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BASEMENT IMPACT ASSESSMENT – REV. D

4 Keats Grove, London NW3 2RT

Marcus Piggott

August 2017

Project no: 51659

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Revision Status

Issue	Date	Description	Prepared	Checked	Approved
1	09/02/2017	Draft without Swimming Pool/ Tree Report	JM/RM	JM/RM	-
A	21/03/2017	Draft with Swimming Pool	JM/RM	RM	JM/RM
B	21/08/2017	Draft Rev. B	JM/RM	RM	JM/RM
C	21/12/2017	Final with Updated Pool	JM/RM	RM	JM/RM
D	03/05/2018	Final with Section 8 – Monitoring added	JM/RM	RM	JM/RM

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Contents:-

Architect's Proposed Plans:

Demolition Drawings D001, D01, D10 & D15.

Proposed Drawings D99, D100, D110, D115 & A06, A07, A08.

Appendices

A – SSFRA Report

B – GI Report (Site Investigation Report)

C – Groundsure Report

D – Tree Report

E – Indicative Foundation Drawing (51659/S/01E)

1. Introduction.

1.1 Richard Jackson Engineering Consultants have been commissioned, by Mr Marcus Piggott, to undertake a Basement Impact Assessment (BIA) for the proposed swimming pool to the studio annex located to the front (NE) side of the main house; at 4 Keats Grove NW3 2RT, in the London Borough of Camden.

1.2 The enclosed document will form part of the planning application required to support the Planning & Listed building applications.

Current Site Use

1.3 The Site has in the past been used as a home dwelling. In recent years the property has been used as flats, including the front studio annex building.

1.4 The main house forms a four-story substantial terrace property, with the front studio annex seen with ground floor and lower ground level.

1.5 The property is accessed from the north elevation on Keats Grove, with the road sloping down to the east, from Downshire Hill located to the west.

Figure 1.1: Site Location Plan, 4 Keats Grove, Hampstead

Proposed Development

The proposed development involves subtle alterations to the main house. However, the studio building located to the front of the main house is proposed to be converted, at lower ground level, in to a swimming pool structure mainly within the footprint of the studio building with the plant room at a deeper level to the south of the studio, as proposed on Richard Griffith Architect's Drawings: 546/ A06, A07 & A08, amended October 2017.

To facilitate the swimming pool installation within the studio building, a new substructure plant room is proposed south of the studio foot print, which will be accessed via a hatch from the lower ground floor level path, and CAT ladder steps down in to the new plant room building (refer to RGA section drawing no. 546/ A07).

Project Context

This report has been prepared in accordance with the London Borough of Camden's (LBC) Planning Guidance document 'Basements and Lightwells' CPG4 July 2015 and 'Guidance for subterranean development document' (LBC, 2010).

Constraints and Limitations

Richard Jackson Engineering Consultants have endeavoured to assess all information provided to them during preparation of this report. The report summarises information from several external sources and cannot offer any guarantees or warranties for the completeness or accuracy of information relied upon. The recommendations summarised in this report relate to details of the proposed development at the time of writing the report. Any substantial changes to the proposed design may require a reassessment of the strategy identified.

This report has been prepared for the exclusive use of Marcus Piggott & the design team, and for the purpose of assisting to assess and mitigate any potential detrimental impacts on the surroundings with respect to surface water flow, groundwater and land stability at the planning stage.

This report should not be used in whole or in part by any third parties without the express permission of Richard Jackson Ltd in writing.

2. Sources of Information

The information contained in this report is based on a review of readily available information pertinent to the site, a comprehensive ground investigation report, and consultation with relevant interested parties.

Records Review

Key reports, drawings and websites pertinent to this assessment are detailed below in Table 2.1.

Document/Website	Author/Publisher	Date
Flood Map, Groundwater Mapping, Reservoir Flood Map – www.environment-agency.gov.uk	Environment Agency	Accessed September 2016
BGS Geoindex – Geology and borehole records - www.bgs.ac.uk/geoindex	British Geological Survey	Accessed October 2016
Camden Planning Guidance – Basements and Lightwells CPG4	London Borough of Camden	2015 ed.

Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development.	London Borough of Camden/Arup.	2010 ed.
Topographic Survey 17723-UG-01A	Survey Solutions	May2016
GroundSure historic mapping (Report refs: GS-3251287)	Groundsure Insights	August 2016
Environment Agency online Flood maps	EA	2016 and 2017
Thames Water Sewer Flooding History Enquiry	Thames Water	2014
London Borough of Camden Preliminary Flood Risk	Drain London	2011
Camden Flood Risk Management Strategy	London Borough of Camden	2013
North London Strategic Flood Risk Assessment	Mouchel	2008
London Borough of Camden Surface Water Management Plan	Halcrow	2011
The Lost Rivers of London	Nicholas Barton	1992
Environment Agency "Product 4" flood risk mapping.	Environment Agency	Accessed 2016
Ground Soil Investigation report	Richard Jackson Ltd	Nov. 2016

Table 2.1: Key Information Sources

Consultation

2.3 The parties consulted as part of this Basement Impact Assessment are detailed in Table 2.2.

Consultee	Form of Consultation	Topics Discussed and Actions Agreed
Environment Agency	"Product 4" – Flood Risk Mapping	The Environment Agency (EA) flood mapping indicates that both the site and Keats Grove are in the EA defined "Flood Zone 1" and are also deemed to be at "very low" risk of surface water flooding.

Table 2.2. List of Parties consulted

Ground Investigation

2.4 Various site investigations were carried out on the site, including an intrusive site investigation by Richard Jackson Ltd; with 2No. Window sample boreholes and 1 No. trial hole with windowless sample undertaken in September 2016. The works and findings from the interpretive report of November 2016 are summarized in Section 6 of this report. The report, with borehole and trial pit logs, location plan and test results are included as Appendix C.

