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Engineering - materials, energy, structure

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5 Gloucester Crescent

Basement Impact Assessment

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Reference:	15085
Revision:	4
Date:	26/02/16

Contents

1. Introduction

It is proposed to create a new basement in the garden of this grade 2 listed property.

Ecos Maclean has been instructed to carry out a Basement Impact Assessment (BIA) to assess the potential impact on surrounding structures, hydrology and hydrogeology.

This report follows an initial scoping review carried out in September 2015, which identified investigations requiring primarily a geotechnical investigation. The results of this investigation have informed the final design and impact assessment. The basement design and impact assessment has been undertaken by the Principal Engineer at Ecos Maclean – Mr Nick Maclean BSc (Hons) 1970 who has over forty years' experience as a practicing structural engineer in London and has extensive experience with basement construction in London. The report has also been reviewed by Mr R. Gulhane MEng, MICE, a civil engineer also of 40 years' experience who has designed and over-seen the construction of basements in Camden. The summary of expertise is given at Appendix 1.

The geotechnical and hydrogeology investigation and analysis has been undertaken by Mr T. Murray MSc, BSc (Hons), FGS a Geotechnical Engineer with Site Analytical Services Ltd.

Camden Planning Guidance CPG4 Basements & Lightwells [1] requires that the impact of any new basement development in the borough be assessed according to the following 5 stages:

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

The initial screening and scoping stages identified the key issues relating to land stability, hydrogeology and hydrology to be considered as part of any proposed basement development.

The report also provides an assessment of geotechnical impacts on adjacent structures and the surrounding area based on available site investigation data. This includes design checks of proposed below ground structure and a damage assessment to predict the impact on adjacent properties.

The proposed basement will be approximately 4 metres below the garden level and extend beyond the external wall of the existing listed property and abut the line of the existing garden walls to the NE & SW.

2. Site Context

2.1 Site Location

The site is located at 5 Gloucester Crescent. The site location is shown in figure 1.

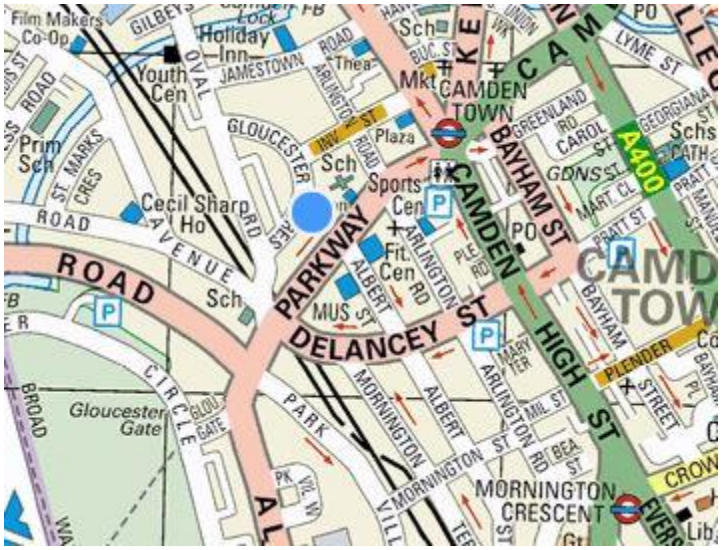


Figure 1: Site location plan

2.2 Site Layout

The property is a terraced dwelling on the South East side of Gloucester Crescent: the rear garden is enclosed by brick walls approximately 1.8 metres in height.

2.3 Proposed Development

The structural details of the work have been developed as a way of reducing the duration and disruption caused by underpinning. The first option normally considered is the installation of a bored pile wall around the perimeter of the excavation, faced with a reinforced concrete wall for strength.

Bored piles are commonly used as the key component of the retaining wall system on the three open sides and thereby allow clear and free access to install the structure. However, the drawback is that the simplification by this construction reduces floor area and results in a maximum of excavation (pile shafts are usually at least twice as much below basement level as above) and correspondingly greater amounts spoil and quantity of concrete. This also increases significantly the noise nuisance and duration of the structural engineering works and then increases the amount of material to be carted away and imported to the site, thereby further increasing lorry movements and associated noise and disruption.

