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Your Ref:

Our Ref: **16/25536-2**
December 2016

28 CANFIELD GARDENS

LONDON, NW6 3LA

BASEMENT IMPACT ASSESSMENT

Prepared for

Martin Redston Associates

Acting on behalf of

Kolyma Investments Limited

Reg Office: Units 14 +15, River Road Business Park,
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1.0 NON-TECHNICAL SUMMARY

1.1 Project Objectives

At the request of Martin Redston Associates, working on behalf of Kolyma Investments Limited, a Basement Impact Assessment has been carried out at 28 Canfield Gardens, London, NW6 2LA in support of a planning application for a proposed development which includes the construction of a single storey basement beneath the current property. It is understood that the proposed basement is at a level of approximately 2.880 mOD.

1.2 Desk Study Findings

From historical map evidence it would appear that the site was first built on between 1871 and 1896, with minor changes taking place to the property since its construction. The surrounding area was initially used for agricultural and recreational uses, however this predominately changed to residential, although some industrial sites including a coal depot, warehouses and a food factory have been present within the area.

1.3 Ground Conditions

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 2.40m in thickness resting on deposits of the London Clay formation. The Made Ground extended down to depths of between 0.60m and 2.40m (43.40mOD to 41.60mOD). The material generally comprised a surface layer of either concrete or slate chippings over a brown, black clayey gravelly sand with brick and concrete fragments underlying a brown, black silty sandy clay containing brick and concrete fragments. The London Clay formation was encountered below the Made Ground and consisted of stiff clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals. These deposits extended down to the full depths of investigation of 15.00m below ground level in Borehole 1 and 10.00m below ground level in Borehole 2 (29.00 to 34.00 mOD). Following drilling operations, groundwater monitoring piezometers were installed in Boreholes 1 and 2 to approximately 8.00m and 8.50m depth.

Groundwater was encountered at respective depths of 5.78m and 0.53m within the standpipes in Boreholes 1 and 2 after a period of approximately four months.

1.4 Recommendations

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

The qualifications required by L. B. Camden are fulfilled as documented in Table A below. All assessors meet the qualification requirements of the council guidance.

Subject	Qualifications Required by CPG4	Relevant persons and qualifications/experience	
		Name/Qualifications	Experience
Surface flow and flooding	A hydrologist or a Civil Engineer specialising in flood risk management and surface water drainage, with either: • The 'CEng' (Chartered Engineer) qualification from the Engineering Council; or a Member of the Institution of Civil Engineers ('MICE') • The CWEM (Chartered Water and Environmental Manager) qualification from the Chartered Institution of Water and Environmental Management	Mr Neil Smith Eur Ing, BSc (Eng), MSc, CEng, FICE, FGS	40+ years' experience in geotechnics and hydrogeology, British Geotechnical Association Member, International Society for Soil Mechanics and Geotechnical Engineering
		Mr Thomas Murray BSc(hons) MSc FGS	2.5+ years of hydrogeological experience
		Mr Andrew Garnham BSc(Hons) MSc FGS	20+ years of hydrogeological experience
Subterranean (ground water flow)	A hydrogeologist with the 'CGeol' (Chartered Geologist) qualification from the Geological Society of London	Mike Brice BSc MSc DIC CGeol	30+ years of hydrological/geotechnical experience and Member British Geotechnical Association)
Land Stability	A Civil Engineer with the 'CEng (Chartered Engineer) qualification from the Engineering Council or specialising in ground engineering; or A Member of the Institution of Civil Engineers ('MICE') and a Geotechnical Specialist as defined by the Site Investigation Steering Group	Mike Brice BSc MSc DIC CGeol	30+ years of hydrological/geotechnical experience and Member British Geotechnical Association)

Table A – Qualifications

2.0 INTRODUCTION

2.1 Project Objectives

At the request of Martin Redston Associates, working on behalf of Kolyma Investments Limited, a Basement Impact Assessment has been carried out at the above site in support of a planning application.

The purpose of this assessment is to consider the effects of a proposed basement construction on the local slope stability, surface water and groundwater regime at the existing residential property.

The recommendations and comments given in this report are based on the information contained from the sources cited and may include information provided by the Client and other parties, including anecdotal information. It must be noted that there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

This report does not constitute a full environmental audit of either the site or its immediate environs.

2.2 Planning Policy Context

The information contained within this BIA has been produced to meet the requirements set out by Camden Planning Guidance – Basements and Lightwells (CPG4) including Camden Development Policies DP27 – Basements and Lightwells (Ref. 1) in order to assist London Borough of Camden with their decision making process.

As recommended by the Guidance for Subterranean Development (Ref. 1) the BIA comprises the following steps

1. **Initial screening** to identify where there are matters of concern

2. **Scoping** to further define the matters of concern

3. **Site Investigation and study** to establish baseline conditions

4. **Impact Assessment** to determine the impact of the basement on baseline conditions

5. **Review and Decision Making** (to be undertaken by LBC)

3.0 SITE DETAILS

(National Grid Reference: TQ261845)

3.1 Site Location

28 Canfield Gardens is a residential property, located on the northern side of Canfield Gardens, South Hampstead at approximate postcode NW6 3LA. The residential dwelling has three levels of accommodation; ground, first and second floor with rooms in the roof space and a lower ground floor. The residential property also comprises a front and rear garden. The site covers an approximate area of 0.03 Hectares with the general area being under the authority of the London Borough of Camden.

The site is located on the northern side of Canfield Gardens with residential properties to the north-east and south-west, with private gardens to the north-west and a roadway to the south-east.

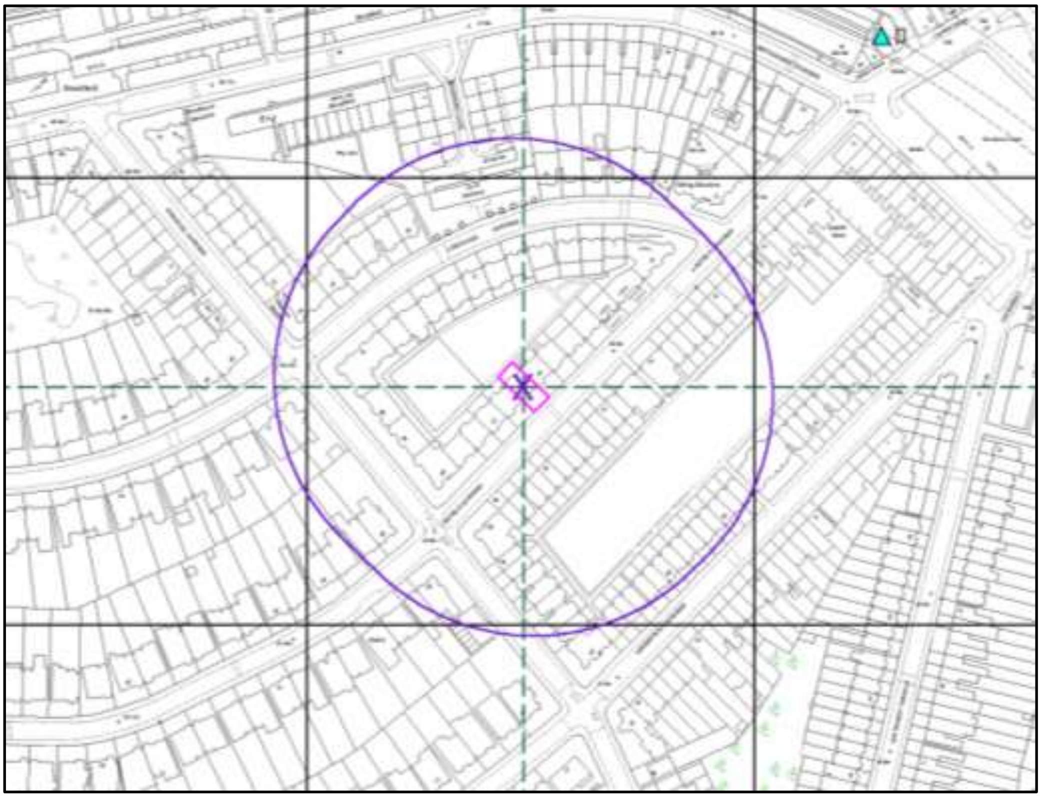


Figure 1. Site Location Plan

3.2 Site Layout and History

The site is accessed from Canfield Gardens located to the south and comprises of a three storey residential property, with front and rear garden areas.

The property is bound by Canfield Road to the south, with residential properties with residential properties to the north-east and south-west.

The property contains a brick paved pathway, with two medium trees on either side, leading up to the front door of the property.

With reference to available spot height data from Ordnance Survey (OS) mapping, an assumed ground level of approximately 43m AOD is anticipated at the site. Based on this level, it is understood that ground level at the site steps down from approximately 43mAOD at the front of the property to approximately 42.15mAOD at lowered rear garden level.

The site slopes very gently to the south-west. The slope angle is less than 7 degrees. Also with reference to the Camden Geological, Hydrogeological and Hydrological Study, (Figure 2 below), the neighbouring properties also have slopes less than 7 degrees.

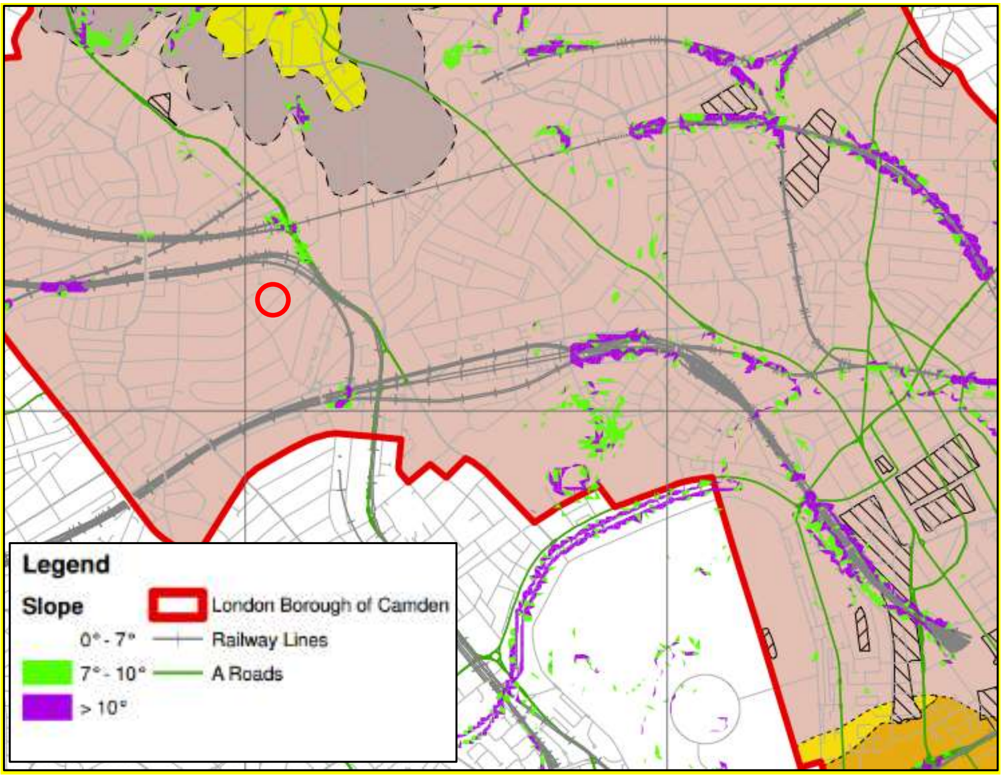


Figure 2. Exact from Figure 16 of the Camden CPG4 showing slope angles within the borough

From historical map evidence it would appear that the site was first built on between 1871 and 1896, with minor changes taking place to the property since its construction. The surrounding area was initially used for agricultural and recreational uses, however this predominately changed to residential, although some industrial sites, including a coal depot, warehouses and a food factory have been present within the area.

3.3 Previous Reports

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 16/25536-1) and Phase 2 Site Investigation (SAS Report Ref: 16/25536) was undertaken across the site by Site Analytical Services Limited in August 2016 and the results are discussed in this BIA.

3.4 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain the London Clay Formation at depth.

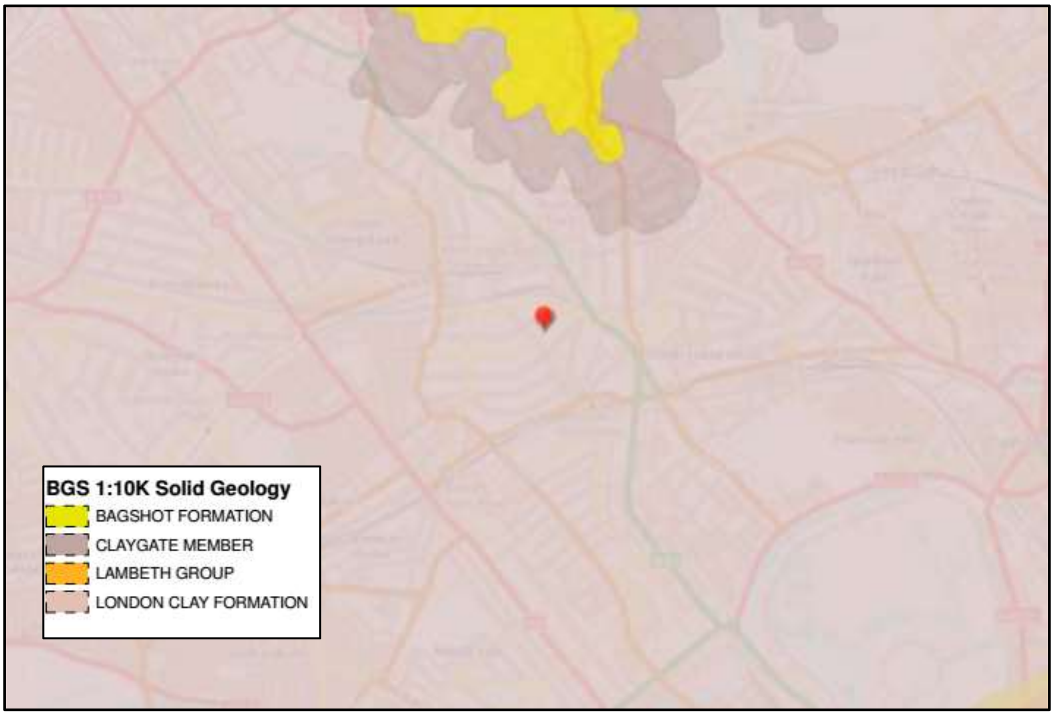


Figure 4. Geology of the Site (Ref. BGS Geoindex)

The British Geological Survey maintains an archive of historical exploratory borehole logs throughout the UK. SAS has searched the database and have found that there are 4 boreholes located within 150m of the site. These reveal Made Ground to a depth of 0.90m underlain the London Clay Formation to the full depth of excavation at 7m.

3.5 Hydrology and drainage

3.5.1 Surface Water

According to Mayes (1997) rainfall in the local area averages around 610mm and significantly less than the national average of around 900mm.

Evapotranspiration is typically 450mm/year resulting in about 160mm/year as 'hydrologically effective' rainfall which is available to infiltrate into the ground or run-off as surface water flow.

With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) a tributary of the 'lost rivers' River Westbourne was located approximately within 5m of the site (Figure 4).

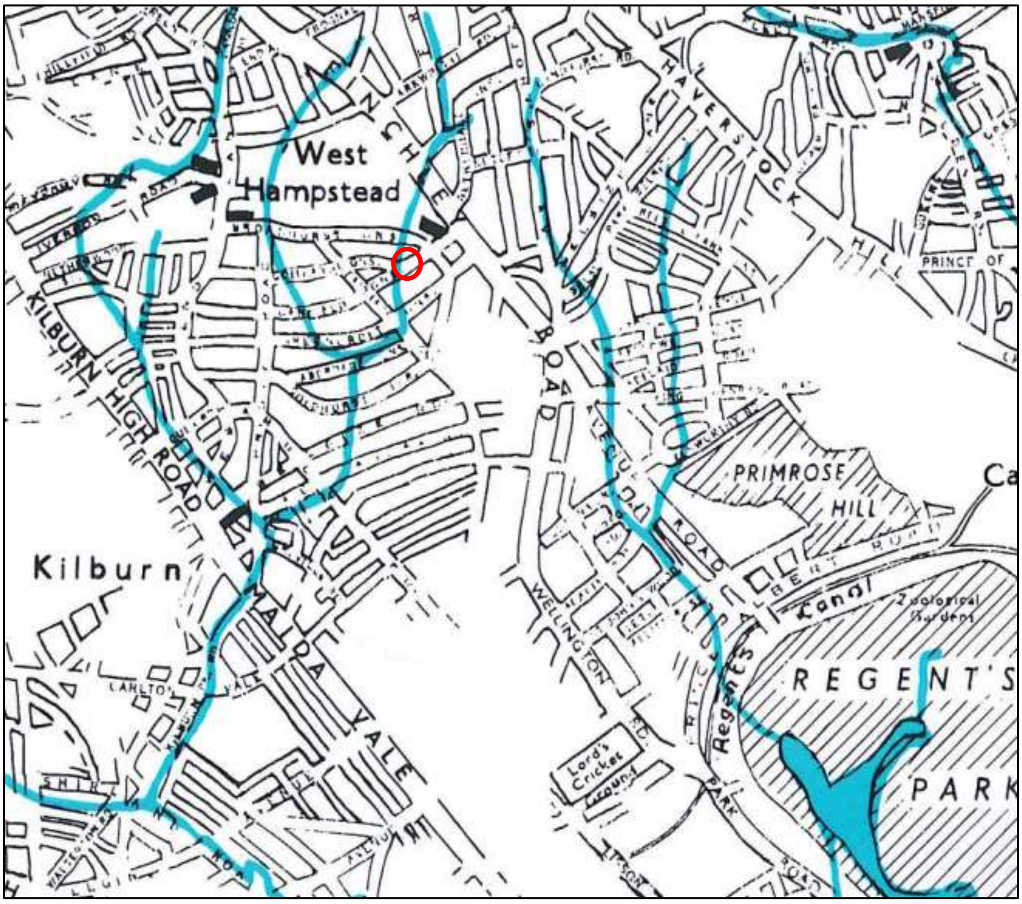


Figure 5. Location of site (circled) relative to the 'Lost Rivers' of London (Source: Barton, 1992)

The River Westbourne flowed in a southerly direction from West Hampstead. From the tributaries it flowed southwards towards Kilburn, across Bayswater Road and into Hyde Park, where it entered the Serpentine. From the Serpentine it flowed southwards under Knightsbridge before issuing into the River Thames within the grounds of Chelsea Hospital.

The watercourses have since been largely lost through a culverting system as the urban extent of the borough has grown over time.

Envirocheck indicates that the closest surface water feature is a drain located 691m east of the site.

The area located immediately around the site is highly developed with more than 80% of the surface covered with hardstanding. Most of the rainfall in the area will run-off hard surface areas and be collected by the local sewer network.

Surface drainage from the site is assumed to be directed to drains flowing downhill to the south-west along Canfield Road.

3.5.2 Flood Risk

3.5.2.1 River or Tidal flooding

According to Environment Agency Flood maps there are no flood risk zones within 1 kilometre of the site. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs. Based on this information a flood risk assessment will not be required.

3.5.2.2 Surface water flooding

Figure 6 shows that Canfield Gardens flooded during the 2002 event, but not in the 1975 flood event.

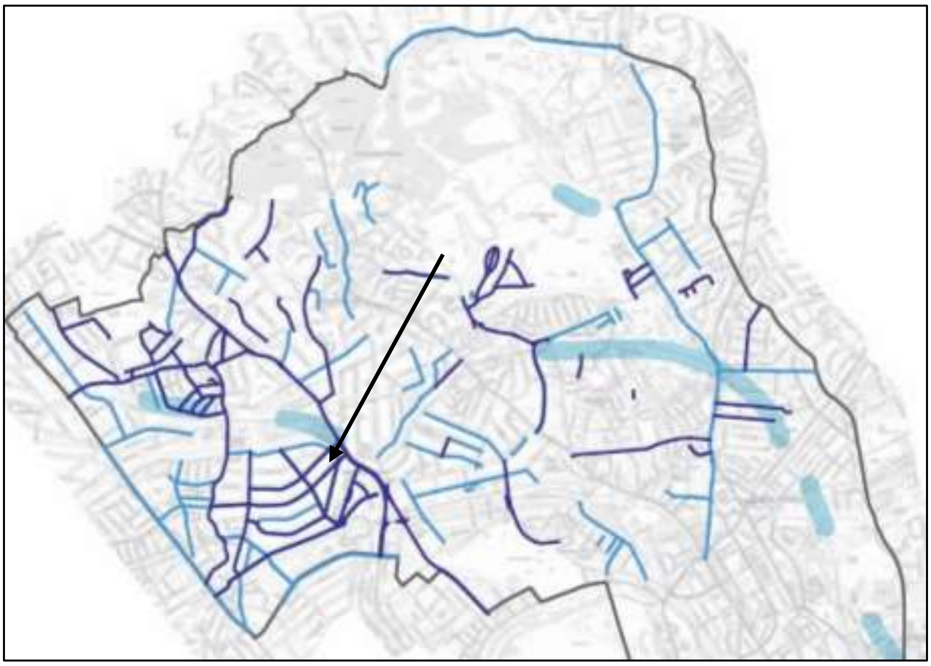


Figure 6. Exact from Figure 15 of the Camden CPG4 showing roads which flooded in 1975 (light blue), in 2002 (dark blue) and 'areas with potential to be at risk from surface water flooding' (wide light blue bands)

Further modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 7. Whilst this map identifies four levels of risk (high, medium, low and very low) it is understood that it is based at least in part on depths of flooding. This modelling shows a 'Very Low' risk of flooding (the lowest category for the national background level of risk) for No.9 and the surrounding area.

3.5.2.3 Sewer flooding

The London Regional Flood Risk Appraisal (2009) advises that foul sewer flooding is most likely to occur where properties are connected to the sewer system at a level below the hydraulic level of the sewage flow, which in general are often basement flats or premises in low lying areas. There is no record of sewer flooding having occurred at 28 Canfield Gardens and therefore the risk of sewer flooding is considered low.

