PROJECT QUAD LIMITED

PROJECT QUAD

HYDROGEOLOGICAL REPORT

REVISION 2

March 2015

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REVISION HISTORY

Revision	Date	Description
Rev. 0	February 2015	Issued for comments
Rev 1	March 2015	Minor changes
Rev 2	March 2015	Minor changes

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EXECUTIVE SUMMARY

It is proposed to refurbish 6-10 Cambridge Terrace and 1 and 2 Chester Gate and construct a basement under the front part of the existing building and further to the west. The basement will be constructed using a combination of underpinning techniques under the walls of the building and bored piles.

A study has been carried out to assess the potential impact of the construction on the local hydrogeology.

The stratigraphy of the site comprises about 30 m of London Clay overlying Lambeth Group, Thanet Sand and Chalk. The London Clay acts as a barrier to flow between the lower (chalk) aquifer and superficial groundwater. The level of the deep aquifer in the area has been estimated to be approximately 50-60m below the level of the site. The groundwater flow is believed to be mostly vertical through the London Clay towards the deeper aquifer.

Perched groundwater could exist at shallower depths immediately above the clay level. The existing foundations and basement already obstruct any potential superficial water flow across the site.

The proposed basement, extending further into the clay, is not likely to alter the existing situation.

No known ponds, springlines or wells are in close vicinity to the site and the site is outside the Hampstead pond chain catchment area.

The proposed basement will be created under the front part of the existing buildings and at the front, and the area above the basement roof will be landscaped. As such the proposal will not alter significantly the existing proportion of hard surfaces/paved areas.

Superficial water flow can be controlled by simple drainage measures.

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1 INTRODUCTION

The existing building is the end of a large regency period terrace to the east of Regent's Park in London. It includes the properties 6-10 Cambridge Terrace and 1-2 Chester Gate. The buildings have a lower ground floor and there are brick vaults along Cambridge Terrace and along Chester Gate outside the wall line above ground.

The buildings were constructed in 1826. It is understood that 7-10 Cambridge Terrace has suffered bomb damage during the Second Word War and fire damage in 1947, following which the structure was demolished. It was reconstructed in 1986 to replicate the original building façade. The new structure was founded on piles and the basement vaults were incorporated within a new basement at the same level. The works also extended to No. 6, whose party walls were supported on piles, and to 1-2 Chester Gate, although the extent of the works on this property is unknown.

It is proposed to reduce the ground level underneath 6-10 Cambridge Terrace to provide an additional basement area and to extend this basement forward and to the west under Cambridge Terrace.

Geotechnical Consulting Group LLP (GCG) has received an instruction from 1 Chester Gate Limited, 2 Chester Gate Limited and Project Quad limited (Project Quad) to undertake a review of the local hydrogeological conditions and how these might be affected by the proposed development.

This report reviews the available information about the site and the current scheme and aims to produce a hydrogeological impact assessment for the proposed basement construction on this site in accordance with the requirements of the London Borough of Camden set out within their Development Policy DP27 and Camden Planning Guidance CPG4 - Basements and Lightwells. It addresses the issues of the subterranean (ground water) flow, the slope stability and the surface flow and flooding screening charts.

GCG have been provided with the scheme drawings prepared by Moxley Architects and sketches showing the proposed method of construction of the basement prepared by the engineers for the project, Michael Barclay Partnership.

2 THE SITE AND THE PROPOSED WORKS

The site is located to the east of Regents Park (Fig 1 and Fig 2). It forms an 'L' shape at the northern end of the terrace and includes the buildings known as 1 and 2 Chester Gate and No. 6 to 10 Cambridge Terrace.

The site fronts onto Cambridge Terrace to the west, which is a private road, and Chester Gate to the north. There is a garden area between Cambridge Terrace and the Outer Circle in which were included a number of trees. The trees have now been removed to be re-planted after completion of the works.

Fig 3 shows a plan of the existing lower ground floor including the vaults. The foundations for these vaults are around 3m below existing ground level.

Fig 4 shows the plan of the proposed new basement, with a mark-up of the proposed formation levels and Figure 5 shows a typical section through the new basement. The footprint of the basement extends under No. 9 and 10 Cambridge Terrace, the western wing of No. 7 and 8 and under the existing vaults along Cambridge Terrace up approximately to the rear pavement line of the Outer Circle. The basement will extend to about 6m below the existing lower ground floor level, and will be deepened up to 9m below the existing level under the northern and middle part of the proposed basement area.

It is anticipated that the sub-surface construction will be completed through a combination of underpinning of the existing structures and the installation of bored piles. In the final condition the basement will be a reinforced concrete box with a roof just below the level of the current lower ground floor. Soil will be placed back over the lid of the box outside the vault area.

3 TOPOGRAPHY AND GEOLOGY

The site lies at about +30mOD on ground surface generally sloping to the east at a gradient of around 1:100. The ground level along Cambridge Terrace and Chester Gate is measured to be approximately +30.5mOD and it is about + 29mOD in Cambridge Mews, to the rear of the site.

More generally, the ground rises to the west up to +35mOD in Regents Park and it falls southwards to approximately +25mOD at about 500m to the south of the site. Further to the south the area is approximately flat.

Regionally, the ground surface falls towards the River Thames, which runs generally from west to east, and is approximately 3km from the site to the south east at its closest approach.

The geology of the area has been identified from British Geological Survey (BGS) maps, record boreholes and from site specific investigations.

The BGS maps 1:10560 scale sheet TQ28NE and sheet V NW and 1:50000 map sheet 256: North London show that the site is underlain by the London Clay Formation. Terrace gravels are shown to be present immediately to the south of the site. Boreholes in the BGS maps and the contour plot of the base of the London Clay in the 1:50000 map indicate that in the area of the site the London Clay is present to depths of approximately 30m below ground level (bgl) (Fig. 6). This is confirmed by additional record borehole logs found in the BGS database. The soils of the Lambeth Group underlie the London Clay and this stratum is probably about 16m thick at the location of the site. About 8m of Thanet Sand underlie the Lambeth Group and Chalk is encountered thereafter.

Site specific ground investigations have been completed by Wimpey Laboratories (1982), LBH Wembley (2009) and Soil Technics (2015). They include a total number of eight cable percussive boreholes up to 20m depth, five window sample holes to 12m depth and two dynamic probes to 20m depth completed on the site. The approximate location of all investigation holes is shown in Figure 7. A number of trial pits inside the building have also been carried out.

