Ground and Project CONSULTANTS LTD

8A BELMONT STREET, LONDON NW1 8HH.Basement Impact Assessment: Land Stability

February 2016

Client:

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Contents

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 8A Belmont Street, London NW1 8HH. The property is located in the London Borough of Camden, London in the Haverstock ward, its location is indicated on Figure 1.

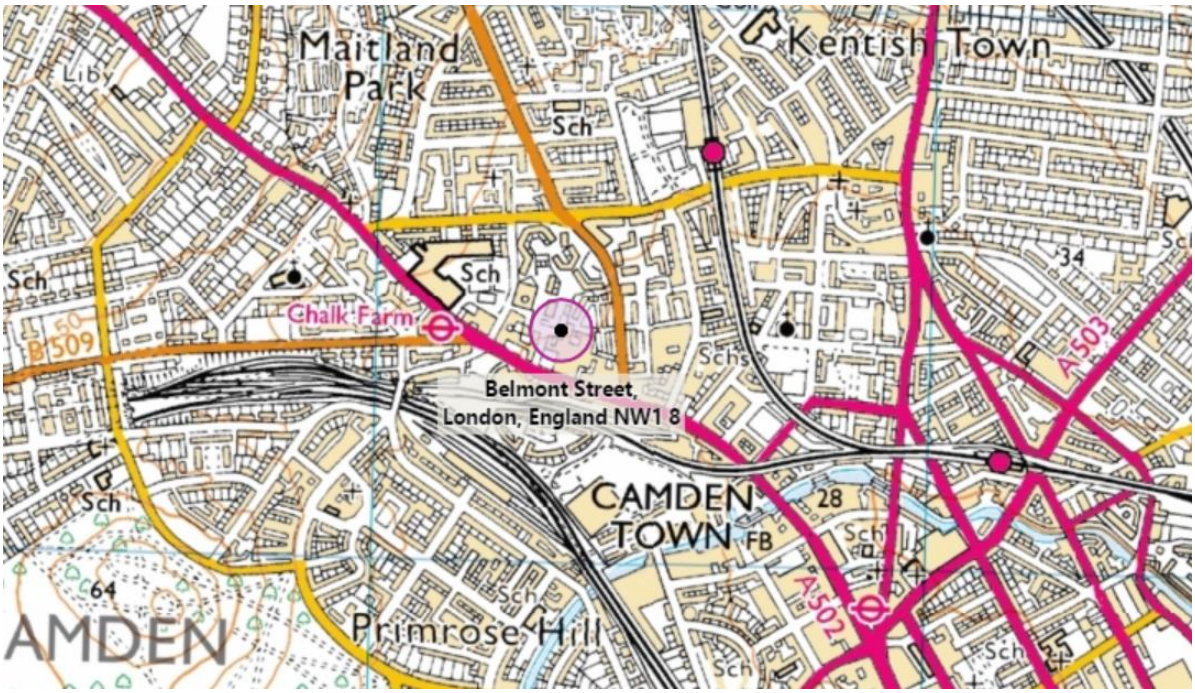

Figure 1: Site Location

2. Scope and Objective

The scope of this report and approach is as follows:

- A review 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 potential ground movements using CIRIA C580.

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 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 property is located at around 30mAOD. The land rises gradually to the North West at a gradient locally of around 1 in 20. There are no local slopes at the property.	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.	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 railway line is around 100m to the SW	None
Question 4: Is the site within a wider hillside setting in which the general slope is greater than 7degrees? (approximately 1 in 8)	The land rises gradually to the North West at a gradient locally of around 1 in 20 (<3^{o}). The general slope angles indicated on Arup Fig 16 are less than 7 degrees.	None
Question 5: Is the London Clay the shallowest strata at the site?	Yes, the geological map (sheet 256) indicates that the site is underlain London Clay with a potential for Head Deposits close to the site.	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).	No but there are trees close to the property and a number of bushes in the gardens and adjacent gardens.	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 indicated as being present at the property. Head deposits can also have high plasticity.	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 that a 'Lost River' is approximately 150m to the northeast of the property. This is a tributary of the River Fleet.	This is further discussed in the Impact Assessment.
Question 9: Is the site within an area of previously worked ground?	None known or suspected. There will be some made ground associated with past construction activities. (see ground investigation)	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). However the basement may extend into the water table.	This is further discussed in the Impact Assessment.
Question 11: Is the site within 50m of the Hampstead Heath ponds?	No. The ponds are around 2.5km to the north.	None
Question 12: Is the site within 5m of a highway or pedestrian right of way?	Yes. The basement will be within 5m of the highway and pavement.	Health Safety and environmental measures will be required to be integrated into the building contractor's methods of working. This is further discussed in the Impact Assessment.
Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	No. It is apparent that there are some cellars/ basements in all or most of the adjacent properties.	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?	No. The site is approximately 95m NE of the Northern Line tube tunnel. However the precise position should be checked.	This is further discussed in the Impact Assessment.

