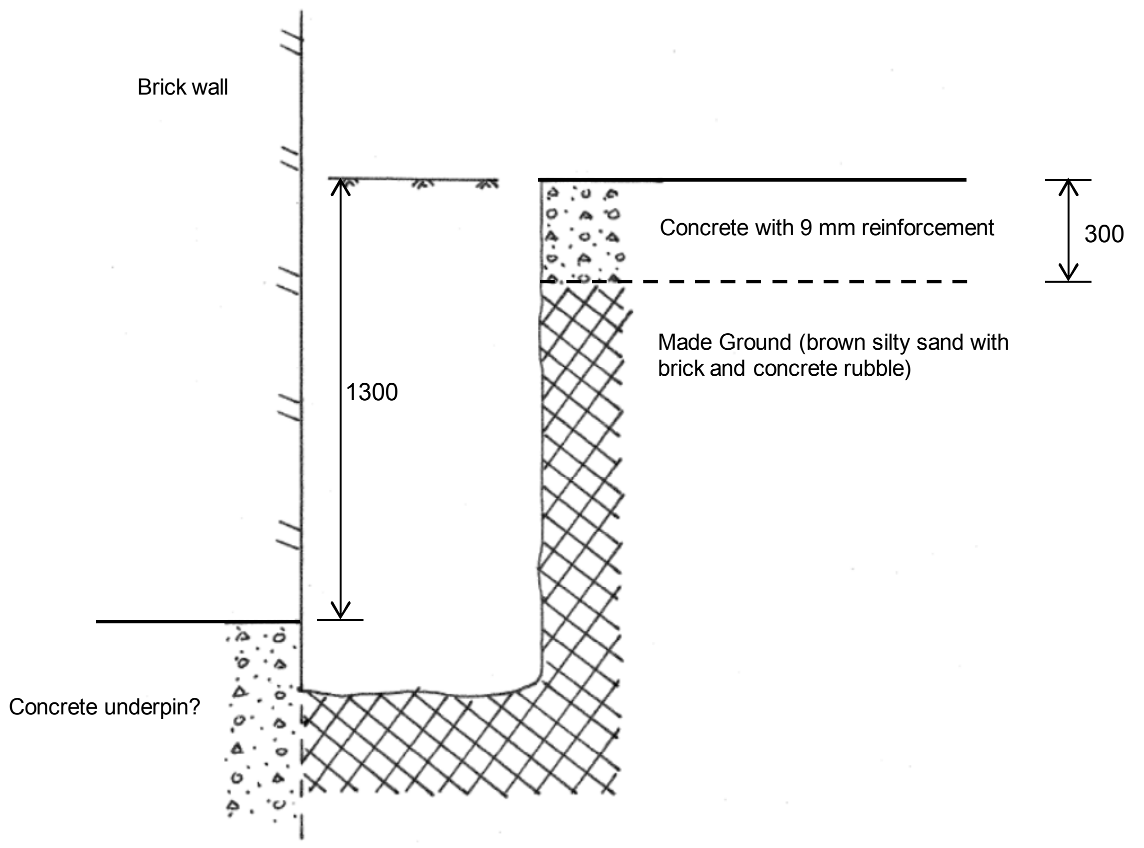


Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** 10 - 11 King's Mews, London WC1N 2ES	**Trial Pit Number** **1**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Manual	700 x 700 x 1500	21.09	Mr Philip Lanaido	J12197
	Location	**Dates**	**Engineer**	**Sheet**
		28/09/2012	Fluid Structures	2 / 3

Section B - B: -



Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

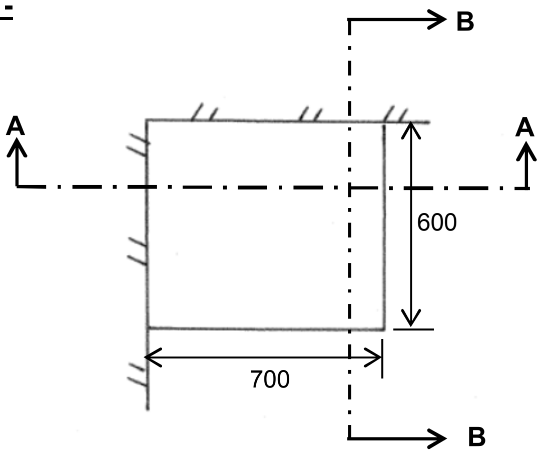
GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** 10 - 11 King's Mews, London WC1N 2ES	**Trial Pit Number** **1**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Manual	550 x 900 x 900		Mr Philip Lanaido	J12197
	Location	**Dates**	**Engineer**	**Sheet**
		28/09/2012	Fluid Structures	3 / 3

Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

GEA Geotechnical & Environmental Associates Tyttenhanger House Coursers Road St Albans Herts AL4 0PG			Site 10 - 11 King's Mews, London WC1N 2ES	Trial Pit Number 2
Excavation Method Manual	Dimensions 700 x 600 x 1500	Ground Level (mOD) 21.09	Client Mr Philip Lanaido	Job Number J12197
	Location	Dates 28/09/2012	Engineer Fluid Structures	Sheet 1 / 3

Plan: -



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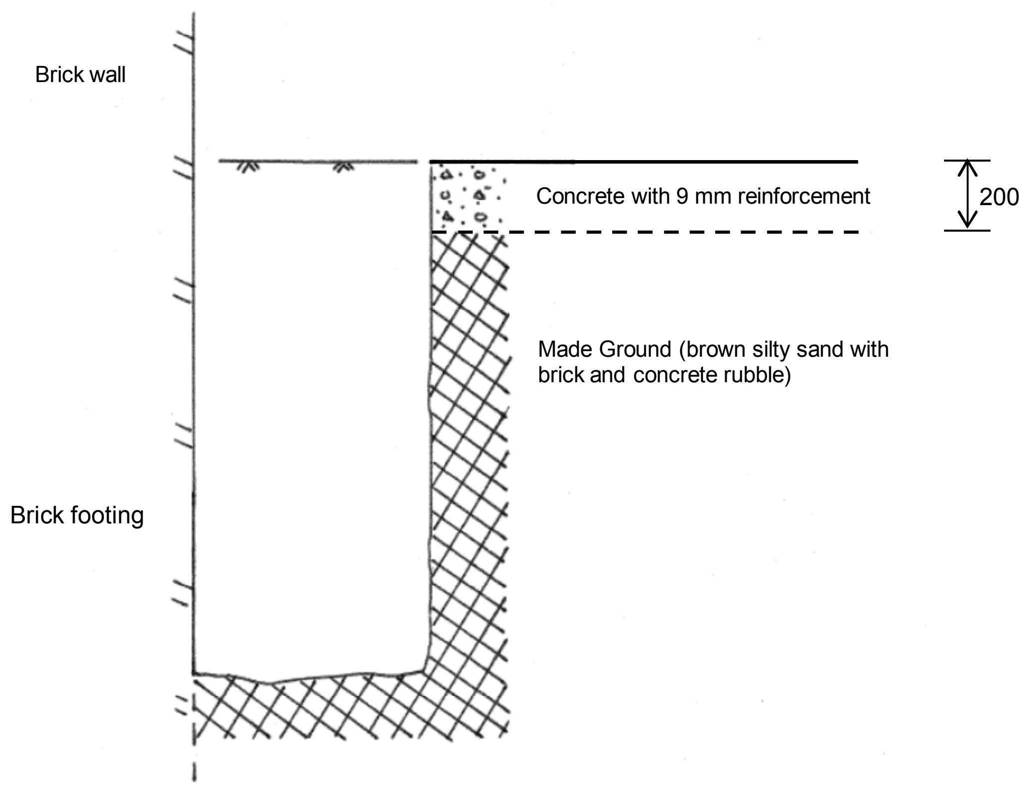
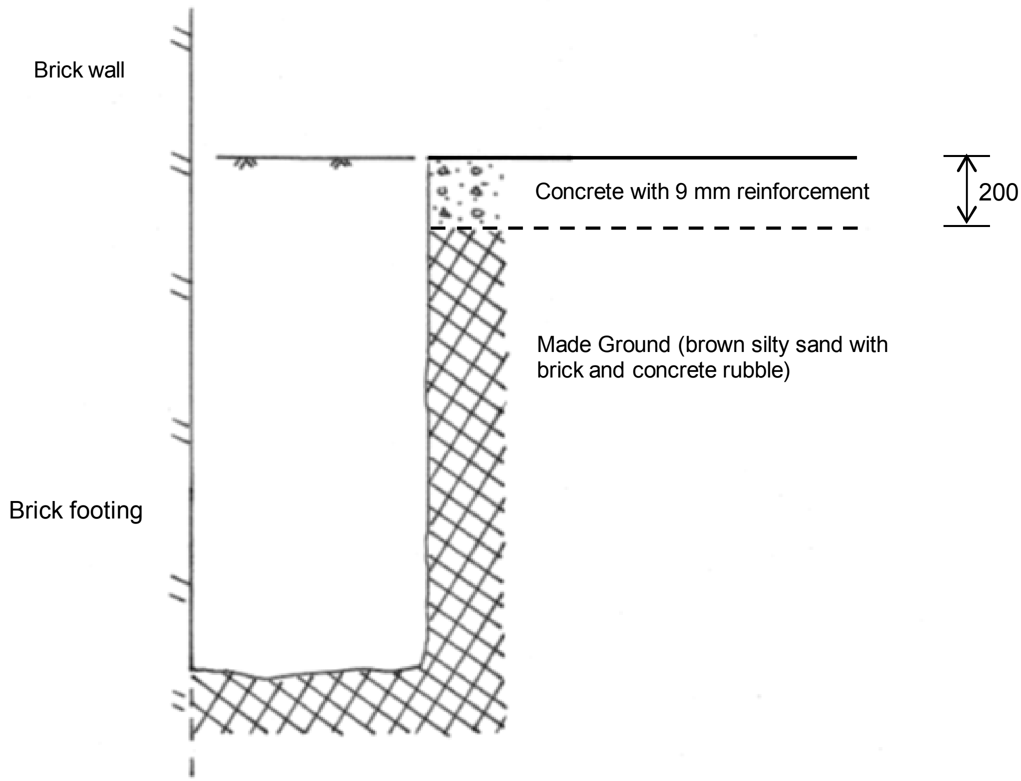


Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** 10 - 11 King's Mews, London WC1N 2ES	**Trial Pit Number** **2**

Excavation Method **Manual**	**Dimensions** 700 x 600 x 1500	**Ground Level (mOD)** 21.09	**Client** Mr Philip Lanaido	**Job Number** J12197
	Location	**Dates** 28/09/2012	**Engineer** Fluid Structures	**Sheet** 2 / 3

Section B - B: -



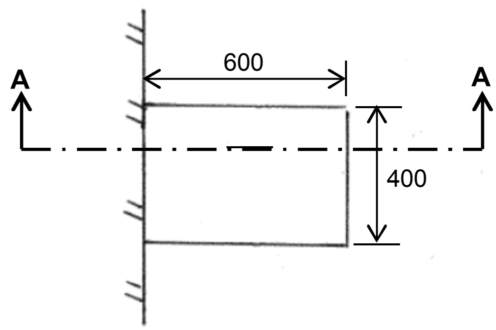
Remarks: All dimensions in millimetres Minor instabilities encountered within the made ground Groundwater: Not Encountered	Base of footing not proved	Scale: 1:20 Logged by: ML

GEA Geotechnical & Environmental Associates Tyttenhanger House Coursers Road St Albans Herts AL4 0PG			**Site** 10 - 11 King's Mews, London WC1N 2ES	**Trial Pit Number** **2**
Excavation Method **Manual**	**Dimensions** 700 x 600 x 1500	**Ground Level (mOD)** 21.09	**Client** Mr Philip Lanaido	**Job Number** J12197
	Location	**Dates** 28/09/2012	**Engineer** Fluid Structures	**Sheet** 3 / 3

Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG		Site 10 - 11 King's Mews, London WC1N 2ES	Trial Pit Number 3
Excavation Method **Manual**	**Dimensions** 600 x 400 x 1500	**Ground Level (mOD)** 21.09	**Client** Mr Philip Lanaido	**Job Number** J12197
	Location	**Dates** 28/09/2012	**Engineer** Fluid Structures	**Sheet** 1 / 2

