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In accordance with RBKC requirements this report has been prepared and checked by chartered structural engineers Edward Bond CEng MInstCE
Barry McCormack CEng MInstCE
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Appendix A - GCG’s Hydrogeological Report
Appendix B - Survey Drawings
Appendix C - Site Investigation
Appendix E - GCG’s Preliminary Ground Movement Assessment Report (Including Building Damage Assessment), January 2016
Executive Summary

This report outlines Robert Bird Group’s proposed construction methodology for the proposed basement alterations and extension at 10 Kensington Palace Gardens.

The development comprises an extension to the existing basement structure and refurbishment and extensions of the existing superstructure.

Proposed works to the superstructure are relatively modest and would not necessitate any specialist construction methods. Therefore this report is limited to the proposed basement construction only.

The proposed basement extension falls into two distinct regions, one under the existing building and one within the garden of the building. Each of these areas requires different construction methods to address the particular constraints and limitations imposed by the site.

A secant piled wall will be installed to the entire perimeter of the basement thus providing support to the face of all excavations and a barrier to restrict ground water ingress into the excavation.

The zone under the existing building will be constructed utilising a restricted access piling rig to install bored piles from within the existing basement. These piles will form both the permanent support for the structure and act as temporary columns during the staged, top down construction sequence.

The zone within the garden area encompasses a large open span area. The long span basement roof at ground level will be formed from a concrete slab supported on large steel trusses spanning between the secant piled walls.

The basements in both zones will adopt a top down construction sequence, whereby the ground level slab is cast and connected to the secant piles and bearing piles prior to excavating below the slab. This process has numerous benefits, primarily:

- The slab will prop the head of the secant wall. Therefore, all of the permanent structure supporting the retained soil would be installed prior to any excavation. Thus, removing the risk of unsupported excavations.
- The slab will form a rigid diaphragm, locked into the secant walls on all sides, thus providing complete lateral restraint to the existing building prior to any excavation.

In conjunction with our geotechnical consultant GCG Ltd we have assessed potential ground movements resulting from the works and determined their possible effects on surrounding structures. This preliminary, conservative assessment shows that the potential for ground movement is negligible.

Providing that the Works are undertaken by a competent contractor, in accordance with our recommendations the building can accommodate the proposed alterations without adversely affecting its stability or the condition or any surrounding structures.

This report is to be read with the 10 Kensington Palace Gardens Stage D Report, reference RBG-R-003. – Refer to Appendix D.

The content of the reports RBG-R-002 and RBG-R-003 address the key Civil, Structural & Geotechnical Engineering aspects of the project in line with Chapters 5, 8 & 9 of the Royal Borough of Kensington & Chelsea document “Basements – Revised Draft Supplementary Planning Document dated November 2015, and is in full compliance with RBKC Policy CL7 (m)

The noise, vibration and dust report to satisfy section 6 of the RBKC SPD is recorded elsewhere.

<table>
<thead>
<tr>
<th>Sequential Process Item</th>
<th>Demonstrate Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appoint an experienced design team including a Chartered Structural or Civil Engineer.</td>
<td>Design team appointed with Robert Bird Group design role as Chartered Structural Engineer</td>
</tr>
<tr>
<td>Retain the services of a Chartered Engineer for the duration of the project.</td>
<td>Robert Bird Group to be retained during the duration of the project</td>
</tr>
<tr>
<td>Engage in consultation with adjoining owners and other who may reasonably be affected by the proposals.</td>
<td>Relevant Party Wall awards will be in place prior to works commencement</td>
</tr>
<tr>
<td>Engage a contractor with relevant experience.</td>
<td>Contractor not on board yet. Design team have the relevant design experience</td>
</tr>
<tr>
<td>Carry out a detailed desk study.</td>
<td>Refer to Chapter 2.0 to 2.2</td>
</tr>
<tr>
<td>Visually appraise the existing and adjoining building for any signs of historical or ongoing movement.</td>
<td>Refer to Chapter 3.1</td>
</tr>
<tr>
<td>Carry out a site investigation to establish ground conditions and any groundwater levels.</td>
<td>Refer to Chapter 2.3 &amp; Appendix C</td>
</tr>
<tr>
<td>Determine nature of existing foundations</td>
<td>Refer to Chapter 3.1 &amp; Appendix C</td>
</tr>
<tr>
<td>Develop details scheme design</td>
<td>Refer to Chapter 5.0 to 5.4 of RBG-R-003 (Appendix D)</td>
</tr>
<tr>
<td>Consider effects on groundwater, drainage, SuDS and flooding.</td>
<td>Refer to Chapter 6.0 to 6.7 of RBG-R-003 (Appendix D)</td>
</tr>
<tr>
<td>Consider effects on trees and, existing structures</td>
<td>Refer to Chapter 6.8 of RBG-R-003 (Appendix D)</td>
</tr>
<tr>
<td>Show how the basement can be constructed safely</td>
<td>Refer to Chapter 5.0 to 5.3</td>
</tr>
<tr>
<td>Assess ground movement and potential damage category</td>
<td>Refer to Chapter 4.5</td>
</tr>
<tr>
<td>Executive Summary.</td>
<td>Refer to page 1</td>
</tr>
<tr>
<td>Results of the desk study.</td>
<td>Refer to Chapter 2.0 to 2.2</td>
</tr>
<tr>
<td>Details of the site investigation including groundwater and monitoring results.</td>
<td>Refer to Chapter 2.3 &amp; Appendix C</td>
</tr>
<tr>
<td>Detail of the structure and foundations of the existing building and relevant adjoining structures.</td>
<td>Refer to Chapter 3.0 to 3.2</td>
</tr>
<tr>
<td>An assessment of the impact of the basement on groundwater including cumulative effects.</td>
<td>Refer to Chapter 4.6 &amp; Appendix A</td>
</tr>
<tr>
<td>Details of surface water and SuDS proposals.</td>
<td>Refer to Chapter 6.4 of RBG-R-003 (Appendix D)</td>
</tr>
<tr>
<td>A flood risk assessment.</td>
<td>Refer to Chapter 6.3 of RBG-R-003 (Appendix D)</td>
</tr>
<tr>
<td>A sequence of construction together with a temporary work scheme design.</td>
<td>Refer to Chapter 5.0 to 5.3</td>
</tr>
<tr>
<td>An assessment of ground movement and the predicted damage category of surrounding buildings.</td>
<td>Refer to Chapter 4.5.4 (Appendix E)</td>
</tr>
<tr>
<td>Extent of root protection areas where relevant.</td>
<td>Refer to Chapter 6.8 of RBG-R-003 (Appendix D)</td>
</tr>
<tr>
<td>Details of any building or site specific issues which may affect by the basement proposal.</td>
<td>Building Grade II listed.</td>
</tr>
</tbody>
</table>

Table 1 – Construction Method Statement compliance check list (fig 4 of RBKC SPD)
1.0 Introduction

1.1 Scope

This report has been prepared by RBG for Mr and Mrs J Hunt. The intention of this document is to outline RBG’s intended construction methodology for the proposed basement alterations and extension at 10 Kensington Palace Gardens, London, W8 4QP.

The primary focus of this document and the extent of RBG’s remit are as follows:

- Determine a practical and safe method of basement construction for the subject building
- Prepare a concept design for the permanent basement works
- Consider support and stability of the existing property and neighbouring buildings during the Works
- Consider any potential impact on surrounding structures

This report has been prepared as an aid to the planning and procurement process and provides an outline of RBG’s proposed construction methodology.

Structural works pertaining to the superstructure of the development are relatively simple and do not necessitate any abnormal construction techniques. Superstructure construction methodology is not addressed in this document.

Contractor’s items such as security fencing, site amenities, scanning for services etc. are considered mandatory requirements and excluded from the scope of this report.

1.2 Definitions and Abbreviations

Hereafter the following definitions and abbreviations shall apply:

Subject building: Existing property at 10 Kensington Palace Gardens, London W8

The Works: The permanent works comprising of alterations and additions to the existing building, as depicted in the Architects proposed drawings.

RBG: Robert Bird Group,

GCG: Geotechnical Consulting Group, 52A Cromwell Road, London

OS: Ordnance Survey

1.3 Background

The proposed development entails additions and alterations to the existing five storey Victorian mansion, the proposed extension to the basement structure (refer to figure 1). RBG have been instructed to prepare a concept structural design for the subterranean works and determine a suitable method of construction.

The building is a domestic residence located approximately 0.5km north-west of Kensington Palace London.

Site Address:

10 Kensington Palace Gardens
LONDON
W8 4QP

OS grid reference:

TQ 2570 8045

Figure 1 - Extract of Architects section illustrating extent of proposed basement works.
1.4 Documents Examined

The following list provides a summary of third party documents and reports that informed the preparation of this report:

- Ground Engineering's Geotechnical Report C10135 dated September 2005
- Ordnance Survey Map – OS Town Plan: LONDON 1:5,280 1850
- Ordnance Survey Map - OS County Series: LONDON 1:2,500 1869-1870
- GCG’s Hydrology report dated November 2015
- IGE’s Arbicultural Impact Assessment dated February 2015
- CIRIA publication C580
2.0 Desktop Study

2.1 Site History

The original building dates from circa 1850. Figure 2 below provides an approximate outline of the site, overlaid on an 1850’s Ordnance Survey map of the area. This map illustrates the pre-development condition of the site. It is understood that prior to development of the area in circa 1845, the site formed part of Kensington Palace’s Kitchen Garden.

No records indicating any signs of industrial activity on the site have been discovered during our investigations. Gravel extraction has reportedly taken place in the region. However, there is no evidence of this on the site either in the historical maps inspected or the site investigation.

Kensington Palace is sited approximately 400m to the south of the site and forms a predominant feature in the local landscape. Building activity on the palace site dates from circa 1605 with the construction of the original Jacobean mansion. Significant alterations and additions were undertaken by Sir Christopher Wren in approximately 1690 following the Crown’s procurement of the site. It has not been possible to attain maps of the area that predate construction of the palace (circa 1605).

Figure 3 below shows the site as depicted on the 1869-1870 Ordnance Survey map “OS County Series”. When compared to the 1850’s map provided in Figure 2, it is evident that the subject building and surrounding dwellings that form a row of houses along Kensington Palace Gardens were constructed at or about the same time.

Figure 2 - Extract of “OS Town Plan” dated 1850

Figure 3 - Extract of 1869-1870 Ordnance Survey map “OS County Series”
Comparison of the 1869-1870 OS map provided in Figure 3 and the current (2014) OS Map provided in Figure 4, indicates that the footprint of the subject building and surrounding structures have remained largely unchanged since their initial construction, circa 1850.

Figure 4 - 2014 Ordnance Survey Map

2.2 Listed Building Details

The subject building was listed by English Heritage on 15th April 1969 and is currently classified as a Grade II Listed Building (English Heritage Building ID: 419865).

The listing details provided by English Heritage discuss alterations to the original building in 1896 and 1903. For further information relating to the historical development of the site refer to WHH Van Sickle Ltd’s report dated February 2003 and Stephen Levrant – Heritage Architecture Ltd’s pre-application statement.

Figure 5 - Typical Ground Profile

2.3 Site Geology

2.3.1 Ground Conditions

The building is founded on dense deposits of natural undisturbed sandy gravel. This stratum extends down from ground level to a depth of approximately 9.5m and overlays firm London Clay. A typical ground profile for the site is shown in Figure 5. Further discussion regarding the geology, together with borehole logs, can be found in Ground Engineering’s Geotechnical Report C10135 dated September 2005.
3.0 Existing Structures

3.1 Existing Building

RBG attended the subject property on Thursday 20\textsuperscript{th} November 2014 to undertake a cursory assessment of the subject building’s structural condition and evaluate site constraints. The following appraisal of existing structural condition is based on a visual assessment only. No destructive testing has been undertaken and only readily accessible areas of the building were examined.