4. Site Information

Existing Property and Basement Proposals

The property at 8A Belmont Street is located on the south side of the road, close its junction with the other section of the street (see figure below) The site is currently occupied by a single storey brick or concrete built storage building with a short steep pitch tiles roof. Regent's Park is approximately 1km to the south and Hampstead Heath approximately 2km to the north. . The elevation of the site is around 30mAOD. The land rises gradually to the North West. The main railway line runs around 100m to the west. The northern line also runs around 100m to the west. See Figure 1 below.

To the west of the property is an 8 storey high probably late-Victorian brick built warehouse. The top two storeys are new additions, built of glass and steel. Next door to the east is a row of 3 storey mid-Victorian houses, brick built with rendering on some faces. Wall ties are noted on these properties. One of these properties

The National Grid reference for the property is TQ 28325 84400. The location of the property is provided in Figure 1 above.

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

The basement proposals comprise a single storey beneath the full footprint of a new single storey building. The basement depth will be around 3.5m maximum excavated depth with a footprint of around 18m by 6m (108m^2). The descriptions and dimensions above have been estimated from drawings and web applications such as google maps and street view. The proposed development is understood to comprise the demolition of the existing properties and construction of a pair of semi-detached two storey properties with roof accommodation and basements.

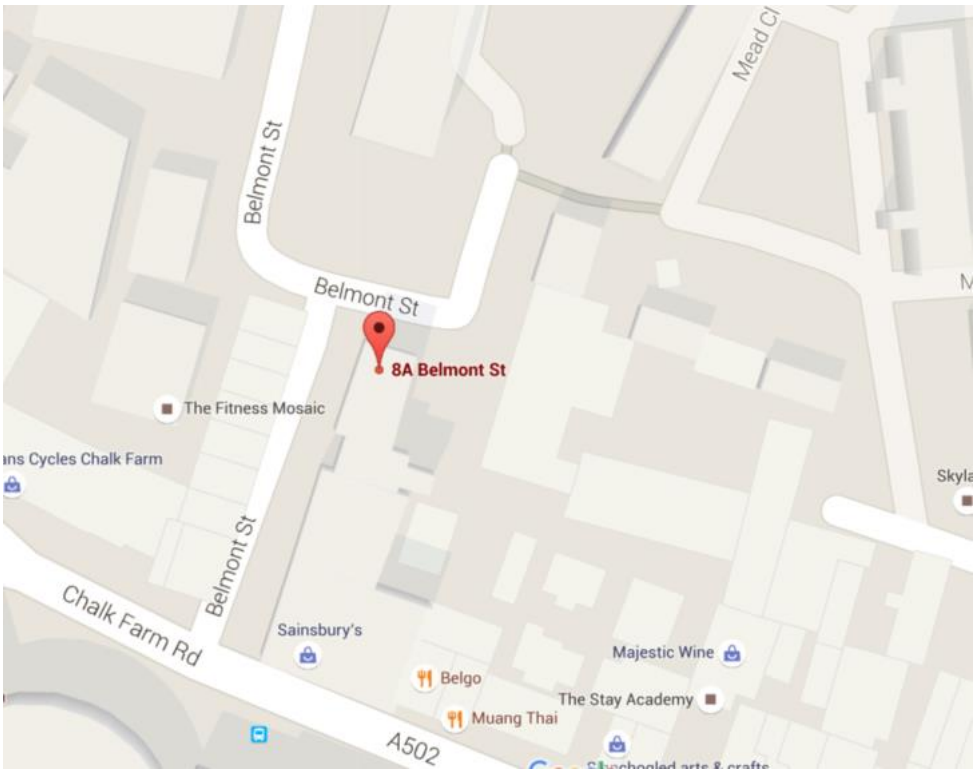

Figure 2: Street Plan

Topography

The OS map indicates the property is at around 30m AOD. The ground surface rises towards the northwest at around 1 in 20 (~3°).

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 within or very close to areas 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 3 below.

