Gondar Gardens

Basement Impact Assessment – Frontage Application Scheme

Planning reference no 2013/7585/P

July 2018

Waterman Structures Limited

Pickfords Wharf, Clink Street, London SE1 9DG

www.watermangroup.com

Client Name: LifeCare Residences Limited

Document Reference: BIA Frontage Application Scheme

Project Number: STR13472

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
00	July 2018	Simona Savastre	Barry Dobbins	Barry Dobbins

Comments

Rev 0	Issued for Planning

Disclaimer

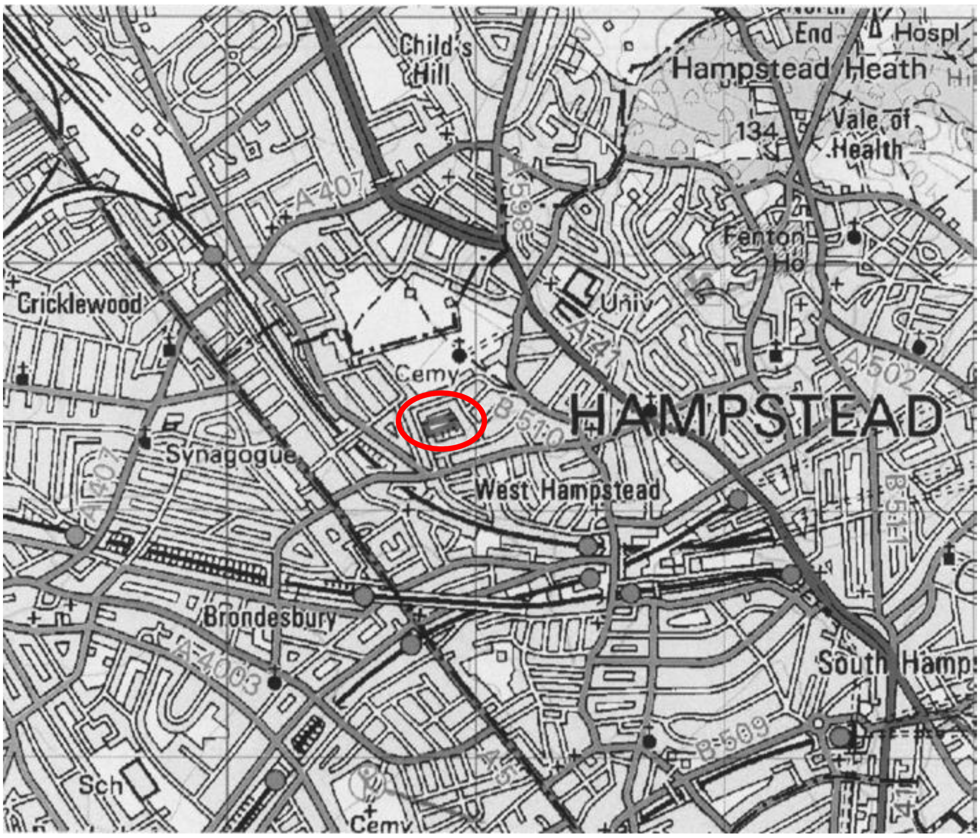
waterman

Contents

Appendices

1. Non-Technical Summary

The site location is Gondar Gardens, West Hampstead, London NW6 1QF.



The current site arrangement comprises a former Thames Water buried reservoir structure constructed in circa 1890 located within a residential area of West Hampstead near Shoot Up Hill. The existing reservoir structure is a masonry structure and formed from arched perimeter walls braced with profile buttresses. The roof structure is formed from barrel vaulted arches supported on cruciform masonry columns.

The proposed development comprises the construction of 28 dwellings close to the Gondar Gardens frontage of the site. These will comprise blocks of 3-4 storeys above a basement level that will contain residential accommodation. The basement will be formed partly within a section of the reservoir and partly by excavation into the adjoining ground, requiring the construction of new retaining walls.

The roof and internal piers of the reservoir structure will be demolished, leaving the outer walls and buttresses. Fill material will be used to form grassed banks against these walls and the remaining void will be landscaped to enhance its biodiversity value.

The following assessments are presented:

- Desk Study
- Screening
- Scoping
- Additional evidence/assessments (as required)

- Site investigation
  - *Ground movement assessment*
  - *Flood risk assessments*
- *Impact Assessment*

All the geotechnical, ground conditions and hydrogeology advice in this report has been compiled from RSK Environment Ltd., who are competent, certified professionals commissioned by Lifecare Residences Ltd. Refer to Appendices B, C, D and E for their full reports.

The ground and groundwater conditions beneath the site are described in more detail in the RSK Flood Risk Assessment report from 2018 and in the RSK Geo-Environmental/Geotechnical Site Assessment Report from 2018. A summary is given below:

Published records for the area indicates the geology of the area to comprise the London Clay Formation. Associated with the reservoir construction, reworked materials (London Clay) are likely to be present.

The Groundwater Vulnerability Map indicates the London Clay Formation to be classified as a non-aquifer. This formation is generally regarded as containing insignificant quantities of groundwater.

The construction methods proposed are detailed in the Construction Management Strategy report (Appendix G).

In the interests of all affected parties it is recommended that a monitoring program be designed and implemented. In conjunction with this and prior to undertaking works on site it is proposed to undertake a full condition survey, including a photographic survey of 1-6 Chase Mansions, 1-6 St. Elmo Mansions, 1-6 South Mansions and Gondar Gardens to record the existing condition of the buildings and road.

Vertical and horizontal movement targets shall be placed at the top of the retaining walls. Up to four inclinometers may also be required within the piles at Sections A-A and B-B.

Settlement targets shall be placed on the side of 1-6 Chase Mansions adjacent to the site and along the Gondar Gardens road at intervals of 5 m.

Prior to construction, three sets of baseline readings shall be taken from all targets. Monitoring of all targets and inclinometers shall be undertaken throughout construction at a frequency dependent on the activities taking place on the site at a given time.

Movements observed during construction should be compared with predicted movements for the same stage of the construction. Deviations of observed measurements from the predicted movements should be referred back to the designer for assessment and a decision on actions required.

A further two sets of monitoring are recommended within the first year of completion of works as some long-term settlements due to the proposed building may occur.

The Geo-Environmental Site Assessment Report confirms that the geology of the site comprises London Clay (both weathered and unweathered), together with areas of Made Ground. It is likely that the reservoir was constructed by excavation into the natural ground level and that the spoil arising was then used to form the perimeter bunds.

The Land Stability Report identifies a potential for settlement of the surrounding ground levels to occur during and after the construction period. As a result, damage could be caused to nearby properties (Nos. 1-6 Chase Mansions and Nos. 1-6 St. Elmo Mansions) and to the roadway and footpath along the adjoining section of Gondar Gardens.

The Report predicts that this damage could, as a worst-case, reach Category 2 under the CIRIA C580 guidance (Embedded Retaining Walls – Guidance for Economic Design, 2003). The C580 categories range from 0 (negligible damage) to 5 (very severe damage). Category 2 represents "slight" damage and is described as follows:

Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some re-pointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.

2. Introduction

The proposal comprises redevelopment of the covered reservoir structure to provide 28 residential units, refuse storage and landscaping of the site for Private Open Space, following substantial demolition of the roof and internal structure.

