PRICE AND MYERS

20 BROWNLOW MEWS, WC1N 2LE

HYDROGEOLOGICAL ASSESSMENT

OCTOBER 2014

REVISION 0

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1 Introduction

It is proposed to construct a basement beneath 20 Brownlow Mews, London, WC1N 2LE. The site location is shown in Figure 1. Price and Myers are the structural engineers for the development. Geotechnical Consulting Group LLP (GCG) has been instructed to prepare a report on the ground conditions and, in particular on the impact of the proposed development on the local groundwater regime.

This report presents the findings of the hydrogeological assessment.

GCG have been supplied with information on the proposed development by Price and Myers. Selected drawings and information provided by Price and Myers are presented in Appendix A. Selected information relating to ground conditions from Geotechnical and Environmental Associates (GEA)and the British Geological Survey (BGS) is presented in Appendix B.

2 The site and proposed development

The site is located on the Brownlow Mews Road at National Grid Reference 530803, 182255. The arrangement of the site and adjacent buildings is shown in Figure 2.

The property is approximately 8m wide and, because the southern boundary is at an angle to the frontage, 11m to 12m long.

20 Brownlow Mews is a three above ground storey, masonry building with a single basement (3m deep) beneath the northern section of the building (as shown in Figure 3). The frontage on the western boundary of the property faces onto the cobbled Brownlow Mews carriageway. On the opposite side of Brownlow Mews Road is the two above ground storey masonry building, 20A Brownlow Mews. The northern boundary wall of 20 Brownlow Mews faces onto the back yards of both No.1 Guildford Street and No.137 of Gray's Inn Road. It shares party walls on its southern and eastern boundaries with No.133 and No.135 Gray's Inn Road respectively.

No.133 and No.135 Gray's Inn Road are also traditional masonry constructed buildings with single storey basements. It is not known whether the basements were constructed during or after the construction of the original buildings. No.133 is the Blue Lion Pub, thought to have been built in 1935. The single basement may have served as a cellar. No.135 is a four above ground storey building with a similar width and length as 20 Brownlow Mews. The rear part of No.133 is single above ground storey building which is approximately 20m long by 8m wide. The northern, southern and eastern boundary walls of the property are all therefore extending approximately 3m below ground level (bgl).

It is proposed to construct a double level basement beneath the northern and central sections of 20 Brownlow mews as shown in Figure 4. A single basement will be constructed in the southern section of the property thereby extending the existing basement under the full building footprint. The double basement floor level will be around 6m bgl and the single basement floor level will be around 3m bgl.

The new load bearing slabs will be around 0.3m thick, so that formation of the double and single basements will require an excavation of typically 6.3m bgl and 3.3m bgl respectively. Local excavations of up to 7m bgl will be required for two column footings in the centre of the basement supporting the superstructure.

Ground level in the vicinity of 20 Brownlow Mews is approximately 20m above ordinance datum (AOD). Gray's Inn Road and the Brownlow Mews carriageway both slope gently downward in a south easterly direction.

It is understood that the basement will be predominantly formed using the traditional 'hit and miss' underpinning technique. Mass concrete underpins will be installed beneath the existing perimeter walls in stages. The first stage of underpinning will only concern the western boundary wall, which will be underpinned to a level matching the three other boundary walls at approximately 3mbgl. Subsequent underpinning will then take the northern, western and eastern walls down to 6m bgl. The southern boundary wall will be brought down to approximately 4.8m bgl to ensure that its load is not transferred to the double basement slab (see Appendix A). The internal basement wall separating the double basement section and the southern single basement section will be constructed using underpins.

Permeation grouting will be employed to facilitate the construction of underpins beneath the water table. The grouting works will limit groundwater flow both into underpin pits and into the main excavation. The proposed construction methodology and selected drawings are included in Appendix A.

No major infrastructures tunnels (London Underground or Network Rail tunnels) are believed to exist close to the site. The Thames Water Asset Search (Appendix A) identified a combined sewer and freshwater supply running beneath the Brownlow Mews carriageway but precise details of their location and depth are unknown. No further information regarding the existence of other utilities has been provided.

N.Barton's "The Lost Rivers of London" identifies two lost rivers in the vicinity of 20 Brownlow Mews (Figure 5). The former course of the River Fleet flows in a southerly direction approximately 200m east of the site. A known tributary of the Fleet River also flows in a easterly direction approximately 140m south of the site. The Fleet River and the local shallow groundwater regime all discharge into the River Thames which is the dominant hydrogeological feature.

Figures 6 to 8 indicate that the risks of flooding at 20 Brownlow Mews due to reservoirs, surface water, rivers and seas respectively are all low.

3 Ground conditions

3.1 Geological Conditions

The 1936's BGS 1:10,560 sheet No.5 (North West) shown in Figures 9 indicates the site is underlain by alluvium. However the 1994 BGS Sheet No.256 shown in Figure 10, referenced by GEA in their 2014 Desk Study & Ground Investigation Report indicates the site is underlain by Hackney gravel. This revision by the BGS may have been based on recent boreholes in the area.

Nevertheless, both geological maps indicate that beneath the site's Quaternary deposits a typical London stratigraphy may be found, consisting of London Clay overlying the Lambeth Group overlying Thanet Sands overlying Chalk.

The BGS online borehole database "Geoindex" suggests some local variability in the ground conditions (Appendix B). Boreholes along the Gray's Inn Road suggests an increasingly thick alluvium deposit towards the cross roads at Guildford Street. A site investigation at No.129 Gray's Inn Road which is approximately 15 metres from 20 Brownlow Mews records the depth to the London Clay varying from 6m to 9m bgl. This variability may be explained by localised buried tributary channels flowing towards the Fleet River.