The existing building comprises of loadbearing masonry construction. The upper floors are formed in timber with the ground and basement -01 floor formed from a combination of ground bearing corbels, vaulted brickwork and timber joist.

The loadbearing brickwork forming the structure is generally in good condition. No significant signs of structural movement were observed.

3.2 Surrounding Structures

Neighbouring properties are sighted adjacent to the proposed works to both the northern and southern boundaries of the site.

9 Kensington Palace Gardens, located to the north of the site, is occupied by the Indian High Commission. The building footprint is approximately 19m x 30m and is of a similar style and stature as the subject building (refer to figure 6)

11 Kensington Palace Gardens to the south of the site is the French Ambassador’s Residence. The building footprint is approximately 30m by 70m encompassing a three storey mansion house with a single storey basement located in the western area of the site (refer to figure 6).
4.0 Description of Works and Primary Considerations

4.1 General Description

The proposed basement encompasses recreational living space over three levels.

The basement construction falls into two distinct zones (refer to figure 7);

**Zone 1**
New basement at the rear of the site, encompassing:

- Structure supporting reflecting pool and soft landscaping supported on the -01 slab.
- Basement level -02 - Grade 3 habitable space in accordance with BS 8102: 2009
- Basement level -03 - Grade 3 habitable space in accordance with BS 8102: 2009

The Works in Zone 1 benefit from good access to the site from the rear. The proposed construction techniques (discussed further in section 5) are conventional construction methods that any competent contractor considering undertaking a project of this scale should be conversant with.

The general form of construction proposed for Zone 1 comprises;

- Secant piled retaining walls to the perimeter of the basement
- Steel trusses and concrete slab forming the basement roof and reflecting pool support
- Concrete slab suspended from the trusses above forming the -02 mezzanine level (slab to provide restraint to retaining walls) and/or cantilever floor sections from the basement wall
- Concrete slab supported on an array of piles forming the -03 lower basement level

**Zone 2**
Basement extension under the existing building at the front of the site encompassing:

- Basement level -01. Residential space under the existing front garden
- Basement level -02. New indoor swimming pool and recreational / leisure area under the existing basement

Works in Zone 2 involve excavations under the existing building to add an additional basement level and swimming pool / spa area. Excavating below an existing structure in this manner requires carefully considered construction methodology to ensure the stability of the excavations and existing structures during the Works.

The general form of construction of Zone 2 comprises;

- Secant piled retaining walls to perimeter of the basement
- Installation of a matrix of small diameter piles along perimeter of existing walls from basement -01 level
  - Piles to be cut down to basement -02 level in permanent condition
- Construction of a reinforced concrete flat transfer slab (temporary/permanent) supported on the matrix of piles to underpin the existing structure at basement -01 level
  - in place of the existing timber joists
  - over the existing masonry arches (that could be removed at a later date)
- Internal loadbearing walls constructed from high density concrete blockwork to deepen basement
- Reinforced concrete slab at -02 level, supported on the small diameter piles (piles are cut down from basement -01 in permanent condition) and the secant piled wall

For both Zone 1 and Zone 2 a top down construction sequence is proposed. Whereby basement level -01 slabs are cast and connected to the Secant walls, prior to extending excavations to the lower levels. This process will provide a rigid diaphragm at -01 level prior to excavation below the existing structures, thus ensuring lateral stability. This process will also restrain the top of the Secant retaining walls and hence mitigate ground movements during basement excavations. This procedure is described in detail in Section 5 of this report.
Stability of Existing Structures during the Works
Providing the processes and methods set out in this document are adhered to, the Works in Zone 2 can be undertaken safely and with negligible risk to the existing house or neighbouring buildings. To mitigate the risks associated with excavation under the existing building a combination of secant piling and staged installation of a transfer structure is proposed. Refer to figures 28 to 48 for phased diagrams of our proposed method.

4.2 Soil Heave
As excavations on the site progress, pressure on the underlying soil will reduce due to a reduction in applied load. This reduction in soil pressure will result in uplift or “heave” of the soil across the affected area. A proportion of this movement is due to elastic recovery of the soil and will occur gradually as the overburden is removed (prior to construction of the lower basement slabs). However, the reduction in load will reduce pore water pressure in the underlying clay. The zone of affected clay will therefore absorb water and swell until the differential pore water pressure has equalised. This process will continue over a number of years.

Considering the above it is necessary to design and detail the lower basement slab in a manner that can accommodate swelling of the soil and the associated earth pressures applied to the structure
Void former will be specified to alleviate any heave loads applied to the -03/-02 slabs. The slabs and piles will also be designed to resist any residual heave pressure (possibly resulting from void former collapse loads).

4.3 Hydrostatic Pressure
The proposed basement in Zone 1 extends below the observed ground water level by approximately 2m (refer to figure 5). The resultant water pressure on the underside of the -03 slab will need to be resisted by both the slab itself and the supporting piles. This condition will create tension in the piles that must be considered during the detailed design stage.

Further ground water monitoring, over winter and spring is recommended to accurately determine the maximum ground water level.

Hydrostatic loads resulting from an accidental situation must also be considered for both Zone 1 and Zone 2. Should a buried water main leak or rupture in close proximity to the basement, the ground water pressure could increase locally resulting in additional loads. However, the upper soil profile is predominately free draining sandy gravel (refer to figure 5). It is therefore unlikely that such an event could raise the water level significantly. As such the effects of an event of this nature would be localised.

4.4 Potential Ground Movement Resulting from the Works
The following discussion surrounding potential ground movements resulting from the works has been developed in conjunction with our geotechnical consultant GCG.

The proposed basement construction, which would involve between 4m and 11m deep excavations (as per the approved scheme), has the potential to cause minor ground movements inside and outside the excavated area as a result of changes in vertical load on the ground. We have therefore developed the construction sequence outlined in section 5 of this report to control any potential movement, to within acceptable limits. The following sections 4.5.1, through 4.5.4 discuss the possible extent of minor ground movement resulting from the works and consider our proposed control measures in further detail.

4.4.1 Zone 2 - Vertical Settlement of the Existing Building (10 Kensington Palace Gardens)
The existing building will be supported on piles during construction and in the final condition. Small settlements will occur as the building loads are transferred to the piles. These settlements will not result in any damage to the building.

4.4.2 Lateral Ground Movement around Basement Perimeter
In the area around the basement perimeter minor ground movements may be caused by the installation of the secant retaining pile walls and by the excavation of the basement, as the lateral stresses in the ground along the excavation boundaries change.

The primary factor affecting potential movement of this nature is support of the excavation. We have therefore developed a top down construction process affording full restraint to the excavations prior to excavation, thus controlling any potential movement.

4.4.3 Vertical Settlements around Basement Perimeter
The proposed basement construction will be carried out using a top-down construction technique (i.e. constructing the permanent structure as the excavation progresses). The piles forming the retaining walls are typically 25m long. The vertical settlements due to pile installation are expected to be between 2mm - 5mm at the rear of the walls (refer to figure 8) and returning to zero at distances between 6m - 30m from the walls. Settlements of this order will be indistinguishable from the effects of seasonal ground movement.
4.4.4 Effect of Ground Movement on Surrounding Structures

An initial assessment of the impact of vertical and lateral ground movements (as discussed in sections 4.5.2 and 4.5.3) on the neighbouring houses has been undertaken on the basis of CIRIA publication C580 by looking at the combined effects of the horizontal strains and the deflection ratio. It was assumed that the neighbouring properties, No. 9 Kensington Palace Gardens and No. 11 Kensington Palace Gardens, are similar in age to No. 10 and they are in good condition. Assessment on this basis shows that the potential implications for the adjoining buildings are very slight in reference to ground movements noted above and likely indistinguishable from the effects of seasonal ground movement. The affects can be classified as “negligible” in accordance with CIRIA C580. A more detailed assessment will be undertaken during our detailed design in order to refine these estimates.

![Diagram showing Capping Beam, Retained Soil, Front Face of Wall, Rear Face of Wall, Secant Piles, Slab, and Capping Beam]

Figure 8

4.5 Site Hydrology

The impact of basement construction on subterranean hydrology is an important consideration. Construction of a basement within a groundwater flow path could inhibit the flow of water and adversely affect surrounding ground conditions. Furthermore, basements constructed on multiple sites in close proximity can compound this effect.

GCG were appointed by Robert Bird Group to assess any potential impact on the site’s hydrology resulting from the proposed development. Refer to GCG’s report dated November 2015 included in Appendix A.

In conclusion the effect on subterranean groundwater flows resulting from the proposed works is considered negligible.
5.0 Construction Methodology and Sequencing

5.1 Construction Sequence

The following diagrams (Figures 9 to 22) depict a typical section through the structure and illustrate the intended construction sequence.

Stage 1
- Prepare piling mat for secant piling

Stage 2
- Carefully remove the existing light-well retaining walls and suspended basement floor where applicable
- Install secant pile wall to perimeter of basement
- Where applicable fill voids below old basement to form level surface for piling

Figure 9

Figure 10

Stage 2 – continued

Figure 11
Stage 3
- Install small diameter piles in Zone 2
- Excavate Zone 1 to a maximum depth of 3m below capping beam level

Stage 4
- Construct steel trusses in Zone 1
- Prepare brick walls in Zone 2 for new transfer slab (refer to figures 39 – 48 for details)

Stage 5 & 6
- Fix reinforcement and cast first section of -01 transfer slab in Zone 2
- Backfill (or prop) Zone 1 encapsulating trusses to form level surface on which to cast -01 slab

Stage 5 & 6 continued
- Complete -01 slab in Zone 2 (refer to figures 28 – 48 for details)
- Cast -01 slab in Zone 1
Stage 7
- Excavate to existing foundation level

Figure 16

Stage 7 continued
- Excavate to -02 formation level
- Prepare base of excavation for -02 slab
- Cast -02 slab in Zone 1 and Zone 2

Figure 17

Stage 7 Continued
- Excavate carefully around piles to existing founding level
- Place void former in Zone 2
- Walls supported on beams fixed between piles in temporary case

Figure 18

Stage 8
- Construct permanent walls and columns between -01 and -02 slabs in Zone 2

Figure 19
Stage 9
- Cut out redundant sections of piles within Zone 2
- Excavate to -03 formation level in Zone 1 and install matrix of piles

Stage 10
- Cast -03 slab in Zone 1
- Construct Zone 1 reflecting pool shell

Figure 20
Figure 21
Figure 22
5.2 Proposed Sequence of Works for Zone 1 (rear garden area)

In order to maintain stability of the existing structure and pre-support all of the proposed excavations a top-down construction sequence is proposed, incorporating a perimeter secant piled wall.

The following construction sequence diagrams (figures 23 – 27) illustrate our proposed construction method for Zone 1.

Stage 1 - 3
- Install piling mat in preparation for secant piling works
- Install secant walls and cast capping beam to entire perimeter of the proposed basement
- Excavate basement area to a maximum depth of 3m below capping beam level

Figure 23 - 3D View, Construction Stage 1-3

Stage 4
- Construct steel trusses forming basement roof structure

Figure 24 - 3D View, Construction Stage 4

Stage 5
- Cast -01 slab in Zone 1
  - Note: construction of pool shell will be undertaken in the final stage as pool void will be required for extraction of excavated soil (mole-hole)

Figure 25 - 3D View, Construction Stage 5
Stage 6
- Excavate to basement -02 and cast floor slab to prop secant walls. Install hangers between trusses and floor slab.

Stage 7 - 9
- Following appropriate curing time of -02 slab excavate to basement formation level and form piling platform.
- Install a grid of small diameter piles across extent of basement to support lower basement floor -03
- Cast -03 slab over mat of compressible void former. Slab to be tied into secant walls and piles.

