Physon Property Limited

23 Rochester Road, London

Basement impact assessment

July, 2014

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Reference CG/08944		Revision 0	Issue Date July 2014

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1. INTRODUCTION

Physon Property Limited (Physon) is proposing to construct a single storey basement beneath the existing residential dwelling at 23 Rochester Road, Borough of Camden, London. Card Geotechnics Limited (CGL) has been instructed to undertake a Basement Impact Assessment (BIA) for the proposed development to assess the potential impact on surrounding structures and hydrological features.

The London Borough of Camden's guidance document *"CPG4, Basements and Lightwells*[1]*",* requires a BIA to be undertaken for new basements in the Borough and sets out 5 stages:

1. Screening
2. Scoping
3. Site investigation
4. Impact assessment
5. Review and decision making

This report is intended to address the screening, scoping, site investigation and impact assessment stages of the BIA. It identifies key issues relating to land stability, hydrogeology and hydrology as part of the screening process (Stage 1). Site investigations have been carried out by others, and the scoping process herein critically reviews the adequacy of the physical investigations. This report also forms a review and interpretation of existing site investigation data to establish a conceptual site model (Stages 2, and 3). The report provides an impact assessment (Stage 4) of potential ground movements on adjacent structures and the hydrogeology of the surrounding area for the purposes of planning.

[1] Camden Planning Guidance, CPG4, Basements and Lightwells, September 2013.

2. SITE CONTEXT

2.1 Site Location

The site is located at 23 Rochester Road, NW1 9JJ in the Borough of Camden, London. The National Grid Reference for the approximate centre of the site is 529079E, 184597N.

The site location is shown in Figure 1.

2.2 Site Layout

The site covers an area of approximately 180m^2 and consists of an existing three storey semi-detached residential property, including a lower ground floor and a three storey rear extension and a private rear garden. Hardstanding is present to the east of the building.

The property has been partitioned into 3 separate self-contained apartments at lower ground floor, upper ground floor and first floor level. The lower ground floor apartment has planning approval for refurbishment and an extension (Application No. 2013/4811/p).

The site is bounded to the west by 24 Rochester Road, a similar property with regency façade with side addition, the north by the rear gardens of 25 Bartholemew Road, the east by 17 to 22 Rochester Road and the south by the pavement and highway of Rochester Road.

The site is approximately 250m east of the *Fleet Sewer* and 300m north-east of a *high relief storm sewer*. In addition, the site lies 200m west of the Northern Line.

The site elevation is recorded at 31mOD, sloping gently downwards from Rochester Road to the site and beyond towards the south.

A site layout plan is presented in Figure 2.

2.3 Proposed Development

The proposed development comprises an excavation beneath the existing property to create a basement level approximately 5.1m below existing ground level to form living accommodation. The lower ground floor flat is to be extended to the rear with the new basement level to continue below these new additions. The existing foundations, including the party wall with 24 Rochester Road, will be underpinned to enable this work.

The basement and lower ground floor extension increase the footprint of the original building by approximately $70m^2$.

Plans of the proposed development are provided in Appendix A.

2.4 Site History

Historical maps for the area have been reviewed to provide a summary of the historical development of the site.

The earliest mapping, dated 1850-1851, indicates the presence of Rochester Road, although individual buildings are not identifiable at the mapping scale. Further detail is noted on the 1873 map, with the establishment of several semi-detached properties along Rochester Road.

No significant change is noted on the site or surrounding area until the 1954-1955 (post war) maps, which indicate that the semi-detached property of 17-20 Rochester Road was replaced by four small detached buildings. The semi-detached structure of 21 and 22 Rochester Road remained unchanged. Between 1950 and 1960, these properties were demolished and redeveloped to form a terraced block comprising No's. 17-22 Rochester Road. No significant changes are noted on the site or in the surrounding area between the 1970s mapping and present day.

2.4.1 Bomb damage

With reference to the London County Council Bomb Damage Maps 1939-1945[2], the buildings of Rochester Road suffered bomb damage ranging in severity from "minor blast damage" to "damaged beyond repair".

The buildings on the site suffered non-structural blast damage. The surrounding buildings generally suffered minor and general blast damage. However, 17-20 Rochester Road, located approximately 30m south-east of the site, suffered structural damage beyond repair.

It is evident, based on these maps and the historical mapping that the redevelopment noted in the 1950s was due to the bomb damage sustained during the Second World War.

[2] London Topographical Society (2005). *Bomb Damage Maps 1939-1945*. The London City Council.

2.5 Geology

2.5.1 Published records

The British Geological Survey (BGS) 1:50,000 sheet 256 (North London)[3] indicates that the site is underlain by the London Clay Formation, over the Lambeth Group, Thanet Sand Formation and Chalk at depth. No superficial deposits are recorded on the site.

The London Clay formation is typically encountered as stiff to very stiff fissured blue grey clay weathering to grey brown very soft to firm clays. Selenite is commonly encountered, particularly within weathered and reworked material. In addition, septarian and claystone nodules form characteristic bands throughout the sequence. The London Clay in this area is likely to be around 50m thick.

2.5.2 Unpublished records

A number of British Geological Survey (BGS) borehole records to 30m in depth exist within 250m of the site. These records generally show the ground conditions in the area to consist of Made Ground over around 1m of gravelly clay (possible Head deposits) and London Clay.

The London Clay Formation to 8m below ground level (bgl) comprises firm becoming stiff lightly fissured dark grey silty clay. Occasional clusters of Selenite are noted, as are iron staining and rootlets. Beneath this, the London Clay Formation comprises stiff to very stiff dark grey brown fissured silty clay containing silt partings and nodular iron pyrites. The London Clay has been locally proven to a depth of 33mbgl.

Selected historical borehole records and location plan showing BGS historical borehole locations are provided in Appendix B.

2.6 Hydrogeology

The Environment Agency[4] has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology and are based on the importance of aquifers for potable water supply and their role in supporting water bodies and wetland ecosystems.

The London Clay Formation and associated clay bearing head deposits are classified as an unproductive stratum. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. Records provided by the

[3] British Geological Survey (1994) North London, England and Wales sheet 256. Solid and drift edition. 1:50,000
[4] http://apps.environment-agency.gov.uk

Environments Agency confirm the site is not located within a groundwater vulnerability zone.

Records of groundwater strikes in local BGS boreholes have been reviewed to give an indication of groundwater conditions on site. Borehole TQ28SE523 at 29.9mOD 250m west of the site recorded groundwater at 2.25mbgl two months after standpipe installation. Adjacent borehole TQ28SE524 at 29.1mOD in the same ground investigation recorded a rise from 22mbgl to 3.64mbgl in the same period. This suggests slow seepage of groundwater within the London Clay Formation.

The site does not fall within a groundwater Source Protection Zone, with the nearest recorded at 1.5km west south-west of the site. Further records from Environments Agency demonstrate the area is not in an area affected by flooding from rivers, seas or reservoirs, and the site has been highlighted as at very low risk of flooding from surface waters.

2.7 Hydrology

The nearest significant surface water body to the site is *Regents Canal* approximately 450m south of the site. Due to the lack of significantly permeable strata, with the exception of localised sand lenses, it is unlikely that this will affect the local groundwater regime.

According to Barton's 'Lost Rivers of London'[5], the former watercourse of the *River Fleet* rises on Hampstead Heath separating into two by Parliament Hill. The eastern arm of the *River Fleet* runs approximately 250m east of the site in a south south-easterly direction towards the River Thames. Given the permeability of strata and the distance to this former watercourse, it is considered the river will not have a significant impact on the local ground or groundwater conditions.

2.7.1 Flood risk

With reference to Environment Agency mapping, the site is not located within a Flood Risk Zone. With reference to Figure 15 (Flood Map) of the Arup report[6], Rochester Road is not identified as being flooded during the 1975 and 2002 surface flooding events and therefore a Flood Risk Assessment is not required.

[5] Barton, N. (1962). *The Lost Rivers of London.* Historical Publications Limited.
[6] Arup. (2010). *London Borough of Camden: Camden geological, hydrogeological and hydrological study*. Guidance for subterranean development.

3. SCREENING

3.1 Introduction

A screening assessment has been undertaken based on the flowcharts presented in Camden planning guidance (CPG4). Responses to the questions posed by the flowcharts are presented below, and where 'yes' or 'unknown' may be simply answered with no analysis required, these answers have been provided.

3.2 Subterranean (Groundwater) flow

This section answers questions posed by Figure 1 in CPG4:

Table 1. Responses to Figure 1, CPG4.

Question	Response	Action Required
1a. Is the site located directly above an aquifer?	No The site is located over London Clay Formation and possible Head deposits which are designated as unproductive strata.	None
1b. Will the proposed basement extend beneath the water table surface?	Unknown Records from previous local investigations indicate the proposed depth of the development will be approximately coincident with groundwater. The groundwater table is locally recorded between 3.5mbgl and 2.25mbgl however seasonal fluctuations of groundwater levels must be considered.	Investigation and assessment
2. Is the site within 100m of a watercourse, well, or potential spring line?	No Historic River Fleet is located approximately 250m west of site.	None
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	None
4. Will the proposed basement development result in a change in the proportion of hard surfaced?	Yes Although the proposed structure will largely cover the area currently occupied by hardstanding and building of 23 Rochester Road, the basement will extend beneath the existing rear garden which is currently covered by soft landscaping.	Assessment
5. As part of site drainage, will more surface water than at present be discharged to ground (e.g. via soakaways and/or SUDS)?	No The shallow soils are unlikely to be a suitable medium for soakage. Surface water will be discharged to the sewer network through existing connections, increasing the volume of water to the sewer network compared to the existing condition.	None
6. Is the lowest point of the proposed excavation close to, or lower than, the mean water	No Although the spring lines and ponds of Hampstead	None

Question	Response	Action Required
level in any local pond or spring lines?	Heath are noted to the north and north-east of the site at a higher elevation than the site, they are at a sufficient distance (>2km) from the site that they are unlikely to have a significant influence on the site.	

a. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 11).*

In summary, the site is located above the London Clay Formation, a relatively impermeable and unproductive stratum, and as such groundwater flows in this material are likely to be negligible. The proposed development is likely to extend through gravelly clay head deposits and into the London Clay Formation.

Shallow groundwater was recorded in previous investigations local to the site and the conditions beneath the site will need to be determined by intrusive investigation. The change in the proportion of hardstanding on the site will require assessment to determine the impacts on groundwater flow.

3.3 Slope/Land stability

This section answers questions posed by Figure 2 in CPG4.

Table 2. Responses to Figure 2, CPG4.

Question	Response	Action required
1. Does the site include slopes, natural or manmade, greater than about 1 in 8?	No The site is set within a generally flat area with a gentle slope up towards the north.	None
2. Will the proposed re-profiling of the landscaping at site change slopes at the property boundary to greater than about 1 in 8?	No No re-profiling or landscaping of significance will occur outside the basement perimeter.	None
3. Does the development neighbour land including railway cuttings and the like with a slope greater than about 1 in 8?	No	None
4. Is the site within a wider hillside setting in which the general slope is greater than about 1 in 8?	No[a]	None
5. Is the London Clay the shallowest stratum on site?	Unknown Although no superficial deposits are mapped on the site by the BGS, the London Clay Formation is likely to be overlain by Head deposits comprising gravelly clays.	Confirm by investigation

Question	Response	Action required
6. Will any trees be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained?	Unknown A large tree is present in rear garden approx. 10m from existing house. It is assumed that this tree will not be felled as part of the redevelopment. The retaining wall for the lightwell will be directly adjacent to a small tree if it is retained.	Assessment
7. Is there a history of shrink/swell subsidence in the local area and/or evidence of such at the site?	Unknown Due to the mineralogy of the London Clay Formation there is the potential for shrink/swell conditions with variations in moisture content. However, the basement excavation and underpinning will deepen the foundations to a level not affected by seasonal variations in moisture content. The vertical stress reduction upon the London Clay Formation will result in heave, the effects of which will need to be assessed.	Investigation and assessment
8. Is the site within 100m of a watercourse or a potential spring line?	No	None
9. Is the site within an area of previously worked ground?	No The BGS geology sheet for the site indicates no worked ground. A thin layer of Made Ground is likely to cover the site associated with the construction of the current buildings on site.	Confirm by investigation
10. Is the site within an aquifer and if so will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No See Table 1, Question 1a. However, shallow groundwater has been identified locally within the London Clay which may be encountered during construction of the basement.	Confirm by investigation
11. Is the site within 50m of the Hampstead Heath ponds?	No	None
12. Is the site within 5m of a highway or pedestrian right of way?	No Although the site is bound to the south by the pavement of Rochester Road, the basement will be set back 6.5m from the pavement of Rochester Road, with the lightwell some 1.5m closer. The lightwell will be approximately 7m from the main carriageway of Rochester Road.	None
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes New foundations are likely to be deeper than the neighbouring properties. Potential movement should be considered. The nearest foundation of 17-22 Rochester Road is approximately 5m from the basement wall in the southern area of the site, and 3m in the northern area of the site, where the basement extends close to the site boundary with 22 Rochester Road. Given these distances, the proposed basement is unlikely to impact upon 22 Rochester Road.	Assessment

Question	Response	Action required
14. Is the site over (or within the exclusion zone of) any tunnels?	No. The Northern Line runs in a north to south direction 200m west of the site	None

a. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 16).*

In summary, the site is located over possible Head deposits and London Clay and it is anticipated that heave movements/long term settlement will occur during construction and over the long-term. Construction related settlement may also occur as the existing foundations are underpinned.

Intrusive investigation will be required to confirm the shallow ground conditions beneath the site, including the depth of the London Clay, the volume change potential of the shallow soils and the standing groundwater level, if encountered.

The volume change potential of the shallow soils, together with the possible removal of tress from the site, will require assessment to determine the possible effects on the proposed development and neighbouring properties.

A basement impact assessment will be undertaken to determine the magnitude of ground movements around the basement perimeter. This will include the effects of deflections and settlement due to underpinning. The results of the ground movement analysis will be used to assess potential damage categories developed in adjacent structures.

3.4 Surface flow and flooding

This section answers questions posed by Figure 3 in CPG4.

Table 3. Responses to Figure 3, CPG4.

Question	Response	Action required
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	None
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 Although the proposed development will increase the amount of hard surfacing. The volumes of surface water run-off from the site are not anticipated in increase significantly. It is understood all surface water will be discharged to the sewer network through existing connections. Volumes of surface water run-off from the	None

	site are not anticipated to increase significantly.	
3. Will the proposed development result in a change in the proportion of hard surfaced/paved external areas?	Yes The proposed basement will occupy the area covered by the existing rear garden.	Assessment
4. Will the proposed basement result in a change to the profile of the inflows of surface water being received by adjacent properties or downstream watercourses?	No It is understood that all surface water will be discharged to the sewer network through existing connections and the volumes of surface water run-off from the site are not anticipated to increase significantly.	None
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No The construction of the basement will remove existing Made Ground from the site. There will be no introduction of contaminants or degradation or in water quality to adjacent properties or downstream water courses.	None
6. Is the site in an area known to be at risk from surface flooding or is it at risk from flooding because the proposed basement is below the static water level of a nearby surface water feature?	No Rochester Road is not identified as being flooded during the 1975 and 2002 surface flooding events. The nearest surface water body is Regents Canal located approximately 450m south of the site.	None

a. Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 15).

In summary, the proposed basement will result in an increase of hard surfaces, specifically in the existing rear gardens, and this will lead to a potential increase in surface water runoff. However, it is understood that all surface water will be discharged to the sewer network through existing connections and the volumes of surface water run-off from the site are not anticipated in increase significantly. Currently the garden is around 165m^2 in area, and is likely to reduce to around 95m^2 following redevelopment. The effects of attenuation due to the construction of the basement are likely to be minimal given the low permeability of the shallow soils and that surface water will be discharged to the sewer network through existing connections.

Rochester Road is not identified as being flooded during the 1975 and 2002 surface flooding events.

3.5 Conclusion

On the basis of this screening exercise, a basement impact assessment is required for this site. This should address the following:

Table 4. Summary of Basement Impact Assessment Requirements.

Item	Description
	Subterranean (Groundwater flow)
1.	Confirm the ground conditions and if groundwater is present within the shallow possible Head or London Clay and, therefore, whether groundwater will be a consideration for the basement design.
2.	Impact assessment to determine effect of increasing the proportion of hardstanding on groundwater flow beneath the site.
	Ground movement (land stability)
3.	Movements associated with construction in the London Clay Formation, including short and long term heave movements, settlement associated with retaining wall deflections, underpin settlement, and ground movements around the basement perimeter.
4.	Impact assessment to determine effect of basement construction on adjacent structures, including neighbouring properties and roads/utilities.
5.	Impact assessment to determine effect of possible on-site tree removal, including induced heave , the proposed development on adjacent structures, including neighbouring properties and roads/utilities.
	Surface flow and flooding
6.	Impact assessment to determine effect of increasing the proportion of hardstanding on surface flow and flooding.

4. SCOPING (STAGE 2) AND INVESTIGATION

4.1 Scoping

On the basis of the screening report, an intrusive investigation is required on site to establish the underlying geological sequence, groundwater levels, and to derive geotechnical design parameters to support basement impact assessment calculations.

The intrusive investigation should comprise the excavation of a minimum of one borehole, with in-situ testing undertaken at regular intervals. Soil samples should be obtained to allow geotechnical classification and strength testing to be undertaken. Monitoring wells should be installed to allow groundwater monitoring.

4.2 Ground investigation

An intrusive investigation was undertaken on 14 April 2014 by CET Infrastructure (CET)[7] and details are presented in Appendix C. The investigation comprised the excavation of one window sampler borehole (WS01) located at the rear of the property to 6.0mbgl. The window sampler was installed with a monitoring well to the base of the hole. The response zone appears to be between 5.0m and 6.0m bgl.

In addition, a single dynamic probe was undertaken using a super heavy weight adjacent to the window sampler borehole. The probe was terminated at 6.2mbgl.

[7] CET (Infrastructure). (May 2014). *23 Rochester Road, London*: Report on ground investigation.

5. GROUND AND GROUNDWATER CONDITIONS (STAGE 3)

5.1 Summary

The ground conditions encountered during the CET ground investigation are summarised in Table 5 below.

Table 5. Summary of ground conditions.

Strata	Depth encountered (mbgl)[a]	Thickness (m)
(MADE GROUND) Comprising grass over firm friable dark brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint, brick, roof tile and ceramic.	0.0	0.6
Firm becoming stiff orange brown slightly gravelly CLAY becoming slightly sandy gravelly CLAY at 1.4mbgl. Sand is coarse, gravel is medium to coarse, becoming fine to coarse, subangular to rounded of flint and rare claystone. [POSSIBLE HEAD]	0.6	0.8
Stiff becoming very stiff orange brown CLAY. Occasionally mottled grey. Occasional orange silt lenses and siltstone gravel noted. [LONDON CLAY FORMATION]	2.5	Proven to 6.0mbgl

a. mbgl = metres below ground level

5.2 In-situ geotechnical testing

In-situ testing was undertaken within window sampler borehole WS1 and comprised pocket penetrometer (pp) and hand vanes (Vh – in kPa). The results are presented on the exploratory hole records (see Appendix C).

