Central Somers Town CIP

Basement Impact Assessment

DECEMBER 2015

Somers Town Community Investment Programme

Camden

Brill Place

Basement Impact Assessment

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Introduction

1.1 General

BuroHappold Engineering was commissioned by London Borough of Camden to carry out a Basement Impact Assessment of the site adjacent to Brill Place in Somers Town.

A Geoenvironmental and Geotechnical Desk Study (Geoenvironmental and Geotechnical Desk Study Report, September 2015) has also been completed by BuroHappold Engineering and has been referred to as necessary.

1.2 Scope and Purpose of Work

The work carried out comprises of a preliminary Basement Impact Assessment which is in accordance to procedures specified in the London Borough of Camden Planning Guidance CPG4.

The aim of the work is to assess if the proposed basement will have detrimental impact on the local drainage and flooding and on the structural stability of neighbouring properties through its effect on groundwater conditions and ground movement. If any impacts are identified these need to be appropriately mitigated by the design of the development.

1.3 Planning Policy Context

The London Borough of Camden policies on basement development are set out in the Council's Planning Guidance (CPG4, July 2015) and the Council's Guidance for Subterranean Development (Camden Geological, Hydrogeological and Hydrological Study, November 2010). As part of the CPG4, subterranean (groundwater) Flow, Slope Stability, and Surface Flow and Flooding screening charts are provided.

1.4 Proposed Development

The proposed development is to construct a residential tower block in the southern area of the site. The tower is at two levels. The taller south tower comprises 24 storeys and the shorter north tower comprises 19. The area surrounding the towers is predominantly soft landscaping with some hard landscaping (access roads to the east and west). There is a potential for a basement to be part of this scheme (currently not decided).

1.5 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the research carried out. The results of the research should be viewed in the context of the work that has been carried out and no liability can be accepted for matters outside the stated scope of the research. Any comments made on the basis of information obtained from third parties are given in good faith on the assumption that the information is accurate.

The Site

2.1 Site Location

The site is located in Somers Town, west of Kings Cross/St Pancras Railway Station, in London Borough of Camden. South of the site is Brill Place and west is Purchase Street. The site occupies approximately 0.7ha and is centred on Ordnance Survey National Grid Reference 529850, 183157.

2.2 Site Layout and History

The site was attended on the 11th September 2015 for the purpose of conducting the site walkover.

The proposed building site is the south eastern area of an open park intersected with tarmac paths. The building area falls to the north, with the remaining park generally falling slightly from the west to east, however the ground profile has significant (>1m) gently undulations throughout the park. A play park, with a rubberised tarmac finish, is located in the north east of the park, 80m north of the proposed building, with swings and metal climbing frames. In the south of the park, adjacent to the west of the proposed building, there is a fenced tarmac court which could not be accessed during the walkover. The remaining ground across the park including the proposed building area is typically covered in grass, with mature ash, sycamore and horse chestnut trees throughout. In some areas (<5% cover) bare earth is on show, which is a brown topsoil with occasional flints.

2.2.1 Neighbouring Properties and Area

To the north and east of the site the area is in residential use (Hampden Close and Coopers Lane respectively), Brill Place forms the south boundary with construction works (Crick research centre) beyond. Purchase Street forms the western boundary, which is constrained by a high brick wall to the south and railings to the north. Further east of the site is St Pancras Railway Station and north-west is Edith Neville Primary School, with Somers Town Medical Centre beyond. The immediate surrounding area of the proposed basement development consists of some soft landscaping, there are some trees present that may require felling for future development. If this is required then consent from the London Borough of Camden will need to be awarded.

Ground Conditions

2.3 Geology

The Geological Survey map of the area (Sheet 256) indicates that the site is underlain by the London Clay Formation, overlying the Lambeth Group which is in turn underlain by the Thanet Sands and then the White Chalk at depth (tabulated below). From historical research (detailed in the Buro Happold Desk Study report, section 2.5) it is likely that the ground beneath the site is underlain by a variable thickness of Made Ground (approximately 4m)..

The ground level lies between 17.25 and 20 m AOD with the average ground level reported in the historical borehole data base as 18.62 m AOD.

Table 0-1 Summary of Geology

Strata	**Description**	Depth to top of stratum mbgl [**Approximate Thickness]**	**Aquifer Status**
Made Ground	Firm greenish grey/brown very silty, sandy CLAY with sub-angular to rounded fine to medium gravel of flint, brick, pottery, ash, coal and wood.	Surface **[<5m]**	-
London Clay	Stiff, grey brown, extremely closely fissured CLAY. Fissures randomly orientated, planar and smooth. Rare fine gravel size selenite crystals. Some pyrite nodules. Locally brown silty fine sand.	1-5 mbgl **[~25m]**	Unproductive
Woolwich and Reading Beds (Lambeth Group)	Very stiff red brown mottled blue grey, friable, thinly to thickly laminated CLAY with thin laminae (<3mm) of brown silty fine sand. Extremely closely fissured, fissures locally slickensided and slightly polished.	21 mbgl (approx.) **[~14m]**	-
Thanet Sand	Glauconite-coated nodular flint at base, overlain by pale yellow-brown, fine-grained sand that can be clayey and glauconitic. Rare calcareous or siliceous sandstones.	34mbgl (approx.) **[~8.5m]**	Secondary (if present potentially in hydraulic continuity with Chalk)
White Chalk	Chalk with flints with discrete marl seams, nodular chalk, sponge-rich and flint seams throughout.	43mbgl **[>100m]**	Principal

2.4 Slope Stability

The site contains small undulations, but overall is predominantly flat in nature. It is unlikely that slope stability will cause any problems with the proposed basement development.

Excavation and construction of the basement has the potential to cause some movement in the surrounding ground which could affect neighbouring sites. The proposed basement could affect the foudantions to the Crick Institute, south of the site. The impact assessment section of this report addresses this issue.

2.5 Hydrogeology

The Chalk underlies the site at a depth in excess of 100m below ground level and is a Principal Aquifer. A Principal Aquifer is defined as layers of rock or drift deposits that have high intergranular and/or fracture permeability capable of supporting water supply and/or river base flow on a strategic scale. In this regard the available data shows there are two groundwater abstractions located over 250m (but within 500m) of the site. The site is not in a source protection zone.

2.6 Hydrology and Drainage

The Grand Union Canal is located >250m north-east of the site. The River Fleet is culverted and located 80m west but was once located adjacent to St Pancras Road, 80m north-east of the site. There are two surface water abstractions, one located 370m north associated with Grand Union Canal/Regent's Canal at Camley Street Nature Park and another 550m north-east associated with Regent's Canal.

