Card Geotechnics Limited
Providing Ground Solutions

Mr Alastair Elphick

9-11 Lawford Road, London

Basement Impact Assessment

April, 2012

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Reference CG/5956		Revision 0	Issue Date April 2012

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1. INTRODUCTION

Mr. Alastair Elphick is proposing to construct a single storey basement beneath the existing residential dwelling at 9 – 11 Lawford Road, London. Card Geotechnics Limited (CGL) has been instructed to undertake a Basement Impact Assessment (BIA) for the proposed development to assess the potential impact on surrounding structures and hydrological features.

Camden Guidance CPG4[1] requires Basement Impact Assessments to be undertaken for new basements in the borough and sets out 5 stages:

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

This report is intended to address the screening, scoping, investigation and impact assessment processes set out in CPG4 and the Camden geological, hydrogeological study (CGHHS)[2]. It identifies key issues relating to land stability, hydrogeology and hydrology as part of the screening process (Section 3) and sets recommendations for site investigation works as part of the scoping process.

The report provides details of intrusive ground investigation works undertaken in accordance with the screening and scoping requirements, and finally provides a basement impact assessment regarding potential issues identified.

[1] Camden Planning Guidance, CPG4, Basements and Lightwells, May 2011.
[2] Ove Arup and Partners, Camden geological, hydrogeological, and hydrological study. Guidance for subterranean development, November 2010.

2. SITE CONTEXT

2.1 Site Location

The site is located at 9 – 11 Lawford Road in Kentish Town in the north of the London Borough of Camden, NW5 2LH. The National Grid Reference for the approximate centre of the site is 529112E, 184721N. The location is shown in Figure 1.

2.2 Site Layout

The site comprises No 9 – 11 Lawford Road and is currently occupied by a rectangular 3 storey building. The building comprises 2 semi-detached houses, both of which are owned by the Client undertaking the works described in this report.

The site does not share party walls with its neighbours; No. 7 is some 2m to the west of No. 9, and No. 13 is some 0.8m to the east of No. 11. A plan showing the site layout is presented in Figure 2.

2.3 Proposed Development

The proposed development is to retain the above ground structure with the inclusion of a single storey basement beneath the north-western corner of the building footprint. A light well extends beyond the rear wall of the existing building. The proposed basement is some 8m long by 4m wide generally, increasing to a width of 7m to the west of the building to accommodate the access stairwell. The proposed basement covers approximately 1 quarter of the building's current footprint, and extends beneath the rear half of No. 9 only (see Figure 2).

2.4 Site History

Historical mapping shows the site to have been developed since at least 1913. Number 9 is shown to have been 'totally destroyed' during the second world war, with No. 11 having been 'damaged beyond repair[3]'.Number 7 is shown to have sustained 'serious damage', whilst number 13 is shown to have sustained 'general blast damage' only. The above is indicative of a direct hit on site, and suggests the potential for re-worked or Made Ground

[3] The London County Council Bomb Damage Maps, 1939 – 1945, London Topographical Society Publication No. 164.

in the garden area derived from the bomb's impact, and the site's subsequent redevelopment.

2.5 Topography

The site is situated at an elevation of approximately 36mOD. Topography within the wider area generally slopes gently from northwest to southeast. The highest point of elevation within the surrounding area is northwest of the site at Hampstead Heath, which is approximately 130mOD and located some 500m to the northwest of the site.

2.6 Published Geology

Available records from the British Geological Survey[4] (BGS) indicate that the site is underlain by London Clay Formation, overlying the Lambeth Formation, Reading and Woolwich Beds.

The London Clay Formation is an over consolidated firm to very stiff, becoming hard with depth, fissured blue to grey silty clay of low to very high plasticity. The upper and lower parts may contain silty or fine grained sand partings. It also contains within it, laminated structured, nodular clay-stone and rare sand partings. The London Clay is typically some 25m to 50m thick in this area, and the Lambeth Formation will not be encountered or affected during the proposed development.

2.7 Unpublished Geology

A ground investigation was undertaken by CGL undertaken on Prince of Wales Road in November 2011, approximately 500m west of the Lawford Road. Ground conditions encountered during the investigation comprised Made Ground to a maximum depth of 0.7metres below ground level (mbgl) over Alluvium deposits of soft to firm dark grey gravelly clay to a maximum recorded depth of 1.3mbgl. Underlying the Alluvium was soft becoming stiff slightly gravelly clay of the London Clay Formation.

A number of publicly available historic (British Geological Survey) borehole records exist within 300m of the site boundary. The references of these boreholes and distances from the site are summarised below in Table 1.

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[4] British Geological Survey (BGS). www.bgs.co.uk (26th March 2012)

Table 1: BGS Borehole Records within 300m

Borehole reference	Distance from site (m)	Direction	Ground Level (mAOD)
TQ28SE413	230	North	33.96
TQ28SE4	300	South	30.48
TQ28SE24	300	West	30.48
TQ28SE523	300	Southwest	29.86

The ground conditions within borehole TQ28SE413 were generally found to comprise stiff brown fissured clay overlying stiff grey-blue silty clay to the base of the borehole at 36.88m bgl. No groundwater was encountered during drilling. Ground conditions encountered within borehole TQ28SE24 to the west of the site are summarised in Table 2 below.

Table 2: Summary of ground conditions from BGS borehole TQ28SE24

Stratum	Depth (m)	Level (mOD)
Brown clay turning blue-grey. Becoming sandy clay towards the base. [LONDON CLAY FORMATION]	0.00	30.48
Hard sandy clay with pebbles over hard sand. Becoming pebbly towards the base. [READING BEDS]	51.82	-21.34
Described as sand with pebbles. [THANET SAND FORMATION]	61.87	-31.39
Described as hard dense chalk with flints. [UPPER CHALK]	64.62	-34.14

2.8 Hydrogeology and Hydrology

The Environment Agency[5] (EA) has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology, and are based on the importance of aquifers for potable water supply and their role in supporting surface water bodies and wetland ecosystems.

According to the Environment Agency no aquifer designation has been given to the superficial or bedrock geology underlying the site. The London Clay is a non-aquifer with a typically permeability of the order of 1 x 10^{-9} m/s. The site is not located within a groundwater source protection zone.

The BGS borehole records indicate groundwater, where encountered, to be present at a depth of 54.86m bgl at the upper boundary of the Reading Beds (borehole TQ28SE24). Groundwater was also encountered within borehole TQ28SE4 at 30.48m bgl.

[5] www.environment-agency.co.uk (26th March 2011)

Available information for the local area from CGL archives indicates that there is a potential for perched water to be present within Made Ground. It is considered that this is due to the underlying London Clay Formation being generally impermeable, providing a barrier to vertical groundwater flow. There is also a precedent for water strikes within the London Clay Formation in the Camden area. This can occur in isolated, localised sand lenses within the London Clay which are not continuous and do not form a general phreatic surface, or water table. General flow through the London Clay is so slow as to be considered negligible.

Figure 11 within the Camden Geological, Hydrogeological, and Hydrological Study[2] indicates that the River Fleet runs broadly north-south under Camden Road, approximately 300m southwest of the site. The River Fleet is understood to have been culverted and runs underground.

2.9 Flood Risk

With reference to the EA website, the site is not within a Flood Risk Zone. In addition, reference to Figure 15 Flood Map of the Arup[2] report confirms the road was not subjected to flooding during the events of 1975 and 2002.

3. SCREENING

3.1 Introduction

A screening process has been adopted in accordance with CPG4, based on the flowcharts presented in that document. These are included in Appendix B for ease of reference. Responses to the questions posed by the flowcharts are presented below, and where 'yes' or 'unknown' may be simply answered with no analysis required, these answers have been provided.

3.2 Subterranean (Groundwater) Flow

This section answers questions posed by Figure 1 in CPG4:

Table 3: Responses to Figure 1, CPG4 (See Appendix B)

Question	**Response**	**Action required**
1a. Is the site located directly above an aquifer	No. The underlying strata have been classified as unproductive.	None
1b. Will the proposed basement extend beneath the water table surface.	No. Any groundwater encountered is likely to be perched and not representative of a general water table. As such the basement will not affect the water table. It is recommended, however, that the potential for perched groundwater is investigated as this may affect the design of basement walls.	None
2. Is the site within 100m of a watercourse, well or potential spring line.	No. The watercourses, wells or springlines are at a distance greater than 100m. The nearest watercourse is the River Fleet located 230m west of the site and presumed to be culverted.	None

3. Is the site within the catchment of the pond chains on Hampstead Heath?	No. The site is over 500m downslope ofthe Hampstead Chain Catchment.	None
4. Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas.	No. The proposed basement (apart from the light well) is under the footprint of the existing building and therefore will not result in a change in the proportion of hard surfaced/paved area.	None
5. As part of site drainage, will more surface water than at present be discharged to ground (e.g. via soakaways and/or SUDS).	No. All surface water will be discharged to the drainage network through existing connections. The volume of water will not be greater than the existing condition. The London Clay is impermeable and is not suitable for soakaway drainage. On this basis the drainage characteristics of the site will not change.	None
6. Is the lowest point of the proposed excavation close to or lower than, the mean water level in any local pond or spring lines.	No. There are no known local water features in the immediate vicinity of this site.	None

In summary, the site is underlain by the London Clay Formation with the Reading Beds at some 25m to 30m depth. Localised 'perched' groundwater may be encountered beneath any Made Ground on site, or within isolated sand lenses within the London Clay.

The proposed development will not increase the proportion of impermeable surfaces and as such there will be no additional recharge to the ground above that of the existing hydrogeological regime. It is understood that surface water from paved areas and roof drainage will be discharged to existing infrastructure.

3.3 Slope/Land Stability

This section answers questions posed by Figure 2 in CPG4.

Table 4: Responses to Figure 2, CPG4 (See Appendix B)

Question	**Response**	**Action required**
1. Does the site include slopes, natural or man made, greater than about 1 in 8?	No. There are no slopes natural or man-made greater than 1 in 8 on site.	None
2. Will the proposed re-profiling of the landscaping at site change slopes at the property boundary to greater than about 1 in 8?	No. No re-profiling or landscaping of significance is planned.	None
3. Does the development neighbour land including railway cuttings and the like with a slope greater than about 1 in 8?	No There are no significant artificial cuttings or embankments within 100m of the site.	None
4. Is the site within a wider hillside setting in which the general slope is greater than about 1 in 8?	No. There are no slopes greater than 1 in 8 within the wider setting that will pose a risk to the site.	None
5. Is the London Clay the shallowest stratum on site?	Yes. The London Clay is expected to extend to a depth of 51m bgl below the site.	None
6. Will any trees be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained?	No. The basement (apart from the light well) is constrained to beneath the current building.	None
7. Is there a history of shrink/swell subsidence in the local area and/or evidence of such at the site.	Unknown. The London Clay is susceptible to seasonal shrink/swell movements and it is likely that these will occur. The impact of this on the proposed development and adjacent properties should be assessed.	Investigation and assessment
8. Is the site within 100m of a watercourse or a potential spring line?	No.	None
9. Is the site within an area of previously worked ground?	Unknown No known or encountered areas of worked ground. Limited Made Ground may be encountered on site, associated with historic developments, and bomb damage during the	Investigation and assessment

	second world war.	
10. Is the site within an aquifer?	No. The underlying strata have been classified as unproductive.	None
11. Is the site within 5m of a highway or pedestrian right of way?	No. The basement is to be constructed below the rear of the existing building. No highway is within 5m of the proposed basement.	None
12. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Unknown. The adjacent properties do not appear to have basements. However it is not known whether any of the properties have deeper existing basements. As such, there is the potential for the foundation differential depths to change. Potential heave movements and construction settlements should be considered.	Investigation and assessment
13. Is the site over (or within the exclusion zone of) any tunnels?	No.	None

In summary, the site is located in the London Clay and it is anticipated that heave movements/long term settlement may occur during construction and over the long-term. It is recommended that a basement impact assessment is undertaken to investigate the magnitude of ground movements around the basement perimeter, and potential settlement due to the underpin construction sequence. This should include retaining wall installation effects and deflections. The results of the ground movement analysis should be used to assess potential damage caused to adjacent structures and walkways.

3.4 Surface Flow and Flooding

This section covers the main surface flow and flooding issues as set out in CPG4.

Table 5: Responses to Figure 3, CPG4 (See Appendix B)

Question	**Response**	**Action required**
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No. The site is more than 500m downslope from the Hampstead Chain Catchment.	None
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off), be materially changed from the existing route?	No. It is understood all surface water will be discharged to the sewer network through existing connections.	None
3. Will the proposed development result in a change in the proportion of hard surfaced/paved external areas?	No. The proposed basement (apart from the light well) is under the footprint of the existing building and therefore it won't result in a change in the proportion of hard surfaced/paved area.	None
4. Will the proposed basement result in a change to the profile of the inflows of surface water being received by adjacent properties or downstream watercourses?	No. Groundwater flow is not generally assumed to occur through the London Clay.	None
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. No as 3, and 4	None
6. Is the site in an area known to be at risk from surface flooding, or is it at risk from flooding because the proposed basement is below the static water level of a nearby surface water feature?	No. The site is not in a Flood Risk Zone and is not identified as a street that flooded in 1975 and 2002.	None

In summary, the site is not with a Flood Risk Zone due to its elevation. There will be no additional surface water flows or discharges to existing infrastructure as connections to the drainage system will be maintained and there will be no significant change to the proportion of hard-standing on site.

3.5 Summary

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

Table 6: Summary of Basement Impact Assessment requirements

Item	Description
	Subterranean (Groundwater flow)
1.	Determine potential for perched groundwater on site within Made Ground or in the London Clay Formation.
	Slope (land stability)
2.	Movements associated with construction in the London Clay, including short and long term heave movements, settlement associated with retaining wall deflections and underpinning, and ground movements around the basement perimeter.
3.	Investigate potential for Made Ground in basement area due to bomb impact/previous structures.
4.	Impact assessment on the existing structure. This should include an estimation of anticipated building damage categories where relevant.

The outcomes of the screening assessment are carried forward into the Basement Impact Assessment in the following report sections.

4. SCOPING

4.1 Introduction

The section of the report covers the scoping process (Stage 2) of the BIA, which is used to identify potential impacts of the proposed scheme and establish a conceptual site model. The scoping stage also informs the scope of the site investigation.

4.2 Preliminary Conceptual Site Model

A preliminary conceptual site model (PCSM) has been developed based on the available data and in accordance with the recommendations of the Arup's CGHHS report and is presented in Figures 2 and 3, with key points summarised in the following sections.

4.2.1 Existing

A PCSM showing the existing conditions on site is presented in Figure 2, with key features summarised below:

1. Made Ground deposits associated with construction of the residential properties over the London Clay to depth and potential bomb damage.

2. Assumed presence of existing shallow strip foundations beneath the properties on site, the depth and extent of which are unknown.

3. Existing paved area and roof space limits recharge. Roof runoff and runoff from paved area is believed to be collected and diverted to existing surface water drainage network on Lawford Road.

4.2.2 Proposed

A PCSM showing conditions on site on completion of the proposed development is presented in Figure 3. Key points of the PCSM are detailed below:

1. Areas of Made Ground/London Clay removed from site as part of the basement excavation.

2. No change to paved area and roof space post-construction. Roof runoff and pavement runoff diverted to existing drainage network on Lawford Road.

3. Possible ground movement.

4.3 Subterranean (Groundwater Flow)

The presence of groundwater should be established to determine whether it will affect the proposed development. This will require an intrusive investigation to coincide with a geotechnical assessment of the soils under the site.

It is recommended that two window sample holes are undertaken at the site to a depth which is likely to be the maximum depth of embedment of the retaining walls utilised during construction. Groundwater conditions will be observed and recorded during excavation of the exploratory holes to determine the presence of any local perched groundwater.

4.4 Slope (Land Stability)

Although site investigation data is not available in close proximity to the site, investigations undertaken within the area have shown ground conditions to correlate with the available BGS records. This information has been used to provide preliminary details on likely ground conditions. Ground conditions are likely to comprise soft becoming stiff slightly gravelly clay of the London Clay present to depth.

Information relevant to design should incorporate *site specific* ground investigation and clarify any uncertainty regarding the following:

- the lithology beneath the site i.e whether potentially deeper Made Ground may exist;
- whether there are water bearing localised sand horizons;
- the depth to London Clay, if not present at ground level;
- the strength of underlying strata.

It is recommended that detailed engineering logs are provided for the window sample holes and geotechnical parameters are determined for design. Information should be provided with specific regard to the following:

- Bearing capacity of soils at foundation levels;

- Deflections of retaining walls and impact on existing foundations and utilities;
- Short / long terms settlements and / or heave movements resulting from the excavation and application of structural loadings;
- Determination of hydrogeological regime to assess potential damage caused by hydrostatic build-up next to the basement walls and aid in the design of appropriate basement drainage.
- Heave/shrinkage potential of the underlying slope and the influence of seasonal variations and trees.

In-situ testing should include hand shear vane testing in cohesive soils and Standard Penetration Testing in granular soils if possible/present.

It is further recommended that foundation inspection pits are excavated in order to investigate existing foundations.

5. INTRUSIVE INVESTGATION

5.1 Site works

An intrusive investigation was undertaken on Friday 30th March 2012 and comprised the excavation of two window sample boreholes to depths of 3.5m below ground level (mbgl). The boreholes were logged by a CGL engineer and borehole records are included in Appendix C. A borehole location plan is provided in Figure 6. Hand shear vane testing was undertaken in each window sample hole.

In addition to the window sample boreholes, two hand-dug trial pits were excavated adjacent to expose the foundations of the existing building. These were excavated by the contractor currently on site, and were logged by CGL engineer. Detailed records are included in Appendix D, and the location of the trial pits is illustrated in Figure 6.

5.2 Ground conditions

The ground conditions on site varied from those expected in the screening report and were found to comprise a thickness of potential River Terrace Deposits and gravels overlying the London Clay. The ground conditions encountered are summarised in Table 7 below:

Table 7: Summary of ground conditions encountered

Stratum	**Depth to top (mbgl)**	**Thickness (m)**
MADE GROUND: Comprising loose to medium dense dark brown gravelly sand and gravel	0	0.6 – 0.8
Soft to firm light brown mottled grey, slightly sandy gravelly CLAY. Gravel is angular to rounded, fine to coarse flint. [RIVER TERRACE DEPOSITS]	0.6 – 0.8	0.6 – 1.8
Medium dense orange brown slightly sandy slightly clayey GRAVEL. Occasional bands of clay, 0.2m to 0.35m thick. [RIVER TERRACE DEPOSITS]	1.2 – 1.9	0.7 – 1.55

Firm to stiff brown silty fissured CLAY. [WEATHERED LONDON CLAY]	2.6 – 2.75	Proven to 3.5mbgl

5.3 Groundwater

Groundwater was encountered at a depth of 3.0mbgl in window sample hole WS01, near the surface of the London Clay. No groundwater was encountered in window sample hole WS02.

5.4 Existing foundations

Foundation pit FP1 was excavated adjacent to the north-western corner of No. 9 and encountered a concrete strip foundation at a depth of 0.7mbgl. The total width of the foundation is assumed to be some 0.9m, based on observed measurements, and it is noted that the footing appears to have been constructed within the cohesive River Terrace Deposits.

Foundation pit FP2 was excavated adjacent to the north-eastern corner of No. 11 and encountered a concrete strip footing at a depth of some 1.3mbgl. The soils exposed in the trial pit in this area were Made Ground for the full foundation depth which appears to extend beneath the foundation in this location. A minor diagonal crack was observed in the brickwork above this foundation which may indicate historic differential settlement.

