Smarter Building and Construction Limited

53 Fitzroy Park, London, N6 6JA

Basement Impact Assessment

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RSK

RSK GENERAL NOTES

Report No.: 371263-01(04)

Title: Basement Impact Assessment for 53 Fitzroy Park, Highgate, London, N6 6JA

Client: Smarter Building and Construction Limited

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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NON-TECHNICAL SUMMARY

NON-TECHNICAL SUMMARY	
Site description	The site is located No.53 Fitzroy Park, Highgate, London N6 6JA, in the London Borough of Camden. The site fronts onto Fitzroy Park, a private residential street, to the east, and is bordered by the gardens of neighbouring detached properties to the north, south and west, and by a pond within the neighbouring garden to the southwest. The site lies within a natural hillslope setting, which descends in a general southwesterly direction from the high ground of Highgate to the northeast. The topography in the general site area is undulating, formed from a series of shallow valleys cut into the slope. The site currently comprises a three-storey detached property, cut into the sloping ground, with two-storeys above ground level and one below ground level at the front of the property (adjacent to Fitzroy Park), and three-storeys above ground level at the rear of the property.
Proposed development	The proposed redevelopment will involve the demolition of the existing structure on site and the construction of a new residential property. The new property partially overlaps the footprint of the existing building in the southwest of the site, but is a larger building and more centrally placed within the site The proposed development comprises a partial basement excavation to form the lower ground floor level with a finished floor level (FFL) of 80.34mAOD. This basement is locally deepened in sub-basement areas to provide accommodation space for a lift pit (FFL 78.74mAOD). Lower ground floor level is at a FFL of 80.34mAOD. The lower ground floor level will be subterranean in the northeast of the development, but at the rear of the property will be at ground level, opening onto the garden to the rear. A ground floor FFL of 83.70mAOD will be at road level adjacent to Fitzroy Park in the east of the site, but will form a 1st floor level at the rear of the property.
Ground / Groundwater conditions	The site is underlain by a variable thickness of Made Ground across the site, ranging from 0.4m to 1.7m thick. The Made Ground generally comprised cohesive brown sandy slightly gravelly clay (reworked London Clay). Distinct fine-grained sediments were encountered locally adjacent to the site's southwestern boundary, close to the large pond located in the grounds of No.55 Fitzroy Park. These sediments are located in an area identified on historical maps as having been formerly partly occupied by this pond. The London Clay Formation was encountered beneath the Made Ground/pond infill material across the site. The upper part of the London Clay was encountered as firm brown mottled grey-green (weathered) silty clay to depths of 5.8m bgl to 6.7m bgl (77.43mAOD to 75.02mAOD), below which the

	London Clay was stiff and dark-brownish grey in colour (generally unweathered). The London Clay was locally slightly sandy (fine sand) with occasional partings of fine sand/coarse silt. Observations made during site works and the results of a groundwater monitoring programme reveal the presence of perched water seepages within the Made Ground overlying the very low permeability London Clay, and localised very slow seepages at depth within the London Clay. A ground penetrating radar survey did not record any anomalous reflections that were indicative of buried pipes or services, and no areas of anomalous ground conditions indicative of preferential drainage pathways between No.53 and the pond in the grounds of No.55. A shallow drainage network has been identified connected to the pond in the grounds of No.55; two pipes exited a shallow inspection chamber, one heading directly to the pond at No.55, the second heading towards the southwest. The inspection also revealed a shallow pipe entering the inspection chamber from the adjacent site of 'The Waterhouse' to the northwest of the pond. However, this latter pipe was sealed with a pipe bung. No water was flowing in the pipework at the time of these observations (November 2011). No connections were observed to indicate direct drainage from No.53 to the pond.
Screening and scoping	**Subterranean (ground water):** No potential impacts identified beyond the scoping stage **Surface flow and flooding:** No potential impacts identified beyond the scoping stage **Land stability:** Potential impacts identified relate to ground stability associated with: • Retaining wall installation and ground excavation; and • Elastic heave of the London Clay in the basement excavation.
Impact Assessment	The following nearby structures were identified for assessment relating to potential ground movements: • The highway of Fitzroy Park beyond eastern site boundary • Nos. 51 and 55 Fitzroy Park to the northwest and southeast of the site, respectively; and • No.1 Fitzroy Park and 'Sunbury', located to the northeast of the site beyond Fitzroy Park. **Structural stability of adjacent structures from retaining wall installation and basement excavation** Movement analyses have been undertaken in accordance with CIRIA C580. All building structures fall into 'Category 0' (Negligible) to 'Category 1' ('Very Slight Damage'). The results fulfil the requirements of CPG4 in that they do not exceed the damage category of 'slight' (Category 2) and reflect categories of cosmetic rather than structural damage.

	The predicted movements associated with the road/pavement of Fitzroy Park indicate one-off very small strain and rotation that will have no damaging effect. **Structural stability of adjacent structures from heave of the basement excavation** Numerical modelling has been undertaken to determine the conditions at key stages in the construction process, namely: • Unloading due to demolition of the existing building and excavation for the new basement; and • Full loading following construction of the new basement and building. In both cases, no potentially damaging vertical movements are predicted beyond the site's boundary.
Cumulative Impacts	No potential cumulative impacts have been identified for the proposed development.

1 INTRODUCTION

1.1 Instructions

On the instructions of Elliott Wood Partnership LLP, on behalf of Smarter Building and Construction Limited (the 'Client'), RSK Environment Limited (RSK) have produced a Basement Impact Assessment for a proposed development at 53 Fitzroy Park, London, N6 6JA, located within the Highgate Ward of the London Borough of Camden.

1.2 Regulatory Context

This assessment is designed to be compliant with guidance provided by the London Borough of Camden (Camden) in their guidance document 'Camden Planning Guidance for Basements and Lightwells, CPG4' (amended September 2013) and its supporting study 'Camden Geological, Hydrogeological and Hydrological Study' produced for Camden by ARUP in November 2010. All the technical analysis and recommendations contained within the planning guidance are taken from this latter study, which is treated as the evidence base and technical advice when Camden are assessing Basement Impact Assessments.

This guidance applies to all developments in Camden that propose a new basement development, or an extension to existing basement accommodation where planning permission is required. In accordance with policy DP27, Camden will only permit basement and other underground development where it can be demonstrated that it will not cause harm to the built and natural environment, including to the local water environment and ground conditions.

Addressing these issues requires the submission of a Basement Impact Assessment (BIA). A BIA will be specific to a particular site and proposed development, but includes the following stages:

- *Screening*; the identification of any matters of concern with regard to hydrogeology, hydrology or ground stability, which should be investigated.
- *Scoping*; production of a statement that defines further the matters of concern identified at the screening stage.
- *Site Investigation and Study*; undertaken to establish the baseline conditions. This can be done by utilising existing information and/or collecting new information.
- *Impact Assessment*; undertaken to determine the impact of the proposed basement on the baseline conditions, taking into account any mitigation measures proposed.
- *Review and Decision-Making*; this final stage is undertaken by Camden and consists of an audit of the information supplied and a decision on the acceptability of the impacts of the basement proposal.

The purpose of the BIA is to enable Camden Council to 'assess whether any predicted damage to neighbouring properties and the water environment is acceptable or can be satisfactorily ameliorated by the developer' as stated in DP27.3.

1.3 Background

By way of background to the current project, a desk study and intrusive site investigation have been undertaken at the site by RSK, as detailed in the report '53 Fitzroy Park, Highgate, North West London, Geotechnical, Hydrogeological and Geoenvironmental Site Investigation Report', reference no. 241919-01(00), dated December 2010. The current assessment draws on the results of that report. For full details reference should be made to the original report.

In addition, a site investigation was previously undertaken at the site by Geotechnical & Environmental Associates (GEA), as presented in their report dated November 2009. This report was made available to RSK for review as part of this study.

Together these reports provide comprehensive site specific information and are compliant with the data requirements as set out in Appendix G of 'Camden Geological, Hydrogeological and Hydrological Study' produced for Camden by ARUP in November 2010. The conditions at the site have not changed since these reports were commissioned and, therefore, the information within these reports is wholly relevant to the proposed scheme described herein.

1.4 Standards and Limitations

This report is based on information available at the time of writing. This report should be considered in the light of any changes in legislation, statutory requirement or industry practices that may have occurred subsequent to the date of issue.

2 SITE DETAILS

2.1 Site description

The site is located at National Grid reference TQ 277 869, as shown on **Figure 1**. The site fronts onto Fitzroy Park, a private residential street, to the east, and is bordered by the gardens of neighbouring detached properties to the north, south and west, and by a pond within the neighbouring garden to the southwest (**Figure 2**).

The site lies within a natural hillslope setting, which descends in a general southwesterly direction from the high ground of Highgate to the northeast. The topography in the general site area is undulating, formed from a series of shallow valleys cut into the slope and their associated interfluves. The topography in the immediate site area indicates that the subject site lies on the northwest-facing flank of a gentle northeast to southwest orientated valley. There is no surface watercourse currently flowing within this valley.

The main geographical and geological features of the general site area are shown on **Figure 3**.

The dissected topography in the site area is associated with the catchment of a stream formerly known as the 'Highgate Brook', which forms one of the tributaries of the River Fleet. The Fleet rises on Hampstead Heath by two heads, separated by Parliament Hill. The eastern, or Highgate, source lies near to the subject site, and is fed via a series of springs in the grounds of Kenwood House, whence the stream flows southwards, via a series of ponds (the Highgate Ponds), which were historically constructed in the channel of the Highgate Brook for water supply. The ponds currently serve a variety of leisure and recreational purposes, and are the subject of a number of conservation and management measures under the Corporation of London's Hampstead Heath Management Plan.

The site at 53 Fitzroy Park, of approximately 0.35 hectares, currently comprises a large detached residential property set within mature, landscaped gardens (**Figure 4**).

Ground levels at the site range from an elevation of approximately 84m above Ordnance Datum (AOD) at the site's eastern boundary (adjacent to Fitzroy Park) to approximately 80.5mAOD to 80mAOD at the site's western and southwestern boundaries, respectively. Ground levels adjacent to the current property are level at approximately 82.5mAOD.

The current building on site comprises a three-storey detached property, cut into the sloping ground, with two-storeys above ground level and one below ground level at the front of the property (adjacent to Fitzroy Park), and three-storeys above ground level at the rear of the property.

