Chelmer
Consultancy Services
'Groundbreaking Services'

Basement Impact Assessment

Site	34 Queens Grove
	London
	NW8 6HN
Client	Cranbrook Basements
Date	June 2015
Our Ref	BIA/5238

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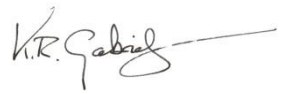
CONTENTS

APPENDICES

- *Appendix A - Photographs*
- *Appendix B - Desk Study - BGS Boreholes*
- *Appendix C - Factual Report on Ground Investigation by FASTRACK*
- *Appendix D - PDISP Heave/Settlement Analyses*
- *Appendix E - Desk Study Data – Geological Data (GroundSure GeoInsight)*
- *Appendix F - Desk Study Data – Environmental Data (GroundSure EnviroInsight)*
- *Appendix G - Desk Study Data – Historic Maps- Large and Small Scales*

Report Status: **FINAL**		
Role	**By**	**Signature**
Lead author:	Keith Gabriel MSc DIC CGeol FGS UK Registered Ground Engineering Adviser	
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Foreword

This report has been prepared in accordance with the scope and terms agreed with the Client, and the resources available, using all reasonable professional skill and care. The report is for the exclusive use of the Client and shall not be relied upon by any third party without explicit written agreement from Chelmer Site Investigations Laboratories Ltd.

This report is specific to the proposed site use or development, as appropriate, and as described in the report; Chelmer Site Investigations Laboratories Ltd accept no liability for any use of the report or its contents for any purpose other than the development or proposed site use described herein.

This assessment has involved consideration, using normal professional skill and care, of the findings of ground investigation data obtained from the Client and other sources. Ground investigations involve sampling a very small proportion of the ground of interest as a result of which it is inevitable that variations in ground conditions, including groundwater, will remain unrecorded around and between the exploratory hole locations; groundwater levels/pressures will also vary seasonally and with other man-induced influences; no liability can be accepted for any adverse consequences of such variations.

This report must be read in its entirety in order to obtain a full understanding of our recommendations and conclusions.

1.0 INTRODUCTION

1.1 This Basement Impact Assessment (BIA) has been prepared in support of a planning application to be submitted to the London Borough of Camden (LBC) for the construction of a single-storey basement beneath No.34 Queen's Grove, NW8 6HN. The assessment is in accordance with the requirements of the London Borough of Camden (LBC) Development Policy DP27 in relation to basement construction, and follows the requirements set out in LBC's guidance document CPG4 'Basements and Lightwells' (September 2013).

1.2 This assessment has been prepared by Keith Gabriel, a Chartered Geologist with an MSc degree in Engineering Geology (who has specialised in slope stability and hydrogeology), and Mike Summersgill, a Chartered Civil Engineer and Chartered Water and Environmental Manager with an MSc degree in Soil Mechanics (geotechnical and hydrology specialist). Both authors have previously undertaken assessments of basements in several London Boroughs.

1.3 A preliminary site inspection (walk-over survey) of the house was undertaken on Friday 24th April 2015. Photos from that visit are presented in Appendix A. Desk study data have been collected from various sources including borehole records (Appendix B) and geological data, environmental data and historic maps from GroundSure which are presented in Appendices E, F and G. Relevant information from the desk study and site inspections is presented in Sections 2–6, followed by the Basement Impact Assessment in accordance with CPG4 Stages 1–4 in Sections 7–10 respectively. The factual report on the ground investigation is included in Appendix C and the findings are summarised in Section 9.

1.4 The following site-specific documents in relation to the proposed basement extension and planning application have been considered:

Cranbrook Basements:

Existing

- Drg No. 2238-100 Lower Ground Floor Layout
- Drg No. 2238-101 Ground Floor Layout
- Drg No. 2238-104 Front and Rear Elevations
- Drg No. 2238-105 Side Elevation
- Drg No. 2238-105 Side Elevation (Section A-A)

Proposed

- Drg No. 2238-200 Basement Layout (see Figure D1, Appendix D)
- Drg No. 2238-201 Lower Ground Floor Layout
- Drg No. 2238-202 Front and Rear Elevations
- Drg No. 2238-203 Side Elevation
- Drg No. 2238-204 Section A-A (see front cover of this report)

Green Structural Engineering (GSE):

- Drawing No. 12686-GA/01 P1 Basement Layout
- Drawing No. 12686-S/01 P1 Sections Through Underpins (1 & 2)
- Drawing No. 12686-MS/01 P1 Construction Sequence For a Typical Underpin Section

This report should be read in conjunction with all the documents and drawings listed above.

1.5 Instructions to prepare this Basement Impact Assessment were confirmed by return of signed order on 9th April 2015.

2.0 THE PROPERTY AND TOPOGRAPHIC SETTING AND PLANNING SEARCHES

2.1 No.34 Queen's Grove is a Grade 2 listed, 4-storey semi-detached house, situated within the St Johns Wood conservation area in the London Borough of Camden (see Photo 1 in Appendix A). Queen's Grove can be accessed at its north-eastern and south-western ends, where it adjoins Avenue Road and Finchley Road respectively, as well as via Woronzow Road which adjoins Queen's Grove immediately to the west of the property. No.34 is situated on the south-east side of Queen's Grove, adjoining No.35 Queen's Grove to the north-east. To the south-east, the plot of No.34 is bounded by No.42 Woronzow Road, an architect's studio, as shown in Figure 1 below. It should be noted that the dashed purple line in Figure 1 represents the western boundary to the London Borough of Camden, therefore No.34 is located adjacent to the borough's boundary with the City of Westminster.

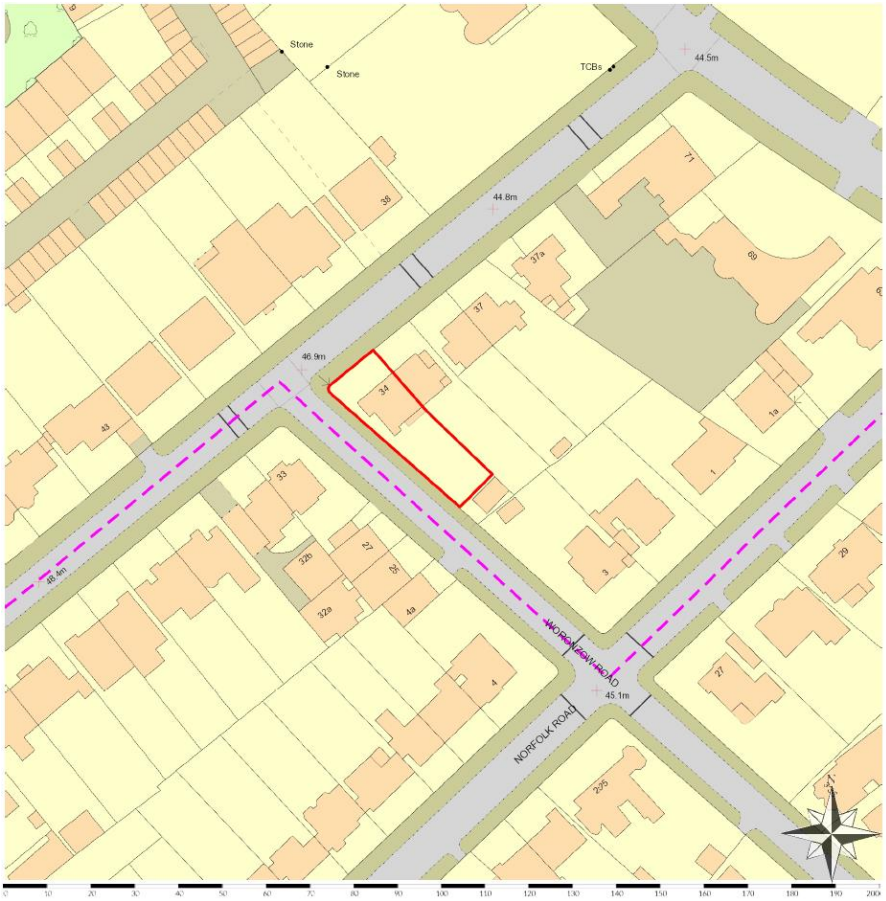

Figure 1: Extract from 1:1,250 OS map (not to scale) with the site outlined in red.