5.5 General observations

A single storey structure linking numbers 7 &9 had been demolished prior to site works commencing and the distance between the external wall of No. 9 and the closest load bearing wall of No. 7 was measured to be some 4.5m. A similar single storey building will be reconstructed in this area and the final distance between the basement wall and the party wall at No. 7 will be some 2.1m. No. 7 was not observed to have a basement and this assumption has been carried forward into the basement impact assessment.

5.6 Geotechnical design parameters

Geotechnical design parameters for the proposed basement are summarised in Table 8 below. These are considered 'worst credible' parameters for design and have been taken as such due to the limited nature of the site investigation information. Soil parameters have been supplemented by extensive published data for London soils.

Table 8: Geotechnical design parameters

Stratum	**Depth to top (mbgl)**	**γ (kN/m^3)**	**ϕ_u [ϕ']**	**C_u (kPa) [c']**	**E_u (MPa) [E']**
Made Ground	0	20	n/a [30[a]]	n/a	n/a [20[b]]
River Terrace (CLAY)	0.7	20	0 [23[c]]	40 [0]	22 [17[b]]
River Terrace (GRAVEL)	1.5	20	n/a [30[a]]	n/a	n/a [20[b]]
London Clay	2.7	20	0 [24]	75 + 5z [2]	37.5 + 2.5z [28[b]+1.9z]

a. *Peck, R.B., Hanson, W.E., and Thornburn, T.H., Foundation Engineering, 2nd edn, John Wiley, New York, 1967, p.310.*

b. *Burland, J.B., Standing, J.R., Jardine F.M. (eds), Building response to tunnelling, Case Studies from construction of the Jubilee Line Extension, London, CIRIA Special Publication 200, 2001.*

c. *BS 8002:1994, code of practice for earth retaining structures*

The London Clay at basement formation level was found to have an undrained shear strength of the order of 75kPa giving rise to an allowable bearing pressure of the order of 130kPa to nominally limit settlements to less than 25mm.

6. BASEMENT IMPACT ASSESSMENT

6.1 Introduction

Previous stages of this Basement Impact Assessment identified the following items for investigation:

1. Potential perched water on site or within London Clay formation.

2. Movements associated with construction of Basement.

3. Potential deeper Made Ground in basement area.

4. Estimation of the potential damage arising from basement construction (primarily to party wall structures).

6.2 Groundwater

Perched groundwater was encountered at a depth of some 3.0mbgl in window sample hole WS01, and is likely to represent localised, perched water within this stratum. This is supported by the fact that WS02, within 3m from WS01 was found to be completely dry on excavation.

It is noted that whilst granular River Terrace Deposits were encountered on site, no groundwater was recorded within them and as such it is considered that the basement does not interrupt a groundwater 'table' that may generate flooding to local basements or similar features. It is further noted that the proposed basement extends only beneath 25% of the building footprint, and as such does not present a significant barrier to any groundwater flow, should any such flow occur in future.

As a conservative precaution however, the basement preliminary design and impact assessment calculations provided in the following sections assume a full height of retained groundwater. This is a conservative assumption, establishing worst-case earth/water pressures on the basement retaining walls.

6.3 Movements associated with the construction of the basement

This Section addresses Items 2,3, and 4 as listed in Section 6.1.

6.3.1 Made Ground

No deep Made Ground was encountered in the vicinity of the basement. This does not, however, preclude the presence of deeper Made Ground in areas not investigated. It is considered that the impact of any potential deeper Made Ground on the retaining wall design has been allowed for in the selection of 'worst credible' design parameters.

6.3.2 Heave

A heave analysis has been undertaken to assess potential ground movements arising from the basement construction. The analysis has been undertaken using Oasys VDISP software, a programme calculating elastic displacements of soils under fully flexible loads. The soil parameters used in the analysis are those shown in Table 8, which are 'worst credible' and therefore conservative.

The analysis results are presented in Figures 7 and 8 for short-term and long-term heave movements respectively, and assume the entire basement is excavated at one time. The analysis makes no allowance for the presence of friction and structural loading on the underpinned basement walls, and as such presents an over-estimate of potential heave movements.

The results indicate a short term heave in the centre of the basement of some 6.5mm, with a further 9mm occurring over the long term giving rise to a total heave movement of 15.5mm. It is considered that this amount of movement would not generate damage to the structure of 9 & 11 Lawford Road.

The basement heave has no impact on No. 13, and potentially gives rise to a negligible heave of some 1.5mm at the party wall of No. 7. On this basis, the heave impact of the proposed basement is considered to be negligible.

6.3.3 Retaining walls

At its nearest, the basement is some 2.1m distant from the closest load-bearing foundations of No. 7 Lawford Road. Assuming a conservative (shallow) foundation depth of 0.6m for the foundations of No. 7, the basement 'zone of influence' potentially affects No. 7. This is shown diagrammatically in Figure 5. Number 13 Lawford Road is not within the zone of influence of the proposed basement, and has a basement itself. Impacts on No. 13 are therefore considered to be negligible and are not considered further.

Preliminary retaining wall calculations have been undertaken using Geosolve GWALL (Gravity retaining WALL) software in order to establish potential bearing bearing pressures and displacements on the basement walls.

At the time of writing, no structural loading information was available for Numbers 9 & 11 Lawford Road, and on this basis a typical line load of 130kN/m run has been applied for the internal party wall between 9 & 11 as a critical section. It is noted that the basement wall closest to the party wall with No. 7 will have a single storey lean-to constructed above and as such vertical loads on this wall are significantly lower, of the order of 5kN/m run to 10kN/m run conservatively.

Two typical retaining wall sections have been analysed:

1. Internal wall between numbers 9 & 11;
2. External wall, 2.1m from No.7.

6.3.3.1 Internal wall, Numbers 9 & 11

A preliminary assessment of the internal wall has been undertaken using GWALL and the results are provided in Appendix D. This wall will be constructed in an underpin sequence with bays limited to a maximum 1.0m width. The internal party wall between No. 9 & 11 will be underpinned during this construction and a line load of 130kN/m has been considered to apply.

The results of the analysis indicate that a heel width of some 0.33m and a toe length of 2.0m is required for stability and to limit bearing pressures beneath the retaining wall to less than 130kPa. The analysis is conservative, assuming a full retained height of groundwater and a 5kPa surcharge on the retained soils. The maximum calculated bearing pressure beneath the wall is some 123kPa.

On the load assumptions provided here, the calculation theoretically indicates that settlement will be minimal beneath the internal wall foundations.

6.3.3.2 External wall, 2.1m from Number 7

A preliminary assessment of the external wall, 2.1m from No.7 Lawford Road has been undertaken, and the results are presented in Appendix D. This wall will be constructed in sequential excavation such that the excavation is supported at all times. No line load has been applied to the wall as this is critical for stability. The foundation to No.7 has been included as a surcharge of 145kPa, assuming a line load of 130kN/m over a 0.9m wide foundation.

The results indicate a heel width of 0.5m is required, and a toe length of 2.4m for overturning and sliding stability. Contact pressures beneath the wall are of the order of 88kPa. On the basis of the above assumptions, the basement wall 2.1m from No. 7 is unlikely to affect the foundations or structure of that building.

6.3.4 Retaining wall deflections

Basement retaining wall deflections have been considered, assuming a 3.29m high concrete wall, some 0.33m thick, acting as a cantilever. Pressures have been derived from the GWALL calculations (see Appendix D) and beam deflection formulae for a cantilever beam have been applied to derive deflections.

Based on the above, deflections on the internal party walls are calculated to be of the order of 10mm, and some 13mm on the external wall. This amount of movement may potentially generate settlements of 5mm to 6mm and is not considered to be of concern.

6.4 Conclusions

The analysis undertaken to date indicates that the impact of the basement on groundwater, slope stability, surface water, and neighbouring properties is tolerable and not detrimental. It is recognised that the analysis is based on limited data (geotechnical and structural). As such, conservative loading assumptions, ground conditions, and groundwater assumptions, have been applied and the resultant calculated movements are considered to represent values towards the upper bound (worst case) of those anticipated.

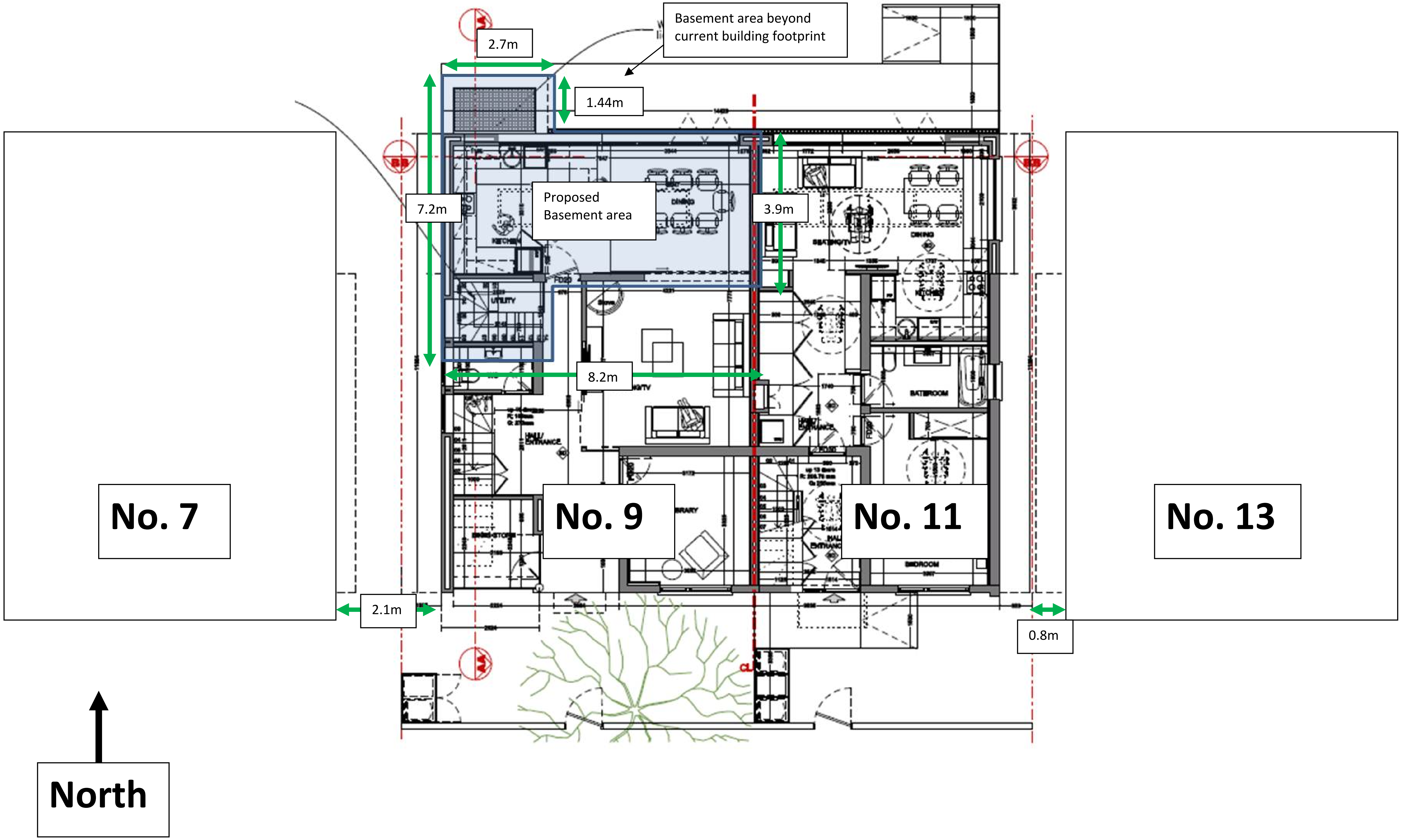
It should be noted that the geotechnical analysis undertaken assumes that construction process and joints will be perfectly executed. The competence, attention to detail, and working methods of the contractors engaged to construct the basement will be critical in ensuring that calculated movements and deflections remain within the limits calculated here.

It is further recommended that the structural engineer for the project undertakes a structural survey prior to commencing site works.

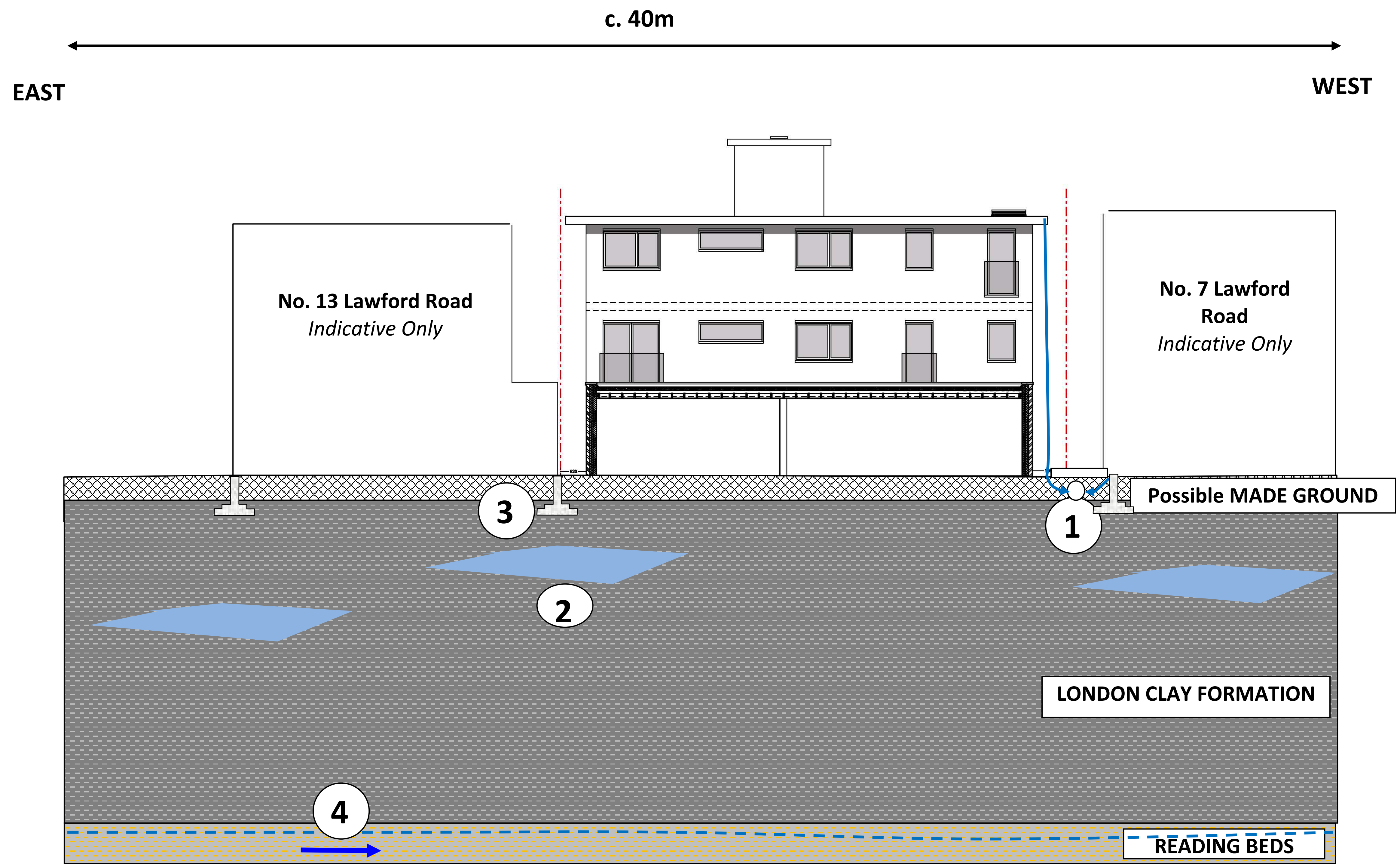
FIGURES

N

Client	Project	Job No
Mr Alastair Elphick	**9 – 11 Lawford Road, London**	**CG/5956**
CGL	Title **Site location plan**	**Figure 1**

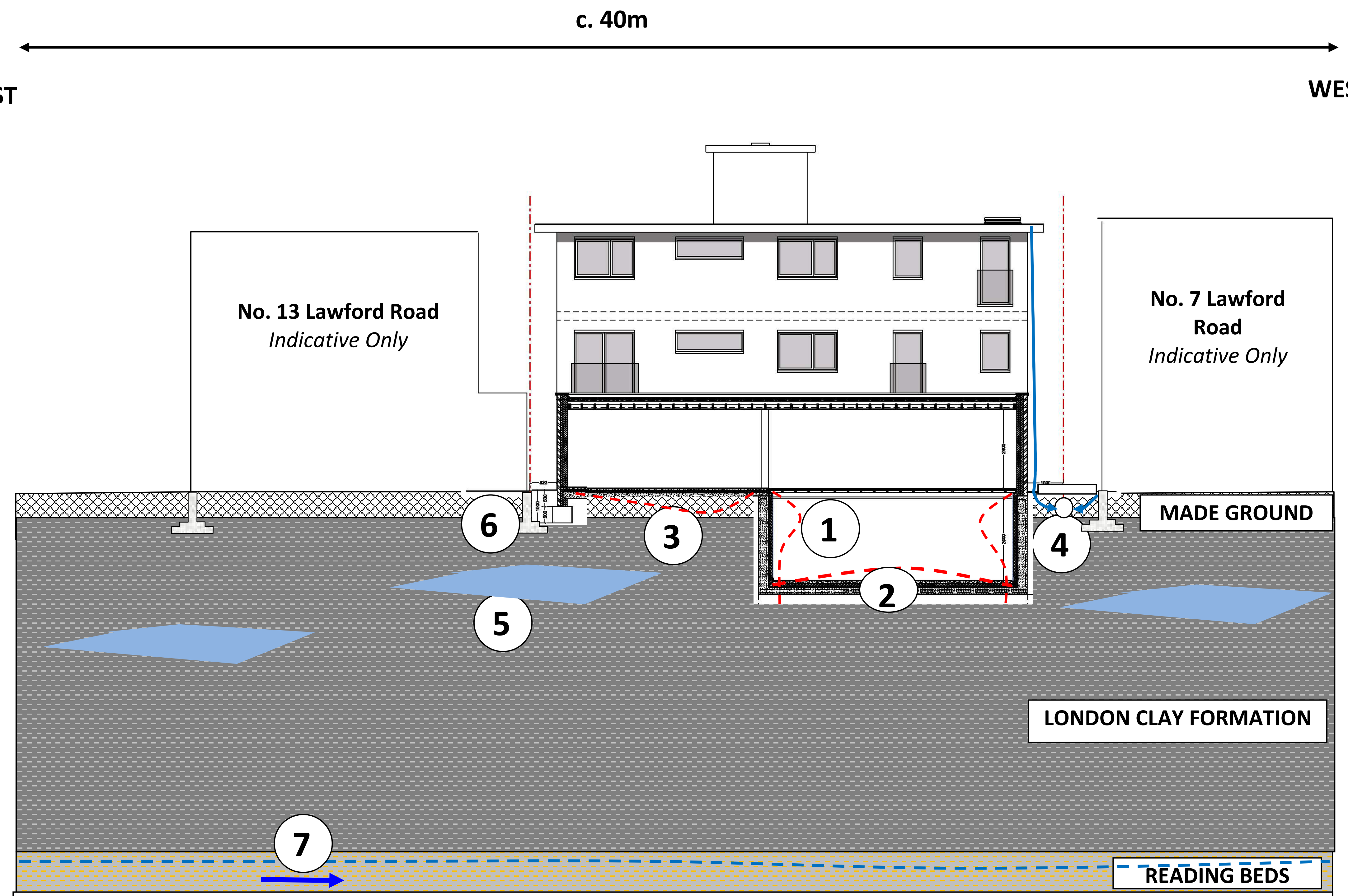


Client	Project	Job No
Mr Alastair Elphick	**9-11 Lawford Road, London**	**CG/5956**
CGL	Title: **Site layout plan showing ground floor and proposed basement**	**Figure 2**



