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51 CALTHORPE STREET, LONDON WC1X 0HH

Basement Impact Assessment Revision A – Volume 1

51 CALTHORPE STREET
LONDON WC1X 0HH
Basement Impact Assessment

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Appendices

Registration of Amendments

Revision	Amendment Details	Revision Prepared By	Revision Approved By
Rev A Final 25/04/16	Updated following BIA audit review and further ground investigation, desk study and design progression.	JM, CB[1], MS	MS[2] & AF

[1] Colin Buchanan BSc (Hons) FGS
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1.0 INTRODUCTION

Brief

1.1 Create Consulting Engineers Ltd has been appointed to provide a Basement Impact Assessment, to support a planning application for 51 Calthorpe Street, London, WC1X 0HH (the Site) in the London Borough of Camden. The scheme consists of the refurbishment and extension of the existing building to enable a change of its use from offices to residential. The scheme will lead to the creation of 14 flats (including three duplexes) over six floors and involves the addition of a basement level below the existing lower ground floor.

Current Site Use

1.2 The Site is located at 51 Calthorpe Street, London, WC1X 0HH, and comprises an existing three storey Victorian building that is currently used as offices and storage. The building's eastern side is located adjacent to the Holiday Inn Hotel and the western side abuts other residential buildings on Calthorpe Street. The front of the existing development faces south-east over Calthorpe Street and is opposite the Mount Pleasant Royal Mail sorting centre. The rear north-west elevation of the development faces the Cubitt Street play centre. The Site is accessed solely via Calthorpe Street.

Figure 1.1: Site Location Plan

Proposed Development

1.3 The development proposals include the partial demolition and removal of some existing structures (including the roof) with the retention of the external walls and some floors followed by the construction of 14 new flats (including three duplexes) over six storeys. This includes a new basement level below the footprint of the building and the excavation of the forecourt to extend the existing lower ground floor.

Project Context

1.4 This report has been prepared in accordance with the London Borough of Camden's (LBC) Planning Guidance document 'Basements and Lightwells' CPG4 Sept 2013 and 'Guidance for subterranean development document' (LBC, 2010).

1.5 This report was first submitted as part of the Planning Submission documentation (planning reference 2015/3049/P) and was updated following a Basement Impact Assessment Audit prepared on behalf of the London Borough of Camden, (LBC) as part of the planning application determination process. This resulted in further ground investigation, further desktop assessment and design and a revision of this Basement Impact Assessment report.

Constraints and Limitations

1.6 Create Consulting disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report.

1.7 The copyright of this report is vested in Create Consulting Engineers Ltd and the Client. The Client, or his appointed representatives, may copy the report for purposes in connection with the development described herein. It shall not be copied by any other party or used for any other purposes without the written consent of Create Consulting Engineers Ltd or the Client.

1.8 Create Consulting Engineers Ltd accepts no responsibility whatsoever to other parties to whom this report, or any part thereof, is made known. Any such other parties rely upon the report at their own risk.

2.0 SOURCES OF INFORMATION

2.1 The information contained in this report is based on a review of readily available information pertinent to the site, a ground investigation, and consultation with interested parties.

Records Review

2.2 Key reports, drawings and websites pertinent to this assessment are detailed below in Table 2.1.

Document/Website	Author/Publisher	Date
Fluvial/Tidal Flood Maps, Surface Water Flood Maps, Groundwater Mapping, Reservoir Flood Map – www.environment-agency.gov.uk	Environment Agency	Accessed May 2015
BGS GeoIndex – Geology and borehole records - www.bgs.ac.uk/geoindex	British Geological Survey	Accessed May 2015
North London Strategic Flood Risk Assessment	Mouchel	2008
London Borough of Camden Strategic Flood Risk Assessment	URS	2014
London Borough of Camden Preliminary Flood Risk Assessment	London Borough of Camden/Drain London	2011
London Borough of Camden Surface Water Management Plan	Drain London/Halcrow	2011
The Lost Rivers of London	Nicholas Barton	1992
Existing Site Layout Plans (Drawings 939-P1-008, 939-P1-010, 939-P1-011, 939-P1-012) (Appendix A)	Centre Line Surveys	2012
Topographic Survey 51 Calthorpe Street (Appendix F)	Centre Line	2012
Proposed Site Layout Plans (Drawings 939-108 to 939-114)	Brooks/Murray Architects	April/May 2015
Thames Water asset plans (Appendix B)	Thames Water	2012
51 Calthorpe Street Flood Risk Assessment	Create Consulting Engineers	May 2015
Camden Geological, Hydrogeological and Hydrological Study Guidance for Subterranean Development	Arup	2010
Thames Water Sewer Flooding History Enquiry (Appendix C)	Thames Water	April 2015
Camden Planning Guidance – Basements and Lightwells CPG4	London Borough of Camden	Sept. 2013
GroundSure EnviroInsight, GeoInsight reports and historic mapping (Report ref FIND-23078)	Find Maps	November 2012
Camden Flood Risk Management Strategy	London Borough of Camden	2013
Borehole log, water level monitoring and lab testing records(Appendix C)	Harrison Group	December 2012

Report on Ground Investigation at 51 Calthorpe Street London (Appendix I)	A F Howland Associates	May 2015
Drawing 21013/GA-04 – Section A as existing - Holiday Inn, 1 Kings Cross Road (Appendix K)	Michael Gallagher Associates	October 2013
Survey Plans of Holiday Inn, 1 Kings Cross Road – Sheet 1 &2 Ground and basement floor plans (Appendix K)	Milton Keynes Surveys Ltd	May 2008
Report on a 2nd Phase 2 Ground Investigation Report at 51 Calthorpe Street London (Appendix I)	A F Howland Associates	January 2016

Table 2.1: Key Information Sources

Consultation

2.3 The parties consulted as part of this Basement Impact Assessment are detailed in Table 2.2.

Consultee	Form of Consultation	Topics Discussed and Actions Agreed
Nick Humphrey, Sustainability Officer, London Borough of Camden (18 April 2013)	Telephone/email correspondence	Latest surface water flood maps reviewed (Figure 2.1) and it was confirmed Camden Council do not consider the vicinity of Calthorpe Street and Mount Pleasant as an area of significant surface water flood risk and have no records of flooding there (Appendix A).
Amy Farthing, Sustainability officer, London Borough of Camden (23 April 2015)	Email correspondence	Updated surface water flood maps were requested. It was confirmed that these can now be found in the 2014 Strategic Flood Risk Assessment. It was also confirmed that Camden Council do not hold records of any particular properties being flooded in the area.
Thames Water	Sewer Flooding History Enquiry	Requested standard search for historic sewer flooding at and in the locality of the Site
Holiday Inn	Telephone/email correspondence/site visit	Details of the basement construction were requested from the Engineering Manager of the Holiday Inn in November 2015. A plan showing a cross-section of the existing building was provided for review along with survey drawings of the ground and basement floor. It was confirmed no detailed construction drawings were available. A site visit was undertaken to inspect a basement room on the party wall with 51 Calthorpe Street.
Transport for London	Telephone/email correspondence	A formal enquiry was submitted to TFL to confirm that there was no underground plant in the immediate

		vicinity of the site. The response (dated 30 November, Appendix M) indicated that London Underground assets will not be affected by the proposed works, but noted that the site is located near the Post Office Railway tunnels.
Royal Mail	Telephone/email correspondence	A formal enquiry was submitted to Royal Mail to establish the location and construction details of Post Office Tunnels/infrastructure in the vicinity of Calthorpe Street. The location and depth of the Royal Mail (Post Office Railway) Tunnel was provided in a formal response dated 17 March 2016 (see Appendix L).

Table 2.2.: List of Parties consulted

Ground Investigation

2.4 Several intrusive ground investigations have been undertaken at the site to inform the redevelopment proposals. A shallow intrusive site investigation borehole was initially undertaken in December 2012, which was followed by a further (deep) borehole investigation in April/May 2015. Subsequently, a deeper ground investigation was undertaken in November 2015 and the findings of these investigations are summarized in Sections 3 and 5 of this report with borehole log, location plan and test results included as Appendix C and Appendix I.

Site visits

2.5 Numerous site visits have been undertaken in preparation of this report including a visual inspection of the existing structure, foundation trial pits and exterior of the adjoining properties. A visit was also undertaken on 8th April 2016 to establish the depth and extent of the Holiday Inn basement. Access was provided to a room in the basement where access was available to the external face of the basement at No. 51 Calthorpe Street. A summary and photographs are included below.

3.0 SITE SETTING

Site Location

3.1 The Site is located on the northern side of Calthorpe Street in the London borough of Camden. The Site lies at grid reference 530931E 182471N at Postcode WC1X 0HH. The area of the Site is approximately 640 m^2.

Description of Site and Surroundings

3.2 The Site comprises an existing three storey Victorian-era building that is currently used as offices and storage. The building's eastern side is located adjacent to the Holiday Inn Hotel and the western side abuts other residential buildings on Calthorpe Street. The front of the existing development faces south-east over Calthorpe Street and is opposite the Mount Pleasant Royal Mail sorting centre. The rear north-west elevation of the development faces the Cubitt Street play centre. The Site is accessed solely via Calthorpe Street.

3.3 Relative to ordnance datum the Site lies at approximately 20.0 mAOD. Calthorpe Street is generally flat; however the surrounding area generally falls towards the south west.

Adjacent Property

3.4 Immediately to the west of the Site is a terrace of three four-storey Victorian-era residential properties; the nearest of which (No.49) abuts the site. To the east of the Site is a hotel; while the Royal Mail's Mount Pleasant Sorting Office site is across Calthorpe Street.

3.5 The adjacent Holiday Inn Hotel has a basement which is greater than that proposed for this site based on the drawing in Appendix K and site measurements undertaken during an inspection of the party wall between 51 Calthorpe Street and the Holiday Inn (see plans in Appendix K and photographs in Appendix O). No. 49 Calthorpe Street is understood to have a lower ground floor level, as do the rest of the terrace; this is approximately 1.25m higher that the existing lower ground floor of the Site.

3.6 It is understood that a branch of the Royal Mail Tunnel runs close to the site, beneath Calthorpe Street. The available details are shown in Appendix L and summarised in paragraphs 8.58 to 8.78.

3.7 There are no trees or shrubs within the Site. The front gardens of the terrace of houses to the west are mainly grass, with some smaller shrubs to the front of their plots and larger planting along the Pakenham Street boundary. To the rear of the Site the adjacent external part of the play centre is hard landscaped.

3.8 There are manhole covers along Calthorpe Street and adjacent streets, which indicate a range of below ground utilities, all taken to be active, with the drainage utility records showing the sewer runs to be within Pakenham Street.

Geology

3.9 The following general assessment of the geology of the site and ground conditions has been inferred from the 1:50,000 BGS Sheet 256 "North London" Solid and Drift Edition, BGS records (Appendix E), the FIND Report Reference 23078 and the 2012 borehole record (Appendix I).

Stratum		Depth to Base (mbgl)	Thickness (m)	Description / Comment
Group	Formation			
Made Ground		>5m at front of site	Unproven	Concrete overlying soils of mixed gradings and composition. Expected to be present over entire site.
Gravels		-	Typically 6m to 10m	Deposits generally consist of sand and gravel of flint or chert commonly in a matrix of silt and clay. Sometimes includes an upper finer grained alluvial material. Expected to be present over entire site.
Thames Group	London Clay	-	Typically 3-14 m	The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Expected to be present over entire site.
Reading Beds		-	Typically 10-20 m	A variety of strata including mottled clay, pebbles and sand and green sand.
Thanet Sand		-	Typically 15-19	Grey sands of varying compactness including bands of flint.
Chalk		-	Unproven	The white chalk subgroup.

Table 3.3: Summary of Expected Geology

Ground Workings

3.10 None are indicated within 1000m of the Site.

Mining, Extraction and Natural Cavities

3.11 No mining activities are recorded on or in the near vicinity of the Site.

Ground Subsidence

3.12 The Site is indicated as being at negligible risk from shrinkage heave, ground dissolution or compressible deposits. The Site is also indicated as being at negligible risk from landslides.

Borehole Records

3.13 Examination of online BGS borehole records (Appendix E) revealed two boreholes in close proximity, i.e. <50m to the Site, which were drilled as part of the historic Mount Pleasant post sorting office development (referenced TQ38SW3091). A deeper borehole (referenced TQ38SW512) was located some 200 m to the east.

3.14 Although not logged in detail, the shallower holes show made ground of between 13' and 16' (approximately 5m) with drift deposits (assumed to be Terrace Gravel) over London Clay at depth. The deep borehole found made ground to 5.5m over gravel to 7.3 m, with London Clay between 7.3 and 21 m, Reading Beds (Lambeth Group) and then Chalk at 35 m depth.

3.15 The investigation in 2012 took a borehole to 5m depth, at the front of the Site. Made Ground of varying composition, but essentially granular, was encountered throughout.

Slope Stability and Subterranean Development

3.16 The Site is not situated within an area where a natural or man-made slope of greater than 7° is present.

3.17 The Site is part underlain by an existing basement, the extension to which forms part of the redevelopment of the site. We also understand that the adjoining property (No. 49 Calthorpe Street and the adjacent Holiday Inn) both have basements.

3.18 Details of the Holiday Inn basement are shown in Appendix K and summarised in relation to the site, which suggests that the Holiday Inn basement is approximately 800mm above than the finished floor level (FFL) of the proposed basement at 51 Calthorpe Street. It is assumed that this basement is piled.

3.19 It appears, from observations made during the site visit, that the lower ground floor of the adjoining terrace property (49 Calthorpe Street) is approximately 1.25m higher than the existing lower ground floor of 51 Calthorpe Street. There is a lightwell at the front of 49 Calthorpe Street, adjacent to the lightwell of 51 Calthorpe Street. Whilst the front garden of 49 Calthorpe Street is at a similar level to the forecourt of 51 Calthorpe Street, the rear garden of 49 Calthorpe Street is a hard landscaped rear yard, approximately a metre higher than the courtyard at the rear of 51 Calthorpe Street.

3.20 A tunnel, understood to be the Metropolitan Tube Line, is indicated as running approximately 76m to the north east of the Site.

3.21 A Royal Mail (Post Office Railway) Tunnel is located adjacent to the site beneath Calthorpe Street. The tunnel is understood to be located at an approximate depth of 16mbgl (see Appendix L.

Hydrology and Hydrogeology

3.22 The Site is not located in a groundwater Source Protection Zone (SPZ). No surface water features were recorded on the Site itself or in the immediate vicinity.

3.23 A study of the aquifer maps on the Environment Agency website revealed the Site to be located within a Secondary "A" Aquifer comprising the superficial drift deposits of the Terrace Gravels. The underlying London Clay Formation is described as Unproductive Strata.

3.24 Secondary aquifers include a wide range of drift and bedrock deposits with an equally wide range of water permeability and storage capacities. Secondary "A" Aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases form an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

3.25 The initial 2012 investigation indicated a perched water table to be present within the made ground beneath the site, although this is inconsistent with subsequent deeper investigations and considered anomalous and unrepresentative. Groundwater is anticipated in the Terrace Gravels, above the London Clay. Groundwater flow in the gravels is considered likely to be to the south but may be locally influenced by the adjacent "lost river" channel to the west of the Site.

3.26 The Site was not recorded as being at risk from flooding from rivers or the sea. The Council's Sustainability Team has confirmed that the Site is not at potential risk from surface water flooding.

Flood Risk

3.27 The Site is located in Flood Zone 1 of the Environment Agency's indicative flood map, indicating that the Site has a less than 1:1000 probability of fluvial flooding (the lowest level indicated on their mapping).

3.28 The Site lies within the Environment Agency's (EA) Flood Zone 1, as shown in Figure 3.1, which is described within the NPPF Technical Guidance as having less than a 1 in 1000 (<0.1%) annual probability of river or sea flooding in any one year. This zone is the lowest risk area.

3.29 The Camden SFRA (2014) and SWMP (2013) show the Site lies within a Critical Drainage Area whilst the SWMP shows the Site does not lie within a Local Flood Risk Zone.

3.30 The Site is not located in an area at risk of reservoir flooding according to the EA flood maps.

3.31 The Site is located within an 'area with potential to be at risk of surface water flooding' according to Camden Geological, hydrogeological and hydrological study (Arup, 2010). It is understood that this outline broadly follows the route of the 'lost' River Fleet which runs to the west of the Site. The Site is not shown to have flooded in 1975 or 2002 according to this map.

3.32 Consultation with Camden Council has provided more up to date and accurate surface water flood modelling (dated July 2012), which is summarised in full in the Flood Risk Assessment. This shows the predicted extent of flooding for a 1 in 75 year event. It shows that the Site is not at risk of flooding during this event. The EA Surface Water Flood Maps (accessed online, May 2015) and updated Camden SFRA (2014) suggest the Site is at a 'very low' risk of surface water flooding (Figure 3.1). The Site is therefore classified as being at a less than 1 in 1000 (<0.1%) risk of flooding from extreme rainfall in any one year.

Figure 3.1: SW flood map from EA website (accessed May 2014)

3.33 Consultation with the Engineering manager of the adjacent Holiday in November 2015 indicated that there had been a leak in the large Victorian main on the junction of Calthorpe Street and Kings Cross Road, which had led to water ingress/damage of the basement several years back. It is understood that this was subsequently fixed by Thames Water. No other historical flooding of the area was reported.

Radon

3.34 From an inspection of the GroundSure report and the relevant radon map, as published by the BRE, the Site does not fall within an area affected by radon. The area is not considered an affected area as less than 1% of homes are above the action level.

Trees

3.35 There are no trees or shrubs within the Site. The front gardens of the terrace of houses to the west are mainly grass, with some smaller shrubs to the front of their plots and larger planting along the Pakenham Street boundary. To the rear of the Site, the adjacent external part of the play centre is hard landscaped.

4.0 SCREENING

Screening Assessment

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

4.2 A number of screening tools are included in the Guidance for Subterranean Development prepared by Arup and reference has been made to them. These consist of a series of questions with a screening flow chart relating to groundwater flow, land stability and surface water flow.

4.3 The following pages tabulate the findings of the initial screening assessment as follows:

- Slope Stability and Subterranean Developments;
- Stability Screening Assessment;
- Surface Flow and Flooding Screening Assessment.

Question	Response	Justification
1a: Is the site located directly above an aquifer?	**Yes**	• The Site is over a secondary "A" aquifer (the Terrace Gravels). • The EA aquifer mapping (accessed online) and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study also confirms this.
1b: Will the proposed basement extend beneath the water table surface?	**Yes**	• Based on published information, the Site is underlain by the Terrace Gravels; which are permeable in nature. Shallow/perched groundwater was encountered during the 2012 investigation.
2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**No**	• Although the Site lies within 50m of the course the former River Fleet, this is now culverted and part of the Thames Water Sewer network running beneath Pakenham Street to the west of the Site. • Based on a review of historical maps (www.oldmaps.co.uk), EA website (Groundwater SPZs in 'what's in my backyard', BGS Geoindex map (accessed online), no watercourses, reservoirs or wells (used/disused) or springs were identified within 100m
3: Is the site within the catchment of the pond chains on Hampstead Heath?	**No**	• The Site is located approx 5.0 km south of the three ponds in this chain, according to Figure 14 of the Camden Geological, Hydrogeological & Hydrological study, placing it outside the catchment.
4: Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	**Yes**	• The Site is currently covered by hardstanding. Some soft landscaped areas/raised planters will be included in the scheme
5: As part of the site drainage, will more surface water (e.g. rainfall/run-off) than at present be discharged to the ground (e.g. soakaways and/or SUDS)?	**No**	• Surface water will continue to be discharged via existing surface water sewers. Sewer flows are likely to decrease very slightly due to the introduction of some soft landscaping/raised planters.
6: Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line.	**No**	• There are no ponds in the locality of the Site. Given the scale of the proposed basement and the Site's distance from any local water bodies, we do not consider that the proposed development will significantly affect flow to any ponds and therefore do not consider any mitigation measures are required.

