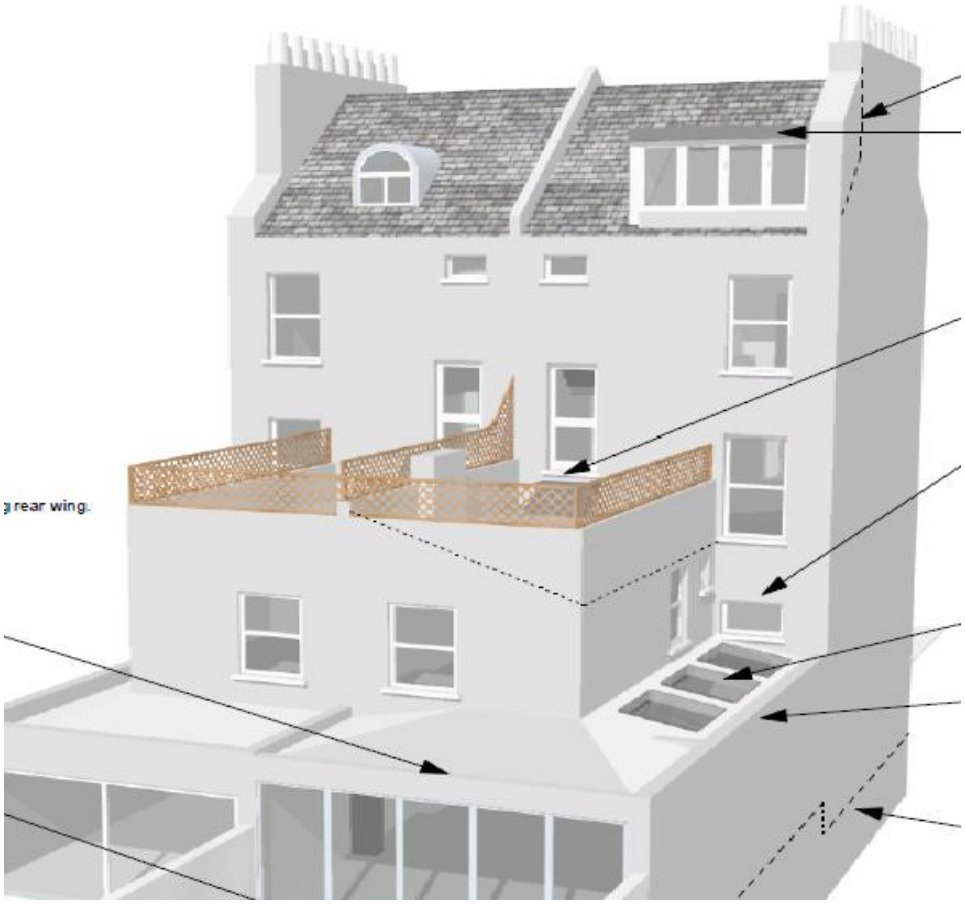
Ground and Project
CONSULTANTS LTD

158 IVERSION ROAD, LONDON, NW6 2HH

Basement Impact Assessment Land Stability

March 2016



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Contents

Non-Technical Summary,

It is proposed to construct a 3.5m deep basement at 158 Iverson Road, London, NW6 2HH. The basement will be built under the full footprint of the existing house.

The screening exercise identified a number of issues for further consideration as follows:

- The property is relatively close to an existing railway cutting
- London Clay is the shallowest natural geological strata
- There is a tree close to the front of the house and there are bushes in the rear garden
- A 'lost river' runs relatively close to the site
- Groundwater may be encountered during construction works
- The basement will be deeper than neighbouring properties

The published geology suggests London Clay at site with the possibility of Head Deposits, which are softer and weaker.

A ground investigation was carried out by Ground & Water consisting of two 5m deep boreholes. These encountered Made Ground (i.e. ground placed by human activity) to 1.0 and 1.5m depth. London Clay was found beneath the Made Ground as a grey silty clay and of high shrinkage potential. Groundwater was not encountered during the investigation.