2.2 Reference to the first available historic Ordnance Survey (OS), the Town Plan dated 1866, shows that the Queen's Grove houses and much of the surrounding area had already been fully developed prior to 1866. Several of the houses on Queen's Grove have subsequently been demolished and the sites redeveloped. For example, between publication of the 1915 and 1936 OS maps, the original houses at No's 40-42 Queen's Grove (opposite No.34) were demolished, and larger houses built in their place. During this time, a small structure (garage?) was also built within rear garden of No.34, adjacent to the south-east boundary to the plot. Between publication of the 1962 and 1973 OS maps, alterations were made to No.34, resulting in a larger footprint. Based on the changes to the outline of the building, these alterations most likely consisted of the construction of the larger, flat roofed, single storey entrance porch and steps at the front of the property, as well as the 4-storey side/rear projection (Photos 1 & 5).

2.3 Externally, there is a front parking area which is bounded by brick walls, except at its access points with the Queen's Grove carriageway, where there are ironwork gates. This area is mostly surfaced with brick paving, with the exception of a perimeter soft landscaped area, which includes a number of large trees (see Photo 1).

2.4 The rear garden to No.34 is also bounded by similar brick boundary walls, except at its pedestrian access point with the Woronzow Road footway, where there is a wooden gate, and at its south-eastern end, where a wooden fence forms the boundary between the rear garden, and the adjoining plot of No.42 Woronzow Road. A large area of wooden decking adjoins the rear of the house at the same level as the lower ground floor from where a set of steps lead up from this area to the main part of the rear garden (see Photo 6, and compare 'Existing Section A-A' with 'Existing Side Elevation' on Cranbrook Basements' two Drgs No's.2238-105). The rear garden is mostly surfaced with paving slabs and gravel, with a herbaceous border around the perimeter (see Photo 7).

2.5 The WW2 bomb map for the Borough of Hampstead shows that the closest hits to the property were two high explosive bombs which landed on Avenue Road and the Queensmead estate, located due north of, and to the north-west of, No.34 respectively. The website www.bombsight.org records another high explosive bomb close to Norfolk Road, to the south of Queen's Grove.

Topographic Setting:

2.6 The eastern end of Queen's Grove is located on a broadly east-facing slope, on the west side of a weakly developed valley, defined by the 45m contour in Figure 2. On the opposite, east side of this valley the ground rises eastwards to Primrose Hill. The contours on Figure 2 indicate an overall slope angle across the site of around 2.1°, calculated between the 50m and 45m contours. The 46.9m and 44.8m spot heights on Queen's Grove give the same 2.1° slope angle, falling north-eastwards. Further upslope of No.34, towards the western end of Queen's Grove, the topography is near level; this is the crest of the ridge followed by Finchley Road (the A41).

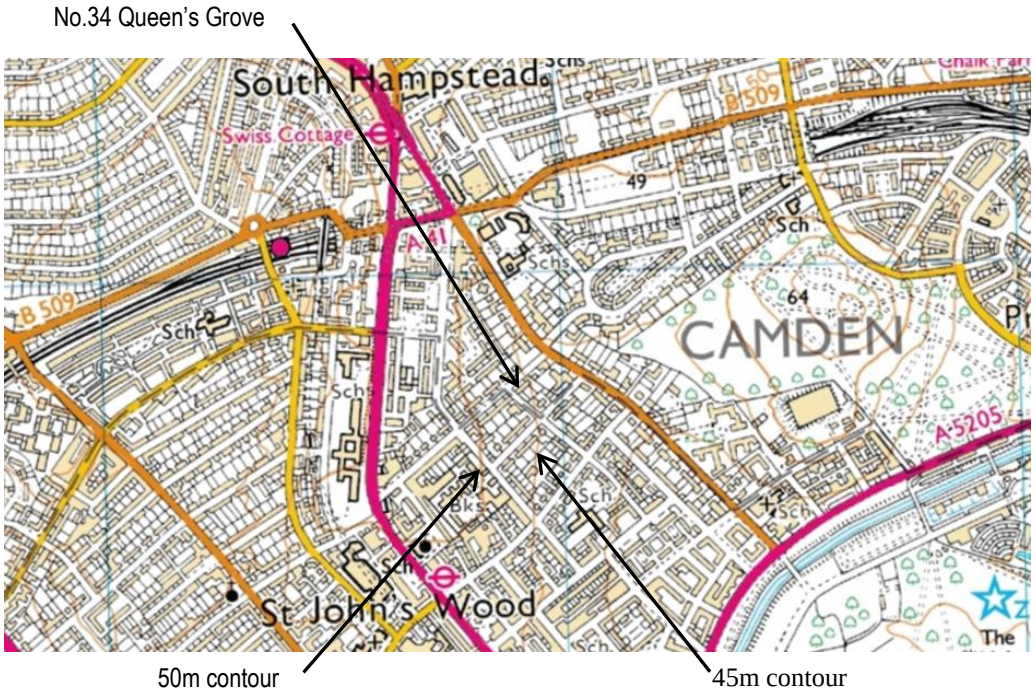

Figure 2: Extract from Ordnance Survey map showing site location.

Planning Searches:

2.7 A search was made of planning applications on the Camden Council's website in order to obtain details of any other basements which have been constructed or are planned in the vicinity of the property. This search found relevant applications for a number of properties on Queen's Grove including:

- Adjoining No.35: Application 2011/2062/L for "*Internal alterations and refurbishment, underpinning to existing foundations and installation of cavity wall membrane to existing dwelling house (C3)*" was granted planning consent on 1st July 2011. No details of the underpinning were provided.
- No 37: Application (2010/3020/L and 2010/2954/P) involving the "*Internal and external alterations including excavation to extend the existing basement to incorporate a swimming pool and associated plant, repairing and rebuilding garden walls and installation of new doors inside lower ground floor level to single dwelling (Class C3)*" was granted planning permission on 30th July 2010. A 'Technical Design Statement' was found, which gave a brief overview of the estimated on-site ground conditions.
- No.40: Application (2008/0679/P) involving the "*erection of a three storey plus basement single-family dwelling house following the demolition of the existing dwelling house and associated landscaping*" was granted planning permission on 25th June 2009. A second application was then submitted (2010/2739/P) following alterations, and was granted planning permission subject to a section 106 legal agreement on 2nd February 2011, then full planning permission on 1st March 2012. A Design and Access statement was found.
- No.41: Application (2007/3397/P) involving the "*Erection of a building comprising basement, ground, first floor and roof storey for use as a single-family dwelling house (following the demolition of existing single dwelling house)*" was granted planning permission on 22nd November 2007. No documents relating to a ground investigation were found on the website.

- No.42: Application (2011/5985/P) involving "*Variation of condition 1 (build in accordance with approved plans) of planning permission granted 04/05/10 (2010/0945/P) as amended on 06/04/11 (2011/0405/P) for excavation and extension of the basement into the rear garden with a green roof, erection of ground and first floor extensions, air conditioning in rear garden, and elevational alterations namely, to increase of the pitch of the mansard roof; alterations to the facade detail treatment and retention of parapet in accordance with 2010 approval*" was granted planning permission on 20th January 2012. No documents relating to a ground investigation were found on the website.

3.0 PROPOSED BASEMENT

3.1 The proposed new basement for which planning permission will be sought, as shown in Cranbrook Basements' drawings (see paragraph 1.4), will comprise:

- A single storey beneath the entire footprint of the house, most of the rear garden, and part of the front parking area;
- Small lightwell in front of the bay to the rear of the house, with the bay continued down to basement level;
- Small lightwell in front of the rear projection, with the rear projection continued down to basement level;
- Small lightwell at the front of the house, immediately to the left (east) of the front entrance.

3.2 CAD measurements from Cranbrook Basements' Proposed Section A-A (Drg No. 2238-204) gives an internal Finished Floor Level (FFL) of 3.58m below the level of the lower ground floor above. With an allowance of 0.25m for blinding, insulation, cavity drainage and floor structure, and a 0.30m thick basement slab, as given on Green Structural Engineering's 'Sections Through Underpins (1 & 2)' (Drawing No. S/01 P1), an excavation depth of 4.13m has been allowed for the basement slab. The same drawing indicates that the thickness of the mass concrete underpins will be 0.35m, therefore an increased excavation depth of 4.18m below the lower ground floor has been allowed for the base of the underpins.