The elevation of the site decreases by between 1.5m and 2.0m along its eastern boundary, stepping down from adjacent street level along Fitzroy Park. Along the northeastern section of the boundary this change in elevation is unretained and is accommodated by a slope, which descends from an elevation of approximately 84.5mAOD adjacent to Fitzroy Park to 82.5mAOD within the gardens of the property.

There is an approximately 1m high retaining wall to the rear of the house, stepping down from ground floor level to the adjacent gardens. The site appears to have been historically cut to allow development of the building currently occupying the site. Some garden areas of the site appear to have been locally landscaped.

No buildings directly adjoin the site's boundaries.

2.2 Planning records

A search of publicly available planning records (dating back to 1924) on Camden's planning website revealed records of granted permissions for basement/lower ground floor development/extension or other subterranean development (e.g. swimming pool accommodation space) at ten properties in the site area, as indicated on **Figure 2**.

The majority of the noted properties are located to the northwest of number 53 Fitzroy Park (i.e. along-gradient of the site), with the exception of No.1 Fitzroy Close and 'Sunbury', which are located to the northeast of the site (i.e. up-gradient of the site), beyond Fitzroy Park.

2.3 Ground / Groundwater Conditions

2.3.1 British Geological Survey Data

The published 1:50,000 scale geological map (Sheet No. 256 'North London') and 1:10,560 scale geological map (TQ28NE) of the area indicate that the immediate site area is underlain by the London Clay Formation (**Figure 3**).

The London Clay Formation is divided by the British Geological Survey (BGS) into five informal units. The lowest four, denoted A to D, are not mapped, whereas the top part of the formation is mapped as the Claygate Member. The site lies on the flank of, and topographically below, a dissected outlier comprising the Claygate Member and the overlying Bagshot Formation. The geological boundary between the Claygate Member and the underlying Unit D of the London Clay Formation is mapped as lying close to the site's eastern boundary along Fitzroy Park. (**Figure 3**). It is therefore considered that the site area lies within Unit D of the London Clay Formation.

The BGS Hampstead Heath borehole (TQ28NE/198, and as reported in Ellison *et al*., 2004) indicates that the Claygate Member in the area is dominated by mainly fine-grained sand and silt whilst Unit D of the London Clay Formation is dominated by silty clay and clay with intervening beds of silt.

No superficial deposits are shown in the site area, but the 1:50,000 scale geological map indicates that the site lies within an area of 'Head Propensity' ('Head' is a slope related solifluction deposit), which is based on the geotechnical properties of the London Clay.

2.3.2 Site Specific Intrusive Investigation Data

2.3.2.1 GEA Investigations

An intrusive site investigation was formerly undertaken at 53 Fitzroy Park by GEA, details of which were provided within their report no. J09196/RR/01, dated November

2009. Four boreholes were advanced to depths of 6.0m below ground level (bgl) across the site. The encountered ground conditions were described as 0.5m to 1.1m thickness of Made Ground, generally comprising brown slightly gravelly slightly sandy clay with occasional fragments of brick (reworked London Clay), overlying the London Clay Formation. The London Clay was described as firm brown fissured silty clay with selenite (gypsum) crystals, typical of weathered London Clay, becoming a firm to stiff grey silty clay below 5.5m bgl, more typical of unweathered London Clay. 'Claystone' bands (carbonate concretions) were also recorded within the London Clay.

2.3.2.2 RSK Investigations

Further intrusive site investigation works were undertaken at the site by RSK, details of which are provided within RSK report no.241919-01 (00), dated December 2010. Five cable-percussive boreholes were drilled to depths of between 10m and 15m bgl and four drive-in sampler boreholes were advanced to depths of 4m bgl across the site.

The RSK exploratory holes confirmed the ground conditions as described by GEA and encountered a variable thickness of Made Ground across the site, ranging from 0.4m to 1.7m thick. The Made Ground generally comprised brown sandy slightly gravelly clay (reworked London Clay).

Distinct fine-grained sediments were encountered locally adjacent to the site's southwestern boundary, close to the large pond located in the grounds of No.55 Fitzroy Park. These sediments are located in an area identified on historical maps as having been formerly partly occupied by this pond. In general, this material comprised water-bearing dark-grey slightly sandy gravelly organic clay, with rare fragments of man-made materials (i.e. glass and pottery), which appear to have accumulated/been utilised to infill this section of the historical pond.

Despite lying in an area of 'Head propensity', no deposits were encountered that could unambiguously be described as 'Head' although elements of the Made Ground (e.g. reworked sandy slightly gravelly clay) could represent Head Deposits reworked my man's activities.

The London Clay Formation was encountered beneath the Made Ground/infill material across the site. The upper part of the London Clay was encountered as firm brown mottled grey-green (weathered) silty clay to depths of 5.8m bgl to 6.7m bgl (77.43mAOD to 75.02mAOD), below which the London Clay was stiff and dark-brownish grey in colour (generally unweathered). The London Clay was locally slightly sandy (fine sand) with occasional partings of fine sand/coarse silt. Particle size distribution analyses confirmed that the London Clay material comprised a slightly sandy (fine) (5 – 10%) silty (45 – 47%) clay (45 – 48%). Plasticity classification testing indicates that the clays are of high to very high plasticity, typical of the London Clay.

The locations of the GEA and RSK boreholes are shown on **Figure 4**.

2.3.2.3 Hydrological/Hydrogeological Conditions Determined by the Site Investigations

No groundwater was encountered during the site works undertaken by GEA in November 2009. However, water levels could be measured within borehole standpipes during a monitoring visit carried out two weeks after completion of the site work. Water levels were measured at depths between 1.04m bgl and 1.93m bgl (81.3mAOD and 78.4mAOD), the water levels decreasing in elevation towards the west, as would be

expected from the topography. However, it should be noted that equilibrium conditions may not have been achieved within the timescale referred to above.

A more comprehensive hydrogeological assessment was undertaken by RSK, with groundwater monitoring undertaken within RSK's boreholes in November and December 2010, with additional monitoring undertaken in 2014. Observations made during RSKs site works and subsequent groundwater monitoring indicates that water is present at the site in the following settings:

- Perched water was locally encountered during the site works as minor seepages at the Made Ground/weathered London Clay interface. Made Ground has been noted to vary across the site from 0.4m to 1.7m in thickness, and minor seepages can be anticipated within this material due to rainfall infiltration.

- Minor seepages were encountered at depth, within the London Clay (BH2A, BH6A, BH8A and BH9A). Three of these boreholes (within or close to the footprint of the proposed development) were pumped dry and rising head tests were undertaken to allow an assessment of recharge and determinations of the coefficient of permeability. Values for the coefficient of permeability within the range 1.83 to 1.98 x 10^{-7} m/s were obtained where seepages had been recorded (BH2A and BH6A), and values of 1.37 x 10^{-8} m/s were obtained for clay where seepages had not been recorded (BH9A). Both values are consistent with clay modified by the effects of weathering and fissuring, which reflects the materials encountered on-site. Any lateral groundwater movement within the London Clay is likely to be through silt lenses/laminae and the secondary effect of fissuring.

- Water was encountered within the pond-infill material in the southwest of the site (BH3A and BH4A) as strikes at depths between 1.38m bgl and 1.46m bgl, rising to approximately 1.0m bgl (79.12mAOD).

- Groundwater monitoring undertaken within BH8A in July 2014 indicated a standing water level of 1.40m bgl.

2.3.2.4 Geophysical survey

Given the location of the site within a northeast to southwest orientated valley, a ground penetrating radar (GPR) survey was undertaken to seek to determine the location of drainage channels, sewers or any other sub-surface anomalies within the southwestern part of the site. The survey was carried out within the grounds of both No.53 and No.55, adjacent to the pond within the latter property.

There were no anomalous GPR reflections that were indicative of buried pipes or services, and no areas of anomalous ground conditions indicative of preferential drainage pathways between No.53 and the pond in the grounds of No.55.

However, during this work, a surface water drainage chamber and pipework were encountered within the grounds of No.55, but to the southwest of the subject site boundary. The cover was lifted and revealed that two pipes exited a shallow inspection chamber, one heading directly to the pond at No.55, the second heading towards the southwest. The inspection also revealed a shallow pipe entering the inspection chamber from the adjacent site of 'The Waterhouse' to the northwest of the pond. However, this latter pipe was sealed with a pipe bung. No water was flowing in the pipework at the

time of these observations (November 2011). No connections were observed to indicate direct drainage from No.53 to the pond.

The location of the chamber and the associated pipework orientations are indicated on **Figure 4**.

3 PROPOSED DEVELOPMENT

The proposed redevelopment will involve the demolition of the existing structure on site and the construction of a new residential property. The new property partially overlaps the footprint of the existing building in the southwest of the site, but is a larger building and more centrally placed within the site.

Across the area of the proposed building the site slopes from approximately 82.3mAOD in the northeast (front) to approximately 80.2mAOD in the southwest (rear). The area to the immediate southeast of the proposed building is currently at an elevation of approximately 82.5mAOD, locally up to 84.0mAOD adjacent to the public highway of Fitzroy Park, which is located to the immediate east of the site boundary. It is proposed to raise this southeastern area adjacent to the house to an elevation of 83.7mAOD to form a private car parking area that is level with the adjacent highway.

The proposed development comprises a partial basement excavation to form the lower ground floor level with a finished floor level (FFL) of 80.34mAOD. This basement is locally deepened in sub-basement areas to provide accommodation space for a lift pit (FFL 78.74mAOD). Lower ground floor level is at a FFL of 80.34mAOD. The lower ground floor level will be subterranean in the northeast of the development, but at the rear of the property will be at ground level, opening onto the garden to the rear. A ground floor FFL of 83.70mAOD will be at road level adjacent to Fitzroy Park in the east of the site, but will form a 1st floor level at the rear of the property.

Proposed engineering plans and sections for the development are included in **Appendix A.**

In the temporary case a propped perimeter contiguous bored piled wall is proposed to support the basement excavation, inside which the basement box will be constructed from reinforced concrete, with reinforced concrete slabs at basement and lower ground floor levels, forming rigid propping in the permanent condition. It is proposed to support the structure on piled foundations.

The basement design has been developed to take account of seepage within the ground and to provide the necessary means for seepage to continue before, during and after construction without being significantly impeded.