An alternative approach to the design has therefore been explored and evaluated, using the principals incorporated into the design of the Barbican Arts Centre with its special needs with respect to earth retaining and limiting of lateral ground movements. This has reduced the potential for negative impacts on

neighbours and the listed building. The intention being to mitigate as described in paragraph 2.48 of CPG 4 by seeking a design and construction method which reduces noise, excavation and lorry movements. This is considered particularly important given that the property is a listed building within a conservation area.

The design also takes account of, effectively, the requirement to consider sustainable construction in terms of materials use and energy efficiency as described in paragraph 2.52 of CPG4. The basis of the design is to utilise precast components to form the retaining wall around the three sides of the basement and just use locally, mass concrete underpinning below the Party Wall corners of the rear external wall of the listed building. Precast components have much better quality control and so are thinner and lighter to give a required strength.

Mass concrete underpinning evolved to work well underneath existing foundations as a way of addressing movement and subsidence in buildings: where there is no evidence of defects, the procedure and sequencing can, with advantage, be simplified and rationalised. This will provide the sides of the part of the basement at the corners of the listed building in combination with a reinforced basement floor slab and concrete beam and block roof deck, to provide a rigid box. This form minimises the effect on existing and adjacent ground and structures.

The formation of the external walls of the basement within the garden can be undertaken more quickly and with less material with either purpose made Stepoc block walling to form the retaining walls or Precast Hollow Concrete Planks. The use of strong precast elements for the remainder after underpinning, facilitates the jacking in of earth pressures, minimising the earth movements which would normally arise as a result of excavation. Using these materials it is possible to create narrower walls and use more dry materials which can be carried into place through the property and placed into trenches excavated by hand. The use of Precast Planks allows the project to proceed more rapidly as there is no delay in waiting for cast concrete to achieve its full strength, which is the case when using faced bored pile walls or Stepoc blocks.

We have therefore concluded that a full design, calculations and working method for precast concrete planks for the majority of the perimeter should be used as a way of mitigating impact on neighbouring property, the local environment and reduce resource and energy use.

2.4 Site History

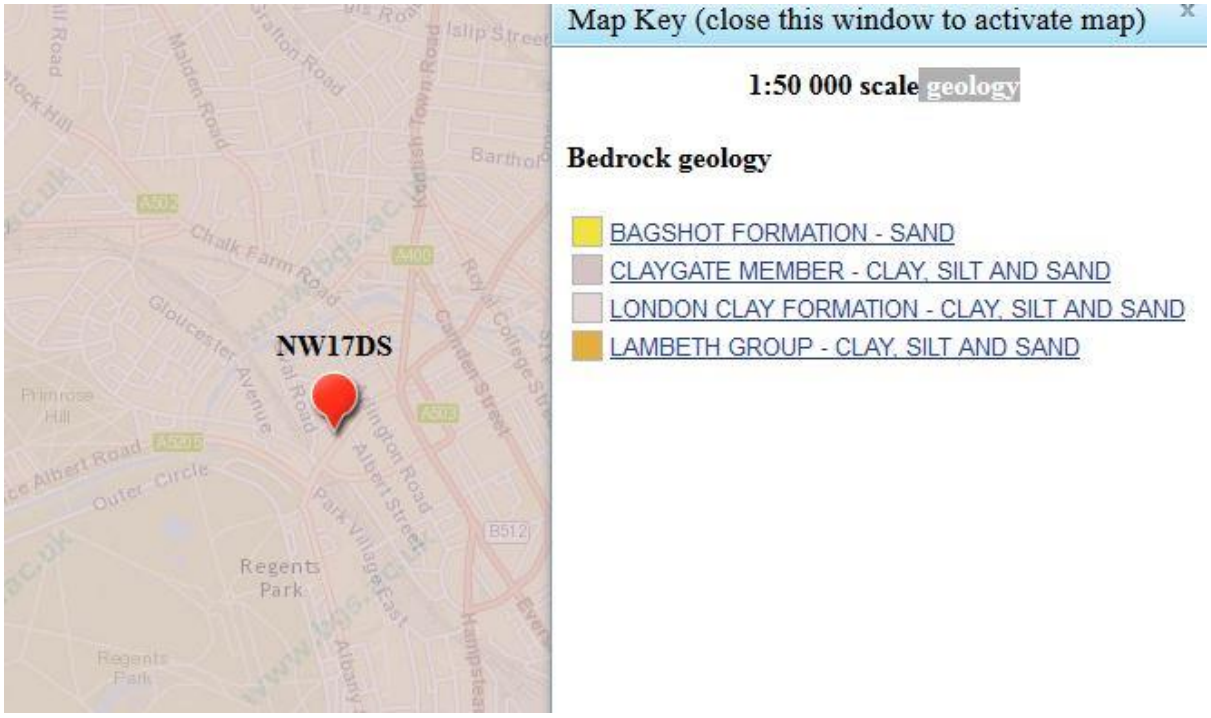
Maps of the site dating from the mid-1800s have been reviewed and show the site has been part of a residential setting since that date and also show Gloucester Crescent in its present day alignment. The general arrangement of the residential dwellings along Gloucester Crescent has not changed since that date.

