Basement Impact Assessment Report

Channing School
The Bank
Highgate
London N6

Client	Channing School
Engineer	Heyne Tillett Steel

J11240

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GEA Geotechnical & Environmental Associates

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1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) Limited has been commissioned by Heyne Tillett Steel, on behalf of Channing School, to carry out a Basement Impact Assessment of this site at Channing School, The Bank, Highgate, London, N6 5HF, in accordance with guidelines from London Borough of Camden ("the Council") in support of a planning application.

A Desk Study and Ground Investigation has also been completed by GEA (report ref J11240 Issue 2 dated 6 January 2012) and has been referred to as necessary.

1.1 Proposed Development

It is proposed to develop the site by demolishing the existing sports hall and constructing a building consisting of three parts; a gymnasium, a sixth form dance studio and a performing arts centre, which will have a partial basement; the playing fields are to undergo some levelling. The Dining Hall in the main school building will be extended to the west by a single storey, which is understood to be subject to a separate planning application.

This report is specific to the proposed development and the advice herein should be reviewed once the development proposals have been finalised.

1.2 Scope and Purpose of Work

The work carried out comprises a Basement Impact Assessment which is in accordance to procedures specified in the London Borough of Camden Planning Guidance CPG4[1] and their Guidance for Subterranean Development[2] prepared by Arup.

The aim of the work is to assess if the proposed partial basement will have a detrimental impact on the surroundings with respect to groundwater and land stability and in particular to assess whether the development will affect the stability of neighbouring properties, local and regional hydrogeology and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3 Qualifications

This assessment has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years specialist experience in ground engineering. The assessment has been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a chartered geologist (CGeol) and Fellow of the Geological Society (FGS) with 25 years experience in geotechnical engineering and engineering geology. Both assessors meet the Geotechnical Specialist criteria of the Site Investigation Steering Group and satisfy the qualification requirements of the Council guidance.

1 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*
2 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

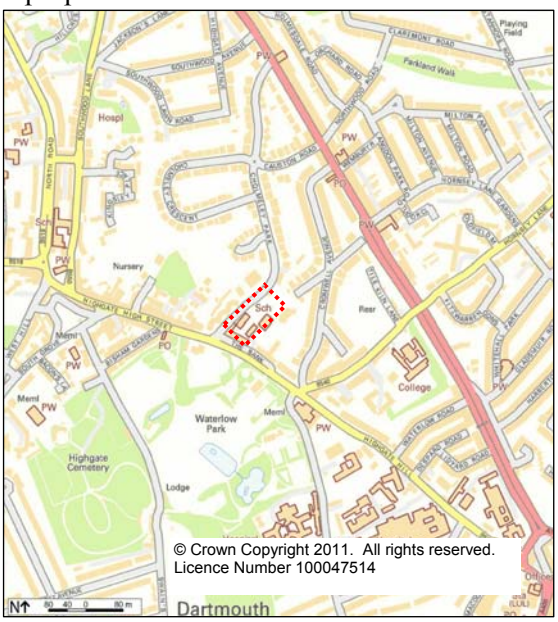
1.4 Limitations

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. No independent validation of third party information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located in Highgate, north London, approximately 830 m to the northwest of Archway London Underground station. The site fronts onto The Bank to the southwest, and is bordered to the northwest by Cholmeley Park, and residential properties to the northeast and southeast. The site may be additionally located by National Grid Reference 528760, 187364, and is shown on the map opposite.



The site covers a roughly rectangular area measuring approximately 175 m by 75 m and is occupied by Channing School.

The site slopes from its maximum elevation in the west down toward the east and north, with a fall across the site of about 9 m to a retaining wall between the school site and the adjacent caretaker's house, which has a retained height of about 3 m. The slope has however been regraded to create level platforms which are used for buildings and playing areas. Within the site the breaks in slope are relatively gradual and well vegetated with grass and trees. There are a number of small retaining walls in the school, but the largest is on the northeastern boundary adjacent to the residential property to the north of the site.

Channing School comprises five main buildings on different levels and locations in the site. The main school building fronts onto The Bank and is a two and five-storey building. The sloping nature of the site means that the lower floor becomes a basement to the north of the building. There are two other buildings used as classrooms in the centre of the site, and a sports hall is located in the east of the site which was constructed over a break in slope, such that it has two separate levels. A temporary building is located on the tennis courts in the lowest area of the site, in the north.