The scoping and assessment of the BIA concluded that:

- Groundwater inflow, if encountered, should be properly managed and controlled such that there is no significant wash out of fine material.
- The retaining wall should be appropriately designed.
- The construction of the basement is carried out by competent and experienced contractors and precautions are taken to maintain the stability of the excavations.
- Care should be taken to minimise the disturbance and damage to bushes and their roots. Should bushes be removed then an assessment of the potential for swelling of the London Clay soils should be carried out.
- Concrete should be designed accounting for the sulphate conditions anticipated.
- Monitoring of the structures should be carried out before and during construction. The exact nature of this monitoring should be determined by the structural engineer.

1 Introduction

Ground and Project Consultants Ltd have been instructed by Ground and Water Ltd (G&W) to undertake the land stability element of a Basement Impact Assessment, for 158 Iverson Road, London NW6 2HH. The property is located in the London Borough of Camden, London in the West Hampstead ward, its location is indicated on Figure 1.

Figure 1: Site Location

2 Scope and Objective

The scope of this report and approach is as follows:

- A review of the existing data supplied by the client has been carried out, including the proposal drawings produced to date, Ground Investigation data, photos of the building and the background data available through London Borough of Camden's website and other freely available data such as BGS geological information and purchased environmental data.
- In line with the London Borough of Camden guidance, CPG4, latest revision:
- In line with the CPG4 guidance:
    - A detailed assessment of the published and encountered geology
    - Development of a ground model including an assessment of geotechnical properties
    - An engineering interpretation including an assessment of slope stability and commentary and assessment regarding ground movements.
- Recommendations for additional work/ monitoring and observation have been provided.

Assessment of Ground Movements due to the proposed basement construction have not been carried out at this stage.

The report has not considered contaminated land aspects of the site.

This report and the work to support it has been carried out by Jon Smithson who is a Director of Ground and Project Consultants Ltd and is a Chartered Geologist (CGeol) with over 30 years' experience.

3 BIA Screening for Slope/Land Stability

A screening exercise has been carried out as per the guidance in Camden's Guidance for Basements, CPG4 as follows:

Question	Answer	Action/ Comment
Question 1: Does the existing site include slopes, natural or manmade, greater than 7 degrees? (approximately 1 in 8)	No. The front garden is approximately 0.5m higher than the rear.	None
Question 2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7deg? (approximately 1 in 8)	No. There are no significant changes in surface profile planned.	None
Question 3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7deg? (approximately 1 in 8)	No. There are no railway cuttings in the immediate vicinity. The closest is around 40m from the rear of the property.	Further discussed in the Impact Assessment.
Question 4: Is the site within a wider hillside setting in which the general slope is greater than 7degrees? (approximately 1 in 8)	No, the slope in the area is around 1 in 15 (2^{o}) based on Ordnance Survey data. The site is close from Hampstead Heath and steeper ground	None
Question 5: Is the London Clay the shallowest strata at the site?	Yes: London Clay is indicated as the shallowest strata on the BGS maps	The presence of London Clay close to surface is further discussed in the Impact Assessment
Question 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).	It is understood that there will not be a need to fell trees. A tree is present close to site on the street in front of the property, some bushes are present in the garden.	Further discussed in the Impact Assessment.
Question 7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	None known. However London Clay is close to surface.	Further discussed in the Impact Assessment
Question 8: Is the site within 100m of a watercourse or a potential spring line?	Possibly: Figure 11 of the Arup report indicates a 'Lost River' close by to the northwest of the property.	This is further discussed in the Impact Assessment
Question 9: Is the site within an area of previously worked ground?	None known or suspected.	None

Question 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 London Clay is classified by the Environment Agency as unproductive strata (rock layers with low permeability and negligible significance for water supply or river base flow). The site is not within a source protection zone of a public water supply. However the basement may extend into the water table.	Groundwater management is discussed in the Impact Assessment.
Question 11: Is the site within 50m of the Hampstead Heath ponds?	No	None
Question 12: Is the site within 5m of a highway or pedestrian right of way?	Yes	This is further discussed in the Impact Assessment. Health Safety and environmental measures will be required to be integrated into the building contractors methods of working
Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	It is understood that shallow basements are present in the neighbouring properties as in no. 158, but the proposed basement is around 1.5m deeper.	This is further discussed in the Impact Assessment.
Question 14: Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	The Jubilee Line passes about 80m south of the site.	None

4 Site Information

Existing Property and Basement Proposals

The property at 158 Iverson Road is located on the south side of the road, about 20m from its junction with Medley Road. The property is a 4 storey terraced property, probably constructed around 1870-80. It is a brick built attached to no. 156 and 160. The property has a small shallow existing basement beneath the footprint of the front part of the house.