Figure 26 - 3D View, Construction Stage 6

Figure 27 - 3D View, Construction Stage 7 - 9

NOTE:
UPPER BASEMENT STRUCTURE SHOWN IN STAGES 1-5 OMITTED FOR CLARITY

SLAB FORMING DIAPHRAGM TO PROP RETAINING WALLS

INSTALL HANGERS TO SUSPEND MEZZANINE SLAB FROM TRUSSES PRIOR TO EXCAVATION OF LOWER LEVEL BASEMENT

CAST -03 BASEMENT SLAB ON MATRIX OF PILES. PROVIDE COMPRESSIBLE VOID FORMER TO UNDERSIDE OF -03 SLAB.

INSTALL GRID OF SMALL DIAMETER PILES TO SUPPORT -03 SLAB
5.3 Proposed Sequence of Works for Zone 2 (area under existing building)

5.3.1 Steps 1-7 Underpinning sequence for walls in non-arching zones (refer to figures 39 – 48 for retained arch details)

Step 1
- Install small diameter bored piles from existing -01 level (refer to Zone 2 Stage 3 diagram – Figure 12)

Step 2
- Carefully break out 600mm long sections of brickwork at base of wall in a hit and miss sequence
- Install steel stools in to slots to support masonry above
- Provide shims and drypack / grout between stools and brick face
Step 3
Repeat Step 2 to form continuous row of steel stools within existing wall

Figure 30 - Typical steel stool

Figure 31
Step 4
- Fix -01 slab reinforcement around stools
- Fix reinforcement into secant walls and lap with pile reinforcement

**Figure 32**

- Existing basement brickwork to remain
- Slab reinforcement to link with pile reinforcement cage

**Figure 33**

- Fix slab reinforcement around steel stool under existing wall
- Cast -01 slab, encapsulating steel stools.
- Top of slab to be set 20/30mm above base of brickwork to ensure appropriate bearing between brickwork and concrete. Expanding grout to be implemented where bearing needs to be improved.
- Top of slab to be set 20/30mm above base of brickwork to ensure appropriate bearing between brickwork and concrete. Expanding grout to be implemented where bearing needs to be improved.
Step 5
- Excavate soil under -01 slab

Step 6
- Fix reinforcement into piles to form connection with -02 slab
- Rebate face of piles to form shear key at pile/slab interface

Figure 34

Figure 35
Step 7
- Fix -02 slab reinforcement
- Cast 500mm thick flat slab at -02 level

Step 8
- Construct permanent -02 structural walls from high density concrete blockwork

Figure 36
- Existing basement brickwork to remain supported on new -01 flat slab.
- New -01 flat slab supported on piles.
- Piles acting as columns in temporary condition.
- Fix reinforcement and cast piled raft at -02 level.
- Piles forming permanent -02 support structure.

Figure 37
- Existing -01 load bearing brickwork.
- -01 flat slab.
- -02 structural walls formed from high density blockwork – utilise expanding grout where bearing at interface needs to be improved.
- Piles forming permanent structural support.
Step 9
- Construct permanent -02 structural walls from high density concrete blockwork

Figure 38
5.3.2 Steps 1-10 Underpinning sequence for walls in retained arch zones

Step 1
- Break out a series of hit and miss slots in existing brickwork wall as shown

Step 2
- Install small diameter piles

Figure 39

Figure 40
Step 3
- Cast new -01 concrete slab over existing arches, stitching through slots in base of wall

Step 4
- Excavate to near base of existing foundation
Step 5
- Install steel beams “needles” between steelwork grillage and piles to support base of existing wall

Figure 43

Step 6
- Excavate to new -02 formation level and prepare base of excavation

Figure 44
Step 7
• Cast new -02 concrete slab

Step 8
• Construct new -02 load bearing walls

Figure 45

Figure 46
Step 9
- Remove temporary steel beam

Step 10
- Trim piles to -02 level

Figure 47

Figure 48
6.0 Discussion and Recommendations

The structure of the existing building is robust, comprising of solid masonry walls 325mm to 440mm thick. Providing that the works are undertaken by a competent contractor, in accordance with our recommendations, the building can accommodate the proposed alterations without adversely affecting its stability or condition.

The sequence and details outlined in section 5 of this report must only be undertaken by a specialist contractor, with substantial experience in projects of this nature. The construction sequence shown in section 5 demonstrates the construction principles that must be adhered to.

Limbs of mature trees both on the site and overhanging from neighbouring properties may impede tall plant (secant piling rig). The Contractor must consult the Arborists report for details of proposed tree protection and pruning, when preparing their method statement.

Prior to the works a detailed structural condition survey should be undertaken to assess the stability and condition of the existing structure. Any remedial works required to support or strengthen the existing structure should be undertaken prior to the Works detailed in this report.

The primary access during the Works will be from the Bayswater Road via Dial Walk to the rear of the property. The rear access is substantial and well suited to the scale of the proposed works. Refer to A.I.A Consulting Ltd’s Construction Traffic Management Plan for further details of proposed access.

In order to accurately establish the maximum annual ground water level we recommend ground water monitoring is undertaken over the winter/spring period, prior to the Works.

Embedding the secant walls into the underlying London Clay will provide a barrier from groundwater. However, provision should be made for any necessary de-watering during the excavation.

Providing that the Works are undertaken by a competent contractor, in accordance with our recommendations, the construction methods and sequence of works outlined in sections 4 and 5 of this report will ensure the stability of existing buildings, both on and adjacent to the site is maintained during the Works. Furthermore, the proposed construction method will ensure that all excavations remain stable throughout the Works.
Appendix A

- GCG’s Hydrogeological Report
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EXECUTIVE SUMMARY

The proposed construction will involve forming a new basement to the rear of the house and extending the existing basement around and under the house. The excavation for the basement will extend to a depth of 11 m below the existing ground level. Before excavation a secant pile retaining wall will be constructed to both retain the soil and keep out water in the temporary conditions. Site investigations and desk studies have shown that the ground conditions are typical for this area and comprise gravel to around 9 m below ground level over the London Clay. There is a perched water table in the gravel resulting in around 1 m of water above the clay surface. The deep water table (in the soils underlying the clay) has no influence on the development. Observations of water levels in the gravels show little change between 2005 and 2011 and local observations elsewhere show consistency with these levels.

The report reviews all the factors relating to ground water that may be relevant to the proposed scheme. Provided that the basement construction is carried out with good workmanship it is not expected to have detrimental effects on the local hydrogeology during construction or in the long term.
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FIGURES xi
1 Introduction

The proposed redevelopment of the property 10 Kensington Palace Gardens includes the construction of a basement over a proportion of the existing site. GCG have been instructed by Robert Bird Group to undertake a hydrogeological study of the site, to assess any potential impact of the proposed works on the hydrological and hydrogeological environment.

This report sets down an outline of the design requirements for the development such that the property remains well-drained and that there would be no detrimental influence on the local hydrogeology and on the neighbouring properties in respect of ground water. A site-specific ground investigation has been carried out including the sinking of five deep boreholes in the front and rear gardens and a number trial pits underneath the house.
The property and the proposed re-development

The property is set to the northwest of Kensington Palace, on the east side of Kensington Palace Gardens (Fig. 1) a tree-lined avenue that runs alongside Kensington Gardens. It occupies an area of approximately 39 m by 80 m and comprises a detached three-storey house with a lower ground floor and vaults beneath. The house is centrally positioned within the western half of the site. The rear garden extends eastwards for about 40 m. Historical information on the area indicates that the house was built around 1847 in the style of an Italian palazzo, but it has been altered during the years. It is listed as a Grade II house in the Kensington Palace Conservation Area Statement. The rear garden overlooks Kensington Walk and Kensington Garden. Neighbouring properties are of similar age and construction and it is believed that they also have at least a lower ground floor.

It is currently proposed to construct a basement consisting of:

- An 11m deep basement running from the rear of the house to 1.5m in front of the rear boundary with the lateral extents generally set 6m from the boundaries.

- A 7m deep basement under the footprint of the house. The basement will extend to 5m below the existing lower ground floor and it will be deepened by further 2m in the central part to locate a swimming pool.

- An 11m deep basement under the north portion of the house (i.e. 9m below the existing lower ground floor) to house a car lift. This portion would extend outside the footprint of the house to about 1.5m from the boundary with 9 Kensington Palace Gardens.

- A 4m deep basement from the front of the house to 8m from the front boundary with the lateral extents set 6m from the boundary with 9 & 11 Kensington Palace Gardens.

The existing building will be supported on a temporary piled foundation during excavation. A section of the proposed basement is shown in Fig 2. The rear basement will be set, generally 6m from the northern and southern boundaries. The front and rear gardens are to be re-levelled above the new basements. It is understood that the rear
garden area will be re-landscaped in two levels. Make-up soil will be placed over the basement roofs for planting, although both garden areas at the front and at the rear will be partly paved.

It is understood that the basement will be constructed using secant pile walls to retain the ground. These will also provide a cut off to water during construction to allow the excavation to be carried out in the dry. The walls will be propped as excavation progresses.
3 Topography and Geology

The site is located in an area that gently falls eastward to the shallow valley of the Westbourne River and southwards to the Thames at an approximate gradient 1:100. The ground level at the front of the property is approximately +29mOD. A map in the Lost Rivers of London (Barton, 1962) shows that the Westbourne River and the Counters Creek run southwards about 800m to the east and to the west of the property. The Round Pond in Kensington Garden is located about 500m to the southeast of the site. There are no other hydrogeological features in the immediate vicinity of the property (Fig. 3).

Figure 4 shows an extract of the British Geological Survey 1:10560 sheets TQ27NE and TQ28NE with the ground level contours. The map indicates that the site is underlain by Lynch Hill Gravel overlying London Clay. The clay outcrops at about 250 mm to the north and west of the site and at about 500 mm to its east. Southwards the level of the clay reduces with the ground level. The ground level rises to the west towards Holland Park.

A site specific ground investigation has been carried out between July and September 2005 by Ground Engineering. The investigation included five boreholes to 30 m depth sunk in the front and rear gardens and a number of trial pits within the existing house, with the purpose of exposing the existing foundations. Standpipes were installed in three boreholes, one at the front and two at the rear of the house to measure the groundwater level and estimate the groundwater flow. The borehole logs confirm the broad information available from record data. The site is underlain by Lynch Hill Gravel that extend to about 9 m depth and overlay London Clay. This information, together with the geological map, suggests that the gravel underneath the site fills a concavity formed by the surface of the London Clay, which outcrops at high levels to the west and at lower levels to the east and north.

The base of the London Clay was not proven in the boreholes, but geological maps indicate that Lambeth Group underlay the London Clay at about -50mOD. About 10-15 m of Thanet Sand underlay the Lambeth Group and Chalk is present at about -80mOD.
Historical information shows that this area formed part of the kitchen gardens of Kensington Palace. The area was previously known as ‘Kensington Gravel Pits’ but the 18th century maps show that the actual pits were to the west and to the north of this site (Fig 5).

Boreholes have been obtained from adjacent sites, the Site Investigation (report Ref-C10135) and the British Geological Survey (BGS) borehole database in order to get a better understanding of the ground conditions and topography. This information has been used to obtain a more detailed picture of the ground conditions in the area and the levels at which the superficial materials are found. Fig 6 shows the location of the record boreholes and the ground surface levels from all the sites examined comparing these to the contours on the BGS map and where the map shows the London Clay to outcrop. Fig 7 shows the levels of London Clay from the record boreholes. Fig 8 summarises the general condition, based on the information collected in two sections, one taken north to south and the other east to west. It can be seen that, immediately beneath the site the surface of the London Clay is relatively flat. This plateau appears to be at between +21 and +19 mOD. There are three ‘terraces’ of the river terrace gravels, one above +30 mOD, the second (at the site) at around +20 mOD and the third, to the south, below +10 mOD. Detailed investigations to the east of the site (at the Royal Geographical Society and the Royal Albert Hall) of the edge of the middle plateau where conditions are very similar, show that this edge is very variable with local channels within the clay surface filled with silts sands and gravels.