The site specific ground investigation by GEA comprised of three boreholes, two dynamic probes and four trial pits. It indicates the site is underlain by 3.5m of Made Ground, followed by 3m of Hackney Gravels before reaching the London Clay. The depth to London Clay in the boreholes varies from approximately 5.9 to 6.4m bgl. The Made Ground is described as being soft silt containing sands, gravels, organic clays and waste material. This Made Ground will have been partially derived from reworked alluvium. Beneath the Made Ground, the boreholes describe two distinct layers of soft to firm sandy clay with gravel and silty sandy gravel. The London clay is described as firm and is described as weathered brown for the first 0.5m.

4 Impact on groundwater

4.1 Shallow aquifer

The shallow aquifer within the Hackney Gravels is identified as a secondary aquifer by the Environment Agency. The groundwater will tend to flow in a south easterly direction, following the historical topography of the area towards the former Fleet River and its tributaries.

According to the BGS "Geoindex" (Appendix B) the nearest recorded well to 20 Brownlow is approximately 100m east of the site on Calthorpe Street.

The boreholes from the GEA ground investigation indicate that the water table of the shallow aquifer is approximately 5 metres bgl. Since the footings for the proposed basement underpins will sit approximately 6.5m bgl, the bottom of the basement will sit 1 to 1.5 metres within the shallow aquifer. The basement will thereby form a permanent barrier to flow. This will lead to a rise in groundwater pressures on the upstream side of the basement and to a decrease in water pressures on the downstream side of the basement.

Although the number of groundwater level measurements taken for the GEA investigation were few, they indicate that the groundwater flows south with a fall in hydraulic head of approximately 1:25 to 1:30. This fall in head is similar to the fall in the ground (slope) surface travelling southwards along Gray's Inn Road.

4.2 Deep aquifer

Historically, extraction of water from the deep aquifer of the Thanet Sand and Chalk beneath the London Basin has caused a significant drop in the aquifer groundwater level. Since the mid-1960s, extraction of water from the deep aquifer has declined greatly, and as a result, the water level has been recovering. The aquifer level is now monitored and the rise in its level is controlled by pumping (as described by the Environment Agency, 2014). Currently, the potential head in the deep aquifer beneath the site is approximately -36mOD and will therefore neither influence nor be influenced by the proposed development.

4.3 Shallow groundwater flow analysis

A seepage analysis has been carried out in order to verify the potential effects of the basement on the surrounding area. The analysis has been conducted using the Geo-Studios finite element program Seep/W. Steady state conditions have been assumed. An area in plan with the approximate dimensions 150m by 110m has been analysed. It has been assumed that an impermeable basement sits into the aquifer.

The influence of the Thames Water sewer, beneath the carriageway of Brownlow Mews, on the local groundwater regime has been ignored in the analysis.

The aquifer is assumed to be fully saturated with an isotropic coefficient of permeability of 10^{-3}m/s. This is a very high and therefore conservative estimate of permeability of the Hackney Gravels. The impact of the basement on the groundwater regime would be expected to be less if the ground has a low permeability.

The direction of groundwater flow has been simplified and assumed to run parallel with the width of the house. Only half of the flow regime has been analysed (utilising symmetry). The house is therefore causing its largest possible obstruction to flow. As mentioned in Section 4.1, in reality the flow is generally moving in a south easterly direction and is close to moving parallel with the longest side of the basement. The analysis is simply to obtain an indication of the possible obstruction to flow caused by the basement. A constant hydraulic gradient of 1:30 was applied for the longest dimension of the aquifer by applying constant head (Dirichlet) boundaries on either side.

Figure 11 shows the idealised hydraulic head regime before the construction of the basement. Figure 12 shows the effect of the construction of the basement on the hydraulic head regime. The effect of the basement is an increase in head on the immediate upstream side of the basement by about 0.2m. Similarly the hydraulic head on the immediate downstream side of the basement decreases by approximately 0.2m. The basements influence on the hydraulic head regime extends over an area approximately 30m upstream and 30m downstream of its location.

The calculated changes in hydraulic head are shown to be very small and are less than the typical seasonal variations in hydraulic head in this area of London. On this basis it can be said that the impact of the basement on the shallow aquifer is very minor.

5 Conclusion

It is proposed to construct a double basement at 20 Brownlow Mews. The depth of excavation required for the double basement will be approximately 6m below ground level of the existing building.

The site specific ground investigation suggests the bottom of the basement will be founded on or close to the surface of the London Clay and around 1 to 1.5m below the water table of the shallow aquifer. The basement will therefore form a permanent barrier to flow and thereby alter the local groundwater flow regime.

A simple analysis was carried out to assess the impact on the groundwater flow. It was calculated that the maximum change in head was approximately 0.2m. The basement's zone of influence in the hydraulic head regime of the shallow aquifer was approximately 30m upstream and downstream of the basement.

This review of the double basement scheme was carried out using the information provided by Price and Myers.

6 References

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Barton N. 1992. *The Lost Rivers of London*. Historical Publications Ltd

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Environment Agency (2014). Interactive flood and groundwater maps [Available online @ http://maps.environment-agency.gov.uk/].