3. Site Setting

Site Location and Description

The site comprises part of the front garden, forming the studio located to the front of the main house at 4 Keats Grove, Hampstead, London NW3 2RT.

A walkover of the area, along with the site investigation fieldwork, was undertaken on Tuesday 12th September 2016.

The following summarises details of the site:

- The site front garden including the studio building is rectangular in shape and has an area of approximately 180m^2, identified by the ordnance survey Grid reference TQ269,856, with an approximate ground elevation of 20.7 metres above Ordnance Datum (mAOD).
- Access is gained from the pavement of Keats Grove at the front gated pedestrian access.
- The property front garden has relatively level access from the public pavement, with stepped access in to the main house and studio building.
- The front site comprises a grassed area, with paved paths leading to the studio and house access, with the lower frontage to the main house fully paved. The boundary of the property is covered in greenery with open rail fencing above a low brick wall.
- There are over grown hedges and greenery to the front garden, with a large Horse Chestnut tree located to the north-west corner of the studio building, as indicated on the site plan.
- The studio building is located to the north-east corner of the site, adjacent to the neighbouring drive to the east, and next to the public pavement to the north.
- No overhead services were recorded on the site front garden.
- Manhole covers can be seen adjacent to the front of the main house, at lower ground level.

Adjacent Property

3.4 The principal house building line is set back from Keats Grove, with the detached studio building located in front of the main house, perpendicular to the pavement. The main house and neighbouring houses share party walls to the east and west of 4 Keats Grove.

3.5 The studio building east wall is adjacent to the drive of the neighbouring property, with a shared porch entrance to the house and studio building.

3.6 The studio east wall is proposed to be underpinned, with the main works being carried out from within 4 Keats Grove, and some temporary works measures will need to be installed during the principal structural works. All the works will be subject to the necessary party wall awards agreed prior to commencement of the works.

3.6 There is a large chestnut tree located to the north west of the studio building, approximately 2.7m to the west external face of the brick studio brick wall.

Geology

3.9 The Ground Investigation report prepared by Richard Jackson Engineering Consultants (report ref 51659; dated 17 November 2016 in Appendix C) and available public mapping suggests that the site is located directly on London Clay Formation deposits, with some surface made ground.

Ground Workings

3.10 Ground workings map confirms the closest historic underground workings to be approximately 120m south of the site.

3.11 Further ground workings exist in the form of the park pond some 176m east of the site.

3.12 Various further ground workings then exist at distances of 219m from the site and further, including ponds, cuttings, reservoirs, tunnels and vent/ air shafts.

Mining, Extraction and Natural Cavities

3.13 The Groundsure investigations confirm that the closest record of Mining, Extraction and Natural Cavities occur at a distance of 461m from the site, forming an 'airshaft' dating back to 1940.

3.14 Further 'airshafts' also occur at 462 and 463m from the site, with further shafts at 536m and further from site.

Ground Subsidence

3.15 The London Clay is susceptible to shrink-swell problems and will require consideration as part of the substructure design; with the plasticity defined as high to very high plasticity, with a medium to high volume change potential, and the close proximity of the large Chestnut tree to the west of the proposed pool building. However, the proposed pool foundations will be increased in depth which further reduces the risk of subsidence at the proposed formation depth.

Borehole & Trial Hole Records

3.16 The site-specific Ground Investigation borehole windowless sampler 1 record located centrally within the front garden, 10m west of the studio building confirms firm to stiff clay to a depth of 6.0m below ground level.

3.17 Windowless sample 1 was monitored for water seepage on a subsequent visit on the 5th of October 2016, and confirmed water seepage to a depth of 5.65m below ground level.

3.18 A further windowless sample 2 borehole was located 5m north of windowless sampler 1, and approximately 9.5m west of the studio building. Windowless sampler 2 was sunk to a depth of 6.0m below ground level and encountered upper made ground to a depth of 2.15m, with very stiff clay to the base of the bore hole.

3.19 Windowless sample 2 was monitored for seepage on 5th October 2016, and was found to be dry, with No water seepage recorded.

3.20 Trial Hole 1 was located to the south wall of the studio building. Trial hole 1 was excavated to a depth of 0.51m below ground level, with a further windowless sample borehole down to a depth of 3.1m below ground level.

3.21 The trial hole excavation confirmed a shallow corbelled brick footing to a depth of 310mm below ground level, with a 200mm thick concrete footing below the existing brick corbelled footing.

3.22 The windowless bore hole to the base of trial hole 1 confirmed made ground to a depth of 850mm below ground level, with the remaining soil confirmed as Firm Brown London Clay to a depth of 3.1m, where the windowless sample was concluded.

3.23 Trial hole 1 and the windowless sample was monitored for water seepage on 5th October 2016, with water seepage seen to a depth of 1.68m below ground level.

Slope Stability and Subterranean Developments

3.15 Whilst the gradient of the area falls gently to the east, the gradient appears to be less than 7°, and is unlikely to affect the site stability.

3.16 The ground sure report highlights the site as low risk of slope instability after significant changes in ground and drainage conditions. However, the proposed underpinning works will be confined to the studio building and the proposed plant room only, with no significant drainage changes envisaged.

3.17 Ground sure report confirms that slope stability problems are unlikely to be present, with no special actions required to avoid landslide problems. No special ground investigations are required.

Hydrology and Hydrogeology

3.17 The strata classification of the sites bedrock geology has been used by the environment agency since April 2010, using aquifer designations consistent with the water framework directives, indicating that the site is classified as 'Unproductive'.

3.18 There are no groundwater Source Protection Zone (SPZ) within 500m of the site. There is no data on any surface water features within 500m of the site.

3.19 The BGS GeoIndex and Environment Agency online mapping show the site lies directly above the London Clay; which is classified by the EA as 'non-productive strata'. The EA aquifer mapping (accessed online) and Figure 8 of the Camden Geological, Hydrogeological and Hydrological study also confirms this classification (Figure A1).