The property is around 2.5km North West of Regents Park and around 1.2km south west of Hampstead Heath. The Jubilee Line passes around 80m south of the site, the Overground line is around 40m south of the property and Thameslink around 100m to the north.

There are a number of bushes in the garden and adjacent gardens.

The basement proposals comprise a single storey beneath the full footprint of the property. The basement depth will be around 3.5m. The basement footprint will be approximately 92m^2. The descriptions and dimensions above have been estimated from drawings provided by G&W.

The National Grid reference for the property is TQ 25228 84702. The location of the property is provided in Figure 1 above.

Topography

The OS map indicates the property is just below 47m AOD. The ground surface rises generally towards the North West at around 1 in 15 (approx. 4^o). There is no significant change in elevation at the property although the front garden level is around 0.5m higher than the back. .

Geology

The available geological mapping (Ref 1.) indicates that the site lies on London Clay which typically comprises a stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. The geological map (North London 256) indicates that the property is very close to an area of 'propensity' for Head Deposits, associated with the higher ground of Highgate Hill. Typically these deposits are thin (<2m) and consist of soft, ocherous brown silty clay with blue-grey mottling in places and angular, frost-shattered fragments of flint occur sporadically throughout. The base of the London Clay is likely to occur significant depth below the property. See figure 2 below.

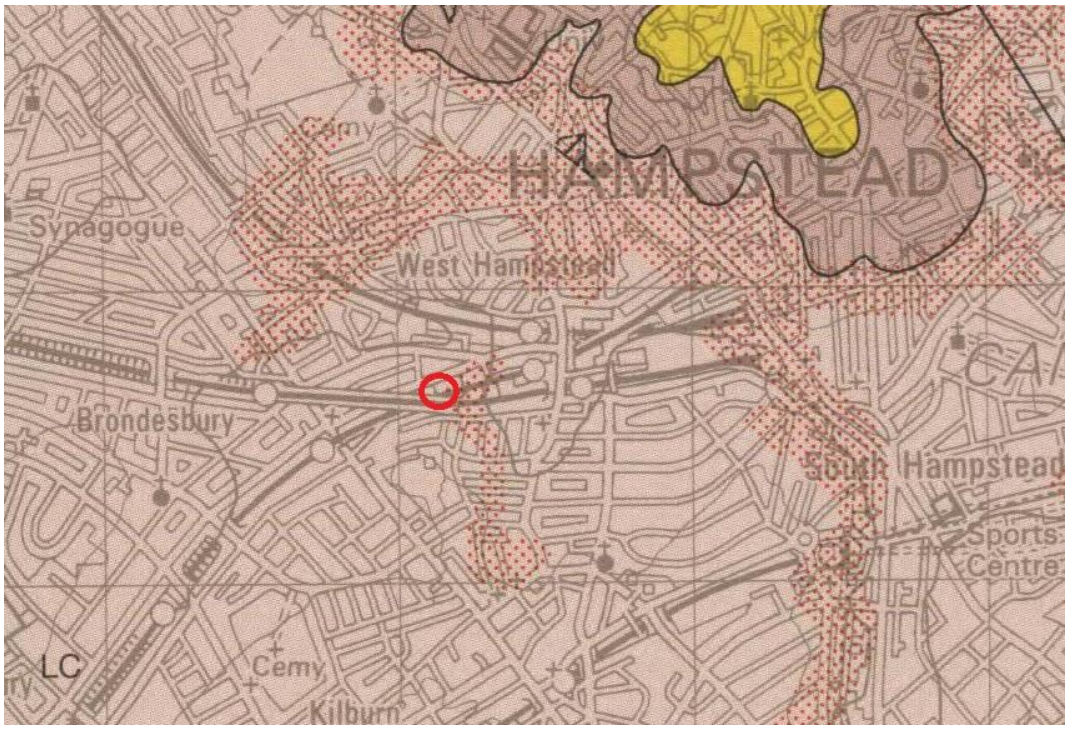

Figure 2: Geology

Hydrology and Hydrogeology

The OS Map indicates that there are no surface water bodies in the vicinity of the site. The Hampstead Ponds are approximately 2km to the NE. There are no springs shown on OS mapping. There is a 'lost river' indicated approximately 50-100m to the northwest.