The purpose of this report is to assess the impact of the proposed basement development at the Former Gondar Gardens Reservoir site in accordance with Camden Planning Guidance Document 'Basement and Lightwells CPG4'. This report, however, only deals with the issues of land stability and effects on adjoining structures and therefore should be read in conjunction with other reports which deal with other issues which CPG4 requires to be addressed.

In accordance with CPG4, a slope stability screening review was undertaken and it was concluded that a Basement Impact Assessment was required.

The BIA approach follows current planning procedure for basements and lightwells adopted by London Borough of Camden and comprises the following elements (CPG Basements):

- Desk Study;
- Screening;
- Scoping;
- Site Investigation, monitoring, interpretation and ground movement assessment;
- Impact Assessment.

2.1 Authors

The BIA has been authored by Simona Savastre, BSc(Hons) and reviewed/approved by Barry Dobbins, BSc(Hons) CEng FIstructE, MICE.

2.2 Existing and Proposed Development

2.2.1 Existing Site Character

The western part of the application site comprises a covered reservoir. This was constructed in 1874 and emptied in the late 1990s, being formally decommissioned as a reservoir under the Reservoir Act in 2002.

It is of brick arch construction with a barrel roof and concrete floor, providing an internal height of up to 7 m. It is about 92 m long and 53 m wide, giving an area of 4,878 sq.m., representing approximately 39% of the site. The condition of the barrel roof structure is deteriorating and, in the absence of remedial action, will continue to do so.

The reservoir is covered with soil and supported by earth bunds on each side. As a result, it forms a plateau-like feature raised above the level of the surrounding area at an elevation of around 80 m AOD. This difference is most pronounced to the south and east, where levels slope steeply towards an elevation of about 72 m AOD at the site boundary. Levels fall more gradually to the north and form a low bank to the west.

The reservoir and most of the site are covered with grass, which is cut periodically. A strip of scrub and trees runs along the eastern boundary, whilst there are also several trees along the southern boundary. Areas of hardstanding and ruderal vegetation, together with three small buildings, are located close to the western boundary.

The northern, eastern and southern boundaries of the site abut the rear gardens of residential properties in Gondar Gardens, Agamemnon Road and Hillfield Road respectively. The western boundary fronts onto Gondar Gardens, the opposite side of which comprises the garages and rear gardens of properties in Sarre Road.

2.2.2 Proposed Development

The proposal comprises the construction of 28 dwellings close to the Gondar Gardens frontage of the site. These will comprise blocks of 3-4 storeys above a basement level that will contain residential accommodation. The basement will be formed partly within a section of the reservoir and partly by excavation into the adjoining ground, requiring the construction of new retaining walls.

The roof and internal piers of the reservoir structure will be demolished, leaving the outer walls and buttresses. Fill material will be used to form grassed banks against these walls and the remaining void will be landscaped to enhance its biodiversity value.

The scheme proposals in the general arrangement drawings, sections and details are shown on drawings SK110 P3, SK120 P3, SK130 P3, SK200 P3, SK210 P2 and SK220 P2 a copy of these are contained within Appendix A.

3. Desk Study

3.1 Site History

The site is located in Gondar Gardens, London. The site comprises a former Thames Water buried reservoir structure constructed on circa 1890 located within a residential area of West Hampstead near Shoot Up Hill. The overall site is rectangular in shape and approximately 1.2 ha.

It is of note that the existing reservoir does not extend beneath the site to the extent to the east. The national grid reference for the approximate centre of the site is 524840E 185310 N.

The site is bounded on 3 sides by residential dwellings and on the remaining side by Gondar Gardens.

The existing reservoir structure is a masonry structure and formed from arched perimeter walls braced with profile buttresses. The roof structure is formed from barrel vaulted arches supported on cruciform masonry columns.

The existing reservoir was partly constructed into the natural ground profile and then adjacent ground levels were raised to cover the structure.

3.2 Geology

The British Geological Survey Sheet 256 (1:50,000 Scale), drift edition, indicates that the geology of the site comprises the London Clay formation.

Due to the presence of the buried reservoir structure, Made Ground and reworked London Clay are likely to be present on the site.

No mining, quarrying or land reclamation activities are recorded as having taken place within 2 km of the site.

These inferred conditions have been generally confirmed by the intrusive investigation undertaken by RSK Geo-environmental/Geotechnical Site assessment report dated July 2018, a copy of which is included within Appendix B.

3.3 Hydrogeology

`

The Groundwater Vulnerability Map indicates the London Clay Formation to be classified as a non-aquifer. This formation is generally regarded as containing insignificant quantities of groundwater. Groundwater flow, although imperceptible, does take place and needs to be considered in assessing risks associated with persistent pollutants. Some non-aquifers scan yield water in sufficient quantities for domestic use.

3.4 Hydrology, Drainage and Flood Risk

Flood risk from fluvial sources is low; this is confirmed by the location of the site in Flood Zone 1 according to the latest Environment Agency Flood Zone map.

The site is located inland and therefore is not at risk from tidal sources.

The development site will be located within a hollow, and as such has the potential for overland flows to collect and pond. This source of flood risk has been considered in the design of the development, which will incorporate sump pumps to ensure any water entering the site will be pumped away from the properties. In addition, any water falling on the site will be utilised on site with the use of rainwater harvesting systems.

A number of Thames Water sewers have been identified in close proximity to the site, according to Thames Water Sewer records. The adopted main sewers in the area are combined accepting both foul and surface water run-off. The nearest sewer to the site is along the western boundary within Gondar Garden Road, where a 940 mm x 635 mm sewer flows in a southern direction. According to the sewer records supplied by Thames Water, a connection point existing to the south-west corner of the site, it is proposed to utilise this connection for the development.

Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption (Ref. 4). One of the design parameters is that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30 year rainfall event. By definition a 1 in 100 year event would exceed the capacity of the surrounding sewer network as well as any proposed drainage.

When exceeded, the surcharged pipework will lead to flooding from backed up manholes and gully connections. This will lead to immediate flooding within highways surrounding the site.

There are no known issues with exceedance of the sewer system in this area.

It is estimated that groundwater flooding affects a few hundred thousand properties in the UK. Groundwater flooding most commonly occurs in low-lying areas, which are underlain by permeable rocks or aquifers. Flooding occurs when the groundwater table rises up from the permeable rocks to the ground surface, flooding low-lying areas or occurring as intermittent springs. Flooding is most likely to occur after prolonged periods of rainfall when a greater volume of rain will percolate into the ground, causing the groundwater table to rise above its usual level. Low lying areas are generally more prone to groundwater flooding because the water table is usually at a much shallower depth and groundwater flow paths tend to travel in a direction from high to low ground. Areas prone to groundwater flooding also often experience surface water flooding problems.

Localised groundwater flooding can also occur around specific geological features, such as areas of permeable soils overlying impermeable strata. Very few groundwater-flooding records are available from the Environment Agency and all of those that are recorded lie within the London Borough of Enfield.

The presence of London Clays below the base of the reservoir could result in a perched groundwater level. However, as the site is to be landscaped away from the properties the flood risk from groundwater flows reaching the surface will be mitigated against. According to the GI for the site groundwater was not encountered in the boreholes, with the exception of BH1 where groundwater seepage was identified 13.0 mbgl. The development will not significantly alter the hydrogeology of the area and groundwater levels are therefore not expected to vary from that at present.