The 1982 investigation included the sinking of six cable percussion boreholes up to 20m depth. Two of them were located under the front area of the existing buildings, where they were sunk from the basement level (+28.6mOD), and four were located further to the east of the site. Two of these latter boreholes were sunk from the ground level (+29.9mOD) in the private road adjacent to No. 3 and 4 Chester Gate. The location of the other two is not known with certainty (Figure 7).

The 2009 investigation included the sinking of three window sample holes to depths of 5.2m, 7.2m and 8.2m in the garden area between Cambridge Terrace and the Outer Circle. They were sunk from levels of about +31mOD.

The 2015 investigation included the sinking of one cable percussive borehole to 20m bgl in Cambridge Terrace (outside No. 7); one cable percussive borehole to 12m inside No. 10 (from basement level), and a driven hole to 9m depth in Cambridge Terrace, to the north of the flower beds. Two dynamic probes to 20m bgl were also sunk in Cambridge Terrace.

All investigation holes sunk in the area of the proposed basement consistently show the presence of Made Ground over London Clay. The London Clay was found at depths between 0.3m and 0.8m under the existing buildings (i.e. from +28.2mOD to +27.8mOD) and from depths of 1.5m to 1.7m outside the buildings. It is described as 'firm' brown and fissured to about 3m depth becoming 'stiff' and 'hard' at greater depths. The log description and the results of the field tests suggest that the upper part of the clay, up to about 5m bgl, is weathered.

The logs of two of the 1982 boreholes sunk further to the east of the site show the presence of sand bands up to 1m thick between depths of 7m and 11m. The exact location of these boreholes in unknown, but they do not appear to be in the area of the proposed basement.

It may be noted that the site falls in a wider area where numerous geological features, such as scour hollows and faults, are known to be present. A scour hollow is known to exist approximately 500m to the west of the site, south from the pond in Regent's Park and a fault is believed to run across Regents Park to the north of the site and in the area around Euston Street and Tottenham Court Road. Evidence of a fault has also been found in Bolsover Street, about 500m to the south east of the site.

Our assessment of record boreholes in the close vicinity of the site and the site-specific boreholes sunk at the site, however, has shown no evidence of significant variability in the shallower strata in the area of the proposed basement that could have significant impacts on the construction.

4 HYDROGEOLOGICAL CONDITIONS AND GEOHAZARDS

Fig 8, taken from 'The lost rivers of London' Barton (1992) shows a section of the map indicating the nearest watercourses to the site. The main one, the Tyburn, passes through the lake in Regents Park but there is a minor tributary of the Fleet, which rises to the south of Euston Road and flows eastwards. They are both now culverted.

4.1 Aquifers

Within the London area, there are two recognised aquifers. The major aquifer is a deep aquifer below the London Clay and lies within the Chalk and the Thanet Sand formation immediately above the Chalk, while the shallow aquifer lies predominantly within the River Terrace Deposits above the London Clay, is variable in both level and thickness, and is discontinuous. It has also been heavily modified by human activity throughout the history of London.

There are no River Terrace Deposits present at the site, and therefore the shallow aquifer does not extend across the site.

The site is underlain by London Clay, which is designated as 'unproductive strata' by the Environment Agency (Figure 9) as it is generally very impermeable. In the site specific investigations the London Clay near the ground surface is described as firm to stiff medium to high plasticity silty clay. It appears to have undergone chemical changes as a result of a weathering process which causes a change of colour from grey at depth to brown. It has also been found to contain numerous fissures especially near to the surface, which results in it falling into small scale lumps when dug. This fissuring can result in an increase in mass permeability near to the ground surface.

The clay is well known for the fact that it changes volume as a result of change in moisture content. Where trees are present the roots extract moisture during the growing season. If sufficient moisture is extracted the clay shrinks resulting in the opening of the fissures. As trees get larger the depth to which such shrinkage occurs can increase as the tree progressively extracts moisture. Although there is some recovery of this moisture during the rest of the year, this can lead to a progressive advance of a region of shrinkage. The rate that this occurs depends amongst other things on the type and size of the tree and its local environment (in terms of exposure of the ground surface to rainfall and surface cover which prevents evaporation from the ground surface).

However the general picture is likely to be one where water flows more easily in the upper part of the ground, especially in the summer months.

Given the nature of the ground and the surroundings it is probable that there is no significant lateral groundwater flow. Any rainfall is either directed down the storm water system from the hard surfaces, or, where it falls on an exposed soil surface, percolates downwards through the upper fissured clay topping up the general ground water which percolates downwards at a very slow rate.

On a macro-scale the London clay sits above more permeable soils with the main aquifer being the Chalk at a depth of around 50m to 60m below ground level in this region. The principal supply to this aquifer is at the margins of the London Basin but over pumping in historical times resulted in it depletion. Since the cessation of extraction there has been steady rise in the water level, but the depressed levels result in a very slow downward drainage of water through the upper clay soils.

All boreholes sunk in the rea of the site have been found dry during drilling, which is likely to be due to the impermeable nature of the investigated ground. Water strikes were recorded though in the 1982 boreholes sunk to the east of the site at the levels of the sand bands (7m to 11m bgls).

Standpipes were installed in all 2015 boreholes to about 10m depth and water levels have been monitored since the completion of the works in December 2014. Water levels were also measured and recorded in all trial pits after these had been left open for 24h. The trial pit observations indicate that the water level is immediately below the existing lower ground floor slabs, at level of about +28.5mOD. The standpipe readings indicate that the water level is slowly rising since the installation of the standpipes and the latest readings, taken at the end of January 2015, indicate that the water level is at about 2.2m bgl in Cambridge Terrace (i.e. about +28mOD). At the location of BH3, inside No 10 Cambridge Terrace, the basement has been found flooded, with the water standing about 1cm above the existing slab (i.e. about +28.6mOD). This is likely to be the groundwater level across the site.

Within the London Clay the water pressure distribution with depth is likely to be sub-hydrostatic.

The ground under the garden area to the west of the buildings is likely to have been subject to desiccation as a result of tree growth. Most of the soil currently affected by the existing trees will be removed during construction and replaced with a backfill suitable for future planting.

It should be noted that at various locations around the site issues with water ingress at relatively shallow depths have been reported either during borehole drilling or during basement constructions. These could be associated with the geological features and the suspected faults in the area surrounding the site. Although there is no evidence of faulting across the site, the risk of potential water ingress that could obstruct the works should be accounted for during construction.