Table 4.1: Subterranean (Groundwater) Flow Screening Assessment - undertaken prior to 2015 site investigations.

Question	Response	Justification
1: Is the site within the catchment of the pond chains on Hampstead Heath?	**No**	• Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study places the Site outside of the catchment for these ponds.
2: As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	**No**	• The majority of the Site currently discharges to the public sewer network in Pakenham Street via a spur in the public sewer which runs to the rear of the adjacent terraced properties. This outfall will be maintained following development.
3: Will the proposed basement development result in a change in the proportion of hard surfaced /paved external areas?	**Yes**	• The impermeable area of the Site will decrease following development due to the introduction of planting to the property and through introduction of planters.
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?	**Yes**	• It is proposed to attenuate surface water run-off from the Site in accordance with the Mayor's Plan.
5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	**No**	• All foul sewerage will be connected to the public sewer network.
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?	**No**	• Although the Site is located within an 'area with potential to be at risk of surface water flooding' according to the Camden Geological, Hydrogeological and Hydrological study (Arup, 2010, it is understood that this outline broadly follows the route of the 'lost' River Fleet which runs to the west of the Site. However, EA Surface water maps (accessed online) indicate a "very low" risk of flooding in the vicinity of the Site (Figure 3.1). • The Site is not shown to have flooded in 1975 or 2002. • The 2013 Surface Water Management Plan indicates that the Site lies within the Critical Drainage Area CDA (3_003) associated with the former "lost river valley", but not within a Local Flood Risk Zone LFRZ . • No records of flooding (other than from water mains, reportedly fixed) in the vicinity of the Site has been identified.

Table 4.2: Surface Flow and Flooding Screening Assessment

Question	Response	Justification
1: Does the existing site include slopes, natural or manmade, greater than 7º? (approximately 1 in 8)	**Yes**	• Within the land of the proposed new property, there is a step down from the existing forecourt to the lower ground floor. The main footprint of the existing building is at this lower level.
2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7º? (approximately 1 in 8)	**Yes**	• The land within the Site boundary is currently generally flatter than 7°; other than between the forecourt and lower ground floor. The new basement level will extend up to the Site boundary on 3 sides and partially under the forecourt, with a resultant step change in levels on each side.
3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7º? (approximately 1 in 8)	**Yes**	• The adjoining land to the north-east is a hotel, which is understood to have a deeper basement than that proposed for the Site. • No.49 Calthorpe St, to the immediate south-west of the Site, also has a lower ground floor that is below the level of their front garden. The basement appears to be approximately 1.25m shallower than the FFL of the site. The rear garden to no 49 is elevated by approximately 1m relative to the site
4: Is the site within a wider hillside setting in which the general slope is greater than 7% (approximately 1 in 8)	**No**	• The area falls gently, generally to the east and south, below the threshold of 7°.
5: Is the London Clay the shallowest strata at the site?	**No**	• Published BGS records and the 2012 borehole show the Site to be underlain by made ground over Terrace Gravels.
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).	**No**	• There are no trees within the Site.
7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	**Unknown**	• The 2012 borehole was taken to 5m and did not prove the base of the made ground. The adjacent property has previously reported movement related issues; however the cause is not known.

Question	Response	Justification
8: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**No**	• There is no known river, pond, reservoir, spring or well within 100 m of the Site. • Although the Site lies within 50m of the course of the former River Fleet, this is now culverted and part of the Thames Water Sewer network running beneath Pakenham Street to the west of the Site. • Based on a review of historical maps (www.oldmaps.co.uk), EA website (Groundwater SPZs in 'what's in my backyard', BGS Geoindex map (accessed online), no watercourses, reservoirs or wells (used/disused) or springs were identified within 100m
9: Is the site within an area of previously worked ground?	**No**	• The only significant previous works were the construction of the existing premises. The 2012 borehole did identify Made Ground to its full depth of 5m.
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?	**Yes**	• The BGS GeoIndex shows the Site lies above a secondary aquifer. The EA aquifer mapping (accessed online) and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study also confirms this. The 2012 investigation recorded standing groundwater in the made ground which suggests shallow/perched water.
11: Is the site within 50m of the Hampstead Heath ponds?	**No**	• Based on OS mapping
12: Is the site within 5m of a highway or pedestrian right of way?	**Yes**	• The existing building is set back from the Site frontage. However the forecourt of the Site adjoins the back of pavement to the public highway. The lower ground floor is to be extended under the forecourt.
13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	**Yes**	• Along the boundary with No.49 Calthorpe St, the new basement will be deeper than the footings to the lower ground floor of No.49.
14: Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	**Yes**	• The Site potentially lies within the exclusion zones of the Royal Mail (Post Office Tunnels)

Table 4.3: Slope Stability Screening Assessment

5.0 SCOPING STUDY

5.1 The following potential impacts and potential consequences were identified based on the initial desktop assessment.

Category	Question	Potential Impact	Possible Consequence
Subterranean (Groundwater) Flow	1a	The Site is over a secondary "A" aquifer (the Terrace Gravels)	• The basement might be at risk of water ingress from any shallow or perched groundwater and there is potential for localised impacts on the water table/water quality if a groundwater table is present.
	1b	There is a possibility of encountering shallow or perched groundwater during construction.	
	4	Some soft landscaped areas/raised planters will be included in the scheme, which will allow some infiltration of rainwater to occur.	• Increased recharge of the shallow groundwater may occur.
Surface flow and flooding	3	Peak surface water run-off will be reduced slightly due to the increase in soft landscaping,	• This has potential to slightly decrease surface water run-off (peak flows and volumes) to the sewer.
	4	The impermeable area of the Site will remain unchanged. However the effective area will be slightly reduced through the introduction of landscaped gardens.	
Slope Stability	1.	There is an existing step down from the existing forecourt to the lower ground floor.	• Without adequate temporary and permanent propping this would lead to slope stability issues.
	2.	The proposals will alter the ground profile and will require a step change in level with the adjacent highway.	
	3.	The house at No.49 to the SW has a lower ground floor that is below its front garden. The adjoining land to the north-east is a hotel, which is understood to have a basement which in parts is deeper than that proposed development for this Site.	• Without adequate temporary and permanent propping this would lead to slope stability issues.
	7.	The 2012 borehole did not prove the base of the made ground. The adjacent property has previously reported movement related issues; however the cause is not known.	• Nearby BGS borehole records show the area to be underlain by Terrace Gravels. • Further investigation is required to a depth sufficient to prove the natural strata beneath the Site.
	8.	The site appears to be overlying the former River Fleet	• Damage to the property • Proper design and construction
	10.	The Site lies above a secondary aquifer.	• Further investigation is required to a depth sufficient to prove the natural strata beneath the Site and hence clarify the

Category	Question	Potential Impact	Possible Consequence
			requirements for any dewatering. Dewatering may result in change of moisture content and settlement issues.
	12.	The lower ground floor will be extended closer to the Site boundary with and extend below the level of the pavement.	• Without adequate temporary and permanent propping this could lead to settlement or collapse of the pavement.
	13.	The new basement will be deeper than both the footing to No.49 Calthorpe St and Holiday Inn Basement in places.	• Without adequate temporary and permanent propping this could lead to settlement or collapse of the adjacent property.

Table 5.1: Potential Impacts

6.0 GROUND INVESTIGATIONS

Objective

6.1 In order to further inform the assessment of the potential impacts of the development and to assist with design of the sub-substructure, so that any impacts of the basement can be mitigated through the design of the temporary and permanent works, an intrusive investigation was scoped.

6.2 This was to build on the findings of the desktop assessment set out in previous sections of this report (which includes the 2012 borehole record and laboratory testing – Appendix C); so as to collect basic geotechnical, chemical and hydrogeological data to further develop the conceptual site model.

6.3 The data was collected during two site investigations, the first was undertaken in April 2015, and the second undertaken in November/December 2015.

Site Work

April 2015 Site Investigation:

6.4 The April 2015 Site Investigation was scoped to increase the depth of data available from the earlier investigation, to reflect the proposed basement depth. The factual report for the April 2015 site investigation is included in Appendix I.

6.5 The investigation comprised the drilling of one borehole (BH101) to investigate the ground conditions at the location of the proposed basement and to check for presence of groundwater within the standpipe.

6.6 The ground investigation fieldwork was carried out on 16th April 2015, at the position shown on the attached exploratory borehole location plan in Appendix I.

6.7 Prior to the intrusive site works, a services scan had been carried out at the proposed borehole location.

6.8 The site work consisted of a borehole, taken below an area of current concrete forecourt slab. The borehole was taken to a depth of 15m using conventional cable percussive techniques ('shell and auger') in 150 mm diameter casing.

6.9 Representative disturbed and bulk disturbed samples were taken from the boring tools at regular intervals throughout the depth of the borehole.

6.10 Undisturbed 100mm diameter samples (U100) were taken in the cohesive material, at regular intervals throughout the depth of the borehole.

6.11 In-situ Standard Penetration Tests (SPTs) were carried out at varying depths.

6.12 On completion of the borehole, a groundwater monitoring standpipe was installed to the base of the bore. This was sealed above the slotted bottom zone of the pipe, so that the piezometric pressure could be recorded. A protective cover was installed flush with the ground surface.

6.13 Groundwater monitoring was carried out during a return site visit on 30th April 2015. The findings are set out in the Groundwater section below

<u>November 2015 Site Investigation:</u>

6.14 A second investigation was undertaken in November 2015 to extend beyond the made ground encountered and to better understand the hydrogeology and the potential presence of a scour feature to further develop the conceptual model to inform a more robust impact

6.15 The investigation comprised the drilling of two boreholes (BH102 and BH103) to a maximum depth of 22.25m using a demountable cable percussive drilling rig and three hand dug trial pits. The boreholes were located in the rear courtyard area and at the front of the building, off Calthorpe Street. The locations of the buildings are include in the 'Report on a 2nd Phase Ground Investigation at 51 Calthorpe Street, London WC1X 0HH' included in Appendix I.

6.16 Sampling and in-situ (SPT) testing were carried out throughout the drilling process with undisturbed and disturbed samples collected for subsequent laboratory testing and to allow accurate inspection of recovered materials for logging.

6.17 The boreholes were monitored for groundwater ingress during the drilling process and where encountered, drilling was temporarily ceased to allow monitoring of the groundwater level until it stabilised. On completion of the drilling, a monitoring well was installed in each borehole to allow subsequent groundwater monitoring. The well was installed with a granular filter annulus and a bentonite seal at surface.

6.18 The trial pits (TP102 to TP103) were located adjacent to the property walls and were excavated by hand to a sufficient depth to expose the foundation at each location. TP101 and TP102 were located in the light well adjacent to No. 49 Calthorpe Street and TP103 was excavated inside the basement of 51 Calthorpe Street adjacent to the party wall with No. 49.

Laboratory Work

6.19 The samples were forwarded to a registered laboratory, where geotechnical tests were conducted and the results are presented in the Appendices.

6.20 The moisture content of selected soil samples was determined.

6.21 Liquid and plastic limits of selected samples at various depths were determined, as a guide, to soil classification and behaviour.

6.22 A test specimen was prepared at full diameter from an undisturbed cohesive sample. Undrained Triaxial Compression testing was undertaken on the sample at a single confining cell pressure.

6.23 Selected samples of soil were analysed to determine the concentration of water soluble sulphate, using the BRE SD1 Pyrite Suite. The pH values were also determined.

6.24 The laboratory certificates are included in Appendix I and are summarised in Table 6.1.

Plasticity Index (NHBC modified)				
Borehole No.	**Sample depth, m**	**Index**	**Soil Class**	
BH01	8.00	25	CH	
BH01	8.40	21	CI	
BH01	9.45	21	CI	
BH01	10.50	17	CI	
BH102	4.00	18	CI	
BH102	5.50	22	CI	
BH102	6.0	29	CI	
BH102	9.0	49	CV	
BH102	11.5	37	CH	
BH102	13.00	41	CH	
BH102	15.00	39	CH	
BH103	10.00	23	CI	
Shear Strength (unconsolidated single stage triaxial)				
Borehole No.	**Sample depth, m**	**Dry density Mg/ m^3**	**Moisture content %**	**C_u kPa**
BH01	9.00	1.69	21	52
BH102	6.00	1.66	21	51
BH102	13.00	1.73	23	90
BH102	15.00	1.64	25	78
BH103	10.00	1.63	27	10

Table 6.1: Summary of Geotechnical Testing

Chemical Tests	
Test – sample at 5.6-9.5m depth	**Range**
Moisture Content (%)	See above
pH	6.8-8.4
Total Sulphate as SO_4 (%)	0.02-0.21
W/S Sulphate as SO_3 (2:1) (g/l)	0.04-0.77
Total Sulphur (mg/kg)	0.01-0.83
Chemical contamination tests on the Made ground	Refer to AFHowland report (Appendix I. Did not exceed guideline values (Except lead at 280-770 mg/kg)

Table 6.1: Summary of Geotechnical Testing (contd.)

6.25 The laboratory test results are consistent with and confirm the soil descriptions in the borehole logs.

6.26 The basement reinforced concrete walls and base will be designed using the strength parameters noted in the Laboratory Tests and a concrete mix will be specified to address the raised sulphate readings, in accordance with BRE Special Digest 1.

Ground Conditions

6.27 The encountered soil conditions are reported in the borehole logs within Appendix I and summarised below.

Made Ground

6.28 The Made Ground comprised variable sandy clay with gravel and occasional cobble sized brick, flint, concrete, chalk, charcoal and slate fragments. The materials were observed to be very soft to soft and ranged in thickness from 5.0 metres (in BH102, which is situated at the rear of the site at a lower elevation) and 8.0 metres at the front of the site.

Clay

6.29 Clay was encountered below the Made Ground across the site and comprised a soft to firm dark brown slightly sandy clay, with fine rootlets and a slight organic odour, and was underlain by firm greyish brown to grey sandy clay. These may represent alluvial deposits, associated with the material that often overlies the River Terraces, or may be related to a former channel of the Lost River Fleet

Gravels

6.30 The gravels were encountered across the site at a depth ranging from 6.4 metres (in BH102) to 12.0m at the front of the site in BH103 and continued to a depth ranging from 7.9 metres

in BH102 at the rear of the site and 22.05 metres at the front of the site (BH103). These broadly comprised a medium dense fine to course gravelly sand (assumed to be the River Terrace).

Clay Bedrock

6.31 The underlying clay bedrock was encountered in BH102, located at the rear of the site, at a depth of 7.9 metres and continued to the total depth of this borehole of 17 metres. This was slightly silty, locally sandy and was initially firm to stiff and became stiff with depth and characteristic of the London Clay Formation. At a depth of approximately 13.90 metres, however, it became very stiff and mottled grey and brown with occasional red mottling which is characteristic of the underlying Lambeth Group. It is therefore possible that this borehole crossed the geological boundary and if so no evidence of the Harwich Formation was identified. The clay encountered in BH103 at 22.05m was evidenced though the results and recovery from continuous SPTs and so any interpretation from these results should be treated with caution.

6.32 In summary, the ground conditions beneath the site are variable owing to the presence of a localised enhanced fluvial scouring feature which has created a deepening to the base of the superficial granular terrace deposits and significant disruption and weakening of the underlying solid geology, as shown in particular in borehole BH103.

Groundwater

6.33 During the drilling of each borehole, groundwater inflow was recorded on encountering the granular soils below the made ground, with an earlier strike encountered (within the made ground) in BH01.

6.34 The groundwater rose in all cases with the exception of BH103 where the rise was negligible. To develop such a significant rise as seen in BH01 and BH102, there would need to be a reasonable pressure head acting on the water body and there to be a reasonable storage capacity. The water strikes observed in BH01 and BH102 would be described as subartesian, held below the low permeability clay and released on penetrating the underlying granular soils. The strike in BH103 was again observed on encountering the granular soils although in this instance no significant groundwater rise developed.

6.35 The standing groundwater levels of the installed monitoring wells on the site were measured in December 2015 and again in April 2016. The standing groundwater levels were then adjusted to the relative elevation of each monitoring well relative to Ordnance Datum (OD). The results of the groundwater monitoring identified groundwater levels in each of the deeper boreholes ranging from between 10.79 and 10.91 metes above OD. The variation of water levels between the wells is not considered to represent a significant difference and would suggest that there is a relatively static groundwater flow in this area with negligible or

insignificant flow. The previously reported groundwater level reported in WS1 is considered to be anomalous and reflect the influence of the base of the monitoring well, rather than a representative standing water level.

6.36 The groundwater levels recorded during return site visits in December 2015 and April 2016 are set out in Table 6.2 below.

Borehole	Date	Ground level (mAOD)	Water Level (mbgl)	Water Level (mAOD)	Top of Response Zone (mbgl)	Base of well (mbgl)
WS1	Dec 2015	N/A	4.82	N/A	2.0	5.0
	April 2016		4.65	N/A		
BH01	Dec 2015	18.19	7.40	10.79	10.9	12.0
	April 2016		7.36	10.83		
BH102	Dec 2015	15.39	4.56	10.83	7.0	8.0
	April 2016		4.54	10.85		
BH103	Dec 2015	18.27	7.42	10.91	12.0	20.0
	April 2016		7.41	10.86		

Table 6.2: Groundwater Monitoring – December 2015 and April 2016

6.37 During the period monitored, the groundwater levels measured in each of the three deep boreholes suggest a consistency in elevation head, regardless of location of the individual response zones and would confirm that the groundwater pressure is hydrostatic and that there is hydraulic continuity between the differing strata. The consistent elevations would suggest that there was insignificant flow taking place although an overriding flow pattern could not be determined from the evidence of such a limited area dictated by the site boundaries. In view of the significant permeability of the underlying soils, it is considered that the presence of the properties is unlikely to have an impact on the groundwater regime.

7.0 IMPACT ASSESSMENT

7.1 Following completion of the site investigation, the potential impacts associated with the scheme have been reassessed in light of the findings. Table 7.1 summarises the assessment and provides appropriate mitigation measures.