It is unlikely that any of the assessed criteria for groundwater will impact the site and its surroundings (according to historical borehole records, no groundwater was encountered) . Groundwater monitoring will take place after completion of the current ground investigation. This will allow for a hydrogeological model to be constructed across the site and its parameters to be determined.

While nowhere in the borough is identified by the Environment Agency as being flood prone from rivers, there are still parts that are identified as being subject to localised flooding from surface water. Areas north of Regents Canal (Grand Union Canal), including Hampstead were particularly badly hit in 1975 and 2002 due to high intensity rainfall event (Ref 2). These areas are not within close enough proximity to have any detrimental impacts upon this proposed development.

2.7 Ground Shrinkage and Swelling

The Groundsure report (Ref 4) has identified seasonal shrink-swell subsidence on the site, the hazard has been identified as **moderate**. The presence of seasonal shrink-swell could cause instability within the site if shallow foundations are adopted. Given that the proposed development is a high-rise structure, deep foundations are likely to be used, hence the impact of swelling/shrinking soils is negated. The presence of these materials is to be confirmed once the site investigation is completed, and foundation design undertaken.

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Stage 3 Site Investigation

3.1 Site Investigation and Study (Stage 3)

A site investigation is currently being carried out to determine the ground model and the hydrogeological model for the site. This will include, extent of the variable thickness of Made Ground and London Clay, groundwater levels and seepages (followed by monitoring), permeability of underlying strata and, investigation of existing obstructions / adjoining foundations. Additional information on the geotechnical and geoenvironmental properties will be obtained by means of in situ and laboratory testing.

The development will include hard surface / paved areas which is likely to create some run-off. The volume of water requiring disposal from this run-off and the disposal methods will be detailed in the drainage strategy (which will come once groundwater monitoring is complete). The site investigation will identify groundwater, if any, and the permeability of the underlying strata.

Geotechnical Assessment

4.1 Geotechnical Parameters

The following sections provide background information on the derivation of geotechnical soil parameters for assessing the impact of basement construction. The information provided by BGS borehole records (TQ28SE1953) proves the geology beneath the site to be mainly underlain by the London Clay, overlying this was varying thicknesses of Made Ground. At depth, the Woolwich and Reading Beds were present. Note that no site investigation information has been used to determine these parameters as it is not currently available. A ground model has been developed to be used in the impact assessment, see Table 0-1.

Table 0-1 Design Ground Model

Soil Type	Top of Layer (m OD)	Thickness (m)	SPT (N Value)**
Made Ground	18.9 (varies)	4.6	28-66
London Clay	14.3	24.1	12-60
Woolwich and Reading Beds	-9.8	Depth not proven	55-66

**SPT 'N' values taken from BGS borehole logs from previous GI*

Table 0-2 Summary of Geotechnical Parameter Information

Stratum	Depth top (m OD)	ɣ (kN/m³) saturated	S_u (kN.m³)	SPT 'N'	c' (kN/m²)	ϕ (°)	v'	k_0	E_{uh}	E'_h	k
										Soil Modulus – Retaining Wall (0.1% Strain) (mN/m²)	Horizontal Permeability m/s
Made Ground (Granular)	18.9	19-20	-	28	0	34	0.2	-		10	10^{-4} to 10^{-8}
Made Ground (Cohesive)	-	15-19	-	66*	0	-	0.2	-		8	10^{-4} to 10^{-8}
London Clay	14.3	18-20.5	60 + 4z [max. 280 kPa]	12-60	0	24	0.2	1.2	800Su [S_u=48 + 3.2z]	600Su [S_u=36 + 2.4z]	10^{-8} to 10^{-10}
Woolwich and Reading Beds	-9.8	19-21	280 kPa [below -10m OD]	55-66*	0	28	0.2	1			10^{-8} to 10^{-4}

**Values taken from historical BGS borehole records – incomplete penetration*

4.1.1 Made Ground

Classification

The Made Ground in this area is described as medium dense, red-brown, locally slightly clayey, fine to coarse SAND with much angular to sub-rounded brick, chalk, flint gravel. Occasional cobble size pockets of firm brown slightly sandy clay with little gravel.

Strength

The effective shear strength parameters of the granular Made Ground material has been directly determined from Standard Penetration Tests (SPT 'N' Values) and descriptions from the historical BGS borehole, TQ28SE1953. The SPTs varied between 28 to 66. Overall a moderately conservative choice of design N value is N=28, for a medium dense material.

The peak (ϕ'_{peak}) and constant volume (ϕ'_{cv}) effective angle of shearing resistance of granular soils were determined using Table 3 from BS8002 (Ref 6), a conservative estimate of A (angularity), B (grading) and C (SPT N value) is as follows: A = 2 , B = 0, C = 2 .

$\phi'_{peak} = 30 + A + B + C$

$\phi'_{cv} = 30 + A + B$

Therefore, following angle of shearing resistance values can be adopted in design:

$\phi'_{characteristic} = 34°$

It should be born in mind that made ground by its very nature can vary significantly from area to area and the parameters adopted here are based on our engineering judgement and experience of similar ground in London. Whilst we belief the assumption made are reasonable the engineering characteristics may vary.

4.1.2 London Clay

Classification

The London Clay lies immediately below the Made ground. The clay was typically firm to very stiff, dark grey, extremely closely fissured, locally slightly sandy and silty. Occasional gravel sized selenite crystals and light brown calcareous claystone were encountered in the upper part. The material became more sandy (fine) below 7.2m bgl. The information shows that this material is typical of London Clay in the London area.

Undrained Shear Strength

The SPT N-values in the London Clay ranged between 12 and 60 reflecting stiff to hard behaviour. SPT results for the London Clay are illustrated in Figure 0-1.

Based on empirical relationships between SPT N-values and undrained shear strength of cohesive soils (Ref 20) values of undrained shear strength can be determined from the SPTs by incorporating a correlation factor for the soil using the relevant plasticity index range.

$Su = f1.N$ (kPa)

Where N = SPT (uncorrected) N-values, Su = undrained shear strength (kPa), f1 = correlation factor based on Plasticity Index.

Based on SPT results and using an f1 factor of 4.5, the undrained shear strength for the London Clay ranges from 60 kPa at the surface and 280 kPa at 60m below ground level.

A moderately conservative undrained shear strength profile has subsequently been adopted as shown below:

$Su = (60 + 4z)$ kPa

where z = depth below top of London Clay in metres

The design parameters adopted in this assessment are summarised in Table 0-2 below.