The Flood Risk and Drainage Assessment confirms that the site is located within Flood Zone 1, which denotes a “low probability” of flooding. This reflects its hilltop location, together with the absence of any watercourses or springs. Sources of flood risk are confined to the possibility of localised ponding of runoff or surcharging of sewers during storm events.

An unknown surface water feature is located 464 m north-west of the site.

No surface water abstractions have been identified within 2 km of the site.

Information on the Environment Agency website indicates the site is not situated within a Flood Zone.

3.5 Other Information

3.5.1 Vibration During Construction

Demolition of the reservoir roof, together with activities associated with construction of the new retaining walls (e.g. piling, concrete pumps), are likely to be a source of vibration. Ground-borne vibration can cause nuisance in nearby properties where it may be perceived as re-radiated noise, and in extreme cases may be sufficient to cause cosmetic damage to building fabric.

The Vibration Impact Assessment confirms that there is a possibility of vibration levels being sufficient, on occasion, to cause annoyance. Levels will be insufficient to cause structural damage, except in the event that masonry is allowed to fall to the reservoir floor during the demolition phase.

Vibration risk is not unusual in a project of this type within a dense built-up area, and a range of mitigation measures are available. These include the adoption of non-percussive piling techniques, based on continuous flight auger (CFA) methods; the provision of a cushion mat of rubble during demolition; timing of the works to avoid sensitive periods; and liaison with local residents.

3.5.2 Amenity of New Residents

The basement residential units have been designed so as to optimise their amenity, specifically in terms of natural lighting. The Sunlight and Daylight Assessment confirms that all rooms would achieve or exceed the Average Daylight Factor (ADF) as recommended in BS8206 and the BRE guidelines. The rooms would also achieve good daylight distribution and will comply with the Mayor of London's Housing Design Guide in terms of glazing area.

3.5.3 Open Space and Trees

Whilst the development would displace the open land adjoining the Gondar Gardens frontage, the remainder of the site – including the reservoir void – would remain open and periodically accessible as private open space.

No significant vegetation (including mature trees) would be removed; such vegetation is confined to the southern and eastern boundaries of the site. Although a substantial degree of disturbance would occur during construction, including removal of much of the grassland cover, the site would be reinstated as green space, including measures to enhance its biodiversity and visual amenity.

3.5.4 Archaeology

The Desk-Based Archaeological Assessment confirms that the site is of negligible archaeological potential. This is mainly because any previous buried assets are likely to have been disturbed or removed during construction of the reservoir.

The reservoir itself is considered to be of low significance as a built heritage asset; it is neither locally nor statutorily listed, is a generic rather than unique structure, is in a deteriorating condition and has very little visible influence on the local area.

4. Screening

4.1 Screening findings

A screening process has been undertaken and the findings are described below.

Question	Response	Details
1a. Is the site located directly above an aquifer?	No	The site is underlain by made ground, generally comprising reworked London Clay, extending to depths 3.20 m bgl to 10.50 m bgl (76.70 m AOD to 69.54 m AOD), which is underlain by London Clay, which extended to the full depth investigated of 50.00 mbgl (29.84 m AOD). The latter is classified as a non-aquifer (non-productive stratum). p.19 of the ARUP guidance document (ref: 213923) which supports CPG4, ARUP states: *"Although groundwater is contained within the microscopic pores of the clayey strata of the London Clay, it permeates so slowly, due to the narrow pores, that in practice it is generally considered a barrier to groundwater".* Therefore, the site does not lie above an aquifer. - RSK Basement Hydrogeology and Hydrology Assessment 2018
1b. Will the proposed basement extend beneath the water table surface?	No	The proposed basement level will extend to a maximum elevation of approximately ~71 m AOD. The investigation and monitoring results appear to indicate that the London Clay is saturated to an elevation of approximately 73.2 m AOD. Porosity within this material is so low as to not maintain significant volumes of water and to be 'unproductive'. In this case water recorded within the London Clay records pore water pressure and the concept of a 'groundwater table' does not really apply. Toe drainage will be incorporated into the proposed slope cuttings in the eastern part of the site, which may cause localised draw down of the saturated level within the London Clay. This is considered unlikely to have a significant impact on the saturated zone/level in the wider area, or to significantly affect groundwater flows within London Clay. - RSK Basement Hydrogeology and Hydrology Assessment 2018

2. Is the site within 100 m of a watercourse, well (used/disused) or potential spring line?	No	The site is not located within 100 m of a known watercourse, well or potential spring line, such as typically present at the Claygate Member/London Clay boundary. - RSK Basement Hydrogeology and Hydrology Assessment 2018
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	The site lies 1.5 km southwest of the nearest Hampstead Heath drainage catchment and will therefore not impact any catchments.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Yes	See Section 4 (Scoping) from RSK Basement Hydrogeology and Hydrology Assessment 2018
5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	Due to the poor drainage characteristics of the underlying London Clay discharge via soakaways and/or SUDS is not feasible, and recourse is given to using a combination of green roof technologies to reduce the amount of impermeable area post development, and to the attenuation of the surface runoff water in cellular storage tanks, and discharging into existing Thames Water foul drainage network, at rates agreed with Thames Water. - RSK Basement Hydrogeology and Hydrology Assessment 2018
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	There are no surface water features within 2 km of the site.

4.2 Slope Stability

Question	Response	Details
1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8)?	Yes	See Section 5 of RSK Land Stability Assessment Report
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8)?	No	The existing slope in the eastern boundary of the slope will be retained in its current configuration, with no reprofiling / landscaping. The existing slope to the southern boundary will be reduced in height by approximately 2m from a current elevation of approximately 79m AOD, down to an elevation of 77m AOD, but no re-profiling of the remaining section of slope will be completed as part of the work.

3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8)?	No	The existing slopes in the east and southern parts of the site, slopping down to the eastern and southern site boundaries respectively, fall within the confines of the site boundary. The neighbouring land beyond these slopes does not contain slopes of greater than 7o,
4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately1 in 8)?	No	Figure 16 of the ARUP guidance document (Ref: 213923) which supports CPG4, indicates that slopes in the site area are locally in the range 7o to 10o, although the regional slope in the site area is generally <7o. The wider site area is urbanised and as such the regional slope in the site's vicinity is likely to have been cut or altered historically due to development and landscaping.
5. Is the London Clay the shallowest strata at the site?	Yes	See Section 5 of RSK Land Stability Assessment Report
6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained?	Yes	See Section 5 of RSK Land Stability Assessment Report
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?`	No	Evidence There is no immediate or direct evidence of seasonal shrink-swell effects on site. However, given that the underlying natural ground is high volume change potential London Clay there is potential for such effects, but it is not known whether there are any structures that have been affected in the wider area, and in any case, these would be unrelated to the subject site and proposed development.
8. Is the site within 100m of a watercourse or a potential spring line?	No	There are no watercourses within 100m of the site. The Claygate Member/London Clay boundary is a potential spring line, but this boundary is up-gradient of the site and cannot, therefore, be affected by the site itself.
9. Is the site within an area of previously worked ground?	Yes	See Section 5 of RSK Land Stability Assessment Report
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 underlain by generally between 3.20m and 6.00m (locally 10.30m) Made Ground and a significant thickness of the London Clay Formation. The latter is classified as a non-aquifer (non-productive stratum).Therefore, the site does not lie above an aquifer. Perched water seepages have been encountered locally within the Made Ground, with water ponding on top of the impermeable London Clay, and seepages within the London Clay have also locally been recorded.