The London Clay is classified by the Environment Agency as unproductive strata (rock layers with low permeability and negligible significance for water supply or river base flow). The site is not within a source protection zone of a public water supply. There are no groundwater abstraction licenses within 2 km of the site and no source protection zones within 500 m of the site. (Ref 5. Groundsure Report).

Other Environmental Data

The Groundsure report for a nearby property gives a wealth of background data on local environmental issues and hazards. (See Appendix A). Some of the key issues relevant to land stability are summarised in the table below:

Local Waste/Landfill sites	There is a waste depot and transfer station 500m to the NE of the property
Drift Deposits	None are indicated on BGS mapping
Made Ground	None are indicated on BGS mapping
Groundwater Abstraction	There is a supply borehole around 1km to the East

Flood Risk	There is unlikely to be flood risk at the property. The area is not prone to groundwater flooding. (This should be the subject of an FRA report if commissioned and is outside of the remit of this report)
Shrink/ Swell	There is a moderate Hazard of shrink and swell from the London Clay soils
Landslide	Very Low Risk
Soluble Rocks	Negligible Risk
Compressible Ground	Negligible Risk
Collapsible Ground	Very Low Risk
Running Sand	Very Low Risk
Mining	None recorded

A number of historic OS maps have been obtained, see figures 3-5 below. These suggests that the property was built in around 1870-80.