The assumed geological sequence is therefore as follows:

- **Made ground:** +28.5m OD to +26m OD
- **RTD (Gravel/Sand):** +26m OD to +19.5m OD
- **London Clay:** +19.5m OD to -50m OD
- **Lambeth Group** -50m OD to -60m OD
- **Thanet Sand** -60m OD to -80m OD
- **Chalk** -80m OD
4 Hydrogeological conditions and geohazards

The London Clay acts as a barrier to flow between the lower (chalk) aquifer and superficial groundwater. The water head in the chalk was about -70OD in 1965, and has been rising since as the demand for water abstraction began to diminish after 1965; in 2006, the water level in the chalk in the area of the site was approximately -35mOD (see Figs. 9 and 10). The current policy, implemented by the Environment Agency, is to maintain water levels in the chalk at about their present levels. Thus, the property is unlikely to be influenced directly by groundwater levels in the chalk, even in the long-term. There are no known underground structures in the vicinity of the site that might indirectly induce local changes of water pressures in the London Clay, which could affect the development.

Information from the site-specific ground investigation shows that the groundwater level lies in the gravel at about 7.5 to 8.5 m depth, i.e. at around +20 mOD to +21mOD. Information collated from adjacent sites, all of which are to the south of no 10, show very similar levels. These are summarised in Fig 11. The overall picture suggests that the only possible sources of water in the gravels are rainfall and leakage from services. It is unlikely that there will be significant infiltration from the higher areas to the west as this area is densely developed. Any flow of water is likely to be to the east or to the south, where it appears that flow is relatively unimpeded. There is no evidence of significant seasonal fluctuation.

Water infiltrating the London Clay will generally tend to flow vertically downwards at a very slow rate towards the lower aquifer.

The existing basement under the main house is in the superficial gravel, well above the water level. The new basement will extend to the level of the clay and it will require the construction of a cut off wall through the gravels into the clay. Dewatering will be required during construction to carry out the excavation in the dry.

Assuming that the pile installation works are carried out with control and good workmanship, there should be no movements related to water during the basement construction.

The basement ‘box’ would create a local barrier to the groundwater currently flowing across the site. The groundwater flow would be expected to deviate around the new
basement causing only some minor increase of water pressure on the uphill side of the basement (north or north-west sides). This effect is likely to be very small and is expected to have no significant impact on the local hydrogeology and the surrounding structures because the water table is deep below ground, the permeability of the ground is high, the gradient of flow is low.

Calculations have been carried out to assess the potential effect on the water levels in the gravel if flow is interrupted by installing a cut-off box. The analyses were carried out with the Geo-Slope program SEEP-W. It has been assumed that the water is flowing at right angles to the major axis of the basement and that the ‘barrier’ is 70 m wide. For a head difference across the plateau of London Clay in this area of 2 m (which is greater than is likely to ever occur), the calculations suggest a rise in water table at the midpoint of the basement of around 200 mm. The contour plot of flow around the basement is shown in Fig 12.
5 Land drainage requirements

Based on the data available from the Environment Agency, there is no risk at the site of flooding from rivers and seas (Flood Zone 1). The superficial groundwater flow is unlikely to be significantly modified by the construction of the basement.

The garden areas should be adequately landscaped to prevent ponding. Rain water will be free-draining through the superficial deposits provided that adequate thickness and quality of earth infill is placed over the basement roofs.

The soil make-up over basement should include a thickness of topsoil and light loam of at least 0.5m thickness. This should be underlain by a minimum thickness of 200mm of type B drainage material (63mm – 10mm size), separated from the overlying loam by a non-woven geotextile (Terram 500 or similar). Alternatively, a composite material or reservoir board may be used to facilitate lateral drainage to the collector drains.

The use of heavier loams may be appropriate where large trees are to be established and the soil make-up should be revised to accommodate the landscape plan.
6 Conclusions

In summary, we do not expect the new basement to cause significant adverse changes in groundwater conditions. The new basement will act as a cut-off to groundwater running through the site. Its effects would be local and would include a minor increase of groundwater level on the upstream side of the property to the west. The garden areas should be adequately landscaped to avoid ponding and appropriate earth infill should be used over the basement roofs.

Provided that appropriate methods are used for the installation of piles to form the peripheral walls to the basement so that the installation of each pile element does not cause problems and that the combined wall is not defective, there should be no movements related to water during construction. The changes in water level as a result of blocking flow of water in the gravels will be negligible.
References


CIRIA Special Publication 69 (1989). The engineering implications of rising groundwater levels in the deep aquifer beneath London


FIGURES
Proposed redevelopment (top) section north-south and (bottom) section east-west
Figure 3

Lost Rivers of London
Barton, 1992
Figure 4

Geology of the area extract from the British Geological Survey 1:10560 sheets TQ27NE and TQ28NE
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Groundwater levels in the deep aquifer in 2006
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- 21.6-20.4
- 21
- 20.5
- 21.1
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Figure 11
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Figure 12
Appendix B

- Survey Drawings
Appendix C
- Site Investigation
LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

No.10 Kensington Palace Gardens is situated approximately 900m north-north-west of Kensington Palace, London W8. The rectangular shaped site area is located towards the northern end, on the eastern side, of Kensington Palace Gardens and is centred at National Grid Reference TQ 2570 8045.

The site extends east for 72m, from its 36m wide frontage onto Kensington Palace Gardens, between neighbouring similar properties to the north and south. At the time of the investigation, No.10 was a large, detached, three-storey house with a basement. The house was centrally positioned within the western half of the site. The front of the house was accessed from Kensington Palace Gardens via an asphalt-surfaced driveway, which formed a crescent shape, between a vehicular entrance and an exit in the western boundary wall. The rear of the property comprised a large lawn, a large central part of which was terraced below the surrounding ground level by approximately 0.30m.

The site was separated from neighbouring properties to the north and south by 1.0m to 1.5m high brick walls whereas the eastern site boundary comprised 1m high metal railings, separating the site from Hyde Park to the east. The site and neighbouring plots contained mature trees, including Beech, Horse Chestnut and Oak.

The site is at an approximate elevation of 20mOD, on level ground.

The 1935, 1:10560 scale geological map shows the site to be covered by Taplow Terrace Gravel and underlain by London Clay.

The 1994 geological map for the area at 1:50,000 scale sheet number 256 “North London” shows the site to be covered by the renamed Lynch Hill Gravel and underlain by the solid geology of the London Clay Formation.

SITE WORK

Five cable percussive boreholes and six trial pits were undertaken on this site at the positions requested by the Engineer and are detailed on the site plan at the rear of this report.

Boreholes

Five boreholes (BH 1 to BH 5) were undertaken by a standard cable percussive boring rig between the 25th July and 5th August 2005.

Prior to boring at each position a starter pit was dug to 1.00m depth using hand tools, in order to ensure the absence of buried services. The boreholes were then advanced using weighted claycutter tools, working initially within 150mm diameter casing. Boreholes BH 1 to BH 5 were completed at their intended depths of 30.00m below ground level.

Undisturbed samples 100mm diameter were taken in clay at regular intervals. The ends of the samples were waxed to maintain them in as representative condition as possible during transit to the laboratory.

Representative small and bulk disturbed samples of soil were taken from the boring tools at regular intervals throughout the depth of the boreholes.

On completion of BH 2, BH 3 and BH 4, 50mm diameter standpipes were installed to 10.00m below ground level for future gas and groundwater monitoring. For each installation a 1.00m thick bentonite seal was placed below the base of the installation. Each standpipe was slotted to within 1.00m below ground level and surrounded with a pea gravel annulus. Another bentonite seal was placed to 1.00m depth, a gas tap inserted and a protective steel stopcock cover concreted in place at ground level. Excess spoil was placed in a skip and disposed of at a licensed facility.

The borehole and trial pit records give the descriptions and depths of the various strata encountered, details of all samples taken, results of the in-situ tests, installation details and
the groundwater conditions observed during boring, on completion and subsequently within the standpipe installations.

On completion BH 1 and BH 5 were backfilled with arisings and the surface layers reinstated.

**Trial Pits**

Six trial pits (TP 1 to TP 6) were excavated on the 8th August 2005 using hand tools. The trial pit locations were excavated beneath the basement floor and were accessed via an opening, made by others, within part of the suspended wooden basement floor at the south-eastern corner of the house. The wooden basement floor was measured at approximately 2.00m below the surrounding external ground level, whereas the deeper sub-basement floor level was highly variable, consisting of bare earth which was locally mounded. All depth measurements for the six trial pits were therefore related to basement floor level.

The pits were excavated to depths of between 0.70m and 1.10m below sub-basement floor level, or 2.40m to 3.45m below basement floor level, by hand tools. Trial pits TP 2 to TP 4 were located against the supporting walls of the house within the basement and TP 1, TP 5 and TP 6 were located against archways within the sub-basement which supported the basement floor.

The strata exposed were logged and sampled by a Geotechnical Engineer. Small disturbed samples of soil were taken at regular intervals throughout these pits and placed in polycarbonate pots pending contamination testing. Bulk samples were taken within coarse grained soils pending sieve analysis.

The trial pit records give descriptions and depths of the various strata encountered, details of all samples taken, results of the in-situ tests and the groundwater conditions observed during excavation. Sections of the foundations uncovered by TP 1 to TP 6 were sketched and photographs were taken, which are presented on the pages following their respective trial pit record.

Following completion, the trial pits were backfilled in compacted layers with the excavated spoil.

**Monitoring**

Two return visits were made on 8th August, 2nd and 6th September 2005 in order to monitor methane, carbon dioxide and oxygen gas levels in the standpipes. Ambient pressures and flow rates were recorded on these occasions, together with the depth to groundwater. The latter has been added to the borehole records, whilst the gas results are tabulated following the borehole and trial pit records.
LABORATORY TESTING

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the exploratory hole records. The sample descriptions are in accordance with BS5930: 1999. The geotechnical test results are presented following the exploratory hole records, whilst the chemical test results are presented in Appendix I.

The moisture content and index properties of selected soil samples were determined as a guide to soil classification and behaviour. The liquid limit was determined by the cone penetrometer method.

Test specimens were prepared at full diameter from selected undisturbed samples. Immediate undrained triaxial compression tests were made on each sample at full diameter at a cell pressure approximately equivalent to the overburden pressure for that sample's depth. The results have been plotted against depth in Figure 1, which is presented following the laboratory test summary sheets. The moisture content and bulk density of the specimens were also determined.

An indication of the settlement characteristics of selected samples were obtained from the consolidation apparatus or oedometer. The tests were performed on samples approximately 19mm thick, contained in steel rings. Each sample was saturated and the swelling pressure balanced prior to applying a constant load with drainage allowed at both ends. When primary compression was complete, the load was increased and this repeated for three increments of load. The sample was then unloaded in two equal stages. The rate and total amount of consolidation were continually monitored using a computer controlled E.L.E. Datasytem 7 Unit. The results were plotted and analysed by the computer for each increment of load to obtain the coefficients of compressibility ($m_o$), and of consolidation ($c_v$), which govern the amount and rate of settlement respectively.

Selected samples of soil and water were analysed to determine the concentration of soluble sulphates. The pH values were also determined using an electrometric method. In addition, selected samples were also analysed for their total sulphate and total sulphur concentrations (Appendix I).

Six soil samples recovered from the exploratory holes were tested for total concentrations of arsenic, cadmium, chromium, lead, mercury, selenium, nickel and benzo(a)pyrene (the CLEA suite), together with speciated polyaromatic hydrocarbons (PAH), boron, copper and zinc, phenols, total and free cyanide, sulphate, sulphide and pH. The soil samples were also tested for loss on ignition.
GROUND CONDITIONS

The ground conditions encountered were generally as expected from the geological records with a cover of made ground underlain by Lynch Hill Gravel and then the initially reworked solid geology of the London Clay Formation.