		Monitoring of standpipe piezometers indicates that the London Clay is saturated from an elevation of ~73.20m AOD. Although this groundwater may constitute ground a ‘water table’, given the very low permeability of the London Clay, any seepage of this water is likely be minimal and any likely requirement to control groundwater in excavations should be easily done with sump pumping during the temporary works. In the permanent case toe drainage will be included in the proposed slopes in the eastern part of the site at lower (2nd) basement level to control groundwater flow. The temporary control and subsequent permanent exclusion from the basement excavation is likely to cause only a very localised draw down of the groundwater table, and will be unlikely to have any effect on either the short-term or long-term groundwater regime or ground stability in the wider area.
11. Is the site within 50m of the Hampstead Heath Ponds?	No	RSK Land Stability Assessment Report
12. Is the site within 5m of a highway or pedestrian right of way?	Yes	See Section 5 of RSK Land Stability Assessment Report
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	The proposed structure is detached and separated from neighbouring properties and foundations to the nearest neighbouring properties of South Mansions and Chase Mansions have been shown to be outside of the 45° active wedge behind the retaining wall. (See Annex A for developments plans). Thus, although foundation depths are likely to be variable within nearby properties (both in terms of elevation differences and different types of foundations) it is considered that there will be no impact in relation to differential foundation depths from the proposed development. Notwithstanding the above, potential damaging movements could occur due to proposed construction. These latter issues are addressed in Section 5 (Scoping) of RSK Land Stability Assessment Report
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No	There are no known tunnels, tunnel exclusion zones, or other buried infrastructure directly beneath the site that could be affected by the proposed redevelopment of the site.

4.3 Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the ponds chains on Hampstead Heath?	No	The site lies 1.5 km southwest of the nearest Hampstead Heath drainage catchment and will therefore not impact any catchments. - RSK Basement Hydrogeology and Hydrology Assessment 2018
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	The ground conditions at the site (thick made ground and impermeable London Clay) are not suitable for the use of SUDS/soakaways and the developer is in discussions with Thames Water to maintain surface water discharge to the existing sewers. The site is currently occupied by a covered reservoir over approximately 40% of the surface area, and can be classed as 'greenfield' across the remainder. As such the ratio of impermeable to permeable is therefore approximately 40:60 in the current case. Whilst the proposed development is envisaged to result in a small net change in the proportion of hard cover across the site, the vast majority of the proposed development (~95%) lies within the footprint of the former covered reservoir. The proposed scheme includes green roofs technologies to reduce the amount of impermeable area post development. Surface run-off from the hard-covered portion of the site will be collected in cellular storage and discharged into the Thames Water foul sewer at agreed rates, with the remaining ~50-60% of the site remaining permeable 'greenfield'. The site is also not underlain by an aquifer, so the proposals will not affect any changes to groundwater levels of flows. - RSK Basement Hydrogeology and Hydrology Assessment 2018
3. Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?	Yes	See Section 4 (Scoping) from RSK Basement Hydrogeology and Hydrology Assessment 2018
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	As per point 2 above.

5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	As per point 2 above.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No	Reference to the EA floodplain maps, North London Strategic Flood Assessment and The London Borough of Camden flood risk management strategy shows that the site does not lie directly within any known flood zones. However, the map shows minor sections surrounding the site that are at risk of flooding from fluvial sources. These flow paths, rather than ponding water, follow that of the fluvial flooding risk. As such, the overall risk of pluvial flooding to the site can be considered **Low,** as discussed in the aforementioned FRA report (ref 371487-R1(02)-FRA, dated May 2007) BGS information indicates that the site does not lie within 50 m of a groundwater flooding susceptibility area. The highest susceptibility to groundwater flooding, based on the underlying geological conditions, is indicated to be 'not prone'.

5. Scoping

5.1 Monitoring and Mitigation

Various references have been made to the measures that will be adopted to mitigate the potential impacts of the development. Further details are provided in the technical reports supporting the application, including the Environmental Statement. This section summarises those measures of most relevance to the BIA.

5.1.1 Land Stability

A pre-construction condition survey (including photographic record) will be carried out of relevant properties and other physical assets (e.g. the footpath and roadway). Settlement targets will be installed, both internally and externally, and these will be monitored during and after the construction period, on the basis of a protocol to be agreed with the Council and with the owners/occupiers of residential properties.

Where damage occurs, and may reasonably be attributable to the construction work, remedial action will be agreed and carried out.

5.1.2 Groundwater

Whilst no specific mitigation is considered to be required in relation to groundwater, the structural survey and monitoring described above would also be sufficient to capture any damage that may result indirectly from changes in soil moisture content (e.g. leading to shrinkage).

As part of routine construction management, any ingress of groundwater into the works will be noted and, if necessary, minimised. Dewatering of excavations will be carried out in accordance with best practice (e.g. discharge towards the site perimeter will not be permitted).

5.1.3 Surface water

The key features of the sustainable drainage system, which is to be incorporated into the design, have been described. This system will ensure that there is no net adverse impact either on the runoff regime of the site or on the urban drainage system. As a result, neither nearby receptors nor the new residents will be subject to any increase in flood risk.

5.1.4 Vibration

The measures described to minimise vibration will form part of a Construction Management Plan, which will be agreed with the Council and implemented by condition. The Plan will also include the use of best practicable means to minimise noise emissions during the demolition and construction phase.

5.1.5 Amenity of New Residents

Adequate levels of natural lighting have been ensured through the detailed design.

6. Site investigation, monitoring, interpretation and ground movement assessment

6.1 GEOTECHNICAL PARAMETERS

This section describes the materials encountered beneath the site and presents material parameters and properties considered appropriate for this preliminary geotechnical design. Where possible these properties were based on results obtained from testing samples, however only one borehole has been carried out on site and hence testing data is limited. Therefore, in general empirical correlations based on the available data for all exploratory holes on the site have been used to derive design parameters. The general ground conditions for the site are summarised in Table 5.1. The exploratory logs for the site as provided by the site investigation contractor, RSK, are included in Appendix B.

Table 5.1 General ground conditions for site at Gondar Gardens

Strata	Depth Top Encountered (m bgl)	Depth Bottom Encountered (m bgl)	Thickness range (m)
Made Ground	0.0	0.5 to >4	0.5 to >4
Weathered London Clay	0.5 to 2.2	8.8	8.3
Unweathered London Clay	8.8	>20	>11.2

6.2 Made Ground

6.2.1 Material Description

Made Ground was encountered in all boreholes with thickness ranging from 0.5 to at least 4 m. The extent of the Made Ground was not proven in PH4 or PH5. The Made Ground is generally described as silty sandy clay with fine to coarse gravel, stone and fragments of concrete, brick and roots to depths of up to 1 m, under which it is generally described as re-moulded firm to stiff brown silty clay with occasional gravel, occasional pockets of sand and occasional fragments of brick and roots. This is likely to be reworked London Clay associated with construction of the reservoir. PH3 and PH7 show a layer of sand and gravel with stone 0.1 m to 0.3 m in thickness at a depth of 0.3 m to 0.8 m bgl.