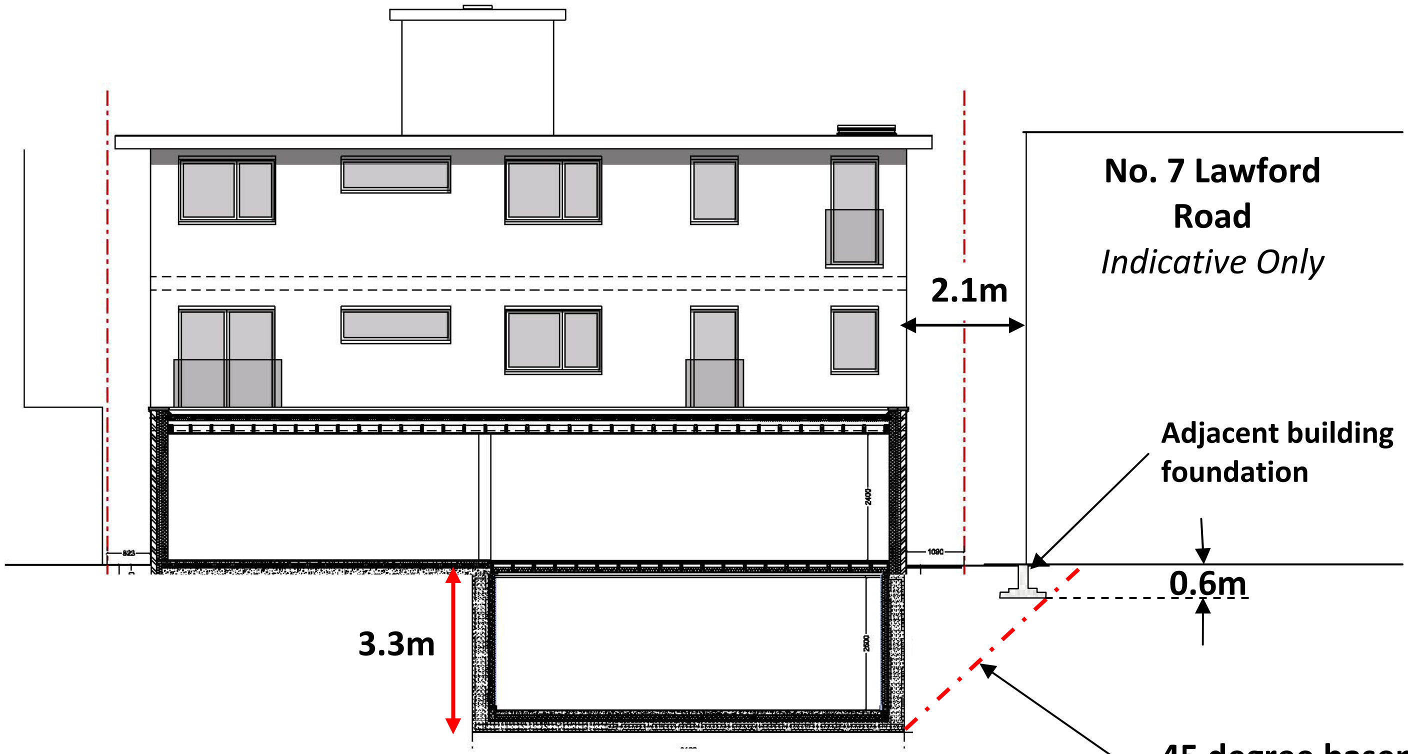
1. Surface and foul water drainage to existing infrastructure.
2. Potential perched water within London Clay.
3. Adjacent foundation at No. 13 Lawford Road (shown for clarity only)
4. Possible groundwater flow – likely to be in Reading Beds at depth.

Client	Project	Job No
Mr Alastair Elphick	9 – 11 Lawford Road, London	CG/5956
CGL	Preliminary Conceptual Site Model - Existing	Figure 3

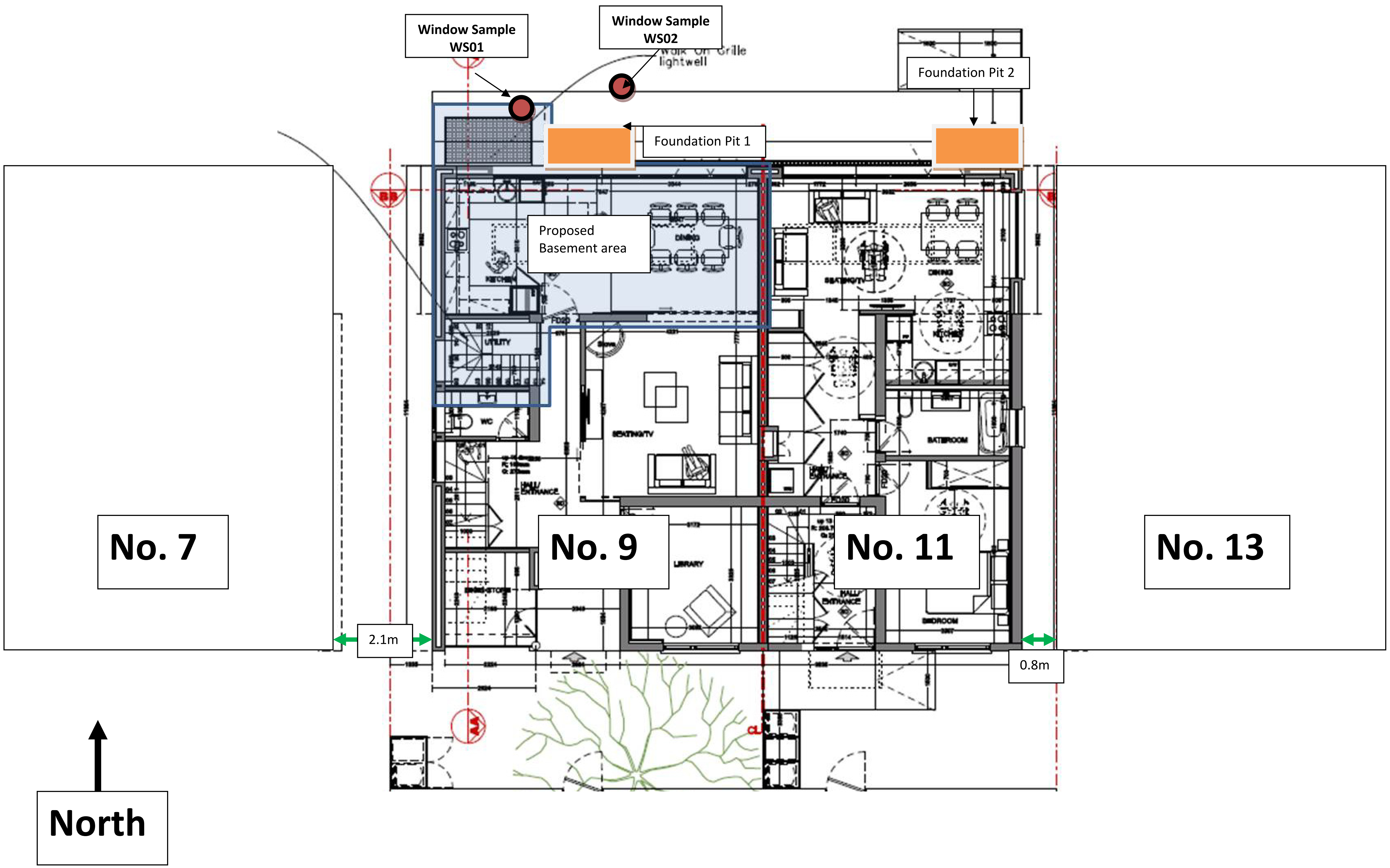


1. Lateral movements from basement installation and long term earth/water pressures.
2. Heave movements due to excavation – reapplication of load from proposed foundations may negate this subject to design.
3. Potential heave/shrinkage due to presence of trees.
4. Surface and foul water drainage to existing infrastructure.
5. Potential perched water within London Clay.
6. Adjacent foundation at No. 13 Lawford Road (shown for clarity only))
7. Possible groundwater flow – likely to be in Reading Beds at depth.

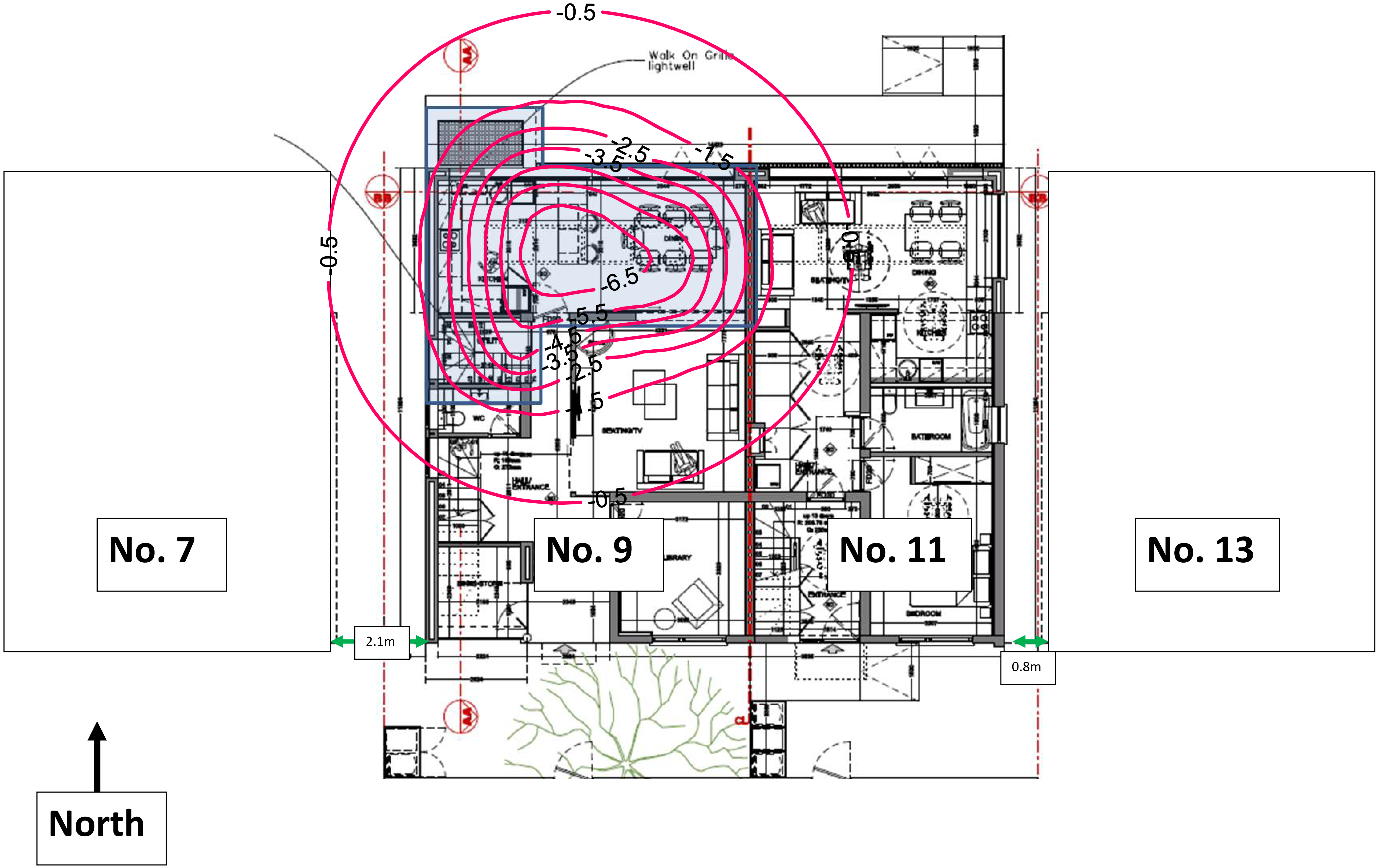
Client	Project	Job No
Mr. Alastair Elphick	9 – 11 Lawford Road, London	CG/5956
CGL	Preliminary conceptual site model - Proposed	Figure 4



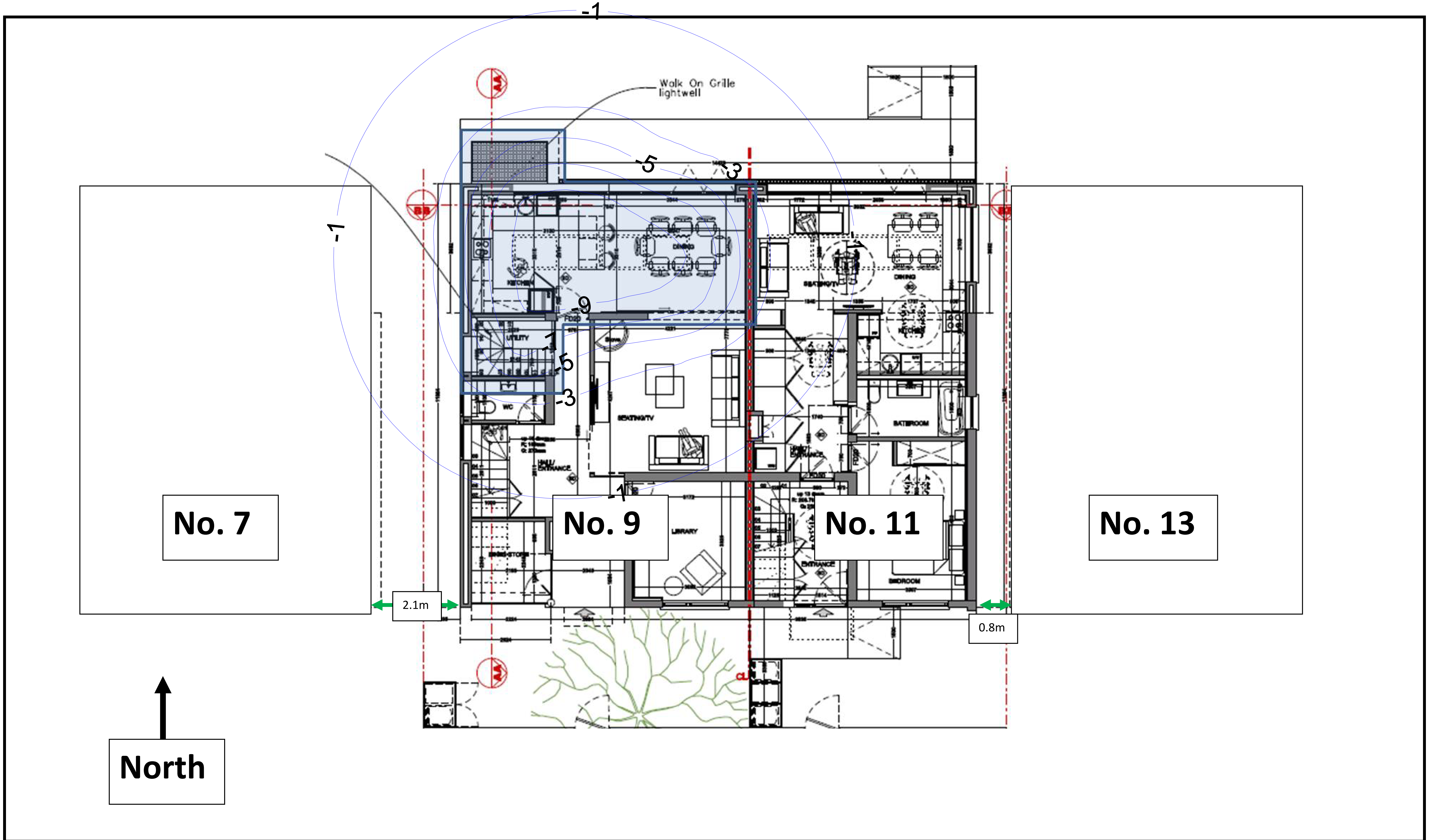
Client	Project	Job No
Mr Alastair Elphick	9 – 11 Lawford Road, London	CG/5956
CGL	Title: Proposed Basement Zone of Influence	Figure 5



Client	Project	Job No
Mr Alastair Elphick	9-11 Lawford Road, London	CG/5956
CGL	Title: Exploratory hole location plan	Figure 6



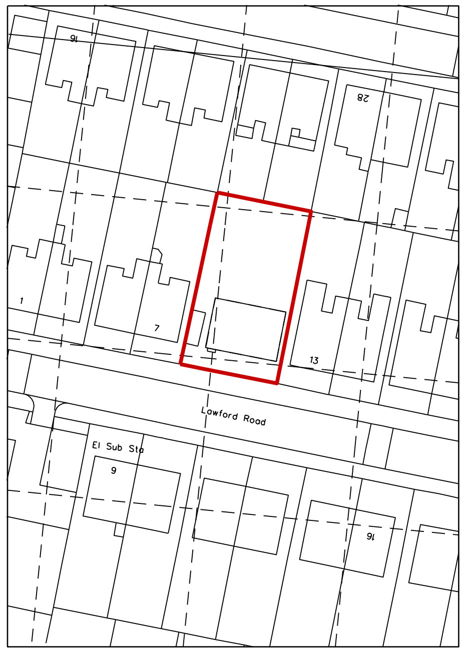
Client	Project	Job No
Mr Alastair Elphick	9-11 Lawford Road, London	CG/5956
CGL	Title: Undrained (short-term) heave contours	Figure 7



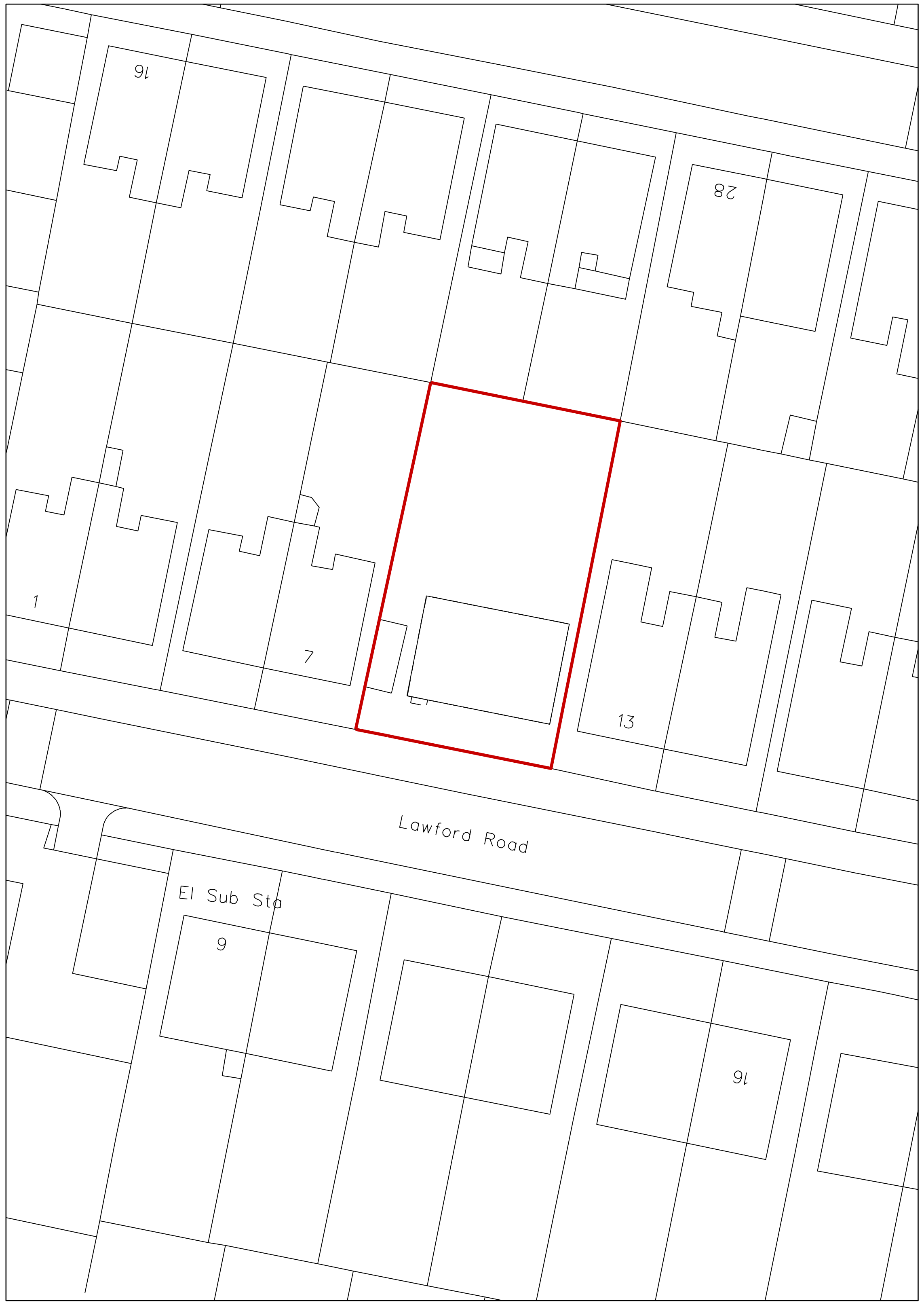
Client	Project	Job No
Mr Alastair Elphick	9-11 Lawford Road, London	CG/5956
CGL	Title: Drained (long-term) heave contours	Figure 8