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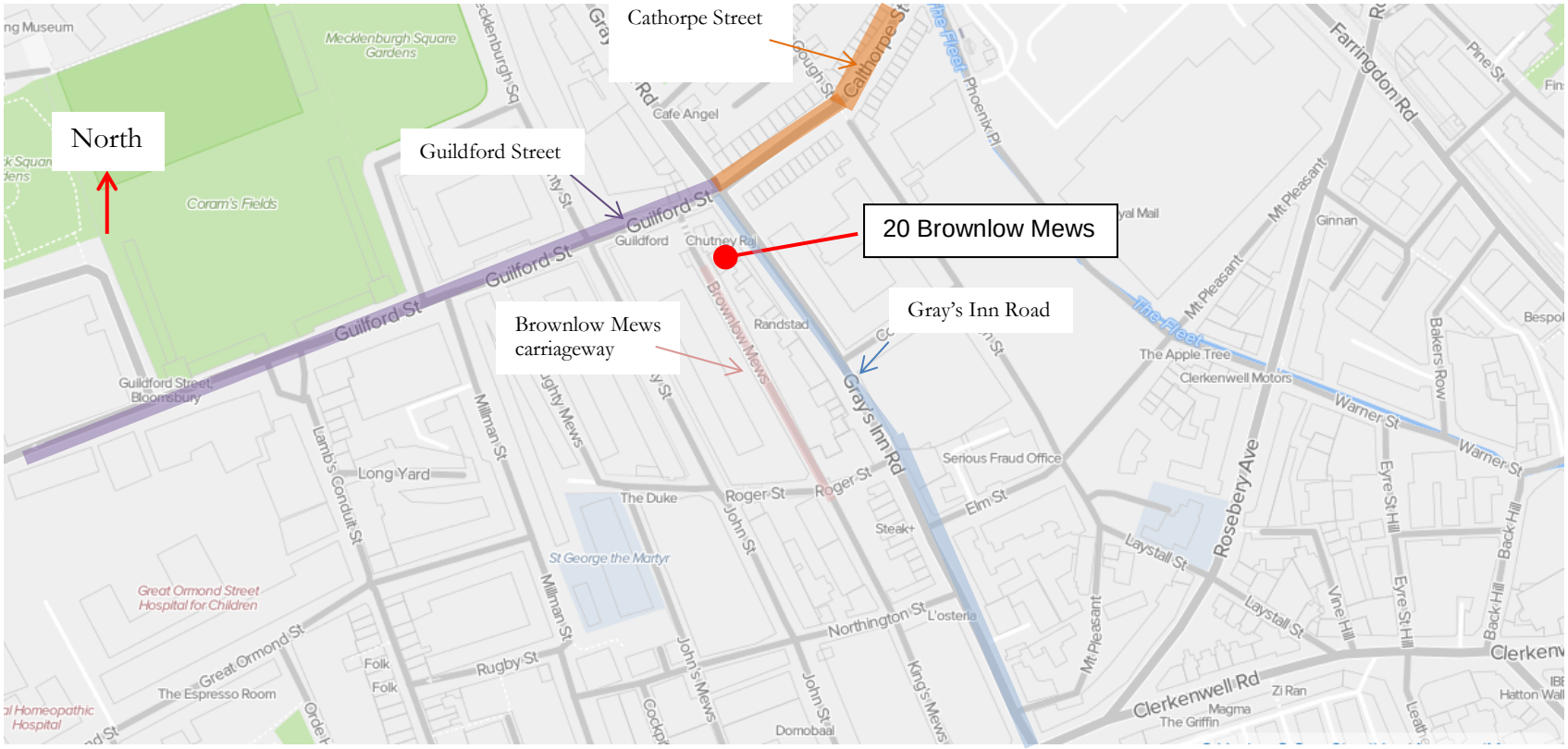
GEA (2014) Desk study & Ground Investigation Report at 20 Brownlow Mews, London WC1N 2LE.

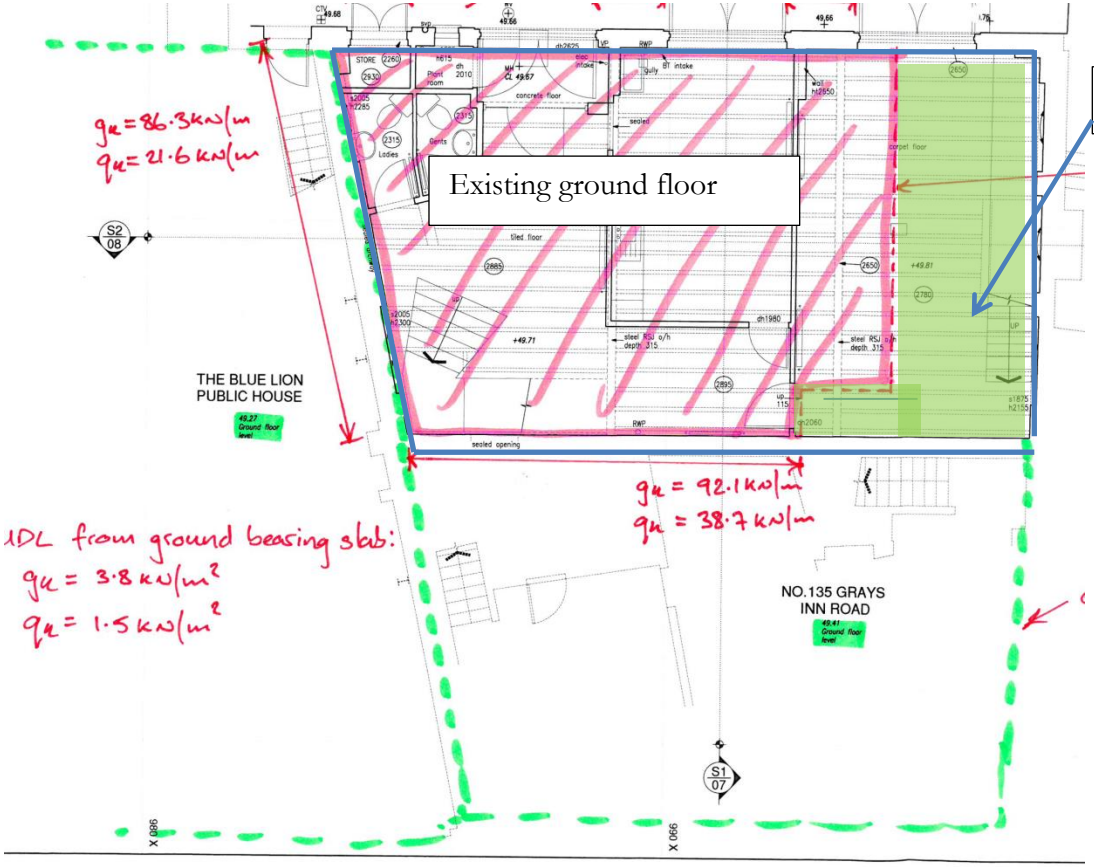
FIGURES



GCG	**Price and Myers** 20 Brownlow Mews, WC1N 2LE **Plan view of local area**	**Figure** **1**