The hand vane results indicate an undrained shear strength (Cu) value of 74kPa in the possible Head deposits, or a relative consistency of ‘firm’, and Cu values in the range of 98kPa to 122kPa for the London Clay, or a relative consistency of ‘stiff’.

The dynamic probe test (DPT), utilising a super heavy weight, was undertaken adjacent to WS1. The probe results are presented in Appendix C. The results indicate DPT N100 values between 1 and 9.

The correlation between super heavy dynamic penetrometer (DPSH) ‘N300’ values (i.e. summation of three consecutive N100 values) and SPT ‘N’ values has not been fully established and is susceptible to the underestimation of the strength of the London Clay where Cu values are derived from established correlations with SPT ‘N’ values.

Utilising an estimated correlation based on the DPSH results presented by CET produces Cu values that are inconsistent with the values provided on the borehole record, or the hand vane results, and on this basis, the correlation is not considered to be appropriate to determine the London Clay strength profile.

5.3 Geotechnical laboratory testing

Geotechnical laboratory testing was undertaken on samples of the Made Ground, possible Head and London Clay.

Classification property testing in the possible Head indicated moisture contents between 18% and 30%, a Liquid Limit of 64%, Plastic Limit of 18% and Plasticity Index of 46%. On the basis of this testing, the possible Head may be classified as a clay of ‘high’ plasticity with a ‘high’ volume change potential[8].

Classification parameters in the London Clay were recorded in the following ranges:

- Moisture contents: 19% to 28%;
- Liquid Limits: 71% to 78%;
- Plastic Limits: 20% to 23%; and
- Plasticity Indices: 50% to 58%.

On this basis, the London Clay may be classified as a clay of ‘very high’ plasticity with a high volume change potential[8].

The results of the classification testing indicate that moistures contents are less than 40% of the Liquid Limit in each of the samples analysed below 1mbgl. The sample from 1mbgl, within the Head, recorded a moisture content greater than 40% of the Liquid Limit. Reduced moisture contents are recorded to a depth of around 3.5mbgl.

[8] NHBC. (2013). *NHBC Standards: Part 4, Chapter 4.2 Building near trees*.

Geotechnical sulfate and pH testing was undertaken on one sample of the possible Head deposits (at 1.5mbgl) and two samples of the London Clay (at 3.5m and 5.5m bgl). The London Clay is potentially a pyritic soil. However, insufficient data is available to undertake a assessment of the oxidisable sulfides (OS % SO4) and total potential sulfate (TPS % SO4) in accordance BRE guidance[9]. The results and design sulfate (DS)/ACEC classes for buried concrete are presented in Table 6 below.

Table 6. Summary of sulfate testing and design concrete classifications.

Stratum	No. of samples	pH	Water Soluble Sulfate as SO_4 (2:1) (mg/l)	DS class	ACEC Class
Possible Head	1	8.1	300	DS-1	AC-1s
London Clay	2	7.8 to 8.1	640 to 2900	DS-3	AC-2s

It should be noted that the design classes presented in Table 6 are based on the water soluble sulfate results only and do not take account of TPS in the London Clay.

5.4 Geotechnical design parameters

Geotechnical design parameters for the proposed development are summarised in Table 7 below. These are based on the borehole records and the results of laboratory and in-situ testing obtained from the current site investigation. Reference has been made to published data for the well-studied London geology.

Table 7. Geotechnical design parameters.

Stratum	Bulk Unit Weight γ_b (kN/m^3)	Undrained Cohesion c_u (kPa) [c']	Friction Angle ϕ' (°)	Young's Modulus E_u (MPa) [E']
Made Ground	18	40	21[a]	20[c] [15][d]
Possible Head deposits	19	70	21[a]	35[c] [26][d]
London Clay Formation	20	$90 + 6.7z$[b] [5]	20[a]	$54 + 4.0z$[c] [$40 + 3.0z$][d]

a. BS 8002:1994 Code of practice for Earth retaining structures, British Standards institution.
b. z = depth below surface of London Clay

[9] Building Research Establishment. (2005). *Concrete in aggressive ground*. Special Digest 1, 3rd Ed.

c. Based on 500 Cu (Made Ground/Possible Head) and 600 Cu (London Clay) - Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.
d. Based on 0.75Eu - Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.

The parameters in Table 7 are unfactored (Serviceability Limit State) and considered to be 'moderately conservative' design values.

Based on the design parameters and formation level of the underpins (i.e. within the London Clay) the allowable bearing pressure below the underpins should be no greater than 150kPa to control settlements.

5.5 Groundwater

No groundwater was encountered during the intrusive investigation.

Subsequent groundwater monitoring undertaken by CGL on three separate occasional between 9th and 27th June 2014 utilising the monitoring well installed in WS01 and are summarised in Table 8.

Table 8. Summary of groundwater levels.

Exploratory hole reference	Groundwater level (mbgl)		
	09/06/14	**19/06/14**	**27/06/14**
WS01	2.49	2.28	4.18

The results of the first two visits indicated groundwater level between 2.28m and 2.49m bgl. The water was bailed on the second visit (19/06/14) to 5.51mbgl and recovered to 5.47mbgl in 20 minutes. Subsequent monitoring on 27th June indicated a groundwater level of 4.18mbgl.

5.6 Conceptual site model (Stage 3)

A conceptual site model (CSM) has been developed based on the available data and is presented in Figure 3. The CSM comprises a plan and section indicating the extent of the proposed basement, variation in excavation depth across the site to reach formation level and the location of neighbouring properties in relation to the proposed development.

The nearest foundation of 17-22 Rochester Road is approximately 5m from the basement wall in the southern area of the site, and 3m in the northern area of the site, where the basement extends close to the site boundary with 22 Rochester Road.

Two critical sections for analysis have been identified for consideration corresponding to:

- Section A-A: from west (24 Rochester Road) to the east (22 Rochester Road) in the southern area of the site where the basement is narrowest and the adjacent foundation of 22 Rochester Road is furthest away; and

- Section B-B: from west (24 Rochester Road) to the east (22 Rochester Road) in the northern area of the site where the basement is widest and the adjacent foundation of 22 Rochester Road is closest.

These sections have been analysed to assess the potential for ground movements due to the construction of the basement to cause damage to the neighbouring properties.

6. SUBTERRANEAN (GROUNDWATER) FLOW (STAGE 4)

6.1 Introduction

This section addresses outstanding considerations raised by the screening process regarding groundwater flow, as summarised in Section 3.2.

6.2 Impact on groundwater flow

The site is underlain by cohesive possible Head Deposits over the London Clay Formation. Based on the findings of the recent groundwater monitoring, groundwater is likely to be encountered within the London Clay.

The proposed basement floor level will be founded into the London Clay at a depth of approximately 5.1mbgl, below the measured groundwater level. However, the water recorded within the London Clay is likely to be confined within the silt lenses encountered in this stratum and recharge is likely to be limited and slow.

Within a few metres of the ground surface the London Clay can be assumed to be saturated. Porosity within this material is so low as to not maintain significant volumes of water and to be 'unproductive' in accordance with EA aquifer mapping. In this regard, the water recorded within the London Clay records pore water pressure and the concepts of a 'groundwater table' and 'groundwater flow' do not really apply. On this basis, the proposed basement would not impact upon the local groundwater regime.

The proposed development will result in a greater proportion of hardstanding on the site than the present condition. This will increase the amount of surface water run-off but reduce the amount of infiltration to the ground. Instead of flowing laterally at the base of the Made Ground, water will flow laterally into drains at ground surface. On this basis, there will be no effect on groundwater 'flow' beneath the site.

6.3 Recommendations for groundwater control

Based on the results of the ground investigation and subsequent monitoring, the water level will be within the cohesive Head/London Clay, and likely to be recharging from impersistent silt lenses, corresponding to a depth above the proposed underpin formation level.

On this basis, some groundwater may be encountered during the construction of the underpins, albeit with slow infiltration rates. It is anticipated that such water may be controlled with appropriate sump pumps during construction.

7. LAND STABILITY (STAGE 4)

7.1 Introduction

This section provides calculations to determine ground movements that may result from the construction of the proposed basement and assess how these may affect adjacent structures. It is understood that an underpinning construction method will be adopted throughout to form the new basement wall and provide support to the existing foundations.

Possible ground movement mechanisms are:

- Heave movements: The London Clay is susceptible to short term heave and time dependant swelling on unloading, which will occur as a result of basement excavation, generating upward ground movements.
- Long term ground movement: Net loading on the formation soils will generate ground movement, which could affect adjacent foundations.
- Underpin deflection: Underpins will act as stiff concrete retaining walls, which limits the potential for wall deflection. However, deflections that do occur may generate surface settlements that could impact adjacent properties.
- Underpin construction: Workmanship in constructing the underpins and providing temporary propping will be critical in controlling movements.
- Underpin settlement: caused as structural loads are transferred to previously unloaded soils.

7.2 Assumed construction sequence

The basement walls below the existing party wall with 24 Rochester Road and the internal walls of 23 Rochester Road will be constructed using traditional underpinning techniques with pins excavated in typically 1.0m to 1.2m wide bays. It is assumed, based on the existing structural drawings and depth of the basement, that the underpins will be constructed in one lift. A toe projection will be cast at the base of each underpin section, forming an L-shaped reinforced retaining wall in the temporary condition to resist sliding, overturning and excessive bearing pressures.

Based on the anticipated line loads, and a recommended allowable bearing capacity of 150kPa in the London Clay, the underpins should be constructed on concrete bases measuring a minimum of 1.7m wide beneath the party walls (assuming line loads of 245kN/m) and 1.0m wide for perimeter basement walls (assuming line loads of 137kN/m).

The underpins will be constructed in supported trenches with a central soil mass retained to provide support for temporary props and formwork. It is recommended that temporary propping be installed at the top of the wall and the bottom of the underpin at each lift to resist sliding and rotation of the wall prior to casting the sub-basement and basement concrete floor slabs. Temporary propping should remain in place until the sub-basement and basement floor slabs develop sufficient strength to sustain soil loads.

The underpins will be generally supported in the permanent condition by the basement floor slab, which should be cast and allowed to gain sufficient strength before removing the temporary propping. In addition, the lower ground floor and ground floor slab will be designed to provide long-term rotational restraint at the top of the underpin.

A typical methodology for the basement formation is presented in Appendix E.

7.3 Assumed loading

Details of loading assumptions used in the heave/settlement analysis are summarised in the following sections. Loading information provided by the client can be found in Appendix C.

7.3.1 Underpin loading

The net loading at formation level below the underpins include stress relief due to the removal of overburden during excavation and the transfer of building loads to the new formation level via the underpins.

The basement is some 5.1m deep, therefore stress relief due to overburden removal is likely to be of the order of 102kPa. The applied pressure beneath the underpins will be 150kPa, giving rise to a net loading of approximately 50kPa beneath the underpins in the undrained and drained condition. This value assumes a typical bulk unit weight of 20kN/m^3 for the excavated soils.

7.4 Ground movements arising from basement excavation

A heave analysis has been undertaken using OASYS Limited *VDISP* (***V****ertical* ***DISP****lacement*) analysis software. *VDISP* assumes that the ground behaves as an elastic material under loading, with movements calculated based on the applied loads and the soil stiffness (E_u and E') for each stratum input by the user. VDISP assumes perfectly flexible loaded areas and as such tends to overestimate movements in the centre of loaded areas and underestimate movements around the perimeters.

7.4.1 Short term heave due to excavation

Maximum short term heave is predicted to be approximately 6.5mm, occurring beneath the central region of the proposed basement.

Approximately 2mm of heave to 0.5mm of settlement is predicted beneath the party wall underpins and negligible movement (i.e. <0.5mm) beneath the existing foundations of 22 Rochester Road.

A contour plot showing the variation of heave over the short term across the basement excavation and likely impact on the adjoining property is presented within Figure 4. Full VDISP output can be provided upon request.

7.4.2 Long term heave/settlement

Long term heave movements may occur as pore pressures recover within the London Clay at depth. Maximum long term heave is predicted to be approximately 10mm beneath the central region of the proposed basement.

Approximately 1mm to 3mm of heave is predicted below the party wall underpins and 1mm to 2mm of heave below the existing foundations of 22 Rochester Road.

A contour plot showing the variation of heave over the long term across the basement excavation and likely impact on the adjoining property is presented within Figure 5. Full VDISP output for both the short and long term ground movement assessments can be provided upon request.

7.4.3 Underpin settlement due to workmanship

The heave/settlement assessment undertaken within VDISP assumes perfect workmanship in the underpin construction and does not allow for settlement of the dry pack between existing footings and the new concrete. With good construction practice, actual settlements would be expected to not exceed 5mm for each underpin lift.

7.5 Damage Category Assessment

The calculated ground movements have been used to assess potential 'damage categories' that may apply to neighbouring properties due to the proposed basement construction. The methodology proposed by Burland and Wroth[10] and later supplemented by the work of Boscardin and Cording[11] has been used, as described in *CIRIA Special Publication 200*[12] and *CIRIA C580*[13]. General damage categories are summarised in Table 10 below:

Table 10: Classification of damage visible to walls (reproduction of Table 2.5, CIRIA C580)

Category	**Description**
0 (Negligible)	Negligible – hairline cracks
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)
2 (Slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm).
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks > 3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but also depends on number of cracks).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

For the critical underpin wall section (Sections A-A' and B-B') the combined impact of short term heave, settlement due to wall loading and assumed settlement due to workmanship have been combined to determine the deflection ratio for the adjacent property and are presented graphically in Figure 6 and Figure 7.

[10] Burland, J.B., and Wroth, C.P. (1974). *Settlement of buildings and associated damage*, State of the art review. Conf on Settlement of Structures, Cambridge, Pentech Press, London, pp611-654
[11] Boscardin, M.D., and Cording, E.G., (1989). *Building response to excavation induced settlement*. J Geotech Eng, ASCE, 115 (1); pp 1-21.
[12] Burland, Standing J.R., and Jardine F.M. (eds) (2001), *Building response to tunnelling, case studies from construction of the Jubilee Line Extension London*, CIRIA Special Publication 200.
[13] CIRIA C580 (2003) *Embedded Retaining Walls – guidance for economic design*

This deflection ratio has then been used to establish a limiting horizontal displacement of 4mm to ensure that the predicted damage category does not exceed Category 1 'very slight' damage. The results are summarised in Table 9.

Table 9. Summary of ground movements and corresponding damage category.

Party Wall Reference	Horizontal movements[c] (mm)	Maximum deflection (mm)	Horizontal Strain Δ/L^b (%)	Deflection ratio δ_h/L^a (%)	Damage category
Section A-A (24 Rochester Rd)	< 4mm	2.0	0.057	0.029	1 - very slight
Section B-B (22 Rochester Rd)	< 4mm	< 0.5	0.06	0.01	1 - very slight

a. See Figure 2.18 (a) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (L = length of adjacent structure in metres, perpendicular to basement; Δ = relative deflection)
b. See Box 2.5 (v) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (δh = horizontal movement in metres.
c. The movement corresponding to the level of the party wall foundations.

The predicted damage category imposed on the neighbouring properties due to the proposed basement development and assuming a good standard of workmanship will be 'Category 1' corresponding to very slight damage. The building interaction chart is presented in Figure 8.

7.6 Construction monitoring

The results of the ground movement analysis suggest that with good construction control, damage to adjacent structures generated by the assumed construction methods and sequence are likely to be (within Category 1) 'very slight'. On this basis, it is recommended that a formal monitoring strategy should be implemented on site in order to observe and control ground movements during construction, and in particular movements of the adjacent property.

The system should operate broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185[14]. Monitoring can be undertaken by using positional surveys compared to baseline values established before any excavation work is undertaken onsite. Survey targets can be affixed to exposed sections of footings and along the face of the adjacent buildings. Regular monitoring of these positions will determine if any horizontal translation, tilt or differential settlement of the neighbouring structure is occurring as the construction progresses. Alternatively, precise levelling can be undertaken at regular

[14] Nicholson, D., Tse, Che-Ming., Penny, C. (1999). *The Observational Method in ground engineering: principles and applications*. CIRIA report R185.

intervals around the perimeter of critical neighbouring properties to give an early and accurate indication of deviating ground movements at these critical locations. Monitoring data should be checked against predefined trigger limits and can also be further analysed to assess and manage the damage category of the adjacent buildings as construction progresses.

8. SURFACE FLOW AND FLOODING (STAGE 4)

8.1 Introduction

This section addresses outstanding considerations raised by the screening process regarding groundwater flow, as summarised in Section 3.4.

8.2 Impact on surface water flow

The proposed basement will result in an increase of hard surfaces, specifically in the existing rear gardens, and this will lead to a potential increase in surface water runoff.

Currently the garden is around 165m^2 in area. Whilst the proposed development will increase the proportion of hardstanding in the existing rear garden by around 60%, the actual area of increase is only around 95m^2.

It is understood that all surface water will be discharged to the sewer network through existing connections and the volumes of surface water run-off from the site are not anticipated in increase significantly.

The effects of attenuation due to the construction of the basement are likely to be minimal given the low permeability of the shallow soils and that surface water will be discharged to the sewer network through existing connections.

On this basis of this impact assessment, the proposed development will not have a significant detrimental effect on surface water flow.

8.3 Flooding

The site is not within an area identified as being at risk of flooding. Additionally, Rochester Road is not identified as being flooded during the 1975 and 2002 surface flooding events. On this basis, the proposed development

9. NON-TECHNICAL SUMMARY

9.1 General

The findings of this Basement Impact Assessment are informed by site investigation data, information regarding construction methods provided by the client and assumed construction sequence and detail.

- From the available information, it is considered that the proposed basement construction will have a minimal effect on groundwater and negligible effect on surface water and flooding at this site.
- Bearing pressures below underpins should be limited to 150kPa to control ground movements. This assumes that formations are within the London Clay.
- The existing on-site investigation identified possible Head deposits over London Clay.
- From groundwater monitoring records and reference to development drawings it is expected that underpins will be formed below standing groundwater level and this will be encountered during underpin construction. Groundwater control, i.e. sump pumping, will be required.
- The construction of the basement will generate ground movements due to a variety of causes including; heave, underpin settlement and underpin wall deflection during and after excavation. Preliminary calculations indicate that these will give rise to a damage category within ‘Category 1’ (very slight damage) for the adjacent properties. The above assumes a good standard of workmanship.
- It is recommended that an appropriate monitoring regime be adopted to manage risk and potential damage to the neighbouring structures.
- The analyses reported should be revised to account for changes to design, loading, construction method or sequence.