APPENDIX A

Site developments plans



SITE PLAN
ESC. 1:1250
Licence number 100020449



SITE PLAN
ESC. 1:500

ISSUE

120312 Issued to Client
120315 Issued to Client
120403 Issued to Planning

1:50

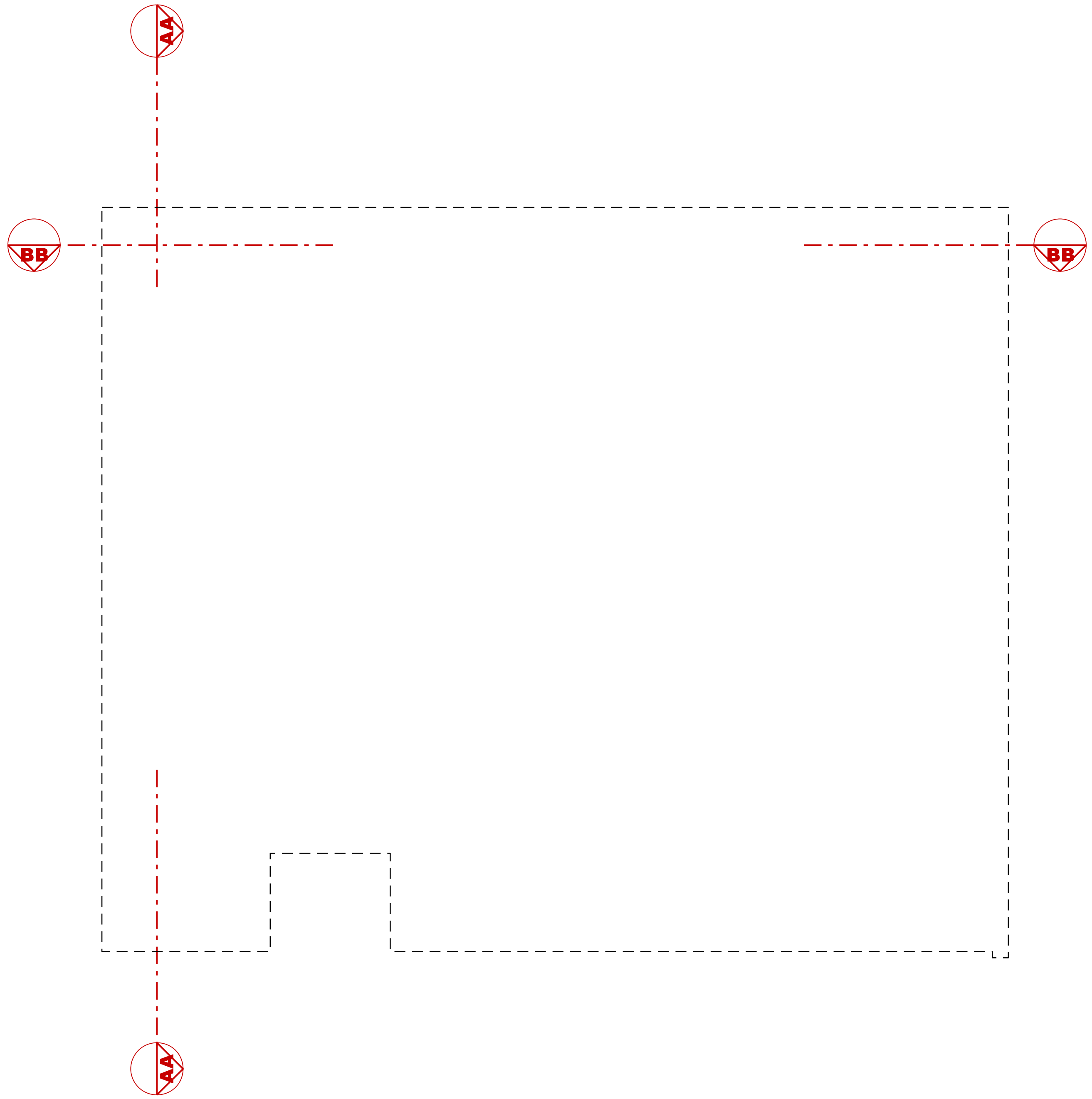
1:100

Notes:
The General contractor is responsible for the verification of all dimensions on site & shall inform the contract administrator of any descrepencies. Do not scale from this drawing. Use figured dimension only. Existing foundations, lintels and wall to be exposed if required by Building Control for assessment & upgrading if found inadequate.

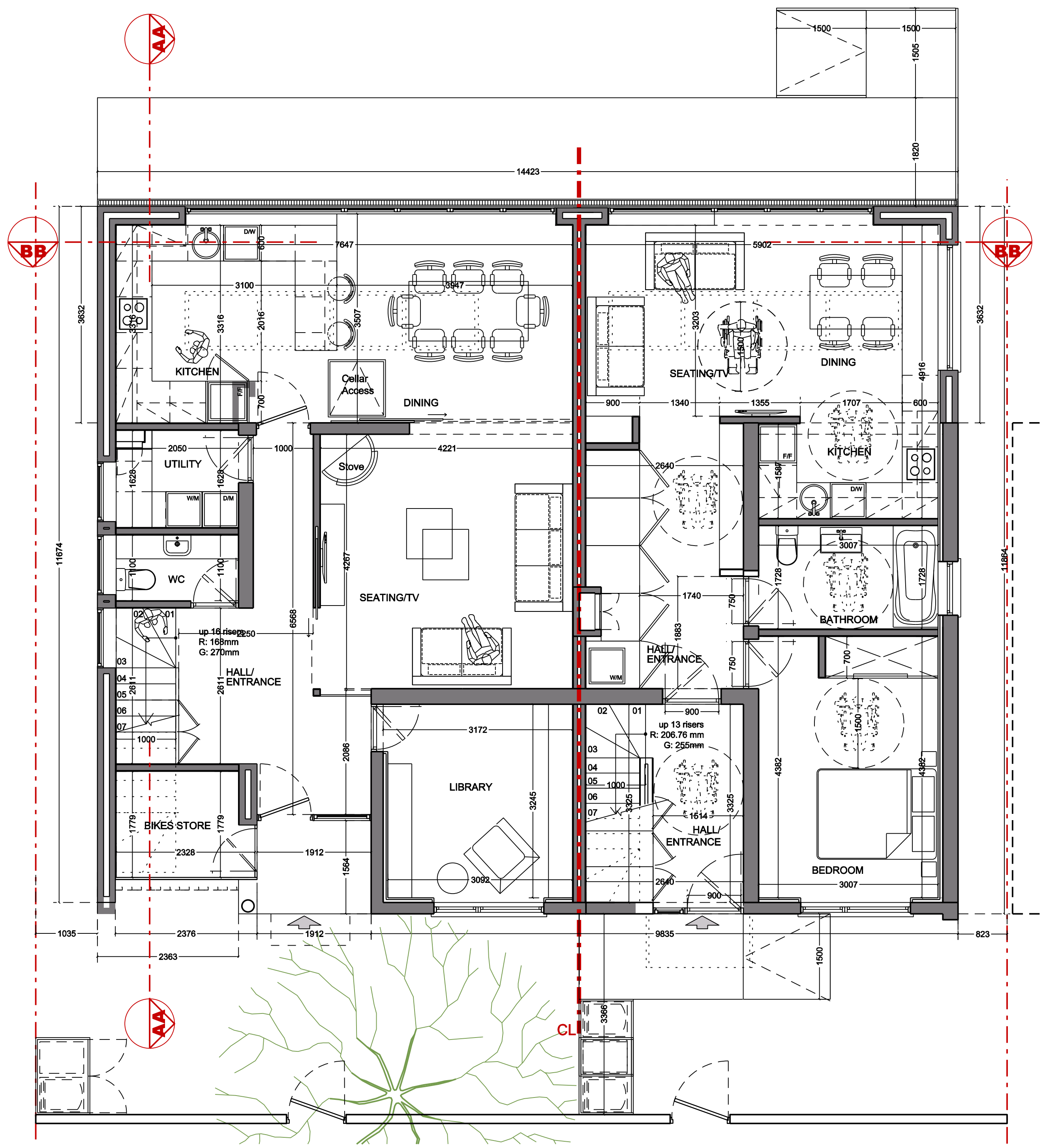
50°NORTH
ARCHITECTURE | DESIGN | SUSTAINABILITY
CONTACT US 08454505909 INFO@50DEGREES.CO.UK

LOCATION 9-11 Lawford Road, NW5 2LH	CLIENT Mr & Mrs Elphick	DRAWING TITLE Site Plan	JOB No 1175 / SIZE A3
JOB DESCRIPTION Basement	SCALE 1:1250 @ A3 / STATUS Planning Application		DRAWING No 001 / REV B

Do not scale, use figured dimensions only. Unless stated otherwise these drawings represent design intent only & approved assembly drawings will be required from the Trade Contractor prior to any work and/or procurement being undertaken. If in doubt, ask



EXISTING GROUND FLOOR FOOTPRINT



EXISTING GROUND FLOOR PLAN

ISSUE

120312 Issued to Client
120315 Issued to Client
120403 Issued to Planning

Notes:
The General contractor is responsible for the verification of all dimensions on site & shall inform the contract administrator of any descrepencies. Do not scale from this drawing. Use figured dimension only. Existing foundations, lintels and wall to be exposed if required by Building Control for assessment & upgrading if found inadequate.

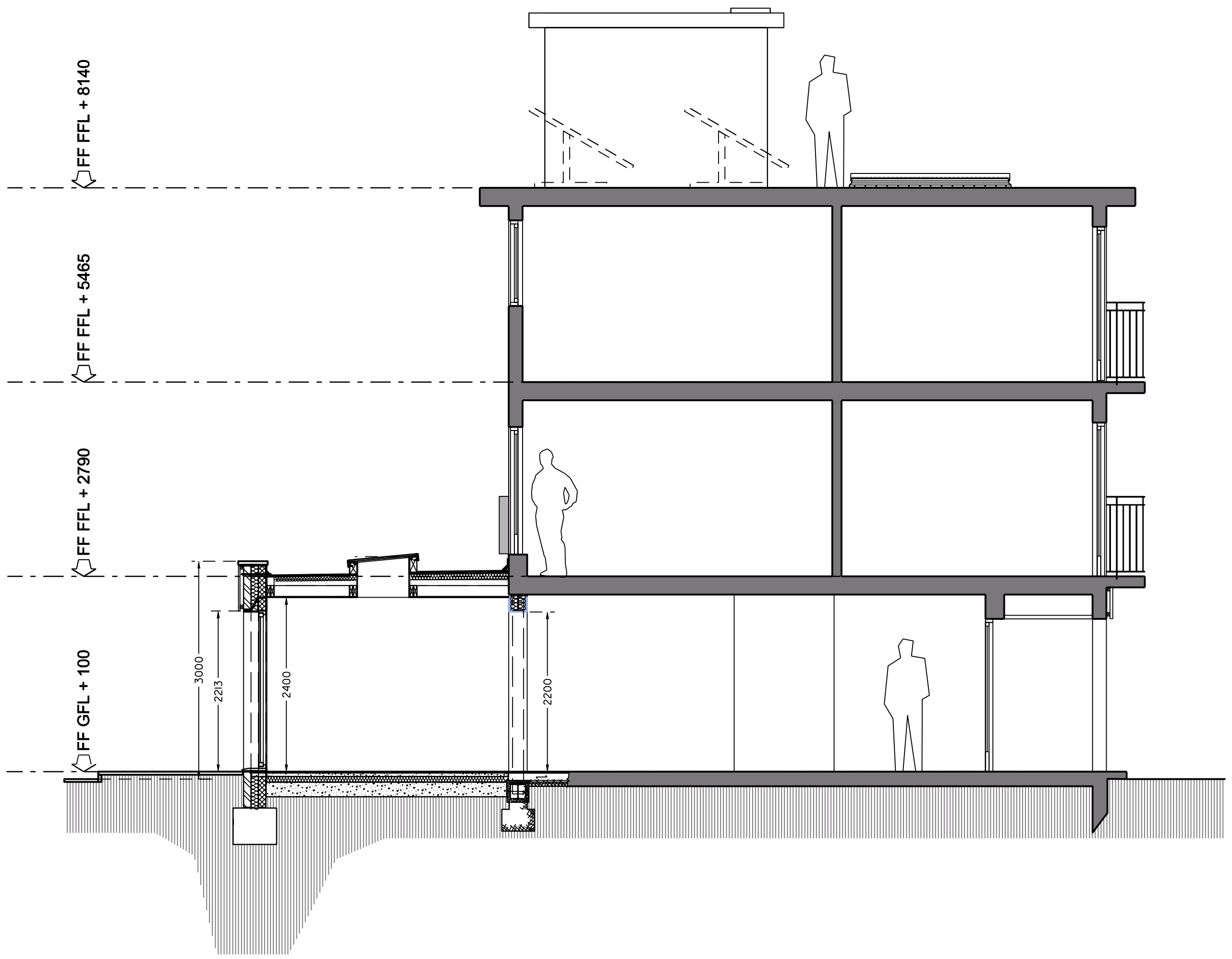
1:50

1:100

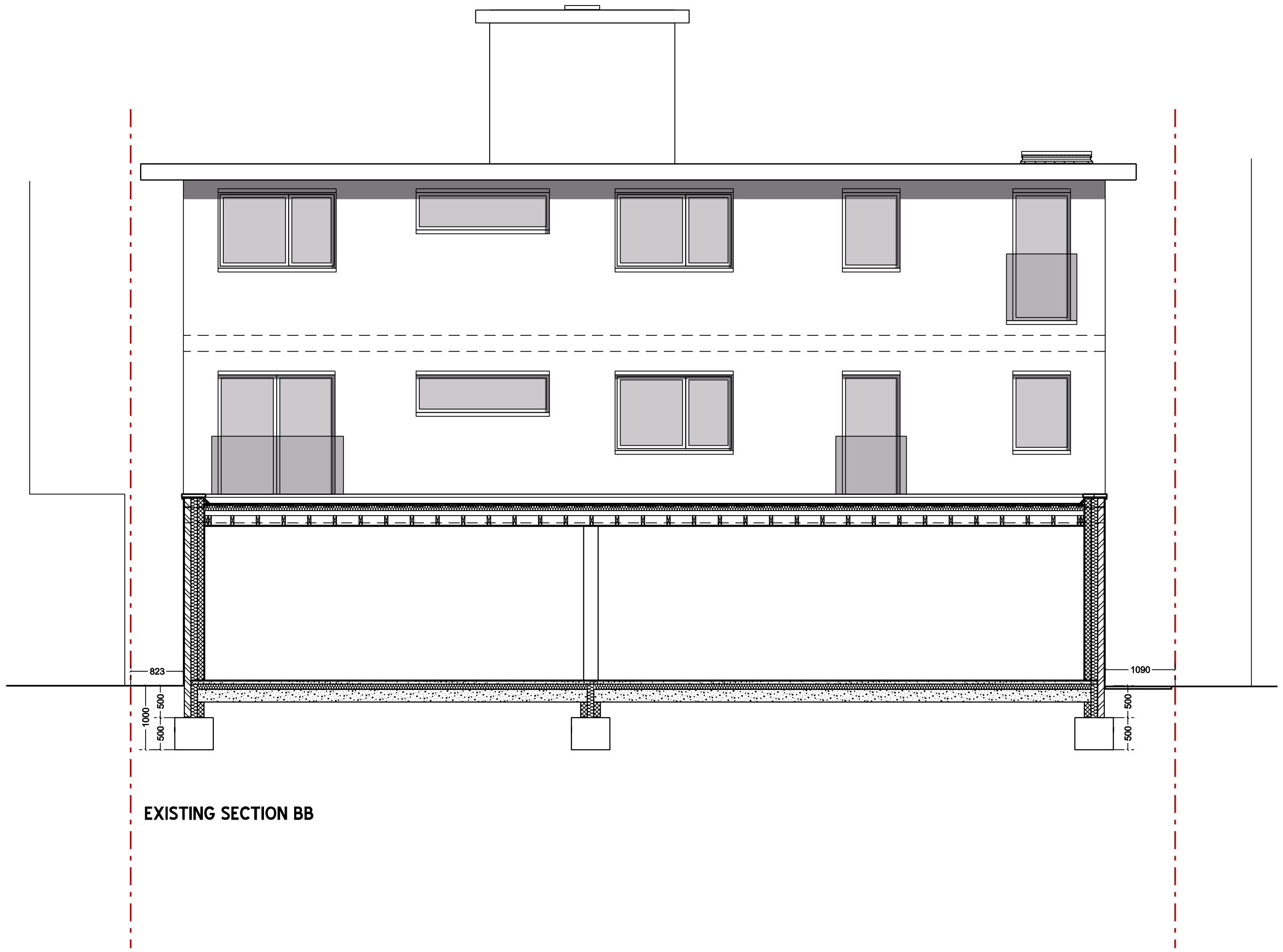
50°NORTH
ARCHITECTURE | DESIGN | SUSTAINABILITY
08454505909 INFO@50DEGREES.CO.UK

LOCATION	CLIENT	DRAWING TITLE	JOB No	SIZE
9-11 Lawford Road, NW5 2LH	Mr & Mrs Elphick	Existing Ground and Ground floor Plan	1175	A3
JOB DESCRIPTION: Basement	SCALE: 1:100 @ A3 / STATUS: Planning Application		DRAWING No: 002	REV: B

Do not scale, use figured dimensions only. Unless stated otherwise these drawings represent design intent only & approved assembly drawings will be required from the Trade Contractor prior to any work and/or procurement being undertaken. If in doubt, ask