3.3 With allowance for the basement's roof slab and the reinstatement soils over the basement, the formation/excavation depths beneath the front and rear gardens will be approximately 5.6m and 4.7m respectively.

4.0 GEOLOGICAL SETTING

4.1 Mapping by the British Geological Survey (BGS) indicates that the site is underlain by the London Clay Formation. Figure 3 shows an extract from Figure 16 of the Camden GHHS (Camden Geological, Hydrogeological and Hydrological Study by Arup, November 2010) which illustrates the site geology of the Primrose Hill area.

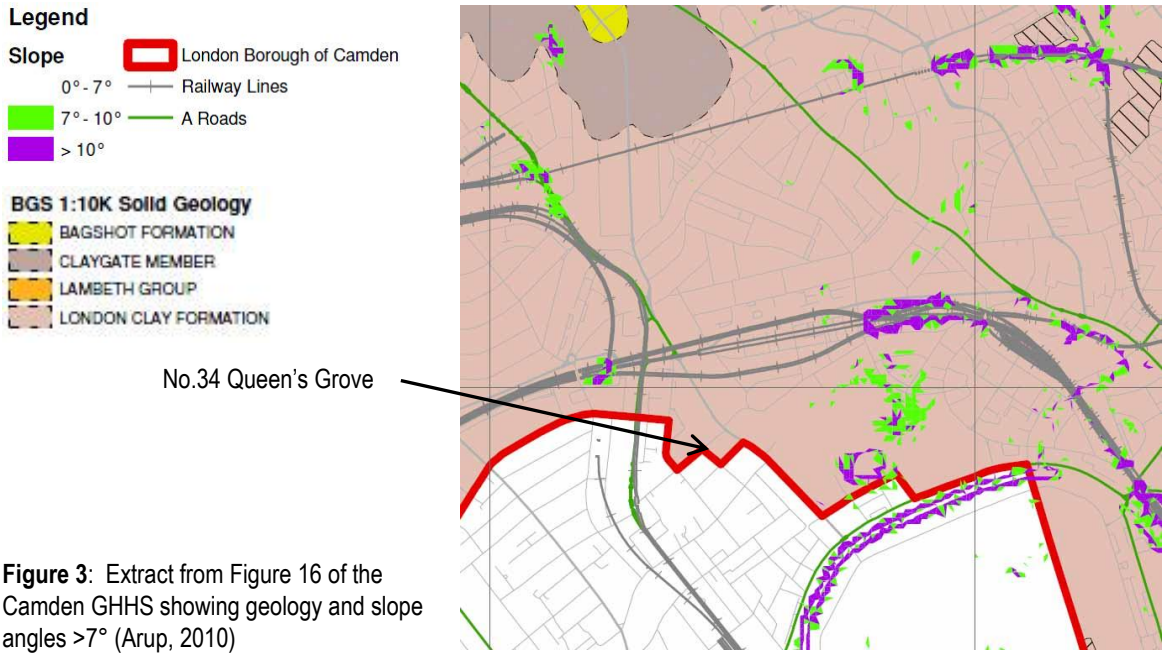

Figure 3: Extract from Figure 16 of the Camden GHHS showing geology and slope angles >7° (Arup, 2010)

4.2 In urban parts of London, the London Clay is typically overlain by Made Ground. A thin superficial layer of natural, locally-derived re-worked soils called Head deposits may also be present (because these are not mapped by the British Geological Survey where they are expected to be less than 1.0m thick). In the areas which have been excavated, some or all of these deposits may have been removed.

4.3 The London Clay is well documented as being a firm to very stiff over-consolidated clay which is typically of high or very high plasticity and high volume change potential. As a result it undergoes considerable volume changes in response to variations in its natural moisture content (the clay shrinks on drying and swells on subsequent rehydration). These changes can occur seasonally, in response to normal climatic variations, to depths of up to 1.50m and to much greater depths in the presence of the trees whose roots abstract moisture from the clay. The clay will also swell when unloaded by excavations such as those required for the construction of basements.

4.4 The results of the BGS natural ground subsidence hazard classifications are provided in the GroundSure GeoInsight report (Appendix E); all indicated 'Negligible' or 'Very Low' hazard ratings with the exception of 'Shrink – Swell Clay' for which a 'Moderate' hazard rating was given, which reflects the outcrop of the London Clay Formation at surface.

4.5 The GroundSure GeoInsight report (Appendix E, Sections 2 & 7) records:

- Historic underground workings, the closest of which are tunnels at 285m and 379m to the north of the site (see App.E, Section 2.2).
- A number of Historic 'mining' features within 1000m of the site, the closest of which are 'Air Shafts' located 384m to the north-west, and 411m to the north-east (see App.E, Section 3.1).
- A tunnel which forms part of London Underground's Jubilee Line, 157m to the west of the site at a depth of 19m below ground level (bgl) (see App.E, Section 7.1).
- The site is within 5km of the planned route of the High Speed 2 railway (see App.E, Section 7.5). Plan and profile maps for Phase 1 of HS2 are available online from www.gov.uk/government/organisations/high-speed-two-limited, and show that the proposed route is approximately 450m to the north of the site (Main Line Sheet 5).

It should be noted that these databases are based on mapping evidence, so inevitably will provide an incomplete record of underground workings.

4.6 A search of the BGS borehole database was undertaken for information on previous ground investigations and any wells in the vicinity of the site, the locations of which are presented on the location plan in Appendix B. The strata depths in a selection of these boreholes are summarised in Table 1. For full strata descriptions reference should be made to the logs in Appendix B. Boreholes TQ28SE/655 (BH1-BH3) were drilled to the south of Queen's Grove, on the east side of Aquila Street. The boreholes display similar information, therefore in Table 1 only the highest and lowest values recorded are presented, giving the range of depths and levels recorded.

Table 1: Summary of Strata in BGS Boreholes

Strata (abbreviated descriptions) GL (mAOD)	**Depths (m) and levels (m AOD) to base of strata in BGS Boreholes**							
	TQ28SE/ 353		**TQ28SE/354**		**TQ28SE/ 655 (BH1–BH3)**		**TQ28SE/ 733**	
	Depth	**Level 51.38**	Depth	**Level 50.65**	Depth	**Level 44.13-43.22**	Depth	**Level 38.48**
Made Ground and/or Topsoil	0.30	**51.08**	1.22	**49.43**	(0.91)-1.52-2.29	**42.31-41.85**	0.50	**37.98**
Brown/mottled brown and grey CLAY with stones (Head?)	0.76	**50.62**	-	**-**	-	-	1.20	**37.28**
Brown/dk brown CLAY, mottled +/- fissured (Weath'd London Clay Formation)	>9.14	**-**	10.36	**40.28**	>4.72-7.62	-	8.00	**30.48**
Blue-Grey CLAY (London Clay Fm)	-	**-**	>10.67	**-**	-	-	>20.00	-
Seepage/Strike	'Nil'	**-**	'Nil'	**-**	'Dry'	-	2.50/-	**35.98**
Groundwater standing level	'Nil'	**-**	'Nil'	**-**	'Dry'	-	-	-

5.0 HYDROLOGICAL SETTING (SURFACE WATER)

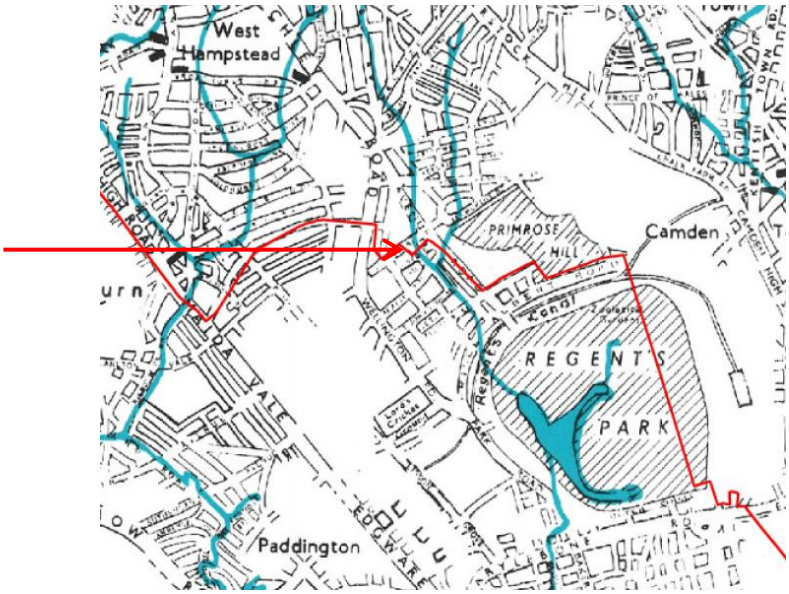

Figure 4: Extract from Figure 11 of the Camden GHHS (Arup, 2010) showing former watercourses, based on Barton (1992).