Table 0-3 Design Parameters

Design Parameter (Unit)	Values
Bulk unit weight, ɣ (kN/m^3)	18 to 20.5*
Undrained shear strength, S_u (kN/m^2)	60 + 4z
Effective cohesion intercept, c′ (kN/m^2)	0
Angle of shearing resistance ϕ′ (°)	24
Undrained Young's modulus, E_u (MN/m^2)	(400S_u)
Drained Young's modulus, E′ (MN/m^2)	(0.75E_u)
Coefficient of earth pressure at rest, K_0	1.2

**Ranges taken from Ref 7*

Stiffness

Ground movements in clays are usually divided into two distinct phases:

1. Undrained movements occurring over a limited period of time in which excess pore water pressures generated by the change in stress state of the soil do not dissipate. As the pore water pressures remain unchanged, the volume of the soil does not change.
2. Drained movements occur as the clay swells or consolidates and the excess pore water pressures dissipate over a given time. The time to a drained state is primarily dependent on the permeability of the soil, and the drainage path.

Vertical Stiffness

Typical relationships between stiffness and undrained vertical shear strength have been adopted for the London Clay (Ref 7), taking into account appropriate strain levels for each substructure element. The strain level determined from Ref 7 is at 0.1%.

For foundation analysis, the following vertical stiffness values are recommended for assessing ground movements at formation level:

- Undrained stiffness: E_u = 400S_u (24+1.6z) MPa, with Poisson's ratio v = 0.5;
- Drained stiffness: E′ = 300S_u (18+1.2z) MPa with Poisson's ratio v = 0.2.

The ground movement data used for deriving the long-term stiffness value includes movements occurring during construction.

Horizontal Stiffness

For the undrained horizontal Young's modulus (E_{uh}) at 0.1% strain (Ref 7), analysis of retaining walls the following stiffness values are recommended:

- Undrained stiffness: E_{uh} = 800S_u (48+3.2z) MPa with Poisson's ratio v = 0.5;
- Drained stiffness: E_h′ = 600S_u (36+2.4z) MPa) with Poisson's ratio v = 0.2.

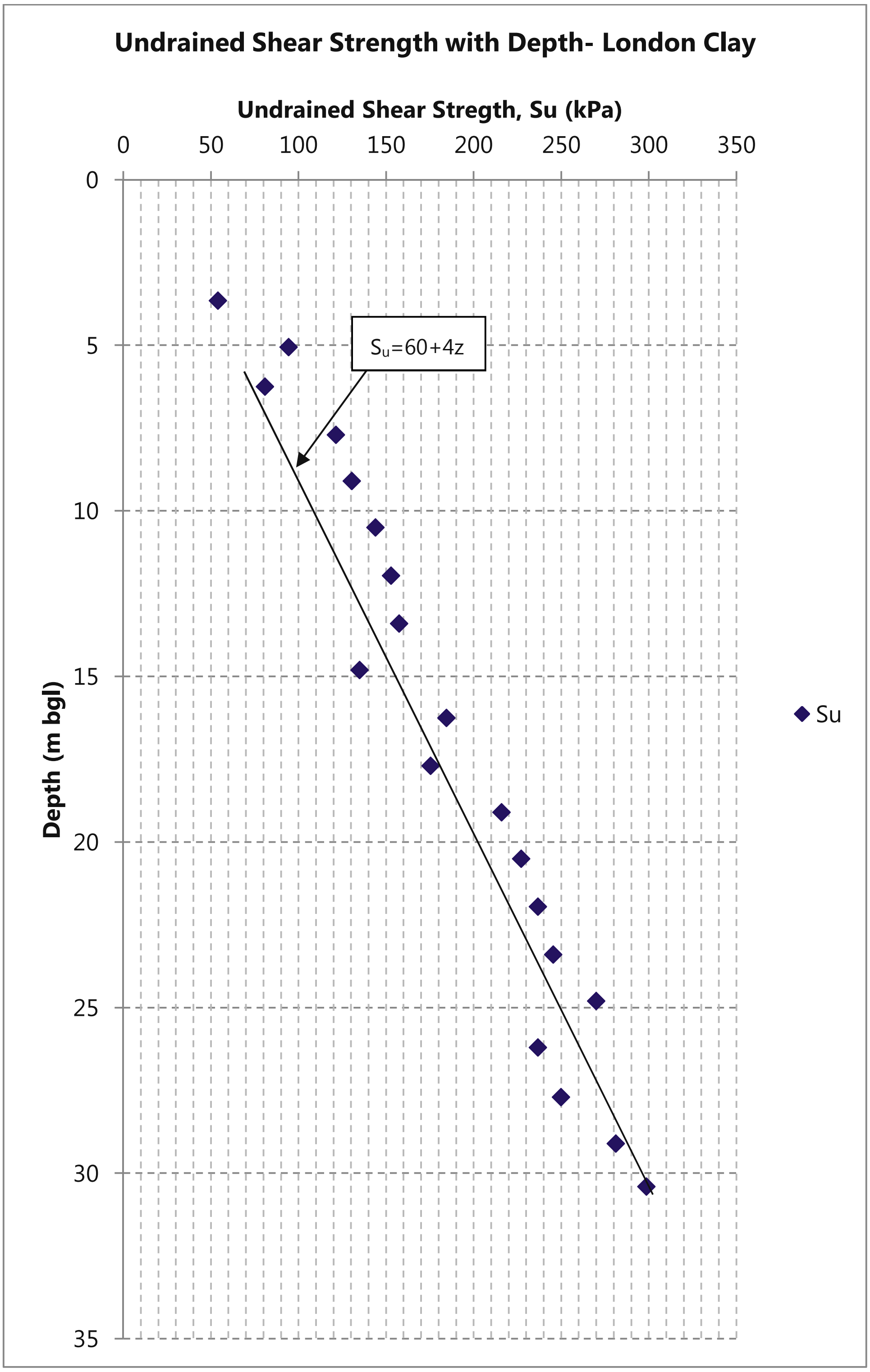


Figure 0-1: Su (undrained shear strength) vs. depth

Impact Assessment

5.1 The Impact Assessment Process

The impact assessment is undertaken to determine the impact of the proposed basement on the baseline conditions around the site and is made based on currently available information based in the public realm.

The parameters and assumptions made in this report are based on conservative parameters, and construction sequencing to provide a conservative estimate of the impact on the surrounding structures.

5.1 The Impact Assessment Process

This section summarises the assumptions, methodology and the results of the assessment that has been carried out to predict the impact of the proposed development on the existing Crick institute. The Crick institute is located on the south side of Brill Place road, and is approximately 16 meters away from the proposed development. No other sensitive buildings are identified as being in the zone of influence of the proposed basement construction, as the proposed development is currently within the boundary of the local park (Brill Place).

5.2 Assumptions & Methodology

The proposed basement FFL is +13.01 m OD. The ground floor FFL is +18.9m OD as shown in the drawing included in this report as Appendix B. The basement slab is assumed to be 0.5m thick. An overdig allowance of 0.5m is assumed for this assessment.