2.5 Topography

The site lies at an elevation of approximately 33 m. OD, is level and covers an area of 250 sq. m. Gloucester Crescent at this point follows the contour and the rear gardens to the south east in which the basement will be constructed, and is located approximately one metre below the road level. Gloucester Crescent is a continuous terrace and so forms a barrier between the road and rear garden thereby protecting the rear garden from surface water flood risk. The road also slopes down from Oval Road to the west, to Inverness Terrace to the north east, further reducing the risks of surface water flooding into the lower ground floor and basement level of the property, which are not increased by the basement forming of a basement.

2.6 Published Geology

The British Geological Survey (BGS) of the area indicates the site to be underlain by the London Clay Formation. The London Clay Formation is an over consolidated firm to very stiff, becoming hard with depth, fissured, brown to grey silty clay of low to very high plasticity.



2.7 Published Geology and Site Investigation

There are two boreholes records within 100m of the site boundary. One from 1907 and one from 2006, the borehole reports were recovered from the British Geological Survey online resource are summaries below.

Table 1: Summary of published Borehole record

	TQ 28SE309	**TQ28SE2266**
Stratum	**Depth (m)**	
MADE GROUND	0 to 2.4 metres	O to 0.4 metres
Brown Clay	2.4 to 12.6 metres	0.4 to 1.8 metres
Blue Clay	12.6 to 13. metres	
Ends	13 metres	1.8 metres

A site investigation was commissioned to establish more precisely the ground conditions and hydrogeology of the site. The full report is at Appendix 2.

The site geology comprises Made Ground to 1.8 metre depth underlain by brown weathered London clay with a low permeability and a low to medium susceptibility to shrinkage and swelling movements due to changes in moisture content.

2.8 Hydrogeology

The Environment Agency (EA) has classified the site location as unproductive strata. The borehole investigation carried out in December 2015 confirmed that there was no groundwater present at the site. The site is not within any groundwater source protection zones.

The presence of groundwater in the sample borehole is considered to be perched water within the Made Ground. This needs to be considered during construction and for the design of the basement structure.

2.9 Hydrology

The site is not located close to any rivers or drainage channels serving the borough of Camden. The garden is one metre below the road, which slopes downhill to the north east. The location of the basement is protected from the road by the terrace. This forms a barrier for surface water flows and so the site is not vulnerable to surface water flooding.