3.20 Thames Water Asset records show that there are water mains and public sewers in the Keats Grove road highway.

3.23 A CCTV survey of the site drainage system confirms that there is a combined drain run that services the property, and discharges towards the Keats grove highway, falling east wards. Similarly, all properties in the area are likely to be connected to the public foul drainage network in the Keats grove road highway.

Flood Risk

3.24 There are no recorded instances of fluvial or tidal flooding of the site, with the falling within flood zone 1 (low probability zone), or 'very low' flood risk.

3.25 The Environment agency indicative flood map (FRA – Appendix D) shows that the site is in flood zone 1, and indicates that there is a less than 1 in 1000 chance of a flood occurring on site each year.

3.26 The site is not located in an area at risk of surface water flooding according to the EA flood maps, and is categorised as very low risk. See Figure 3.1 below.

3.27 Hampstead Heath ponds are located to the north-east of the site and are above the site level. However, the site is not located in an area at risk of reservoir flooding according to the EA flood maps. See Figures 3.1 and 3.2 below.

3.27 The Camden Geological, Hydrogeological and Hydrological Study confirms the various effects on the site are as discussed in the Groundsure report.

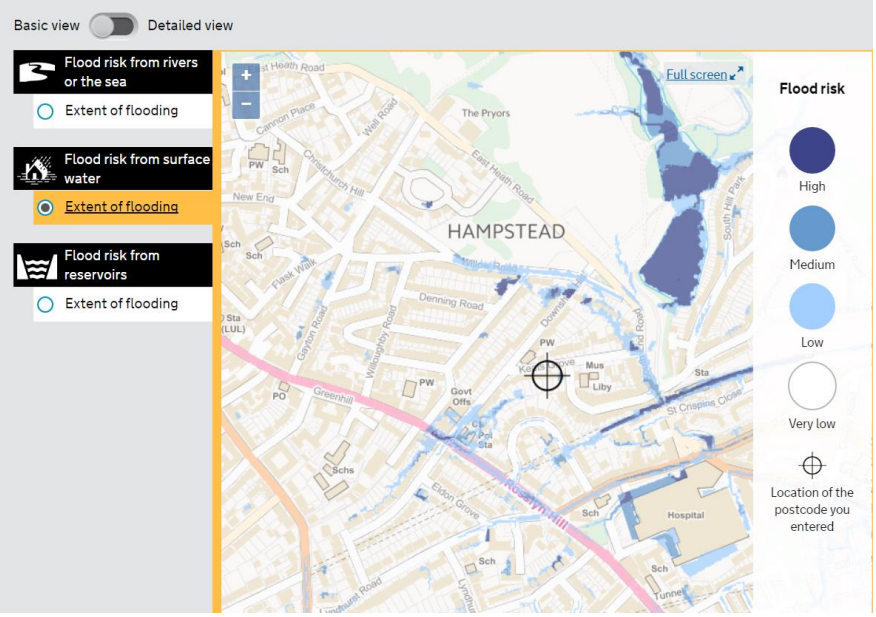


Figure 3.1: SW flood map from EA website (accessed Nov. 2016)

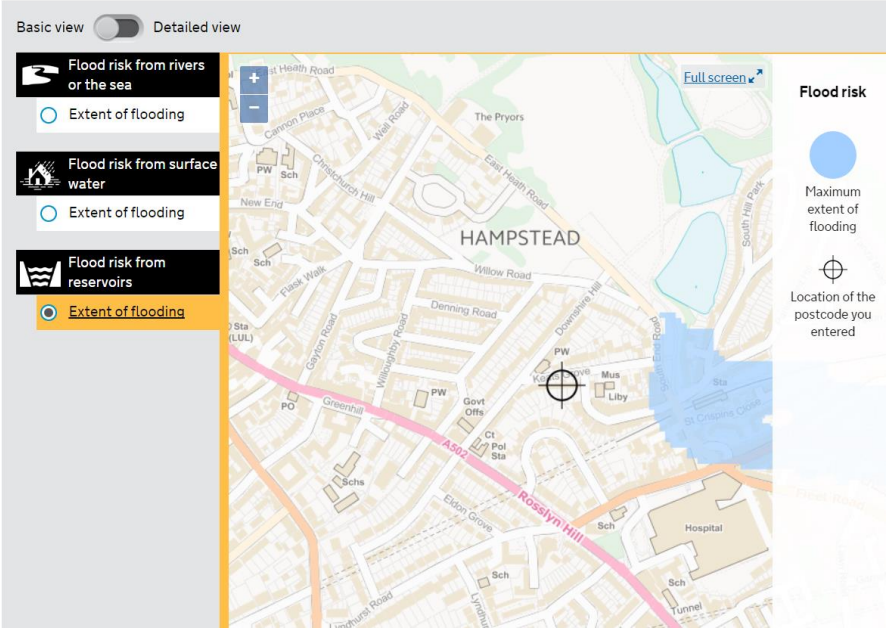


Figure 3.2: SW flood risk from reservoirs map from EA website (accessed Nov. 2016)

Radon & Gas Measures

3.33 Radon and general gas measures is discussed in the geotechnical desk study report, and may occur as a function of made ground which exists in the upper layers of the soil strata. The risk posed by the ground gasses was considered to be low, particularly so where the new structure will be founded within the clay layer of the soil.

Trees

3.34 There are a number of trees and bushes located in the front garden and in particular a significant mature horse chestnut tree west of the studio and to the front boundary of the site. Full details are contained in the Arboricultural Survey and Impact Assessment report, January 2017 by Marcus Foster in Appendix D.