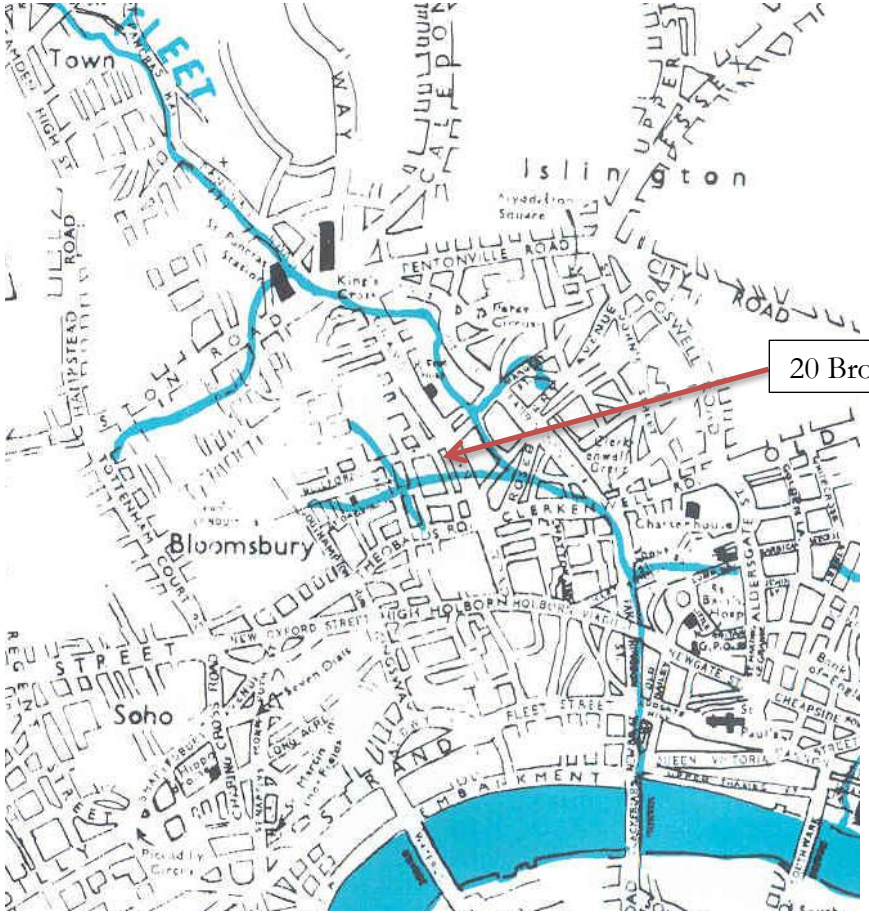
North

	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure** **2**
	Site location with neighbouring buildings	

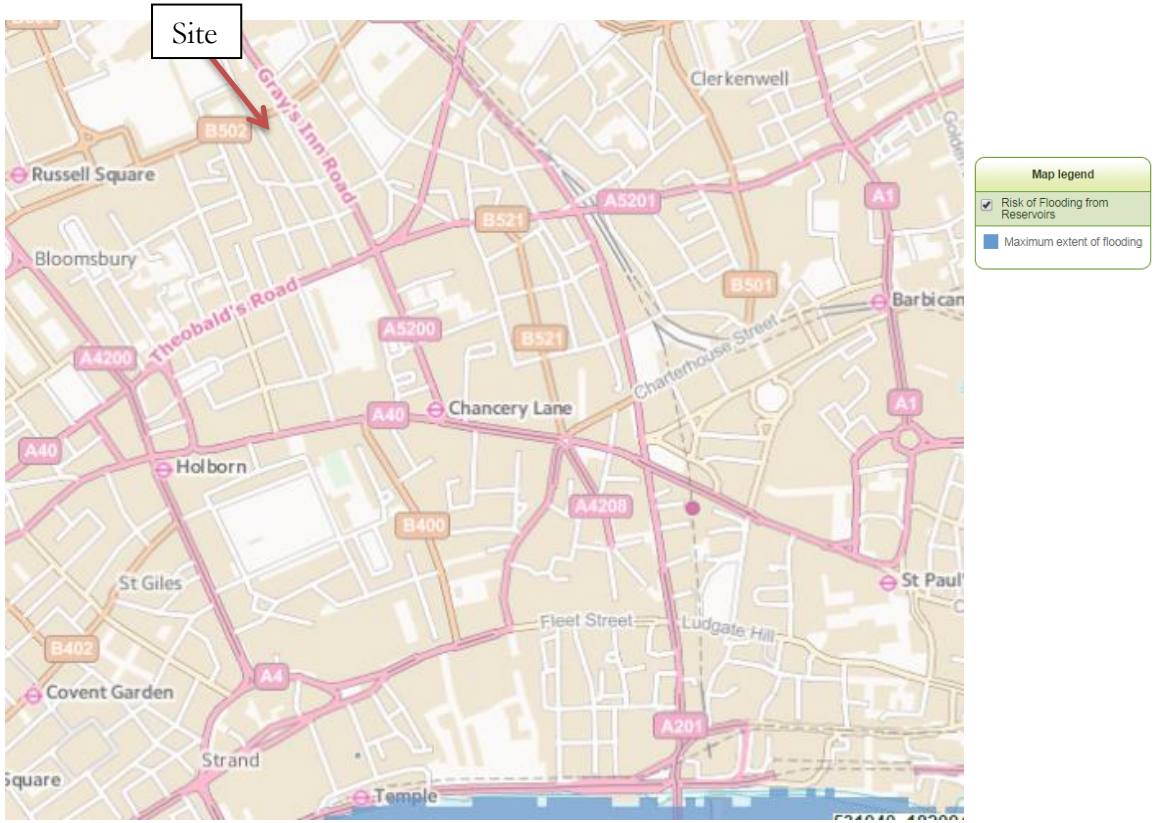


	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure** **3**
	Existing plan view of site and adjacent basements	

