Appendix A

Glossary

Alluvium: Sediments deposited by flowing rivers.

Aquiclude: A low- permeability unit that forms either the upper or lower boundary of a ground-water flow system.

Aquifer: Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquitard: A low-permeability unit that can store ground water and also transmit it slowly from one aquifer to another.

Basement: All works that are subterranean, or constructed wholly or partly under the natural ground level.

Confined Aquifer: An aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

Confining Layer: A body of material of low hydraulic conductivity that is stratigraphically adjacent to one or more aquifers.

Dewatering: Lowering of the water table by abstraction of groundwater (i.e. pumping), typically to prevent excavation below the water table from flooding.

Discharge: The volume of water flowing in a stream or through an aquifer past a specific point in a given period of time.

Catchment basin/ drainage basin: The land area from which surface runoff drains into a stream system.

GIS: A geographic information system (GIS), geographical information system, or geospatial information system is any system that captures, stores, analyzes, manages, and presents data that are linked to location.

Groundwater: The water contained in interconnected pores located below the water-table in an unconfined aquifer or located in a confined aquifer.

Hydraulic conductivity: A coefficient of proportionality describing the rate at which water can move through a permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity.

Hydraulic gradient: The change in total head with a change in distance in a given direction. The direction is that which yields a maximum rate of decrease in head.

Hydrogeology: The study of the interrelationships of geologic materials and processes with water, especially ground water.

Hydrology: The study of the occurrence, distribution and chemistry of all water of the earth.

Measurement: a method of determining quantity, capacity, or dimension

Monitoring: to test or sample, especially on a regular or ongoing basis

Perched aquifer: A region in the unsaturated zone where the soil may be locally saturated because it overlies a low-permeability unit.

Permeability: See Hydraulic Conductivity.

Piezometer: A nonpumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface. A piezometer generally has a short well screen through which water can enter.

Polar coordinates: The means by which the position of a point in a two-dimensional plane is described; based upon the radial distance from the origin to the given point and the angle between a horizontal line passing through the origin and a line extending from the origin to the given point.

Porosity: The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

Runoff: The total amount of water flowing in a stream. It includes overland flow, return flow, interflow and baseflow.

Sedimentary rock: A rock formed from sediments through a process known as diagenesis or formed by chemical precipitation in water.

Soil: In the geotechnical engineering context the term "soils" means geological strata (except rock) as well as the familiar horticultural or agricultural material.

Sediment: An assemblage of individual mineral grains that were deposited by some geologic agent such as water, wind, ice or gravity.

Surcharge pressure: An overloaded main sewer will come under pressure created by water flows from areas upstream in the sewer system, causing the effect of water backing up out of manholes and gully gratings onto the streets and also out of toilets, sinks and baths directly into buildings.

Surface water: Water found in ponds, lakes, inland seas, streams and rivers.

Unconfined aquifer: An aquifer in which there are no confining beds between the zone of saturation and the surface. There will be a water table in an unconfined aquifer. Water-table aquifer is a synonym.

Unsaturated zone: The zone between the land surface and the water table. It includes the root zone, intermediate zone and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched ground water, may exist in the unsaturated zone. Also called the zone of aeration and vadose zone.

Water table: The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric. It can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.

Appendix B

Brief for Camden geological and hydrological study (June 2010)

Brief for Camden geological and hydrological study

1. Introduction

The London Borough of Camden is commissioning a geotechnical, geological and hydrological study and assessment for the borough. The study will identify areas susceptible to land instability and flooding, including underground flooding. It will inform the decision making process on planning applications by recommending ways for the Council to determine the suitability of proposed developments with a subterranean element. This will include a methodology that developers should follow in order to provide adequate information to accompany a planning application and recommendations on any proposed or required remediation measures for preventing ground movement and detrimental flooding at and beyond a development site.

This work will focus primarily on the impact of subterranean development, but may also consider the impacts of other development on land stability and hydrology. This brief sets out the background to the project, explains its detailed requirements and sets out the tender process.

2. Background

The study should assess the susceptibility all of Camden to ground movement and underground flooding, however the land on and around Hampstead Heath is specifically known to be vulnerable to flooding and instability due to its underlying geology. This has never been formally investigated or mapped in detail. Hampstead Heath and the surrounding land are also known to have specific hydrological issues which are related to the local geology and topography. Other areas within Camden with distinctive hydrology may stem from Hampstead Heath, for example areas once channelling the River Fleet, or where water may be trapped between less permeable layers. The Council has been receiving a growing number of planning applications for subterranean development across the borough, generically called basement developments. These applications are causing concern in the local areas, especially with regard to land stability and local flooding. If land stability is an issue, the approach recommended by this study may also apply to other forms of development. This study is intended to provide a robust evidence base to support the policy on basements in the Council's emerging Local Development Framework.

3. Objectives of the project

In order to make informed decisions on planning applications, specifically subterranean development across the borough, the Council needs evidence of the existing geological and hydrological conditions, their geotechnical response to subterranean development and a methodology for assessing such applications.

The following are the main objectives for the study.

1. gather information, including through any necessary site work, to identify areas susceptible to instability and localised flooding due to the local geology and hydrology, and identify the potential impacts of subterranean and other development on such areas.
2. identify what hydrological, geological and other technical information developers should be required to submit with relevant planning applications, including a methodology developers should follow to assess the impact of their development on the local ground conditions.
3. identify suitable construction methods and potential mitigation measures for developments that may affect stability and hydrology.
4. advise on how the Council can best assess the technical information submitted.

4. Project tasks

In carrying out the study, tasks will include, but are not limited to the following.

1. Identifying the study area and implications for development:
   - Desk top study of geology in the Hampstead Heath area;
   - Desk top study of hydrology in the Hampstead Heath area, both surface and below ground. The methodology of this element should be in line with that carried out for City of London Corporation's. *Hydrological and Water Quality Investigation and modelling of the Hampstead Heath lake chains and associated catchments.* Discussions must be had with the City Corporation's panel engineer and hydrology consultants;
   - Identify gaps in existing information;
   - Identify and carry out any further field work required (to be agreed in advance with the Council)
   - identify the study area (to be agreed with the Council);
   - Identify the potential impact of subterranean development on local drainage patterns, flooding, land instability and neighbouring properties, including implications from any works that do not require planning permission;
   - Case studies of the impact of subterranean development around Hampstead Heath – for example developments in Christchurch Hill, Parliament Hill, Heath Street, New End and developments adjacent to the ponds on Hampstead Heath

2. Devise a methodology for information to accompany a planning application:
   - Review a representative sample of recent subterranean developments to identify impacts, potential remediation measures and their effects;
   - Review existing information and guidance, including but not limited to:
     - national legislation and guidance
     - best practice with regards to the planning and construction of subterranean development – especially excavating beneath existing buildings, development on unstable land, development

    in areas with hydrological issues, and engineering requirements and solutions;
- Provide guidance on what information should be provided with applications for subterranean and other relevant development so they can be assessed in terms of their impact on:
    - water flow and local flooding,
    - ground conditions and stability
    - impact on neighbouring properties;
- Suggest whether information requirements should vary depending on the geographical location as a result of differences in ground and drainage conditions and any other relevant factors;
- Identify the extent of sub-surface investigations required on an application site (depth, number) to provide necessary geological, geotechnical and hydrological information.

