Card Geotechnics Limited
Providing Ground Solutions

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4 March, 2013

Mr. Rob Tulloch
Planning Officer – East Team
Development Management,
Regeneration and Planning,
Culture and Environment Directorate,
London Borough of Camden, Town Hall Extension,
Argyle Street, London
WC1H 8ND

Your ref: 2012/5825/P

Our ref: CG/08264

Please reply to: Richard Ball/Nick Langdon

Dear Mr. Tulloch,

8 Pilgrim's Lane

Please see below our review of the Basement Impact Assessment undertaken and counter argument existing for 8 Pilgrim's Lane. We provide initially our independent review of the site investigation data, ground conditions, and potential impacts of the proposed development. Subsequently we provide comment on the previous submissions received.

1. Independent review of data

General
The site is located off Pilgrim's Lane and the ground generally slopes towards the east/southeast. There is a total drop in level of approximately 3.3m from Pilgrim's Lane in the northwest to the back garden in the southeast. This drop occurs over a combination of sloping ground in the northwest and southeast with a 1m high retaining wall to the back garden.

Ground and groundwater conditions
A total of nine boreholes have been excavated across the site during two separate intrusive investigations by Geotechnical and Geo-environmental Associates Ltd. (GEA) in February 2011, and by Listers Geotechnical Consultants (LGC) in April 2012. In addition a total of 13 hand-excavated foundation inspection pits have been excavated during the two phases of investigation. This number of boreholes is higher than normally seen for a development of this size and the ground conditions on site are summarised in Table 1 below:

Table 1: Summary of ground conditions

Stratum	Depth to surface (mbgl)	Thickness (m)
MADE GROUND. Variable, comprising in places topsoil, brick fill, soft to firm orange brown clay becoming black in places.	0	0.5 to 3.2
Firm becoming stiff light brown mottled grey slightly silty fissured CLAY.	0.5 to 3.2	3.6 to 5.3

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[CLAYGATE FORMATION]		
Firm becoming stiff to very stiff fissured grey CLAY with rare pyrite nodules. **[LONDON CLAY FORMATION]**	6.0 to 6.9	Proven to 20m depth

Details of the strata encountered are summarised below.

Made Ground was generally at its thickest in the central area of the site close to the existing structure. At its thickest, the Made Ground comprises brick fill which may have been used to raise ground levels for the original construction of the existing building on site.

The Claygate Formation is recorded to a depth of typically 6mbgl to 6.9mbgl overlying the London Clay. It is noted however that particle size distribution testing (PSD) reported in the LGC report record sand and silt contents of 67% to 79% in samples from 13mbgl and 8mbgl respectively. This would suggest that the Claygate Formation materials are present to greater depth and may have been misidentified as London Clay during logging. To maintain consistency with previous work, this material has been termed London Clay within CGL's analysis and reporting.

Standard Penetration Testing (SPT) 'N' values recorded within the soils are summarised in Figure 1 and undrained shear strengths (Cu) values for cohesive soils are summarised in Figure 2, plotted against level (mOD). Shear strengths have been established based on conservative correlations between 'N' and Cu (f1 = 4.5)[i], and on the basis of Quick Undrained Triaxial testing (QUU). The results show reasonable correlation and indicate a general increase in shear strength with depth for the soils encountered on site.

Geotechnical design parameters for the soils encountered on site are summarised in Table 2:

Table 2: Geotechnical design parameters

Stratum	**Design Level (mOD)**	γ (kN/m^3)	Plasticity Index (%)	ϕ'	Cu (kPa) [c']	Eu (MPa)	E' (MPa)
Made Ground (Granular)	80 – 82	19	-	30	-	-	18
Made Ground (Clay)	78.5 – 80.5	19	35[a]	24[b]	40 [0]	20[c]	15[d]
Claygate Formation	77.5	19	35	24	70 [0]	35	26.25
London Clay (sic)	73	20	32	25	80 [0]	40	30

a. Not tested – value assumed from Claygate Formation testing
b. Critical state angle of shearing resistance – BS 8002:1994 Code of practice for earth retaining structures.
c. Based on 500 x Cu
d. Based on 0.75 x Eu

Groundwater was encountered in five boreholes at depths between 1.15mbgl and 2.7mbgl. Groundwater was not encountered within any of the foundation excavation pits. This finding suggests that groundwater is discontinuous across the site, and is likely to be encountered perched within silty/sandy horizons within the

Claygate Formation. Based on the levels recorded, there does appear to be a slight fall in groundwater level towards the east/southeast, following the slope in the ground.