5.1 As shown in Figure 4, the site lies just to the west of the river Tyburn, one of the 'lost' rivers of London, most of which now run in dedicated culverts or the sewer system. This is also illustrated by the 45m contour in Figure 2, which reveals a weakly developed valley, broadly at the location of Avenue Road, a feature which was also observed during the recent site visit (Photo 3). This tributary was visible on Greenwood's map of 1827 (the boundary stone on Queen's Grove about 60m to the north-east of No.34 formerly stood on the west bank of the Tyburn). The river was culverted when the area was developed, and the Camden Strategic Flood Risk Assessment (URS, 2014) records that the Tyburn now flows in the King's Scholars Sewer; the diverted route of that sewer crosses Queen's Grove about 240m to the west of No.34 (as shown in the borehole location plan for that sewer in Appendix B).

5.2 The brick walls which surround the front parking area to No.34 (see paragraph 2.3), together with the fall of both the front parking area and the adjoining public footway away from the front of the house (see Photos 1 & 2), are sufficient to ensure that surface water on the Queen's Grove carriageway will run-off downhill (eastwards) under most conditions. There will also be no run-off from or to No.35's garden. Thus, the surface water catchment for the front garden/amenity area is restricted almost exclusively to direct rainfall, and any drains which discharge into it. The front garden was surfaced with brick paving in good condition, so infiltration will effectively be nil except in the sot landscaped areas.

5.3 The gentle fall of the Woronzow Road footway away from the property's brick boundary wall, together with the southwards fall of Woronzow Road (see Photo 4), is likely to prevent surface water on the carriageway from reaching the rear garden under most conditions. The rear garden is separated from No.35's rear garden by a brick boundary wall, however a wooden fence forms the south-eastern boundary to the rear garden, separating it from the adjoining plot of No.42 Woronzow Road (see Photo 7), and is unlikely to prevent surface water flow from No.34 to No.42. Thus, the surface water catchment for the rear garden will be limited to direct rainfall, run-off down the path alongside the house and any drains which discharge into it. Infiltration is likely to occur within

the gravelled and surrounding soft landscaped areas, and is assumed to occur within the wooden decking area, although the nature of the surfacing beneath the decking is unknown.

5.4 Figure 5 shows that Queen's Grove did not flood during either the 1975 or the 2002 flood events. The closest roads to the property which did flood were Avenue Road which flooded in 2002, and Boundary Road (approximately 200m to the north-west) which flooded in 1975. While the whole length of these roads are recorded as having flooded, the floods generally affected only a short length of these roads at their lowest points.

5.5 Maps on the website of the Environment Agency (EA) show that the site lies within Flood Zone 1, which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs.

5.6 The following hydrological data for the site has been obtained from the GroundSure EnviroInsight report (see Appendix F), including:

- The closest 'river' (or more specifically "Detailed River Network" entry) is the culverted river Fleet, located 232m to the east of the property (see App.F, Section 5.10).
- There are no surface water features within 250m of the site (see App.F, Section 5.11).
- The closest surface water abstraction licence is 1269m to the south of the property, at Regents Canal (App.F, Section 5.4).
- There are no flood defences, no areas benefitting from flood defences and no flood storage areas within 250m of the site (App.F, Sections 6.2, 6.3 & 6.4).

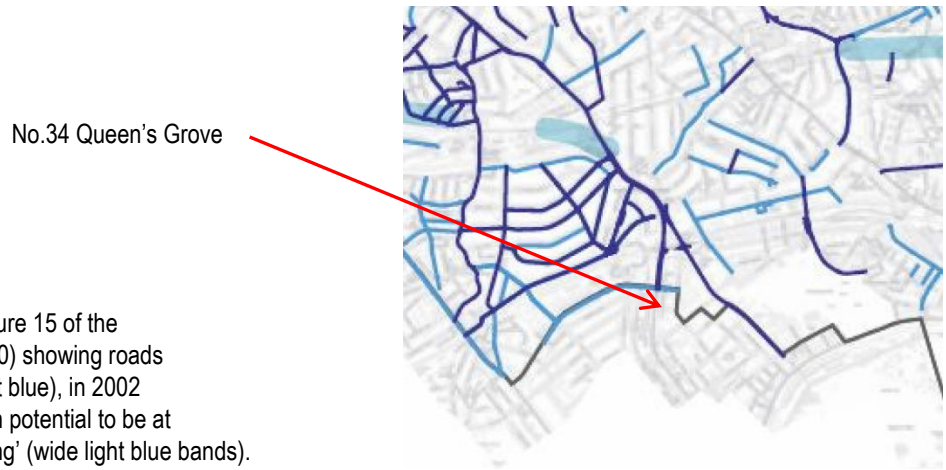

Figure 5: Extract from Figure 15 of the Camden GHHS (Arup, 2010) showing roads which flooded in 1975 (light blue), in 2002 (dark blue), and 'Areas with potential to be at risk of surface water flooding' (wide light blue bands).

5.7 Modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 6. While this map identifies four levels of risk (high, medium, low and very low) it is understood that it is based at least in part on depths of flooding. This modelling shows a 'Very Low' risk of flooding (the lowest category for the national background level of risk) for No.34 and most of the surrounding area. It should be noted however, that a number of small localized areas at a 'Low' risk from surface water flooding are shown adjacent to the property, on the north side of the Queen's Grove carriageway, directly opposite the property, immediately to the west of the property, within the Woronzow carriageway, and within the garden to No.33 Queen's Grove. Also of interest is Avenue Road to the east of the property, which is shown as at a 'High' risk of flooding from surface water. The extension of this

into the eastern-most part of Queen's Grove follows closely the route of the Tyburn shown on Greenwood's 1827 map.

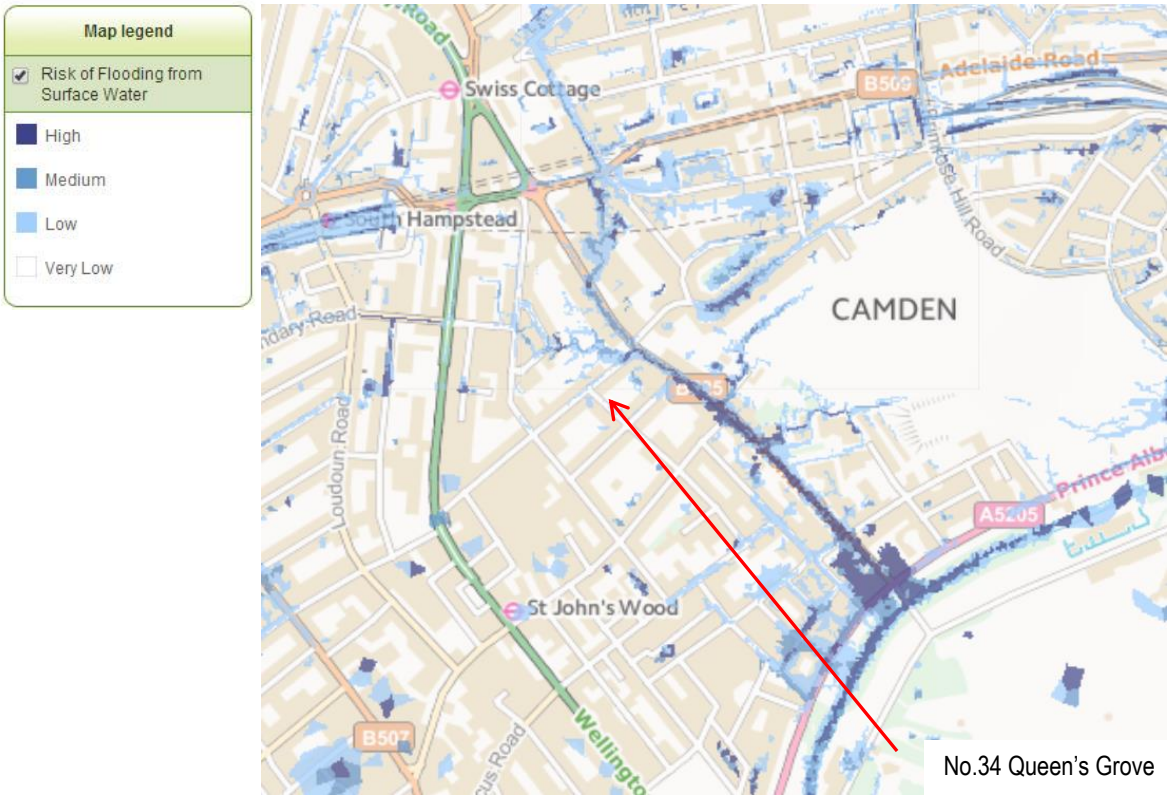

Figure 6: Extract from the Environment Agency's 'Risk of Flooding from Surface Water'.