Also, the observation of groundwater during the site investigation and the presence of gravel deposits nearby suggest that perched water exists across the site which could be in continuity with the shallower aquifer in the gravel to the south of the site. The presence of shallow groundwater should also be taken into account during construction and, if necessary, measures should be taken to ensure that the works can be carried out in the dry.

4.2 Surface flooding

The site is not identified in an area at risk of flooding (Flood Scrutiny Panel, 2003) and data from the Environment Agency (2011) confirm that there is no identified risk of groundwater flooding of the site (Figure 11).

There are no known watercourses or spring line at close distance and the site is more than 100m away from the Hampstead Chain Catchment.

It is often the case that the principal sources of local water in the ground arise from leaks in either water supply services or waste and storm water system. This is completely unpredictable, but may be an issue affecting temporary works.

5 THE LIKELY EFFECTS OF THE PROPOSED DEVELOPMENT ON GROUNDWATER CONDITION

The prevailing conditions are such that there is unlikely to be any flow of water across site. Even if there were, the ground conditions are such that flow would only occur very near the surface and therefore either already be blocked by the existing lower ground or flow through ground above the new area of basement to the west. Therefore the new basement, in our view, presents no significant change to the existing hydrological condition and therefore no hazard with respect to flood risk.

Consideration will have to be given to the impact of the new basement under the garden area with regard to the availability of moisture for trees which will be planted in future. This is an issue to be addressed by others.

6 CONCLUSIONS

The site is underlain by London Clay, which is an ‘unproductive stratum’. Due to the nature of the soil, perched groundwater could exist at shallower depths immediately above the clay level, but the existing foundations and basement already obstruct any potential superficial water across the site.

The proposed basement, extending further into the clay, is not likely to alter the existing situation.

No known ponds, springlines and wells are in close vicinity to the site and the site is outside the Hampstead pond chain chatchment area.

The proposed basement will be created under part of the existing buildings and at the front and the area above the basement roof will be landscaped. As such the proposal will not alter the existing proportion of hard surfaces/paved areas.

In summary, the proposed basement construction is not believed to cause adverse changes to the local hydrogeology.

7 REFERENCES

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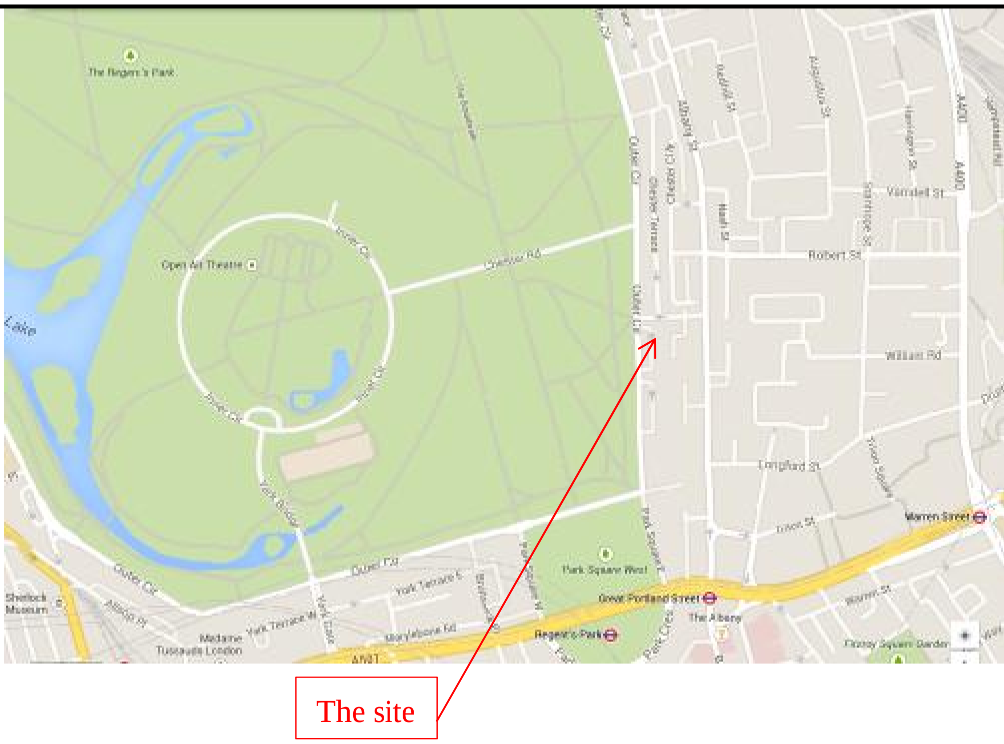
Wimpey Laboratories (1982). Lab Ref No. S/1922