Surface flow and flooding
It is noted that the proposed development does not significantly alter the overall footprint area of the structure and therefore that surface flow and flooding are unlikely to be significantly affected. The site is not in an area reportedly affected by flooding. It is considered that with appropriate drainage design, the volume of the flow to be controlled will not be materially affected and as such the development does not impact on surface flow and flooding.

Subterranean (groundwater)flow
The ground investigation data suggests that groundwater is discontinuous across the site, potentially present within silt and sand horizons within the Claygate Formation. There is a perceived flow trend towards the east/southeast, however it is considered that flow rates are likely to be very low, indeed permeability testing within the Claygate Formation recorded hydraulic conductivity values of the order of 7.5×10^{-6} m/s.

The basement will extend below the groundwater level and as such disruption to groundwater flow is a potential consideration.

Land Stability
The proposed development comprises the excavation of an additional basement level beneath the eastern wing of the existing building, and extending the existing lower ground floor by a depth of some 0.4m beneath the western wing of the building. The building itself is to be retained.

The property shares party wall boundaries with No. 10 Pilgrim's Lane to the north, No. 6 Pilgrim's Lane to the south, and Downshire Studios to the east. The new basement level has been located such that it is immediately adjacent only to Downshire Studios, single storey properties, to the east. A 'cartoon' plan showing proposed dig depths relative to party wall footings is provided in Figure 3. The perceived impacts are summarised in Table 3, these are relevant to the 'Land Stability' section of CPG4[ii].

Table 3: Perceived construction impact on party wall structures

Location	Proposed construction	Perceived impact
Party Wall with No. 6 (Western section adjacent to single storey basement)	Ground floor to be lowered by between 400mm to 600mm. Requires excavation of between 725mm to 925mm assuming floor slab construction thickness of 325mm. 0.5m wide strip left adjacent to No. 6 that is not excavated.	LGC trial pits TP01 and TP02 are on internal walls. No investigation of party wall depth. If foundation depths are assumed to be similar to those recorded elsewhere (e.g. 1.0m and 1.2m) then excavation does not affect stability in the short term and underpinning is not required. Recommend PW 6 foundation depth is confirmed by trial pit.
Party Wall with No. 6 (Eastern section adjacent to	Basement excavation in this area is some 4.1m to formation. Existing flank wall, between 6 & 8 is to be	The structure of No. 6 is offset by some 1.5m from the basement boundary at this point and could

double storey basement)	underpinned to a depth of some 5.3m. Total retained height is 5.3m.	potentially be affected by ground movements during the deep, two stage underpinning. The area between the basement and No. 6 appears to be laid to concrete paving.
Party Wall with Downshire Studios. (Southern section underpinned)	Basement excavation is 4.1m to formation. Downshire Studios directly underpinned. Retained height approximately 2.5m (assumed)	Downshire Studios to be directly underpinned. Foundation depth currently not known.
Party Wall with Downshire Studios. (Northern section secant pile wall)	Basement excavation is 4.1m to formation (approx.) Secant wall constructed offset from Downshire Studios. Retained height approximately 2.5m (assumed)	Secant piled wall installation causes ground movements that should be taken into account in ground movement analysis, Downshire Studios structures will surcharge the wall and this should be accounted for in ground movement analysis.
Party wall with No. 10 (Western Section adjacent to car port)	No excavation immediately adjacent to No. 10 structure. Excavation 2.5m distant to a maximum depth of some 925mm. Current proposals show underpinning for ½ length of this wall.	First floor of No. 10 extends across to No.8 and is supported on two columns adjacent to No. 8. These two columns are likely to be on strip foundations however they have not currently been investigated. Depending on formation level, these could potentially be undermined during deepening of the basement of No. 8.
Party wall with No. 10 (Eastern Section adjacent to garden wall)	Secant piled wall and excavation of 4.1m approximately.	Area remote from structure of No. 10, but could potentially affect garden wall and garden through movements caused by secant wall installation and deflection during construction.
Internally – Structure of No.8	Excavation levels beneath the existing building vary considerably and consideration should be given to differential heave/settlement across the structure, and the potential to cause distortion.	