3.35 The mature horse chestnut tree has a Tree preservation order, and is identified as a significant tree. The horse chestnut tree will be subject to a tree protection zone during the construction phase of work, as outlined in the Arboricultural Survey Impact Assessment Report in appendix D.

4. Screening

Screening Assessment

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

A number of screening tools are included in the Guidance for Subterranean Development prepared by Arup and reference has been made to them. These consist of a series of questions with a screening flow chart relating to groundwater flow, land stability and surface water flow.

The following pages tabulate the findings of the initial screening assessment as follows:

- Slope Stability and Subterranean Developments;
- Stability Screening Assessment;
- Surface Flow and Flooding Screening Assessment.

Question	Response	Justification
1a: Is the site located directly above an aquifer?	**No**	• The BGS GeoIndex shows the site lies directly above the London Clay; which is classed as non-productive strata. The EA aquifer mapping (accessed online) and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study (reproduced in Figure A1 and A5) also confirms this.
1b: Will the proposed basement extend beneath the water table surface?	**Unknown**	• Based on published information, the site is underlain by London Clay; which is a very low permeability stratum. • The BGS groundwater flooding susceptibility rating is negligible based on the underlying geological conditions.
2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**No**	• Based on a review of historical maps (Appendix C), EA website (Groundwater SPZs in 'what's in my backyard', BGS Geoindex map (accessed online), no watercourses, no wells (used/disused) or springs were identified to the property frontage.
3: Is the site within the catchment of the pond chains on Hampstead Heath?	**No**	• The site is located approx 0.25 km south west and below the level of the three ponds in this chain, according to Figure 14 of the Camden Geological, Hydrogeological & Hydrological study (reproduced in Figure A2), placing it outside the catchment. • Given the site's location relative to these features, we do not consider that the proposed development will affect flow to the ponds.
4: Will the proposed basement development result in a change in the proportion of hard surfaced /paved areas?	**Yes**	• The impermeable area of the site will be marginally increased by 1m^2 through the introduction of a below ground plant room, which currently has some plant beds adjacent to the existing south studio wall.
5: As part of the site drainage, will more surface water (e.g. rainfall / run-off) than at present be discharged to the ground (e.g. soakaways and/or SUDS)?	**Yes**	• The impermeable area of the site may slightly be increased by approximately 1m^2 through the introduction of a below ground plant room. • The property is likely to increase foul flows slightly, but this will be discharged to the public sewer.
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 ponds in the locality of the site. Given the scale of the proposed basement and the site's distance from any local water bodies, we do not consider that the proposed development will significantly affect flow to any ponds and therefore do not consider any mitigation measures are required.

Table 4.1: Subterranean (Groundwater) Flow Screening Assessment - undertaken prior to site-specific site investigation

Question	Response	Justification
1: Is the site within the catchment of the pond chains on Hampstead Heath?	**No**	• Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study (reproduced in Figure A2) places the site outside the catchment for these ponds. • Given the scale of the proposed basement and the sites vicinity from the pond chains, we do not consider that the proposed development will significantly affect flows to Hampstead Ponds
2: As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	**No**	• The site currently discharges to the public sewer network in the adjacent roads and this route will be maintained as the main source of disposal. Peak runoff will be reduced slightly due to the increase in soft landscaping,
3: Will the proposed basement development result in a change in the proportion of hard surfaced /paved external areas?	**Yes**	• The impermeable area of the site will be marginally increased by approximately 1m^2, through the introduction of a below ground plant room.
4: Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?	**No**	• On the basis that the property is currently drained to sewer, and following development all surface water falling on the buildings will be captured by the new site drainage network, we anticipate that there will be no impact on neighboring properties or downstream watercourses.
5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	**No**	• All foul sewerage will be connected to the public sewer network.
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**	• The Camden Geological, Hydrogeological and Hydrological Study shows the site to outside of streets flooded in 1975 or 2002 (Figure 15). EA Surface water maps do not indicate flooding in the vicinity.

Table 4.2: Surface Flow and Flooding Screening Assessment

Question	Response	Justification
1: Does the existing site include slopes, natural or manmade, greater than 7º? (approximately 1 in 8)	**No**	• Within the land of the proposed new building, the site is currently generally flatter than 7°, other than a small change of level between the house and external paved area).
2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7º? (approximately 1 in 8)	**No**	• The land within the site boundary is generally flatter than 7°. The new basement is within the site and does not adjoin the site boundary.
3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7º? (approximately 1 in 8)	**No**	• The adjoining land slopes slightly along Keats Grove, although the overall area falls to the South-east; but below the 7° threshold.
4: Is the site within a wider hillside setting in which the general slope is greater than 7% (approximately 1 in 8)	**No**	• The area falls generally gently to the south-east, below the threshold of 7°.
5: Is the London Clay the predominate strata on the site?	**Yes**	• The BGS GeoIndex shows the site lies directly above the London Clay. This is confirmed by the site investigation.
6: Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained? (Note that consent is required from LB Camden to undertake work to any tree/s protected by a Tree Protection Order or to tree/s in a Conservation Area if the tree is over certain dimensions).	**No**	• No trees are due to be removed. However, the Arboricultural Impact Assessment notes that the basement will be within the root protection zone of the mature Horse Chestnut tree close to the studio building, but the proposed deeper plant area will be further away from the Horse Chestnut tree location.
7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	**Unknown**	• The site is understood to be underlain by the London Clay; which is prone to shrink-swell. No significant evidence of heave effects was seen to the house or nearby properties.
8: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**No**	• Based on a review of historical maps (Appendix C), EA website (Groundwater SPZs in 'what's in my backyard', BGS Geoindex map (accessed online), no wells (used/disused) or springs were identified. • Given the scale of the proposed basement and the fact that the underlying geology is of a very low permeability, we do not consider that the proposed development will significantly affect flow to any watercourse.
9: Is the site within an area of previously worked ground?	**No**	• The only significant previous works were the construction of the existing premises.