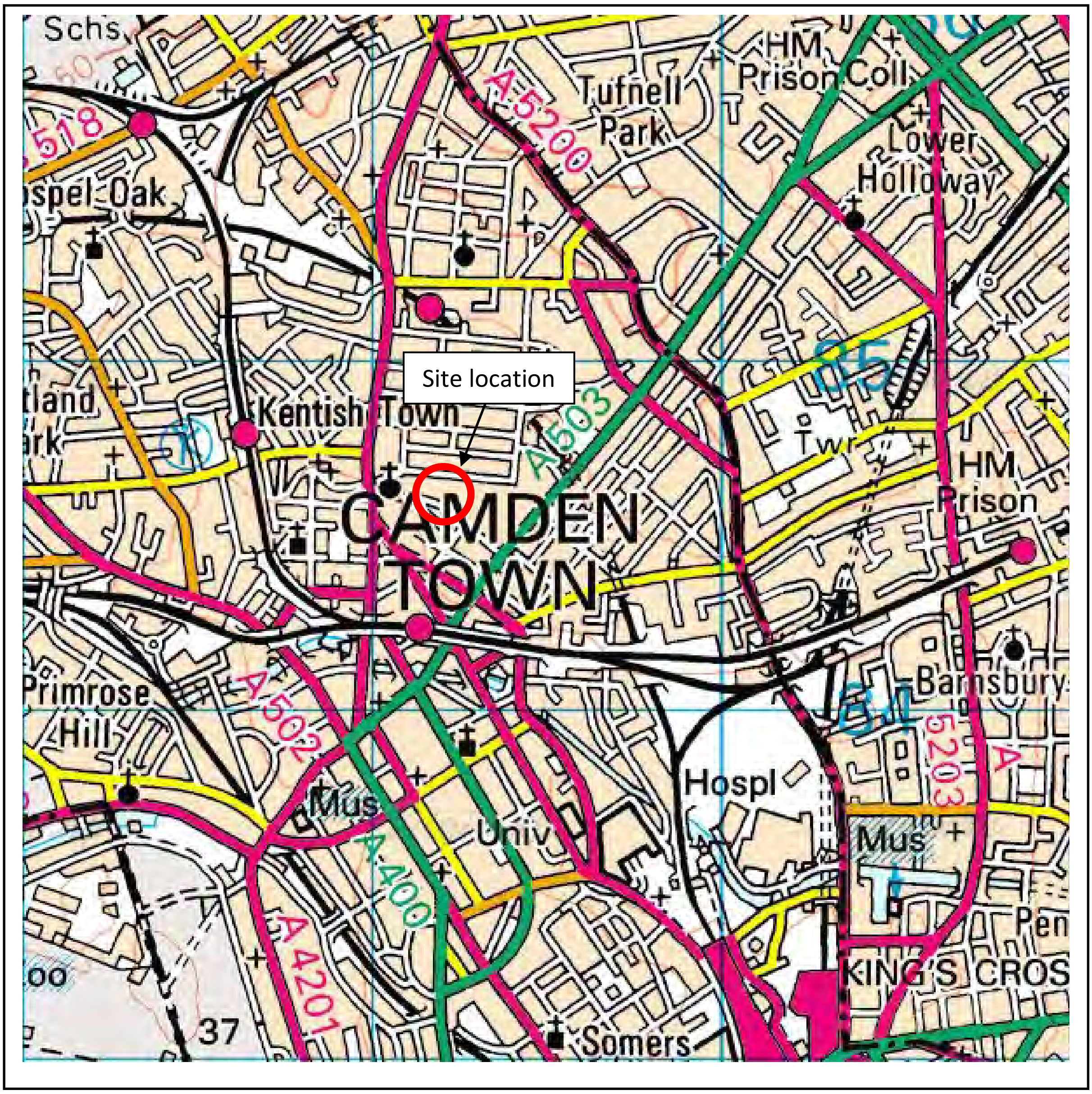
9.2 Cumulative impacts

Based on a review of the Camden planning portal, the existing properties local to the site do not appear to have basements. The ground movement and building damage category assessment have indicated that damage to neighbouring properties will be limited to ‘very slight damage'. It is considered that there are no cumulative impacts in respect of ground or slope stability.

The shallow ground conditions beneath the site comprise Made Ground over cohesive Head and London Clay. Groundwater was encountered within the cohesive soils. However, these water levels are likely to record pore water pressure within the cohesive soils and the concepts of a 'groundwater table' and 'groundwater flow' do not really apply. On this basis, and given the absence of basements in the surrounding area, it is considered that the proposed development will not form part of a dam to seepage which could potentially cause 'groundwater' levels to rise and/or be diverted. It is considered that proposed development would not contribute further to any cumulative effects.

The proposed development will increase the proportion of hand standing in the existing rear garden by around 60%. However, this corresponds to an area measuring some 11m by 8m, or 90m^2. It is understood that the additional surface water run-off will be discharged to the sewer network through existing connections and the volumes of surface water run-off from the site are not anticipated in increase significantly. On this basis, the development is not considered to contribute to any significant cumulative impact with regard to surface flow or flooding.

FIGURES



Reproduced from the Ordnance Survey 1:50,000 map with permission of the Controller of Her Majesty's Stationary Office, Crown Copyright.

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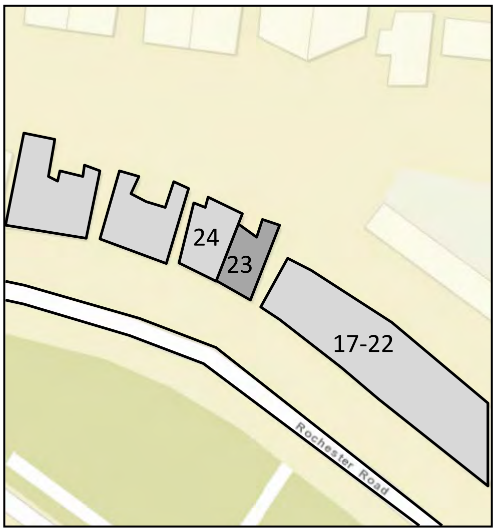
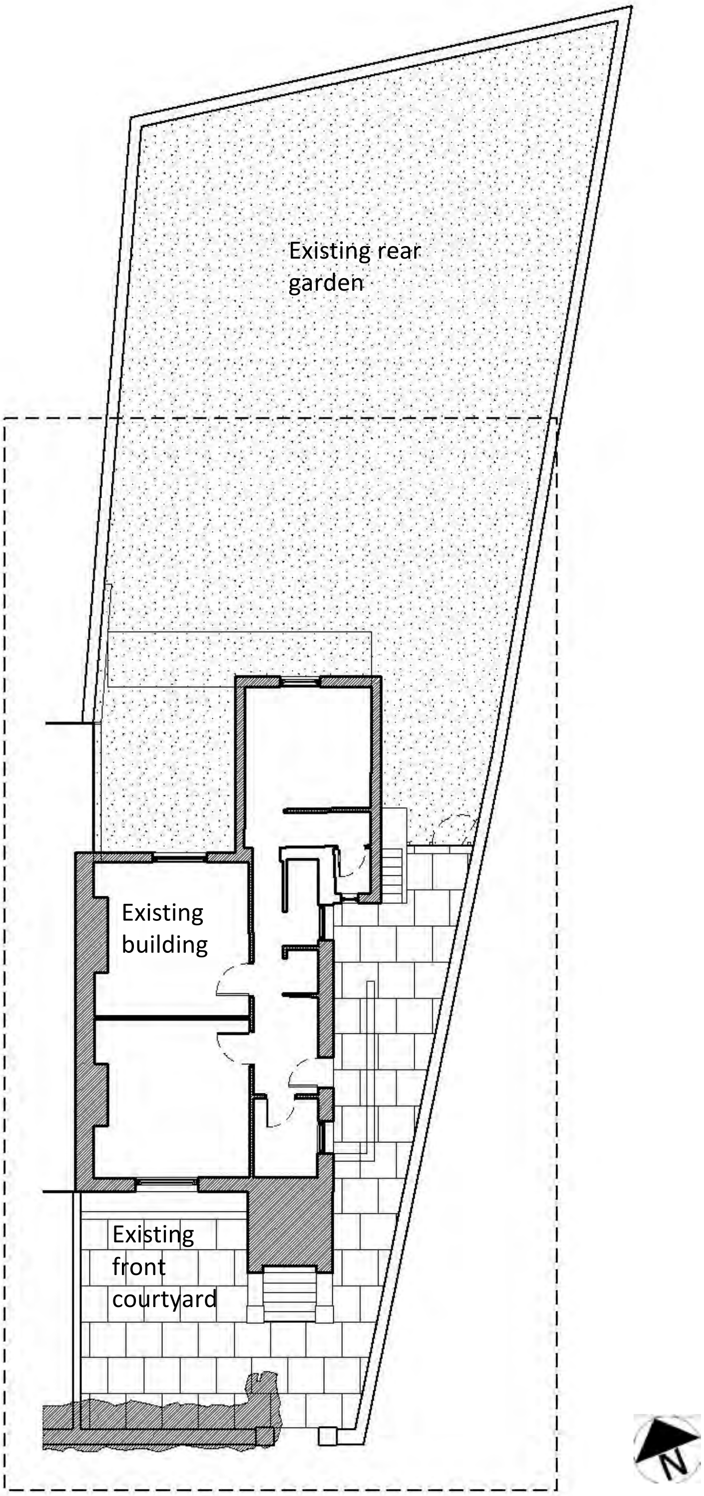
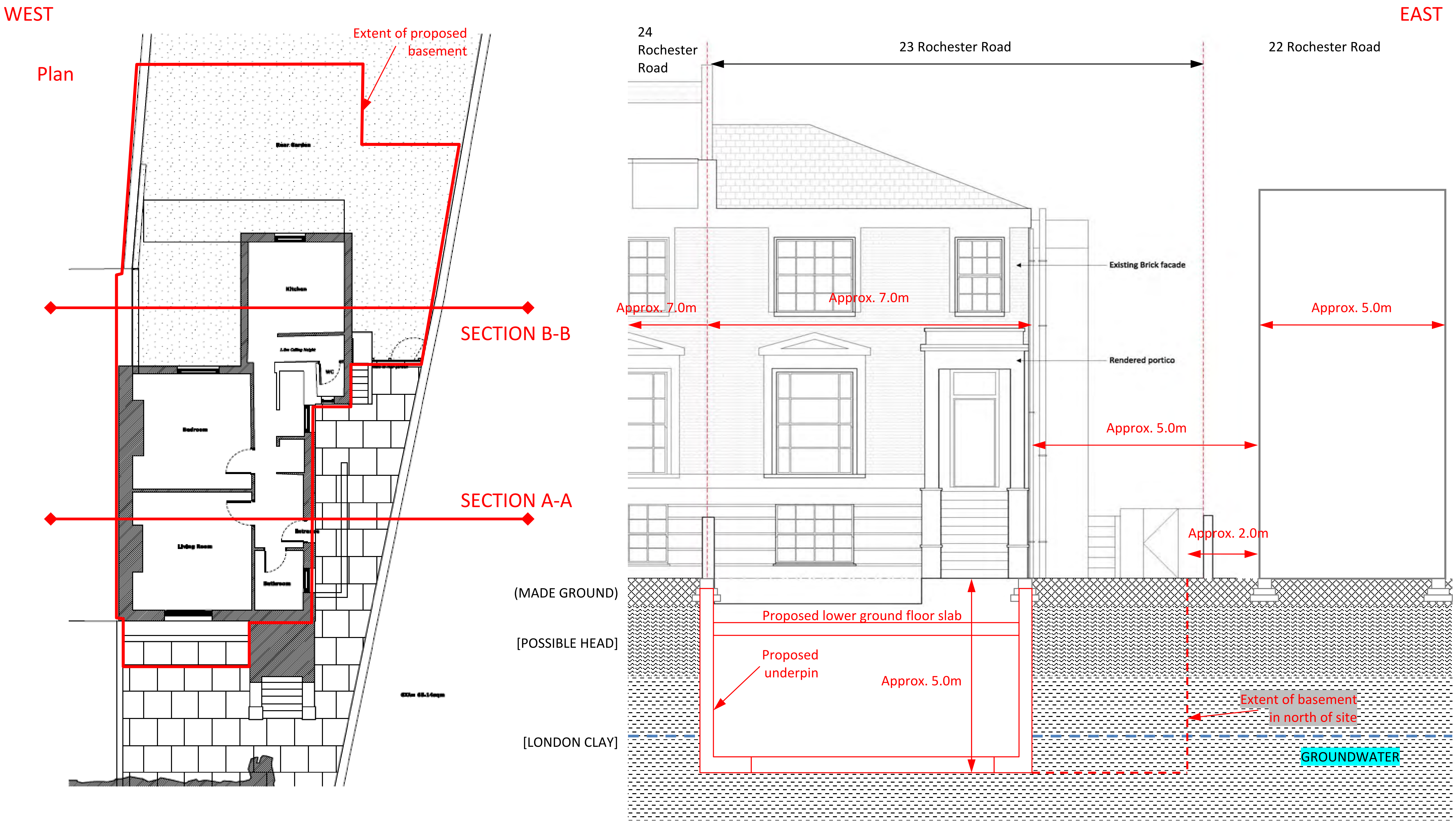
Client	Project	Job No
Physon Homes Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Site location plan**	**Figure 1**

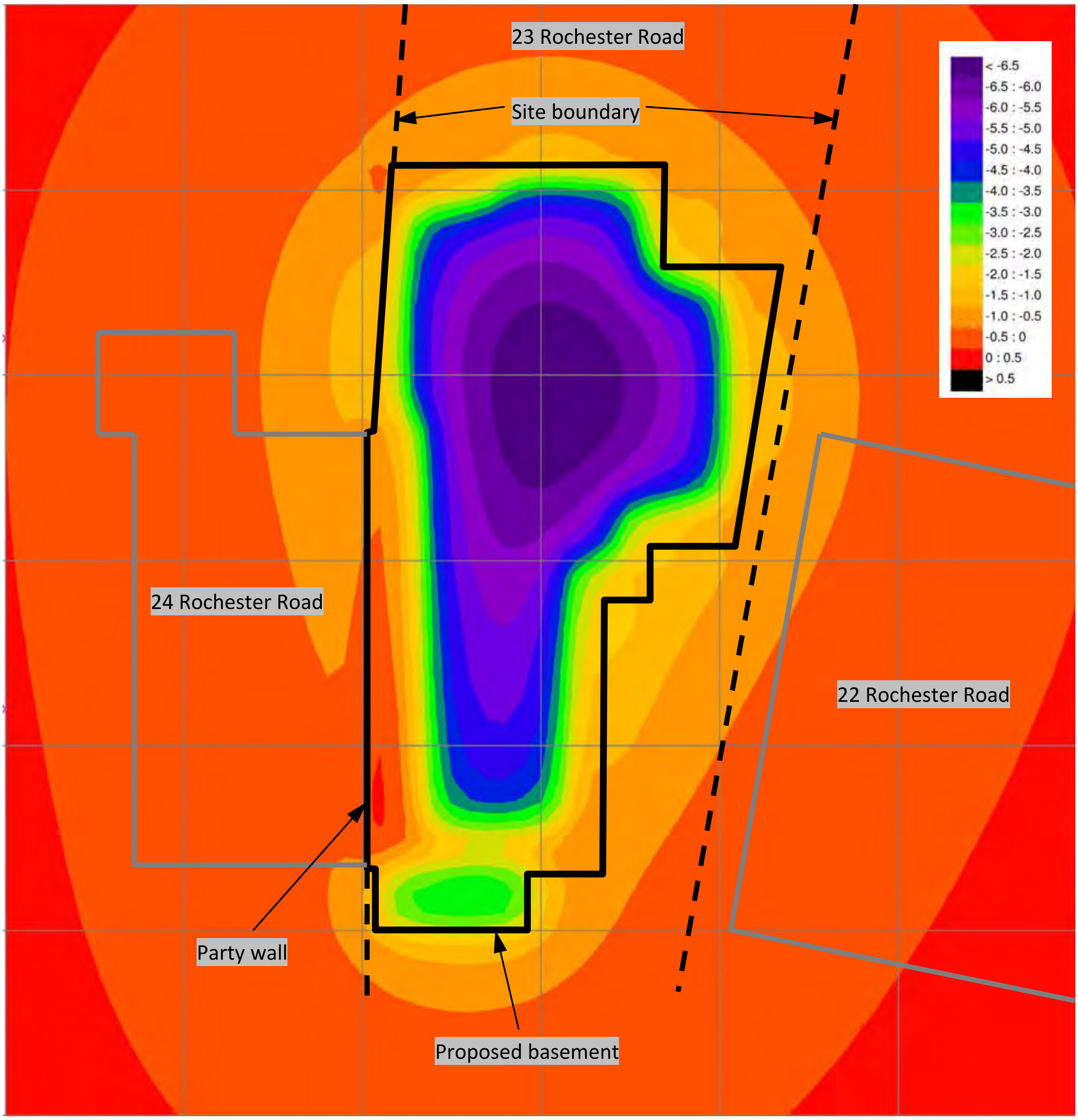




Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Site layout plan**	**Figure 2**



Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Conceptual site model**	**Figure 3**



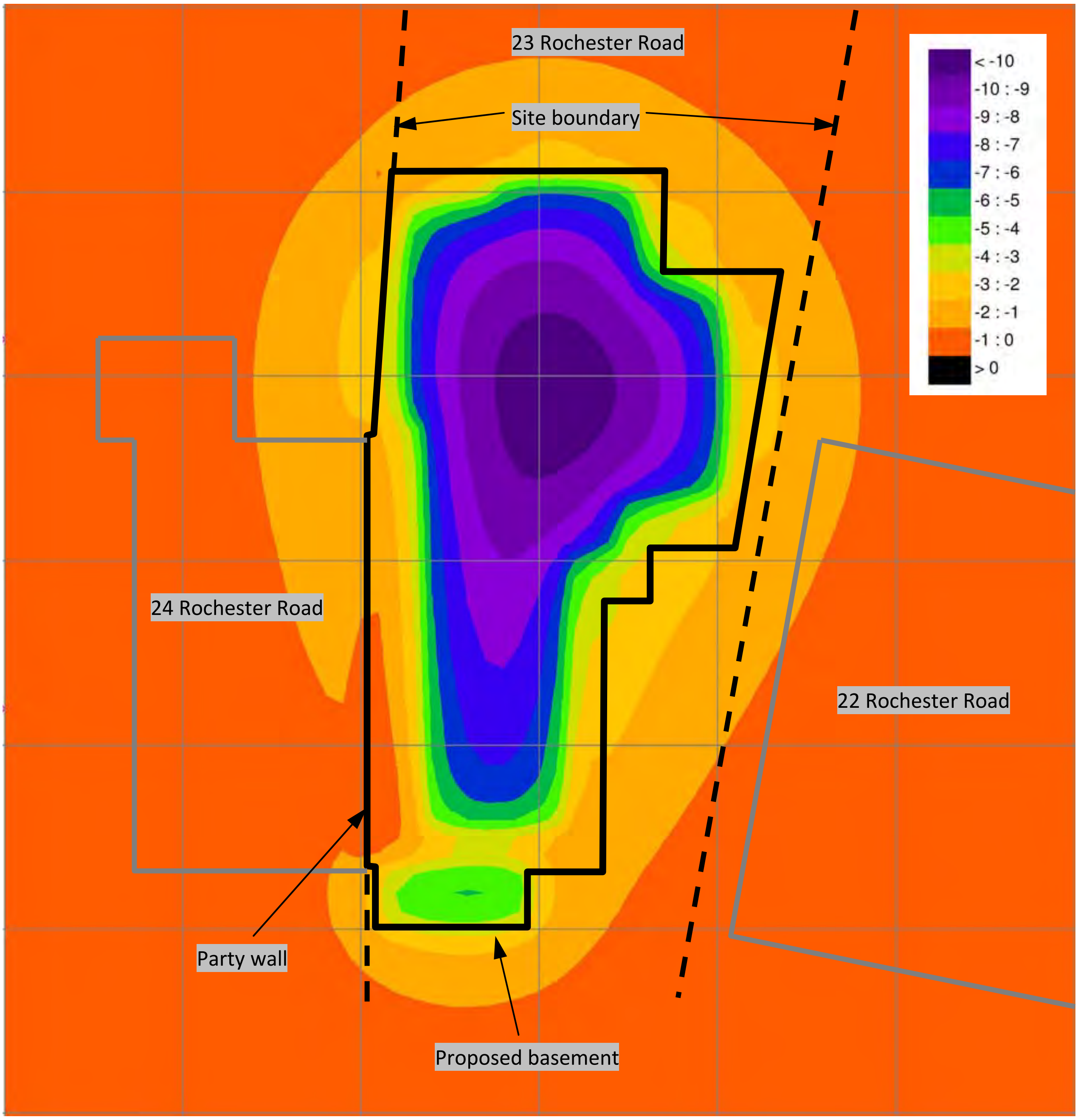
Ground movements in mm.