Plan: -



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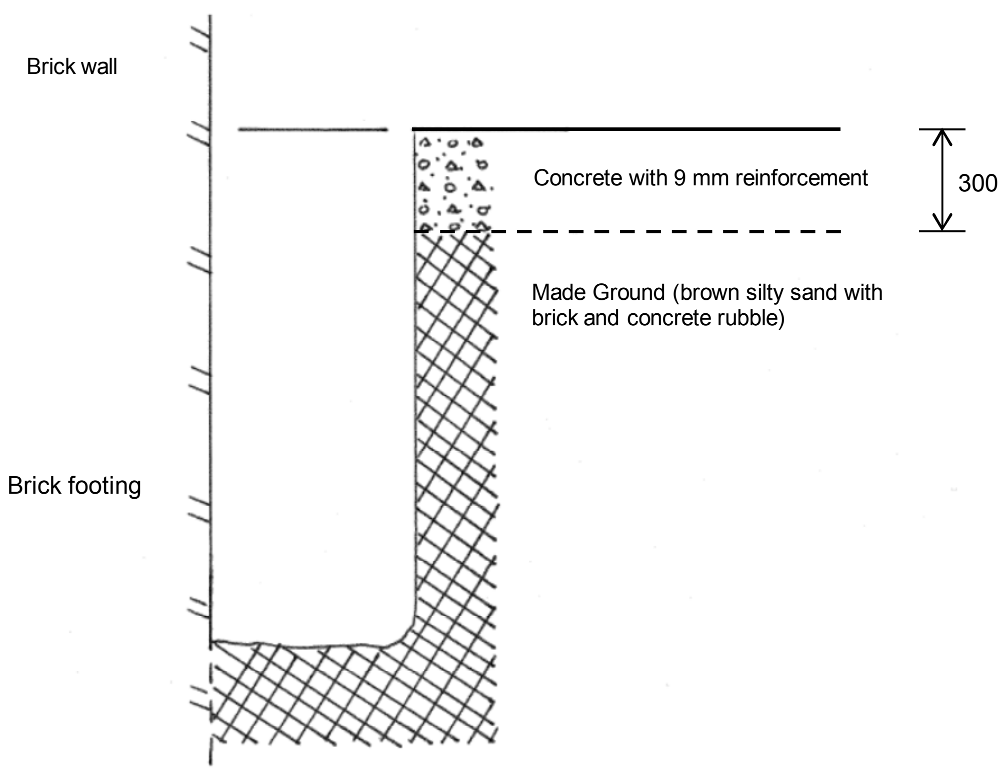


Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	Site 10 - 11 King's Mews, London WC1N 2ES	Trial Pit Number 3

Excavation Method **Manual**	**Dimensions** 600 x 400 x 1500	**Ground Level (mOD)**	**Client** Mr Philip Lanaido	**Job Number** J12197
	Location	**Dates** 28/09/2012	**Engineer** Fluid Structures	**Sheet** 2 / 2

Remarks:		Scale:
All dimensions in millimetres	Base of footing not proved	1:20
Minor instabilities encountered within the made ground		Logged by:
Groundwater: Not Encountered		ML

PROJECT NAME	10 - 11 KING'S MEWS, LONDON, WS1N 2ES Job Number: J12197	Date	03/09/2012
		Approved	Simon Burke
PROJECT NO:	GEO / 18660	Page	1 of 1

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression Tests			Chemical Tests			
Borehole No.	Depth (m)	No.	Type	Description	MC (%)	LL (%)	PL (%)	PI (%)	<425 mic (%)	Bulk (Mg/m³)	Dry (Mg/m³)	Cell Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	pH	2:1 W/S SO4 (g/l)	Ground Water SO4 (g/l)	Other tests and comments
BH1	5.00	B5	B	Brown slightly clayey sandy GRAVEL														Particle Size Distribution
BH1	6.00	B6	B	Brown sandy gravelly silty CLAY														Particle Size Distribution
BH1	6.70	D1	D	Dark greyish brown silty CLAY	31	79	28	51	100									
BH1	7.50	U1	U	Stiff fissured grey CLAY	27					2.02	1.59	150	209	104				
BH1	8.00	D2	D												8.3	1.00		
BH1	10.50	U2	U	Stiff fissured grey CLAY	26					2.03	1.62	210	293	146				
BH1	13.50	U3	U	Very stiff fissured grey CLAY	22					2.09	1.72	270	390	195				
BH1	14.00	D6	D												8.6	1.00		