Made Ground

Boreholes BH 1 and BH 2 were positioned within the driveway at the front of the property and proved the surface layer of asphalt to be 0.05m thick. Boreholes BH 3, BH 4 and BH 5 were undertaken within the rear garden of the property. BH 3 encountered made ground initially consisting of a dark brown slightly gravelly, sandy silt with occasional fine brick and ash fragments. Below sub-basement floor level in TP 1 and TP 2, 0.40m below ground level in BH 3 and ground level in BH 4 and BH 5, made ground was encountered as a brown or light brown silty or clayey sand and gravel, with occasional cobble size concrete, brick, fine ash, rare oyster shell and ceramic fragments.

The trial pits were undertaken within the sub-basement of the house beneath the basement floor. The basement floor was constructed of wooden floor boards 20mm thick, locally covered by a 30mm thick surface screed layer of concrete (TP 1, TP 5 and TP 6) with the exception of the flooring in the position of TP 3 which comprised a 0.30m thick slab of concrete. A sub-floor gap or void was present beneath the basement floor throughout the house. Made ground was then encountered below depths of 1.30m (TP 3) to 2.50m (TP 1) below basement floor level (basement floor level was approximately 2.00m below surrounding ground level). This comprised a brown, locally light brown, slightly silty or silty, sandy gravel, with occasional to abundant brick, concrete and ceramic fragments. Trial pits TP 1 and TP 4 were completed within this made ground at depths of 3.20m and 2.70m below basement floor level, respectively.

Lynch Hill Gravel

Lynch Hill Gravel was encountered within TP 2, TP 3, TP 5 and TP 6, from 2.10m to 2.80m below basement floor level, and within BH 1 to BH 5 at 1.70m to 3.20m below ground level. Within the trial pits this comprised a medium dense orange brown, locally slightly clayey or silty, sandy gravel. Within the boreholes the Lynch Hill Gravel was encountered as a very dense, locally silty or clayey, orange brown sandy or very sandy gravel, locally becoming dense with depth and light brown in colour. The gravel fraction consisted of flint, quartz and quartzite. Trial pits TP 2, TP 3, TP 5 and TP 6 were completed within the Lynch Hill Gravel at depths of 2.40m to 3.45m below basement floor level (approximately 4.40m to 5.45m below ground level).

The base of the Lynch Hill Gravel was proven within BH 1 to BH 5 at depths of 8.70m to 9.40m below ground level.

London Clay

The London Clay encountered below the Lynch Hill Gravel, within BH 1 to BH 5, at depths of 8.70m to 9.40m below ground level was initially reworked. The reworked horizon comprised a stiff brown and grey motiled, locally slightly gravelly clay with occasional orange brown silt and sand partings. The gravel fraction consisted of fine to medium angular to sub-angular flint. This 0.20m to 0.30m thick layer was penetrated within BH 1 to BH 5 at 8.90m to 9.70m below ground level.

Beneath the reworked London Clay, the boreholes encountered the London Clay as a very stiff, fissured, locally closely fissured to stiff in BH 1, dark grey clay with rare light grey silt partings, black carbonaceous specks, medium gravel size pyrite nodules, fossil shell fragments and rare calcareous mudstone nodules. Below depths of 19.50m to 23.00m the London Clay was generally encountered as a hard, fissured, locally closely fissured to very stiff, dark grey clay with rare grey silt partings, black carbonaceous specks and fossil shell fragments.

All five boreholes were completed within this stratum at 30.00m below ground level.
Groundwater

Possible water seepages were noted within BH 1 and BH 3 at depths of around 8.80m, at the base of the gravel, however, the addition of water to enable the drilling in the coarse grained soils beneath this site may well have masked water ingress at shallower depths. Casing was driven into the London Clay within each borehole to a depth of 9.00m, which sealed out these groundwater seepages. Slight water were recorded within the London Clay within BH 1, BH 3, BH 4 and BH 5 at depths between 14.00m and 25.00m, although all of the boreholes were dry on completion of boring.

Borehole BH 2 and the trial pits were all dry during excavation/boring and on completion.

The return visits to monitor the standpipes within BH 2, BH 3 and BH 4 on 8th August 2005, found the respective groundwater levels at depths of 8.08m, 8.19m and 7.70m; the return visit on 2nd September 2005 found groundwater at 8.10m, 8.13m and 7.77m; and the return visit on 6th September 2005 found groundwater at 7.88m, 8.07m and 7.67m, respectively.

Excavation Stability

The sidewalls of trial pits TP 1 to TP 6 collapsed when excavated within the coarse grained made ground and Lynch Hill Gravel from depths of 1.40m below basement floor level.

Live Roots

Live roots, were observed within all five boreholes to depths of between 0.70m and 1.50m below ground level. Live roots were not encountered within the trial pits.

Evidence of Contamination

Based on inspection the made ground contained occasional ash fragments. Olfactory or visual evidence of hydrocarbon contamination was not detected within the soils beneath this site.

Existing Foundations

The foundations of the external walls of the house were exposed within TP 2, TP 3 and TP 4 and comprised brick corbels, with no concrete base, based within the Lynch Hill Gravel (TP 2 and TP 3) or the made ground (TP 4) at depths of 2.15m to 2.80m below basement floor level (4.15m to 4.80m below ground level) with projections of 0.25m to 0.37m.

The foundations of the supporting columns between sub-basement archways were exposed within TP 1, TP 6 and TP 5 and consisted of brick corbels, with no concrete footing, based within the Lynch Hill Gravel (TP 5 and TP 6) or made ground (TP 1) at depths of 2.15m to 2.80m below basement floor level (4.15m to 4.80m below ground level) with projections of 0.13m to 0.25m. TP 5 also exposed the foundations of a wall that blocked an archway; this wall had foundations consisting of brick corbels based within the Lynch Hill Gravel at 2.30m below basement floor level (4.30m below ground level).
COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION

The investigation found a cover of made ground, encountered to 1.70m to 3.20m below ground level in BH 1 to BH 5 and to 2.10m to 2.80m below basement floor level (basement floor level was approximately 2.00m below surrounding ground level) within TP 2, TP 3, TP 5 and TP 6, underlain by Lynch Hill Gravel and then the expected solid geology of the London Clay. The London Clay was found to be stiff, becoming very stiff and locally hard, and should provide a suitable bearing stratum into which the envisaged piled foundations may be installed.

Piled Foundations

The dense and very dense Lynch Hill Gravel, and stiff, very stiff and locally hard London Clay, should provide suitable strata into which piles can be installed. The advice of a specialist piling contractor should be sought prior to design, with particular regard to piling through possible obstructions within the made ground and access to the site. The use of driven piles should be ruled out on this site on the basis of: the potential for vibrations caused by the piling to be potentially damaging to the neighbouring properties; and noise levels during installation in this residential area.

For the purposes of preliminary pile design, the pile bearing coefficients given over page, which are based on the following assumptions, may be used to assess working loads for a bored pile. The pile bearing coefficients are based on the in-situ SPT ‘N’ and laboratory determined shear strength test results.

1. The ultimate load on a pile would be the sum of the shaft friction/adhesion together with the end bearing load ignoring any contribution from the made ground.

2. The shaft friction/adhesion and the end bearing would be a function of the SPT ‘N’ or lower-bound shear strength values of the material in which the pile is embedded.

3. A factor of safety of at least 2.0 would be used to assess the working load and, if test loading of selected piles were not practical, the factor of safety would be increased to at least 2.5.

<table>
<thead>
<tr>
<th>Item</th>
<th>Ultimate Pile Bearing Value (kN/m²)</th>
</tr>
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<tbody>
<tr>
<td>Shaft adhesion/friction in made ground</td>
<td>nil</td>
</tr>
<tr>
<td>Average shaft friction in Lynch Hill Gravel</td>
<td>30</td>
</tr>
<tr>
<td>Shaft adhesion in London Clay 10m to 30m</td>
<td>80</td>
</tr>
<tr>
<td>End bearing in London Clay</td>
<td>1450</td>
</tr>
</tbody>
</table>

Based on these coefficients, a single 450mm diameter bored pile, installed to 20.00m depth at the location of BH 3, where the deepest made ground was identified, would have an estimated working load in the order of 700kN (F=2.5). However, as the basement will be excavated between the piles, to a depth of 10.00m, thus below the depth of the base of the Lynch Hill Gravel and into the London Clay, shaft adhesion would be restricted to that available within the underlying London Clay. A similar pile installed at the same position and to the same depth, but with any shaft adhesion ignored within 10.00m depth of ground level, would have a working load of 550kN.

Different pile lengths, or diameters, from those detailed above would give different available working loads, which could be tailored to suit the working loads required. A piling specialist should undertake final design of piles.
Basement Floor

The floor of the deepened and new basements could be cast directly on the London Clay at the reduced level following careful inspection and adequate preparation.

The removal of 10.00m of material to create the basements will reduce the overburden pressure at the new basement floor level by an estimated 1800kN/m², assuming the water table is at 8.00m below ground level. Below the existing building, which has had an approximately 4m deep basement for more than a century, the reduction in overburden pressure has been estimated as 100kN/m².

Theoretical base heave at the centre of the basement excavations could occur following excavation and the removal of this overburden pressure and will depend on the size of the structures. The results of the consolidation tests indicate theoretical base heave, where the 20m wide and 40m long, 10.00m deep rear garden basement is excavated, would be in the order of 90mm to 100mm. Base heave of the smaller basement beneath the front garden (say 10m wide and 20m long) could be in the order of 60mm, whilst a similar size basement beneath the existing building where the reduction in overburden pressure would be lower could be approximately 30mm to 40mm.

Such movement would be expected to occur soon after excavation, unless confined by the loading imposed during construction of the basement floor shortly after excavation.

The net reduction in overburden pressure will need to be taken into account in the design of the basement floor slab, which will need to be adequately reinforced to withstand this uplift. The swelling stage of the oedometer test undertaken on the undisturbed sample below the new basement level gave a pressure of 233kPa. Such a swelling pressure was recorded after the sample was fully saturated, which could occur during construction if the basement excavations are inundated. Water should therefore be rigorously excluded from the basement excavations.

The design of piled foundations on this site will also need to take into account potential tensile stresses in the piles during basement construction, resulting from potential heave, where little structural load is to be imposed.

Excavations/Groundwater

The stability of excavations for the basement, pile caps, beams and services within the made ground and Lynch Hill Gravel should not be relied upon in the short or long term. Excavations will therefore require support to remain stable and any excavated surfaces should be protected from deterioration since the soils revealed by the borehole are prone to rapid deterioration in the presence of water. Statutory safety precautions should not be neglected, especially where personnel are to enter excavations, when close side support will be required.

Excavations extending below 7.00m depth are likely to encounter groundwater if conditions remain as found during the investigation and subsequently within the standpipe installations. This should be confirmed closer to the time of construction by further monitoring of the installations in BH 2, BH 3 and BH 4. Dewatering will therefore be necessary to temporarily suppress the water table below basement excavation level. Groundwater will be encountered at the proposed basement level and this should be dealt with by pumping from screened well points or pumping wells.

The use of a contiguous piled wall around the perimeter of the basement should provide support and reduce the scale of any dewatering required within the basement excavation. The advice of specialist contractors in this field should be sought prior to proceeding with design. Contiguous piling to a sufficient depth to mobilise adequate passive pressure below the basement level should be feasible on this site. The excavation of a 10.0m deep basement could then be undertaken between the contiguous piled walls.

The base of the basement excavation should be inspected on completion to ensure that the condition of the soil complies with that assumed in design. Should pockets of inferior material be present, they should be removed and replaced with well graded hardcore or lean mix
concrete. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay.