Positive values are settlement, negative values are heave.

NOT TO SCALE

N

Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Short term ground movement contour plot**	**Figure 4**



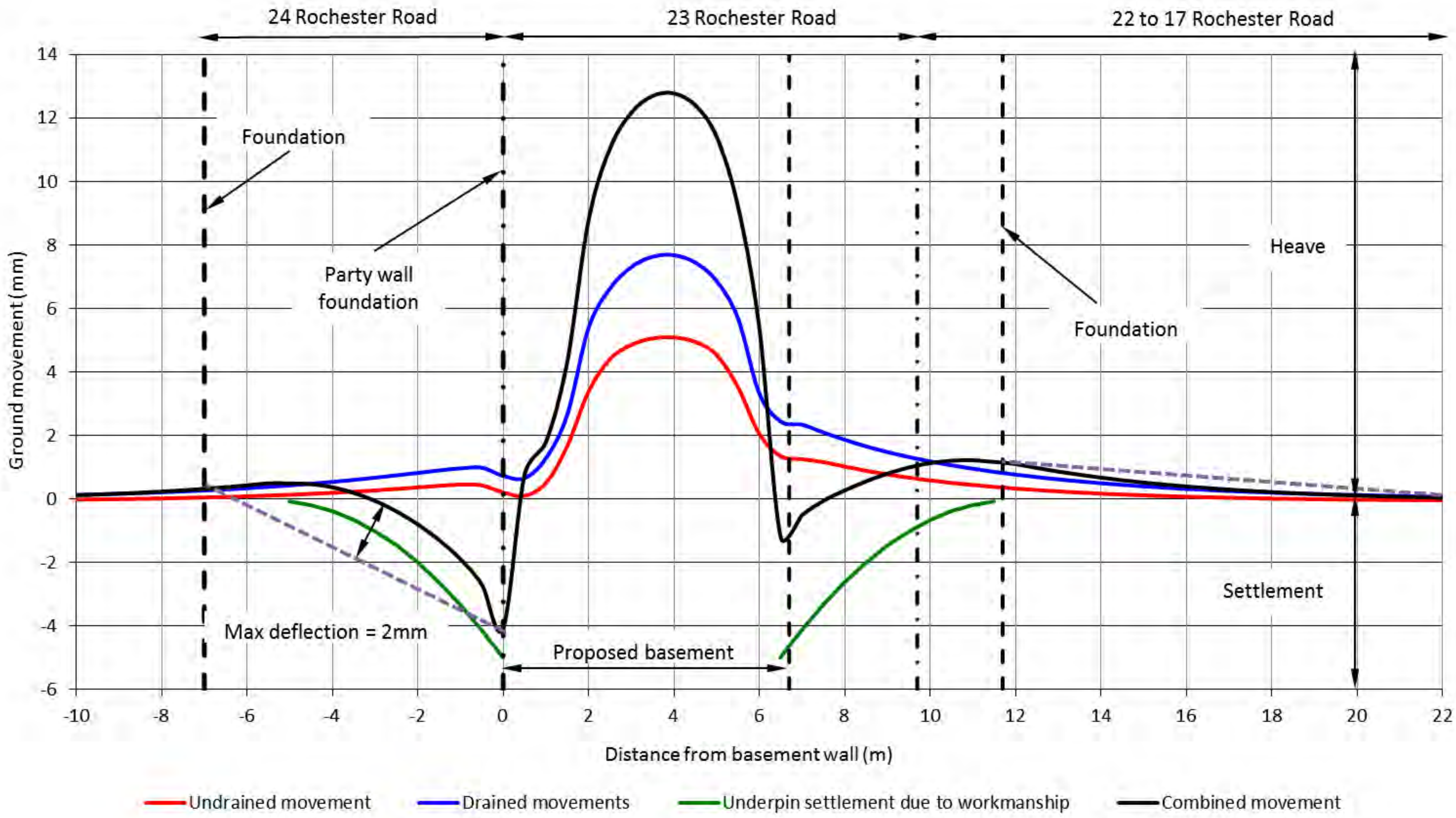
Ground movements in mm.

Positive values are settlement, negative values are heave.

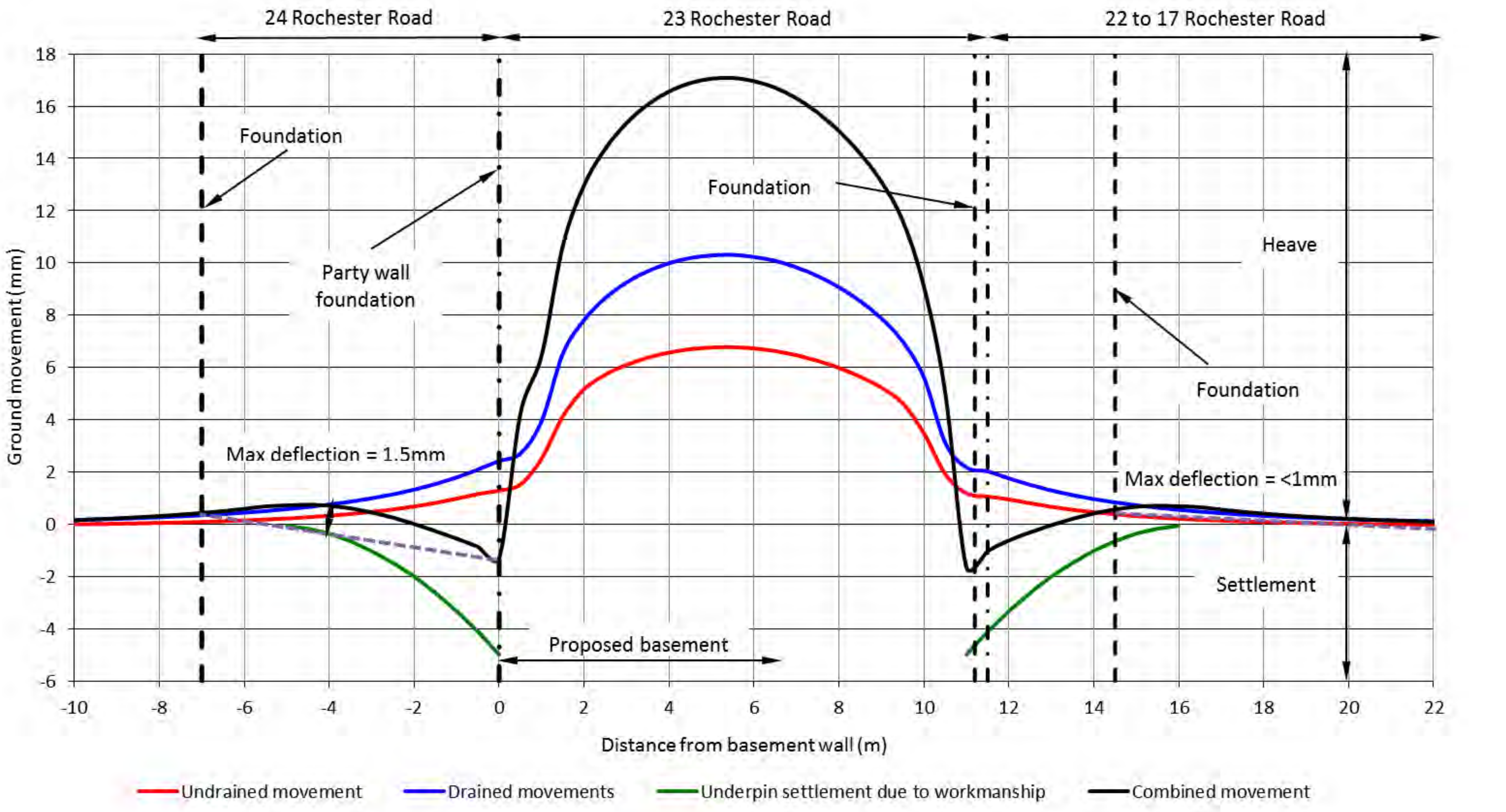
NOT TO SCALE

N

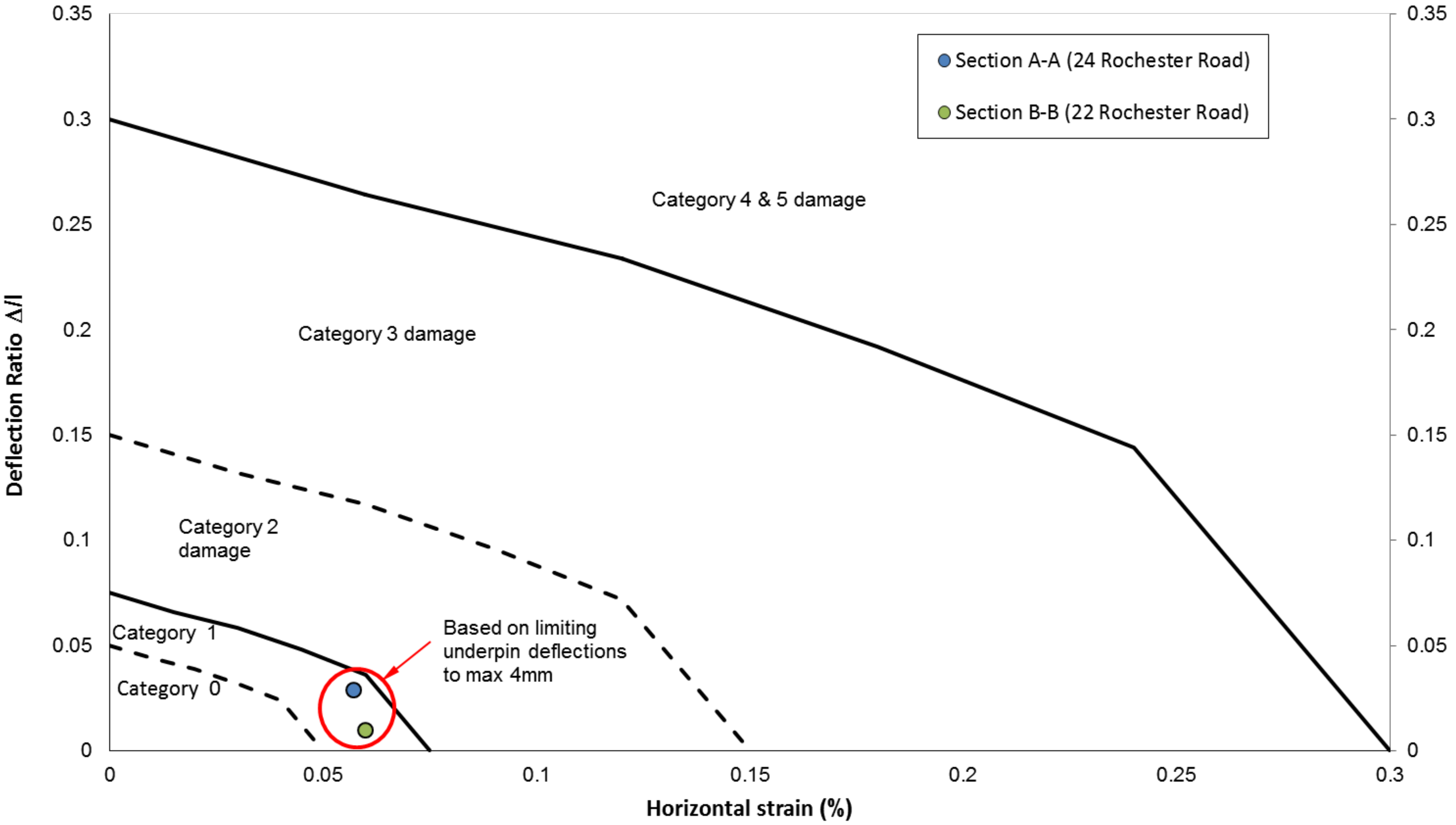
Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Long term ground movement contour plot**	**Figure 5**



Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Combined vertical movements: Section A-A**	**Figure 6**



Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Combined vertical movements: Section B-B**	**Figure 7**



Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	Title **Building interaction chart**	**Figure 8**

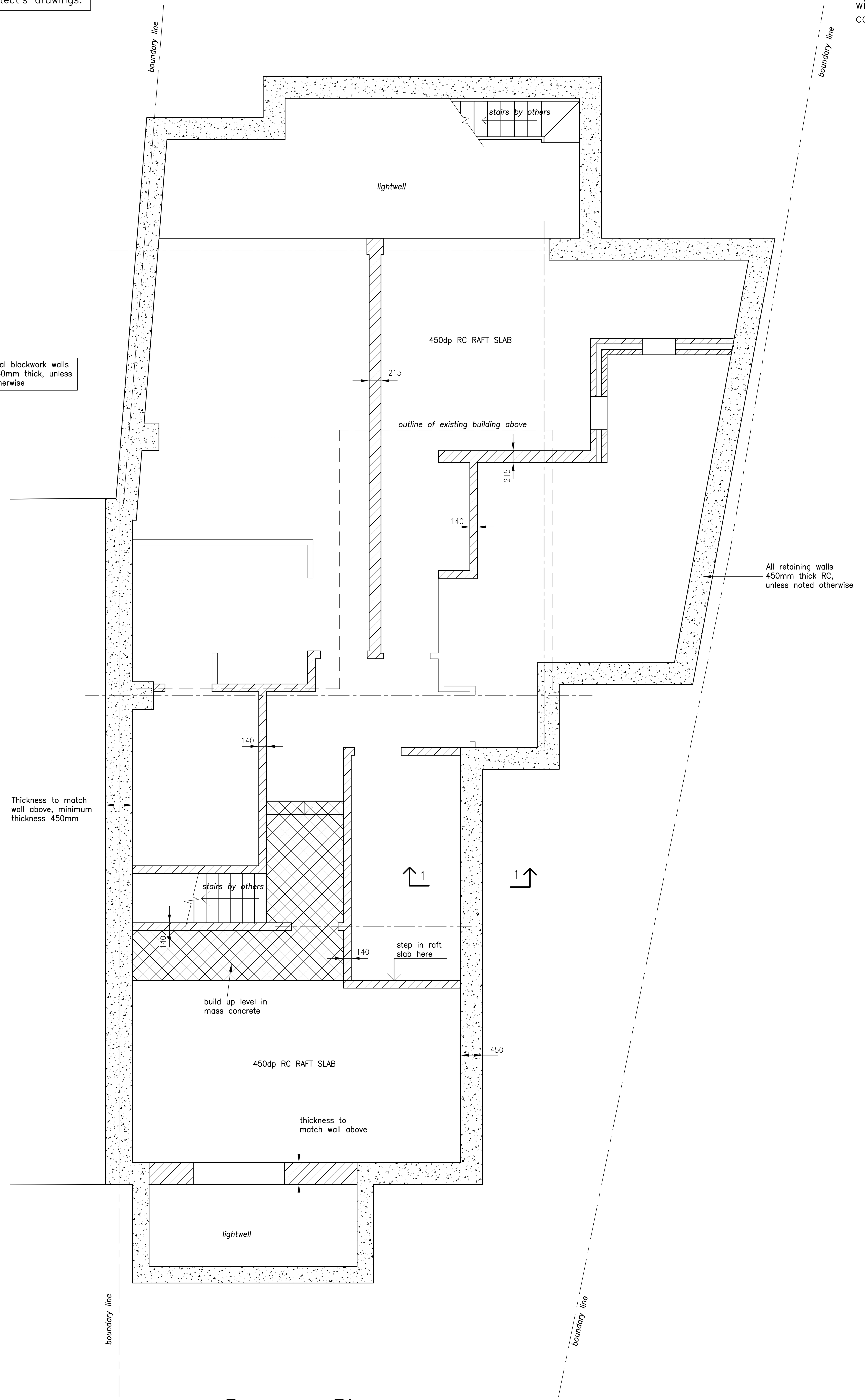
APPENDIX A

Proposed development drawings

For water/damp proofing of the structure refer to the Architect's drawings.

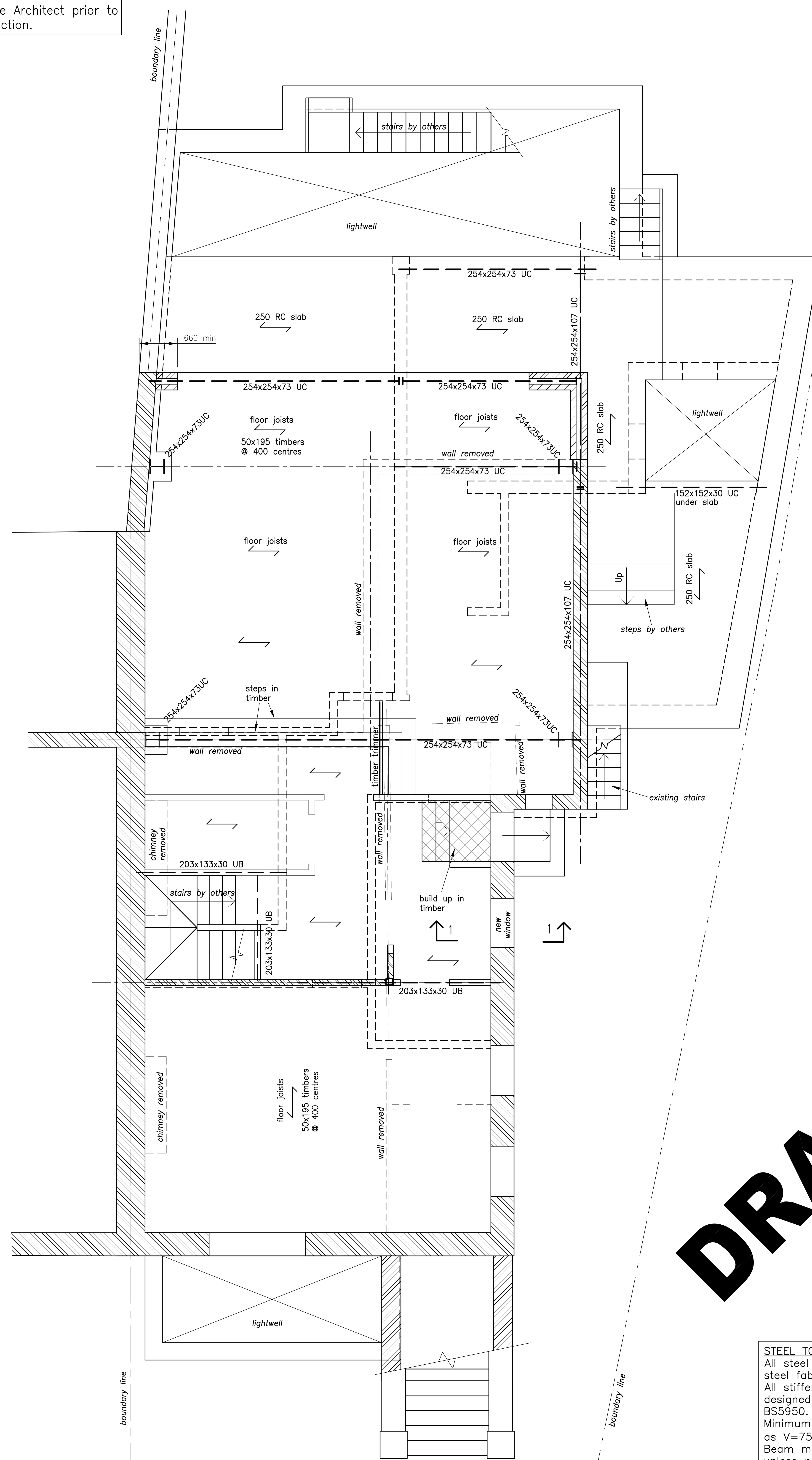
LEVELS
All levels to be confirmed with the Architect prior to construction.