SUMMARY OF GEOTECHNICAL TESTING

GEOLABS®

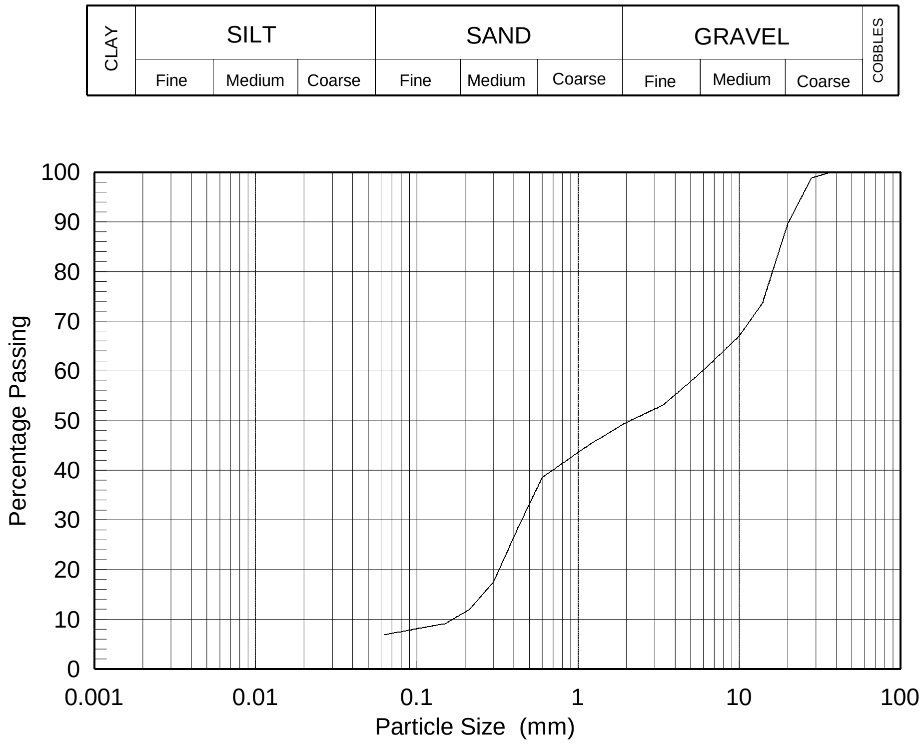
BS1377 : Part 2 : Clause 9 : 1990

Determination of Particle Size Distribution

Borehole Number:	BH1	Description:
Sample Number:	B5	Brown slightly clayey sandy GRAVEL
Depth (m):	5.00	

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	99
20 mm	90
14 mm	74
10 mm	67
6.3 mm	61
5 mm	58
3.35 mm	53
2 mm	50
1.18 mm	45
600 µm	39
425 µm	28
300 µm	18
212 µm	12
150 µm	9
63 µm	7



Particle Proportions		
Cobbles	0.0	%
Gravel	50.4	%
Sand	42.8	%
Silt & Clay	6.9	%

Checked and Approved	Project Number:	
Initials: SB	GEO / 18660	
Date: 03/09/2012	Project Name: 10 - 11 KING'S MEWS, LONDON, WS1N 2ES	
	Job Number: J12197	UKAS TESTING 1982

GEOLABS®

BS1377 : Part 2 : Clause 9 : 1990

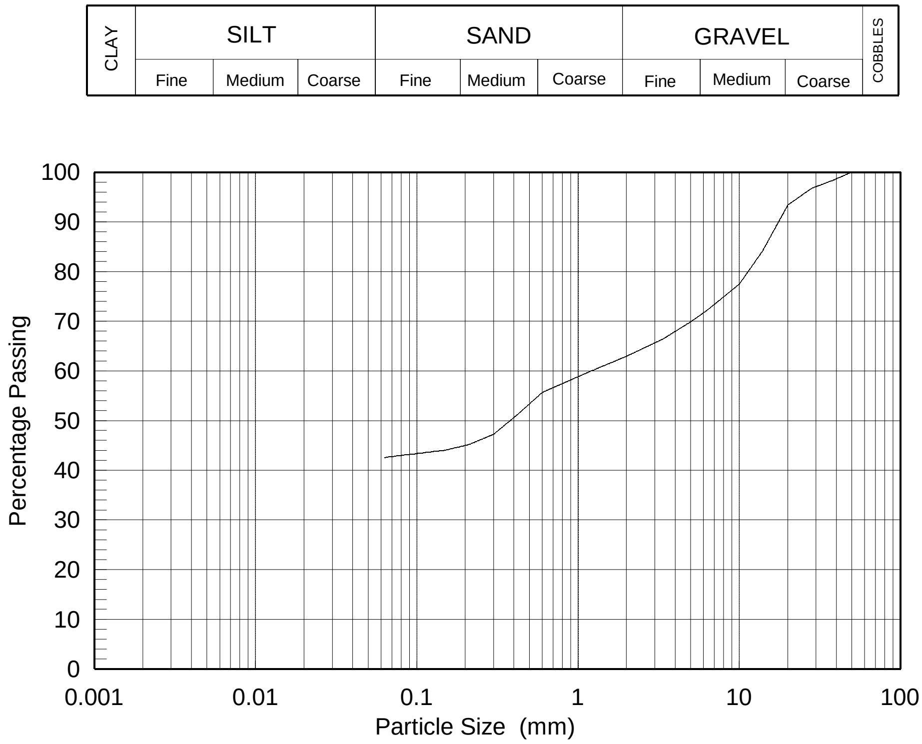
Determination of Particle Size Distribution