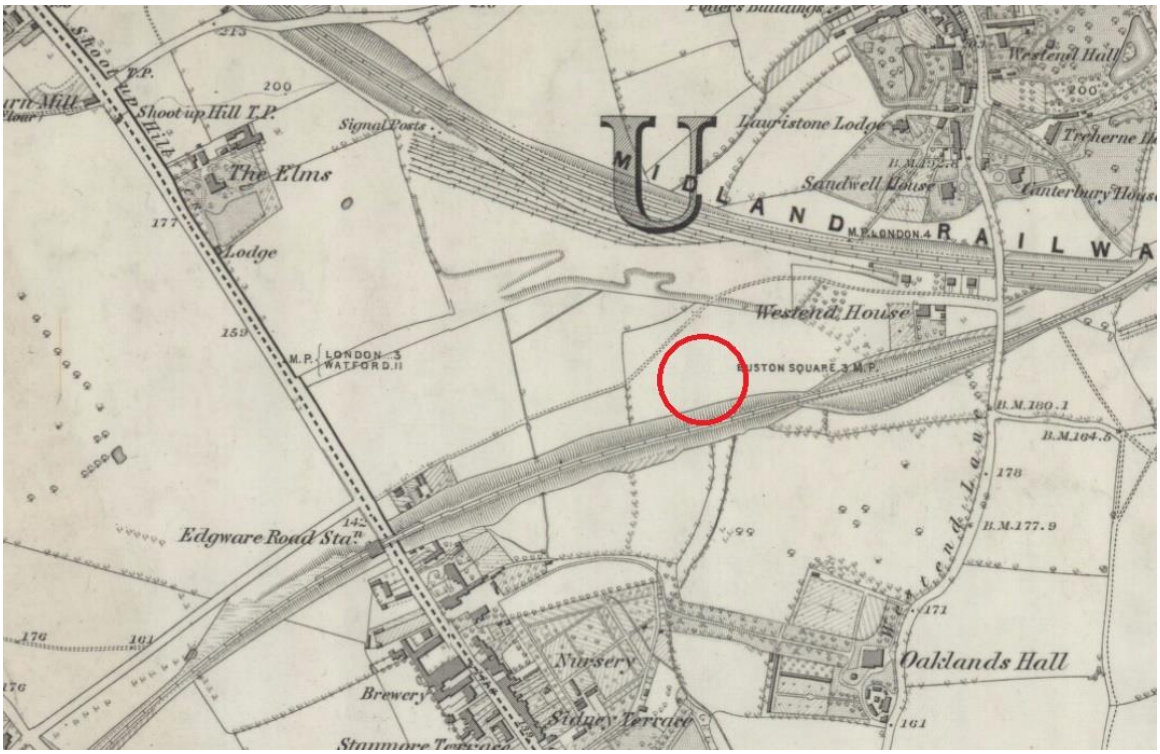

Figure 3: Historic Map 1866

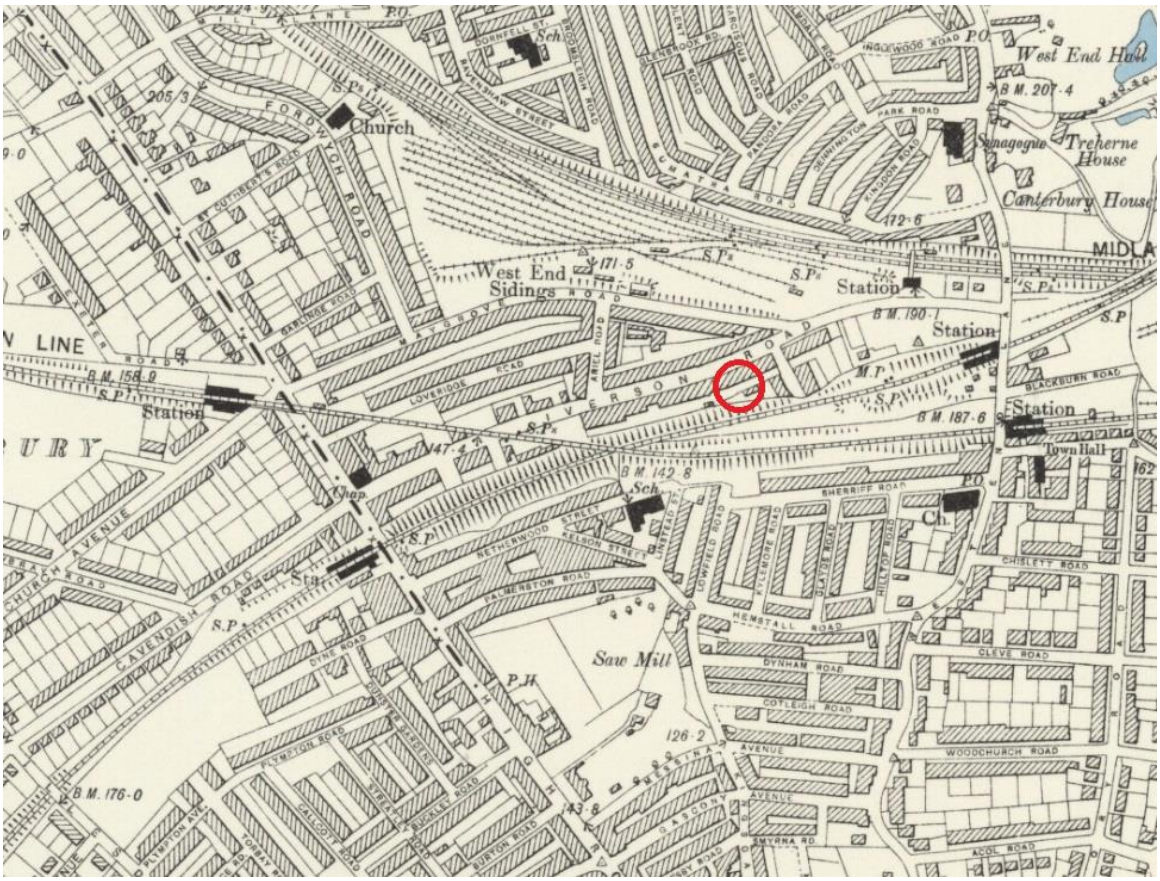

Figure 4: Historic Map 1894

5 Ground Investigation

A ground investigation (GI) has been carried out at the site by Ground and Water Ltd and results of these have been made available by G&W. The GI was carried out in March 2016.

The work comprised two window sample boreholes (WS1 and 2) to 5.00m bgl in front and rear garden areas of the property respectively. Two hand dug trail pit were also excavate to expose existing foundations. A dynamic probe was also drilled to 10m. No groundwater monitoring equipment was installed.