3. Identifying relevant construction methods and potential mitigation measures:
    - review current building practices for subterranean development, especially excavation below existing buildings;
    - review mitigation measures applicable to subterranean and other relevant developments on unstable land and areas with specific hydrological concerns;
    - identify any possible negative impacts mitigation may have on project length, environmental sustainability issues, neighbouring amenity etc.;
    - this should be produced in a form that can be used as a guidance note.

4. Suggest measures to enable the Council to assess accurately material submitted with applications for subterranean development:
    - review best practice for assessing subterranean developments;
    - identify ways the Council can assess technical information submitted by applicants and objectors;
    - advise on the future monitoring of the effects of subterranean development.

5. Considerations Relating to the Project

In carrying out the tasks above, consideration should be had to the following matters:

- what subterranean development falls within the allowance of Permitted Development under the General Permitted Development Order 1985;
- construction methods for subterranean development;
- the size of subterranean development;
- geographical location;
- cumulative impacts;
- whether the likely impact in particular locations means that any subterranean development would be unsuitable;
- need for compliance with PPG14 and PPS25 and its companion guide;
- potential use of Article 4 Directions to control subterranean development;
- applicability to other areas in Camden;

- any implications for the ponds on Hampstead Heath, especially those covered by the Reservoirs Act.

6. Project outputs

The consultant will deliver the following outputs in a single report:

Output 1: Findings on the geology and hydrology within Camden and the implications of subterranean and other relevant development on surface and sub-surface water levels and flows and ground conditions and neighbouring properties, and possible mitigation measures. These findings should be mapped where appropriate.

Output 2: A methodology for the provision of supporting information on hydrology and geology and their affects on land stability and flooding etc with applications for subterranean and other relevant development

Output 3: A list and details of relevant construction methods appropriate to prevent the creation of unstable land and undesirable and unnatural ground water conditions; and of recommended possible mitigation measures.

Output 4: Recommendations on how the Council can assess the information submitted with applications for subterranean and other relevant development, especially the technical elements where conflicting counter evidence may be submitted. Recommendations on how cumulative impact and future monitoring should best be considered.

7. Information for the project

The Council will make the following information available to the selected consultant:

- emerging LDF Core Strategy and Development Policies documents;
- planning permissions for subterranean developments, including supporting or opposing evidence / submissions;
- North London Strategic Flood Risk Assessment;
- Camden Council's GIS layers;
- Ladbroke Association report *A report on a survey carried out in Northern Kensington in Spring 2009 by the Ladbroke Association on the impact of subterranean developments on neighbours;*
- Royal Borough of Kensington and Chelsea Supplementary Planning Document on Subterranean Development

Other data to review will include, but is not limited to -

- *Hydrological and Water Quality Investigation and modelling of the Hampstead Heath lake chains and associated catchments.* - The City of London Corporation (Open Space Department);
- data from The British Geological Survey;
- data from the Geological Society;
- data from the Environment Agency;

8. Reporting

A draft and final report should be produced, with an executive summary. The form of the report and the presentation of data must facilitate its future use as part of the Council's on-going research.

All information collected during the study should be presented in a form that is compatible with the LBC's IT software and, as necessary, Geographical Information System (MapInfo).

Fifteen colour copies of the final documents (and executive summary) should be produced, with a loose-leaf copy for photocopying as well as an electronic copy compatible with LBC's IT software. The documents should also be capable of reproduction in black and white. The final reports should be laid out in accordance with the contents page agreed between the Consultants and the LBC. The maps should also be provided separately in electronic format to enable their use separate from the main report.

The LBC shall hold the copyright to all material related to the project. The LBC shall be able to distribute the material in part or whole to any organisation or individual it determines, at no extra cost.

9. Management of the Commission

On the client side, the study will be managed by a Working Group, which will report to senior management within the LBC. The selected consultant should expect to attend around three meetings of the Working Group, to initiate the study and discuss the draft report/guidance note. The draft report and guidance note will be presented by the selected consultant to the Working Group. The Working Group will include a named contact with whom the consultant should liaise closely, and with whom informal meetings will be arranged as appropriate. The named contact will be identified following award of the commission.

10. Timescale

The envisaged timescale for this project is completion within three months of the commencement date. An indicative timetable is set out below:

Invitation to tender	16 June 2010
Closing date for tenders	28 June 2010
Appointment of consultant	2 July 2010
Project to commence (Inception Meeting)	8 July 2010 (Morning)
Draft Report (presentation by consultant)	20 August 2010

11. Guide cost

The Council recommends an estimated cost of the work to be £15,000 to £20,000. Tenders should include a breakdown of costs.

12. Tenders

Three copies (one unbound) of the tender should be received by noon on 28 June 2010. They should be sealed in a plain envelope clearly marked TENDER: Geological and Hydrological Study of land in the London Borough of Camden.

The mailing address is Planning Policy and Information, Forward Planning, Culture and Environment Department, London Borough of Camden, 6th Floor Town Hall Extension, Argyle Street, London WC1H 8EQ.

Tenders may be hand delivered to the Environment Reception on the 5th Floor of the Town Hall Extension (entrance in Argyle Street).

EMAIL ldf@camden.gov.uk or celeste.giusti@camden.gov.uk

All tenders must include:

- a project proposal indicating an appreciation of the tasks required, a method for the study, a schedule of research, consultation and analysis work to be undertaken, a programme for the work including dates for the delivery of reports and meetings;
- details of previous experience on similar projects, including client names and contact details for two recent relevant clients;
- details of any aspects of the work that will be handled by subcontractors, and details of subcontractors and their relevant experience;
- the names, position and experience of the members of staff and subcontractors who will be carrying out the work, including a breakdown of the amount of time each individual is expected to spend working on the project;
- the fixed price of the work, including a breakdown of the cost of each of the study tasks and estimates of expenses; and
- the declaration of any potential conflicts of interest.

The successful consultant should be prepared to present and give evidence on the study at hearings and Public examinations related to the LDF and relevant planning applications. It is not anticipated that such tasks would be included within the tender price.

The successful consultant will be selected on the basis of an evaluation of their tender, which will include price, quality, time and experience in undertaking this form of research. The Council will not necessarily select the cheapest tender. The Council will expect a multi-disciplinary team to work on the project.

Work on the study will be expected to start immediately following selection.

13. Contact Details

All enquiries with regard to this brief should be directed to:

Celeste Giusti
Tel: 020 7974 2085
Fax: 020 7974 1930
Email: celeste.giusti@camden.gov.uk

Or

Brian O'Donnell
Tel: 020 7974 5502
Fax: 020 7974 1930
Email: brian.odonnell@camden.gov.uk

Address: Planning Policy and Information Team
Planning and Public Protection
Culture and Environment Department
London Borough of Camden
6th Floor, Town Hall Extension
Argyle Street
London
WC1H 8EQ

STANDARD CONDITIONS APPLYING TO ALL CONTRACTS

Every contract requires the contractor to agree to the following:

(a) compliance with all legislation and specifically the law on health and safety at work and discrimination on the grounds of race;

(b) compliance with the Council's insurance requirements;

(c) a prohibition on assignment and/ or subletting without the written consent of a Chief Officer or an officer authorised by a Chief Officer;

(d) provision for the Council to cancel the contract and recover any resulting loss from the contractor if the contractor does anything which is contrary to the Prevention of Corruption Acts 1889 to 1916 or Section 117 (2) of the Local Government Act 1972;

(e) that the contractor shall pay liquidated damages to the Council if any of the terms of the contract are not duly performed;

(f) that if the contractor is in breach of contract the Council can:

  (i) determine all or part of the contract or determine the contractor's employment;

  (ii) perform the contract in whole or in part;

  (iii) recover from the contractor any additional cost resulting from the completion or cancellation of the contract;

(g) that if the contractor has obtained or received by whatever means any information which gives or is intended or likely to give the contractor unfair advantage over any other tenderer (including the Council's own workforce) in relation to the tendering for and award of any works/ services contract, that the Council shall be entitled to terminate that contract;

(h) that the contractor shall be required to make available to the Council or its auditors such documents or access to information or access to the staff/ offices of the contractor as is necessary to conduct any audit investigation into the contract; and

(i) use of any software supplied under this contract by the Council's contractors shall not amount to use by a third party for which an additional software licence might otherwise be required.