6.2.2 Material Properties

16 No. SPT tests (using both open and solid modes) were carried out within the Made Ground. The N values ranged from 5 to 18, with an average value of 9.

The parameters derived for this material are summarised in Table 5.2, below.

Table 5.2 Derived parameters for Made Ground

Material	Cu (kPa)	E (MPa)	φ' (°)	c' (kPa)
Made Ground	35	12.2	20	0

6.3 Weathered London Clay

6.3.1 Material Description

Weathered London Clay was encountered in all exploratory holes on the site except PH4 and PH5. The top of the stratum was encountered between 0.5 and 1.9 m bgl.

The base of the stratum was encountered in BH1 only, at a depth of 8.8 m bgl. The material is generally described as firm becoming stiff and very stiff brown occasional mottled grey silty CLAY with occasional fine to medium gravel and occasional pockets of sand. Due to the presence of tree roots, the clay within PH1, PH2, PH3 and PH7 is considered to have been desiccated during dry seasons in the past to about 3.0 mbgl.

Due to the presence of gravel and pockets of sand, it is possible that some reworking of the material has taken place at the time of the construction of the reservoir.

6.3.2 Material Properties

13 No. SPT tests (using both open and solid modes) were carried out within the Weathered London Clay. The N values ranged from 11 to 31, with an average value of 18.

4 No. Atterberg Limit tests were carried out within the Weathered London Clay. The plasticity index values ranged from 42% to 48%.

3 No. Unconsolidated Undrained Triaxial Compression tests were carried out within the Weathered London Clay. All tests were undertaken on samples from BH1, and therefore indicate properties at one location only. The undrained shear strength values ranged from 78kPa to 110kPa.

The parameters derived for this material, considering in situ and laboratory data, are summarised in Table 5.3, below.

Table 5.3 Derived Parameters for Weathered London Clay

Material	Cu (kPa)	E (MPa)	φ' (°)	c' (kPa)
Weathered London Clay	60	21	22	0

6.4 Unweathered London Clay

6.4.1 Material Description

Unweathered London Clay was encountered in BH1 at a depth of 8.8m bgl. The base of the stratum was not proven. The material is described as stiff grey silty CLAY with occasional fine gravel and occasional pockets of sand.

6.4.2 Material Properties

4 No. SPT tests were carried out within the Unweathered London Clay. The SPT N values ranged from 20 to 32, with an average value of 24.

4 No. Unconsolidated Undrained Triaxial Compression tests were carried out within the Unweathered London Clay. All tests were undertaken on samples from BH1, and therefore indicate properties at one location only. The undrained shear strength values ranged from 144kPa to 215kPa.

The parameters derived for this material, considering in situ and laboratory data, are summarised in Table 5.4, below.

Table 5.4 Derived Parameters for Unweathered London Clay

Material	Cu (kPa)	E (MPa)	φ' (°)	c' (kPa)
Unweathered London Clay	95	33.2	22	0

6.5 Groundwater

Groundwater seepage was encountered at a depth of 13 m bgl in BH1. Groundwater was not encountered in any other locations.

No groundwater monitoring has been carried out. The level of the groundwater table is therefore unknown and will vary seasonally.

Basements are typically designed to survive ground water levels at the surrounding ground level. Whilst it may be considered unlikely to occur, this is a sensible safety precaution to ensure that catastrophic failure does not occur to the substructure of the development.

6.5.1 Ground Model Assumed for Analysis of Basement Retaining Wall

The ground model for the basement retaining wall at the Gondar Gardens edge of the site has been based the nearest exploratory holes; BH1, PH1, PH2 and PH7. The exploratory holes located further from the proposed basement retaining wall show a much greater thickness of Made Ground. The potential effect of a greater thickness of Made Ground on the design of the retaining wall should be considered during detailed design.

The material properties have been adopted as detailed above based on all exploratory holes within the site. Only one borehole has been undertaken and testing is very limited, particularly below 4 m bgl (the extent of the probe holes). All parameters have therefore been derived by empirical correlations and should be validated for detailed design.

The adopted ground model is summarised in Table 5.5, below.

Table 5.5 Ground Model and Material Parameters for Analysis of Basement Retaining Wall

Material	Depth to top of strata (m bgl)	Thickness of strata (m)	Cu (kPa)	E (MPa)	φ' (°	c' (kPa)
Made Ground	0.0	2.2	35	12.2	20	0
Weathered London Clay	2.2	6.6	60	21	22	0
Unweathered London Clay	8.8	-	95	33.2	22	0

6.6 Engineering Interpretation

This section assesses the predicted lateral wall movements of the proposed retaining walls and ground movements behind these walls at five cross-section locations (A-A, B-B, C-C, D-D and E- E). These cross-sections and their locations are shown in on the scheme proposals contained within Appendix A.

The lateral movements of the proposed retaining walls and the ground movements and potential damage to structures behind the walls have been assessed using the methods set out in CIRIA C580 Section 2.5.2 and Section 2.5.4. The method within CIRIA C580 for predicting ground movements behind the walls is an empirical method based on field measurements from case histories of retaining walls installed in stiff clay. Estimates of lateral movements of the wall based on its stiffness are obtained from a chart in CIRA C580 which is based on results of finite element analysis rather than the empirical data used to predict movements in the ground behind the walls. Although these two methods within CIRIA C580 use data from different sources, the results for the lateral movements of the wall and the settlements of the ground behind it should be compatible provided that a system of appropriate stiffness has been chosen.

Predicted ground movements and lateral wall deflections have been estimated by using the CIRIA C580 methods outlined above. The deflections and settlements have then been compared to check that the results obtained are of a similar magnitude, indicating that the system stiffness proposed is appropriate to the predicted movements.

The effect of vertical loading on the retaining walls has not been assessed as this is not considered as part of the CIRIA C580 approach. The vertical loading may cause some localised additional vertical settlement; however, this is likely to be small when compared to the settlements due to installation of the wall and excavation in front of the wall. Some additional pile length may be required at appropriate locations to support the vertical loads. This should be assessed further at the detailed design stage at appropriate locations.

All predicted deflections and settlements and suggested pile lengths and diameters are the result of a preliminary assessment only and shall be confirmed during detailed design.

6.7 Design Assumptions

All proposed retaining walls have been assumed to be contiguous bored pile walls of moderate to high system stiffness.

Dimensions used for the analysis have been taken from preliminary architects' drawings and plans.

It has been assumed that all proposed retaining walls will be installed from the reduced ground level prior to any excavation taking place in front of the retaining walls. Where there are two separate walls (upper and lower), it has been assumed that both walls have been installed from the reduced ground level and that the lower wall has been cut to its final level following excavation in front of the upper wall.

Loading on the proposed retaining walls from the existing structures is not considered as part of the CIRIA C580 assessment. These loads should be considered during the detailed design stage.

Detailed design shall also include an assessment of any settlements which may affect the adjacent structures as a result of the loading from the proposed building and its foundations. These settlements are likely to be small compared to the settlements resulting from the retaining walls.

6.8 Analysis of Wall Behaviour (Based on CIRIA C580)

Assessments have been made of the wall movements and the effects of ground movements on the adjacent assets using the empirical approaches outlined above.