Category	Question	Potential Impact	Possible Consequence	Work undertaken to investigate likelihood and significance of impact	Revised conceptual model following ground Investigation	Mitigation measures	Risk following mitigation	Justification
Subterranean (Groundwater) Flow	1a	There is the possibility of encountering shallow/perched groundwater during construction.	The basement may be at risk of flooding from any perched/shallow groundwater and there is potential for localised impacts on the water table if a groundwater table is present which may affect neighbouring foundations or result in flooding of below ground structures.	Several phases of site investigation were undertaken to characterise the groundwater regime to the founding depth.	During the site investigation, localised perched groundwater was encountered within the made grounds and shallow groundwater was encountered within the granular superficial soils underlying the cohesive overlying clay deposits under subartesian conditions which the design will need to consider.	Basement will need to be appropriately waterproofed.	Low	This will protect the basement property from water ingress.
	1b		The foundation methods may create pathways for potential contamination between the made ground and any perched/shallow groundwater to the underlying aquifer.	Site investigation is required to characterise the chemical properties of the made ground and to characterise the groundwater regime to the founding depth.	Some elevated Lead concentrations are present in the Made Ground	A piling risk assessment should be undertaken to establish suitable mitigation measures for implementation to limit or remove this potential for contamination of the underlying aquifer.	Low	This will protect groundwater quality This will ensure no negative impacts on groundwater quality.
	4	Some soft landscaped areas will be included into the scheme, which will allow some infiltration of rainwater to occur.	Increased recharge of the shallow groundwater may occur.	Investigate permeability of made ground and ground quality	Some elevated Lead concentrations are present in the Made Ground	Add a thickness of clean topsoil to cover the made ground	Low	Lead is relatively insoluble, note the leachate value from WAC testing which was only slightly above drinking water standards.
Surface flow and flooding	3	Peak surface water runoff will be slightly reduced, due to the increase in soft landscaping,	This has potential to slightly decrease surface water runoff (peak flows and volumes) to the public sewer.	None required	Unchanged.	Include as much attenuation for surface water flows, to further reduce peak runoff rates in line with policy requirements of London Plan.	Low	Development will have a positive impact by reducing flows in to the public sewer, which will contribute to a reduced flood risk in the receiving public sewer.
	4	The impermeable area of the Site will remain largely unchanged. However the effective area will be slightly reduced through the introduction of landscaped gardens.						
Slope Stability	1 & 2	The proposals will alter the ground profile and will require a step change in levels with adjacent highway.	Without adequate temporary and permanent propping this would lead to slope stability issues.	Site investigation has tested ground conditions within the Site and has provided soil characteristics / parameters for design.	Unchanged.	A structural retaining wall will be included in the proposals. The design of this structure will be based on the Site investigation results (see Section 8 for concept design) and relevant Eurocodes/British Standards allowing for surcharge loads from the Highway	Low	This will enable safe construction and provide long term stability. The design will be submitted to the LA and checked in accordance with the Approval in Principle.

Category	Question	Potential Impact	Possible Consequence	Work undertaken to investigate likelihood and significance of impact	Revised conceptual model following ground Investigation	Mitigation measures	Risk following mitigation	Justification
	3	The house at No.49 has a lower ground floor that is below its front garden	Without adequate temporary and permanent propping this would lead to slope stability issues.	A external visual site inspection of the two properties. Trial pit(s) to identify depth of the footings to No.49 and Site investigation has tested ground conditions within the Site and has provided soil characteristics/parameters for design.	It is assumed that foundations of No. 49 and 51 are separate.	Substructure will be designed to provide lateral support to the footing of No.49. The basement wall is stepped-back from the boundary of number 49. Top-down construction is proposed to provide a very stiff box and limit lateral and vertical movement.	Low	This will ensure the integrity of the adjacent property during and after construction; without creating a potentially 'hard' zone under its end wall.
	7	The Site is understood to be underlain by the Clay Formation, which is prone to shrink-swell.	Differential movement may occur in the structure and adjacent buildings, if not taken into account in the design of the temporary works and the permanent design of the substructure. Without adequate temporary and permanent propping this could lead to the collapse of the pavement.	The depth to and geotechnical properties of the Clay were established through site investigation.	The Clay was confirmed to be of High-Medium plasticity, however, given the depth of Made Ground at the Site, the Clay is at a depth that is below the zone where seasonal or tree influence will affect the clay.	The potential for shrink-swell to occur is low, but will be considered in the detailed design of the temporary works and the permanent design of the substructure (see Section 6 and also Section 8 for concept design). A structural condition survey of neighbouring properties, as part of the Party Wall award process, will be undertaken prior to commencement of works. A heave matt will be required to the underside of the basement slab.	Low	The depth to Clay is below the zone where it is likely to be influenced. The basement will be adequately designed for the prevailing ground conditions. A baseline will be established, to demonstrate that there has been no impact to the neighbouring property, both during and after construction. This is a standard Party Wall award process.
	8	The Site is located over the lost River Fleet	The presence of the River Fleet has affected the geology under the site which may pose structural issues to the site and surrounding properties without appropriate design and construction	Ground investigation to obtain appropriate design parameters and robust structural design	The ground conditions encountered showed Made Ground to a thickness of ~8m and underpinning solution for the existing structure was not considered appropriate and a deeper foundation solution was considered necessary.	Design amended to piling solution taking into account ground conditions and method of construction to reduce ground movement. Further site investigations are required to obtain confidence in soil strength and settlement information for detailed foundation design.	Low	The detailed design supported by additional soil properties will enable a suitable foundation design solution for the development
	10	The Site lies above a secondary aquifer.	The foundation methods may extend below the water table and Dewatering may be required. Dewatering can result in a change of moisture content and settlement issues.	A site investigation has been undertaken to characterise the natural strata and establish the groundwater regime to the founding depth and hence clarify the requirements for any dewatering.	Monitoring of the site investigation recorded localised perched groundwater and a shallow groundwater body which the design will need to consider.	Groundwater is considered to be deeper than excavation depth	Low	As the basement will partly piled, any seepage from the Made Ground and underlying strata will be minimal though dewatering of the excavation itself may be required during the construction works. As only limited dewatering within the excavation may be required, any dewatering is unlikely to affect any shallow/perched groundwater levels in the Made Ground outside of the excavation.

Category	Question	Potential Impact	Possible Consequence	Work undertaken to investigate likelihood and significance of impact	Revised conceptual model following ground Investigation	Mitigation measures	Risk following mitigation	Justification
	12	The lower ground floor will be extended closer to the Site boundary adjacent to the pavement.	Without adequate temporary and permanent propping this could lead to collapse of the pavement.	The geotechnical properties of the soils have been established through site investigation.	Unchanged.	Propping will be required as part of the detailed design of the temporary works and the permanent design of the substructure (see Section 8 for concept design). Agree proposals with Camden's Highways Department as part of the standard AIP process.	Low	This will ensure the integrity of the highway during and after construction.
	13	The new basement will be deeper than the footing to No.49 Calthorpe St.	Differential movement may occur in the structure and adjacent buildings, if not taken into account in the design of the temporary works and the permanent design of the substructure.	The geotechnical properties of the soils have been established through site investigation and trial pits on the party wall have been excavated.	The depth of footings of No.49 are assumed to be shallower than at 51.	Substructure will be designed to provide lateral support to the footing of No.49.	Low	This will ensure the integrity of the adjacent property during and after construction; without creating a potentially 'hard' zone under its end wall.

Table 7.1: Assessment of Impacts

8.0 DETAILED BASEMENT PROPOSALS AND DESIGN CONSIDERATIONS

Design Overview and Summary

8.1 This section sets out the proposed permanent and temporary works and the proposed methodology for the construction of the basement, which includes consideration of the following:

- Structural stability (resistance to earth pressure, etc.);
- Below ground strata including geological features;
- Presence of groundwater;
- Design parameters;
- The temporary works and construction methodology and sequence assumed in the design;
- Permanent construction works (above and below ground); and
- Predicted ground movement and impact on neighbouring structures/infrastructure.

8.2 To inform the chosen design a feasibility study was undertaken to appraise the different potential permanent works solutions and construction methods available. Expert advice was sought from specialist basement contractors and piling contractors including Abbey Pynford. Abbey Pynford are a specialist contractor highly experienced in basement construction, who undertook a site walkover jointly with Create to discuss the practical construction considerations and options.

8.3 Several potential methods of retaining the ground in the temporary and permanent conditions have been assessed as part of the design evolution. The primary objective in selecting the preferred basement design solution has been to ensure that the most suitable form of structure and method of construction for the given site conditions is chosen to limit potential impact on adjacent structures in line with best practice.

8.4 The basement design proposal is set out below and fully addresses the potential impacts identified in Table 7.1.

8.5 In summary the basement structure will comprise a concrete box formed from reinforced concrete lined secant piled retaining walls with a nominal 500mm thick reinforced concrete transfer slab at lower ground floor level forming the lid and a piled basement raft slab. Top down construction will minimise any ground movement.

8.6 This lower ground floor RC transfer slab will be needled into the existing building's perimeter solid masonry walls underpinning the walls and transferring any additional loads from the superstructure's additional two storeys into new piled foundations. The reduction in live

load from conversion of the building from office use to residential will also help balance the additional load from additional floors applied to the existing foundations.

8.7 The transfer slab will also be needled into internal load bearing walls and piers underpinning the superstructure and transferring the superstructure loads above to a new configuration of load bearing walls and columns in the basement. Existing piers that support large areas of floor will, subject to detailed design, either be supported by the transfer slab or directly underpinned (once the basement is excavated) by constructing new continuous reinforced concrete or steel columns to new foundation level.

8.8 The transfer slab is supported at the perimeter by a new reinforced concrete secant piled retaining wall that forms the basement box and internally by columns (constructed as plunge columns) located within the new basement configuration of walls and columns.

8.9 The basement slab will be constructed as a piled raft slab.

8.10 The perimeter secant piled wall will be lined with a water-tight reinforced concrete (RC) wall minimum 250-300mm thick.

8.11 The lower ground floor slab (transfer slab) and basement slab will provide lateral restraint to the new basement secant piled retaining wall.

8.12 Providing a very stiff 500mm thick transfer slab at lower ground level and using top down construction techniques delivers the greatest level of lateral restraint to the basement during the construction process and the least potential for ground movement reducing any influence on adjacent structures.

8.13 The superstructure will be modified including removal of the existing roof, construction of two additional floors, remodelling of internal floors and construction of a new roof.

8.14 Sketches of the proposed engineering design, construction sequence, methodology and temporary works are included in Appendix N.

Engineering Commentary / Discussion on the Ground Conditions

8.15 A desk top study of published work[3] and the three ground investigations at the site suggest that the underlying ground profile is influenced by the presence of a particular geological feature associated with localised enhanced fluvial scouring, which created a deepening to the base of the superficial granular terrace deposits.

[3] including: Berry F. G. 1979 Late Quaternary Scour-Hollows in Central London; V. J. Banks et al 2015 Research Article published in Quarterly Journal of Engineering Geology and Hydrology; S Bricker et al Controls on the Distribution of Drift Filled Hollows in London (Engineering Geology of Scour Features) British Geological Survey January 2013, Barton 1992 The Lost Rivers of London.

8.16 This geological feature is also referred to as a Drift-Filled Hollow (DFH) to describe similar recorded occurrences of deepening to the base of the superficial deposits across central London formed from a number of geological processes. The process of understanding how they are formed is not clear; different processes have been proposed in published work including; Scour Features, Pingos, Dissolution Features, Frost Heave and Ice Wedges and Diapirism.

8.17 Engineering works in central London have unearthed a number of DFH, which can be up to 500m wide and more than 60m deep. The majority of DFH are located in a small area between Battersea and Charing Cross. Only 2 DFH reported in the literature, reviewed as part of this study, are outside of this cluster; one particular incidence has been recorded in the vicinity of the site between Gray's Inn Road and Calthorpe Street.

8.18 The ground investigation at the site confirms the underlying soil comprises made ground, up to 8m below ground level (m bgl) at the front of the property, over natural materials, the character of which varied between boreholes.

8.19 The made ground, through which the basement will be constructed, is generally cohesive in nature.

8.20 The proposed basement level will be set at 12.83m AOD and the underside of the basement raft slab will be set at approximately 12.3m AOD. This will sit within the made ground and above the water table, which was encountered at approximately 10.85m AOD.

8.21 The made ground comprised variable sandy clay that contained gravel and occasional cobble size pieces of brick, flint, concrete, chalk, etc. The materials are assessed as very soft.

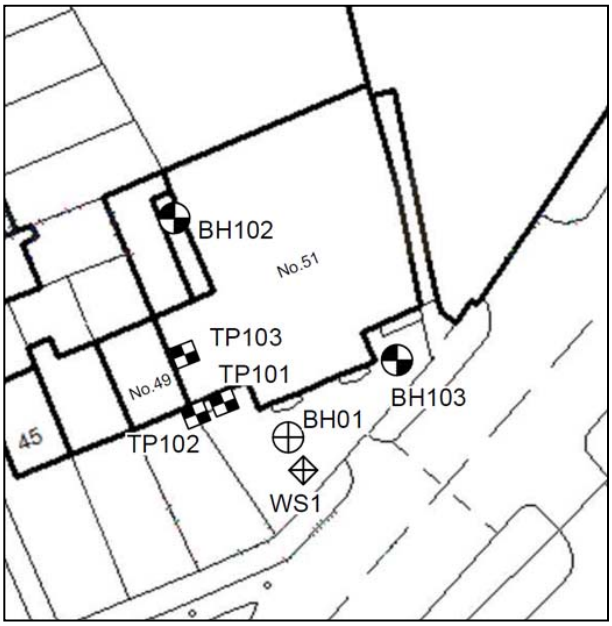


Figure 8.1: Site Plan Indicating Borehole Locations

8.22 Borehole BH01 (Figure 8.1) proved natural cohesive deposit at approximately 10.2m AOD (8.0m m bgl). This is underlain by granular deposits at approximately 13.1m AOD (10.9m m bgl).

8.23 The ground conditions in Borehole BH103 were broadly similar to BH01. At 14.2m AOD (12m bgl) the clay was underlain by granular material that extended to a depth of 24.25m AOD (22.05m bgl).

8.24 In BH102 (drilled at rear of the property within the lower ground courtyard), a sandy clay was present immediately below made ground which was thinner than at the front of the property. The sandy clay was underlain by granular material, which again was thinner than that encountered in BH01 and BH103, at the front of the property. Below the granular material, clay (interpreted as Lambeth Group) was proven to the base of BH102 which became very stiff from a depth of 15.2m AOD.

8.25 Published work suggests that the course of the former River Fleet crosses close to the site and that a substantial fluvial scour is present within the vicinity (Berry, 1979; Banks et al 2015).

8.26 Figure 8.2 (reproduced from Figure 16 in the 1979 paper by Berry F. G. on Late Quaternary Scour-Hollows in Central London maps) shows the contours of the DFH (scour feature) in Calthorpe Street based on local borehole records and tunnel works, in relation to the site. The contoured map also suggests the former River Fleet passes directly under the site or adjacent to 51 Calthorpe Street (depending on the accuracy levels of the plan). Examination of the 'Lost Rivers of London' also suggests the River Fleet ran in the vicinity of the site and that the site is located close to the confluence of another tributary to the former River Fleet.

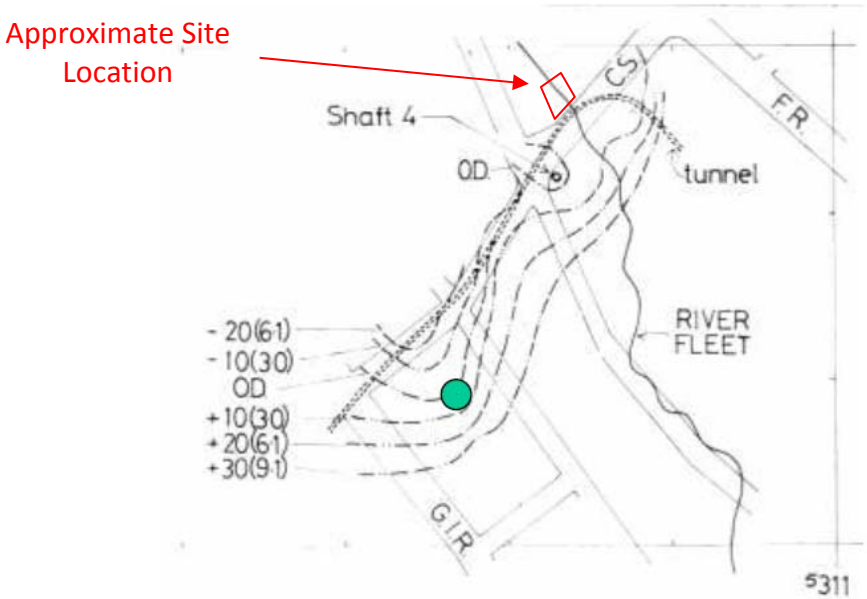


Figure 8.2: Berry Fig 16 Gray's Inn Road – Calthorpe Street (GIR = Gray's Inn Road; CS = Calthorpe Street; FR = Farringdon Road), based on 25 borehole records and numerous tunnel levels

8.27 The line of the now culverted river passes under Pakenham Street to the West of the site and forms part of the local sewer network (see Thames Water record, Appendix D)

8.28 The work by Berry, which is based on the ground conditions encountered during construction of tunnelling work for the post office railway below Mount Pleasant sorting office and Calthorpe Street in 1915-16, and a number of boreholes in the vicinity, suggest a complex variable sequence to be present at anything down to elevation of -20m AOD.

8.29 This feature was encountered again during site investigation and later excavation for a deep basement for the 'Times' new building 1969-71 on the south side of Calthorpe Street.

8.30 Until now no published data is available for the area of the DFH to the north side of Calthorpe Street (the area of the site). Contouring suggests a hollow about 305m across from the north-east to south-west.

8.31 There are marked differences in the fill between the two lobes (parts) of the hollow with the London Clay / Woolwich and Reading Beds (now Lambeth Group) rising towards the eastern margin of the site but at the western end lobe (or hollow) the level of the base of the hollow is down to -20.0m AOD in the Lambeth Group.

8.32 Table 5 of the V. J. Banks *et al.* Article (reproduced here as Figure 8.3) suggests that the hollow is not within the zone of artesian ground water levels; not overlain by Kempton Park gravels, but is located within the valley of the former River Fleet and overlain by Hackney Gravel formation.

Table 5. *Buried hollows that fall outside hazard susceptibility zones A and B*

Hollow	Criteria not met	Evaluation
5a, Greys Inn	Not within the zone of artesian groundwater levels; not overlain by Kempton Park Gravel	Located within the valley of the former River Fleet (Barton 1992) and overlain by Hackney Gravel Formation
8a, Peckham	Not overlain by Kempton Park Gravel; London Clay Formation and Lambeth Group Clays are absent	Associated with the Streatham Fault; within 200 m of the mapped extent of the Kempton Park Gravel; along the valley of the former Peck stream (Barton 1992)
10a, Highbury Corner	Not within the zone of artesian groundwater levels; not overlain by Kempton Park Gravel	'Dry' sand encountered; not within close proximity to river channel or mapped fault
11a, Tulse Hill	Not within the zone of artesian groundwater levels; not overlain by Kempton Park Gravel	Associated with the Streatham Fault; Lambeth Group is locally uplifted; within 200 m of the former river Effra

Figure 8.3. Anomalous Buried Hidden Hollows in London(Table 5 from Banks *et al.)*

8.33 This local scour feature accounts for the discrepancy in the ground sequence expected from the mapped regional geology and that recorded in the boreholes of the ground investigation.