It is proposed to facilitate this by providing free-draining or permeable zones around the basement structure both vertically and horizontally to allow seepage to continue in both the temporary and permanent conditions around and under the building. The permeable zones will comprise a hardcore type material or no-fines concrete that both have reliable levels of porosity. Geotextiles may be used to prevent silting up of the voids.

It is proposed that the temporary basement perimeter retaining wall would be formed using contiguous piles with spaces between them to allow the seepage of water. In order to avoid loss of fines in the soil it is proposed that the shallow soil would be excavated immediately behind the upstream piled wall to allow the insertion of a geotextile membrane which will allow water to continue to seep but would prevent the fines from being washed out. Should water flows be high then a series of counterfort type drains could also be incorporated within the porous layer.

The vertical layer may be formed by using a proprietary form voiding material that is then removed following construction of the permanent reinforced concrete basement wall. The void between the temporary contiguous bored piles and the permanent basement retaining wall can be backfilled with a free-draining material. The temporary piled wall would be left in place. This form of construction will develop hydrostatic pressures to the basement perimeter walls and slabs. The basement construction will therefore be designed in the permanent condition as a water retaining structure in accordance with BS8007, design of concrete structures for retaining aqueous liquids, with a secondary means of defence such as an internal drained cavity system and associated sumps and pumps, in accordance with BS8102.

During construction, seepage will continue into the excavation through the contiguous bored piled wall, in the same manner as the permanent condition. In the temporary condition, water in the excavation will need to feed into sumps formed below the temporary formation level. The engineering design notes for the development indicate that any collected water will be pumped to the existing water system in the short-term.

4 STAGE 1 - SCREENING

This section of the report provides information for the purpose of screening in accordance with CPG4 and addresses all questions raised within the relevant sections of that document. Tables summarising the screening flowcharts are shown as Tables 1 to 3. In accordance with procedure, where a 'yes' or 'unknown' response is returned, the potential issue is taken to the scoping stage in **Section 5**.

Table 1: Subterranean (ground water) screening

Question		Answer	Evidence/Comment
1	Is the site located directly above an aquifer?	No	The site is underlain by 0.4m to 1.7m of generally cohesive Made Ground overlying the London Clay Formation. The latter is classified as a non-aquifer (non-productive stratum). p.19 of the ARUP guidance document (Ref: 213923) which supports CPG4, states: *"Although groundwater is contained within the microscopic pores of the clayey strata of the London Clay, it permeates so slowly, due to the narrow pores, that in practice it is generally considered a barrier to groundwater".* Therefore, the site does not lie above an aquifer.
1a	Will the proposed basement extend beneath the water table surface?	No	Perched water has been encountered locally within the Made Ground, ponding on top of the impermeable London Clay. This does not constitute a 'water table'. Within a few metres of the ground surface the London Clay can be assumed to be saturated i.e. all available pore space within the clay filled with water. Porosity within this material is so low as to not contain significant volumes of water and to be 'unproductive'. In this case water recorded within the London Clay records pore water pressure and the concept of a 'groundwater table' does not strictly apply. Values for the coefficient of permeability within the range 1.83 to 1.98 x 10^{-7} m/s were obtained where seepages have been recorded within the London Clay and values of 1.37 x 10^{-8} m/s were obtained for clay where seepages had not been recorded. Both values are consistent with clay modified by the effects of weathering and fissuring, which reflects the materials encountered on-site, and represent very low permeability soils with poor drainage characteristics. Therefore the proposed basement will not penetrate any significant 'water tables' that might be affected by changes to groundwater levels or flows.

Question		Answer	Evidence/Comment
2	Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No	The 'Fleet Brook' and associated chain of Highgate Ponds are >100m southeast of the site. The pond in the grounds of No.55 is a very shallow static water body, not a watercourse. Further, investigations have indicated that the principal route of drainage is to the west of the site, through a shallow drainage network that may also feed the pond. The Claygate Member/London Clay boundary is a potential springline, but this boundary lies up-gradient of the site and cannot, therefore, be affected by the site itself.
3	Is the site within the catchment of the pond chains on Hampstead Heath?	Yes	See Section 5 (Scoping)
4	Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No	The current impermeable area at the site (existing lower ground floor and adjacent external hardstanding) occupies approximately 261m^2. The proposed lower ground floor footprint occupies an area of 253m^2. This is a percentage decrease of 3%. In terms of overall plot size, the existing impermeable area accounts for 19.3% of the plot, whilst the proposed will account for 18.8%. It is however, noted that two new external hardstanding areas are proposed, one to the southeast of the new building at road level for parking and one to the rear of the new building to form a garden patio area at lower ground level. It is however, understood that these external hardstanding areas will comprise permeable paving, which can be designed to provide storm run-off attenuation and capacity to allow drainage into the underlying soils at natural (greenfield) drainage rates.
5	As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	See response to Question 4, above. It is proposed that the existing drainage connection to the public combined sewer in Fitzroy Park is retained and reused. This will be subject to approvals from Thames Water as well as to its location and condition, which will be confirmed by CCTV survey.

Question		Answer	Evidence/Comment
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	See Section 5 (Scoping)

Table 2: Surface flow and flooding screening

Question		Answer	Evidence/Comment
1	Is the site within the catchment of the pond chains on Hampstead Heath?	Yes	See Section 5 (Scoping)
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	See responses to Questions 4 and 5, Table 1 (Subterranean (ground water) screening)
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	No	See response to Questions 4 and 5, Table 1 (Subterranean (ground water) screening)
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?	No	See responses to Questions 4 and 5, Table 1 (Subterranean (ground water) screening). For the temporary condition, the engineering design notes indicate that any collected water will be pumped to the existing water system. In the permanent condition, the provision of a contiguous bored pile retaining wall and granular drainage blanket around the basement structure will ensure long-term transmissivity of sub-surface seepage.
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	There is the potential for pollution discharge or run-off of silty water during the construction phase to impact the pond in the grounds of No.55 Fitzroy Park, and possibly the wider Highgate Ponds. However, it is considered that

Question		Answer	Evidence/Comment
			any potential risks could be readily managed by employing one or a combination of several mitigation techniques that are regularly and successfully employed throughout the construction industry. Control measures employed at the site should comply with CIRIA Report 532 'Control of Water Pollution from Construction Sites' and Environment Agency pollution prevention guidelines, principally PPG6 'Working at Construction and Demolition Sites' and should be included at the detailed design stage.
6	Is the site in an area known to be at risk from surface water flooding, 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?	No	Reference to the EA floodplain maps, North London Strategic Flood Assessment and The London Borough of Camden flood risk management strategy shows that the site does not lie within any known flood zones. Fitzroy Park is not in Camden's own list of streets at risk of surface water flooding and does not lie in an area of known flooding from sewer surcharge (Figure 15 of the ARUP report). The proposed basement level is below the level of the pond in the grounds of No.55. See response to Question 6, Table 1 (Subterranean (ground water) screening). However, with regard to surface water flooding, the lower ground floor level is set above the level of the pond and it is understood that landscaping at the sites boundary will be considered at the detailed design stage to provide further mitigation, if required.

Table 3: Land Stability Screening

Question		Answer	Evidence/Comment
1	Does the existing site include slopes, natural or manmade, greater than 7°?	Yes	See Section 5 (Scoping)
2	Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No	The existing slope in the northeast of the site is to be retained in its current configuration with no landscaping/re-profiling. To the front of the property the ground is to be re-profiled as a slope rising from an elevation of approximately 82.40mAOD to 83.70mAOD, adjoining an area of land raising in the southwest corner of the site, adjacent to No.55. This re-profiling is shown to be at 7° and will be engineered and is, therefore, not considered to present a risk. The area of land-raising in the southwest, adjacent to No.55, will be retained and will not present a slope stability risk.
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Yes	See Section 5 (Scoping)
4	Is the site within a wider hillside setting in which the general slope is greater than 7°?	No	Figure 16 of the ARUP guidance document (Ref: 213923) which supports CPG4, indicates that slopes in the site area are locally in the range 7° to 10°, although the regional slope in the site area is generally <7°. The wider site area is urbanised and as such the regional slope in the site's vicinity is likely to have been cut or altered historically due to development and landscaping.
5	Is the London Clay the shallowest stratum at the site?	Yes	See Section 5 (Scoping)
6	Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained?	Yes	See Section 5 (Scoping)
7	Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	No	There is no immediate or direct evidence of seasonal shrink-swell effects on site. However, given that the underlying natural ground is high volume change potential London Clay there is potential for such effects, but it is not known whether there are any structures that have been affected in the wider area, and in any case, these would be unrelated to the subject site

Question		Answer	Evidence/Comment
			and proposed development.
8	Is the site within 100m of a watercourse or a potential spring line?	No	The 'Fleet Brook' and associated chain of Highgate Ponds are >100m southeast of the site. The pond in the grounds of No.55 is a very shallow static water body, not a watercourse. Further, investigations have indicated that the principal route of drainage is to the west of the site, through a shallow drainage network that may also partially feed the pond in No.55. The Claygate Member/London Clay boundary is a potential spring line, but this boundary is up-gradient of the site and cannot, therefore, be affected by the site itself.
9	Is the site within an area of previously worked ground?	No	A natural ground stability hazard dataset supplied by the BGS and historical and geological mapping (included in the previous RSK desk study and site investigation report) reveal that there are no recorded hazards associated with previously worked ground, landfilling or compressible and collapsible ground at the site that could lead to stability issues. The site investigations undertaken at the site confirm these ground conditions. Although between 0.4m and 1.7m of Made Ground have been recorded from the site, these soils appear to comprise reworked materials associated with previous development of the land and are not considered to present a risk with regard to land stability, particularly as most of this material will be removed as part of the development and the new structure will be supported on piled foundations.
10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No	The site is underlain by 0.4m to 1.7m of Made Ground and a significant thickness of the London Clay Formation. The latter is classified as a non-aquifer (non-productive stratum). Therefore, the site does not lie above an aquifer. Perched water seepages have been encountered locally within the Made Ground, with water ponding on top of the impermeable London Clay, and seepages within the London Clay have also locally been recorded. Although seepage of this water is likely to require controlling in excavations (probable sump pumping) during the temporary works, this water does not constitute

Question		Answer	Evidence/Comment
			ground water with a 'water table', and its temporary exclusion from the basement excavation is unlikely to have any effect on either the short-term or long-term groundwater regime or ground stability. In the long-term, the contiguous bored pile wall and granular blanket surrounding the basement structure will allow water to seep around the basement, maintaining long-term sub-surface water flows.
11	Is the site within 50m of the Hampstead Heath ponds?	No	The nearest Highgate Pond (the Bird Sanctuary Pond) is located approximately 140m southwest of the site.
12	Is the site within 5m of a highway or pedestrian right of way?	Yes	See Section 4 (Scoping)
13	Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	The proposed structure is detached and widely separated from neighbouring properties (>20m distant from No.1 Fitzroy Close and 'Sunbury to the northeast of the site, and >10m distant from No.51 Fitzroy Park and No.55 Fitzroy Park, located northwest and southeast of the site, respectively). Thus, although foundation depths are likely to be variable within nearby properties (both in terms of elevation differences and different types of foundations) it is considered that there will be no impact in relation to differential foundation depths from the proposed development. Notwithstanding the above, potential damaging movements could occur due to basement construction associated with retaining walls movements and basement excavation. These latter issues are addressed in Section 5 (Scoping).
14	Is the site over (or within the exclusion zone of) any tunnels?	No	There are no known tunnels, tunnel exclusion zones, or other buried infrastructure directly beneath the site that could be affected by the proposed redevelopment of the site.