EXISTING SECTION AA



EXISTING SECTION BB

ISSUE

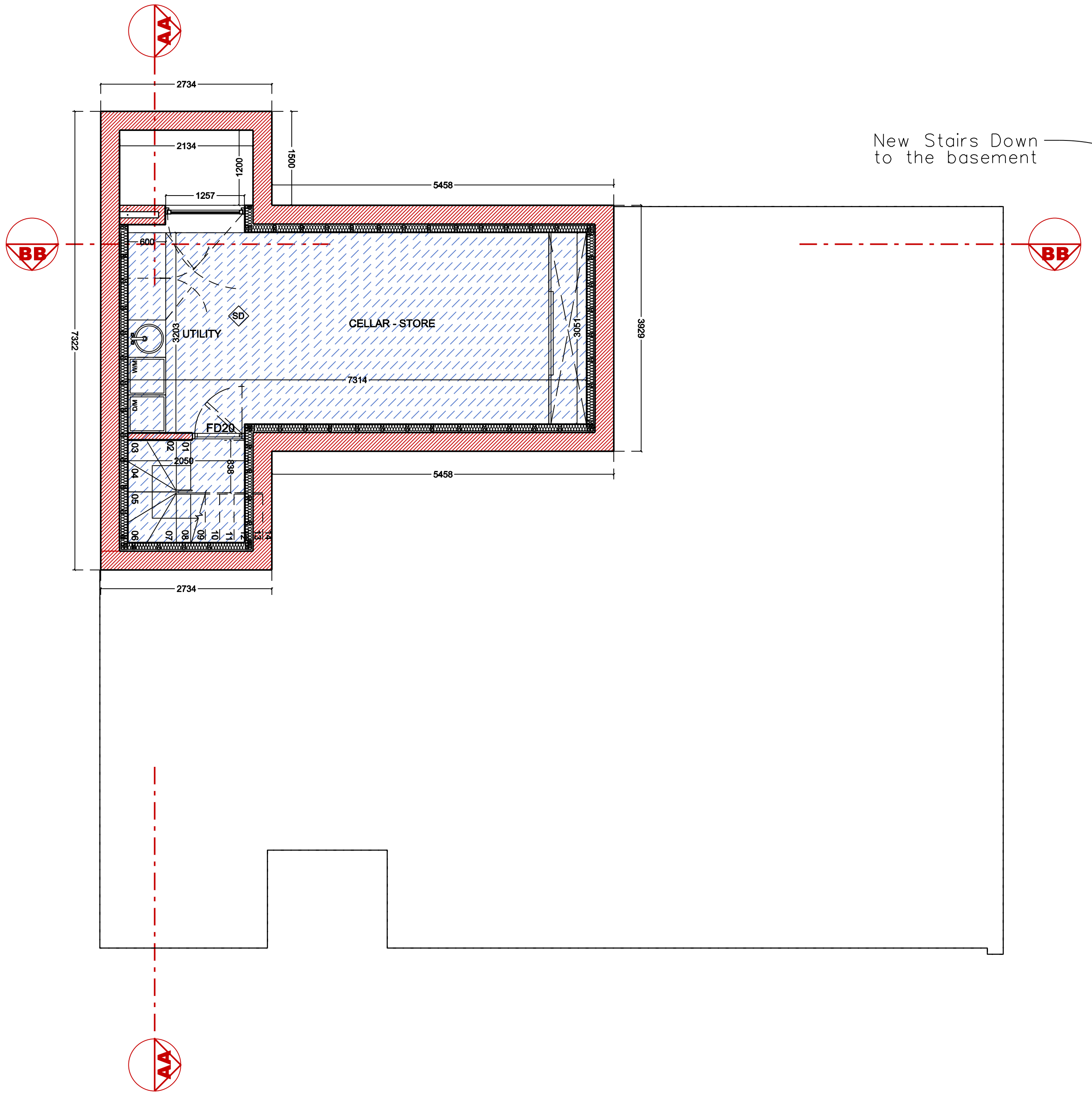
120312 Issued to Client
120315 Issued to Client
120403 Issued to Planning

Notes:
The General contractor is responsible for the verification of all dimensions on site & shall inform the contract administrator of any descrepencies.
Do not scale from this drawing. Use figured dimension only. Existing foundations, lintels and wall to be exposed if required by Building Control for assessment & upgrading if found inadequate.

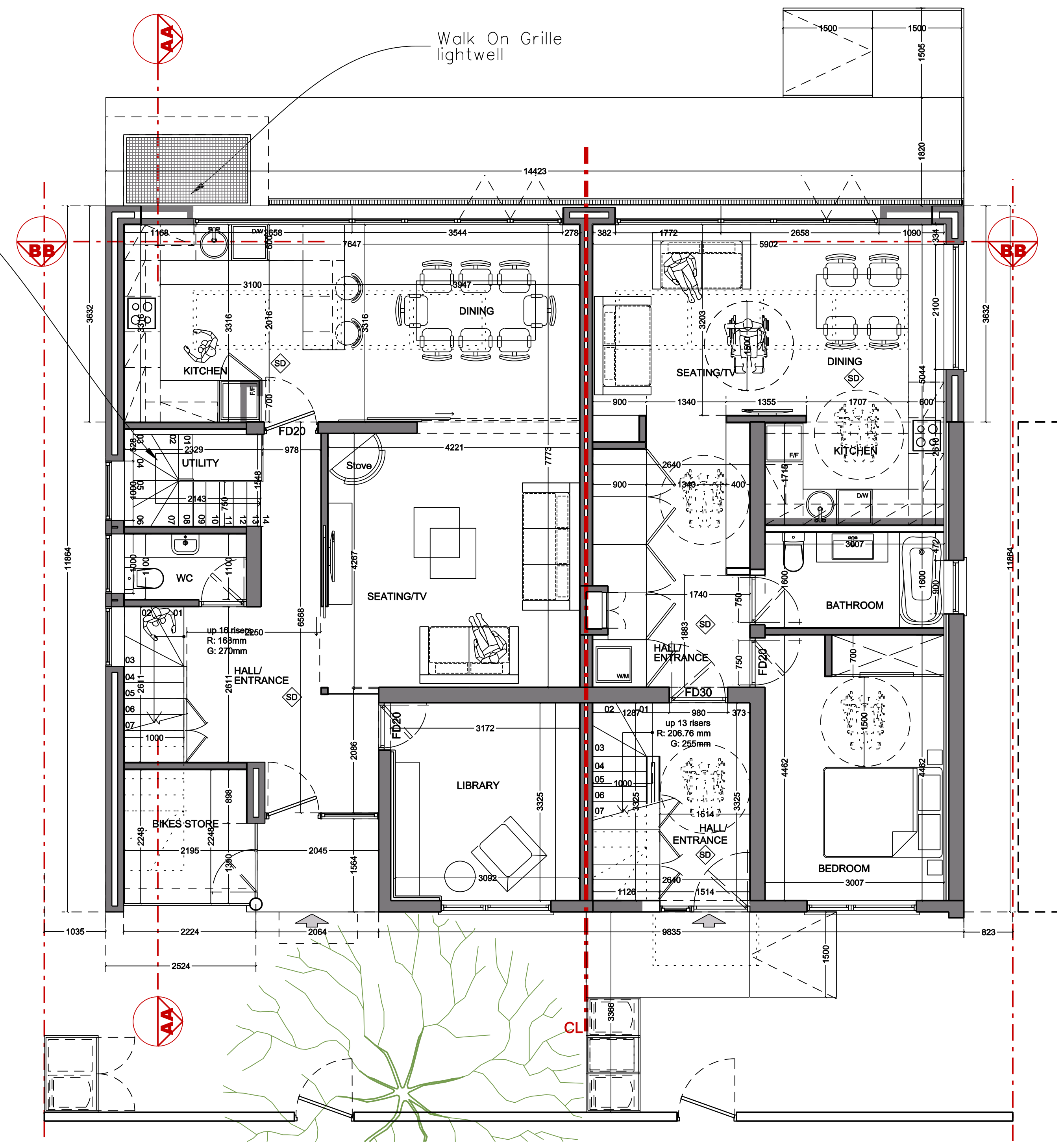
1:50 1:100

50° NORTH ARCHITECTURE | DESIGN | SUSTAINABILITY CONTACT US 08454505909 INFO@50DEGREES.CO.UK	LOCATION 9-11 Lawford Road, NW5 2LH	CLIENT Mr & Mrs Elphick	DRAWING TITLE Exitisting Section AA - BB	JOB No 1175 / SITE A3
	JOB DESCRIPTION Basement	SCALE 1:100 @ A3 / STATUS Planning Application		DRAWING No 003 / REV B

Do not scale, use figured dimensions only. Unless stated otherwise these drawings represent design intent only & approved assembly drawings willbe required from the Trade Contractor prior to any work and/or procurement being undertaken. If in doubt, ask



PROPOSED BASEMENT FLOOR PLAN



PROPOSED GROUND FLOOR PLAN

- Building Extension
- Demolition
- New Walls
- Existing Walls

ISSUE

120312 Issued to Client
120315 Issued to Client
120403 Issued to Planning

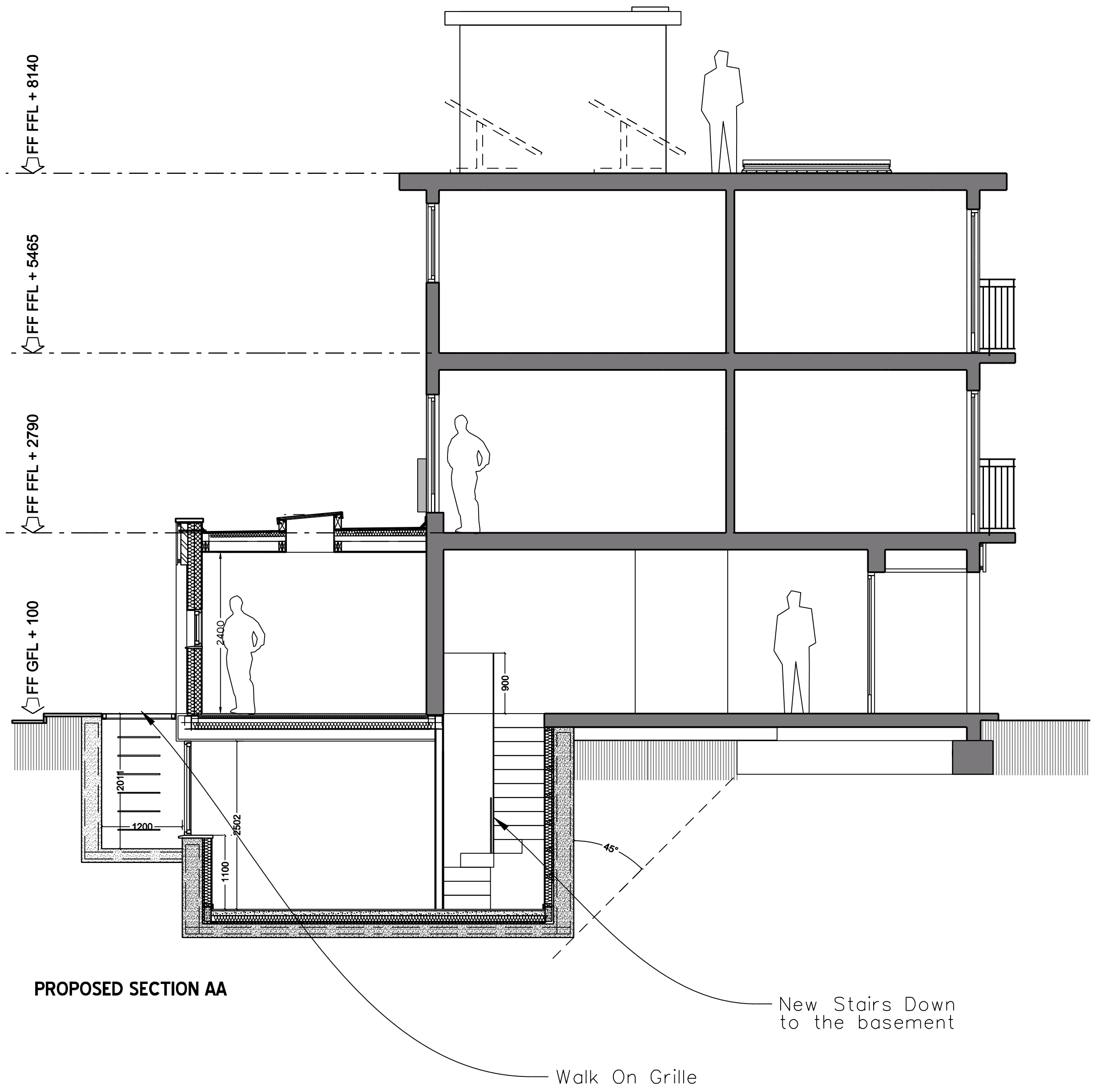
Notes:
The General contractor is responsible for the verification of all dimensions on site & shall inform the contract administrator of any descrepencies. Do not scale from this drawing. Use figured dimension only. Existing foundations, lintels and wall to be exposed if required by Building Control for assessment & upgrading if found inadequate.

1:50   1:100

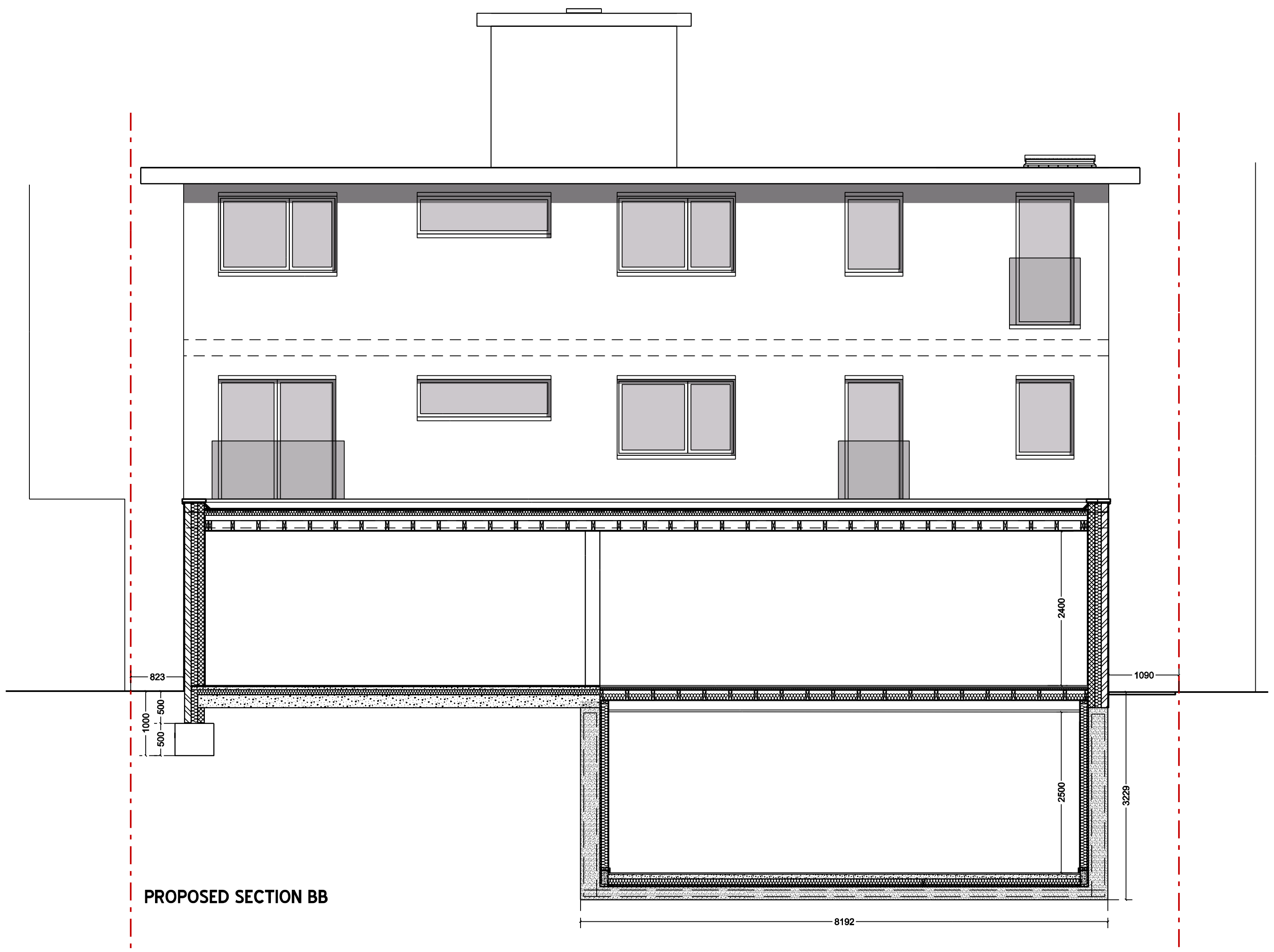
50°NORTH
ARCHITECTURE | DESIGN | SUSTAINABILITY
CONTACT US 08454505909 INFO@50DEGREES.CO.UK

LOCATION	CLIENT	DRAWING TITLE	JOB No	SIZE
9-11 Lawford Road, NW5 2LH	Mr & Mrs Elphick	Proposed Basement and Ground Floor Plans	1175	A3
JOB DESCRIPTION: Basement	SCALE: 1:100 @ A3	STATUS: Planning Application	DRAWING No: 004	REV: B

Do not scale, use figured dimensions only. Unless stated otherwise these drawings represent design intent only & approved assembly drawings will be required from the Trade Contractor prior to any work and/or procurement being undertaken. If in doubt, ask



PROPOSED SECTION AA



PROPOSED SECTION BB

ISSUE

120312 Issued to Client
120315 Issued to Client
120403 Issued to Planning

Notes:
The General contractor is responsible for the verification of all dimensions on site & shall inform the contract administrator of any descrepencies.
Do not scale from this drawing. Use figured dimension only. Existing foundations, lintels and wall to be exposed if required by Building Control for assessment & upgrading if found inadequate.