Below is a summary derived from the Ground Investigation report. The boreholes encountered a cover of Made Ground 1.00 to 1.80m thick. This can be summarised as a variably brown sand silty clay with brick, flint cement and carbonaceous fragments. Below this the borehole encountered a clay deposit described as brown, orange brown and grey silty clay with some silty pockets and selenite crystals. The clay is likely to be London Clay.

Groundwater was not encountered during drilling. Roots were noted above 0.8m and 1.8m depth.

The dynamic probe hole can be summarised as having N100 values less than 5 from ground level to 5 m bgl and between 5 to 10 from 5 to 10m bgl. These results can be correlated to SPT equivalents and in turn correlated to undrained shear strength. The results may be equated to an undrained shear strength range for the London Clay between 20 and 60 kPa from 1.3 to 5m bgl and 50 to 100kPa from 5.0 to 10.0 m bgl.

TP1 was excavated next to the west side of the front bay window. It encountered made ground to 1.0m overlying London Clay. Adjacent to this the pit revealed a stepped brick wall and underlying foundation with a founding depth of 1.11m (i.e. on London Clay). TP2 was located at the rear of the property and co-located with WS2. This encountered a thin cover of Concrete and Made Ground to 0.14m bgl overlying London Clay. Again the wall overlies a stepped brick foundation with the foundation base being at 0.20m below ground level, again onto London Clay.

Laboratory tests were carried out on the samples collected from the boreholes. Testing consisted of the following:

6 No. Atterberg Limit test including moisture content determination
2 No. Soluble Sulphate, pH and related tests for Concrete Classification on soil samples
1 No. one dimensional Consolidation Test

All of the Atterberg tests were conducted in the London Clay. These show general consistency with a slight reduction in water content with depth.

- Moisture content: 24 to 28%
- Plastic Limit: 23 to 28%
- Liquid Limit: 65 to 74%
- Plasticity Index: 41 to 51%
- Liquidity Index -0.02 to 0.06

The low variation in liquid, plastic limits and plasticity index is consistent with undisturbed London Clay. There is limited correlation to the dynamic probe tests. The low liquidity index values are suggestive of a firm to stiff or stiff consistency. The London Clay here is of medium to high plasticity and has high shrinkage potential.

The consolidation test was performed on a presumably remoulded sample is of limited value but indicates a soil of medium compressibility for the higher applied pressures.

6 Conceptual Ground Model

From the above a conceptual Ground model has been developed and is presented in tabular form below:

Strata	Typical Description	Depth at Property encountered in GI	Geotechnical Properties – Tentative Characteristic Values*	Other
Made Ground	Dark brown, very silty clay, with grave	Ground level to between 0.14 and 1.8m	N/A	Made Ground should not be relied upon as a bearing strata. Made Ground is likely to be encountered to greater depths at the front of the property.
London Clay	Brown and grey silty clay. Probably firm to stiff becoming stiff with depth.	0.90 to 5.00m (base not proven).	C' =0 $\phi' = 20^o$ Cu = 50 increasing to 100kN/m^2 at formation. **	The undrained shear strength of the London Clay should be confirmed prior to construction
Groundwater		Not encountered during drilling		May significantly vary seasonally or after prolonged wet or dry periods.

Table 3: Summary of Strata Characteristics

*The determination of parameters is tentative due to the lack of test data.

**Strength should be verified by hand held shear vane/ inspection during ground excavation.

7 Impact Assessment

There are no apparent major issues which should seriously affect the viability of the construction of the new basement. However the assessment of the geological environment of 158 Iverson Road and the screening exercise indicate some areas for further discussion in this report with suggested mitigation where appropriate.

Adjacent Cutting:

The London Overground is located in cutting some 40m to the south of the property. The depth of the cutting should be determined, but it is considered unlikely that there will any any impact from the basement on stability of the cutting.

London Clay/Shrink and Swell:

The basement will be founded in London Clay. These soils at this site are of medium to high plasticity and high volume change potential. The basement will be founded at around 3.5m bgl, therefore below any seasonal shrink and swell. The London Clay soils are known for their high levels of soluble sulphate. The concrete mix design should take appropriate account of sulphate levels in accordance with BRE Special Digest 1. The basement structure should be designed to account for swelling pressures. It will be important to account for the shallow nature of the existing foundations at the property and its neighbours. Any change in drainage or significant interruption/change to groundwater levels and flow patterns will need to be assessed for its implication on soil water content and consequential effect on soil volume change.