It can be seen from Table 3 that the proposed construction generates potential risks to all of the party wall properties to varying degrees.

2. Review of submission documents

We have reviewed the submission documents provided by the applicant in order to assess initially whether they identify similar risks to those set out in Section 1 above. The documentation has also been reviewed to assess whether appropriate consideration/analysis has been undertaken to understand those risks and to allow construction control measures to be installed to mitigate them.

The documents reviewed are:

A. *Arup Limited (August 2012) – 8 Pilgrim's Lane, Basement Impact Assessment*

B. *RKD Consultants Limited (November 2012) – 8 Pilgrim's Lane, Ground Movement Assessment Report: New Basement.*

A. Arup Basement Impact Assessment

Section	Arup Finding	CGL comment
3.2 – Matters carried forward from screening report.	Basement could potentially impact on surface water flow, groundwater flow, and land stability.	The matters raised by Arup concur with those considered by CGL.
4, 5 & 6	These sections are factual based and concur with the findings of CGL with the exception of the depth to the London Clay, which may have been misreported on site.	
7.1 – Groundwater flow modelling.	Groundwater rises may be a concern due to basement damming, however numerical analysis offers an option to reduce this.	The analysis is reasonably detailed and provides what appear to be conservative results. It is clear that the impacts have been considered and that, with appropriate design, the issues are not insurmountable. The effect of deeper, more permeable material should be considered. Final design, and verification of that design, would be required to confirm that the proposed drainage is effective.
7.4.1 – Excavation overall stability, methodology.	Table 3 illustrates Plasticity Index values in the London Clay of 32%, this is lower than that recorded in the Claygate Formation (34%).	This may reflect the presence of deeper Claygate Formation than has been allowed for.
7.4.2 & 7.4.3– Excavation overall	Arup state that underpins and piles will be stable in the short term.	There is no reference to temporary propping, which will certainly be required

stability – results & Excavation internal stability.	Arup state that ground movements will be reviewed within a separate report by RKD Consultants Ltd.	during construction of the 5.3m high underpins in order to maintain stability and control movements. Consideration of overall stability should include basic calculations to demonstrate that the underpins do not fail in overturning (as rigid walls) or by generating excessive bearing pressure at their toe. It is also noted that these underpins will have to be constructed in two 'lifts'. There is no mention or calculation of underpin settlement/deflection, however there is reference to a separate report undertaken by RKD Consultants.
8.1 – Surface water flow and flooding	Arup conclude that the potential impact of the proposed basement on surface water flow and local flooding risk is negligible.	CGL consider this finding to be appropriate.
8.2 – Subterranean groundwater flow.	Arup conclude that the impact of the proposed basement on subterranean groundwater flow is considered negligible when mitigation measures are incorporated into the final design.	CGL consider that whilst drainage measures may alleviate the problem of changing groundwater levels, they will require detailed and audited design, and should consider the impact of a thicker layer of Claygate Formation material beneath the basement.
8.3 – Slope stability	Arup conclude that the potential impact of the proposed basement on slope stability is considered negligible.	This statement cannot be made on the basis of the analysis undertaken for this report. The analysis considers only circular failure of the ground beneath the proposed underpins, and does not consider overturning/overall stability of the underpins. All discussion of ground movement is referred to the RKD Consultants report.

RKD consultants Limited have provided a *Ground Movement Assessment Report* to determine the potential impact of the new basement on party wall structures. The findings of this report are reviewed and commented on below.