8.34 The variability of the ground conditions beneath the Site is shown in Figure 8.4 below (Street level datum = 18.2m OD):

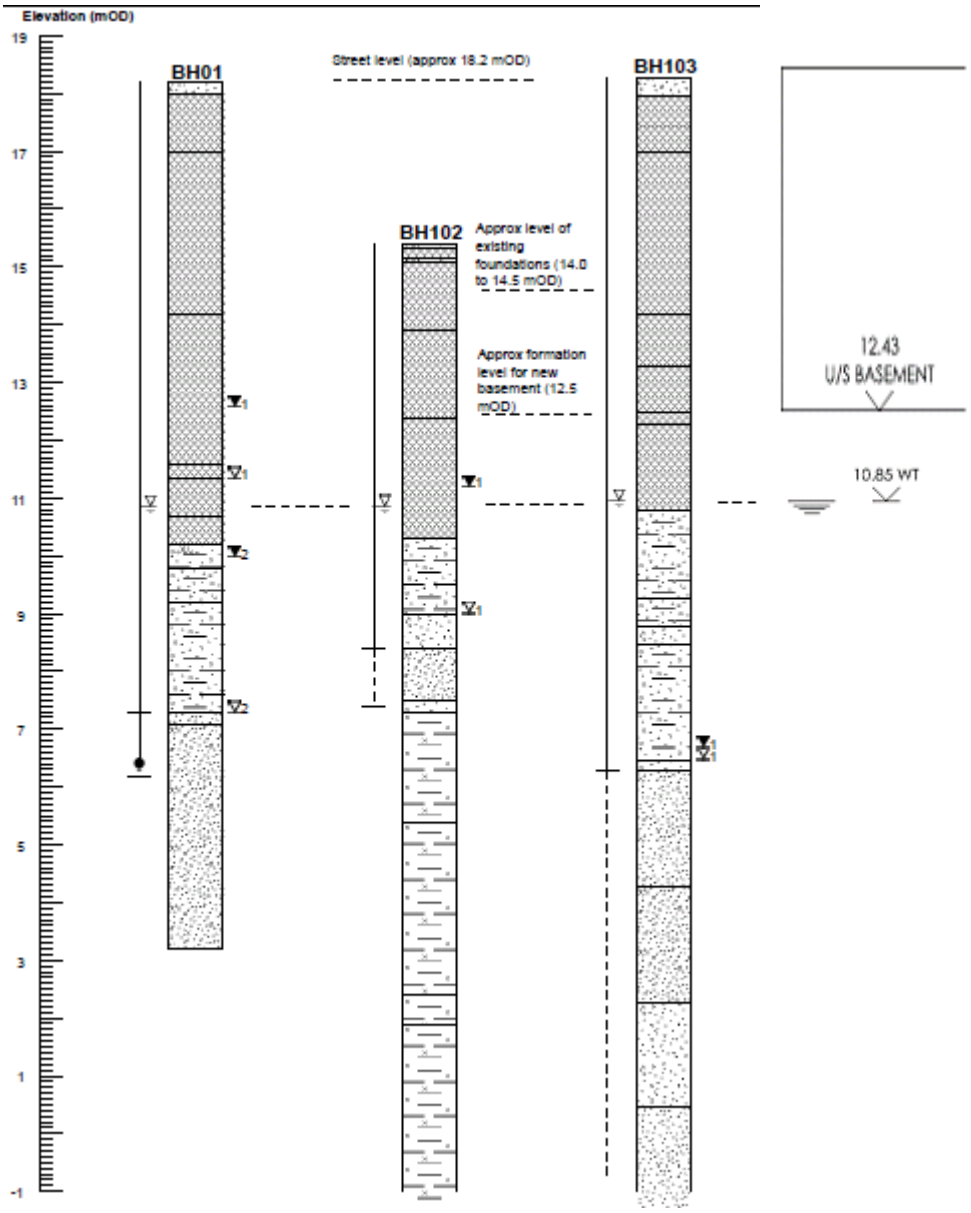


Figure 8.4: Ground Cross Section (Howlands, 2015) below the Site showing relative depth of proposed basement construction and level of the groundwater

8.35 The disturbance of the natural sequence and expected stratigraphic levels, in particular the absence of London clay over part of the site, will impact on the design parameters adopted in design, in particular of the design of piled retaining walls and their embedment lengths. The variability of the infill materials will require consideration in the geotechnical design parameters adopted in design. Design parameters are dealt with in detail in section 8.145.

8.36 The absence of London clay formations over part of the site means not all of the toe of the basement piled wall can be sealed into the clay, sealing the underside of the basement from water ingress. However, the water table sits at a level below the underside of the proposed development and there is a clay layer below the made ground (which is also cohesive in nature). The use of secant piled walls rather than contiguous piles, is therefore

precautionary and because of the soft nature of the clay made ground rather than to make the structure water tight in the temporary condition.

8.37 Given the depths at which the static water table appears and the proposed depth of the planned basement it is considered that there will be no adverse effects by the development to the local hydrology of the area. No competent groundwater flows were recorded within the made ground (perched groundwater only).

8.38 The permanent design will, however, allow for an increase in the water table and potential uplift forces this may generate.

Lost Rivers of London

8.39 Examination of the 'Lost Rivers of London' (Barton, 1992) indicates that the site is located close to an historical confluence of two watercourses. The former River Fleet is joined by a tributary that ran east to west parallel to Calthorpe Street originating east of Farringdon Road Figures 8.5 and 8.6

Figure 8.5: Lost Rivers of London, Barton 1992

8.40 The confirmation of the lost River Fleet and a tributary in proximity to the site is further evidence of a likely scour hollow feature having removed the London Clay over much of the area.

Figure 8.6: Part copy of a Historical Map of the River Fleet

Summary of Existing Building and Proposed Alterations

8.41 The existing building located at No. 51 Calthorpe Street is a three storey, of early Victorian-construction comprising load bearing masonry that has been historically extended to the rear. The interior has been re-configured with the introduction of floor beams supported on brick piers to removal internal walls.

8.42 It is understood that the building was originally built as a school, later became a drill hall, and more recently took on its present use as an office block.

8.43 The proposed redevelopment of No. 51 Calthorpe Street comprises the partial demolition of the property, removal and replacement of some floors, whilst retaining external walls, demolition of the roof, adding two additional floors and reconstruction of the roof. The building will provide 14 residential apartments when completed.

8.44 As part of the works, the existing lower ground floor will be extended out beneath the forecourt at the front of the property to provide storage space, CHP plant room, refuse and recycling areas.

8.45 A new basement is proposed beneath the current building footprint.

8.46 Existing external and internal load bearing masonry walls are solid brickwork.

8.47 Visual examination of the exterior frontage of Nos. 49 and 51 Calthorpe Street suggest that the buildings are independent buildings and do not share a party wall or foundations. No. 49 Calthorpe Street is understood to be part of a group of Terrace houses believed to have been built before No. 51. It appears, from observations made during the site visit, that the lower ground floor of the adjoining terrace property (No. 49 Calthorpe Street) is approximately 1.25m higher than the existing lower ground floor of No. 51 Calthorpe Street.

8.48 Trial pits excavated in the lower ground lightwell indicate that the existing foundations comprise traditional stepped brickwork footing extending 150mm beyond the wall on a concrete strip foundation extending approximately 550mm beyond the face of the wall. Assuming the foundation is symmetrical and a wall thickness of 328mm, the overall foundation width is approximately 56 inches wide (1422mm). The underside of foundation is approximately 1100mm (13.16m AOD) below lower ground finished floor level (FFL 14.26m AOD).

8.49 Details, including the following cross section of the foundations (Figure 8.6), are provided in the Howland Associates 2nd Phase Ground Investigation Report (Ref AFH/15.116/Phs 2 report).

8.50 The trial pit in the lower ground floor proves the existing floor is a 30mm screed with 120mm thick ground bearing concrete slab, 150mm thick construction overall (assumed to actually comprise 5" of ground bearing slab and 1" screed, 6" overall).

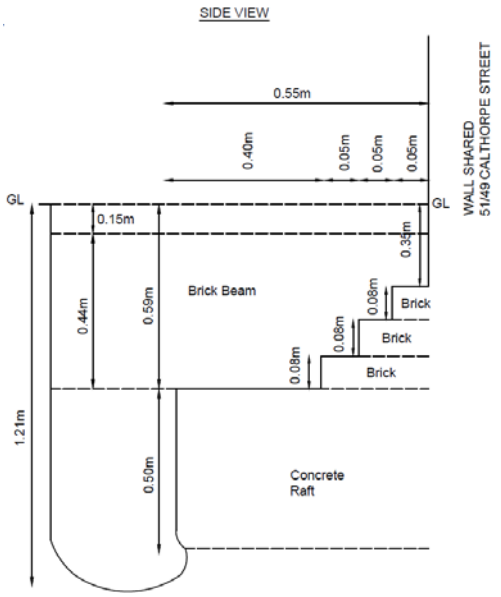


Figure 8.7: Cross-section through the foundation of No. 51 Calthorpe Street at the boundary with No. 49 Calthorpe Street

Assessment of Impact to Underground Features, Neighbouring Buildings, Adjacent Infrastructure and Highways

8.51 A further desk top study was undertaken in order to establish the positions of any underground infrastructure to assess whether they impact on the basement proposal and ensure no impact on the existing infrastructure.

8.52 The investigations that show services are dealt with in detail earlier in the report. However, the Contractor should carry out his own investigations before works can commence as there may be additional unknown service locations (that may exist and that may have been installed during the time elapsed between planning and construction).

<u>London Underground</u>

8.53 A preliminary search shows no underground tube lines are located within the vicinity of the development. The search shows that the Circle and Metropolitan are the closest underground lines, located approximately 70m to the northeast of the site running along Kings Cross and Farringdon Roads.

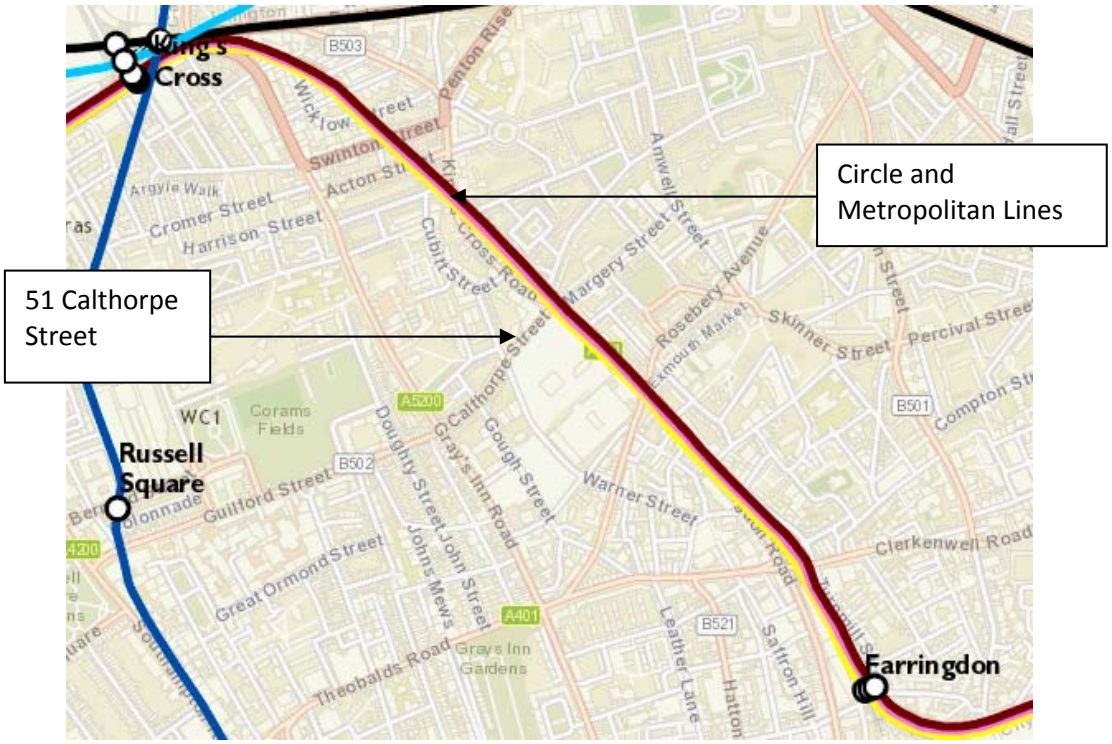


Figure 8.8: Extract Showing the True Geography of the London Underground

8.54 Transport for London (Tfl) have confirmed that no underground tunnels are within the vicinity of the subject site (see Appendix M).

8.55 On that basis, it will not be necessary to consult London Underground (tfl) asset protection team on the proposal.

Royal Mail Group

8.56 Maps of the London Post Office/Royal Mail railway show tunnels are present between Mount Pleasant Sorting Office and the Western Central District Post Office, High Holborn and King Edward Building near St Pauls.

8.57 The Royal Mail Group (RMG) confirmed the presence of Royal Mail (Post Office Railway) Tunnels located under Calthorpe Street parallel to the site as indicated in Figure 8.9 and 8.10 below (and provided in Appendix L).

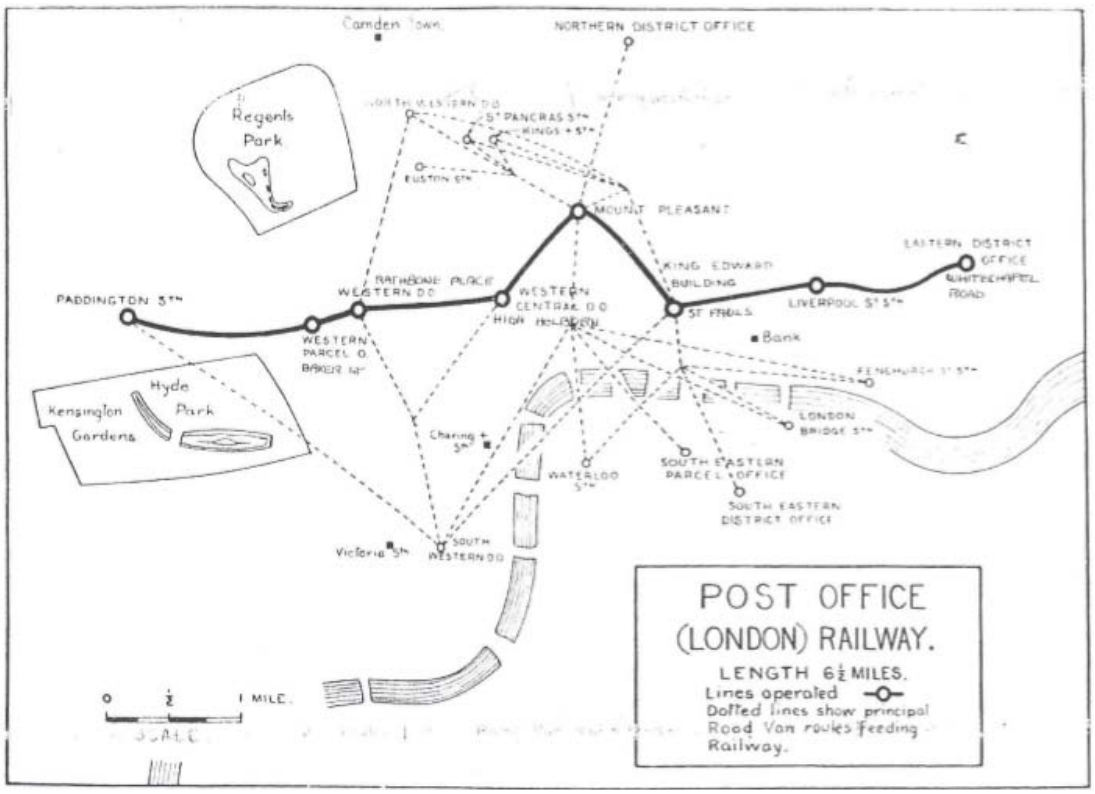


Figure 8.9: Post Office (London) Railway

8.58 The Safe Guarding Guidelines state that any works within 50m of their tunnels will require their approval to proceed.

8.59 It will therefore be necessary at the technical design stage (RIBA stage 4) to provide details of the basement works to The Royal Mail Group and their advisers for review and agreement before any works can commence to ensure no detrimental effects on the tunnels.

8.60 Restrictions are placed on piling adjacent to the tunnels with a minimum recommended horizontal clearance of 2m for bored piles and minimum vertical clearance of between

crown of the tunnel and toe of pile or foundation of 4m, reference RMG Safe Guarding Guidelines.

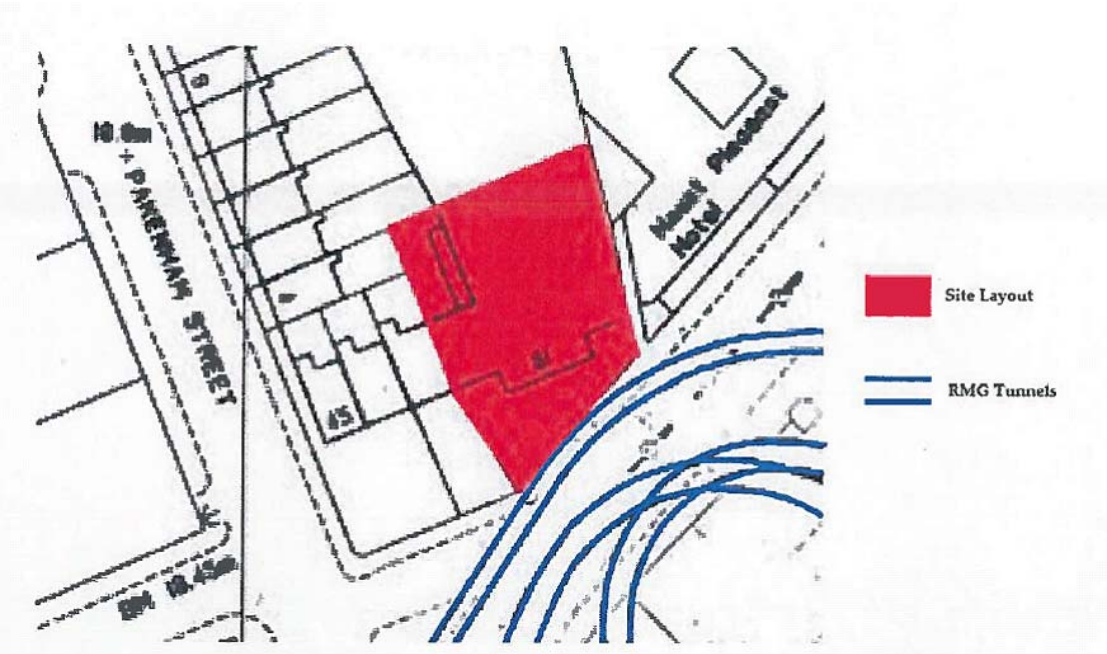


Figure 8.10: Site Layout of Calthorpe Street Showing the Location of RMG Tunnels

8.61 When piling within 5m of the tunnel (measured horizontally) additional provisions apply. Depending upon the likely potential impact of the works on the tunnels, Royal Mail may require a line and level survey, a tunnel condition survey and consideration of possible monitoring and ground movement/tunnel impact assessment.

8.62 Royal Mail group have advised that the tunnel is approximately 16m below ground level (2.2m AOD).

8.63 Typically the trains run in single tunnel 9 ft diameter, with a double 2 ft gauge track. At station approaches, the main tunnel divides into two 7ft tunnels, each with a single track.

8.64 To mitigate any impact on the tunnels, the design of the basement has been modified to exclude piling adjacent to the boundary of the site with Calthorpe Street in order to comply with the 5m rule and eliminate the need for extensive engineering and monitoring works.

8.65 The proposed basement is set back from Calthorpe Street; the FFL is set at 12.83m OD, which is approximately 10.63m above the tunnel. The extension of the existing lower ground level under the forecourt in front of the building footprint adjacent Calthorpe Street is set at 15.63m OD, approximately 13.43 m above the tunnel.