On the basis of the above assumptions, the total retained height is 7m approx. It is assumed that the retaining system will comprised of Hard/Firm secant pile wall (600mm diameter piles; centre to centre spacing of 900mm) supported by the temporary steel prop under short term conditions and the permanent slab under long term conditions. This method of construction is typically used for these ground conditions in London. These wall properties have been used to assess the wall system stiffness and consequent behaviour and response of the ground. This wall configuration will almost certainly be different to that used in the eventual construction but we believe that these assumption will reflect reasonably closely the design that will be used.

The assumed construction sequence is as follows

Stage 1: Wall Installation

Stage 2: Apply surcharge of 20kPa on the active side of the wall.

Stage 3: Excavate 1m below ground level

Stage 4: Install the temporary prop

Stage 5: Excavate to +12.51m OD

Stage 6: Install the Base Slab

Stage 7: Install the roof slab

Stage 8: Remove the temporary steel prop

Stage 9: Long term conditions.

The stratigraphy and the soil properties are summarised in the Table 7.2.

5.3 Retaining wall design.

This assessment assumes thefinal design will be carried out in accordance with Eurocode 7 (EC7).

The minimum required embedment for wall stability was determined by using EC7 combination 2 of design approach 1 (DA1C2). This combination is more critical as compared to the combination 1. The combination 1 is used to determine the load effects induced in the wall in view of structural design of the wall. However, this is arbitrary as this BIA focuses on the movement of the wall under SLS (serviceability limit states) conditions.

The minimum embedment of the wall was calculated to 5.5m, for a single propped system. The maximum bending moment induced in the pile was 285 kN-m/pile. The bending moment envelope is shown below as Figure 8-1

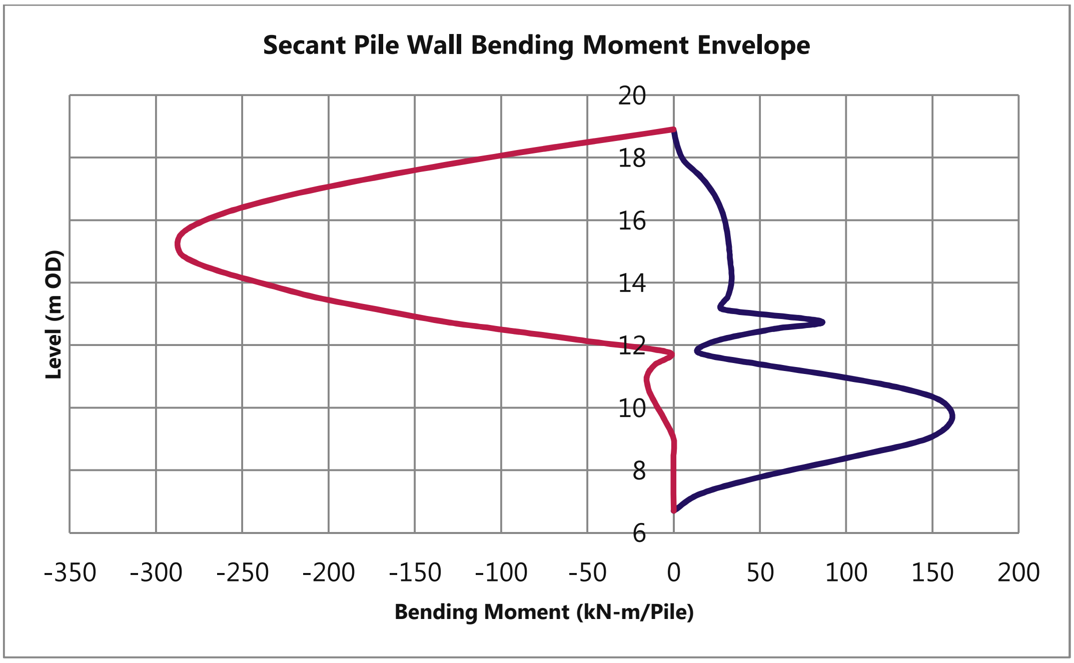


Figure 8-1: Secant Pile Wall Bending Moment Envelope

5.4 Ground Movements

Ground movements adjacent to any excavation are a function of the stiffness of the ground, the wall and prop stiffness, referred to as the system stiffness and the depth of the excavation.,CIRIA C580 case history ground movement profiles have been adopted to assess these ground moments. The curves are normalised representations of ground response due to excavations behind retaining walls.

The ground movement modelling tool OASYS XDisp has been used to inform the assessment.

The following curves were used to make a prediction of ground movement.

A) High stiffness curve from Figure 2.11 (a) "Ground surface movements due to excavation in front of wall in stiff clay (Horizontal Movements)",

B) High stiffness curve from Figure 2.11 (b) "Ground surface movements due to excavation in front of wall in stiff clay (Vertical Movements)".

The vertical and horizontal ground movements due to the basement excavation are shown below as Figure 8-2 and Figure 8-3 respectively. These movements have been used to calculate the maximum tensile strain in the Crick institute basement wall as a result of the proposed excavation.