1:50 — Metres 0 1 2 3 4 5 / Feet 0 5 6 7

1:100 — Metres 0 1 2 3 4 5 6 7 / Feet 0 10 20

50°NORTH
ARCHITECTURE | DESIGN | SUSTAINABILITY
CONTACT US 08454505909 INFO@50DEGREES.CO.UK

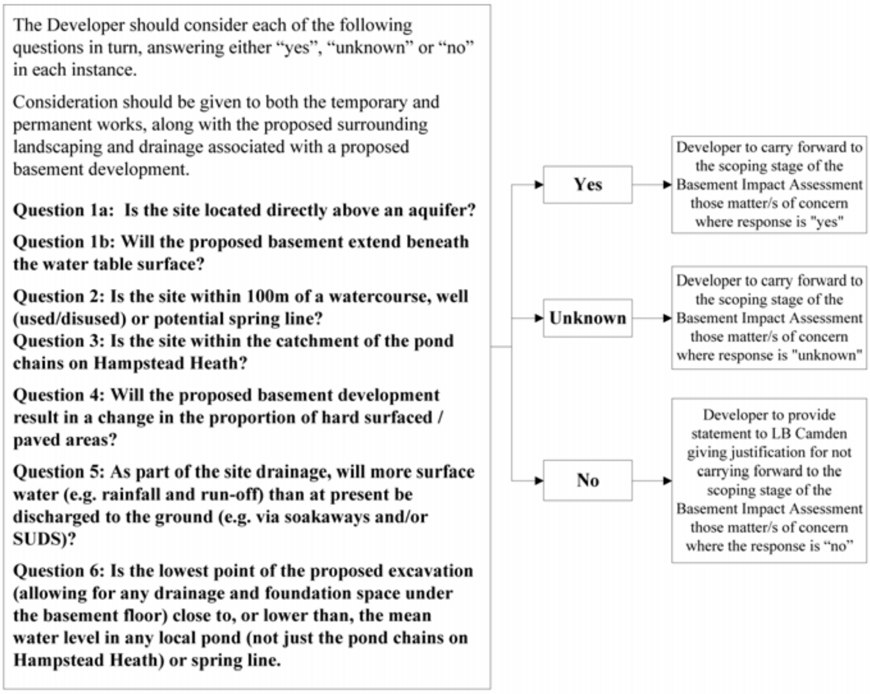
LOCATION: 9-11 Lawford Road, NW5 2LH	CLIENT: Mr & Mrs Elphick		DRAWING TITLE: Proposed Section AA-BB	JOB No: 1175 / SITE: A3
JOB DESCRIPTION: Basement	SCALE: 1:100 @ A3	STATUS: Planning Application		DRAWING No: 005 / REV: B

Do not scale, use figured dimensions only. Unless stated otherwise these drawings represent design intent only & approved assembly drawings will be required from the Trade Contractor prior to any work and/or procurement being undertaken. If in doubt, ask

APPENDIX B

Screening flowcharts (CPG4)

Figure 1. Subterranean (ground water) flow screening chart



Notes / sources of information

Question 1: In LB Camden, all areas where the London Clay does not outcrop at the surface are considered to be an aquifer. This includes the River Terrace Deposits, the Claygate Member and the Bagshot Formation. The location of the geological strata can be established from British Geological Survey maps (e.g. 1:50,000 and 1:10,000 scale). Note that the boundaries are indicative and should be considered to be accurate to ±50m at best.
Additionally, the Environment Agency (EA) "Aquifer Designation Maps" can be used to identify aquifers. These can be found on the "Groundwater maps" available on the EA website (www.environment-agency.gov.uk) follow "At home & leisure" > "What's in Your Backyard" > "Interactive Maps" > "Groundwater". Knowledge of the thickness of the geological strata present and the level of the groundwater table is required. This may be known from existing information (for example nearby site investigations), however, it may not be known in the early stages of a project. Determination of the water table level may form part of the site investigation phase of a BIA.
Question 2: Watercourses, wells or spring lines may be identified from the following sources:

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

Where a groundwater well or borehole is identified, it will be necessary to determine if it is extending into the Lower Aquifer (Chalk) or the Upper Aquifer (River Terrace Deposits, Bagshot Formation, Claygate Member etc). It is water wells extending into the Upper Aquifer which are of concern with regard to basement development.
Question 3: Figure 14 in the attached study, (prepared using data supplied by the City of London Corporation's hydrology consultant, Haycocks Associates) shows the catchment areas of the pond chains on Hampstead Heath.
Question 4: This will be specific to the proposed development and will be a result of the proposed landscaping of areas above and surrounding a proposed basement.
Question 5: This will be specific to the proposed development and will be a result of the chosen drainage scheme adopted for the property.
Question 6: The lowest point will be specific to the proposed development. Knowledge of local ponds may be taken from

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

Figure 2. Slope stability screening flowchart

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

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

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

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

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

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

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

Question 6: Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained? (Note that consent is required from LB Camden to undertake work to any tree/s protected by a Tree Protection Order or to tree/s in a Conservation Area if the tree is over certain dimensions).

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

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

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

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

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

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

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

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

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

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

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

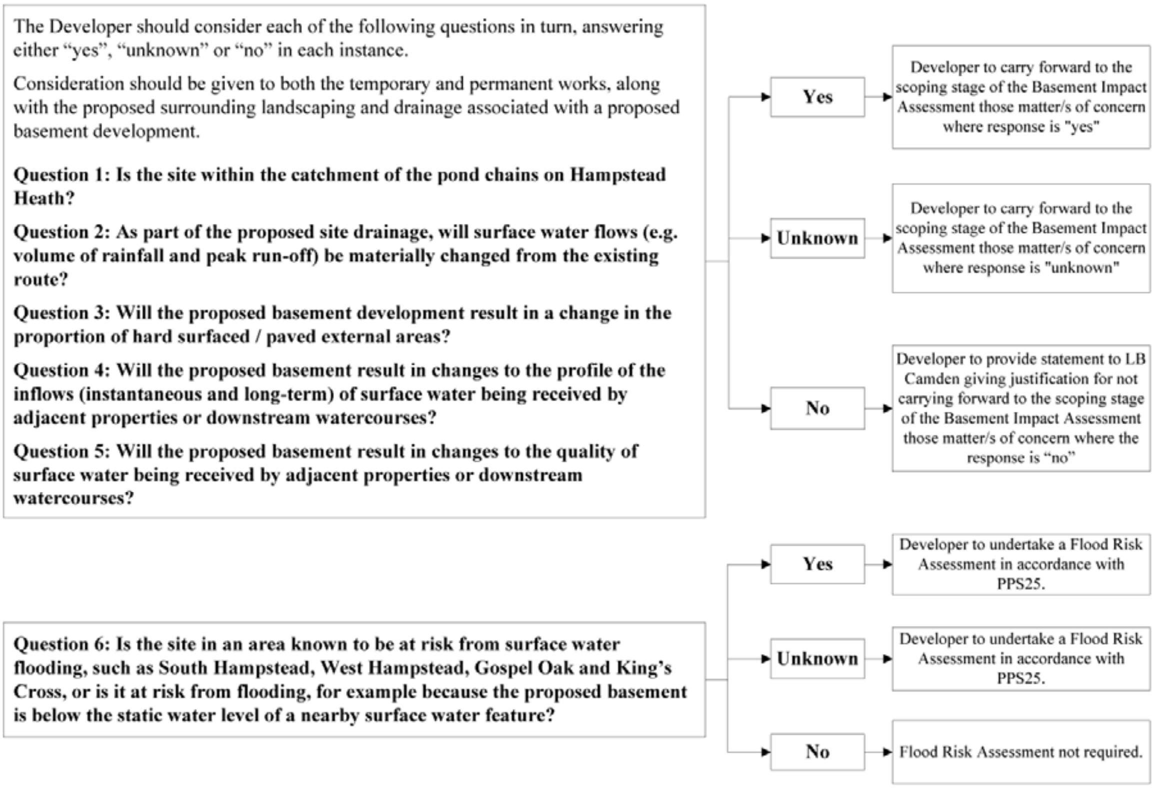
Notes / sources of information

Question 1, 3 & 4: The current surface slope can be determined by a site topographical survey. Slopes may be estimated from 1:25,000 OS maps, however in many urban areas such maps will not show sufficient detail to determine surface slopes on a property-by-property scale, just overall trends. With regard to slopes associated with infrastructure, e.g. cuttings, it should be ensured that any works do not impact on critical infrastructure.
Question 2: This will be specific to the proposed development and will be a result of the proposed landscaping of areas above and surrounding a proposed basement.
Question 5: The plan footprint of the outcropping geological strata can be established from British Geological Survey maps (e.g. 1:50,000 and 1:10,000 scale). Note that the boundaries are indicative and should be considered to be accurate to ±50m at best.
Question 6: this is a project specific determination, subject to relevant Tree Preservation Orders etc.
Question 7: this can be assessed from local knowledge and on-site observations of indicative features, such as cracking. Insurance firms may also give guidance, based on post code. Soil maps can be used to identify high-risk soil types. Relevant guidance is presented in BRE Digest 298 "Low-rise building foundations: the influence of trees in clay soils" (1999); BRE Digest 240 "Low-rise buildings on shrinkable clay soils: part 1" (1993); and BRE Digest 251 "Assessment of damage in low-rise buildings" (1995).
Question 8: Watercourses or spring lines may be identified from the following sources:

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

Question 9: Worked ground includes, for example, old pits, brickyards, cuttings etc. Information can be gained from local knowledge and/or site walkovers, and from historical Ordnance Survey maps (at 1:25,000 or 1:10,000 scale, or better) and British Geological Survey maps (at 1:10,000 scale, current and earlier editions). Earlier geological maps (e.g. the 1:10560 scale series from the 1920s) include annotated descriptions such as "old pits", "formerly dug", "brickyard" etc.
Question 10: In LB Camden, all areas where the London Clay does not outcrop at the surface are considered to be an aquifer. This includes the River Terrace Deposits, the Claygate Member and the Bagshot Formation. The general footprint of the geological strata can be assessed from British Geological Survey maps (e.g. 1:50,000 and 1:10,000 scale). Note that the boundaries are indicative and should be considered to be accurate to ±50m at best.
The Environment Agency (EA) Aquifer Designation Maps can be used to identify aquifers. These are available from the EA website (www.environment-agency.gov.uk), by clicking on 'At home & leisure' > 'What's in Your Backyard' > 'Interactive Maps' > 'Groundwater'.
Details are required of the thickness of the geological strata present and the level or depth of the groundwater table. This may be known from existing information (for example nearby site investigations); however, it may not be known in the early stages of a project. Determination of the water table level may form part of the site investigation phase of a BIA and may require specialist advice to answer. Depth of proposed development is project specific.
Question 11: From local knowledge and/or site walkovers, and from Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). In relation to the stability and integrity of the pond structures and dams, the guidance of a Panel Engineer should be sought. (Details of Panel Engineers can be found on the Environment Agency website: http://www.environment-agency.gov.uk/business/sectors/64253.aspx). Duty of care needs to be undertaken during any site works in the vicinity of the ponds.
Question 12: From local knowledge and/or site walkovers, and from Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale). Any works should not impact on critical infrastructure.
Question 13: From local knowledge and/or site walkovers. May find some details on neighbouring properties from searches of LB Council databases, e.g. planning applications and/or building control records.
Question 14: From local knowledge and/or site walkovers, from Ordnance Survey maps (e.g. 1:25,000 or 1:10,000 scale) and directly from those responsible for tunnels (e.g. TfL or Network Rail). Any works should not impact on critical infrastructure.

Figure 3. Surface flow and flooding screening flowchart



<u>**Notes / sources of information**</u>

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

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

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

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

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

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

APPENDIX C

Borehole logs

Window Sample Logsheet WS01

Project: 9-11 Lawford Road, Camden

Project No: CG/5956

Client: Mr. Alastair Elphick

Date: 30 Mar 2012

Location: Camden

Ground level:

Sheet: 1 of 1

Card Geotechnics Limited

SUBSURFACE PROFILE				SAMPLE/TESTS				Well data	Depth to water (m)
Depth	Description	Legend	Depth (m)	No.	Type	Depth (m)	Undrained shear strength (kPa)		
0.00	Ground Surface		0						
0.60	MADE GROUND: Comprising loose to medium dense dark brown gravelly sand, becoming medium dense sandy gravel with depth. Gravel is generaly flint and brick, with occasional brick cobbles.								
1.20	Soft light brown mottled grey, slightly sandy slightly gravelly to gravelly CLAY. Gravel is angular to rounded, fine to coarse flint. [RIVER TERRACE DEPOSITS]		1		SS		92kPa		
2.75	Medium dense orange brown slightly sandy, slightly clayey GRAVEL. Gravel is angular to sub-rounded, fine to coarse flint. Bands of clay occasional, 0.2m to 0.35m thick. [RIVER TERRACE DEPOSITS]		2						
3.50	Firm brown silty CLAY. [LONDON CLAY]		3		SS		86kPa	▼	
	End of hole				SS		83kPa		

Logged by: AK

Checked by: RJB

Excavation Method: Hand-held window sample

Orientation:

Dimensions: 0.1

Comments and Notes

1. Borehole complete at 3.5mbgl
2. Groundwater encountered at 3.0mbgl
3. Shear strength values based on Hand Shear Vane testing.

Card Geotechnics Limited
4 Godalming Business Centre
Woolsack Way
Godalming, Surrey
GU7 1XW

Window Sample Logsheet WS02

Card Geotechnics Limited

Project: 9-11 Lawford Road, Camden

Project No: CG/5956

Client: Mr. Alastair Elphick

Date: 30 Mar 2012

Location: Camden

Ground level:

Sheet: 1 of 1

SUBSURFACE PROFILE				SAMPLE/TESTS				Well data	Depth to water (m)
Depth	Description	Legend	Depth (m)	No.	Type	Depth (m)	Undrained shear strength (kPa)		
0.00	Ground Surface		0						
0.80	MADE GROUND: Comprising loose to medium dense dark brown gravelly sand, becoming medium dense sandy gravel with depth. Gravel is generaly flint and brick, with occasional brick cobbles.								
1.90	Soft light brown mottled grey, slightly sandy slightly gravelly to gravelly CLAY. Gravel is angular to rounded, fine to coarse flint. [RIVER TERRACE DEPOSITS]		1		SS		89kPa		
2.60	Medium dense orange brown slightly sandy, slightly clayey GRAVEL. Gravel is angular to sub-rounded, fine to coarse flint. [RIVER TERRACE DEPOSITS]		2						
3.50	Firm brown silty CLAY. [LONDON CLAY]		3		SS		99kPa		
	End of hole								

Logged by: AK

Checked by: RJB

Excavation Method: Hand-held window sample

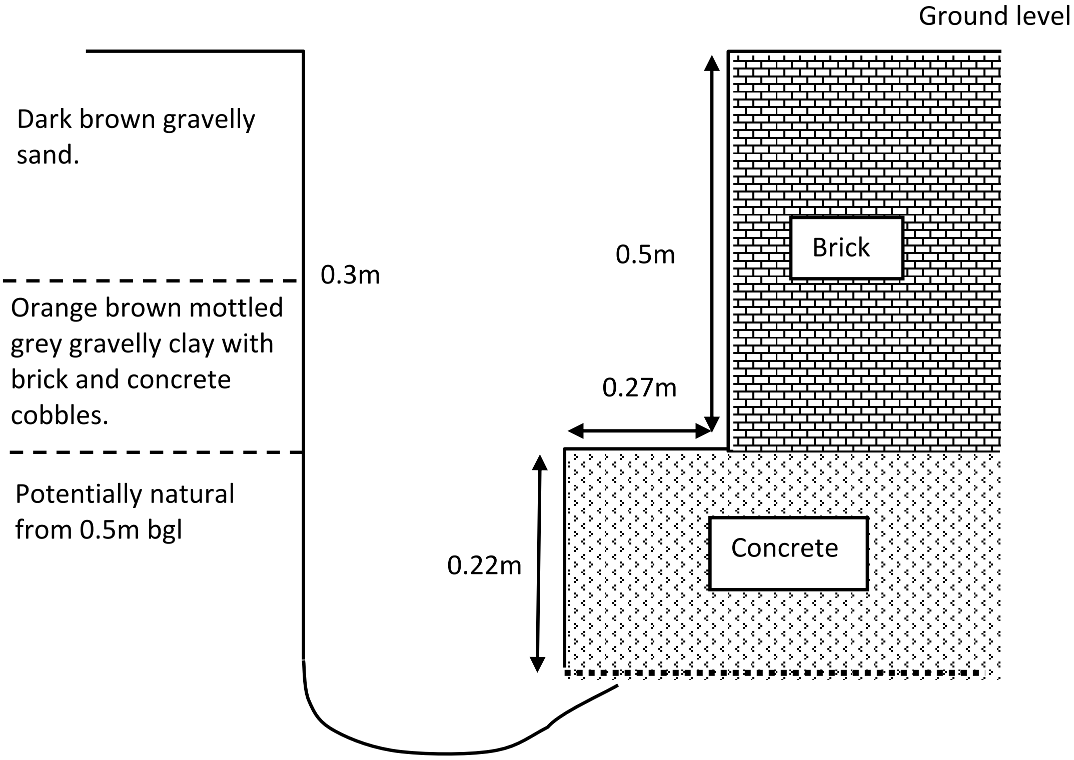
Orientation:

Dimensions: 0.1

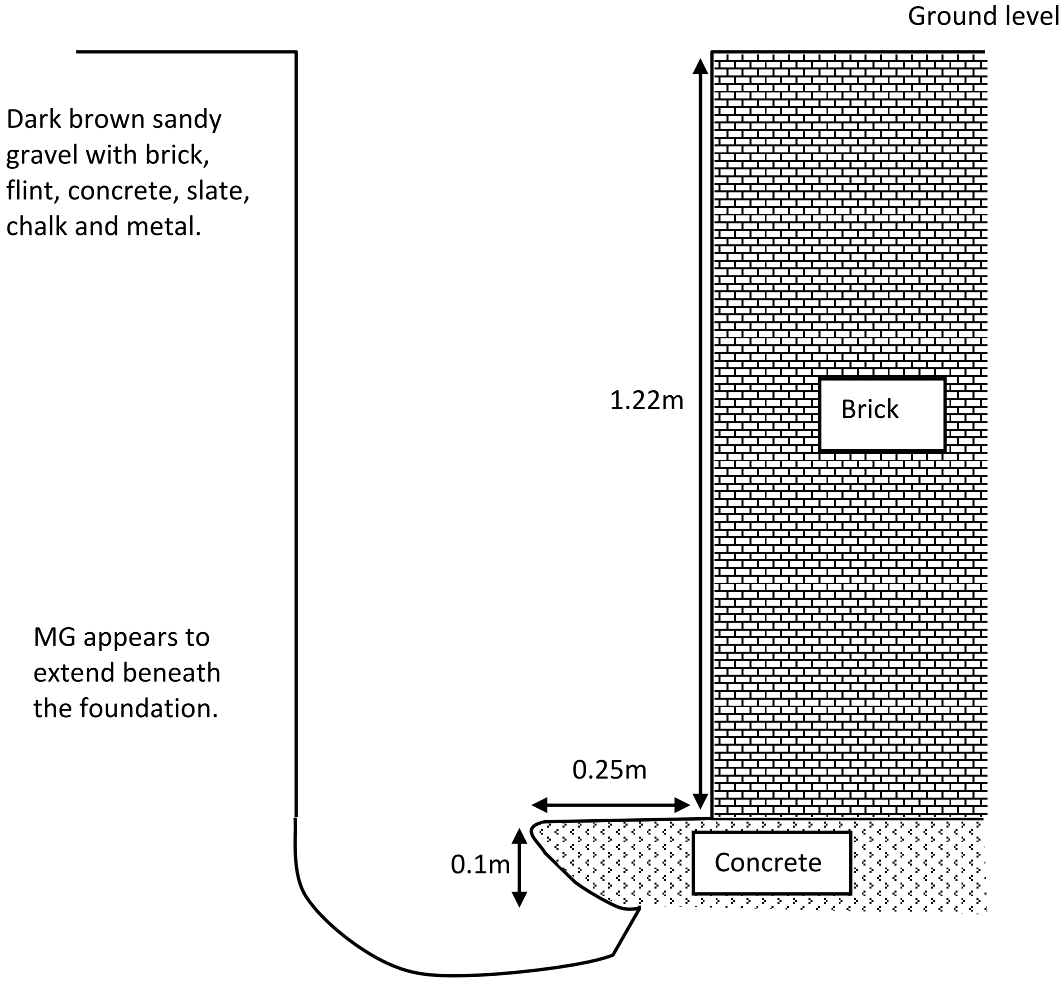
Comments and Notes

1. Borehole complete at 3.5mbgl
2. No groundwater encountered
3. Shear strength values based on Hand Shear Vane testing.

Card Geotechnics Limited
4 Godalming Business Centre
Woolsack Way
Godalming, Surrey
GU7 1XW



Client	Project	Job No
Mr Alastair Elphick	**9 – 11 Lawford Road, London**	**CG/5956**
CGL	Title **Foundation Pit 1**	**C1**



Client	Project	Job No
Mr Alastair Elphick	**9 – 11 Lawford Road, NW5, London**	**CG/5956**
CGL	Title **Foundation Pit 2**	**C2**

APPENDIX D

GWALL results

Units: kN,m

INPUT DATA

SOIL PROFILE

Active side: Stratum no.	Active side: Elevation of top of stratum	Active side: Soil type	Passive side: Stratum no.	Passive side: Elevation of top of stratum	Passive side: Soil type
1	3.29	1	1	0.00	4
2	2.59	2			
3	1.79	3			
4	0.59	4			

SOIL PROPERTIES

Soil type No.	Description	Bulk unit wt. above GWL kN/m3	Bulk unit wt. below GWL kN/m3	Phi degs.	Cohesion kN/m2	Active pressure due to compaction kN/m2
1	Made Ground	20.00	20.00	30.00	0.00	0.00
2	River Clay	20.00	20.00	23.00	0.00	0.00
3	River Gravel	20.00	20.00	30.00	0.00	0.00
4	London Clay	20.00	20.00	0.00	75.00	0.00