FIGURES



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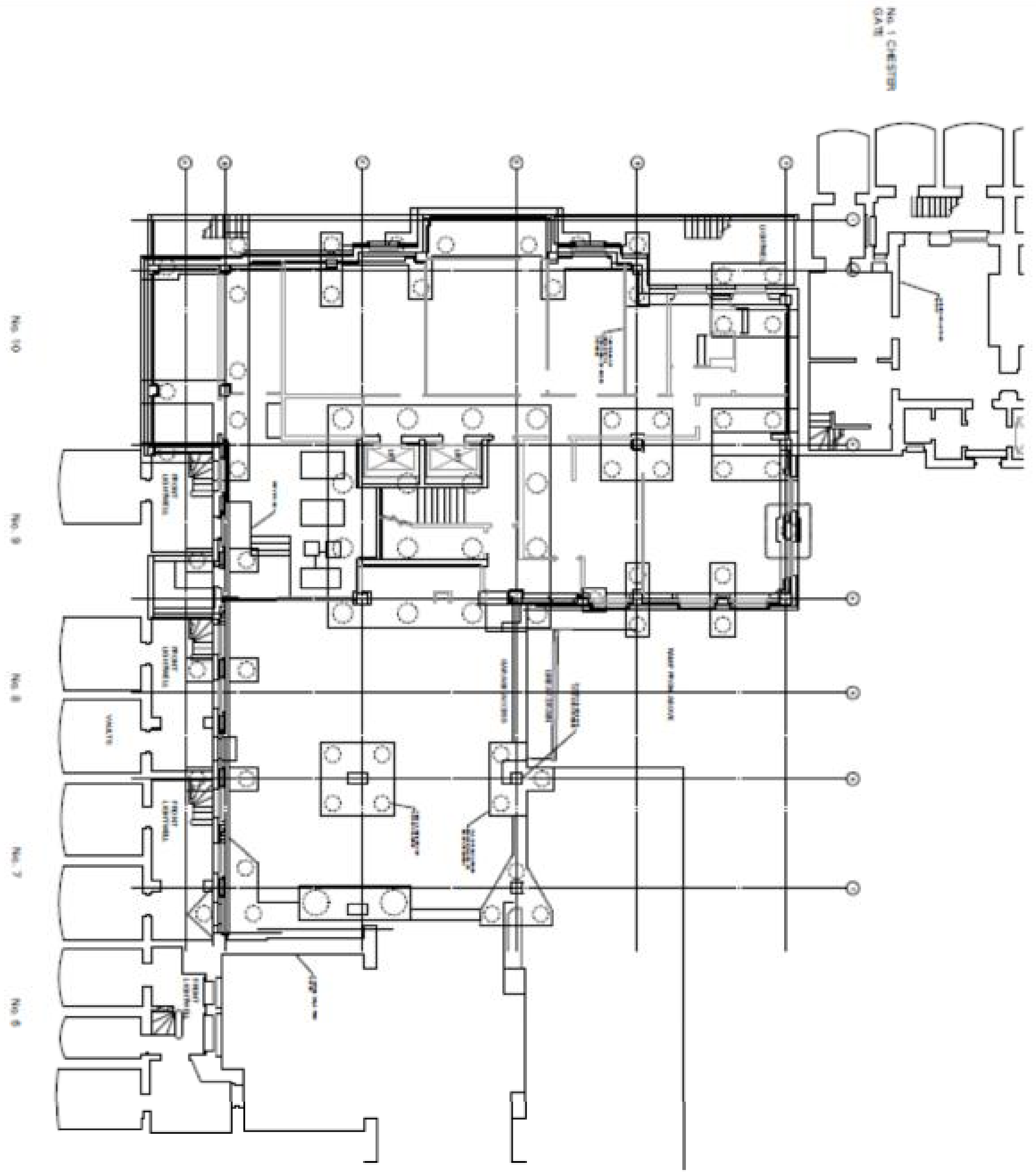
Site location

Figure

1

	Project Quad Limited Project Quad	**Figure**
	The existing structure	**2**



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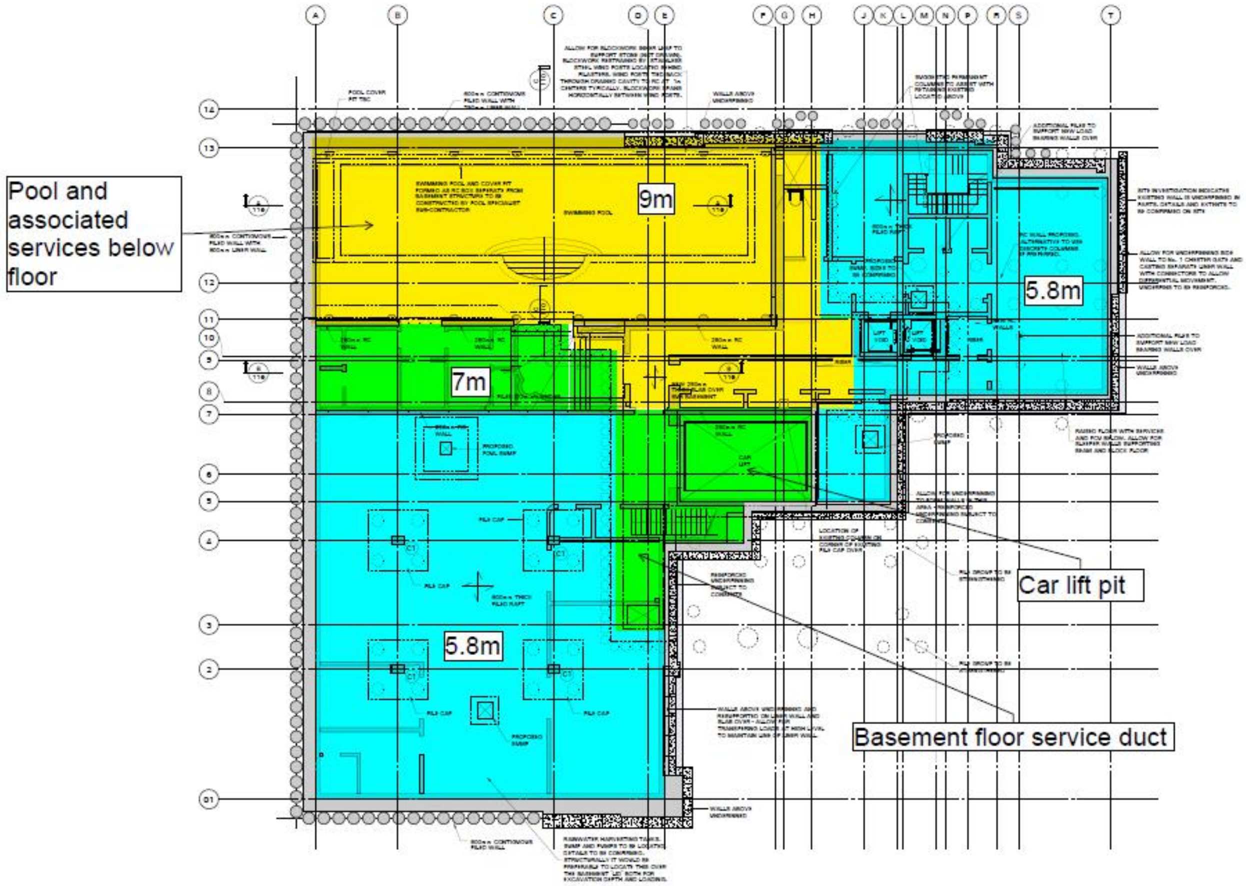
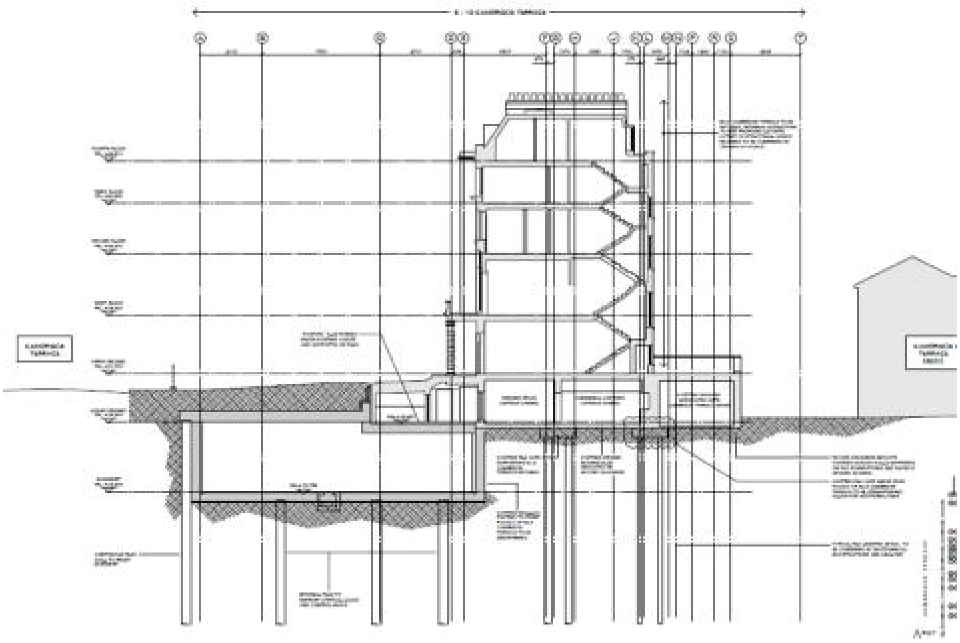
Plan of the existing lower ground floor