B. RKD Consultants Ground Movement Assessment Report

Section	RKD Finding	CGL comment
2.2 – A note on heave	RKD state that heave is not of direct consequence to neighbouring structures.	The basement area to be constructed is of a reasonable size and would be expected to generate heave beyond the basement boundaries. In this regard heave does affect the neighbouring properties and should be considered within the analysis.
2.3 – Nature and design of the underpinning and piled retaining walls	RKD make no mention of multi-stage underpinning.	A 5m depth of underpinning requires considerable temporary works and excavation to be achievable in a single lift. In reality would this be excavated in two vertical stages and this would potentially have an impact on predicted construction settlement.
	"Particular care is required in relation to the underpinned footing structure in the Car Port area"	Agreed. Current drawings show that underpinning does not extend for the full length of the car port wall. It is not clear how the floor level in this area will be successfully reduced. Furthermore the level of the column foundation to No. 10 is not currently known and as such it is unknown whether this foundation would be undermined or affected. The structure of No. 10 is likely to flexible in this area, and susceptible to ground movements.
	Analysis description: shallow section underpin area.	No allowance is made for road surcharging derived from Pilgrims Lane.
	Analysis description: deep section underpin area. There is no record of a building surcharge having been included in the analysis of the deep section underpins.	At this location the structure of No. 6 is some 1.5m behind the basement wall and will impart a surcharge load to the structure. Along the eastern section, Downshire Studios is present, which will also impart a surcharge load to the wall.

		Surcharge loading from the neighbouring structures should be considered in the analysis.
	Analysis description: piled wall area. There is no record of building surcharge having been included in the analysis.	At this location, the foundations for Downshire Studios are set back close to the retaining wall. Surcharge loading from the neighbouring structures should be considered in the design.
	General comments: Soil parameters, assumed groundwater levels, and construction sequences are not provided and it is therefore not possible to assess them.	
2.4 – Workmanship	It is assumed that the contractor is expecting to pump away groundwater.	Groundwater seepage through the Claygate Formation is expected. This brings with it the possibility of fines being washed out and consequent ground settlement behind the wall if water is poorly controlled. The impact of perched groundwater on the stability of the underpin excavations should be considered.
3.2 – Underpinning movements	Assumes 5mm settlement for a well – constructed wall.	Whilst settlement of underpins is largely dependent on the workmanship in their construction there is also a component of settlement of the soils as load is applied to previously unstressed soils at greater depth. This component should be assessed analytically.
3.3 – Piled Wall movement	Assumes 0.04% ground settlement caused by installation of the wall.	Greig-Ling drawing 612 – 01 suggest that wall will be secant, therefore allow 0.05% for movements. Very minor impact, wall movements on installation increase from 2.4mm to 3.0mm.
	Assumes 0.04% lateral ground movement caused by installation of the wall.	This is appropriate for a contiguous piled wall, but is not appropriate for a secant piled wall, which would see movements of 0.08% (based on very limited data).

		Equivalent to 4.8mm lateral movement caused by pile installation.
4.1 – Basement excavation results	Results of 0.5mm, 2.8mm, and 3.5mm lateral movement are reported for the shallow, deep, and piled wall sections respectively.	It is not clear how these are derived in terms of soil parameters, construction sequences, water levels assumed, and surcharge loading. It is therefore not possible to comment on these values.
	A PLAXIS analysis is undertaken to assess the western section adjacent to No. 6.	No PLAXIS input or output is provided. No details are provided as to the surcharge load applied by the footing. The analysis assumes that the new formation level is 400mm below the existing foundation level, however it is not clear if this includes the new slab and blinding thickness of 325mm. CGL's data review suggests that the foundation depth in this area is not known (LGC trial pits are against 'internal walls') and as such further investigation is recommended.
	Ground movement contours.	Given the comments set out above, CGL are not confident in the contours provided. It follows that CGL is not confident in the building damage assessment subsequently undertaken.

Summary

On the basis of the information provided, the risks to the party wall structures have been adequately identified, however there is not sufficient information to make an informed judgement on the adequacy of the analysis undertaken. Furthermore there are omissions and assumptions within the analysis which will potentially affect the predicted ground movements.

The documents reviewed do not set out construction methodology in sufficient detail to limit the potential for damage to the party wall structures. This includes a review of the Construction Management Plan, which sets out a requirement for monitoring but makes no reference to trigger limits and associated contingency/action plans to control movements and damage during construction.

Our conclusions may be summarised as follows:

Consideration	Conclusion
Surface Water Flow and Flooding	Information provided is appropriate and risks can be adequately controlled.
Subterranean (groundwater) Flow	Risks have been appropriately considered and can be adequately controlled subject to final design.
Land Stability	Information provided **does not** adequately address the potential risk of damage to party wall properties and additional information and analysis is required.

The commentary provided above represents our professional, independent opinion of the data provided. We trust this assists and are available to contact should you have any further questions or comments.