With the water table level at about 8.00m below ground level, and hence above the floor of the proposed basement, it will be necessary to waterproof the basement in order to prevent the ingress of groundwater into the completed structure.

The contiguous piled walls of the proposed basements will act as retaining walls and will need to be designed accordingly. For a permanent retaining wall analysis effective stress parameters would be appropriate, however, in the absence of effective stress testing on samples from this site, published parameters for the “grey” London Clay and the in-situ test results could be used as a conservative approach. The design of retaining walls around the basement area may be based on the stress parameters below:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Bulk Density (Mg/m³)</th>
<th>Angle of Shearing Resistance (degrees) φ°</th>
<th>Shear Strength (kPa)</th>
<th>Effective Shear Strength (kPa) c'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Made ground</td>
<td>1.80</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lynch Hill Gravel</td>
<td>2.10</td>
<td>38</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>London Clay to 10m</td>
<td>2.00</td>
<td>23</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>London Clay below 10m</td>
<td>2.00</td>
<td>23</td>
<td>160</td>
<td>2</td>
</tr>
</tbody>
</table>

**Sulphate Requirements**

Sulphate analysis of the twenty-six soil and three water samples gave results in Design Sulphate Classes D8-1, D8-2 and in one instance D8-3 of the recently revised BRE Special Digest 1, Table C2 (June 2005), presented in Appendix 2. The elevated results were obtained from the London Clay. The mean of the highest 20% of these results, to the nearest 100mg/l (900mg/l), would be taken as the characteristic value for this dataset, that is a Class D8-2 result. The pH results were mildly alkaline, 7.6 to 8.8.

London Clay is listed in this publication as being a stratum that may contain sulphides, such as pyrite, hence oxidation due to disturbance during the excavation of foundations/basements may increase the total potential sulphate content. Visual evidence of pyrite in the London Clay at depth was recorded within these boreholes.

The total sulphur (TS) and total sulphate (AS) results from the ten samples tested indicate determined oxidisable sulphate (OS) contents of up to 2.35%. As the amount of OS was greater than 0.30% in all ten instances, it can be concluded that pyrite is probably present in significant amounts and so the Design Sulphate Class equivalent to the mean of the highest 20% of the derived total potential sulphate (TPS) values, 1.95%, could be considered appropriate, that is DS-4.

It should be noted that the use of piled foundations would minimise disturbance of the ground and consequently reduce the potential for the oxidation of any pyritic clay, but that the exposure of large surface areas of London Clay during basement excavation and construction could enhance the potential for oxidation of any disturbed pyritic clay.

Using the characteristic Class D8-2, characteristic derived TPS, and pH results an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2 would be considered appropriate for buried concrete on this site, as detailed in the above cited revised BRE document, where the concrete is not exposed to disturbed London Clay. However, where buried concrete is exposed to disturbed London Clay a Class AC-4 classification for buried concrete will need to be adopted.
COMMENTS ON THE CHEMICAL TEST RESULTS

Eighteen samples of made ground from the exploratory holes within the site were chemically analysed for characterisation purposes. The results have been used to assess the likely classification of the tested soils in accordance with CLEA Soil Guideline Values in relation to a standard residential with plant uptake use as the potential ‘worst case’ criteria for the proposed development.

CLEA Series Guideline Values

Toxicological data for arsenic, cadmium, chromium, lead, mercury, selenium, nickel and benzo[a]pyrene have been provided in the CLEA series of contaminated land reports, by the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency (EA) in March 2002. Using the toxicological data, Soil Guideline Values (SGVs) can be derived for various standard land uses as defined in the CLEA Series. The SGVs are not binding standards, but are intended to inform judgements about the need for action to ensure that a new use of land does not pose any unacceptable risks to the health of the intended users. On this site, SGVs for a standard residential with plant uptake end use have been used in the table below.

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Min Value Detected mg/kg</th>
<th>Max Value Detected mg/kg</th>
<th>Soil Guideline Values for Standard Residential with plant uptake end use mg/kg</th>
<th>Fraction of samples Exceeding Soil Guideline Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.01</td>
<td>0.04</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.005</td>
<td>0.1</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Chromium (Total)</td>
<td>0.001</td>
<td>0.01</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Lead</td>
<td>0.01</td>
<td>0.05</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.001</td>
<td>0.01</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.001</td>
<td>0.05</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.001</td>
<td>0.05</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
<tr>
<td>Benzo[a]pyrene</td>
<td>0.001</td>
<td>0.05</td>
<td>2 (pH 7)</td>
<td>0/18</td>
</tr>
</tbody>
</table>

The three SGVs that were exceeded within the samples tested were those for arsenic, lead and benzo[a]pyrene. The elevated results were all obtained from the near surface samples of clay fill tested from the trial pits.

One of the eighteen arsenic results was elevated, the mean value test was passed in respect of arsenic (mean 14mg/kg and US95 of 15mg/kg), whilst the maximum value test indicates that the elevated result is representative of the whole data set.

Eight of the eighteen lead results were elevated. For the data set obtained, the mean value test would not be passed in respect of lead (geometric mean 427mg/kg and US95 of 1396mg/kg), whilst the maximum value test indicates that the elevated results are representative of the whole data set.

One of the eighteen benzo[a]pyrene results was elevated, the mean value test was passed in respect of benzo[a]pyrene (mean 0.56mg/kg and US95 of 0.6mg/kg), whilst the maximum value test indicates that the elevated result is representative of the whole data set.

ICRCL Soil Assessment Criteria

In the absence of CLEA SGVs for certain contaminants, and for comparison purposes, the results have also been collated with data provided in the now-withdrawn Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) Guidance Note 59/83, 2nd Edition, 1987 (Department of the Environment). The ICRCL guidance used a system of Threshold Trigger Values (TTV) below which the levels of the determinand would have previously not been considered significant for the intended end use and Action Trigger Values (ATV) above which some form of remedial action would have been recommended. The stipulated Threshold Trigger Values do not constitute a definitive baseline for remediation. The document allowed for the exercise of an informed judgement where results exceed the Threshold Trigger Value.
Tests were performed to determine the concentrations of ICRCL 59/83 Table 3B determinants, which are phytotoxic but not normally hazardous to health and are compared in the table presented below.

<table>
<thead>
<tr>
<th>ICRCL Determinant (Group B)</th>
<th>Min Value Detected (mg/kg)</th>
<th>Max Value Detected (mg/kg)</th>
<th>ICRCL 'Threshold Trigger Value' Where Plants are to be Grown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>TTV (mg/kg) Exceeding TTV</td>
</tr>
<tr>
<td>Boron (water sol.)</td>
<td>0.5</td>
<td>7.2</td>
<td>3</td>
</tr>
<tr>
<td>Copper</td>
<td>11</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>19</td>
<td>320</td>
<td>300</td>
</tr>
</tbody>
</table>

Two elevated concentrations of boron and a single elevated result for zinc were found to exceed the thresholds for these phytotoxic metals.

In the absence of CLEA guidelines the results of chemical testing the soil for total PAH, phenols, total and free cyanide, total sulphate, sulphide and pH have been compared with ICRCL 59/83 Table 4 'Trigger Concentrations' for end uses including 'Domestic Gardens, Landscaped Areas, Buildings and Hard Cover'.

One of the eighteen PAH results exceeded the threshold trigger value for domestic gardens and play areas, but none approached the action trigger value for any use.

None of the other thresholds detailed in ICRCL Table 4 were surpassed for the envisaged end use.

**Hydrocarbon Fuel Pollution in Soil**

Olfactory or visual evidence of hydrocarbon pollution was not detected within the soils beneath this site.

**Effects on Structures and Services**

Aqueous solutions of sulphate can cause the attack and degradation of concrete and this has been discussed in the previous section of this report. The concentrations of benzo[a]pyrene recorded in the near surface made ground may be considered potentially aggressive to services.

**Conclusions**

On the basis of the work carried out and the proposed end use, laboratory testing indicates that several of the samples of made ground tested contained elevated concentrations of arsenic, lead and benzo[a]pyrene in excess of the applicable CLEA Soil Guideline Values.

These results are considered to indicate that the made ground beneath this site would be considered to present the potential for significant harm to human health in the context of Part IIA of the Environmental Protection Act (1990).

However, there is considered a low risk to future site users from contamination beneath this site where the final development includes a building and hardcover, as there would be no plausible pathway for individuals to come into contact with potential contaminants.

The main targets at risk are construction workers via ingestion and skin contact from soil contaminants. The presence of contamination due to these contaminants does not

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**Footnote:**

* - No ATV for sulphate (total)/hard cover, ATV for sulphate (total)/buildings, 50,000 mg/kg.

Elevated concentrations of total sulphate were recorded in ten of the eighteen samples tested for all uses, with one exceeding the action threshold value (ATV) of 10,000 mg/kg for gardens, allotments and landscaped areas. The 50,000 mg/kg ATV for buildings was not surpassed.
require any special precautions to be taken, providing standard precautions are taken during the
development of the site where skin contact and possible ingestion may occur of the near surface
soils during groundworks.

The following actions are recommended when the site is to be used for a
residential end use:

- Removal of at least 0.30m of the made ground, where present across proposed landscaped or
gressed areas, will remove the source of shallow contamination on this site. The replacement
of any made ground with 300mm of clean inert imported topsoil will be necessary in order to
provide a suitable growing medium. This will also avoid risk of potential soil ingestion via
either plant uptake or children with a 'pica' habit. A greater depth of clean inert imported
topsoil will be necessary if vegetable gardens were proposed on this site.

- The contaminants encountered in the made ground should be considered in relation to
proposed areas of landscaping because the phytotoxic effects of some compounds can affect
the growth of some plants. A provision should therefore be given to adopting a sufficient
cover of clean topsoil to ensure that proposed planting can be sustained.

- During groundworks, the potential for windblown dusts should be minimised as these could
contain soil contaminants. Damping down of soils could reduce this hazard.

- As with any construction work on brown-field or potentially contaminated land it is
recommended that a site-specific health and safety plan is produced and agreed with the
contractor. Workers may require appropriate personal protective equipment during the
construction works. The advice contained within the HSE ‘Blue Book’ HS(G)66 should be
followed. In particular, groundworkers should wear coveralls with sleeves rolled down
together with gloves and adequate wash facilities should be provided.

- The contaminated made ground, could be left in place in areas beneath proposed buildings, if
suitable for engineering purposes.

- Protected plastic mains and plastic service pipes may be required across the site where there
is benzo[a]pyrene contamination of near surface soils. A basic precaution would be to run
services in trenches backfilled with clean granular bedding, so as to prevent taste or odour
impairment of drinking water.

- Excavated material and excess spoil should always be classified prior to removal from site as
required by ‘Duty of Care’ (Environmental Protection Act 1990) legislation. This means that
material has to be given a proper description and waste classification prior to removal. The
site plans, exploratory hole logs and certificates of chemical analysis should be sent to the
Environment Agency or a suitably licensed waste disposal contractor for classification of the
material prior to disposal off-site during any redevelopment works.

The intrusive investigation may not have revealed the full extent of contamination
on this site and appropriate professional advice should be sought if subsequent site works reveal
materials that appear to be contaminated.