3.6 Hydrogeological setting

The Environment Agency Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems.

The Bedrock geology underlying the site (London Clay) has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Other hydrogeological data obtained from the Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 16/25536) for the site include:

- The underlying soil classification of the site is of high leaching potential.

- The site is located 516m to the east of a Zone II (Outer Protection Zone) Source Protection Zone.

- There are 4 groundwater abstraction licences listed within one kilometre of the site. The closest is located 686m east of the site and relates to spray irrigation.

3.7 Proposed Development

It is proposed to extend the existing basement beneath the full footprint of the existing property.

The proposed basement extension is split into three different areas with various depths of excavation:

- An area below the north eastern section of the existing building adjacent to No. 26 Canfield Gardens which will be extended to 2.48m below ground level or 0.89m below existing basement level (circa 40.52mOD). This area is described as the new 'basement' in this report;

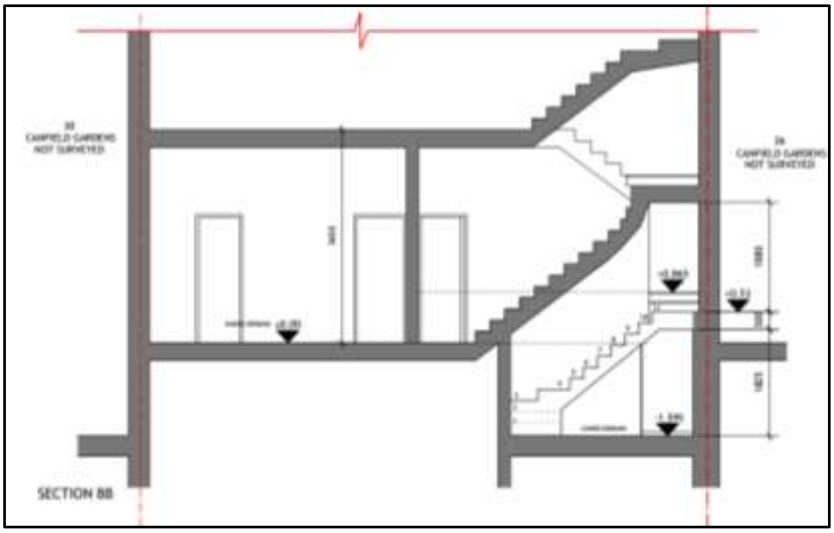
- An area below the south western section of the existing building adjacent to No. 30 Canfield Gardens which will extend to 3.39m below ground level or 1.80m below existing basement level (circa 39.62OD). Due to its deeper depth, this area is described as the 'sub-basement' in this report.

- Lightwells at the front and rear of the site which are proposed to extend to the same depth as the sub-basement (i.e 3.39mbgl or 39.62mOD).

Within this report, the deepest level of excavation (39.62mOD) will be reference in relation to possible water levels encountered during site work.

Sections showing the proposed developments are detailed in Figure 8 below.

Existing



Proposed

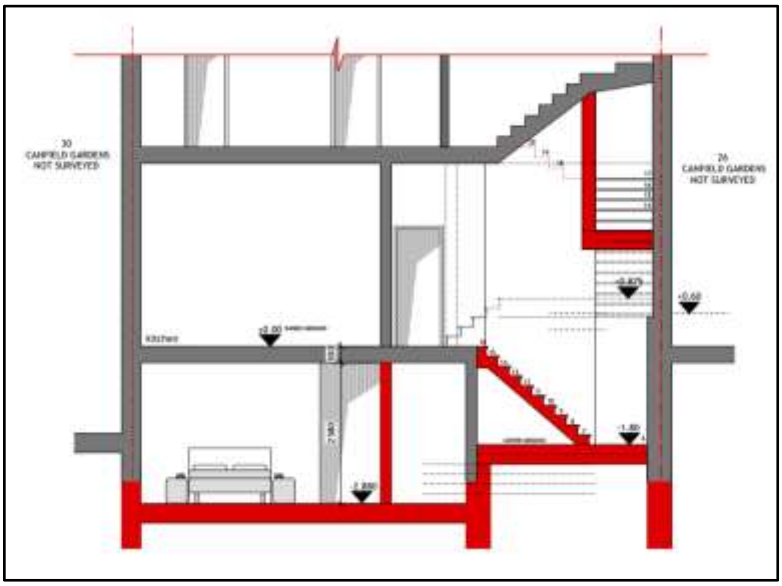


Figure 8. Sections of the proposed elevations of the property.

3.8 Results of Basement Impact Assessment Screening

A screening process has been undertaken for the site and the results are summarised in Table 1 below:

Table 1 : Summary of screening results

Item	Description	Response	Comment
Sub-terranean (Ground water Flow)	1a. Is the site located directly above an aquifer.	No	The site has been classified as being situated above an unproductive (negligibly permeable) formation (London Clay) that is generally regarded as containing insignificant quantities of groundwater.
	1b. Will the proposed basement extend beneath the water table surface?	Unknown – to be confirmed by Ground Investigation	Given the presence of a non-aquifer below the site it is unlikely that groundwater will be encountered during any excavations for the proposed basement, however this will be confirmed by the ground investigation.
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	Yes	Envirocheck indicates that the closest surface water feature is a drain located 691m east of the site. With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) a tributary of the 'lost rivers' River Westbourne was located approximately within 5m of the site (Figure 4). From the British Geological Society 'Geoindex' the nearest water well is located approximately 2.37 km south of the site.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	No	The amount of hardstanding on-site is not expected to change.
	4. As part of site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS).	No	Existing drainage paths are to be utilised where possible. Whether soakaways/SUDS are used on the proposed development is to be confirmed (beyond the scope of this report). An appropriately qualified engineer should be engaged to ensure mandatory requirements are met.
	5. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line.	Yes	Envirocheck indicates that the closest surface water feature is a drain located 691m east of the site. With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) a tributary of the 'lost rivers' River Westbourne was located approximately within 5m of the site (Figure 4). From the British Geological Society 'Geoindex' the nearest water well is located approximately 2.37 km south of the site.

Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8).	No	There is a slight slope from north to south across the site, but is below 7 degrees.
	2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8).	No	Re-profiling of landscaping at the site is not proposed.
	3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8).	No	The surrounding area drops to the south-east, but from survey information and with reference to Figure 16 from Camden CPG 4, this is at angles of less than 7 degrees.
	4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8).	No	There is a general slope in the area towards the south down to the south-east, but this is at an angle of less than 7 degrees.
	5. Is the London Clay the shallowest strata at the site.	Yes	With reference to available BGS records, the London Clay formation is expected to be encountered from ground level.
	6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained.	No	It is understood that no trees are to be felled as part of the development.
	7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	Yes	The site lies above the London Clay formation well known as having a high tendency to shrink and swell.
	8. Is the site within 100m of a watercourse or a potential spring line.	Yes	Envirocheck indicates that the closest surface water feature is a drain located 691m east of the site. With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) a tributary of the ‘lost rivers’ River Westbourne was located approximately within 5m of the site (Figure 4).
	9. Is the site within an area of previously worked ground.	No	According to records from the BGS the site is not in the vicinity of any recorded areas of worked ground.

	10. Is the site within an aquifer. If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction.	No	The site has been classified as being situated above an unproductive (negligibly permeable) formation (London Clay) that is generally regarded as containing insignificant quantities of groundwater.
	11. Is the site within 50m of the Hampstead Heath Ponds	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	12. Is the site within 5m of a highway or pedestrian right of way.	Yes	The site lies within 5m of Canfield Gardens.
	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes	The development will increase the depths of foundation at the site, although the foundation depths of adjacent properties are not known.
	14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	Unknown / outside scope of report	A full statutory service search was outside the scope of this report and must be completed prior to any excavations
Surface Water and Flooding	1. Is the site within the catchment of the ponds chains on Hampstead Heath	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	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	No – any additional surface water generated from an increased hardstanding area will be attenuated to ensure they are not increased or altered. The basement will be beneath the footprint of the new dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report, does not apply across these areas.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	Yes	The amount of hardstanding on-site is not expected to increase.

	4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses.	No	All surface water for the site will be contained within the site boundaries and collected as described above; hence there will be no change from the development on the quantity or quality of surface water being received by adjoining sites. The basement will be beneath the footprint of the dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report does not apply across these areas.
	5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	The surface water quality will not be affected by the development, as in the permanent condition collected surface water will be generally be from roofs, domestic hard landscaping or collected from beneath the landscaping layer over the basement.
	6. Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature	Yes	Canfield Gardens flooded during the 2002 flood event. According to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.28 and the surrounding area.

3.9 Non-Technical Summary of Chapter 3.0

28 Canfield Gardens is a residential property, located on the northern side of Canfield Gardens, South Hampstead at approximate postcode NW6 3LA. The residential dwelling has three levels of accommodation; ground, first and second floor. The residential property also comprises a front and rear garden.

The property is constructed on very slightly sloping ground from north-east to south-west.

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by the London Clay formation. The London Clay formation is classed as unproductive strata or a non-aquifer.

Envirocheck indicates that the closest surface water feature is a drain located 691m east of the site.

According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is located approximately 5m north-west of the site respectively (Figure 4).

According to Environment Agency Flood maps there are no flood risk zones within 1 kilometre of the site. The EA’s website also shows that this area does not fall within an area at risk of flooding from reservoirs.

Based on this information a flood risk assessment will be required. Canfield Gardens flooded during the 2002 flood event. Modelling of surface water flooding by the Environment Agency shows a ‘Very Low’ risk of flooding (the lowest category for the national background level of risk) for No.28 and the surrounding area.

The Screening Exercise has identified the following potential issues which will be carried forward to the Scoping Phase

Subterranean Groundwater Flow

- Will the proposed basement extend beneath the water table surface?
- Is the site within 100m of a watercourse, well (used / disused) or potential spring line.
- Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line.

Slope Stability

- Is the London Clay the shallowest strata at the site?
- Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?
- Is the site within 100m of a watercourse or a potential spring line?
- Is the site within 5m of a highway or pedestrian right of way?
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?
- Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?

Surface Water and Flooding

- Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?

4.0 SCOPING PHASE

4.1 Introduction

This purpose of the scoping phase is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified impact factors and recommendations are stated.

A conceptual ground model is usually complied at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Chapter 4.

Subterranean (Groundwater Flow)

Potential Issue (Screening Question)		Potential impacts and actions
1	Will the proposed basement extend beneath the water table surface?	**Potential impact:** Local restriction of groundwater flows (perched groundwater or below groundwater table). **Action:** Ground investigation required, the review.
2	Is the site within 100m of a watercourse, well (used / disused) or potential spring line	**Potential impact:** The flow from a spring, well or watercourse may increase or decrease if the groundwater flow regime is affected by the proposed basement **Action:** Review hydrogeology of the site and undertake a ground investigation.

Slope Stability

3	Is the London Clay the shallowest strata at the site?	**Potential impact:** The London Clay is prone to seasonal shrink-swell (subsidence and heave). **Action:** Ground investigation required, the review.
4	Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	**Potential Impact:** Ground movements will occur during and after the basement construction. **Action:** Ground investigation required, then review.
5	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Excavation of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice working methods.

6	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the new foundations to neighbouring properties if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice methods.
7	Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	**Potential impact:** Excavation of basement damages the underlying tunnels **Action:** Ensure foundation solution is agreed with Network Rail prior to commencing on site.

Surface Water and Flooding

Potential Issue (Screening Question)		**Potential impacts and actions**
8	Is the site in an area known to be at risk from surface water flooding?	**Potential impact**: Flooding occurs during the excavation of the basement **Action**: A groundwater exception test should be carried out prior to any construction works.

These potential impacts have been further assessed through the ground investigation, as detailed in Section 4 below.

4.2 Non-Technical Summary of Chapter 4.0

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Review of site's hydrogeology and groundwater control requirements.

All these actions are covered in Stage 4 or Stage 3 for the ground investigation.

5.0 SITE INVESTIGATION DATA

5.1 Records of site investigation

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in July to December 2016 and included two continuous flight auger boreholes (Boreholes 1 and 2).

The factual findings from the investigation are presented in Appendix B, including a site plan, exploratory hole logs, groundwater monitoring and laboratory test results.

5.2 Ground conditions

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 2.40m in thickness resting on deposits of the London Clay formation.

5.2.1 Made Ground

The Made Ground extended down to depths of between 0.60m and 2.40m in the boreholes 1 and 2 (40.60mOD to 41.55mOD). The material generally comprised a surface layer of either concrete or slate chippings over a brown, black clayey gravelly sand with brick and concrete fragments underlying a brown, black silty sandy clay containing brick and concrete fragments.

5.2.2 London Clay Formation

The London Clay formation was encountered below the Made ground and consisted of stiff clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals. These deposits extended down to the full depths of investigation of 15.00m below ground level in Borehole 1 and 10.00m below ground level in Borehole 2 (28.00 to 32.15 mOD).

5.3 Groundwater

Groundwater was not encountered within the boreholes and the soils remained essentially dry throughout.

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

Following drilling operations groundwater monitoring piezometers were installed in Boreholes 1 and 2 to approximately 8.00m and 8.50m depth respectively.

Groundwater encountered at a depth of 1.02mbgl (41.13mOD0 within Borehole 2 and was not encountered within Borehole 1 during September 2016. In November 2016 groundwater was encountered at respective depths of 5.78mbgl (37.22mOD) and 0.53mbgl (41.62mOD).

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (July to December 2016) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

5.4 In-Situ and Laboratory Testing

The results of the laboratory and in-situ tests are presented in the factual report contained in Appendix A.

5.4.1 Hand Vane Tests

In the essentially cohesive natural soils encountered at the site, in-situ shear vane tests were made at regular depth increments in order to assess the undrained shear strength of the materials. The results indicate that the natural soils are of a generally high strength in accordance with BS 5930:2015.

5.4.2 *Mackintosh Probe Tests*

Mackintosh Probe tests were made at regular depth increments in order to assess the relative density of the soils encountered in the boreholes. The results can be interpreted using the generally accepted correlation for Mackintosh Probe Tests which is as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

5.4.3 Classification Tests

Atterberg Limit tests have been conducted on three selected samples taken from Boreholes 1 and 2, and showed the samples tested to fall into Class CH according to the British Soil Classification System.

These are fine grained silty clay soils of high plasticity and as such generally have a low permeability and a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values of between 41% and 43%, with all of the samples being above the higher 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

5.4.4 Sulphate and pH Analyses

The results of the sulphate and pH analyses show the natural soil samples to have water soluble sulphate contents of up to 2.56g/litre associated with near neutral pH values.

5.5 Non-Technical Summary of Chapter 5.0

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in July 2016 and included two continuous flight auger boreholes (Boreholes 1 and 2) drilled to 15m and 10m below ground level.

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 2.40m in thickness resting on deposits of the London Clay Formation.

Following drilling operations groundwater monitoring piezometers were installed in Boreholes 1 and 2 to approximately 8.00m and 8.50m depth.

Groundwater encountered at a depth of 1.02mbgl (41.13mOD0 within Borehole 2 and was not encountered within Borehole 1 during September 2016. In November 2016 groundwater was encountered at respective depths of 5.78mbgl (37.22mOD) and 0.53mbgl (41.62mOD).

6.0 FOUNDATION DESIGN

6.1 Introduction

It is proposed to extend the existing basement beneath the entire footprint of the property.

It is understood that the proposed basement is at a level of approximately 41.12 mOD (2.880m below ground level).

6.2 Site Preparation Works

The main contractor should be informed of the site conditions and risk assessments should be undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions. It is recommended that extensive searches of existing man-made services are undertaken over the site prior to final design works.

6.3 Ground Model

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows:

- Made Ground extends to depths of between 0.60m to 2.40m depth below ground level (40.60mOD to 41.55mOD).

- The London Clay formation comprising stiff silty sandy clay with gypsum crystals to the full depths of investigation of 10.00m and 15.00m below ground level (28.00 to 32.15 mOD).

- Groundwater encountered at a depth of 1.02mbgl (41.13mOD0 within Borehole 2 and was not encountered within Borehole 1 during September 2016. In November 2016 groundwater was encountered at respective depths of 5.78mbgl (37.22mOD) and 0.53mbgl (41.62mOD).

6.4 Basement Excavation

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure. Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the stability of the soil and to further investigate the presence of any groundwater inflows.

6.5 Conventional Spread Foundations

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in the boreholes, it should be possible to support the proposed new development on conventional strip or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural stiff sandy silty clay deposits which occur at depths of between approximately 0.60m and 2.40m below ground level over the site. Foundations should be placed in the natural deposits at a minimum depth of 1.00m below final ground level in order to avoid the zone affected by seasonal moisture content changes.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 175kN/m^2 at 2.00m depth increasing to 250kN/m^2 at 4.00m depth in order to allow for a factor of safety of 2.5 against general shear failure. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from “Foundation Design and Construction”, Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

In addition, foundations may need to be taken deeper should they be within the zones of influence of both existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, “Building near Trees" and it is considered that this document is relevant in this situation.

6.6 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

6.7 Retaining Walls

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure’s construction. The excavation of the basement must not compromise the integrity of adjacent structures.

The full design of temporary and permanent retaining structures is beyond the scope of this report. However, the following design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table 2 below to assist the design of these structures.

Stratum	Depth to top (mOD)	Bulk Density (Mg/m3) (ɣ)	Effective Angle of Internal Friction (Φ)
Made Ground	43.40 to 41.60	2.00	28
London Clay Formation	34.00 to 29.00	2.00	23

Table 2. Retaining Wall Design Parameters

The designer should use these parameters to derive the active and passive earth pressure coefficients ka and kp. The determination of appropriate earth pressure coefficients, together with factors such as the pattern of the earth pressure distribution, will depend upon the type/geometry of the wall and overall design factors.

6.8 Chemical Attack on Buried Concrete

The results of the chemical analyses show the natural soil samples tested to have water soluble sulphate contents of up to 2.56g/litre associated with near neutral pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and also are well known to occur within London Clay deposits. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such concrete in accordance with full Class DS-3 conditions.

6.9 Non-Technical Summary of Chapter 6.0

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows: Made Ground extends to depths of between 0.60m to 2.40m depth below ground level (43.40 to 41.60 mOD), The London Clay formation extends to the full depth of investigation of 10.00m and 15.00m below ground level (34.00 to 29.00 mOD). Groundwater was encountered at respective depths of 5.78m and 0.53m within the standpipes in Boreholes 1 and 2 after a period of approximately four months.

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure’s construction. The excavation of the basement must not compromise the integrity of adjacent structures.

Based on the water soluble sulphate tests carried out as part of these works, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and also are well known to occur within London Clay deposits. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such concrete in accordance with full Class DS-3 conditions.

7.0 BASEMENT IMPACT ASSESSMENT

7.1 Summary

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

Potential Impact	Site Investigation conclusions	Impact sufficiently addressed without further justification?
The proposed basement extends beneath the water table surface.	Groundwater encountered at a depth of 1.02mbgl (41.13mOD0 within Borehole 2 and was not encountered within Borehole 1 during September 2016. In November 2016 groundwater was encountered at respective depths of 5.78mbgl (37.22mOD) and 0.53mbgl (41.62mOD). It is likely that the water encountered within the standpipes is not representative of the true groundwater level and is likely caused by perched water from the Made Ground or surface water infiltration	Yes
The site is within 100m of a watercourse, well (used / disused) or potential spring line	The site lies within 5m of the one of the former River Westbourne.	No – see below for further details.
The lowest point of the proposed excavation is close to, or lower than, the mean water level in any local pond or spring line		
There a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	The London Clay was proven below the site and was recorded as having a high susceptibility to shrinkage and shrinkage. However, the base of proposed basement will extend well below the potential depth of root action.	Yes
The site is within 5m of a highway or pedestrian right of way.	The proposed basement is not to be extended below Canfield Gardens and therefore it is suggested that the impact on these access roads is likely to be minimal. There is nothing unusual in the proposed development that would give rise to any concerns with regard to the stability of public highways.	Yes.
The site is in an area known to be at risk from surface water flooding.	There is a potential risk of surface water following the construction.	No – see below for further details.

7.2 Outstanding risks and issues

The site is within 100m of a watercourse, well (used / disused) or potential spring line & the lowest point of the proposed excavation is close to, or lower than, the mean water level in any local pond or spring line

As noted, there are no watercourses in the vicinity of the site.

The site is within a densely developed urban area, with a number of barriers to overland flow created by the existing residential development (i.e. the building footprint and the walls around the perimeter of the site).

Current information suggests that 28 Canfield Road marks the route of the River Westbourne, a former watercourse that has become lost through culverting and urban development of the catchment.

Assuming the watercourse exists in the area within a culverted section, this would flow southwards towards Kilburn, across Bayswater Road and into Hyde Park, where it entered the Serpentine. From the Serpentine it flowed southwards under Knightsbridge before issuing into the River Thames within the grounds of Chelsea Hospital. In an extreme flood event, the highway provides an open - and largely unobstructed - flow route.

The proposed basement development is located under existing property and would be outside the extent of any such flow route. As such, no overland pathways to or from this feature exist across the site.

The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. This will require close collaboration with the appointed contractor's temporary works coordinator.

The Party Wall Act (1996) will apply to this development because neighbouring houses lie within a defined space around the proposed building works. The party wall process should be followed and adhered to during this development.

A ground movement assessment was carried out at the site by Fairhurst under the instruction of Site Analytical Services Limited (Report Reference 117401/R1). The report is provided as Appendix B to this report and concludes that providing that good workmanship and construction sequences are used along with appropriate support during excavations, and groundwater management, the proposed basement construction is unlikely to cause significant damage to the surrounding structures. Based on the predicted ground movements, the adjacent structures are not expected to suffer any damage greater than CIRIA C580 Damage Category 1 (Very Slight).

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

The site is in an area known to be at risk from surface water flooding.

Canfield Gardens flooded during either the 2002 flood event. According to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.28 and the surrounding area.