Trees and Bushes:

No trees are located in the garden although there are some bushes and a tree outside on the pavement to the front. Roots have been noted in the ground investigation at 0.8m and 1.8mbgl. Care should be taken to minimise root damage during construction works. Should bushes be removed there is potential for the soils to swell as a result which may affect this and neighbouring properties and this should be accounted for in design and further assessed as appropriate.

Groundwater/Aquifer:

Groundwater was not encountered during the ground investigation. This lack of measurement will not necessarily be representative groundwater presence and levels within the London Clay. It is recommended that a design level of ground surface is used, this accounts for seasonal variations and leaks from water supply, etc. Groundwater may be encountered during the works, particularly as seepages through sandy silty layers within London Clay or at the base of the Made Ground. These should be managed carefully to prevent ground loss particularly through loss of fines. Softening of formation due to water

ingress is a risk and softened soils should be excavated and replaced where practicable. Consideration should be given to limiting the size and time of face exposures during construction should significant flows be encountered during construction. Baseline and ongoing regular monitoring of the building and its immediate neighbours for settlement and movement/distress is highly recommended during building works and for a short period after completion. It is recommended that ongoing monitoring of groundwater levels is carried out during and up to the end of construction of the basement structure.

Lost River:

There is a lost river indicated 50m to 100m from distance from site. It is considered that this is unlikely to have an impact on the proposal, but its exact location should be verified before proceeding.

Basement Depth:

It is proposed to be construct the basement to a level of approximately 3.5m below the existing ground floor. The property adjoins neighbouring houses either side. The proposals to construct the basement is to be via underpinning at the party and rear and front walls. Underpinning proposals are understood to involve a 'hit and miss' approach in stages so each 'panel' is separated by 3-5 others from the next open one. It will be important that the building contractor is closely supervised and is experienced in this type of construction. It will be critical to prevent exposed faces from collapse or significant ground loss into the new excavation and temporary face support should be maintained where practicable. It is understood the there are no deep basements in adjoin/adjacent properties. Most ground movement should occur during wall installation, excavation of the basement and construction so the adequacy of temporary support will be critical in limiting ground movements. Heave movements will occur due to removal of soils.

A number of factors will assist in limiting ground movements:

- The speed of propping and support
- Good workmanship
- Ensuring that adequate propping is in place at all times during construction
- Installation of the first (stiff) support quickly and early in the construction sequence.
- Avoidance of ground loss through the gaps between the piles.
- Avoid leaving ground unsupported.
- Minimise deterioration of the central soil mass by the use of blinding/ covering with a waterproof membrane.
- Avoid overbreak
- Control dewatering to minimise fines removal and drawdown.

Construction near footpath and highway:

The proximity of the front of the property to the pavement and highway, means that works will be carried out in close proximity. A thorough assessment of risks to the public and the workforce will need to be developed and mitigation measures put in place where risks cannot be eliminated.

8 Conclusions

The methodology and approach of CPG4 has been followed in developing this BIA with respect to Land stability. It is concluded that with the construction of the new basement at 158 Iverson Road should not have significant impacts on land stability provided that:

- Groundwater inflow, if encountered, is reduced to a minimum and properly controlled such that there is no significant wash out of fine material. Groundwater levels should be monitored before and during construction.

- The retaining wall should be appropriately designed.

- The construction of the basement is carried out by competent and experienced contractors and precautions are taken to maintain the stability of the excavations.

- Care should be taken to minimise the disturbance and damage to bushes and their roots. Should bushes be removed then an assessment of the potential for swelling of the London Clay soils should be carried out.

- Concrete should be designed in accordance with BRE Special Digest 1 accounting for the sulphate conditions anticipated.

- Monitoring of the structures is carried out before and during construction. The exact nature of this monitoring should be determined by the structural engineer.

9 References

1. BGS Geological Map Sheet 256.
2. Ordnance Survey Map, Explorer 173, London North
3. Arup: Camden Geological, Hydrogeological and Hydrological Study.
4. Design Drawings supplied by G&W
5. G&W Ground Investigation Data available at 13/4/16
6. Groundsure EnviroInsight report for Priory Rd, GS-2103155