5.8 More recently, surface water flood modeling has been undertaken by URS as part of a Strategic Flood Risk Assessment (SFRA) for the London Borough of Camden, which was published in July 2014; an extract from their model is presented in Figure 7. As per the Environment agency modelling, this map identifies the same four levels of risk (high, medium, low and very low), and shows a 'Very Low' risk of flooding for No.34 and most of the surrounding area. Avenue Road is also shown as at a 'High' risk of flooding from surface water, and this modelling appears to show a 'Low' risk of flooding on the Queen's Grove Road carriageway opposite No.34, although this is not clear.

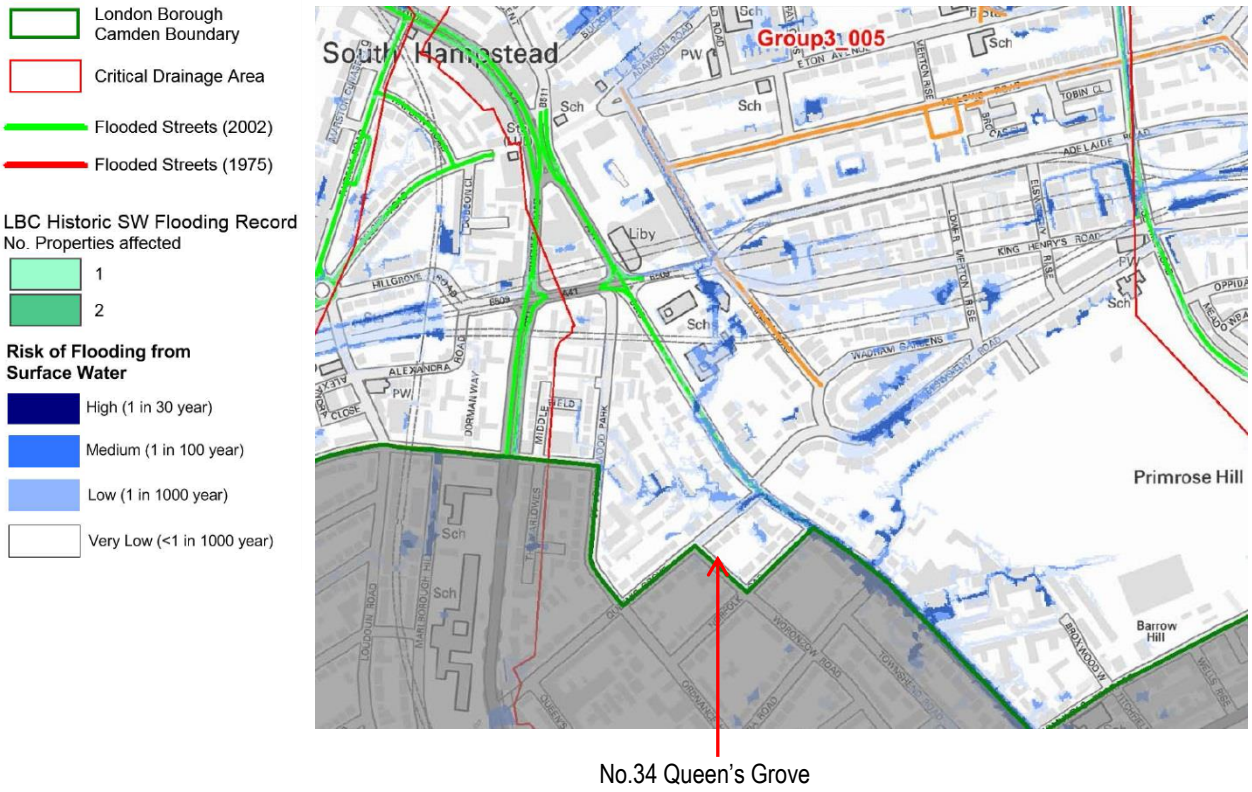

Figure 7: Extract from Figure 3v of the Camden Strategic Flood Risk Assessment (SFRA) (URS, July 2014) showing risk of flooding from surface water.

5.9 The SFRA places No.34 in the Critical Drainage Area (CDA) Group3_005, as shown in Figure 7 above. The implications from these flood models are discussed in Section 10.8.

Sewer flooding:

5.10 In postcode area NW8 6, the Camden SFRA reports no external sewer flooding incidents and one internal sewer flooding event in "the past 10 years".

5.11 A 'Sewer Flooding History Enquiry' report has been obtained from Thames Water Utilities Ltd (TWU). In response to the question 'Is the requested address or area at risk of flooding due to overloaded public sewers?' (TWU's wording) the response given was: "*The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers*". A copy of the report is available on request.

6.0 HYDROGEOLOGICAL SETTING (GROUNDWATER)

6.1 The London Clay Formation is classified by the Environment Agency as an 'Unproductive Stratum', as indicated by Figure 8.

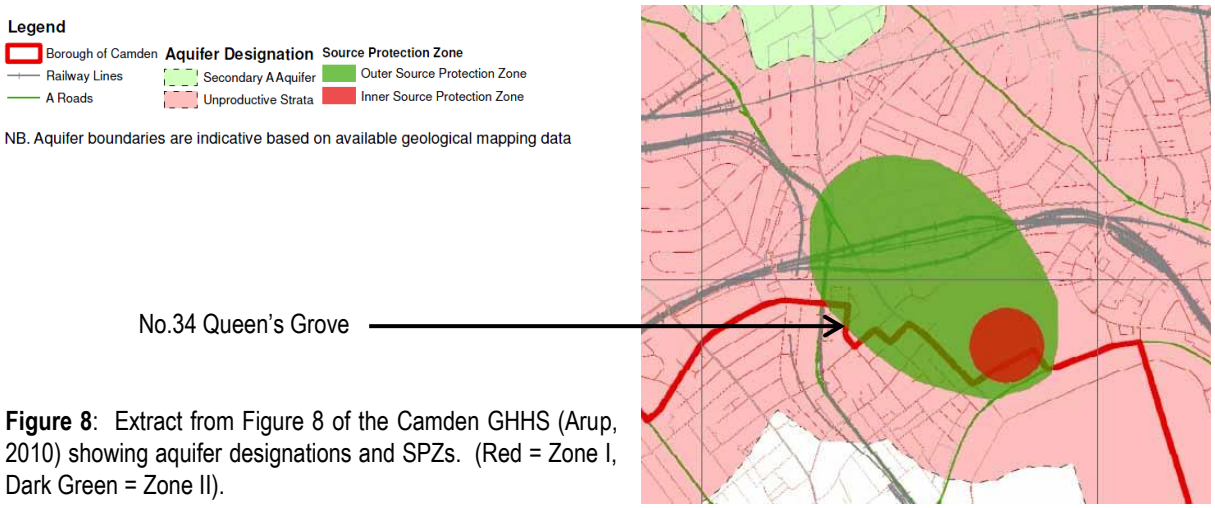

Figure 8: Extract from Figure 8 of the Camden GHHS (Arup, 2010) showing aquifer designations and SPZs. (Red = Zone I, Dark Green = Zone II).