Yours sincerely,

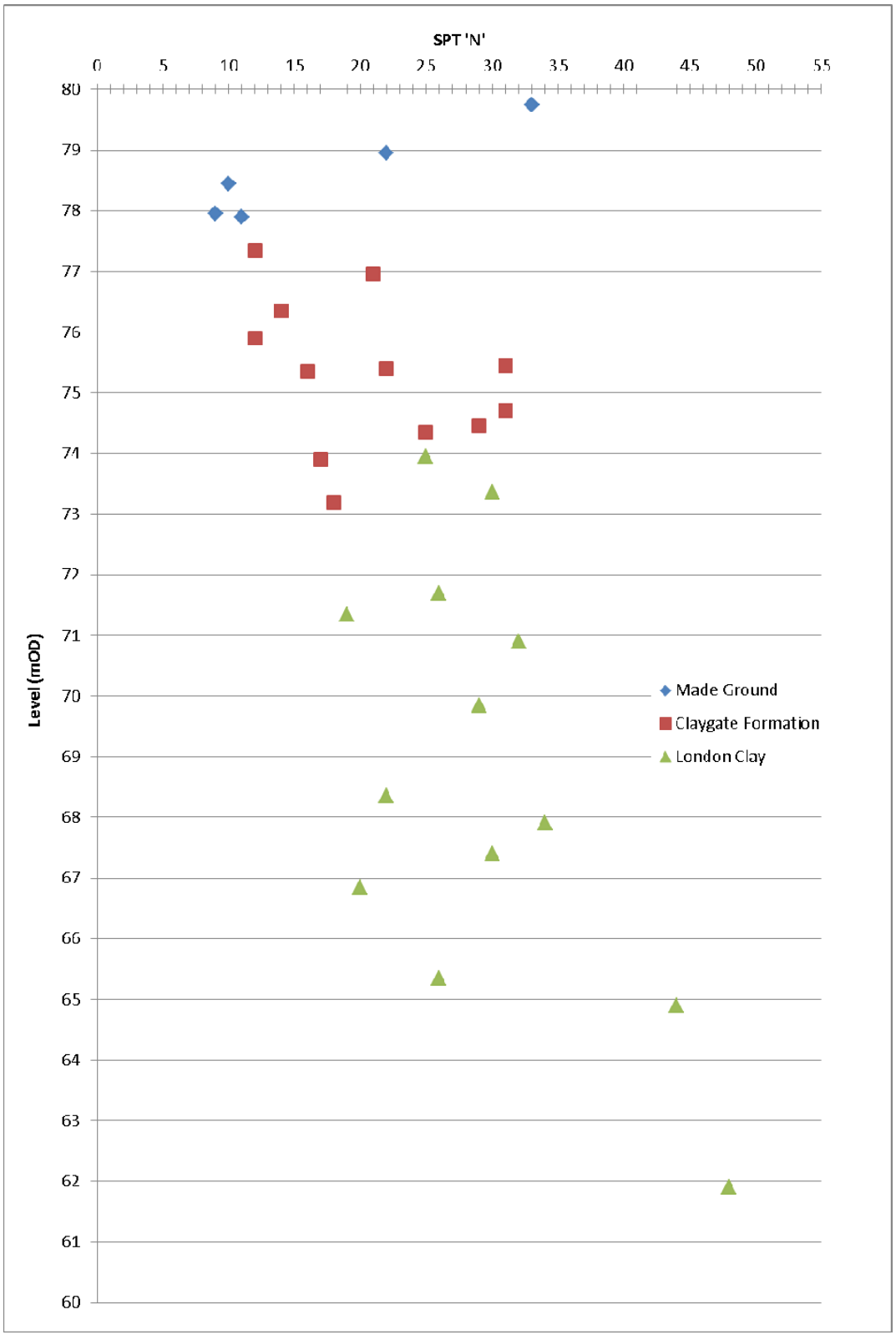
Ian Marychurch, Director
Card Geotechnics Limited