Figure 3



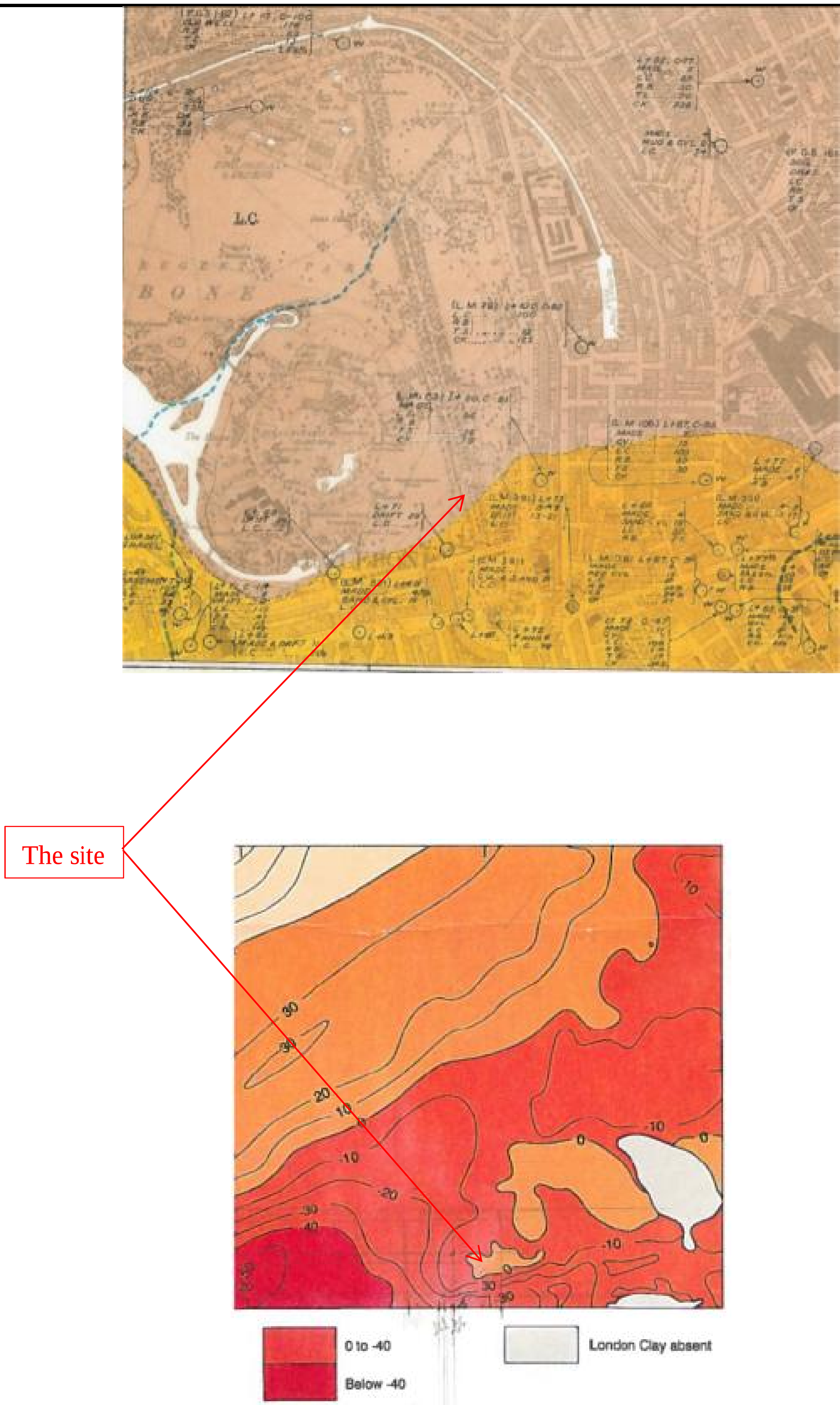
	Project Quad Limited Project Quad	**Figure**
	Proposed basement structure	**4**

(a)