8.66 Piling for the works will be restricted to constructing the basement, which is set back from Calthorpe Street; the extension to the lower ground under the forecourt will be formed by constructing a propped cantilever reinforced concrete retaining wall, the underside of

foundation level of which will be set at approximately 15.0m AOD (3.3m below road level) and 12.8 m above the RMG tunnel and thus have less impact on the tunnel than the highway above.

8.67 Anticipated ground movement is expected to be minimal and suppressed by the stiffness of the proposed permanent works and proposed construction methodology.

8.68 Preliminary assessment of the ground movement as a consequence of the basement works is expected to be less than 6mm, which falls within Category 0-1 negligible building damage classification table in accordance with CIRIA C580 guidance (classification of visible damage to walls after Burland). Given the horizontal and vertical distance of the tunnel from the basement works and predicted movements we conclude that the works will not have a detrimental effect or cause any adverse additional stresses to the tunnel(s) and that no detailed ground movement assessment will be required (the latter will subject to RMG agreement).

8.69 Monitoring of the surrounding buildings and highway will be carried out during the works to assess possible movements and the findings will be reported. Any discrepancy from the predicted movement will trigger specific actions agreed with RMG (if required) and third parties.

8.70 Ground movement is dealt with in more detail later in the report (see section 8.142).

8.71 Contactor's method statements will be submitted to RMG (if required) for approval before works commence.

Neighbouring Properties

8.72 The group of Terraced Houses Southwest of No. 51 Calthorpe Street (left-hand side viewed from the street) including the adjacent neighbouring property No. 49 Calthorpe Street.

8.73 This group of Victorian terraced houses are Grade II listed. No.49 Calthorpe Street has clearly suffered historical ground movement and the building repaired and the owner suggests this (as well as damage to No. 51 Calthorpe Street) occurred as a result of the basement construction of the Holiday Inn located on the opposite right hand side of No. 51 Calthorpe Street.

8.74 A visual examination of the buildings at Nos. 49 and 51 Calthorpe Street suggest they are independent of each other and do not share a party wall or foundation.

8.75 The gap between Nos. 49 and 51 Calthorpe Street appears to narrow near the top of the buildings and even appear to lean against each other suggesting historical local movement along the boundary between the properties.

8.76 Approximate measurement of the levels in the adjacent light wells to the basements in each property suggests the lower ground level of 51 Calthorpe Street is approximately 1.25m lower than that of 49 Calthorpe Street. This suggests the FFL of No. 49's lower ground level is 15.51m AOD and the foundations for No. 49 are founded approximately at 14.41m AOD (similar to the FFL of 51 Calthorpe Street).

8.77 Foundations to the property are likely to comprise traditional corbelled brickwork footing perhaps with a concrete strip foundation, similar to that found in the trial pits at No. 51 Calthorpe Street.

8.78 There is a vault below the garden at the front of 49 Calthorpe Street, which is set at a similar level to their lower ground / basement level and approximately 1.25m higher than the lower ground level at 51 Calthorpe Street.

Holiday Inn

8.79 The basement below the footprint of the Holiday Inn property is on 4 levels and up to approximately 10m deep (below street level).

8.80 The building line of the Holiday Inn and extent of the basement adjacent No. 51 Calthorpe Street is set-back from No. 51 by approximately 1.3m (varies along the boundary becoming wider towards the rear of No. 51). This is shown in the cross-sections in Appendix N.

8.81 Construction details of the Holiday Inn property and in particular the foundations were not available for review. We understand that the structural engineer's drawings were not provided to site management on completion of the construction due to a dispute and therefore no records were available for review. Create, jointly with the engineering manager of the Holiday Inn, inspected the basement and observed the presence of a subterranean area between the two properties. This subterranean space is accessed by a door within the Holiday Inn basement RC wall.

8.82 The observed subterranean void or space in the 1.3m wide strip of land between the properties of number 51 and the Holiday Inn is originally believed to have been part of the basement of the building on the holiday Inn site prior to demolition and construction of the Holiday Inn.

8.83 The space has been enclosed with a reinforced concrete slab above; the level of which is generally at ground level. At about 11m from the front elevation of No. 51 Calthorpe Street, the ground level slab over the subterranean space drops down approximately 3.0m to the level of the lower basement floor of 51 Calthorpe Street; this forms a lightwell to the basement windows of 51 Calthorpe Street on this elevation. The subterranean space between the two buildings continues below the lowered slab but with reduced head height until a return in the Holiday Inn basement at the rear of 51 Calthorpe Street.

A selection of photographs are included as Appendix O.

8.84 This void was probably originally kept to provided working space behind the Holiday Inn basement wall when the Holiday Inn property was constructed and provide lightwells to the lower ground floor of number 51.

8.85 The extent of the subterranean space between the two properties is the line of the front elevation of No. 51 Calthorpe Street and is defined by a RC retaining wall. The slab at ground level forming the roof cantilevers over the space from the Holiday Inn structure and appears to simply abut No. 51 Calthorpe Street and is not connected or built into the brick structure.

8.86 The flank wall and lower ground floor wall of No. 51 Calthorpe Street is exposed and the 'below ground' drainage from the front of No. 51 is hung from the wall in cast iron pipes which exit to the rear of the property.

8.87 Therefore the basement wall of the Holiday Inn on the boundary with No. 51 Calthorpe Street is not retaining. The internal FFL of the subterranean space is approximately 1.56m below the lower ground level of No. 51 Calthorpe Street.

8.88 The proposed basement perimeter secant piled wall of No. 51 Calthorpe Street is set back internally from the line of the existing flank wall of No. 51 Calthorpe Street, which is then separated from the Holiday Inn basement by the subterranean space. The Holiday Inn is likely to be built on piled foundations and therefore will not be affected by the expected ground movements resulting from the construction of the basement of No. 51 Calthorpe Street, which are considered to be negligible. This also applies should the Holiday Inn property be constructed on spread foundations.

Highway

8.89 It is proposed to extend the existing lower ground level of No. 51 Calthorpe Street out under the forecourt to the boundary of the site adjacent the B502 public highway (and footway), of Calthorpe Street.

8.90 The basement retaining walls adjacent to the highway will be designed for a surcharge loading in accordance with BS 8002:2015 Code of Practice for Earth Retaining Structures taking account of vehicular loading.

8.91 The retaining walls support the footway/highway and thus will be subject to a design approval process and certificates. This is dealt with in more detail in the following section.

8.92 The works will be constructed in a manner to minimise disruption to the public highway/footway.

Approvals and Party Wall Consents, etc.

8.93 The Holiday Inn hotel and No. 49 Calthorpe Street are both less than 6m from the Site; so the work will be subject to Party Wall awards, on account of the basement works being both within 3m and below a 45 degree line from the underside of a neighbour's foundations that are less than 6m away. As part of the Party Wall Award process, various safeguards are applicable, and prior to excavation work commencing a visual condition survey of the site boundary and of the immediately adjacent properties will be carried out. This record will enable a comparative assessment to be made, should it be considered that the works have resulted in any movement cracks to the buildings.

8.94 Although beyond the 6m zone defined by the Party Wall award process, it will be prudent for a visual condition survey of other nearby properties to be undertaken, such as the remainder of the terrace of which No. 49 Calthorpe Street is the nearest house.

8.95 Agreement will be required from the Highway Authority, given that the extension of the lower ground floor below the forecourt will abut the ground under the pavement and thus the retaining structure will uphold the integrity of the pavement. This would be through the Approval in Principle submission and approval process.

8.96 An agreement and approval process with the Royal Mail Group and compliance with their Safeguarding Guidelines, etc. will be required in relation to the mail tunnels located under Calthorpe Street.

Permanent Works

8.97 Construction of the new basement is envisaged as a watertight reinforced concrete box up to lower ground level (external level at the front of the property); this will include the area of the private gardens and also the extension of the lower ground floor under the forecourt. For the lower ground floor under the forecourt, the waterproof box will include the slab that provides support for the forecourt.

8.98 Sketches of the proposed scheme are included in Appendix N.

8.99 Owing to the ground conditions and in particular the scour feature, it has been decided not to underpin the existing foundations. Instead piled foundations and retaining walls have been selected.

8.100 The classification and grade of basement waterproofing and methodology is a client decision, this does not impact on the structural stability, etc.; however, the proposed methodology for waterproofing the basement is included here for information.

8.101 The basement waterproofing protection will be grade 3 for inhabitable space in accordance with BS 8102:2009 Code of practice for protection of below ground structures against water from the ground.

8.102 The basement box will be constructed using reinforced concrete secant piles installed around the perimeter of the proposed basement within the footprint of the existing building perimeter walls. The extended lower ground floor out under the forecourt will be formed using cantilever reinforced concrete retaining walls.

8.103 The piles will be lined with a reinforced concrete liner wall. To minimise the loss of residential space within the basement, a waterproofing additive provided to the concrete mix for the concrete to the perimeter walls and base, together with reinforcement spacing and a concrete mix designed to make the concrete watertight will be used.

8.104 Where the water table classification based on Table 1 of BS 8102 2009 is considered high risk a combined approach will be adopted using water-tight concrete and a drained cavity to wall and slab. The drained cavity will be formed using a proprietary high density polyethylene internal drainage membrane and connected to a sump and pump. Access will be provided to the pumps for maintenance. The membrane can be dry-lined or plastered in accordance with the final Architect's details.

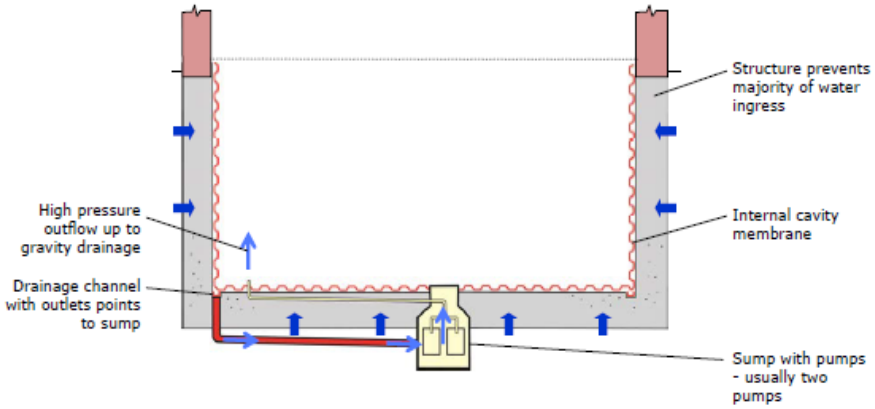


Figure 8.11: Type C Protection – Drained Cavity Waterproofing

8.105 As a precaution, waterproofing measures will be designed on the basis of water being present to the full height of the retained ground at some time during the structure's life. The waterproofing will be extended to all buried parts of the substructure such as the forecourt slab just below ground level.

8.106 The structural solution and construction methodology adopted is chosen to minimise and control movements of the basement walls wanting to move inwards towards the excavation;

pushed by the weight of the retained ground behind when the soil from within the footprint of the basement piled walls is excavated.

8.107 This is particularly significant in relation to No. 49 Calthorpe Street, which has historically subsided and appears to lean towards No. 51 Calthorpe Street.

8.108 To control movement, the proposal is to construct the basement using a top-down construction technique, eliminating the need for temporary propping at lower ground level.

8.109 Before any excavation starts a transfer slab (500mm thick, subject to detailed design) that will form the new lower ground slab will be cast in place. A hole will be left within the slab (probably using the lift shaft and/or stairwells) to allow access for the work personnel, excavation machinery and soil arising. Excavation will then proceed under the transfer slab using tunnelling techniques.

8.110 The lower ground floor transfer slab structure is to be keyed-in to the existing perimeter and internal load bearing walls of the building superstructure to support or 'underpin' these walls once the basement is formed and allow a new vertical supporting structure to fit within the proposed basement configuration (to be hidden within the internal walls); see Figure 8.12 below.

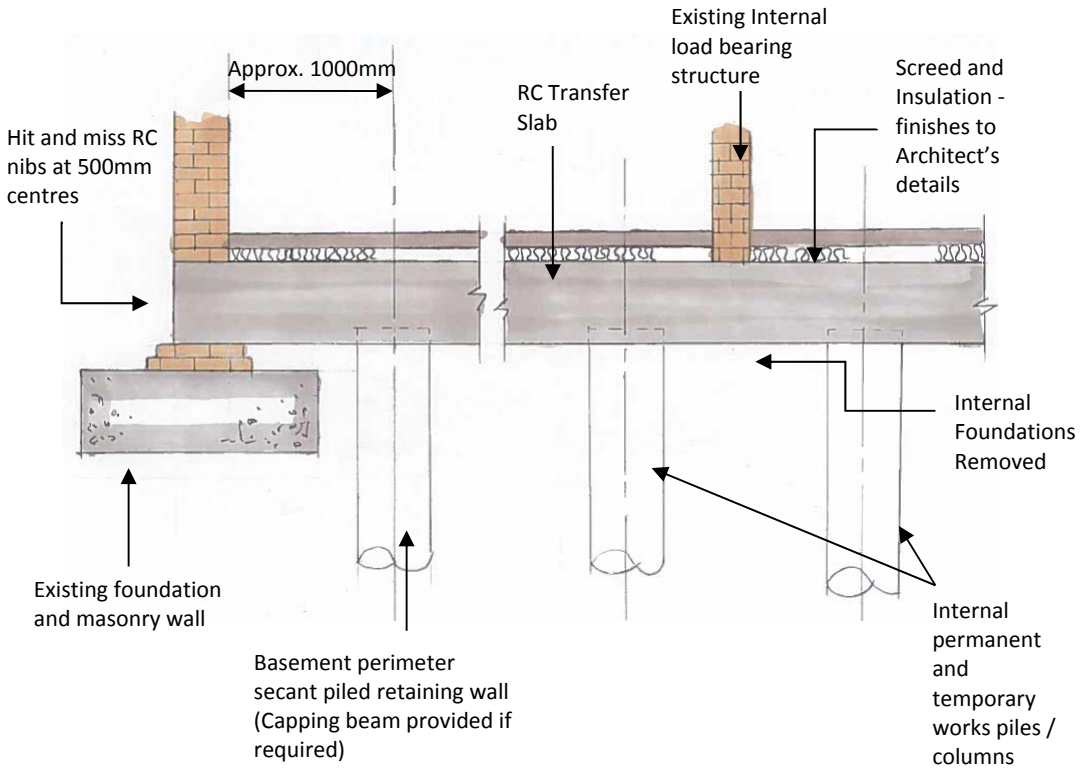


Figure 8.12: Lower Floor Level Transfer Slab with 'Hit and Miss' Nibs Built in to the Perimeter Walls

8.111 Before the transfer slab is cast, the existing lower ground slab will be cored through (or locally broken out) to install the new basement secant piles. The exiting lower ground floor slab will be used as a working platform for the piling rig.

8.112 The basement perimeter reinforced secant piled retaining wall will be installed from lower ground level.

8.113 Vertical load bearing piles within the building basement and any temporary works piles (required to support any temporary works structures needed to support the superstructure above) will be installed from lower ground floor level through the existing lower ground floor slab. Plunge columns will be installed to provide permanent support to the transfer slab.

8.114 The existing lower ground floor slab will be broken out, piles broken down to their cut-off level and the perimeter and internal load bearing walls prepared to receive the new transfer slab.

8.115 The transfer slab will be cast integrally with the installed perimeter and internal piles.

8.116 The basement will be excavated working around the installed permanent plunge columns and temporary piles. The permanent plunge columns will become columns within the basement space supporting the transfer slab, which will be designed as a flat slab acting across the full width of the building.

8.117 When the excavation reaches basement slab level, anti-heave mat will be installed and then the slab will be cast. The basement slab will be designed as a piled raft.

8.118 The secant piled wall will form a physical barrier around the basement perimeter, which will block the horizontal flow of new water back into the excavation. Any water inside the perimeter will be removed as the basement is excavated. The layer of clay under the site and the cohesive nature of the Made Ground will prevent water flowing up inside the perimeter from below.

8.119 Excavation of the basement and the basement slab will be above the water table. In the unlikely event that excavated soil and reduced pressure cause water seepage into the basement excavation, this will be controlled with pumping.

8.120 The key structural advantage of this approach to the construction is that the lower ground floor slab (i.e. the transfer slab) will provide a very stiff rigid box-like support to the basement side walls from the outset. Ground movements using this form of top-down construction are relatively small and within acceptable limits.

8.121 This form of construction provides the greatest stability and reduced ground movement.

8.122 The secant reinforced concrete piles forming the perimeter wall will be designed to limit lateral deflection of the piles between the top lower ground slab and basement slab. The addition of internal perpendicular walls will provide further long term stiffness to the overall structure.

8.123 The secant piled wall adjacent to No. 49 Calthorpe Street will be designed to support the foundation load from the No. 49 flank wall (surcharge load applied at the appropriate level – approximately 1.25m above the existing lower ground level of No. 51 Calthorpe Street), avoiding the need to alter the existing foundations of that property.

8.124 The lower ground level transfer slab will provide lateral restraint to resist this surcharge load from the outset.

8.125 The underpinned perimeter and internal load bearing walls will increase the bearing capacity and stiffness of the building.

8.126 There is an option for the Contractor to choose to construct an additional temporary access to the lower ground floor and basement (to supplement the access through the transfer slab – lift shaft) to ease excavation of the basement through the front of the property. The extension to the lower ground level under the forecourt once excavated can be used to access the lower ground and basement under the footprint of the building.

8.127 Since the superstructure floors are going to be removed and rebuilt, the new vertical support structure is likely to be reconfigured to suit the proposed internal layouts. Therefore, the existing load bearing masonry columns only require to be temporarily supported (by steel needles passing through the masonry, which in turn will be supported on temporary piles placed either side) during construction of the basement.

8.128 However, should the existing masonry structure be reused this will be extended to basement foundation level by installing new reinforced concrete or structural steel columns under the existing ones, which will be temporarily supported (steel needles passing through the masonry will be supported on temporary piles placed either side), once the basement is excavated.

8.129 For the basement works, the perimeter walls would be designed to be propped by the lower ground floor slab (500mm thick transfer slab) which will act as a plate across the building as well as the basement slab at low level. Around the private sunken rear gardens, which are adjacent to the rear gardens of the adjacent property No. 49 Calthorpe Street, the walls will be freestanding with only the basement slab to prop the wall.

8.130 Around the sunken private rear gardens, the capping beam for the secant piled cantilever retaining wall will be designed to span horizontally between strong points (which are the return in the retaining wall and the lower ground floor transfer slab) to increase wall stiffness and reduce ground movement.

8.131 It is not possible (without removing a section of the building's perimeter wall) to construct a continuous line of secant piled wall across the interface between internal and external areas; where they cross the line of the rear (or front) wall of the property. Therefore the secant piled wall will be stopped either side of the line of building wall and an infill panel constructed using underpinning techniques to plug the gap.

8.132 Construction of the reinforced concrete base and walls would be detailed around any temporary props, so that they could remain in place until sufficient of the concrete works have been completed.

8.133 Given the nature of the ground and more pertinently the Terrace Gravel strata, heave of the ground resulting from the bulk excavation is not expected to be significant and should be largely instantaneous. The overall heave, which can occur for a single level basement, is generally not significant.

8.134 However the basement slab, piles and structure will be designed (in terms of both forces and movement) for any anticipated residual heave following construction arising from cohesive material at depth. Tension piles for both heave and potential upward water pressure together with a heave mat will be provided below the basement slab if required to reduce the potential loading on the slab.