In applying the Exception Test and assessing the risk associated with surface water and sewer flooding the following is considered:

- The proposed basement construction does not change the impermeable proportion at the site (this remains essentially the same). As such, the basement will not have an adverse impact on the site's surface water run-off.

- Intrusive investigation indicated that the groundwater table is below the proposed basement level. Groundwater is therefore unlikely to adversely impact the site as a result of the development.

- At the time of writing this report, the drainage details had not been finalised; however it is our understanding that the drainage details will incorporate a pumping device to protect the property from sewer flooding.

The proposed development will not increase flood risk at the site or the surrounding area. Also since the development is on already developed land, it will not adversely impact the Council's sustainability objectives.

7.3 Advice on Further Work and Monitoring

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

7.4 Non-Technical Summary of Chapter 7.0

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. It is not considered that the proposed basement would result in a significant change to the groundwater flow regime in the vicinity of the proposal. Also, given limited scope of the scheme and limited increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of NPPF and Camden policy.

Given good workmanship, the basement to No. 28 Canfield Gardens can be constructed without imposing more than negligible damage on the adjoining properties. The development is not likely to significantly affect the existing local groundwater regime.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations.

8.0 REFERENCES

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9. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

10. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

Appendix A. Ground Investigation Factual Report

Site Analytical Services Ltd.

Site Investigations, Analytical & Environmental Chemists, Laboratory Testing Services.

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Consultants: G. Evans, BSc., M.Sc., P.G. Dip., FGS., MIEnvSc. A. J. Kingston, BSc C.Eng. MIMM
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Your Ref:

Our Ref: **Ref: 16/25536-1**
December 2016

28 CANFIELD GARDENS,

LONDON, NW6 3LA

FACTUAL REPORT ON A GROUND INVESTIGATION

Prepared for

Martin Redston Associates

Acting on behalf of

Kolyma Investments Limited

CONTENTS

1.0 INTRODUCTION

1.1 Outline and Limitations of Report

At the request of Martin Redston Associates, working on behalf of Kolyma Investments Limited, a ground investigation was carried out in connection with a proposed residential basement development at the above site. A Phase 1 Preliminary Risk Assessment (Desk Study) is presented under separate cover in Site Analytical Services Limited Report Reference 16/25536.

The information was required for the design and construction of foundations and infrastructure for the proposed development at the existing site.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

2.0 SITE DETAILS

(National Grid Reference: TQ261845)

2.1 Site Location

28 Canfield Gardens is a residential property, located on the northern side of Canfield Gardens, South Hampstead at approximate postcode NW6 3LA. The residential dwelling has three levels of accommodation; ground, first and second floor with rooms in the roof space and a lower ground floor. The residential property also comprises a front and rear garden. The site covers an approximate area of 0.03 Hectares with the general area being under the authority of the London Borough of Camden.

The site is located on the northern side of Canfield Gardens with residential properties to the north-east and south-west, with private gardens to the north-west and a roadway to the south-east.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, ‘North London’, Solid and Drift Edition) indicates the site to be underlain by the London Clay formation.

The British Geological Survey maintains an archive of historical exploratory borehole logs throughout the UK. SAS Limited has searched the database and have found that there are 4 boreholes located within 150m of the site. These reveal Made Ground to a depth of 0.90m underlain the London Clay formation to the full depth of excavation at 7m.

2.3 Previous Investigations

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 16/25536, dated December 2016) has been undertaken across the site by Site Analytical Services Limited.

3.0 SCOPE OF WORK

3.1 Site Works

The exploratory investigation included for an inspection of the site and near surface soils in order to: -

- Determine the presence, extent and significance of potential contaminants in the sub-surface strata associated with current and former activities at the site and surrounds identified during the Phase 1 PRA.
- Assess the significance of potential impacts on sensitive receptors at or adjacent to the site.
- Assess the potential environmental liabilities and consequences associated with the site.
- Identify requirements for further works, including the design of any additional investigative/monitoring works and remedial measures if deemed necessary.

The proposed scope of works was agreed by the client prior to the commencement of the investigations. To achieve this, the following works were undertaken:-

- The drilling of two continuous flight auger boreholes to depths of 10.00m and 15.00m below ground level (Boreholes 1 and 2).
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes.
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory holes.
- Factual reporting on the results of the investigation.

3.2 Ground Conditions

The locations of the exploratory holes are shown on the site sketch plan, Figure 1.

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 2.30m in thickness resting on deposits of the London Clay formation.

These ground conditions are summarised in the following table. For detailed information on the ground conditions encountered in the boreholes, reference should be made to the exploratory hole records presented in Appendix A.

Strata	Depth to top of strata (mbgl)	Level to top of strata (mOD)	Depth to base of strata (mbgl)	Level to base of strata (mOD)	Description
Made Ground	0.00	43.00 to 42.15	0.60 to 2.40	41.55 to 40.60	Concrete or slate chippings over a brown, black clayey gravelly sand with brick and concrete fragments underlying a brown, black silty sandy clay containing brick and concrete fragments.
London Clay Formation	0.60 to 2.40	41.55 to 40.60	10.00/15.00 (base of BH's 1 & 2)	32.15 to 28.00	Stiff clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals.

Table A: Summary of Ground Conditions in Exploratory Holes

3.3 Groundwater

Groundwater was not encountered within Boreholes 1 and 2 and the soils remained essentially dry throughout.

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

Groundwater was encountered at a depth of 1.02mbgl (41.13mOD0 within borehole 2 and was not encountered within Borehole 1 during September 2016. In November 2016 groundwater was encountered at respective depths of 5.78mbgl (37.22mOD) and 0.53mbgl (41.62mOD).

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (July to December 2016) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU TESTING AND LABORATORY TESTS

4.1 Hand Vane Tests

In the essentially cohesive natural soils encountered at the site, in-situ shear vane tests were made at regular depth increments in order to assess the undrained shear strength of the materials. The results indicate that the natural soils are of a generally high strength in accordance with BS 5930:2015.

4.2 Mackintosh Probe Tests

Mackintosh Probe tests were made within the Made ground in order to assess the relative density of the soils encountered in Borehole 1. The results can be interpreted using the generally accepted correlation for Mackintosh Probe Tests which is as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

4.3 Classification Tests

Atterberg Limit tests were conducted on three samples taken at depth in Boreholes 1 and 2 and showed the samples tested to fall into Class CH according to the British Soil Classification System.

The test results are given in Table 1, contained in Appendix B.

4.4 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on five samples are presented on Table 2, contained in Appendix B.

4.5 Waste Acceptance Criteria Analysis

A sample of soil from 1.00m depth in BH1 was analysed using the 'Catwastesoil' assessment tool, which concluded that the sample from the site was not hazardous in nature.

The sample was analysed for Waste Acceptance Criteria Testing in order to classify soils for disposal purposes.

For the purpose of waste disposal, the soil samples would be classified as follows:

Borehole 1 @ 1.00m *Inert Waste*

p.p. SITE ANALYTICAL SERVICES LIMITED

T P Murray MSc BSc (Hons) FGS
Geotechnical Engineer

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1. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

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11. Stroud M.A. and Butler F.G. (1975) Symposium on the Engineering Behaviour of Glacial Materials; the Midland Soil Mechanics and Foundation Engineering Society; pgs 124 et seq.

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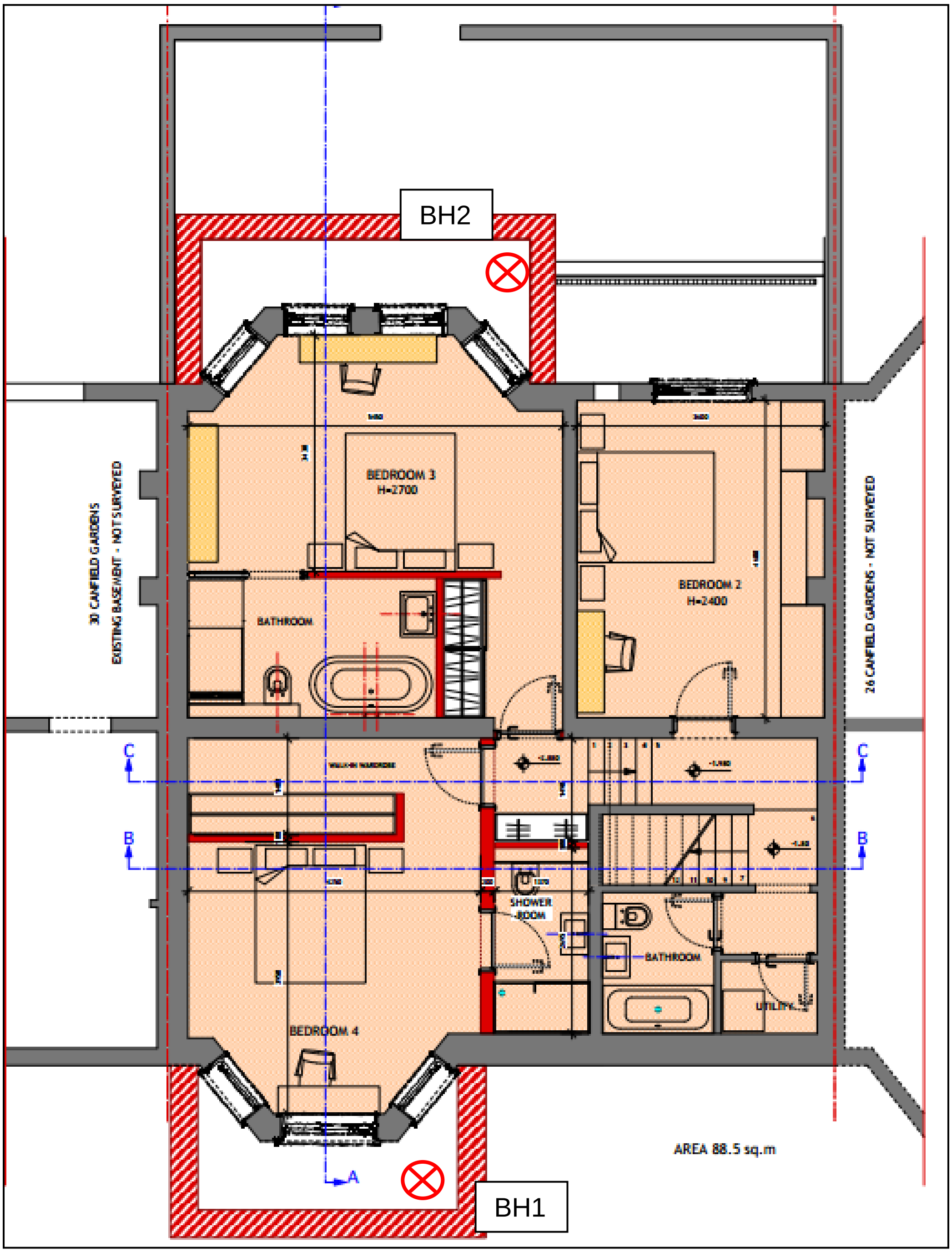
Site Analytical Services Ltd.			REF:	16/25536
LOCATION:	28 Canfield Gardens, London, NW6 3LA		FIG:	1
TITLE:	Site Sketch Plan	DATE: Dec 2016	SCALE:	NTS



A P P E N D I X `A'

Borehole Logs

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	43.00	KOLYMA INVESTMENTS LIMITED	1625536
	Location	**Dates**	**Engineer**	**Sheet**
	TQ260845	21/07/2016	MARTIN REDSTON ASSOCIATES	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.70)	MADE GROUND: Slate chippings over dark brown black slightly gravelly clayey sand with fragments of brick and concrete rubble. Gravel is fine to coarse of sub-angular to sub-rounded flint.		
0.25	D1								
0.50	D2								
					42.30	0.70	MADE GROUND: Soft, brown silty sandy clay with fragments of brick and concrete rubble.		
0.75	D3					(0.50)			
1.00	D4								
1.00-1.30	M1 94/300				41.80	1.20	MADE GROUND: Stiff, light brown silty sandy clay with fragments of brick and concrete rubble.		
1.50	D5								
1.50	V1 95					(1.20)			
2.00	D6								
2.00	V2 117								
					40.60	2.40	Stiff, brown sandy silty CLAY.		
2.50	D7								
2.50	V3 130+								
3.00	D8								
3.00	V4 130+								
3.50	D9								
3.50	V5 130+								
4.00	D10								
4.00	V6 130+								
4.50	D11								
4.50	V7 130+					(4.80)			
5.00	D12								
5.00	V8 130+								
6.00	D13								
6.00	V9 130+								
7.00	D14								
7.00	V10 130+								
					35.80	7.20	Stiff, brown blue sandy silty CLAY.		
8.00	D15								
8.00	V11 130+					(2.80)			
9.00	D16								
9.00	V12 130+								

Remarks
D= Disturbed Sample
M= Makintosh Probe - Blows/Penetration (mm)
V= Vane Test - Result in kPa
Groundwater was not encountered during boring/excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	EW

Figure No. 1625536.BH!

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	43.00	KOLYMA INVESTMENTS LIMITED	1625536
	Location	**Dates**	**Engineer**	**Sheet**
	TQ260845	21/07/2016	MARTIN REDSTON ASSOCIATES	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					33.00	10.00	Stiff, brown blue sandy silty CLAY.		
10.00	D17								
10.00	V13 130+								
11.00	D18								
11.00	V14 130+								
12.00	D19								
12.00	V15 130+								
						(5.00)			
13.00	D20								
13.00	V16 130+								
14.00	D21								
14.00	V17 130+								
					28.00	15.00	Complete at 15.00m		
15.00	D22								
15.00	V18 130+								

Remarks
D= Disturbed Sample
M= Makintosh Probe - Blows/Penetration (mm)
V= Vane Test - Result in kPa
Groundwater was not encountered during boring/excavation

Scale (approx)	Logged By
1:50	EW

Figure No. 1625536.BH!

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH1

Installation Type	Dimensions		Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm		KOLYMA INVESTMENTS LIMITED	1625536
	Location	**Ground Level (mOD)**	**Engineer**	**Sheet**
	TQ260845	43.00	MARTIN REDSTON ASSOCIATES	1/1

Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
					Bentonite Seal
			42.00	1.00	
					Slotted Standpipe
			35.00	8.00	
					Bentonite Seal
			34.00	9.00	
					General Backfill
			28.00	15.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings				Depth Sealed (m)
					5 min	10 min	15 min	20 min	

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)

Instrument Groundwater Observations

Inst. [A] Type : Slotted Standpipe

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks
Lockable cover set in cement

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	42.15	KOLYMA INVESTMENTS LIMITED	1625536
	Location	**Dates**	**Engineer**	**Sheet**
	TQ260845	21/07/2016	MARTIN REDSTON ASSOCIATES	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					42.10	0.05	MADE GROUND: Concrete slab		
					42.08	0.07	MADE GROUND: Thin layer of concrete		
0.25	D1					(0.43)			
					41.65	0.50	MADE GROUND: Black silty sandy clay with fragments of brick and concrete rubble.		
0.50	D2								
					41.55	0.60	MADE GROUND: Brown silty sandy clay with fragments of brick and concrete rubble.		
0.75	D3						Firm becoming stiff, brown sandy silty CLAY		
1.00	D4								
1.00	V1 70								
1.50	D5								
1.50	V2 81								
2.00	D6								
2.00	V3 87								
2.50	D7								
2.50	V4 93								
3.00	D8								
3.00	V5 101								
						(5.90)			
3.50	D9								
3.50	V6 113								
4.00	D10								
4.00	V7 122								
4.50	D11								
4.50	V8 127								
5.00	D12								
5.00	V9 130+								
6.00	D13								
6.00	V10 130+								
					35.65	6.50	Stiff, dark blue grey sandy silty CLAY with occasional gypsum crystals.		
7.00	D14								
7.00	V11 130+								
8.00	D15								
8.00	V12 130+								
						(3.50)			
9.00	D16								
9.00	V13 130+								
10.00	D17								
10.00	V14 130+				32.15	10.00			

Remarks
D= Disturbed Sample
M= Makintosh Probe - Blows/Penetration (mm)
V= Vane Test - Result in kPa
Groundwater was not encountered during boring/excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	EW

Figure No. 1625536.BH2

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH2

Installation Type	Dimensions	Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm	KOLYMA INVESTMENTS LIMITED	1625536

Location	Ground Level (mOD)	Engineer	Sheet
TQ260845	42.15	MARTIN REDSTON ASSOCIATES	1/1

Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
					Bentonite Seal
			41.15	1.00	
					Slotted Standpipe
			33.65	8.50	
					Bentonite Seal
			32.65	9.50	
					General Backfill
			32.15	10.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)

Instrument Groundwater Observations

Inst. [A] Type : Slotted Standpipe

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks

Remarks

Lockable cover set in cement

A P P E N D I X `B'

Laboratory Test Data

Ref: 16/25536-1

**PLASTICITY INDEX &
MOISTURE CONTENT
DETERMINATIONS**

LOCATION 28 Canfield Gardens, London, NW6 3LA

BH/TP No.	Depth m	Natural Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 425 μm %	Class
BH1	3.50	30	65	24	41	100	CH
	4.00	31	64	22	42	100	CH
BH2	4.00	32	69	26	43	100	CH

Ref: 16/25536-1

SULPHATE & pH DETERMINATIONS

LOCATION 28 Canfield Gardens, London, NW6 3LA

BH/TP No.	DEPTH BELOW GL m	SOIL SULPHATES AS SO_4 TOTAL %	SOIL SULPHATES AS SO_4 WATER SOL g/l	WATER SULPHATES AS SO_4 g/l	pH	CLASS	SOIL - 2mm %
BH1	8.00		2.25		6.2	DS-3	100
	13.00		2.23		6.3	DS-3	100
BH2	5.00		2.56		6.2	DS-3	100
	7.00		1.09		6.6	DS-2	100
	9.00		0.81		6.7	DS-2	100

Classification – Tables C1 and C2 : BRE Special Digest 1 : 2005

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russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 16-47575

Site Reference: 28 Canfield Gardens London, NW6 3LA

Project / Job Ref: 16\25536

Order No: 22973

Sample Receipt Date: 03/08/2016

Sample Scheduled Date: 04/08/2016

Report Issue Number: 1

Reporting Date: 10/08/2016

Authorised by:

Kevin Old
Associate Director of Laboratory

Authorised by:

Russell Jarvis
Associate Director of Client Services

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Soil Analysis Certificate						
QTS Environmental Report No: 16-47575	**Date Sampled**	None Supplied				
Site Analytical Services Ltd	**Time Sampled**	None Supplied				
Site Reference: 28 Canfield Gardens London, NW6 3LA	**TP / BH No**	BH1				
Project / Job Ref: 16\25536	**Additional Refs**	D4				
Order No: 22973	**Depth (m)**	1.00				
Reporting Date: 10/08/2016	**QTSE Sample No**	220895				

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Screen	N/a	N/a	**ISO17025**	Not Detected				
pH	pH Units	N/a	**MCERTS**	8.1				
Total Cyanide	mg/kg	< 2	NONE	< 2				
Complex Cyanide	mg/kg	< 2	NONE	< 2				
Free Cyanide	mg/kg	< 2	NONE	< 2				
Total Sulphate as SO_4	mg/kg	< 200	NONE	669				
Total Sulphate as SO_4	%	< 0.02	NONE	0.07				
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	256				
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.26				
Sulphide	mg/kg	< 5	NONE	< 5				
Organic Matter	%	< 0.1	**MCERTS**	1.7				
Total Organic Carbon (TOC)	%	< 0.1	**MCERTS**	1				
Arsenic (As)	mg/kg	< 2	**MCERTS**	15				
W/S Boron	mg/kg	< 1	NONE	< 1				
Cadmium (Cd)	mg/kg	< 0.2	**MCERTS**	< 0.2				
Chromium (Cr)	mg/kg	< 2	**MCERTS**	49				
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2				
Copper (Cu)	mg/kg	< 4	**MCERTS**	26				
Lead (Pb)	mg/kg	< 3	**MCERTS**	108				
Mercury (Hg)	mg/kg	< 1	NONE	< 1				
Nickel (Ni)	mg/kg	< 3	**MCERTS**	18				
Selenium (Se)	mg/kg	< 3	NONE	< 3				
Zinc (Zn)	mg/kg	< 3	**MCERTS**	77				
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Javeed Malik

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate - Speciated PAHs						
QTS Environmental Report No: 16-47575	Date Sampled	None Supplied				
Site Analytical Services Ltd	Time Sampled	None Supplied				
Site Reference: 28 Canfield Gardens London, NW6 3LA	TP / BH No	BH1				
Project / Job Ref: 16\25536	Additional Refs	D4				
Order No: 22973	Depth (m)	1.00				
Reporting Date: 10/08/2016	QTSE Sample No	220895				

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1				
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1				
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluoranthene	mg/kg	< 0.1	MCERTS	0.32				
Pyrene	mg/kg	< 0.1	MCERTS	0.27				
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.17				
Chrysene	mg/kg	< 0.1	MCERTS	0.15				
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.15				
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1				
Coronene	mg/kg	< 0.1	NONE	< 0.1				
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	< 1				
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	< 1				
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6				
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	< 1.7				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - TPH CWG Banded						
QTS Environmental Report No: 16-47575	**Date Sampled**	None Supplied				
Site Analytical Services Ltd	**Time Sampled**	None Supplied				
Site Reference: 28 Canfield Gardens London, NW6 3LA	**TP / BH No**	BH1				
Project / Job Ref: 16\25536	**Additional Refs**	D4				
Order No: 22973	**Depth (m)**	1.00				
Reporting Date: 10/08/2016	**QTSE Sample No**	220895				