Appendix C

Extract on Flood Risk Assessments from PPS25

From paragraph E3 of PPS25: At all stages of the planning process, the minimum requirements for flood risk assessments are that they should:

- be proportionate to the risk and appropriate to the scale, nature and location of the development;
- consider the risk of flooding arising from the development in addition to the risk of flooding to the development;
- take the impacts of climate change into account;
- be undertaken by competent people, as early as possible in the particular planning process, to avoid misplaced effort and raising landowner expectations where land is unsuitable for development;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure including raised defences, flow channels, flood storage areas and other artificial feature together with the consequences of their failure;
- consider the vulnerability of those that could occupy and use the development, including arrangements for safe access;
- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development or land use;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems; and
- be supported by appropriate data and information, including historical information on previous events.

Paragraph E10 of PPS25: The FRA should form part of an Environmental Statement when one is required by the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 as amended.

Extract from Paragraph H10 of PPS25: The presence of reservoirs and implications for flood risk should be recognised in Flood Risk Assessments (FRAs). Flood risk assessments should take into account information received from the reservoir undertakers and Flood Plans when they are available and relevant.

Appendix D

Effects of excavation on foundation strength

(Extracted from Arup report to Royal Borough of Kensington and Chelsea, “Town Planning Policy on Subterranean Development: Phase 1 - Scoping Study”, 2008)

D1 Effect of excavations on the load bearing capacity of shallow foundations, including influence of geology

D1.1 Executive summary

This appendix discusses the influence of excavations on the load bearing capacity of shallow foundations (pad footings and strip footings, but not deep piles) of the type that typically support residential properties in the Borough. Attention is drawn to the three ways that shallow foundations gain their load bearing capacity from the soil around them, namely:

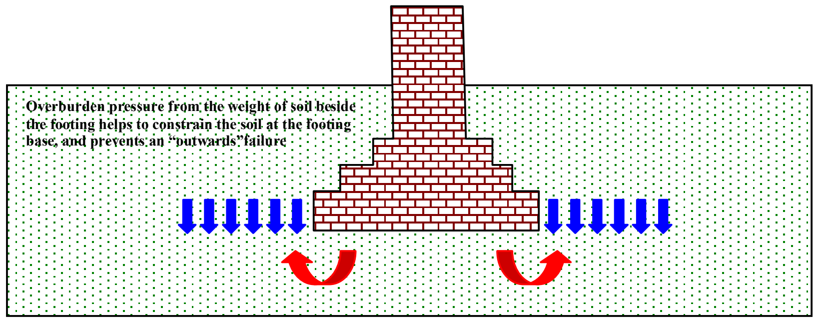
- the frictional strength of the soil;
- the "cohesive" strength of the soil;
- the self-weight of the soil that overlies the footing (called the "overburden").

When the soil around a footing is excavated, the beneficial effects of the "overburden" will be reduced or even wholly removed, depending on the depth of the excavation. The load bearing capacity of a footing is therefore reduced by a nearby excavation. When assessing the implications of a reduction in overburden due to excavation close to a footing, three possible scenarios can be considered:

- If the load bearing capacity of the exposed footing becomes **significantly** less than the load that the footing is trying to support, then the footing could potentially fail and this could lead to the collapse of the structure that the footing supported.
- If the load bearing capacity of the exposed footing becomes **moderately** less than the load that the footing is trying to support, then the footing may settle more than is desirable (but without fully failing), and this may cause cracking of the structure that the footing supports.
- If the load bearing capacity of the exposed footing becomes only **slightly** less than the load that the footing is trying to support, then no settlement or cracking is likely to occur.

The magnitudes of the adverse effects of an excavation near a footing differ significantly for foundation in clayey soils and foundations in gravelly soils. Specifically, the overall impact of a loss of overburden is typically much greater in gravelly soils than in clayey soils. Within the Borough, the northern districts are generally on clayey soils (London Clay) whereas the southern districts are generally on gravelly soils (River Terrace Gravels).

In the following sections, simple engineering calculations illustrate in more detail the potential effects of loss of overburden, and how the magnitudes of these effects can differ in clay soils and gravel soils. The calculations make use of assumed generic values for soil properties, and they are intended for illustrative purposes only, not guidance.



D1.2 Some soil theory

The mechanical behaviour of soil is often modelled using the Mohr-Coulomb strength criterion, which describes the overall strength of soil in terms of a "cohesive" component (denoted *c*) and a frictional component (denoted ϕ).

In general, a clay soil under load will show a relatively high cohesive component but a negligible frictional strength component. In contrast, a gravel soil under load will typically show a relatively high frictional component, but negligible cohesive component.

Some typical generic values for gravel and clay are listed in Table A1. These values will be used for the illustrative calculations presented below.

Table A1: Assumed typical soil properties for gravel and clay (illustrative only)

Soil type	Frictional strength component: Effective angle of shearing resistance of soil (ϕ) [°]	"Cohesive" strength component: Shear strength of soil (c) [kPa]
Gravel	30	Nil
Clay	nil	60

D1.3 Calculating the load bearing capacity of a footing

The design of a foundation requires an evaluation of the ultimate bearing capacity of the soil; that is, the ability of the soil to bear the weight of the building without failing.

Broadly, the load bearing capacity of a shallow footing (a pad or a strip footing) is made up of three components:

Load bearing capacity of footing	=	frictional component from soil strength	+	"cohesive" component from soil strength	+	overburden contribution from self-weight of soil, to depth of footing

More formally in engineering terms, the bearing capacity of a footing can be calculated using well-established formulae published in the technical literature. A common approach, which is widely used to calculate the ultimate (that is, "just-at-failure") load capacity of a shallow footing, was given by Brinch Hansen (1970)[11]. The Brinch Hansen formula takes account of the geometry of the foundation (for

[11] Brinch Hansen, J. (1970) *A revised and extended formula for bearing capacity*. Danish Geotechnical Institute Bulletin No.28, 5-11

example, square pads differ from long thin strips), the properties of the soil in which the footing sits, and the effects of the overburden that acts above the foundation level.

$$q_{ult} = [0.5\ \gamma\ B.N_\gamma] + [c.N_c] + [\gamma\ D.N_q]$$

where:

q_{ult}	is the ultimate bearing capacity
$0.5\gamma\ B.N_\gamma$	is the frictional contribution
$c.\ N_c$	is the cohesion contribution
$\gamma\ D.N_q$	is the overburden contribution

and the symbols mean:

γ	self-weight of the soil, per unit volume
B	width of the foundation
D	depth of the base of the footing, below ground level
c	soil cohesion
N_γ, N_c, N_q	bearing capacity factors for friction, cohesion, overburden

(Vesic, 1975)

The friction angle (ϕ) does not appear explicitly in the Brinch Hansen formula, but in practice it strongly influences the Vesic "N" coefficients. Using the generic soil properties given in Table A1, Table A2 shows the "N" coefficients derived using the Vesic (1975)[12] approach.