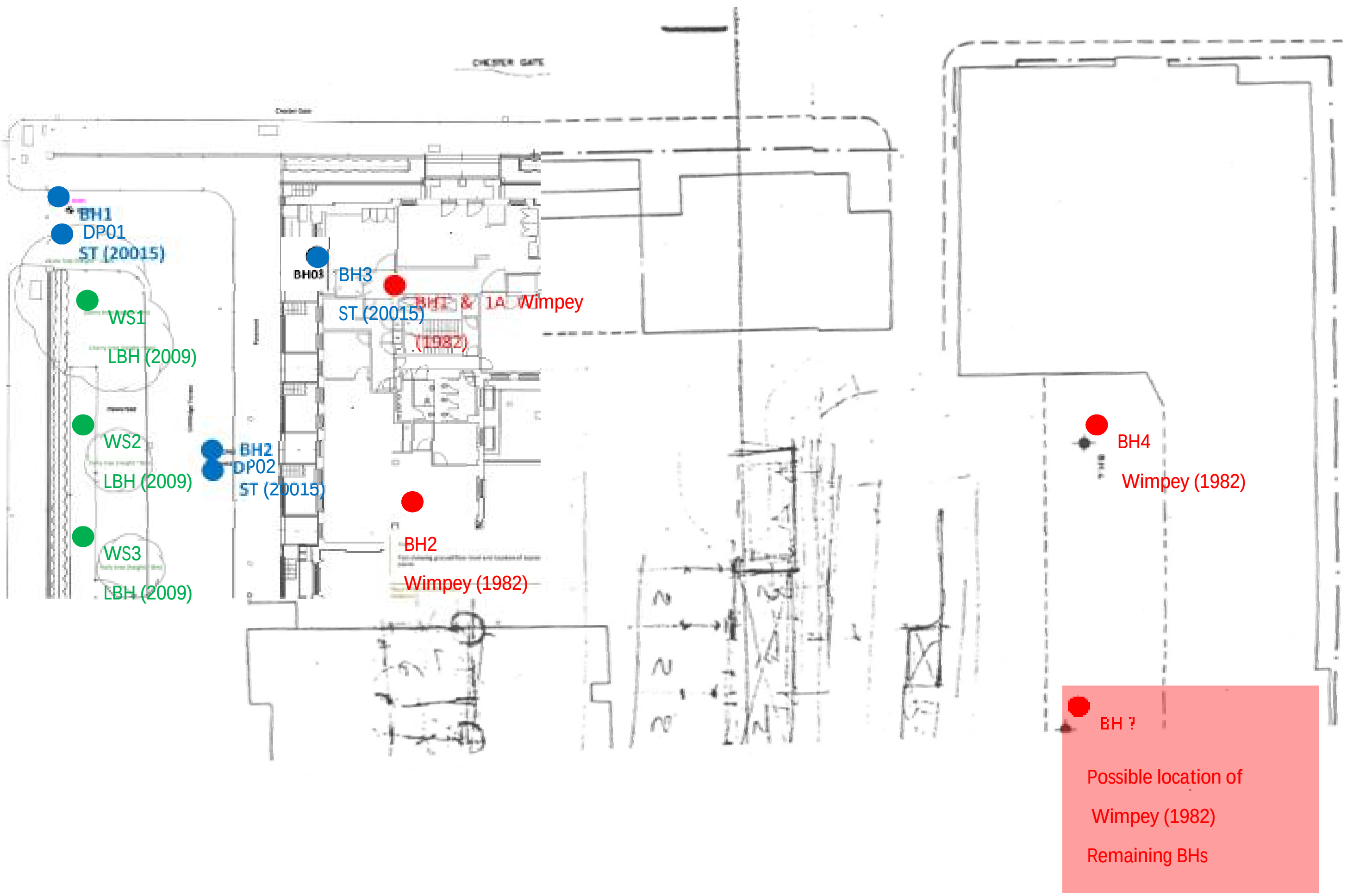


(b)

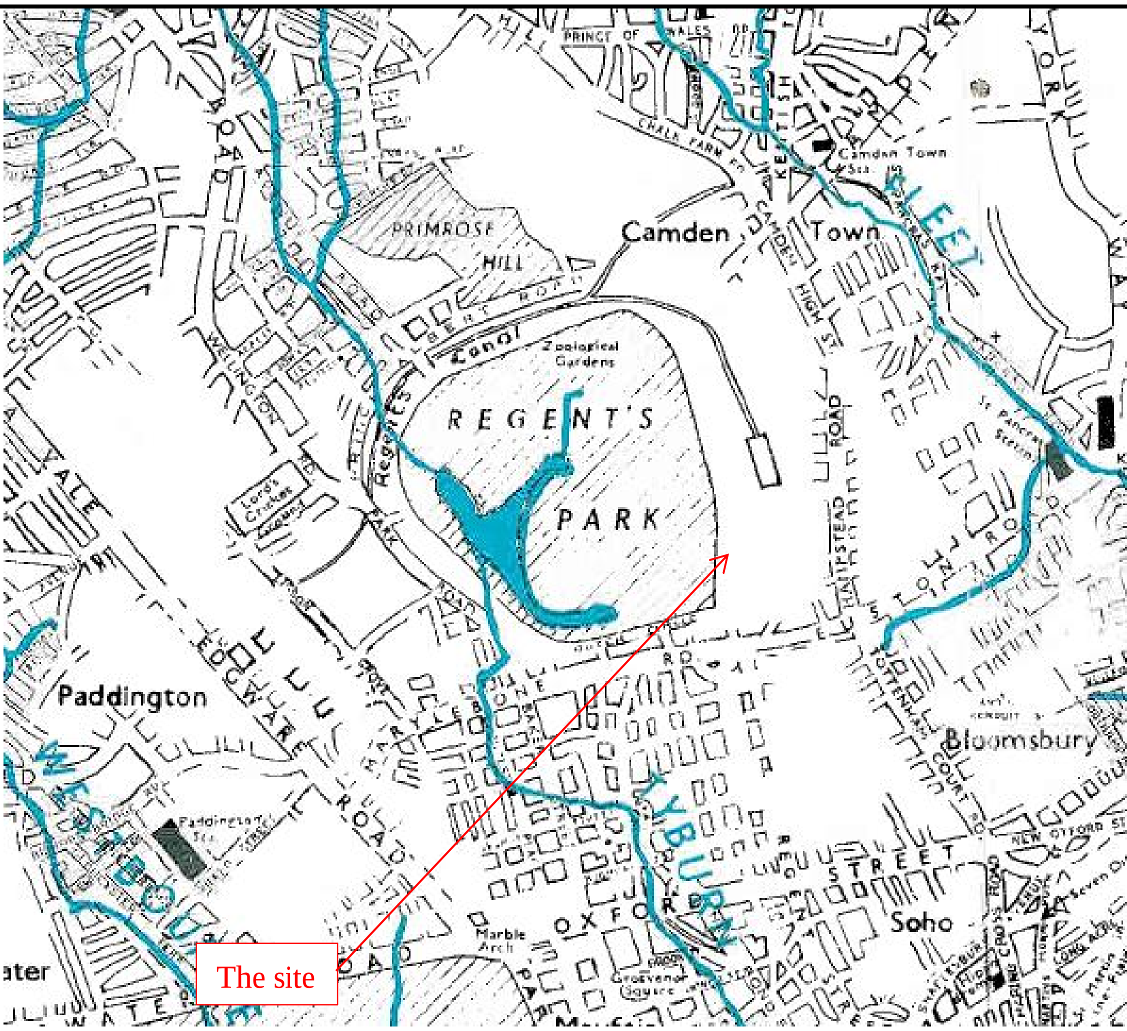
GCG	**Project Quad Limited** Project Quad	**Figure**
	Sections of proposed basement (a) north-south (b) east-west	**5**