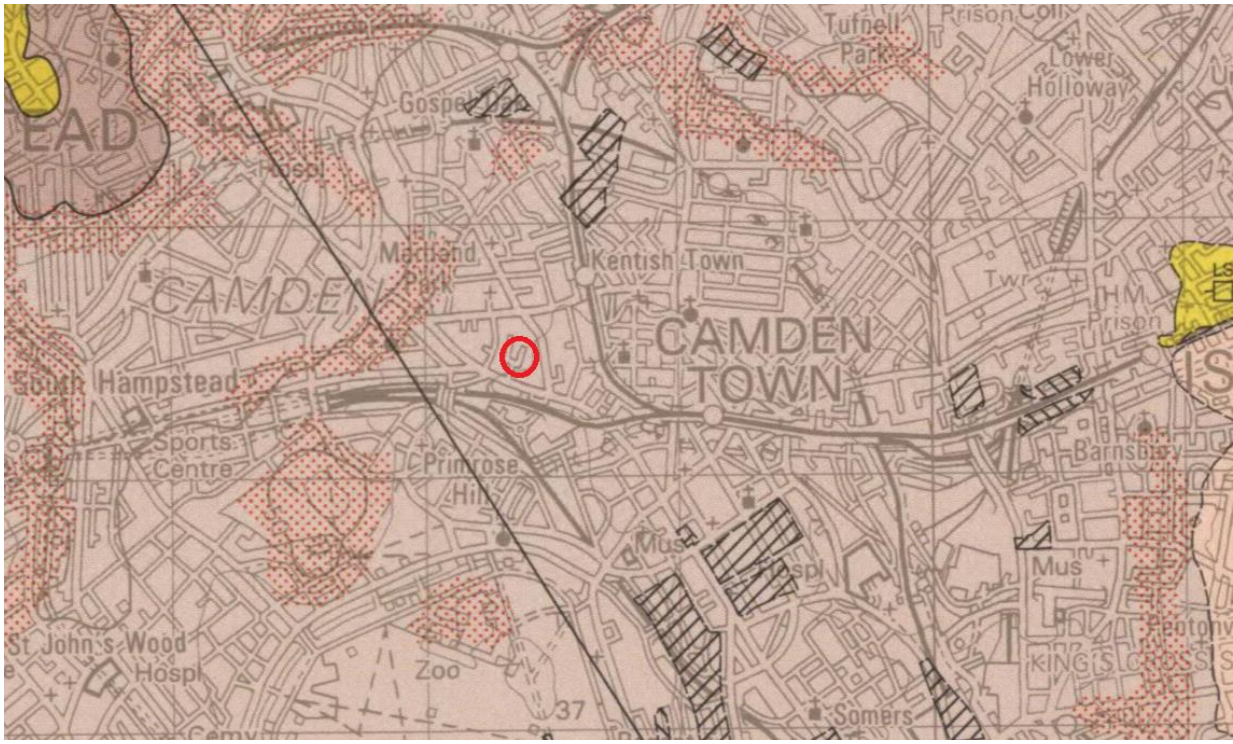

Figure 3: Geology

Hydrology and Hydrogeology

The OS Map indicates that Hampstead Ponds are located around 2.5km to the North. Figure 11 of the Arup report indicates the 'headwaters' of a 'Lost River' to the northeast of the property. There are no springs shown on OS mapping.

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).

Other Environmental Data

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

Drift Deposits	None are indicated on BGS mapping (note comments re Head Deposits above)
Made Ground	None are indicated on BGS mapping
Groundwater & Abstraction	Site on unproductive strata (London Clay). There is a groundwater abstraction point 554m to NE and a surface water abstraction point 398m to SE, and others within 1 and 2km.
Current Uses	Railway sidings 59 m to S. Other rail infrastructure and buildings within 200m. Tunnel indicated 499m to W. Sub-station 35m to NE. Petrol station 51m to W (Texaco). Various other Part A (2) and B processes within 500m. Various industrial facilities within 200m of site.
Historical Uses	Several historical tanks within 84 to 500m of site. Garage at site and 43m W and 160m E of site. Others within 500m.
River Network	Canal approx. 400m to SSE
Flooding	Very Low Risk
Ground Subsidence Risk	Moderate
Shrink/ Swell	There is a moderate Hazard of shrink and swell from the London Clay soils. Report advises: “Ground conditions predominantly high plasticity. Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. For new build, consideration should be given to advice published by the National House Building Council (NHBC) and the Building Research Establishment (BRE).”
Landslide	Very Low Risk
Soluble Rocks	Negligible Risk
Compressible Ground	Negligible Risk
Collapsible Ground	Very Low Risk
Running Sand	Negligible Risk
Mining	None recorded
Radon	Not in a Radon Affected Area

5. Ground Investigation

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

The work comprised one window sample borehole (WS1) to 4.00m bgl in the north part of the site. A dynamic probe (DP1) was carried out at the location of WS1 to 10m depth. A standpipe piezometer was installed into WS1 at 2.7m with the response zone from 1.0 to 2.7m bgl.