Determinand	**Unit**	**RL**	**Accreditation**					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01				
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05				
Aliphatic >C8 - C10	mg/kg	< 2	**MCERTS**	< 2				
Aliphatic >C10 - C12	mg/kg	< 2	**MCERTS**	< 2				
Aliphatic >C12 - C16	mg/kg	< 3	**MCERTS**	< 3				
Aliphatic >C16 - C21	mg/kg	< 3	**MCERTS**	< 3				
Aliphatic >C21 - C34	mg/kg	< 10	**MCERTS**	< 10				
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21				
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01				
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05				
Aromatic >C8 - C10	mg/kg	< 2	**MCERTS**	< 2				
Aromatic >C10 - C12	mg/kg	< 2	**MCERTS**	< 2				
Aromatic >C12 - C16	mg/kg	< 2	**MCERTS**	< 2				
Aromatic >C16 - C21	mg/kg	< 3	**MCERTS**	< 3				
Aromatic >C21 - C35	mg/kg	< 10	**MCERTS**	< 10				
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21				
Total >C5 - C35	mg/kg	< 42	NONE	< 42				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 16-47575	Date Sampled	None Supplied				
Site Analytical Services Ltd	Time Sampled	None Supplied				
Site Reference: 28 Canfield Gardens London, NW6 3LA	TP / BH No	BH1				
Project / Job Ref: 16\25536	Additional Refs	D4				
Order No: 22973	Depth (m)	1.00				
Reporting Date: 10/08/2016	QTSE Sample No	220895				

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2				
Toluene	ug/kg	< 5	MCERTS	< 5				
Ethylbenzene	ug/kg	< 2	MCERTS	< 2				
p & m-xylene	ug/kg	< 2	MCERTS	< 2				
o-xylene	ug/kg	< 2	MCERTS	< 2				
MTBE	ug/kg	< 5	MCERTS	< 5				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

QTS Environmental Report No: 16-47575	**Date Sampled**	None Supplied	
Site Analytical Services Ltd	**Time Sampled**	None Supplied	
Site Reference: 28 Canfield Gardens London, NW6 3LA	**TP / BH No**	BH1	
Project / Job Ref: 16\25536	**Additional Refs**	D4	
Order No: 22973	**Depth (m)**	1.00	
Reporting Date: 10/08/2016	**QTSE Sample No**	220895	

Determinand	**Unit**	**MDL**		**Landfill Waste Acceptance Criteria Limits**		
				Inert Waste Landfill	**Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
TOC[MU]	%	< 0.1	1	3%	5%	6%
Loss on Ignition	%	< 0.01	6.40	--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05	6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1	1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10	500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7	100	--	--
pH[MU]	pH Units	N/a	8.1	--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	< 1	--	To be evaluated	To be evaluated

Eluate Analysis	**2:1 mg/l**	**8:1 mg/l**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
Arsenic[U]	< 0.01	< 0.01	< 0.2	0.5	2	25
Barium[U]	0.04	< 0.02	0.2	20	100	300
Cadmium[U]	< 0.0005	< 0.0005	< 0.02	0.04	1	5
Chromium[U]	< 0.005	< 0.005	< 0.20	0.5	10	70
Copper[U]	< 0.01	< 0.01	< 0.5	2	50	100
Mercury[U]	< 0.005	< 0.005	< 0.01	0.01	0.2	2
Molybdenum[U]	0.009	0.008	< 0.1	0.5	10	30
Nickel[U]	< 0.007	< 0.007	< 0.2	0.4	10	40
Lead[U]	< 0.005	< 0.005	< 0.2	0.5	10	50
Antimony[U]	0.008	0.006	< 0.06	0.06	0.7	5
Selenium[U]	< 0.005	< 0.005	< 0.1	0.1	0.5	7
Zinc[U]	< 0.005	< 0.005	< 0.2	4	50	200
Chloride[U]	4	1	12	800	15000	25000
Fluoride[U]	1.1	1	9.7	10	150	500
Sulphate[U]	16	3	31	1000	20000	50000
TDS	121	66	679	4000	60000	100000
Phenol Index	< 0.01	< 0.01	< 0.5	1	-	-
DOC	11.6	6.6	67.9	500	800	1000

Leach Test Information	
Sample Mass (kg)	0.21
Dry Matter (%)	84.6
Moisture (%)	18.2
Stage 1	
Volume Eluate L2 (litres)	0.32
Filtered Eluate VE1 (litres)	0.06

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

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Soil Analysis Certificate - Sample Descriptions
QTS Environmental Report No: 16-47575
Site Analytical Services Ltd
Site Reference: 28 Canfield Gardens London, NW6 3LA
Project / Job Ref: 16\25536
Order No: 22973
Reporting Date: 10/08/2016

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 220895	BH1	D4	1.00	15.4	Light brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

^ no sampling date provided; unable to confirm if samples are within acceptable holding times

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 16-47575
Site Analytical Services Ltd
Site Reference: 28 Canfield Gardens London, NW6 3LA
Project / Job Ref: 16\25536
Order No: 22973
Reporting Date: 10/08/2016

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D **Dried**
AR **As Received**

Appendix B. Ground Movement Assessment

28 Canfield Gardens, London NW6 3LA

Ground Movement Assessment

December 2016

FAIRHURST

FAIRHURST

CONTROL SHEET

CLIENT:	**SITE ANALYTICAL SERVICES LIMITED**
PROJECT TITLE:	**28 CANFIELD GARDENS, LONDON NW6 3 LA**
REPORT TITLE:	**GROUND MOVEMENT ASSESSMENT**
PROJECT REFERENCE:	**117401**
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					Check	
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					Approve	

This document has been prepared in accordance with procedure OP/P02 of the *Fairhurst Quality and Environmental Management System*

This document has been prepared in accordance with the instructions of the client, Site Analytical Services Ltd, for the client's sole and specific use. Any other persons who use any information contained herein do so at their own risk.

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FIGURES

APPENDIX

1.0 INTRODUCTION

1.1 Background

Fairhurst has been commissioned by Site Analytical Services Limited (SASL) to complete a Ground Movement Assessment (GMA) in connection with a proposed residential development at 28 Canfield Gardens, London, NW6 3LA. The purpose of this assessment is to determine what effects the proposed basement construction at the site may have upon nearby structures.

A site specific Phase II Ground Investigation has previously been carried out by SASL in July 2016. The ground investigation was designed by SASL and the results have been used in the derivation of parameters utilised in this assessment. Fairhurst cannot be held responsible for any inaccuracy in the factual data provided.

It is understood that this report will be included as part of a planning application to be submitted to the London Borough of Camden (LBC) by the client.

1.2 Proposed Development

With reference to the proposed development plans provided by the client and presented as Appendix A, it is understood that the property owner is intending to extend the existing basement under the existing building footprint along with the excavation of two new proposed lightwells at the front and back of the property.

The proposed basement extension is split into three different areas with various depths of excavation:

1. An area below the north eastern section of the existing building adjacent to No. 26 Canfield Gardens which will be extended to 2.48m below ground level or 0.89m below existing basement level (circa 40.52m AOD). This area is described as the new ‘basement’ in this report;
2. An area below the south western section of the existing building adjacent to No. 30 Canfield Gardens which will extend to 3.39m below ground level or 1.80m below existing basement level (circa 39.62m AOD). Due to its deeper depth, this area is described as the ‘sub-basement’ in this report;
3. Lightwells at the front and rear of the site which are proposed to extend to the same depth as the sub-basement (i.e 3.39mbgl or 39.62m AOD).

1.3 Limitations

The conclusions and recommendations made in this report are made on the basis of the site specific ground investigations undertaken by SASL undertaken in July 2016. The ground investigation was designed by SASL and the results of the work should be viewed in the context of the range of data sources consulted and the information provided, the number of locations where the ground was sampled and the number of samples tested. No liability can be accepted for inaccuracies in the factual data, information in other data sources or conditions not revealed by the sampling or testing.

In addition to this SASL have recommended the use of third party data where appropriate, it is assumed that reliance on that data used in this report has been agreed by SASL.

2.0 BASELINE CONDITIONS

2.1 Site Description

The site is located at 28 Canfield Gardens, London, NW6 3LA located in the London Borough of Camden at approximate grid reference 526099, 184507. A site location plan is presented as Figure 1. The site currently comprises a four storey terraced residential house with an existing basement level along with front and rear garden areas.

Reference to available architect's drawings indicates that there is limited survey information relating to the footprint of the existing basement below the site. Following correspondence with the client and for the purposes of this report it is assumed that the existing basement extends beneath the entire footprint of the existing building at a depth of 1.595mbgl (41.10mAOD).

With reference to available spot height data from Ordnance Survey (OS) mapping, an assumed ground level of approximately 43m AOD is anticipated at the site. Based on this level, it is understood that ground level at the site steps down from approximately 43mAOD at the front of the property to approximately 42.15mAOD at lowered rear garden level.

The ground in the surrounding area generally slopes to the south from approximately 47m AOD along Broadhurst Gardens, approximately 150m north of the site, to circa 41m AOD at the intersection between Greencroft and Fairhazel Gardens 150m south of the site. This equates to a slope angle of approximately 1°.

The surrounding area is generally residential. Details of the buildings located adjacent to the site are described below in Table 1 and highlighted on Figure 2.

Table 1. Summary of Structures Surrounding the Site

Structure Name	Description	Estimated Height (m) ignoring roof space	Distance from the site
No. 30 Canfield Gardens	4 storey terraced residential dwelling with basement	9.12	Connected by party wall, directly south west of the property.
No. 26 Canfield Gardens	4 storey terraced residential dwelling with basement	9.12	Connected by party wall, directly north east of the property.

2.2 Geology

The British Geological Survey (BGS) map of the area (North London, Sheet 256) indicates that the site is underlain by the London Clay Formation with no superficial deposits directly mapped at the site. However Head Deposits (Prodensity) are indicated to be present approximately 30m north west of the site. These deposits have not been formally mapped by the BGS and have been interpreted from slope analyses and borehole data only.

Superficial Head Deposits generally comprise clays, silts, sands and gravels and were formed up to 3 million years ago in the Quaternary Period in a local environment previously dominated by subaerial slopes.

The London Clay Formation is detailed by the BGS to comprise blue clay which becomes brown when weathered with occasional bands of fine silty sand and nodular lumps of pyrite and selenite. These soils were formed approximately 34 to 56 million years ago in the Palaeogene Period in a local environment previously dominated by deep seas.

There are 7 No. historical BGS Boreholes close to the site (BGS references: TQ28SE514 to TQ28SE521) related to the construction of residential properties on Broadhurst Gardens approximately 100m to 200m north of the site in the 1950s. The boreholes indicate up to 4m thickness of Made Ground overlying deposits typical of the London Clay Formation. Groundwater seepages are generally recorded within Made Ground at depths of between 3 and 4mbgl.

2.3 Adjacent Ground Investigations

Review of the LBC planning portal indicates that several recent planning applications have been made for basement extensions at various properties within 150m of the site. Ground investigation works were carried out as part of the associated planning applications which are summarised in Table 2 below.

Table 2. Summary of Adjacent Basement Construction and Ground investigation

Site address (distance from site)	Planning application reference	Planning application status	Ground investigation details	Scope of works
No. 44 Canfield Gardens (110m south west from site)	2010/3616/P	Granted 23-11-2010	Herts and Essex Investigation Ltd (Report Ref: MRS/9764A dated 18th October 2010)	• 2 No. cable percussive boreholes to 6m maximum depth; • 7 No. hand excavated trial pits to 1.4m maximum depth to expose buildings foundations.
No. 50 Canfield Gardens (150m south west from site)	2012/2812/P	Granted 04-03-2013	Land Science Ltd (Report Ref: LS048 dated from 2nd of May 2012)	• 2 No window sampler boreholes to 8m maximum depth; • 4 No. hand excavated trial pits to 1.5m maximum depth to expose buildings foundations.
No. 29 Compayne Gardens (140m west from site)	2016/0320/P	Granted 17-06-2016	Chelmer Site Investigation Ltd (Report Ref: FACT/6028 dated from 3rd of November 2015)	• 2 No. continuous flight auger boreholes to 8m maximum depth; • 4 No. hand excavated trial pits to 2.17m maximum depth to expose buildings foundations.

The section below provides a brief summary of the findings of the above ground investigations although reference should be made to the original reports for full details of the findings. Approximate ground level elevations for the investigation works have been taken from spot heights on available OS maps.

2.3.1 Ground Conditions

The exploratory holes recorded ground conditions that were generally consistent with the geological records and known history of the area with between 0.40m to 1m of Made Ground overlying deposits typical of the London Clay Formation. A summary of the ground conditions encountered is presented in Table 3 below:

Table 3. Summary of Adjacent Ground Investigation

Strata	Depth mbgl (mAOD)		Maximum Thickness (m)	Description
	Top	Bottom		
Fill/Made Ground	GL (42.5 to 44.5)	0.4 to 1.0 (44 to 41.6)	1	Generally described as a dark brown, slightly sandy, silty CLAY, with occasional gravel, brick and clinker fragments
London Clay Formation	0.4 to 1.0 (44 to 41.6)	6 to 8 (36.6 to 35)	8.5*	Generally described as grey and then blue firm becoming stiff, slightly sandy, silty CLAY, with partings of brown and orange silt and fine sand and occasional selenite crystals

*Maximum thickness of London Clay Formation not proven in any of the ground investigations

Groundwater was not generally encountered as part of the Ground Investigation works and the boreholes and trial pits remained essentially dry throughout. However a slight seepage was recorded within a trial pit at 50 Canfield Road at depth of 0.75 to 1.10mbgl.

The results of groundwater monitoring carried out following drilling is summarised below:

- No post field work groundwater monitoring data is provided within the Herts and Essex Report at No. 44 Canfield Gardens;
- At 50 Canfield Gardens, a monitoring standpipe was installed by Land Science to a depth of 5.00m and subsequently monitored on 19th April 2012 recording a water depth of 0.70mbgl within the London Clay Formation;
- At 29 Compayne Gardens monitoring standpipes were installed by Chelmer to 8.0m bgl in both of the boreholes drilled at the site, and water level readings were taken on 10th and 20th November 2015. During this period of monitoring, the water level in BH1 rose from 2.60m to 1.26m bgl, whereas the water level in BH2 fell from 6.25m to 7.96m bgl.

2.3.2 In Situ and Laboratory Testing

In-situ and laboratory testing was carried out as part of the ground investigation works described above and the full results are contained in the relevant factual reports.

In summary, 28 No. samples of the London Clay formation were tested for Atterberg limits tests as part of the adjacent ground investigations. The results indicate Plasticity Index (PI) varying between 27 and 56%. The results are indicative of Class CI and CV according to the British Soil Classification System which are representative of fine grained clays of intermediate to very high plasticity and as such generally have a medium to high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2.

Furthermore, 46 No. in-situ Hand Shear Vane (HSV) tests were undertaken within the London Clay Formation with recorded undrained shear strengths varying between 44 and 168kN/m^2 (generally increasing with depth), with an average of 107kN/m^2. The results are indicative of a medium to very high strength material at depth and are within the expected range for the London Clay Formation.

3.0 GROUND INVESTIGATION AND MONITORING

3.1 Records of Site Investigations

A site specific ground investigation was undertaken by Site Analytical Services Limited (SASL) in July 2016. The site works undertaken at the site comprised the following:

- 2 No. boreholes using hollow stem auger methods, one to 15m bgl at the front of the property (BH1) and one to 10m bgl at the rear garden of the property (BH2) with in-situ hand shear vane tests completed at regular intervals in both holes;
- Collection of disturbed soil samples for geotechnical laboratory testing;
- Installation of 2 No. 50mm internal diameter groundwater monitoring wells in BH1 and BH2 to depths of 8.00m to 8.50m bgl respectively.
- Two rounds of groundwater level monitoring following the site works on 2nd September and the 22nd of November 2016

The factual information describing the results of the investigation dated July 2016 is presented in Appendix B.

3.2 Ground Conditions

The boreholes recorded ground conditions that were generally consistent with the geological records, known history of the area and the findings from the nearby historical ground investigations with up to 2.40m thickness of Made Ground encountered overlying the London Clay Formation to the full depths of drilling of 12.0m bgl. A summary of the ground conditions encountered is presented in Table 4 below:

Table 4. Summary of the Site Specific Ground Investigation (2016)

Strata	Depth mbgl (mAOD)		Maximum Thickness (m)	Description
	Top	Bottom		
Made Ground	GL (43)	0.5 to 2.4 (42.5 to 40.6)	2.4	Slate chippings over dark brown black slightly gravelly clayey SAND with fragments of brick and concrete rubble. Gravel is fine to coarse of sub-angular to sub-rounded flint.
London Clay Formation	0.5 to 2.4 (42.5 to 40.6)	10 to 15 (33 to 28)	12.6*	Stiff brown sandy silty CLAY overlying stiff brown blue sandy silty CLAY.

*Maximum thickness of London Clay Formation not proven

3.3 Groundwater

Groundwater was not encountered as part of the Ground Investigation works and the boreholes remained dry. Monitoring standpipes were installed in BH1 and BH2 to 8.0 and 8.50mbgl respectively, and water level readings were taken on the 2nd of September 2016, as summarised in table 5 below.

Table 5. Monitoring Summary

Date	Borehole ID	Ground Level	Response Zone			Groundwater Level	
		m AOD	m bgl	m AOD	(Strata)	m bgl	m AOD
02/09/2016	BH1	43	1.00 to 8.00	42.00 - 35.00	MG/LC	DRY	DRY
	BH2	42.15	1.00m to 8.50	41.15 - 34.15	LC	1.00	41.15
22/11/2016	BH1	43	1.00 to 8.00	42.00 - 35.00	MG/LC	5.78	37.22
	BH2	42.15	1.00m to 8.50	41.15 - 34.15	LC	0.53	41.62

The results of the ground water monitoring carried out at the site indicate that groundwater levels are above the maximum proposed excavation depth of 3.39mbgl (39.62m AOD) in BH2 at a maximum level of 42mAOD.

It should be noted that the above comments on groundwater conditions are based on two monitoring visits at the site undertaken in the September 2016 and relate to observations made at that time. Changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions. It is considered prudent to continue ground water monitoring for as long as possible prior to construction.

3.4 In-Situ and Laboratory Testing

The results of the laboratory and in-situ tests are presented within the SASL factual information dated from July 2016 and presented in Appendix B.

3.4.1 Atterberg Limit Tests

Atterberg Limit tests have been conducted on 3No. selected samples of the London Clay Formation. The results indicate moisture contents varying between 30% and 32% and Plasticity Index values (PI) of between 41% and 43% indicating materials of Class CH according to the British Soil Classification System. These are representative of fine grained CLAY of high plasticity and as such generally have a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2 (2015).

The Atterberg limit tests results have been plotted on a Casagrande plot, and are presented on Figure 3 of the report along with the results of the historical investigations.

3.4.2 Shear Vane Testing

In the London Clay Formation, in-situ shear vane tests were undertaken at regular depth intervals to assess the undrained shear strength profile of the materials. The testing has recorded undrained shear varying from 70kPa up to 130kPa which is the limiting value of the shear vane apparatus. This correlates to cohesive materials of medium to (at least) high strength which is in keeping with the historical laboratory testing results at the adjacent sites. The results of the shear vane tests are presented on Figure 4 along with the results of the historical investigations.

4.0 PREDICTION OF GROUND MOVEMENTS

4.1 Introduction

In connection with the planning requirements of the proposed basement construction from LBC a ground movement and damage assessment has been undertaken at the site. The purpose of this assessment is to determine the effects of the proposed basement construction upon the neighbouring structures.

The calculations provided in this ground movement and damage assessment are specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

4.2 Adjacent Properties

The properties or structures more likely to be affected by ground movements associated with the proposed basement construction are detailed on Figure 2 and summarised below:

- No. 30 Canfield Gardens located to the south west;
- No. 26 Canfield Gardens located to the north east;

4.3 Ground Model

The stratigraphic sequence utilised in this assessment is based on the site specific ground investigation undertaken by SASL at the site. This comprises Made Ground to a depth of 2.40m bgl overlying the London Clay Formation below.

To increase accuracy of the analyses, the in-situ and laboratory results from the nearby historical boreholes described in section 2.3 have been used in combination with the site specific investigation. It should be noted that no liability can be accepted for inaccuracies in the factual data of the nearby historical investigation and it is understood that reliance on this data has been sought by SASL.

4.3.1 Model parameters

The method of Ground Movement Analyses undertaken requires soils stiffness parameters to be used. In accordance with BS8004:2015 section 4.3.1.6 'Soil Stiffness' it is acknowledged that both the drained and undrained stiffness moduli of soils (E', E_u) are highly strain dependent. The change in axial strain will directly influence the resultant stiffness of the soil, and in turn the stiffness of the soil will influence the strain exhibited.

Therefore in order to define a stiffness modulus applicable to the engineering problem considered, it is necessary to assess the magnitude of axial strain which the soil will be subjected to. In accordance with the recommendations made in BS8004:2015 the strain generally applicable to foundations design is in the range of 0.075 to 0.2%. The material stiffness values used for the analysis of the ground movements have been interpreted as follows.

Made Ground

The stiffness parameter for the Made Ground was estimated conservatively considering a high compressibility material with a coefficient of volume compressibility (m_v) of 0.4 as specified in Tomlinson (7th ed, 2001).

London Clay

Based on the maximum (i.e. most conservative) axial strain of 0.2% prescribed in BS8004:2015, the following correlation has been used to determine the Young's Modulus (Eu) of the London Clay. The relation has been taken from ICE manual of geotechnical engineering (2012), Volume II, chapter 53.7 and matches ratio of Eu/Cu at 0.2% axial strain recommended in Tomlinson (7th, 2001) based on works by Jardine et al. (1986):

$$Eu = 330Cu\ (kN/m^2)$$

The ratio of end of construction (Undrained) settlement to total settlement (fully drained) was taken as taken as 60% as specified in ICE manual of geotechnical engineering (2012), Volume II, chapter 53.6.

Therefore:

$$Eu = 200Cu\ (kN/m^2)$$

In addition a drained (υ') and undrained (υ) poison's ratio of 0.2 and 0.5 respectively were utilised as specified in Tomlinson 7th ed. A plot of Young's modulus versus depth is presented as Figure 5 to this report.