5 STAGE 2 – SCOPING

As defined in CPG4, the scoping stage is used to identify the potential impacts of the proposed scheme for each of the matters of concern identified in the previous screening stage (i.e. those questions answered with a “yes” or “unknown” response). The sections below present statements that define further the matters of concern identified at the screening stage. The data summarised in **Section 2** and **Section 3** has been used to develop a conceptual ground model to carry out the scoping stage.

5.1 Subterranean (Ground water) Scoping

5.1.1 QUESTION: Is the site within the catchment of the pond chains on Hampstead Heath?

POTENTIAL IMPACT: Any reduction in the spring inflow to the ponds would reduce the overall flow through the ponds, which in turn could allow and increased build-up of contaminants.

It is acknowledged that the site lies within a natural fluvially dissected hillslope setting, and that specifically the site lies on the northwest-facing flank of a gentle northeast to southwest orientated valley, which forms part of the catchment of the Highgate Ponds. There is no surface watercourse currently flowing within this valley.

As described in **Section 3**, the basement design has been developed to take due account of seepage within the ground near the proposed basement structure, and to provide the necessary means for seepage to continue during and after construction without being significantly impeded.

This is to be achieved by provision of free-draining or permeable zones around the basement structure both vertically and horizontally to allow seepage to continue in both the temporary and permanent conditions around and under the building. The permeable zones will comprise a hardcore type material or no-fines concrete that both have reliable levels of porosity. Geotextiles may be used to prevent silting up of the voids.

It is proposed that the temporary basement perimeter retaining wall would be formed using contiguous bored piles with spaces between them to allow the seepage of water. The void between the temporary contiguous bored piles and the permanent basement retaining wall will be backfilled with this free-draining material. The temporary piled wall would be left in place.

During construction, seepage will continue into the excavation through the contiguous bored piled wall, in the same manner as the permanent condition. In the temporary condition, water in the excavation will need to feed into sumps formed below the temporary formation level. The engineering design notes for the development indicate that any collected water will be pumped to the existing water system in the short-term.

It is considered that the proper design and construction of the contiguous bored pile wall and drainage layer will provide sufficient long-term transmissivity to maintain seepages across the building footprint. This type of construction has been successfully

applied in other basement developments and will be sufficient mitigation in regard to sub-surface seepages.

In the long-term shallow seepage through the shallow soils will be managed via a series of land drains, which will aid the distribution of the water back in to the ground. The engineering notes recommend that further *in-situ* testing is undertaken at the detailed design stage to establish the design the land drains. Thus, through proper design and implementation of the dewatering and land drain system, seepages across the building footprint need not be significantly disrupted.

5.1.2 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?

POTENTIAL IMPACT: Groundwater may drain from the pond or spring and flow into the basement/excavation space.

The lowest excavations at the site are for the sub-basement structures, within which excavations will extend to 77.84mAOD in the lift pit, allowing for 0.9m of excavation for clayboard, drainage blanket and slabs. The proposed basement floor slab is at an elevation of 80.34mAOD.

The current base of the pond in the grounds of No.55 Fitzroy Park is, from information provided by others, understood to lie at an elevation of approximately 79.30mAOD and is a shallow surface water feature, with the depth of water varying seasonally from 0.15m to 0.75m.

As previously noted, and with reference to **Figure 3**, the subject site lies on the northwest-facing flank of a northeast to southwest orientated valley. There is no surface watercourse currently flowing within this valley and historical maps dating from the 1870s indicate that there was no overland flow (e.g. stream or drain) within the valley by at least that time. The map of 1896 shows two small ponds within the valley, up-gradient from the site, which were evidently dug to capture water, as it would also appear for the larger pond within the grounds of No.55 Fitzroy Park. These ponds lie on a northeast-southwest trend close to the axis of this small valley system. A drain is evident at the extreme southwestern end of this system where it enters the Wildfowl Reserve Pond within the chain of Highgate Ponds.

It is therefore considered that this drainage system, including the pond at No.55 is a shallow surface feature, fed by surface flow.

At this point it is worth reviewing the ground and hydrogeological conditions at the site. The site is underlain by between 0.4m and 1.7m of cohesive made ground, comprising reworked London Clay, below which the London Clay Formation was encountered. The London Clay on site has been determined, both by field and laboratory testing, to be high plasticity silty clay.

Perched water seepages have been encountered locally within the Made Ground. Within a few metres of the ground surface the London Clay can be assumed to be saturated i.e. all available pore space within the clay filled will water. Porosity within this material is so low that the soils do not contain significant volumes of water. The permeability of this material has been determined to be of the order 10^{-7} to 10^{-8} m/s.

These values are consistent with clay modified by the effects of weathering and fissuring, which reflects the materials encountered on-site, and represent very low permeability soils with poor drainage characteristics.

Therefore, although there is a 'head differential' between the water in the pond and the basement excavations, it is considered that, given the encountered ground and hydrogeological conditions, that it is considered highly unlikely that there would be sufficient hydraulic connectivity between the pond and basement excavations to allow drainage of the pond into the excavations. Although shallow water-bearing pond-infill material has been identified on the sites southwestern boundary (BH3A and BH4A), boreholes located closer to the proposed excavation (BH2A, BH4, BH5A, BH9A, **Figure 4**) did not record this infill, indicating that it does not extend into the area of excavation and this material is therefore unlikely to provide a preferential flowpath.

5.2 Surface Flow and Flooding Scoping

5.2.1 QUESTION: Is the site within the catchment of the pond chains on Hampstead Heath?

POTENTIAL IMPACT: Several potential impacts, but principally changes to surface inflows to and contamination of the Highgate Ponds.

With respect to changes in surface water inflows to the Highgate Ponds, see the response to Question 5.1.1, above.

In addition, it has been previously noted that impermeable areas at the site will remain similar between the existing and proposed conditions. Although two new external hardstanding areas are proposed, it is understood that these will surfaced with permeable paving, which can be designed to provide storm run-off attenuation and capacity to allow drainage into the underlying soils at natural drainage rates.

With regard to contamination, although there is the potential for pollution discharge or run-off of silty water during the construction phase to impact the pond in the grounds of No.55 Fitzroy Park, and possibly the wider Highgate Ponds, it is considered that any potential risks could be readily managed by employing one or a combination of several mitigation techniques. Such techniques are regularly and successfully employed throughout the construction industry. Control measures employed at the site should comply with CIRIA Report 532 'Control of Water Pollution from Construction Sites' and Environment Agency pollution prevention guidelines, principally PPG6 'Working at Construction and Demolition Sites' and should be developed at the detailed design stage.

5.3 Land Stability Scoping

5.3.1 QUESTION: Does the existing site include slopes, natural or manmade, greater than 7°?

POTENTIAL IMPACT: Local slope stability within the site.

Measured slope angles at the site generally range between 3° and 4°, locally up to 5°, across the site in the direction of regional slope (towards the southwest). However, in the northeastern section of the site, the site boundary with the adjacent highway of

Fitzroy Park comprises a slope rising at an angle of approximately 25° from an elevation of approximately 82.5mAOD at the toe of the slope in the garden of No.53 to approximately 84.5mAOD at the boundary line with the adjacent pavement along Fitzroy Park.

This slope is currently vegetated with several mature and semi-mature trees (principally sycamore and lime) and is to be maintained in its current configuration as part of the proposed development.

Observations made at the site have not revealed any significant issues associated with the stability of the existing slope, although it is acknowledged that given the slope angle and the formative soils the slope is likely to be close to its limiting state of equilibrium. It is highly likely that the roots of the mature vegetation on this slope are playing a significant role in maintaining slope stability through their binding effect.

Under the proposed development plans no works are proposed for this area and the trees on the slope are to be retained, with a suitable root protection zone and tree protection area provided, which will protect the slope from any potentially damaging vehicle movements and within which 'no dig' construction activities are prescribed.

The proposed contiguous bored pile basement wall is located approximately 5m from the toe of the slope. It is proposed to install the retaining wall and then to excavate the basement utilising stiff propping from surface so as to minimise any potential ground movements. This rigid system will restrict ground movements that could potentially have a destabilising effect. It is understood that detailed design will take account of global slope stability and surcharge from the slope in retaining wall design.

In addition, it should be ensured in the detailed design that there are no landscaping or groundworks activities in the vicinity of the slope that might potentially steepen the slope or remove its toe, or otherwise reduce the factor of safety on stability.

5.3.2 QUESTION: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?

POTENTIAL IMPACT: Slope stability within neighbouring site(s).

Figure 16 of the ARUP guidance document (ref: 213923) which supports CPG4, indicates that slopes in the site area are locally in the range 7° to 10°, although the regional slope in the site area is generally <7°. The site area is urbanised and as such the slopes in the site's vicinity are likely to have been cut or altered historically due to development and landscaping.

With reference to topographical site plans, there are no identified significant slopes across the sites boundaries with the Waterhouse to the west, No.51 to the northeast and No.55 to the southwest. This entire area generally follows the local trend of sloping towards the southwest at angle ≤7°, albeit locally modified by landscaping within individual plots.

Therefore, it is considered that there are no significant slopes in neighbouring land that could potentially be affected by the proposed works at No.53.