*NOTE. All ground levels are assumed and need to be verified on site.



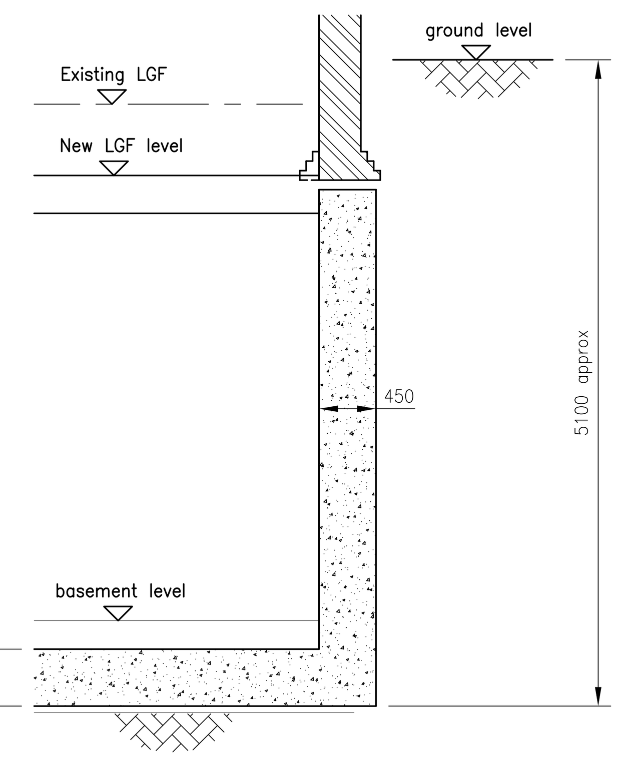
Basement Plan

1:50



Lower Ground Floor Plan

1:50



Section 1-1

1:50

DRAFT COPY

STEEL TO STEEL CONNECTIONS NOTES
All steel to steel connections to be designed by the steel fabricator in accordance with BS 5950.
All stiffeners, etc relating to connections to be designed by the steel fabricator in accordance with BS5950.
Minimum beam reaction at connection to be taken as V=75kN (factored) unless noted otherwise.
Beam moment at connection to be taken as M=0kN unless noted otherwise.
All moments and forces indicated are factored.
Reactions are indicated thus:- V=45
Moments are indicated thus:- M=30
All bolts to be grade 8.8 except holding down bolts.

NOTES
1) This drawing should not be scaled
2) All dimensions and levels to be confirmed by the Architect
3) Any discrepancies in drawings or details to be immediately reported to Glencross and Hudson.
4) This drawing remains the property of Glencross and Hudson and must not be reproduced with out prior written consent
5) All details are subject to Building Regulations Approval

Date	Rev	Detail
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

Glencross & Hudson
Structural Engineers & Building Surveyors
25 Claremont Avenue, Lower Sunbury
Middlesex TW16 5LX
London Office: 020 8914 8214
email: info@glencrossandhudson.co.uk

Project
23 Rochester Road
London NW1 9JJ

Drawing Title
Structural Arrangements Basement and Lower Ground Floor Plans

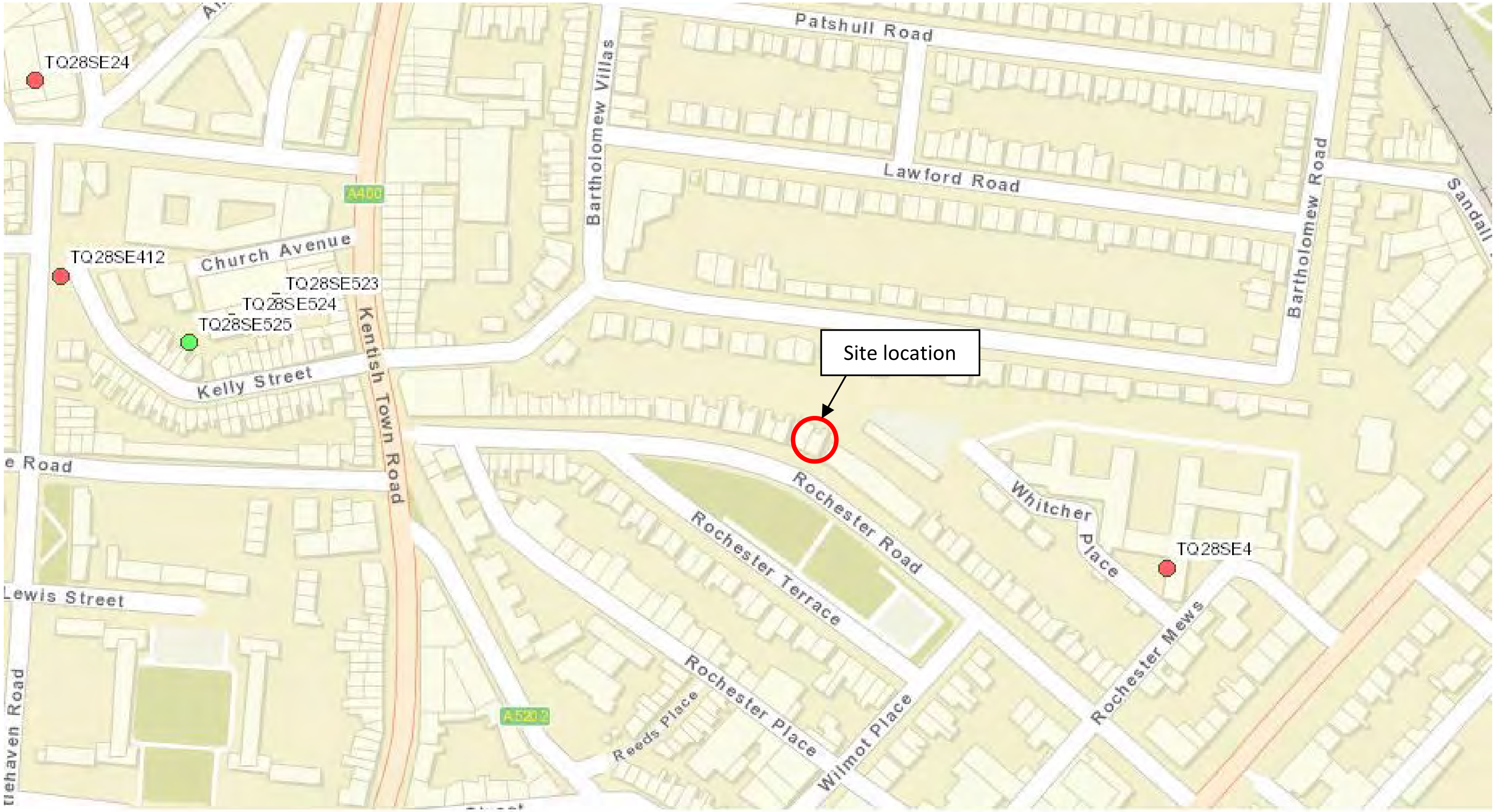
Scale
1:50 @ A1 size

Date: June 14
Checked: RH

Drawing No.: 1858/14/01
Revision:

APPENDIX B

Historical BGS borehole records



Client	Project	Job No
Physon Property Limited	**23 Rochester Road, London**	**CG/08944**
CGL	**Title** **BGS borehole location plan**	**Appendix B**

CT6 2 (stamp) 598

RECORD of WELL or BORING

Survey No. 256
1" N.S.
1" O.S.

at Camden Road B 4 No 1

Town, Village, &c. Camden Town NW St. Pancras. County London Six-inch map n.5.NW

Exact site (unless a tracing from a map is supplied, give distance and direction from parish church, cross-roads, or other object shown on maps). A little to the SW from Camden Town Stn. sited sheet 16 Vol 1. Popular edition (Sheet of one-inch map. (Square) TQ28/50

Surface level of ground c 85 ft. above Ordnance Datum. Well or Bore commenced at ...... ft. below surface level of ground.

Sunk 4 ft., diameter 16 ft. Bored ...... ft.; diameter of boring: at top ...... in., at bottom ...... in.

Details of lining tubes (internal diameters preferred) 34'2" of 16 in. Top. 3'4" b/a
197'6" of 12 .. .. 2'6" ..

Water struck at depths of (feet) 301', 315' 333' NGR TQ 2902 8412

Rest-level of water below top of well or bore 278 ft. Pumping level ?278 ft. Time of recovery ...... hours.

Suction at 598 ft. depth. Yield: (i) on test 7000/8000 galls. per hour, (ii) normal ...... galls. per ......

Quality (attach copy of analysis if available) Hardness (Perm) 0°. Temp 4°. Total 4°.

Made by LE GRAND, SUTCLIFFE & GELL, LD. for Mr. Aerated Bread Co. Ltd Date of boring Aug/Oct 1934

Information from LE GRAND, SUTCLIFFE & GELL, LD. S134/p. 673.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
Made 2	Made ground	2	.	2	.
	Brown clay	30	.	32	.
L.C. 106	Blue clay	18	.	50	.
	Blue clay & stone	25	.	75	.
	Blue clay	33	.	108	.
	Mottled clay	39	.	147	.
W.R.S. 50	Conglomerate	6	.	153	.
	Green loamy sand	5	.	158	.
T.S. 20	Thanet Sand	19	.	177	.
	Green flints	1	.	178	.
CK. 474	Chalk & flints	232	.	410	.
	Hard grey Chalk	242	.	652	.

SB 25:10:35.

Site visited 30th July 1946.
Pumping controlled by demand &
Well top in basement 10' below ground level.

Confidential Water very soft – have to harden it.

8 July 1946

~~Rwl~~ P.W.L. 300 Yield 10,328 Nov. 1937

Geological Survey and Museum, South Kensington, London, S.W.7.

For Survey use only.

Date received.	G.S.M.	M. of H. notified.	Site marked on 1" map.
Oct 1935			

(11969B) Wt 10256/0175 2,500 9/32 H, J, R & L, Ld

British Geological Survey

N.G.K. 2887.8462 TQ 28 SE/835

British Geological Survey

soil mechanics department

BOREHOLE No. 3
Continuation Sheet No. 1

CONTRACT KENTISH TOWN T.E. EXTENSION

REPORT No. 5600/75/KWL

Description	Depth (Scale 20mm = 1 m)	Legend	Sample Ref. No.	Type	Sample Taken From m.	To m.	N blows/0.3 m.
Stiff dark grey-brown fissured silty clay becoming very stiff with depth, with occasional dustings of selenite crystals, partings of orange-brown silt and nodules of iron pyrites. (Blue London Clay). (cont'd.)			2149	U	9.50	9.95	
			2150	J	10.25		
			2151	U	11.00	11.45	
			2152	J	11.75		
			2153	U	12.50	12.95	
			2154	J	13.25		
			2155	U	14.55	15.00	
	15.00						

Standpipe Readings (M.)

Date	Water Level
12.8.75	None
13.8.75	None
14.8.75	None
15.8.75	None
27.10.75	9.08

CODES: U ...

N.G.R. 2887, 8462 TQ 28 SE / 525

soil mechanics department

BOREHOLE No. 3

CONTRACT KENTISH TOWN T.E. EXTENSION

REPORT No. 5600/75/KWL

Client: Property Services Agency

Ground Level: 29.01 O.D.

Cha./Co-ords.

Site Address: Church Avenue, Kentish Town, London.

Boring Commenced: 12.8.75

Boring Completed: 12.8.75

Shell & Auger Boring 200 mm. dia. to 15.00 m. mm. dia. to m.

Rotary Drilling dia. to m. Circulation Fluid–

dia. to m. Circulation Fluid–

Ground Water Record	Strikes	Inflow	Sealed at	Date					
	None m.		m.	Hole Depth					
	m.		m.	Casing Depth					
	m.		m.	Water Level					

Remarks

Standpipe installed to depth of 15m.

Description	Depth (Scale 20mm = 1 m)	Sample Ref. No.	Type	Sample Taken From m.	To m.	N blows/0.3 m.
Concrete.	0.10					
Made ground (brick, clay, ash, etc.)		2135	J	0.30		
	1.10					
Light brown sand to gravel-sized angular and rounded flints with interstitial soft to firm mottled grey and brown silt clay. (?Fill)		2136	J	1.10		
		2137	D	1.35	1.65	6
	1.90	2138	J	1.90		
Firm brown silty clay with grey veins becoming firm to stiff brown lightly fissured silty clay with grey staining in fissures with depth, and with occasional clusters of selenite crystals, dustings of orange-brown silt, iron staining and roots. (Brown London Clay).		2139	U	2.00	2.45	
		2140	J	2.75		
		2141	U	3.50	3.95	
		2142	J	4.25		
		2143	U	5.00	5.45	
		2144	J	5.75		
		2145	U	6.50	6.95	
	7.80					
Stiff dark grey-brown fissured silty clay becoming very stiff with depth, with occasional dustings of selenite crystals, partings of orange-brown silt and nodules of iron pyrites. (Blue London Clay).		2146	J	7.80		
		2147	U	8.00	8.45	
		2148	J	8.75		

British Geological Survey

N.G.R. 2889. 8483 TQ 28SE/524

soil mechanics department

BOREHOLE No. 2
Continuation Sheet No. 2

CONTRACT KENTISH TOWN T.E. EXTENSION

REPORT No. 5600/75/KWL

Description	Scale 20mm = 1 m Depth	Legend	Sample Ref. No.	Type	Sample Taken From m.	Sample Taken To m.	N blows/ 0.3 m.
Stiff dark grey-brown fissured silty clay becoming very stiff with depth, with occasional dustings of selenite crystals, partings of light grey-brown silt and nodules of iron pyrites. (Blue London Clay). (cont'd.)			2130	J	21.25		
			2131	J	22.00		
			2132	U	23.00	23.45	
			2133	J	23.75		
			2134	U	24.55	25.00	
	25.00						

British Geological Survey

N.G.R. 2887, 8463 TQ 28 SE / 524

soil mechanics department

BOREHOLE No. 2
Continuation Sheet No. 1

CONTRACT KENTISH TOWN T.E. EXTENSION

REPORT No. 5600/75/KWL

Description	Scale 20mm = 1 m Depth	Legend	Sample Ref. No.	Type	Sample Taken From m.	Sample Taken To m.	N blows/ 0.3 m.
Stiff dark grey-brown fissured silty clay becoming very stiff with depth, with occasional dustings of selenite crystals, partings of light grey-brown silt and nodules of iron pyrites. (Blue London Clay). (cont'd.)			2114	J	9.25		
			2115	U	10.00	10.45	
			2116	J	10.75		
			2117	U	11.50	11.95	
			2118	J	12.25		
			2119	U	13.00	13.45	
			2120	J	13.75		
			2121	U	14.50	14.95	
			2122	J	15.25		
			2123	U	16.00	16.45	
			2124	J	16.75		
			2125	U	17.50	17.95	
			2126	J	18.25		
			2127	U	19.00	19.45	
			2128	J	19.75		
			2129	U	20.55	20.95	

CODES: U—Undisturbed Sample, P-Piston Sample, D-Large Disturbed Sample, J-Jar Sample, W-Water Sample

British Geological Survey

N.G.R. 2889.8463 TQ 28 SE/524

soil mechanics department

BOREHOLE No. 2

CONTRACT	KENTISH TOWN T.E. EXTENSION
REPORT No.	5600/75/KWL
Client	Property Services Agency
Ground Level	29.21 m.O.D.
Cha./Co-ords.	
Site Address	Church Avenue, Kentish Town, London.
Boring Commenced	11.8.75
Boring Completed	11.8.75

Shell & Auger Boring 200 mm. dia. to 25.00 m. mm. dia. to m.
Rotary Drilling dia. to m. Circulation Fluid–
dia. to m. Circulation Fluid–

Ground Water Record	Strikes	Inflow	Sealed at	Date
	None m.		m.	Hole Depth
	m.		m.	Casing Depth
	m.		m.	Water Level

Remarks

Standpipe installed to depth of 25m. Claystone encountered at 22m. depth.

Description	Depth (Scale 20mm = 1 m)	Legend	Sample Ref. No.	Type	Sample Taken From m.	Sample Taken To m.	N blows/ 0.3 m.
Concrete.	0.10						
Made ground (brick, clay, ash, etc.)	0.70		2101	J	0.70		
Light brown sand to gravel-sized angular and rounded flints with interstitial soft to firm brown silty clay. (?Fill).	1.20		2102	J	1.20		
Firm brown silty clay with grey veins becoming stiff brown lightly fissured silty clay with grey staining in fissures with depth, and with occasional clusters of selenite crystals, dustings of orange-brown salt, iron staining, roots and siltstones. (Brown London Clay).			2103	U	1.30	1.75	
			2104	J	2.05		
			2105	U	2.80	3.25	
			2106	J	3.55		
			2107	U	4.30	4.75	
			2108	J	5.05		
			2109	U	5.80	6.25	
			2110	J	6.55		
			2111	U	7.30	7.75	
Stiff/	8.30		2112	J	8.30		
cont'd.			2113	U	8.50	8.95	

Standpipe Readings (m)

Date	Water Level
11.8.75	None
12.8.75	22.20
13.8.75	18.90
14.8.75	8.30
15.8.75	7.60
27.10.75	3.64

British Geological Survey

N.G.R. 2891 8464 TQ 28SE/523

British Geological Survey

soil mechanics department

BOREHOLE No. 1

Continuation Sheet No. 1

CONTRACT KENTISH TOWN T.E. EXTENSION

REPORT No. 5600/75/KWL

Description	Depth (Scale 20mm = 1 m)	Sample Ref. No.	Type	Sample Taken From m.	Sample Taken To m.	N blows/ 0.3 m.
Stiff dark grey-brown fissured silty clay becoming very stiff with depth, with occasional dustings of selenite crystals, partings of orange-brown silt and nodules of iron pyrites. (Blue London Clay). (cont'd.)						
		2170	U	9.50	9.95	
		2171	J	10.25		
		2172	U	11.00	11.45	
		2173	J	11.75		
		2174	U	12.50	12.95	
		2175	J	13.25		
		2176	U	14.55	15.00	
	15.00					

Standpipe Readings (m)

Date	Water Level
13.8.75	None
14.8.75	None
15.8.75	None
27.10.75	2.25

CODES: U–Undisturbed Sample, P-Piston Sample, D-Large Disturbed Sample, J-Jar Sample, W-Water Sample

N.G.R. 2891 8464 TQ28SE/523

[illegible]	soil mechanics department	BOREHOLE No. 1

CONTRACT KENTISH TOWN T.E. EXTENSION	REPORT No. 5600/75/KWL
Client Property Services Agency	Ground Level 29.86 m.O.D. Chs./Co-ords.
Site Address Church Avenue, Kentish Town, London.	Boring Commenced 13.8.75 Boring Completed 13.8.75

Shell & Auger Boring 200 mm. dia. to 15.00 m. mm. dia. to m.
Rotary Drilling dia. to m. Circulation Fluid–
dia. to m. Circulation Fluid–

Ground Water Record	Strikes	Inflow	Sealed at	Date				
	None. m.		m.	Hole Depth				
	m.		m.	Casing Depth				
	m.		m.	Water Level				

Remarks Standpipe installed to depth of 15.00m.

