Ground and Project CONSULTANTS LTD

128-130 GRAFTON ROAD, LONDON, NW5 4BA

Basement Impact Assessment:

Land Stability Assessment Report

March 2019

Client:

Eta Bridging Ltd

4 Laburnum Grove

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Contents

1 Introduction

Ground and Project Consultants Ltd have been instructed by Eta Bridging Ltd to undertake a Basement Impact Assessment regarding the land stability, for 128-130 Grafton Road, London, NW5 4BA. The property is located in the Borough of Camden, London in the Gospel Oak ward, its location is indicated on Figure 1.

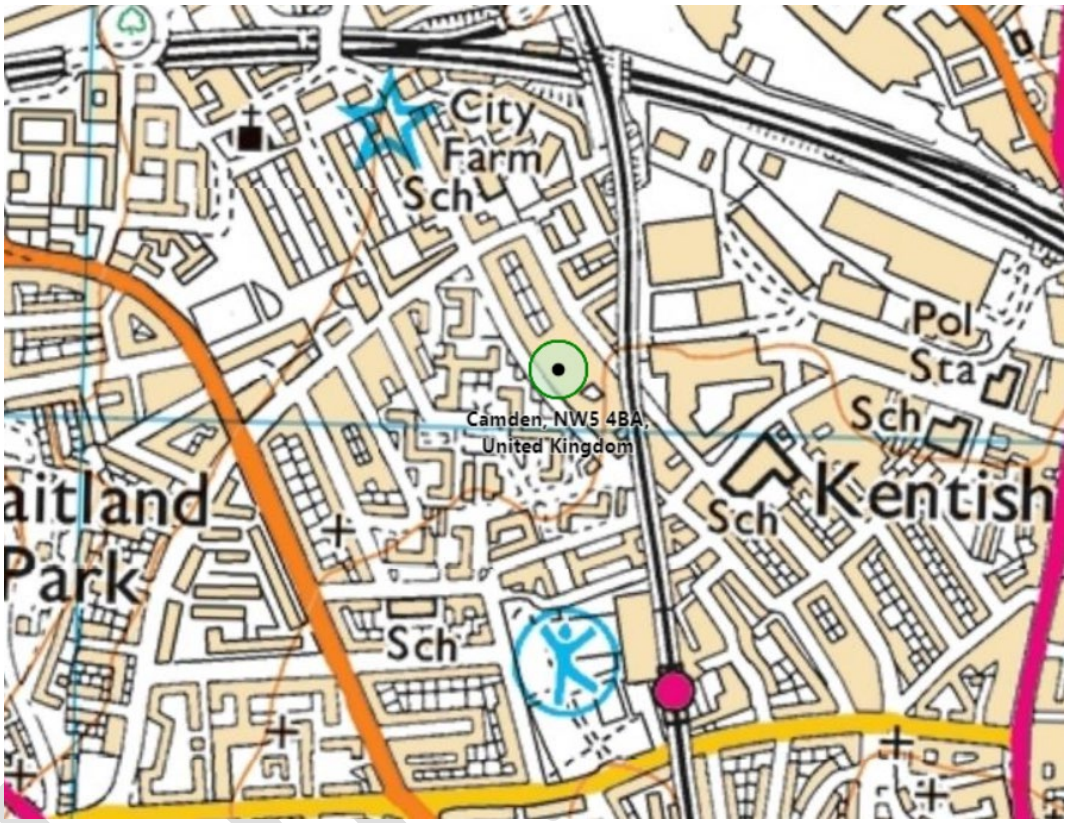

Figure 1: Site Location

2 Scope and Objective

A previous screening and scoping report (Report No. 40213-1) was produced by Ground and Project Consultants in September 2017. This report incorporates the subsequent ground investigation data to assess the potential for ground movement.

The scope of this report and approach are as follows:

- A review of the existing data supplied by the client has been carried out, including the proposal drawings produced to date, photos of the building and other freely available data such as BGS geological information and purchased environmental data.
- In line with the methodology set out in the London Borough of Camden guidance, CPG4, latest revision:
    - An assessment of the published and encountered geology.
    - Responses to the Screening questions.
    - Development of Scoping Issues.
- A review of the Ground & Water Limited ground investigation data.
- Assessment of the data to develop a ground model and carry out and engineering interpretation and impact assessment of the land stability.