Table A2: Examples of Vesic "N" factors for gravel and clay soils (illustrative only)

Soil type	**Friction factor N_γ**	**Cohesion factor N_c**	**Overburden factor N_q**
Gravel	22	30	18
Clay	Nil	5	1

Special attention is drawn to the high N_q value for gravel compared with the low value for clay (Table A2). It is mainly through this difference in the N_q factors for gravel and clay that the impact of losing overburden tends to be proportionally greater in gravel than in clay.

The ultimate bearing capacity (q_{ult}) is the calculated stress at which a footing is expected to be just-at-failure. Obviously, having a foundation that is close to failure should be avoided in practice. Therefore, in modern design, the allowable design bearing capacity of the footing (q_d) is typically taken as, for example, one third of the calculated ultimate bearing capacity (q_{ult}). Thus, there is a "factor of safety" of 3 in the design of the footing. Inherent within this empirical factor of safety is an allowance that keeps settlements within tolerable limits.

$$q_d = q_{ult} / 3$$

where:

q_d is the design load bearing capacity of the footing (the maximum working stress)
q_{ult} is the ultimate bearing capacity of the footing (from the previous equation)
3 is the factor of safety on the design of the footing.

It should be noted that this describes how shallow footings would typically be designed by engineers nowadays. Much of the older building stock in

[12] Vesic, A.S. (1975) *Bearing capacity of shallow foundations* Foundation Engineering Handbook, ed. Winterkorn & Fang, publ. Van Nostrand Reinhold Co., New York, pp.121-147

the Borough is likely to be founded on shallow footings that were not "designed" in the modern engineering sense. The footings would have been constructed by masons and builders based on rules-of-thumb and experience, and in response to local variations in the ground that these artisans encountered when they started digging at any given location. Nevertheless, the bearing capacities and factors of safety of old foundations can be back-analysed and estimated using formulae such as those outlined above.

D1.4 Effects of excavation: a calculated example

When an underpin is being installed for a basement development, a trench is excavated down to the founding level on one side of the existing footing (see Figure 2.1). Although the trench excavation is only dug on one side of the footing, the beneficial contribution of the total overburden on both sides of the wall can no longer be taken into account, because an asymmetric failure of the footing could potentially occur towards the excavated side.

The following illustrative example looks at the case of a foundation that extends 1.5m below ground level. It considers the effects of digging a 1.5m deep trench along one side of this footing, extending right down to the base of the footing.

For both clay and gravel soils, the typical self-weight of soil per unit volume is assumed to be 20 kN/m^3 (this means a density of 2,000 kg per cubic metre of soil). The loss of overburden by digging out 1.5m of soil is therefore 30 kPa (=1.5*20 kilopascals). However, according to the design formulae given above, this stress value must be factored by significantly different N_q factors for gravel and for clay (Table A2).

Table A3 shows the results of applying Brinch Hansen's formula for calculating bearing capacity, both before and after digging a 1.5m trench alongside the illustrative 1.5m deep footing. Estimates are given for footings founded in gravel and clay soils, respectively.

Table A3: Theoretical change in ultimate load bearing capacity, before and after digging a 1.5m deep trench next to the illustrative footing (see text for details)

Soil type	Before or after the 1.5m excavation ?	Frictional component [$0.5\gamma B N_\gamma$] (kPa)	"Cohesive" component [$c N_c$] (kPa)	Overburden component [$\gamma D N_q$] (kPa)	Ultimate bearing capacity q_{ult} [kPa]
Gravel	Before digging	224	0	552	776
Gravel	After digging	224	0	nil	224
Clay	Before digging	0	308	30	338
Clay	After digging	0	308	nil	308

D1.5 Conclusions

For foundations on **clay** soil, Table A3 shows that the bearing capacity of a footing should not be substantially affected by loss of overburden associated with excavation near the footing. In the example used, the post-dig value of 308 kPa compares closely to the pre-dig value of 338 kPa: there is only a 10% post-dig reduction in the ultimate bearing capacity of the footing analysed here. Unless the building load being supported by a clay-founded footing happens already to be close to the ultimate bearing capacity of that footing (which is unlikely, although it should be checked for), then a 10% loss in foundation capacity is likely to have little adverse effect on the structure being supported.

In contrast for the **gravel** soil, Table A3 shows a major reduction in the bearing capacity of the footing due to the loss of overburden (down to 224kPa, from an initial value of 776kPa). For the gravel soil, there is a 70% decrease in the bearing capacity for the footing analysed here. For an historic building, it is unlikely that the existing "factor of safety" on the foundation design would be as high as the safety factors that are used nowadays (such as the modern value of 3 that was discussed above). Analyses by Arup of shallow foundations in London of historical structures founded on the River Terrace Gravels show typical ratios of the calculated ultimate bearing capacity to the applied load in the range 1.6 to 2.5. A 70% decrease in the load bearing capacity of a footing that already has a factor of safety of only 1.6 is likely to be significant and adverse. However, a 70% decrease in the load bearing capacity of a footing that has an existing factor of safety of 2.5 is likely to be much less significant, because the modified factor of safety should still be satisfactorily high, albeit reduced. For foundations on gravel soils, a detailed analysis of the existing load bearing capacity and existing factor of safety of the foundations is therefore especially important. Any adverse reduction in the factor of safety must be carefully mitigated by the design, the construction method (including temporary works), and the workmanship adopted on site.

It is important to emphasise that the numbers quoted in this appendix are examples, and have been presented here for illustrative purposes only. They do not relate directly to any specific foundation or structure. Other factors also affect foundation stability, including the length of time that an excavation is left open. This factor particularly affects clay soils.

Appendix E

BIA screening flowcharts for developers and LB Camden Planning Officers

Surface flow and flooding screening flowchart

The Developer should consider each of the following questions in turn, answering either “yes”, “unknown” or “no” in each instance.

Consideration should be given to both the temporary and permanent works, along with the proposed surrounding landscaping and drainage associated with a proposed basement development.

Question 1: Is the site within the catchment of the pond chains on Hampstead Heath?

Question 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?

Question 3: Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?

Question 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 or downstream watercourses?

Question 5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?

Yes → Developer to carry forward to the scoping stage of the Basement Impact Assessment those matter/s of concern where response is "yes"

Unknown → Developer to carry forward to the scoping stage of the Basement Impact Assessment those matter/s of concern where response is "unknown"

No → Developer to provide statement to LB Camden giving justification for not carrying forward to the scoping stage of the Basement Impact Assessment those matter/s of concern where the response is “no”

Question 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 King’s Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?

Yes → Developer to undertake a Flood Risk Assessment in accordance with PPS25.

Unknown → Developer to undertake a Flood Risk Assessment in accordance with PPS25.