8.135 The basement structure, slab piles etc. will be designed for forces arising from hydrostatic water pressure/uplift resulting from a raised water table above the basement slab level in accordance with BS 8102:2009 Code of practice for protection of below ground structures against water from the ground and BS 8002:2015 CoP for Earth Retaining Structures. The water table will be classed as Variable – fluctuates above the basement slab.

8.136 The concrete mix for all concrete in the ground will be to suit the results of the site investigation chemical tests; that is up to 0.37 g/l sulphate (SO_3) in groundwater and up to 0.21% of soluble sulphate (SO_4) and pH levels of up to 8.4 in the soil. The soluble sulphate results correspond with a design sulphate class of DS-1 and DS-2 in accordance with BRE Special Digest 1. As the pH level is higher than 6.5 guidelines suggest that for the buried concrete an aggressive chemical environment for concrete (ACEC) clarification of AC-2 is appropriate.

8.137 All new on site drainage will be separated until the point of connection to the public sewer in order to meet Thames Water requirements. To inform the detailed design of the drainage, a full CCTV drainage survey will be carried out to agree the existing points of connection to be reused as part of the development with Thames Water and to confirm any necessary diversions to existing private drainage.

8.138 An indicative foul and surface water drainage strategy is included on SK001 and SK002 (Appendix H). Detailed calculations and a summary of the drainage proposals are included in the FRA.

8.139 The proposed surface water drainage strategy can be summarized as follows:

- All roof drainage, and front light wells/external areas including the forecourt will be designed to drain under gravity to an attenuation tank. This will be sized for the 1 in 100 year plus 30 % climate change event and will need to be accommodated in a 13.4 m^3 attenuation tank. It is considered that a structure of this size can be accommodated beneath the lower ground floor slab under the forecourt. The tank will be located below the private use area and CHP plant room away from the boundary with Calthorpe Street (the exact position to be determined at the detail design stage), shown provisionally on SK001.
- A flow control device (hydrobrake) will restrict the outflow from the attenuation feature to 5.0 l/s (in line with best practice) as greenfield runoff rates have been estimated to be less than 5.0 l/s for the Site.
- The existing terminal manhole (assumed to be under the ownership of Thames Water based on the asset plans) will be relocated and incorporated as a raised structure within one of the basement gardens and a disconnecting manhole constructed next to it. Surface water will drain from the attenuation tank under gravity to the disconnecting manhole before leaving Site.
- The rear light wells/courtyards (and any basement cavity drainage, ref. 8.106) will be drained by individual sump pumps outfalling direct to the disconnecting manhole.
- The surface water drainage system will incorporate pollution control measures in line with the SUDS Manual.

8.140 The basement secant piled retaining wall along the front of the property will, in the temporary condition, form the rear wall of the excavation for attenuation tank. The front and sides of the excavation for the attenuation tank will be temporarily supported using traditional shoring and propping techniques. The attenuation tank will only be built after the permanent retaining wall has been constructed along Calthorpe Street and the ground excavated and lower ground level slab cast. Either a proprietary tank system will be installed in the excavation and backfilled or the tank formed from a reinforced concrete box comprising RC walls on three sides and lining the rear face of the secant wall on the fourth side.

8.141 The proposed foul water drainage strategy can be summarized as follows:

- It is proposed that foul drainage from all flats will drain under gravity to a sump beneath the store/plant room, from where it will be pumped to the aforementioned raised disconnecting manhole via a backdrop connection, prior to a gravity outflow

to the final manhole within the courtyard garden of flat 1, and then the Thames Water Sewer network in Pakenham Street.

8.142 The drainage design will be agreed with Thames Water and Camden Council as part of the detailed design. Regular inspection and maintenance of highway drainage, public and private drainage (including pumped drainage) by Camden Council, Thames Water, residents and site management respectively, will minimise the residual risks associated with surface water/sewers.

Design Parameters

8.143 The soil parameters required for design were identified prior to the ground investigation and are listed in Section 4.1 and the design values for each given in Table 1, repeated here, of Howlands additional Phase 2 GI report.

8.144 To keep differential settlements within acceptable limits the design of piled walls and foundations will take account of the settlement response of the system acting into each soil type and not just based on load capacity.

8.145 The design of the retaining walls will be in accordance with relevant Eurocodes or British Standards and Code of Practices. For the structural design of the proposed retaining walls active earth pressures will be calculated. Design of the perimeter secant piled embedded retaining wall will be undertaken by a specialist piling Contractor using suitable design geotechnical design software such as Finite Element software.

Parameter	Made Ground	Natural cohesive soils (not LC)	Natural granular soils	London Clay (LC)
Stratum thickness[1]	8 m from street level (base approx 10.5 mOD)	Variable (has the potential to be present to the full depth investigated)	Variable (has the potential to be present to the full depth investigated)	Variable (has the potential to be to be present to the full depth investigated)
Stratum Type[1]	Cohesive	Cohesive	Cohesionless	Cohesive
State of Consolidation[2]	Not applicable	Over-consolidated, unless fully softened by disturbance	Not applicable	Over-consolidated
Bulk weight, γ_k (weight density)[3]	17.5 to 20	19.0 to 20.0	17.0 to 20.0	20.0
Undrained strength, kNm^{-2},[4]	20.0	20.0 increasing to 40.0 where the strata is thicker	Not applicable	40.0 increasing to 150.0 with depth
Drained strength, c' kNm^{-2} / φ' degrees[3]	0 / 25	0 / 25	0 / 30	0 / 20
Coefficient of earth pressure at rest, Ko[5]	0.75	0.75	0.40 (loose or medium dense 0.80 (dense)	1.00
Poisson's ratio[5]	0.2 to 0.3	0.4 to 0.5	0.20	0.4 to 0.5
Young's Modulus, MNm^{-2},[6]	0.5 to 5 (very soft to soft)	5 (soft) 5 to 8 (firm)	30 to 80 (loose) 80 to 160 (medium dense 160 to 320 (dense)	4 to 7 (firm) 7 to 20 (stiff/very stiff)
Water table elevation, mOD[1]	10.85	10.85	10.85	10.85

Table 1 : Soil Parameters

NB. Data source:
1 – Borehole records; **2 – Geological provenance derived from geological setting;**
3 – BS 8002 (BSI, 2015b); **4 – Derived from SI data;**
5 - Tomlinson (1996); **6 - www.geotechdata.info/parameter/soil-young's-modulus.html.**

Figure 8.13: Soil Parameters (Table 1 from AF Howland Phase 2 report)

Temporary Works, Construction Methodology and Sequence of Construction

Overview

8.146 The contractor will be required to provide a detailed method statement for the works. This will set out their proposed method for constructing retaining walls, forming the excavation, maintaining the stability of the sides of the excavation until such time as the new concrete basement is sufficiently complete and for constructing the permanent basement and forecourt ground slab. The method statement will also set out how the Site will be secured

by appropriate hoarding during the demolition and construction phase to ensure safety to the general public, including neighbours.

8.147 This method statement will provide an approach that will allow the basement design to be correctly implemented and any temporary support provided during construction works. The Contractor will be responsible for the final temporary works and construction sequence/methodology once appointed. This will be checked by the designer for compliance with the design intent to ensure structural stability and safety is maintained during the construction stage. Where necessary, the design will be adjusted to accommodate Contractor specific details or sequences in order to ensure the design and construction methodology are coordinated and compliant.

8.148 The construction method statement will be agreed with the Party Wall surveyors and other third parties (Royal Mail) before commencement and any changes during the construction process advised to all parties.

8.149 Groundwater is anticipated just below the underside of the basement slab (approx. 1.6m deeper than the bulk excavation). Until the basement slab and liner walls are sealed, any water entering the excavation will be locally pumped. As water table levels naturally rise and fall over time, which does not lead to subsidence, the pumping of small amounts of water from within the basement excavation is considered unlikely to affect the surrounding ground. There is only a risk of subsidence from large scale pumping of soil which lowers the water table below its natural lowest level.

8.150 The basement excavation is proposed within the Made Ground, which has been observed to cohesive by nature with some gravel and sand; therefore the cohesive nature of the ground should limit water ingress into the excavation. The use of secant piles for the basement walls as a precautionary measure will also limit water ingress.

8.151 A traditional underpinning infill panel will be required where the basement crosses the line of the front (and rear) wall of the property. If in the unlikely event groundwater is present, and pumping alone is inadequate to control water ingress, permeation grouting will be used to resist the groundwater inflows at the gap beneath the interface between internal and external areas. Permeation grouting will be used if required to plug any unexpected holes in the temporary piled walls that leads to water ingress during construction, though the need for this is considered very unlikely.

8.152 The basement construction uses top down construction technique where the upper level slab (lower ground level transfer slab) is built before the basement is excavated (See Figure 8.14).

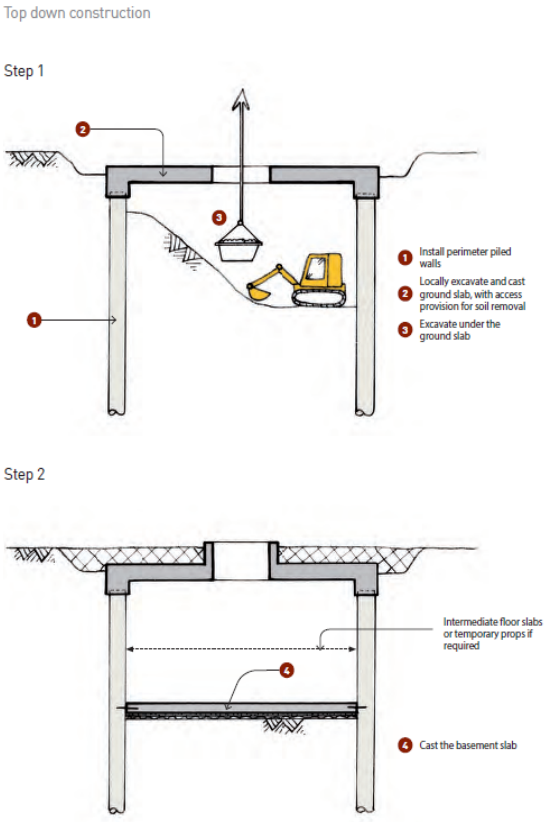


Figure 8.14: Top Down Construction

Suggested Method Statement - Enabling Works

8.153 The site will be made secure and safe with hoarding to prevent unauthorised access and control access throughout the works.

8.154 Licences will be obtained and relevant notices posted on the hoarding.

8.155 Set-up monitoring stations and install monitoring points.

8.156 Undertake pre-condition / party wall surveys, etc.

Suggested Method Statement - Construction sequence and temporary works

8.157 A Low headroom / restricted access mini piling rig will be used to install temporary works piles required to support vertical temporary works structures in order to allow the part removal of the ground floor.

8.158 The mini piling rig will be lowered down into the lower ground floor through the light well or other agreed route (it can be craned in over the property into the rear open lower ground floor area and brought in through an opening in the rear).

8.159 The existing lower ground floor concrete slab will be used as a working platform for the piling rigs.

8.160 To provide sufficient headroom for the main piling rig and installation of reinforcement, in a controlled sequence, sections of existing ground floor slab will be removed and temporary horizontal wailers installed together with propping to external and internal walls as works proceed. Horizontal propping is installed as sections of floor slab are removed in order to ensure continuous lateral support to the walls.

8.161 A slot or trench will be saw-cut in the existing floor slab along the proposed basement perimeter and the slab removed between the cuts. Concrete upstands will be cast and doweled into the existing slab along both sides of the cut slot in the floor slab to form a raised guide wall for the pile installation. The combined thickness of the slab and upstand will form a guide wall to control accurate pile installation for the secant piled wall.

8.162 Basement perimeter RC 450mm diameter (subject to detailed design) secant piled walls will be constructed working from lower ground level down. The depth and timing and sequence of the piling works will be to the piling contractor's detail design and method statement. The plan layout of the piles is shown in the sketches in Appendix N.

8.163 Piles with plunge columns to support the transfer slab in the permanent case will be installed to suit the proposed basement configuration.

8.164 Additional temporary piles to support temporary works will be installed, coring through the existing slab.

8.165 The basement perimeter secant piled retaining wall will generally be constructed internally within the existing building perimeter walls; the exception to this is the front elevation. Here the basement piled secant wall will be constructed externally from the existing forecourt level (street level) following the external front elevation.

8.166 To safely allow installation of the external perimeter basement wall from forecourt level the existing light wells will be blocked up and backfilled.

8.167 The basement perimeter walls in the forecourt and rear areas will be constructed in a similar way to those internally, first forming a concrete guide wall to control setting out, installing the soft piles followed by the hard reinforced concrete piles.

8.168 On completion of the piling works the piling machinery will be removed.

8.169 The infill panels at the interface of internal and external basement areas will be constructed using traditional underpinning techniques. The reinforced concrete pin will be connected to the adjoining piles with post fixed rebar resin anchored into the pile before casting the pin.

8.170 Where the pin crosses the property external wall it will be cast to underside of foundation and either side of the property wall the pin will be cast up to underside of transfer slab. Reinforcement bars will be left protruding out of the top of the pin (either side of where the pin crosses the external wall) to tie into the transfer slab.

8.171 The concrete pin will be poured and after a minimum of 24 hours 'dry packed' between the existing wall foundation (where the pin crosses the external wall) and new pin concrete below.

8.172 The existing lower ground level floor (concrete slab) will be removed and the ground lowered to formation level and blinded with concrete. Reinforced concrete nibs will be built into the existing building perimeter walls at approximately 500mm centres (by removing sections of brickwork). The reinforcement for the 500mm thick lower ground floor transfer slab will be fixed and the concrete cast.

8.173 Water-bars/hydrophilic strips will be installed at all construction joints.

8.174 The reinforcement protruding from the top of the reinforced concrete local infill panels/pin at the interface with the outside will be tied into the transfer slab reinforcement before it is cast making the two monolithic.

8.175 Reinforcement starter bar strips will be cast in the underside of the transfer slab to tie into the 300mm thick liner wall and other internal load bearing walls. (Vertical void formers (tubes) can be cast in the slab along the lines of walls to be built below to allow concrete to be pumped into the walls when they are constructed after the basement is excavated and ensure a solid connection.)

8.176 Access holes will be formed in the lower ground floor slab to allow the work below to continue. The RC Slab will be given sufficient time to gain sufficient strength before bulk excavation begins.

8.177 Along the central section of the property front elevation external wall, openings in the wall similar to the nibs formed in the perimeter walls will be formed through the solid masonry walls at approximately 500mm centres. Reinforced concrete beams/needles will be constructed through the openings formed in the wall underpinning the front elevation. The transfer slab and needles passing through the wall are supported by the external piled basement wall installed from the forecourt level.

8.178 Internal structural elements of the building will be supported vertically either by permanent or temporary works.

8.179 Where internal walls are retained and need supporting openings through the walls will be formed similar to the nibs in the perimeter walls and the front elevation of the property.

This will allow RC needles to be constructed through the wall connecting the raft either side of the wall and support internal walls once the basement is excavated

8.180 Internal masonry columns/piers will be supported by inserting steel needles through the pier that are supported on temporary piles.

8.181 The return front flank walls ether side of the existing light wells will be temporarily supported using steel needle beams supported on temporary piles. In the permanent case the walls will be underpinned down to basement level by new RC walls after bulk excavation.

8.182 Bulk excavation of the basement will begin from the upper level using the access hole through the transfer slab cast at lower ground level.

8.183 There is an option for the Contractor to choose to construct the extension to the lower ground floor out under the forecourt before proceeding with the bulk excavation to the basement. This will allow the Contractor to tunnel below the transfer slab from the external front elevation, providing an alternative or additional temporary access to the lower ground floor and basement. This will ease bulk excavation of ground from the basement by removing it through the front of the property.

8.184 The process of bulk excavation will continue tunnelling under the transfer slab until the full dig depth is reached.

8.185 The soil will be excavated and removed via the front of the property initially using small excavators and grabs working through the access hole removing soil up to the ground level before transfer to lorry as per the construction/traffic management plan. As the bulk dig deepens the soil will then be excavated using a combination of small excavators tunnelling below the transfer slab, grabs and conveyor belts.

8.186 As excavation proceeds, if required, horizontal propping will be provided to the infill panel/pin at the interface with the external wall.

8.187 Where the design dictates, horizontal propping will be provided just above the full basement dig depth prior to completion of bulk excavation.

8.188 At basement formation the ground will be blinded with concrete. The lift pit, attenuation tank and drainage sumps, etc will be constructed using shoring and propping to support the excavations. Any drainage below the basement ground slab will be constructed.

8.189 The anti-heave mat will then be laid.

8.190 The load bearing piles supporting the basement slab and any tension piles will be tied into the RC basement slab. The RC slab will be tied into the face of the perimeter basement secant piled wall using reinforcement post fixed to the hard piles. A shear key will also be

formed by cutting a slot in the piles the depth of the slab. The reinforcement will be fixed and the basement raft slab concrete cast.

8.191 With the starter bars sticking out from the basement slab upper surface, hydrophilic water bars will be installed and the reinforced concrete liner wall to the perimeter basement secant piled retaining wall constructed. (Piles cleaned, reinforcement fixed and concrete placed.)

8.192 Temporary trench shoring and props will support the ground at the front of the property forecourt whilst the lower ground level is excavated. The ground will be excavated in sections and the permanent retaining wall constructed as works proceed.

8.193 The lower ground cantilever reinforced concrete retaining wall will be constructed with sufficient foundations to provide permanent support. When the retaining wall is complete to the boundary, the remainder of the lower ground slab will be cast, followed by internal walls.

8.194 In situ concrete internal basement walls will be constructed and tied to the underside of the transfer slab.

8.195 Concrete surrounding plunge columns will be broken back to expose the permanent steel column beneath and any additional permanent columns installed, e.g. steel column placed and dry packed concrete inserted between top plate and underside of transfer slab or existing structure.

8.196 Internal RC walls will be constructed in the lower ground floor to the front of the property before constructing the reinforced concrete ground floor slab to the forecourt. A waterproofing membrane system will be applied to the top surface of the external forecourt RC slab and lapped with water-tight concrete walls.

8.197 The waterproofing cavity drainage membrane and drainage system will be fixed on the basement slab and liner walls, forecourt retaining walls and slabs followed by the finishes (insulation and screed).

8.198 Once the basement works are sufficiently progressed (or complete) the superstructure will be modified including removal of the existing roof, construction of two additional floors, remodelling of internal floors and construction of a new roof.

Predicted Ground Movement Assessment, Monitoring, Impact / Damage and Mitigation on Neighbouring Structures and Infrastructure

8.199 The comments (from the previous planning application consultation process) of the neighbours' at No. 49 Calthorpe Street on the potential for damage to their property from

the basement works have been considered and mitigating engineering measures adopted to deal with their concerns.

8.200 The basement permanent works design solution has been chosen to minimize ground movement. Mitigation measures adopted to reduce, avoid or off-set significant adverse impacts are as follows:

- Proposal to step-back the basement wall from the boundary of No. 49 Calthorpe Street;
- Proposal to use a piled retaining wall (not underpin); and, importantly
- To construct a 500mm thick transfer slab that will act as a horizontal prop, of sufficient stiffness and strength, before bulk excavation commences and to bulk-excavate using top down construction.

8.201 Therefore movements during construction are not expected to be significant; vertical movement is expected to be less than the 6mm that has been calculated in paragraph 8.212.