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

The report assumes the full involvement of a suitably qualified and experienced Structural Engineer in the design and supervision of the basement construction.

This report and the work to support it, have 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 Site Information

i. Site Location

The property at 128-130 Grafton Road, London, NW5 4BA is located on the east side of the road. The property is around 1.4 km north of Regent's Park and 900m north of Camden Locks. The National Grid Reference for the property is TQ 28495 85038. The location of the property is indicated in Figure 1 above.

ii. Site Description

The existing property is a single-storey terraced industrial building/warehouse comprising a ground floor and a mezzanine floor with associated forecourt area / off-street parking for approximately 5 vehicles to the front of the property. It is currently occupied by E & D Scaffolding Co Ltd. The existing building is brick built and is understood to be in overall good condition, with minor signs of distress.

There are no trees on the property with the site comprising hardstanding throughout. However, there are some trees close by to the front of the property immediately to the south and along the road.

The property is bound by residential or commercial/industrial buildings and Grafton Road to the southwest. The property adjoins a four-storey residential scheme on its south-eastern side (no. 126). There is an attached two-storey industrial building "Spring Lighting" on its north-western side (no. 132-134). The property backs onto a five-storey building fronting Spring Place to the northeast which is in commercial/industrial use as a lighting manufacturer.

iii. Topography

The OS map indicates the property is at around 36m AOD. The ground surface at the site and surrounding area is relatively flat.

iv. Proposals

The proposals for the site comprise demolition of the existing structure and construction of a five-storey residential building with a basement and roof terrace. The basement will be approximately 3m deep and expected to be deeper for the lift shaft. The footprint of the basement including sunken terraces is approximately 14.1m wide by 16.8m deep with a resultant area of around 237m^2. The descriptions and dimensions above have been estimated from drawings provided by Redrock Development Group.

v. Geology

The available geological mapping (Ref 1.) indicates that the site lies on the London Clay Formation. The London Clay Formation 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 base of the London Clay Formation is likely to occur at significant depth below the property. An area of worked ground (the hatched area) is indicated close by to the east and north. An area of potential Head Deposits is shown around 300m to the northwest. See Figure 2 below.