Scale 20mm = 1 m

Description	Depth	Legend	Sample Ref. No.	Type	Sample Taken From m.	To m.	N blows/0.3 m.
Concrete.	0.25						
Made ground (brick, clay, ash etc.)			2156	J	0.70		
	1.20		2157	J	1.20		
Light brown sand to gravel-sized angular and rounded flints with interstitial soft to firm light brown silty clay. (?Fill).			2158	D	1.45	1.75	8
	2.20		2159	J	2.20		
Firm brown silty clay with grey veins becoming stiff brown lightly fissured silty clay with grey staining in fissures with depth, and with occasional clusters of selenite crystals, dustings of orange-brown silt iron staining and roots. (Brown London Clay).			2160	U	2.30	2.75	
			2161	J	3.05		
			2162	U	3.80	4.25	
			2163	J	4.55		
			2164	U	5.30	5.75	
			2165	J	6.05		
			2166	U	6.80	7.25	
	7.70		2167	J	7.70		
Stiff dark grey-brown fissured silty clay becoming very stiff with depth, with occasional dustings of selenite crystals, partings of orange-brown silt and nodules of iron pyrites. (Blue London Clay).			2168	U	8.00	8.45	
			2169	J	8.75		

British Geological Survey

30, 31.

METROPOLITAN WATER BOARD.

BOROUGH OF ST. PANCRAS.

PROPOSED POSITION OF BOREHOLES.

⌐ Actual positions of boreholes

Scale 1/2500

TQ 28SE/41A-413

British Geological Survey

GROUND LEVEL: 111·4 A.O.D. 33·96m N.G.R. 2916, 8490
NOMINAL B.H. DIA.: 8" Casing
DATE OF BORING: 25 Feb. to 2 March '60

BOREHOLE No. 31 (Contd.)

GROUNDWATER LEVEL	GROUNDWATER DATE	SAMPLE DEPTH	B.H.	DEPTH	R.L.		DESCRIPTION OF STRATA
				80'-0"	+31·4		
		84'-6" to 86'-0"	■				Stiff grey - blue fissured silty clay
		92'-6" to 94'-0"	■				
				36·88m 121·0	-2·92m -9·6		Bottom of borehole

REMARKS:

SAMPLES
■ Undisturbed
• Disturbed

SCALE: 1/8" to 1'-0"

METROPOLITAN WATER BOARD
MAIN IN TUNNEL BETWEEN THAMES AND LEA VALLEYS.

SOILS No. S/371

DRWG. No. S/R/530

GEORGE WIMPEY & CO. LTD., CENTRAL LABORATORY, SOUTHALL.

British Geological Survey

GROUND LEVEL: 111·4 A.O.D. 33·96m N.G.R. 2916 8490
NOMINAL B.H. DIA.: 8" Casing
DATE OF BORING: 25 Feb. to 2 March '50

BOREHOLE No. 31

GROUNDWATER LEVEL	GROUNDWATER DATE	SAMPLE DEPTH	B.H.	DEPTH	R.L.		DESCRIPTION OF STRATA
				0'			
				0'-3" 0.08m	+111·1 +33·86m		Tarmacadam
				2'-3" 0.69m	+109·1 +33·25m		Hard core
				33'-0" 10.06m	+78·4 +23·90 m		Stiff brown fissured clay
		76'-6" to to 78'-0"		24.38m 80'-0"	+9.58m +31·4		Stiff grey-blue fissured clay (Changing to a silty clay)

Contd.

REMARKS:
No water in borehole

SAMPLES
■ Undisturbed
• Disturbed

SCALE: 1/8" to 1'-0"

METROPOLITAN WATER BOARD
MAIN IN TUNNEL BETWEEN THAMES AND LEA VALLEYS.

SOILS No. S/371

DRWG. No. S/R/530

GEORGE WIMPEY & CO. LTD., CENTRAL LABORATORY, SOUTHALL.

British Geological Survey

British Geological Survey

METROPOLITAN WATER BOARD.

BOROUGH OF ST. PANCRAS.

PROPOSED POSITION OF BOREHOLES.

⌐ Actual positions of boreholes

Scale 1/2500

TQ 28SE/41A-413

~~8 846~~ 2f2 256 TQ 28SE/412

LEVEL: 94·5 A.O.D. 28·80m N.G.R. 2881 8465

AL B.H. DIA.: 8" Casing to 20ft.

OF BORING: 25 Feb. to 4 March '30

BOREHOLE No. 30 (Contd.)

WATER LEVEL	WATER DATE	SAMPLE DEPTH	B.H.	DEPTH	R.L.	DESCRIPTION OF STRATA
				81'-6"	+13·0	Mudstone boulder
				82'-0" / 24·99m	+12·5 / +3·81m	Stiff grey-blue fissured clay
				26·52m / 87'-0"	+2·29m / +7·5	Mudstone boulder
				87'-6" / 26·67m	+7·0 / +2·13m	Stiff grey-blue fissured clay
				111'-6" / 33·99m	-17·0 / -5·18	Stiff grey-blue sandy silty clay (traces of peat at 112 ft.)
				35·36m / 116'-0"	-6·55 / -21·5	Fine bright green silty sand & traces of peat & some water content
				117'-0" / 35·66m	-22·5 / -6·86	Stiff grey-blue fissured clay
				131'-6" / 40·08m	-37·0 / -11·28	Bottom of borehole

REMARKS:

SAMPLES
Undisturbed
• Disturbed

SCALE: 1/8" to 1'-0"

METROPOLITAN WATER BOARD

MAIN IN TUNNEL BETWEEN THAMES AND LEA VALLEYS.

SOILS No. S/371

DRWG. No. S/R/529

GEORGE WIMPEY & CO. LTD., CENTRAL LABORATORY, SOUTHALL.

British Geological Survey

~~288 896~~ 1 of 2 256 TQ 28SE/412

N.G.R. 2881/8465

GROUND LEVEL: 94.5 A.O.D. 28.80m
NOMINAL B.H. DIA.: 8" Casing to 20ft.
DATE OF BORING: 25 Feb. to 4 March '58

BOREHOLE No. 30

GROUNDWATER LEVEL	GROUNDWATER DATE	SAMPLE DEPTH	DEPTH	R.L.	DESCRIPTION OF STRATA
			0'		
			0'-6" 0.15m	+94.0 +28.65m	~~Tarmacadam~~
			5'-0" 1.52m	+89.5 +27.28m	Fill
			22'-0" 6.71m	+72.5 +22.10m	Stiff brown fissured clay
			46'-0" 14.02m	+48.5 +14.78m	Stiff grey-blue fissured clay
			46'-6" 14.17m	+48.0 +14.63m	~~Mudstone boulder~~
		63'-6" to 65'-0"	70'-6" 21.49m	+24.0 +7.32m	Stiff grey-blue fissured clay
			71'-0" 21.64m	+23.5 +7.16m	~~Mudstone boulder~~
		71'-6" to 73'-0"			Stiff grey-blue fissured clay
		79'-6" to 81'-0"	81'-6" 24.84	+13.0 +3.96m	Contd.

REMARKS	SAMPLES	SCALE
Some water observed in green sand layer at 116 ft. to 117 ft.	■ Undisturbed • Disturbed	1/8" to 1'-0"

METROPOLITAN WATER BOARD MAIN IN TUNNEL BETWEEN THAMES AND LEA VALLEYS.	SOILS No. S/371 DRWG. No. S/R/529

GEORGE WIMPEY & CO. LTD., CENTRAL LABORATORY, SOUTHALL.

256/425
TQ 28/49

256/425

142

2. Rochester Road, Witcher Place. Messrs. Idris & Co.
100 feet above Ordnance Datum.
Made by the Firm in 1905, and communicated by Mr. T. H. W. Idris, M.P.
Diameter of bore 13 inches. Water-level 100 feet below O.D. Yield 3,000 gallons an hour.
London Map 7, N.W. (b. 4).

		Thickness. Feet.	Depth. Feet
[London Clay.]	Yellow clay ...	42	42
	Blue clay ...	105	147
	Green sand ...	3	150
[Reading Beds.]	Yellow clay ...	41	191
	Green sand ...	34	225
	Chalk	195	420

	ft.	ins
London Clay	150	0
Woolwich + Reading Beds (? Reading Type) / Thanet Sand	75	0
Upper Chalk	195	0

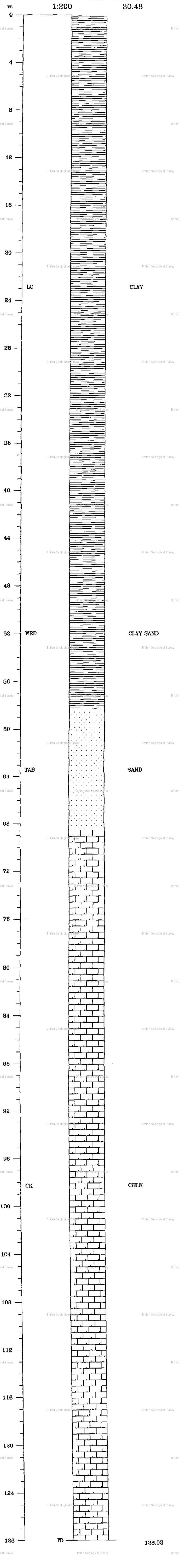
[illegible] 1976

British Geological Survey

N-WITCHER PLACE

Grid Reference: 29326 84525

Scale: 1:200 Ordnance Datum: 30.48



APPENDIX C

CET investigation report

CET INFRASTRUCTURE
Giving our all

REPORT ON GROUND INVESTIGATION

23 ROCHESTER ROAD, LONDON

For

PATTERSON HOMES

Contents

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Approval Sheet and Foreword

Report Number: F14/146509/GEO

GROUND INVESTIGATION

For

PATTERSON HOMES

At

23 ROCHESTER ROAD, LONDON, NW1 9JJ

Report Status/Issue No: Final		Date of Issue: July 2013
Issued to: Patterson Homes		Job No: F14/146509/GEO
	Name:	Signature:
Author:	Phil West	
Approved:	Paul Ettinger	
Issued for and on behalf of CET Infrastructure by the above signatories.	Northdown House Ashford Road Harrietsham Kent ME17 1QW	Tel: + 44 (0) 1622 858545 Fax: + 44 (0) 1622 858544 Web: www.cet-uk.com

FOREWORD

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Distribution Sheet

Our ref: F14/146509/GEO

GROUND INVESTIGATION

For

PATTERSON HOMES

At

23 ROCHESTER ROAD, LONDON, NW1 9JJ

DISTRIBUTION			
Date:	Issued to:	Name:	No:
May 2014	Patterson Homes	Lawrence Patterson	1
May 2014	CET Infrastructure	File	1

1.0 INTRODUCTION AND BACKGROUND

1.1 CET Infrastructure (CET) was instructed by Patterson Homes, via an email dated 02 April 2014, to undertake a ground investigation of a study site located at 23 Rochester Road, London, NW1 9JJ.

1.2 It is proposed to construct a lower ground floor beneath the existing residential property at 23 Rochester Road. A nominated ground investigation, comprising a single driven window sampler borehole and a single dynamic probe, was requested to provide parameters for the design of the proposed basement.

1.3 This report presents details of the ground conditions encountered in the driven window sampler borehole and dynamic probe undertaken on 14 April 2014. It also presents the results of laboratory tests carried out on recovered samples and a discussion of the ground conditions with respect to the proposed development.

1.4 Attention is drawn to the fact that, whilst every effort has been made to ensure the accuracy of the data supplied and any analysis derived from it, the possibility exists of variations in ground and groundwater conditions around and between the exploratory hole position. No liability can be accepted for any such variations in these conditions. Furthermore, any recommendations are specific to the development as detailed in this report and no liability will be accepted should these be used for the design of alternative schemes without prior consultation with CET Structures Limited.

1.5 A Desk Study as outlined in BS5930 “Code of practice for site investigations” was not requested and therefore has not been carried.

2 THE SITE AND GEOLOGY

2.1 Number 23 is a semi-detached property situated on the north side of Rochester Road, London NW1 9JJ. The property is located towards the south side of an almost rectangular plot of land that slopes downward from Rochester Road to the rear of the site. To the rear of the property is an area of grassed lawn with trees and shrubs around the perimeter. The site is centred at approximate National Grid Reference TQ 290845 as shown on Figure 1.

2.2 The site is bounded to the west by the adjoining property and to the east and north by further residential properties.

2.4 Reference to the publications of the British Geological Survey indicates that the site is underlain by London Clay Formation that is typically encountered as stiff, fissured, blue grey clay that weathers to brown where it outcrops. Characteristic of the London Clay Formation are septarian, or claystone, nodules that occur in bands throughout the sequence. Selenite is also commonplace within this stratum, particularly within the weathered material.

2.5 Clay soil such as the London Clay Formation may exhibit significant volume changes with variations in moisture, with shrinkage, and consequential subsidence of the ground surface, occurring on a reduction in moisture content and the reverse, swelling and heave of the ground surface, occurring on the recovery of any moisture deficit. A reduction in moisture content, or desiccation, may occur due to seasonal drying during summer months to depths of up to 1.5m whilst trees and vegetation may abstract moisture to depths of 4m to 5m or more. Desiccation and consequential subsidence as well as heave on the recovery of any moisture deficit, may have a detrimental effect on foundations within the affected zone. The London Clay Formation is normally of high to very high plasticity and commonly of high shrinkage potential as defined by NHBC Standards Chapter 4.2.

2.6 The ground investigation confirmed the presence of the London Clay Formation beneath the site, which was overlain by Made Ground and soil that has been tentatively been identified as Head. This latter stratum is material that has been derived from the weathering, erosion and re-deposition of soils that outcrop in the area.

3.0 GROUND INVESTIGATION

3.1 The ground investigation comprised a single driven window sampler borehole and a single dynamic probe carried out using DPSH techniques, on 14 April 2014, at the approximate location shown on Figure 2.

3.2 Details of the ground conditions encountered in the exploratory hole are presented on the engineer's log included in Appendix A. Reference should be made to this log for detailed descriptions of the strata penetrated, the depth and type of recovered samples and the results of any in situ testing. A summary only is presented below.

3.3 Window sampler borehole WS01, carried out at the rear of the property, encountered Made Ground to 0.6m below ground level and comprised slightly gravelly, fine to coarse sandy CLAY with the gravel consisting of flint, brick, roof tile and ceramic.

3.4 Beneath the Made Ground, firm becoming stiff with depth, orange brown, slightly gravelly CLAY, becoming slightly sandy, gravelly CLAY from 1.4m below ground level, was penetrated and this has tentatively been identified as Head.

3.5 The London Clay Formation was encountered at 2.5m below ground level and proved to the base of the borehole at 6m. The London Clay Formation comprised predominantly of stiff, becoming very stiff with depth, orange brown CLAY. Rare selenite crystals were observed throughout this stratum.

3.6 The window sampler borehole remained dry whilst open however the absence of observed water ingress into the borehole does not preclude the possibility of a groundwater table being present since the borehole was only open for a relatively short time. In addition, the soils encountered were generally of relatively low permeability and the water table, if present, is unlikely to have been expressed as a seepage whilst the borehole was open. Furthermore the groundwater table level may vary both seasonally and in the long term. The possibility of a groundwater table being present cannot therefore be entirely ruled out. A piezometer was installed at the base of the borehole at 6m below ground level to allow for monitoring of the water table and this should be monitored to determine whether a groundwater table is present.

3.7 Roots and rootlets were observed to depths of 5m below ground level.

3.8 A single dynamic probe by the super heavy method, DPSH, was undertaken adjacent to the window sampler borehole. The probe blow count versus depth profile is included in Appendix A. Within the London Clay Formation the blow counts were typically 2 per 100mm increasing to 3 per 100mm towards the base of the probe at 6.2m. Locally elevated results were recorded at 3.8m and 3.9m below ground level although nothing was observed in the borehole that would account for this anomaly.

4.0 LABORATORY TESTING

4.1 A geotechnical laboratory testing programme was scheduled to provide further information on the engineering properties of the subsoil. Unless stated otherwise, these tests were carried out in accordance with BS 1377 "Methods of Test for Soils for Civil Engineering Purposes". CET Structures Limited have been accredited for specific tests (indicated *) by the United Kingdom Accreditation Service (U.K.A.S.). Individual full format reports for tests are available, if required. Other tests indicated ** have been carried out by UKAS accredited suppliers to CET Structures Limited. The following tests were carried out and the results are presented in Appendix B.:

- Five Atterberg limits tests*
- Twelve moisture content determinations*
- Three water soluble sulphate** and pH determinations**

5 DISCUSSION

5.1 It is proposed to construct a basement beneath the existing property at 23 Rochester Road, London NW1. A ground investigation, comprising a single window sampler borehole and a single dynamic probe to nominal depths of 6m below ground level, was carried to provide parameters for foundation design.

5.2 The ground investigation has established that the site is underlain by Made Ground to a depth of 0.6m below ground level overlying possible Head deposits and the London Clay Formation successively with depth. The London Clay Formation was encountered at 2.5m below ground level.

5.3 Groundwater seepages were not observed in the borehole however the comments made in Section 3 of this report should be borne in mind. A piezometer was installed in the borehole and it is recommended that this is monitored to determine the likelihood of a water table being present below the site.

5.4 The Atterberg limits tests indicate that the clay horizons of the Head Deposits and London Clay are of high (CH) and very high plasticity (CV) and of high shrinkage potential as defined by NHBC Standards Chapter 4.2 “Building near trees”.

5.5 At equilibrium, i.e. when the soils are not desiccated, the moisture content of clay soil is normally somewhat higher than the plastic limit. The results of the moisture content determinations and plastic limits have been plotted with depth and these are included in Appendix C. This profile suggests that desiccation is present to between 4m and 5m below ground level.