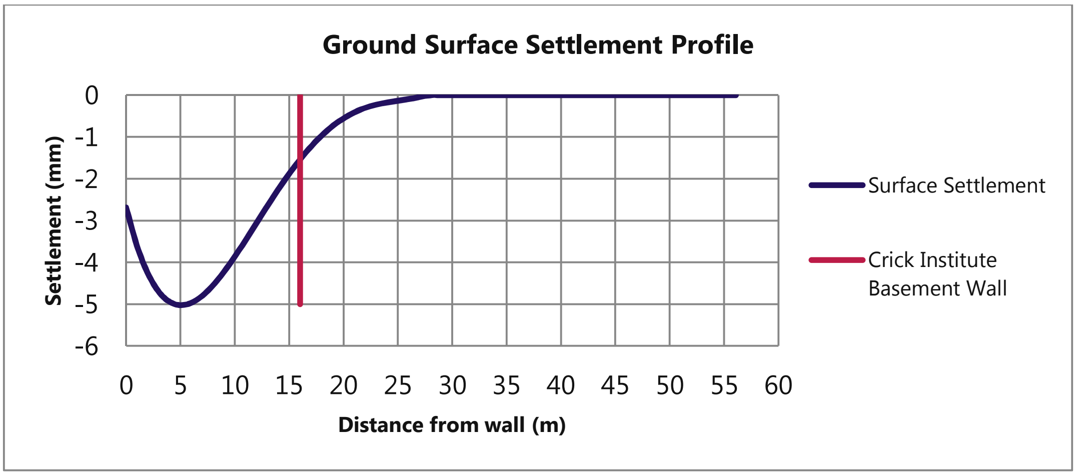


Figure 8-2: Ground surface settlement

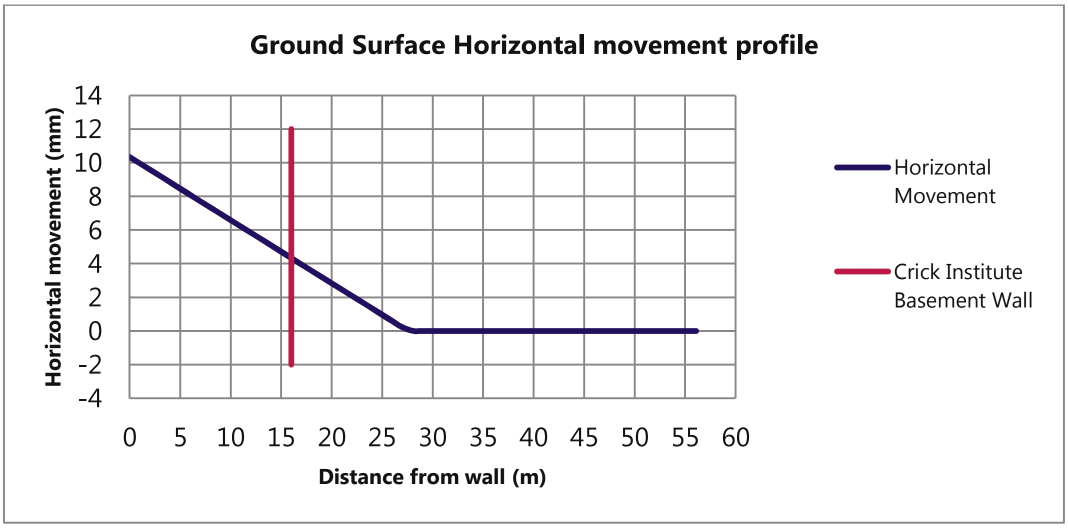


Figure 8-3: Ground surface horizontal movement

The vertical and horizontal ground movements contours due to the basement excavation are shown below in Figures 8-4 and 8-5 respectively.

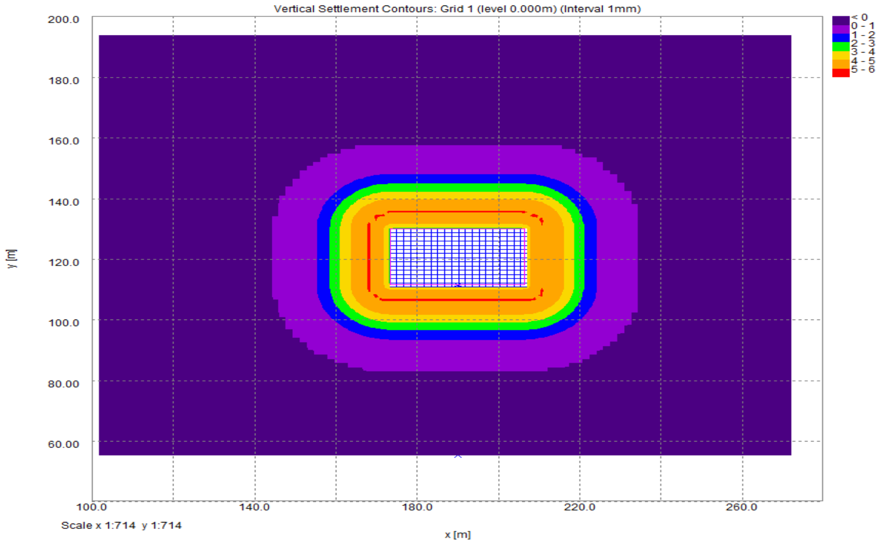


Figure 8-4: Settlement contours

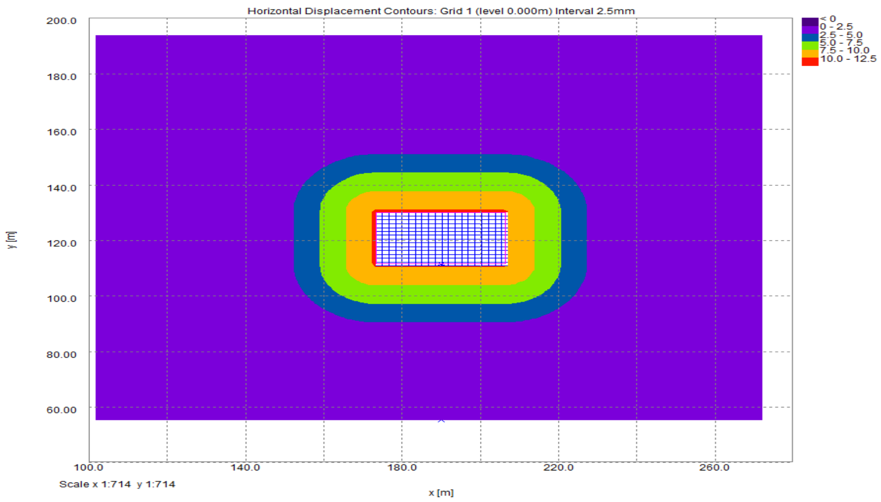


Figure 8-5: Horizontal ground movement contours

5.5 Damage Category

The damage category of the Crick's institute lower basement is determined by using the method proposed by Burland and Wroth (1974).

The results of the damage assessment are summarised below in Table 8-1

Curvature	Max. Tensile Strain	Damage Category
Hogging	0.039	Negligible (see table 8-2)
Sagging	0.038	Negligible (see table 8-2)

Table 8-1: Damage Category of Crick's Institute

Building / Structure Damage Risk Classification (Burland (1997))

Damage Category	Category of damage	Description of typical damage+ (Ease of repair is underlined)	Approx. crack width* (mm)	Limiting tensile strain (%)
0	Negligible	Hairline cracks	< 0.1	< 0.05
1	Very Slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in buildings. Cracks in external brickwork visible on inspection.	< 1	0.05 - 0.075
2	Slight	Cracks easily filled. Redecorating probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weather tightness. Doors and windows may stick slightly.	< 5	0.075 - 0.15
3	Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weather tightness often impaired.	5 - 15 or a number of cracks > 3	0.15 – 0.3
4	Severe	Extensive repair work involving breaking out and replacing sections of walls, especially over doors and windows. Windows and door frames distorted, floor sloping noticeably. Walls leaning and bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15 - 25 but also depends on number of cracks	> 0.3
5	Very Severe	This requires a major repair job involving partial or complete rebuilding. Beams lose bearing, walls lean badly and require shoring. Windows broken due to distortion. Danger of instability.	Usually > 25 but depends on number of cracks.	-

Table 8-2: Building / Structure Damage Risk Classification (Burland (1997))

Summaries and Conclusions

6.1 Summary

A Basement Impact Assessment has been carried out to identify any potential impacts the proposed development may have on neighbouring properties relating to subterranean flow, excavation works and surface water and flooding. The assessment is made on ground data in the public realm. No site specific information is available however a moderately conservative approach has been adopted. This is based on our assessment and experience of the most likely ground conditions and ground properties that could be encountered.