The site is mainly covered in hardstanding with the exception to the playing fields in the centre of the site and a grassed picnic area to the southwest of the sports hall. There are numerous trees of differing species and maturity around the site.

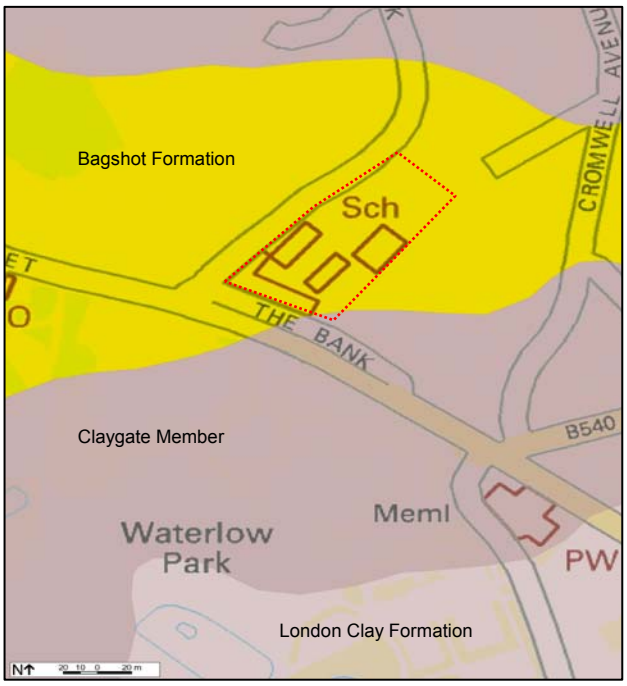
The boundaries of the school in the north are mainly formed by retaining walls, with evidence of bowing and general weathering of the bricks noted. The wall forming the northwest of the site is locally fenced off and new brick buttresses have been built to support the wall which is leaning towards the east.

3.0 GROUND CONDITIONS

3.1 Soil Conditions

The Geological Survey map of the area (sheet 256) indicates that the site should be underlain by the Bagshot Formation, overlying the Claygate Member which is in turn underlain by the London Clay Formation.

The geology in this area is generally horizontally bedded such that the boundary between the geological formations roughly follows the ground surface contour lines. The boundary between the Bagshot Formation and the underlying Claygate Member is located near to the southernmost point of the site, the boundary between the Claygate Member and the London Clay Formation is in the region of 190 m to the south of the site.



Below a variable thickness of made ground, the Bagshot Formation was encountered over the Claygate Member of the London Clay Formation, which was inturn underlain by the London Clay.

The made ground was absent from one location, but elsewhere was found to extend to depths of between 0.40 m (49.60 m TBM) and 5.60 m (36.97 m TBM) and to typically comprise dark brown silty sandy gravelly clay or a clayey sand with fragments of brick and occasionally ash, glass, pottery and clinker. The Bagshot Formation generally comprised light brown, fine sand with occasional silt and fine gravel, and was recorded to have a clay layer near to the top of the stratum. The Claygate Member comprised either orange-brown mottled grey silty very sandy clay or silty very clayey sand which was proved to a depth of 12.7 m (37.30 m TBM). The underlying London Clay comprised firm becoming stiff grey silty fissured clay with occasional selenite crystals which graded into a silty sandy clay below a depth of 16.5 m (33.5 m TBM).

3.2 Groundwater Conditions

The Bagshot Formation and Claygate Member are classified as a Secondary 'A' Aquifers meaning they have permeable layers capable of supporting water supplies at a local rather than

strategic scale, and in some cases forming an important source of base flow to rivers as defined by the Environment Agency (EA). The London Clay Formation is classified as unproductive strata with soils that have a low permeability and negligible significance to local water supply, as defined by the EA.

The topographical maps shows that the nearest surface water features are the Waterlow Park ponds, which are located approximately 200 m to the south of the site. The site is not within an area at risk from flooding as defined by the EA.