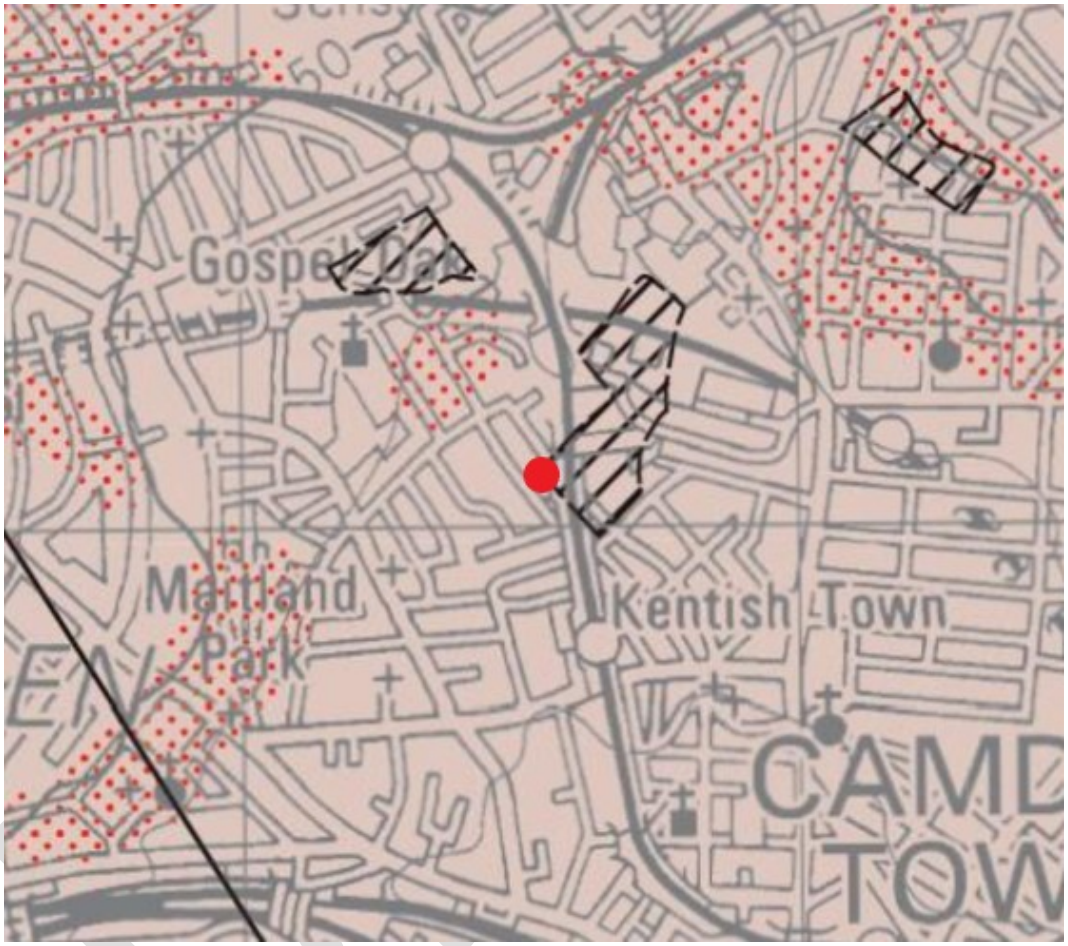

Figure 2: Geology

vi. Hydrology and Hydrogeology

The OS Map indicates that there are no surface water bodies in the near vicinity of the site. The Hampstead Ponds are located approximately 1.4km to the northwest. Tributaries of the 'lost' River Fleet are understood to run in culvert around 100-200m to the east and west of the site.

The underlying 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 ground or surface water abstraction licences within 250m of the site.

4 BIA Screening for Slope/Land Stability

A screening exercise has been carried out as per the guidance in 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 ground surface at site is relatively level.	None
Question 2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7 degrees?	No. It is understood that there are no planned significant changes in surface profile.	None
Question 3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees?	No. There are no railway cuttings in the immediate vicinity. The close by railway line is on a bridge.	None
Question 4: Is the site within a wider hillside setting in which the general slope is greater than 7 degrees?	No. The slope in the area is less than 1 in 50 (2^{o}) based on published Ordnance Survey data. This is confirmed by Figure 16 from the Arup Report.	None
Question 5: Is the London Clay the shallowest strata at the site?	Yes. The geological maps indicate London Clay is the shallowest deposit. There are potential Head deposits indicated to the north. Made Ground is also likely to be present	The engineering significance of the site geology is further discussed in the Scoping 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).	Possibly. There are no trees on the property, however, there are trees within influencing distance located at the front of neighbouring properties to the south.	The significance of the proximity of trees is further discussed in the Scoping 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. It is understood that the existing buildings at site are in good condition given their age and show only minor signs of distress.	The engineering significance of the site geology is further discussed in the Scoping assessment.

Question 8: Is the site within 100m of a watercourse or a potential spring line?	No. Two tributaries to the 'Lost' River Fleet run approximately 100-200m east and west of the property.	To be confirmed by the Hydrology Report.
Question 9: Is the site within an area of previously worked ground?	No. However, worked ground is indicated close by the east.	The engineering significance of the site geology is further discussed in the Scoping assessment.
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 non-productive strata.	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 contractor's methods of working.
Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes. It is understood that the adjoining properties do not have basements.	This is further discussed in the Scoping Assessment.
Question 14: Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. The LNWR main line is overground and around 40m to the east.	None

5 BIA Scoping for Slope/Land Stability

From the screening assessment carried out in Section 4 it is considered, based on the information available at this stage, that the construction of a basement at 128-130 Grafton Road is viable subject to further assessments and appropriate design and construction considerations. The following issues have been carried forward for scoping:

1) London Clay is the shallowest (mapped) strata.
2) Trees are locally present.
3) Shrink and Swell Clays (although there is no known history the presence of London Clay means that this issue needs to be further assessed).
4) The local presence of Worked Ground.
5) The site is within 5m of the footway.
6) The neighbouring properties are not known to have basements so that there may be a significant increase of the differential depth of foundations.

A ground investigation and further assessment was recommended.

6 Ground Investigation

A ground investigation was carried out at the site by Ground and Water Ltd on 1st February 2019. The ground investigation comprised two boreholes drilled to 6.45m and 7.10m bgl using a window sampler rig and two foundation inspection pits.