6.2 Under the old groundwater vulnerability classification scheme, which now applies only to superficial soils, the area is unclassified.

6.3 While the London Clay Formation is classified as an 'Unproductive Stratum', it can still be water-bearing. The water pressures within the clay in the depths of current interest are likely to be hydrostatic, which means they increase linearly with depth, except where they are modified by tree root activity or the influence of man-made changes such as utility trenches (which can act either as land drains or as sources of water and high groundwater pressures). Any silt or sand partings, laminations or thicker beds are likely to contain free groundwater and, where these are laterally continuous, they can give rise to moderate water entries into excavations. In most cases, there will be only very limited or no natural flow in these silt/sand horizons.

6.4 Perched groundwater would typically be expected in any Made Ground, and possibly also in any Head deposits which overlie the London Clay, in at least the winter and early spring seasons. Variations in groundwater levels and pressures will occur in response to seasonal climatic changes and with other man-induced influences.

6.5 The groundwater catchment areas upslope of No.34 are likely to differ for each of the main stratigraphic units:

- Made Ground: The catchment for any perched groundwater in the Made Ground is probably limited to the immediately adjoining areas of Made Ground, as well as No.34's own garden, except where the trenches for drains and other services provide greater interconnection.
- London Clay Formation: The catchment for the underlying London Clay will comprise recharge from the overlying soils in the vicinity of the site plus, possibly, a much wider area determined by the lateral extent of any interconnected silt/sand horizons.

6.6 Other hydrogeological data obtained from the GroundSure EnviroInsight report (Appendix F) include:

- The nearest groundwater abstraction licences are 526-532m to the north of the site at the Swiss Cottage Open Space Borehole (TQ28SE1769) (App.E, Section 5.3) with a maximum permitted abstraction of 28.8 m^3/day. This borehole is 159m deep with 6" steel casing grouted into the London Clay and abstracts water from the Chalk below -56mOD, so it will have no effect on the proposed basement. Groundwater abstraction licences are also located 710-714m east of the site at Barrow Hill Pumping Station (App.E, Section 5.3), with a maximum permitted abstraction of 2000 m^3/day. Likewise, these boreholes abstract water from the Chalk so are also irrelevant to the proposed basement.
- The closest abstraction licences for potable water are also located at Barrow Hill Pumping Station, 710-714m east of the site (App.E, Section 5.5), and are therefore irrelevant to the proposed basement.
- The site is within the Source Protection Zone 2 – Outer Catchment for the Barrow Hill Pumping Station, and is 428m from the associated Source Protection Zone 1 – Inner Catchment (see Appendix E, Section 5.6). Thus, the information provided in Section 5.7 of the EnviroInsight report regarding the absence of Source Protection Zones for the confined aquifer within 500m of the site should be ignored.
- The BGS has classified the area within 50m of the site as 'Not Prone' to groundwater flooding, based on the presence of London Clay to surface (App.E, Sections 6.5 and 6.6).

6.7 Details of what was found by the site-specific ground investigation in December 2014 are presented in Section 9.

7.0 STAGE 1 - SCREENING

7.1 The screening has been undertaken in accordance with the three screening flowcharts presented in LBC's CPG4 guidance document. Information to assist with answering these screening questions has been obtained from various sources including the site-specific ground investigation, the Camden geological, hydrogeological and hydrological study (Arup, 2010), historic maps and data obtained from GroundSure (see Appendices E, F & G) and other sources as referenced.

7.2 Subterranean (groundwater) flow screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1a	Is the site located directly above an aquifer?	No – Site underlain by London Clay	4.1 & Figure 3
1b	Will the proposed basement extend beneath the water table surface?	No, not beneath the water table in an aquifer, though it may extend below the phreatic surface of the groundwater in the London Clay.	8.2, Sections 10.2 & 10.3
2	Is the site within 100m of a watercourse?	No – There are no surface water features within 250m of site. The former Tyburn tributary was approx. 60m to the north-east of the site; that now flows in the Kings Scholars Sewer, about 240m to the south-west of the site.	5.1 & 5.6
3	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 2.0km south of the nearest pond chain catchment.	
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	Unknown, potentially yes – the existing surfacing below the wooden decking is not known. Only a very thin layer of soil will in future exist between the decking and the proposed basement.	Carried forward to Scoping: 8.2, Section 10.5
5	As part of the site drainage, will more surface water (eg: rainfall and run-off) than at present be discharged to the ground (eg: via soakaways and/or SUDS)?	No – Soakaways would be inappropriate in London Clay.	
6	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?	No – There are no surface water features within 250m of the site. Nearest springs are likely to be approx 1.3km to the north of the site (at the London Clay-Claygate Member interface).	5.6 & Figure 3

While the answer to question Q1b above was no, the design of the basement must allow for the presence of groundwater in the Made Ground, which was found to be predominantly clayey, and the London Clay. The temporary works during construction must also allow for the presence of groundwater. These matters are considered in Sections 10.1 to 10.3.

7.3 Slope/ground stability screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1	Does the existing site include slopes, natural or man-made, greater than 7°? (approximately 1 in 8)	No – The slopes within No.34's site are all very gentle.	
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°?	No – No re-profiling is proposed.	
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No – Figure 16 in the Camden GHHS shows no land greater than 7° in the vicinity of this property.	2.6 & Figure 3
4	Is the site in a wider hillside setting in which the general slope is greater than 7°?	No – The slope angle across the site is around 2.1° and reduces to near level upslope.	2.6 & Figure 3
5	Is the London Clay the shallowest strata at the site?	Yes, it is the shallowest strata mapped by the BGS (though it may be overlain by Head Deposits).	Carried forward to Scoping: 4.1, 8.3, Section 9
6	Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree root protection zones where trees are to be retained?	Yes – some of the smaller trees within the rear garden will need to be felled. The root zone of larger trees within the front parking area, and the Maple tree adjacent to the south-east boundary of the rear garden (Photo 8) will need to be assessed.	Carried forward to Scoping: 8.3, Section 10.4
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	Potentially, yes - although no evidence of current damage consistent with differential foundation movement was seen, some evidence of repairs to render. Two anchor plates were visible on the higher front wall of No's 34 & 35, potentially structural.	Carried forward to Scoping: 8.3, Section 10.4
8	Is the site within 100m of a watercourse or potential spring line?	No – see Q2 & Q6 in subterranean flow screening above. No springs in the vicinity.	
9	Is the site within an area of previously	No – See BGS map extract	4.1, Figure 3 &

	worked ground?	(Figure 3 herein) and maps on pages 8 & 15 of the GeoInsight report (in Appendix E).	Appendix E.
10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No – London Clay Formation is classified as an 'Unproductive Strata'.	6.1
11	Is the site within 50m of the Hampstead Heath ponds?	No – Site is approx 2.0km from Hampstead No.1 Pond.	
12	Is the site within 5m of a highway or a pedestrian right of way?	Yes.	Carried forward to Scoping: 8.3, Section 10.4
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	Yes.	Carried forward to Scoping: 8.3, Section 10.4
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	Unknown – Re both railway and other tunnels.	Carried forward to Scoping: 8.3, 10.1.3, 10.1.4

7.4 Surface flow and flooding screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 2.0km south of the nearest pond chain catchment.	
2	As part of the proposed site drainage, will surface water flows (eg volume of rainfall and peak run-off) be materially changed from the existing route?	No – Flow routes at surface should be unchanged. Only change to surface water flow route will be the lightwells (from where the surface water will have to be pumped into the drainage system)	Section 10.8
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Unknown, potentially yes – see Q4 in subterranean flow screening above.	3.1, 5.2, 5.3 Carried forward to Scoping: 8.4 & Section 10.8
4	Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by the adjacent properties or downstream watercourses?	No –There should be no change in the surface water run-off to adjacent properties. The historic natural watercourse downslope of the property has been culverted since the 1800's.	5.1, 5.2 & 5.3
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No – There should be no significant change in surfaces generating run-off. None of the run-off from this property goes directly to a surface watercourse.	5.2 & 5.3
6	Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	No – Queen's Grove did not flood during either the 1975 or 2002 flood events, and surface water flood modelling by the Environment Agency indicated a 'Very Low' flood risk (the lowest) for this property and a limited area of 'Low' risk on the Queen's Grove carriageway.	5.7, 5.8, Figures 5, 6 & 7.