Richard Ball, Principal Engineer
Card Geotechnics Limited

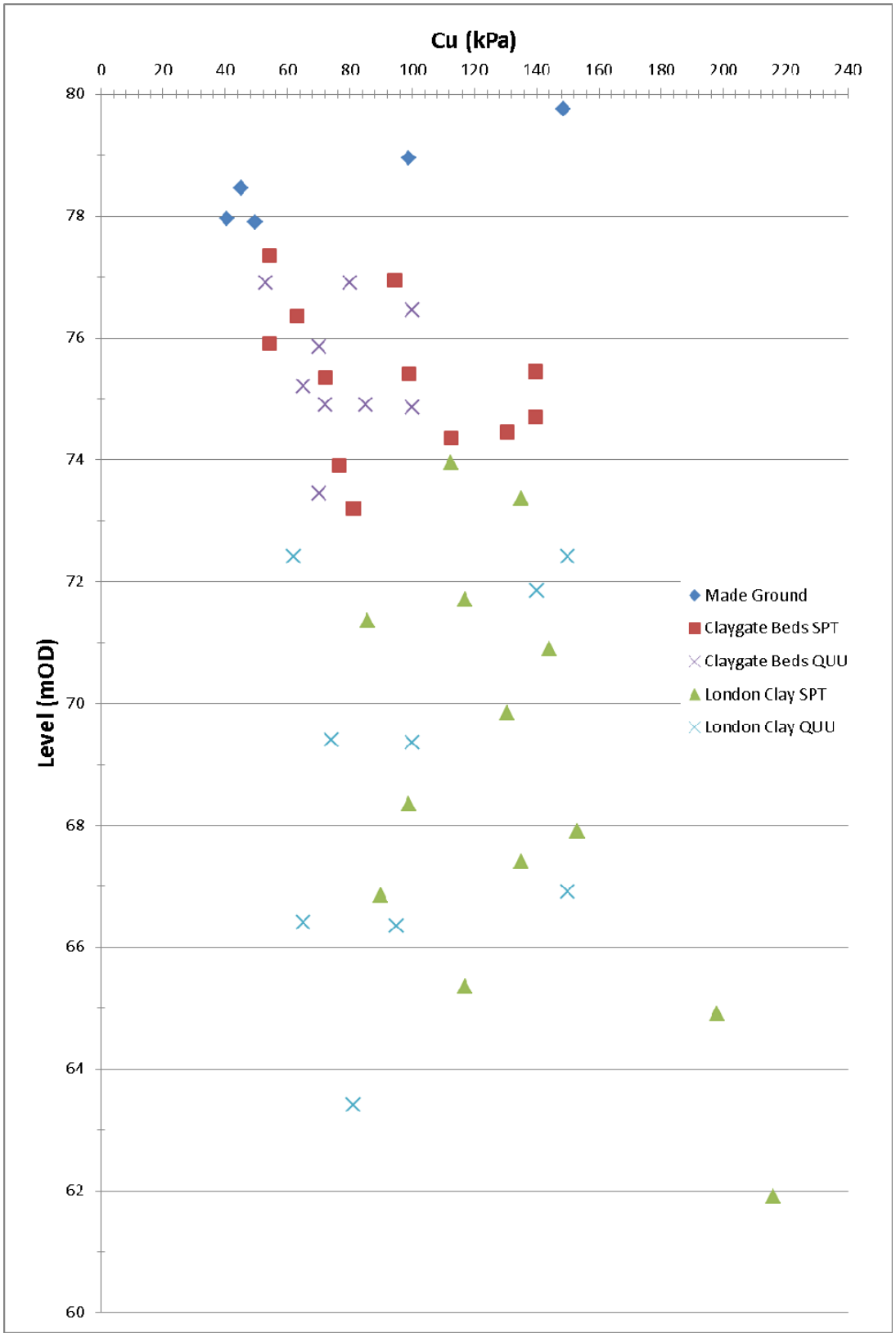
Enc:

Figure 1 – SPT 'N' vs. Level
Figure 2 – Undrained shear strength (Cu) vs. Level
Figure 3 – Sketch of basement and party wall structures