6.2 Conclusions

The current assessment has shown:

- Negligible ground movement due to the proposed basement construction will occur, assuming best practice in basement construction is adopted. Based on the findings of this preliminary assessment based on conservative parameters; negligible impact (category 0-1) is predicted for the Crick Institute basement wall.

- Following the completion of the ground investigation and detailed design of the basement structure, this impact assessment should be reviewed and revised accordingly to confirm that the predicted movements are within the tolerance of neighbouring structures.

- Following the completion of the ground investigation, and subsequent monitoring of ground water, a comprehensive assessment should be made of the impact of the basement on ground water flows in the vicinity of the development.

References

Ref 1. Camden Planning Guidance (July 2015) Basements and Lightwells.

Ref 2. The London Borough of Camden (2013) Flood Risk Managing Strategy.

Ref 3. London Borough of Camden (2010), Guidance for Subterranean Development (Camden Geological, Hydrogeological and Hydrological Study).

Ref 4. BuroHappold Engineering Geoenvironmental and Geotechnical Desk Study Report (September 2015). Includes Groundsure Report.

Ref 5. BRE, "BR414. Protective Measures for Housing on Gas Contaminated Land," BRE, 2001.

Ref 6. British Standard, "BS8002:1994 Code of practice for Earth retatining structures," British Standard Institution, LONDON, 2001.

Ref 7. J.B. Burland, J.R.Standing and F.M.Jardine, "Building Response to Tunneling – case studies from construction of the Jubilee line extension, London", Thomas Telford Publishing, 2001.

Appendix A

V98

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
CTRL GI DATA - Entire NDATA19 data set	SA3719

Boring Method	Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion		17.40	UR/LCE	Issue 1

	Location	Dates	Engineer	Sheet
	529941 E 183198 N	20/11/1995	RLE	1/4

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					17.32	0.08	Brick sets. (MADE GROUND)
					17.22	0.18	Medium to coarse sand and fine and medium gravel. (Driller's description);(MADE GROUND)
					17.12	(0.10) 0.28 (0.10)	TARMACADAM (Old road surface);(MADE GROUND)
					16.60	(0.52) 0.80	CONCRETE;(MADE GROUND)
0.80	K2						Medium dense red brown locally slightly clayey fine to coarse SAND with much angular to subrounded predominantly fine to coarse brick; chalk and flint gravel. Occasional up to cobble size pocketsof firm brown; grey and red brown slightly sandy clay with a little gravel.;(MADE GROUND);At 2.20m; possibly very dense.;Below 2.20m; becoming clayey.
0.80	V3						
0.80-1.20	B1						
1.20-1.65	CPT N=28			4,7/4,5,8,11			
1.20-1.70	B4						
1.80	K5						
1.80	V6						
						(2.30)	
2.20-2.58	CPT 50/225	2.00		2,6/15,19,16			
2.20-2.80	B7						
2.80	K8						
2.80	V9						
3.10	K11				14.30	3.10	Firm; becoming stiff with depth; brown extremely closely fissured CLAY. Fissures randomly orientated; smooth and planar; locally gleyed grey. Occasional partings of orange brown silty fine sand and occasional medium and coarse sand size selenite crystals; concentrated on fissures. Occasional roots (<2mm) on fissures.;(LONDON CLAY - GRADE IIIb);Below 3.60m; becoming grey brown.;Below 5.00m; becoming brown grey locally blue grey; fissures occasionally iron stained. ;At 5.05m; occasional up to medium gravel size selenite crystals and a little light brown calcareous claystone; weak. Recovered as angular andsubangular fine gravel size fragments.
3.10	V12						
3.10	D10						
3.15-3.60	U13			23 blows			
3.60	D14						
3.65-4.10	SPT N=12	3.10		2,3/2,3,3,4			
3.65-4.10	D15						
4.30	K16						
4.30	V17					(2.60)	
4.55-5.00	U18			61 blows			
5.00	D19						
5.05-5.50	SPT N=21	4.50		3,6/7,4,5,5			
5.05-5.50	D20						
5.30	K21						
5.30	V22						
5.70	D23				11.70	5.70	Stiff; grey; very closely fissured CLAY. Fissures randomly orientated; smooth and planar to curviplanar and undulose. Occasional partings and thin laminae (<1mm) of light brown and dark grey silty fine sand.;(LONDON CLAY - GRADE IIa);UNCERTAIN BOUNDARY;Below 7.20m; locally becoming slightly sandy (fine) with extremely closely spaced partings.;
5.70	V25						
5.70	K24						
5.80-6.25	U26			47 blows			
6.25-6.70	SPT N=18	6.00		2,3/4,4,5,5			
6.25	D27						
6.30-6.75	D28						
7.20-7.65	U29			65 blows			
7.65	D30						
7.70-8.15	SPT N=27	6.00		3,4/5,6,8,8			
7.70-8.15	D31						
8.60-9.05	U32			61 blows			
9.05	D33						
9.10-9.55	SPT N=29	6.00		4,4/5,7,8,9			
9.10-9.55	D34						

Remarks
1) Prior to boring an inspection pit was excavated by hand to 1.20m depth. ;2) Groundwater was not encountered.;3) Arrangements for Aquifer Protection were implemented.;4) The borehole was advanced by chiselling from 2.50m to 2.70m for 45 minutes.;5) Insitu tests for gas composition were carried out during borehole construction.;6) On completion of boring; a 19mm standpipe piezometer was installed with a Casagrande tip at 15.00m and the following detail: From 30.90m to 16.30m; cement/bentonite grout; from 16.30m to15.30m; bentonitseal; from 15.30m to 13.30m; sand filter response zone; from 13.30m to 12.30m; bentonite seal; from 12.30m to 1.00m; cement/bentonite grout; andfrom 1.00m to ground level concrete and a double flush lockable cover.

Scale (approx)	Logged By
1:50	SRJ

Figure No.