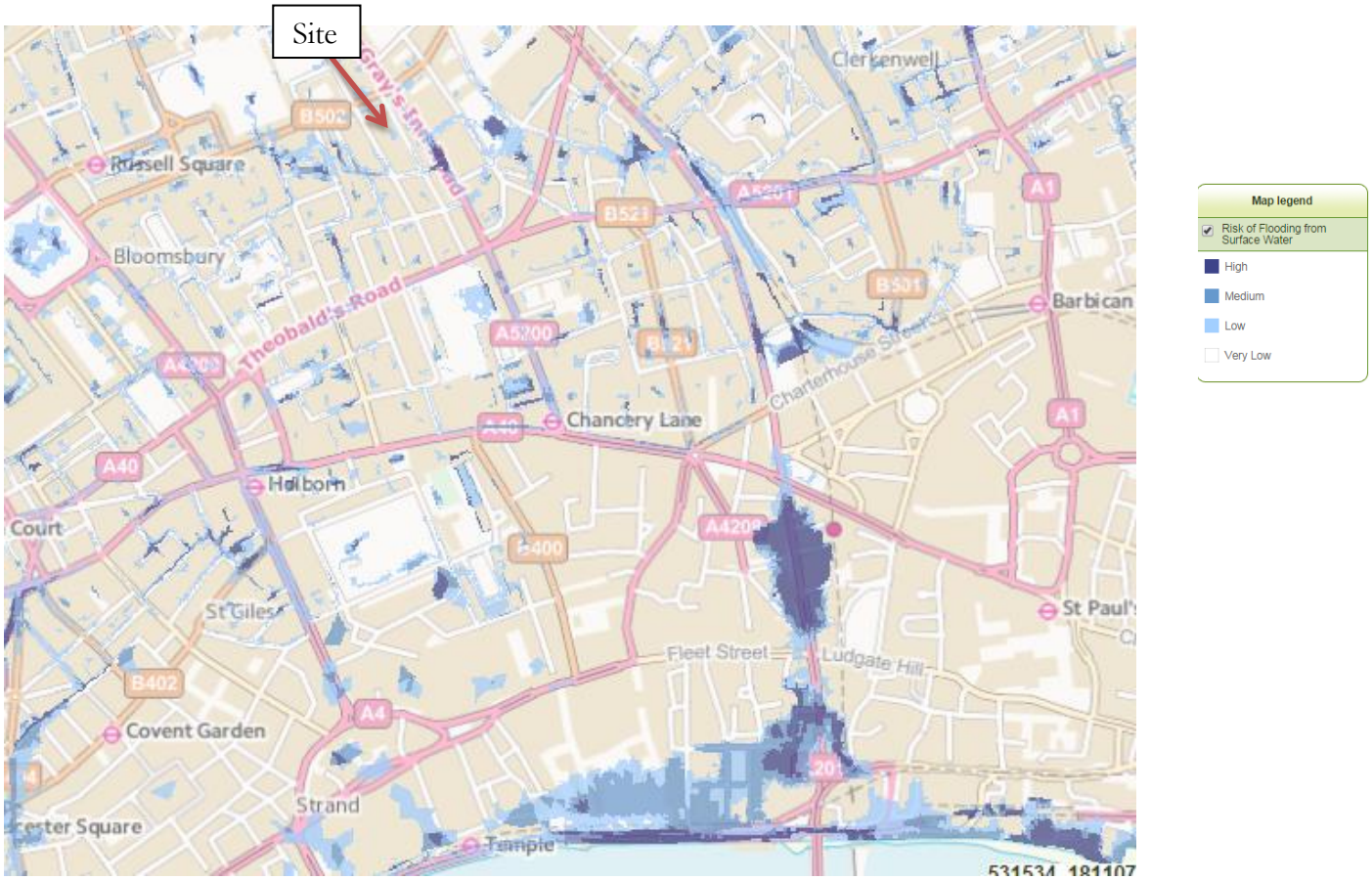
	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure** **4**
	Section of existing and proposed basements	