GROUND ENGINEERING

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F.G.S.
Geotechnical Engineer

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M.Sc., M.C.S.M.,
C.GeoI., F.G.S.,
Director
**GROUND ENGINEERING**

**Site:** 10 KENSINGTON PALACE GARDENS, LONDON W8

**Hole Size:** 150mm dia to 30.00m

---

**BOREHOLE BH1**

**Geo-Environmental Specialist 01712 949 543**

<table>
<thead>
<tr>
<th>Samples and in-situ Tests</th>
<th>Description of Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth m</td>
<td>Type</td>
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</tr>
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<td>05</td>
</tr>
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<td>19.50</td>
<td>019</td>
</tr>
<tr>
<td>19.95</td>
<td>020</td>
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</tbody>
</table>

---

**REMARKS**

Borehole completed at 30.00m depth.
### GROUND ENGINEERING

**Site:** 10 KENNINGTON PALACE GARDENS, LONDON W8

#### BOREHOLE BH2

**Sampled and In-situ Tests**

<table>
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<tr>
<th>Depth m</th>
<th>Date: 04/08/05</th>
<th>16/08/05</th>
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<table>
<thead>
<tr>
<th>Description of Strata</th>
<th>Legend</th>
<th>Depth m</th>
<th>G.D. Level m</th>
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</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>Casing</th>
<th>Inst.</th>
<th>Description of Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10-0.30 B1</td>
<td></td>
<td></td>
<td>MUD GRIND - CLAY with rare brick, mortar, ceramic and fine ash fragments</td>
</tr>
<tr>
<td>0.30-0.60 B2</td>
<td></td>
<td></td>
<td>MUD GRIND - Brown slightly clayey, sandy gravel with rare brick, mortar, ceramic and fine ash fragments</td>
</tr>
<tr>
<td>1.00-1.50 B3</td>
<td>C</td>
<td>N/16</td>
<td>MUD GRIND - Light brown silty, gravelly sand with abundant fine ash, silt, clay and brick fragments</td>
</tr>
<tr>
<td>1.50-1.65 B4</td>
<td>C</td>
<td>50A</td>
<td>MUD GRIND - Stiff brown slightly sandy, gravelly clay with occasional brick, fine ash and coal fragments</td>
</tr>
<tr>
<td>2.00-2.50 B4</td>
<td>C</td>
<td>50A</td>
<td>Very dense brown very sandy gravel. Gravel consists of flint, quartz and quartzite</td>
</tr>
<tr>
<td>2.15-2.28 B4</td>
<td>C</td>
<td>50A</td>
<td>LYNCH HILL GRAVEL</td>
</tr>
<tr>
<td>3.00-3.50 B5</td>
<td>C</td>
<td>50A</td>
<td>Very dense becoming very dense light brown sandy gravel. Gravel consists of flint, quartz and quartzite</td>
</tr>
<tr>
<td>3.15-3.36 B5</td>
<td>C</td>
<td>50A</td>
<td>LYNCH HILL GRAVEL</td>
</tr>
<tr>
<td>4.00-4.50 B6</td>
<td>C</td>
<td>50A</td>
<td>Dense becoming very dense light brown sandy gravel. Gravel consists of flint, quartz and quartzite</td>
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<tr>
<td>4.15-4.30 B6</td>
<td>C</td>
<td>50A</td>
<td>LYNCH HILL GRAVEL</td>
</tr>
<tr>
<td>5.00-5.50 B7</td>
<td>C</td>
<td>50A</td>
<td>LYNCH HILL GRAVEL</td>
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<td>5.10-5.42 B7</td>
<td>C</td>
<td>50A</td>
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</tr>
<tr>
<td>7.50-8.00 B9</td>
<td>C</td>
<td>50A</td>
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<td>7.65-7.86 B9</td>
<td>C</td>
<td>50A</td>
<td>LYNCH HILL GRAVEL</td>
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<tr>
<td>8.00-8.25 B10</td>
<td></td>
<td>75</td>
<td>Stiff brown and grey mottled slightly gravelly clay with occasional brown grey banded pebbles. Gravel consists of medium angular to sub-angular flint and quartzite (LONDON CLAY)</td>
</tr>
<tr>
<td>8.90-9.25 U1</td>
<td></td>
<td>75</td>
<td>Very stiff, fibrous dark grey clay with rare light grey silt partings, shell fragments and medium gravel size flint and quartzite (LONDON CLAY)</td>
</tr>
<tr>
<td>9.25 B10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Ground Engineering

#### Borehole BH2

- **Site:** 10 Kensington Palace Gardens, London W8
- **Date:** 04/06/05 to 05/06/05
- **Hole Size:** 150mm dia to 30.00m

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Type</th>
<th>Blk</th>
<th>Casing</th>
<th>Description of Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.00</td>
<td>V</td>
<td></td>
<td></td>
<td>Very stiff, fissured, dark grey CLAY with rare light grey silt, black carbonaceous specks, fossil shell fragments and marine gravel size</td>
</tr>
<tr>
<td>21.00-21.40</td>
<td>U9</td>
<td>75</td>
<td></td>
<td>Sand, dark grey with very stiff, dark grey CLAY with rare grey silt, black carbonaceous specks and fossil shell fragments</td>
</tr>
<tr>
<td>21.45</td>
<td>V</td>
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<tr>
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<td>30.00</td>
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**Remarks:**
- Borehole completed at 30.00m depth
- Project No: 10235

#### Borehole BH3

- **Site:** 10 Kensington Palace Gardens, London W8
- **Date:** 29/07/05 to 30/07/05
- **Hole Size:** 150mm dia to 30.00m

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Type</th>
<th>Blk</th>
<th>Casing</th>
<th>Description of Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00-2.50</td>
<td>B4</td>
<td></td>
<td></td>
<td>MADE GROUND - Sand brown, slightly gravelly, sandy silt with occasional fine brick and ash fragments</td>
</tr>
<tr>
<td>2.50-2.90</td>
<td>C</td>
<td></td>
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<tr>
<td>3.00-3.50</td>
<td>B5</td>
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<tr>
<td>3.50-3.95</td>
<td>C</td>
<td>N20</td>
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<td>4.00-4.50</td>
<td>B6</td>
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<td>4.50-4.75</td>
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<td>N25</td>
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<td>5.00-5.50</td>
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<td>5.50-5.90</td>
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<td>6.00-6.50</td>
<td>B8</td>
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<td>6.50-6.90</td>
<td>C</td>
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<td>7.00-7.50</td>
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<td>7.50-7.95</td>
<td>C</td>
<td>N20</td>
<td>0.00</td>
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</tbody>
</table>

**Remarks:**
- Excavating a pit from 0.00m to 4.25m for 1 hour
- Borehole at a pit, excavated to 9.25m depth
- Borehole capped at 9.50m depth
- Borehole installed at 10.00m depth
- Live roots observed at 15.00m depth
- Project No: 10239

### Groundwater

#### Groundwater Strikes

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Notes</th>
<th>Data</th>
<th>Hole</th>
<th>Casing</th>
<th>Water</th>
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#### Groundwater Observations

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<th>Depth m</th>
<th>Notes</th>
<th>Data</th>
<th>Hole</th>
<th>Casing</th>
<th>Water</th>
</tr>
</thead>
</table>

### Key
- D = Drilled Sample
- B = Bulk Sample
- U = Undrilled Sample
- W = Water Sample
- S/C = SPI Spool Core
- Y = Water Level
- X = Water Rise
- N = SPI Blows for 0.3m
- T = Blows for quoted penetration
- V = Vane Shear Test
- C = Cohesion (kPa)
- T/C = Tidal Compaction
- E = Level on compaction
- L = Level compaction withdrawn
- S = Standpipe Level
- M = Standpipe Level
### GROUND ENGINEERING

**Site:** 10 KENSINGTON PALACE GARDENS, LONDON W8

**BOREHOLE**

**BH3**

**Date:** 29/07/05

#### Samples and Tests

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Type</th>
<th>Blade</th>
<th>Casing</th>
<th>Incl.</th>
<th>Description of Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.10</td>
<td>02</td>
<td></td>
<td></td>
<td></td>
<td>Very stiff, flinty, locally fissured to stony, dark grey clay with rare light grey silt particles, black carbonaceous spots, fossil shell fragments, medium gravel size pebbles and a nodule of calcareous quartzite at 13.98m to 14.00m depth.</td>
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<tr>
<td>10.10</td>
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<td>11.30-11.75</td>
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<td>16.50-16.45</td>
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<td>16.45</td>
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<td>17.00</td>
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**REMARKS**

Project No: 10135

Scale: 1:50 Page: 2/5

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#### Groundwater Observations

<table>
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<th>Groundwater Strikes</th>
<th>Depth (m)</th>
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<th>Depth (m)</th>
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**Key**

- N: SPT Blow for 0.3m
- B: Blow Sample
- U: Undisturbed Sample
- V: Vacuum Chamber
- SIC: SPT Spoon Cone
- W: Water Sample
- W: Water Rise
- Level on completion
- Level casing withdrawn
- Water Level

---

### GROUND ENGINEERING

**Site:** 10 KENSINGTON PALACE GARDENS, LONDON W8

**BOREHOLE**

**BH3**

**Date:** 29/07/05

#### Samples and Tests

<table>
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<tr>
<th>Depth (m)</th>
<th>Type</th>
<th>Blade</th>
<th>Casing</th>
<th>Incl.</th>
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**REMARKS**

Borehole completed at 30.00m depth

Project No: 10135

Scale: 1:50 Page: 3/5

---

#### Groundwater Observations

<table>
<thead>
<tr>
<th>Groundwater Strikes</th>
<th>Depth (m)</th>
<th>Groundwater Observations</th>
<th>Depth (m)</th>
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</thead>
<tbody>
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<td></td>
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</table>

**Key**

- N: SPT Blow for 0.3m
- B: Blow Sample
- U: Undisturbed Sample
- V: Vacuum Chamber
- SIC: SPT Spoon Cone
- W: Water Sample
- W: Water Rise
- Level on completion
- Level casing withdrawn
- Water Level

---
**Groundwater Observations**

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Groundwater Strikes</th>
<th>Groundwater Observations</th>
</tr>
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<td>0.00</td>
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<td>1.00</td>
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<td>2.00</td>
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<td>2.50</td>
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<td>3.00</td>
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<td>8.00</td>
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<tr>
<td>9.50</td>
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</tr>
<tr>
<td>10.00</td>
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</tbody>
</table>

**Remarks**

1. Exclusively a gill from 0.00m to 1.00m for 1 hour
2. Farouqui aged to 0.00m for 1 hour
3. Sandstone aged to 1.00m
4. Drilling from 1.00m to 1.20m for 0.70 hours
5. Live roots observed to 1.00m depth
### BOREHOLE BH4

**Ground Engineering**  
Geo-Environmental Specialties  
[Contact Information]

**Samples and In-situ Tests**

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Type</th>
<th>Black</th>
<th>Description of Strata</th>
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</thead>
<tbody>
<tr>
<td>20.00</td>
<td>UB</td>
<td>71</td>
<td>Very stiff, locally hard, frescoed dark grey CLAY with rare light grey silt partings, black carbonaceous spots, fossil shell fragments</td>
</tr>
<tr>
<td>23.00</td>
<td>U8</td>
<td>90</td>
<td>Dark, friable, locally fissured to very stiff dark grey CLAY with rare grey silt partings, black carbonaceous spots and fossil shell fragments</td>
</tr>
<tr>
<td>30.00</td>
<td>U8</td>
<td>90</td>
<td>(LONDON CLAY)</td>
</tr>
</tbody>
</table>

**Legend**

- 85 - MUD BOUND - Medium dense brown slightly sandy, clayey gravel with occasional silt particles, rare coal, salt and oyster shell fragments
- 84 - MUD BOUND - Brown, clayey gravel with occasional coal size concrete, brick, rare fine sand, ceramic and glass fragments
- 69 - Very dense greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite
- 68 - Very dense, greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite
- 65 - LYNCH HILL GRANULE