A summary of the stiffness values utilised in this analysis is presented in Table 6 below based on the trendline presented on Figure 5:

Table 6. Soil Stratigraphy and Stiffness Parameters Adopted

Strata	Level at top (mbgl)	Bulk Unit Weight ϒ (kN/m^3)	Short-term (undrained)			Long-term (drained)		
			Top	Bottom	Poisson's Ratio (υ)	Top	Bottom	Poisson's Ratio (υ')
			E_u kPa	E_u kPa		E' kPa	E' kPa	
Made Ground	GL	16	5000	5000	0.5	2500	2500	0.2
London Clay Formation	2.4	20	23000	43000	0.5	13000	26000	0.2

4.4 Basement Foundation and Load Case

With reference to development plans provided (Appendix A) and Martin Redston Associates Ltd load drawings (Appendix C), it is understood that the walls to No. 30 and No. 26 Canfield Gardens will be underpinned. The proposed lightwells to the front and back of the property will be constructed with a reinforced concrete retaining wall excavated and cast in 1m sections with a traditional hit and miss sequence.

It is understood that the retaining wall will be cast with an eccentric base section. The base will be placed against the un-excavated soil to prevent sliding and the top of the wall will be propped to resist overturning.

In the permanent condition, the loads of the structure above the newly constructed basement will be transferred to the underlying soils via a ground bearing raft foundation with an average unfactored gross Uniformly Distributed Load (UDL) of 95kN/m^2 being applied at the base of the foundation.

The assessment presented in Section 4.5 is specific to the construction sequence and load case described above and should be updated in accordance with any changes made to the proposed developments at the site.

4.5 Ground Movements inside the Area of the New Basement.

Following excavation of the basement area the soil at this level and along the boundary of the excavation will tend to heave upwards due to vertical stress relief. The magnitude and distribution of ground movements inside the excavated area are a function of the excavation size and shape along with the stiffness of the underlying soils.

The stress conditions and resultant settlement/heave have been assessed using the Boussinesq's method and geotechnical software PDISP. The software calculates vertical strains on the basis of the calculated stress changes and then integrated to obtain vertical movements.

Three stages of the redevelopment have been modelled as follows:

1. A first stage simulating excavation across the site with unloading due to the removal of soil. Assuming that no delays occur during the construction process, this stage has been simulated using short term soil parameters only (i.e. undrained conditions).

   The proposed excavation levels are 3.39mbgl within the proposed lightwells and proposed sub-basement area located within south western section of the site adjacent to No. 30 Canfield Gardens and 2.48m bgl within the new basement area located within north eastern section of the site adjacent to No. 26 Canfield Gardens.

The existing lower ground floor underneath the property currently sits at 1.595mbgl. The undrained removal of the overburden will therefore cause an unloading pressure of approximately -33kN/m^2, -15kN/m^2 and -58kN/m^2 within the sub-basement, basement and lightwells respectively. The PDISP analysis outputs at sub-basement and basement levels are presented in Appendix D (figure D1 and D2).

2. A second stage simulating the conditions at the end of the construction phase when the site is to be re-loaded with the pressures from the proposed structures has also been analysed.

   The new loads are to be transferred via a ground bearing raft with a gross UDL of 95kN/m^2 this equates to a net UDL of approximately 62kN/m^2, 80kN/m^2, 37kN/m^2 within the sub-basement, basement and lightwells respectively. The PDISP analysis outputs at sub-basement and basement level for this stage are presented in Appendix E (Figure E1 and E2).

3. A final third stage simulates a long term condition after construction, when the stress conditions within the soil have been allowed to equilibrate under the new pressures (i.e fully drained conditions). The PDISP analysis outputs at sub-basement and basement level for this stage are presented in Appendix F (Figure F1 and F2).

The elastic parameters for the soil have been chosen as appropriate for the short and long term conditions. Undrained parameters have been used for the short term analyses whilst fully drained parameters have been used for the long term assessments. The vertical boundary of the model has been fixed at 15 mbgl where the effective vertical stress due to foundation unloading decreases to approximately 20% of the effective overburden as required in EC7.

The results of the PDISP analysis indicate movement beyond the site boundaries as shown on the output models. The modelling is based on an unrestrained excavation and is therefore unable to take account of the mitigating effect of the retaining wall supporting the excavation sides, which in reality will combine to restrict these movements within the basement excavation. The movements predicted at or just beyond the site boundaries are unlikely to be fully realised and should not therefore have a detrimental impact upon any nearby structures as long as temporary works measures and design are robust in nature.

It should be noted that the movements detailed in section 4.5.1 to 4.5.3 below are not cumulative.

4.5.1 Stage 1- Undrained elastic ground movements due to excavation

Sub-basement/lightwells

The analysis shows that the ground is expected to heave upward by approximately 3mm within the central area of the excavation and by approximately 2 to 2.5mm along the southwest edge of the sub-basement adjacent to No. 30 Canfield Gardens. Approximately 2 to 2.5mm of heave is expected within the proposed lightwells.

Basement

The ground at proposed new basement level is expected to heave upwards by approximately 1mm within the central area of the excavation and by less than 1mm around the perimeter.

4.5.2 Stage 2 - Undrained Ground movements after reloading

Sub-basement/lightwells

At this stage the ground is expected to settle due to the net pressure proposed at that level. The settlement magnitude is expected to reach approximately 5mm within the central area of the excavation and approximately 3.5mm along the southwest edge of the sub-basement adjacent to No. 30 Canfield Gardens. Approximately 1mm of settlement is expected within the proposed lightwells.

Basement

The ground at the proposed basement level is predicted to settle by approximately 6.5mm within the central portion area of the excavation and by approximately 3.4mm 4.6mm to the northwest and southeast of the basement and adjacent to No. 26 Canfield Gardens.

4.5.3 Stage 3 - Long term (drained) movements

Sub-basement/lightwells

At this stage further settlement is anticipated due to dissipation of excess pore water pressures. Approximately 9mm of total settlement is expected within the central portion of the proposed sub-basement and approximately 6.5mm along the southwest edge of the excavation adjacent to No. 30 Canfield Gardens. Approximately 2mm of settlement is expected within the proposed lightwells.

Basement

The ground at proposed new basement level is predicted to settle by approximately 12mm within the central portion area of the excavation in the long term and by approximately 7mm to 9mm to the northwest and to the southeast of the basement and adjacent to No. 26 Canfield Gardens.

4.5.4 Conclusions and recommendations

It is understood that the proposed basement and sub-basement will be constructed using RC ground bearing raft founded on the London Clay Formation. The ground at proposed basement level is expected to settle by approximately 12mm within the central portion of the excavation in the long term and by approximately 9mm adjacent to No. 26 Canfield. Within the sub-basement the ground is expected to settle by 9mm within the central area of the excavation and 6.5mm along the southwest edge adjacent to No 30 Canfield Gardens.

Worst case differential movements are expected within the basement, where an angular distortion of 1:575 is expected. This is within distortion criterions of 1:500 commonly acceptable for many structures and as such the structural integrity of the RC slab is not predicted to be compromised assuming good workmanship. This should be confirmed at detailed design stage and accounted for in the design of the raft sub-base engineered layer.

4.6 Ground Movements Outside the Area of the New Basement.

4.6.1 Approach and assumptions

Ground movements due to basement excavations are typically estimated based on guidance given in the CIRIA publication C580 (2003). The document is based on the behaviour of various excavations supported by embedded walls at numerous sites in the London area. The actual amount of ground movement depends on the quality of workmanship and the type of construction sequencing used. Based on the predicted ground movement, a damage assessment can then be carried out in accordance with CIRIA C580 based on works by after Burland et al. (1977), Boscardin and Cording (1989) and Burland (2001).

In this study, the ground movements outside the area of the new basement and the subsequent damage assessments have been carried out using the software package XDISP licensed from Oasys. This programme is based on the soil movement relationships given within CIRIA C580.

When a re-intrant corner is specified between two walls, XDISP sums the displacements arising from each wall and this leads to overestimated movements within these zones. This behaviour is acknowledged by Oasys and, as such, in order to avoid unrealistic movements and damage predictions the proposed basement shape has been simplified to avoid such occurrences.

The proposed excavation depth varies across the site and due to the limitations of the software this cannot be modelled accurately. As such the maximum excavation depth of 3.39mbgl proposed for the lighwells and sub-basement has been applied across the full extent of the proposed excavation (i.e. including the new basement) as a conservative approach.

4.6.2 Assessment Methodology

As detailed in section 4.4 the main basement box is to be constructed using an underpin type sequence towards No. 30 and No. 26 Canfield Gardens. The proposed lightwells at the front and back of the property will be constructed with a reinforced concrete retaining wall excavated and cast in 1m sections with a traditional hit and miss sequence.

Ground movements arising from the formation of the lightwells have been modelled using the ground movement curve 'Installation of planar diaphragm wall in stiff clays' and 'excavation in front of a high stiffness wall in stiff clays' as this is the support methodology proposed on site in that section. Movement arising from the combination of the two ground movement curves have been utilised to assess likely ground movement surrounding the excavation. It is understood that the top of the wall will be propped and as such in accordance with CIRIA C580, the curve for high stiffness walls are applicable in this case.

Ground movements resulting from underpinning are not discussed within CIRIA C580. In the absence of underpinning-specific guidance, the same assessment methodology utilised for the lightwells has been used for the underpinned sections.

As stated in CIRIA C580, ground movement due to the 'wall installation' by boring or excavating panels are due to a reduction of the horizontal effective stresses close to the wall. This situation generally reflects the conditions occurring during formation of an underpinning section, as such an underpin sequence could be modelled with a ground movement curve for 'wall installation' only. Nevertheless, the ground movement curve relating the wall deflection "excavation in front of a wall" have been considered in the analysis as a conservative approach even though they are not fully applicable to the proposed construction methodology.

The ground conditions during the excavation of the basement are anticipated to comprise 2.4m of Made Ground overlying the London Clay Formation. Reference to the individual case histories presented in the CIRIA C580 document also indicates there were substantial thicknesses of Made Ground present at many of the recorded sites and therefore the results are taken to be applicable to this.

It is important to note that open excavations and underpinning, even in cohesive materials, can result in significant ground movements when not properly retained/managed. The magnitude of movement is almost entirely a function of the standard of the workmanship which is assumed to be of sufficient quality in this analysis.

4.6.3 Groundwater

Observations made during post ground investigation ground water monitoring indicate that the groundwater levels at the site could be up to c. 0.53mbgl (41.62mAOD), as perched water within the Made Ground overlying the London Clay Formation. The chosen contractor should therefore have a comprehensive ground movement mitigation plan in place stating how ground movements are to be reduced to a minimum at the site and how ground water will be dealt with when encountered. Useful guidance is provided in the ICE Manual of Geotechnical Engineering (2012) Chapter 83.

It is also recommended to continue monitoring the ground water levels prior to construction works, to provide a better understanding of the ground water conditions at the site.

4.6.4 Results

Ground movements have been analysed using XDISP and a building damage assessment has been undertaken based on the results of the predicted ground movements. Contours of vertical and horizontal ground movement and full tabular output of the analysis are presented in Appendix G. Summary tables are provided in Section 4.7 below.

4.7 Building Damage Assessment

4.7.1 General

The building damage assessment was carried out on the relevant adjacent structures, as detailed in Figure 6 and summarised below in Table 7.

Table 7: Summary of Structures

Structure	Structure ID (As specified on Figure 6)	Assumed structural Height (m)	Approximate Line Length (m)
No. 30 Canfield Gardens	wall 1	9.12	9.3

Structure	Structure ID (As specified on Figure 6)	Assumed structural Height (m)	Approximate Line Length (m)
	wall 2	9.12	9.3
	wall 3	9.12	9.3
	wall 4	9.12	9.8
No. 26 Canfield Gardens	wall 5	9.12	9.3
	wall 6	9.12	9.3
	wall 7	9.12	9.3
	wall 8	9.12	9.8

4.7.2 Results

Table 8 presents the damage assessments for the structures listed above. The table also presents the CIRIA C580 approximate crack widths corresponding to the damage categories. The full tabular output for the basement and sub-basement is presented as Appendix G.

Table 8: Ground Movement Summary

Structure ID (Figure 6)	Maximum settlement (mm)	Maximum Tensile Strain (%)	Average Horizontal Strain (%)	Damage Category[(1)]	Approximate Crack Width (mm) (CIRIA C580)
Wall 1	3.14	0.0747	0.0690	Very Slight	<1mm
Wall 2	3.14	0.0747	0.0690	Very Slight	<1mm
Wall 3	3.14	0.0747	0.0690	Very Slight	<1mm
Wall 4	3.07	0.000	0.000	Negligible	<0.1mm
Wall 5	3.13	0.0745	0.0689	Very Slight	<1mm
Wall 6	3.13	0.0745	0.0689	Very Slight	<1mm
Wall 7	2.41	0.0573	0.0530	Very Slight	<1mm
Wall 8	3.084	0.0140	0.0144	Very Slight	<1mm

[(1)] After Burland et al, 1977, Boscardin and Cording, 1989; and Burland, 2001

Based on these predicted ground movements, the properties surrounding the site are not expected to suffer any damage greater than CIRIA C580 Damage Category 1 (Very Slight).

4.8 Summary of Ground Movement Assessment and Advice on Further Monitoring

Providing that good workmanship and construction sequences are used along with appropriate support during excavations, and groundwater management, the proposed basement construction is unlikely to cause significant damage to the surrounding structures. Based on the predicted ground movements, the adjacent structures are not expected to suffer any damage greater than CIRIA C580 Damage Category 1 (Very Slight).

Despite the predicted low level of damage, it is recommended that movement monitoring of the walls to the neighbouring buildings is carried out and a ground movement sensitivity monitoring plan is set out at design stage which should include a movement monitoring strategy, instrumentation and action plans. More specifically trigger levels on movements will need to be defined and this should be done by way of precise levelling or reflective survey targets being installed at the neighbouring buildings. The temporary and permanent works will need to be designed to limit eventual movement.

Open excavations and underpinning, even in cohesive materials, can result in significant ground movements when not properly retained/managed. The magnitude of movement is almost entirely a function of the standard of the workmanship which is assumed to be of sufficient quality in this analysis.

Additionally, observations made during post ground investigation ground water monitoring, indicate that the groundwater levels at the site is likely to be at c. 0.53mbgl (41.62mAOD), perched within the Made Ground overlying the London Clay Formation which will be above the depths of excavation. The chosen contractor should have a comprehensive plan in place to deal with groundwater when encountered to ensure stability of the excavations.

It is recommended to continue monitoring the ground water levels prior to construction works, to provide a better understanding of the ground water conditions at the site.

Figure 1 – Site Location Plan

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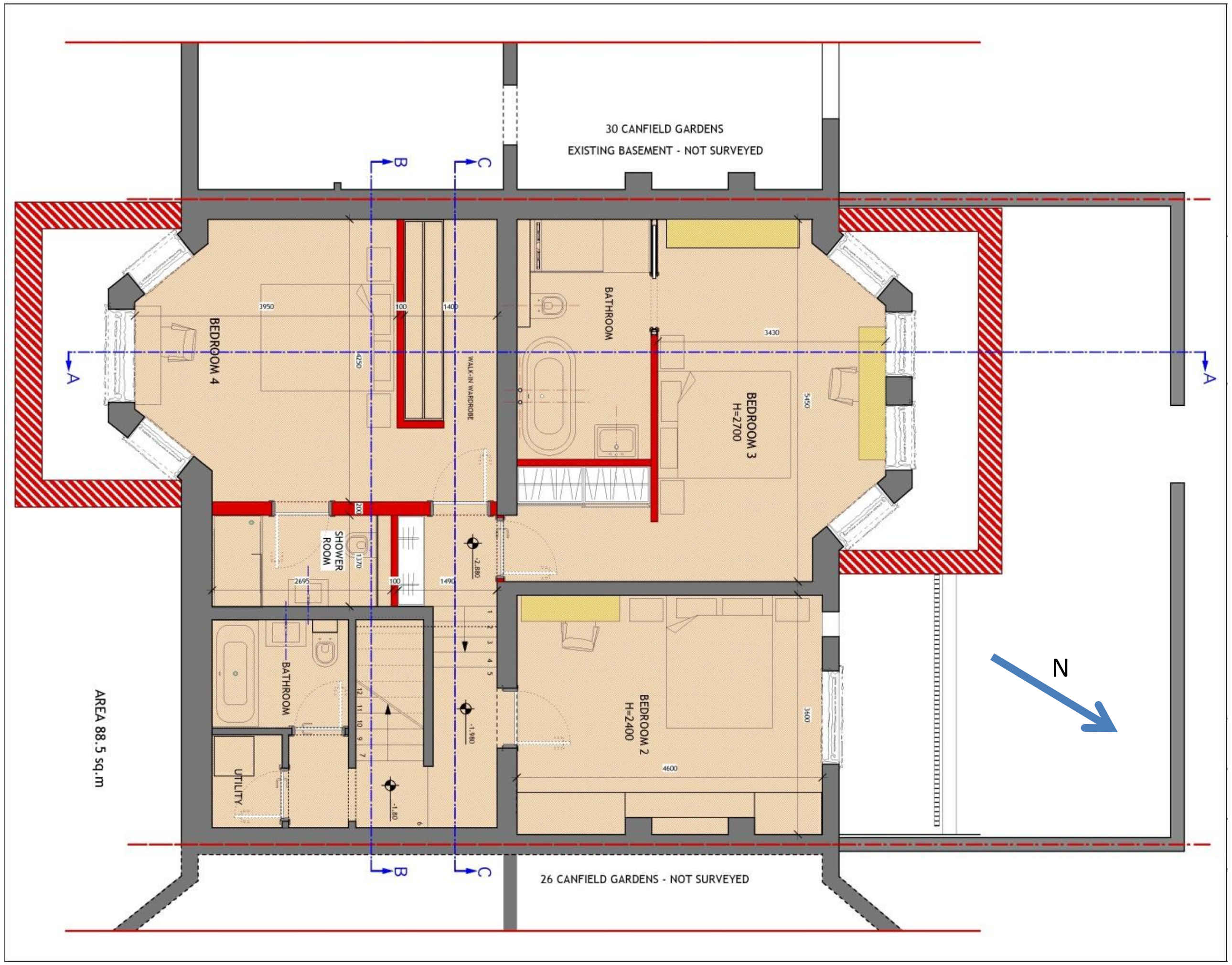
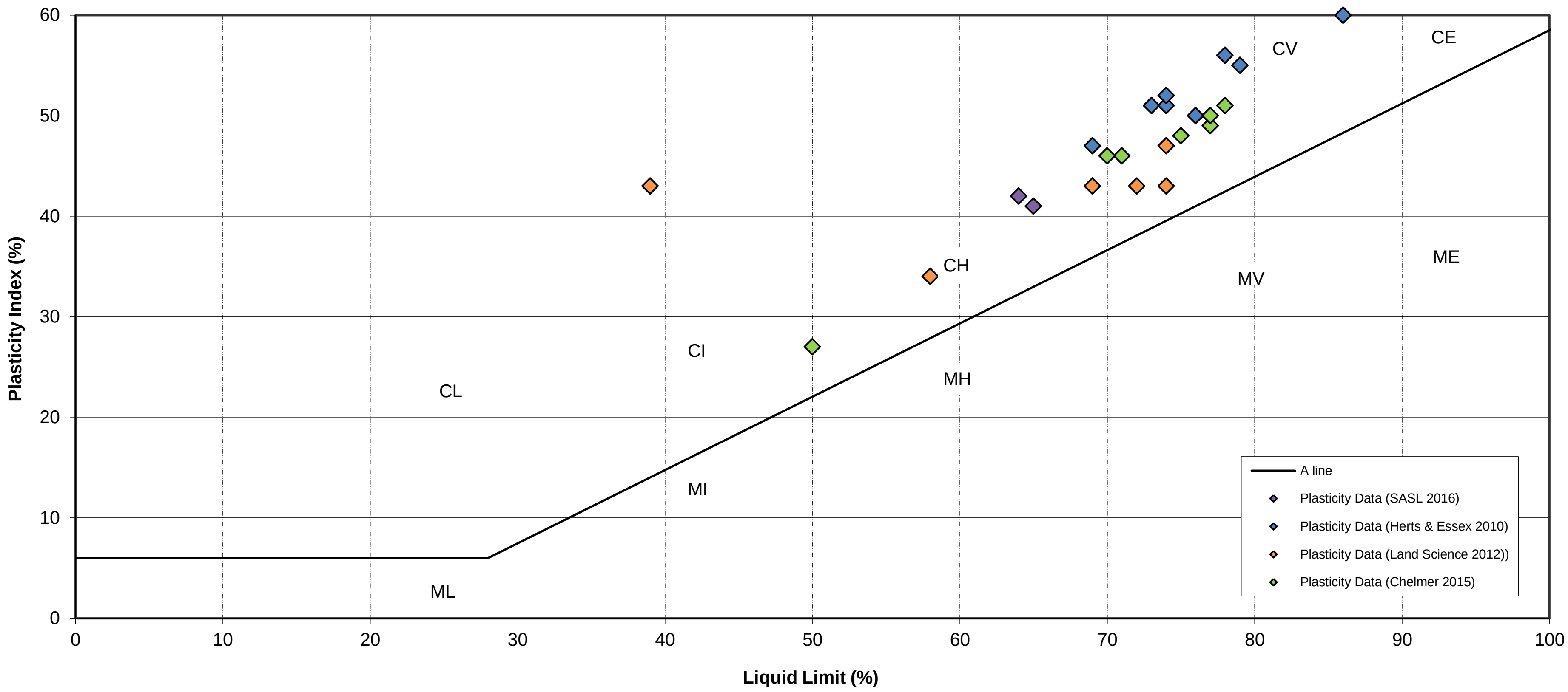
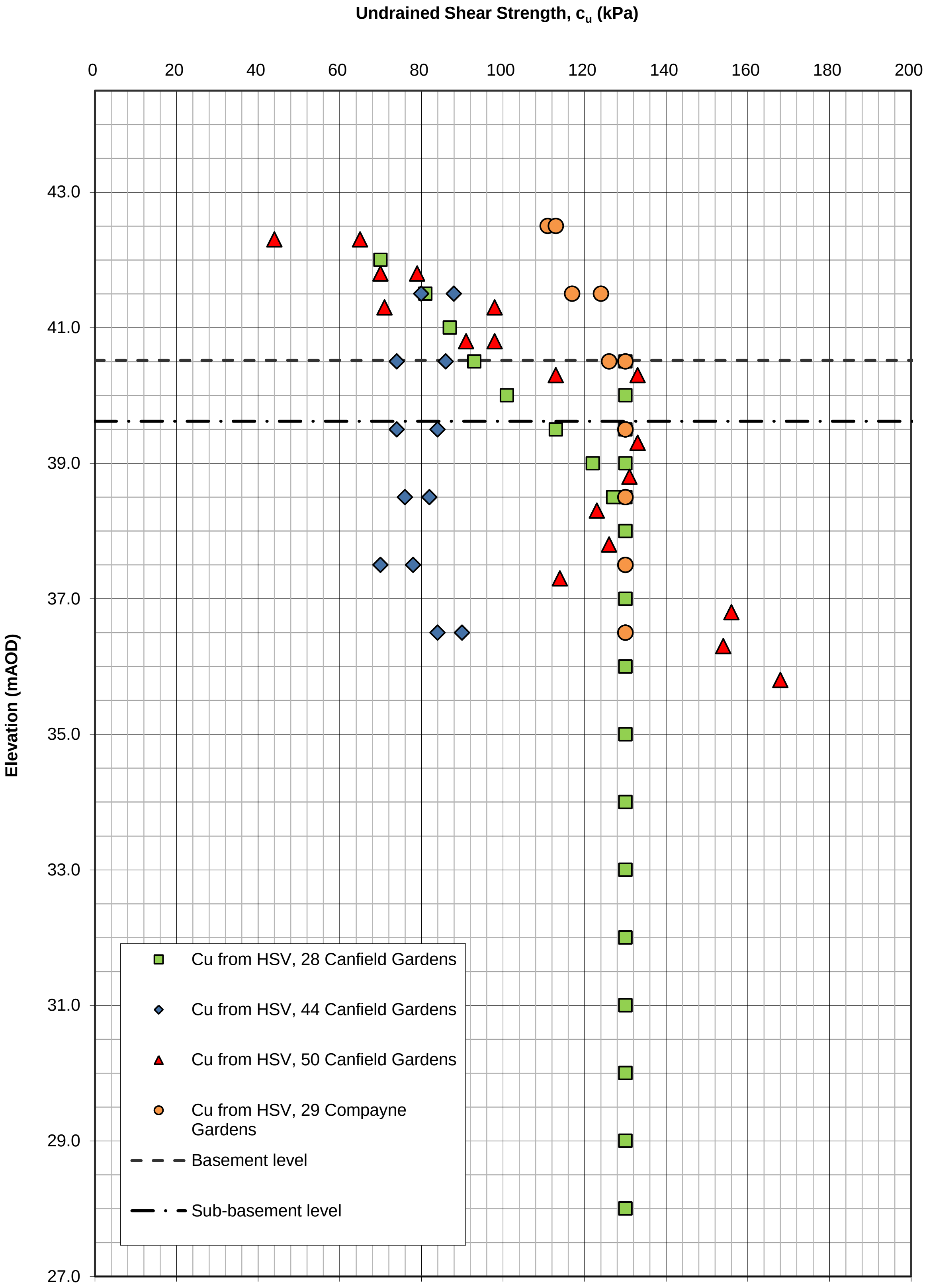
Figure 2 – Site Plan Showing Neighbouring Properties to the Site