5.3.3 QUESTION: Is the London Clay the shallowest stratum at the site?

POTENTIAL IMPACT: The London Clay is prone to seasonal shrink-swell (subsidence and heave)

The existing buildings on site and the proposed basement development are detached from any adjacent structures and do not share any party walls or foundations. The new structure will have basement levels and will be supported on a piled foundation and the foundations will not, therefore, be at any risk from seasonal shrink-swell.

Similarly, given the wide separation between adjacent properties, it is considered highly unlikely that the proposed development could affect changes to the 'shrink-swell' regime at the site that could extend beyond the site boundary to affect other structures in the area.

5.3.4 QUESTION: 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?

POTENTIAL IMPACT: The soil moisture deficit associated with felled trees will gradually recover. In high plasticity clay soils (such as the 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 ground stability.

Four trees are to be removed as part of the development. Two 19m high sycamores and a 16m high wild cherry are located within the footprint of the proposed development and as such will require removal. These trees are all located within the zone of basement excavation and, therefore, any soils that are desiccated due to tree-related soil moisture deficit should be removed and, therefore, cannot present a risk outwith the site boundary. The effects of potential lateral pressures on retaining walls in the proposed development should be considered should any desiccated soils remain.

A 16m high Lime, located within the current gardens, lies close to the building line at Lower Ground Floor level (80.18mAOD) and will require removal to facilitate development. Given the proposed foundation configuration of the development (piled raft) this will not present a risk to the property's foundations, although some consideration may be required in relation to lateral swelling pressures for retaining wall design.

The Lime is located some 22m distant and some 3m lower than the pavement on Fitzroy Park and cannot present a risk to the public highway. Similarly, this tree is located approximately 20m away from the closest point of any structure within the grounds of No.55 Fitzroy Park, to the southwest of the site.

An assessment of the influence of this tree (based on worst case conditions of high volume change potential, high water demand and the mature heights of the identified species, from NHBC Chapter 4.2) demonstrates that removal of this tree would have no impact on the foundations of this structure.

In addition, some new tree planting is proposed in the north of the site, close to the boundary with No.51. At this stage, no specific species has been selected, although a selection of appropriate tree species for constricted sites is provided in the arboricultural impact assessment for the site (provided by Landmark Trees).

The area of proposed planting is located at a minimum distance of 10.4m from the foundation line of No.51. An assessment of the influence of tree planting (NHBC Chapter 4.2) on the foundations of No.51 (which may locally comprise shallow foundations and ground bearing elements) indicates that for broad leaved trees of

moderate water demand, the planting would have no impact on the foundations of No.51. For a high water demand tree species (such as Hawthorn) a minimum planting distance of 12.5m would be required.

It is therefore considered that proposed tree removal or planting at the site will not impact neighbouring structures, and any potential influence may be easily mitigated.

5.3.5 QUESTION: Is the site within 5m of a highway or pedestrian right of way?

POTENTIAL IMPACT: Excavation for a basement may result in damage to the road, pavement or any underground services buried in trenches beneath the road or pavement.

The eastern boundary of the site lies immediately adjacent to the pavement along Fitzroy Park.

There is the potential for ground movements associated with basement piled wall installation and basement excavation to impact the adjacent road. An impact assessment addressing this issue is reported in **Section 7**.

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

POTENTIAL IMPACT: Excavation for a basement may result in structural damage to neighbouring properties/structures if there is a significant differential depth between adjacent foundations.

The proposed structure is detached, shares no party walls, and is widely separated from neighbouring properties (>20m distant from No.1 Fitzroy Close and 'Sunbury to the northeast of the site, and >10m distant from No.51 and No.55 Fitzroy Park, which are located northwest and southeast of the site, respectively).

Thus, although differential foundation depths will almost certainly be present (both due to elevation differences and different types of foundations) it is considered that there will be no impact in regard to neighbouring structures foundations due to the large separations.

Notwithstanding the above, potential damaging movements could occur due to basement construction. The identified hazards are associated with ground movements from perimeter retaining wall installation and ground excavation, and elastic heave of the London Clay in the basement excavation associated with stress release.

As part of this assessment the following nearby structures have been identified as being potentially at risk from damaging ground movements:

- The highway of Fitzroy Park beyond the eastern boundary;
- Nos. 51 and 55 Fitzroy Park to the northwest and southeast of the site, respectively; and
- No.1 Fitzroy Park and 'Sunbury', located to the northeast of the site beyond Fitzroy Park.

An impact assessment addressing these issues is reported in **Section 7**.

6 STAGE 3 – SITE INVESTIGATION AND STUDY

As previously noted, a full desk study, intrusive site investigation and monitoring programme was undertaken at the site by RSK between October and December 2010, as detailed in the report '53 Fitzroy Park, Highgate, North West London, Geotechnical, Hydrogeological and Geoenvironmental Site Investigation Report', reference no. 241919-01(00), dated December 2010. The investigation is compliant with the data requirements as set out in Appendix G of 'Camden Geological, Hydrogeological and Hydrological Study' produced for Camden by ARUP in November 2010.

The results of report 241919-01(00) have been utilised to inform the scoping stage of the BIA and the current assessment draws on the results of that report. For full details, reference should be made to the original report.

7 STAGE 4 - IMPACT ASSESSMENT

This stage is concerned with evaluating the direct and indirect implications of the proposed basement development. It involved describing, quantifying and aggregating the effects of the development on those attributes or features which have been identified in the scoping stage as being potentially affected.

The only potential impacts that have been identified by this assessment relate to ground stability hazards associated with:

- Movements associated with basement retaining wall installation and ground excavation; and
- Elastic heave of the London Clay in the basement excavation associated with stress release.

The following nearby structures have been identified for assessment in relation to potential ground movements

- The highway of Fitzroy Park beyond eastern site boundary
- Nos. 51 and 55 Fitzroy Park to the northwest and southeast of the site, respectively; and
- No.1 Fitzroy Park and 'Sunbury', located to the northeast of the site beyond Fitzroy Park.

Likely ground movements and building strains associated with basement construction can be estimated in two ways: by an empirical approach adopted by reference to previous case studies of similar developments, and computer analysis employed to model the basement excavation and its construction.

For this project both approaches have been adopted in an attempt to give a balanced estimate of the ground movements that may occur.

The assessment of vertical ground movements (heave and settlement due to unloading and loading of the ground) has been carried out by numerical modelling, while ground movements resulting from installation of the contiguous bored pile wall and basement excavation have been determined by reference to empirical results.

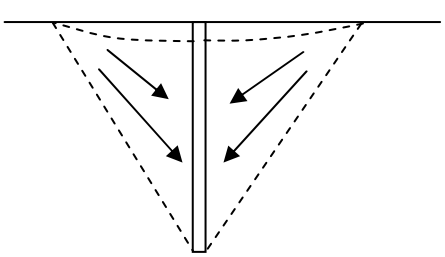
7.1 Structural stability of adjacent structures from retaining wall installation and basement excavation

Below ground construction, involving the installation of basement retaining walls and excavation of the ground to form the basement accommodation space, has the potential to cause movements in the surrounding ground.

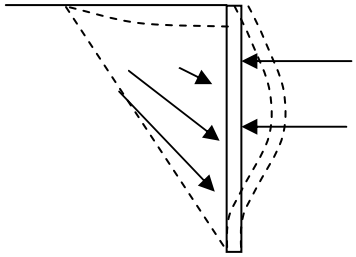
We have undertaken ground movement analyses based on the empirical approach described in CIRIA C580 "*Embedded Retaining Walls – Guidance for Economic Design*". This document provides charts of vertical and horizontal ground movements resulting from installation of embedded retaining walls and excavation in front of the walls, as shown schematically in **Illustration 1** below. The C580 charts have been

normalised with wall length and excavation depth to facilitate their use for new developments.

Illustration 1: Schematic illustration of potential ground movements associated with contiguous bored pile wall installation and excavation in front of the retaining wall



Ground Movement Due to Pile Installation



Ground and Wall Movement Due to Excavation

In the temporary condition, the proposed basement excavation will be retained by a contiguous bored pile wall supported by rigid propping. In the permanent condition the retaining wall will be rigidly propped by the basement floor and lower ground floor reinforced concrete slabs.

In this assessment we have allowed for a uniform of excavation of 6.1m at all points (based on a basement floor level of 76.75mAOD and allowing for an extra 0.9m of dig to facilitate pile cap, void former, granular base and slab construction). For this analysis we have assumed an embedment depth of 1.5 times the retained height for the contiguous bored pile wall, wholly embedded in stiff clay under conditions of a high standard of workmanship during construction. We have considered the retaining wall to be of high stiffness on the basis that temporary props of high stiffness will be installed before permanent props at high level (in accordance with C580).

A summary of the specific dimensions and construction details used for this analysis is presented in Table 4.

Table 4: Specific dimensions used for C580 analyses

Adjacent Structure	Estimated Wall Depth (m)	Excavation Depth (m)	Distance to Face of Structure (m)	Length of Structure Perpendicular to Basement (m)
Highway of Fitzroy Park	10.00	Generally 3.36m, locally up to 4.96	10.4 (average)	5.0
No.51 Fitzroy Park			13.2	18.8
No.1 Fitzroy Close			25.5	17.5
'Sunbury'			22.7	11.3
No.55 Fitzroy Park			11.0	15.0

The estimated ground movements at the front and rear of the adjacent structures resulting from both wall installation and basement excavation, based on the empirical assessment in CIRIA 580 are presented **Table 5** and **Table 6**.

Table 5: Ground Movements Resulting from Wall Installation

Adjacent Structure	Wall Type	Ground Movement at Front of Adjacent Structure		Ground Movement at Rear of Adjacent Structure	
		Lateral (mm)	Vertical (mm)	Lateral (mm)	Vertical (mm)
Highway of Fitzroy Park	Contiguous bored pile	0.8	1.9	0.0	0.9
No.51 Fitzroy Park		0.3	1.4	0.0	0.0
No.1 Fitzroy Close		0.0	0.0	0.0	0.0
'Sunbury'		0.0	0.0	0.0	0.0
No.55 Fitzroy Park		0.7	1.8	0.0	0.0

Table 6: Ground Movements Resulting from Excavation

Adjacent Structure	Wall Type	Ground Movement at Front of Adjacent Structure		Ground Movement at Rear of Adjacent Structure	
		Lateral (mm)	Vertical (mm)	Lateral (mm)	Vertical (mm)
Highway of Fitzroy Park	Contiguous bored pile	3.6	1.7	1.7	0.4
No.51 Fitzroy Park		2.6	1.0	0.0	0.0
No.1 Fitzroy Close		0.0	0.0	0.0	0.0
'Sunbury'		0.0	0.0	0.0	0.0
No.55 Fitzroy Park		3.4	1.5	0.0	0.0

The aggregation of the above results has then been used to determine the horizontal tensile strains and deflection ratios for the adjacent structures in the way described in **Appendix B**. The resulting horizontal strains and deflection ratios are presented **Table 7**.