No → Flood Risk Assessment not required.

Notes / sources of information

Question 1: Figure 14 in the attached study (prepared using data supplied by the City of London Corporation’s hydrology consultant, Haycocks Associates) shows the catchment areas of the pond chains on Hampstead Heath

Question 2: This will be specific to the proposed development and will be a result of the proposed landscaping of areas above and surrounding a proposed basement. The developer should provide documentation of discussion with Thames Water to confirm that the sewers have capacity to receive any increased wastewater flows.

Question 3: This will be specific to the proposed development and will be a result of the chosen drainage scheme adopted for the property

Question 4: This will be specific to the proposed development and will be a result of the proposed landscaping and chosen drainage scheme adopted for the property. SUDS will be required to compensate any increases in peak flow.

Question 5: This will be specific to the proposed development and will be a result of the proposed landscaping and chosen drainage scheme adopted for the property. SUDS will be required to compensate any increases in peak flow.

Question 6: The principles outlined in PPS25 should be followed to ensure that flood risk is not increased.

Subterranean (groundwater) flow screening flowchart

The Developer should consider each of the following questions in turn, answering either "yes", "unknown" or "no" in each instance.

Consideration should be given to both the temporary and permanent works, along with the proposed surrounding landscaping and drainage associated with a proposed basement development.

Question 1a: Is the site located directly above an aquifer?

Question 1b: Will the proposed basement extend beneath the water table surface?

Question 2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?

Question 3: Is the site within the catchment of the pond chains on Hampstead Heath?

Question 4: Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?

Question 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)?

Question 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.

Yes → Developer to carry forward to the scoping stage of the Basement Impact Assessment those matter/s of concern where response is "yes"

Unknown → Developer to carry forward to the scoping stage of the Basement Impact Assessment those matter/s of concern where response is "unknown"

No → Developer to provide statement to LB Camden giving justification for not carrying forward to the scoping stage of the Basement Impact Assessment those matter/s of concern where the response is "no"

Notes / sources of information

Question 1: In LB Camden, all areas where the London Clay does not outcrop at the surface are considered to be an aquifer. This includes the River Terrace Deposits, the Claygate Member and the Bagshot Formation. The location of the geological strata can be established from British Geological Survey maps (e.g. 1:50,000 and 1:10,000 scale). Note that the boundaries are indicative and should be considered to be accurate to ±50m at best.

Additionally, the Environment Agency (EA) "Aquifer Designation Maps" can be used to identify aquifers. These can be found on the "Groundwater maps" available on the EA website (www.environment-agency.gov.uk) follow "At home & leisure" > "What's in Your Backyard" > "Interactive Maps" > "Groundwater". Knowledge of the thickness of the geological strata present and the level of the groundwater table is required. This may be known from existing information (for example nearby site investigations), however, it may not be known in the early stages of a project. Determination of the water table level may form part of the site investigation phase of a BIA.

Question 2: Watercourses, wells or spring lines may be identified from the following sources:

- Local knowledge and/or site walkovers
- Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). If features are marked (they are not always) the following symbols may be present: W; Spr; water is indicated by blue colouration. (check the key on the map being used)
- British Geological Survey maps (e.g. 1:10,000 scale, current and earlier editions). Current maps will show indicative geological strata boundaries which are where springs may form at the ground surface; of relevance are the boundary between the Bagshot Formation with the Claygate Member and the Claygate Member with the London Clay. Note that the boundaries are indicative should be considered to be accurate to ±50m. Earlier geological maps (e.g. the 1920's 1:10560 scale) maps show the location of some wells.
- Aerial photographs
- "Lost Rivers of London" by Nicolas Barton, 1962. Shows the alignment of rivers in London and their tributaries.
- The British Geological Survey (BGS) GeoIndex includes "Water Well" records. See www.bgs.ac.uk and follow "Online data" > "GeoIndex" > "Onshore GeoIndex".
- The location of older wells can be found in well inventory/catalogue publications such as "Records of London Wells" by G. Barrow and L. J. Wills (1913) and "The Water Supply of the County of London from Underground Sources" by S Buchan (1938).
- The Environment Agency (EA) "Source Protection Zone Maps" can be used to identify aquifers. These can be found on the "Groundwater maps" available on the EA website (www.environment-agency.gov.uk) follow "At home & leisure" > "What's in Your Backyard" > "Interactive Maps" > "Groundwater".
- The EA hold records of licensed groundwater abstraction boreholes. LB Camden is within the North East Area of the Thames Region. Details can be found on the EA website.
- LB Camden Environmental Health department may hold records of groundwater wells in the Borough.

Where a groundwater well or borehole is identified, it will be necessary to determine if it is extending into the Lower Aquifer (Chalk) or the Upper Aquifer (River Terrace Deposits, Bagshot Formation, Claygate Member etc). It is water wells extending into the Upper Aquifer which are of concern with regard to basement development.

Question 3: Figure 14 in the attached study, (prepared using data supplied by the City of London Corporation's hydrology consultant, Haycocks Associates) shows the catchment areas of the pond chains on Hampstead Heath.

Question 4: This will be specific to the proposed development and will be a result of the proposed landscaping of areas above and surrounding a proposed basement.

Question 5: This will be specific to the proposed development and will be a result of the chosen drainage scheme adopted for the property.

Question 6: The lowest point will be specific to the proposed development. Knowledge of local ponds may be taken from

- Local knowledge and/or site walkovers
- Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). If features are marked (they are not always) the following symbols may be present: W; Spr; water is indicated by blue colouration. (check the key on the map being used)
- Aerial photographs

Slope stability screening flowchart

The Developer should consider each of the following questions in turn, answering either “yes”, “unknown” or “no” in each instance.

Consideration should be given to both the temporary and permanent works, along with the proposed surrounding landscaping and drainage associated with a proposed basement development.

Question 1: Does the existing site include slopes, natural or manmade, greater than 7^{o}? (approximately 1 in 8)

Question 2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7^{o}? (approximately 1 in 8)

Question 3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7^{o}? (approximately 1 in 8)

Question 4: Is the site within a wider hillside setting in which the general slope is greater than 7^{o}? (approximately 1 in 8)

Question 5: Is the London Clay the shallowest strata at the site?

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).

Question 7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?

Question 8: Is the site within 100m of a watercourse or a potential spring line?

Question 9: Is the site within an area of previously worked ground?

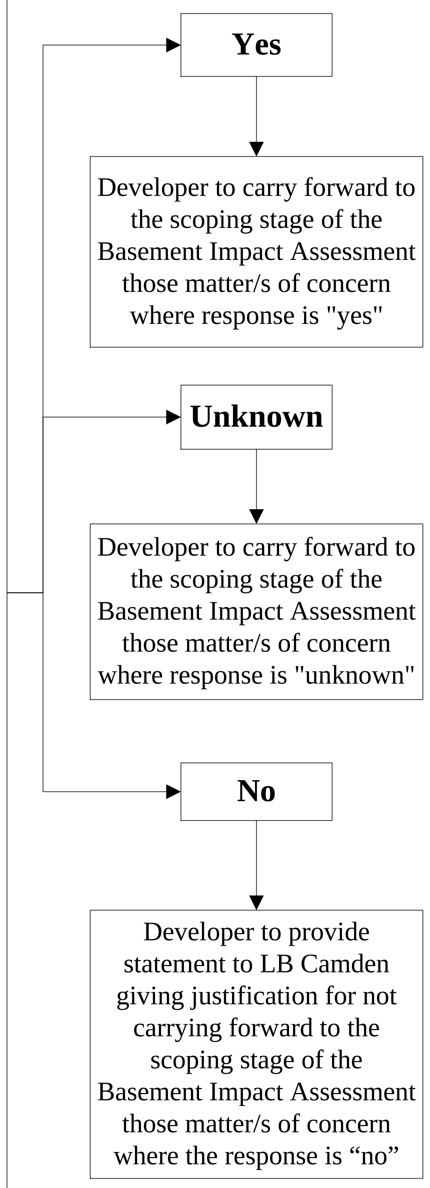
Question 10: Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?