5.6 At equilibrium the strength of the London Clay typically increases linearly with depth. As the soil becomes desiccated due to either seasonal drying or abstraction of moisture by trees the strength increases above that at equilibrium moisture content. A relative measure of strength has been made using the pocket penetrometer. The results of the pocket penetrometer readings have been plotted with depth and these are included in Appendix C. This profile suggests elevated strengths, and thus desiccation, to a depth of about 4.5m below ground level.

5.7 Roots and rootlets were observed to depths of 5m, which is consistent with depths of desiccation determined from the moisture content and pocket penetrometer profiles.

Foundations

5.8 Foundations will need to be constructed below the depth of desiccation to protect against the risk of subsidence or heave on the growth or removal of trees, respectively. Based on the ground conditions encountered in the borehole desiccation is likely to be present to depths of 4m to 5m below ground level and locally, closer to the existing trees, deeper.

5.9 The results of the Atterburg limits tests indicate that the Head and the London Clay Formation are of high and very high plasticity and have a high shrinkage potential as defined by NHBC Standards Chapter 4.2 "Building near trees". Due to the presence of clay soils of high shrinkage potential, foundations will need to be designed in accordance NHBC Standards Chapter 4.2 taking into consideration the presence of existing or proposed vegetation or vegetation that has been removed in the past 25 years both on and in proximity to the site.

5.10 The depth of foundations should be based on the greater depth of the following:

- At least 1.5m below existing or proposed ground level;
- At the minimum depths recommended in the NHBC Standards Chapter 4.2 based on the mature height of existing and/or any proposed trees;
- Below the depth of any root penetration;
- At least 0.3m below any Made Ground; and
- At least 0.3m into the London Clay Formation.

5.11 Foundation design will also need to consider the impact of potential heave on the death or removal of trees imposing increased lateral loads on retaining walls and the consequential increase in stress on the soils beneath the retaining wall.

5.12 For preliminary design, a presumed net bearing value, which takes no account of settlement, of 100kN/m^2 is considered appropriate for foundations bearing in the London Clay Formation.

Ground Floors

5.13 Ground bearing floor slabs bearing on Made Ground are not recommended due to the unpredictable bearing and settlement characteristics of this material as well as the risk of collapse settlement. Suspended ground floor slabs will therefore be required. In addition, the potential presence of desiccated soil would preclude the use of ground bearing slabs within the zone of influence of trees. Within the influence of trees, suspended ground floor slabs will need to incorporate an underlying minimum void as defined in Chapter 4.2.

Groundwater Control

5.14 Groundwater was not observed in the borehole however it is recommended that the piezometer installed in the borehole is monitored to confirm the requirements for groundwater control measures in the temporary and permanent works.

Concrete Below Ground

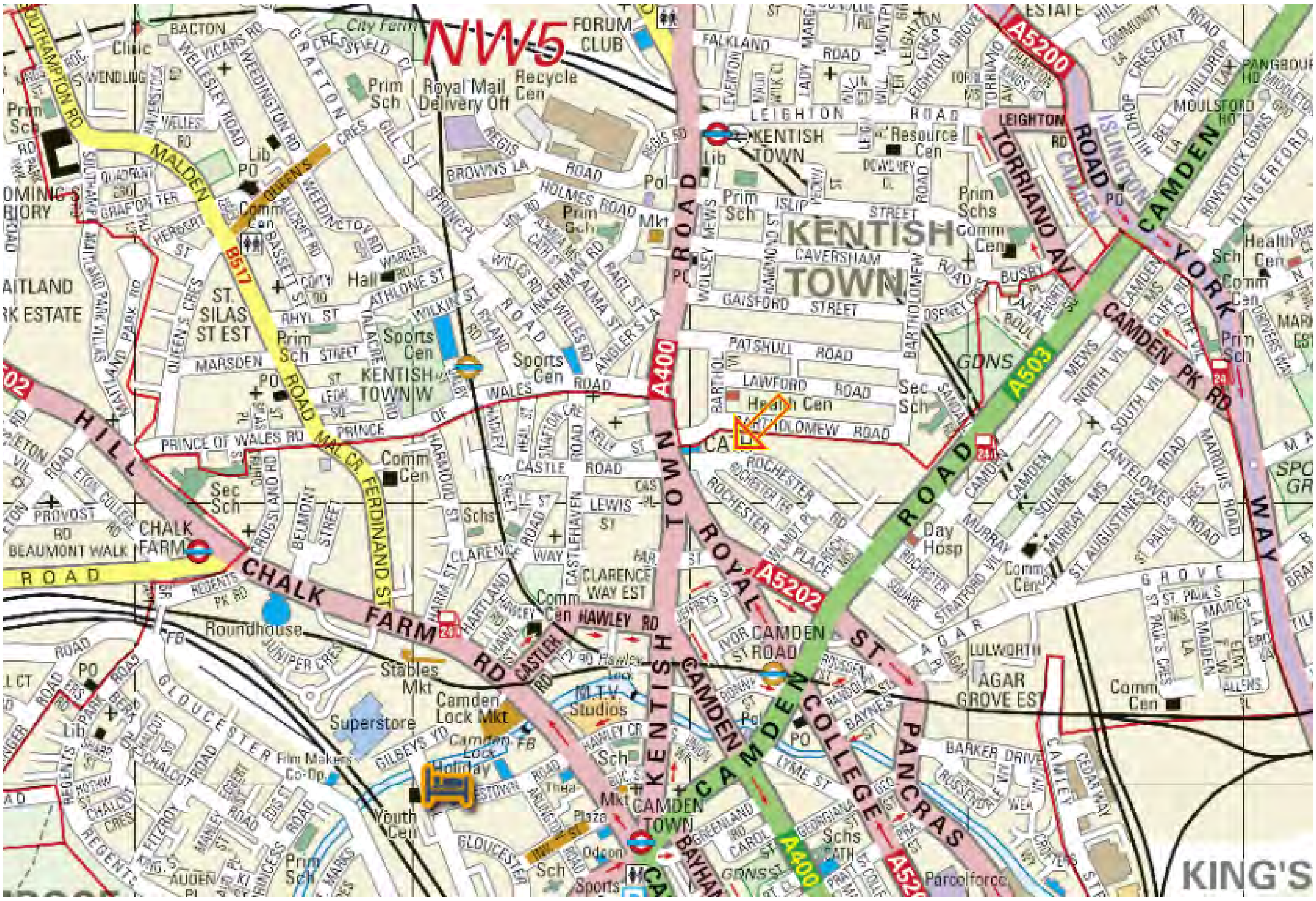
5.15 The results of the sulphate and pH testing indicate that in accordance with BRE Special Digest 1: 2005 “Concrete in aggressive ground” the soils beneath the site comply with Design Sulfate class DS-3 and ACEC Class AC-2s assuming a brownfield location and static groundwater.

FIGURES

CET INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

23 Rochester Road, London			Lead No. 146509
			Sheet 1 of 1
Created By: JAC	Checked:	Approved:	Date: May 2014



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Site Location Plan	Scale: NTS
	FIGURE 1

INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

23 Rochester Road, London			Lead No. 146509
			Sheet 1 of 1
Created By: JAC	Checked:	Approved:	Date: May 2014

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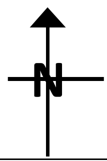


Site Location Plan

Scale: NTS

FIGURE 1

APPENDIX A

Exploratory Hole Logs

Client: **Patterson Homes**	Hole Diameter (mm): 75 tapering with depth to 6.00m	**BOREHOLE NUMBER WS01**
Method: Window Sampler		Sheet 1 of 2
Date: 14/04/14 — Co-ordinates E N	Ground Level (m AOD) — Ref. No: 146509	

Backfill/Well (m)	Water Depth (m)	Samples Depth (m)	Samples Type	In Situ Tests Results	Reduced Level (m AOD)	Depth & (Thickness) (m)	Description of Strata
0.10						(0.60)	Grass over firm, friable, dark brown, slightly gravelly, fine to coarse sandy CLAY. Gravel is angular to sub-rounded, fine to coarse flint, brick, roof tile and ceramic. (Made Ground)
		0.50	D				
						0.60	Firm becoming stiff at 0.9m, orange brown, slightly gravelly CLAY. Gravel is sub-angular to rounded, medium and coarse flint. (Head?)
		1.00	D	Vh = 74 pp = 3.5		(0.80)	
		1.25		pp = 2.6			
						1.40	Stiff, orange brown, slightly coarse sandy, gravelly CLAY. Gravel is sub-angular to rounded, fine to coarse flint and rare claystone. (Head?)
		1.50	D	pp = 4.4			
		1.75		pp = 4.4			
		2.00	D			(1.10)	
		2.50	D	pp = 4.9		2.50	Stiff becoming very stiff towards base of stratum, orange brown CLAY with occasional fine gravel size pockets/ lenses of stiff grey clay, fine to coarse gravel size pockets/ lenses of light brown and orange silt and rare fine gravel size white siltstone. Rare selenite noted throughout stratum. (Weathered London Clay Formation)
		2.75		pp = 5.7			
		3.00	D	Vh = 98 pp = 4.3			
		3.25		pp = 4.1			
		3.50	D	pp = 3.9			
		3.75		pp = 3.9			
		4.00	D	Vh = 102 pp = 4.3			
		4.25		pp = 3.7		(3.50)	
		4.50	D	pp = 3.7			
		4.75		pp = 4.3			

Continued on next sheet

General Remarks:
1. Exploratory hole remained dry and stable whilst open.
2. Abundant roots and rootlets noted to 0.6m below ground level and rare rootlets noted down to 5.0m below ground level.

Driller:	CB	BOREHOLE RECORD Scale 1:25 See Key Sheet for explanation of symbols, etc.	CET INFRASTRUCTURE Giving our all
Logged:	JAC		
Chked:		23 Rochester Road, London	**FIG A1**
Appr'd:			

Client: **Patterson Homes**	Hole Diameter (mm): 75 tapering with depth to 6.00m	**BOREHOLE NUMBER**
Method: Window Sampler		**WS01**
Date: 14/04/14	Co-ordinates E N	Ground Level (m AOD)	Ref. No: 146509	Sheet 2 of 2

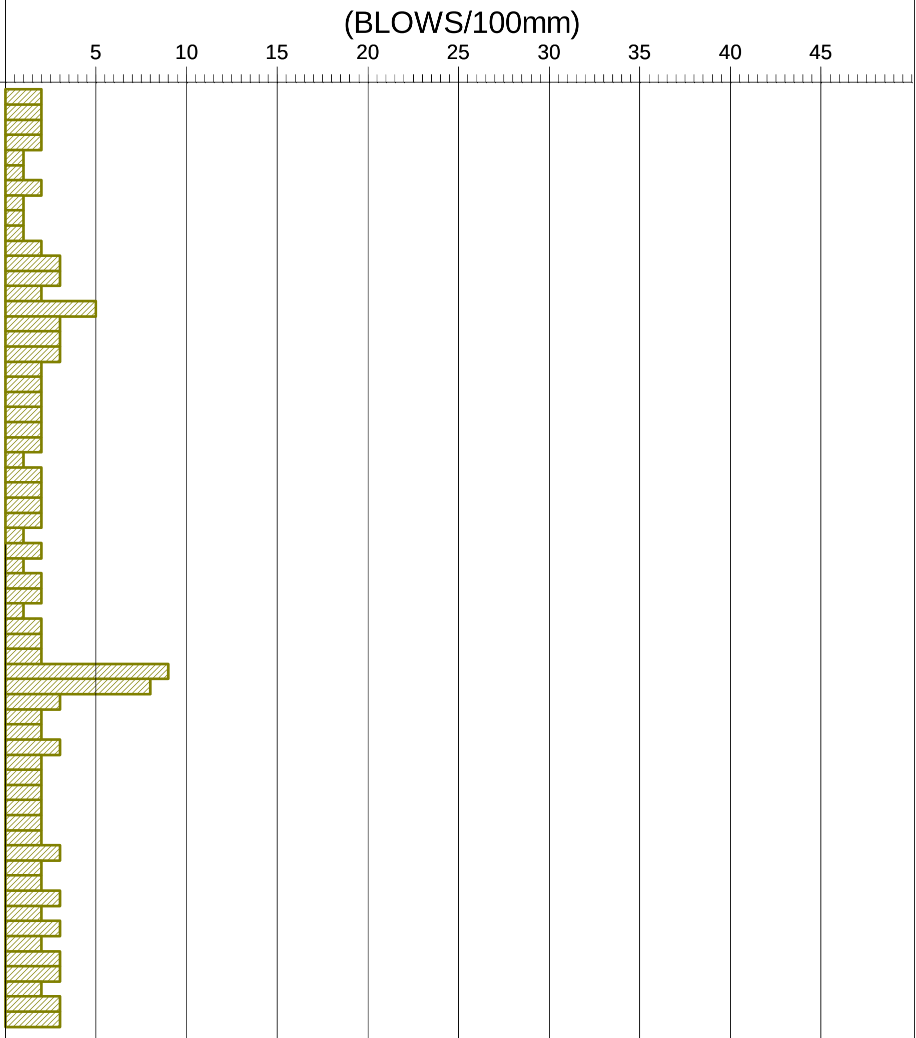
Backfill/Well (m)	Legend	Water Depth (m)	Samples Depth (m)	Samples Type	In Situ Tests Results	Reduced Level (m AOD)	Depth & (Thickness) (m)	Description of Strata	Legend
5.00			5.00	D	Vh = 92 pp = 5.0			Stiff becoming very stiff towards base of stratum, orange brown CLAY with occasional fine gravel size pockets/ lenses of stiff grey clay, fine to coarse gravel size pockets/ lenses of light brown and orange silt and rare fine gravel size white siltstone. Rare selenite noted throughout stratum.	
			5.25		pp = 4.5				
			5.50	D	pp = 4.9				
			5.75		pp = 4.6				
6.00			6.00	D	Vh = 122 pp = 5.4		6.00	*End of Borehole at 6.00 m*	

General Remarks:
1. Exploratory hole remained dry and stable whilst open.
2. Abundant roots and rootlets noted to 0.6m below ground level and rare rootlets noted down to 5.0m below ground level.

Driver:	CB	BOREHOLE RECORD Scale 1:25 See Key Sheet for explanation of symbols, etc.	CET INFRASTRUCTURE Giving our all
Logged:	JAC		
Chked:	[signature]	23 Rochester Road, London	**FIG A1**
Appr'd:	[signature]		

Client **Patterson Homes**	Fall Height(mm): 750	Cone Dia(mm): 50	**PROBE NUMBER DP01**
Site 23 Rochester Road, London	Hammer Wt(kg): 63.50	Final Depth(m): 6.20	
E / N / Level / Date 14/04/14	Probe Type: DPSH	Scale 1:50	Sheet 1 of 1

Depth (m)	Readings Blows/100mm				
0.50	2	2	2	2	1
1.00	1	2	1	1	1
1.50	2	3	3	2	5
2.00	3	3	3	2	2
2.50	2	2	2	2	1
3.00	2	2	2	2	1
3.50	2	1	2	2	1
4.00	2	2	2	9	8
4.50	3	2	2	3	2
5.00	2	2	2	2	2
5.50	3	2	2	3	2
6.00	3	2	3	3	2
6.20	3	3			



Torque (Nm)

Job Ref: **146509**

Super Heavy Dynamic Probe

INFRASTRUCTURE
Giving our all

FIG A2

Chec`d

Appr`d

General Remarks:
1. Super heavy dynamic probe carried out alongside WS01.

APPENDIX B

Laboratory Testing

ATTERBERG LIMITS AND MOISTURE CONTENT DETERMINATION TEST RESULTS

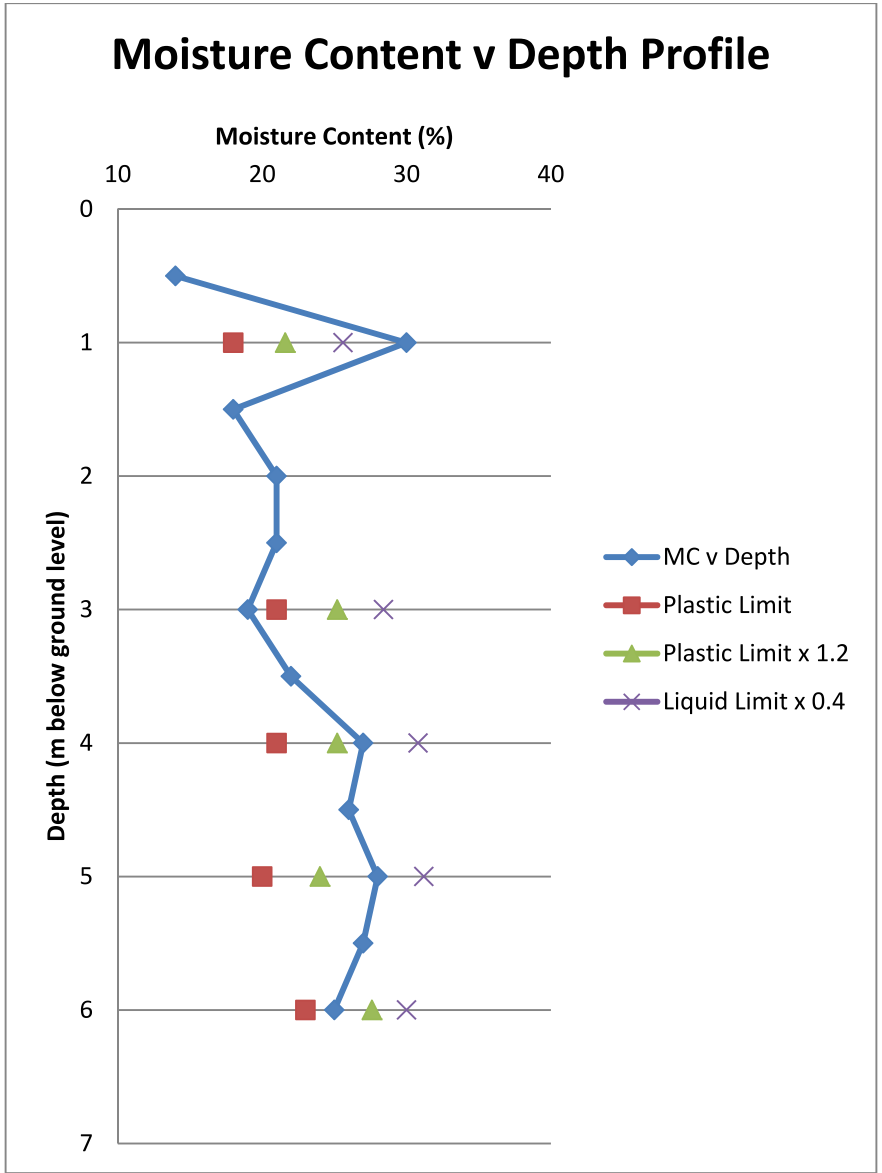
BH	Depth (m bgl)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Classification
WS01	0.5	14				
WS01	1.0	30	64	18	46	CH
WS01	1.5	18				
WS01	2.0	21				
WS01	2.5	21				
WS01	3.0	19	71	21	50	CV
WS01	3.5	22				
WS01	4.0	27	77	21	56	CV
WS01	4.5	26				
WS01	5.0	28	78	20	58	CV
WS01	5.5	27				
WS01	6.0	25	75	23	52	CV