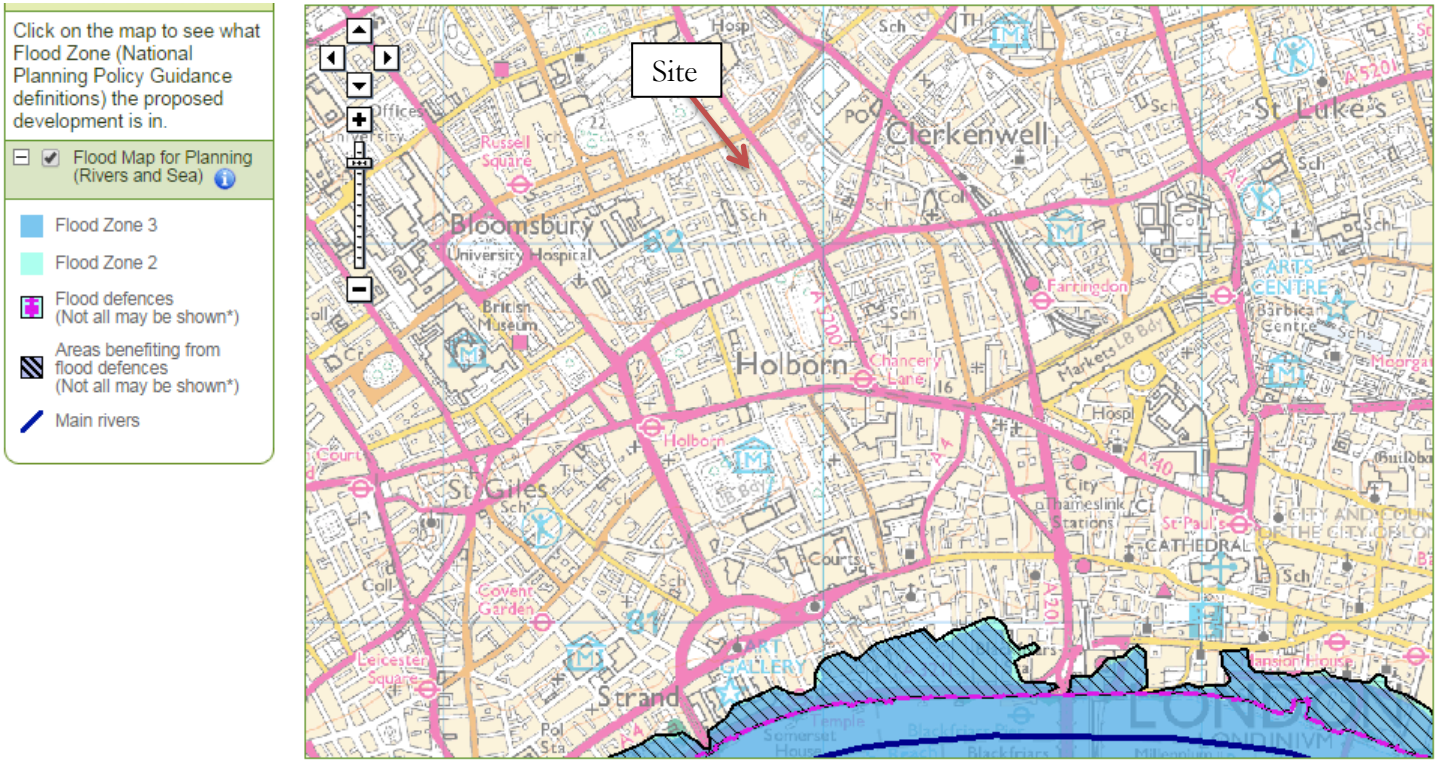
GCG	**Price and Myers** 20 Brownlow Mews, WC1N 2LE	**Figure** **5**
	Extract from 'Lost Rivers of London'	



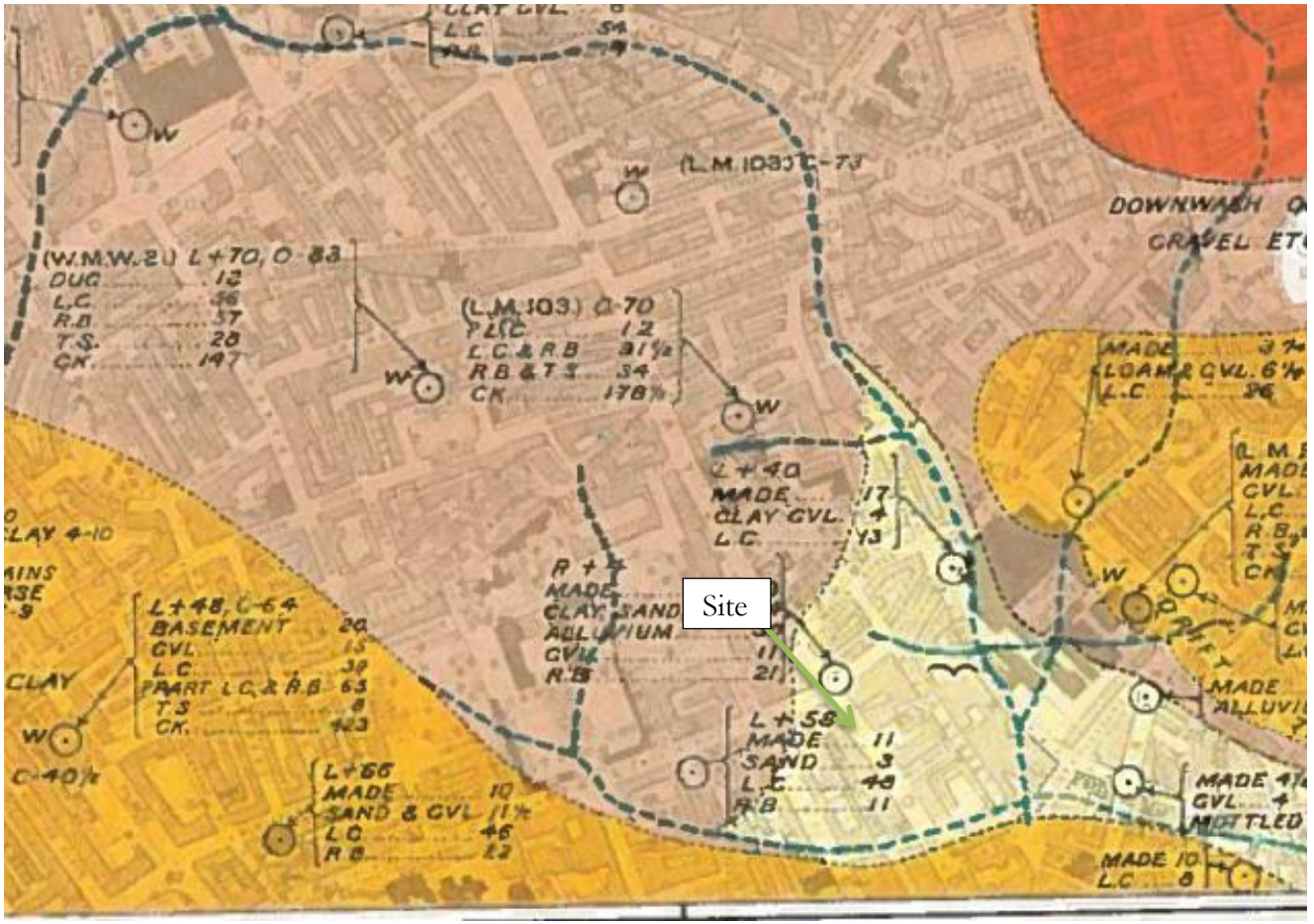
	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure** **6**
	Environment Agency – Local flood risk due to reservoirs	