Question 11: Is the site within 50m of the Hampstead Heath ponds?

Question 12: Is the site within 5m of a highway or pedestrian right of way?

Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?

Question 14: Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?



Notes / sources of information

Question 1, 3 & 4: The current surface slope can be determined by a site topographical survey. Slopes may be estimated from 1:25,000 OS maps, however in many urban areas such maps will not show sufficient detail to determine surface slopes on a property-by-property scale, just overall trends. With regard to slopes associated with infrastructure, e.g. cuttings, it should be ensured that any works do not impact on critical infrastructure.

Question 2: This will be specific to the proposed development and will be a result of the proposed landscaping of areas above and surrounding a proposed basement.

Question 5: The plan footprint of the outcropping geological strata can be established from British Geological Survey maps (e.g. 1:50,000 and 1:10,000 scale). Note that the boundaries are indicative and should be considered to be accurate to ±50m at best.

Question 6: this is a project specific determination, subject to relevant Tree Preservation Orders etc.

Question 7: this can be assessed from local knowledge and on-site observations of indicative features, such as cracking, Insurance firms may also give guidance, based on post code. Soil maps can be used to identify high-risk soil types. Relevant guidance is presented in BRE Digest 298 "Low-rise building foundations: the influence of trees in clay soils" (1999); BRE Digest 240 "Low-rise buildings on shrinkable clay soils: part 1" (1993); and BRE Digest 251 "Assessment of damage in low-rise buildings" (1995).

Question 8: Watercourses or spring lines may be identified from the following sources:

- Local knowledge and/or site walkovers
- Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). If features are marked (they are not always) the following symbol may be present "Spr"; water is indicated by blue colouration. (check the key on the map being used)
- Geological maps will show indicative geological strata boundaries which are where springs may form at the ground surface; of relevance are the boundary between the Bagshot Formation with the Claygate Member and the Claygate Member with the London Clay. Note that the boundaries are indicative should be considered to be accurate to ±50m at best. British Geological Survey maps (e.g. 1:10,000 scale, current and earlier editions).
- Aerial photographs
- "Lost Rivers of London" by Nicolas Barton, 1962. Shows the alignment of rivers in London and their tributaries.

Question 9: Worked ground includes, for example, old pits, brickyards, cuttings etc. Information can be gained from local knowledge and/or site walkovers, and from historical Ordnance Survey maps (at 1:25,000 or 1:10,000 scale, or better) and British Geological Survey maps (at 1:10,000 scale, current and earlier editions). Earlier geological maps (e.g. the 1:10560 scale series from the 1920s) include annotated descriptions such as "old pits", "formerly dug", "brickyard" etc.

Question 10: In LB Camden, all areas where the London Clay does not outcrop at the surface are considered to be an aquifer. This includes the River Terrace Deposits, the Claygate Member and the Bagshot Formation. The general footprint of the geological strata can be assessed from British Geological Survey maps (e.g. 1:50,000 and 1:10,000 scale). Note that the boundaries are indicative and should be considered to be accurate to ±50m at best.

The Environment Agency (EA) Aquifer Designation Maps can be used to identify aquifers. These are available from the EA website (www.environment-agency.gov.uk), by clicking on 'At home & leisure' > 'What's in Your Backyard' > 'Interactive Maps' > 'Groundwater'.

Details are required of the thickness of the geological strata present and the level or depth of the groundwater table. This may be known from existing information (for example nearby site investigations); however, it may not be known in the early stages of a project. Determination of the water table level may form part of the site investigation phase of a BIA and may require specialist advice to answer. Depth of proposed development is project specific.

Question 11: From local knowledge and/or site walkovers, and from Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). In relation to the stability and integrity of the pond structures and dams, the guidance of a Panel Engineer should be sought. (Details of Panel Engineers can be found on the Environment Agency website: http://www.environment-agency.gov.uk/ business/sectors/64253.aspx). Duty of care needs to be undertaken during any site works in the vicinity of the ponds.

Question 12: From local knowledge and/or site walkovers, and from Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). Any works should not impact on critical infrastructure.

Question 13: From local knowledge and/or site walkovers. May find some details on neighbouring properties from searches of LB Council databases, e.g. planning applications and/or building control records.

Question 14: From local knowledge and/or site walkovers, from Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale) and directly from those responsible for tunnels (e.g. TfL or Network Rail). Any works should not impact on critical infrastructure.

Appendix F

Potential impacts linked to screening flowchart

F1 Surface flow and flooding impact identification

The following impacts are consequent upon or may result from conditions identified in the surface flow and flooding screening flowchart.

Screening flowchart question		Potential impacts
1	Is the site within the catchment of the pond chains on Hampstead Heath?	With regard to the pond chains on Hampstead Heath, in particular the bathing ponds, changes in quality would be of concern; in particular the risk of contamination. This may potentially lead to the bathing ponds not attaining the required Bathing Water Directive water quality standards. Any reduction in the surface water inflow to the ponds would reduce the overall flow through the ponds, which in turn could allow an increased build-up of contaminants. Any increase in surface water inflow to the ponds could result in an increase in contaminants (e.g. animal faeces and organic matter) being washed into the ponds. Any increase in surface water inflow to the ponds could also result in an increase in the "normal" volume of water in the ponds. With more water in the ponds on a day-to-day basis, the available spare capacity in the ponds for receiving storm rainfall would be reduced, thus increasing the risk of the ponds over-topping when, in the event of a storm, that spare capacity is needed. If overtopping were to occur, this could cause inundation of land and properties downstream
2	As part of the site drainage, will surface water flows (e.g. rainfall and run-off) be materially changed from the existing route?	Basement development may increase the load on the sewer and drainage systems if it leads to increased occupancy of dwellings. In turn this may increase the risk of flooding should the sewer and drainage systems become overwhelmed. Constructing a basement, either beneath or adjacent to an existing building will typically remove the permeable shallow ground that previously occupied the site footprint. This reduces the capacity of the ground to allow rainfall to be stored in the ground (which in essence acts as a natural SUDS, or sustainable urban drainage system). This runoff must then be managed by other means (eg through construction of SUDS), to ensure that it doesn't impact on adjoining properties or downstream watercourses. For sites in the catchments of the pond chains the potential impacts listed above under (1) apply if the resulting changes in drainage affect the flow to the ponds.