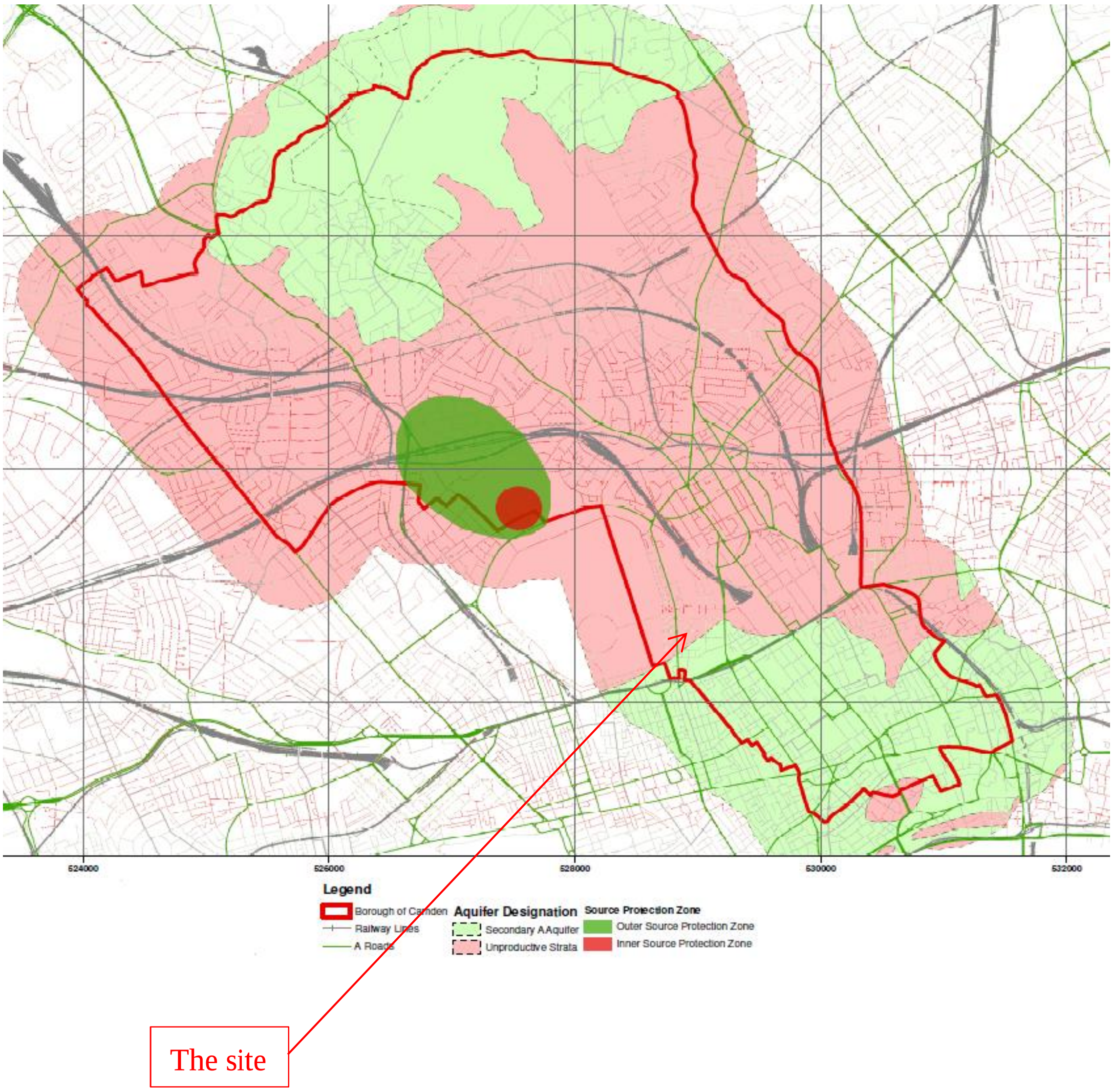
GCG	**Project Quad Limited** Project Quad	**Figure**
	BGS geological map (a) 1:10560 map (b) contour plot of the base of the London Clay in mOD	**6**