Borehole Number: BH1
Sample Number: B6
Depth (m): 6.00

Description:
Brown sandy gravelly silty CLAY

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	98
28 mm	97
20 mm	93
14 mm	84
10 mm	77
6.3 mm	72
5 mm	70
3.35 mm	66
2 mm	63
1.18 mm	60
600 µm	56
425 µm	51
300 µm	47
212 µm	45
150 µm	44
63 µm	43



Particle Proportions		
Cobbles	0.0	%
Gravel	37.0	%
Sand	20.4	%
Silt & Clay	42.5	%

Checked and Approved
Initials: SB
Date: 03/09/2012

Project Number: GEO / 18660

Project Name: 10 - 11 KING'S MEWS, LONDON, WS1N 2ES

Job Number: J12197

UKAS TESTING 1982

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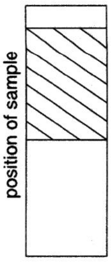
BS1377 : Part 7 : Clause 8 : 1990

Quick Undrained Triaxial Compression Test

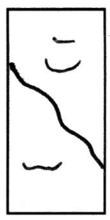
Borehole Number: BH1 Sample Number: U1 Depth (m): 7.50	Description: Stiff fissured grey CLAY

Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	202.0
Diameter (mm):	103.3
Moisture Content (%):	27
Bulk Density (Mg/m^3):	2.02
Dry Density (Mg/m^3):	1.59
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	0.6
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	150
Strain at failure (%):	7.9
Maximum Deviator Stress (kPa):	209
Shear Stress Cu (kPa):	104



Mode of failure:



Checked and Approved Initials: SB Date: 03/09/2012	Project Number: **GEO / 18660** Project Name: **5 JOHN STREET, LONDON, WS1N 2ES** **Job Number: J12197**	UKAS TESTING 1982 / GEOLABS®

BS1377 : Part 7 : Clause 8 : 1990

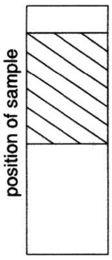
Quick Undrained Triaxial Compression Test

Borehole Number:	BH1	Description:
Sample Number:	U2	Stiff fissured grey CLAY
Depth (m):	10.50	

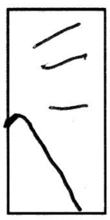
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	202.0
Diameter (mm):	102.7
Moisture Content (%):	26
Bulk Density (Mg/m³):	2.03
Dry Density (Mg/m³):	1.62
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	0.5
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	210
Strain at failure (%):	6.9
Maximum Deviator Stress (kPa):	293
Shear Stress Cu (kPa):	146

Orientation and position of sample



Mode of failure:



Checked and Approved Initials: SB Date: 03/09/2012	Project Number: **GEO / 18660** Project Name: **5 JOHN STREET, LONDON, WS1N 2ES** **Job Number: J12197**	UKAS TESTING 1982 — GEOLABS®

BS1377 : Part 7 : Clause 8 : 1990

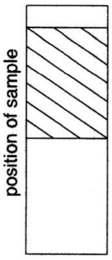
Quick Undrained Triaxial Compression Test

Borehole Number:	BH1	Description: Very stiff fissured grey CLAY
Sample Number:	U3	
Depth (m):	13.50	

Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	203.0
Diameter (mm):	103.1
Moisture Content (%):	22
Bulk Density (Mg/m³):	2.09
Dry Density (Mg/m³):	1.72
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	0.7
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	270
Strain at failure (%):	11.8
Maximum Deviator Stress (kPa):	390
Shear Stress Cu (kPa):	195

Orientation and position of sample



Mode of failure:

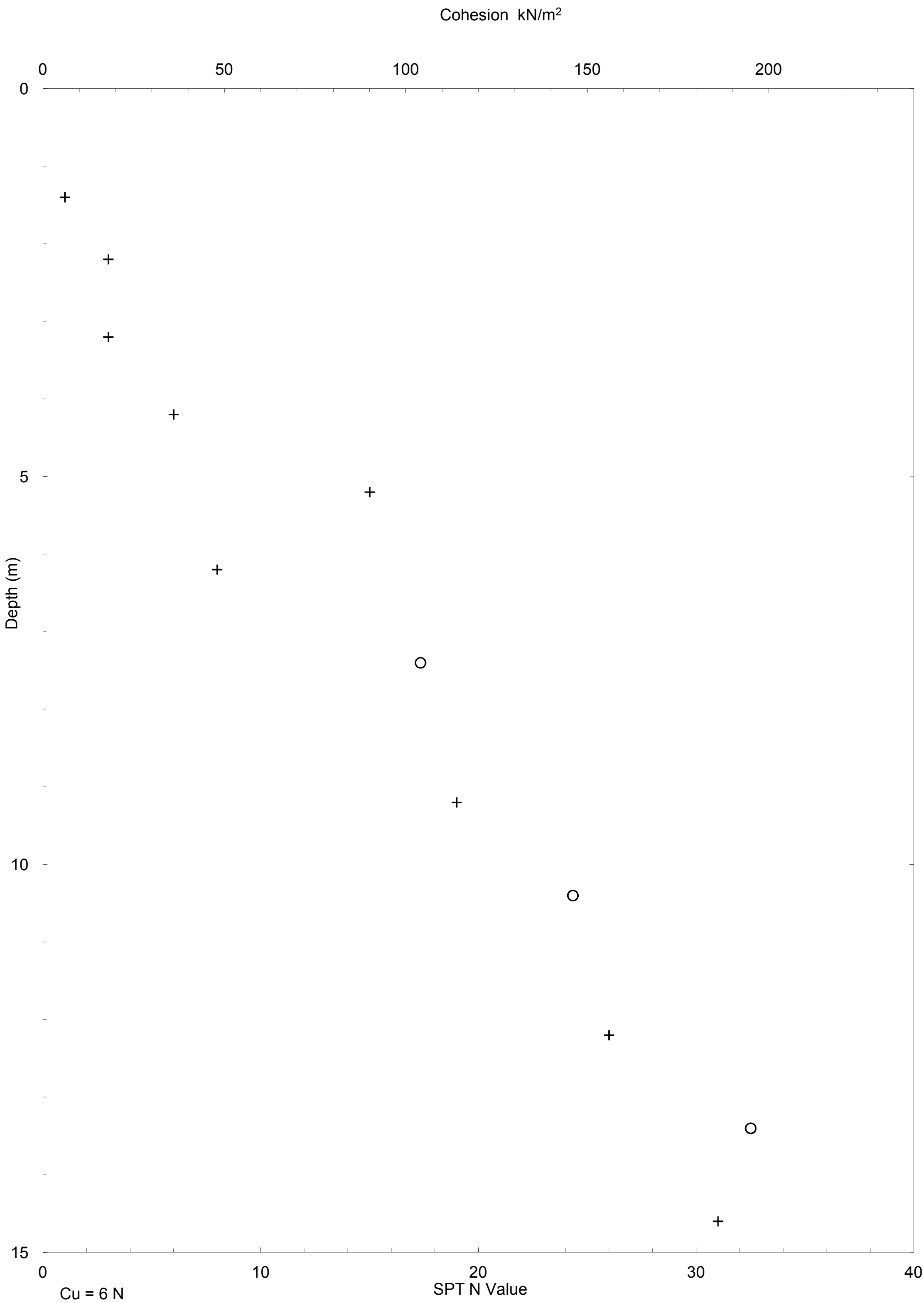
Checked and Approved Initials: SB Date: 03/09/2012	Project Number: **GEO / 18660** Project Name: **5 JOHN STREET, LONDON, WS1N 2ES** **Job Number: J12197**	UKAS TESTING 1982 — GEOLABS®

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

SPT & Cohesion / Depth Graph

Site	10 - 11 Kings' Mews, London WC1N 2ES	**Job Number** J12197
Client	Mr Philip Laniado	**Sheet** 1 / 1
Engineer	Fluid Structures	