Th ground investigation encountered Made Ground, overlying Head Deposits, overlying the London Clay Formation. Roots were recorded up to 3.0m bgl. No groundwater was encountered. The findings are summarised below.

i. Made Ground

Made Ground was encountered from ground level to depth of between 0.95m to 1.8m bgl as concrete hardstanding with a thickness of between 0.17m and 0.2m, over sandy gravelly clay with the gravel consisting of fine to coarse flint with rare brick fragments.

ii. Head

Head deposits were encountered each of the exploratory holes, excluding WS1 which encountered the thickest Made Ground. The Head was described as sandy silt gravelly clay, with the gravel consisting of fine to coarse flint top depths proven up to 2.0m bgl. One SPT taken within the Head gave an 'N' value of 2, indicating the stratum to be soft. One Atterberg test and moisture content test was carried out on the Head deposits. The results indicate a liquid limit of 76%, plastic limit of 25%, plasticity index of 51% and a moisture content of 33%, indicating the Head is clay of very high plasticity and high volume change potential. The high moisture reflects the low N value and apparent low shear strength.

iii. London Clay Formation

The London Clay Formation was encountered beneath the Made Ground and Head deposits to the base of the boreholes. It is described as a brownish grey slightly sandy silty clay with sand lenses and selenite crystals recorded in WS1. SPT 'N' values are generally between 6 and 22, indicating soft increasing to stiff with depth, with an SPT refusal at 6.7m bgl in WS1 suspected to be due to a claystone nodule. This high N value is considered not representative of the stratum. Four Atterberg tests and moisture content tests were carried out on the London Clay Formation. The results indicate a liquid limit of between 70% and 73%, plastic limit of 25% or 28%, plasticity index of between 42% and 48% and a moisture content of 30% or 32%, indicating the London Clay Formation is clay of very high plasticity and high shrinkage potential. Sulphate testing on three samples of the London Clay Formation gave characteristic values of sulphate being 4100mg/l, total sulphur of 0.24% and pH of 7.15.

iv. Groundwater

Groundwater was not encountered during drilling up to 7.1m bgl.

v. Foundation Inspection Pits

The foundation inspection pits encountered a brick wall resting on concrete foundations from 0.35m or 0.70m bgl, with the base extending to 1.15m and 1.00m bgl respectively.

7 Ground Model

The investigation encountered Made Ground, overlying Head, overlying the London Clay Formation. The Made Ground was consistent with typical Made Ground and no evidence of "worked ground" was encountered. The Head comprised soft silty sandy slightly gravelly clay of very high plasticity with the gravel comprising flint. The London Clay Formation comprised firm to stiff brownish grey silty sandy clay of very high plasticity with sand lenses and selenite crystals. Roots were encountered down to 3.0m bgl. The London Clay Formation has been found to have elevated sulphates and therefore the design sulphate class for the site is DS-4, with an ACEC of AC-3s.

A ground model has been developed by interpreting the available data and is detailed below.

Strata	Description	Encountered Surface (m bgl)	Geotechnical Properties	Comments
Hardstanding	Concrete	G.L	N/A	N/A
Made Ground	Sandy gravelly clay with the gravel consisting of fine to coarse flint and brick.	0.17 – 0.20	C' =0 ϕ' = 20°	Made Ground is likely to be highly variable and compressible. Not suitable as a founding stratum.
Head	Sandy silt gravelly clay.	0.95 – 1.1	C' =0 ϕ' = 21° Cu =10kN/m^2	Not suitable as a founding strata due to low strength.
London Clay Formation	Silty slightly sandy clay with sand lenses, selenite crystals and suspected claystones.	1.8 - 2.0	C' =0 ϕ' = 21° Cu =30kN/m^2 at 2.0m bgl, increasing approximately linearly to 100kN/m^2 at 6m bgl	Shrinkable soils may be impacted by tree roots. High sulphate content.
Groundwater	N/A	None encountered	N/A	Not encountered due to clay. Some seepages may occur

8 Impact Assessment

There are no apparent major issues which seriously affect the viability of the construction of the new basement. However, the screening exercise and subsequent assessment of the geological environment of 128-130 Grafton Road indicate some areas for further discussion in this report with suggested mitigation where appropriate.