Question	Response	Justification
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**	• The BGS GeoIndex shows the site lies directly above the London Clay which is classed as non-productive strata. The EA aquifer mapping (accessed online) and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study also confirms this.
11: Is the site within 50m of the Hampstead Heath ponds?	**No**	• Based on OS mapping
12: Is the site within 5m of a highway or pedestrian right of way?	**Yes**	• The site adjoins the pavement to the public highway of Keats Grove and the existing studio building is on that boundary. However, the proposed basement will be set back from the boundary with the public highway.
13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	**No**	• The only directly neighbouring property to the proposed building is the existing property at No. 5 Keats Grove; which we believe has a lower ground floor similar to that of No. 4 Keats Grove. Foundation depths are likely to extend to a deeper level, although the proposed plant structure has been designed to ensure that the existing north wall of the principal house is NOT undermined.
14: Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	**No**	• The site lies outside of exclusion zones.

Table 4.3: Slope Stability Screening Assessment

5.0 Scoping Study

5.1 The following potential impacts and potential consequences have been identified based on the initial desktop assessment.

Category	Question	Potential Impact	Possible Consequence
Subterranean (Groundwater) Flow	1b	There is a slight possibility of encountering shallow or perched groundwater during construction.	• The basement might be at risk of water ingress from any shallow or perched groundwater and there is potential for localised impacts on the water table if a groundwater table is present, which will need to be controlled during the construction phase.
	4	The proposals will slightly increase hard standing areas within the site.	• This may slightly decrease infiltration to the ground, which may increase groundwater recharge locally.
	5	The proposals will slightly increase hard standing areas within the site.	• This may slightly decrease infiltration to the ground, which may increase groundwater recharge locally.
Surface flow and flooding	3	The proposals will slightly increase hard standing areas within the site.	• This has potential to slightly increase surface water runoff (peak flows and volumes) to the sewer.
Slope Stability	2	The proposals will alter the ground profile and will require a step change in level with the adjacent highway.	• Without adequate temporary and permanent propping this would lead to slope stability issues.
	5	The site is understood to be underlain by the London Clay Formation, which is prone to shrink-swell.	• Differential movement may occur in the structure and adjacent buildings if not taken into account in the design of temporary works and permanent design of the substructure.
	6	Working within the root protection area of the front tree could affect moisture in the ground	
	7	The site is understood to be underlain by the London Clay	• Differential movement may occur in the structure and adjacent buildings if not taken into account in the design of temporary works and permanent design of the substructure.

Category	Question	Potential Impact	Possible Consequence
		Formation, which is prone to shrink-swell.	
	12	The basement is away from the site boundary with the pavement.	• The proposed works should not affect the highway.

Table 5.1: Potential Impacts

6. Ground Investigation

Objective

6.1 In order to further inform the assessment of the potential impacts of the development and to assist with design of the sub-substructure, so that any impacts of the basement can be mitigated through the design of the temporary and permanent works, an intrusive investigation was scoped.

6.2 This was to build on the findings of the desktop assessment set out in previous sections of this report, so as to collect basic geotechnical, chemical and hydrogeological data to further develop the conceptual site model.

Site Work

6.3 Prior to the intrusive site works, a services scan had been carried out at the proposed borehole locations.

6.4 The borehole positions were chosen to investigate the ground conditions at the location of the proposed dwelling and to check for presence of groundwater within the standpipe.

6.5 A ground investigation was carried out in September 2016, at the positions shown on the attached exploratory borehole location plan in Appendix E.

6.6 The site work consisted of a window sampling borehole below an area of current paving. This was drilled using a modular collapsible rig and taken to 6m depth, that is sufficiently below the proposed basement construction to identify a consistent founding strata.

6.7 Representative disturbed and bulk disturbed samples were taken from the boring tools at regular intervals throughout the depth of the borehole.

6.8 Undisturbed 38mm diameter samples were taken in the clay at regular intervals throughout the depth of the borehole.

6.9 In-situ Standard Penetration Tests (SPTs) were carried out at varying depths.

6.10 On completion of the boreholes a gas and ground water monitoring standpipe was installed to the base of the bores. These were sealed above the slotted bottom zone of the pipe, so that the piezometric pressure could be recorded. A protective cover was installed flush with the ground surface at each borehole.

6.11 Groundwater monitoring was carried out during a return site visit in October 2016. The findings are set out in the Groundwater section below.

Laboratory Work

6.12 The samples were forwarded to a registered laboratory, where geotechnical tests were conducted, and the results are presented in the Appendices.

6.13 The moisture content of selected soil samples was determined.

6.14 Liquid and plastic limits of selected samples at various depths were determined, as a guide to soil classification and behaviour.

6.15 Test specimens were prepared at full diameter from selected undisturbed samples. Undrained triaxial compression tests were undertaken on the samples at a single confining cell pressure.

6.16 Selected samples of soil were analysed to determine the total potential sulphate content from the oxidation of pyrites in the London clay, using the BRE SD1 Pyrite Suite. The design sulphate class was determined as DS-5, and the aggressive chemical environment for concrete (ACEC) classification confirmed as AC-4s.