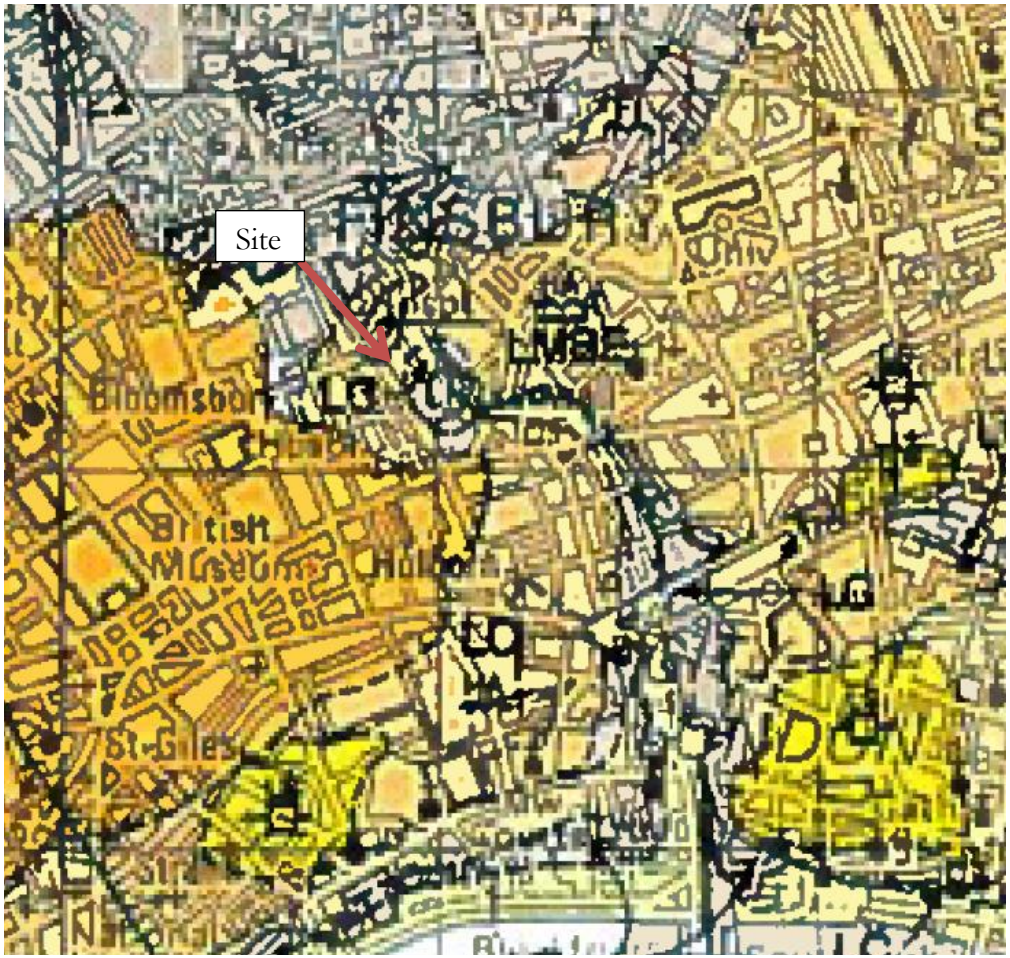
	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure** **7**
	Environment Agency – Local flood risk due to surface waters	



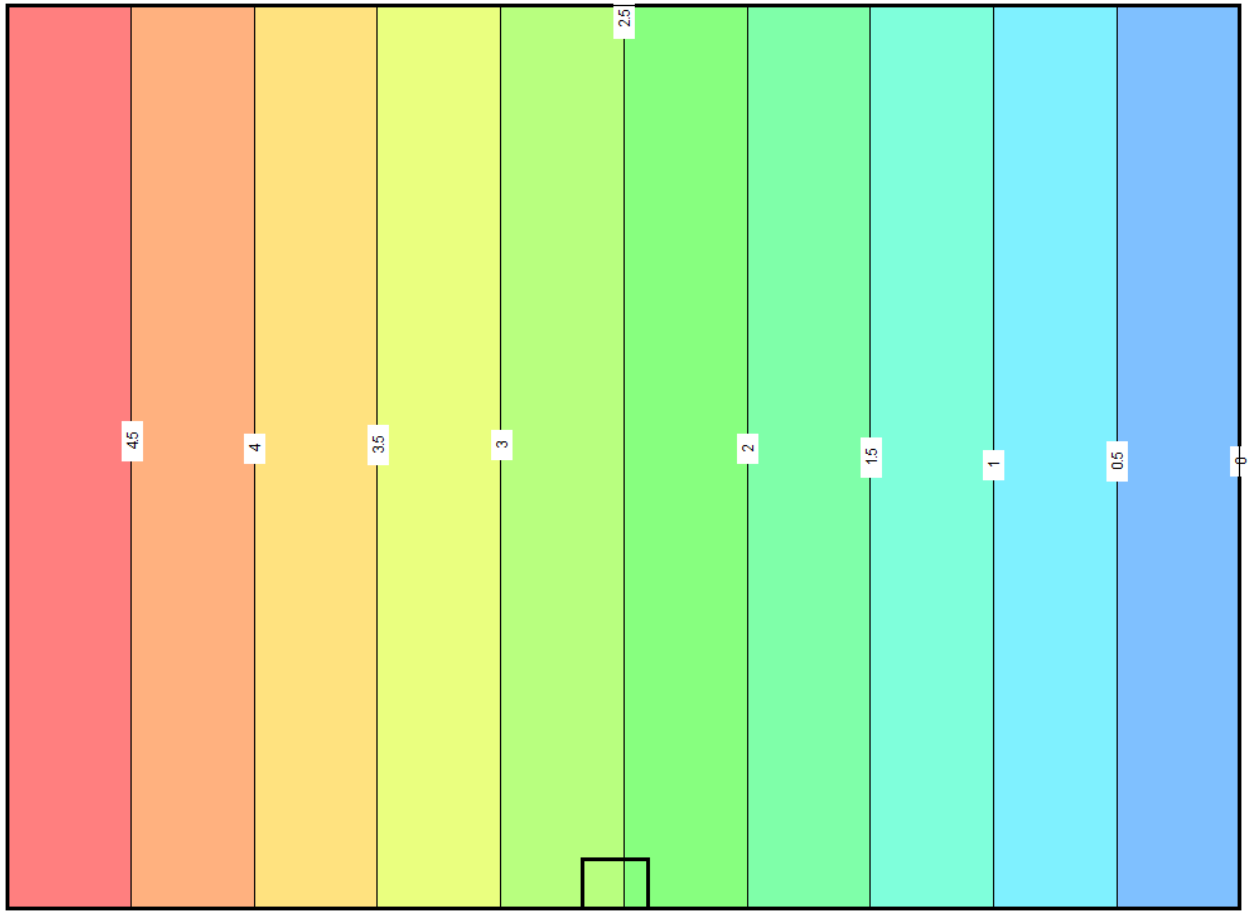
GCG	**Price and Myers** 20 Brownlow Mews, WC1N 2LE	**Figure** **8**
	Environment Agency – Local flood risk due to sea and rivers	