Impact Question	Answer and Justification	Impact
Question 5: Is the London Clay the shallowest strata at the site?	No. Head deposits are the shallowest natural strata.	The Head and London Clay Formation have high volume change potential.
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?	Yes. There are no trees on the property, however, there are trees within influencing distance located at the front of neighbouring properties to the south. It is not known if these are protected.	Based on the presence of shrinkable soils beneath the site, foundations will require to be deepened below the zone of influence of trees. Measures to minimise damaging roots should be carried out.
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. It is understood that the existing buildings at site are in good condition given their age and show only minor signs of distress.	The presence of high volume change potential clays indicate that measures to prevent heave should be undertaken.
Question 12: Is the site within 5m of a highway or pedestrian right of way?	Yes.	Safe method of working should be compiled in the Constructors Risk Assessment and Method Statements.
Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes. It is understood that the adjoining properties do not have basements.	Potential for unacceptable ground movements which could adversely affect the adjoining properties. Monitoring before and during construction should be carried out. Design and Construction must be appropriate to the context.

i. Basement Depth and Foundations

The proposals for the site include the construction of a basement. It is anticipated that the basement founding level will be approximately 3m below the current ground level, with a deeper area for the lift shaft. It will be critical to prevent exposed faces from collapse to minimise ground loss into the new excavation. Adequate temporary face support should be provided. In addition, it is recommended that monitoring is carried out prior to construction and during the excavation and development of the site to reduce

the risk to neighbouring properties. The monitoring will need to include threshold and action levels, with appropriate actions and mitigation measures.

An evaluation of allowable bearing pressures accounting for load distribution, foundation shape and size and settlement tolerances should be carried out as part of the design process. Bearing capacity and settlement issues are not within the remit of this report, however, the data gained from the ground investigation can be used for such assessments.

ii. Founding strata

Based on the anticipated depths, the basement will be founded in the London Clay Formation. The London Clay Formation is a high plasticity clay and as such has the potential for volume change, which will need to be accounted for in the design of the retaining walls and base slab. The design should also account for the influence of trees off site to the south and seasonal variations in moisture content.

iii. Groundwater

Groundwater was not encountered during the ground investigation and therefore significant groundwater ingress is not expected, however, allowances for a sump pump for any superficial runoff during high rainfall is recommended.

Care should be taken to minimise disturbance to the formation and to avoid softening of the soils due to any rainwater. Softened soils should be excavated and replaced where practicable.

iv. Trees

The presence of trees will need to be accounted for in design and construction, with deepened foundations in proximity to any trees as well as limiting root damage. If appropriate advice should be sought from an arboricultural expert.

v. Ground Movement

A number of factors will assist in limiting ground movements:

- Detailed foundation design to take into account the findings of the ground investigation data;
- Good workmanship;
- Ensuring that adequate support is in place where required at all times during construction;
- Minimise ground loss;
- Minimise deterioration of the central soil mass by the use of blinding/ covering with a waterproof membrane;

- The underpinning method should use hit and miss panels with significant gaps between working panels.

A detailed assessment of potential ground movement is not within the remit of this report.

vi. Construction near footpath and highway

The close proximity of the front of the property to the pavement and highway, means that construction related activities will be carried out in areas adjacent to public access. 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 or managed appropriately.

9 Conclusions and Recommendations

The methodology and approach of CPG4 has been followed in developing this BIA with respect to Land stability. It is concluded that the construction of a basement at 128-130 Grafton Road should not have significant impacts on land stability provided that:

- Design of the permanent and temporary works should be carried out by a competent and experienced Structural Engineer, who should assess and approve method statements as appropriate.
- The construction of the basement is carried out by competent and experienced contractors and precautions are taken to maintain the stability of the excavations.
- Anticipated conditions are such that the support of excavated ground will need to be carefully managed in order to provide adequate and good support to the ground to prevent excessive movements against the temporary and permanent support. Ground loss should be kept to an absolute minimum.
- Propping of the wall both in the temporary and permanent cases is critical and stiff props should be utilised.
- Care should be taken to minimise the disturbance and damage to trees and their roots.
- Concrete should be designed in accordance with BRE Special Digest 1 accounting for the sulphate pH and groundwater conditions anticipated.
- Monitoring of the building and its immediate neighbours for settlement is carried out before and during construction. The exact nature of this monitoring should be determined by the Structural Engineer.
- A detailed assessment of ground movement is recommended.

10 References

1. BGS Geological Map Sheet 256, North London.
2. Ordnance Survey Map, Explorer 173, London North.
3. Arup: Camden Geological, Hydrogeological and Hydrological Study.
4. CPG4: Basements and Lightwells.
5. Redrock Development Group: various proposal drawings