Active earth pressure coefficients

Soil type No.	Description	ULS (for Stability calcs.) Ka	ULS Kac	ULS Wall friction coefficient	SLS (for Moment calcs.) Ka	SLS Kac	SLS Wall friction coefficient
1	Made Ground	0.351	1.349	0.50	0.500	0.000	0.50
2	River Clay	0.453	1.546	0.50	0.500	0.000	0.50
3	River Gravel	0.351	1.349	0.50	0.500	0.000	0.50
4	London Clay	0.9998	2.389	0.50	1.000	2.000	0.00

Passive earth pressure coefficients

Soil type No.	Description	ULS (for Stability calcs.) Kp	ULS Kpc	ULS Wall friction coefficient	SLS (for Moment calcs.) Kp	SLS Kpc	SLS Wall friction coefficient
1	Made Ground	3.585	5.373	0.67	1.500	0.000	0.67
2	River Clay	2.521	4.300	0.67	1.500	0.000	0.67
3	River Gravel	3.585	5.373	0.67	1.500	0.000	0.67
4	London Clay	1.000	2.390	0.50	1.000	2.000	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Active side	Passive side
Water table elevation	3.29	0.00
Piezometric elevation at base elev.	3.29	0.00

WALL PROPERTIES

Backfill angle behind wall =	0.00 degs
Unit weight of wall =	24.00 kN/m3
Elevation of base of wall =	0.000
Elevation of top of wall =	3.290
Width of base of stem =	0.330 m
Width of top of stem =	0.330 m
Batter angle of back of wall =	0.00 degs
Thickness of base of wall =	0.330 m
Width of heel of wall =	0.500 m
Width of toe of wall =	2.400 m
Depth of shear key =	0.000 m
Width of shear key =	0.000 m
Distance from toe to front of shear key =	0.000 m
Friction on base of wall =	0.00 degs
Adhesion on base of wall =	37.50 kN/m2

SURCHARGE LOADS

Surcharge no.	Elevation	Distance from wall	Width perpend. to wall	Length parallel to wall	Surcharge magnitude kN/m2
1	GL	0.00	3.00	20.00	5.00
2	GL	2.10	0.90	12.00	145.00

LOADS APPLIED TO THE WALL

Horizontal line load on top of wall = 0.00
Vertical line load on top of wall = 10.00
Distance of line load from front edge of wall = 0.15
Moment applied to top of wall = 0.00 kN.m/m run

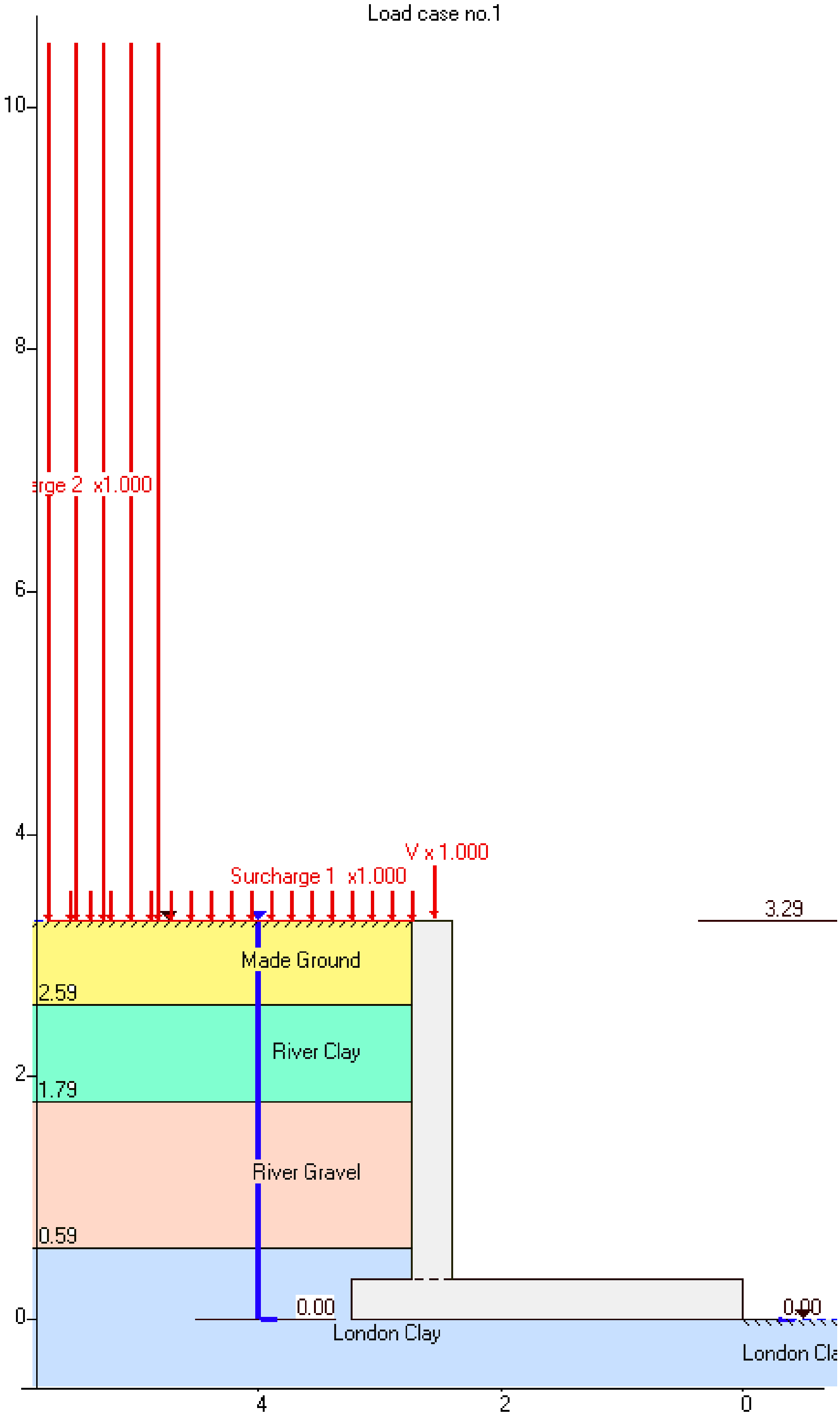
LOAD CASES

Load Case no.	Selected surcharges (Load case description)	Surcharge load factor	Vertical load factor	Horizontal load factor	Moment load factor	Anchor load factor
1	1,2	1.00	1.00	1.00	1.00	1.00

FACTOR OF SAFETY AND ANALYSIS OPTIONS

Minimum Equivalent Fluid Density	= 5.00 kN/m3
Maximum depth of water filled tension crack	= 2.00
Partial FoS on Drained Cohesion and Phi'	= 1.20
Partial FoS on Undrained Cohesion	= 1.50
Partial factor of safety on passive (ULS only)	= 1.00
Include base shear in base bending moments?	- Yes

```
CARD GEOTECHNICS LIMITED                                       | Sheet No.
Program: GWALL  Version 3.01  Revision A02.B02.R35             |
                            Licensed from GEOSOLVE             | Job No. CG/5956
Run ID. External Wall adj No 7                                 | Made by :    RJB
External Wall 2.1m from No. 7                                  | Date: 2-04-2012
Preliminary Calculation for BIA only                           | Checked :
-----------------------------------------------------------------------------
                                                       Units: kN,m
```



Units: kN,m

Ultimate Limit State Analysis - STABILITY **Load Case No.1**

Surcharge Nos. 1,2 apply with a Partial factor = 1.00
Partial factor on Vertical Load = 1.00

Horizontal forces	Force kN/m run	Moment kN.m/m run	Resultant Height above base	Resultant Elevation
Active soil	21.58	44.95	2.083	2.083
Active water	54.12	59.35	1.097	1.097
Passive soil	0.00	0.00	0.000	0.000
Passive water	0.00	0.00	0.000	0.000
Load on top of wall	0.00	0.00	3.290	3.290
Anchor force	0.00	0.00	0.000	0.000
Nett horizontal load	75.70	104.30	1.378	1.378
Base shear resistance	-80.75	0.00		
Shear key resistance	0.00	0.00		
Total sliding resistance	-80.75	0.00		

Vertical forces	Force kN/m run	Moment kN.m/m run	Distance of resultant from toe
Wall weight	49.02	-101.45	2.069
Fill above heel	29.60	-88.21	2.980
Fill above toe	0.00	-0.00	0.000
Water above heel	0.00	-0.00	0.000
Water above toe	0.00	-0.00	0.000
Active wall friction	21.51	-69.47	3.230
Passive wall friction	0.00	0.00	0.00
Surcharges	2.50	-7.45	2.980
Load on top of wall	10.00	-25.55	2.555
Anchor force	0.00	-0.00	0.000
Uplift water pressure	-53.13	114.41	2.153
Nett vertical load	59.50	-177.71	2.987
Moment applied to wall		0.00	
Moment of horiz. loads		104.30	
Soil reaction on base	-59.50	73.41	1.234

Soil contact pressure at toe 31.5 kN/m2
Soil contact pressure at X = 3.230 5.4 kN/m2
Line of action of resultant 1.234 m from toe

	Factor of safety	Disturbing force or moment	Restoring force or moment
Sliding stability (base shear)	1.067	75.7 kN/m	-80.8 kN/m
Sliding stability (base+passive)	1.067	75.7 kN/m	-80.8 kN/m
Overturning stability	1.336	218.7 /m	-292.1 /m

Notes
1. Nett water pressures are used in calculating the disturbing forces and moments for the factors of safety on sliding and overturning.
2. All ULS results include a partial factor of 1.00 on passive.

Units: kN,m

Ultimate Limit State Analysis - STABILITY **Load Case No.1**

Earth pressures on vertical planes through heel and toe of wall

Elevation	---- Active pressures -----				---- Passive pressures ----			
	Soil type	Water kN/m2	Vert. kN/m2	Active kN/m2	Soil type	Water kN/m2	Vert. kN/m2	Passive kN/m2
3.290	1	0.00	5.00	1.75	0	0.00	0.00	0.00
3.115	1	1.75	6.81	2.39	0	0.00	0.00	0.00
2.940	1	3.50	8.94	3.14	0	0.00	0.00	0.00
2.765	1	5.25	11.61	4.07	0	0.00	0.00	0.00
2.590	1	7.00	14.90	5.23	0	0.00	0.00	0.00
	2	7.00	14.90	6.75	0	0.00	0.00	0.00
2.415	2	8.75	18.72	8.48	0	0.00	0.00	0.00
2.240	2	10.50	22.89	10.37	0	0.00	0.00	0.00
2.015	2	12.75	28.48	12.90	0	0.00	0.00	0.00
1.790	2	15.00	33.98	15.39	0	0.00	0.00	0.00
	3	15.00	33.98	11.92	0	0.00	0.00	0.00
1.595	3	16.95	38.46	13.49	0	0.00	0.00	0.00
1.400	3	18.90	42.59	14.94	0	0.00	0.00	0.00
1.120	3	21.70	47.84	16.78	0	0.00	0.00	0.00
0.855	3	24.35	52.10	18.27	0	0.00	0.00	0.00
0.590	3	27.00	55.75	19.55	0	0.00	0.00	0.00
	4	Total>	82.75	13.50m	0	0.00	0.00	0.00
0.330	4	Total>	88.44	14.80m	0	0.00	0.00	0.00
0.165	4	Total>	91.85	15.63m	0	0.00	0.00	0.00
0.000	4	Total>	95.13	16.45m	0	0.00	0.00	0.00

Serviceability Limit State Analysis - BENDING MOMENTS

Earth pressures normal to the stem of the wall

Elevation	---- Active pressures -----				---- Passive pressures ----			
	Soil type	Water kN/m2	Vert. kN/m2	Active kN/m2	Soil type	Water kN/m2	Vert. kN/m2	Passive kN/m2
3.290	1	0.00	5.00	2.50	0	0.00	0.00	0.00
3.115	1	1.75	6.77	3.39	0	0.00	0.00	0.00
2.940	1	3.50	8.67	4.34	0	0.00	0.00	0.00
2.765	1	5.25	10.81	5.40	0	0.00	0.00	0.00
2.590	1	7.00	13.24	6.62	0	0.00	0.00	0.00
	2	7.00	13.24	6.62	0	0.00	0.00	0.00
2.415	2	8.75	15.96	7.98	0	0.00	0.00	0.00
2.240	2	10.50	18.96	9.48	0	0.00	0.00	0.00
2.015	2	12.75	23.10	11.55	0	0.00	0.00	0.00
1.790	2	15.00	27.40	13.70	0	0.00	0.00	0.00
	3	15.00	27.40	13.70	0	0.00	0.00	0.00
1.595	3	16.95	31.15	15.57	0	0.00	0.00	0.00
1.400	3	18.90	34.81	17.40	0	0.00	0.00	0.00
1.120	3	21.70	39.81	19.91	0	0.00	0.00	0.00
0.855	3	24.35	44.19	22.09	0	0.00	0.00	0.00
0.590	3	27.00	48.19	24.09	0	0.00	0.00	0.00
	4	Total>	75.19	13.50m	0	0.00	0.00	0.00
0.330	4	Total>	81.36	14.80m	0	0.00	0.00	0.00

Units: kN,m

Serviceability Limit State Analysis - BENDING MOMENTS **Load Case No.1**

Surcharge Nos. 1,2 apply with a Partial factor = 1.00
Partial factor on Vertical Load = 1.00

Forces on Base for Calculating Bending Moments

Horizontal forces	Force kN/m run	Moment kN.m/m run	Resultant Height above base	Resultant Elevation
Shear on heel	0.00	0.00	0.33	0.33
Shear on toe	0.00	0.00	0.33	0.33
Shear at base of stem	74.21	24.49	0.33	0.33
Nett horizontal force	74.21	24.49	0.33	0.33

Components of sliding resistance	
Base shear	-1.13
Shear key	0.00
Total sliding resistance	-1.13

Vertical forces	Force kN/m run	Moment kN.m/m run	Distance of resultant from toe
Components of dead load			
Weight on heel	13.02	-43.58	3.35
Weight on toe	0.00	0.00	0.00
Stem load	52.52	-134.71	2.57
Weight of base	25.58	-41.31	1.62
Total dead load	91.12	-219.61	2.41
Uplift water pressure	-53.13	114.41	2.15
Nett vertical force	37.99	-105.19	2.77
Moment at base of stem		80.32	
Moment of horiz. forces		24.49	
Soil reaction on base	-37.99	0.38	0.01

Base contact pressures

Soil contact pressure at toe	2532.8 kN/m2
Soil contact pressure at X = 0.03	-0.0 kN/m2
Line of action of resultant	0.01 m from toe

*** Resultant lay outside base of wall -
Moment from stem reduced to obtain an equilibrium
set of forces for calculating base bending moments

*** SLS results do NOT include a partial factor on passive.

Units: kN,m

Serviceability Limit State Analysis - BENDING MOMENTS **Load Case No.1**

Forces in stem of wall

Elevation	Shear force kN/m run	Axial force kN/m run	Bending moment kN.m/m run
3.290	-0.00	10.00	0.10
3.115	0.67	11.58	0.12
2.940	1.80	13.29	0.28
2.765	3.42	15.15	0.65
2.590	5.55	17.14	1.32
2.415	8.20	19.09	2.43
2.240	11.41	21.16	4.02
2.015	16.39	24.00	6.96
1.790	22.36	27.05	11.09
1.595	28.33	30.32	15.73
1.400	35.04	33.80	21.58
1.120	45.94	39.16	32.36
0.855	57.61	44.63	45.50
0.590	70.54	50.46	61.84
0.330	74.21	52.52	80.65

Forces along base of wall

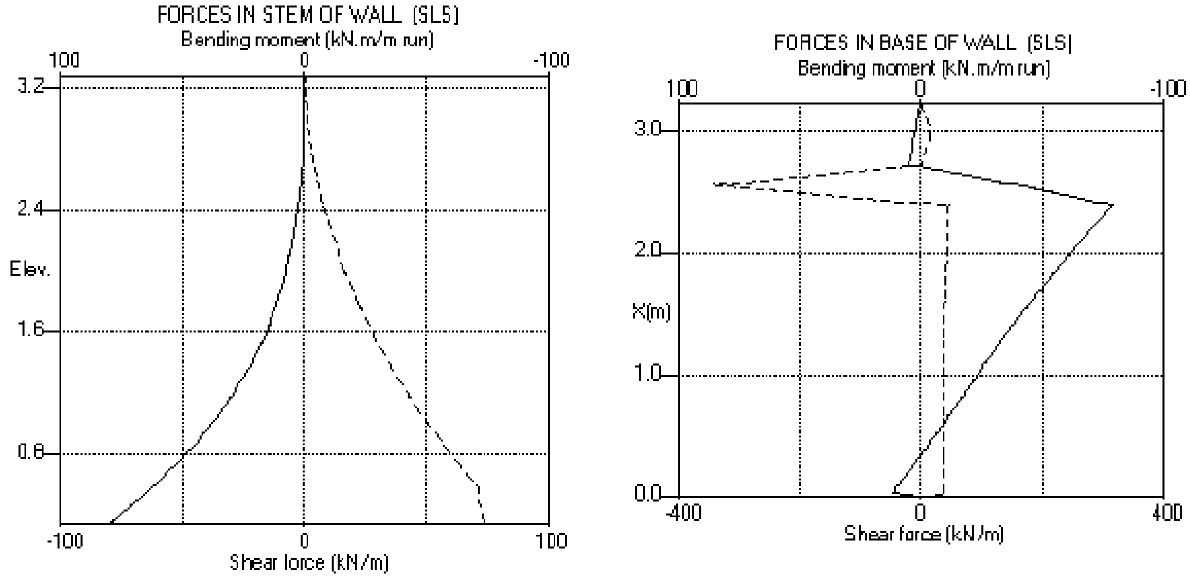
Distance from toe m	Shear force kN/m run	Bending moment kN.m/m run
3.230	0.00	0.00
2.980	14.89	2.44
2.730	1.81	5.11
2.565	-340.18	-38.97
2.400	48.32	-79.21
2.160	44.65	-68.07
1.920	41.56	-57.74
1.600	38.36	-44.98
1.280	36.20	-33.08
0.960	35.08	-21.70
0.640	35.01	-10.51
0.335	35.91	0.28
0.030	37.76	11.49
0.000	0.00	-0.00

*** SLS results do NOT include a partial factor on passive.

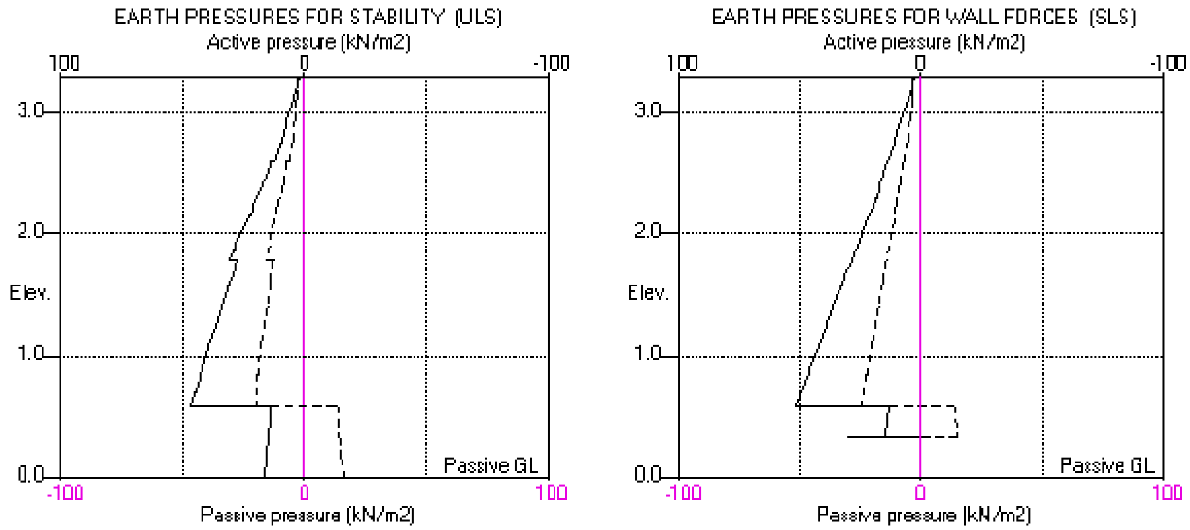
CARD GEOTECHNICS LIMITED | Sheet No.
Program: GWALL Version 3.01 Revision A02.B02.R35 |
Licensed from GEOSOLVE | Job No. CG/5956
Run ID. External Wall adj No 7 | Made by : RJB
External Wall 2.1m from No. 7 | Date: 2-04-2012
Preliminary Calculation for BIA only | Checked :

Units: kN,m

Load case no.1



Load case no.1



Units: kN,m

SUMMARY RESULTS

Load Case No.	Sliding stability (base shear) FoS	Sliding stability (base + passsive) Fos	Overturning stability Fos	Contact press. at toe kN/m2	Distance of resultant from toe m
1	1.067	1.067	1.336	31.46	1.23

Notes 1. Nett water pressures are used in calculating the disturbing forces and moments for the factors of safety on sliding and overturning.
2. All ULS results include a partial factor of 1.00 on passive.