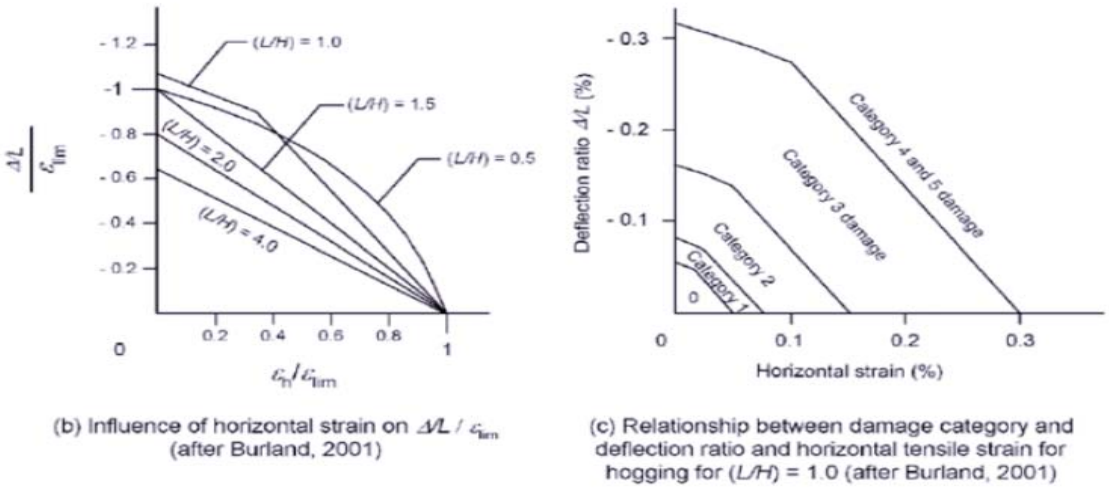
8.202 Often the largest component of deflection/ground movement behind piled retaining walls takes place as the piled wall cantilevers after initial excavation and before the first level of horizontal props are installed. By constructing a 500mm thick reinforced concrete transfer slab, restraining the piled retaining wall in place, and forming a rigid box before bulk excavation, this mitigates movement and thus damage.

8.203 Adoption of secant piled retaining wall installed offset from the boundary within the site of No. 51 Calthorpe Street avoids the need for underpinning the party wall and minimizes movement to the adjacent footings. The secant piled wall will be designed for the surcharge load from the adjacent house footings.

8.204 Providing a very stiff 500mm thick transfer slab at lower ground level and using top down construction techniques delivers the greatest level of lateral restraint to the basement during the construction process and the least potential for ground movement reducing any influence on adjacent structures.

8.205 This assessment of potential ground movement and damage covers both short term and long term movements relating to the construction and the performance of the permanent works. The design and construction methodology aims to limit damage to the existing building on the site and to all adjoining buildings to Category 1, as set out in Table 2.5 of CIRIA report C 580.

8.206 This assessment has used empirical means as set out in CIRIA C580 Embedded Retaining Walls: Guidance for Economic Design. The relevant calculations are included in section 8.209.



(b) Influence of horizontal strain on Δ/L / ε_{lim} (after Burland, 2001)

(c) Relationship between damage category and deflection ratio and horizontal tensile strain for hogging for (L/H) = 1.0 (after Burland, 2001)

Figure 8.15: Predicted Ground Movement after Burland 2001

8.207 The calculated ground movement and thus anticipated cracking for the basement works falls within category 0; negligible damage in CIRIA C580 (classification of visible damage to walls after Burland).

8.208 Therefore the maximum level of cracking anticipated is hairline cracking, which is acceptable in accordance with the Party Wall act (although not desirable) and can be repaired with decorative coverings/filler. To mitigate this risk, The Party Wall Act is to be followed and a Party Wall Surveyor will be appointed.

8.209 Figure 8.16 and 8.17 are extracts from 'Guidance on Subsidence of Low-rise Buildings by the Institution of Structural Engineers and the BRE document 'Subsidence Damage to Domestic Buildings'. Both tables indicate the level of cracking and repair with particular reference to type of repair, and rectification and indicate where the predicted movement/damage sits in the hierarchy of damage classification.

8.210 Calculation of predicative ground movement and category of damage in accordance with CIRIA C580:-

CALCULATION SHEET

create CONSULTING ENGINEERS LTD

Project: 51 CALTHORPE STREET, LONDON, WC1X 0HH	Job No: P12-385	Sheet No: 1	Rev.
Subject: GROUND Movement (Including Existing L.G.F.)	Made by: MA	Checked by: MS	
	Date: 04.03.16	Date: 03/16	

Horizontal Movement CIRIA C580; Embedment retaining wall : Guide to Economic Design

Existing building height (Excluding Lower Ground Floor)

H = 8.8m

Existing building width = 10.4 = L

$L/H = 10.4/8.8 = 1.18$

Ground surface movement due to Bored pile

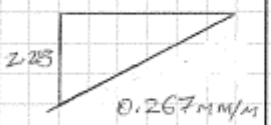
Proposed basement depth (including existing LGF Lower Ground Level) = 5.7m or 5700mm

Horizontal surface movement = 0.04%

$\delta_H = \frac{0.04}{100} \times 5700 = 2.28mm$

Vertical surface movement = 0.04%

$\delta_V = 0.04/100 \times 5700 = 2.28mm$



Distance behind wall

LH = 5700 x 1.5 = 8550

Potential movement due to wall excavation

Horizontal surface movement 0.15%

$0.15/100 \times 5700 = 8.55mm$

Vertical surface movement

$\frac{0.1}{100} \times 5700 = 5.7mm$

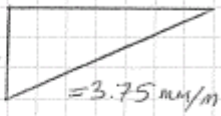
Distance behind wall to negligible movement → PTO

CALCULATION SHEET

create CONSULTING ENGINEERS LTD

Project: 51 CALTHORPE STREET, LONDON, WC1X 0HH	Job No: P12-385	Sheet No: 2	Rev.
Subject: Ground Movement (Including Existing G.L.G.F.L)	Made by: MA	Checked by: MS	
	Date: 04.03.16	Date: 03/16	

5700 x 4 = 22800mm



Node		Excavation movement distance δ_v		Installation movement distance δ_v	
	x	22800	0	8550	0
	y	0	-5.7	0	-2.28

The result obtained are based on CIRIA C580, Maximum horizontal movement due to development

is 2.28 + 8.55 = 10.83mm

Maximum vertical movement due to development

is 2.28 + 5.7 = 7.98mm

DETERMINING The damage Category

δ_H = 10.83mm

distance behind Wall to negligible movement = 22800

Damage Category = $10.83/22800 \times 100 = 0.0475\%$

Based on table 2.4 of CIRIA C580

Damage Category	Degree of damage	Limiting tensile strain
0	Negligible	0.00% - 0.05
1	Very sligh	0.05% - 0.075%
2	Very Slight	0.075% - 0.15%
3	Moderate	0.15% - 0.3%
4-5	Severe to Very Severe	>0.3%

Therefore, Anticipated damage may be categorised as negligible

Table 6.2 Classification of visible damage to walls with particular reference to type of repair, and rectification considerations

Category of damage	Approximate crack width	Definition of cracks and repair types/considerations.
0	Up to 0.1	HAIRLINE – Internally cracks can be filled or covered by wall covering, and redecorated. Externally, cracks rarely visible and remedial works rarely justified.
1	0.2 to 2	FINE – Internally cracks can be filled or covered by wall covering, and redecorated. Externally, cracks may be visible, sometimes repairs required for weather tightness or aesthetics. Note: Plaster cracks may, in time, become visible again if not covered by a wall covering.
2	2 to 5	MODERATE – Internal cracks are likely to need raking out and repairing to a recognised specification. May need to be chopped back, and repaired with expanded metal/plaster, then redecorated. The crack will inevitably become visible again in time if these measures are not carried out. External cracks will require raking out and repointing, cracked bricks may require replacement.
3	5 to 15	SERIOUS – Internal cracks repaired as for MODERATE, plus perhaps reconstruction if seriously cracked. Rebonding will be required. External cracks may require reconstruction perhaps of panels of brickwork. Alternatively, specialist resin bonding techniques may need to be employed and/or joint reinforcement.
4	15 to 25	SEVERE – Major reconstruction works to both internal and external wall skins are likely to be required. Realignment of windows and doors may be necessary.
5	Greater than 25	VERY SEVERE – Major reconstruction works, plus possibly structural lifting or sectional demolition and rebuild may need to be considered. Replacement of windows and doors, plus other structural elements, possibly necessary. Note: Building & CDM Regulations will probably apply to this category of work, see sections 10.4, 10.6 and Appendix F.

Figure 8.16: Extract From Institution of Structural Engineers 'Subsidence of Low-Rise Buildings'

Table 1 BRE classification of damage (based on ease of repair of damage)

Category of damage	Description of typical damage (*Nature of repair in italic type*)
0	Hairline cracking which is normally indistinguishable from other causes such as shrinkage and thermal movement Typical crack widths 0.1 mm ***No action required***
1	Fine cracks. Damage generally restricted to internal wall finishes. Cracks rarely visible in external brickwork Typical crack widths up to 1 mm ***Easily treated using normal decoration***

Figure 8.17: Extract From BRE 'Subsidence Damage to Domestic Buildings'

8.211 The change of use of the building following redevelopment (office to residential) with the corresponding imposed load reduction (live load reduced from 4.0 kN/m2 to 1.5 kN/m2) off-sets the addition of a storey on top of the existing building. The increased load is also off-set by the removal of overburden load by the excavation of the basement. Vertical bearing pressures will be designed so that the soil will not be stressed any more than it is currently. The allowable bearing pressure increases with depth, which will help reduce the potential settlements. The use of piles transfers load into deeper stronger stable strata thus reducing pressure in the shared ground with the neighbours.

Proposals for Monitoring during Construction

8.212 Monitoring of movement to check there are no undue settlements occurring as a consequence of the basement works, in particular with reference to the adjacent terrace property at No. 49 Calthorpe Street and Royal Mail tunnels in Calthorpe Street, will be undertaken weekly until completion of the excavation, casting of basement walls and slabs. Thereafter subject to the agreement of the party wall surveyor and depending on whether there has been significant unexpected movement recorded, monitoring will be monthly. If movement is recorded that is significantly greater than expected, then monitoring will continue weekly or more frequently (daily) if required.

8.213 Written results from the monitoring will be compared with the agreed limits using a traffic light system and reported to the basement structural engineer and relevant parties within 48 hours of measurements being taken.

8.214 The limitations on movement within the traffic light system are to be agreed with the Contractor, the Party Wall Surveyor, Royal Mail's adviser and the Engineer; however we recommend that it follows a similar approach to that outlined here:-

Traffic light	Movement Range mm	Action
Green	0 - 6	No action
Amber	6 – 12	Investigate and review, consider implementing additional/ greater construction control measures, increase frequency of monitoring.
Red	Greater than 12	Stop work to review and agree suitable and sufficient measures before starting work again.

Programme

8.215 The development is expected to commence in late 2017 and is anticipated to finish within 18-20 months. The initial phase provisionally comprises enabling works, piling and partial demolition of the existing building on the site (approx. 1-3 months), followed by constructing the transfer slab and bulk excavation, construction and associated works (15 months) and fit out (2 months).

9.0 NON TECHNICAL SUMMARY

Brief

9.1 Create Consulting Engineers Ltd has been appointed to provide a Basement Impact Assessment, to support a planning application to refurbish, extend and change the use of or 51 Calthorpe Street, London, WC1X 0HH (the Site) in the London Borough of Camden.

Project Context

9.2 The Site comprises an existing three storey Victorian building built before 1874 and now in use as commercial uses (mainly offices). The building is located between a large Holiday Inn Hotel (east of the site) and a row of Grade II Listed Victorian residential Villas (west of the site) on Calthorpe Street. The front of the existing development faces south-east over Calthorpe Street beyond which lies the Mount Pleasant Royal Mail sorting centre. The rear of the property backs onto the Cubitt Street play centre.

9.3 The scheme consists of the refurbishment and extension of the existing building to enable a change of its use from offices to 14 residential apartments over six floors and involves the addition of a basement level below the existing lower ground floor.

As the scheme involves the construction of a basement, this report has been prepared in accordance with the London Borough of Camden's (LBC) Planning Guidance document 'Basements and Lightwells' CPG4 Sept 2013 and 'Guidance for subterranean development document' (LBC, 2010).

9.4 This report was first submitted as part of the Planning Submission documentation (planning reference 2015/3049/P) and was updated following a Basement Impact Assessment Audit prepared on behalf of the London Borough of Camden, (LBC) as part of the planning application determination process. This resulted in further ground investigation, further desktop assessment & design and a revision of this Basement Impact Assessment report.

The Building Construction

9.5 The building at No. 51 Calthorpe Street has been historically extended to the rear and the interior re-configured with the introduction of floor beams supported on brick piers. The proposed development consists of converting offices to residential.

9.6 A basement is proposed below the building footprint of No. 51 Calthorpe Street and to the rear of this property with an extension of lower ground level at the front of the property (under the existing forecourt).

Neighbouring Properties

9.7 The existing foundations of No. 51 Calthorpe Street and the neighbouring terrace properties are independent traditional brick footings on concrete strips approximately 1.0m below Lower Ground Level finished floor level. The level of the foundation for No. 49 Calthorpe Street is approximately 1.25m above that of No. 51 Calthorpe Street.

9.8 The Holiday Inn on the corner of Kings Cross Road and Calthorpe Street has a basement of varying depth up to approx. 10m over the extent of the building footprint. The foundations could not be proven but are assumed to be piled foundations given the type and scale of building.

9.9 The Royal Mail Group (RMG) confirmed the presence of Royal Mail (Post Office Railway) Tunnels under Calthorpe Street, running parallel to the site and at a depth of approximately 16 metres below ground level. RMG's Safe Guarding Guidelines state that any works within 50m of the tunnels will require their approval to proceed.

Site Setting

9.10 The ground investigation and desktop study suggests the site is located above or in the proximity to the course of the original River Fleet sometimes referred to as the lost River Fleet, which is now culverted in Pakenham Street. An east-west water course that was a tributary to the River Fleet ran along or close to Calthorpe Street. The confluence of the two water courses formed a scour feature in the ground, which means the flow of water over time eroded away much of the original ground to form a depression. This depression was later filled with river alluvium deposits and made ground of variable quality.

9.11 The ground conditions vary across the site between fully cohesive (clay) to fully non-cohesive (gravels and sand). The made ground (ground that has been disturbed during its history and is not natural formation), is particularly deep and up to 8m thick. An idealised cross-section of the ground below the site can be described as consisting of; Made Ground over Clay over Gravels over Bedrock Clay.

Screening

9.12 A screening assessment of the development proposal was undertaken to determine whether a full Basement Impact Assessment was required, in accordance London Borough of Camden guidance. The screening assessment considered groundwater flow, land stability and surface flow and flooding.

9.13 The results of the screening assessment confirmed that a Basement Impact Assessment was required on the basis of the following:

- The site is located over a Secondary 'A' aquifer and the proposed basement may extend beneath the water table.
- The proposed develop will result in the change in proportion of hand surfaced / paved areas and changes to the profile of inflows of surface water being received by adjacent properties or downstream watercourses.
- The site includes a slope greater than 7° and the proposed basement will extend the site boundary with a resultant step change in level each side. The adjacent land to the east (Holiday Inn) has a deeper basement and the property to the west (No. 49 Calthorpe Street) has a lower ground floor that is below the level of their front garden. The basement appears to be approximately 1.25m shallower than the FFL of the site. The rear garden to No. 49 is elevated by approximately one metre relative to the site.
- Unknown history of seasonal shrink-swell subsidence on the area, as site investigations (at this time) did not prove the base of the Made Ground and the adjacent property reported movement related issues.
- The forecourt of the site adjoins the back pavement to the public highway and the lower ground floor is to be extended under the forecourt.
- The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties.
- The site potentially lies within the exclusion zone of the Royal Mail (Post Office) Tunnels.

Scoping

9.14 A scoping assessment was undertaken to identify potential impacts of the proposed development and the possible consequences of these impacts, which are summarised below:

- Underlying shallow groundwater poses a risk of water ingress into the proposed basement and results in local impacts on groundwater flow and water quality.
- Inclusion of soft landscaped areas would increase recharge to shallow groundwater.
- Reduction of peak surface run-off due to increase in soft landscaping will result in a decrease in peak flows and volumes to sewer.
- The existing step down from existing forecourt to lower ground floor and proposal to alter the ground profile would lead to slope stability issues without adequate temporary and permanent propping.
- The property at No. 49 Calthorpe Street has a lower ground floor that is below its garden and the hotel to the east has a basement which in parts is deeper that the proposed development level would pose slope stability issues without adequate temporary and permanent propping.
- The investigation (2012) did not prove the natural ground and there is reported movement related issues. Local borehole records show the area to be underlain by

Terrace Gravels although further investigations are required to prove the depth of the natural strata.

- The site appears to be overlying the former River Fleet which could result in damage to the property without proper design and construction.
- The lower ground floor extends close to the site boundary and extends below the level of the pavement which without adequate temporary and permanent propping could lead to settlement or collapse of the pavement.
- The new basement will be deeper than both the footing to No. 49 Calthorpe Street and the Holiday Inn basement (in places) which without adequate temporary and permanent propping could lead to settlement or collapse of the adjacent property.

Ground Investigations

9.15 Further ground investigations were undertaken in April and November 2015 to confirm ground conditions across the site. Samples were collected from each borehole for laboratory testing and allow accurate inspection of the underlying ground conditions. On completion of each borehole, a groundwater monitoring well was installed to enable measurement of standing water levels.

9.16 The ground conditions encountered beneath the site were variable owing to the presence of as 'scour' feature which has disrupted and significantly weakened the underlying geology. The ground conditions generally comprise made ground (up to 8m) over clay (believed to be alluvial deposit associated with the former River Fleet) over Gravels (assume to be River Terrace) over Clay bedrock.

9.17 The standing groundwater levels were consistently measured at approximately 7.4 metres below ground level at the front of the site and 4.5 metres below ground level at the rear of the property (which is approximately three metres below the front of the site). The variation in groundwater levels is negligible and suggests that there is negligible or insignificant ground flow in this area.

Impact Assessment & Mitigation

9.18 On completion of the further ground investigations, the potential impacts associated with the scheme were reviewed and the following mitigation measures identified:

- Underlying groundwater was proven to be deeper than the proposed basement although the design will allow for appropriate waterproofing to cater for potential for rising groundwater levels or perched groundwater present in the Made Ground.
- A piling risk assessment will be undertaken prior to construction to protect underlying groundwater resources from contamination.
- A cover system of clean topsoil will be provided to soft landscaped areas to mitigate any health risks to future end users.

- Attenuation of surface water flows will be maximised to further reduce peak runoff rates.
- A structural retaining wall will need to be included in the proposals to provide adequate propping and mitigate the risk of slope stability issues.
- The substructure will be designed to provide lateral support to the footing of No. 49 Calthorpe Street; the basement wall will be stepped back from the boundary and top-down construction is proposed to mitigate the risk of slope stability issues.
- The potential for shrink-swell will be considered in the detailed design of the temporary works and the permanent design of the substructure. A structural condition survey of neighbouring properties will be undertaken prior to commencement of works.
- The design has been amended to provide a piling solution on the basis of recent site investigation information and to reduce risk of ground movement. Further site investigations will be required to support detailed design.
- Dewatering is no longer considered necessary (seepage considered likely to be minimal) as groundwater level has been proven to be below the depth of the excavation.
- Propping will be required as part of the detailed design of the temporary works and the permanent design of the substructure to mitigate risk of settlement or collapse of the pavement.
- The substructure will be designed to provide lateral support to the footing of No. 49 Calthorpe Street.