Existing and historical spring lines are present at the interface of the Bagshot Beds and the Claygate Member and also at the junction with the underlying essentially impermeable London Clay. These springs have been the source of a number of London's "lost" rivers, notably the Fleet, Westbourne and Tyburn. Historically[3], an eastern tributary of the Fleet originated near Kenwood House, Highgate, which drained into man made ponds before crossing what is now Highgate West Hill toward Swain's Lane, which is south of the site, adjacent to Waterlow Park. The Fleet flowed in a southerly direction where it ultimately joined the River Thames near Blackfriars Bridge.
Any water infiltrating the London Clay will generally tend to flow vertically downwards at a very slow rate towards the chalk aquifer. Due to the predominantly cohesive nature of the soils, the groundwater flow rate is anticipated to be very slow. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-10} m/s and 1 x 10^{-8} m/s, with an even lower vertical permeability. Vertical permeability within the Claygate is also likely to be slow in view of the presence of layers of clay, but horizontal permeability is likely to be one or two orders of magnitude higher. The Bagshot Formation is likely to have a permeability of about 1 x 10^{-5} m/s to 1 x 10^{-6} m/s

Groundwater was encountered during drilling within the made ground, Bagshot Formation and Claygate Member at depths of between 2.0 m (38.00 m TBM) and 8.0 m (42.00 m TBM).

The results of monitoring of the standpipes installed at the site are presented in the table below.

Borehole No	Standpipe Depth m (Level m TBM)	Depth to groundwater in m (Level (m TBM))		
		29/11/11	7/12/11	14/12/11
1	7.0 (35.57)	4.05 (38.52)	4.02 (38.55)	4.03 (38.54)
2	7.0 (40.60)	5.11 (42.49)	5.07 (42.53)	5.07 (42.53)
3	8.5 (41.50)	7.12 (42.88)	7.15 (42.85)	7.19 (42.81)
4	13.0 (37.0)	6.65 (43.35)	6.65 (43.35)	6.67 (43.33)

The results of the groundwater monitoring indicate groundwater flowing towards the east, thus following the general topography as expected.

4.0 SCREENING

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

3 Nicholas Barton (2000) *London's Lost Rivers.* Historical Publications Ltd

4.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E which includes a series of questions within a screening flowchart for three categories; groundwater flow; land stability; and surface water flow. Responses to the questions are tabulated below.

4.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for Channing School
1a. Is the site located directly above an aquifer?	Yes, Secondary 'A' Aquifer
1b. Will the proposed basement extend beneath the water table surface?	Probably not, but will need to be confirmed by ground investigation. If a piled retaining wall is adopted it may extend below the basement level.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No known spring or well within 100 m of the site, the nearest water feature is approximately 200 m south, which is thought to be fed from natural springs.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Yes, the proposed performance centre will reduce the percentage of grassed areas.
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)?	It is assumed that additional surface water will be discharged to existing surface water sewers, however this is not known (outside scope of this report)
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 or spring line?	No

The above assessment has identified the following potential issues that need to be assessed:

Q1 The site is underlain by a Secondary 'A' Aquifer.
Q2 The site may be within 100 m of a spring line
Q4 A new extension will increase paved areas

4.1.2 Stability Screening Assessment

Question	Response for Channing School
1. Does the existing site include slopes, natural or manmade, greater than 7°?	Yes, there are manmade slopes greater than 7°
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	Yes, Parts of the natural hillside setting include slopes greater than 7°.
5. Is the London Clay the shallowest strata at the site?	No, the Claygate Member is the shallowest strata

Question	Response for Channing School
6. Will any trees 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, some trees will be felled and it is understood that there are no protected trees.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	No - although the retaining walls forming the site boundary are old and appear to be suffering from bowing and weathering.
8. Is the site within 100 m of a watercourse or potential spring line?	No.
9. Is the site within an area of previously worked ground?	No
10. Is the site within an aquifer?	Yes, a Secondary 'A' aquifer
11. Is the site within 50 m of Hampstead Heath ponds?	No
12. Is the site within 5 m of a highway or pedestrian right of way?	Yes , the site is adjacent to The Bank, Winchester Place and Cholmeley Park
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	No, the site is typically set higher than the neighbouring properties and the proposed basement will decrease differential depths of foundations.
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	No

The above assessment has identified the following potential issues that need to be assessed:

Q1 Currently there are slopes greater than 7°.
Q4 Parts of the natural hillside setting include slopes greater than 7°.
Q6 Some trees will be felled but and it is understood that there are no protected trees.
Q10 The site is underlain by a Secondary 'A' Aquifer.
Q12 The site is within 5 m of a public highway.