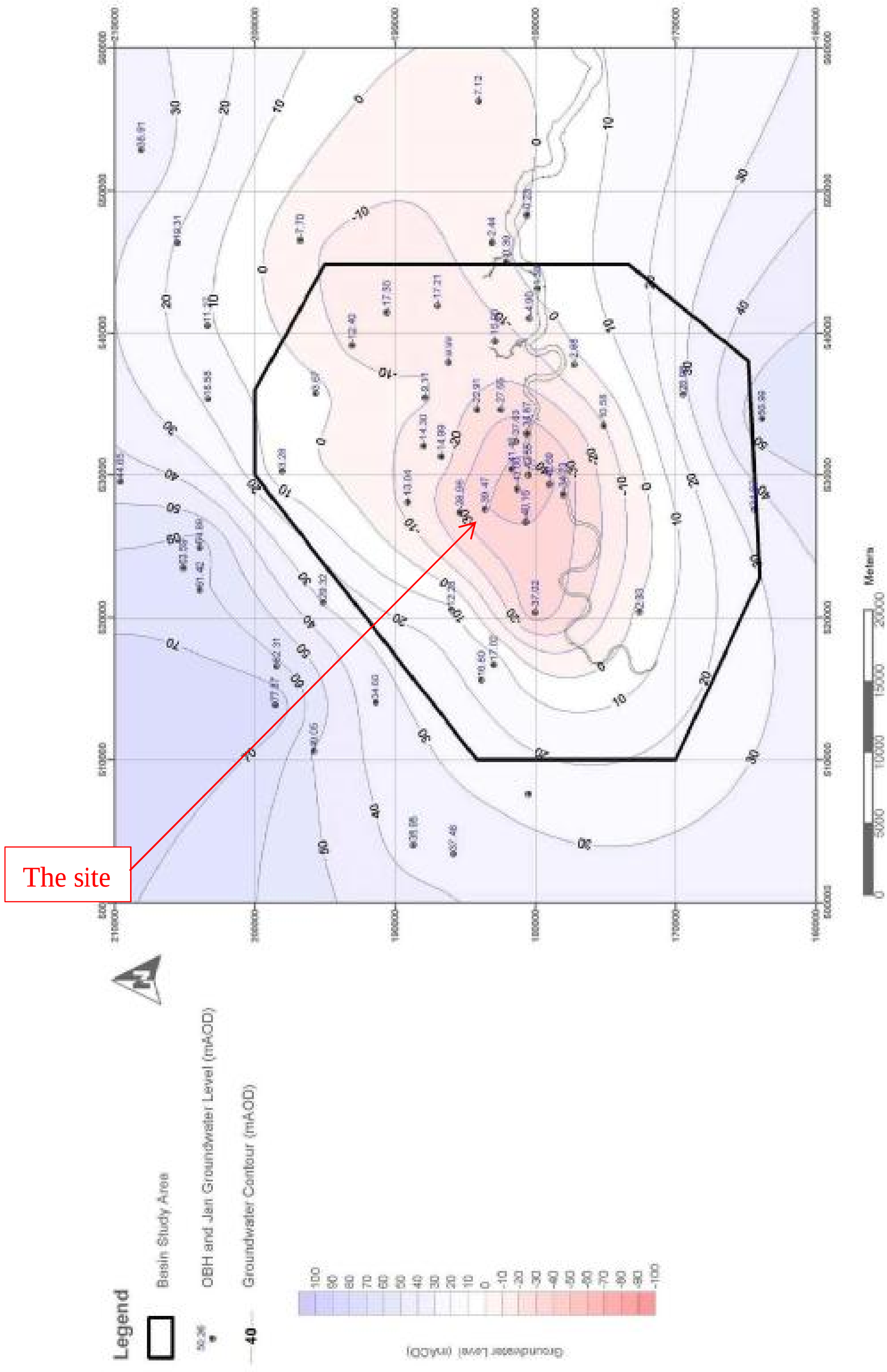
GCG	**Project Quad Limited** Project Quad	**Figure** **7**
	Location of the site specific holes	



	Project Quad Limited Project Quad	**Figure** **8**
	Lost rivers of London Extract from Barton N. (1992)	



	Project Quad Limited Project Quad	**Figure**
	Camden aquifer designation map	**9**



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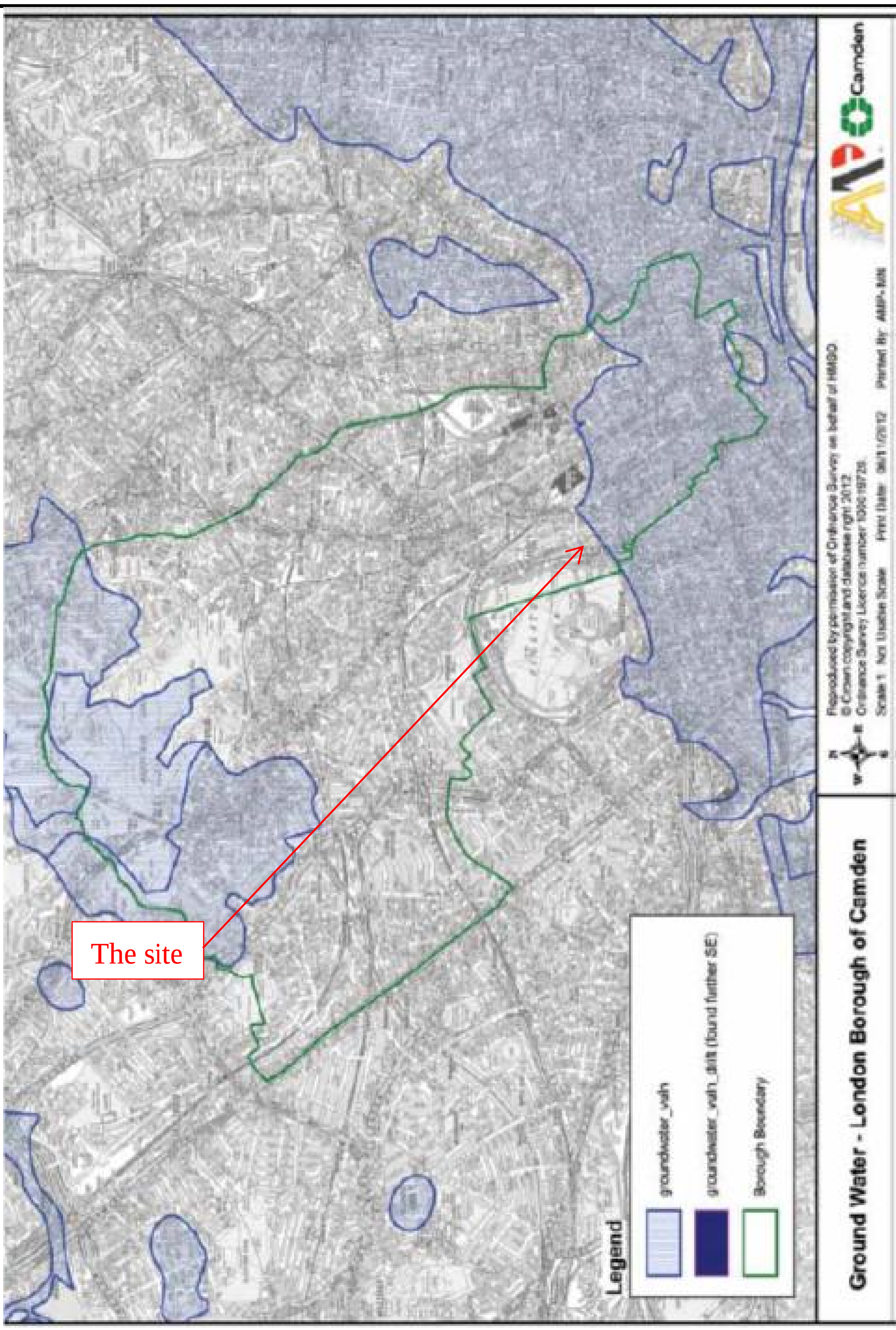
Groundwater level in the deep aquifer in 2010 (Environment Agency)

Figure 10



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Surface water sensitivity map (Environment Agency)

Figure 11