2.10 Flood risk

With reference to the Environment Agency website Gloucester Crescent is not within a flood risk zone from Rivers or Surface Water Flooding

3. SCREENING

3.1 Subterranean (ground water) flow screening - Fig 1 [1]

	Question	Response	Justification	Reference
1a	**Is the site located directly above an aquifer?**	No	The site is located on unproductive strata as defined by the Environment Agency with low permeability that has negligible significance for water supply or river base flow.	Fig. 8 CGHH
1b	**Will the proposed development extend beneath the water table surface?**	No	The water table is below the impermeable clay which is below the level of the basement excavations	Table 1 Borehole Data & Appendix 2 - Ground Investigation Report Appendix 2.
2	**Is the site within 100m of a watercourse, well (used/disused) or potential spring line?**	No	Evidence from maps and site walk over shows that there is no record or evidence of a well or spring line	Fig. 8, 11 and 12 CGHH [5] [6]
3	**Is this site within the catchment of the pond chains on Hampstead Heath**	No	Evidence from Map	Fig. 14 CGHH
4	**Will the proposed development change the proportion of hard surfaced/paved areas?**	No	The basement will occupy part of the garden and so mitigation will need to be identified, but the existing garden is currently partly paved and the area of the basement will be below this existing patio area.	
5	**As part of the site drainage, will more surface water than at present be discharged to the ground (e.g. via soak ways and/or SUDS)?**	No	The basement design will include the addition of one metre of soil which will have the same attenuation capacity as the existing made ground on site.	Appendix 2 - Ground investigation report
6	**Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line.**	No	The site is a over a mile from ponds or any spring lines.	Fig. 11 and 12 CGHH

3.2 Slope stability screening - Fig 2 [1]

	Question	Response	Justification	Reference
1	**Does the existing site include slopes, natural or manmade, greater than 7°? (approximately 1 in 8)**	No	The slope of land around the site is less than 7°.	Site survey Fig. 16 CGHH [7]
2	**Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°?**	No	The slopes at the property boundary will be unaffected by the development.	Appendix 1
3	**Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?**	No	Evidence from site location plan	
4	**Is the site within a wider hillside setting in which the general slope is greater than 7°?**	No	Evidence from site plan and site walk over	
5	**Is the London Clay the shallowest strata at the site?**	Yes	Evidence from BGS geology map	Fig. 2 CGHH
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?**	No	Evidence from site walk over	
7	**Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?**	No	There is no evidence to suggest any history of shrink-swell subsidence from inspection of the property and neighbouring properties	
8	**Is the site within 100m of a watercourse or a potential spring line?**	No	Evidence from maps and site walk over	Fig. 8, 11 and 12 CGHH [5] [6]
9	**Is the site within an area of previously worked ground?**	No	Evidence from maps and site walk over	[8]
10	**Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?**	No	The site is situated on unproductive strata with negligible permeability that has a negligible significance for water supply or river base flow	Fig. 8 CGHH
11	**Is the site within 50m of the Hampstead Heath ponds?**	No	Evidence from map	Fig. 2 CGHH
12	**Is the site within 5m of a highway or pedestrian right of way?**	No	The front of the building is set back from the highway	

13	**Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?**	Yes	The foundation of the new basement will be approx. 2.5 to 3 metres below the foundations of the garden wall and neighbouring properties	
14	**Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?**	No	Evidence from location map	

3.3 Surface flow and flooding screening - Fig 3 [1]

	Question	Response	Justification	Reference
1	**Is the site within the catchment of the pond chains on Hampstead Heath?**	No	Evidence from location map	Fig. 14 CGHH
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	Site drainage will be channelled along the existing routes.	Proposed LGF plan
3	**Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?**	No	The basement will covered with garden soil	Proposed LGF plan
4	**Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?**	No	Evidence from plan of existing and proposed	Proposed LGF plan
5	**Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?**	No	Existing surface water drainage arrangements will be maintained	Proposed LGF plan
6	**Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?**	No	Evidence from location map	Fig. 14 CGHH

4. SCOPING

4.1 Introduction

This section of the report covers the scoping process of the BIA, which is used to identify potential impacts of the proposed scheme on the groundwater, slope stability and surface water flow identified as risks in the screening stage. The scoping stage also informs the scope of any necessary site investigations and is used to establish a Conceptual Site Model (CSM).