4.1.3 Surface Flow and Flooding Screening Assessment

This element of the BIA is provided for guidance only and should be confirmed by a suitably qualified engineer experienced in carrying out surface water assessments.

Question	Response for Channing School
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No
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
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Yes, some grassed areas will become developed with a new Performance Centre
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No, but the increased hardstanding will increase the peak flow to existing surface water drainage.
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	No

Question	Response for Channing School
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	No

The above assessment has identified the following potential issues that need to be assessed:

Q3 Some soft landscaping will be reduced by the construction of an extension

5.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential consequences are assessed for each of the identified potential impact factors.

The investigation of the potential impacts is carried out through a suitable site investigation and this has been carried out by GEA in December 2011. It is considered that the scope of the investigation complies with the guidance issued by the Council and is therefore a suitable basis on which to assess the potential impacts.

5.1 Potential Impacts

The following potential impacts have been identified.

Potential Impact	Possible Consequence
The existing site includes slopes, natural or manmade, greater than 7°	Local slope instability within the site
The site within 100 m of a watercourse, well (used/ disused) or potential spring line	The flow from a spring, well or watercourse may increase or decrease if the groundwater flow regime is affected by a proposed basement. If the flow is diverted, it may result in the groundwater flow finding another location to issue from with new springs forming or old springs being reactivated. A secondary impact is on the quality of the water.
The site is within a wider hillside setting in which the general slope is greater than 7°?	Ground instability
Tree/s to be felled as part of the proposed development and/or works proposed within any tree protection zones where trees are to be retained?	The removal of trees may cause the recovery of the soil moisture deficit of clay, which may lead to swelling of the clay. Existing root systems may be adding stability to the existing slope and the removal of trees may induce instability.
The site is within an aquifer	Dewatering can cause ground settlement. The zone of settlement will extend for the dewatering zone, and thus could extend beyond a site boundary and affect neighbouring structures. Conversely, an increase in water levels can have a detrimental effect on stability.
Site within 5 m of a highway or pedestrian right of way	Excavation of a basement may result in structural damage to the road or footway; however work for the proposed basement at this site will take place at a distance of greater than 5 m from adjacent public highways.
Proposed basement development may result in a change in the proportion of hard surface / paved external areas	A change in the proportion of hard surfaced or paved areas of a property will affect the way in which rainfall and surface

Potential Impact	Possible Consequence
	water are transmitted away from the property. This includes changes to the surface water received by the underlying aquifers, adjacent properties and nearby watercourses. Changes could result in decreased flow, which may affect ecosystems or reduce amenity, or increased flow may additionally increase the risk of flooding.
Site located directly above an aquifer	Potentially the basement may extend into the underlying aquifer and thus affect the groundwater flow regime.

These potential impacts have been investigated through the site investigation, as detailed below.

6.0 BASEMENT IMPACT ASSESSMENT

The screening identified a number of potential impacts. The desk study and ground investigation information has been used below to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

Potential Impact	Site Investigation Conclusions
The site is underlain by an aquifer	The investigation has confirmed that the site is underlain by Secondary 'A' Aquifers: the Bagshot Formation and Claygate Member. On the basis of the findings of the investigation the proposed basement will not be located below the measured groundwater level; however, if sheet piles or any other form or piled wall are adopted they may be below the water table, and positioned roughly perpendicular to groundwater flow. However, groundwater flow should not be adversely as there is ample space outside the basement area for groundwater to flow around the piles, and possibly below them if they are shallow. Water should not therefore build up, nor will any dewatering be required.
Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	The desk study indicated that the site is not within 100 m of a water course or known well. It may however be within 100 m of a potential spring line. However the investigation has not indicated that the water levels are such that they will be affected by the proposed basement.
The development will reduce grassed areas and increase paved areas	It is understood that additional surface water will be discharged to existing sewers, which if necessary should be increased to cope with the extra capacity. Some grassed areas will still be in existence therefore flow to aquifers will remain.
Slopes greater than 7°	There are some manmade slopes at the site, some of which are vegetated and all appear to be in a stable state. The re-levelling of the site will create new slopes, however they will be suitably engineered to ensure that stability is maintained
Felling of trees	It is understood that the proposed trees that will be felled are mainly in the area of the proposed performance centre, which is mainly on flat land and does not thus present a significant negative impact on slope stability. Desiccation of the shallow clay has not been found in the investigation and on that basis there is not considered to be a risk of clay heave.