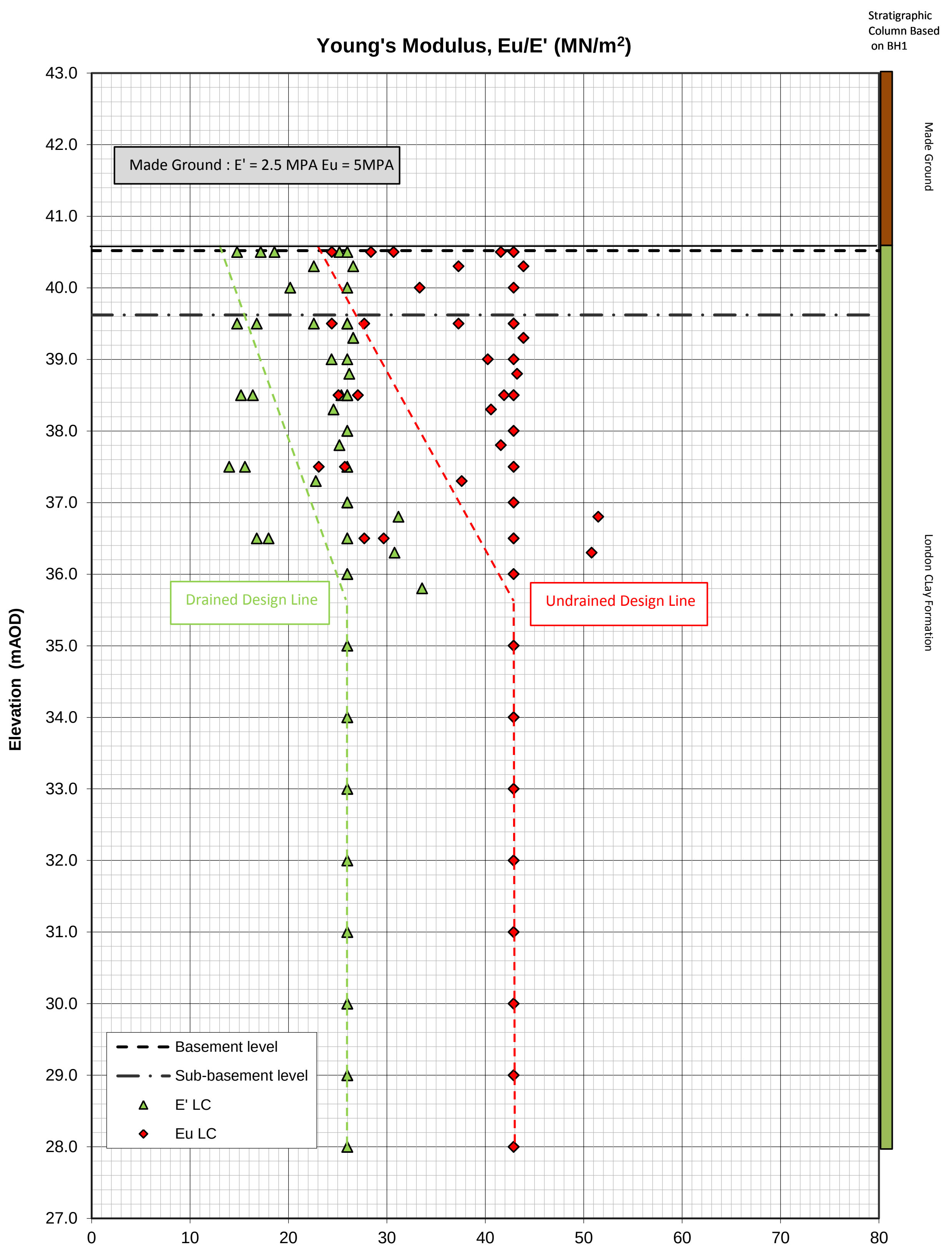




PROJECT TITLE:- **28 Canfield Gardens**	ORIGINATOR:- FAIRHURST
FIG TITLE:- **Ground Movement Assessment** Casagrande Plasticity Chart	FIG No.:- **Figure 3**
	REPORT No.:- **117401**
	DATE:- **December-2016**

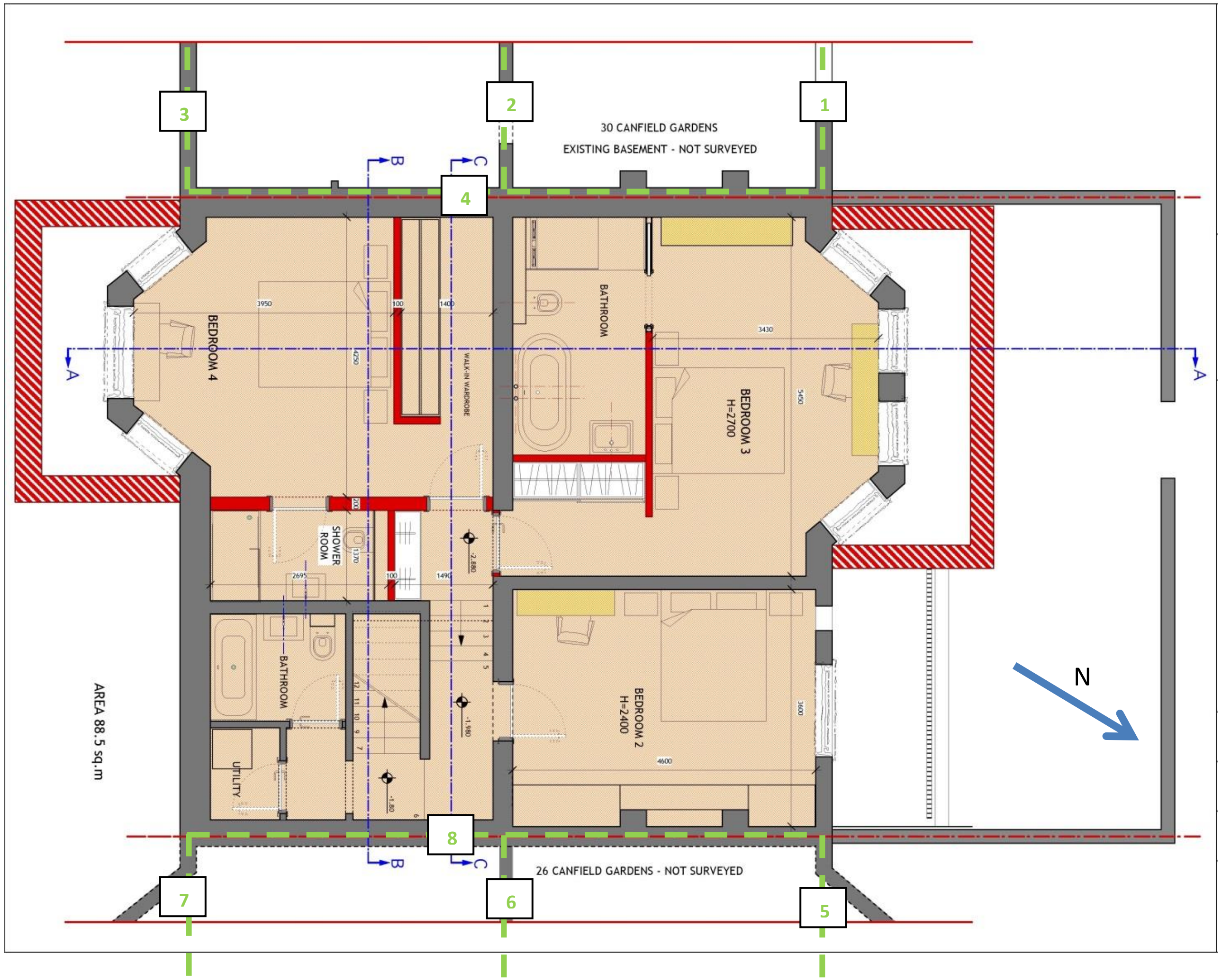


PROJECT TITLE:- **28 Canfield Gardens**	ORIGINATOR:- FAIRHURST
FIG TITLE:- **Ground Movement Assessment** Undrained Shear Strength versus Depth	FIG No.:- **Figure 4** REPORT No.:- **117401** DATE:- **December-2016**



PROJECT TITLE:- **28 Canfield Gardens**	ORIGINATOR:- FAIRHURST
FIG TITLE:- **Ground Movement Assessment** Young's Modulus vs Depth	FIG No.:- **Figure 5** REPORT No.:- **117401** DATE:- **December-2016**

Figure 6 – Wall Plan used for XDISP Analysis



Appendix A – Architects Existing and Proposed Drawings

THE TREATMENT ARCHITECTURE LTD.

11 WOODBERRY CRESCENT, LONDON N10 1PJ, UK
Email: thetreatment@mac.com
Landline: 020 8883 2503 Mobile: 07887 646505

PROJECT: 28 CANFIELD GARDENS LONDON NW6 3LA

DRAWING NAME: 13 - PROPOSED FRONT ELEVATION

DRAWING Ref.	DRAWEN :	SCALE :	PROJ No.	REV. No.	SHEET :	DATED :
28CanfieldBasement@Camden16052016	RCB	1/50	NW63LA	00	A3	01/06/2016

THE TREAT MENT ARCHITECTURE LTD.

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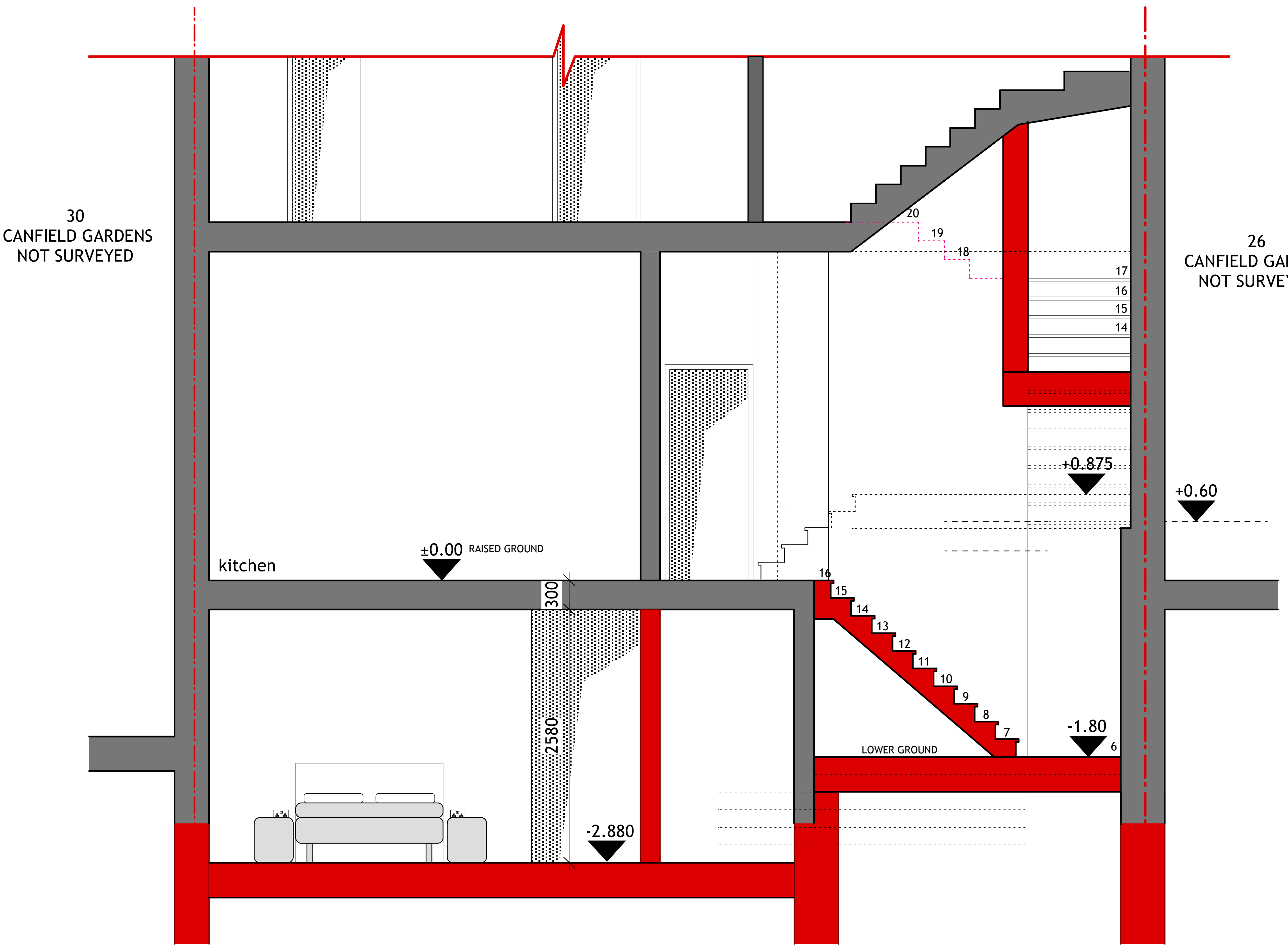
28 CANFIELD GARDENS
LONDON NW6 3LA

PROJECT

12 - PROPOSED SECTION BB

DRAWING NAME

DRAWING Ref. 28CanfieldBasement@Camden16052016			RCB DRAWEN :
1/50 SCALE :	NW63LA PROJ No.	00 REV. No.	A3 SHEET :
			01/06/2016 DATED :



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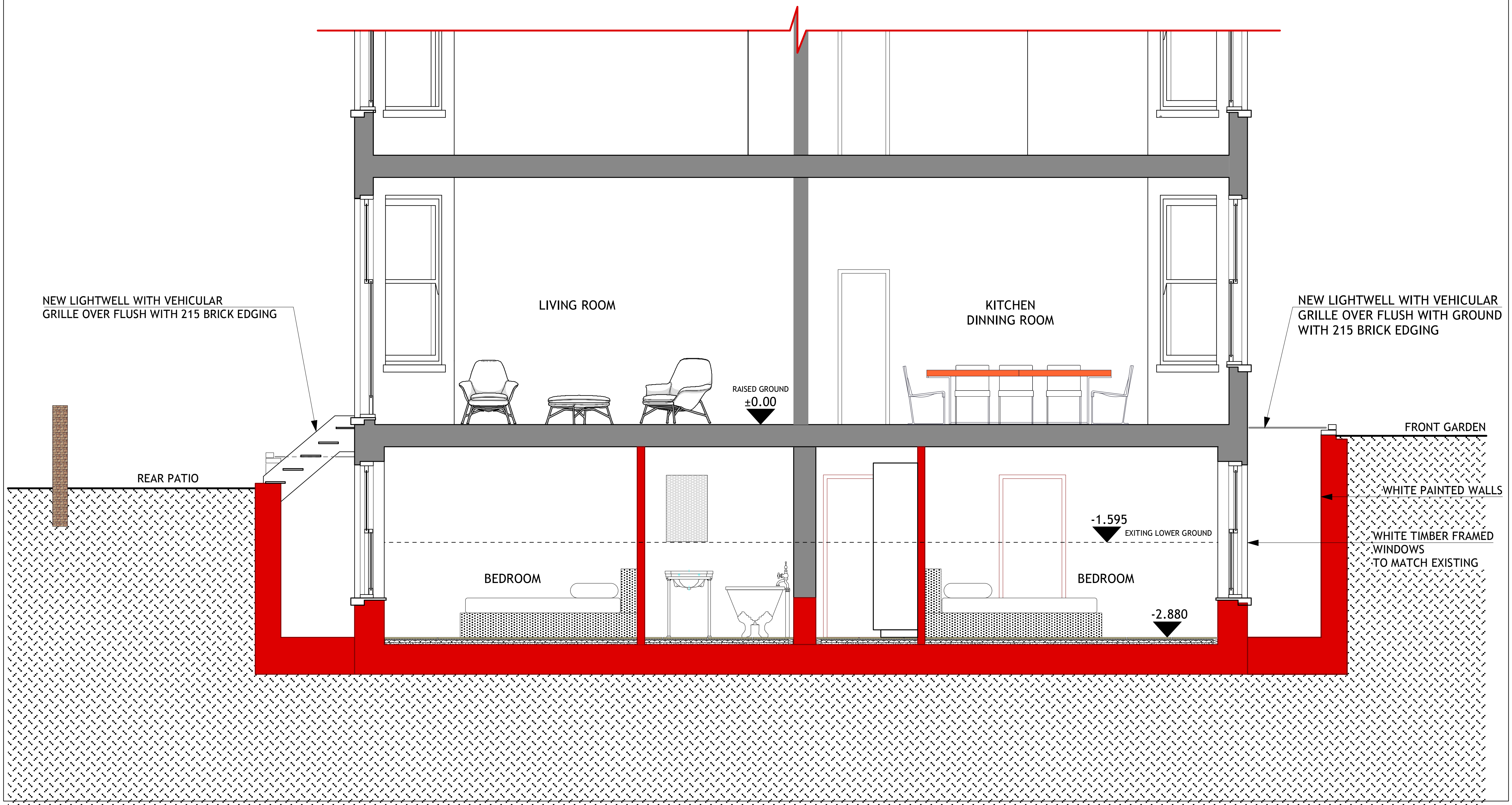
PROJECT	28 CANFIELD GARDENS LONDON NW6 3LA
DRAWING NAME	11 - PROPOSED SECTION AA
DRAWING Ref.	28CanfieldBasement@Camden16052016
DRAWEN :	RCB
SCALE :	1/50
PROJ No.	NW63LA
REV. No.	00
SHEET :	A3
DATED :	01/06/2016
LEGENDE:	