7.5 Non-technical Summary – Stage 1:

The screening exercise in accordance with CPG4 has identified eight issues which need to be taken forward to Scoping (Stage 2); one is related to groundwater, six are related to ground stability and one is related to flooding potential.

8.0 STAGE 2 - SCOPING

8.1 The scoping stage is required to identify the potential impacts from the aspects of the proposed basement which have been shown by the screening process to need further investigation. A conceptual ground model is usually compiled at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Stage 4 (see Section 10.1).

8.2 Subterranean (groundwater) flow scoping:

Issue (= Screening Question)		Potential impact and actions
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	**Potential impact:** Increased hard surfacing would decrease infiltration of surface water into the ground. **Action:** Review appropriate types of SuDS for use as site-specific mitigation.

8.3 Slope/ground stability scoping:

Issue (= Screening Question)		Potential impact and actions
5	Is the London Clay the shallowest strata at the site?	**Potential impact:** Heave in response to the unloading caused by the basement excavations, and as Q6 and Q7 below. **Action:** Ground investigation required, followed by appropriate design.
6	Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree root protection zones where trees are to be retained?	**Potential impact:** Heave from removal of trees; slope(s) become less stable; damage to trees. **Action:** Arboricultural assessment and review of potential impact on stability of buildings and/or slopes as relevant.
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	**Potential impact:** Weakened structures from past movement would be more susceptible to damage during works. Future differential movement between the building above the basement and the adjoining structures. **Action:** Review potential impact of future vegetation growth. Designer and contractor to take account of any weakening of the structure caused by past movements.
12	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Construction of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice underpinning methods.
13	Will the proposed basement substantially increase the differential depth of	**Potential impact:** Loss of support to the ground beneath the foundations to the adjoining buildings if

	foundations relative to neighbouring properties?	basement excavations are inadequately supported. Differential movement (see Q7 above). **Action:** Ensure adequate temporary and permanent support by use of best practice underpinning methods. Consider the need for transition underpinning.
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	**Potential impact:** Stress changes on any tunnel lining. Piles or boreholes penetrating the tunnel**.** **Action:** Undertake services search to check that there are no tunnels / deep services in the vicinity.

8.3 Surface flow and flooding scoping:

Issue (= Screening Question)		**Potential impact and actions**
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	**Potential impact:** May increase flow rates to sewer, and thus increase the risk of flooding (locally or elsewhere). **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SuDS for use as site-specific mitigation.

8.4 Non-technical Summary – Stage 2:

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Assess the net change in area of hard surfacing and the potential for change in discharges to the sewer system.
- Investigate existing drainage system, to confirm capacity and condition.
- Review need to implement appropriate types of Sustainable Drainage System (SuDS) in order to offset (mitigate) any potential increase in discharge to mains sewers.
- An arboricultural assessment regarding the root zones of trees in the vicinity of the basement, followed by a review of the potential impact of the proposed basement on those trees.
- Designer and contractor to take account of any weakening of the structure caused by past movements.
- Ensure adequate temporary and permanent support by use of best practice underpinning methods.
- Undertake a services search to check whether there are any other deep services/ railway tunnels which might be affected by the basement.
- Review flood risk and include appropriate flood resistance and mitigation measures in the scheme's design.

All these actions are covered in Stage 4, or Stage 3 for the ground investigation.

9.0 STAGE 3 – GROUND INVESTIGATION

9.1 The ground investigation site work was carried out by Fastrack on 10th December 2014 and consisted of a single borehole (BH1) drilled to a depth of 6.0m below ground level (bgl) within the rear garden, using a mechanical flight auger rig. The location plan and borehole log from Fastrack's Geotechnical Survey Report are presented in Appendix C.

9.2 The site's geology as found by the borehole may be summarised as:

- Made Ground: found immediately beneath 0.30m of Topsoil, the Made Ground was proved to a depth of 0.80m bgl, and was recorded as "Dark brown, clayey MADE GROUND containing brick and gravel".
- Weathered London Clay Formation: proved from the base of the Made Ground to the base of the borehole at 6.0m bgl was "Mid brown CLAY containing grey mottle". The CLAY was noted to contain "orange sand pockets" from 0.80m to 2.20m bgl.

9.3 Hand vane measurements of undrained shear strength were taken in-situ in BH1. In the upper part of the Weathered London Clay, these tests gave averaged values of 104kPa at 1.0m, rising to 120kPa at 2.0m. At 3.0m and below, all readings were given as 140kPa (the maximum reading for the instrument). These values do not allow for the clay's fabric such as fissures, so typically over-estimate the soil's strength and should NOT be used for design.

9.4 No roots were observed within the borehole.

9.5 The borehole was described as dry on completion of drilling. No standpipe was installed so groundwater levels have not been monitored.

9.6 Non-technical Summary – Stage 3:

9.6.1 The findings of the site specific ground investigation confirm that the site is underlain by the London Clay Formation, as indicated in Section 4. Overlying the London Clay was a thin layer of Made Ground and topsoil.

9.6.2 No groundwater entries were recorded in the borehole during drilling, and the groundwater levels have not been monitored.

10.0 STAGE 4 – BASEMENT IMPACT ASSESSMENT

10.1 Conceptual Ground Model

10.1.1 The desk study evidence together with the ground investigation findings suggest a conceptual ground model, including hydrogeological model, for the site characterised by:

- Made Ground: Proved to a maximum depth of 0.80m below ground level (bgl) (including 0.3m of Topsoil); the Made Ground was described as "Dark brown" and "clayey", so may be derived from the underlying weathered London Clay Formation. Brick and gravel were found throughout the Made Ground, however other materials, as well as other soil types and greater thicknesses/depths are also likely to be present on site, owing to the inherent variability of Made Ground.
- Weathered London Clay Formation: Mid brown CLAY was recorded from the base of the Made Ground to the maximum depth drilled (6.0m bgl, see Section 9.3 for a more detailed description). These clays are likely to be fissured and will undergo heave movements in response to unloading by the basement excavation. They are also likely to contain selenite, a form of gypsum, which is aggressive to concrete, and locally contain hard claystone nodules/seams.
- London Clay Formation (un-weathered): Un-weathered London Clay was not encountered during the recent site investigation. Based on the logs of deeper boreholes provided in Table 1, the base of the Weathered London Clay in the surrounding area has been found at depths ranging from 8.0–10.36m bgl. The closest borehole to No.34 (TQ28SE/353) was drilled approximately 175m to the north-west of the site, to a depth of 9.14m bgl, but did not intercept the base of the weathered London Clay Formation.
- Hydrogeology:
    - Perched groundwater may occur locally within the Made Ground, supported on horizons of lower permeability or the underlying London Clay; such perched groundwater may only be present during the wetter winter and spring seasons.
    - Groundwater pressures in the London Clay are expected to be essentially hydrostatic within the depth of current interest, except where modified by tree root action or artificial influences (see below). Groundwater flow through these clays is likely to be minimal, in practice being limited to seepage through any of the silt/sand partings which are sufficiently interconnected.
- Other influences on the Groundwater regime:
  The hydrogeology may be complicated further by the backfill in service trenches and granular pipe bedding (where present) forming preferential groundwater flow pathways within the strata they pass through.

10.1.2 The hydrogeological regime outlined above will be affected by long-term climatic variations as well as seasonal fluctuations, all of which must be taken into account when selecting a design water level for the permanent works. No multi-seasonal monitoring data are available, so a conservative approach will be needed, in accordance with current geotechnical design standards which require use of 'worst credible' groundwater levels/pressures. See paragraph 10.2.5 for the recommended provisional design groundwater level.

10.1.3 Infrastructure (including tunnels), for sewers, cables or communications might be present within the zone of influence of the proposed basement, so an appropriate services search should be undertaken. If any such infrastructure is identified, then its potential influence on the proposed basement must be assessed. These searches will not identify any private services.