Screening flowchart question		Potential impacts
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	A change in the in proportion of hard surfaced or paved areas of a property will affect the way in which rainfall and surface water are transmitted away from a 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 which may additionally increase the risk of flooding. For sites in the catchments of the pond chains the potential impacts listed above under (1) apply if the resulting changes affect the flow to the ponds.
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 or downstream watercourses?	Changes could result in decreased volume, which may affect ecosystems or reduce amenity, or increased flow which may additionally increase the risk of flooding. For sites in the catchments of the pond chains the potential impacts listed above under (1) apply if the resulting changes in drainage affect the flow to the ponds.
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	Changes could result in decreased quality, which may affect ecosystems or reduce amenity. For sites in the catchments of the pond chains the potential impacts listed above under (1) apply if the resulting changes affect the quality of flow to the ponds.

F2 Subterranean (groundwater) flow impact identification

The following impacts are consequent upon or may result from conditions identified in the subterranean (groundwater) flow screening flowchart.

	Screening flowchart question	Potential impacts
1	Is the site located directly above an aquifer?	Potentially the basement may extend into the underlying aquifer and thus affect the groundwater flow regime.
	If yes to (a), will the proposed basement extend beneath the water table surface?	The groundwater flow regime may be altered by the proposed basement. Changes in flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally. For existing nearby structures then the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.
2	Is the site within 100m 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 which supports that water feature 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 issuing or abstracted from the spring or water well respectively.
3	Is the site within the catchment of the pond chains on Hampstead Heath?	With regard to the pond chains on Hampstead Heath, any reduction in the spring inflow to the ponds would reduce the overall flow through the ponds, which in turn could allow an increased build-up of contaminants. This may potentially lead to the bathing ponds not attaining the required Bathing Water Directive water quality standards
4	Will the proposed basement development result in a change in the area of hard surfaced / paved areas?	The sealing off of the ground surface by pavements and buildings to rainfall will result in decreased recharge to the underlying ground. In areas underlain by an aquifer, this may impact upon the groundwater flow or levels – this would then have similar impacts to those listed in 1b) and 2). In areas of non-aquifer (i.e. on the London Clay), this may mean changes in the degree of wetness which in turn may affect stability.
5	As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharge to the ground (e.g. via soakaways and/or SUDS)?	In areas underlain by an aquifer, this may impact upon the groundwater flow or levels – this would then have similar impacts to those listed in 1b) and 2). In areas of non-aquifer (i.e. on the London Clay), this may mean changes in the degree of wetness which in turn may affect stability.

Screening flowchart question		Potential impacts
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.	Groundwater may drain from the pond or spring and flow into the basemen/excavation space.

F3 Stability impact identification

The following impacts are consequent upon or may result from conditions identified in the stability screening flowchart.

Screening flowchart question		Potential impact
1	Does the existing site include slopes, natural or manmade, greater than 7^{o} ? (approximately 1 in 8)	Local slope instability within the site
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7^{o}? (approximately 1 in 8)	Local slope instability within and adjoining the site
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7^{o}? (approximately 1 in 8)	Slope instability within neighbouring site(s).
4	Is the site within a wider hillside setting in which the general slope is greater than 7^{o}? (approximately 1 in 8)	Potential for a larger slope failure system, including re-activation of a pre-existing slide.
5	Is the London Clay the shallowest strata at the site?	Of the at-surface soil strata present in LB Camden, the London Clay is the most prone to seasonal shrink-swell (subsidence and heave).
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).	The soil moisture deficit associated with felled tree will gradually recover. In high plasticity clay soils (such as London Clay) this will lead to gradual swelling of the ground until it reaches a new value. This may reduce the soil strength which could affect the slope stability. Additionally the binding effect of tree roots can have a beneficial effect on stability and the loss of a tree may cause loss of stability.
7	Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	Multiple potential impacts depending on the specific setting of the basement development. For example, in terraced properties, the implications of a deepened basement/ foundation system on neighbouring properties should be considered.
8	Is the site within 100m of a watercourse or a potential spring line?	Seasonal springlines and changes to groundwater regimes within slopes can affect slope stability.
9	Is the site within an area of previously worked ground ?	Previously worked ground may be less homogeneous than natural strata, and may include relatively uncontrolled backfill zones.
10	Is the site 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
	If yes to (a), will the proposed basement extend beneath the water table such that dewatering may be required during construction?	

		increase in water levels can have a detrimental effect on stability.
11	Is the site within 50m of the Hampstead Heath ponds?	The Panel Engineer for the reservoirs would require details of excavations in the vicinity of the reservoirs.
12	Is the site within 5m of a highway or pedestrian right of way?	Excavation for a basement may result in damage to the road, pathway or any underground services buried in trenches beneath the road or pathway.
13	Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Excavation for a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations.
14	Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Excavation for a basement may result in damage to the tunnel.

Appendix G

Typical site investigation document content lists

G1 Desk Study

Typical contents
The site • Location: site address or six figure grid reference – refer to figure. • Site boundaries and size. • Site ownership • Existing development within and around site and its present condition (if open land, discuss vegetation).
Proposed development • Description and relationship to existing building – refer to plan • Dimensions • Structural form
Topography, geomorphology and drainage Consider both within and around the site: • Site elevation • Natural water courses • Old river courses • Seepage/springs or 'issues' • Impeded / poorly drained areas • Possibility of flooding • Stability of existing slopes • Trees – current and historical
Geology and ground conditions • Anticipated underlying geology • Surface and thickness of strata • Previous site investigations
Hydrogeology/groundwater • Groundwater table • Groundwater flow into/out of the site • Interaction with surface flow
History of site Consider • Previous development and its effect on the site • Evidence of mining and/or quarrying • Evidence of wells and shafts • Possibility of old cess pits / burial grounds • Evidence of fill being placed • Reclaimed land • Former industrial processes carried out on the site • Former structures
Site Visit/Reconnaissance • Evidence of groundwater • Location of surface waters • Behaviour of any existing structures • Areas of instability • Anecdotal evidence of historical activities/site use • Include dates of observations and qualification of person/s undertaking any site visit/reconnaissance.

Underground features Identify structures on-site and in the area which may be impacted or may impact on the proposed basement, e.g. • Railway tunnels • Canal tunnels • Telecommunications tunnels • Old basement / cellar • Neighbouring foundations and basements • Buried tanks • Sewers • Pipes, gas, water, sewerage drainage • Utilities cables • Ground anchors of adjacent walls If available, include construction details (depth, design etc).
Other factors to consider, which depending on the site may be relevant: • Chemical contamination • Archaeological potential

G2 Site investigation factual report

Typical content	Notes
Introduction Objective and scope	Purpose and scope of the investigation Name of all consultants and sub-contractors used
Site location and description	Site plan showing exploratory hole locations
Fieldwork procedure	Factual account of all field and laboratory work, including dates of when investigation undertaken.
In situ testing Laboratory testing	Exploratory hole records (boreholes, trial pits, window sample holes), including grid co-ordinates and ground elevation In situ test results Laboratory test results including any contamination test results (including dates of sampling and testing) Groundwater level and geoenvironmental monitoring (including time and date of monitoring) Other specialist results (geophysics etc)