**Remarks**

Borehole completed at 30.00m depth

### BOREHOLE BH5

**Ground Engineering**  
Geo-Environmental Specialties  
[Contact Information]

**Samples and In-situ Tests**

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<tbody>
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<td>0.20-0.70</td>
<td>B1</td>
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<td>MUD BOUND - Brown, clayey gravel with occasional coal size concrete, brick, rare fine sand, ceramic and glass fragments</td>
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<td>1.25-1.65</td>
<td>C</td>
<td>k29</td>
<td>MUD BOUND - Grey, clayey gravel with occasional silt particles, rare coal, salt and oyster shell fragments</td>
</tr>
<tr>
<td>2.00-2.50</td>
<td>B3</td>
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<td>MUD BOUND - Very dense greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<tr>
<td>2.15-2.45</td>
<td>C</td>
<td>k29</td>
<td>MUD BOUND - Very dense greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<tr>
<td>3.00-5.30</td>
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<td>MUD BOUND - Very dense greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<tr>
<td>3.15-3.38</td>
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<td>55*</td>
<td>MUD BOUND - Very dense greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<td>3.50-4.00</td>
<td>B5</td>
<td></td>
<td>MUD BOUND - Very dense greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<tr>
<td>4.00-4.50</td>
<td>B6</td>
<td></td>
<td>MUD BOUND - Very dense, greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<tr>
<td>4.15-4.50</td>
<td>C</td>
<td>52*</td>
<td>MUD BOUND - Very dense, greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<td>5.00-5.50</td>
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<td>MUD BOUND - Very dense, greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<td>6.00-6.50</td>
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<td>MUD BOUND - Very dense, greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
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<td>6.15-6.35</td>
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<td>50*</td>
<td>MUD BOUND - Very dense, greyish brown silty clayey and GRANULE. Gravel consists of flint, quartz and quartzite</td>
</tr>
</tbody>
</table>

**Remarks**

1. Boreholes were cored to 10.00m depth
2. Drilling was stopped at 10.00m depth
3. Water levels obtained at 0.70m depth

### Additional Notes

**Key**

- N: SPB Bore for 0.3m
- C: Water Sample
- T: Water Strike
- S: Water Silt
- G: Water Gas
- W: Water Level
- U: Undisturbed Sample
- B: Bulk Sample
- V: Vane Shear Test
- C: Chemical Analysis
- D: Disturbed Sample

**Groundwater Strikes**

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Hole</th>
<th>Black</th>
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<th>Sample Size</th>
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**Groundwater Observations**

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<th>Depth m</th>
<th>Hole</th>
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<th>Casing</th>
<th>Sample Size</th>
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**Scale**

- 1:50

**Project No.**

10135
### Borehole BH5

**Date:** 29/07/05  
**Geo-Environmental Specialties:** 01713 068880

#### Groundwater Observations

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<th>Depth m</th>
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<td>Cold</td>
<td></td>
<td>Very stiff, fissured, dark grey clay with rare light grey silt partings, black carbonate specks, pyrite nodules, fossil shell fragments and a module of calceous mudstone at 16.50m to 16.70m depth</td>
</tr>
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<td>20.00</td>
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<tr>
<td>22.00-22.35</td>
<td>U9</td>
<td>90</td>
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<td>Hard, fissured, locally fissured to very stiff, dark grey clay with rare grey silt partings, black carbonate specks and fossil shell fragments</td>
</tr>
<tr>
<td>22.35</td>
<td>018</td>
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**Remarks:** Borehole completed at 30.00m depth

---

### Groundwater Stakes

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<th>Depth m</th>
<th>N</th>
<th>Type</th>
<th>Casing</th>
<th>Water Pipe</th>
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<td>11.50-11.90</td>
<td>05</td>
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<tr>
<td>12.50</td>
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<td>13.00-13.40</td>
<td>05</td>
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<td>14.50-14.90</td>
<td>08</td>
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**Scale:** 1:50

**Page:** 2/3

---

**Notes:**
- **N:** N-value (Blows for 0.3m)
- **D:** Drilled Sample
- **B:** Bulk Sample
- **U:** Undrilled Sample
- **W:** Water Sample
- **S:** SPT Sample
- **V:** Visually described
- **T:** Tapped
- **C:** Core Recovered
- **X:** Water Pipe
- **St. Level:** Standard Level
- **SH:** Subsurface Horizon
- **Cass:** Casing
- **Date:** Date of sampling

---

**Groundwater Stakes**

<table>
<thead>
<tr>
<th>Depth m</th>
<th>N</th>
<th>Type</th>
<th>Casing</th>
<th>Water Pipe</th>
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**Scale:** 1:50

**Page:** 1/3

**Groundwater Stakes**

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<th>N</th>
<th>Type</th>
<th>Casing</th>
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<td>55</td>
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<td>13.00-13.40</td>
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<td>14.50-14.90</td>
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<td>U7</td>
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<td>015</td>
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</table>
**Ground Engineering**

**Site:** 10 Kensington Palace Gardens, London W8

**Date:** 09/08/05

**Pit Size:** 0.60m L x 0.50m W x 3.20m D.

**Ground Level:**

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Type</th>
<th>Legend</th>
<th>Description of Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.60</td>
<td>01</td>
<td>0.05</td>
<td>MARL GROUND - compacted on wooden floor boards</td>
</tr>
<tr>
<td>3.00</td>
<td>02</td>
<td>0.40</td>
<td>MARL GROUND - Flitchwork archway</td>
</tr>
</tbody>
</table>

**Remarks:**
1. Pit sidewall collapse at 2.80m to 3.20m depth
2. Pit dry
3. No live roots observed
4. All measurements are related to basement floor level, which is approximately 2.00m below ground level.

**Project:** No.10 Kensington Palace Gardens, London W8

**Client:** Graham Sutherland

**Not to Scale**

**Scale:** 1:25

**Page:** 1/1
**GROUND ENGINEERING**

**Site:** 10 KENSINGTON PALACE GARDENS, LONDON W8

**Trial Pit TP2**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Type</th>
<th>Result</th>
<th>Description of Soils</th>
<th>Legend</th>
<th>0.0 Level (m)</th>
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</thead>
<tbody>
<tr>
<td>0.02</td>
<td></td>
<td></td>
<td>ROCK FLOOR - Wooden floor boards</td>
<td></td>
<td>0.0 Level (m)</td>
</tr>
<tr>
<td>1.70</td>
<td></td>
<td></td>
<td>MADE GROUND - Light brown slightly silt, sandy GRAVEL with abundant bricks, mortar fragments and rare ceramic fragments</td>
<td></td>
<td>1.70</td>
</tr>
<tr>
<td>2.25</td>
<td></td>
<td></td>
<td>Makes dense orange brown slightly silt, sandy GRAVEL with rare cobbles, gravel and cobbles consists of flint, quartz and quartzite</td>
<td></td>
<td>2.25</td>
</tr>
<tr>
<td>2.80</td>
<td></td>
<td></td>
<td>ROCKFILL GRAVEL.</td>
<td></td>
<td>2.80</td>
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</tbody>
</table>

**Trial pit completed at 2.80m depth**

**KEY**
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- J - Jar Sample
- S - Water Sinker
- T - Level on completion
- MP - Mackintosh Probe
- TN - Hand Tensiometer
- C - Vane Shear Test
- Cohesion (kPa)

**REMARKS**
- Pit sidewall collapse at 2.20m to 2.80m depth
- 3) Pit BR
- 4) No live roots observed
- 5) All measurements are related to basement floor level, which is approximately 2.00m below ground level
## Sections and Plan Trial Pit 3

### Plan TP3

![Plan TP3 Diagram](image)

### Cross Section A

- **Basement Floor Level**
- **Brick Column**
- **2.45m**
- **2.80m**
- **0.30m**

### Cross Section B

- **Basement Floor Level**
- **Brick Column**
- **2.45m**
- **2.80m**
- **0.32m**

---

### Samples and Tests

<table>
<thead>
<tr>
<th>Depth m</th>
<th>Type</th>
<th>Description of Soils</th>
<th>Legend</th>
<th>Depth m</th>
<th>O.D. Level m</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>MADE GROUND - CONCRETE</td>
<td></td>
<td>0.30</td>
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<tr>
<td></td>
<td></td>
<td>VOID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.60</td>
<td>01</td>
<td>MADE GROUND - Brown slightly silty, sandy GRAVEL with</td>
<td></td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>rare brick, mortar and fine concrete fragments</td>
<td></td>
<td>2.60</td>
<td></td>
</tr>
<tr>
<td>3.20-3.40</td>
<td>B1</td>
<td>Orange brown slightly clayey, sandy GRAVEL. GRAVEL consists of Fine, quartz and quartzite</td>
<td></td>
<td>3.45</td>
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<td>CLAY COVER GRAVEL</td>
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</table>

- **Trial pit completed at 3.45m depth**

---

### Remarks

- Pit sidewall collapsed at 2.75m to 3.45m depth
- Pit dry
- No live roots observed
- All measurements are related to basement floor level, which is approximately 2.00m below ground level
<table>
<thead>
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<th>Depth (m)</th>
<th>Type</th>
<th>Result</th>
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<th>Legend Depth</th>
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<tbody>
<tr>
<td>0.00</td>
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<td></td>
<td>MADE GROUND - wooden floor beams</td>
<td>0.02</td>
</tr>
<tr>
<td>1.40</td>
<td>01</td>
<td></td>
<td>MADE GROUND - light brown slightly sandy, silty GRAVEL with abundant bricks, concrete and ceramic fragments</td>
<td>1.30</td>
</tr>
<tr>
<td>1.60</td>
<td>02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.30</td>
<td>04</td>
<td></td>
<td>Medium dense orange brown slightly clayey, sandy GRAVEL, gravel, clasts of flint, quartz and quartzite (CLICH)</td>
<td>2.50</td>
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<td>2.40-2.48</td>
<td>HP1</td>
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<td>Trial pit completed at 2.40m depth</td>
<td>2.60</td>
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**KEY**
- D: Disturbed Sample
- B: Bulb Sample
- U: Unbudded Sample
- R: Root Sample
- J: Jet Sample
- W: Water Sample
- V: Water Inflow
- X: Water Rise
- L: Level or completion
- MP: Macintosh Probe
- P: Hand Penetrometer
- C: Cohesion [kPa]
- V: Vane Shear Test
- T: Tensile Strength

**REMARKS**
- Pit sidewall collapsed from 1.40m to 2.40m depth
- 1. Pit dry
- 2. No live roots observed
- 4. All measurements are related to basement floor level, which is approximately 2.08m below ground level

**Project No**: 10135
**Scale**: 1:25
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### Sections and Plan Trial Pit 5

**Plan TP5**

- **A'** to **C'** Brick Column
- **B'** Brickwork Archway

**Cross Section A**

- Basement Floor Level
- Well of Bricked Up Archway
- 2.15m
- 2.30m
- Brick Corbels

**Cross Section B**

- Basement Floor Level
- 2.10m
- 2.29m
- Brick Corbels

**Cross Section A**

- Basement Floor Level
- 1.60m
- 1.05m
- 2.30m
- Brick Corbels
- Lime Mortar
- 0.25m

---

**Key:**
- D: Disturbed Sample
- B: Bulk Sample
- U: Undisturbed Sample
- R: Root Sample
- W: Water Sample
- J: Air Sample
- S: Soil Sample
- W: Water Flow
- L: Level on completion
- MP: Mackinrow Probe
- R1: Hand Penetrometer
- Cohesion [kPa]
- V: Vane Shear Test
- Cohesion [kPa]

---

**Project:** No.10 Kensington Palace Gardens, London W8
**Client:** Graham Sutherland

---

**Project No.:** C10135
**Tel.:** 01733 566566

---

**Legend:**
- Depth (m)
- Description of Strata
- [0.60, Level m]

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Type</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.60</td>
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<td></td>
</tr>
<tr>
<td>2.20</td>
<td>02</td>
<td></td>
</tr>
<tr>
<td>2.40-2.70</td>
<td>03</td>
<td></td>
</tr>
<tr>
<td>2.70-2.75</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Pit itself collapsed at 2.00m to 2.70m depth
- **St:** Pit dry
- **St:** No line marks observed
- **St:** No line marks are related to basement floor level, which is approximately 2.00m below ground level

---

**Project No.:** 10135
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**Page:** 1/1