Location of public highway	The basement will be located within the site, at approximately 25 m from the closest highway; therefore this is not considered to represent a risk.

The results of the site investigation have therefore been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

Site is underlain by an aquifer

The site is underlain by a Secondary 'A' aquifer which is in turn underlain by unproductive strata. If groundwater in the upper aquifer were forced to find an alternative flow route past an underground obstruction, that could cause the groundwater level within the zone encompassed by the new flow route to increase locally. The new basement will be underlain by the Bagshot Formation which will permit flow beneath the basement, as it does not toe into the London Clay.
The investigation has indicated that the groundwater level is below the proposed development, such that dewatering should not be necessary, and associated settlement will not occur. However, the proposed construction technique of utilising a sheet piled wall may provide a barrier to groundwater if they are to extend to a level of 42.00 m TBM. It is considered that the use of a sheet piled wall will not provide a significant barrier to groundwater flow as water will be able to pass around it, as there are no nearby basements and may also be able to pass underneath the piles as sand has been recorded to a level of 41.00 m TBM. Any increase in groundwater levels to the west of the sheet piled wall are likely to be minimal and should not cause associated instability.

Significant areas of grassland will remain at the site, so some percolation into the underlying aquifer will continue. The development should therefore not significantly affect the groundwater flow regime by lowering groundwater levels.

Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?

The basement will not interrupt any flow of groundwater as the groundwater level is lower than the proposed basement, furthermore the amount of groundwater within the aquifer should not rise as some soft landscaping areas will be removed. The development will decrease the amount of percolation at the site, however this is not considered to be significant as large areas of soft landscaping will remain, in the form of the playing fields. Therefore there is not considered to be any scope for detrimental impacts to groundwater.

The development will reduce grassed areas and increase percentage of hard standing

It is understood that extra surface water will be discharged to existing sewers, which if necessary should be increased to cope with the extra capacity, which should ensure that flooding is not caused by the development. Some grassed areas will still be in existence therefore flow to aquifers will remain, meaning there is a limited impact on local ecosystems.

Slopes within and adjacent to the site greater than 7°

At present the site is well vegetated and the existing slopes generally show no sign of any recent movement. It is understood that the re profiling of the site will not create any new significant slopes and will be designed and engineered during the site works.

The adjacent land does not have a known history for land instability, and it is considered that the proposals will not induce any significant forces to induce greater land instabilities off site.

Retaining walls form some parts of the site boundary and further investigation is proposed to confirm the founding depth and details. However, the investigation and proposed structure will incorporate suitable design to ensure no additional load is passed onto the retaining walls.

Location of public highway

The basement excavation will be approximately 25 m from the nearest public highway, such that the construction of the basement will not have a detrimental effect on the stability of adjacent highways.

Felling of trees

It is understood that trees proposed to be removed are in areas of mainly flat land, therefore removal of these trees will not have a detrimental impact on slope stability.

Felling of the trees should not have a significant negative impact on the soils, as they are currently underlain by a substantial thickness of sand, the Bagshot Formation.

7.0 CONCLUSIONS

Whilst located on the very periphery of the London Borough of Haringey and in the absence of specific guidance by the Borough Council, a Basement Impact Assessment has been carried out following the information and guidance published by the London Borough of Camden. Information from a Site Investigation has been used to assess potential impacts identified by the screening process.

It is concluded that the proposed development is unlikely to result in any specific issues relating to land or slope stability, the hydrogeology and hydrology of the site. Suitable construction methods will ensure slope stability at the site and there should not be any negative impact on the groundwater.

Geotechnical & Environmental Associates (GEA) is an engineer-led and client-focused independent specialist providing a complete range of geotechnical and contaminated land investigation, analytical and consultancy services to the property and construction industries.

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