Table 7: Calculated Horizontal Strains and Deflection Ratios

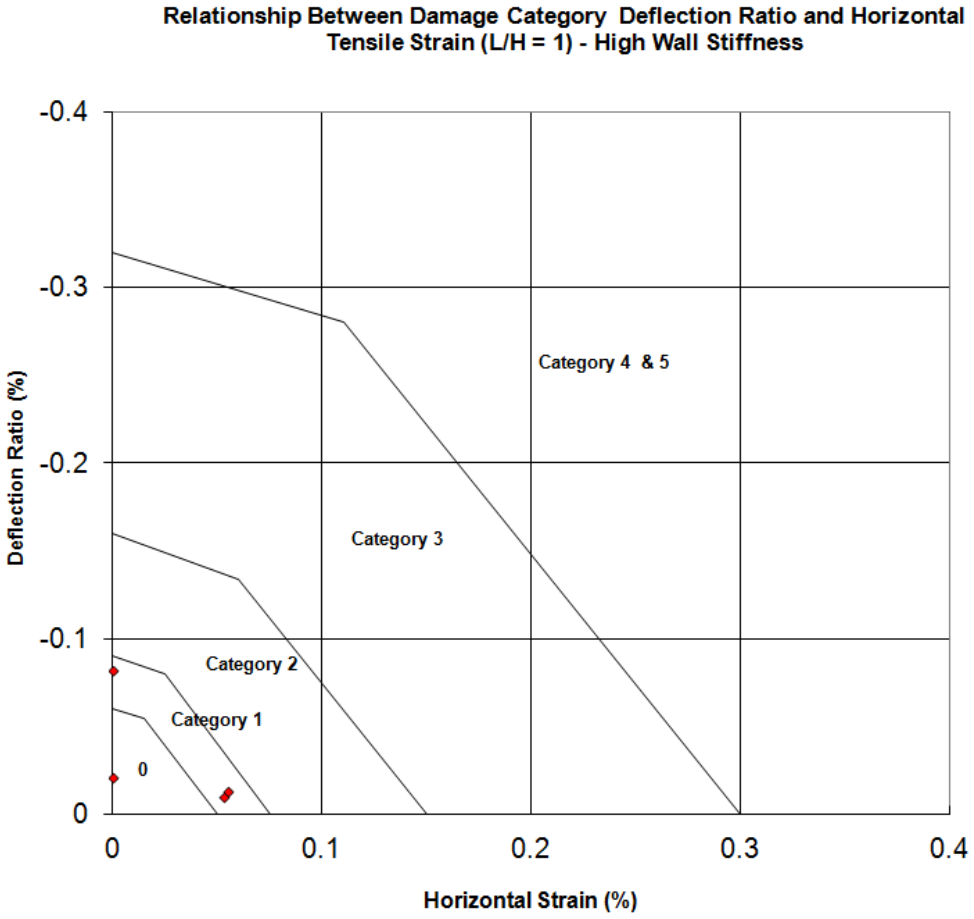
Adjacent Structure	Horizontal Strain (%)	Deflection Ratio (%)
Highway of Fitzroy Park	0.055	0.000
No.51 Fitzroy Park	0.053	-0.010
No.1 Fitzroy Close	0.000	-0.082
'Sunbury'	0.000	-0.021
No.55 Fitzroy Park	0.055	-0.013

CIRIA 580 also provides a methodology for assessing the potential damage to structures within the zone of influence of the basement excavation.

This methodology uses the relationship between Damage Category, lateral strain and deflection ratio developed by Boscardin and Cording (1989) and Burland (2001). These damage categories assume affected structures to be of brick masonry with cement mortar. This methodology of damage classification has also been adopted by Camden and is presented in Camden's CPG4 guidance document, p.14. In this regard the damage classification scheme is not applicable for the road pavement of Fitzroy Park.

The above results have been plotted on the Damage Category chart presented in CIRIA 580 as shown in **illustration 2**.

Illustration 2: Relationship between damage category, deflection ration and horizontal tensile strain



In accordance with C580, all structures fall into 'Category 0' to 'Category 1' ('Negligible' to 'Very Slight'). The definitions of these categories are presented in **Appendix C**.

The results fulfil the general requirements of CPG4 in that they do not exceed the damage category of 'Slight' (Category 2), below which the categories reflect cosmetic rather than structural damage.

With regard to the pavement of Fitzroy Park, a vertical differential movement of 1.3mm is calculated over the width of the pavement (taken as 5000mm) perpendicular to the proposed basement. No damaging deflections are recorded and the differential movement is rotational (tilt). The vertical differential of 1.3mm across 5000mm equates to a gradient of 1 in 3846. A tensile horizontal strain of 0.055% is recorded, equating to 1.9mm of horizontal differential movement distributed over 5000mm of road pavement. Given that the road pavement is a flexible structure it is considered that this one-off very small strain and rotation will have no damaging effect on the highway of Fitzroy Park.

7.2 Structural stability of adjacent structures from heave of the basement excavation

The removal of overburden due to excavation and subsequent reloading from the building may potentially cause some vertical ground movement in the underlying soils, the final magnitude depending on the net loading applied at the formation level. Therefore, an analysis has been undertaken to elucidate any potential risk from the excavation of the new basement to the identified nearby structures.

Numerical modelling has been undertaken to determine the conditions at key stages in the construction process, namely:

- Unloading due to demolition of the existing building and excavation for the new basement; and
- Full loading following construction of the new basement and building.

Calculations were carried out using the PDISP Version 19.3 computer package supplied by Oasys Ltd. adopting the Boussinesq method of elastic analysis. This calculates the stresses and strains within the ground due to applied loads and then determines the displacements by integrating the vertical and horizontal strains. It should be noted, however, that the calculated results do not take into consideration the influence of the contiguous bored pile basement perimeter wall, as the increased stiffness at this boundary cannot be incorporated into the model. As such, the analyses can be considered conservative.

A linear elastic drained (long-term) soil stiffness (E') increasing with depth has been assumed for the purpose of analysis. Values have been estimated primarily from SPT'N' values using the correlation presented by Stroud and are presented in Appendix C. This correlation to some extent allows the influence of strain on stiffness to be taken into consideration. The undrained (short-term) Young's Modulus (E_u) has been obtained using the relationship of $E' = 0.8E_u$. Given fact that the stiffness rapidly increases at greater depths, for the purpose of the assessment, a rigid boundary was effectively assumed at 50m depth.

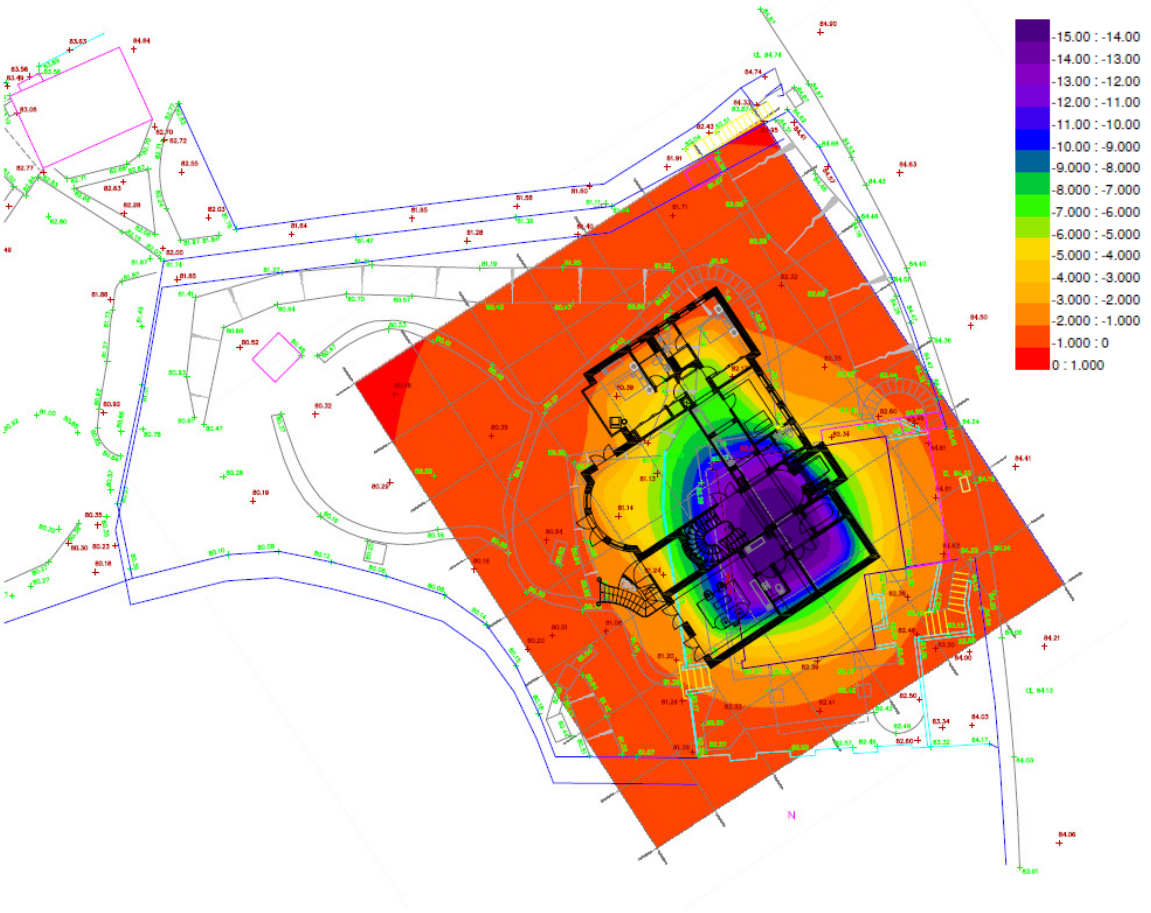
7.2.1 Movements arising from demolition and basement excavation

For the initial unloading stage (demolition and excavation), the underlying clay soils will be in fully undrained conditions, therefore the analysis has been undertaken using short-term parameters.