Load	Stem				Base			
Load	- Bending moment-		-- Shear force --		- Bending moment-		-- Shear force --	
Case	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum
No.	kN.m/m	kN.m/m	kN/m	kN/m	kN.m/m	kN.m/m	kN/m	kN/m
1	80.65	0.00	74.21	-0.00	11.49	-79.21	48.32	-340.18

Units: kN,m

INPUT DATA

SOIL PROFILE

Active side: Stratum no.	Elevation of top of stratum	Soil type	Passive side: Stratum no.	Elevation of top of stratum	Soil type
1	3.29	1	1	0.00	4
2	2.59	2			
3	1.79	3			
4	0.59	4			

SOIL PROPERTIES

Soil type No.	Description	Bulk unit wt. above GWL kN/m3	Bulk unit wt. below GWL kN/m3	Strength parameters Phi degs.	Cohesion kN/m2	Active pressure due to compaction kN/m2
1	Made Ground	20.00	20.00	30.00	0.00	0.00
2	River Clay	20.00	20.00	23.00	0.00	0.00
3	River Gravel	20.00	20.00	30.00	0.00	0.00
4	London Clay	20.00	20.00	0.00	75.00	0.00

Active earth pressure coefficients

Soil type No.	Description	ULS (for Stability calcs.) Ka	Kac	Wall friction coefficient	SLS (for Moment calcs.) Ka	Kac	Wall friction coefficient
1	Made Ground	0.351	1.349	0.50	0.500	0.000	0.50
2	River Clay	0.453	1.546	0.50	0.500	0.000	0.50
3	River Gravel	0.351	1.349	0.50	0.500	0.000	0.50
4	London Clay	0.9998	2.389	0.50	1.000	2.000	0.00

Passive earth pressure coefficients

Soil type No.	Description	ULS (for Stability calcs.) Kp	Kpc	Wall friction coefficient	SLS (for Moment calcs.) Kp	Kpc	Wall friction coefficient
1	Made Ground	3.585	5.373	0.67	1.500	0.000	0.67
2	River Clay	2.521	4.300	0.67	1.500	0.000	0.67
3	River Gravel	3.585	5.373	0.67	1.500	0.000	0.67
4	London Clay	1.000	2.390	0.50	1.000	2.000	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Active side	Passive side
Water table elevation	3.29	0.00
Piezometric elevation at base elev.	3.29	0.00

WALL PROPERTIES

Backfill angle behind wall =	0.00 degs
Unit weight of wall =	24.00 kN/m3
Elevation of base of wall =	0.000
Elevation of top of wall =	3.290
Width of base of stem =	0.330 m
Width of top of stem =	0.330 m
Batter angle of back of wall =	0.00 degs
Thickness of base of wall =	0.330 m
Width of heel of wall =	0.330 m
Width of toe of wall =	2.000 m
Depth of shear key =	0.000 m
Width of shear key =	0.000 m
Distance from toe to front of shear key =	0.000 m
Friction on base of wall =	0.00 degs
Adhesion on base of wall =	37.50 kN/m2

SURCHARGE LOADS

Surcharge no.	Elevation	Distance from wall	Width perpend. to wall	Length parallel to wall	Surcharge magnitude kN/m2
1	GL	0.00	3.00	20.00	5.00
2	GL	2.10	0.90	12.00	145.00

LOADS APPLIED TO THE WALL

Horizontal line load on top of wall = 0.00
Vertical line load on top of wall = 130.00
Distance of line load from front edge of wall = 0.15
Moment applied to top of wall = 0.00 kN.m/m run

LOAD CASES

Load Case no.	Selected surcharges (Load case description)	Surcharge load factor	Vertical load factor	Horizontal load factor	Moment load factor	Anchor load factor
1	1	1.00	1.00	1.00	1.00	1.00

FACTOR OF SAFETY AND ANALYSIS OPTIONS

Minimum Equivalent Fluid Density	= 5.00 kN/m3
Maximum depth of water filled tension crack	= 2.00
Partial FoS on Drained Cohesion and Phi'	= 1.20
Partial FoS on Undrained Cohesion	= 1.50
Partial factor of safety on passive (ULS only)	= 1.00
Include base shear in base bending moments?	- Yes

Units: kN,m

Ultimate Limit State Analysis - STABILITY **Load Case No.1**

Surcharge Nos. 1 apply with a Partial factor = 1.00
Partial factor on Vertical Load = 1.00

Horizontal forces	Force kN/m run	Moment kN.m/m run	Resultant Height above base	Resultant Elevation
Active soil	9.76	28.25	2.894	2.894
Active water	54.12	59.35	1.097	1.097
Passive soil	0.00	0.00	0.000	0.000
Passive water	0.00	0.00	0.000	0.000
Load on top of wall	0.00	0.00	3.290	3.290
Anchor force	0.00	0.00	0.000	0.000
Nett horizontal load	63.88	87.60	1.371	1.371
Base shear resistance	-66.50	0.00		
Shear key resistance	0.00	0.00		
Total sliding resistance	-66.50	0.00		

Vertical forces	Force kN/m run	Moment kN.m/m run	Distance of resultant from toe
Wall weight	44.51	-78.77	1.770
Fill above heel	19.54	-48.74	2.495
Fill above toe	0.00	-0.00	0.000
Water above heel	0.00	-0.00	0.000
Water above toe	0.00	-0.00	0.000
Active wall friction	18.86	-50.16	2.660
Passive wall friction	0.00	0.00	0.00
Surcharges	1.65	-4.12	2.495
Load on top of wall	130.00	-280.15	2.155
Anchor force	0.00	-0.00	0.000
Uplift water pressure	-43.76	77.60	1.773
Nett vertical load	170.80	-384.34	2.250
Moment applied to wall		0.00	
Moment of horiz. loads		87.60	
Soil reaction on base	-170.80	296.74	1.737

Soil contact pressure at toe 5.2 kN/m2
Soil contact pressure at X = 2.660 123.2 kN/m2
Line of action of resultant 1.737 m from toe

	Factor of safety	Disturbing force or moment	Restoring force or moment
Sliding stability (base shear)	1.041	63.9 kN/m	-66.5 kN/m
Sliding stability (base+passive)	1.041	63.9 kN/m	-66.5 kN/m
Overturning stability	2.796	165.2 /m	-461.9 /m

Notes 1. Nett water pressures are used in calculating the disturbing forces and moments for the factors of safety on sliding and overturning.
2. All ULS results include a partial factor of 1.00 on passive.

Units: kN,m

Ultimate Limit State Analysis - STABILITY **Load Case No.1**

Earth pressures on vertical planes through heel and toe of wall

	---- Active pressures -----				---- Passive pressures ----			
Elevation	Soil type	Water kN/m2	Vert. kN/m2	Active kN/m2	Soil type	Water kN/m2	Vert. kN/m2	Passive kN/m2
3.290	1	0.00	5.00	1.75	0	0.00	0.00	0.00
3.115	1	1.75	6.75	2.37	0	0.00	0.00	0.00
2.940	1	3.50	8.50	2.98	0	0.00	0.00	0.00
2.765	1	5.25	10.24	3.59	0	0.00	0.00	0.00
2.590	1	7.00	11.97	4.20	0	0.00	0.00	0.00
	2	7.00	11.97	5.42	0	0.00	0.00	0.00
2.415	2	8.75	13.70	6.21	0	0.00	0.00	0.00
2.240	2	10.50	15.42	6.99	0	0.00	0.00	0.00
2.015	2	12.75	17.62	7.98	0	0.00	0.00	0.00
1.790	2	15.00	19.80	8.97	0	0.00	0.00	0.00
	3	15.00	19.80	6.94	0	0.00	0.00	0.00
1.595	3	16.95	21.67	7.60	0	0.00	0.00	0.00
1.400	3	18.90	23.54	8.26	0	0.00	0.00	0.00
1.120	3	21.70	26.21	9.19	0	0.00	0.00	0.00
0.855	3	24.35	28.73	10.08	0	0.00	0.00	0.00
0.590	3	27.00	31.24	10.96	0	0.00	0.00	0.00
	4	Total>	58.24	13.50m	0	0.00	0.00	0.00
0.330	4	Total>	63.30	14.80m	0	0.00	0.00	0.00
0.165	4	Total>	66.51	15.63m	0	0.00	0.00	0.00
0.000	4	Total>	69.72	16.45m	0	0.00	0.00	0.00

Serviceability Limit State Analysis - BENDING MOMENTS

Earth pressures normal to the stem of the wall

	---- Active pressures -----				---- Passive pressures ----			
Elevation	Soil type	Water kN/m2	Vert. kN/m2	Active kN/m2	Soil type	Water kN/m2	Vert. kN/m2	Passive kN/m2
3.290	1	0.00	5.00	2.50	0	0.00	0.00	0.00
3.115	1	1.75	6.75	3.37	0	0.00	0.00	0.00
2.940	1	3.50	8.50	4.25	0	0.00	0.00	0.00
2.765	1	5.25	10.24	5.12	0	0.00	0.00	0.00
2.590	1	7.00	11.97	5.99	0	0.00	0.00	0.00
	2	7.00	11.97	5.99	0	0.00	0.00	0.00
2.415	2	8.75	13.70	6.85	0	0.00	0.00	0.00
2.240	2	10.50	15.42	7.71	0	0.00	0.00	0.00
2.015	2	12.75	17.62	8.81	0	0.00	0.00	0.00
1.790	2	15.00	19.80	9.90	0	0.00	0.00	0.00
	3	15.00	19.80	9.90	0	0.00	0.00	0.00
1.595	3	16.95	21.67	10.84	0	0.00	0.00	0.00
1.400	3	18.90	23.54	11.77	0	0.00	0.00	0.00
1.120	3	21.70	26.21	13.11	0	0.00	0.00	0.00
0.855	3	24.35	28.73	14.36	0	0.00	0.00	0.00
0.590	3	27.00	31.24	15.62	0	0.00	0.00	0.00
	4	Total>	58.24	13.50m	0	0.00	0.00	0.00
0.330	4	Total>	63.30	14.80m	0	0.00	0.00	0.00

Units: kN,m

Serviceability Limit State Analysis - BENDING MOMENTS **Load Case No.1**

Surcharge Nos. 1 apply with a Partial factor = 1.00
Partial factor on Vertical Load = 1.00

Forces on Base for Calculating Bending Moments

Horizontal forces	Force kN/m run	Moment kN.m/m run	Resultant Height above base	Resultant Elevation
Shear on heel	0.00	0.00	0.33	0.33
Shear on toe	0.00	0.00	0.33	0.33
Shear at base of stem	64.78	21.38	0.33	0.33
Nett horizontal force	64.78	21.38	0.33	0.33

Components of sliding resistance	
Base shear	-99.75
Shear key	0.00
Total sliding resistance	-99.75

Vertical forces	Force kN/m run	Moment kN.m/m run	Distance of resultant from toe
Components of dead load			
Weight on heel	4.71	-14.46	3.07
Weight on toe	0.00	0.00	0.00
Stem load	169.92	-367.88	2.17
Weight of base	21.07	-28.02	1.33
Total dead load	195.70	-410.36	2.10
Uplift water pressure	-43.76	77.60	1.77
Nett vertical force	151.94	-332.77	2.19
Moment at base of stem		73.06	
Moment of horiz. forces		21.38	
Soil reaction on base	-151.94	238.33	1.57

Base contact pressures

Soil contact pressure at toe	26.4 kN/m2
Soil contact pressure at X = 2.66	87.9 kN/m2
Line of action of resultant	1.57 m from toe

*** SLS results do NOT include a partial factor on passive.

Units: kN,m

Serviceability Limit State Analysis - BENDING MOMENTS **Load Case No.1**

Forces in stem of wall

Elevation	Shear force kN/m run	Axial force kN/m run	Bending moment kN.m/m run
3.290	-0.00	130.00	1.30
3.115	0.67	131.58	1.32
2.940	1.79	133.29	1.47
2.765	3.38	135.13	1.85
2.590	5.42	137.11	2.51
2.415	7.92	139.03	3.58
2.240	10.88	141.04	5.12
2.015	15.36	143.77	7.90
1.790	20.58	146.66	11.75
1.595	25.72	149.69	16.01
1.400	31.42	152.88	21.30
1.120	40.59	157.74	30.92
0.855	50.33	162.65	42.47
0.590	61.10	167.86	56.70
0.330	64.78	169.92	73.06

Forces along base of wall

Distance from toe m	Shear force kN/m run	Bending moment kN.m/m run
2.660	0.00	0.00
2.495	-3.42	-0.62
2.330	-30.60	-3.76
2.165	-293.93	-45.69
2.000	107.88	-76.19
1.780	89.07	-55.44
1.560	71.97	-38.64
1.300	53.98	-23.37
1.040	38.39	-12.46
0.780	25.19	-5.29
0.520	14.40	-1.24
0.260	6.00	0.32
0.000	0.00	0.00

*** SLS results do NOT include a partial factor on passive.

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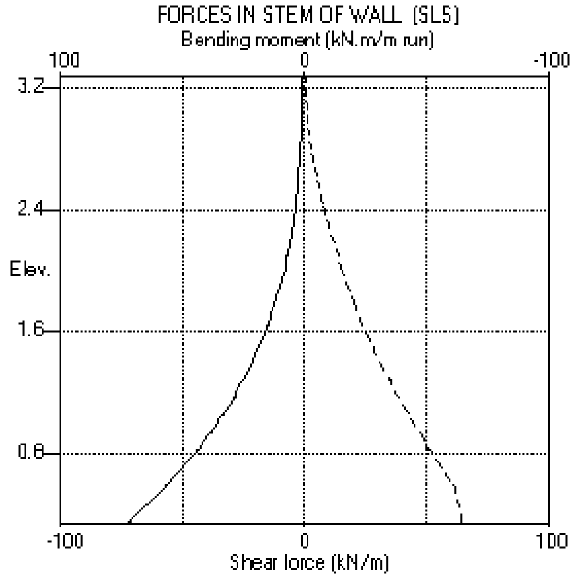
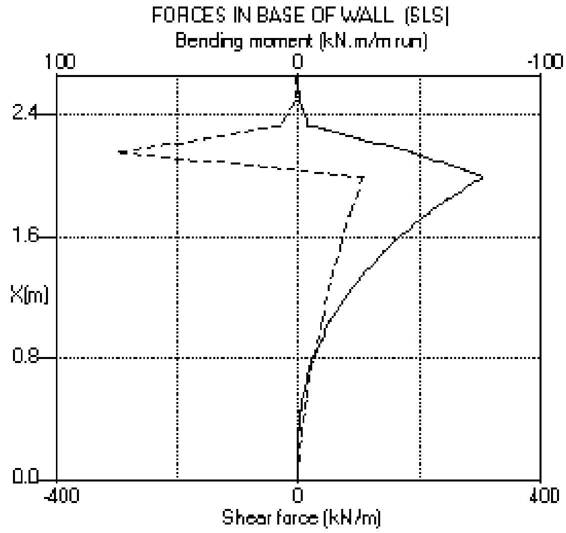
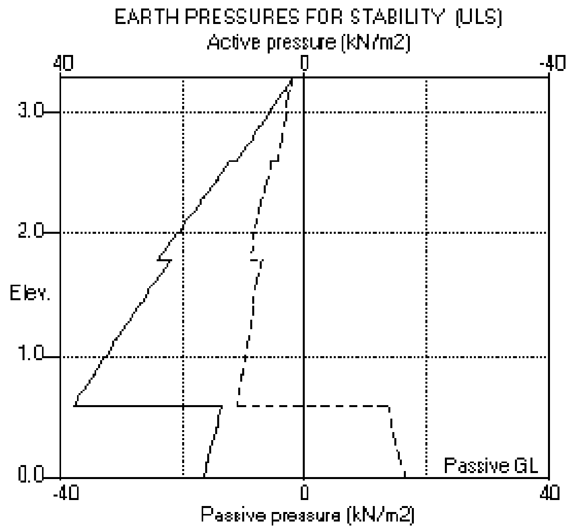
CARD GEOTECHNICS LIMITED                                      | Sheet No.
Program: GWALL  Version 3.01  Revision A02.B02.R35            |
                            Licensed from GEOSOLVE            | Job No. CG/5956
Run ID. Internal Party Wall                                   | Made by :   RJB
Internal Party Wall (9&11)                                    | Date: 2-04-2012
Preliminary Calculation for BIA only                          | Checked :
-----------------------------------------------------------------------------
                                                       Units: kN,m
```

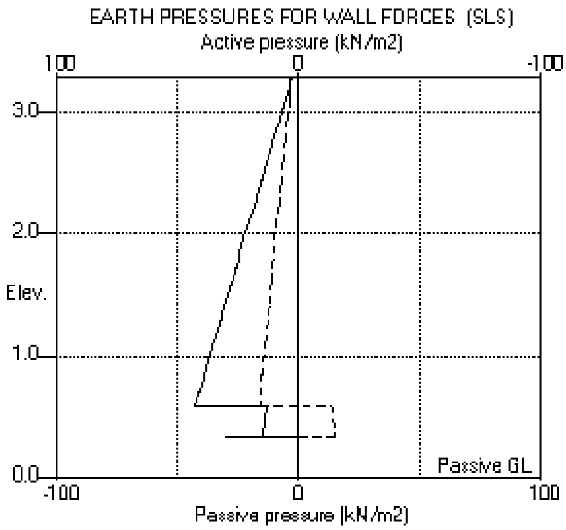
Load case no.1





Load case no.1





Units: kN,m

SUMMARY RESULTS

Load Case No.	Sliding stability (base shear) FoS	Sliding stability (base + passsive) Fos	Overturning stability Fos	Contact press. at toe kN/m2	Distance of resultant from toe m
1	1.041	1.041	2.796	5.20	1.74

Notes 1. Nett water pressures are used in calculating the disturbing forces and moments for the factors of safety on sliding and overturning.
2. All ULS results include a partial factor of 1.00 on passive.

Load	Stem				Base			
Case	Bending moment		Shear force		Bending moment		Shear force	
No.	maximum kN.m/m	minimum kN.m/m	maximum kN/m	minimum kN/m	maximum kN.m/m	minimum kN.m/m	maximum kN/m	minimum kN/m
1	73.06	0.00	64.78	-0.00	0.32	-76.19	107.88	-293.93