4.2 Groundwater

The screening questions identified ground water as a risk and the Borehole logs found some evidence of ground water; however the design is shallow and so is unlikely to impact on the ground water below the overlying London Clay formation. The ground investigation report (Appendix 2) paragraph 3.3 confirms that there is no ground water present on site and that the water present in the borehole after six weeks was perched water within the made ground in the top 1.8 metres.

The ground investigation report recommends that the design and working method should allow for perched water percolating into excavations and to be present after construction.

4.3 Slope Stability

The shallowest strata at the site is London Clay which is known to be a consolidated clay formation and is therefore subject to some changes in volume when excavating. The potential impact of excavating is the possibility of volume changes causing movement and cracking of existing structures. However, the site is not into the over-consolidated London Clay, merely the 'weathered' brown London Clay which has no significant potential for volume change that might affect the adjoining structures or this new structure. The ground investigation analysis of the clay soil found plasticity index values of 37% and 39% which indicates the soil to be of a low to medium susceptibility to shrinkage and swelling.

4.4 Surface Water Flow and Flooding

It was found in the screening stage that there is no risk of flooding or history of flooding in Gloucester Crescent. The quantity or quality of surface water flows will be unaffected by this scheme and so existing arrangements for surface water drainage will be maintained to drain the site.

4.5 Consultation with local residents

A letter has sent to all immediate neighbours informing them of the plans and explaining the ways in which the design has sought to mitigate negative impacts and that they will be consulted on the construction management plan prior to construction commencing. This is in addition to the agreements required as part of Party Wall Agreements with adjacent neighbours.

4.6 Conceptual Site model

A conceptual site model before and after the proposed development has been formed based on a thorough investigation of the site and the surrounding area, in accordance with the recommendations of the Camden geological, hydrogeological, and hydrological study it is summarised in sections 4.6.1 and 4.6.2 below.

The site is located in the London Borough of Camden on Gloucester Crescent. Below the main ground is the London Clay Formation assumed to be at least approximately 25m thick, designated by the Environment Agency as unproductive strata in terms of ground water flow. The water table lies at least 25m below the current level of the site.

Hard surfacing is the predominant surface covering in the local area including parts of the gardens to the east of the property. The majority of rainfall falling on the surrounding area will run-off into local guttering and drainage system surrounding the site, with a proportion evaporating, a small proportion retained in the soil and root layer, and a very small proportion being absorbed by the London Clay.

The property and the neighbouring properties are constructed on shallow stepped or corbelled foundations.

4.6.1 Existing

1. Made Ground to 1.8 metre depth

2. The London Clay Formation below Made Ground to at least 25 m depth.

3. Weathered London Clay to 8 m depth of low to medium shrinkage and swelling.

4. Rainwater is channelled as surface run-off into the main drainage system, with a small proportion being evaporated.

5. Vertical load from party wall between properties restrained by existing foundations

4.6.2 Proposed

1. Excavation of approx. 4m of London Clay below existing garden.

2. Rainwater from extension roof is channelled as surface run-off into the main drainage system, with a small proportion being evaporated.

3. Basement constructed with pre-stressed concrete planks and beams to form a rectangular box to act as a retaining structure for the adjacent garden and garden walls.

4. External drainage zone using geotextile, pea-shingle and ridged solid insulation will drain surface water to a pumped sump and so effectively eliminate ground water pressure on the new structure.

5. Underpinning of corner of adjacent structures together with precast planks to reduce risk substantially of cracking caused by shrinkage of concrete during curing process.

5. Impact Assessment

5.1 Geotechnical Information

The Site Investigation Report at Appendix 2 confirms the site conditions, hydrogeology and geotechnical information for this location.

5.2 Subterranean (Groundwater) Flow

The site is located above London Clay which presents an almost complete barrier to groundwater. The development will have a negligible impact on the groundwater flow as the site is identified as being unproductive strata.

5.3 Slope (Land Stability) Assessment

Adjacent Structures

The design has modelled the impact of the underpinning and retaining wall design upon the adjacent listed buildings. The method statement at Appendix 3 has been developed to reduce risks to neighbouring structures caused by ground movement.