Below is a summary derived from the Ground Investigation report. The boreholes encountered a cover of Made Ground 2.20m thick. This can be summarised as a light brown clayey sand and gravel overlying Grey/brown sandy gravelly silty clay. Below this the borehole encountered London Clay described as a brown with occasional orange brown and grey mottled silty CLAY.

The dynamic probe-hole results can be interpreted as follows:

Depth (mbgl)	N100 Values	Probable Undrained Shear Strength (kPa)	Probable strata
GL to 2.6	Mainly 0	N/A	Made Ground
2.6 to 3.7	2 to 4	40 to 75	London Clay
3.7 to 5.1	5 to 10	75 to >150	London Clay
5.1 to 10	>10	>150	London Clay

This correlation with undrained shear strength follows a paper by S Huntley (Ref 9).

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

3 No. Atterberg Limit test including moisture content determination
2 No. Soluble Sulphate, pH and related tests for Concrete Classification on soil samples

All of the Atterberg tests were conducted in the London Clay. These are consistent with similar values both of water content and atterberg limits as follows:

- Moisture content: 31 to 32%
- Plastic Limit : 27 to 28%
- Liquid Limit: 74 to 79%
- Plasticity Index: 46 to 51%
- Liquidity Index 0.06 to 0.10

The minimal variation in liquid, plastic limits and plasticity index is indicative of London Clay, indicating a clay of high plasticity. The water content and liquidity index are reflective of a firm or firm to stiff clay.

No groundwater was encountered during the drilling of the borehole. A return visit to site on the 8th March 2016 revealed a standing water level of 2.10m bgl within the well installed in WS1.

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	Brown silty clayey sand with gravel/ silty sand clay with gravel is brick, concrete, flint	Ground level to 2.20m	N/A	Made Ground should not be relied upon as a bearing strata.
London Clay	Brown silty clay. Probably firm becoming firm to stiff.	2.20- 4.00m (base not proven). Likely London Clay in DP hole to 10m	C' =0 $\phi' = 20^o$ Cu 40kN/m^2 at 2.6m increasing with depth to 150kN/m^2 from below 4.7m**	
Groundwater		2.10m bgl		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/ borehole during ground excavation or post demolition.

The correlations with SPT values and the DPSH n100 values are not consistent with the atterberg results, nor with our experience of weathered London Clay. We have therefore suggested a characteristic value at the London Clay surface of 75kN/m^2. This is consistent with n100 values of 5 and the DP probe shows that these values steadily increase. Furthermore it likely, given the low n100 values that the DP probe encountered a greater thickness of Made Ground than the nearby borehole. It should be noted that a 16m deep embedded retaining wall has been assumed and this will be largely installed in stiff clay.

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 8A Belmont Street and the screening exercise indicate some areas for further discussion in this report with suggested mitigation where appropriate.

London Clay/Shrink and Swell:

The basement will be founded in London Clay. The soils are of 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.

Trees:

Semi-mature and bushes are located in the vicinity of the property. Care should be taken to minimise root damage during construction works. Should trees 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.

Groundwater/Aquifer:

Groundwater was encountered below the proposed basement formation level. 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 some distance from site. It is considered that this can have no impact on the proposal.

Tunnel:

A tunnel is indicated relatively close to the site. The Groundsure report confirms that distance to the tunnel is 499m to the west. It is therefore considered that the tunnel need not be considered further. The designer should confirm this location.

Basement Depth:

The basement is proposed to be constructed involving an excavation to approximately 3.5m deep. The property adjoins a neighbouring house at no.2 and is approximately 4.5m from no.16. The proposals to construct the basement is understood to be via the installation of a contiguous bored pile wall. It will be important that the piling and building contractor is closely supervised and is experienced in this type of construction. It will be critical to prevent exposed faces between piles from collapse or significant ground loss into the new excavation and temporary face support should be maintained where practicable. (See discussion on Ground Movements in Section 8. below).

8. Assessment of Ground Movement

An assessment of ground movements has been carried out as follows:

- Movements have been assessed for the adjoining property (No.2) due to the excavation of the basement which will directly adjoin and for the nearby warehouse type building (No 10a). Movements have also been assessed for no's 4, 6 and 8 Belmont Street
- Movement due to Wall installation has been assessed and the magnitude of ground movements has been assessed for the excavation in front of the installed retaining structure. A wall depth of 16m has been assumed.