British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL	Site CTRL GI DATA - Entire NDATA19 data set	Borehole Number SA3719

Boring Method	Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion		17.40	UR/LCE	Issue 1
	Location 529941 E 183198 N	Dates 20/11/1995	Engineer RLE	Sheet 2/4

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.00-10.45	U35			71 blows		(6.30)			
10.45	D36								
10.50-10.95	SPT N=32	6.00		3,6/7,7,8,10					
10.50-10.95	D37								
10.70	K38								
10.70	V39								
11.45-11.90	U40			60 blows					
11.90	D41								
11.95-12.40	SPT N=34	6.00		5,7/8,7,9,10	5.40	12.00	Very stiff; dark grey; very closely to closely fissured slightly sandy (fine) CLAY. Fissures; smooth and planar. Locally with a dusting of silty fine sand.;(LONDON CLAY - GRADE Ib);From 15.75mto 16.20m; with occasional thin laminae of grey silty fine sand.		
11.95-12.40	D42								
12.90-13.35	U43			65 blows					
13.35	D44								
13.40-13.85	SPT N=35	6.00		4,6/7,9,9,10					
13.40-13.85	D45								
14.30-14.75	U46			65 blows					
14.75	D47								
14.80-15.25	SPT N=30	6.00		3,5/6,7,8,9					
14.80-15.25	D48								
						(6.50)			
15.70	K49								
15.70	V50								
15.75-16.20	U51			79 blows					
16.20	D52								
16.25-16.70	SPT N=41	6.00		6,8/9,10,11,11					
16.25-16.70	D53								
17.20-17.65	U54			93 blows					
17.65	D55								
17.70-18.15	SPT N=39	6.00		6,8/8,9,10,12					
17.70-18.15	D56								
18.50	V59				-1.10	18.50			
18.50	K60								
18.50	K58								
18.50	D57								
18.50	V61								
18.60-19.05	U63			86 blows					
19.10-19.55	SPT N=48	6.00		7,9/10,11,13,14					
19.05	D64								
19.10-19.55	D65								

Remarks	Scale (approx)	Logged By
	1:50	SRJ
	Figure No.	

British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL			Site	Borehole Number
			CTRL GI DATA - Entire NDATA19 data set	SA3719
Boring Method Cable Percussion	**Diameter**	**Ground Level (mOD)** 17.40	**Client** UR/LCE	**Job Number** Issue 1
	Location 529941 E 183198 N	**Dates** 20/11/1995	**Engineer** RLE	**Sheet** 3/4

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
20.00-20.45	U66			81 blows					
20.45	D67								
20.50-20.95	SPT 50/297	6.00		8,11/12,12,13,13					
20.50-20.95	D68								
21.45-21.90	U69			100 blows					
21.90	D70								
21.95-22.39	SPT 50/285	6.00		6,10/11,13,14,12					
21.95-22.40	D71								
22.90-23.35	U72			87 blows		(8.70)			
23.35	D73								
23.40-23.83	SPT 50/275	6.00		9,12/12,15,14,9					
23.40-23.85	D74								
23.50	K75								
23.50	V76								
24.30-24.75	U77			93 blows					
24.75	D78								
24.80-25.20	SPT 50/250	6.00		8,12/13,14,16,7					
24.80-25.25	D79								
25.70-26.15	U80			89 blows					
26.15	D81								
26.20-26.64	SPT 50/285	6.00		6,9/12,14,13,11					
26.20-26.65	D82								
27.20-27.65	U83			93 blows	-9.80	27.20	Very stiff multicoloured (mainly brown and blue grey mottled) extremely closely fissured CLAY. Fissures predominantly inclined 40 to 80 degrees and randomly orientated; smooth; planar to undulose; locally polished and striated.;(WOOLWICH AND READING BEDS - UPPER MOTTLED CLAY);At 20.00m; stiff.		
27.65	D84								
27.70-28.12	SPT 50/270	6.00		9,11/12,14,16,8					
27.70-28.15	D85								
28.50	V87								
28.50	K86								
28.60-29.05	U88			94 blows					
29.05	D89								
29.10-29.49	SPT 50/240	6.00		8,13/14,15,17,4					
29.10-29.55	D90								
29.90-30.35	U91			98 blows					

Remarks	Scale (approx)	Logged By
	1:50	SRJ
	Figure No.	

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

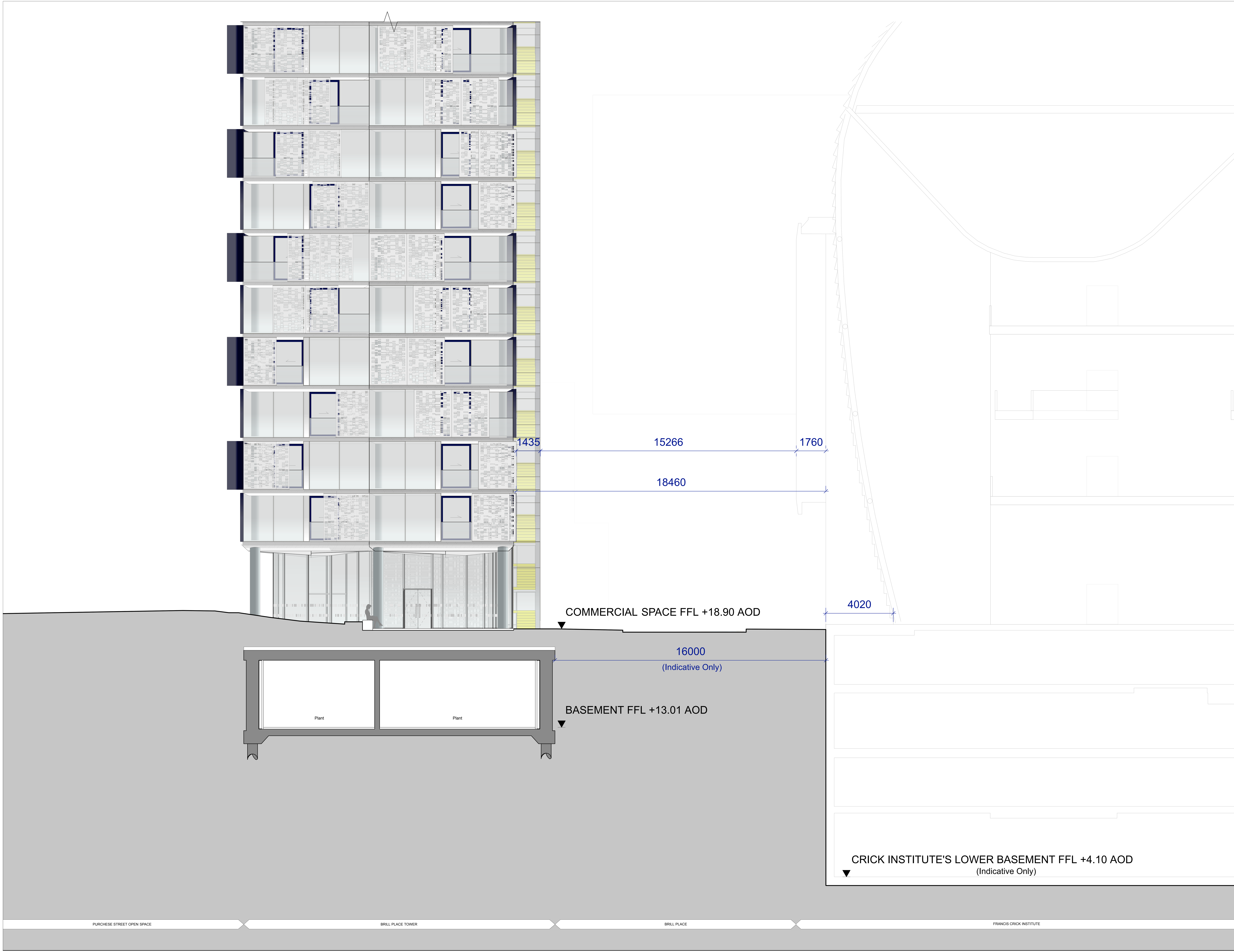
Site	Borehole Number
CTRL GI DATA - Entire NDATA19 data set	SA3719