Cu = 6 N
o cohesion
+ SPT N Value

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Site Plan

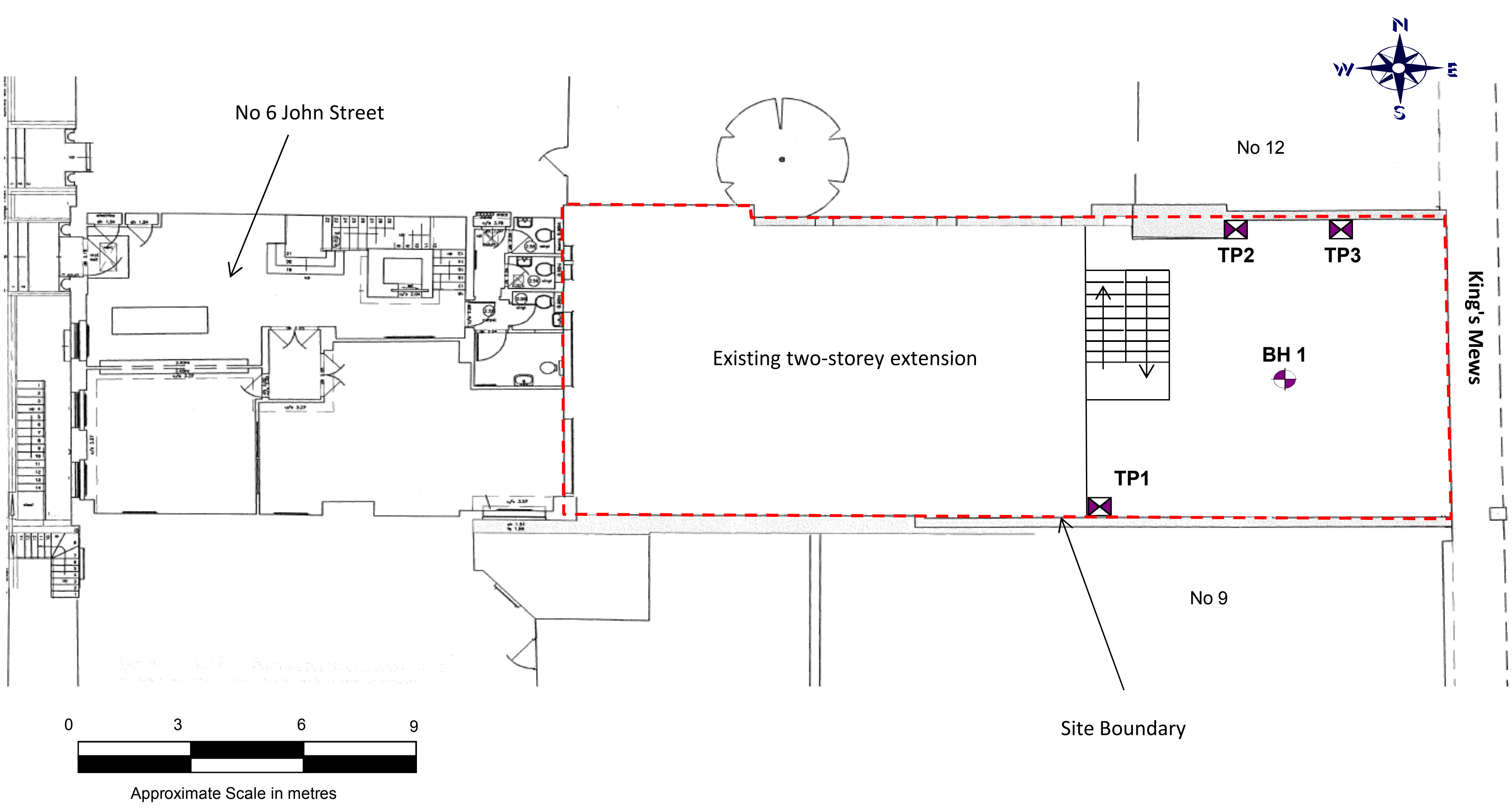
Job Number J12197

Sheet 1 / 1

Site 10 - 11 King's Mews, London WC1N 2ES

Client Philip Lanaido

Engineer Fluid Structures



Geotechnical & Environmental Associates (GEA) is an engineer-led and client-focused independent specialist providing a complete range of geotechnical and contaminated land investigation, analytical and consultancy services to the property and construction industries.

We have offices at

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NG11 0DE
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midlands@gea-ltd.co.uk

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where information can be found
on all of the services that we offer.

GEA Geotechnical & Environmental Associates