11 - PROPOSED SECTION AA



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28 CANFIELD GARDENS
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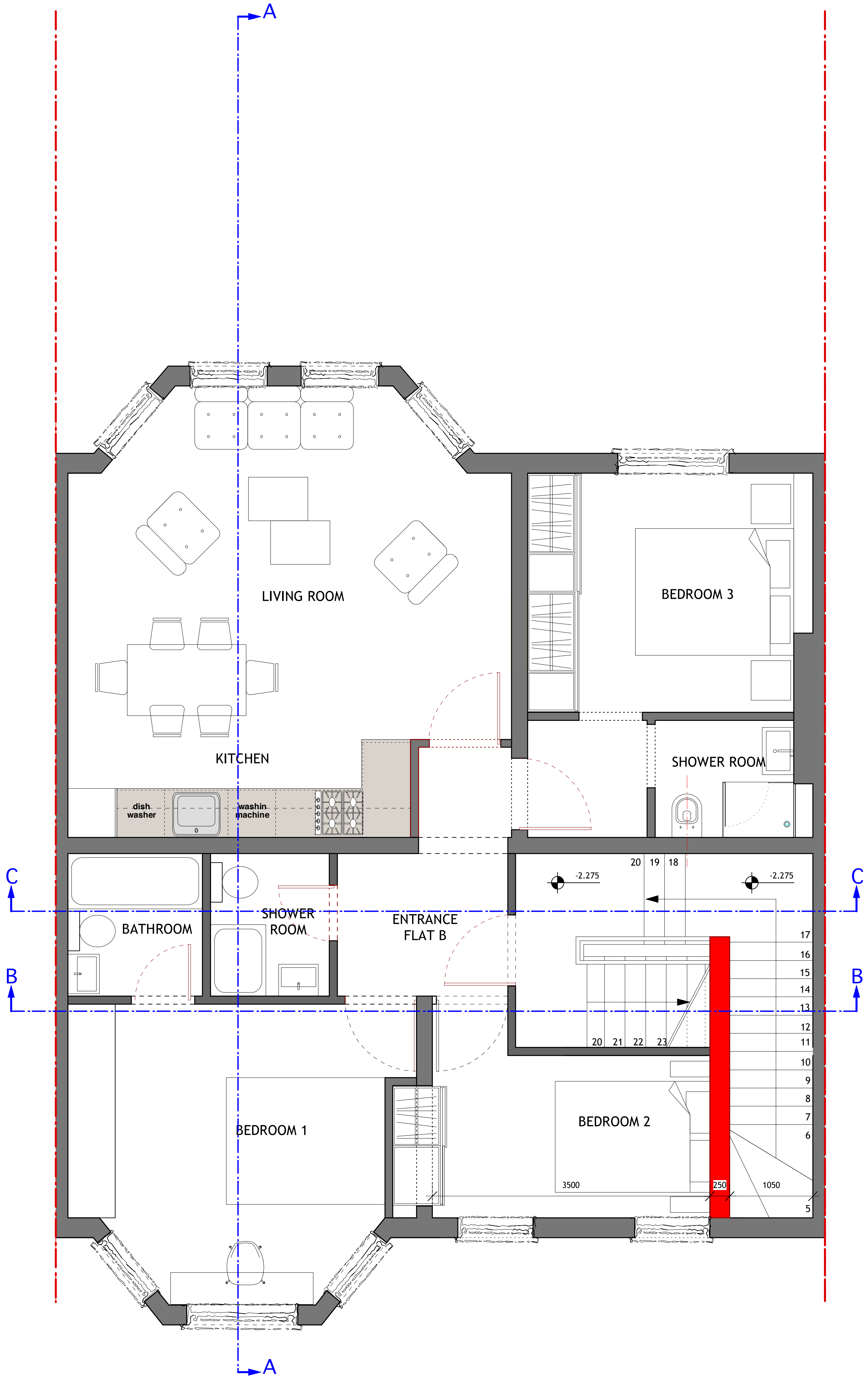
PROJECT

10 - PROPOSED FIRST FLOOR PLAN

DRAWING NAME

DRAWING Ref.	DRAWEN :	SCALE :	PROJ No.	REV. No.	SHEET :	DATED :
28CanfieldBasement@Camden16052016	RCB	1/50	NW63LA	00	A3	01/06/2016



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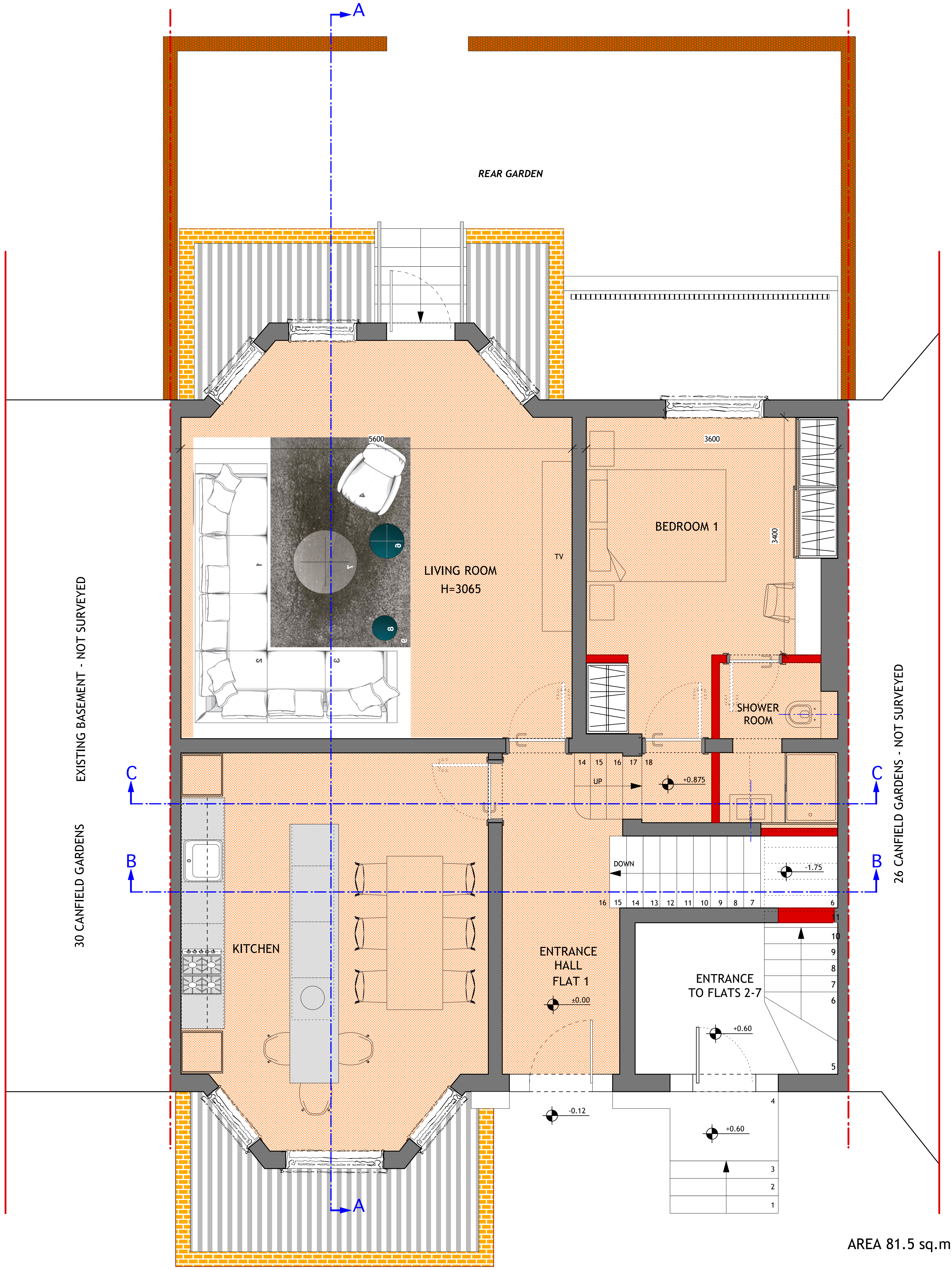
PROJECT

09 - PROPOSED GROUND FLOOR PLAN

DRAWING NAME

DRAWING Ref.	28CanfieldBasement@Camden16052016
DRAWEN :	RCB
SHEET :	A3
SCALE :	1/50
PROJ No.	NW63LA
REV. No.	00
DATED :	01/06/2016



AREA 81.5 sq.m

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PROJECT

08 - PROPOSED BASEMENT FLOOR PLAN

DRAWING NAME

DRAWING Ref.	DRAWEN :	SHEET :	DATED :	SCALE :	PROJ No.	REV. No.
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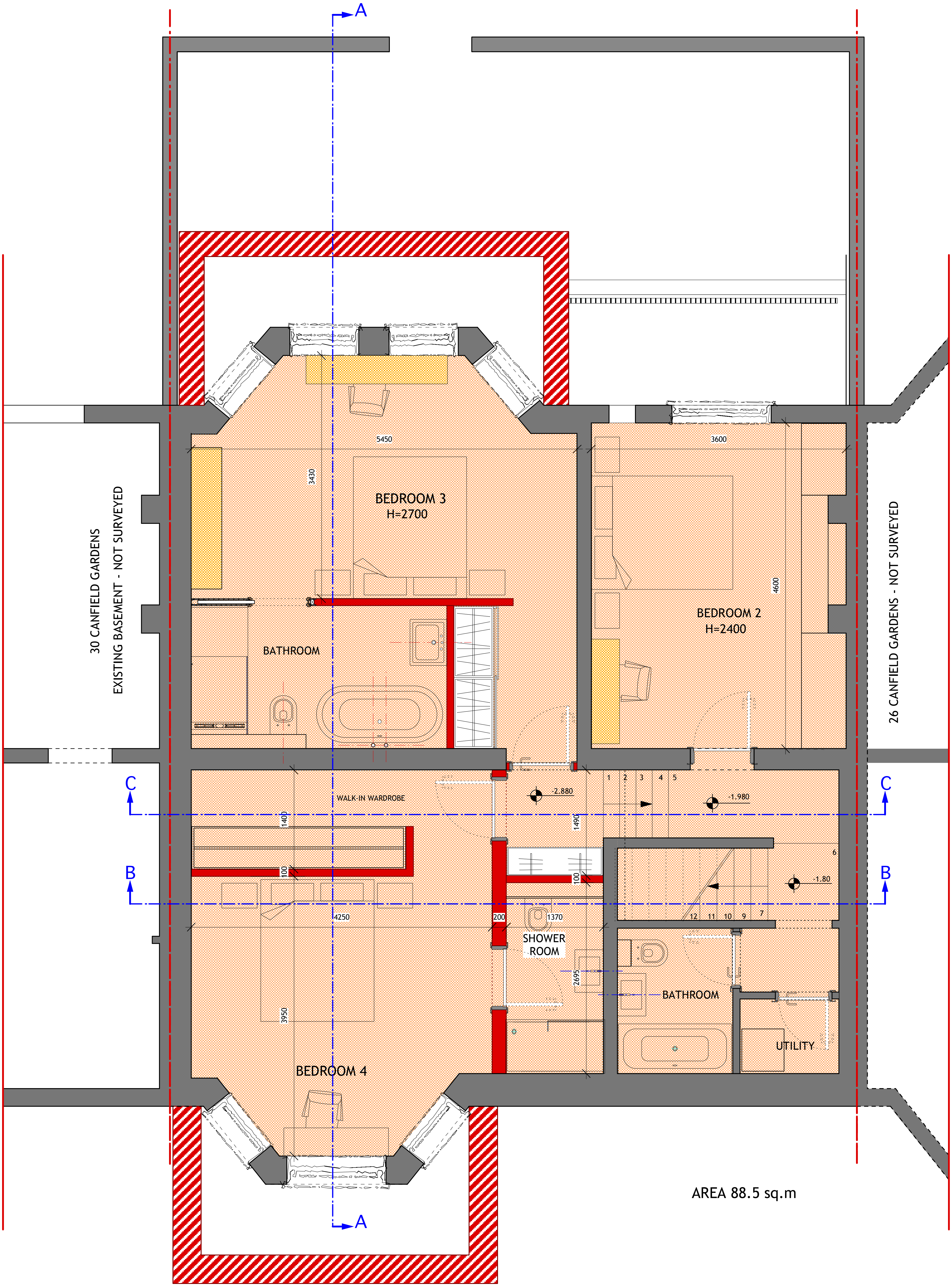

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PROJECT

07 - EXISTING REAR ELEVATION

DRAWING NAME

DRAWING Ref.	DRAWEN :	SCALE :	PROJ No.	REV. No.	SHEET :	DATED :
28CanfieldBasement@Camden16052016	RCB	1/50	NW63LA	00	A3	01/06/2016

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DRAWING Ref.
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RCB
DRAWEN :

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LONDON NW6 3LA
PROJECT

06 - EXISTING FRONT ELEVATION

DRAWING NAME

SCALE :	PROJ No.	REV. No.	SHEET :	DATED :
1/50	NW63LA	00	A3	01/06/2016

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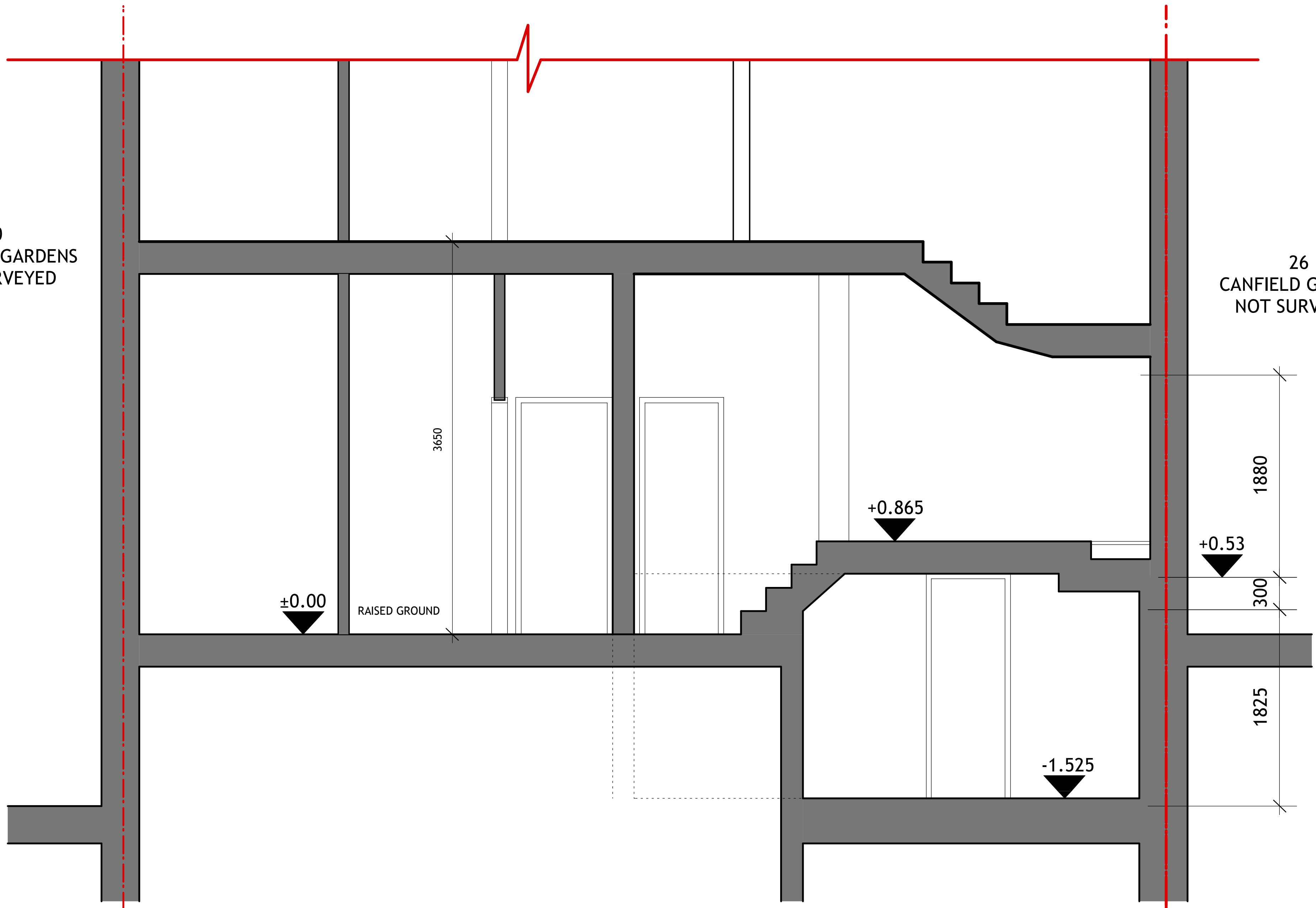
LONDON NW6 3LA
PROJECT

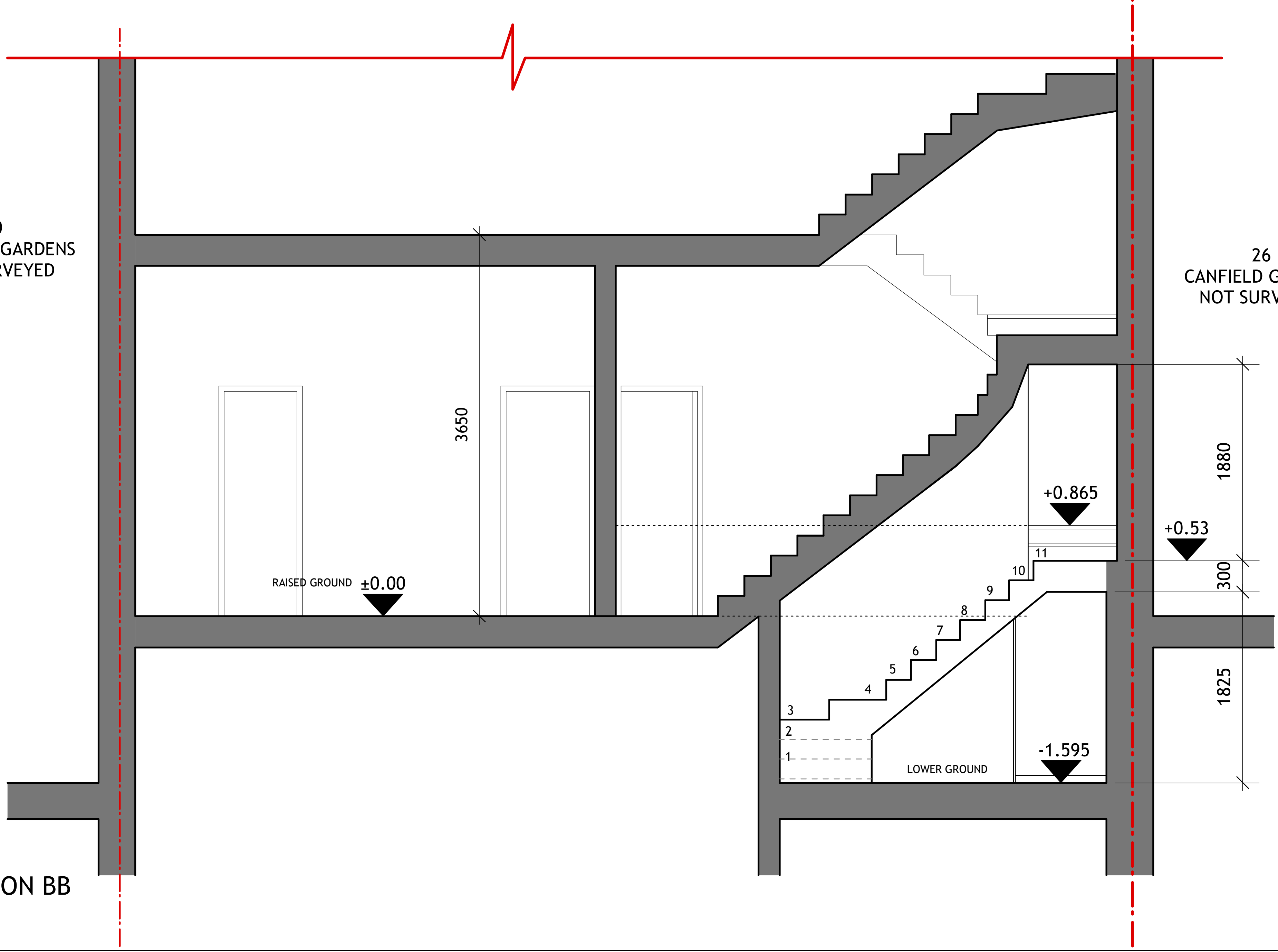
05 - EXISTING SECTIONS BB & CC

DRAWING NAME

DRAWING Ref.	28CanfieldBasement@Camden16052016
DRAWN :	RCB
SHEET :	A3
SCALE :	1/50
PROJ No.	NW63LA
REV. No.	00
DATED :	01/06/2016



SECTION CC



SECTION BB

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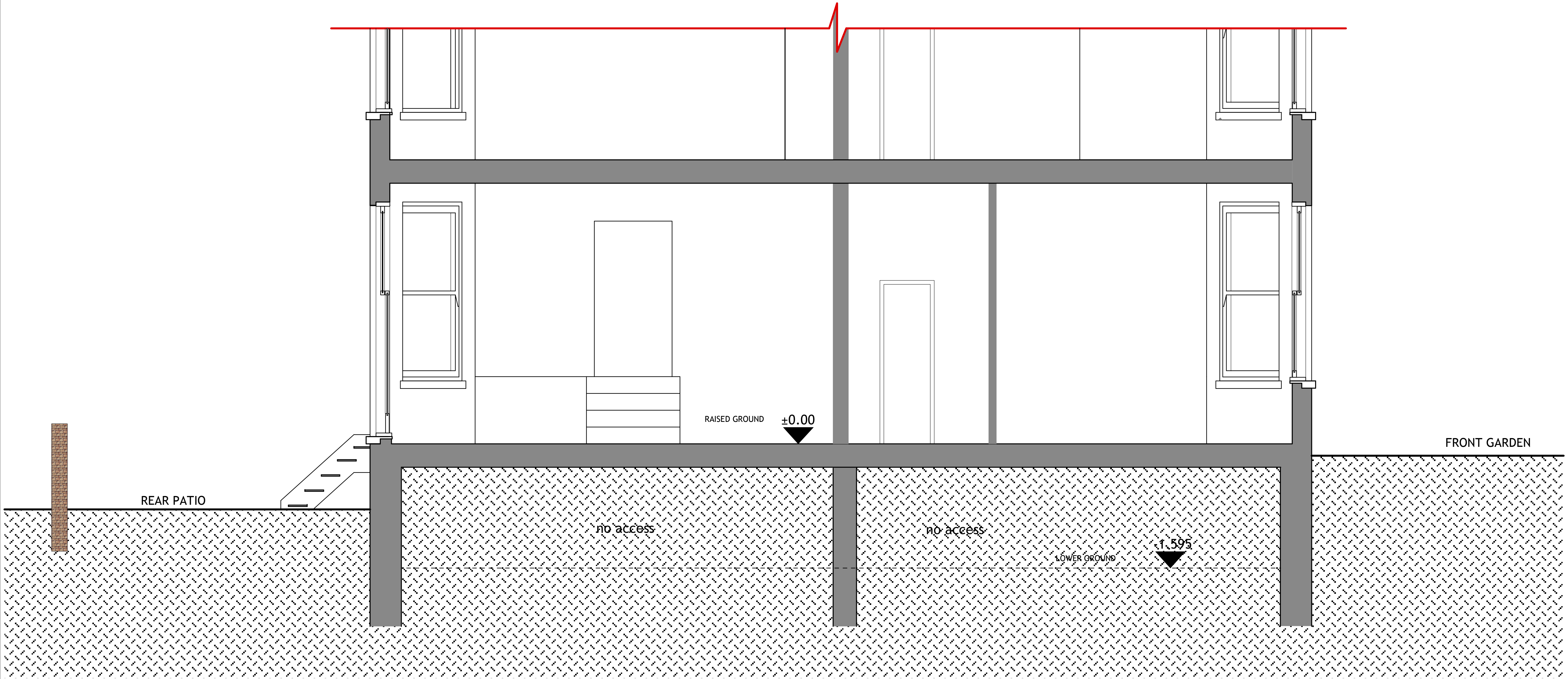
PROJECT

04 - EXISTING SECTION AA

DRAWING NAME

DRAWING Ref.	DRAWEN :	SCALE :	PROJ No.	REV. No.	SHEET :	DATED :	LEGENDE:
28CanfieldBasement@Camden16052016	RCB	1/50	NW63LA	00	A3	01/06/2016	



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ARCHITECTURE LTD.