6.17 The laboratory certificates are included in Appendix E and are summarised in Table.

Plasticity Index (NHBC modified)				
Trial Hole/ Borehole No.	Sample depth, m	Index	Soil Class	
TH1	1.0	35	CH	
TH1	3.0	56	CV	
WLS1	2.5	37	CH	
WLS1	5.0	55	CV	
WLS2	6.0	55	CV	
Shear Strength (unconsolidated single stage triaxial)				
Trial Hole/ Borehole No.	Sample depth, m	Dry density Mg/ m3	Moisture content %	Cu KN/m2
TH1	1.0	-	32	73
TH1	3.0	-	30	98
WLS1	2.5	-	24	130
WLS1	5.0	-	35	90
WLS2	6.0	-	33	141
Chemical Tests				
Test – sample at 3.5m		Range		
Moisture Content %		24/ 24		
pH		7.0/ 7.5		
Total Sulphate as SO4 mg/kg		2120		
W/S Sulphate as SO4 (2:1) g/l		0.52/ 1.7		
Total Sulphur mg/kg		2175		
Magnesium (soluble) g/l		0.072/ 0.21		
W/S Chloride (2:1) mg/kg		0.071/ 0.077		
Ammonium as NH4 mg/kg		0.01		
W/S Nitrate (2:1) as NO3 mg/kg		0.01		

Table 6.1: Summary of Geotechnical Testing

Ground Conditions

6.18 The encountered soil conditions are reported in the borehole logs within Appendix E and summarised below.

Made Ground

6.19 At the windowless sample borehole locations WLS1 and 2 indicate made ground from ground level to a depth of 2.15 to 2.25m. the made ground is a mixture of clay soil/ sand/ roots with coal dust, and brick/ concrete fragments.

6.20 TH1 confirmed made ground to a depth of 0.85m, with the an upper York stone slab paving sitting on a sand/ cement bed.

6.21 It is likely that the studio building at the south wall (TH1) may be sited on made ground, with the brick corbel foundation sited on a lean mix base.

London Clay

6.20 London Clay was encountered below the made ground within the windowless samples WLS1 and WLS2 from 2.15 and 2.25m to a depth of 6m. The made ground also has clay within the soil, and from 1.70 and 1.80m depths are described as very stiff brown/ reddish brown mottled, slightly gravelly sandy clay.

6.21 The London Clay is described as Stiff, slightly fissured, brown/ grey mottled, silty clay with rare orange/ brown silt partings.

Ground Water

6.22 No perched groundwater was recorded in the Made Ground, nor was groundwater recorded during the drilling of the boreholes.

6.23 The ground water level was recorded during a return site visit in October 2016, as set out in Table 6.2.

Location	Ground level (mAOD)	Water Level (mbgl) On 12/09/16	Water Level (mbgl) On 05/10/16	Water Level (mAOD)	Base of well (mbsl)
WLS1	20.76	None (Dry)	5.65	15.11	-
WLS2	20.76	Dry	Dry	Dry	-
TH1	18.60	Dry	1.68	17.12	-

Table 6.2: Groundwater Monitoring – 5th October 2016

6.24 Groundwater was not encountered in the exploratory bore holes during formation, but was encountered during subsequent monitoring on the 5th October 2016.

6.25 The subsequent monitoring visit did confirm standing water at a depth of 5.65m for WLS1, and 1.68m for TH1.

6.26 The exploratory bore hole WLS2 was subsequently found to be dry during the monitoring visit.

Interpretation of Geotechnical Testing results

6.25 The laboratory test results are consistent with and confirm the soil descriptions in the borehole log, namely that beneath the layer of paving and Made Ground the site is underlain by a competent medium to generally high strength brown London Clay deposits.

6.26 The NHBC modified Plasticity Index identifies the clay as being a high-volume change potential soil, consistent with London Clay. In relation to the influence of nearby trees to the site, the NHBC guidance Chapter 4.2 'Building Near Trees' sets out the minimum recommended depth to which new foundations should thus be taken.

6.27 The proposed building is within the tree protection zone of the Horse Chestnut tree at the front of the site. This is approx. 18m tall from the Chestnut tree family, that has been heavily pollarded. This is likely to have restricted the root zone. NHBC Chapter 4.2 Table 12 identifies a Horse Chestnut tree as being of Moderate water demand. In relation to tree influence, Table 15 (high shrinkage potential soil and moderate water demand tree) gives the appropriate depth of new foundations at zero offset as 2.4m. The proposed basement will founded at a greater depth below ground level and will thus be deeper than this requirement.

6.28 The basement reinforced concrete walls and base will be designed using the Strength parameters noted in the Laboratory Tests and a concrete mix will be specified to address the raised sulphate readings; for which BRE Special Digest 1 identifies a Chemical Design Class of DS-5.

7.0 Impact Assessment

7.1 Following completion of the site investigation, the potential impacts associated with the scheme have been re-assessed in light of the findings. Table 7.1 summarises the assessment and provides appropriate mitigation measures.