For this stage, the results indicate that the resultant unloading will result in a maximum vertical heave displacement of approximately 15mm in the centre of the excavation. The influence of the heave reduces to 0mm (i.e. no effect) within the boundary of No.53 Fitzroy Park and only very marginally impacts the footpath in the grounds of the 'The Waterhouse' to the immediate north of the site, where movements could be anticipated to be <1mm. The actual line of zero deflection predicted by the model demonstrates that vertical movements are zero outwith the site boundary.

Long-term (drained) conditions have not been calculated for this stage as it is considered extremely unlikely that this condition will arise during a standard construction programme.

Illustration 3: PDISP model results for undrained short-term (temporary) heave



7.2.2 Movements arising following re-loading from the construction

For the final loading stage, a drained analysis has been undertaken as fully drained conditions are expected to occur in the long-term.

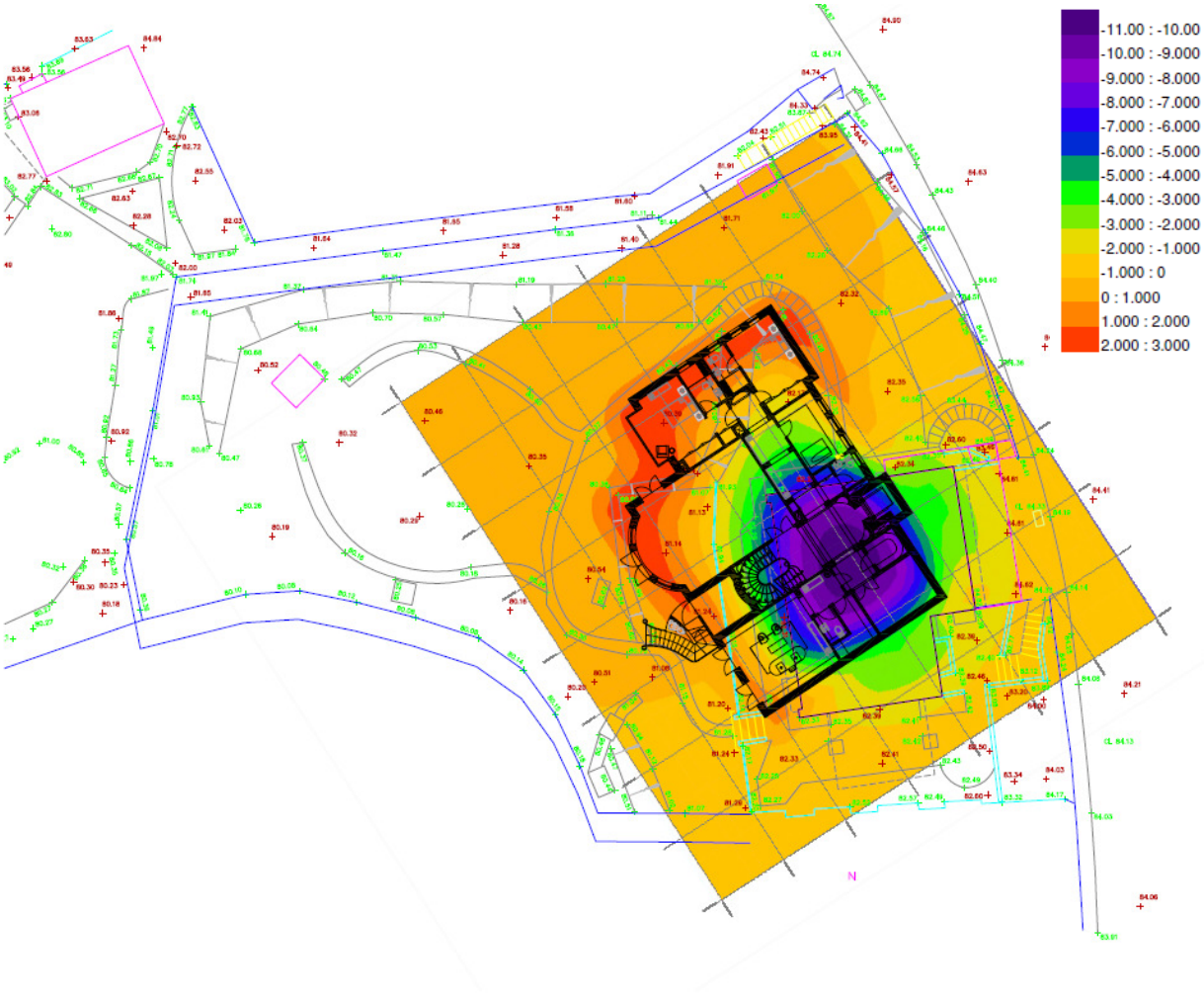
Piled foundations are the proposed foundation option for the development. At the time of writing no detailed piling scheme has been developed for the site. For the basis of this analysis we have utilised preliminary design loading on the basement of 16415kN, distributed over 28 piles, with each pile carrying a working load of 586kN. Similarly, a load of 3125kN has been applied at lower ground floor level, distributed over nine piles such that each pile has a working load of 347kN.

From a preliminary pile design the appropriate pile working loads are achievable through 400mm diameter CFA piles constructed to a depth of 16m below basement level. The load have, therefore, been applied at a depth equal to 2/3 of the pile length over an area determined assuming a 1 in 4 spread of load from the top of the pile in accordance with Tomlison's "*Pile Design in Construction Practice"*.

The results indicate that at full loading stage in the drained, long-term condition, heave at the centre of the excavation would be approximately 11mm, but again the influence of the heave reduces to 0mm (i.e. no effect) within the boundary of No.53 Fitzroy Park.

It is, therefore, considered that there are unlikely to be any vertical ground movements resulting from elastic heave beyond the sites boundary.

Illustration 4: PDISP model results for drained long-term (permanent) heave



8 CUMMULATIVE IMPACTS

A requirement of CPG4 is to consider the aggregate (cumulative) potential for impacts associated with basement construction.

A search of publicly available planning records (dating back to 1924) on Camden's planning website revealed records of granted permissions for basement/lower ground floor development/extension or other subterranean development (e.g. swimming pool accommodation space) at ten properties in the site area, as indicated on **Figure 2**.

The majority of the noted properties are located to the northwest of number 53 Fitzroy Park (i.e. along-gradient of the site), with the exception of No.1 Fitzroy Close and 'Sunbury', which are located to the northeast of the site (i.e. up-gradient of the site), beyond Fitzroy Park.

8.1 Hydrogeology

In regard to cumulative impacts, the concern is that there is a the gradual construction of a 'dam' to seepage beneath the southwestern flank of Parliament Hill towards the Highgate chain of Ponds, as more basement developments occur, which could potentially cause 'groundwater' levels to rise and/or be diverted.

In the sloping environment of this area there will undoubtedly be a 'gradient' in pore water pressure concomitant with the topography. This will result in seepage from higher to lower pressures downslope. In reality, the volume and rate of seepage passing beneath the proposed basement at 53 Fitzroy Park is likely to be small given the low porosity and permeability of the materials encountered on site, although it is acknowledged that localised areas of higher flow may be encountered due to enhanced permeability. Clearly the basement box will penetrate below ground and will intercept the saturated clay, but the deeper retaining structures (contiguous bored pile wall) will form no barrier to the likely imperceptibly slow rate of seepage beneath the site. We therefore consider it highly unlikely that the proposed basement at 53 Fitzroy Park will have any significant impact on the 'groundwater' regime.

On p.19 of the ARUP guidance document (ref: 213923) which supports CPG4, ARUP state:

"Although groundwater is contained within the microscopic pores of the clayey strata of the London Clay, it permeates so slowly, due to the narrow pores, that in practice it is generally considered a barrier to groundwater".

This concern is generally illustrated by reference to Figure 23 of the ARUP document, which gives an example of 'damming' effects relating to terraced houses at the same elevation. It needs to be stressed that this case is inapplicable to the developments in the Fitzroy Park area because they are large detached residences with significant horizontal and vertical gaps between the developments through which seepage occurs. Reference to **Figure 2** shows the relative separation and elevation of basement elements in the vicinity of the proposed development.

Even if basement elements 'upstream' of 53 Fitzroy Park (i.e. No.1 Fitzroy Close and 'Sunbury') were having a damming effect (perhaps due to very deep cut-off structures),

we consider that the design of the retaining structures at the No.53 Fitzroy Park development would not contribute further to any cumulative effects.

8.2 Hydrology

As previously noted, given the horizontal and vertical separation of the basement structures in the site area, and the variable designs, it is considered that there is little risk of any cumulative impact from these developments on the long-term seepage of shallow perched water within the surficial layers. In any case, it is considered that the proposed development at No.53 Fitzroy Park would not contribute to any significant cumulative impact for the following reason.

The existing property at the site is currently founded on spread foundations. Given the thicknesses of Made Ground encountered at the site these foundations will certainly be founded within the London Clay, and probably at sufficient depth to allow for the presence of shrinkable clay soils and significant vegetation at the site (even if they if they do not comply with modern NHBC standards). Therefore, the existing spread foundations will cut the Made Ground/London Clay interface and penetrate into the London Clay, thereby forming a continuous barrier to perched water flow. As part of the proposed redevelopment, the existing foundations will be removed and the new building will be supported on a piled foundation. In addition, a comprehensive drainage strategy has been developed for the new basement, which will help to mitigate against the potential obstruction, and lateral and vertical displacement, of water seepages.

We therefore consider that there will be negligible potential for impact and no cumulative impact on shallow water flows in the vicinity of the proposed development.

8.3 Land Stability

From the results of the elastic displacement analyses it is indicated that in both the short-term and long-term (once building loads are applied) net movements beyond the site boundary will be negligible.

For cumulative ground movements associated with piled wall installation and basement excavation, resultant horizontal strains and deflection ratios are very small and are unlikely to be damaging to the identified features.

It should be noted that the calculations undertaken as part of this assessment are necessarily preliminary and these calculations should be re-checked at the detailed design stage to ensure that more detailed predicted movements are within tolerable limits.