G3 Site investigation interpretative report

Typical content
The site This section sets the scene. If a desk study has been completed, this information will come from the desk study. • Location • Present use – structural form, conditions, foundations etc. • Proposed • Topography, geomorphology and drainage • Geology and ground conditions • Hydrogeology/groundwater • History of site • Underground features • Other factors e.g. contamination and archaeology
Review of site investigation Describe the site investigation undertaken. • Contractor, scope of work, dates of field and lab work, supervision, British Standards and codes complied with • Reference to Contractors factual report. • Details of boreholes and trial pits: (number, locations – refer to figure, depths, diameters, details of installations (e.g. standpipes, piezometers), difficulties encountered, water. • Details of samples taken and in-situ tests • Details of laboratory tests • Full review of the field and laboratory work (including time of year in which the investigation was undertaken, as this could affect groundwater levels) • Detailed description of all formations including geological context, physical properties • Comments on irregularities such as pockets, depressions, cavities and boulders • Identification of geological, geotechnical or other hazards
Ground conditions • Stratigraphy – general description of strata – tabulated • Groundwater • Description of individual strata e.g. for London Clay • Consideration of the individual strata in detail, with reference to any proposed foundations. • Includes factors such as undrained shear strength, compressibility, effective strength, bearing capacity etc. • A review and summary of the derived values of geotechnical parameters.
Earthworks and drainage • Soil removal • Excavations • Slopes • Cuttings • Embankments • Ground movements • Stability of temporary excavations • Drainage

Retaining wall design • Functional requirements • Design of retaining wall and assumptions • Analysis of wall behaviour • Deflection of wall • Ground settlements • Adjacent structures • Propping system • Temporary • Permanent • Grade of water tightness • Concrete
Summary and recommendations (including mitigation measures) • Summary of identified risks / potential matters of concern • Simple descriptions summarising potential/proposed mitigation measures to reduce the impact of identified risks / potential matters of concern • Summary / discussion of residual impact of identified risks / matters of concern.

Appendix H

Hypothetical case study examples

H1 Hypothetical case study 1 - residential basement excavation on London Clay adjacent to Hampstead No. 1 Pond

Description

Residential basement excavation beneath the footprint of an existing property founded on Made Ground overlying the London Clay. The property is adjacent to the Hampstead No. 1 Pond. The basement will be used for habitable use and will extend through the entire Made Ground and key into the London Clay. The founding level of the basement will be below the normal water level of the Hampstead No. 1 Pond.

Potential issues relating to excavation

- Stability issues with basement excavation within the London Clay and in proximity to a dam structure.
- The property is adjacent to a large body of water which could potentially present a flood risk particularly since the basement will be used for habitable purposes.
- There is a potential for groundwater to be present within Made Ground particularly if it is laterally extensive and in hydraulic continuity with the Hampstead No. 1 Pond.
- By founding the basement within the London Clay, any groundwater flow in the Made Ground beneath the footprint of the building could be affected which could potentially lead to changes in water level.
- If groundwater within the Made Ground is affected by the basement there is the potential for this to affect neighbouring properties including structural stability issues.
- Potential for removal of water from basement excavation during construction and the need for dewatering of the Made Ground.

Information that may reasonably be expected to be included in application (based on flowcharts)

- Assessment of land stability with respect to proximity to Hampstead No. 1 Pond, potential dewatering of the Made Ground and London Clay stability.
- Ground investigation to determine geological materials in which the basement will be founded and the presence of perched water in the Made Ground.
- If groundwater is found to be present within the Made Ground within the basement footprint, groundwater monitoring to determine groundwater levels in the Made Ground and any variation in levels.
- If the basement will extend below groundwater levels, a detailed hydrogeological impact assessment to determine the impact of the basement construction on groundwater within the Made Ground and impact on subsurface flows to the Hampstead No. 1 Pond.
- Surface water impact assessment to determine the potential impacts to the nearby Hampstead No. 1 Pond.
- Since the basement is close to a surface water body and will be used for habitable use, a flood risk assessment for the basement should be provided.

H2 Hypothetical case study 2 - large basement excavation on Bagshot Formation

Description

A large two level residential basement excavation partially beneath the existing property, and partially within the forecourt of the property founded on the Bagshot Formation. The basement will be used for habitable space and lead to some reduction of vegetation where the basement extends outside the footprint of the existing property. The property is located within the Hampstead Heath Ponds catchment area.

Potential issues relating to excavation

- The Bagshot Formation is a relatively permeable geological unit which allows water to flow through it. A large deep basement excavation has the potential to impact groundwater flow in the area.
- A deep basement could impede groundwater flow if the formation level of the basement is below the groundwater level. This could lead to an increase in water levels behind the basement and a decrease in water levels downstream.
- A large basement may affect drainage and surface water flows close to the excavation due to potential changes in land use at the surface/removal of vegetation. This could have the potential to affect water flow and quality into the Hampstead Heath pond catchment.
- Perched water within the Bagshot Formation may be encountered during excavation of the basement and could lead to inflow into the excavation.
- If the basement is below groundwater level, water pressures on the structure will need to be taken into account in the design of the basement.
- Dewatering and removal of water in excavation may be required during basement construction to prevent inundation of the excavation.

Information that may reasonably be expected to be included in application (based on flowcharts)

- Since the property is within the Hampstead Ponds catchment a hydrogeological assessment will be required.
- Ground investigation including at least three boreholes to prove geological materials in which the basement will be founded and to determine if groundwater is present within the basement footprint.
- If groundwater is present, groundwater monitoring across the basement footprint to determine groundwater flow and variation in groundwater levels over an appropriate period of time.
- If the basement will extend below the level of groundwater, a detailed hydrogeological impact assessment detailing impact on the groundwater caused by the basement if any and appropriate mitigation measures.
- A land stability assessment in relation to dewatering (if required) and removal of vegetation and alteration to party walls (if appropriate).
- Since the property lies within the Hampstead Ponds catchment area a surface water impact assessment should be provided.
- Since the basement will be used for habitable purposes a flood risk assessment should be provided.

H3 Hypothetical case study 3 - residential basement excavation on Claygate Member of London Clay

Description

Residential basement excavation beneath the footprint of an existing property founded on the Claygate Member of the London Clay. The basement will be used for storage/non-habitable space. The property is located above, or very near to, a tunnelled section of London Overground line track.

Potential issues relating to excavation

- The Claygate Member is considered to be permeable in parts and may contain groundwater. The groundwater may be mobile if the unit is particularly sandy.
- A basement could impede groundwater flow if the formation level of the basement is below the groundwater level. This could lead to an increase in water level behind the basement and a decrease in water level downstream although this effect is likely to be small given the relatively small basement.
- Perched water within the Claygate Member may be encountered during excavation of the basement.
- If basement is below groundwater level, water pressures on the structure will have to be taken into account in the design of the basement.
- Removal of water in excavation may be required during basement construction to prevent inundation of the excavation.
- Structural stability of the ground may be an issue particularly with respect to the tunnel located near to/below the property.

Information that may reasonably be expected to be included in application (based on flowcharts)

- Assessment of land stability with respect to the buried infrastructure, potential dewatering of the Claygate Member and London Clay stability.
- Ground investigation to determine geological materials in which the basement will be founded and the presence of groundwater within the Claygate Member.
- If the site investigation proves that groundwater is present within the basement footprint, monitoring to determine variation in groundwater levels.
- If monitoring shows that the basement will extend into the underlying groundwater, a detailed hydrogeological impact assessment to determine the impact of the basement construction on the groundwater.
- The basement is not likely to have an impact on surface water so a hydrological assessment is not necessary.
- Since the basement is not being used for habitable uses and not within a flood risk area, a flood risk assessment is not necessary.