Category	Question	Potential Impact	Possible Consequence	Work undertaken to investigate likelihood and significance of impact	Revised conceptual model following ground Investigation	Mitigation measures
Subterranean (Groundwater) Flow	1b	There is the slight possibility of encountering shallow/perched groundwater during construction.	The basement may be at risk of flooding from any perched/shallow groundwater and there is potential for localised impacts on the water table if a groundwater table is present which may affect neighbouring foundations or result in flooding of below ground structures.	Site investigation was undertaken to confirm presence/absence of groundwater.	Monitoring of the site investigation borehole did not record any groundwater. However, some water may percolate through the upper Made Ground and the design needs to account for this possibility.	As the basement will be constructed using temporary sheet piles, any seepage from the Made Ground will be minimal though dewatering of the excavation itself may be required during the construction works. As only limited dewatering within the excavation may be required, any dewatering is unlikely to affect any shallow/perched groundwater levels in the Made Ground outside of the sheet piled excavation.
						Basement will need to be appropriately waterproofed.
					No significant impact on groundwater levels are anticipated based on the findings of the site investigation	None
	4	The plant room proposals will slightly increase hard standing areas within the site.	This will potentially decrease runoff to the public sewer which will potentially increase infiltration to the ground	The local drainage proposals are likely to be re-newed, in light of site investigation, no additional mitigation measures are anticipated.	The site investigation showed that the basement excavation will be formed within the London Clay.	Upgrade drainage system to pick up any new rain water on hard standings.
	5	The swimming pool proposals will slightly increase hard standing areas within the site.	This may potentially increase infiltration to the ground which may slightly increase groundwater recharge locally.	Consideration of drainage proposals in light of site investigation	The site investigation showed that the basement excavation will be formed within the London Clay.	Upgrade drainage system to pick up any new rain water run off.
Surface flow and flooding	3	The proposals will slightly increase hard standing areas within the site.	This will potentially decrease runoff to the public sewer.	Consideration of drainage proposals in light of site investigation.	The site investigation showed that the basement excavation will be formed within the London Clay.	Upgrade drainage system to pick up any new rainwater run off.
Slope Stability	2	The proposals will alter the ground profile and will require a step change in levels with adjacent highway.	Without adequate temporary and permanent propping this would lead to slope stability issues.	Site investigation has confirmed uniform ground conditions (London Clay) across the site and has provided soil characteristics.	Unchanged.	A structural retaining wall will need to be included in the proposals. The design of this structure will be based on the site investigation results (see Section 8 for concept design)
	5	The site is understood to be underlain by the London Clay Formation which is prone to shrink-swell.	Differential movement may occur in the structure and adjacent buildings if not taken into account in the design of temporary works and permanent design of the substructure.	The geotechnical properties of the London Clay Formation have been established through site investigation.	Unchanged.	The design of this structure will be based on the site investigation results (see Section 6 and also Section 8 for concept design)
	6	Proximity of a tree could affect moisture in the ground	Differential movement may occur in the structure and adjacent buildings, if not taken into account in the design of temporary works &	The geotechnical properties of the London Clay Formation have been established through site investigation.	Unchanged	None required.

Category	Question	Potential Impact	Possible Consequence	Work undertaken to investigate likelihood and significance of impact	Revised conceptual model following ground Investigation	Mitigation measures
			permanent design of the substructure.			
	7	The site is understood to be underlain the London Clay Formation which is prone to shrink-swell.	Differential movement may occur in the structure and adjacent buildings if not taken into account in the design of temporary works and permanent design of the substructure. Without adequate temporary and permanent propping this could lead to collapse of the pavement.	The geotechnical properties of the London Clay Formation have been established through site investigation.	Unchanged	Potential for shrink-swell to occur will be considered in the detailed design of the temporary works and permanent design of the substructure (see Section 6 and also Section 8 for concept design). Undertake a structural condition survey of neighbouring properties, as part of party wall award process prior to commencement of works.

Table 7.1: Assessment of Impacts

8.0 Conceptual Design

8.1 Based on the assessment of potential impacts, initial concept design solutions are set out below to demonstrate how the temporary and permanent works might be progressed as part of the detailed design process in accordance with Table 7.1.

8.2 Construction of the new basement plant room is envisaged as a watertight reinforced concrete box up to ground level, and an indicative plan with section is indicated in Richard Jackson Engineering Consultants Drawing No. 51659/S/01E.

8.3 The studio building will have a concrete base slab and will be underpinned to the required formation depth. To avoid loss of residential space within the basement, the waterproofing would be a membrane system to the outside of the concrete wall; together with an appropriate reinforcement design with concrete tight concrete mix specified.

Surveys & Consents

8.4 To inform both the permanent design and the temporary works, it is proposed to agree with the client/ neighbour for an appropriate underpinning sequence to the east flank of the studio, so that minimum disruption is caused to the neighbouring property.

8.5 The only building in close proximity (less than 6m) is the house; which is in the same ownership. So the work normally would not be subject to a Party Wall award; in relation to the basement works being within 3m or where it will be below a 45 degree line from the underside of the existing foundation. However, the same safeguards are applicable and prior to excavation work commencing, a visual condition survey will be carried out of the site boundary and of the immediately adjacent property, specifically the east flank wall to the studio which is adjacent to the neighbouring access drive. This record will enable a comparative assessment, should it be considered that the works have resulted in any movement cracks to the building.

8.6 Although beyond the 6m zone defined by the Party Wall award process, it will be prudent for a visual condition survey of the adjacent properties to also be undertaken.

8.7 The necessary building regulations approvals will need to be obtained and passed for the full extent of the proposed works.

Temporary Works

8.8 The contractor will be required to provide a detailed method statement, setting out their proposed method for forming the excavation, maintaining the stability of the sides of the excavation until such time as the new concrete basement is sufficiently complete and for construction of the permanent basement slab, walls and ground slab. The method statement will also set out how the site will be secured by appropriate hoarding during the demolition and construction phase to ensure safety to the general public including neighbours.

8.9 In outline, excavation for the plant room basement construction and removal of spoil will be accompanied by installation of temporary sheet piles to the boundary of the opening; embedded; to secure the bottom of the sheets and with propped wailing beams to support the upper part of the sheets in place. The temporary works design criteria will be set to limit potential movement of the soil behind the sheets, to limit the risk of undue movement and hence damage to adjacent properties.

8.10 Given that the plant room basement is single storey, it is expected that a single horizontal wailer beam will be required to support the sheet piles, near the existing ground level. The temporary sheets would thus be designed to support the applied ground, nominal groundwater loads and also those resulting from the spread of foundation load from the studio building. To inform this part of the design, the sequencing of the studio underpin would be carried out initially to limit the impact during the plant room basement construction. To minimise horizontal deflection of the wailer beam, it would be propped at regular centres; with the props taken down at an incline to temporary footings within the excavation or horizontally across the excavation.

8.11 Given the granular nature of the Made Ground, the contractor's method statement will need to include provision for dewatering of any seepages in to the basement excavation.

Permanent Works

8.12 Construction of the new plant room basement is envisaged as a watertight reinforced concrete box up to ground level; to include the area of the sunken garden. To avoid loss of residential space within the studio building, the waterproofing would be a membrane system to the outside of the brick/ concrete wall; together with reinforcement spacing and a concrete mix designed to watertight concrete criteria. Granular backfill will be installed behind the wall, on removal of the temporary sheet piles.