Boring Method	Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion		17.40	UR/LCE	Issue 1
	Location	**Dates**	**Engineer**	**Sheet**
	529941 E 183198 N	20/11/1995	RLE	4/4

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(3.71)			
30.35	D92								
30.40-30.79	SPT 52/235	6.00		11,13/15,15,17,5					
30.40-30.85	D93								
30.90	V97				-13.51	30.91			
30.90	K94								
30.90	V95						Complete at 30.91m		
30.90	K96								

Remarks	Scale (approx)	Logged By
	1:50	SRJ
	Figure No.	

Appendix B



Camden

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

- DISTANCES ABOVE GROUND LEVEL ARE BASED ON THE ORDNANCE SURVEY MAP
- CRICK INSTITUTE'S SECTION AND LEVELS INDICATIVE ONLY

REVISION NOTES

REV	DESCRIPTION	BY	CHK	QA	DATE

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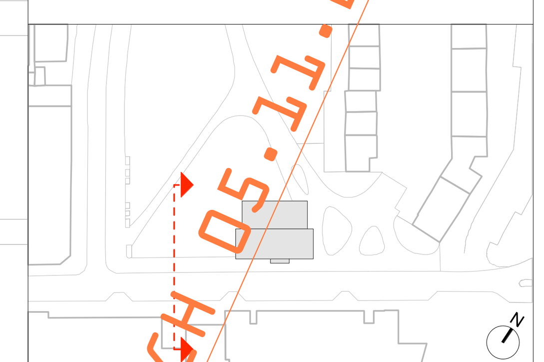
SITE PLAN - KEY



SKETCH 05.11.2015

AUTHOR
dRMM ARCHITECTS

TITLE
BASEMENT CROSS SECTION

PROJECT	SCALE	SIZE
	1:100	A1
BRILL PLACE	1:200	A3

DRAWING NO	REVISION
372-SK119	00

Appendix C Screening Assessment

Subterranean (groundwater):

Question	Response for Brill Place
1a. Is the site located directly above an aquifer?	No, the Principal Aquifer (chalk) is approximately 43mbgl, with London Clay (unproductive strata) above.
1b. Will the proposed basement extend beneath the water table surface?	No, the proposed basement will remain in the London Clay (unproductive strata).
2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No, however, the culverted River Fleet is located 80m west of the site. Regents Canal (Grand Union Canal) is located >250m north-east.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No, the catchment of the pond chains are much further north.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Yes, however, it is unlikely proposed development will use SUDS due to cohesive geology.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No, currently site is soft landscaping (current drainage is all to ground). It is unlikely proposed development will use SUDS due to cohesive geology.
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 surface water within the vicinity of the site.

Slope Stability:

Questions	Response for Brill Place
1. Does the existing site include slopes, natural or manmade, greater than 7°? (approximately 1 in 8)	No, the site has small undulations due to landscaping but no slopes greater than 7°. The subterranean Development Report (Ref 3) provides evidence of this.
2. Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°? (approximately 1 in 8)	Unknown, dependant on final earthworks levels, but very unlikely.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°? (approximately 1 in 8)	No, the surrounding area is predominantly flat residential use.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°? (approximately 1 in 8)	No, the surrounding area is relatively flat.
5. Is the London Clay the shallowest strata at the site?	Yes, it is unknown how much Made Ground is present but using BGS borehole records (Ref 4) and BuroHappold Desk Study report (Section 2.5) (Ref 4) it is approximately 4m thick.
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	Yes, consent will be needed

Area if the tree is over certain dimensions).	
7. Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	Yes, the Groundsure report within the BuroHappold Desk Study report (Ref 4) identifies a moderate hazard of shrink-swell due to London Clay.
8. Is the site within 100m of a watercourse or a potential spring line?	No, however, the culverted River Fleet is located 80m west of the site. Grand Union Canal is located >250m north-east.
9. Is the site within an area of previously worked ground?	Yes, the site has been worked in the past, see BuroHappold Desk Study report (Ref 4)
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 Principal Aquifer (chalk) is approximately 43mbgl, with London Clay (unproductive strata) above.
11. Is the site within 50m of the Hampstead Heath ponds?	No, the Hampstead Heath ponds are much further north of the borough.
12. Is the site within 5m of a highway or pedestrian right of way?	Yes, see section 2.2.1
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes, there is a large basement associated with the Crick Institute, located on the other side of Brill Place (south).
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No, exclusion zones for railways (i.e. HS2) and tunnels was checked when BuroHappold carried out the Desk Study report (Ref 4), the site is outside of the exclusion zones and does not interfere with any tunnels / railways below ground level.

Surface Flow and Flooding:

Questions	Response for Brill Place
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No, the Hampstead Heath ponds are much further north of the borough and the catchment areas are not near.
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 amount of hardstanding on-site will be changing therefore could affect surface water run-off after development, however this process is very unlikely as the amount of hardstanding won't be significant.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes, the current site is predominantly soft landscaping, the proposed development will result in an increased proportion of hard surfaced areas, however not a significant amount for it to alter surface flow and flooding.
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 downstream watercourses?	No, the proposed basement will remain in the London Clay (unproductive strata).
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No, the proposed basement will remain in the London Clay (unproductive strata).

Questions	Response for Brill Place
6. Is the site in an area identified to have surface water	No, according to the Camden Flood Risk Management

flood risk according to either the Local Flood Risk Management Strategy of the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	Strategy (Ref 2) the chance of surface water run-off flooding in South Camden per year is 1.33%.

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