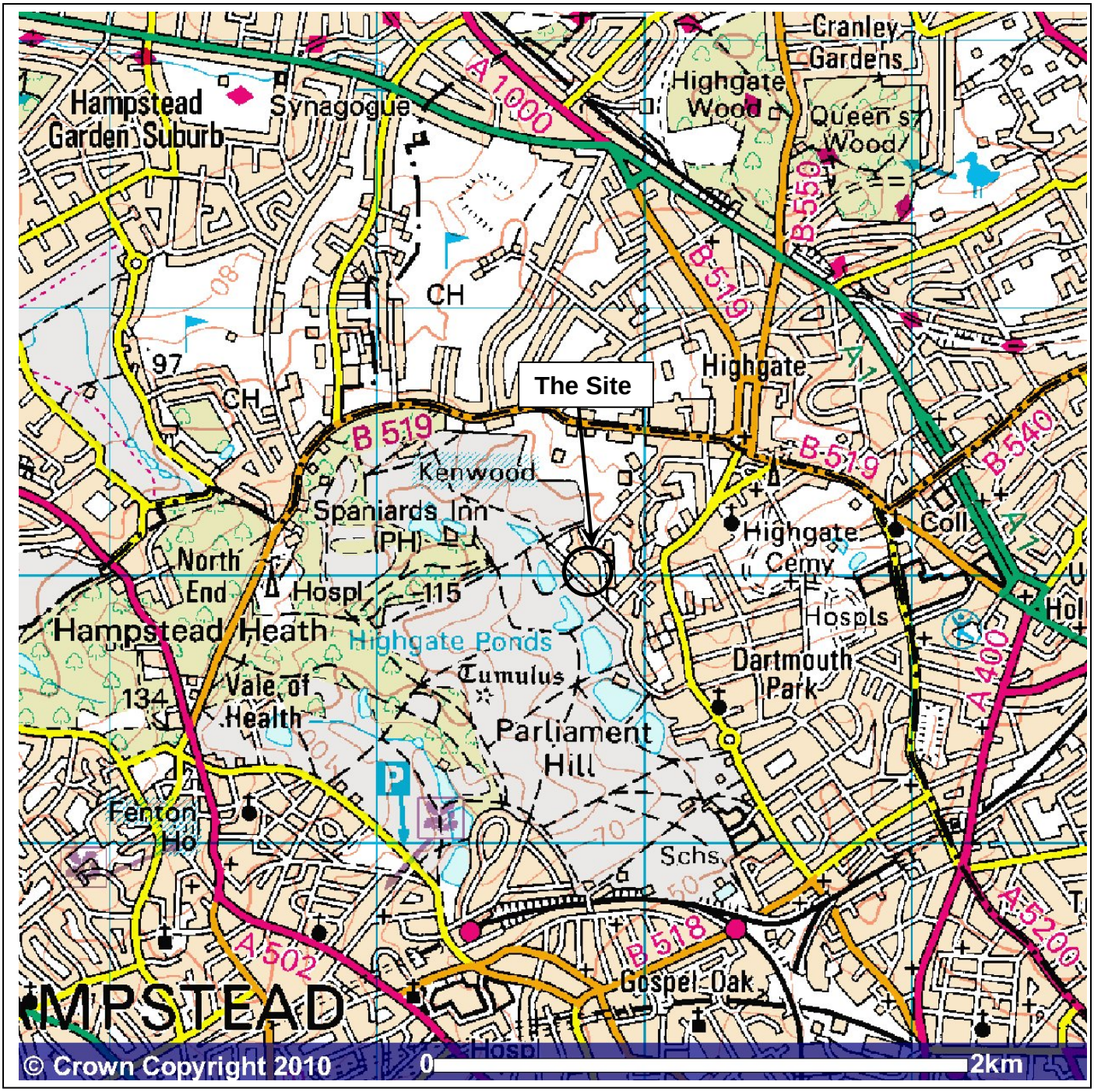
8.3.1 Control of ground movements

In order to reduce the potential for any movement over and above that expected, the following methods of safe practice should be considered prior to and during construction:

- Good workmanship will be required to ensure that pile installation induced settlements are kept to a minimum. It will be essential to ensure that the made ground is not allowed to collapse prior to casting of the contiguous piled wall;

- The contiguous piled wall should be installed to a suitable depth and have adequate embedment in stiff strata for satisfactory vertical and lateral stability;
- It should be ensured that basement slab is cast as early as possible and tight to the piled retaining wall. Sufficient time should be given for the slab to cure and gain strength prior to continuation of excavation below;
- Where temporary props are required they should be designed to provide adequate restraint to limit lateral ground movements. Walings should be tied in so they do not rely on friction or adhesion between the prop end and waling to be held in place;
- The first stage of excavation should be minimised and the first (stiff) support should be installed as early as possible in the construction sequence;
- The construction of the wall and its support systems should not be delayed;
- Over-excavation should be avoided;
- Monitoring both above and below ground should be carried out to ensure that the expected displacements are not exceeded. Limits of lateral and vertical displacement should be set beyond which the method of construction should be re-assessed.

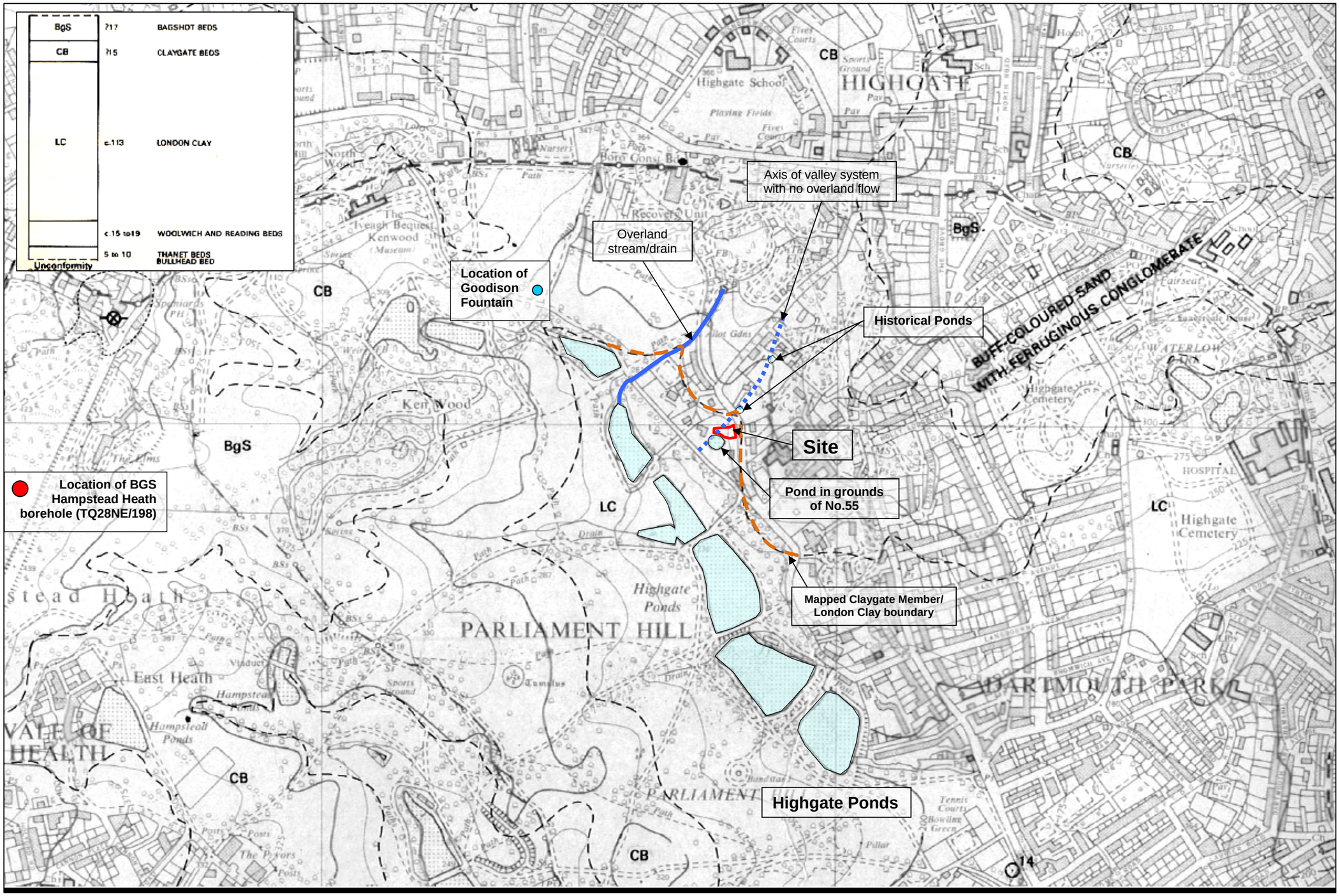
FIGURES



RSK	**SITE LOCATION PLAN**	**Client:**	Smarter Building and Construction Ltd	**Figure:**	1
		Site:	53 Fitzroy Park	**Job No:**	371263-01
		Scale:	See scale bar	**Source:**	OS

Buildings with basements or planning approvals for basements /subterranean structures

RSK	**SITE AREA PLAN**	**Client:**	Smarter Building and Construction Limited	**Figure No:**	2
		Site:	Fitzroy Park	**Job No:**	371263
		Scale:	NTS	**Source:**	Wolff Architects



RSK	**GEOLOGICAL MAP EXTRACT**	**Client:**	Smarter Building and Construction Limited	**Figure No:**	3
		Site:	53 Fitzroy Park	**Job No:**	371263-01 (00)
		Scale:	NTS	**Source:**	BGS 1:10560 Sheet TQ28NE

RSK Borehole Locations 2010

GEA Borehole Locations 2009

Site Boundary

Fitzroy Park

BH1A

BH7A

BH1

BH2

BH6A

BH3A

BH2A

BH4A

Gate

Gate

Manhole cover

BH4

BH9A

BH8A

BH3

BH5A

No.53

Pond in grounds of
No.55 Fitzroy Park

N

RSK	SITE LAYOUT AND EXPLORATORY POINT LOCATION PLAN	**Client:** Smarter Building and Construction Ltd	**Figure No:** 4
		Site: 53 Fitzroy Park	**Job No:** 371263-01 (00)
		Scale: NTS	**Source:** Client

APPENDIX A
PROPOSED DEVELOPMENT PLANS AND SECTIONS