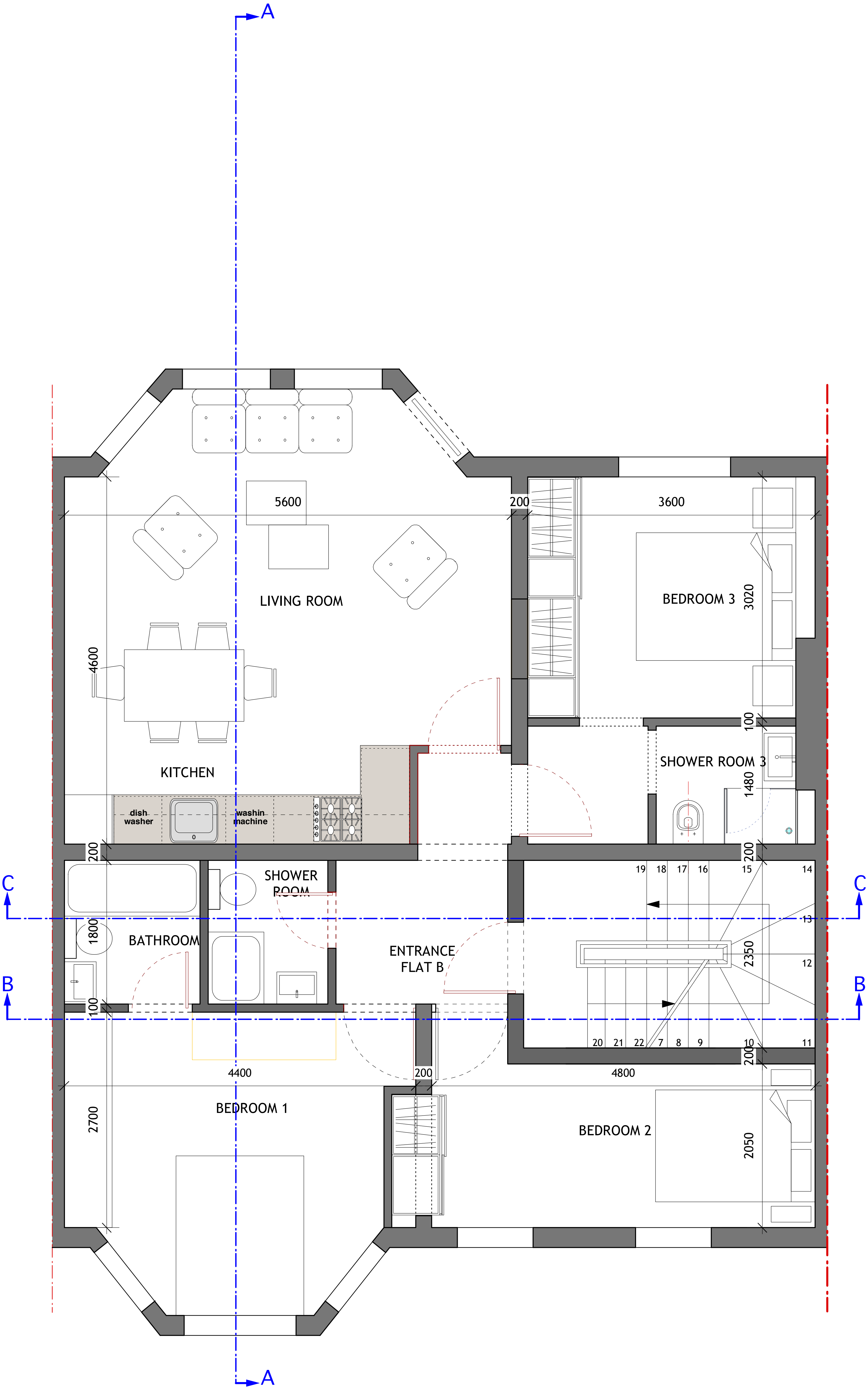
28 CANFIELD GARDENS
LONDON NW6 3LA

PROJECT

03 - EXISTING FIRST FLOOR PLAN

DRAWING NAME

DRAWING Ref.	DRAWEN :	SHEET :	SCALE :	PROJ No.	REV. No.	DATED :
28CanfieldBasement@Camden16052016	RCB	A3	1/50	NW63LA	00	01/06/2016



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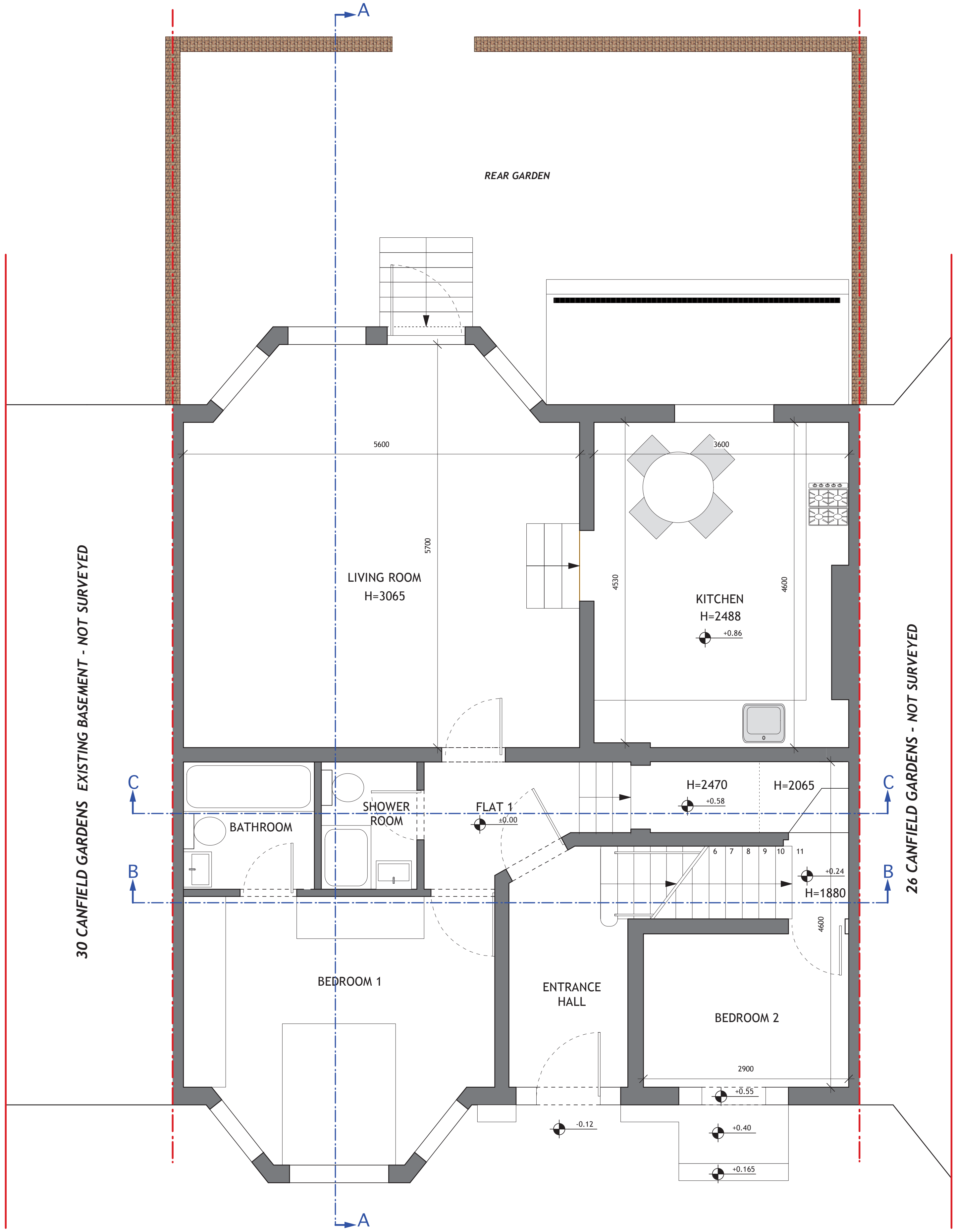
28 CANFIELD GARDENS
LONDON NW6 3LA
PROJECT

02 - EXISTING GROUND FLOOR PLAN

DRAWING NAME

DRAWING Ref.	DRAWEN :
28CanfieldBasement@Camden16052016	RCB

SCALE :	PROJ No.	REV. No.	SHEET :	DATED :
1/50	NW63LA	00	A3	01/06/2016



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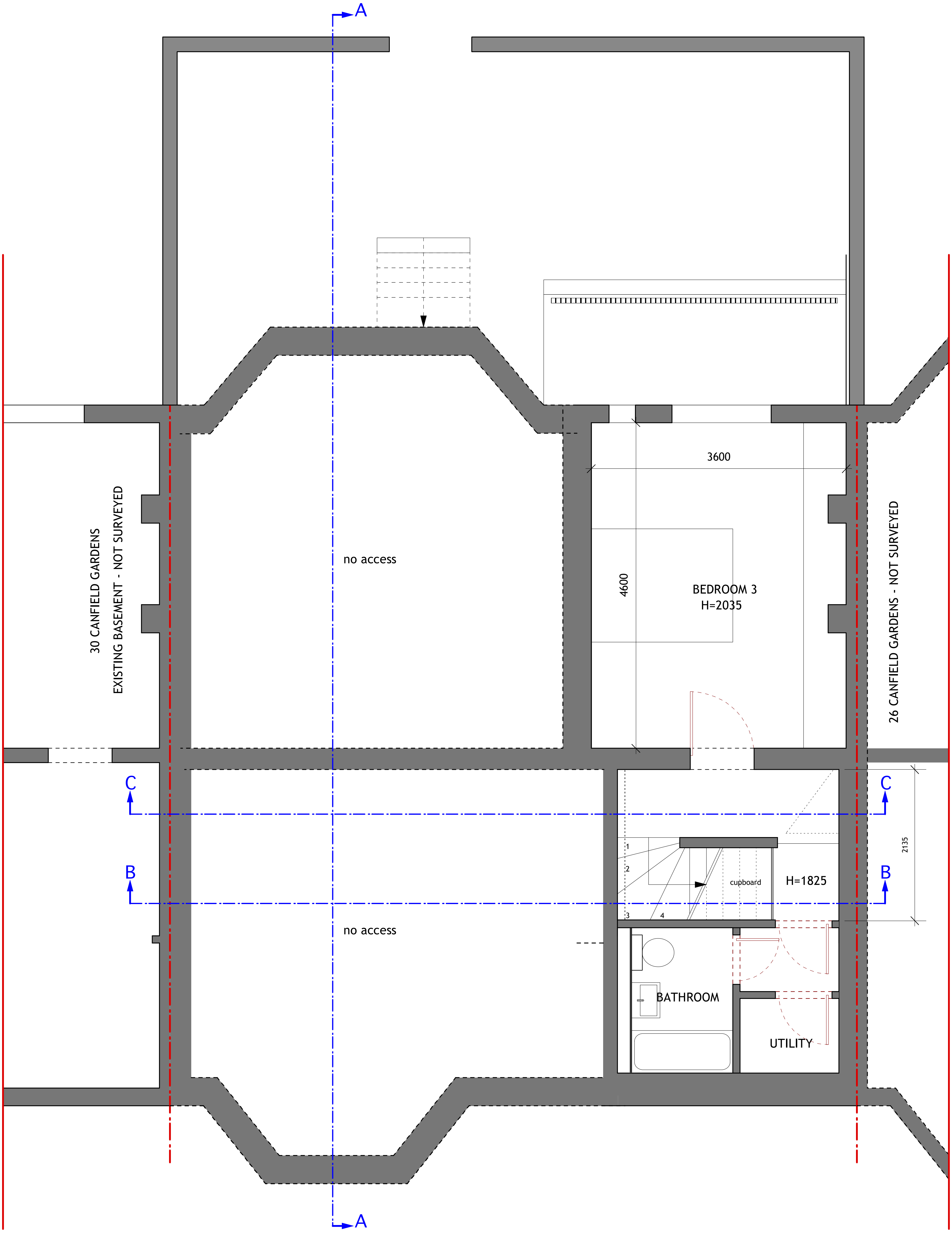
Email: thetreatment@mac.com
Landline: 020 8883 2503 Mobile: 07887 646505

PROJECT: 28 CANFIELD GARDENS LONDON NW6 3LA

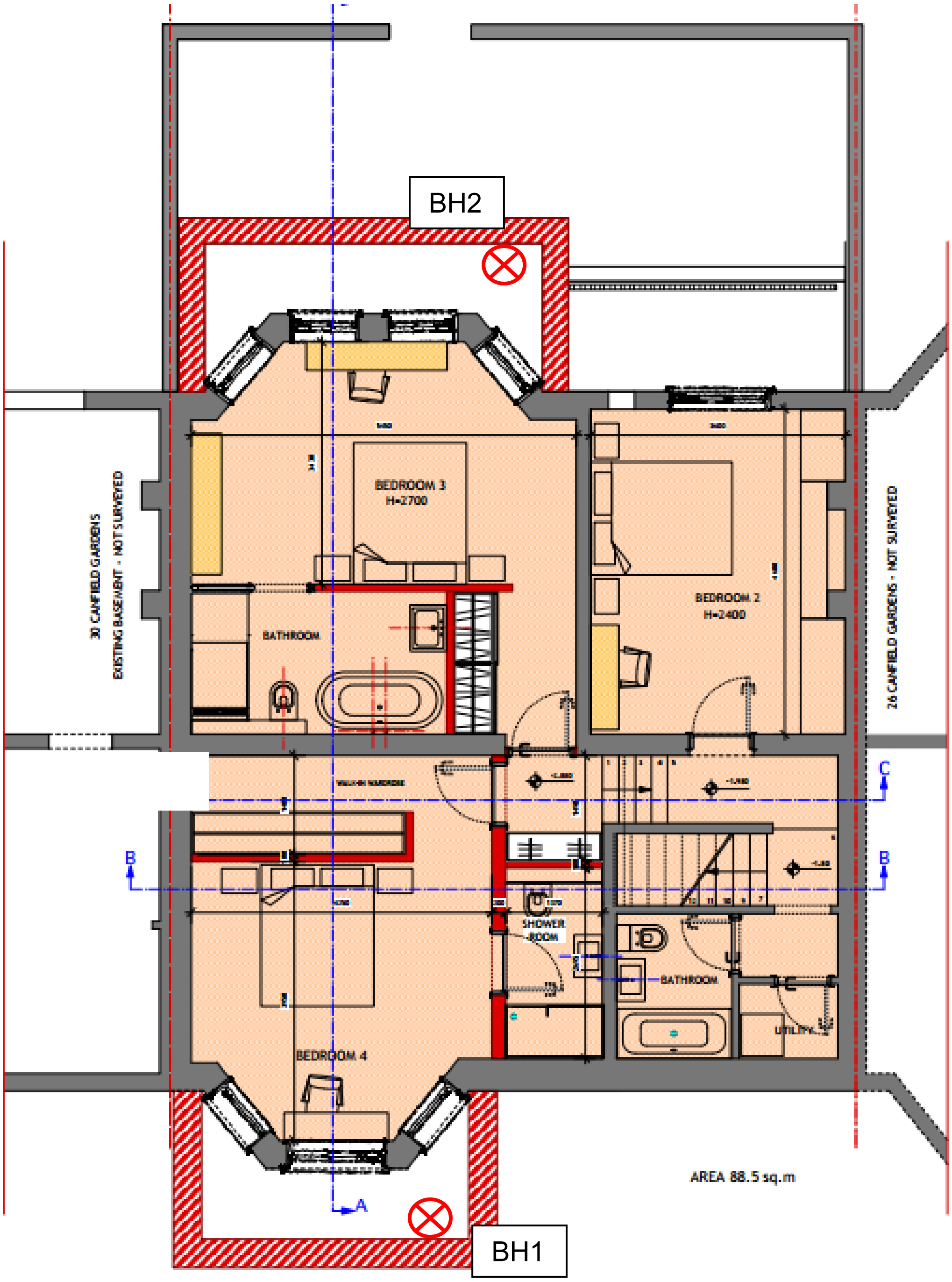
DRAWING NAME:

01 - EXISTING BASEMENT FLOOR PLAN

DRAWING Ref.	28CanfieldBasement@Camden16052016
DRAWEN :	RCB
SHEET :	A3
DATED :	01/06/2016
SCALE :	1/50
PROJ No.	NW63LA
REV. No.	00



Appendix B – Site Analytical Service Limited Site Investigation Data


BH2
BEDROOM 3
H=2700
BATHROOM
BEDROOM 2
H=2400
30 CANFIELD GARDENS
EXISTING BASEMENT - NOT SURVEYED
26 CANFIELD GARDENS - NOT SURVEYED
WALK-IN WARDROBE
SHOWER
-ROOM
BATHROOM
UTILITY
BEDROOM 4
B
B
C
A
AREA 88.5 sq.m
BH1

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MARTIN REDSTON	1625536
	Location	**Dates**	**Engineer**	**Sheet**
	TQ260845	21/07/2016		1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.25	D1					(0.70)	MADE GROUND: Slate chippings over dark brown black slightly gravelly clayey sand with fragments of brick and concrete rubble. Gravel is fine to coarse of sub-angular to sub-rounded flint.		
0.50	D2								
0.75	D3					0.70	MADE GROUND: Soft, brown silty sandy clay with fragments of brick and concrete rubble.		
1.00	D4					(0.50)			
1.00-1.30	M1 94/300					1.20	MADE GROUND: Stiff, light brown silty sandy clay with fragments of brick and concrete rubble.		
1.50	D5								
1.50	V1 95					(1.20)			
2.00	D6								
2.00	V2 117					2.40	Stiff, brown sandy silty CLAY.		
2.50	D7								
2.50	V3 130+								
3.00	D8								
3.00	V4 130+								
3.50	D9								
3.50	V5 130+								
4.00	D10								
4.00	V6 130+								
4.50	D11								
4.50	V7 130+					(4.80)			
5.00	D12								
5.00	V8 130+								
6.00	D13								
6.00	V9 130+								
7.00	D14								
7.00	V10 130+					7.20	Stiff, brown blue sandy silty CLAY.		
8.00	D15								
8.00	V11 130+					(2.80)			
9.00	D16								
9.00	V12 130+								

Remarks
D= Disturbed Sample
M= Makintosh Probe - Blows/Penetration (mm)
V= Vane Test - Result in kPa
Groundwater was not encountered during boring/excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	EW

Figure No. 1625536.BH!

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MARTIN REDSTON	1625536
	Location	**Dates**	**Engineer**	**Sheet**
	TQ260845	21/07/2016		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						10.00	Stiff, brown blue sandy silty CLAY.		
10.00	D17								
10.00	V13 130+								
11.00	D18								
11.00	V14 130+								
12.00	D19								
12.00	V15 130+								
						(5.00)			
13.00	D20								
13.00	V16 130+								
14.00	D21								
14.00	V17 130+								
						15.00	Complete at 15.00m		
15.00	D22								
15.00	V18 130+								

Remarks
D= Disturbed Sample
M= Makintosh Probe - Blows/Penetration (mm)
V= Vane Test - Result in kPa
Groundwater was not encountered during boring/excavation

Scale (approx)	Logged By
1:50	EW

Figure No. 1625536.BH!

Site Analytical Services Ltd.

Site	Borehole Number
28 CANFIELD GARDENS,LONDON,NW6 3LA	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MARTIN REDSTON	1625536
	Location	**Dates**	**Engineer**	**Sheet**
	TQ260845	21/07/2016		1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						0.05	MADE GROUND: Concrete slab		
						0.07 (0.43)	MADE GROUND: Thin layer of concrete		
0.25	D1								
0.50	D2					0.50	MADE GROUND: Black silty sandy clay with fragments of brick and concrete rubble.		
						0.60	MADE GROUND: Brown silty sandy clay with fragments of brick and concrete rubble.		
							Firm becoming stiff, brown sandy silty CLAY		
0.75	D3								
1.00	D4								
1.00	V1 70								
1.50	D5								
1.50	V2 81								
2.00	D6								
2.00	V3 87								
2.50	D7								
2.50	V4 93								
3.00	D8								
3.00	V5 101								
3.50	D9					(5.90)			
3.50	V6 113								
4.00	D10								
4.00	V7 122								
4.50	D11								
4.50	V8 127								
5.00	D12								
5.00	V9 130+								
6.00	D13								
6.00	V10 130+								
						6.50	Stiff, dark blue grey sandy silty CLAY with occasional gypsum crystals.		
7.00	D14								
7.00	V11 130+								
8.00	D15								
8.00	V12 130+					(3.50)			
9.00	D16								
9.00	V13 130+								
10.00	D17								
10.00	V14 130+					10.00			

Remarks
D= Disturbed Sample
M= Makintosh Probe - Blows/Penetration (mm)
V= Vane Test - Result in kPa
Groundwater was not encountered during boring/excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	EW

Figure No. 1625536.BH2