10.1.4 The GroundSure GeoInsight report (Appendix E, Section 7) indicates that the closest underground railway tunnel is located 157m to the west of the site at a depth of 19m below ground level (bgl), and forms part of London Underground's Jubilee Line (see map in Appendix E, Section 7, p34). From maps obtained for other projects, it is understood that London Underground's Metropolitan Line is slightly further to the west and visible in open cut sections on both north and south sides of Queens Grove, close to Finchley Road, while the Chiltern Mainline is further west again. Despite this, the transport map on www.bing.com's website indicates that London Underground's Metropolitan Line may pass directly underneath the site of No.34 Queen's Grove, or underneath the immediately surrounding area. Whilst that is believed to be wrong, London Underground should be asked to confirm the location of the Metropolitan Line, and any other tunnels they own in the vicinity. The service owners should be contacted if any tunnels are located beneath or close to the site.

10.2 Subterranean (Groundwater) Flow – Permanent Works

10.2.1 The Made Ground in BH1 was recorded only as "clayey" (and contained bricks and gravel), so would be expected to be a relatively low permeability material, although other more permeable materials may be present elsewhere. The clayey Made Ground is likely to permit little or no flow of any perched groundwater (unless the clays are voided). No groundwater entry was recorded in BH1 during drilling, although the lack of a groundwater entry into a small diameter borehole in clayey strata does not necessarily mean that groundwater was absent; rather the low permeability of the clays merely means that the flow rate was too slow for groundwater entries to occur before the borehole was backfilled. As the Made Ground was less deep (where investigated) than the lower ground floor of this house, the only location where flow might occur through the Made Ground is beneath the path alongside the flank wall. As BH1 was located at the south end of that path, the clayey nature of the Made Ground is relevant. The founding depth of the boundary walls also remains unknown; if founded in natural ground, they would also prevent most flow into the site's Made Ground from upslope. Thus flow through the Made Ground is most likely to occur where service trenches or granular pipe bedding facilitate channelled flow.

10.2.2 The proposed basement will extend out to the south-west site boundary and walk-on glass skylights are proposed alongside the flank wall (ie: there will be no soil above the roof of the basement in that area). Thus, the basement would block any flow which is able to occur through that area. In the excavations do encounter flow through the Made Ground alongside the house, then installation of a groundwater bypass might be required (depending on the level of the foundations to the boundary walls).

10.2.3 The basement is expected to be founded throughout in the London Clay. The lack of a groundwater entry into BH1 suggests that the proposed basement is unlikely to be detrimental to groundwater flow (if any) in the London Clay. The service trenches beneath the carriageways/footways to Queen's Grove and Woronzow Road are likely to provide flow paths with higher permeabilities than the surrounding natural ground, so probably already provide a route for any groundwater flow to pass around the proposed basement.

10.2.4 In the unlikely event that the basement excavations encounter a local deposit of more permeable soils or a water-bearing claystone horizon which has remained undetected within the London Clay, of sufficient thickness

and extent to permit significant flow, then it is possible that an engineered groundwater bypass might be required. This bypass would have to be detailed once the geometry of the permeable soil unit is known.

10.2.5 Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. No groundwater monitoring has been undertaken; however on sites such as this where high plasticity clays are present close to surface, the groundwater table (or phreatic surface) may rise into the overlying Made Ground, at least in the wettest winters, unless mitigation measures such as land drainage can be installed. No acceptable disposal location exists for such water (because there is no accessible watercourse nearby, and Thames Water generally will not allow disposal of groundwater to the mains drainage system). As a result, use is recommended of provisional design groundwater levels equal to ground level for short-term (total stress) design situations, and equal to 0.5m below ground level for long-term (effective stress) design situations. If the design is undertaken in accordance with Eurocode 7 (BS EN 1997-1), then groundwater should be taken at ground level in both short-term and long-term situations.

10.2.6 The basement structure must be designed to resist the buoyant uplift pressures which would be generated by groundwater at the design level around the perimeter of the basement. The variable depth of the basement means that the uplift pressures will vary across the basement from up to 56kPa beneath the front garden to up to 47kPa at the rear end of the basement (both un-factored).

10.2.7 The proposed basement will need to be fully waterproofed in order to provide adequate long-term control of moisture ingress from the groundwater. Detailed recommendations for the waterproofing system are beyond the scope of this report although it is noted that, as a minimum, it would be prudent for the system to be designed in compliance with the requirements of BS8102:2009.

10.2.8 The National House Building Council published new guidance on waterproofing of basements in November 2014 (NHBC Standards, Chapter 5.4). Compliance is only compulsory when an NHBC warranty is required, which is unlikely to apply in this case, but it still provides a useful guide to current best practice.

10.3 Subterranean (Groundwater) Flow – Temporary Works

10.3.1 Groundwater may be present at multiple levels within the depth of excavations required for this basement, despite the lack of any groundwater entry into BH1, so it should be assumed that groundwater control will be required during the basement construction works. Water entries should be manageable by sump pumping. An appropriate discharge location must be identified for the groundwater removed by sump pumping.

10.3.2 A careful watch should be maintained to check that fine soils are not removed with the groundwater. If any such erosion/removal of fines is noticed, then pumping should cease and the advice of a suitably experienced and competent ground engineer should be sought.

10.3.3 The unloaded clays at/beneath formation level will readily absorb any available water which would lead to softening and loss of strength. It will therefore be important to ensure that the clays at formation level (onto which the underpins and the basement slab will bear) are protected from all sources of water, with suitable channelling to sumps for any groundwater seeping into the excavations. The formation clays should be inspected and then blinded with concrete immediately after completion of final excavation to grade. Any unacceptably soft/weak areas must be excavated and replaced with concrete.

10.3.4 A leaking water supply pipe to the property could increase significantly the volume of water entries, so it would be prudent to ensure the isolation stopcock is both accessible and operational before the start of the works.

10.4 Slope and Ground Stability

Slope Stability

10.4.1 With overall slope angles of approximately 2.1° upslope of this property, the proposed basement excavation raises no concerns in relation to the overall stability of the slope, subject to normal precautions in supporting the ground around the basement.

Underpinning Methods and Ground Movements alongside the Basement

10.4.2 GSE's drawing No.12686-GA/01 P1 shows the proposed layout of underpinning bases required for the basement extension. Their load takedown has been annotated by hand onto the architectural plan by Cranbrook Basements, Drg No.2238-200 (see Figure D1 in Appendix D). The rear wall of the basement will not be on the boundary so will be constructed in a series of reinforced concrete (RC) panels not exceeding 1.0m in width, as shown on GSE's plan, on the same 'hit and miss' basis as the underpinning.

10.4.3 No.34 is listed, but it is not known whether the listing includes the boundary walls. If not, then it might be acceptable to the planning authority, and technically easier, to take down some of the boundary walls, construct the perimeter basement walls as RC panels, in the same manner as the rear wall (see above), and then re-build the boundary walls. Major cracking was present at two locations in the boundary wall close to trees in the front garden, one of which was close to the proposed basement; these sections of wall will need to be rebuilt with appropriate allowance for future growth of the adjacent trees.

10.4.4 Underpinning methods involve excavation of the ground in short lengths in order to enable the stresses in the ground to 'arch' onto the ground or completed underpinning on both sides of the excavation, together with the ability of stiff homogenous clays to stand un-supported for a limited period of time. Loads from the structure above will similarly arch across the excavation, provided that the structure is in good condition.

10.4.5 Some ground movement is inevitable when basements are constructed. When underpinning methods are used, the magnitude of the movements in the ground being supported by the new basement walls is dependent primarily on:

- the geology,
- the adequacy of temporary support to both the underpinning excavations and the partially complete underpins prior to installation of full permanent support;
- the quality of workmanship when constructing the permanent structure.

A high quality of workmanship and the use of high stiffness temporary support systems, installed in a timely manner in accordance with best practice methods, are therefore crucial to the satisfactory control of ground movements alongside basement excavations (see also 10.4.7 below). Any cracks in load-bearing walls which have weakened their structural integrity should be fully repaired in accordance with recommendations from the appointed structural engineers before any underpinning is carried out.

10.4.6 The minimum temporary support requirements recommended for the excavations for the proposed underpins and RC retaining walls at No.34, subject to inspection and review as described in 10.4.7 below, are:

- Full face support should be installed as the excavations progress for all excavations through the Made Ground.
- Closely spaced support where any firm clay is present at the top of the London Clay.
- More widely spaced temporary support may be adequate in the stiff or very stiff clays of the London Clay Formation, depending on the degree of fissuring, except at corner excavations where closely spaced support should be provided.