The assumed behaviour of the wall as defined in CIRIA C580 will be used to set the performance specification for the detailed design of the retaining structure.

Detailed design calculations which demonstrate compliance will be submitted during the detailed design phase.

6.8.1 Ground Settlements

The predicted ground movements have been estimated using the empirical methods set out in CIRIA C580 Section 2.5.2. It is not possible to predict ground movements accurately without good ground data and significant time spent on analyses, and the below values are estimations only based on field measurements of previously constructed walls in stiff clay. The magnitude of ground movements due to installation is largely dependent on the quality of workmanship and large local ground movements can be expected where construction problems are encountered.

All walls have been assumed to be contiguous bored pile walls. Moderate to high support stiffness has been assumed as it has been considered that the ground floor and lower ground floor will act as props at the top of the upper and lower walls respectively. Where light wells are present, careful consideration should be given during detailed design to the system stiffness and buttresses or props across the light wells may be required to avoid the use of larger diameter piles.

The embedded length of the retaining walls has been assumed to be 2.5 times the retained height to provide a high factor of safety and hence better performance.

All ground movements are conservatively quoted are at ground level, as exact foundation depths of the adjoining buildings are unknown. Settlements at the founding level of 1-6 Chase Mansions and 1-6 St Elmo Mansions and hence settlements of this building should be less than those quoted.

Cross-section drawings showing the sections described below are presented in Appendix A.

6.9 Section A-A

The ground movements under 1-6 Chase Mansions due to installation of the piles and due to excavation in front of the retaining wall have been estimated using Figure 2.8 and Figure 2.11 of CIRIA C580.

The removal of existing material to the proposed reduced ground level will cause settlements to 1-6 Chase Mansions. To give a conservative estimate of the potential ground movements due to the reduction of the ground level as well as the installation of and excavation in front of the wall, it has been assumed that the retained height of the wall includes the thickness of the removed material.

The estimated ground movements are summarised in Table 5.7, below.

Table 5.6 Approximate Ground Movements Behind Wall at Section A-A

Horizontal Distance from Wall to Near Edge of 1-6 Chase Mansions (m)		1.95
Approximate Predicted Ground Surface Movements at Near Edge of 1-6 Chase Mansions (mm)	Horizontal	9 to 12
	Vertical	7 to 9

Ground movements at the far edge of 1-6 Chase Mansions at this cross-section location are less than 5 mm.

6.10 Section B-B

The ground movements under 1-6 Chase Mansions and 1-6 St Elmo Mansions due to installation of the piles and due to excavation in front of the retaining walls have been estimated using Figure 2.8 and Figure 2.11 of CIRIA C580.

The removal of existing material to the proposed reduced ground level will cause settlements to 1-6 Chase Mansions and 1-6 St Elmo Mansions. To give a conservative estimate of the potential ground movements due to the reduction of the ground level as well as the installation of and excavation in front of the wall, it has been assumed that the retained height of the upper wall includes the height of the material removed.

The retained height assumed for the lower wall is equal to the actual retained height as the movements due to the removal of the upper material has already been considered during the assessment of the outer wall. It is currently proposed to install the piles for the lower wall from the reduced level, prior to excavation in front of the outer wall. The piles will be cut to the correct level when the excavation takes place. The total pile length assumed for movements due to installation has included this additional height.

To calculate the total ground movements beneath the structure, the estimated movements from each wall have been superposed. Any interaction effects that may exist between the two walls have not been considered.

The estimated ground movements are summarised in Table 5.7, below.

Table 5.7 Approximate Ground Movements Behind Upper Wall at Section B-B

Horizontal Distance from Upper Wall to Near Edge of 1-6 Chase Mansions (m)		0.9
Horizontal Distance from Lower Wall to Near Edge of 1-6 Chase Mansions (m)		5.8
Approximate Ground Surface Movements at Near Edge of 1-6 Chase Mansions due to installation of and excavation in front of Upper Wall (mm)	Horizontal	10 to 15
	Vertical	7 to 10
Approximate Ground Surface Movements at Near Edge of 1-6 Chase Mansions due to installation of and excavation in front of Lower Wall (mm)	Horizontal	7 to 10
	Vertical	7 to 8
Approximate Total Predicted Ground Surface Movements at Near Edge of 1-6 Chase Mansions (mm)	Horizontal	17 to 25
	Vertical	14 to 18

Ground movements at the far edge of 1-6 St. Elmo Mansions are negligible.

The estimated ground movements presented above are a conservative estimate as they do not consider interaction between the two walls. Detailed design is likely to show movements lower than those estimated at this stage.

6.11 Section C-C

The ground movements under the Gondar Gardens road and footpaths due to installation of the piles and due to excavation in front of the retaining walls have been estimated using Figure 2.8 and Figure 2.11 of CIRIA C580.

The removal of existing material to the proposed reduced ground level will cause settlements to Gondar Gardens. To give a conservative estimate of the potential ground movements due to the reduction of the ground level as well as the installation of and excavation in front of the wall, it has been assumed that the retained height of the upper wall includes a 1 m thick layer of removed material.

The retained height assumed for the lower wall is equal to the actual retained height as the movements due to the removal of the upper material has already been considered during the assessment of the outer wall. It is currently proposed to install the piles for the lower wall from the reduced level, prior to excavation in front of the outer wall. The piles will be cut to the correct level when the excavation takes place. The total pile length assumed for movements due to installation has included this additional height.

To calculate the total ground movements beneath the structure, the estimated movements from each wall have been superposed. Any interaction effects that may exist between the two walls have not been considered.

The estimated ground movements are summarised in Table 5.8, below.

Table 5.8 Approximate Ground Movements Behind Upper Wall at Section C-C

Horizontal Distance from Upper Wall to Near Edge of Gondar Gardens Footpath (m)		0.6
Horizontal Distance from Lower Wall to Near Edge of Gondar Gardens Footpath (m)		6.1
Approximate Ground Surface Movements at Near Edge of Gondar Gardens Footpath due to installation of and excavation in front of Upper Wall (mm)	Horizontal	10 to 15
	Vertical	6 to 10
Approximate Ground Surface Movements at Near Edge of Gondar Gardens Footpath due to installation of and excavation in front of Lower Wall (mm)	Horizontal	6 to 10
	Vertical	6 to 8
Approximate Total Predicted Ground Surface Movements at Near Edge of Gondar Gardens Footpath (mm)	Horizontal	16 to 25
	Vertical	12 to 18

Ground movements at the far edge of the Gondar Gardens road and footpaths are less than 5 mm, which are considered negligible.

The estimated ground movements presented above are considered to be a conservative estimate as they do not consider interaction between the two walls. Detailed design is likely to show movements lower than those estimated at this stage.

6.12 Section D-D

The ground movements under the Gondar Gardens road and footpaths due to installation of the piles and due to excavation in front of the retaining wall have been estimated using Figure 2.8 and Figure 2.11 of CIRIA C580.

The removal of existing material to the proposed reduced ground level will cause settlements to Gondar Gardens. To give a conservative estimate of the potential ground movements due to the reduction of the ground level as well as the installation of and excavation in front of the wall, it has been assumed that the retained height includes a 1m thick layer of removed material.