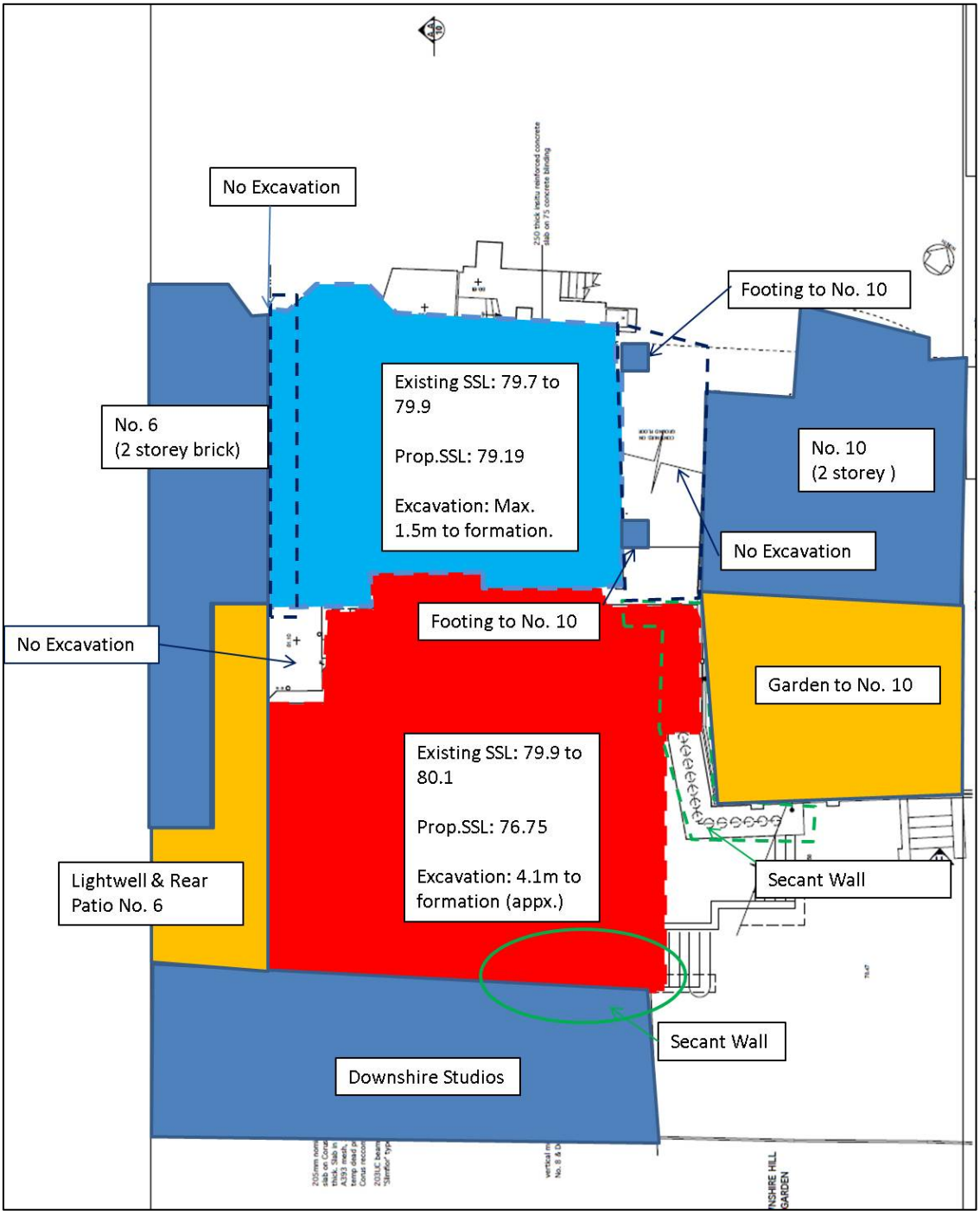
[i] Stroud, M.A., The standard penetration test in insensitive clays and soft rocks, *Proceedings of the European Symposium on Penetration Testing,* **2,** 367-375 (1975).
[ii] Camden Planning Guidance CPG4, Basements and Lightwells, London Borough of Camden.



Client	Project	Job No
London Borough of Camden	**8 Pilgrim's Lane**	**CG/08264**
CGL	Title **SPT 'N' vs. Level**	**Figure 1**



Client	Project	Job No
London Borough of Camden	**8 Pilgrim's Lane**	**CG/08264**
CGL	Title **Undrained Shear Strength (Cu) vs. Level**	**Figure 2**



Client	Project	Job No
London Borough of Camden	**8 Pilgrim's Lane**	**CG/08264**
CGL	Title **Sketch of basement and party wall structures**	**Figure 3**