The perceived risks to all the potential impacts identified following implementation of the identified mitigation measures are confirmed to be 'low'.

Design Concept

9.19 The basement construction, which in summary is a concrete box, will be built within the made ground, which is clayey in nature and above the local water table.

9.20 The perimeter of the basement structure will be built from a secant (interlocking) piled walls embedded in the ground, which will be lined internally with a reinforced concrete wall to keep the water out.

9.21 Given the depths at which the static water table appears and the proposed depth of the basement it is safe to conclude there will be no adverse effects by the sealed basement on the local hydrogeology of the area.

9.22 The basement perimeter walls will be set back internally from the line of the original building brick walls of No. 51 Calthorpe Street by approximately 1.0m and combined with a basement slab and new lower ground floor slab will form a water-tight box.

9.23 The design and construction technique proposed for the basement has been chosen to control and minimise ground movement and thus mitigate concerns about causing damage to neighbouring properties.

9.24 The proposal is to construct a lower ground reinforced concrete transfer slab to prop the installed perimeter piled wall before any bulk excavation of the ground. The key advantage of this is that the slab will provide a very stiff rigid box-like support to the basement walls from the outset, keeping them in place and preventing ground movement behind. A hole will be left in the slab to allow access for the work personnel, excavation machinery and dug soil. Bulk excavation of the basement will start through the hole in the slab and proceed under the slab using tunnelling techniques. This form of construction provides the greatest level of stability and stiffness compared to other construction techniques.

9.25 The proposed basement construction avoids the need for underpinning the party wall, which minimizes movement to the adjacent footings. The lower ground slab will be 'toothed' / keyed-in to the existing building perimeter walls of No. 51 Calthorpe Street using reinforced concrete nibs cast into holes cut in the wall. These reinforced concrete nibs will underpin the walls from the inside of the building footprint of No. 51 Calthorpe Street. This means no work (underpinning) will be required to the neighbouring properties' foundations.

9.26 The basement permanent works design solution has been chosen to minimize ground movement. Mitigation measures adopted to reduce, avoid or off-set significant adverse impacts are; the proposal to step-back the basement wall from the boundary of No. 49 Calthorpe Street, the proposal to use a piled retaining wall and importantly, to construct a 500mm thick slab that will act as a horizontal prop, of sufficient stiffness and strength, before bulk excavation commences and to bulk-excavate using top-down construction.

9.27 Using top-down construction, the ground movements are expected to be small and not significant. Top-down construction techniques deliver the greatest level of lateral restraint to the basement during the construction process and the least potential for ground movement reducing any influence on adjacent structures.

9.28 Expected vertical ground movements have been calculated using standard industry techniques; these are expected to be no more than 6mm and will have negligible effect on the neighbouring properties. Using the Institution of Structural Engineers guide 'Subsidence of Low-Rise Buildings' and BRE report 'Subsidence Damage to Domestic Buildings' the potential damage falls under the category of hairline cracking, which is normally indistinguishable from other causes such as shrinkage and thermal movement and is generally restricted to internal finishes that can be easily filled or covered by wall covering and redecoration and will be covered by a party wall agreement.

9.29 The Royal Mail Group have confirmed the presence of their tunnels below (approx 16m below) Calthorpe Street. The Royal Mail Group and their technical advisers will be consulted

throughout the design and construction process and their Safe Guarding Guidelines implemented, including restrictions on piling. Relevant approvals and agreements will be put in place before any works start on site. The proposed construction for the lower ground floor extension adjacent Calthorpe Street has been modified to mitigate the impact on the tunnels by setting piles back from Calthorpe Street and using reinforced concrete retaining walls to the front site boundary. This means the foundations are kept shallow and less deep than the existing foundations for the property. Any ground movement and impact on the tunnels is considered negligible.

9.30 Monitoring of movement to check there are no undue settlements occurring as a consequence of the basement works, in particular with reference to the adjacent terrace property at No. 49 Calthorpe Street and the Royal Mail tunnels in Calthorpe Street, will be undertaken in accordance with Party Wall and Third Party agreements. Contingencies and control measures will be agreed in advance.

9.31 The contractor will be required to provide a detailed method statement for the works. This will set out their proposed method for constructing retaining walls, forming the excavation, maintaining the stability of the sides of the excavation until such time as the new concrete basement is sufficiently complete and for constructing the permanent basement and forecourt ground slab. The method statement will also set out how the Site will be secured by appropriate hoarding during the demolition and construction phase to ensure safety to the general public, including neighbours.

9.32 A method statement is included in the report that provides an approach that will allow the basement design to be correctly implemented and any temporary support provided during construction works. The Contractor will be responsible for the final temporary works and construction sequence/methodology once appointed. This will be checked by the designer for compliance with the design intent to ensure structural stability and safety is maintained during the construction stage. Where necessary, the design will be adjusted to accommodate Contractor specific details or sequences in order to ensure the design and construction methodology are coordinated and compliant.

9.33 This can be summarised as follows: install piles that form the basement wall, cast a lower ground reinforced concrete transfer slab leaving an opening in the slab for access to tunnelling under the transfer slab using grabs and small machinery to excavate the ground from the basement, constructing the basement reinforced concrete slab and reinforced concrete liner walls to line the piles and make the basement waterproof. Construct the internal walls and finishes and undertake the modifications to the superstructure of the property.

9.34 The soil will be excavated and removed via the front of the property working through the access hole in the lower ground slab and lower ground level under the forecourt before transfer to lorry.

9.35 The assessment demonstrates that the proposed scheme provides structural stability, which minimises ground movement and disturbance to neighbour's properties.

10.0 CONCLUSIONS

10.1 A Basement Impact Assessment has been carried out in accordance with the guidance published by the London Borough of Camden.

10.2 Based on our current understanding of the Site setting and ground conditions, we do not envisage that the proposed development will result in material impacts on subterranean groundwater flow, surface water flow and flooding and slope stability, as long as the mitigation measures set out in Table 7.1 are incorporated into the detailed design of the temporary and permanent works. The detailed design should develop the concept design set out in Section 8.0 of this report.

10.3 In order to minimise any negative environmental impacts to neighbouring residents associated with the construction process, all demolition and construction should be undertaken in accordance with the Considerate Constructors Scheme standards and the ICE demolition Protocol (www.ice.org,uk) and should have regard to the Guide for Contractors Working in Camden Guidance (dated Feb 2008) and the GLA's best practice guidance document The Control of Dust and Emissions from Construction (www.London.gov.uk). An outline Construction Management Plan (CMP) has been prepared as part of the planning submission.

11.0 REFERENCES

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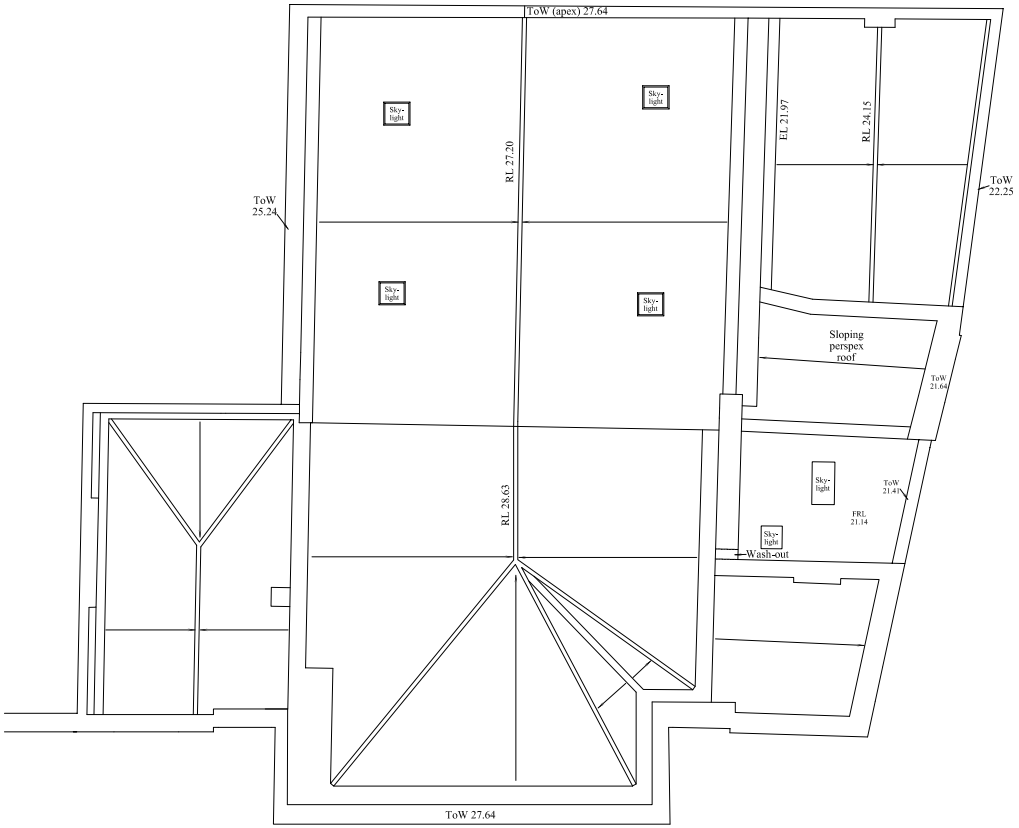
APPENDICES

APPENDIX A



Roof

Fit point

LEGEND

EL	Eaves level
FRL	Flat roof level
RL	Ridge level
ToW	Top of wall

NOTE:

Due to limited access some of the roof information has been obtained through photography.

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Survey at

51 CALTHORPE STREET
LONDON
ROOF PLAN

File: BRM312	Sheet 4 of 4
Scale 1:100 (A2 Sheet)	

Date of survey: March 2012

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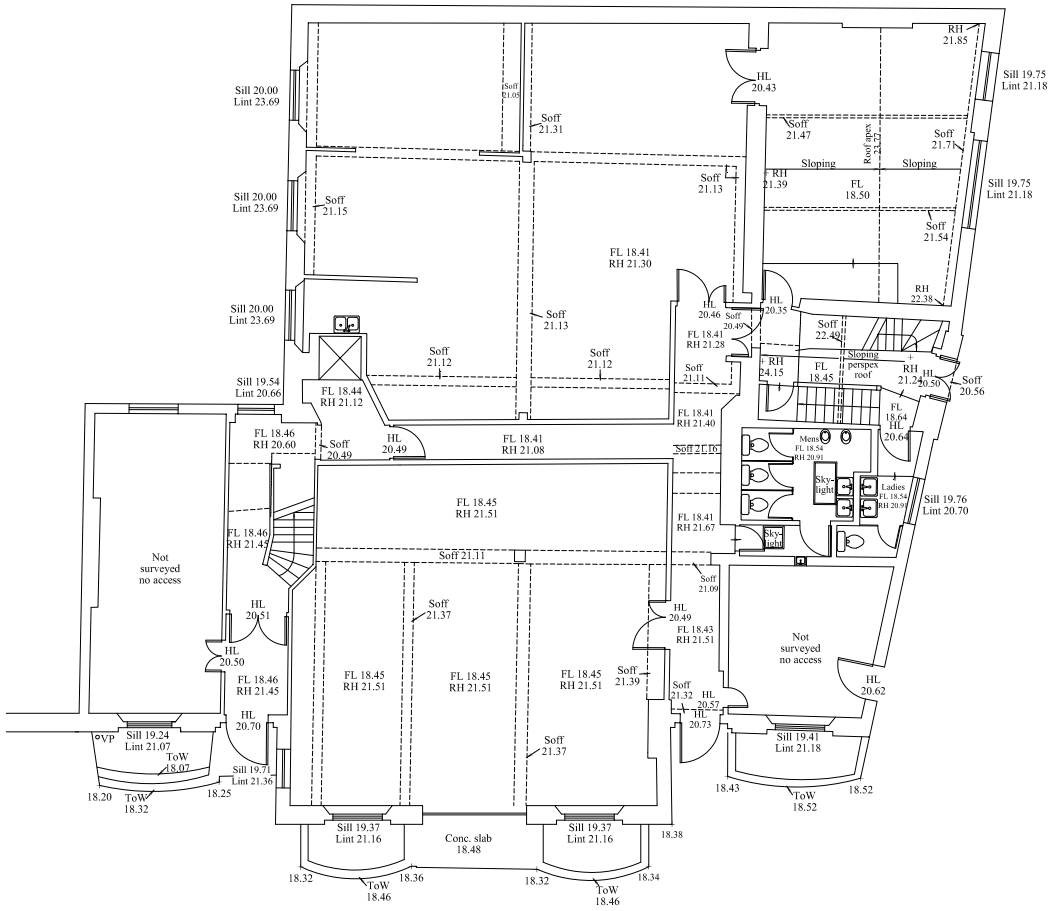

Ground floor

LEGEND

CBD	Cupboard
FL	Floor level
HL	Head level
Lint	Lintel level
RH	Room height
Sill	Sill level
Soff	Soffit level
ToW	Top of wall
VP	Vent pipe

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Survey at

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FLOOR PLANS

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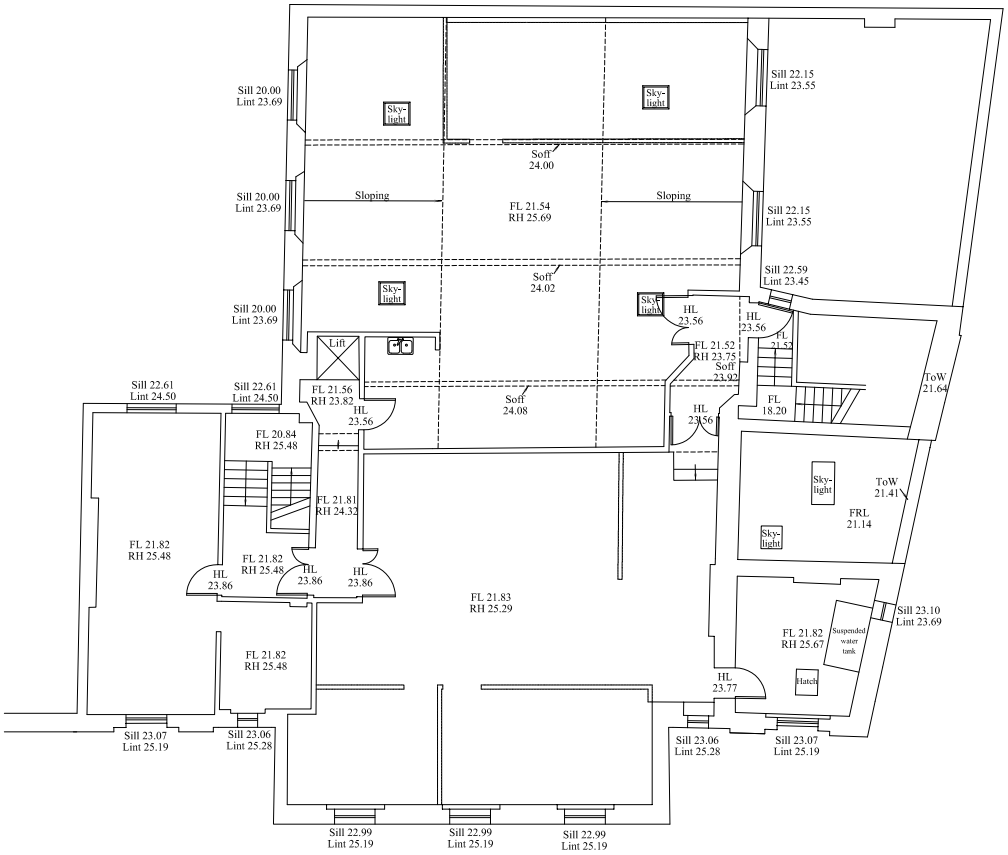

First floor

LEGEND

CBD	Cupboard
FL	Floor level
HL	Head level
Lint	Lintel level
RH	Room height
Sill	Sill level
Soff	Soffit level
ToW	Top of wall

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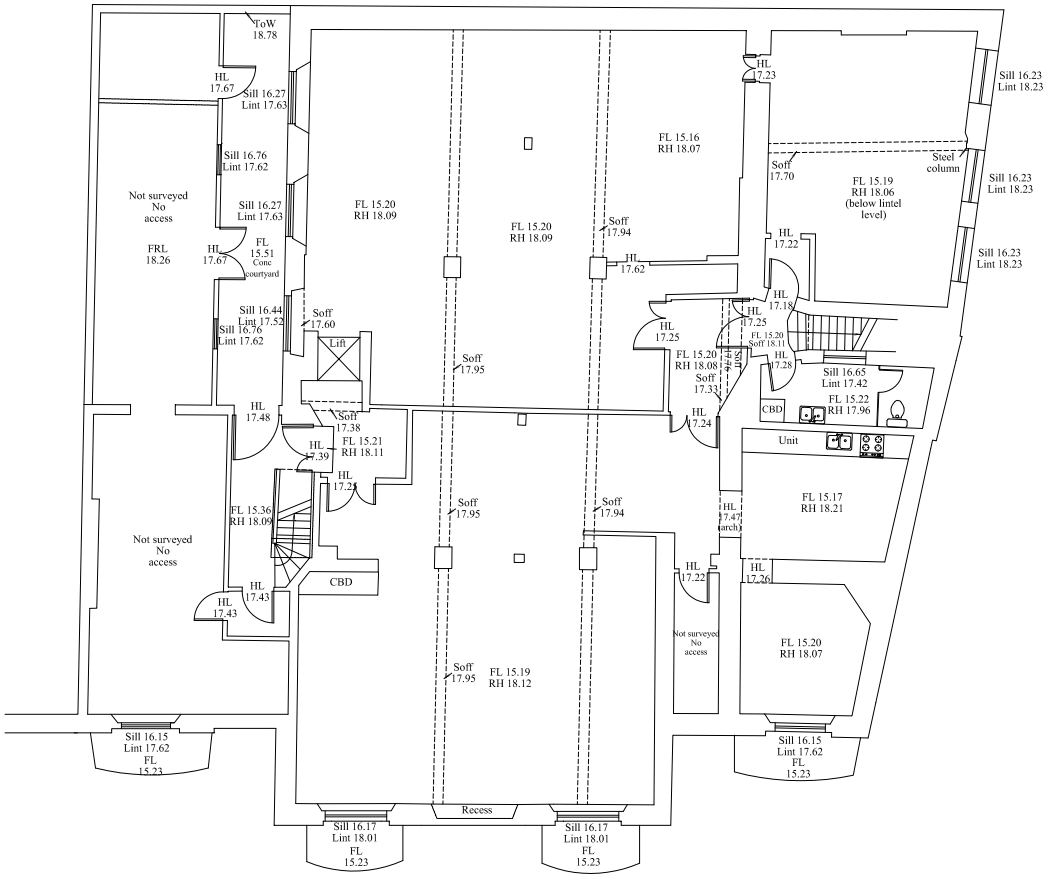

Basement

Fit point

LEGEND

CBD	Cupboard
FL	Floor level
FRL	Flat roof level
HL	Head level
Lint	Lintel level
RH	Room height
Sill	Sill level
Soff	Soffit level
ToW	Top of wall

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