The estimated ground movements are summarised in **Table** 5.9, below.

Table 5.9 Approximate Ground Movements Behind Wall at Section D-D

Horizontal Distance from Wall to Near Edge of Gondar Gardens Footpath (m)		1.5
Approximate Total Predicted Ground Surface Movements at Near Edge of Gondar Gardens Footpath (mm)	Horizontal	9 to 12
	Vertical	7 to 9

Ground movements at the far edge of the Gondar Gardens road and footpaths are less than 5 mm, which are considered negligible.

6.13 Section E-E

The ground movements under the Gondar Gardens road and footpaths due to installation of the piles and due to excavation in front of the retaining wall have been estimated using Figure 2.8 and Figure 2.11 of CIRIA C580.

The removal of existing material to the proposed reduced ground level will cause settlements to Gondar Gardens. To give a conservative estimate of the potential ground movements due to the reduction of the ground level as well as the installation of and excavation in front of the wall, it has been assumed that the retained height includes a 1.5 m thick layer of removed material.

The estimated ground movements are summarised in Table 5.10, below.

Table 5.10 Approximate Ground Movements Behind Wall at Section E-E

Horizontal Distance from Wall to Near Edge of Gondar Gardens Footpath (m)		4.3
Approximate Total Predicted Ground Surface Movements at Near Edge of Gondar Gardens Footpath (mm)	Horizontal	16 to 20
	Vertical	13 to 16
Approximate Total Predicted Ground Surface Movements at Far Edge of Gondar Gardens Road and Footpaths (mm)	Horizontal	8 to 10
	Vertical	7 to 8

As the lower ground floor of the proposed building will act as a prop mid-way down the wall as well as the ground floor acting as a prop at the top of the wall, it is likely that movements will be closer to the lower end of the ranges given above.

![waterman logo]

7. Impact on Adjacent Structures - Effects of Potential Ground Movement and Comment on Stability of Existing Foundations

The effects of the estimated ground movements presented in Section 5.8.1 on the adjacent structures have been assessed using Figure 2.18 and Box 2.5 of CIRIA C580. This method assigns a damage category to the adjacent structure based on the deflection ratio and the horizontal strain across the structure, assuming that the structure is of negligible stiffness.

7.1 Section A-A

At this cross-section location, 1-6 Chase Mansions is separate from the adjacent 1-6 St. Elmo Mansions. As no elevation data is available for the rear of the building, it has been assumed that the height of the structure is the same as the height at the front of the building. It has been assumed that the ground behind the retaining walls and the ground underneath 1-6 Chase Mansions is flat and is at the same level as the ground directly behind the retaining wall. The building at 1-6 Chase Mansions has been assumed to be of negligible stiffness.

The settlements estimated in Section 5.8.1 imply that for 1-6 Chase Mansions a damage category of 1 to 2 applies at the location of this cross-section.

The description from CIRIA C580 of the typical damage for Damage Category 1 is as follows:

> *"Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection."*

The description from CIRIA C580 of the typical damage for Damage Category 2 is as follows:

> *"Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly."*

This assessment of the damage category is based on conservative estimates of the ground movements and assumes that the structure has negligible stiffness.

The ground movements used in this assessment are at ground level. Settlements at the founding level of 1-6 Chase Mansions and hence settlements of this building should be less. It is therefore likely that the actual damage to the structure will be less than that described above.

7.2 Section B-B

At this cross-section location, 1-6 Chase Mansions is joined to the adjacent 1-6 St. Elmo Mansions. It has been assumed that the ground behind the retaining walls and the ground underneath 1-6 Chase Mansions and 1-6 St. Elmo Mansions is flat and is at the same level as the ground directly behind the retaining wall. 1-6 Chase Mansions and 1-6 St. Elmo Mansions have been assumed to be acting as a single building of negligible stiffness.

Although the ground movements at the far side of 1-6 St. Elmo Mansions are negligible, the method assesses strain and deflection across the whole building, therefore the damage category assigned applies to both 1-6 Chase Mansions and 1-6 St. Elmo Mansions. A detailed damage assessment could be undertaken at the detailed design stage to further investigate the soil- structure interaction and the extent and location of likely damage to 1-6 Chase Mansions and 1- 6 St. Elmo Mansions if this is considered necessary.

The settlements estimated in Section 5.8.1 imply that for 1-6 Chase Mansions and 1-6 St. Elmo Mansions a damage category of 2 applies as described for Section A-A, above.

This assessment of the damage category is based on conservative estimates of the ground movements and assumes that the structure has negligible stiffness. The ground movements used in this assessment are at ground level. Settlements at the founding level of 1-6 Chase Mansions and 1-6 St. Elmo Mansions and hence settlements of this building should be less. It is therefore likely that the actual damage to the structure will be less than that described above.

7.3 Section C-C

It has been assumed that the ground behind the retaining walls and the ground underneath the Gondar Gardens road and footpaths is flat and is at the same level as the ground directly behind the retaining wall. The roads and footpaths have been assumed to be acting as a single structure of negligible stiffness.

The CIRIA C580 method for assessment of damage category is for assessment of buildings. For the purposes of assigning a category to the Gondar Gardens road for this assessment, the method has been used with the highest structure length to height ratio (L/H=4) given within CIRIA C580.

The settlements estimated in Section 5.8.1 imply that for the Gondar Gardens road and footpaths a damage category of 2 applies as described for Section A-A, above.

As the road and pavements will be built from more flexible material than a brittle masonry structure and the road is a flexible thin layer and not a fully three-dimensional building, it is unlikely that significant cracking of the road surface will occur. Should any cracking occur, local repairs to the footpath and roadway may be required. Services are unlikely to be affected.

This assessment of the damage category is based on conservative estimates of the ground movements. It is therefore likely that the actual damage to the structure will be less than that described above.

7.4 Section D-D

It has been assumed that the ground behind the retaining walls and the ground underneath the Gondar Gardens road and footpaths is flat and is at the same level as the ground directly behind the retaining wall. The roads and footpaths have been assumed to be acting as a single structure of negligible stiffness.

The CIRIA C580 method for assessment of damage category is for assessment of buildings. For the purposes of assigning a category to the Gondar Gardens road for this assessment, the method has been used with the highest structure length to height ratio (L/H=4) given within CIRIA C580.

The settlements estimated in Section 5.8.1 imply that for the Gondar Gardens road and footpaths a damage category of 1 to 2 applies as described for Section A-A, above.

As the road and pavements will be built from more flexible material than a brittle masonry structure and the road is a flexible thin layer and not a fully three-dimensional building, it is unlikely that significant cracking of the road surface will occur. Should any cracking occur, local repairs to the footpath and roadway may be required. Services are unlikely to be affected.

This assessment of the damage category is based on conservative estimates of the ground movements. It is therefore likely that the actual damage to the structure will be less than that described above.

7.5 Section E-E

It has been assumed that the ground behind the retaining walls and the ground underneath the Gondar Gardens road and footpaths is flat and is at the same level as the ground directly behind the retaining wall. The roads and footpaths have been assumed to be acting as a single structure of negligible stiffness.

The CIRIA C580 method for assessment of damage category is for assessment of buildings. For the purposes of assigning a category to the Gondar Gardens road for this assessment, the method has been used with the highest structure length to height ratio (L/H=4) given within CIRIA C580.