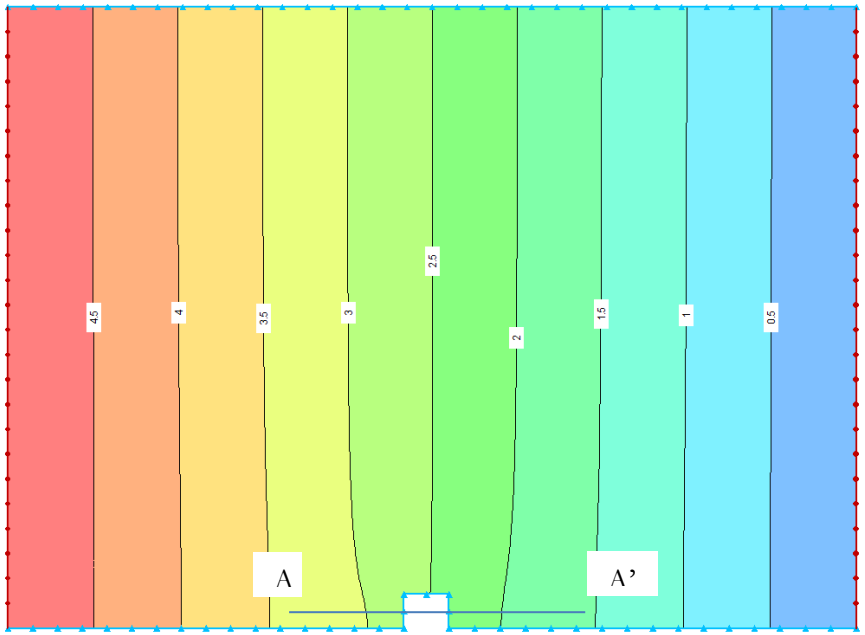
	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure**
	BGS (1936) 1:10,560. London. Sheet 5, NW. Geology	**9**



	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure**
	BGS (1994) – 1:10,000 Sheet 256 North London.	**10**

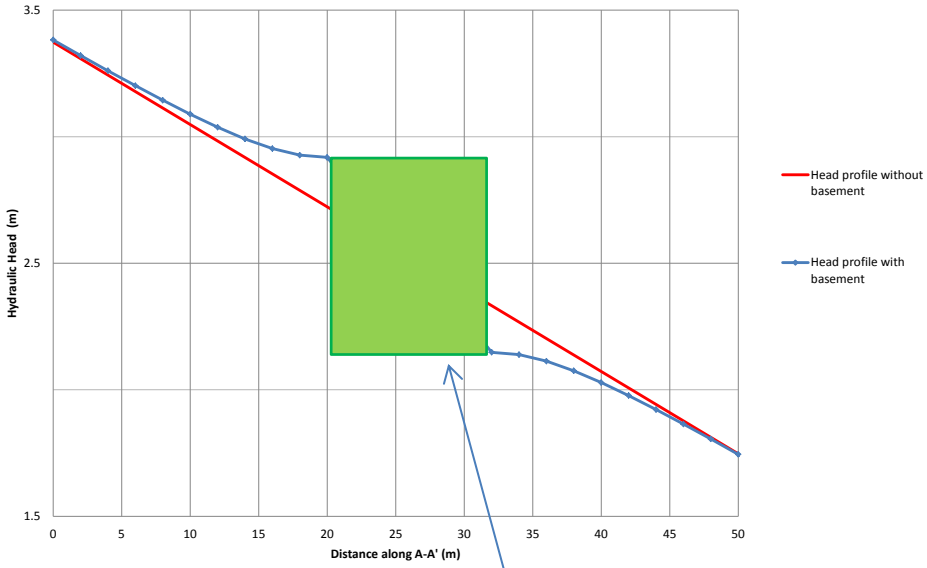


	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure**
	Groundwater analysis – no basement	**11**



a)

Hydraulic head profile over section A'A with and without basement



b)

Footprint of basement

	Price and Myers 20 Brownlow Mews, WC1N 2LE	**Figure** **12**
	Groundwater analysis – no basement a) Plan view of basement b) section A'- A showing basement's effect	