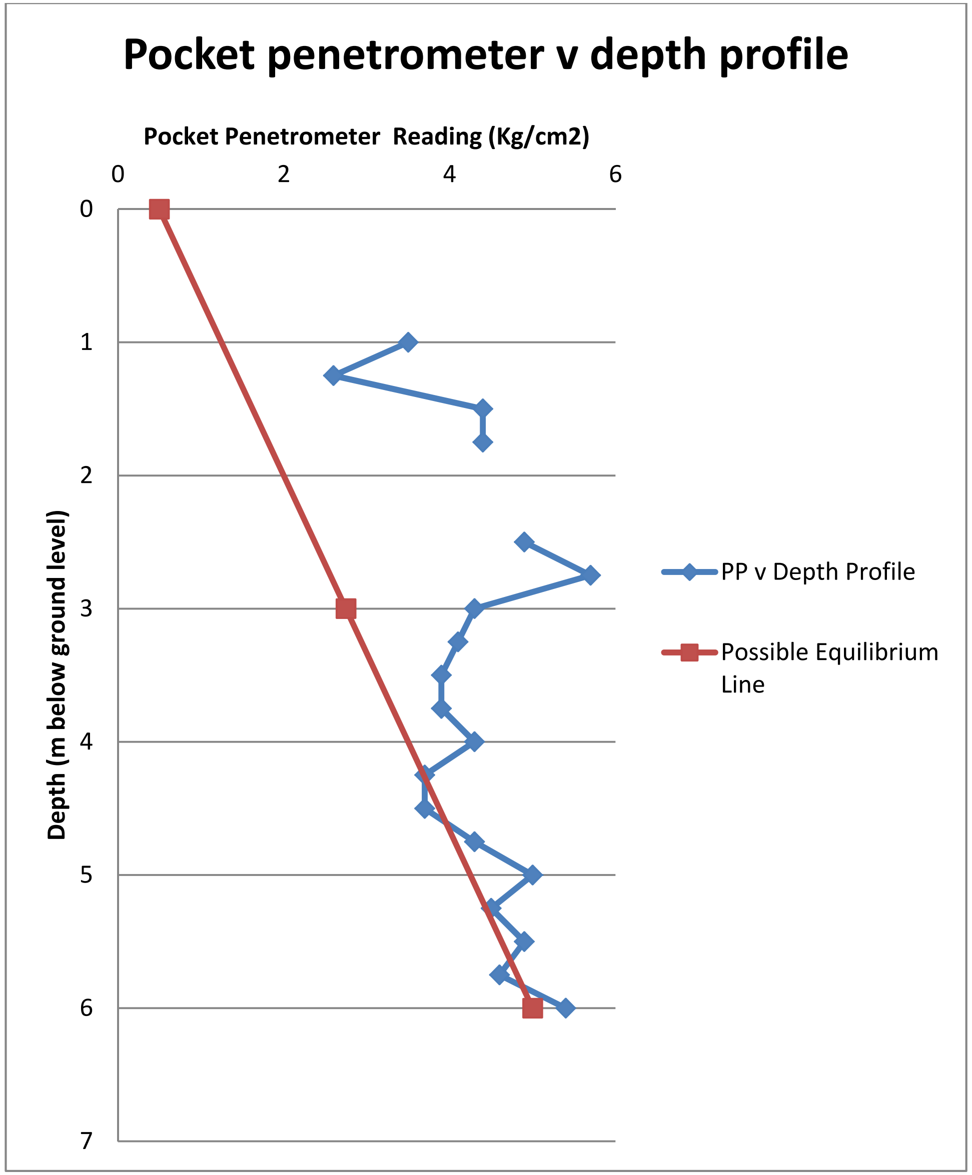
WATER SOLUBLE SULPHATE AND PH DETERMINATIONS

BH	Depth (m bgl)	Water Soluble Sulfate (SO_4) (g/l)	pH Value	Design Sulfate Class for Location	ACEC Class for Location
WS01	1.5	0.30	8.1	DS-1	AC-1s
WS01	3.5	0.64	8.1	DS-2	AC-1s
WS01	5.5	2.9	7.8	DS-3	AC-2s

APPENDIX C

Moisture Content and Pocket Penetrometer v Depth Profiles


Moisture Content v Depth Profile
Moisture Content (%)
10
20
30
40
0
1
2
3
4
5
6
7
Depth (m below ground level)
MC v Depth
Plastic Limit
Plastic Limit x 1.2
Liquid Limit x 0.4


Pocket penetrometer v depth profile
Pocket Penetrometer Reading (Kg/cm2)
0
2
4
6
0
1
2
3
4
5
6
7
Depth (m below ground level)
PP v Depth Profile
Possible Equilibrium Line

APPENDIX D

Structural loads

Richard Ball

From:	Andy O'Dea
Sent:	25 June 2014 14:39
To:	Richard Ball
Subject:	FW: 23 Rochester Road
Attachments:	Rochester Road 140625.dwg

Richard

Over to you.

Regards
Andy

From: Richard Hudson [mailto:richard@glencrossandhudson.co.uk]
Sent: 25 June 2014 14:13
To: Andy O'Dea
Cc: Philip McDowell
Subject: 23 Rochester Road

Andy

Further to our telephone conversation earlier today please find attached copy of our dwg file as requested.

I also confirm that the party wall line load is 245kN/m and the flank wall is 137kN/m (these figures include the rc wall).

The retaining walls will be designed as cantilevers propped at the bottom in the permanent condition only and constructed in 1.0 to 1.2m widths as underpinning.

Regards

Richard

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APPENDIX E

Basement Formation Suggested Method Statement

Basement Formation Suggested Method Statement

1.1. This method statement provides an approach which will allow the basement design to be correctly considered during construction, and the temporary support to be provided during the works. The contractor is responsible for the works on site and the final temporary works methodology and design on this site and any adjacent sites.

This method statement has been written in accordance with the recommendations stated in the Royal Borough of Kensington and Chelsea Town Planning policy on Subterranean Development & Camden New Basement Development Guidance Notes. The sequencing has been developed considering guidance from ASUC.

1.2. This method has been produced to allow for improved costings and for inclusion in the party wall Award. Should the contractor provide alternative methodology the changes shall be at their own costs, and an Addendum to the Party Wall Award will be required.

1.3. Contact party wall surveyors to inform them of any changes to this method statement.

1.4. The approach followed in this design is; to remove load from above and place loads onto supporting steelwork, then to cast cantilever retaining walls in underpin sections at the new basement level.

1.5. The cantilever pins are designed to be inherently stable during the construction stage without temporary propping to the head. The base benefits from propping, this is provided in the final condition by the ground slab. In the temporary condition the edge of the slab is buttressed against the soil in the middle of the property, also the skin friction between the concrete base and the soil provides further resistance. The central slab is to be poured in a maximum of a 1/3 of the floor area.

1.8. Allowance should be made for pumping the basement dry should water be encountered.

2. Enabling works

2.1. The site is to be hoarded with ply sheet to 2.2m to prevent unauthorised public access.

2.2. Licenses for Skips and conveyors to be posted on hoarding.

3. Basement Sequencing

3.1. Excavate Light well to front of property down to 600mm below external ground level.

3.2. Excavate first front corner of light well. (Follow methodology in section 4)

3.3. Excavate second front corner of light well. (Follow methodology in section 4)

3.4. Continue excavating section pins to form front light well. (Follow methodology in section 4)

3.5. Place cantilevered retaining wall to the left side of front opening. After 72 hours place cantilevered retaining wall to the right side of front opening.

3.6. Needle and prop front wall. Insert support.

3.7. Excavate out first 1.2m around front opening prop floor and erect conveyor.

3.8. Continue cantilevered wall formation around perimeter of basement following the numbering sequence on the drawings.

3.8.1. Excavation for the next numbered sections of underpinning shall not commence until at least 8 hours after drypacking of previous works. Excavation of adjacent pin to not commence until 24 hours after drypacking. (24hours possible due to inclusion of Conbextra 100 cement accelerator to dry pack mix)

3.8.2. Floor over to be propped as excavations progress. Steelwork to support Floor to be inserted as works progress.

3.9. Cast base to internal wall. Construct wall to provide support to floor and steels as works progress.

3.10. Provide structure to ground floor, which ties the top of the retaining walls.

3.11. Excavate a maximum of a 1/3 of the middle section of basement floor. Place reinforcement to central section of ground bearing slab and pour concrete. Excavate next third and cast slab. Excavate and cast final third and cast.

3.12. Provide water proofing to retaining walls as required.

4. Underpinning – Cantilevered Wall Creation

4.1. Excavate first section of retaining wall (no more than 1200mm wide). Where excavation is greater than 1.2m deep provide temporary propping to sides of excavation to prevent earth collapse (Health and Safety). A 1200mm width wall has a lower risk of collapse to the heel face.

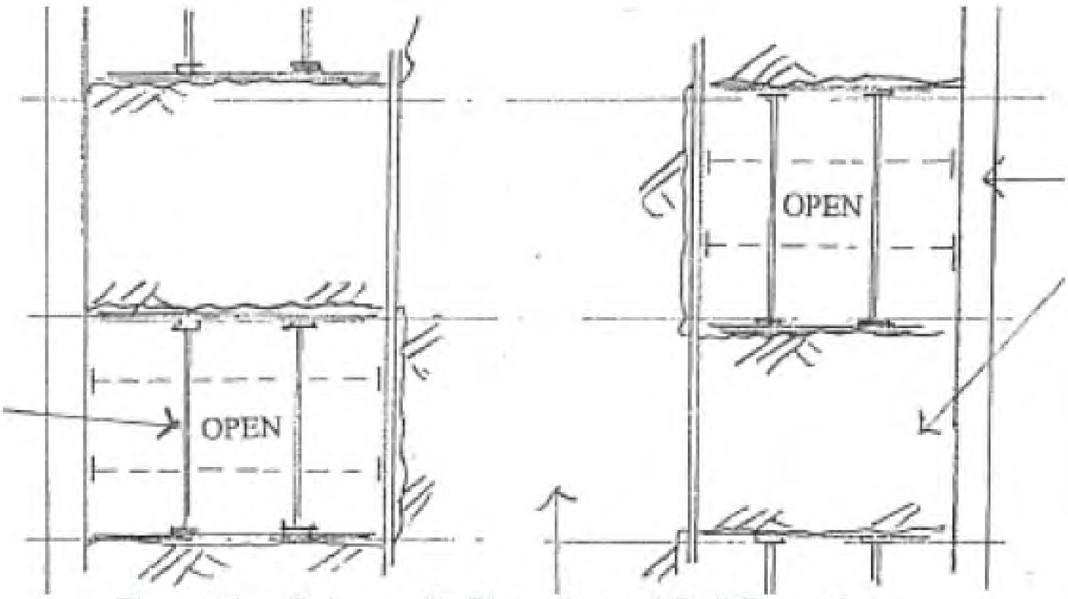
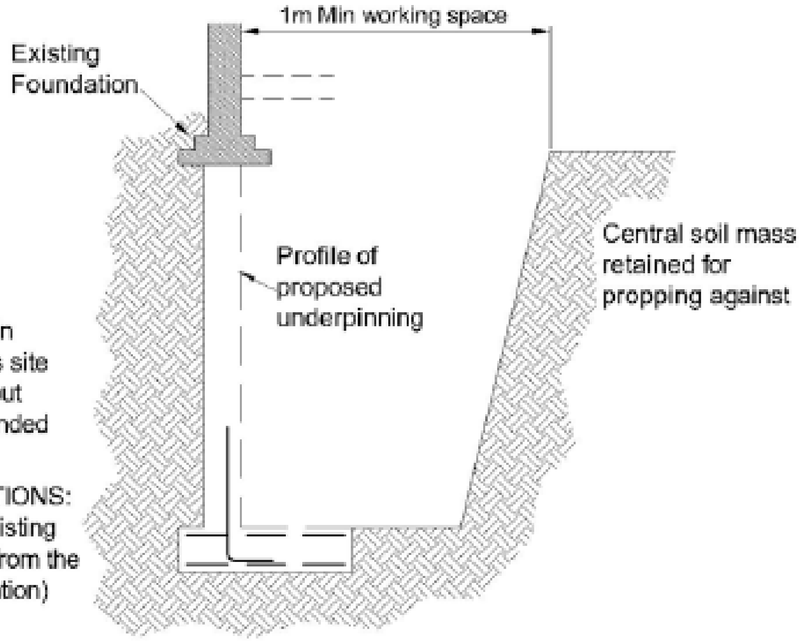


Figure 1 – Schematic Plan view of Soil Propping

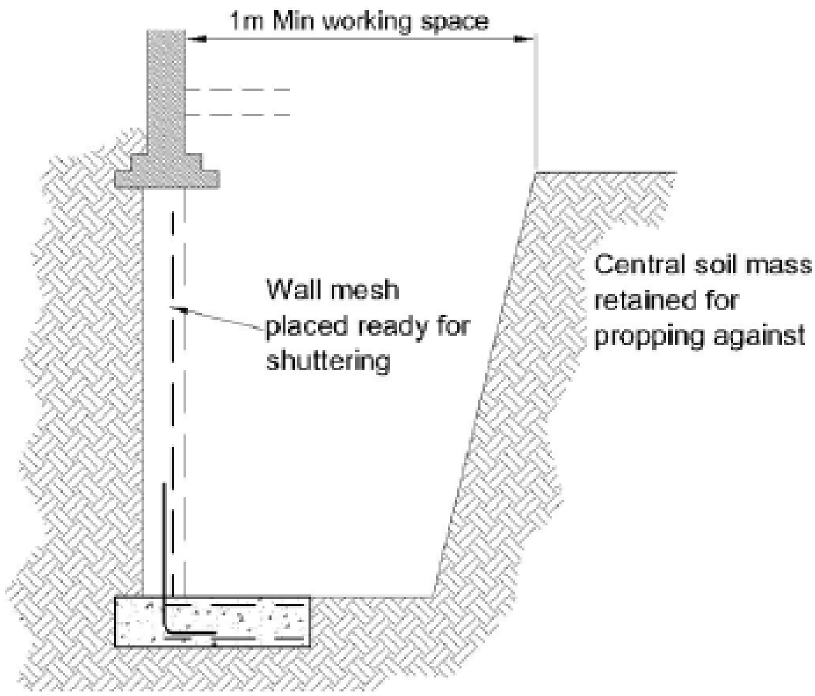

Figure 2 Propping

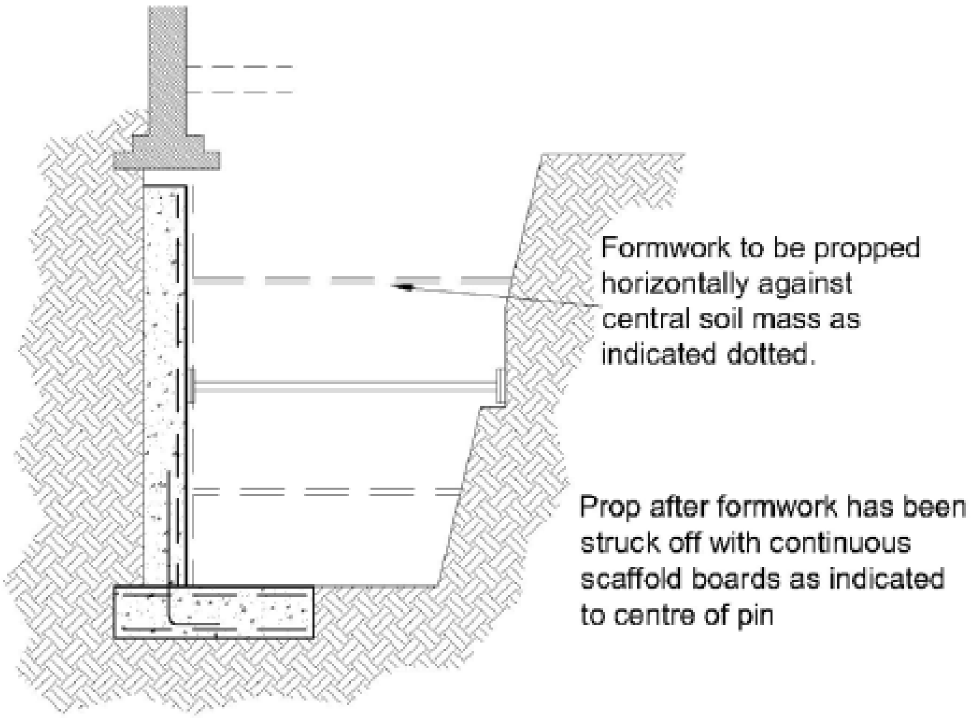


The rear of excavation may remain unsupported for max 48 hrs (or as site conditions permit) during works, but supported when the site is unattended

NOTE RE EXISTING FOUNDATIONS:
The staging of the removal of existing foundations / corbels may vary from the drawing (following site investigation)
Refer to method statement

Where the underside of the existing footings is found to be unstable. ie- in the case of loose brickwork as opposed to concrete foundations, then the underside is to be supported as necessary with a sacrificial prop if required





CLAY SOILS - STAGE 3

4.1.1. Where gravels or soft spots encountered back prop with Precast lintels. Prior to casting place layer of DPM between PC lintels and new concrete. The lintels are to be cut into the soil by 150mm either side of the pin. A site stock of a minimum of 10 lintels to be present for to prevent delays due to ordering.

4.1.2. If the soil support to the ends of the lintels is insufficient then brace the ends of the PC lintels with 150x150 C24 Timbers and prop with Acros diagonally back to the floor.

4.2. Provide propping to local brickwork, if necessary props to be sacrificial and cast into the retaining wall.

4.3. Provide propping to floor where necessary.

4.4. Excavate base. Mass concrete heels to be excavated. If soil over unstable prop top with PC lintel and sacrificial prop.

4.5. Clear underside of existing footing.

4.6. Local authority inspection to be carried for approval of excavation base.

4.7. Place blinding.

4.8. Place reinforcement for retaining wall base, heel & toe. Site supervisor to inspect and sign off works for proceeding to next stage.

4.9. Cast base. Take 2 cubes of concrete and store for testing. Test at 14 days and 28 days and provide results to client and design team as they become available.

4.10. Horizontal temporary prop to base of wall to be inserted. Alternatively cast base against soil.

4.11. Place reinforcement for retaining wall stem. Site supervisor to inspect and sign off works for proceeding to next stage.

4.12. Drive H16 Bars UBars into soil along centre line of stem to act as shear ties to adjacent wall.

4.13. Place shuttering & pour concrete for retaining wall. Stop a minimum of 75mm from the underside of existing footing. Take 2 cubes of concrete and store for testing.

4.14. Ram in drypack between retaining wall and existing masonry. (24 hours after pouring the concrete pin the gap shall be filled using a dry pack mortar.)

4.15. Using light hand tools trim back existing concrete footing and masonry corbel on internal face.

4.16. Site supervisor to inspect and sign off for proceeding to the next stage.

5. Approval

5.1. Building control officer/approved inspector to inspect every pin base and reinforcement prior to casting concrete.

5.2. Contractor to keep list of dates pins inspected & cast.

5.3. One month after work completed the contractor is to contact adjacent party wall surveyor to attend site and complete final condition survey and to sign off works.