The settlements estimated in Section 5.8.1 imply that for the Gondar Gardens road and footpaths a damage category of 2 applies as described for Section A-A, above.

As the road and pavements will be built from more flexible material than a brittle masonry structure and the road is a flexible thin layer and not a fully three-dimensional building, it is unlikely that significant cracking of the road surface will occur. Should any cracking occur, local repairs to the footpath and roadway may be required. Services are unlikely to be affected.

This assessment of the damage category is based on conservative estimates of the ground movements. It is therefore likely that the actual damage to the structure will be less than that described above.

7.6 Existing Foundations of Adjacent Structures

It has been assumed that the foundations of 1-6 Chase Mansions are at the same distance behind the proposed retaining walls as the existing outer wall of the building that they support. No light wells can be seen, indicating that it is unlikely that any existing basement structures beneath 1-6 Chase Mansions and 1-6 St. Elmo Mansions are present.

Loading on the proposed retaining walls from the existing structures is not considered as part of the CIRIA C580 assessment. For costing purposes, the proposed piles could be increased to one pile size larger to allow for the additional loading on the walls, but this should be assessed fully during detailed design.

Detailed design shall also include an assessment of any settlements which may affect the adjacent structures as a result of the loading from the proposed building and its foundations. These settlements are likely to be small compared to the settlements resulting from the retaining walls. The final design should develop a construction sequence that will limit damage in the adjacent assets to category 2 or as agreed with the asset owners.

7.6.1 Deflection Based on Preliminary Assumptions of Adopted Wall Stiffness

The predicted lateral wall movement can be estimated using Figure 2.13 of CIRIA C580.

System stiffness is defined as $\rho = EI / (\gamma_w h^4)$ where EI is the Young's modulus multiplied by the second moment of area of the wall section, γ_w is the bulk unit weight of water and h is the average vertical prop spacing.

For the lateral wall movements presented below, it has been assumed that each wall is propped at the top and that there is a prop half way down the retained height of each wall, with the exception of Section E-E, where it has been assumed that the wall has been propped at intervals of 0.25 times the retained height. All permanent structures shall be constructed to provide adequate stiffness prior to any temporary propping being removed. Assumed prop spacings are for the purposes of this preliminary assessment only and shall be further assessed during detailed design. At sections where two retaining walls are proposed, the upper wall shall be propped to a point beyond the lower wall. If the use of props is not considered desirable, it is likely that larger pile diameters than those presented below will be required in order to achieve an adequate system stiffness.

Approximate lateral movements have been calculated for pile diameters of 300 mm, 450 mm and 500 mm. These diameters are indicative only and final pile diameters shall be confirmed during the detailed design stage. The wall deflections calculated are of a similar order of magnitude to the ground movements calculated in Section 5.2.1, indicating that an appropriate system stiffness can be achieved subject to detailed design.

Young's modulus E has been assumed to be equal to 15000 MPa.

A factor of safety of at least 2.0 against basal heave has been assumed. This is a conservative estimate and it is likely that a factor of safety of at least 3 will be achieved, further reducing the estimated movements.

7.7 Section A-A

At section A-A, the approximate expected maximum lateral wall movements have been estimated as shown in Table 5.12, below. The movements of the ground behind the wall will decrease with distance from the wall.

Table 5.11 Predicted Lateral Movements for Propped Upper Wall at Section A-A

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	2.6	10
450		7
500		7

7.8 Section B-B

At section B-B, the approximate expected maximum lateral wall movements have been estimated as shown in Table 5.12 and Table 5.13, below. The movements of the ground behind the wall will decrease with distance from the wall.

Table 5.12 Predicted Lateral Movements for Propped Upper Wall at Section B-B

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	3.0	10
450		9
500		8

Table 5.13 Predicted Lateral Movements for Propped Lower Wall at Section B-B

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	3.6	17
450		12
500		11

Although the estimated values for the maximum lateral wall movements for the lower wall appear high, the values are very conservative as the interaction between the two walls has not been considered. During detailed design it is likely that these values will be significantly reduced.

7.9 Section C-C

At section C-C, the approximate expected maximum lateral wall movements have been estimated as shown in Table 5.14 and Table 5.15, below.

Table 5.14 Predicted Lateral Movements for Propped Upper Wall at Section C-C

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	3.0	10
450		9
500		8

Table 5.15 Predicted Lateral Movements for Propped Lower Wall at Section B-B

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	3.1	13
450		9
500		9

Although the estimated values for the maximum lateral wall movements for the lower wall appear high, the values are very conservative as the interaction between the two walls has not been considered. During detailed design it is likely that these values will be significantly reduced.

7.10 Section D-D

At section D-D, the approximate expected maximum lateral wall movements have been estimated as shown in Table 5.12, below. The movements of the ground behind the wall will decrease with distance from the wall.

Table 5.16 Predicted Lateral Movements for Propped Upper Wall at Section D-D

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	3	10
450		9
500		8

7.11 Section E-E

At section E-E, the approximate expected maximum lateral wall movements have been estimated as shown in Table 5.12, below. The movements of the ground behind the wall will decrease with distance from the wall.

It has been assumed that the wall has been propped at intervals of 0.25 times the retained height. If the lateral movements need to be further reduced, additional props will be required. The lower ground floor slab will act as a permanent prop and will reduce lateral movements. It shall be ensured that the permanent structure (including the lower ground floor slab and the stairwell present at this location) have been constructed to adequate stiffness before temporary propping is removed.

Table 5.17 Predicted Lateral Movements for Propped Upper Wall at Section E-E

Pile Diameter (mm)	Retained Height (m)	Approximate Maximum Lateral Wall Movement (mm)
300	5.8	23
450		17
500		15

8. Conclusions

The proposed development involves the opening up of an existing basement structure (the covered reservoir) and the creation of a substantially smaller new basement, partly by excavating into the surrounding ground.

The assessment has concluded that there would be no significant effects associated with groundwater, surface water flooding, the amenity of the new residents, open space and trees, or archaeology.

A potential for significant effects has been identified in relation to ground settlement, giving rise to a risk of cosmetic damage to nearby buildings, and to vibration during construction. Ground settlement will be monitored and any need for remedial work to affected properties will be agreed with the Council and owner/occupiers. Vibration will be controlled by the adoption of appropriate methods and precautions (e.g. non-percussive piling) as part of a Construction Management Plan.

With monitoring and mitigation in place, the residual impacts will fall within the limits of acceptability for an urban location, and the policy requirements of the Council are considered to be met.

waterman

APPENDICES

1. Appendix A: Existing and Proposed Development Drawings

2. Appendix B: Geo-Environmental/Geotechnical Site Assessment

3. Appendix C: Land Stability Report – 2012 by URS

Land Stability Report – 2017 by RSK*

*The latest report (2017) has relevant site information which was included in this report, however it refers to the alternative scheme which will not be built.

4. Appendix D: Flood Risk Assessment

5. Appendix E: Basement Hydrology Assessment

6. Appendix F: Vibration Impact Assessment

7. Appendix G: Construction Management Strategy

8. Appendix H: Sunlight & Daylight Assessment

9. Appendix I: Desk-Based Archaeological Assessment

10. Appendix J: Built Heritage Assessment

UK and Ireland Office Locations