8.13 For the new plant room, the walls would be designed as propped by the basement slab and also by the ground floor slab, acting as a plate across the building. Around the sunken garden, the walls will be freestanding. Regardless of the lack of groundwater identified within the borehole, the walls and basement slab design would include for the appropriate depth of hydrostatic water pressure; using the requirements of the British Standard for Basement construction (BS.8004).

8.14 The concrete mix for all concrete in the ground will be to suit the results of the chemical tests; adopting a Design Class DS-5 in accordance with BRE Special Digest 1.

8.15 Construction of the reinforced concrete base and wall and installation of the waterproof membrane behind it would be detailed around the temporary props, so that they could remain in place until the concrete works are sufficiently and safely completed. Except where the concrete wall is designed as a free-standing cantilever, such as to the plant room, this will be once a part of the ground slab is in place to prop that portion of the wall. The props and wailer beam can then be removed, and the penetrations made good.

8.16 The proposed foundation base and walls are appropriately detailed to maintain a chamfered base to the access chambers and ensure that the north principal house wall is NOT undermined. This design must be adopted to ensure that the main house wall is not compromised, and other temporary interventions may be instigated such as localised sheet piling if deemed appropriate.

8.17 The foul and surface water drainage design will be developed in line with the FRA and is unlikely to impact on the surrounding strata.

Monitoring Movement

8.18 The monitoring of both the existing and adjacent neighbouring building will be implemented as outlined in the Movement Monitoring Strategy dated May 2018.

8.19 The movements during construction are not expected to be a problem, as the bearing pressures will be designed so that the soil will not be over stressed any more than it is currently, and the allowable bearing pressure increases with depth, which will help reduce the likelihood of potential settlements even further.

8.20 Traditional underpinning is also a well-known way of forming basements and should not cause any problems with settlement provided the Contractor installs them correctly in the sequence stated, ensuring adequate temporary works are implemented.

8.21 The closest property to the coach house is to the east, approximately 3.5m from the rear of the coach house. The likelihood of damage to neighbouring properties is considered low due to the distance, and proposed design which ensures that any adjacent building foundations are NOT undermined. Damage to neighbouring properties should be limited to Category 2 as given in CIRIA C580.

8.22 The proposed pool structure to the coach house increases the foundation formation depth by approximately 2m, which should act as a further barrier to the existing large Horse Chestnut tree located north of the coach house building and reduce the risk of desiccation of soils south/ south-east of the coach house.

8.23 The implementation of the monitoring regime, combined with the correct temporary works will look to reduce the effects of any movement to the neighbouring properties.

9.0 Conclusions

9.1 A Basement Impact Assessment has been carried out in accordance with the guidance published by the London Borough of Camden.

9.2 Based on our current understanding of the site setting and ground conditions, we do not envisage that the proposed development will result in material impacts on subterranean groundwater flow, surface water flow, flooding & slope stability; as long as the mitigation measures set out in Table 7.1 are incorporated into the detailed design of the temporary and permanent works. The detailed design should develop the concept design set out in Section 8.0 of this report.

9.3 In order to minimise any negative environmental impacts to neighbouring residents associated with the construction process, all demolition and construction should be undertaken in accordance with the Considerate Constructors Scheme standards and the ICE demolition Protocol (www.ice.org,uk) and should have regard to the Guide for Contractors Working in Camden Guidance (dated Feb 2008) and the GLA's best practice guidance document The Control of Dust and Emissions from Construction (www.London.gov.uk). An outline Construction Management Plan (CMP) has been prepared as part of the planning submission.

10.0 References

i. Bakewell, I. (2008) *North London Strategic Flood Risk Assessment.* Mouchel.

ii. London Borough of Camden Planning Guidance CPG4 Basements and Lightwells (2013).

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

iv. Find Ground Sure EnviroInsight Report (Ref GS-3251287).

v. Find Richard Jackson's Geotechnical Desk Study Report (Ref: 51659).

vi. BSI British Standard, BS5930:1999+A2:2010 "Code of Practice for Site Investigations".

vii. BS EN ISO 22475-1:2006 & 22475-2/3:2011 Geotechnical investigation and testing. Sampling methods and groundwater measurements.

viii. BS EN ISO 22476:2005+A1:2011 Geotechnical investigation and testing. Various.

ix. BS EN ISO 14688-2:2004 Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification.

x. BSI British Standard. 1990. BS1377:1990, "Methods of Test for Soils for Civil Engineering Purposes".

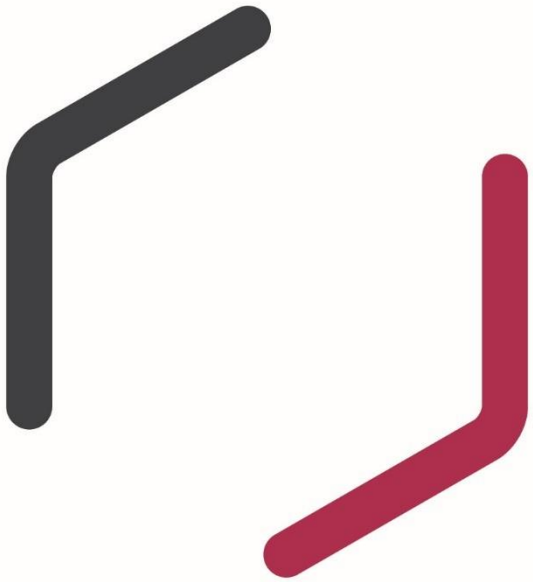
xi. BS EN 1997-1 Eurocode 7 Part 1 "General Rules".

xii. BS EN 1997-2 Eurocode 7 Part 2 "Ground Investigation and Testing"

RG Architect's PLANS

APPENDICES

APPENDIX A - E



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