Outline planning drawings developed by Martin Evans Architects and supplied by G&W have been reviewed and used to inform this assessment as well as photographs and site inspection information provided by Croft Structural Engineers.

The following key assumptions have been made:

- The maximum excavation depth is approximately 3.5m bgl.
- The method of basement construction will be the installation of a contiguous bored pile wall.
- A high wall stiffness has been assumed.
- In the permanent case the wall will always be propped at high level.
- The adjoining property (No.2) is attached to the subject property.
- No.10a is 4.5m from the property.
- No's 4, 6, 8 are 6m from the property.
- The width and height of no. 2 have been assumed to be 9m and 14m respectively.
- The width and height of no. 10a have been assumed to be 12m and 23m respectively.
- The width and height of no's 4,6 and 8 have been assumed to be 9m and 12m respectively
- A London Clay soil of at least firm to stiff consistency has been assumed, as per C580.

From figure 2.11 in C580 the following calculated assessments of ground movements have been developed due the excavation of soils in front of the wall. An excavation depth of 3.3m has been assumed.

No 10a

Distance from wall* (m)	4.5 (Near side)	16.5 (Far side)	
Horizontal Movement (mm)	9	1	
Vertical Movement (mm)	8	5	The near wall of no.10a is also the location of maximum vertical movement

No 2

Distance from wall*(m)	0m (Near side)	9m (Far side)	Max Vertical Movement
Horizontal Movement (mm)	12	4	
Vertical Movement (mm)	8	5	The max vertical movement is calculated at 2m from the basement wall at around 9-10mm.

No's 4, 6, 8

Distance from wall*(m)	6m (Near side)	15m (Far side)	Max Vertical Movement
Horizontal Movement (mm)	8	<2	
Vertical Movement (mm)	7	3-4	The near wall is also the calculated location of maximum vertical movement

This assumes that the wall is propped high and therefore a high stiffness can be assumed when reading from the graphs. It is understood that there will be adequate propping in the temporary case to justify this assumption and in the permanent case the structure will provide adequate support to the retaining walls and act as a high level prop.

There are a number of key points to note in using this assessment:

- Most ground movement will occur during wall installation, excavation of the basement and construction so the adequacy of temporary support will be critical in limiting ground movements.
- The speed of propping and support is key to limiting ground movements
- Good workmanship will contribute to minimising ground movements.
- The assessment assumes the embedded wall is installed in stiff/competent clay.
- Larger movements will be expected where soft soils are encountered at, above and below formation.

  Ground movement can be minimised by adopting a number of measures, including:

- 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.

It must be noted that the movements are calculated values based on the findings and methods of CIRIA C580. Larger movements may be generated if any one or any combination of the above recommendations and/or assumptions are not heeded or if ground conditions are different to a firm to stiff or stiff London Clay.

In terms of building damage assessment and with reference to Table 2.5 of C580 (after Burland et al, 1977), the 'Description of typical damage' given the ***calculated*** ground movements is likely to be:

- For no. 10a : 'Slight'
- For no. 2 : 'Slight'.
- For no. 4, 6 and 8 : Very Slight to Slight

Heave

Heave of the ground will occur within the basement due to soil removal and consequent unloading of the soil. Using elastic and consolidation theories, both immediate and longer term heave movements have been calculated for within the basement. These are maximum calculated

figures and apply to the centre of the basement. The figures will be significantly lower at the edges and lower still at the corners.

Immediate upward (elastic) movements have been calculated of the order of 5mm. These will be completed upon completion of soil excavation. Longer term soil swelling will also occur and this has been calculated to be of the order of 20mm.

9. 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 8a Belmont Street 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 a 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 trees and their roots. Should tress 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.
- The shear strength of the London Clay deposits at site should be confirmed and verified after demolition of the existing structure via an additional borehole/ hand held shear vane during ground excavation.

10. References

1. BGS Geological Map Sheet 256.
2. Ordnance Survey Map, Explorer 173, London North
3. Arup: Camden Geological, Hydrogeological and Hydrological Study.
4. Martin Evans Architects drawing
5. Croft Photos and correspondence
6. Ground&Water: Ground Investigation Report:. 8A Belmont Street
7. Groundsure Enviroinsight report for8A Belmont Street, HMD-445-2757166
8. CIRIA C580
9. Huntley S.L. (1990). Use of a dynamic penetrometer as a ground investigation and design tool in Hertfordshire, from Field Testing in Engineering Geology published by Geological Society Engineering Geology Special Publication No.6. (For clay).