The design has removed the risks of settlement caused by concrete shrinkage during the three stages of the curing process. The only risk that remains is the consolidation settlement caused by the increased loading of the clay at the new foundation depth, but this will be offset by the reduction in weight on the ground arising from the excavation.

The method of construction will reduce this risk by the jacking in of the earth pressures, effectively pre-stressing the existing wall and new foundation structure. This will be equal to the movement that is predicted from consolidation settlement and so reduces the risk of cracking to 1 on the Burland Scale.

The basement within the garden is designed as a retaining structure. The design using reinforced concrete elements for the wall, floor and ceiling mean that the soil on which the adjacent garden walls are founded will be fully restrained and so there will be a low risk of lateral and vertical movement and damage to the structure. The addition of pea shingle as an external drainage medium ensures that any voids created during excavation are filled and the use of a geotextile membrane will ensure that there is no long-term erosion of fine material from the retained ground which might lead to long-term settlement.

Damage Category Assessment

The risk of cracking of the adjoining party wall has been assessed and if the design and construction method is followed cracking will be no more than Category 1 on the Burland Scale.

The risk of cracking of the adjoining garden walls has been assessed to be no more than Category 1 on the Burland Scale.

5.4 Surface Flow and Flooding

Gloucester Crescent is outside the EA flood risk zone. The basement will be protected from water ingress by internal tanking and a drained cavity which are to be specified by the architect. All the surface run-off from the garden can be transmitted to the existing drainage by gravity.

5.5 Sustainable Resource & impact on local environment

The design utilising hollow core concrete planks when compared to the alternative using mass concrete underpinning will reduce the amount of concrete used by 60 to 70 % as a result of the reduced thickness of the new walls of the basement and the fact that the planks are hollow.

This also means that there will be fewer lorry movements importing the planks in a smaller number of loads compared to multiple small/part loads of concrete for the underpinning sequence.

6. References

1. Camden Planning Guidance, CPG4, Basements and Lightwells, Sept 2013.
2. Advance Laboratory Characterisation of London Clay, Apollonia Gasparre, July 2005
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6. BGS Onshore Geoindex – Water Wells, February 2013.
7. Ordinance Survey Map – London Borough of Camden 1:2500
8. BGS Onshore Geoindex – Artificial Ground 1:50000, February 2013
9. Burland, J.B., and Wroth, C.P. (1974). *Settlement of buildings and associated damage,* State of the art review. Conf on Settlement of Structures, Cambridge, Pentech Press, London, pp611-654
10. Boscardin, M.D., and Cording, E.G., (1989). *Building response to excavation induced settlement*. J Geotech Eng, ASCE, 115 (1); pp 1-21.
11. Burland, Standing J.R., and Jardine F.M. (eds) (2001), *Building response to tunnelling, case studies from construction of the Jubilee Line Extension London,* CIRIA Special Publication 200.

Appendix 1 - The Authors

Nick Maclean an engineer with over 40 years of experience has approved the basement impact assessment. He has above average experience of basements, commencing with being the Assistant Resident Engineer on the Barbican Arts Centre Site in 1973, (i.e. 43 years), specific duty there being investigating and overseeing remedial works to the many defects in retaining walls, walls to be prestressed as waling beams, and 1.5m thick jacked, cross-site, prop walls, which defects delayed the project for so long. This tiered basement was up to 28m below street level, below the piled foundations of the adjacent 140m high Tower Blocks and the adjacent Metropolitan & Circle line tunnels.

Additionally, he has in the last 28 years in Private Consultancy been involved in numerous basements in Camden and other Inner London Boroughs, with two under construction presently and three in the design phase. Additionally he is active acting as checking engineer for Party Wall Matters on two basements where his intervention to refine the design is resulting in less excavation and steel.

Roger Gulhane MICE – an engineer in private practice for two decades having previously been a chartered engineer in Ove Arup specialist structures division. His practice is based in Camden and has worked on several basement projects in North London in the last decade.